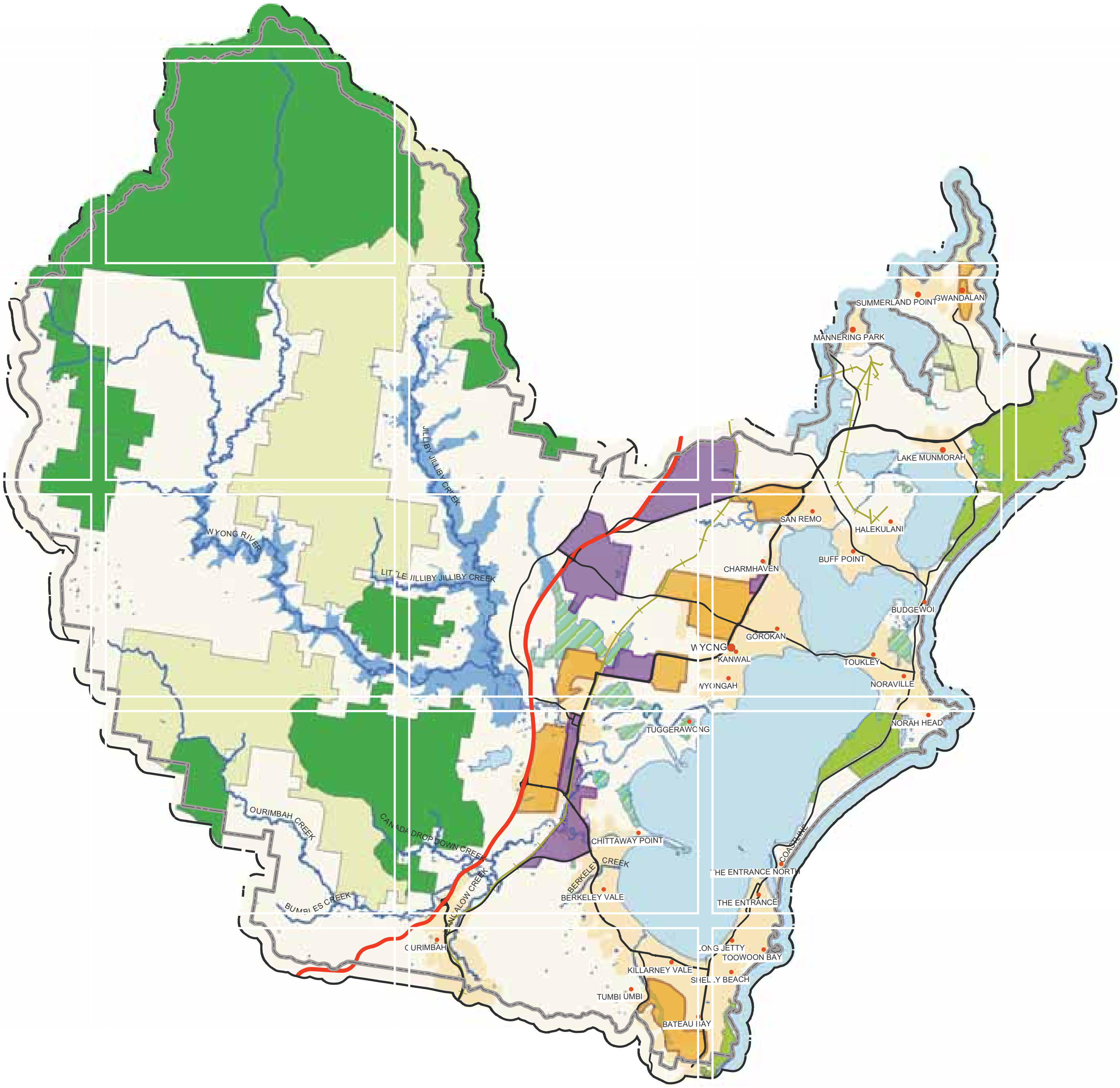

Wallarah No 2 Coal Project
Flood Impact Assessment

for Wyong Areas Coal Joint Venture

March 2009

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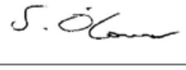
Position:	Project Director
Signed:	
Date:	*March, 2009*

Environmental Resources Management Australia Pty Ltd Quality System

FINAL REPORT

Wyong Areas Coal Joint Venture

Wallarah 2 Coal Project
Flood Impact Assessment

March 2009

Environmental Resources Management Australia
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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Limited (ERM) was originally commissioned by the Wyong Areas Coal Joint Venture in 1999 to investigate and assess the potential impacts on flooding as a result of subsidence due to proposed undergrounding mining within the Dooralong Valley the Yarramalong Valley and the Hue Hue Creek catchment areas. Assessments were made in 2000, 2003, 2006 and 2007 for previous mine plans which have been fundamental in the development of the current final mine plan assessed in this report. This report presents the results of these revised assessments based on detailed hydrological and hydraulic modelling and using highly accurate topographic data for existing and post-subsidence conditions.

The flood model also became an integral component in the finalisation of the mine plan and has been developed in conjunction with subsidence and groundwater assessments. The process has been iterative with several modifications being made to the mine plan in order to achieve the best outcome for flood affected properties within the mining area and to minimise the extent and severity of potential flood impacts. Of particular note were the benefits of adjusting the mine plan to eliminate flood impacts from almost all of the Yarramalong Valley and to reduce the risk of changes to the alignment of Little Jilliby Jilliby Creek as well as overall impacts in the Dooralong Valley and Hue Hue Creek.

Previous baseline flood modelling information was provided to Wyong Council in 2000 to assist their planning and flood risk management obligations. Updated baseline flooding information derived from the current study has also been made available to Wyong Council for similar purposes. There was no significant difference in flood levels and extents calculated by the two models for existing topographic conditions.

The project's original hydrological modelling continued to be valid as no significant changes had occurred to rainfall and recorded flood data since the previous assessments. A slight change had occurred to the methodology for calculating the Probable Maximum Flood (PMF), resulting in a 4% increase in the PMF hydrographs used in the hydraulic model; otherwise all previously determined hydrographs were used in this assessment.

Key outcomes of the flood assessment undertaken for the Project are provided below, however it should be noted that despite the accuracy of both the subsidence modelling and the flood modelling, the precise impacts of both subsidence and changes to flood behaviour on dwellings and infrastructure will need to be confirmed once subsidence monitoring data has been obtained and the subsidence model is validated.

- *Both the Dooralong and Yarramalong Valleys are currently significantly flood prone with the 1 in 100 year (1%AEP) flood having a significant flood extents throughout both valleys.*

- *Subsidence can cause both positive and negative effects on flood extents and flood depths due to changes in the hydraulic behaviour of flood flows.*

- *Virtually no changes will occur to flood extents and depths in the Yarramalong Valley as a result of mine subsidence. Negligible subsidence (from zero to less than 15cm) is predicted under short stretches of the main channel of the Wyong River and minor subsidence in the adjacent northern floodplain (including two backwater areas).*

- *Approximately 53.8ha of additional land will become flood affected in the combined Yarramalong (0.8ha) and Dooralong (53ha) valleys while approximately 9ha of existing flood affected land in the Dooralong Valley will become flood free.*

- *There will be seven dwellings that will experience a major impact caused by an increase in flood depths (five of which were previously not flood prone in the 1% AEP flood) with a further ten dwellings that will experience moderate impacts. The majority of these dwellings (eight) are already subject to flooding in the 1% AEP (1 in 100 year) flood.*

- *There will be ten properties that will experience an increase in flood affectation to more than 5% of their land.*

- *There will be two dwellings that are currently flood affected that will experience a negligible increase in flood level while an additional 15 dwellings will experience minor decreases in freeboard but will remain unaffected by floods.*

- *The majority (45) of the 79 dwellings in the Yarramalong/Dooralong study area will not be adversely affected, and a proportion will in fact be beneficially impacted. Most of these positive effects are small, generally in the order of 5 to 20 cm, and are typically the result of detention of flood peaks in the subsided areas.*

- *Seven dwellings will experience no change or effect as a result of subsidence impacts on flooding.*

- *There will be no significant change to flood hazard or risk categories as a result of subsidence.*

- *There will be no significant change in hydrology or catchment yield.*

- *In addition to the above, three dwellings near Hue Hue Creek will be adversely impacted by changes to flooding as a result of mine subsidence and one will be beneficially impacted.*

Subsidence will occur along a 5.2km length of the Dooralong Valley floodplain (including part of Jilliby Jilliby Creek, Little Jilliby Jilliby Creek and minor tributaries). Subsidence generally of between zero and 1.3 metres will occur within the affected sections of the Jilliby Jilliby Creek channel. Isolated small areas of the adjacent floodplain may experience greater subsidence of approximately 1.6 metres. Subsidence levels in the lower Jilliby Jilliby Creek channel (below the confluence with Little Jilliby Jilliby Creek) are expected to be mostly less than 0.75 metres. This change in the topography will cause changes in flood depths of -1.1 metres to +1.1 metres even though absolute flood levels (in mAHD) will drop by zero to 1.85 metres.

Greater subsidence is expected in the forested and unpopulated mountainous areas, but this will have no impact on general runoff characteristics or on flooding in the valleys.

For Hue Hue Creek, mining will result in subsidence of up to 0.95 metres under the floodplain and will cause changes in flood depths of -0.1 metres to +0.7 metres with reductions in flood levels within or near the subsided areas of 0 to 0.5 metres. There will be a net increase of approximately 1ha in flood affected area in the Hue Hue Creek area due to subsidence.

Options available to mitigate against flood impacts on dwellings include construction of flood levees, raising houses in-situ and relocating or reconstructing houses on higher ground within the property. It is expected that most, if not all, potentially adversely affected dwellings and properties will be adequately modified to mitigate impacts. For potentially impacted houses that are unable to be protected, raised or moved, properties may need to be purchased. Some options are also available to reduce post-subsidence flooding by channel improvements.

This study presents mitigation options that the project could undertake to address these impacts so that post mining conditions are better or at least no worse than existing conditions.

Subsidence will also cause several low points in roads and some bridges within the Dooralong Valley and Hue Hue Valley to become untrafficable for longer periods than the existing situation during flood events. No significant impacts to roads or other infrastructure will occur in the Yarramalong Valley. Options are available to mitigate against these impacts, including raising bridges, raising low sections of roads, and improving the hydraulic capacity of channels in some sections to lower flood depths. It may also be possible to make flood proof some sections of road that are currently flood prone.

The preferred mitigation option for each dwelling, property and road will need to be determined individually, prior to mining commencing near each particular location. This will require appropriate consultation with each land owner and with Council and other stakeholders. Determination of appropriate mitigation works and strategies for public infrastructure will be developed as part of the Subsidence Management Plan while specific works on private property will be developed as part of the individual Property Subsidence Management Plans.

The report by the independent expert panel for the Strategic Review into coal mining potential in the Wyong LGA was reviewed following its release in December 2008. The Strategic Review report findings and recommendations are consistent with the conclusions and proposed commitments set out in this flood impact assessment.

1 INTRODUCTION

1.1 OVERVIEW

Wyong Areas Coal Joint Venture (WACJV) is proposing to develop an underground coal mine near Wyong on the Central Coast of New South Wales. This project is known as the Wallarah 2 Coal Project (W2CP). As part of the environmental and technical assessments that are being undertaken in the development of the proposal, WACJV has engaged Environmental Resources Management Australia Pty Limited (ERM) to undertake a flood impact assessment. This assessment looks at the potential flooding impacts associated with subsidence from the proposed underground mining and examines mitigation measures that may be required.

Similar assessments were undertaken by ERM in 2000 and 2003 for a previous proposal for underground mining. However, changes to the mine plan have resulted in changes to the predicted subsidence patterns so that revised modelling of flood impacts has been required. Several additional changes in the mine plan have also been made in 2006 and 2007 in order to further minimise impacts on existing river channels.

The major catchments within the mine subsidence area are the Yarramalong and Dooralong Valleys and the unnamed catchment between Buttonderry Creek and Jilliby Jilliby Creek, designated herein as Hue Hue Creek. The main waterways within these catchments – Wyong River, Jilliby Jilliby Creek and Hue Hue Creek – are significantly flood prone. The floodplain within the Yarramalong and Dooralong Valleys is subject to regular inundation, causing bridges and culverts to be cut-off for extended periods. Large sections of the main roads into both valleys are flood prone and many of the access roads pass through the floodplain. The flood depths in the Hue Hue Creek floodplain are significantly less than in the other two valleys. All of the flood prone land is located in rural/agricultural or public open space areas of the catchments rather than in residential areas, although a number of dwellings are located within the existing floodplains.

The current study builds on the previous studies that were undertaken and assesses the potential impacts on flooding that may result from subsidence as a result of the proposed mine plan.

1.2 STUDY OBJECTIVES

This study concentrates on flood behaviour in two catchments, the Wyong River catchment – including both the Yarramalong and Dooralong Valleys – and the Hue Hue Creek catchment. Portions of the study area are predicted to be impacted by subsidence resulting from the proposed underground coal mine.

The objectives of this study are to:

- review the previous studies that have been completed to confirm existing flood behaviour in the catchments;
- determine the extent of flood impacts resulting from predicted subsidence in the area; and
- present options to mitigate the flood impacts.

1.3 THE FLOODPLAIN RISK MANAGEMENT PROCESS

In New South Wales, the process to assess the impacts of flooding on a community is set out in the New South Wales Government's Floodplain Management Manual (2005). The process is based on the New South Wales Government's Flood Prone Land Policy.

The floodplain risk management study forms part of the floodplain risk management process. A process diagram showing the floodplain management process is shown in *Figure 1.1*.

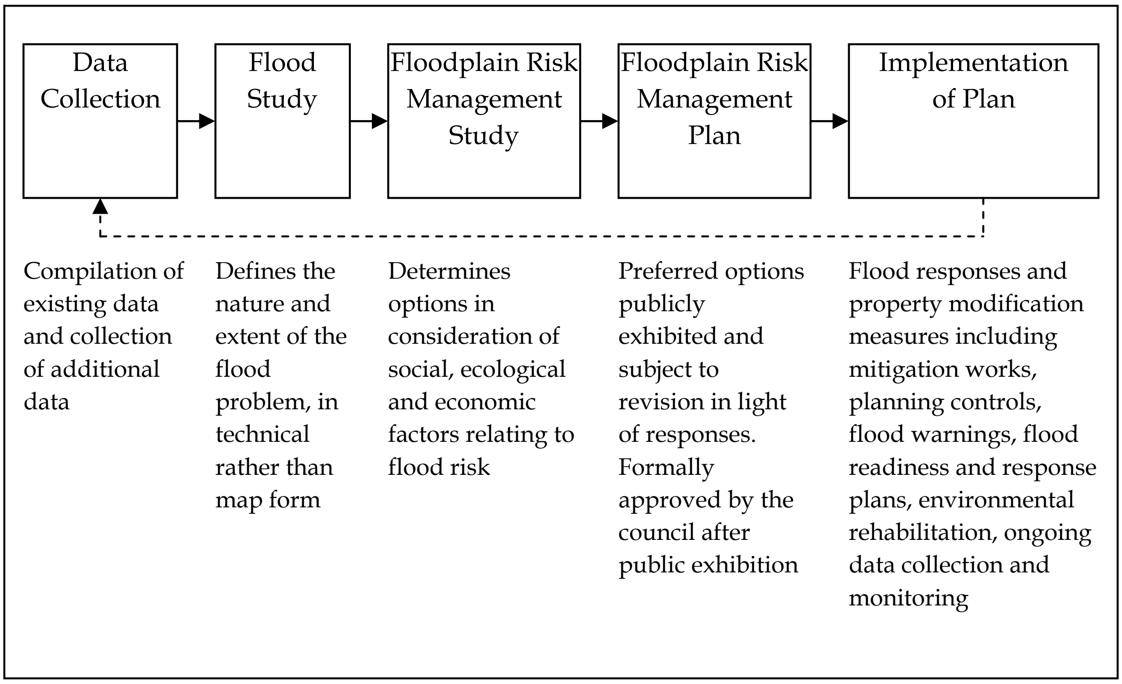


Figure 1.1 The Floodplain Management Process (NSW Govt, 2005)

This study does not include a floodplain risk management study as it is not a requirement of the study to address existing flood impacts. The study has been undertaken to assess the changes in flood behaviour as a result of underground mining and associated subsidence and the extent of impacts as a result of these changes. The study also presents mitigation options to address these impacts so that post mining conditions could be better or at least no worse than existing conditions.

1.4 REPORT STRUCTURE

The report is structured in the following format:

- *Chapter 1* provides an introduction to the study and defines the study objectives;
- *Chapters 2 and 3* provide a description of the study area, summarise available data, give an overview of what is known of existing flooding and summarise the predicted subsidence;
- *Chapters 4 and 5* detail the hydrologic and hydraulic modelling that has been undertaken;
- *Chapter 6* details the predicted flood impacts resulting from predicted subsidence;
- *Chapter 7* presents mitigation options; and
- *Chapter 8* provides a conclusion to this report.

Subsidence related impacts on environmental hydrology that are beyond the scope of this report include:

- fluvial geomorphology;
- low flow hydrology and river hydraulics;
- sediment transport and deposition; and
- riparian ponding, riffle systems and associated ecological habitat.

These studies have been undertaken by others and are reported in the Environmental Assessment (EA).

2 *STUDY AREA*

2.1 *OVERVIEW*

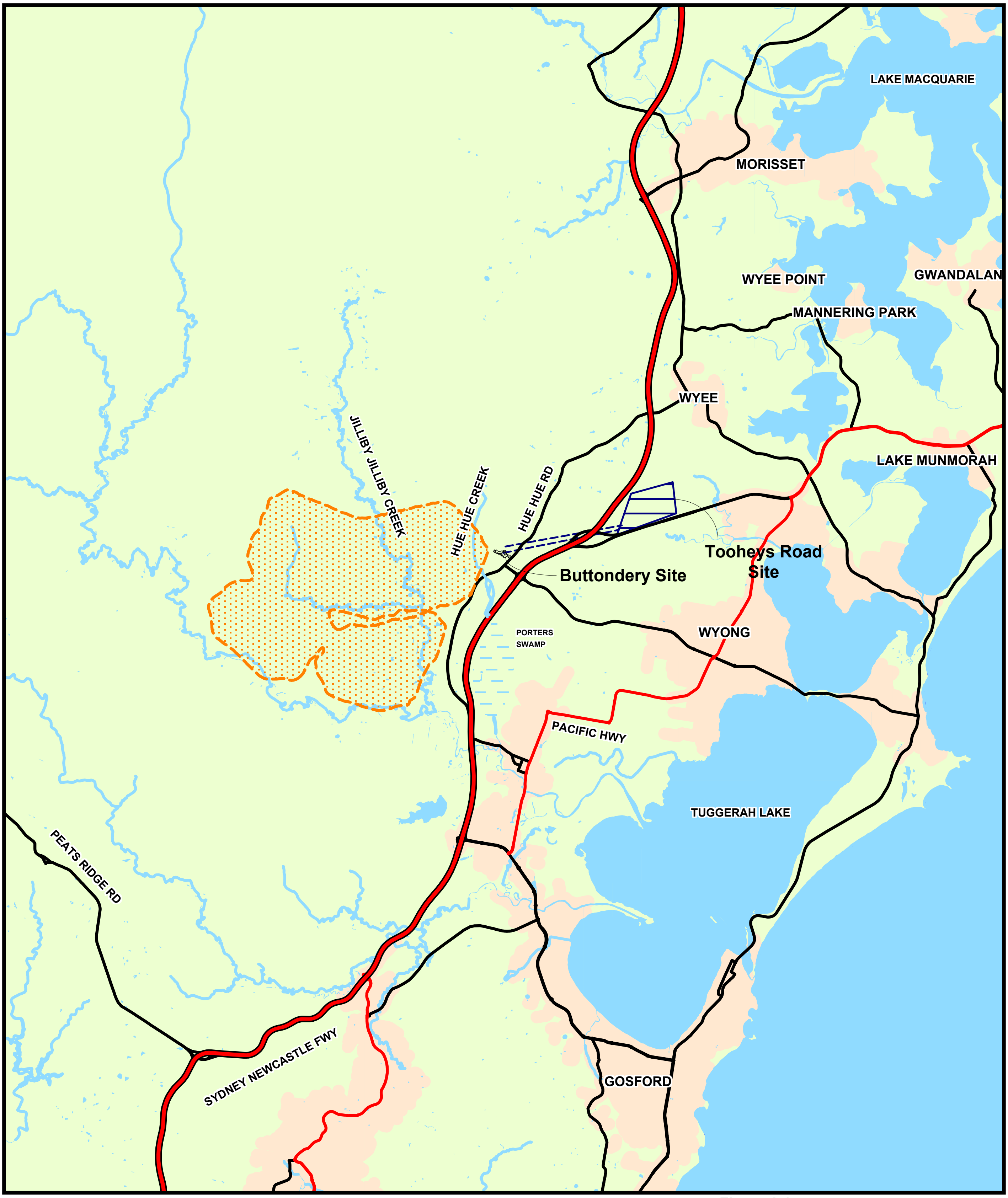
The proposed W2CP is located near Wyong on the Central Coast of New South Wales (see *Figure 2.1*). The proposed mine plan is shown in *Figure 2.2*.

The study area for this assessment includes the Yarramalong and Dooralong Valleys, which have been modelled as a combined Wyong River catchment, and the Hue Hue Creek catchment. Both catchments are upstream of the Sydney-Newcastle F3 Freeway. Subsidence will alter the topography within the floodplains of these catchments and hence, potentially, the flood behaviour. Subsidence within the main river channel and the floodplain of the Yarramalong Valley (Wyong River) will be negligible, being generally less than 15 cm, and limited to a small area. Thus, negligible changes will occur to flood extents and depths in the Yarramalong Valley as a result of predicted mine subsidence and most will be marginally beneficial. Subsidence will extend approximately 5.2 km of the Dooralong Valley floodplain from zero up to generally 1.2 m near the channel of Jilliby Jilliby Creek, with small isolated areas in the adjacent floodplain of the order of approximately 1.6 m. Subsidence of up to 1.8 m may occur at one isolated location within the Dooralong Valley floodplain at some distance from any residences or access roads. Subsidence of up to 0.95 m will occur along a over 1.3 km length of the Hue Hue floodplain. Impacts of subsidence on flooding are discussed in *Chapter 6*.

All major streams within the two catchments were modelled from near to the F3, which is well downstream of potential subsidence impacts, to locations well upstream of the subsidence areas. Modelling demonstrated that flood impacts did not extend beyond a limited portion of these streams. The study area has consequently been defined as:

- Wyong River between Chainage 30957 metres (approximately 2000 metres upstream of F3 Freeway) and Chainage 15554 metres.
- Jilliby Jilliby Creek between Chainage 17820 metres (confluence with Wyong River) and Chainage 7690 metres.
- Little Jilliby Jilliby Creek from confluence with Jilliby Jilliby Creek to approximately 5000 metres upstream.
- Hue Hue Creek from F3 Freeway to 5480 metres upstream.

The study area is shown in *Figure 2.3.*



Legend

- Extent of Subsidence
- Decline
- Surface Facilities

Figure 2.1

Locality Plan

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project Flood Impact Assessment
Drawing No:	0044971s_GIS01_R2
Date:	19.02.2009 Drawing Size: A4
Drawn By:	JF Reviewed By: SO
Source:	-
Scale:	Refer to Scale Bar

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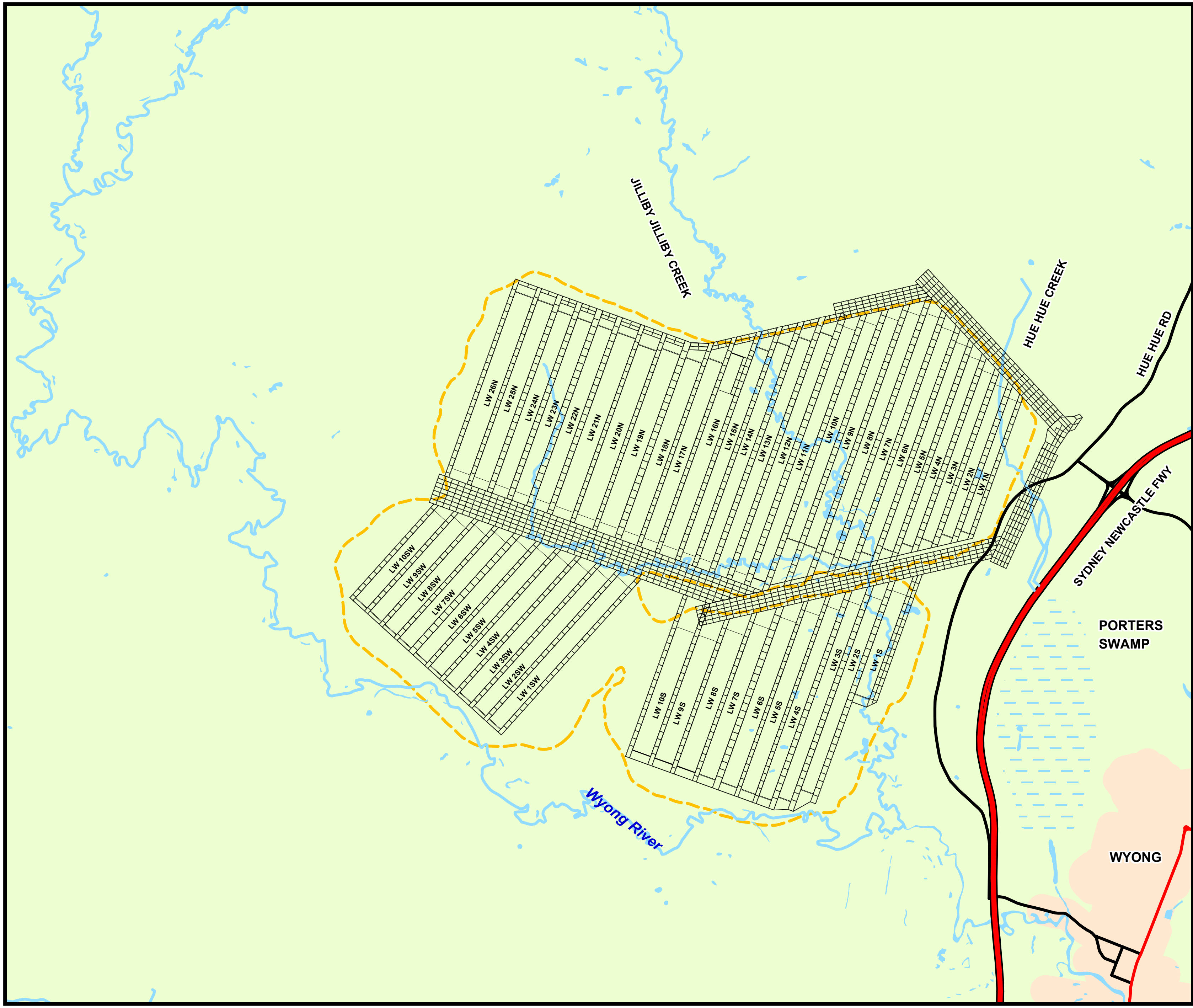

Legend

- Extent of Subsidence
- Mine Plan
- Drift

Figure 2.2

Mine Plan

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project Flood Impact Assessment
Drawing No:	0044971s_GIS02_R2
Date:	19.02.2009 Drawing Size: A4
Drawn By:	JF Reviewed By: SO
Source:	-
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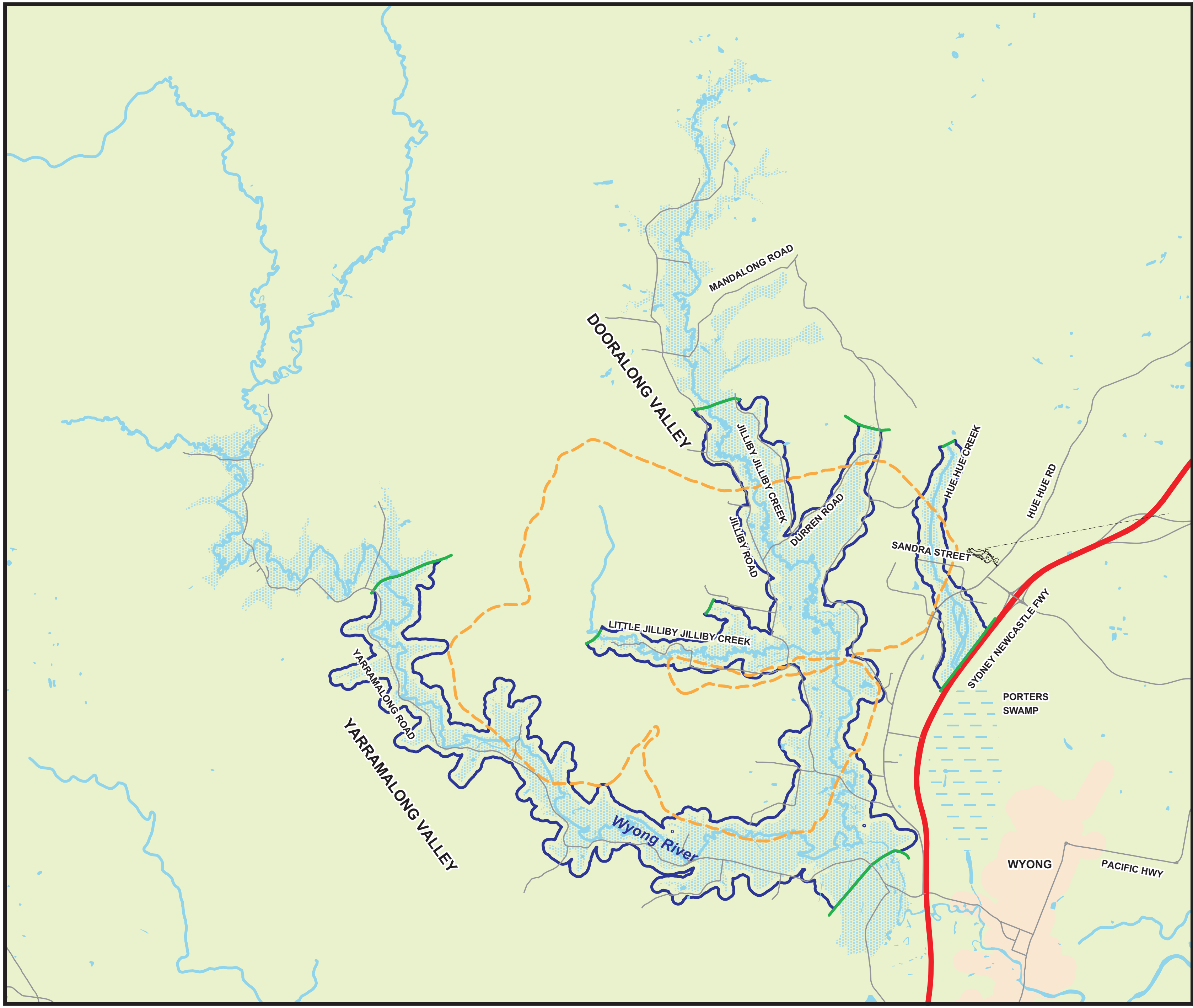

Legend

- Extent of Subsidence
- Extent of Study Area
- Drift
- Floodplain Extent

Figure 2.3

Study Area

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project Flood Impact Assessment		
Drawing No:	0044971_GIS03_R2		
Date:	19.02.2009	Drawing Size:	A4
Drawn By:	JF	Reviewed By:	SO
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2.2 *YARRAMALONG AND DOORALONG VALLEYS*

The major waterways within the Yarramalong and Dooralong Valleys include the Wyong River, Jilliby Jilliby Creek and Little Jilliby Jilliby Creek which are accompanied by a number of small unnamed tributaries. The Wyong River flows through the Yarramalong Valley, while Jilliby Jilliby Creek drains the Dooralong Valley before joining the Wyong River approximately 2.8 kilometres (km) upstream of the F3 Freeway. Little Jilliby Jilliby Creek joins Jilliby Jilliby Creek approximately 5.7 km upstream of the confluence with Wyong River. The Wyong River then continues beyond the Freeway through the Wyong Industrial Estate, under the Old Pacific Highway and Main Northern Railway at Wyong and finally discharges to Tuggerah Lake at Tacoma.

This study concentrates on the floodplain within a 350 square kilometre (km^2) catchment upstream of Woodburys Bridge (Bridge 1) on Yarramalong Road, just upstream of the F3 Freeway.

The Wyong River rises in the Watagan Mountains in the Olney State Forest. The river valley has been cleared for agricultural land uses, primarily grazing. The steep hillsides and ridges are heavily vegetated and generally located within State Forests and Jilliby State Conservation Area.

The Wyong River upstream of the Jilliby Jilliby Creek confluence has a total catchment area of 250 square kilometres. Within the study area there are 21 bridges over the Wyong River which alter the natural flooding patterns. The majority of the bridges provide access to private properties; however, there are significant road crossings at Yarramalong Road and Bunning Creek Road.

Jilliby Jilliby Creek also rises in foothills of the Watagan Mountains. The upper sections of the Dooralong Valley are contained within the Olney State Forest and are covered in dense vegetation. Further downstream, the floodplain has been partially cleared for mixed rural land uses, including grazing, orchards and turf farms.

Jilliby Jilliby Creek has a total catchment area of 98 square kilometres. There are eleven bridges that cross the creek within the study area. The major road into the valley is Dooralong Road, which crosses the creek and its tributaries at a number of locations. There are also significant bridges over Jilliby Jilliby Creek at Durren and Mandalong Roads.

Between the confluence of Jilliby Jilliby Creek with the Wyong River and Woodburys Bridge, the topography of the valley changes. The floodplain narrows as the river flows through this location and the northern bank becomes steeper and more vegetated. This creates a significant restriction to the passage of flood flows.

2.3 *HUE HUE CREEK*

The Hue Hue Valley catchment is located to the west of Hue Hue Road between Wyong and Wyee on the Central Coast of New South Wales. It drains into Porters Swamp just downstream of the F3 Freeway. Porters Creek flows from Porters Swamp, under a bridge at Alison Street, Wyong, immediately prior to joining the Wyong River. For the purposes of this report, and consistency with previous reports, the creek is referred to as Hue Hue Creek.

The study area includes the Hue Hue Creek catchment above the F3 Freeway. The total area of this catchment is 8.2 km^2. The Hue Hue Creek portion of the study area is also shown in *Figure 2.3*.

The majority of the upper reaches of the Hue Hue catchment and the steeper hillsides are heavily vegetated. The valley in the mid reaches of the catchment has been predominantly cleared and mainly consists of small rural and rural-residential land holdings. Residential development is concentrated in the area around Sandra Street and Hue Hue Road. There is a smaller residential subdivision at Cottesloe Road higher in the catchment.

The drainage system within the Hue Hue Valley consists of a series of small, poorly defined, ephemeral watercourses draining to the south east. There are three locations where roads cross the creek, these are:

- two separate culverts under the F3 Freeway;
- a culvert under Sandra Street; and
- a culvert at Hue Hue Road.

Two private access roads from the end of Cottesloe Road also cross Hue Hue Creek.

3 DATA REVIEW

3.1 PREVIOUS STUDIES

A number of previous studies have investigated flooding within and adjacent to the study area and contain information that is relevant to the current assessment. These studies are described below.

Upper Wyong River Flood Study, Public Works Department (PWD), 1988

The Upper Wyong River Flood Study is particularly relevant to the current investigation, as it:

- defined flooding downstream of the study area, which was used to establish the downstream boundary conditions for the hydraulic model; and
- compiled available flood calibration data within the Yarramalong and Dooralong Valleys prior to 1988, including summaries of rainfall and corresponding streamflow information.

The study developed a Watershed Boundary Network Model (WBNM) hydrologic model and a CELLS hydraulic model of the Wyong River catchment to Tuggerah Lake. The hydraulic model was limited from the perspective of the current assessment because it did not focus on the hydraulic characteristics of the Yarramalong and Dooralong Valleys. It also did not produce dynamically routed flood hydrographs. Dynamically routed hydrographs more accurately account for the attenuation of a flood wave as it moves through the river system due to the effects of floodplain storage and downstream hydraulic constraints.

The hydrologic model was also considered inappropriate for the current study as full run-off hydrographs were needed for the hydraulic model and greater discretisation of the catchment was required to define flows at structures and major confluences.

Trunk Drainage Investigation Warnervale East 7b Stage 1- Flood Study, Willing and Partners, May 1990

The study of Warnervale East provides flood levels for the section of Porters Creek downstream of the freeway. These levels have been used in setting boundary conditions for the hydraulic model of Hue Hue Creek in the current study. The study involved development of an XP-RAFTS model for the entire Porters Creek catchment, inclusive of Hue Hue Creek, and a CELLS hydraulic model of the downstream section of Porters Creek to estimate flood levels for the 1%, 2% and 5% Annual Exceedance Probability (AEP) storm events.

Yarramalong and Dooralong Valleys Baseline Flood Study, ERM, May 2000

The Yarramalong and Dooralong Valley Baseline Flood Study was undertaken by ERM in 2000 for Coal Operations Pty Ltd. An XP-RAFTS model was developed for both valleys and calibrated using three Department of Land and Water Conservation (now DWE) streamflow gauges for 11 recorded storm events. A MIKE 11 hydraulic model was developed to estimate flood levels for a range of design floods including the Probable Maximum Flood (PMF), 1%, 2%, 5%, 10% and 20% AEP storm events.

[NOTE: The Average Recurrence Interval (ARI) is the reciprocal of the AEP i.e. 1% AEP = 1 in 100 year ARI, 2% AEP = 1 in 50 year ARI etc.]

The baseline flood study found that the topography of the valleys is well defined with steep valley walls and a relatively flat floodplain. As water depth increases with the magnitude of each flood, the submerged area increases only marginally. Therefore, there is little difference between the area inundated in a 1% AEP flood and a 20% AEP flood.

The following conclusions about existing flood behaviour were drawn from the baseline flood study:

- the rivers and creeks have little capacity and most of the flood flows break out of the main channel and inundate the floodplain for storms in excess of the 20% AEP event;

- the 1% AEP flood is approximately 1.1 metres higher than a 20% AEP flood in the centre of the study area;

- flood widths range from 500 m to in excess of 1 km in the lower sections of the valley;

- average velocities are low due to the width of the floodplain;

- higher localised flow velocities occur near bridges in the upper reaches of the valleys;

- the local community has a good understanding of flood behaviour in the valleys due to the frequency and extent of flooding;

- this intuitive knowledge of flood behaviour is demonstrated by the fact that most residences are located either outside the floodplain or on the flood fringe;

- some bridges for private access roads are overtopped by floodwaters in small floods, and during major events they are overtopped early in the flood; and

- bridges on public roads generally have greater capacity than those serving private properties, but several public bridges are also overtopped in frequent flood events.

Yarramalong and Dooralong Valleys - Flood Impact Assessment, ERM, March 2003

This flood impact assessment was commissioned by Hunter Valley Energy Coal (HVEC) on behalf of the Wyong Areas Coal Joint Venture to assess potential impacts associated with subsidence from underground mining and to develop any mitigation measures that may be required. The study area included the Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks but did not include Hue Hue Creek.

The study found that overall, changes to flood behaviour would be fairly minimal, existing flow patterns would be retained and inundation areas would not significantly change. Changes to flood behaviour in the Dooralong Valley were found to be more significant than in the Yarramalong Valley.

(NOTE: Mine plans and subsidence assessments have changed since this 2003 study; hence comparison between the 2003 study and the current study in terms of predicted impacts on flooding due to subsidence may no longer be valid.)

Hue Hue Creek, Baseline Flood Study DRAFT, ERM, March 2000

This study investigated flood behaviour in the Hue Hue Valley. Using XP-RAFTS and HEC-RAS, the study:

- determined peak flood levels, flow rates and velocities for the PMF, 1%, 2%, 5%, 10% and 20% AEP design storms; and

- identified flood hazards for roads, bridges, and structures located within the 1% AEP floodplain.

The purpose of the study was to establish existing flood behaviour in the catchment and a baseline from which the impacts of the proposed coal mining on flood behaviour could be assessed.

(NOTE: No modelling was undertaken in the 2000 study to assess impacts of mine subsidence on flooding in Hue Hue Creek. This work was subsequently undertaken as part of this current study.)

Dwelling Status Report – Flood Prone Areas (Preliminary Report), Grahame Lindsay & Claire Byrne, June 2001

This report identified and summarised dwellings that were within the predicted subsidence areas with particular focus on those that were within the 1 in 100 year (1%AEP) flood areas calculated in the two previous studies.

3.2 TOPOGRAPHIC DATA

3.2.1 Maps and Plans

Orthophoto maps at a scale of 1:4000 with a contour interval of 2 metres (m) were used to define catchment boundaries for both catchments. These maps were used for defining sub-catchments, calculating catchment areas, and estimating surface slopes for input to the hydrologic models.

High resolution colour aerial photographs of the entire catchments were supplied in August 1999 by AAM Surveys Pty Ltd. More recent aerial photographs and aerial laser surveys were provided in October 2006 by WACJV. The photographs were used to confirm estimates of surface roughness values and the percentage imperviousness of each sub-catchment for the hydrologic and hydraulic models.

3.2.2 Digital Terrain Model

WACJV supplied a Digital Terrain Model (DTM) of the floodplain between the F3 Freeway to upstream of Cottesloe Road, within the Hue Hue Creek catchment, and for the full extent of the Yarramalong and Dooralong Valleys. The DTM was used to extract cross section information for input into the hydraulic models.

3.2.3 Detailed Survey

As part of both previous Baseline Flood Studies, a detailed survey was undertaken to accurately define the creek sections and structure details at culverts and bridges in the Yarramalong and Dooralong Valleys and Hue Hue Creek (ERM, 2000). Bridges were found to vary significantly in size and level and many can act as hydraulic controls of during floods. Twenty-one bridges in the Yarramalong Valley and eleven bridges in the Dooralong Valley were surveyed, as well as cross-sections immediately upstream and downstream of the bridges. Within the Hue Hue Creek catchment a detailed survey of the one bridge and five culvert crossings upstream of the F3 Freeway was undertaken. Details of survey information are provided in *Annex* A.

3.2.4 *Post-Subsidence Topography*

Subsidence modelling was undertaken by Mine Subsidence Engineering Consultants, based on the mine plan developed by WACJV, to quantify subsidence predictions. The WACJV DTM was then regenerated to produce contour information for the post-subsidence condition. The subsided DTM was used to extract cross section information to enable development of post-subsidence hydraulic models to predict changes to flood levels. These cross sections were at the same locations as those representing existing conditions.

3.3 *SIGNIFICANT FLOODS OF RECORD*

The Baseline Flood Studies (ERM, 2000) reviewed historical flood and rainfall information. Significant historical floods were identified from a range of sources including Council's records, previous studies and streamflow records. Significant floods occurred in the following years:

- 1964 (June);
- 1967 (June);
- 1967 (August);
- 1974 (June);
- 1977 (March);
- 1978 (March);
- 1984 (November);
- 1985 (October);
- 1989 (June);
- 1990 (February); and
- 1992 (February).

The 1964 event was the largest of these floods. It was described at the time as the worst flood in 40 years at Wyong. This and other floods are described in the Upper Wyong River Study (PWD, 1988).

No significant flood events were noted since the 2003 Flood Impact Assessment was completed so that no additional calibration was possible for the current study. The most recent flood was in June 2007, which was estimated to have an AEP of between 30% and 20% (1 in 3 to 1 in 5 year ARI). WACJV provided information on this flood to Wyong Council as well as baseline information on mapping and flood modelling developed as part of the current report.

3.4 *RAINFALL DATA*

3.4.1 *Introduction*

The Baseline Flood Studies (ERM, 2000) required rainfall data for two distinct purposes. The first was to provide information of actual rainfall in the catchment during previous moderate floods that could be entered into a hydrologic model for calibration purposes. This data is referred to as "event" data. Only a short duration of record extending over about three days was required, provided it coincided with the period of interest. The second was to provide information on rare or extreme storms, (usually annual maxima) to derive design floods. Design storm data requires stations with many years of continuous records. No significant change was noted in estimates of the design storms since the 2000 and 2003 studies were undertaken.

Rainfall data is most useful if it coincides with direct streamflow measurements. In such instances the parameters in the rainfall runoff model are adjusted until computed discharges match measured values. An indirect, though less reliable, calibration can also be achieved using recorded flood levels in conjunction with a hydraulic model. In this instance the parameters of the two models are adjusted until agreement is reached between computed flood hydrographs and levels and recorded hydrographs and levels.

The most useful rainfall data is obtained from pluviographs, which record rainfall continuously over time. Pluviographs give rainfall intensities over the duration of the storm, providing details of the temporal distribution of rainfall. Daily read rain gauge stations yield less information about the storm, but can still be useful indicators of the spatial distribution of rainfall.

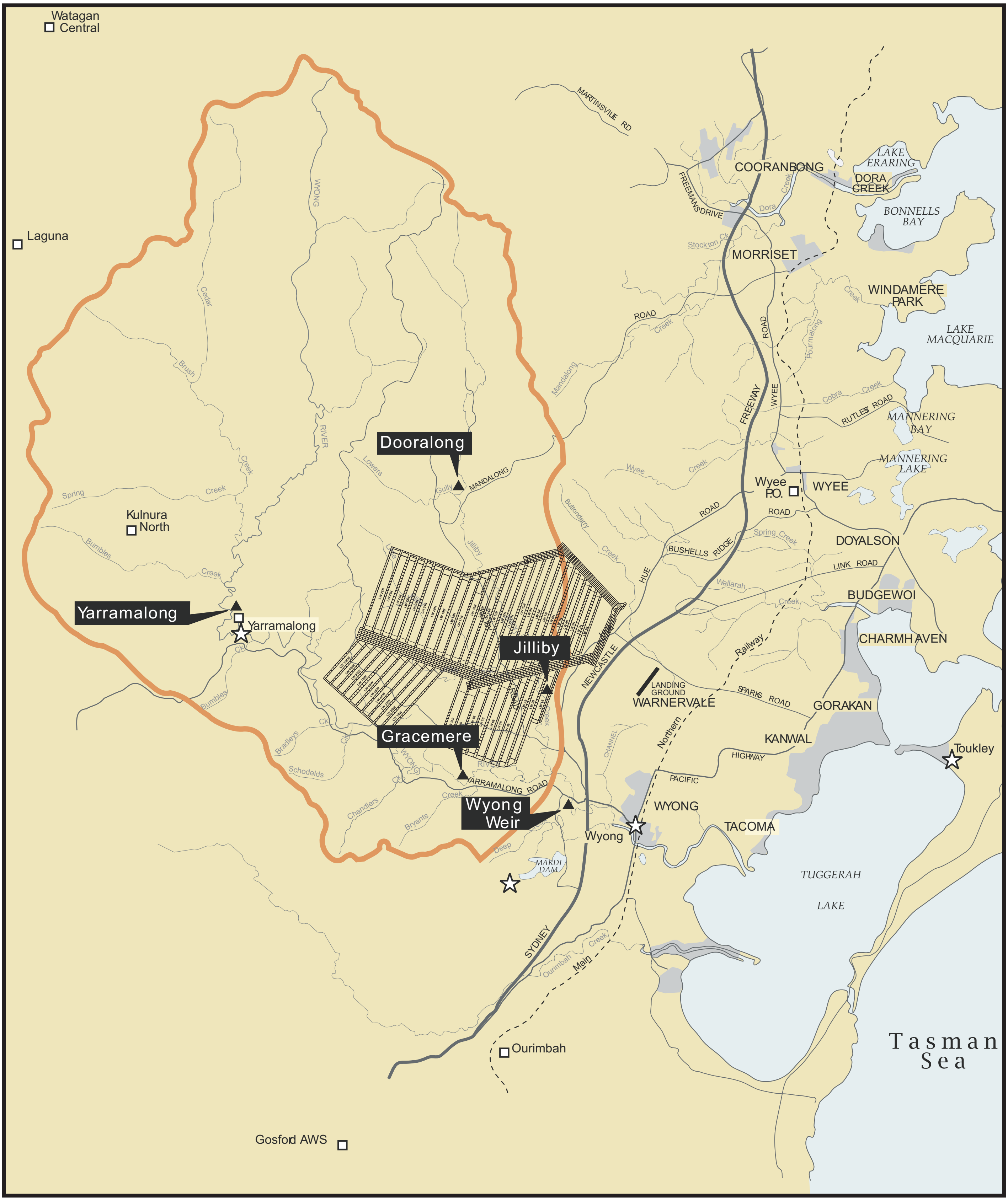
3.4.2 *Event Data*

The Baseline Flood Studies identified a number of rainfall gauges within or adjacent to the catchment which are useful for event data. These gauges are summarised in *Table 3.1* and their locations are shown in *Figure 3.1*.

Table 3.1 Summary of Rain Gauges

Gauge Type	Location	Data Source	Recording Frequency
Pluviograph	Mardi Dam	MHL	2 minutes
Pluviograph	Toukley	MHL	5 minutes
Pluviograph	Wyong	MHL	10 minutes
Pluviograph	Yarramalong	MHL	2 minutes
Rainfall	Wyee Post Office	BOM	Daily
Rainfall	Gosford (Narara Research Station) AWS	BOM	Daily
Rainfall	Ourimbah (Dog Trap Road)	BOM	Daily
Rainfall	Laguna (Kolongba)	BOM	Daily
Rainfall	Kulnura North (Jeavons)	BOM	Daily
Rainfall	Watagan Central	BOM	Daily
Rainfall	Yarramalong (Lewinsbrook)	BOM	Daily
Rainfall	Norah Head Lighthouse	BOM	Daily

Notes:
1. BOM abbreviates Bureau of Meteorology.
2. MHL abbreviates Manly Hydraulics Laboratory.



Legend

- Urban Areas
- Catchment Boundary
- Daily Read Rainfall Gauge
- Stream Gauge - Owned by D.L & W.C
- Pluviometer - Owned by B.O.M
- Mine Plan

Figure 3.1

Stream Flow and Rain Gauging Stations

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_03_R1
Date:	12/02/2009 Drawing size: A4
Drawn by:	GC Reviewed by: -
Source:	-
Scale:	Refer to Scale Bar

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The storms listed below were further analysed in the Baseline Flood Studies:

- 8 June 1964;
- 21 June 1967;
- 5 August 1967;
- 2 June 1974;
- 1 March, 1977;
- 18 March, 1978;
- 5 November, 1984;
- 12 October, 1985
- 19 June, 1989;
- 2 February, 1990; and
- 7 February, 1992.

Based on available data, temporal and spatial patterns of rainfall were defined for each storm used in the calibration and verification process. The final selection was based on the availability of data including rainfall, streamflow, flood heights and approximate AEP of the storm. The selected storms have the most complete data set and are discussed further in *Section 3.4.4*.

3.4.3 Design Rainfall

Design storm data published in *Australian Rainfall and Runoff* (AR&R), 1998 was used in the baseline studies. Due to the size of the catchment it was necessary to divide the area into rainfall zones so that accurate values of local rainfall intensities could be calculated for each zone. Details of the rainfall zones and design intensities calculated for each zone are provided in *Annex B*.

3.4.4 Rainfall Data for Calibration Events

At the time of the Yarramalong/Dooralong Baseline Flood Study, complete data sets were available for three storms since 1988 that could be used to calibrate and verify the models. Pluviograph data was collected by Manly Hydraulics Laboratory for the Department of Public Works and Services.

Daily rainfall data at various locations within and adjacent to the catchment were obtained from the Bureau of Meteorology. These were supplemented by daily rainfall records provided by the community during the 1999/2000 public consultation process.

An isohyetal rainfall distribution map was developed for each calibration storm and used to obtain rainfall depths for each zone and accurately represent spatial variation in rainfall across the catchment for each storm event.

Following calculation of rainfall depths within each zone a temporal distribution was obtained by inspecting pluviograph records. The pluviograph station selected as best representing each calibration storm was determined based on its location, its operational state and its consistency with other rainfall records. For the 1989 storm, pluviograph data was obtained from stations at Toukley, Mardi Dam and Yarramalong. Pluviograph data was examined for stations at Wyong and Yarramalong for the 1990 storm and for Yarramalong during the 1992 storm.

Based on a review of the data and initial modelling results, the following pluviographs were adopted for the calibration:

- 1989 storm temporal data from Toukley;
- 1990 storm temporal data from Wyong (Yarramalong produced similar results); and
- 1992 storm temporal data from Yarramalong.

3.5 STREAMFLOW DATA

Operational streamflow gauges in the valley are shown in *Figure 3.1*. *Table 3.2* gives their operational condition during floods since 1988.

Streamflow gauges, which measure flow within Wyong River, are located near the Yarramalong and Wyong Creek localities. For reporting purposes, these gauges are named Yarramalong and Gracemere respectively. In addition, the Wyong Weir flow gauge is located approximately 1.6 kilometres downstream of Woodburys Bridge. Within the Dooralong Valley, flow gauges are found near the Dooralong and Jilliby townships. These gauges are named Dooralong and Jilliby, respectively.

Yarramalong Flow Gauge

The Department of Water and Energy (DWE) (formerly DNR) operates a streamflow gauging station on the Wyong River at Yarramalong. The catchment area to the gauge is 181 square kilometres. The available period of record is 1976 – present.

A streamflow gauging station is also located on the Wyong River at Gracemere. The DWE maintains the station and its period of record is 1972 – present. The catchment area to this station is 236 square kilometres.

Jilliby Flow Gauge

The Jilliby flow gauge is located on Jilliby Jilliby Creek upstream of the confluence with the Wyong River. The DWE operates the station and the period of record is 1972 – present. The catchment area to the station is 92 square kilometres. It was noted in the PWD 1988 study that there are doubts about the accuracy of the rating curve for this station for high flow conditions. Comparisons of gauged flows with observed flood marks at the station by the DWE for the June 1975 flood also demonstrated that the rating curve was under-predicting high flows.

Table 3.2 Operational Streamflow Gauges

Station	Identification	Operation in Flood		
		1989	1990	1992
Yarramalong	211014	No	Yes	Yes
Gracemere	211009	Yes	Yes	No
Jilliby	211010	Yes	No	Yes

Details of streamflow records prior to 1988 are included in the PWD 1988 study. This combined data set was used to calibrate the hydrologic model as part of the baseline study. The Dooralong flow gauge was not used, as it is only read at irregular intervals, and the quality of the available data was rated poor by the DWE.

3.6 FLOOD HEIGHT DATA

3.6.1 Wyong Council Records

Only limited recorded flood height data is available in the catchment. Council records of historic flood heights were provided on an ISO A1 sized plan. Flood marks used in the calibration of the models are tabulated in *Annex C*.

3.6.2 Records Provided by Community

Another important source of information on past floods was the local community. Historic records including photographs, videos, flood marks and rainfall charts were sought as part of the original baseline study from residents in Yarramalong and Dooralong Valleys through a community consultation process. Information was assessed for suitability and then used in the calibration of the flood models.

Surveyors subsequently measured the level and location co-ordinates of each flood mark so they could be used in the calibration process. Recorded flood marks supplied by the community are also included in *Annex C*.

3.6.3 Downstream Conditions

Hydraulic models require the definition of the boundary conditions at the downstream end of the model. The boundary conditions can be entered as:

- a constant water surface level;
- a time varying relationship of water surface levels; or
- a rating curve providing water surface levels for various flow rates.

The Upper Wyong River Flood Study (PWD, 1988) defined flood levels for the area immediately downstream of Woodburys Bridge. These water surface levels were used to develop a time varying relationship of water surface levels for each storm event at the downstream boundary of the model.

4 *HYDROLOGIC MODELLING*

4.1 *OVERVIEW*

A rainfall runoff model was developed using XP-RAFTS during the preparation of both the and the draft Hue Hue Catchment Baseline Flood Study (ERM, 2000).

These hydrologic models and associated data from these studies have been reviewed and found to be sufficient for the purposes of this study without further revision with the exception of the assessment of the Probable Maximum Flood (PMF). Since the earlier investigations, no additional major storm events (greater than 1 in 10 year ARI flood) have occurred that would enable further calibration, nor have there been significant changes in catchment use and characteristics such as urban development or land clearing. The methodology and results of these studies are summarised in this report for completeness.

The methods used to determine the PMF have changed slightly since the original baseline studies. This is discussed in more detail in Section 4.3.4; however, the outcome of the revised PMF assessment was to increase the PMF by a factor of 1.04 over the previous assessment. This revised PMF has been used in the subsequent hydraulic modelling.

4.2 *DESCRIPTION OF XP-RAFTS*

XP-RAFTS was developed as a general purpose rainfall runoff model suitable for a wide range of natural and modified (urbanised) catchments. The model uses a non-linear routing procedure developed by Laurenson to convert rainfall into runoff.

XP-RAFTS can be used to estimate flood discharges for any observed or design (synthetic) storm. Parameters such as slope, catchment area, impervious areas, surface roughness and rainfall losses are used to simulate the catchment response to a specific storm and to generate hydrographs where required. For computational purposes the catchment is sub-divided into a series of sub-catchments which are differentiated by drainage sub-division, topography, land use or soil type. Discharges are computed at the outlet of each sub-catchment. Sub-catchments may be further sub-divided to provide discharges at confluences, bridges or other points of interest.

XP-RAFTS allows different rainfall temporal patterns and intensities to be applied to each sub-catchment to simulate the variation of rainfall over a river network. XP-RAFTS can simulate the storage behaviour of basins and can represent a wide range of outlet types. Channel routing effects can be specifically modelled by use of the Muskingum-Cunge channel routing module.

XP-RAFTS includes two options to account for soil losses. The first option is a simple approach that allows an initial loss followed by a continuing loss. The continuing loss may be a constant rate or a ratio of the incremental rainfall. This option only generates surface runoff and does not include the contributions to flooding from base flow and interflow. The second approach uses the Australian Representative Basin Module (ARBM) to simulate soil loss processes in more detail. ARBM allows interflow and base flow to be modelled, but involves more effort and data to set-up and calibrate.

4.3 *YARRAMALONG AND DOORALONG VALLEY*

4.3.1 *Model Layout*

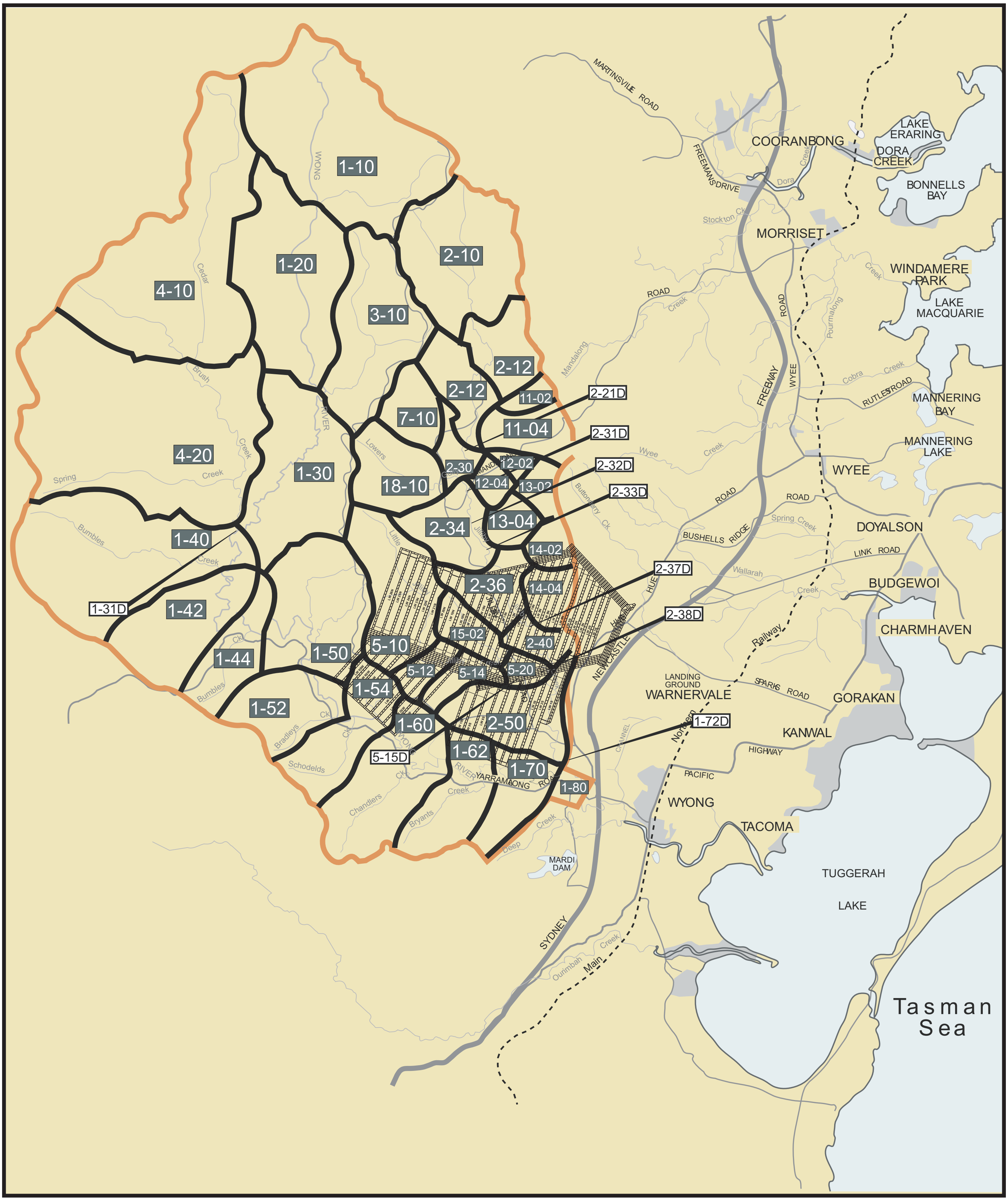
The XP-RAFTS hydrologic model of the Yarramalong and Dooralong Valley consists of a series of sub-catchments generally representing tributary inflows to the main valleys. For each sub-catchment the physical properties determined included area, sub-catchment slope and surface roughness. Each sub-catchment was also assigned rainfall/infiltration properties. Parameters used in development of the hydrologic model are detailed in *Annex D*.

The XP-RAFTS model has 43 sub-catchments and 12 junction nodes to define the catchment topography, land use and river network sub-catchments. Junction nodes have negligible areas, but are included to ensure that hydrographs are generated at significant confluences. The model layout is shown in *Figure 4.1*. Details of key parameters are provided in Yarramalong and Dooralong Valleys, Baseline Flood Study (ERM, 2000).

There are two methods used in XP-RAFTS for summing flows as they move through the river system. The first is a simple link lagging procedure where the flows from the upstream node are delayed by the time of travel through the downstream channel. The second is a channel routing procedure where channel parameters are entered and the attenuation of flows as they move through the river network is approximated. The simple link lagging procedure was used in this model as the MIKE 11 hydraulic model uses a more accurate channel routing procedure to produce dynamically routed hydrographs.

The choice between the initial loss/continuing loss module and the Australian Representative Basin Module (ARBM) was made during the model calibration phase. The ARBM gave a better calibration and was therefore adopted for subsequent model runs.

The main purpose of the hydrologic investigations was to develop runoff or inflow hydrographs for routing through the hydraulic model. Inflow hydrographs were required at 25 locations for the MIKE 11 hydraulic model.



Legend

- Urban Areas
- Catchment Boundary
- Sub-catchment Boundary
- 1-80 XP - Rafts Catchment Label
- Mine Plan

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_02_R1
Date:	12/02/2009 — Drawing size: A4
Drawn by:	GC — Reviewed by: -
Source:	-
Scale:	Refer to Scale Bar

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0 1 2 3km

Figure 4.1

Yarramalong and Dooralong XP Rafts Layout

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4.3.2 *Calibration*

Three sites, Mardi Dam, Toukley and Yarramalong township were used in the calibration process. Streamflow data was available at three locations: Yarramalong, Gracemere and Jilliby.

Ten moderate storms were recorded since a severe flood occurred in 1964. Data obtained from these storms provided sufficient information to calibrate the XP-RAFTS model. Information obtained from moderate floods was judged more complete and accurate. Therefore the XP-RAFTS model is considered to be accurate for small to moderate storms, and allows a reasonable extrapolation of calibration parameters to larger storms. The eleven storms listed in *Section 3.4.2* were used for calibration.

The model was calibrated by adjusting parameters so that computed discharges at the streamflow stations at Yarramalong, Gracemere and Jilliby agreed with the recorded discharge hydrographs, while maintaining realistic catchment parameters.

Calibration results based on XP-RAFTS modelling alone are shown in *Table 4.1*.

Table 4.1 Comparison of Peak Flows for Observed and Modelled Historical Floods

Flood Event	Gauging Station	Observed Flow (m^3/s)	Modelled Flow (m^3/s)	% Difference
June 1964		Not recorded	1257 [1]	n.a.
June 1967	Wyong Weir	377	289 [1]	-23
August 1967	Wyong Weir	425	424 [1]	0
June 1974	Gracemere	190	224 [1]	18
	Jilliby	61	181 [1]	53
March 1978	Gracemere	394	415 [2]	5
	Jilliby	75	124 [2]	65
November 1984	Yarramalong	207	211 [1]	2
	Gracemere	198	237 [1]	20
	Jilliby	53	142 [2]	168
October 1985	Yarramalong	223	289 [1]	30
	Gracemere	198	327 [1]	65
	Jilliby	58	62 [2]	7
June 1989	Yarramalong	299	370 [1]	24
	Jilliby	67	58 [2]	-13
February 1990	Yarramalong	301	315 [2]	5
	Gracemere	312	364 [2]	17
February 1992	Yarramalong	183	171 [2]	-7
	Jilliby	73	202 [2]	177

Notes:
1. Initial wetness value equal to one hundred percent (see ERM 2000).
2. Initial wetness value equal to sixty percent (see ERM 2000).

It can be seen that the computed hydrograph peaks match the observed hydrograph peaks reasonably well with the exception of the 1984 and 1992 events at Jilliby. The initial wetness adopted for each run is also shown in *Table 4.1*. Note that it is valid to vary soil losses from one storm event to another in response to temporal differences in antecedent moisture conditions, however, the other model parameters should not be changed.

The values in *Table 4.1* should be interpreted with care. Flows in the XP-RAFTS model will tend to be over-predicted as the storage and attenuation effects due to the movement of floodwaters through the river system are not accounted for. These effects appear to be more significant in Jilliby Jilliby Creek than the Wyong River. That is, the reductions of peak flows in the MIKE 11 model compared to the XP-RAFTS results are much greater.

Catchment roughness (pern) and ARBM values were adjusted during calibration. The final calibrated XP-RAFTS model adopted a pern value of 0.10, which is consistent with recommendations in the XP-RAFTS User's Manual for forested catchments. The adopted global calibration factor Bx was 1.0. Adopted parameters in the ARBM rainfall infiltration model are discussed in the Baseline Flood Study (ERM, 2000), and are based on recommendations in the XP-RAFTS User's Manual.

4.3.3 Estimation of Design Storm Hydrographs

The calibrated XP-RAFTS model was used to generate design runoff hydrographs at key locations throughout the catchment. A range of storm durations for each AEP event were run to determine the critical storm. The critical storm duration for this purpose is defined as the storm duration which produces the largest discharge.

The XP-RAFTS model parameters used for design hydrograph estimation were the same as the calibrated model discussed in *Section 4.3.2.* The initial wetness was assumed to be saturated (100%), in accordance with common practice for design hydrologic simulations.

Design storm rainfall was determined in accordance the standard procedures described in Chapter 2 of AR&R (1998). Parameters for each rainfall zone were calculated using the maps provided in Volume 2 of AR&R, (1998). The design rainfall intensities for each rainfall zone are included in the Baseline Flood Study (ERM, 2000).

4.3.4 *Probable Maximum Precipitation (PMP) Calculations*

Probable Maximum Precipitation (PMP) at various locations was calculated in all previous studies using the Generalised Short Duration Method (GSDM) as described in the Bureau of Meteorology's Bulletin 53 (1994). This method is currently considered suitable for catchments up to 1000 km^2 in area and for storms up to 6 hours in duration. Bulletin 53 was revised in June 2003, with the moisture adjustment factor (MAF) being changed to reflect updated moisture data that has been used by the Hydrometeorology Section of the Bureau of Meteorology since 2001. There has been no change to the design temporal patterns or to the method for determining the spatial distribution of rainfall.

Other methods of PMP estimation applicable to the catchment are the Generalised Southeast Australia Method (GSAM), which provides estimates for storm durations ranging from 1 to 4 days, and the revised Generalised Tropical Storm Method (GTSMR), which provides estimates for storm durations ranging from 1 to 5 days. The study area is in the transition zone between the GSAM and GTSMR methods of PMP estimation for longer duration storms, however, the GSAM was not publicly available until October 2006, while the GTSMR was not finalised until 2003 and is only applicable to those parts of Australia that are affected by tropical storms. Neither of these methods was therefore used in the original PMF assessment.

Under the revisions to Bulletin 53, the moisture adjustment factor for the catchment increased by approximately 4% from 0.68 to 0.71. As this is a relatively insignificant change with respect to the limits of accuracy of the analysis, additional modelling was not considered to be warranted and PMF flows were simply multiplied by a factor of 1.04. GSDM estimates have been factored up to account for the increase in moisture adjustment factor, however, any estimates should still only be used to provide an indication of flood behaviour in an extreme event. Longer duration rainfall events would be expected to produce greater discharges and higher flood levels in this catchment.

4.3.5 *Discussion*

In large floods the floodplain is inundated creating a large volume of flood storage. The effect of floodplain storage is to reduce peak discharges. XP-RAFTS can in a simplistic way account for these effects by using the Muskingum-Cunge module or by introducing conceptual storages. It is important not to account for storage effects in both the hydraulic and hydrologic models. In this study total hydrographs have been exported from the XP-RAFTS models at the start of river reaches in the hydraulic model but only local runoff hydrographs have been exported at downstream nodes.

Care should be taken when interpreting calibration results, particularly discharges from the XP-RAFTS model, no attempt has been made to account for the attenuation of flows through the river system in the XP-RAFTS model. This model has been used to provide flow inputs at specific locations in the MIKE 11 model.

4.4 HUE HUE CATCHMENT

4.4.1 Model Layout

The layout of the hydrologic model is shown in *Figure 4.2.* Details of specific parameters used in the model are provided in *Annex D.* The model was not calibrated against recorded data as there was no calibration data available for the Hue Hue catchment itself. Adopted model parameters were based on data from the Dooralong and Yarramalong Valleys (immediately to the east of the Hue Hue catchment). Output from this model has been used for the current study.

4.4.2 Estimation of Design Hydrographs

A summary of the peak flow rates at each node for the nine hour storm event is provided in the table below. The nine hour storm event was the critical duration storm event.

Table 4.2 Peak Flowrates for Design Storm Events (Hue Hue Creek)

Node	Peak Flowrates for Critical Storm Durations (m^3/s)					
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	PMF
H1.000	5.3	6.9	8.7	11.0	12.8	70.1
H1.020	9.8	12.9	16.6	21.1	24.8	134.6
H2.000	3.0	3.8	4.9	6.2	7.2	40.5
H1.03j	12.4	16.2	20.8	26.5	31.1	170.2
H1.040	14.5	19.0	24.5	31.4	36.8	202.5
H3.000	5.1	6.1	7.2	8.3	9.4	51.5
H1.05j	16.7	21.8	28.1	36.8	43.4	237.5
H1.060	18.0	23.6	30.9	40.6	47.9	260.4
H4.000	2.3	2.7	3.2	3.7	4.2	24.9
H5.000	2.3	2.8	3.3	3.8	4.3	25.8
H1.080	23.8	31.1	40.4	52.3	61.5	338.4
H6.000	4.2	5.1	6.0	6.9	7.8	46.9
H7.000	3.4	4.1	4.8	5.7	6.4	36.9
H1.09j	28.4	37.0	47.4	60.8	71.4	397.9
H1.10	31.8	41.2	52.4	66.9	78.4	439.6
H8.000	3.9	4.8	5.6	6.4	7.3	40.4
H1.11j	34.6	44.7	56.6	71.9	84.3	471.5
H10.00	3.2	4.0	4.7	5.4	6.1	34.1
H1.120	40.8	52.7	66.4	83.5	97.6	545.6
H9.00	4.3	5.4	6.4	7.4	8.3	46.4
H1.13j	44.1	56.7	71.2	89.4	104.3	586.5
out	44.1	56.7	71.2	89.4	104.3	586.5

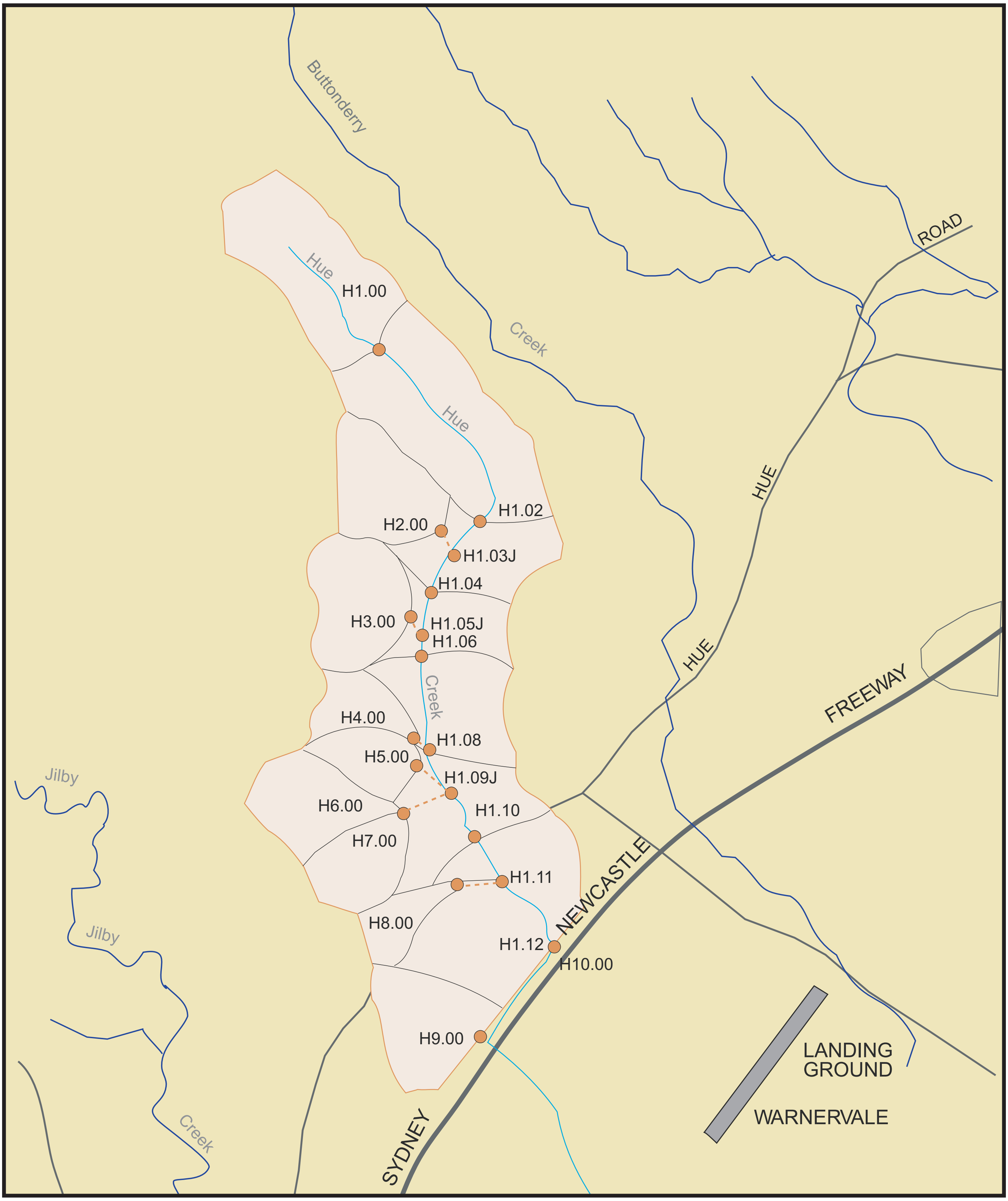

Figure 4.2

Hue Hue XP Rafts Layout

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_01
Date:	12/03/2007 — Drawing size: A4
Drawn by:	ML — Reviewed by: -
Source:	-
Scale:	Refer to Scale Bar

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4.4.3 *Discussion*

The XP-RAFTS results for Hue Hue Creek indicated that flood behaviour could be adequately determined by a one-dimensional steady state hydraulic model. The shape of the catchment and the steepness of the upper catchment mean that there is only minor attenuation of the flood hydrographs as they pass through the creek system. The difference in timing in mainstream flood peaks between the top of the creek and the outlet is less than 10 minutes. Hence a HEC-RAS hydraulic model was used rather than MIKE11 for this stream as described in *Section 5.2*.

5 HYDRAULIC MODELLING

5.1 YARRAMALONG AND DOORALONG VALLEY

5.1.1 Methodology

In selecting the most suitable hydraulic model the local flow characteristics and the purpose of the model must be considered. Due to the possible effects of subsidence on floodplain storage, an unsteady hydrodynamic model was the most appropriate for the Dooralong and Yarramalong Valley. Given the topography of the valleys, a one-dimensional model with capacity for quasi two-dimensional flow where alternate flow paths occur was adequate to represent flood behaviour in the valleys.

The unsteady flow hydrodynamic model MIKE 11 was used to simulate the flood behaviour of the valleys. A hydraulic model for Wyong River, Jilliby Jilliby Creek, Little Jilliby Jilliby Creek and other minor tributaries was established. Each river was represented by a series of cross-sections, with hydraulic controls such as bridges and weirs.

The model allows flood levels, velocities, extents of inundation and flow paths to be assessed for a range of historical and design floods. It requires input hydrographs, which were provided by the XP-RAFTS model. MIKE 11 is an unsteady flow model developed by the Danish Hydraulic Institute to simulate flows in rivers, estuaries and other water bodies. The model solves both branched and looped river tributary configurations and accounts for hydraulic structures such as weirs, culverts and bridges.

Hydraulic models can either be steady state where the flow is assumed to be constant or unsteady where the flows are able to vary with time. Unsteady models are needed to accurately describe flood behaviour in river systems where there are tributaries with differences in the timing of flood peaks and significant floodplain storage.

MIKE 11 uses an implicit finite difference solution for unsteady flow computations. It can describe subcritical as well as supercritical flow conditions through a numerical process which is altered according to local flow conditions. Computational modules are included to describe flow through hydraulic structures such as weirs, culverts and bridges. The formulation can be applied to looped networks and quasi two-dimensional flow situations, such as those that occur on floodplains. The computational scheme is applicable for vertically homogenous flow conditions extending from steep river flows to tidal influenced estuaries.

MIKE 11 provides a choice of three different flow descriptions:

- **Kinematic Wave**

  The flow is calculated from the assumption of a balance between friction and gravity forces. This simplification means that the kinematic wave approach cannot simulate backwater effects.

- **Diffusive Wave**

  In this approach the hydrostatic gradient is added to friction and gravity forces. This allows the user to take downstream boundaries and backwater influences into account.

- **Dynamic Wave**

  This uses the full momentum equation, including acceleration forces, in conjunction with the continuity equation. It allows the simulation of fast transients and tidal flows, as well as backwater effects. The dynamic wave formulation was adopted for this study.

MIKE 11 solves the vertical integrated equations conserving volume and momentum as derived by Saint Venant. It adopts a computational grid based on the centred six point Abbot scheme (Danish Hydraulic Institute, 1995). The dynamic wave solution method was used in this study.

5.1.2 MIKE 11 Model Layout

The MIKE 11 model established for the Baseline Flood Study covered over 54 kilometres of the Yarramalong and Dooralong Valleys upstream of Woodburys Bridge (Bridge 1) on Yarramalong Road. The model was extended to include approximately 900 metres of river downstream of Woodburys Bridge (to Chainage 32.574) to ensure hydraulic conditions at the bridge as modelled were unaffected by model boundary conditions.

A series of river branches were used to model all major creeks, significant tributaries and flow paths. Each river consisted of a series of cross-sections approximately 100 to 200 metres apart. Additional cross-sections were also added immediately upstream and downstream of bridges and weirs.

Since the Baseline Flood Study was carried out in 2000, a number of developments to the MIKE 11 software have been made. The previous model information, including much of the cross-sectional data, bridge and weir information was reviewed and various amendments made which more accurately represented site conditions and made better use of MIKE 11's new features.

The model layout was also modified to include anabranches and to more accurately represent flow distances between sections for larger floods. Breakouts over the floodplain, side channels and similar topographical features have been represented in the current model. This required amendment of previous cross-sectional layouts and linkages in the model. New cross-sections were generated from the more recent and accurate DTM. Current model chainages are therefore not directly comparable to those developed for the previous model, although most are at similar locations.

The model layout is shown in *Figure 5.1*. It consists of 332 cross sections within ten branches. These branches included:

- Wyong River in the Yarramalong Valley (*YAR*), chainage 4.138 to 32.574 kilometres;

- Jilliby Jilliby Creek in the Dooralong Valley (*DOR*), chainage 0 to 17.82 kilometres;

- Little Jilliby Jilliby Creek and a small tributary (*DRE & DRH*), chainage 0 to 4.50 kilometres; and

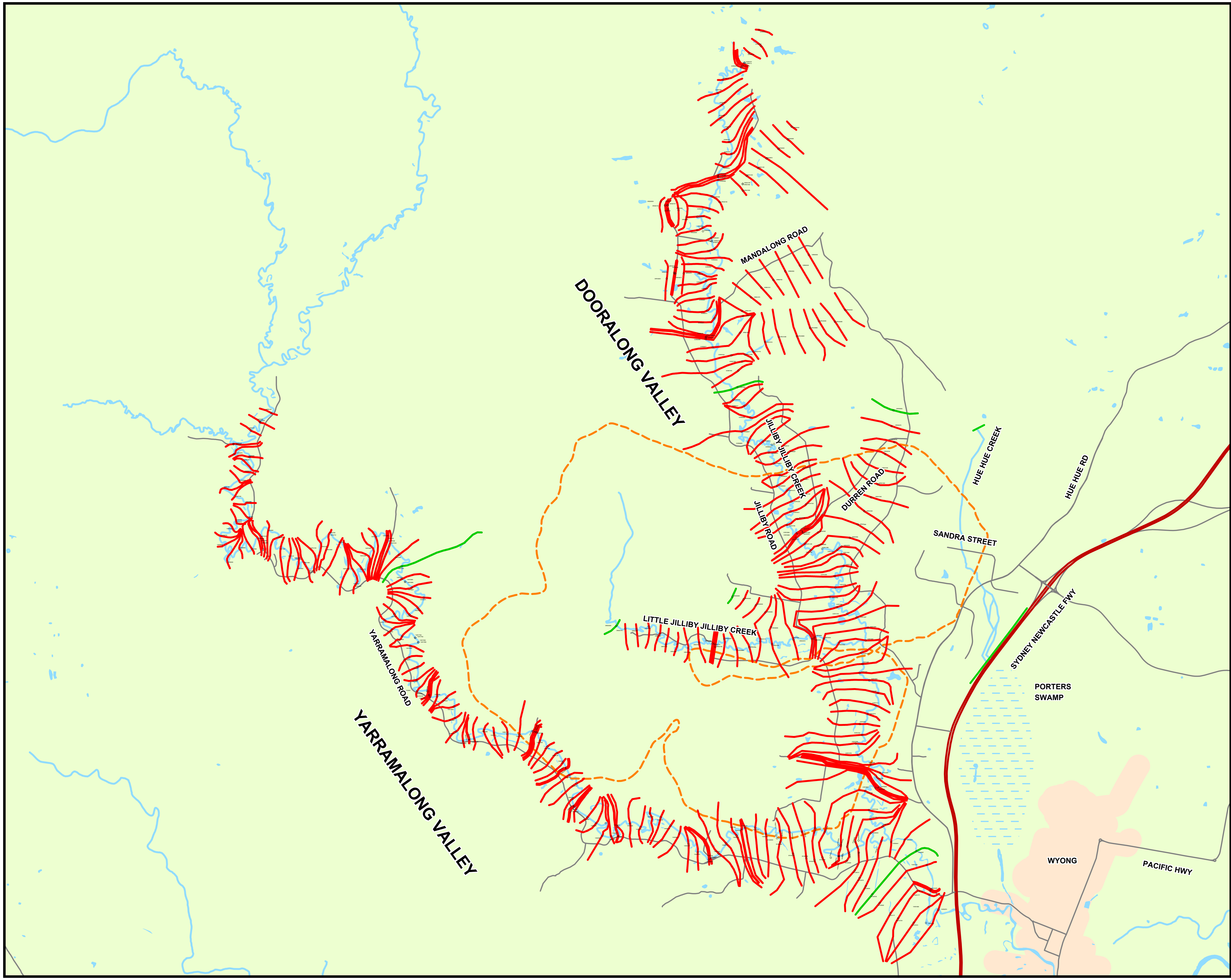
- other tributaries flowing into Jilliby Jilliby Creek (*DRA, DRB, DRC, DRD, DRF & DRG*).

An additional four branches (BYA, BYB, BYC & BDA) with 31 cross sections were used to model anabranches adjacent to both the Wyong River and Jilliby Jilliby Creek. More detailed plans showing the location of cross sections and the river station are included in *Annex E.*

Structures

There are twenty-one bridges crossing the Wyong River and a further eight bridges and three culverts crossing Jilliby Jilliby Creek and some of its tributaries. These typically span the river channel without significant abutments and approaches that would seriously impede flow. Some bridges have intermediate supports. The deck levels of most of these bridges are below the existing 1% AEP flood level and would therefore impede flood flows and cause increases to flood levels upstream (afflux). Because most bridges are relatively small in relation to flood flow cross sections their effects are small and are generally localised. Each bridge was been surveyed, and the survey plans are included in *Annex A*.

Bridges and culverts have been modelled by using the appropriate hydraulic structure module in MIKE 11. Surveyed bridge data was used to input appropriate deck levels, widths, and waterway opening data and to represent any weir effects of raised approach roads. Roughness values were estimated from site inspections and survey information for the bridges.



Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Section

Figure 5.1

MIKE11 Model Layout

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS04		
Date:	23.05.08	Drawing Size:	A3
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Source:	-		
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5.1.3 *Hydraulic Model Parameters*

Roughness Values

Bed resistance can be calculated in the MIKE 11 model using either the Chezy or Manning's formulation of the resistance equation. The Manning's formulation was adopted for this study.

In MIKE 11 a global roughness values is entered and this value can be varied at specific locations or between river chainages. Roughness values can also be varied between each point on a cross section by adjusting the relative roughness values in the cross section data.

In many areas of the river system the riparian zone is more densely vegetated than the floodplains. This has been accounted for by increasing the relative roughness values in these areas for each cross-section as relevant.

Aerial photographs were used to assign initial roughness values to each cross section. Roughness values were estimated by comparing the vegetation and topography of the creek and floodplain with published data (Chow, 1986). These values were then adjusted in the calibration process to achieve a close match between observed and modelled flood levels.

The adopted Manning-Strickler roughness values range from 12 to 5. These are at the higher end of the range of values generally adopted in similar flood studies. The Upper Wyong River Study (PWD 1988) used values generally in the range of 20 to 10. The Warnervale East 7B (Willing and Partners 1990) study used values generally between 12.5 and 8.

The riparian zone of the catchment is very heavily vegetated with large trees and dense undergrowth. Tributaries, side channels and billabongs within the floodplain are similarly densely vegetated. The majority of the floodplain has been cleared for agricultural land use and so lower roughness values have been used for the floodplain.

The floodplain roughness values are higher than would be adopted on the basis of a preliminary assessment of aerial photographs. Detailed assessment of the aerial photographs revealed that large stands of trees are orientated perpendicular to the direction of flood flows at numerous locations in both the Dooralong and Yarramalong Valley. These raise the average roughness values of the floodplain as they pose a significant impediment to the passage of floodwaters.

Downstream of the confluence the flood behaviour becomes more complex and hydraulic losses increase. The width of the river valley narrows as flows are channelled between hills on the right and left banks, the riparian zone becomes wider and the northern bank more densely vegetated. In addition some of the floodwater flows in the right overbank break across Yarramalong Road and towards Deep Creek. These factors would all be expected to increase losses in this section of the model.

In the current model losses downstream of the confluence have been accounted for by adopting a more complex hydraulic model structure than was used in the Baseline Flood Study (ERM, 2000). This reduces the need to adjust roughness values to calibrate the model. This was not previously considered necessary as flood behaviour in this area has been well described in the PWD 1988 study and the proposed mining operation will be located several kilometres upstream.

Simulation Parameters

The numerical stability of a finite difference model is affected by a number of parameters. Key parameters include the simulation time step, solution scheme adopted and the initial conditions.

The simulation time step is affected by the flood wave celerity (speed) and the distance between cross sections. Cross sections in the model are generally spaced at 200m intervals but closer cross section spacing has been adopted in a number of locations to adequately describe transitions at structures and changes in channel geometry. In addition the longitudinal slope of the river and its tributaries is relatively steep. A time step of less than 0.15 minutes was found to achieve a stable solution.

Model stability was further improved by forward centring the numerical computational scheme. This has the effect of damping out small short term oscillations in the computations (Cunge, Holly & Verway, 1980).

In order to obtain satisfactory results it was necessary to use a "hotstart" file. The upper sections of the river network are relatively steep and the initial flow is generally very small. Problems were encountered with sections of the model 'drying out'.

A hotstart file was created by introducing a small constant flow at each inflow node in the model. The model was then run for a simulation period longer than the duration of the inflows. When the results indicated that flows and water depths in the model had stabilised and would not affect the design simulations, the results were saved. The result file was then used as a hotstart file to provide initial conditions for the design simulations.

Downstream Boundary Conditions

MIKE 11 requires the user to specify the boundary conditions at the downstream end of the model. The downstream end of the model is located 900 metres downstream of Woodburys Bridge. Rating curves have been developed for the various flood events based on the PWD study.

While the hydraulic model extends downstream of Woodburys Bridge the focus of this study is the river system upstream of the confluence of Jilliby Jilliby Creek and the Wyong River, particularly in the vicinity of predicted subsidence approximately 0.9 to 6.5km upstream. Irregularities in downstream boundary conditions were noted to have dissipated within 400 metres of Woodburys Bridge, well downstream of the confluence and well outside of areas impacted by subsidence.

Inflow Hydrographs

Inflow hydrographs generated by XP-RAFTS during the Baseline Flood Study were imported into the current MIKE 11 hydraulic model, simulating the hydrology associated with each historical (for calibration purposes) and design storm event. Total hydrographs, consisting of flow derived from upstream areas, were imported at the start of each river or creek system. Local runoff hydrographs were imported at internal cross sections within the river network. Inflow hydrographs from the XP-RAFTS model were imported at the 26 locations listed in *Table 5.1*.

Table 5.1 Hydrographs Imported Into MIKE 11

XP-RAFTS Node	River	Chainage (km)	Hydrograph Type
1-31DT	YAR	4.138	Total
1_40L	YAR	5.000	Local
1_42L	YAR	8.560	Local
1_44L	YAR	11.305	Local
1_50L	YAR	15.775	Local
1_52L	YAR	19.038	Local
1_54L	YAR	22.308	Local
1_60L	YAR	22.757	Local
1_62L	YAR	26.940	Local
1_70L	YAR	28.608	Local
1_80L	YAR	31.255	Local
2_12T	DOR	0.000	Total
2_20L	DOR	3.576	Local
2_30L	DOR	4.660	Local
2_34L	DOR	7.690	Local
2_36L	DOR	10.512	Local
2_40L	DOR	12.765	Local
2_50lL	DOR	16.106	Local
11_04T	DOR_A	0.000	Total
12_04T	DOR_B	0.000	Total
13_04T	DOR_C	0.000	Total
14_04T	DOR_D	0.000	Total
5_20T	DOR_E	0.000	Total
18_10T	DOR_F	0.000	Total
17_10T	DOR_G	0.000	Total
15_02T	DOR_H	0.000	Total

1. YAR abbreviates the Yarramalong Valley network
2. DOR abbreviates the Dooralong Valley network

5.1.4 *Model Calibration*

Calibration uses historical floods where stream gauging and reported flood levels have been recorded. Model results are compared with recorded data and model parameters adjusted until a satisfactory correlation is achieved.

Stream gauging data was obtained for Wyong River and Jilliby Jilliby Creek for the Baseline Flood Study undertaken in 2000. Historic rainfall pluviograph data and daily rainfall records for the Valleys and surrounding areas were obtained for the calibration floods. The spatial variability of rainfall across the catchment was based on an isohyetal map of rainfall depth developed for each storm. No additional significant events have been recorded since this study and the same data has been used for calibration of the current hydraulic model.

Reported flood marks were obtained from Council and through consultation with local communities. Residents who reported flood marks were interviewed and a surveyor was engaged to determine precise levels of the identified flood marks for the original Baseline Flood Study.

Historic storm rainfall depths and temporal patterns were entered into the XP-RAFTS model. Hydrologic and hydraulic parameters were adjusted interactively to achieve a reasonable calibration fit to observed flood levels and stream gauging results. These calibration factors modified the runoff characteristics from the catchments as well as the progress of floodwaters through the floodplains. The calibration compared favourably with the earlier study of the Upper Wyong River (PWD, 1988).

Recorded floods chosen to calibrate the hydraulic model were the 1964, 1974, 1985, 1989, 1990 and 1992 floods. The MIKE 11 model was initially calibrated against the recorded hydrographs at the stream gauging stations. Unfortunately insufficient recorded flood levels were available for the 1964 to enable calibration. Rainfall and streamflow records for the 1964 flood were also poor.

The 1989, 1990 and 1992 floods were the only recorded floods where flood marks were recorded at enough locations in the valleys to allow the hydraulic model parameters to be refined. It was found that the initial roughness values adopted under-predicted flood levels at most locations for all three floods. Global roughness values were increased until a suitable match between the observed and modelled peak flood levels was achieved.

Field inspections were carried out in 2000 to examine the reasonableness of the calibrated roughness values. It was found that while in many areas land had been cleared for agricultural purposes large stands of vegetation remained. Most of the heavily vegetated areas were aligned perpendicular to the direction of flood flows in the floodplain. The planting of trees along road and property boundaries also creates a significant barrier to flood flows in these areas. As a result the calibrated roughness values were considered appropriate and adopted.

High resolution aerial photographs were used to refine roughness values for the current model. It was found that some changes had occurred to the extent of riparian vegetation since the 2000 study but that previously estimated global roughness values were still appropriate. These changes were incorporated into the current model by adjusting localised roughness multipliers at relevant sections. It was not appropriate and unnecessary to recalibrate the current model for these minor physical changes and comparisons of flows and levels for all design storms for "existing" conditions indicated that differences were negligible.

A comparison between peak flow discharges modelled in 2000 and recorded values at the three gauging stations is given in *Table 5.2*.

Table 5.2 Comparison of Peak Flows for Observed and Modelled Historical Floods

Flood Event	Gauging Station	Observed Flow (m^3/s)	Modelled Flow (m^3/s)	% Difference
June 1964		Not Recorded	921	na
June 1974	Gracemere	190	152	- 20
	Jilliby	61	60	- 2
October 1985	Yarramalong	223	243	9
	Gracemere	198	192	- 3
	Jilliby	58	44	- 32
June 1989	Yarramalong	299	326	9
	Jilliby	67	83	24
February 1990	Yarramalong	301	285	- 5
	Gracemere	312	284	- 9
February 1992	Yarramalong	183	229	25
	Jilliby	73	121	66

Note: Hydrologic modelling assumed an initial wetness value of one hundred percent (i.e. saturated)

Overall, calibration is considered acceptable given the purpose of this study is to assess the impacts of subsidence on flood levels and flows rather than absolute values.

5.1.5 *Simulation of Design Floods*

The calibrated MIKE 11 model was used to simulate flood behaviour for the 1%, 2%, 5%, 10% and 20% AEP design storms. Storm durations of 18 hours to 72 hours were modelled. The results indicated that the 24, 36 and 48 hour storms produced the highest flood levels and discharges at most locations in the Valleys. The six hour PMF storm was also modelled.

The six hour duration PMF has been used to provide an indication of flood behaviour in an extreme event. Longer duration PMP rainfalls would be expected to produce higher discharges and flood levels in a catchment of this size. However, the generalised short duration method has an upper limit of six hours for the east coast of Australia. Peak flood levels in the six hour PMF event are estimated to be approximately four metres higher than the 1% AEP event within most of the study area.

Flood heights are important when assessing property damage, especially crop and pasture damage, effects on agricultural capability and household buildings and contents damage. Flow velocities are relevant for assessing potential structural damage and erosion, whilst a combination of depths and velocities will be relevant to evacuation safety and access.

5.1.6 *Comparison with Previous Models*

An improvement applied to the current (2007) MIKE 11 hydraulic model was the modelling of anabranches, which produced results indicating level differences of up to 0.3m across valley wide sections. This is indicative of the need for water levels in the main channels to overtop the natural levees that are commonly formed along river banks, before flows commence in the anabranches. Previous models assumed the entire cross section conveyed flows at all stages, thus potentially underestimating flood levels slightly. Chainages were also changed in the current model to better represent average flow distances between sections during larger floods.

Comparison between the 2000 model runs and 2007 model runs for existing conditions during the 100 year 36 hour design flood indicated a maximum difference in calculated flood levels of 1.05m (reduction) at DOOR 17.82 near the confluence with the Wyong River. This is due to the more accurate modelling of the Woodbury Bridge and its approaches and is dissipated within 400m upstream. Almost all other differences are less than +/- 0.5m and the average difference is +/- 0.16m. These deviations from the 2000 model results were relatively uniform for return periods of 5, 10, 20 and 50 years with the average difference increasing uniformly to +/- 0.3m for the 5 year 36 hour flood. These results are well within the range of accuracy of the models and generally represent changes as a result of improvements to data inputs and to improved MIKE 11 software which allows better modelling of bridges.

It was also found that design flood extent lines did not vary significantly between the 2000 study and the current model. While six additional houses appear to have been constructed within the floodplain since the 2000 study, there were no additional houses found to be within the floodplain as a result of differences between the models for "existing" conditions.

5.2 *HUE HUE VALLEY*

5.2.1 *Methodology*

The Hue Hue hydraulic model boundary was determined following examination of the DTM, the proposed mine plan and the downstream flood behaviour described in the studies undertaken by Willing and Partners, 1990, and the Public Works Department, 1988. The upstream boundary of the hydraulic model was set 1km upstream of Cottesloe Road and the downstream boundary was set 500 metres downstream of the Sydney-Newcastle Freeway. Predicted extents of subsidence based on current mine plans indicate that only the area between Cottesloe Road and Hue Hue Road will be subject to subsidence. Preliminary model runs indicated that impacts on flood levels did not extend below Hue Hue Road or more than 200 metres upstream of Cottesloe Road.

HEC-RAS, a steady state hydraulic model, was selected as the most appropriate hydraulic modelling software. The major reasons for this choice include:

- The section of Hue Hue Creek in the study area is short and occupies the lower 25% of the catchment so that peak flow would not vary significantly over its length. In addition, selection of the maximum flow over the full length is a conservative approach;

- The creek has no major tributaries and therefore there are no substantial influences on the timing of flood peaks;

- Flood flow is one dimensional and largely controlled by the culverts and roads;

- Floodplain storage in this catchment is adequately accounted for in the hydrologic model;

- For the proposed mine plan, subsidence will be limited in this area and the flow conditions will not change due to subsidence regardless of impacts on water levels; and

- It is not practical to use a more complex dynamic model without sufficient calibration data.

Peak flows from the XP-RAFTS model were entered into the HEC-RAS model. The flood levels, velocities and inundation extents were then calculated for the critical duration storm event for each recurrence interval.

HEC-RAS is a hydraulic model developed by the United States Army Corps of Engineers. It has been developed from the HEC 2 model that has been widely used for flood modelling over the past 25 years both in Australia and the United States.

HEC-RAS calculates water surface profiles assuming steady state or gradually varied flow. It is able to simulate flows in branched river systems. The steady flow component can model subcritical, supercritical, and mixed flow regimes.

The computational procedure is based on the solution of Bernoulli's one dimensional energy equation. Friction losses are calculated using Manning's equation and contraction and expansion losses by changes in the velocity head. The momentum equations are used were the flow regime is rapidly varied such as at junctions, bridges or hydraulic jumps.

The effects of obstructions such as bridges, culverts, and weirs can be modelled. The model has been used extensively for flood studies, floodplain management studies, and to evaluate changes in water surface levels due to the changes in the geometry of floodplains.

HEC-RAS requires the following information as input:

- Geometry of channels including both the stream bed and floodplains;
- Details of bridges, culverts and any other obstructing structures;
- Floodplain and channel roughness; and
- Boundary conditions.

5.2.2 *HEC-RAS Model Layout*

The HEC-RAS model layout is shown in *Figure 5.2*. WACJV has created a digital terrain model of the catchment from low level photogrammetry. Cross sections were extracted from this DTM.

Cross sections were located at intervals of approximately 200 metres as well as at changes in the creek and floodplain geometry, and immediately upstream and downstream of structures. *Annex F* contains details of the cross sections from the HEC-RAS model to give an indication of the creek and floodplain geometry within the catchment.

To model the impacts of subsidence, cross section data was adjusted to account for predicted topographical changes. The subsided cross sections were developed in the same locations as the cross sections for existing conditions. Details of subsided cross sections from the HEC-RAS model are also provided in *Annex F*.

Structures

There is one bridge and five culvert crossings along Hue Hue Creek upstream of the Porters Creek Swamp. These structures have a significant effect on the flood levels in the area immediately upstream of each structure.

Detailed field surveys were prepared for each of the six crossings of Hue-Hue Creek, copies are included in *Annex A*. All six structures have been included in the HEC-RAS model.

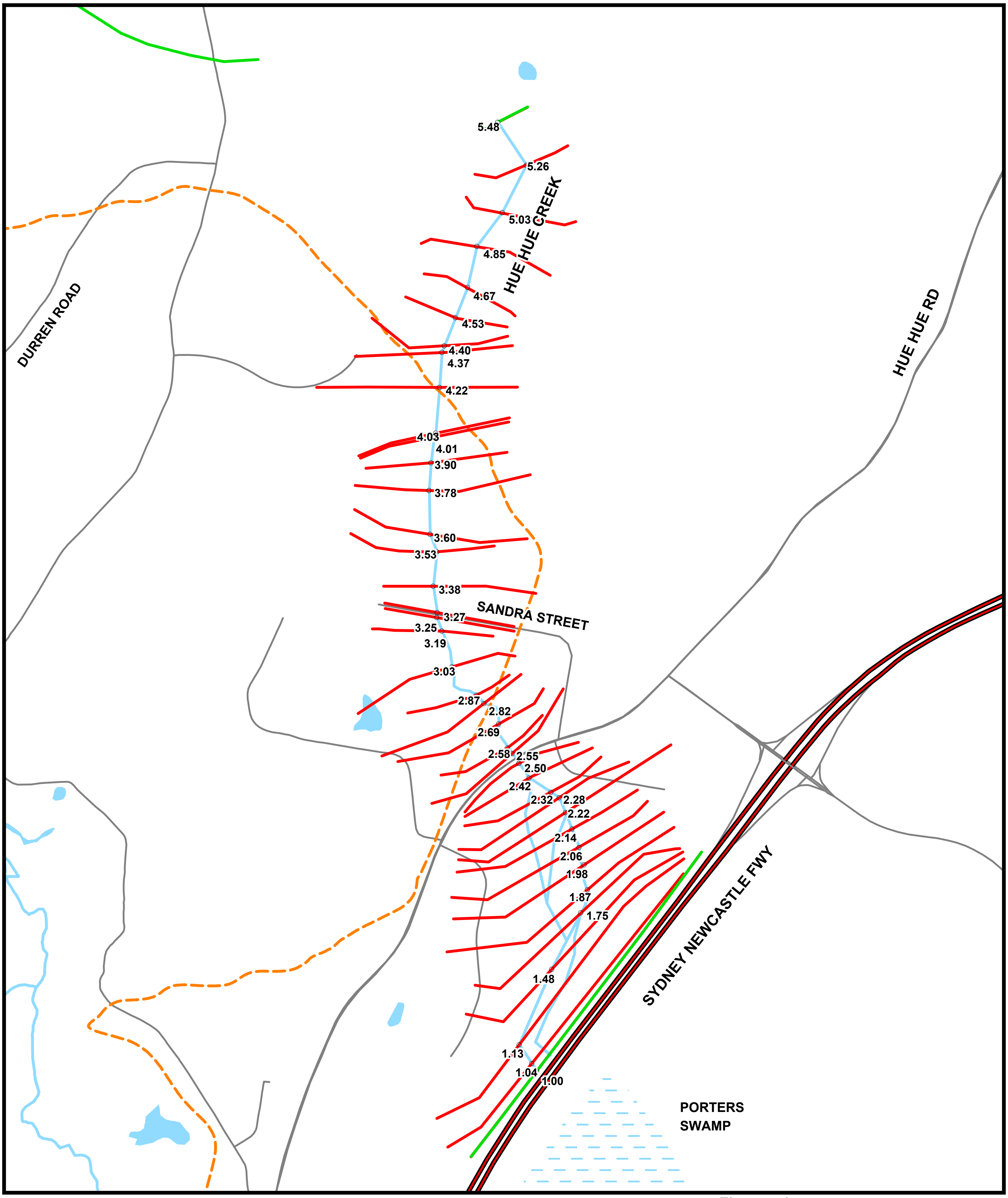

Figure 5.2

HEC RAS Model Layout

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- HEC RAS Cross Section

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project Flood Impact Assessment		
Drawing No:	0044971_GIS05		
Date:	23.05.08	Drawing Size:	A4
Drawn By:	JS	Reviewed By:	SO
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5.2.3 Model Parameters

Roughness Values

Manning's 'n' roughness coefficients were assigned to the left overbank, right overbank and main channel for each cross section. In the absence of calibration data, roughness values were estimated by field inspections and aerial photography during the baseline flood study.

The floodplain and channel roughness were compared to values tabulated in the HEC-RAS Hydraulic Reference Manual. The adopted roughness values are tabulated in *Annex G.*

Boundary Conditions

The HEC-RAS model when used for mixed flow simulations requires input for upstream and downstream boundary conditions. The upstream boundary condition was set at normal depth for all design storm simulations.

The downstream boundary was located at a cross section approximately 500m downstream of the Sydney-Newcastle Freeway. This is the area known as Porters Creek swamp. Inflow to Porters Creek swamp occurs not only for local run-off but also from flooding in the Wyong River (Willing and Partners, 1990). The area acts as flood storage with flood levels controlled by the Wyong River.

Flood levels for Porters Creek Swamp were obtained from the Warnervale East Flood Study (Willing and Partners, 1990) for the 1% AEP event. This was used to establish a fixed tailwater level as the downstream boundary condition for the HEC-RAS model.

Flow Inputs

The peak design flood flows for the creek were determined using the XP-RAFTS model and entered into the HEC-RAS model. *Table 5.3* shows the HEC-RAS river stations at which flows were entered and the corresponding XP- RAFTS node. Peak flows during the 1%AEP flood at each location are defined in *Table 5.3*.

Table 5.3 Flow Inputs to HEC-RAS Model

HEC-RAS River Station	XP-RAFTS Node	Peak Flowrates for Critical Storm Durations (m^3/s)					
		20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	PMF
5.48	**H1.000**	5.3	6.9	8.7	11.0	12.8	70.1
4.67	**H1.020**	9.8	12.9	16.6	21.1	24.8	134.6
4.22	**H1.040**	14.5	19.0	24.5	31.4	36.8	202.5
4.03	**H1.060**	18.0	23.6	30.9	40.6	47.9	260.4
3.27	**H1.080**	23.8	31.1	40.4	52.3	61.5	338.4
2.82	**H1.09J**	28.4	37.0	47.4	60.8	71.4	397.9
2.55	**H1.10**	31.8	41.2	52.4	66.9	78.4	439.6
2.28	**H1.11J**	34.6	44.7	56.6	71.9	84.3	471.5
1.13	**H1.13J**	44.1	56.7	71.2	89.4	104.3	586.5

5.2.4 *Sensitivity Analysis*

Due to the lack of historical flood data it was necessary to select parameters based on published data adopted or calculated for similar studies. Because no calibration data was available, it was important to examine the sensitivity of the design flood levels to key parameters. These parameters included:

- downstream boundary conditions;
- Manning's roughness coefficients; and
- design flows.

A sensitivity analysis was carried out by re-running the hydraulic model for the 1% AEP flood and varying these parameters.

It was found that changing the downstream boundary conditions from a fixed tailwater level to normal depth caused no significant change in flood levels upstream of the Sydney-Newcastle Freeway. This is due to the constriction of culverts under the freeway acting as a hydraulic control on water levels upstream over the full range of design flows.

When Manning's roughness coefficients were globally increased in the model by 25%, the maximum increase in flood levels was 0.12m. When global roughness values were reduced by 25%, the maximum reduction in flood levels was 0.12m. This is considered insignificant and does not alter the number of houses affected by flooding for both existing and post-subsidence conditions.

To examine the sensitivity of the results to changes in the peak flows the initial wetness parameter used in the XP-RAFTS model was varied from the median value of 80% saturated to 100% saturated. The consequent increased flow rates were input into the HEC-RAS model, resulting in a maximum increase in the 1% AEP flood levels of 0.18m. Because the critical duration for the Hue Hue Creek design storm is relatively short (9 hours, compared to 36 hours for Yarramalong/Dooralong) it would be overly conservative to use 100% as the design initial wetness parameter as this would involve joint probabilities of a "wetting" storm occurring immediately prior to a high intensity short duration design storm.

The sensitivity analysis indicated that the hydraulic model is robust and generally insensitive to changes in key parameters. This is due to the topography of the river valley and to the localised effects of road crossing structures acting as chokes or hydraulic controls.

Hue Hue Creek is shallow with a wide and relatively flat floodplain. Small increases in water levels create a large increase in the conveyance of cross sections. This causes the predicted flood to be relatively insensitive to changes in roughness values or flood flows.

6 FLOOD IMPACT ASSESSMENT

6.1 OVERVIEW OF POTENTIAL SUBSIDENCE IMPACTS

Subsidence can cause a change in floodplain storage or a change in hydraulic gradients within the floodplain. This will alter flooding behaviour to some extent with the significance depending on panel widths and orientation and their influence on subsided topography. Such effects can have adverse or beneficial impacts on flooding within the subsided area and in areas upstream and downstream, depending on the provisions made for flood management.

Control measures will be required to mitigate potential flood impacts. Specific issues to address include:

- risk and degree of property flooding;
- flood hazards; and
- access to properties.

Access to properties may be temporarily disrupted if floodwaters overtop bridges or culverts, or extend across roads. A flood hazard may be posed by floodwaters of certain velocities and depths flowing across roads and in the vicinity of properties.

Conversely, the proposed mine is likely to provide flood mitigation benefits in alleviating existing flooding experienced downstream at Wyong. However, this should not be considered a benefit unless all adverse effects on properties within the valleys are adequately addressed or mitigated.

The predicted subsidence values are shown in contour format in *Figure 6.1*. The proposed underground mine will lead to differential subsidence within the floodplains. The extent of subsidence represented as subsidence contours is shown in *Figure 6.1*. It can be seen that subsidence within the vast majority of the floodplain of the Yarramalong Valley is negligible (<150mm). Subsidence will extend over approximately a 5.2km length of the Dooralong Valley floodplain and a 1.3km length of the Hue Hue Valley floodplain.

Subsidence can cause increases in local velocities and potential scour where gradients are increased and ponding at the downstream end of depressed areas. Hydraulic capacity can also be reduced where higher unsubsided ground blocks flows from subsided areas upstream, thus increasing flood depths upstream and slightly reducing depths downstream.

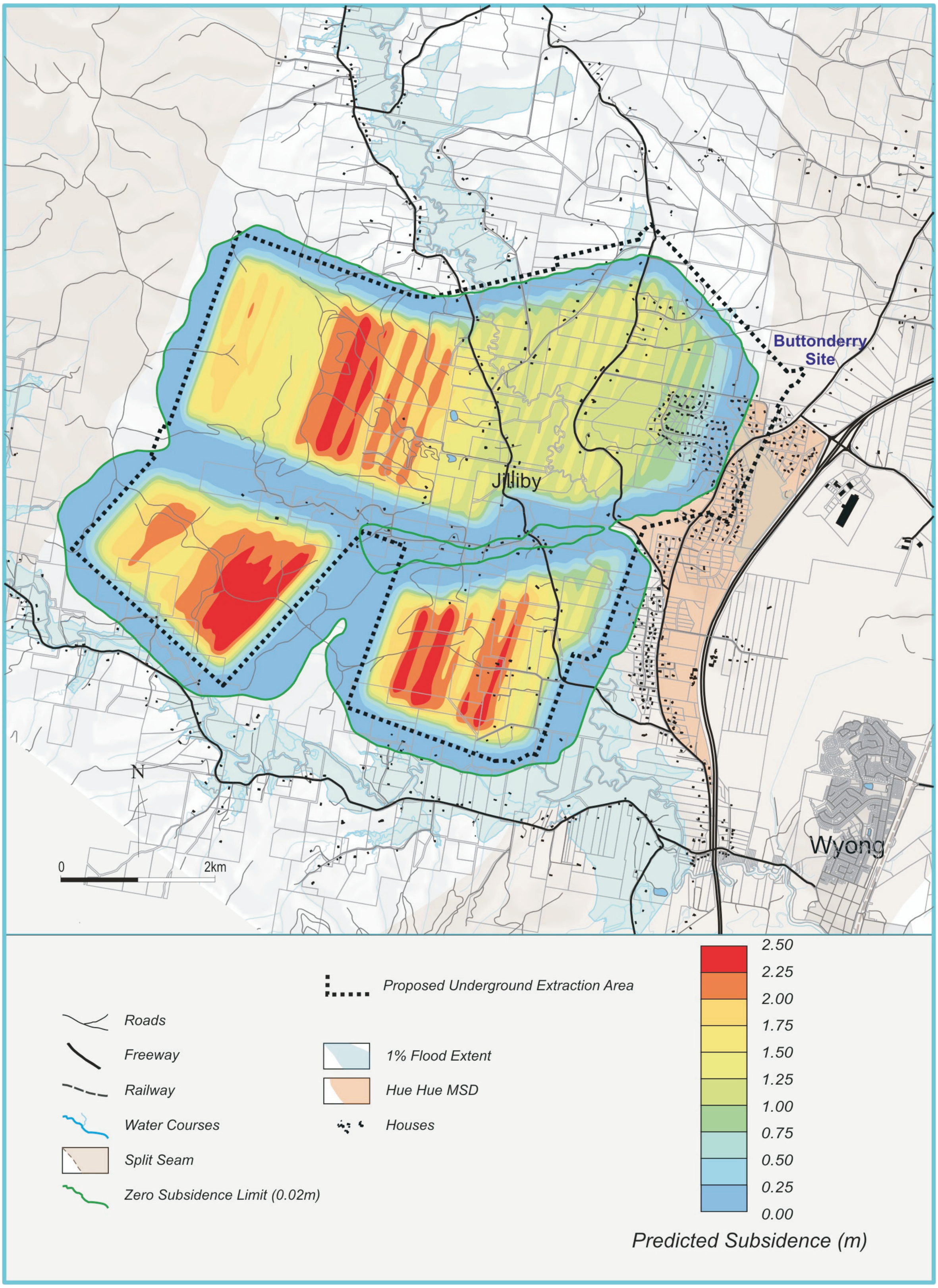

Figure 6.1

Predicted Subsidence

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_06_R0		
Date:	20/02/2009	Drawing size:	A4
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6.2 YARRAMALONG AND DOORALONG VALLEYS

Following completion of the MIKE 11 calibration and the remodelling of design storms for existing conditions, the model was amended and re-run to assess post mining flood levels and velocities within the study area. The area affected by subsidence includes the floodplains of the Wyong River, Jilliby Jilliby Creek, Little Jilliby Jilliby Creek, and one of the other tributaries of Jilliby Jilliby Creek.

Cross-sections in the hydraulic model were adjusted to account for subsidence, using predicted surface contours provided by WACJV. Geometry of bridges, culverts and approach roads within the subsidence area were also adjusted based on the subsidence contours.

The amended model was re-run for all floods. Calculated flood levels and velocities for the existing topography and the subsided topography are included in *Annex H*. Changes to flood behaviour are discussed below.

6.2.1 Flood Hazard Assessment

According to the NSW Floodplain Management Manual (2001), floodplain areas can be divided into specific categories that are used to determine appropriate land uses. Categories include:

- Hydraulic categories that represent the impact of development on flood behaviour – floodway, flood storage and flood fringe; and

- Hazard categories (low hazard and high hazard) that show the impact of flooding on structures and people.

Diagrammatic definitions of these categories are provided in *Figure 6.2* and *Figure 6.3*.

The floodplain was defined using these flood categories for all river reaches where flood behaviour may be potentially impacted by the mine plan. This area is shown in the flood maps included in *Annex I* and is described below. Note that the hydraulic model extended beyond this study area:

- Wyong River (YAR) from chainage 15.554km to 30.957km;

- Jilliby Jilliby Creek (DOR) from chainage 7.690km to 18.000km (confluence with Wyong River);

- Little Jilliby Jilliby Creek (DOR_E & DOR_H); and

- Other tributaries to Jilliby Jilliby Creek (DOR_A to DOR_G).

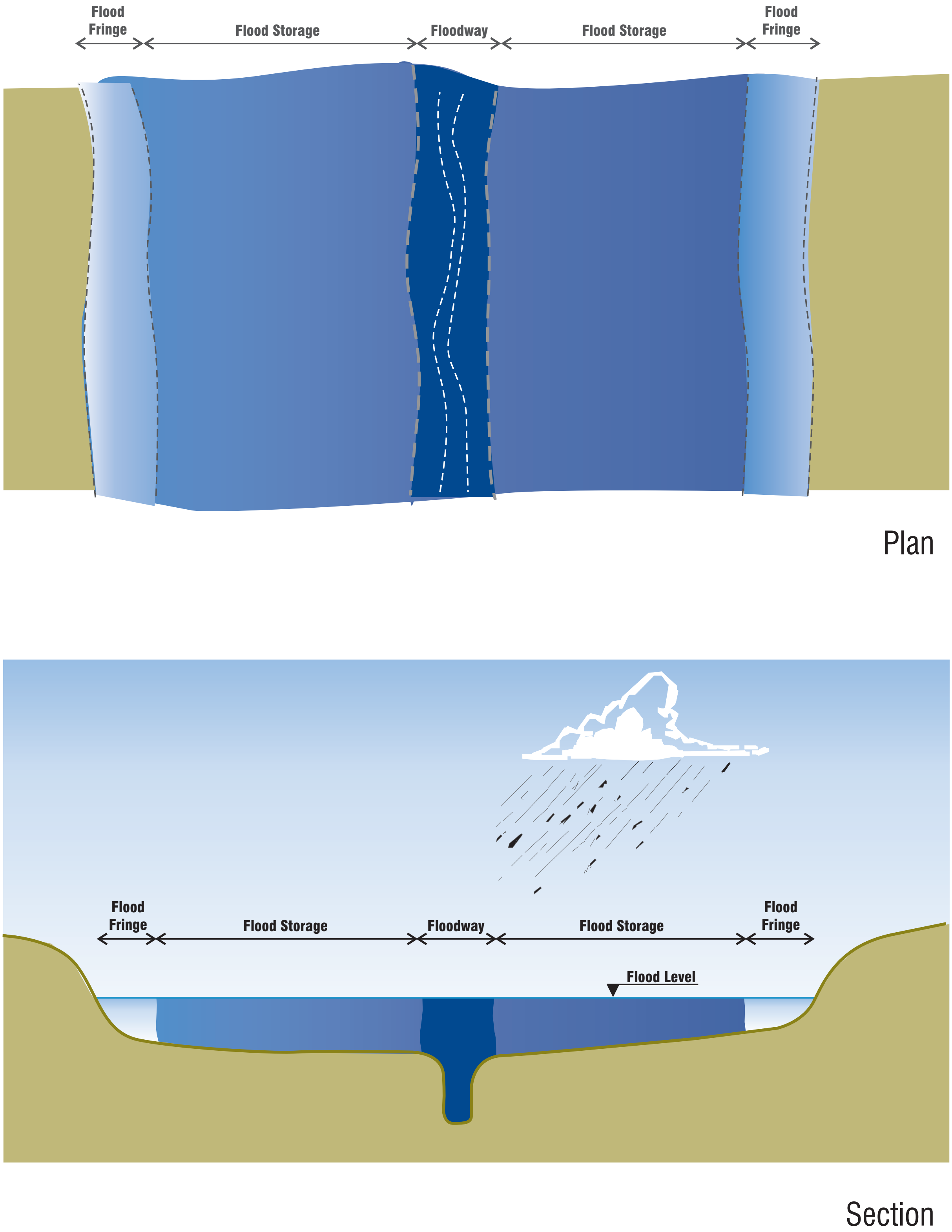

Figure 6.2

Hydraulic Categories

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Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_04		
Date:	12/03/2007	Drawing size:	A4
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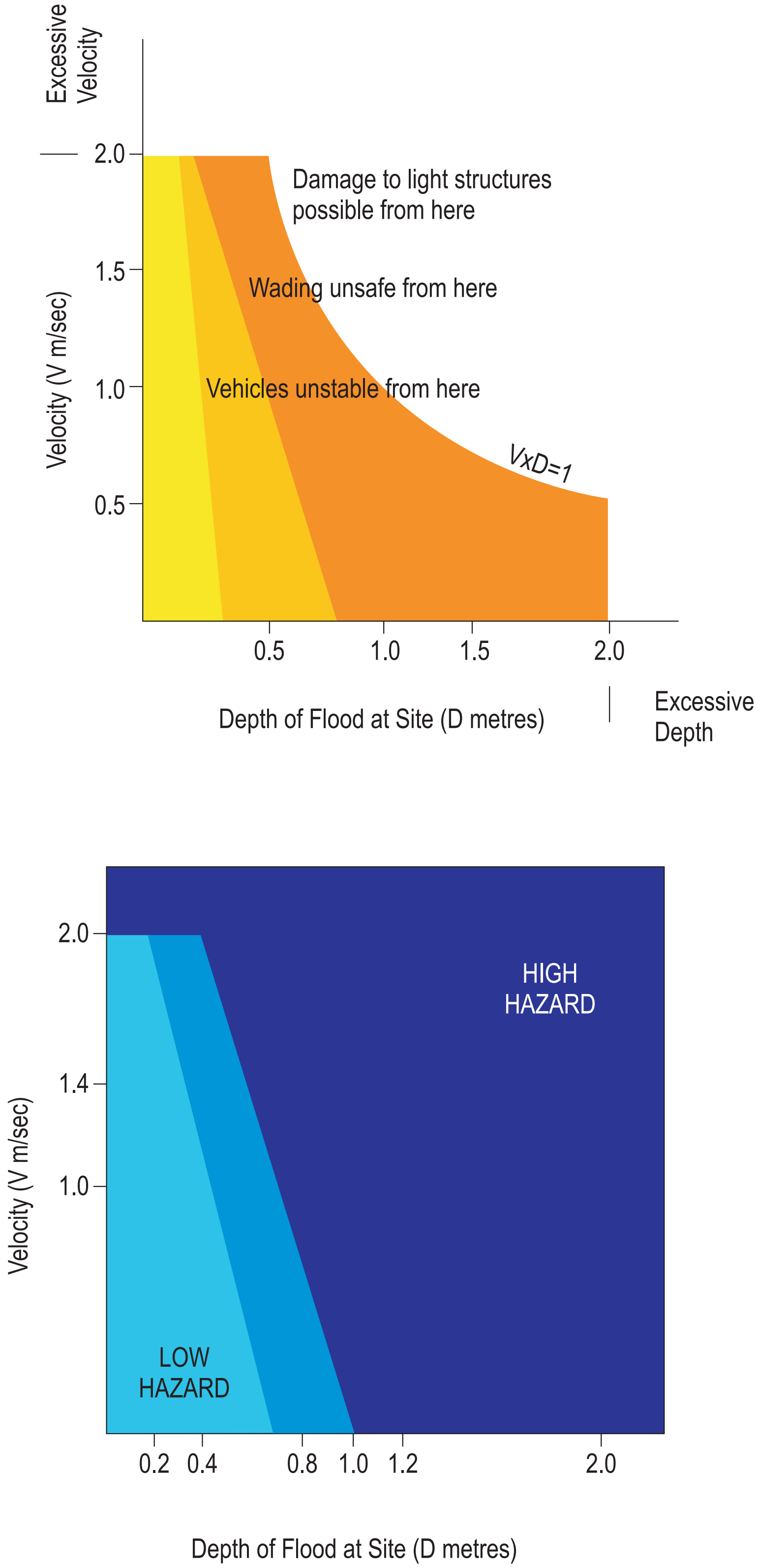

Figure 6.3

Hazard Categories

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_05		
Date:	12/02/2009	Drawing size:	A4
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Floodway Extents

The NSW Floodplain Management Manual (2001) defines floodways as the areas of the floodplain which convey a significant proportion of the flood flow and where partial blocking will adversely affect flood behaviour. Velocities are highest in this section of the floodplain.

Cross section data was transferred into a steady state hydraulic HEC-RAS model in order to determine floodway extents. Peak water levels were fixed at the flood levels calculated from the MIKE 11 model. The cross sections were progressively blocked until an afflux of 0.3 m was produced. This defined the limits of the floodway.

In the 2000 Baseline Flood Study the process was carried out for the 1% and 20% AEP floods for both baseline and post-mining topography. However, for the current study it was only necessary to determine the existing floodway extent lines.

The floodway extents at each modelled cross section were then plotted and the floodway limits interpolated based on the topography.

Flood Storage Extents

Flood storage areas are defined by the NSW Floodplain Management Manual (2001) as those areas outside of the floodway and extending to the flood fringe that, if filled, would cause peak flood levels anywhere on the floodplain to increase by more than 0.1 m and/or the peak discharge downstream to increase by more than 10%. Flood storages are generally characterised by relatively low velocities.

Previous modelling undertaken defined flood storage extents for all events using the MIKE 11 model. The cross sections were manually adjusted to restrict the width of the cross sections until the flood levels were increased by more than 0.1m or flood flows were increased by more than 10% downstream.

The flood storage extents at each cross section were plotted. Flood storage extents were mapped by interpolating between cross sections based on the local topography and flood behaviour.

Flood Fringe Extents

Flood fringe areas are defined as those areas outside of the flood storage and extending to the edge of the floodplain that, if filled, would cause peak flood levels anywhere on the floodplain to increase by less than 0.1m and the peak discharge downstream to increase by less than 10%. Flood fringes are generally characterised by zero or negligible velocities.

Flood Hazard Categories

Flood hazard relates to the threat to personal safety and structural damage caused by floods. The Floodplain Management Manual defines hazard categories as either:

- *High Hazard* – possible danger to personal safety, evacuation by trucks difficult, able bodied adults have difficulty wading to safety, potential for significant structural damage to buildings; or
- *Low Hazard* – trucks can evacuate people and their possessions, able-bodied adults would have little difficulty in wading to safety.

Flood hazard depends largely on the velocity and depth of floodwaters. These two parameters were used to define flood hazard areas throughout the study area.

Flood Depths

Flood extents were estimated for all events using flood levels derived from the MIKE 11 model. The flood depths for all inundated areas were then calculated using the terrain models derived for existing and post mining topography.

Flood Velocities

Overbank and mainstream channel velocities were necessary for the flood hazard assessment. As MIKE 11 produces an average velocity across the floodplain cross-section, velocity distribution was estimated based on conveyance values across the sections.

Velocities were defined across the floodplain for the river reaches within the study area by:

- defining and mapping the overbank areas;
- mapping backwater areas, where flow velocities approach zero;
- extracting and tabulating the average velocity from the MIKE 11 model for each of the four events; and
- proportioning the average MIKE 11 velocity based on mainstream, left overbank and right overbank conveyance.

Hazard Mapping

Hazard areas were defined using the hazard velocity/depth relationship from the NSW Floodplain Management Manual. Hazard areas were mapped and adjusted based on the velocity distribution.

6.2.2 *Flood Behaviour*

Flood levels and velocities for existing and subsided topography are presented in *Annex H*. This data was used to produce 1% and 20% AEP flood hazard maps for both scenarios as presented in *Annex I.* The maps show:

- the extent of the mine subsidence zone;
- property boundaries;
- flood extents;
- floodway, flood storage and flood fringe areas; and
- high hazard and low hazard areas.

Existing Flood Behaviour

The Yarramalong and Dooralong Valleys differ significantly in their flood behaviour.

Results for the Yarramalong Valley show that:

- the floodplain is relatively narrow (typically 300 to 600m wide in comparison to the Dooralong Valley which is 900 to 1400m wide);
- flood flows in the Yarramalong Valleys are twice as large as those in the Dooralong Valley;
- the floodway is approximately 100 to 200m wide and restricted to the zone immediately adjacent to the river
- the flood storage areas extend almost to the flood limits with the flood fringe making up less than 5% of the total floodplain area;
- flow velocities in the main channel range from 0.7 to 2.2 m/s and the overbank velocities range from 0.3 to 0.6 m/s; and
- the majority of the floodplain is classified as high hazard based on flood depths. Velocities are typically low except in the main river channel and downstream of bridges.

The Dooralong Valley results show that:

- the flood fringe in the valley areas is more extensive than in the Yarramalong Valley. Flood fringe areas are generally between 10% and 20% of the floodplain area;
- the floodway is typically 50 to 100m wide;
- the majority of the floodplain is classified as a low hazard storage;
- main channel velocities range from 0.5 to 2.0 m/s and the overbank velocities range from 0.02 to 0.6 m/s;
- high hazard zones are mainly restricted to low lying areas adjacent to Jilliby Jilliby Creek and large farm dams; and
- flood behaviour in the lower 2.5km of the Dooralong Valley is dominated by backwater from the Wyong River and is classified as high hazard based on flood depths.

Subsidence Impacts on Flooding

Mine subsidence will generally lower the topography of the Dooralong Valley and, to a lesser extent, the Yarramalong Valley and will subsequently cause a change in the flood behaviour within the valleys. This has the potential to impact on existing properties and future developments in the area. Maps for existing and subsided scenarios showing both the 1% and 20% AEP flood extents are presented in *Annex I* with an overview map provided in *Figure 6.4*.

Flood behaviour in the Yarramalong Valley will not significantly change as a result of subsidence. The model indicates flood levels generally reduce by 0.01 to 0.08m in the vicinity of subsidence areas. Flood depths reduce by a similar amount with the exception of a 1.2km section of the Wyong River between Chainage 21.580 and 22.757km where depths increase by up to 0.13m. With the exception of a small backwater between Chainage 21.308 and 21.552 and described below, lateral flood extents vary only by less than 5m after mining. Flow velocities will be unaffected.

Results for the Dooralong Valley show that:

- post-subsidence flood levels within the study area were generally between zero and 1.31m lower than levels for existing conditions (this is a function of water levels dropping with the subsided land surface);
- flood depths increased by up to 1.08m and inundation extents increased by up to 150m within the areas directly affected by subsidence;
- in some locations flood depths decreased by up to 1.1m;

- changes to flood behaviour in Jilliby Jilliby Creek extended between Chainage 9.100 and 17.820km i.e. over approximately 8.7km of the 9km upstream of its confluence with the Wyong River;
- post-subsidence flow velocities are similar to existing velocities.

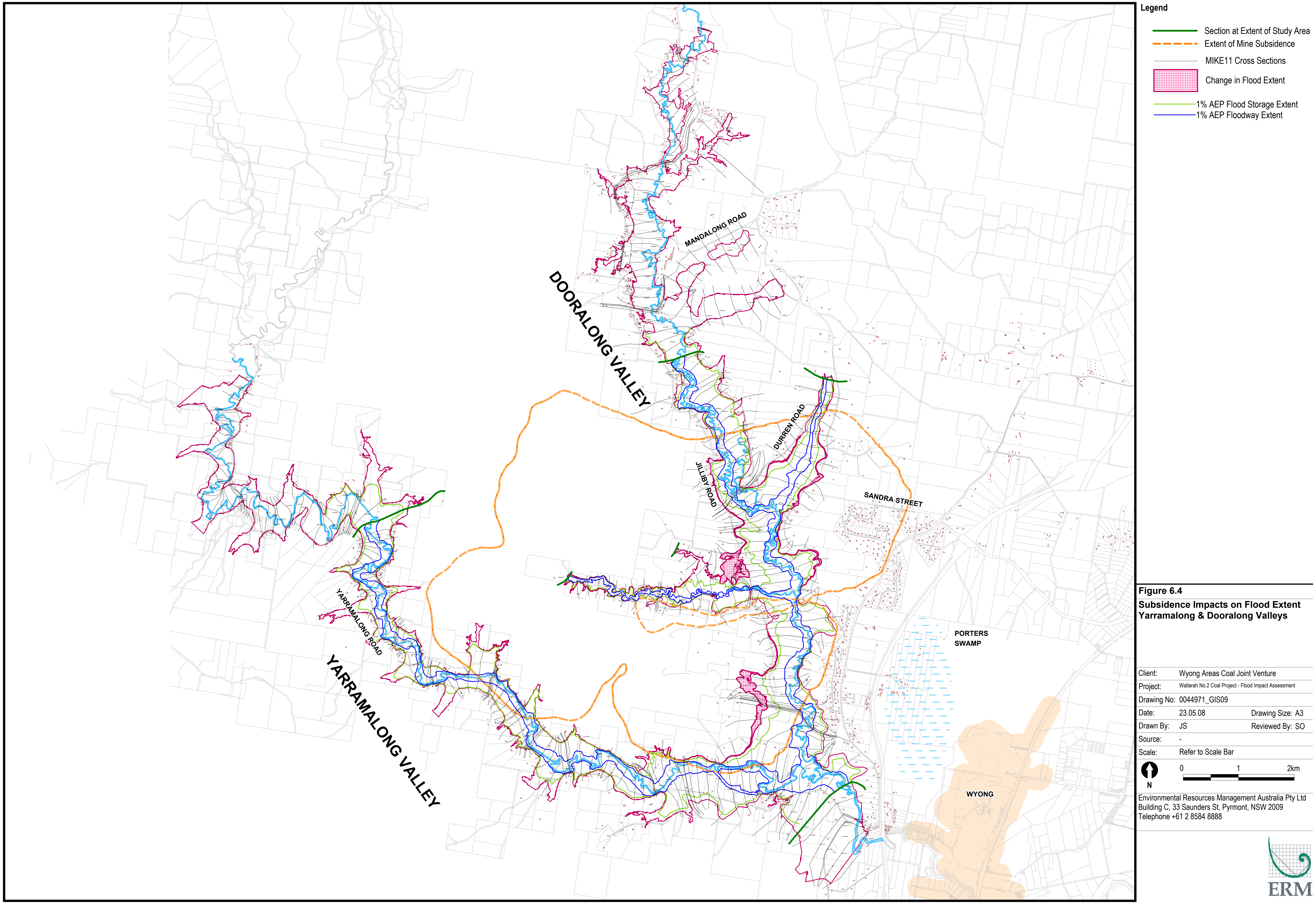

Figure 6.4

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys

Client: Wyong Areas Coal Joint Venture

Project: Wallarah No.2 Coal Project - Flood Impact Assessment

Drawing No: 0044971_GIS09

Date: 23.05.08 Drawing Size: A3

Drawn By: JS Reviewed By: SO

Source: -

Scale: Refer to Scale Bar

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In the 1% AEP flood, additional land within the Dooralong Valley becomes flood prone. The major changes are shown in the flood maps included in *Annex I* and are summarised as follows. Subsidence results in the following:

- an increase in flood prone land of 0.8ha on the right bank and a slight increase of 0.3ha in flood prone land on the left bank of Jilliby Jilliby Creek upstream of the Durren Road culverts (Bridge C);
- a net increase in flood prone land of 23.3ha on the right bank and 6.5ha on the left bank of Jilliby Jilliby Creek between the junction with Little Jilliby Jilliby Creek and Durren Road;
- a net increase in flood prone land of 14.6ha on the right bank and a net decrease of 0.6ha on the left bank of Jilliby Jilliby Creek between the Wyong River and Little Jilliby Jilliby Creek; and
- flood behaviour in the downstream reaches of Little Jilliby Jilliby Creek is effectively governed by flood levels in Jilliby Jilliby Creek. Following subsidence, flood behaviour in Little Jilliby Jilliby Creek is altered due to flooding of additional low lying areas.

Downstream of the confluence of Jilliby Jilliby Creek and the Wyong River flood levels reduce by up to 0.06m with a consequent small reduction in inundation extent and area. This is a result of detention effects within the subsidence area within the Jilliby Jilliby Creek floodplain, which slightly reduces peak flows.

Flood Hazard and Hydraulic Categories

Hydraulic categories in the 1% and 20% AEP floods will be altered in several areas within the subsidence zone. In areas which are negatively impacted, development controls may be required to ensure appropriate land uses in the future.

Current studies indicated that the major negative impacts in the Dooralong Valley were:

- 28ha previously classified as flood fringe would become flood storage and
- 12ha previously classified as flood storage would become floodway.

The major positive impacts in the Dooralong Valley were:

- 7ha previously classified as flood storage would become flood fringe and
- 4ha previously classified as floodway would become flood storage.

There was a slight decrease in impacts for the current mine plan (compared to the 2003 mine plan) due to the reduction in subsidence area within the Jilliby Jilliby Creek floodplain.

There were no significant changes in flood hazard and hydraulic categories in the Yarramalong Valley for the current mine plan. This is mainly the result of curtailment of mining outside of the Wyong River floodplain. With the exception of a small backwater on the left bank of the Wyong River in the vicinity of Chainage 21.308 to 21.552km, there will be no discernable overall flood impacts. Within this backwater the 1%AEP flood fringe will extend by up to 15m to cover an additional 0.8ha. This is due to direct subsidence impacts rather than changes to the 1% AEP flood levels.

A number of flood prone properties within the Dooralong Valley will be subjected to both positive and negative changes in flood hazard and flood hydraulic categories following mining. Areas of the floodplain which are negatively impacted may require development controls which are appropriate to the new flood category. Development controls are discussed in *Section 7.1.2*.

6.2.3 *Property Hazard Assessment*

Post-subsidence flood impacts to properties and dwellings were determined via a hazard assessment which aimed to:

- determine what changes, if any, would be required to existing dwellings so that existing flooding conditions are not exacerbated; and
- examine the development controls required for properties which have been negatively impacted due to a change in flood hazard or flood category.

Within the study area, there are 283 properties which have land located within the existing and post-mining floodplains of the Wyong River and Jilliby Jilliby Creek. Of these properties, there are 79 dwellings located within the floodplains, the majority of which are located in low hazard flood storage or low hazard flood fringe zones.

Flood behaviour near flood prone dwellings was determined for pre and post mining scenarios to determine which dwellings will be negatively impacted. The assessment included only those dwellings within the study area that are in the zone of changed flood behaviour. This includes all flood prone dwellings downstream of chainages DOR 7.690km and YAR 15.554km and upstream of chainage YAR 30.957km.

Dwellings impacted by subsidence related changes to the 1% and 20% AEP floods are identified in *Table 6.1*. The extent of impacts for these floods is given in *Table 6.2*. It is known that at least five of the “dwellings” throughout the flood study areas are more accurately described as “sheds” and cannot be considered as primary dwellings.

In the study area, of the 79 flood affected dwellings, 34 dwellings (two of which are sheds) will be adversely affected, 38 dwellings (two of which are sheds) will be beneficially impacted to a slight marginal degree or better (i.e. reduced flooding) and seven will be unchanged.

Of the 34 dwellings adversely affected, 19 dwellings will be subjected to increased flood inundation (flood level greater than floor level) in the 1% AEP flood after subsidence. The majority of these dwellings are already subject to flooding in the 1% AEP flood but five of these will be dwellings that were not previously inundated. The remaining 15 will have reduced freeboard (height of floor above flood level) but will not be inundated and only three of these will have freeboard of less than 0.3m.

For the 38 dwellings that are potentially beneficially affected, 28 will have some degree of very minor to negligibly decreased inundation and ten will have increased freeboard. Six dwellings were not previously identified as inundated and appear not to have been included in the 2000 and 2003 studies as they may have been constructed since these studies. There were also four dwellings with freeboard less than 0.3m prior to subsidence and four with insufficient freeboard after subsidence although only two dwellings were common to both sets.

In the Yarramalong Valley seven houses and one shed are adversely affected as a direct result of subsidence rather than any change in flood levels. Only five of these buildings (D0767, D0615, D0049, D0041 and S0041) have the potential to become inundated. However, because floor levels were not known at the time of this study and were assumed as 0.3m above ground level, this will need to be confirmed during the preparation of individual Property Subsidence Management Plans (PSMP) nearer to the time of mining in that locality.

For the 20% AEP flood after subsidence, 33 dwellings will be adversely affected 36 will be beneficially affected and 10 will be unchanged. Only 10 dwellings will be subjected to increased inundation and 9 will have decreased inundation during a 20%AEP flood. This is considered to be an appropriate indicator of the overall change in frequency of flood impacts on dwellings.

Impact categories were developed to summarise the severity of impacts that may occur to dwellings and to property inundation as a result of subsidence impacts on flooding. These are given in *Table 6.3* and *Table 6.4* and are cross-referenced in *Table 6.2*. It would be reasonable to expect that mitigation works will be required for dwellings in Category A (Major Impacts) and Category B (Moderate Impacts). However, dwellings in other categories are unlikely to require mitigation works.

Mitigation options need to be examined for dwellings which will be moderately or highly impacted by increased flood depths as a result of mine related subsidence. Options available to mitigate these impacts include construction of flood levees and raising or relocating houses to higher ground within the property. For impacted houses that are unable to be protected, raised or moved, properties may need to be purchased. Limited options are also available to reduce post-subsidence flooding by channel improvements. Mitigation options for dwellings are discussed in *Chapter 7.*

Table 6.1 Dwellings Affected by Flooding

Dwelling ID	Existing Ground Level (mAHD)	Existing Floor Level (mAHD)	Subsidence (m)	Subsided Ground Level (mAHD)	Subsided Floor Level (mAHD)	Within Subsidence Zone	Within Existing 1% AEP Flood Extent	Within Subsided 1% AEP Flood Extent	Within Existing 20% Flood Extent	Within Subsided 20% Flood Extent	Comment
Adverse Impacts											
D0863[DV]	14.50	14.80*	-1.182	13.32	13.62	Y	N	Y	N	Y	Not currently inundated
D0870[DV]	11.16	11.46*	-0.928	10.23	10.53	Y	Y	Y	N	N	Not currently inundated
D0207[DV]	14.00	15.00	-1.166	12.83	13.83	Y	Y	Y	N	N	Not currently inundated
D0060[DV]	11.78	12.18	-1.311	10.46	10.86	Y	N	Y	N	N	Not currently inundated
D0737[DV]	11.29	11.92	-0.796	10.49	11.12	Y	Y	Y	N	N	Not currently inundated
S0041	15.11	15.41*	-0.068	15.04	15.34	Y	Y	Y	Y	Y	Increased Inundation
D0767	16.81	17.11*	-0.197	16.62	16.92	Y	Y	Y	Y	Y	Increased Inundation
D0017[DV]	9.50	10.08	-0.139	9.36	9.94	Y	Y	Y	Y	Y	Increased Inundation
D0063[DV]	10.29	10.79	-1.361	8.93	9.43	Y	Y	Y	Y	Y	Increased Inundation
D0237[DV]	13.33	13.63*	-1.120	12.21	12.51	Y	Y	Y	N	Y	Increased Inundation
D0851[DV]	14.89	15.19*	-1.311	13.58	13.88	Y	Y	Y	Y	Y	Increased Inundation
S0776[DV]	15.81	16.11	-1.404	14.41	14.71	Y	Y	Y	Y	Y	Increased Inundation
D0776[DV]	15.86	16.16*	-1.417	14.44	14.74	Y	Y	Y	Y	Y	Increased Inundation
D0041	17.46	17.76*	-0.096	17.36	17.66	Y	Y	Y	N	N	Increased Inundation
D0058[DV]	9.59	10.29	-0.173	9.42	10.12	Y	Y	Y	N	N	Increased Inundation
D0736[DV]	9.50	10.70	-0.042	9.46	10.66	Y	Y	Y	Y	Y	Increased Inundation
D0615	13.47	13.77*	-0.018	13.45	13.75	Y	Y	Y	N	N	Increased Inundation
D0061[DV]	10.36	11.06	-0.393	9.96	10.66	Y	Y	Y	N	N	Increased Inundation
D0049	14.13	14.43*	-0.027	14.11	14.41	Y	Y	Y	N	N	Increased Inundation
D0220[DV]	15.00	15.30*	-1.156	13.84	14.14	Y	N	Y	N	N	Freeboard less than 0.3m
D0773[DV]	16.37	17.47	-1.326	15.05	16.15	Y	Y	Y	Y	Y	Freeboard less than 0.3m

Dwelling ID	Existing Ground Level (mAHD)	Existing Floor Level (mAHD)	Subsidence (m)	Subsided Ground Level (mAHD)	Subsided Floor Level (mAHD)	Within Subsidence Zone	Within Existing 1% AEP Flood Extent	Within Subsided 1% AEP Flood Extent	Within Existing 20% Flood Extent	Within Subsided 20% Flood Extent	Comment
D0713 DV	15.31	15.61*	-1.200	14.11	14.41	Y	N	Y	N	N	Freeboard less than 0.3m
D0050	14.01	14.81	-0.028	13.99	14.79	Y	Y	Y	N	N	Freeboard reduced, but > 0.3m
D0432 DV	15.57	15.87*	-1.347	14.22	14.52	Y	N	Y	N	N	Freeboard reduced, but > 0.3m
D0862 DV	15.00	15.30*	-0.881	14.12	14.42	Y	N	Y	N	N	Freeboard reduced, but > 0.3m
D0614	14.13	14.43*	-0.043	14.08	14.38	Y	Y	Y	N	N	Freeboard reduced, but > 0.3m
D0197 DV	16.31	16.61*	-1.325	14.99	15.29	Y	N	Y	N	N	Freeboard reduced, but > 0.3m
D0209 DV	15.33	15.60	-1.076	14.25	14.52	Y	Y	Y	N	N	Freeboard reduced, but > 0.3m
D0236 DV	16.00	16.30*	-1.214	14.78	15.08	Y	Y	Y	N	N	Freeboard reduced, but > 0.5m
D0170 DV	21.38	21.60	0.000	21.38	21.60	N	Y	Y	N	N	Freeboard reduced, but > 0.5m
D0201 DV	21.15	22.15	0.000	21.15	22.15	N	Y	Y	N	N	Freeboard reduced, but > 0.5m
D0221 DV	16.00	16.30*	-1.010	14.99	15.29	Y	N	Y	N	N	Freeboard reduced, but > 0.5m
D0240 DV	17.00	17.30*	-0.355	16.65	16.95	Y	N	Y	N	N	Freeboard reduced, but > 0.5m
D0042	18.66	21.86	-0.515	18.15	21.35	Y	Y	Y	N	N	Freeboard reduced, but > 0.5m
Beneficial Impacts											
S0099	8.00	8.30*	0.000	8.00	8.30	N	Y	Y	Y	Y	Reduced Inundation
D0828	19.50	19.80*	0.000	19.50	19.80	N	Y	Y	Y	Y	Reduced Inundation
D0739	11.50	11.80*	0.000	11.50	11.80	N	Y	Y	Y	Y	Reduced Inundation
D0089	10.48	11.28	0.000	10.48	11.28	N	Y	Y	Y	Y	Reduced Inundation
D0876	19.11	19.41*	0.000	19.11	19.41	N	Y	Y	Y	Y	Reduced Inundation
S0824	16.71	17.01*	-0.017	16.69	16.99	N	Y	Y	Y	Y	Reduced Inundation
D0099	10.00	10.30*	0.000	10.00	10.30	N	Y	Y	Y	Y	Reduced Inundation
D0104	11.78	12.08*	0.000	11.78	12.08	N	Y	Y	Y	Y	Reduced Inundation
D0120	10.85	11.15*	0.000	10.85	11.15	N	Y	Y	Y	Y	Reduced Inundation

Dwelling ID	Existing Ground Level (mAHD)	Existing Floor Level (mAHD)	Subsidence (m)	Subsided Ground Level (mAHD)	Subsided Floor Level (mAHD)	Within Subsidence Zone	Within Existing 1% AEP Flood Extent	Within Subsided 1% AEP Flood Extent	Within Existing 20% Flood Extent	Within Subsided 20% Flood Extent	Comment
D0734	11.94	12.62	0.000	11.94	12.62	N	Y	Y	Y	Y	Reduced Inundation
D0820	20.32	20.62*	0.000	20.32	20.62	N	Y	Y	N	N	Reduced Inundation
S0101	10.49	10.79*	0.000	10.49	10.79	N	Y	Y	Y	Y	Reduced Inundation
D0052	12.42	12.92	0.000	12.42	12.92	N	Y	Y	Y	Y	Reduced Inundation
D0113	11.39	11.99	0.000	11.39	11.99	N	Y	Y	Y	Y	Reduced Inundation
D0002	19.50	19.80	0.000	19.50	19.80	N	Y	Y	Y	Y	Reduced Inundation
D0103	12.50	13.00	0.000	12.50	13.00	N	Y	Y	Y	Y	Reduced Inundation
D0381	8.32	8.92	0.000	8.32	8.92	N	Y	Y	Y	Y	Reduced Inundation
D0370	7.99	8.29	0.000	7.99	8.29	N	Y	Y	N	N	Reduced Inundation
D0110	13.00	13.30	0.000	13.00	13.30	N	Y	Y	Y	Y	Reduced Inundation
D0053	12.48	13.48	0.000	12.48	13.48	N	Y	Y	Y	Y	Reduced Inundation
D0013	19.16	19.46*	0.000	19.16	19.46	N	Y	Y	N	N	Reduced Inundation
S0371	8.83	8.83	0.000	8.83	8.83	N	Y	Y	N	N	Reduced Inundation
D0852 DV	15.50	15.80*	-1.197	14.30	14.60	Y	Y	Y	Y	Y	Reduced Inundation
D0091	13.20	13.70	0.000	13.20	13.70	N	Y	Y	N	N	Reduced Inundation
D0051	13.34	13.84	-0.005	13.33	13.83	N	Y	Y	N	N	Reduced Inundation
D0097	12.69	13.39	0.000	12.69	13.39	N	Y	Y	N	N	Reduced Inundation
D0108	11.00	11.30*	0.000	11.00	11.30	N	Y	Y	N	N	Reduced Inundation
D0012	18.97	20.17	0.000	18.97	20.17	N	Y	Y	N	N	Reduced Inundation
D0740	10.07	10.57	0.000	10.07	10.57	N	Y	Y	N	N	Increased freeboard
D0095	11.08	11.38	0.000	11.08	11.38	N	Y	Y	N	N	Increased freeboard
D0115	13.84	14.34	0.000	13.84	14.34	N	Y	Y	N	N	Increased freeboard
D0385	9.50	9.80	0.000	9.50	9.80	N	Y	Y	N	N	Increased freeboard

Dwelling ID	Existing Ground Level (mAHD)	Existing Floor Level (mAHD)	Subsidence (m)	Subsided Ground Level (mAHD)	Subsided Floor Level (mAHD)	Within Subsidence Zone	Within Existing 1% AEP Flood Extent	Within Subsided 1% AEP Flood Extent	Within Existing 20% Flood Extent	Within Subsided 20% Flood Extent	Comment
D0363	8.83	10.33	0.000	8.83	10.33	N	Y	Y	N	N	Increased freeboard
D0765 [DV]	28.47	29.18	-0.061	28.41	29.12	Y	Y	Y	N	N	Increased freeboard
D0100	12.51	13.00	0.000	12.51	13.00	N	Y	Y	N	N	Increased freeboard
D0009	21.57	22.57	0.000	21.57	22.57	N	Y	Y	N	N	Increased freeboard
D0004	19.66	21.86	0.000	19.66	21.86	N	Y	Y	N	N	Increased freeboard
D0003	22.84	23.80	0.000	22.84	23.80	N	Y	Y	N	N	Increased freeboard
Unchanged											
D0869	14.71	15.01*	0.000	14.71	15.01	N	Y	Y	Y	Y	No change to inundation
D0048	15.06	15.86	0.000	15.06	15.86	N	Y	Y	Y	Y	No change to inundation
D0035	13.73	14.13	0.000	13.73	14.13	N	Y	Y	Y	Y	No change to inundation
D0040	15.77	16.57	0.000	15.77	16.57	N	Y	Y	Y	Y	No change to inundation
D0038	16.50	16.80	0.000	16.50	16.80	N	Y	Y	Y	Y	No change to inundation
D0106	10.13	10.43*	0.000	10.13	10.43	N	Y	Y	N	N	No change to inundation
D0712 [DV]	20.85	21.15	0.000	20.85	21.15	N	Y	Y	N	N	No change to freeboard

* Indicates that floor level was estimated assuming clearance of 0.3m above ground level

[DV] Located in Dooralong Valley (Note: all other dwellings are in Yarramalong Valley)

Table 6.2 Extent of Flood Impacts on Dwellings

Dwelling ID	Cat.*	Existing 1% AEP Flood Level (mAHD)	Existing 1% AEP Flood Depth (m)	Existing 1% AEP Freeboard/ (Inund.) (m)	Subsided 1% AEP Flood Level (mAHD)	Subsided 1% AEP Flood Depth (m)	Subsided 1% AEP Freeboard/ (Inund.) (m)	Change in 1% AEP Freeboard/ Innund. (m)	Existing 20% AEP Flood Level (m)	Existing 20% AEP Flood Depth (m)	Existing 20%AEP Freeboard / (Inund.) (m)	Subsided 20% AEP Flood Level (m)	Subsided 20% AEP Flood Depth (m)	Subsided 20% AEP Freeboard/ (Inund.) (m)	Change in 20% AEP Freeboard/ Innund. (m)
Adverse Impacts															
D0863[DV]	A1	14.336	0	0.46	14.354	1.04	(0.74)	-1.20	13.694	0	1.11	13.334	0.02	0.28	-0.82
D0870[DV]	A1	11.114	0	0.34	11.022	0.80	(0.50)	-0.84	8.989	0	2.47	8.92	0	1.61	-0.86
D0207[DV]	A1	14.332	0.33	0.67	14.019	1.19	(0.19)	-0.85	13.075	0	1.93	12.617	0	1.22	-0.71
D0060[DV]	A1	11.092	0	1.08	10.998	0.53	(0.13)	-1.22	8.968	0	3.21	8.896	0	1.97	-1.24
D0737[DV]	A1	11.25	0	0.67	11.195	0.70	(0.07)	-0.74	9.19	0	2.73	9.128	0	2.00	-0.73
S0041	B2	18.555	3.45	(3.15)	18.557	3.52	(3.22)	-0.07	16.482	1.37	(1.07)	16.487	1.45	(1.15)	-0.07
D0767	B2	19.223	2.41	(2.11)	19.158	2.54	(2.24)	-0.13	17.178	0.36	(0.06)	17.122	0.50	(0.20)	-0.14
D0017[DV]	B1	11.386	1.89	(1.31)	12.163	2.80	(2.22)	-0.92	10.3	0.80	(0.22)	10.3	0.94	(0.36)	-0.14
D0063[DV]	A2	11.657	1.37	(0.87)	11.342	2.42	(1.92)	-1.05	9.887	0	0.90	9.488	0.56	(0.06)	-0.96
D0237[DV]	A2	14.352	1.03	(0.73)	14.024	1.82	(1.52)	-0.79	13.095	0	0.53	12.619	0.41	(0.11)	-0.64
D0851[DV]	B2	16.254	1.36	(1.06)	15.052	1.47	(1.17)	-0.11	15.558	0.67	(0.37)	14.343	0.76	(0.46)	-0.10
S0776[DV]	B2	17.084	1.28	(0.97)	15.798	1.39	(1.09)	-0.12	16.345	0.54	(0.24)	15.07	0.67	(0.37)	-0.13
D0776[DV]	B2	17.068	1.21	(0.91)	15.784	1.35	(1.05)	-0.13	16.331	0.48	(0.18)	15.057	0.62	(0.32)	-0.14
D0041	B2	18.573	1.12	(0.82)	18.576	1.21	(0.91)	-0.10	16.496	0	1.26	16.503	0	1.16	-0.10
D0058[DV]	B2	11.093	1.50	(0.80)	10.999	1.58	(0.88)	-0.08	8.969	0	1.32	8.896	0	1.22	-0.10
D0736[DV]	B2	11.046	1.55	(0.35)	11.296	1.84	(0.64)	-0.29	9.326	0	1.37	9.278	0	1.38	0.01
D0615	C2	14.288	0.82	(0.52)	14.275	0.83	(0.53)	-0.01	12.467	0	1.30	12.459	0	1.29	-0.01
D0061[DV]	B2	11.112	0.76	(0.05)	11.019	1.06	(0.36)	-0.30	8.987	0	2.07	8.918	0	1.75	-0.32
D0049	C2	14.453	0.32	(0.02)	14.442	0.34	(0.04)	-0.02	12.591	0	1.84	12.584	0	1.82	-0.02

Dwelling ID	Cat.*	Existing 1% AEP Flood Level (mAHD)	Existing 1% AEP Flood Depth (m)	Existing 1% AEP Freeboard/ (Inund.) (m)	Subsided 1% AEP Flood Level (mAHD)	Subsided 1% AEP Flood Depth (m)	Subsided 1% AEP Freeboard/ (Inund.) (m)	Change in 1% AEP Freeboard/ Innund. (m)	Existing 20% AEP Flood Level (m)	Existing 20% AEP Flood Depth (m)	Existing 20%AEP Freeboard / (Inund.) (m)	Subsided 20% AEP Flood Level (m)	Subsided 20% AEP Flood Depth (m)	Subsided 20% AEP Freeboard/ (Inund.) (m)	Change in 20% AEP Freeboard/ Innund. (m)
D0220 DV	C1	14.302	0	1.00	14.012	0.17	0.13	-0.87	13.046	0	2.25	12.613	0	1.53	-0.72
D0773 DV	D	17.286	0.91	0.18	15.984	0.94	0.16	-0.02	16.529	0.16	0.94	15.247	0.20	0.90	-0.04
D0713 DV	C1	14.961	0	0.65	14.205	0.10	0.20	-0.44	14.029	0	1.58	12.852	0	1.56	-0.02
D0050	D	14.496	0.48	0.32	14.485	0.50	0.30	-0.02	12.627	0	2.19	12.62	0	2.17	-0.02
D0432 DV	C3	14.961	0	0.91	14.205	0	0.32	-0.59	14.029	0	1.84	12.852	0	1.67	-0.17
D0862 DV	C3	14.248	0	1.05	14.015	0	0.40	-0.65	13.019	0	2.28	12.648	0	1.77	-0.51
D0614	C3	13.947	0	0.48	13.935	0	0.45	-0.03	12.182	0	2.25	12.171	0	2.21	-0.03
D0197 DV	C3	15.877	0	0.74	14.839	0	0.45	-0.29	15.076	0	1.54	13.881	0	1.41	-0.13
D0209 DV	C3	14.518	0	1.08	14.069	0	0.45	-0.63	13.324	0	2.28	12.648	0	1.88	-0.40
D0236 DV	D	15.695	0	0.60	14.565	0	0.52	-0.08	15.015	0	1.28	13.838	0	1.25	-0.04
D0170 DV	D	20.891	0	0.71	20.904	0	0.70	-0.01	19.973	0	1.63	19.982	0	1.62	-0.01
D0201 DV	D	21.063	0	1.08	21.074	0	1.07	-0.01	20.155	0	1.99	20.166	0	1.98	-0.01
D0221 DV	D	14.249	0	2.05	13.999	0	1.29	-0.76	12.998	0	3.30	12.607	0	2.68	-0.62
D0240 DV	D	15.932	0	1.37	15.604	0	1.34	-0.03	15.578	0	1.72	15.334	0	1.61	-0.11
D0042	D	19.532	0.87	2.33	19.456	1.31	1.89	-0.44	17.389	0	4.47	17.32	0	4.03	-0.45
Beneficial Impacts															
S0099	E3	12.34	4.34	(4.04)	12.321	4.32	(4.02)	0.02	10.505	2.51	(2.21)	10.489	2.49	(2.19)	0.02
D0828	E3	22.622	3.12	(2.82)	22.614	3.11	(2.81)	0.01	20.072	0.57	(0.27)	20.069	0.57	(0.27)	0.00
D0739	E3	14.493	2.99	(2.69)	14.482	2.98	(2.68)	0.01	12.624	1.12	(0.82)	12.617	1.12	(0.82)	0.01
D0089	E3	13.601	3.12	(2.32)	13.587	3.11	(2.31)	0.01	11.843	1.36	(0.56)	11.828	1.35	(0.55)	0.02
D0876	E3	21.536	2.43	(2.13)	21.521	2.42	(2.12)	0.02	19.232	0.13	0.17	19.223	0.12	0.18	0.01
S0824	E2	19.103	2.40	(2.10)	19.039	2.35	(2.05)	0.05	17.074	0.37	(0.07)	17.019	0.33	(0.03)	0.04

Dwelling ID	Cat.*	Existing 1% AEP Flood Level (mAHD)	Existing 1% AEP Flood Depth (m)	Existing 1% AEP Freeboard/ (Inund.) (m)	Subsided 1% AEP Flood Level (mAHD)	Subsided 1% AEP Flood Depth (m)	Subsided 1% AEP Freeboard/ (Inund.) (m)	Change in 1% AEP Freeboard/ Innund. (m)	Existing 20% AEP Flood Level (m)	Existing 20% AEP Flood Depth (m)	Existing 20%AEP Freeboard / (Inund.) (m)	Subsided 20% AEP Flood Level (m)	Subsided 20% AEP Flood Depth (m)	Subsided 20% AEP Freeboard/ (Inund.) (m)	Change in 20% AEP Freeboard/ Innund. (m)
D0099	E3	12.369	2.37	(2.07)	12.348	2.35	(2.05)	0.02	10.535	0.54	(0.23)	10.519	0.52	(0.22)	0.02
D0104	E3	14.054	2.27	(1.97)	14.044	2.26	(1.96)	0.01	12.281	0.50	(0.20)	12.272	0.49	(0.19)	0.01
D0120	E3	13.027	2.18	(1.88)	13.01	2.16	(1.86)	0.02	11.271	0.42	(0.12)	11.256	0.41	(0.11)	0.02
D0734	E3	14.49	2.55	(1.87)	14.479	2.54	(1.86)	0.01	12.622	0.68	0.00	12.615	0.68	0.01	0.01
D0820	E3	22.267	1.95	(1.65)	22.257	1.94	(1.64)	0.01	19.791	0	0.83	19.787	0	0.84	0.00
S0101	E3	12.421	1.93	(1.63)	12.4	1.91	(1.61)	0.02	10.602	0.11	0.19	10.586	0.09	0.21	0.02
D0052	E3	14.51	2.09	(1.59)	14.5	2.08	(1.58)	0.01	12.641	0.22	0.28	12.634	0.22	0.28	0.01
D0113	E3	13.498	2.11	(1.51)	13.484	2.10	(1.50)	0.01	11.737	0.35	0.25	11.722	0.33	0.27	0.02
D0002	E3	21.299	1.80	(1.50)	21.282	1.78	(1.48)	0.02	19.035	0	0.77	19.024	0	0.78	0.01
D0103	E3	14.242	1.74	(1.24)	14.229	1.73	(1.23)	0.01	12.43	0	0.57	12.421	0	0.58	0.01
D0381	E2	10.149	1.83	(1.23)	10.093	1.77	(1.17)	0.06	8.396	0.07	0.53	8.35	0.03	0.57	0.05
D0370	E2	9.49	1.50	(1.20)	9.44	1.45	(1.15)	0.05	7.795	0	0.49	7.748	0	0.54	0.05
D0110	E3	14.418	1.42	(1.12)	14.406	1.41	(1.11)	0.01	12.568	0	0.73	12.561	0	0.74	0.01
D0053	E3	14.568	2.09	(1.09)	14.559	2.08	(1.08)	0.01	12.702	0.23	0.77	12.696	0.22	0.78	0.01
D0013	E2	20.445	1.29	(0.99)	20.404	1.25	(0.95)	0.04	18.249	0	1.21	18.225	0	1.23	0.02
S0371	E2	9.807	0.98	(0.98)	9.768	0.94	(0.94)	0.04	8.362	0	0.47	8.323	0	0.51	0.04
D0852 DV	E2	16.598	1.10	(0.80)	15.366	1.06	(0.76)	0.03	15.859	0.36	(0.06)	14.637	0.33	(0.03)	0.02
D0091	E3	14.415	1.22	(0.72)	14.403	1.21	(0.71)	0.01	12.566	0	1.13	12.559	0	1.14	0.01
D0051	E3	14.523	1.19	(0.69)	14.512	1.18	(0.68)	0.01	12.652	0	1.18	12.645	0	1.19	0.00
D0097	E3	14.019	1.33	(0.63)	14.008	1.32	(0.62)	0.01	12.249	0	1.14	12.239	0	1.15	0.01
D0108	E3	11.805	0.81	(0.50)	11.785	0.79	(0.48)	0.02	10.308	0	0.99	10.302	0	1.00	0.01
D0012	E2	20.438	1.46	(0.26)	20.397	1.42	(0.22)	0.04	18.243	0	1.93	18.22	0	1.95	0.02

Dwelling ID	Cat.*	Existing 1% AEP Flood Level (mAHD)	Existing 1% AEP Flood Depth (m)	Existing 1% AEP Freeboard/ (Inund.) (m)	Subsided 1% AEP Flood Level (mAHD)	Subsided 1% AEP Flood Depth (m)	Subsided 1% AEP Freeboard/ (Inund.) (m)	Change in 1% AEP Freeboard/ Innund. (m)	Existing 20% AEP Flood Level (m)	Existing 20% AEP Flood Depth (m)	Existing 20%AEP Freeboard / (Inund.) (m)	Subsided 20% AEP Flood Level (m)	Subsided 20% AEP Flood Depth (m)	Subsided 20% AEP Freeboard/ (Inund.) (m)	Change in 20% AEP Freeboard/ Innund. (m)
D0740	E2	10.371	0.30	0.20	10.313	0.54	0.26	0.06	9.475	0	1.10	9.464	0	1.11	0.01
D0095	E3	11.099	0.02	0.28	11.093	0.01	0.29	0.01	10.202	0	1.18	10.2	0	1.18	0.00
D0115	E1	14.205	0.37	0.13	14	0.16	0.34	0.21	12.5	0	1.84	12.5	0	1.84	0.00
D0385	E3	9.44	0	0.36	9.423	0	0.38	0.02	8.376	0	1.42	8.347	0	1.45	0.03
D0363	E3	9.95	1.12	0.38	9.925	1.09	0.41	0.02	8.738	0	1.60	8.715	0	1.62	0.02
D0765 DV	E2	28.687	0.22	0.49	28.598	0.19	0.52	0.03	27.999	0	1.18	27.924	0	1.20	0.01
D0100	E3	12.313	0	0.69	12.294	0	0.71	0.02	10.48	0	2.52	10.464	0	2.54	0.02
D0009	E3	21.596	0.03	0.97	21.581	0.01	0.99	0.02	19.282	0	3.29	19.273	0	3.30	0.01
D0004	E3	20.474	0.81	1.39	20.434	0.77	1.43	0.04	18.27	0	3.59	18.247	0	3.62	0.02
D0003	E3	21.336	0	2.46	21.32	0	2.48	0.02	19.066	0	4.73	19.055	0	4.75	0.01
Unchanged															
D0869	U	18.354	3.64	(3.34)	18.358	3.64	(3.34)	0.00	16.309	1.60	(1.30)	16.311	1.60	(1.30)	0.00
D0048	U	18.189	3.13	(2.33)	18.190	3.13	(2.33)	0.00	16.172	1.12	(0.32)	16.180	1.12	(0.32)	0.00
D0035	U	16.171	2.44	(2.04)	16.172	2.44	(2.04)	0.00	14.032	0.31	0.10	14.032	0.31	0.10	0.00
D0040	U	17.602	1.83	(1.03)	17.602	1.83	(1.03)	0.00	15.575	0	0.99	15.574	0	0.99	0.00
D0038	U	17.661	1.16	(0.86)	17.662	1.16	(0.86)	0.00	15.633	0	1.17	15.631	0	1.17	0.00
D0106	U	10.692	0.56	(0.26)	10.690	1.13	(0.26)	0.00	9.982	0	0.45	9.977	0	0.46	0.00
D0712 DV	U	21.12	0.27	0.03	21.12	0.27	0.03	0.00	20.1	0	1.05	20.1	0	1.05	0.00

*** Refer to Table 6.3 for description of Impact Categories**

Table 6.3 Impact Categories for Dwellings

Category	Description	Number Affected	Houses Affected	Impacts
A	**Major Impacts**			
A1	House floor not flooded by 1:100 yr ARI (1%AEP) flood prior to mining but becomes flooded after mining.	5	D0863, D0870, D0207, D0060, D0737 (Note these houses remain unaffected by the 1:5 yr (20%AEP) flood after mining)	Significant Impact – major increase in damage costs.
A2	House floor flooded by 1:100 yr (1%) flood prior to mining with >0.3m increase in flooding after mining PLUS house floor not flooded by 1:5 yr (20%) flood prior to mining but becomes flooded after mining	2	D0063, D0237	Major Impact – increase in frequency of damage plus some increase in maximum damage costs
B	**Moderate Impacts**			
B1	House floor flooded by 1:100 yr (1%) flood prior to mining with >0.3m increase in flooding after mining BUT will remain unaffected by 1:5 yr (20%) flood	1	D0017 (Also a local heritage silo affected)	Moderate Impact – moderate increase in frequency and cost of damage from larger floods.
B2	House floor flooded by 1:100 yr (1%) flood prior to mining with only minor (<0.3m) increase in flooding after mining.	9	D0767, D0851, D0776, D0041, D0058, D0736, D0061 and includes two sheds: S0041 S0776,	Moderate Impact - minor increase in frequency and cost of damage from very large floods
C	**Minor Impacts**			
C1	House floor not flooded by 1:100 yr flood (1%) prior to mining nor flooded after mining, BUT freeboard reduced from >0.5m before mining to < 0.3m after mining.	2	D0713, D0220	Minor Impact - no change in risk and no direct cost impacts but planning constraints no longer satisfied for freeboard.
C2	House floor flooded by 1:100 yr flood (1%) prior to mining with negligible (<0.05m) increase in flooding after mining	2	D0049, D0615	Minor Impact - negligible change in risk or cost impacts
C3	House floor not flooded by 1:100 yr (1%) flood prior to mining nor flooded after mining, BUT freeboard reduced to < 0.5m	5	D0432, D0862, D0614, D0197, D0209	Minor Impact - less than desirable freeboard but no risk or cost impacts
D	**Negligible Impacts**			
D	House floor not flooded by 1:100 yr (1%) flood prior to mining nor flooded after mining and/or change in freeboard <0.05m	8	D0773, D0050, D0236, D0170, D0201, D0221, D0240, D0042	No impacts and no significant change
E	**Beneficial Impacts**			
E1	Significant (>0.2m) reduction in flood levels in 1:100yr (1%) flood after mining PLUS achieving a freeboard of at least 0.3m after mining.	1	D0115	Moderate Beneficial Impact
E2	Minor (<0.2m) reduction in flood levels in 1:100yr flood (1%) after mining and no change to flood category after mining.	9	D0381, D0370, D0013, D0852, D0012, D0740, D0765 and includes two sheds: S0824, S0371	Minor Beneficial Impact
E3	Negligible (<0.05m) reduction in flood levels and/or freeboard after mining for all floods	28	(see Table 6.2)	No impacts and no significant change
U	**Unchanged**			
U	No change in flood depths after mining but minor change in ground levels	7	D0869, D0048, D0035, D0040, D0038, D0106, D0712	No impacts

Table 6.4 Impact Categories for Properties

Category	Description	Number Affected	Land/Properties Affected	Impacts
L1	Reduction in Flood Extent of 1:100 yr flood (1%) by more than 5% of individual property area after mining	2	Generally grazing land near property boundary	Moderate Beneficial Impact
L2	Reduction in Flood Extent of 1:100 yr flood (1%) by less than 5% of individual property area after mining	3	Generally grazing land near property boundary	Minor Beneficial Impact
L3	Increase in Flood Extent of 1:100 yr flood (1%) by more than 5% but less than 20% of individual property area after mining	4	Mostly grazing land plus some areas of non-agricultural and uncleared land	Minor to Moderate Impact
L4	Increase in Flood Extent of 1:100 yr flood (1%) by more than 20% of individual property area (or other major effect) after mining	6	Agricultural land plus a plant nursery and one cattle property	Moderate to Major Impact

Dwellings were also examined for changes to hydraulic and hazard categories. In the 1% AEP flood, subsidence will result in:

- five dwellings which are currently flood free changing to low hazard flood fringe;

- three dwellings located in a low hazard flood storage area changing to high hazard flood storage;

- one dwelling located in a low hazard flood fringe area changing to high hazard flood fringe;

- one dwelling located in a low hazard flood fringe area changing to low hazard flood storage; and

- no changes in hydraulic and hazard categories for dwellings in the Yarramalong Valley.

Changes to hydraulic and hazard categories are usually more significant for the land within property boundaries than for existing dwellings, sheds and other buildings on the properties. In cases where properties are subjected to adverse changes in hydraulic and hazard categories, additional development controls may be required to prevent inappropriate land use. Impacts on properties are discussed below.

6.2.4 Property Access

Flood duration, or length of time a community or single dwelling is cut off by floodwaters can significantly impact on the costs and disruption associated with flooding. Subsidence will result in an increase in the flood duration at low points along access routes within the Dooralong Valley. There are no expected impacts of subsidence on property access in the Yarramalong Valley. Mitigation measures will be required in affected locations to maintain existing flood access.

Access Routes

Primary and secondary access routes to the Dooralong and Yarramalong Valleys were documented. This included the identification of the most direct route to the Newcastle/Sydney Freeway along with emergency evacuation routes.

Determination of Key Low Points

Key locations that will be affected directly by subsidence or by subsidence induced increases in flood depth comprise low points on roads and bridges that are inundated during the initial stages of flooding. These locations are considered critical if floodwaters will cut off access to dwellings or restrict emergency evacuation routes for long periods of time. These locations were determined using:

- long sections of each of the roads from DTM supplied by WACJV;
- survey plans of bridges prepared by Monteath and Powys (1997);
- CAD plans showing flood extents, topographic data, dwelling locations and drainage lines; and
- 1:25,000 scale topographic maps produced by the Central Mapping Authority.

Cross section locations adjacent to each low point were identified and recorded to link low points to the hydraulic model.

Safe Evacuation Levels

A velocity/depth relationship was used to determine vehicle stability in floodwaters. Vehicles can become unstable when flood depths over roads exceed 0.15 - 0.30 m (depending on flow velocity and vehicle characteristics) and when flood velocities exceed 2m/s. Trafficable flow depths were determined at each low point based on the relevant velocities shown in *Table 6.5*.

Table 6.5 Safe Depth for Vehicles at Specified Flow Velocities

Flow Velocity (m/s)	Maximum Safe Depth (m)
0 – 0.5	0.30
0.5 – 1.0	0.25
1.0 – 1.5	0.20
1.5 – 2.0	0.15

Source: NSW Floodplain Management Manual (2001)
Note: No depth is considered safe for flow velocities greater than 2m/s

Duration of Flooding

Flood durations at each of the key low points were determined for each scenario using stage hydrographs from the MIKE 11 model.

Affected Dwellings

The durations of blocked accesses were determined for roads and access tracks servicing properties within the study area through the following steps:

- a list was compiled detailing the evacuation route for each dwelling and the low points on the route;
- for each low point, the location, flow velocity, flood duration and maximum flood depth were tabulated; and
- each dwelling was assigned a key low point for all of its evacuation routes. This is the low point which is untrafficable for the longest duration along any route.

Post Mining Topography

The physical changes to the positions and elevations of the low points were determined from post-subsidence topography data. Any new low points were also identified.

Access Impact Assessment

Changes to flooding depths and durations at low points after mining were calculated for the 1% and 20% AEP flood events.

Key Low Points

Key low points are shown in *Figure 6.5* and are summarised in *Table 6.6* including the existing and subsided road surface or bridge deck levels obtained from topographic or survey data and the number of dwellings for which each low point is on their primary access route. It should be noted the primary access routes may have several low points that may be affected by flooding.

A number of these low points may also block secondary access routes during floods. Only D70 is critical for both primary and secondary access. Details on the low points and the dwellings that would be impacted if primary accesses were blocked and secondary access was required are given in *Table 6.7*.

Table 6.6 Key Low Points – Primary Access Routes

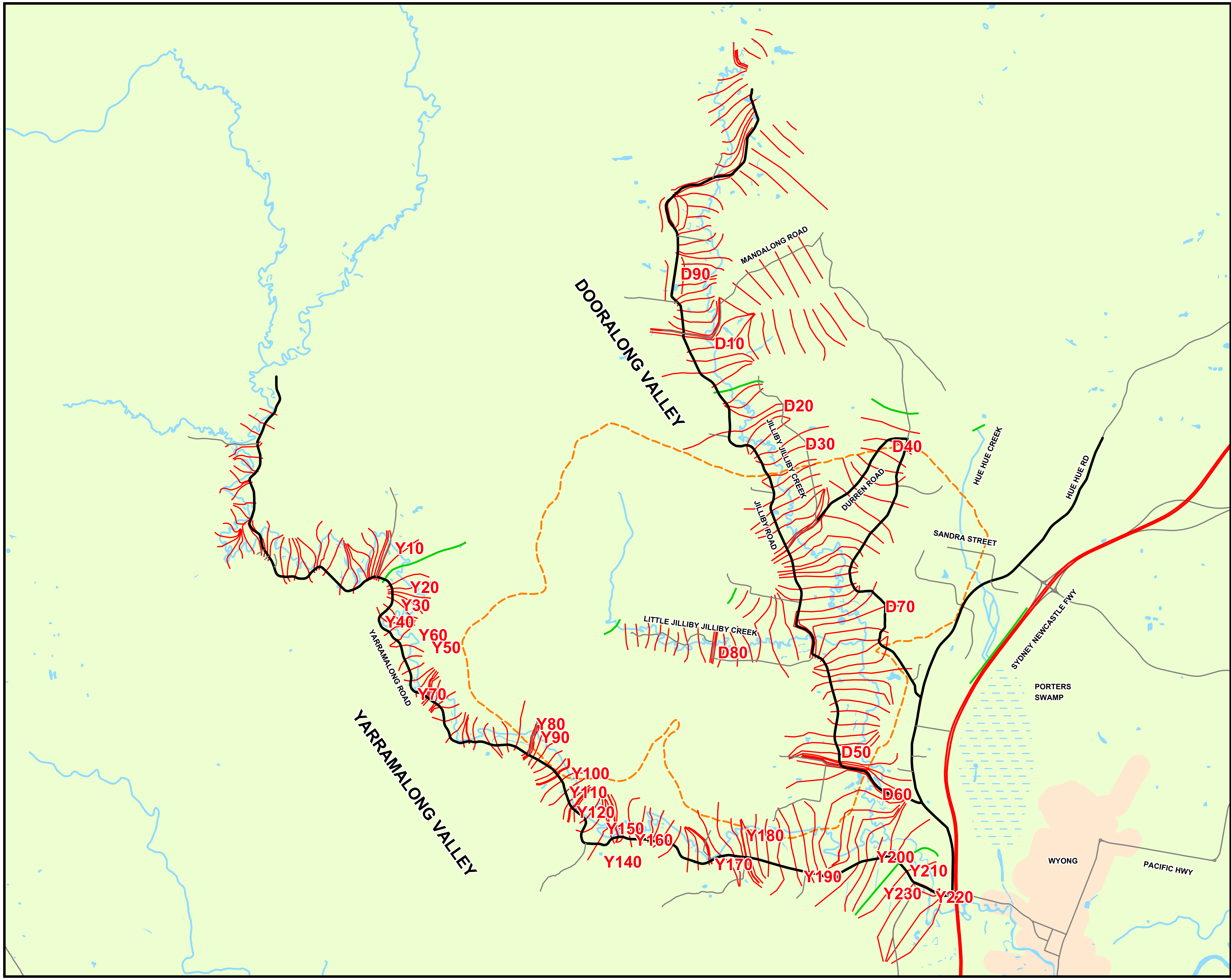
Low Point Identifier	Grid Coordinates[1]		MIKE 11 Cross Section		Minimum Road or Bridge Deck Level (m AHD)		Dwellings Serviced as Primary Access
	Easting	Northing	River	Chainage (km)	Existing	Subsided	
D10 (Bridge D)	333463	1326117	DOR	6.448	24.16	24.16	0
D20	334650	1325049	DOR	8.365	19.69	19.69	3
D30	335028	1324402	DOR	9.329	18.96	18.96	11
D40	336526	1324355	DOR_D	0.53	18.05	18.05	0
D50	335624	1319119	DOR	15.908	9.68	8.40	172
D60 (Bridge A)	336336	1318402	DOR	16.842	7.52	7.52	192
D70	336399	1321613	DOR	13.367	12.73	11.4	29
D80 (Bridge B)	335220	1320955	DOR_E	4.025	14.61	13.40	150
D90 (Bridge E)	332878	1327310	DOR_F	0.21	26.98	26.98	44
Y10 (Bridge 13)	327941	1322614	YAR	15.098	17.89	17.89	0
Y20 (Bridge 12)	328197	1321944	YAR	15.858	17.14	17.14	2
Y30	328040	1321636	YAR	16.670	18.89	18.89	0
Y40	327767	1321358	YAR	17.112	17.19	17.19	7
Y50 (Bridge 10)	328420	1320915	YAR	17.856	14.92	14.92	1
Y60 (Bridge 11)	328369	1320983	YAR	17.762	17.21	17.21	1
Y70	328320	1320117	YAR	18.849	16.19	16.19	20
Y80	330367	1319602	YAR	21.552	12.32	12.12	1
Y90 (Bridge 7)	330441	1319375	YAR	21.600	12.86	12.76	3
Y100 (Bridge 6)	330968	1318756	YAR	22.450	13.73	13.68	1
Y110	330929	1318435	YAR	22.757	13.60	13.60	54
Y120 (Bridge 5)	331056	1318092	YAR	23.152	13.66	13.66	58
Y130	331102	1318105	YAR	23.172	12.80	12.80	1
Y140	331596	1317440	YAR	24.033	13.12	13.12	72
Y150 (Bridge 4)	331859	1317591	YAR	24.157	11.45	11.45	2
Y160	331960	1317569	YAR	24.305	12.49	12.49	75
Y170 (Bridge 3)	333439	1317201	YAR	26.340	9.59	9.59	95
Y180 (Bridge 2)	333982	1317696	YAR	27.090	8.96	8.96	2
Y190	334974	1316991	YAR	27.976	8.99	8.99	122
Y200	336345	1317195	YAR	30.273	8.90	8.90	140
Y210	336711	1317092	YAR	30.957	8.19	8.19	143
Y220 (Bridge 1)	337245	1316635	YAR	31.676	10.23	10.23	148
Y230	336941	1316780	YAR	31.706	7.81	7.81	148

1. Coordinates in NSW ISG

Table 6.7 Key Low Points – Secondary Access Routes

Low Point Identifier	Primary Access Points[1]	MIKE 11 Cross Section		Minimum Road or Bridge Deck Level (m AHD)		Dwellings Serviced as Secondary Access
		River	Chainage (km)	Existing	Subsided	
D10 (Bridge D)	D90, D20, D60	DOR	6.448	24.16	24.16	197
D20	D10, D30	DOR	8.365	19.69	19.69	3
D30	D20, D40	DOR	9.329	18.96	18.96	11
D40	D30, D70	DOR_D	0.53	18.05	18.05	0
D50	D60	DOR	15.908	9.68	8.40	20
D70	D60	DOR	13.367	12.73	11.4	198
D80	D50, D60	DOR_E	4.025	14.61	13.40	10
D90 (Bridge E)	D60, D50, D80	DOR_F	0.21	26.98	26.98	44

1. Points which, if inundated, means secondary access must be used



Legend

- Extent of Modelling
- Extent of Mine Subsidence
- Primary Access Road
- Secondary Access Road
- D10 Road Low Point

Figure 6.5

Access Roads in Yarramalong and Dooralong Valleys

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS08		
Date:	23.05.08	Drawing Size:	A3
Drawn By:	JS	Reviewed By:	SO
Source:	-		
Scale:	Refer to Scale Bar		

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Access Routes

Primary and secondary access routes for properties in the Dooralong and Yarramalong Valleys are shown in *Figure 6.6.* Flood durations at key low points along access roads for both existing and subsided terrains are presented in the following sections.

For any residence, the primary access route is the most direct route to the Newcastle/Sydney Freeway. This generally includes Yarramalong Road for residents in the Yarramalong Valley, and Jilliby Road for residents in the Dooralong Valley. Jilliby Road and the two secondary routes to the Freeway from the Dooralong Valley (Durren Road and Mandalong Road) were investigated to identify which had the shortest duration of inundation.

The primary access route for dwellings on the right bank (western side) of the Dooralong Valley was found to be Jilliby Road which crosses Jilliby Jilliby Creek at Flack's Bridge. The primary access road for properties on the left bank of Dooralong Valley is Mandalong Road to Morisset.

The primary access route for dwellings on the right bank (southern side) of the Yarramalong Valley is Yarramalong Road. Most dwellings on the left bank are accessed by short link roads to Yarramalong Road which cross the Wyong River over low bridges.

A secondary route for dwellings on the right bank of Dooralong Valley is Mandalong Road via Durren Road. An alternative secondary route is Mandalong Road directly from Jilliby Road.

The MIKE11 model was run for the critical durations of inundation for both existing and subsided topography at the low points listed in *Table 6.6*. The upper and lower bounds of inundation were found to be represented by:

- the critical duration (36 hour) 1% AEP and
- the critical duration (48 hour) 20% AEP flood.

For each low point along the primary access route, the depth at which the road becomes untrafficable and the duration of inundation for the relevant scenarios are presented in *Table 6.8*.

Table 6.8 Primary Access Impacts

Low Point ID	Maximum Existing Trafficable RL (m AHD)	Maximum Subsided Trafficable RL (m AHD)	Existing Inundation Duration (hours)		Post-mining Inundation Duration (hours)		Increase in Inundation Duration (hours)	
			1% AEP	20% AEP	1% AEP	20% AEP	1% AEP	20% AEP
D10 (Bridge D)	24.41	24.41	11	4	11	4	Nil	Nil
D20	20.0	20.0	19	9	19	9	Nil	Nil
D30	19.3	19.3	5	0	5	0	Nil	Nil
D40	18.35	18.35	19	8	19	8	Nil	Nil
D50	10.0	8.7	19	0	44	35	25	35
D60 (Bridge A)	7.9	7.9	36	18	36	19	Nil	1
D70	13.0	11.7	18	0	37	26	19	26
D80 (Bridge B)	14.9	13.7	8	0	22	15	14	15
D90 (Bridge E)	27.3	27.3	0	0	0	0	Nil	Nil
Y10 (Bridge 13)	18.09	18.09	48	45	48	45	Nil	Nil
Y20 (Bridge 12)	17.34	17.34	54	50	54	50	Nil	Nil
Y30	19.2	19.2	30	28	30	28	Nil	Nil
Y40	17.5	17.5	44	42	44	42	Nil	Nil
Y50 (Bridge 10)	15.17	15.17	60	57	60	57	Nil	Nil
Y60 (Bridge 11)	17.50	17.50	38	37	38	37	Nil	Nil
Y70	16.5	16.5	45	44	45	44	Nil	Nil
Y80	12.6	12.4	71	68	73	69	2	1
Y90 (Bridge 7)	13.06	12.95	62	54	63	55	1	1
Y100 (Bridge 6)	13.88	13.83	49	48	49	48	Nil	Nil
Y110	13.9	13.9	47	45	47	45	Nil	Nil
Y120	14.0	14.0	40	38	40	38	Nil	Nil
Y130 (Bridge 5)	12.95	12.95	58	56	58	56	Nil	Nil
Y140	13.4	13.4	46	45	46	45	Nil	Nil
Y150 (Bridge 4)	11.65	11.65	69	66	69	66	Nil	Nil
Y160	12.7	12.7	50	49	50	49	Nil	Nil
Y170 (Bridge 3)	9.84	9.84	51	49	51	49	Nil	Nil
Y180 (Bridge 2)	9.20	9.20	51	50	51	50	Nil	Nil
Y190	9.3	9.3	37	32	37	32	Nil	Nil
Y200	9.2	9.2	22	12	22	12	Nil	Nil
Y210	8.5	8.5	22	3	22	3	Nil	Nil
Y220 (Bridge 1)	10.48	10.48	0	0	0	0	Nil	Nil
Y230	8.10	8.10	9	0	9	0	Nil	Nil

1. primary access route only

6.2.5 Access Impact Assessment

Yarramalong Valley – Primary Access Route

The results show that for all events modelled, post mining flooding durations are similar or less than existing durations for almost all low points within the Yarramalong Valley. There will be no dwellings in this valley that will have access cut off where it is not cut off under existing conditions.

Only three dwellings (D0016, D0028 and D0042) within the Yarramalong Valley will be adversely affected in terms of duration of impacts on access along the primary access route. Following subsidence, these dwellings will be cut off at low point Y80 for a maximum duration of 73 hours during the critical 1% AEP flood event. This is an increase of 2 hours over the existing situation.

Dooralong Valley – Primary Access Route

There will be no dwellings in the Dooralong Valley that will have access cut off where it is not cut off under existing (pre-mining) conditions. Up to 218 dwellings within the Dooralong Valley may be adversely affected in terms of duration of impacts on access out of the valley along their relevant primary access route. These include:

- 172 dwellings that will be cut off at low point D50 for a maximum duration of 44 hours during the critical 1% AEP flood event and 35 hours in the 20% AEP flood. This is an increase of 25 and 35 hours respectively over the existing situation;

- 20 additional dwellings will be cut off at low point D60 (Bridge A) for a maximum duration of 35 hours during the critical 1% AEP flood event and 19 hours during the 20% AEP flood. This is an increase of 17 hours for only the 20%AEP flood over the existing situation; and

- 26 additional dwelling will be cut off at low point D70 for a maximum duration of 37 hours during the critical 1% AEP flood event and 26 hours for the 20% AEP flood. This is an increase of 19 and 26 hours respectively over the existing situation.

Point D80 (Bridge B) will impact most of the same dwellings as point D50 but the durations of inundation will be less and the increase in duration will also be less, as a result of subsidence.

Dooralong Valley –Secondary Access Routes

Up to 198 dwellings within the Dooralong Valley can be adversely affected in terms of access out of the valley if both primary and secondary access routes are inundated. This would occur if both D50 and D70 were cut off simultaneously. The shortest duration dwellings will be cut off under these circumstances will be dependent on low point D70 and will be for a maximum duration of 37 hours during the critical 1% AEP flood event after mine subsidence. This is an increase of 19 hours over the existing (pre-mining) situation.

6.3 *HUE HUE CATCHMENT*

Flood levels, flood depths and flow velocities were calculated along the modelled section of Hue Hue Creek for the 1%AEP event. Detailed results are tabulated in *Annex J*.

Hydraulic modelling indicated that flood depths may increase as a result of subsidence by up to 0.27m in some locations. Within the subsidence affected area, modelling indicated that an average increase in flood depth of 0.08m may be expected. *Figure 6.6* shows the impact that subsidence has on flood extents along Hue Hue Creek.

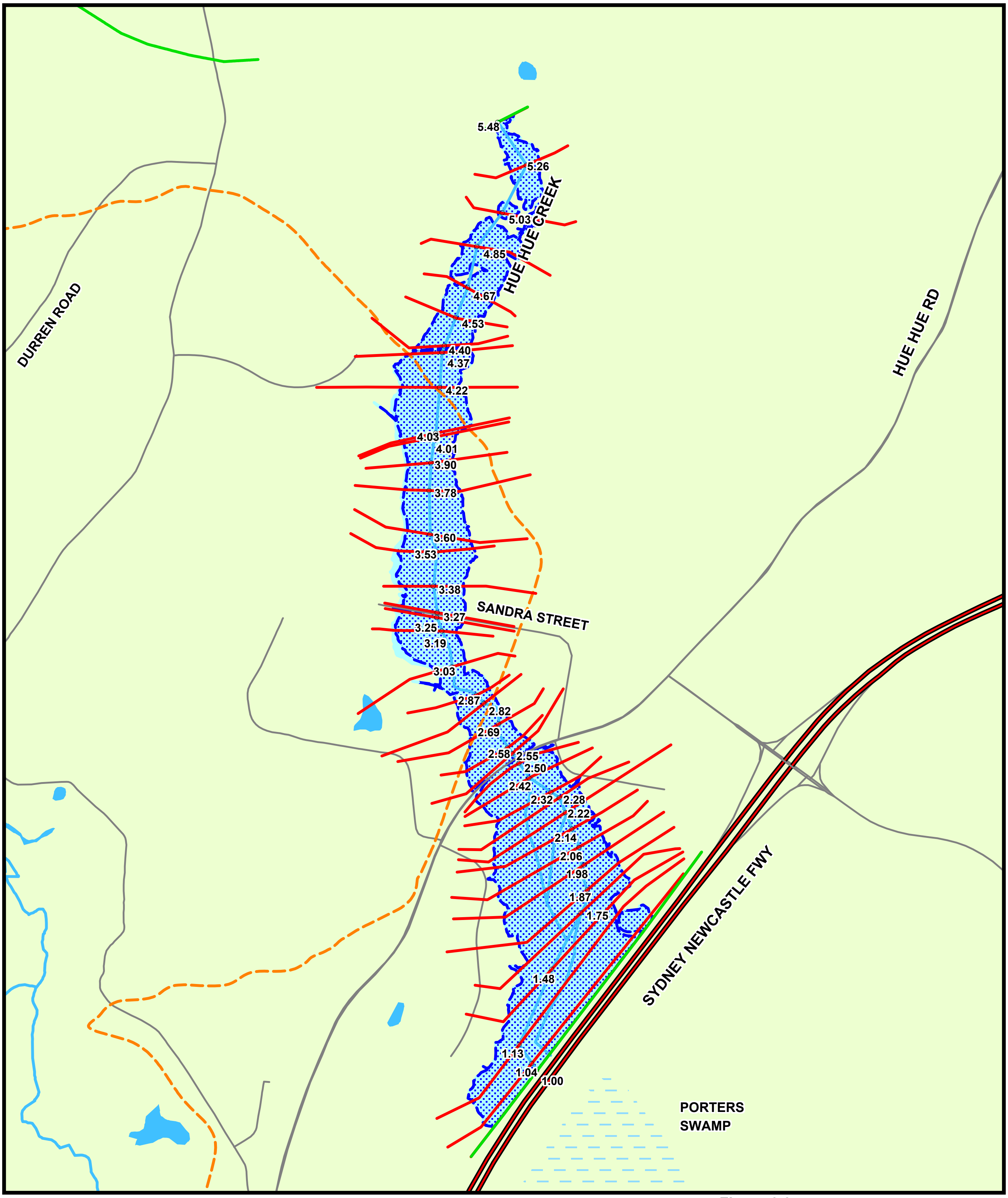
Modelling of existing conditions indicates that three of the four road/access road crossings of Hue Hue Creek which are upstream of the Sydney-Newcastle Freeway are inundated during a 1%AEP event. It is only the bridge across the Cottesloe Road that does not overtop. This is also the case under subsided conditions. The model indicates that the Sydney-Newcastle Freeway is well above the 1% AEP flood level both for existing and subsided conditions.

There are a number of dwellings (including at least one shed or non-primary dwelling) located along the length of Hue Hue Creek, with most located between Sandra Street and the Freeway and two dwellings located just upstream of Sandra Street. Currently six of these dwellings are flood affected during a 1% AEP event. Of these:

- two dwellings are inundated (i.e. flood water above floor levels) during the 1% AEP flood under existing conditions,
- one is flood affected as a result of having access cut during a 1%AEP flood, and
- three have less than 0.5m freeboard.

The HEC-RAS model indicates that subsidence would cause one of the dwellings with insufficient freeboard to become inundated, and an additional dwelling that is currently not flood impacted to have freeboard reduced to less than 0.5m. *Table 6.9* indicates which dwellings are affected, their estimated floor level and predicted 1% AEP flood level.

It was necessary to consider each house along the creek on an individual basis rather than simply comparing the flood level or flood depth before and after subsidence. Predicted subsidence will not occur evenly across the valley.



Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- HEC RAS Cross Section
- Existing Flood Extent
- Subsided Flood Extent

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project Flood Impact Assessment
Drawing No:	0044971_GIS07
Date:	23.05.08 Drawing Size: A4
Drawn By:	JS Reviewed By: SO
Source:	-
Scale:	Refer to Scale Bar

N

0 200 400 600m

Figure 6.6

Subsidence Impact on Flood Extent Hue Hue Creek

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As indicated in *Table 6.9*, the primary impacts are to dwellings D0430, D0415, D0513, and D0589. Dwelling D0430 currently has less than 0.5m freeboard and subsidence with cause this dwelling to become flood prone. Dwelling D0415 currently has less than 0.5m freeboard and as a result of subsidence will no longer be flood affected. This is due to its location on the opposite side of Hue Hue Creek to where most of the subsidence is predicted to occur. Dwelling D0513 is currently not flood affected, and subsidence will mean that this dwelling will have insufficient freeboard during a 1% AEP flood event. Dwelling D0589 is currently flood prone and subsidence will cause the 1% AEP flood depth at this dwelling to be an additional 0.3m above its current depth.

The flood effects on dwellings downstream of Hue Hue Road will not be altered as a result of subsidence. The predicted extent of subsidence does not extend this far down Hue Hue Creek and flooding in this reach is governed by the culverts under the freeway and vegetation in the creek.

Table 6.9 Flood Affected Dwellings, Hue Hue Creek

Dwelling	Cat. [2]	HEC-RAS Cross Section	Existing Ground level	Existing Floor Level [1]	Existing Flood Level (1% AEP)	Existing Freeboard (m)	Comment	Subsided Ground Level	Subsided Floor Level	Subsided Flood Level (1% AEP)	Subsided Freeboard (m)	Comment
D0430	A1	3.38	14.42	14.42	14.1	0.32	Insufficient freeboard	13.6	13.6	13.82	-0.22	Inundated
D0415	E1	3.38	14.2	14.5	14.1	0.40	Insufficient freeboard	14.1	14.4	13.82	0.58	Beneficial Impact
SANDRA STREET												
D0513	C1	3.25	14.5	14.5	13.86	0.64		13.78	13.78	13.73	0.05	Insufficient freeboard
D0507	D	3.19	14.5	14.5	13.82	0.68		14.3	14.3	13.70	0.60	
D0587	D	2.87	13.9	13.9	12.83	1.07		13.7	13.7	12.84	0.86	
D0588	D	2.87	13.4	13.4	12.83	0.57		13.35	13.35	12.84	0.51	
D0589	B2	2.82	12.35	12.35	12.55	-0.20	Inundated	12.3	12.3	12.53	-0.23	Inundated
D0590	E3	2.82	14	14	12.55	1.45		14	14	12.54	1.46	
D0753	U	2.69	14.2	14.2	11.96	2.24		14.2	14.2	11.96	2.24	
HUE HUE ROAD												
D0461	U	2.32	10	10.8	9.93	0.87		10	10.8	9.93	0.87	
D0462	U	2.28	10.5	10.5	9.7	0.80		10.5	10.5	9.7	0.80	
D0463	U	2.22	9.5	9.5	9.4	0.10	Insufficient freeboard	9.5	9.5	9.4	0.10	Insufficient Freeboard
D0464	U	2.14	9	9	9.02	-0.02	Inundated	9	9	9.02	-0.02	Inundated
D0465	U	2.06	8.6	9.3	8.62	0.68	Flood affected access	8.6	9.3	8.62	0.68	Flood affected access
D0466	U	2.06	9	9.3	8.62	0.68		9	9.3	8.62	0.68	
D0467	U	1.98	9	9	8.22	0.78		9	9	8.22	0.78	
D0468	U	1.98	9.5	9.5	8.22	1.28		9.5	9.5	8.22	1.28	

Notes: 1. Floor levels estimated from Dwelling Status Report Flood Prone Areas, Preliminary report, MEGS for COAL, 2001, and topographic data from WACJV DTM

2. Refer Table 6.3 for description of Impact Categories

7 MITIGATION MEASURES

7.1 YARRAMALONG AND DOORALONG VALLEYS

7.1.1 *Property Hazard Mitigation Measures*

It will not be the responsibility of the mine to address the existing (pre-mining) impacts of flooding in the Yarramalong and Dooralong Valleys. However, where properties become more flood prone as a result of mining induced subsidence, mitigation measures will need to be examined. All costs associated with mitigating the impacts of flooding as a result of mining will be borne by the WACJV. Potential management measures are outlined in the NSW Floodplain management Manual (2201) and are listed in *Table 7.1*. They are grouped into three categories:

- *Property modification* – modify properties and/or impose controls on property and infrastructure development;
- *Response modification* – modify the response of the population at risk to better respond to a flood event; and
- *Flood modification* –modify the behaviour of the flood.

Table 7.1 Flood Management Measures

Category	Measure
Property modification	Zoning Voluntary purchase House raising Building and development controls Flood proofing buildings Raising roads and bridges
Response modification	Community awareness Community readiness Flood predictions and warning Local flood plans Evacuation arrangements Recovery plans
Flood modification	Flood control dams Retarding dams Flood levees Bypass floodways Channel improvements Flood gates

1. NSW Floodplain Management manual (2001)

There are a number of options available to the community to mitigate flooding impacts; however many options may not be practical for the existing circumstances or for the type of impacts that result from subsidence. Further, due to the current scale of flooding in the valleys, flood modification structures such as flood control dams or bypass floodways would not be practical or effective. Four mitigation options are recommended for properties significantly impacted by the project within the study area. These are:

- flood levees.
- house raising;
- house relocation; and
- voluntary purchase or other compensation measures.

In the case of house raising and/or relocation, the design floor level would include a freeboard above the 1% AEP post-subsidence flood. This is preferably 500mm but is usually within the range of 300mm to 500mm, depending on the potential for wind waves and turbulence. Council planning requirements also need to be considered. In the case of flood levees, the impacts of the levees themselves on the local environment and other properties need to be considered.

House Raising and House Relocation

House raising is a widely accepted method of reducing flood damage and has been implemented in many flood prone areas in New South Wales. House relocation involves the complete relocation of the dwelling to higher ground preferably nearby within the land-owner's property.

Not all houses are suitable for raising or relocation. Houses best suited to raising or relocation are timber framed and clad with non-masonry materials. There are methods for raising houses constructed on slabs, however these are usually not cost effective.

The following dwellings impacted by subsidence have floor joists and are timber framed. Depending on the existing floor height above the ground level, it may be possible to raise or relocate these dwellings to achieve the required design height:

- Dwelling D0060 – raise 0.63m, or relocate;
- Dwelling D0061 – raise 0.86m, or relocate; and
- Dwelling D0237 – raise 2.02m, or relocate.

Other timber framed dwellings may exist for which similar measures can be taken.

Flood Levees

Ring levees are frequently the most economically viable measure to protect single dwellings in flood prone areas. Ring levees are generally a grassed earthen bund constructed around the dwelling and can be constructed from select fill material obtained from the property. The design also requires a controlled outlet at the lowest point of the levee to drain stormwater and a pump to dewater during rain whenever floodwaters are high. Flood levees are typically designed to protect dwellings from floodwaters up to the 1% AEP flood.

The use of flood levees may be suitable for the following dwellings subject to discussions with the property owners:

- Dwelling D0017 – 1% AEP flood depth 2.8m;
- Dwelling D0058 – 1% AEP flood depth 1.6m;
- Dwelling D0207 – 1% AEP flood depth 1.2m;
- Dwelling D0737 – 1% AEP flood depth 0.7m;
- Dwelling D0773 – 1% AEP flood depth 0.9m;
- Dwelling D0063 – 1% AEP flood depth 2.4m.

These measures have the added benefit of potentially reducing or even eliminating existing flooding impacts on an already partly flood prone property. These works may therefore increase the overall property value and improve agricultural capability.

Voluntary Purchase

In certain high hazard areas of the floodplain it is impractical to mitigate the impacts of flooding on properties at risk. Under such circumstances, the property may need to be purchased at an equitable price or other negotiated compensation may need to be made.

It may be necessary to purchase some properties due to post mining changes in flooding behaviour and if raising or relocating the dwellings or constructing flood levees is impracticable.

7.1.2 *Development Controls*

The NSW Floodplain Management Manual outlines interim guidelines which identify the types of land use, developments and conditions that are generally appropriate to the various hydraulic and hazard categories of flood prone land. These guidelines are used to develop planning controls for land which is impacted by flooding.

The guidelines outlined in the manual recommend development controls based on land use and development categories. The land uses are defined as residential, commercial, industrial, open space, rural/non-urban, and special use.

Residential and rural/non-urban land uses have been reviewed for this study. Development categories which have been reviewed are existing development, infill development and redevelopment.

Development controls for the six flood categories are shown in *Table 7.2*. A number of the controls listed are based on the Flood Planning Level (FPL). Typically, councils in New South Wales adopt the 1% AEP flood for the FPL.

Table 7.2 Development Controls for New Developments

Hydraulic and Hazard Categories	Development Guideline		SPECIAL
	Residential	Rural/non-urban	
High hazard floodway	1,2,3,5 and SPECIAL	1,2,3,5 and SPECIAL where warranted	Incorporate measures to ensure the safe evacuation of people from the area should a design flood or greater occur. Ensure development does not significantly increase flood hazard or flood damage to other properties or adversely affect flood behaviour
High hazard flood storage	1,2,3,5 and SPECIAL	1,2,3,5 and SPECIAL	Incorporate measures to ensure the safe evacuation of people from the area should a design flood or greater occur. Ensure development does not significantly increase flood levels or flood hazard, either at the proposed site or elsewhere
High hazard flood fringe	1,2,3,5 and SPECIAL	1,2,3 and 5	Incorporate measures to ensure the safe evacuation of people from the area should a design flood or greater occur. Ensure that the displacement of these people will not significantly add to the overall cost and community disruption caused by the flood.
Low hazard floodway	1,2,3,5 and SPECIAL	1,2,3,5 and SPECIAL	Ensure development does not significantly increase flood levels or flood hazard at the proposed site or elsewhere.

Hydraulic and Hazard Categories	Development Guideline		SPECIAL
	Residential	Rural/non-urban	
Low hazard flood storage	1,2,3 and SPECIAL	1,2,3 and SPECIAL where warranted	Ensure development does not significantly increase flood levels or flood hazard at the proposed site or elsewhere.
Low hazard flood fringe	1,2 and 3	1,2 and 3	None

Source: NSW Floodplain Management Manual (2001)

1. Any portion of a building or structure below the Flood Planning Level (FPL) should be built from flood compatible materials
2. The habitable floors of new residences and new commercial and industrial developments, together with normally occupied floors of special use developments, should either have a floor level at or above the FPL or be flood proofed to this level
3. Special consideration should be given to caravan parks
5. Building or structure should be able to withstand the force of flowing floodwaters

7.1.3 *Access Mitigation Options*

Subsidence will cause the roads at low points D50, D70 and D80 to become untrafficable for longer periods than for the existing situation. In addition, low points Y80 and Y90 will be marginally impacted in the 1%AEP flood and D60 will be slightly impacted by the 20%AEP flood. Mitigation options are assessed for each low point below.

Low Point D50

The 1%AEP flood levels in the vicinity of D50 vary from RL11.4 to 11.6 m AHD for existing and RL11.1 to 11.3 m AHD for subsided conditions. Parts of the road currently at about RL9.7 m AHD will drop to about RL8.4 m AHD due to subsidence. To reinstate the status quo of 19 hours for which the D50 would be untrafficable would require raising the road over a distance of 440m to RL9.5 m AHD after subsidence.

Low Point D60

Low point D60 at RL7.52 m AHD is located approximately 160m to the northwest of Bridge A. Bridge A itself is at RL8.3 m AHD and is also outside the subsidence area. It may be possible therefore to raise the approach roads by up to 0.8m for a distance of 330m to the west and 160m to the east of Bridge A to reduce the duration this route is untrafficable from 35 hours to 27 hours. There may be slight impacts of flood levels in the vicinity of the raised road but the advantage of reducing duration of inundation would outweigh this effect.

Low Point D70

This low point is significantly affected by subsidence for all floods. The lowest point on the road will subside from RL12.7 to 11.4 m AHD, thereby increasing duration and frequency of inundation. It is relatively simple to raise this road to RL14.0 m AHD over a distance of 400m after subsidence has occurred. This would ensure the road is flood free for all events up to the 1% AEP flood.

Low Point D80

Low point D80 (RL14.61 m AHD) is currently located on Jilliby Road approximately 120m to the north of Bridge B spanning Little Jilliby Jilliby Creek. After subsidence this low point will shift approximately 520m to the north where the road is currently at RL14.7 m AHD and will drop to approximately RL13.4 m AHD. To mitigate these impacts would require raising the road by up to 1.1m to RL14.5 m AHD over a distance of about 480m. Because this would be in the flood fringe, there would be no significant change in final flood levels.It may be possible to flood proof this section of road by raising to RL15 m AHD. However, significant culverts would be required to maintain flow capacity.

Low Point Y80

Three dwellings are affected by flooding increases at low point Y80 for up to 74 hours in the 1% AEP flood, which is an increase of 2 hours on existing conditions. The road could be raised by up to approximately 0.4m over a distance of 80m to mitigate the increase in flooding duration at the low point.

Low Point Y90 (Bridge 7)

The access across the Wyong River (Bridge 7) will become the critical low point if Y80 is raised sufficiently to reduce inundation duration to less than 63 hours in the 1% AEP flood. Because this bridge may subside by approximately 0.1m it would be beneficial if the bridge were also raised by at least this amount.

7.1.4 Emergency Evacuation Routes

Access routes to higher ground were investigated for the case when primary and secondary access routes become untrafficable. It was found that for most dwellings, access to higher ground is available during large floods.

While many access roads in the Yarramalong and Dooralong Valleys become untrafficable during floods, there are roads which provide residents with access to higher ground if required. These include Bantman Drive and Watagan Forest Drive. Although these routes pass through catchments where flood levels are unknown, residents are able to use these routes during emergencies.

The primary access route for residents in the Yarramalong Valley is Yarramalong Road which runs along the right bank of the Wyong River and joins the Newcastle-Sydney Freeway to the east of the study area. Emergency evacuation routes for residents in the Yarramalong Valley are:

- Yarramalong Road to the west which provides access to the Yarramalong district; and
- Bantman Road (unsealed single lane) which provides access to the Sydney-Newcastle Freeway. The Bantman Road emergency evacuation route is described in *Table 7.3.*

Table 7.3 Bantman Road – Emergency Evacuation Route

	Road/River Crossing Name	Northing	Easting
Intersection	Yarramalong Rd into Bantam Rd	6317100	348800
Intersection	Bantam Rd into Red Hill Rd	6315250	347500
Intersection	Red Hill Rd into Wallaby Rd	6314700	345400
Crossing	Drainage Channel	6311400	346700
Intersection	Wallaby Rd into Palmdale Creek Rd	6311300	347150
Bridge	Drainage Channel	6311400	347200
Bridge	Canada Drop Down Creek	6311000	347800
Bridge	Ourimbah Creek	6310500	349000
Intersection	Palmdale Creek Rd into Sydney Newcastle Fwy	6310400	349100

The primary access route for residents on the right bank of Dooralong Valley is Jilliby Road (sealed, single/two lane) which joins Hue Hue Road (sealed, two lanes). Hue Hue Road then joins the Sydney-Newcastle Freeway to the east of the study area. The secondary access routes are:

- Durren Road (unsealed, single lane) which crosses Jilliby Jilliby Creek and joins Dickson Road (unsealed, single lane). Dickson Road joins Hue Hue Road which provides access to the Sydney-Newcastle Freeway. Dickson Road also joins Mandalong Road (unsealed, two lane) to the north which provides access to Morisset; and
- Mandalong Road (sealed/unsealed, single/two lane) which crosses Jilliby Jilliby Creek and provides access to Morisset.

An emergency evacuation route for residents on the left bank of the Yarramalong Valley and right bank of Dooralong Valley is Watagan Forest Drive, this road provides access to Morisset. The Watagan Forest Drive evacuation route is described in *Table 7.4.*

Table 7.4 Watagan Forest – Emergency Evacuation Route

	Road/River Crossing Name	Northing	Easting
Intersection	Jilliby Rd into Dunks La	6318900	349400
Crossing	Drainage Channel	6319000	348900
Name Change	Watagan Rd	6319300	347900
Name Change	Watagan Forest Dr	6321400	343500
Intersection	Watagan Forest Rd into Martinsville Hill Rd	6338200	346500
Crossing	Drainage Channel	6340500	350500
Intersection	Martinsville Hill Rd into Martinsville Rd	6340800	351400
Crossing	Drainage Channel	6340700	351700
Bridge	Merchants Creek	6340100	352500
Crossing	Un-named creek	6339600	353000
Bridge	Un-named creek	6339400	353900
Bridge	Burnt Bridge Creek	6338800	354200
Intersection	Martinsville Rd into Freemans Dr	6338700	355000

7.2 *HUE HUE CATCHMENT*

To reduce the impacts of subsidence, and to minimise impact of flooding to the houses located within the Hue Hue Creek catchment, four main options were investigated to improve flow in the creek. These included:

1. Upgrading Sandra Street and Hue Hue Road crossings;
2. Improve the channel, by modifying the slope and providing a more defined low flow channel;
3. A combination of channel improvements and upgrading Sandra Street and Hue Hue Road crossings; and
4. A combination of channel improvements, upgrading the Hue Hue Road crossing and raising the level of Sandra Street and its crossing.

Each of the above options are detailed below.

7.2.1 *Option 1*

The Sandra Street and Hue Hue Road crossings currently consist of box culverts. Details of the culverts are provided in *Annex A* with the Sandra Street culvert providing an 8.25m opening and the Hue Hue Road culvert providing a 9m opening. Option 1 (a) involves widening the opening under each road crossing to 60m.

Modelling results indicate that there is no significant improvement to the condition of flood affected dwellings achieved through upgrading the road crossings to provide an opening of 60m.

The effect of increasing the width of the openings further (120m bridges at each crossing) was investigated as Option 1 (b), to assess any additional benefit this may bring.

Modelling results indicate that there is no significant benefit in providing the additional openings.

7.2.2 *Option 2*

The second option assessed involved improving the channel along Hue Hue Creek in a section between Sandra Street and Hue Hue Road as well as a section downstream of Hue Hue Road. Improvements included provision of a defined channel, with a 10m base and sides sloping at 1V:3H, and steepening of the channel in these sections. Results of this analysis are presented in *Table 7.5*.

Table 7.5 Option 2 Impacts

Dwelling	HEC-RAS Cross Section	Subsided Ground level	Subsided Floor Level	Flood Level after works (1% AEP)	Freeboard after works (m)	Comment
D0430	3.38	13.6	13.6	13.83	-0.23	No change
D0415	3.38	14.1	14.4	13.83	0.57	No change
SANDRA STREET						
D0513	3.25	13.78	13.78	13.73	0.05	No change
D0507	3.19	14.3	14.3	13.71	0.59	No change
D0587	2.87	13.7	13.7	12.84	0.86	No change
D0588	2.87	13.35	13.35	12.84	0.51	No change
D0589	2.82	12.3	12.3	12.5	-0.2	No change
D0590	2.82	14	14	12.5	1.5	Increased Freeboard
D0753	2.69	14.2	14.2	11.94	2.26	Increased Freeboard
HUE HUE ROAD						
D0461	2.32	10	10.8	9.82	0.98	Increased Freeboard
D0462	2.28	10.5	10.5	9.64	0.86	Increased Freeboard
D0463	2.22	9.5	9.5	9.23	0.27	Increased Freeboard
D0464	2.14	9	9	8.85	0.15	No longer inundated
D0465	2.06	8.6	9.3	8.54	0.76	Increased Freeboard
D0466	2.06	9	9.3	8.54	0.76	Increased Freeboard
D0467	1.98	9	9	8.09	0.91	Increased Freeboard
D0468	1.98	9.5	9.5	8.09	1.41	Increased Freeboard

The channel improvements modelled downstream of Hue Hue Road resulted in no dwellings in this section of Hue Hue Creek being flood prone; two dwellings however will have freeboards less than the 0.5m used for assessment purposes in this report (one dwelling will have a freeboard of 0.27m and the other 0.15m). It should be noted that this area will not be affected by subsidence. These dwellings are currently flood prone and the suggested mitigation options would assist owners of these properties by alleviating current flood impacts.

The channel improvements modelled downstream of Hue Hue Road resulted in no dwellings in this section of Hue Hue Creek being flood prone; two dwellings however will have freeboards less than the 0.5m used for assessment purposes in this report (one dwelling will have a freeboard of 0.27m and the other 0.15m). It should be noted that this area will not be affected by subsidence. These dwellings are currently flood prone and the suggested mitigation options would assist owners of these properties by alleviating current flood impacts.

The channel improvements assessed in the section of Hue Hue Creek between Sandra Street and Hue Hue Road produce similar results to improving the crossing at Hue Hue Road. Dwelling D0430 is flood prone under both scenarios, however Option 2 reduces the depth of inundation by 7 cm. Dwelling D0513 has insufficient freeboard under both scenarios, however the freeboard is 1cm greater with Option 2. Dwelling D0589 is flood prone under both scenarios, however Option 2 reduces the depth of inundation by 1 cm.

7.2.3 Option 3

This option assesses a combination of implementing both Option 1(a) and Option 2. Results of the modelling of this option are presented in *Table 7.6*.

Table 7.6 Option 3 Impacts

Dwelling	HEC-RAS Cross Section	Subsided Ground level	Subsided Floor Level	1%AEP Flood Level after works	Freeboard after works (m)	Comment
D0430	3.38	13.6	13.6	13.9	-0.3	Inundation increased 80mm
D0415	3.38	14.1	14.4	13.9	0.5	No significant change
SANDRA STREET						
D0513	3.25	13.78	13.78	13.73	0.05	No significant change
D0507	3.19	14.3	14.3	13.7	0.6	No significant change
D0587	2.87	13.7	13.7	12.84	0.86	No significant change
D0588	2.87	13.35	13.35	12.84	0.51	No significant change
D0589	2.82	12.3	12.3	12.47	-0.17	Reduced inundation
D0590	2.82	14	14	12.47	1.53	Increased Freeboard
D0753	2.69	14.2	14.2	12.04	2.16	Reduced Freeboard
HUE HUE ROAD						
D0461	2.32	10	10.8	9.82	0.98	Increased Freeboard
D0462	2.28	10.5	10.5	9.64	0.86	Increased Freeboard
D0463	2.22	9.5	9.5	9.23	0.27	Increased Freeboard
D0464	2.14	9	9	8.85	0.15	No longer inundated
D0465	2.06	8.6	9.3	8.54	0.76	Increased Freeboard
D0466	2.06	9	9.3	8.54	0.76	Increased Freeboard
D0467	1.98	9	9	8.09	0.91	Increased Freeboard
D0468	1.98	9.5	9.5	8.09	1.41	Increased Freeboard

The model indicates that this option will produce similar results to Option 2.

7.2.4 *Option 4*

This option includes the same works assessed in Option 3, as well as raising of Sandra Street to a level of 14 mAHD. The existing level of Sandra Street where it crosses Hue Hue Creek is 13.62 mAHD, which falls to 13.5 mAHD as a result of subsidence. This Option was assessed as a means of protecting dwelling D0513, located immediately downstream of Sandra Street. The modelling results for this option are shown in *Table 7.7*.

Table 7.7 Option 4 Impacts

Dwelling	HEC-RAS Cross Section	Subsided Ground level	Subsided Floor Level	1%AEP Flood Level after works	Freeboard after works (m)	Comment
D0430	3.38	13.6	13.6	14.01	-0.41	Inundation increased 130mm
D0415	3.38	14.1	14.4	14.01	0.39	No significant change
SANDRA STREET						
D0513	3.25	13.78	13.78	13.73	0.05	No significant change
D0507	3.19	14.3	14.3	13.70	0.60	No significant change
D0587	2.87	13.7	13.7	12.84	0.86	No significant change
D0588	2.87	13.35	13.35	12.84	0.51	No significant change
D0589	2.82	12.3	12.3	12.47	-0.17	Reduced inundation
D0590	2.82	14	14	12.47	1.53	Increased Freeboard
D0753	2.69	14.2	14.2	12.04	2.16	Reduced Freeboard
HUE HUE ROAD						
D0461	2.32	10	10.8	9.82	0.98	Increased Freeboard
D0462	2.28	10.5	10.5	9.64	0.86	Increased Freeboard
D0463	2.22	9.5	9.5	9.23	0.27	Increased Freeboard
D0464	2.14	9	9	8.85	0.15	No longer inundated
D0465	2.06	8.6	9.3	8.54	0.76	Increased Freeboard
D0466	2.06	9	9.3	8.54	0.76	Increased Freeboard
D0467	1.98	9	9	8.09	0.91	Increased Freeboard
D0468	1.98	9.5	9.5	8.09	1.41	Increased Freeboard

This option makes flood conditions worse at dwelling D0430. It reduces the freeboard at dwelling D0415 to approximate existing conditions. The freeboard at dwelling D0513 is similar to the other options assessed but flows would be reinstated to the main channel rather than across the subsided low point adjacent to this dwelling. Results at other flood affected properties are similar to Option 3.

7.2.5 *Summary*

The following list provides a summary of the above analysis of mitigation options in relation to each flood affected property:

Dwelling D0430: This property currently has 0.39m freeboard for existing conditions. As a result of subsidence, this house will become flood prone, with the 1%AEP flood level being 0.22m above the estimated subsided floor level, which is 0.82m lower than the existing floor level. The mitigation options considered above are unable to alleviate flooding at this property. Two options are considered appropriate for mitigation of flood impacts resulting from subsidence to this dwelling:

1. Construct a levy around the property, the height of which would depend on what other mitigation works were being undertaken along Hue Hue Creek. Based on the modelling results from the options considered above the levy would need to be between 0.20m and 0.41cm high.

2. Purchase the property or provide other appropriate negotiated compensation.

- *Dwelling D0415:* This dwelling currently has 0.4m freeboard. As a result of subsidence, this dwelling will not be flood affected partly because it is located on the opposite side of Hue Hue Creek to where most of the subsidence is predicted to occur. It is estimated that the floor level of this dwelling will drop by 0.1m. Of the options considered above, only Option 4 results in a change to this, where flood conditions would return to approximate existing conditions at this property.

- *Dwelling D0513:* This dwelling is currently not flood affected. Its existing floor level is 0.64m above the existing 1%AEP flood level. As a result of subsidence, the floor level of this dwelling is estimated to drop by 0.72m, and freeboard will reduce to 0.04m. Sandra Street, located just upstream from this dwelling, also subsides by a similar amount resulting in more of the flow passing over this side of the valley and hence creating additional impacts. None of the options considered above alleviate flooding at this property. However implementing Option 4 (raising Sandra Street) combined with construction of a small levy would mean that this property could be protected.

- *Dwelling D0589:* This dwelling is understood to be a 'granny flat' located on the same property as Dwelling D0588. This dwelling is currently flood prone, with flood levels being about 0.2m above existing floor levels. As a result of subsidence, this dwelling would remain flood prone with flood levels being 0.23m above estimated subsided floor levels. The channel improvements assessed would result in flood levels being reduced to 0.17m above estimated subsided floor levels. Given the proximity of this property to Hue Hue Creek, and its location within the floodway, there are few practical options available to protect against flooding.

Dwellings D0463, D0464 and D0465: These properties are downstream of the area affected by subsidence. They are currently flood prone and the predicted subsidence upstream of these properties will not impact on flooding at these properties. Channel improvements in this section of Hue Hue Creek were modelled to assess potential for alleviating flooding. The channel improvements modelled were found to result in none of the dwellings in this area being flood prone and left only two with freeboards less than 0.3m (dwellings D0463 and D0464).

8 *CONCLUSION*

8.1 *GENERAL IMPACTS*

Impacts of subsidence on flooding are generally limited to subsidence areas. Downstream of subsidence areas flood depths reduced slightly due to the detention affects of extra flood storage volumes in subsided areas. Upstream of subsided areas flood depths reduced as a result of lower tailwater levels. The effects of these reductions generally dissipated within 600 meters of the subsidence areas.

There will be no measurable impacts on hydrology, catchment yield or overall flood volumes as a result of subsidence. There will be a very small reduction in peak flows as a result of detention effects which will be matched by a very slight increase in flood durations; however, these effects will be insignificant (2% reduction in peak flow, 6% increase in duration and 0% reduction in volume at the freeway).

It was found that negligible changes will occur to flood extents and depths in the Yarramalong Valley (Wyong River) as a result of predicted mine subsidence. Subsidence predictions suggest that the maximum subsidence under the main channel of the Wyong River will be in the order of 0.15 metres over a very short section.

In the Dooralong Valley (Jilliby Jilliby Creek and tributaries) subsidence generally of between zero and up to 1.3 metres will occur within the affected sections of the channel. Isolated small areas of the adjacent floodplain will experience subsidence of the order of approximately 1.6 metres. Subsidence levels in the lower Jilliby Jilliby Creek channel (below the confluence with Little Jilliby Jilliby Creek) are expected to be mostly less than 0.75 metres. Reductions of flood levels within or near the subsided areas of 0 to 1.85 metres and changes in flood depth of -1.1 metres to +1.1 metres can be expected.

For Hue Hue Creek, mining will result in subsidence of up to 0.95 metres under the floodplain and will cause reductions in flood levels within or near the subsided areas of 0 to 0.5 metres with changes in flood depths of -0.1 metres to +0.7 metres.

8.2 *IMPACTS ON DWELLINGS AND PROPERTIES*

Only three dwellings near Hue Hue Creek will be adversely impacted by changes to flooding as a result of mine subsidence and one dwelling will have a beneficial impact of greater freeboard (height of floor level above the 1% AEP flood).

Of the 79 dwellings in the Yarramalong/Dooralong study area located within the 1 in 100-year ARI floodplain, 34 will be subject to some degree of potential adverse impacts. Of these dwellings subject to potential adverse impacts, 19 will be subject to increased flood inundation. The majority of these are already subject to inundation by the existing 1% AEP flood but five are not currently inundated in the 1%AEP flood.

In terms of impact categories (refer *Table 6.3*):

- Seven dwellings will experience major impacts, comprising five dwellings that will become newly subject to flooding by the 1% AEP event (1 in 100 year flood) and two that are already subject to these floods but which will experience additional flood depths of more than 0.3m in flood level;

- Ten dwellings will experience moderate impacts, mostly comprising dwellings already affected by the 1% AEP flood, but which will be expected to experience minor additional flood depths of less than 0.3m post-mining;

- 17 will experience minor or negligible impacts, mainly comprising dwellings that are flood free but will have reduced freeboard (height of floor level above the flood);

The majority (45) of the 79 dwellings in the Yarramalong/Dooralong study area will not be adversely affected, and a proportion will in fact be beneficially impacted:

- One dwelling will experience a significant benefit in reduction of flood levels and will achieve a freeboard of more than 0.3m post-mining;

- Nine dwellings will experience a minor benefit in reduction of flood levels after mining (<0.2 m);

- 28 dwellings (the largest proportion of the 79 dwellings in the study area) will register negligible to very minor beneficial impacts; and

- Seven dwellings will experience no change or effect as a result of subsidence impacts on flooding.

A number of additional properties may be subject to changes in floodwaters on their land but will otherwise not be impacted by changes to flood conditions as a result of subsidence. A total of 53.8ha of additional land, mainly in the Dooralong Valley, will be inundated in the 1% AEP flood following the subsidence as a result of mining. However, 9ha will no longer be classified as flood prone after mining. The consequences of this additional extent of floodable land are expected to be minor as most is grazing land. However, each property will need to be assessed individually as part of the PSMP process to confirm land use and potential for damage closer to the time of mining in that location.

8.3 *IMPACTS ON FLOOD HAZARD AND RISK*

There will be no significant changes in flood hazard with the exception of the additional land inundated which will become part of the flood fringe. There will be no significant changes in flood velocities but increase in flood depths can be viewed as a form of increased hazard. Dwellings on higher ground within the flood extent will have increased risk of evacuation routes being cut off wherever subsidence increases flood depths.

8.4 *IMPACTS ON ACCESS ROUTES*

Three low points (D50, D70 and D80) on two primary access routes (Jilliby Road and Dickson Road) will be adversely impacted by changes to the 1%AEP as a result of subsidence. The depth and duration of inundation will increase at these low points. Only one property access road affecting three properties in the Yarramalong Valley will be affected by subsidence (at points Y80 and Y90).

8.5 *MITIGATION OPTIONS*

General options available to reduce flood levels include channel improvements and provision of additional waterway area at bridges and other constrictions. These types of options have limited benefit and are often not cost effective. However, for the reach of Jilliby Jilliby Creek between Chainage 13.6km and 14.6km, the main channel may need regrading to prevent ponding of water upstream of the unsubsided zone over the main underground mine access roadways.

Options available to mitigate against flood impacts on dwellings include construction of flood levees, raising houses in-situ and relocating or reconstructing houses on higher ground within the property. Where impacted dwellings are unable to be protected, raised or moved, properties may need to be purchased or the landowners compensated in accordance with the regulatory provisions including conditions of approvals and leases. Prior to mining taking place in that particular location, each dwelling will need to be assessed individually and properties where land but not dwellings are affected will also need to be considered.

Options to mitigate against impacts on access routes, include raising bridges, raising low sections of roads, and improving the hydraulic capacity of channels in some sections. All low points discussed in *Section 8.4* can be addressed by moderate road raising.

8.6 *BENEFITS*

There are a significant number of dwellings that will have slight beneficial impacts as a result of subsidence related changes to flooding. While these are small (generally less than 20mm reduction in flood levels) they should be considered in overall assessments.

There are also opportunities to improve situations compared to existing conditions in many locations. Dwellings that are currently flood prone which are raised, relocated or reconstructed will become flood free. Several roads including Jilliby Road, Dickson Road, Hue Hue Road and Sandra Street can be raised or otherwise modified to reduce inundation to less than existing conditions.

8.7 *IMPLICATIONS FROM STRATEGIC REVIEW*

On 5 February 2007 the NSW Government Minister for Planning announced an independent strategic review into potential coal mine developments in the Wyong local government area (LGA), including the Dooralong and Yarramalong Valleys. An Independent Expert Panel was appointed to conduct the review and report on:

1. Whether coal mining under the catchment for the Mardi Dam would compromise, in any significant way, the water supply of the Central Coast;

2. Environmental impacts of any underground coal mining, with a particular emphasis on:

   - surface and groundwater resources, especially on drinking water supply and flooding;
   - hazards and risks of subsidence impacts; and
   - the amenity of the community, including dust and noise impacts;

3. Social and economic significance of any underground coal mining to the local community, the region and State; and

4. Areas where mining should not be permitted, or if permitted the conditions under which it may proceed, having regard to the matters listed above and the NSW Government's strategic planning policies that apply to the area.

There were a number of findings and recommendations for future coal mining activities in the Wyong LGA as a result of the review. The subsequent Strategic Review Report dated July 2008 was released on 17 December 2008.

ERM has reviewed the Strategic Review report which raised a number of issues relevant to current flooding behaviour in the Dooralong and Yarramalong Valleys as well as potential flooding impacts associated with the Wallarah No 2 Coal Project (W2CP). The issues raised and a response to these issues, are provided in the *Table 8.1*.

Table 8.1 *Findings and Recommendations of the Strategic Review*

Issue Raised by the Strategic Review	Comment/ Response to the Issue
(Exec Summ, p1) "…subsidence is unlikely to compromise in any significant way the water supply of the Central Coast, since the nature of the geology, geomorphology and depth of the coal seams make it unlikely that underground mining will result in a loss of surface water." "…subsidence-induced hydraulic connectivity between Wyong River, Jilliby Jilliby Creek or their alluvial systems and any underlying mine workings is extremely unlikely."	This flood impact assessment report has been prepared in close association with the specialist studies on subsidence and groundwater and accordingly the Strategic Review report's findings by independent experts are consistent with the conclusions ERM has drawn and are therefore supported. Further assessments have been undertaken based on comprehensive modelling and these assessment are documented in this report. Flood study investigations have resulted in changes to the proposed mine plan which have effective mitigated the adverse impacts of flooding.
(Executive Summary, page1) "…community concerns were particularly related to an ongoing guarantee for the quality and quantity of the region's water supplies. The Yarramalong and Dooralong Valleys and their streams supply 35-40% of the Central Coast's drinking water."	This flood impact assessment report agrees that water security is important and that these streams supply approximately 35%-40% of the Central Coast's drinking water. Only about 10% of water supply is of direct relevance (that sourced from Jilliby Jilliby Creek) given that the Wyong River will not be mined beneath and therefore there will not be any significant fluvial impacts on that water source. However, only a much smaller percentage of the flows is actually able to be harvested for water supply and the majority of river flows continue to the Tuggerah Lake as uninterrupted environmental flows [refer Chapter 7 of the EA report]. There is unlikely to be any loss of catchment water yield arsing from mining activity.
(Exec Summ, p2) Groundwater sourced from the Wyong River and Jilliby Jilliby Creek alluvial systems account for between 3.5% and 6% of the water supply of the Central Coast and "any mining activity would not significantly impact on the existing groundwater levels or groundwater availability".	This flood impact assessment report supports this Strategic Review report finding.
(Exec Summ, p2) "Impacts arising from upsidence are also likely to be minimal because of the nature and thickness of the alluvial deposits and underlying strata"	This flood impact assessment report supports this Strategic Review report finding. .
(Exec Summ, p2) "Flooding already occurs on a regular basis within the Wyong LGA, including in the Yarramalong and Dooralong Valleys. Subsidence would normally be	The issue of instream ponding formed part of the iterative development of the mine plan. The location of the permanent underground main roadways beneath the Little Jilliby Jilliby

Issue Raised by the Strategic Review	Comment/ Response to the Issue
expected to expose some features to an increased frequency of flooding or to a risk of flooding that may not have existed previously. The Panel considers that there is a likelihood of some change in the distribution and extent of ponding, due to mining-induced subsidence. To alleviate any adverse consequences, effective mitigation and remediation measures (eg improved drainage) should therefore be planned and implemented."	Creek and the orientation and length of the lonwall panels near the confluence with Jilliby Jilliby Creek were purposely configured to avoid adverse instream ponding impacts.
(Section 3.3.5, page 68) "..increased flooding risks and changed flood behaviour are further matters which must be addressed in detail in an environmental assessment lodged under Part 3A in respect of Wallarah 2")	This flood impact assessment report provides a comprehensive review of flooding risks and potential changes to flood behaviour, thereby addressing this requirement expressed in the Strategic Review report.
(s 3.3.5, pp69-70) "The location and depth of subsidence depressions in the Jilliby Jilliby Creek floodplain and any necessary mitigation or remediation measures are matters which should be addressed in some detail in the environmental assessment lodged under Part 3A in respect of Wallarah 2".	This flood impact assessment report has been prepared in association with specialist studies on subsidence and groundwater which also discuss relevant mitigation measures. Relevant flood mitigation and remediation measures are discussed in Chapter 7.
(s4.1.2.1, p92) "Wyong Shire Council's Flood Prone Land Development Policy provides that the floor level of newly-built habitable rooms must be at least 300 mm above the 1% AEP flood level (and a further 200 mm above this height for locations close to Tuggerah Lake). The Panel believes that these standards are also appropriate to apply to mining-induced subsidence impacts on privately owned dwellings. Consequently, it considers that rectification of subsided dwellings should elevate them to this level wherever that is feasible and is requested by the owner of the dwelling."	ERM agrees with this finding. The flood impact assessment report adopts this approach. Flood impact mitigation and rectification strategies are described in Chapter 7. W2CP also concurs with the proposal for rectification of subsided dwellings to these levels, where practicable and requested by the landowner.
Inquiry Recommendations Relevant to Flooding	
2) Future coal mine proponents in the Wyong LGA should be required to demonstrate a strong commitment and systematic approach to keeping the community informed and responding to community concerns. Particular issues that need to be addressed by future mine proponents include: a) developing a trust relationship between the mine proponent and the local community; b) investing in relationships and an information sharing process with other companies and government agencies in order to gather accurate and consistent baseline data; c) providing the community with accurate, high quality information; and	This flood impact assessment documents the process of data sharing undertaken by ERM and the WACJV in relation to flood modelling for over a decade (refer Chapters 3, 4 and 5). This includes accurate and high quality survey data, technical investigations and flood modelling data that have been shared with Council and the community. A significant community consultation program has been undertaken in relation to flooding. Chapter 7 outlines the intentions and commitments for ongoing and constructive interaction with relevant landowners, authorities and the community, in relation to monitoring, impact management and emergency procedures. W2CP is also a member of Wyong Council's Tuggerah Lakes Estuary, Coastal and Floodplain Management Committee and has

Issue Raised by the Strategic Review	Comment/ Response to the Issue
d) establishing processes to respond to and review community concerns or complaints.	provided multiple briefings on W2CP to this committee.
5c) In relation to groundwater and surface water resources: State Government funding should be allocated for development of a systematic monitoring network with automatic data logging;	W2CP has advised that it agrees with this specific recommendation and other items listed under Recommendation 5. An integrated long term monitoring strategy has been developed for the W2CP (outlined in brief Chapter 14 of the EA) including matters relevant to flooding issues including subsidence, property surveys, fluvial geomorphology inspections and surface water monitoring [Also refer to Rec13f].
6) Subsidence impacts from new underground coal mines within the Wyong LGA should be mitigated such that affected privately-owned dwellings will be in accordance with Wyong Shire Council's Flood Prone Land Development Policy after mining is completed (either by impact minimisation or rectification), or otherwise subject to appropriate compensation.	W2CP supports this Recommendation. W2CP has advised that it also concurs with the recommendation for post-mining rectification of subsided privately-owned dwellings to be in accordance with this policy, where practicable and where requested by the landowner, or otherwise subject to appropriate compensation. This study has taken a conservative approach to evaluation of potential impacts and it includes consideration of the implications of both 0.3m and 0.5m potential flood freeboard scenarios.
13f) In respect of the Wallarah 2 Project proposal: Wyong Shire Council and the community should be encouraged to allow water monitoring stations to be installed and accessed to allow for better collection of baseline and monitoring data.	ERM agrees with this Recommendation to ensure that monitoring is facilitated so as to provide more baseline data set prior to the commencement of underground longwall mining operations beneath alluvial floodplain areas. Existing surface monitoring stations are currently operated by the State Government along both Jilliby Jilliby Creek and Wyong River. Water quality monitoring at various flow points has been undertaken by WACJV for over 10 years and this is proposed to continue in future. W2CP has advised that it would support a condition of consent that reflects its proposals (in Chapter 14 of the EA) for establishing an appropriate monitoring network for both surface and groundwater relevant to its project area of impacts.

No new issues relevant to flooding impacts associated with the W2CP were raised by the Strategic Review report which were not already addressed in the initial design of the project. ERM has undertaken modelling and assessments in accordance with relevant standards and is satisfied that the proposed mitigation and remediation measures recommended are in line with current industry best practice.

REFERENCES

Bureau of Meteorology (1994) *Bulletin 53*

Department of Planning (December 2008) *Impacts of Potential Underground Coal Mining in the Wyong Local Government Area – Strategic Review*

ERM (March 2003) *Yarramalong and Dooralong Valleys - Flood Impact Assessment*

ERM (March 2000) *Hue Hue Creek Baseline Flood Study DRAFT*

ERM (May 2000) *Yarramalong and Dooralong Valleys Baseline Flood Study*

Grahame Lindsay & Claire Byrne (June 2001) *Dwelling Status Report – Flood Prone Areas (Preliminary Report)*

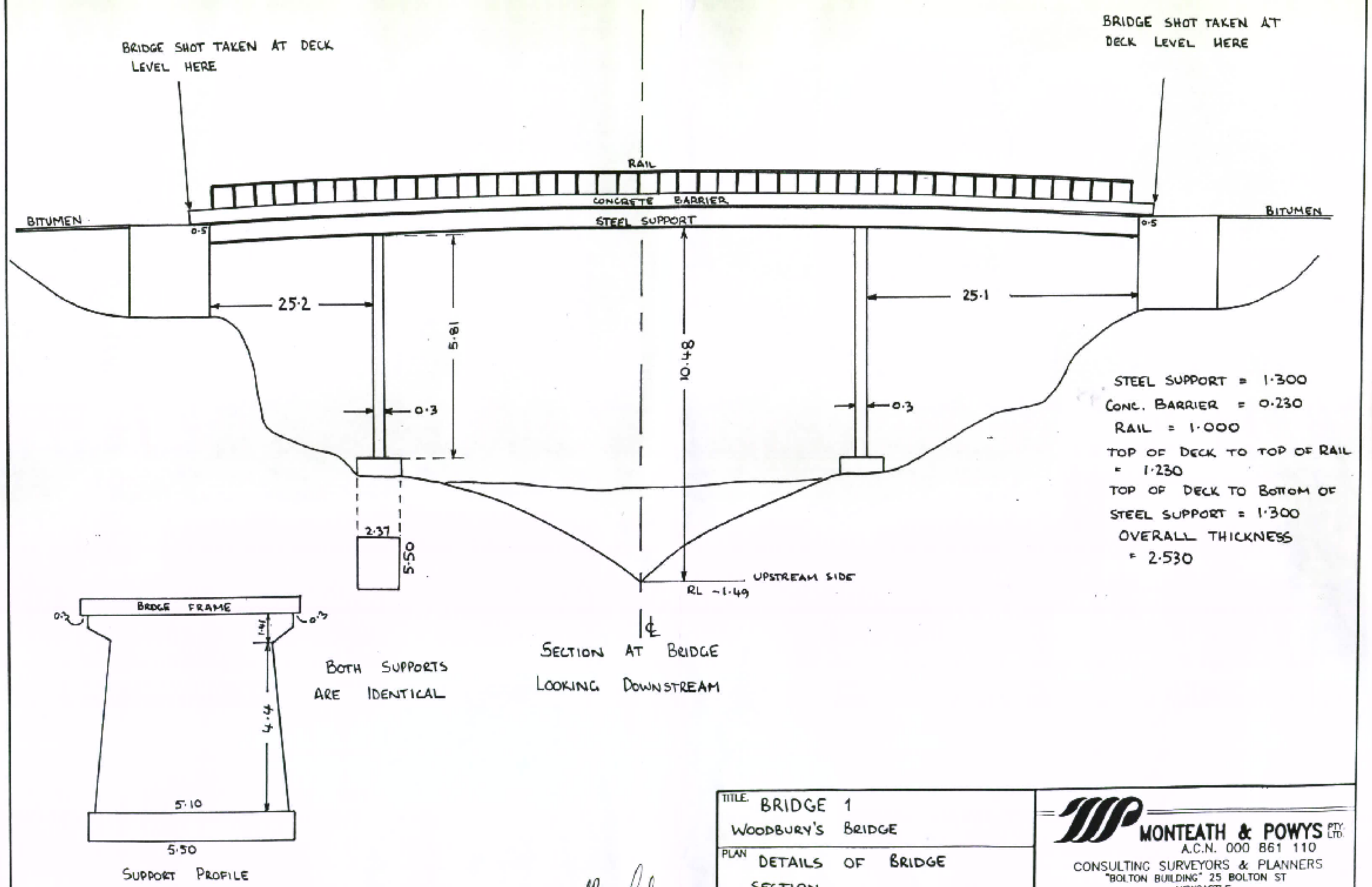
New South Wales Government (2005) *Floodplain Management Manual*

Public Works Department (1988) *Upper Wyong River Study*

Willing and Partners (May 1990) *Trunk Drainage Investigation Warnervale East 7b Stage 1- Flood Study*

Annex A

Detailed Survey



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WOODBURY'S BRIDGE

PLAN: DETAILS OF BRIDGE SECTION

DATE: 14/8/97 | R.R. NOT TO SCALE | REF: 96/110

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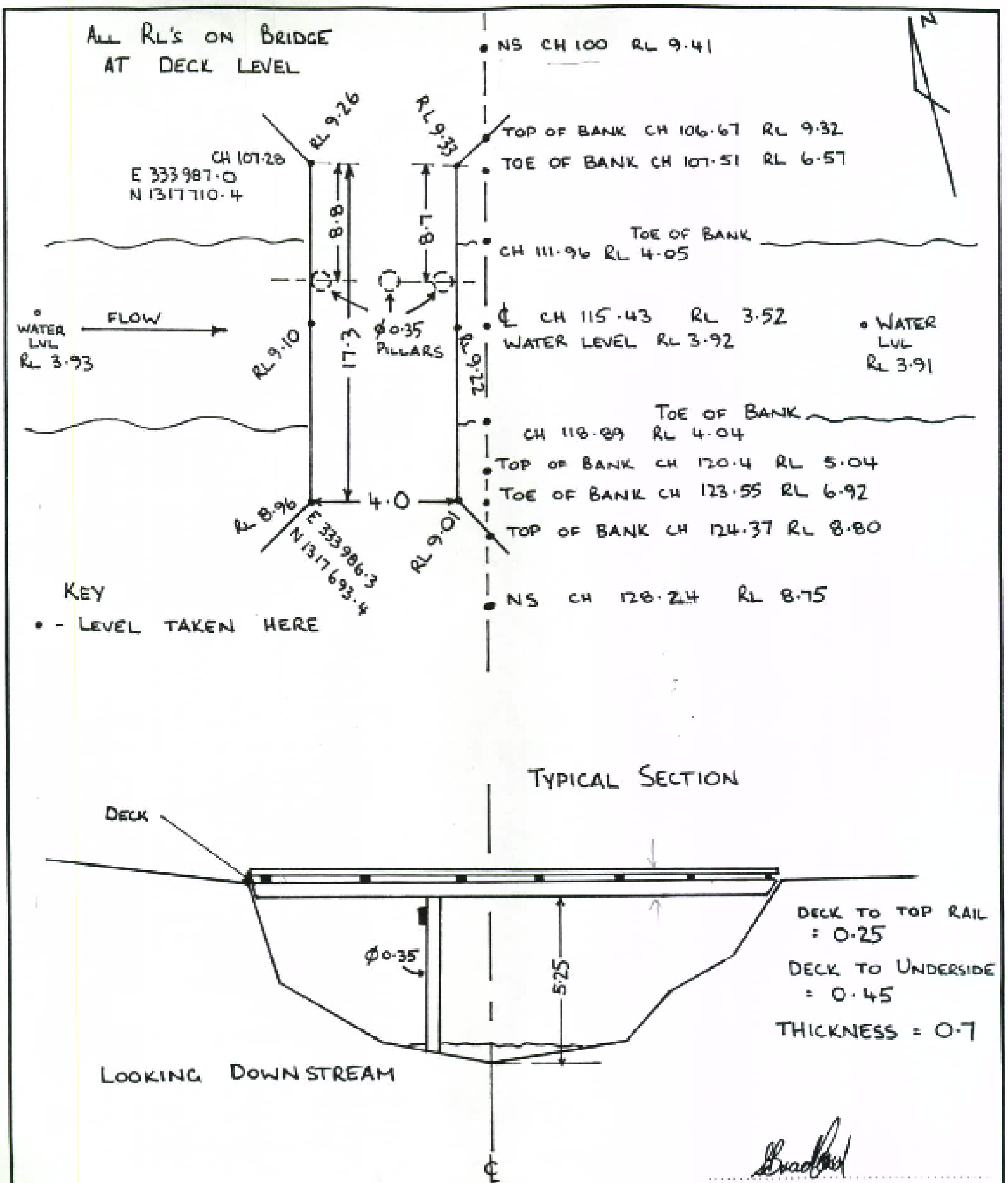

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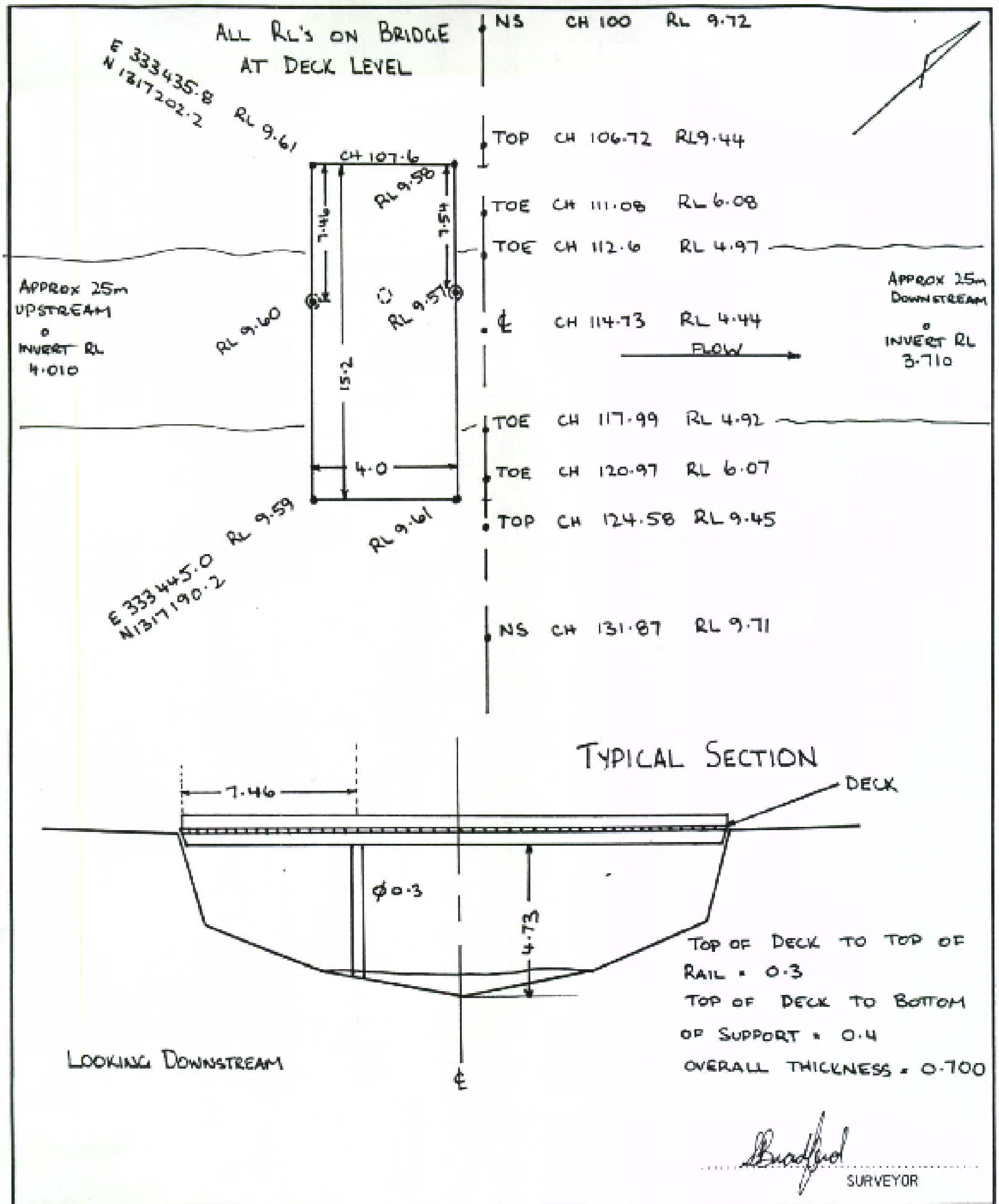
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	PHONE (049) 261888 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888
DATE 29/7/97 · R.R. NOT TO SCALE · REF 96/110	



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DATE 11/8/97	R.R. NOT TO SCALE	REF. 96/110

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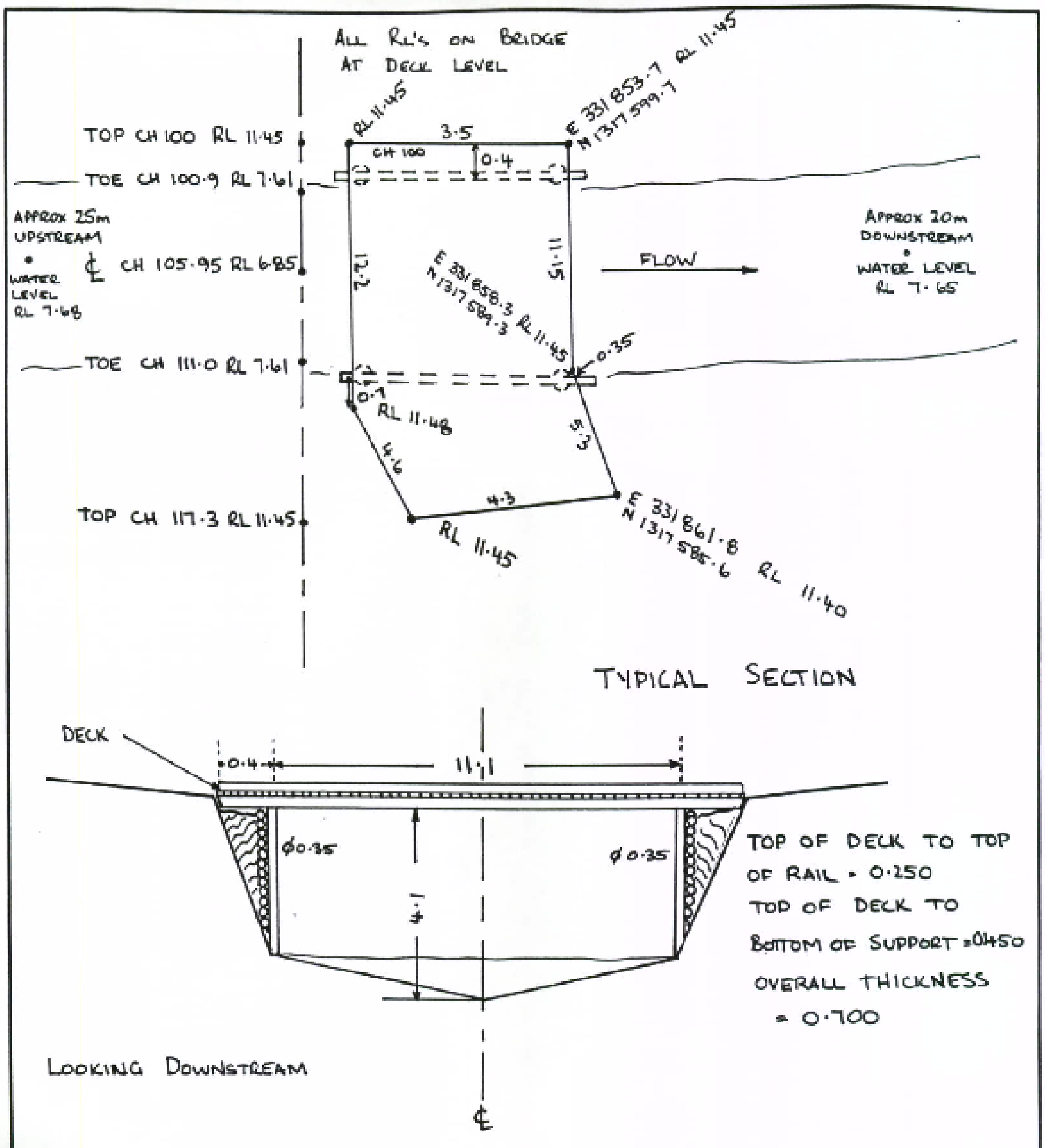

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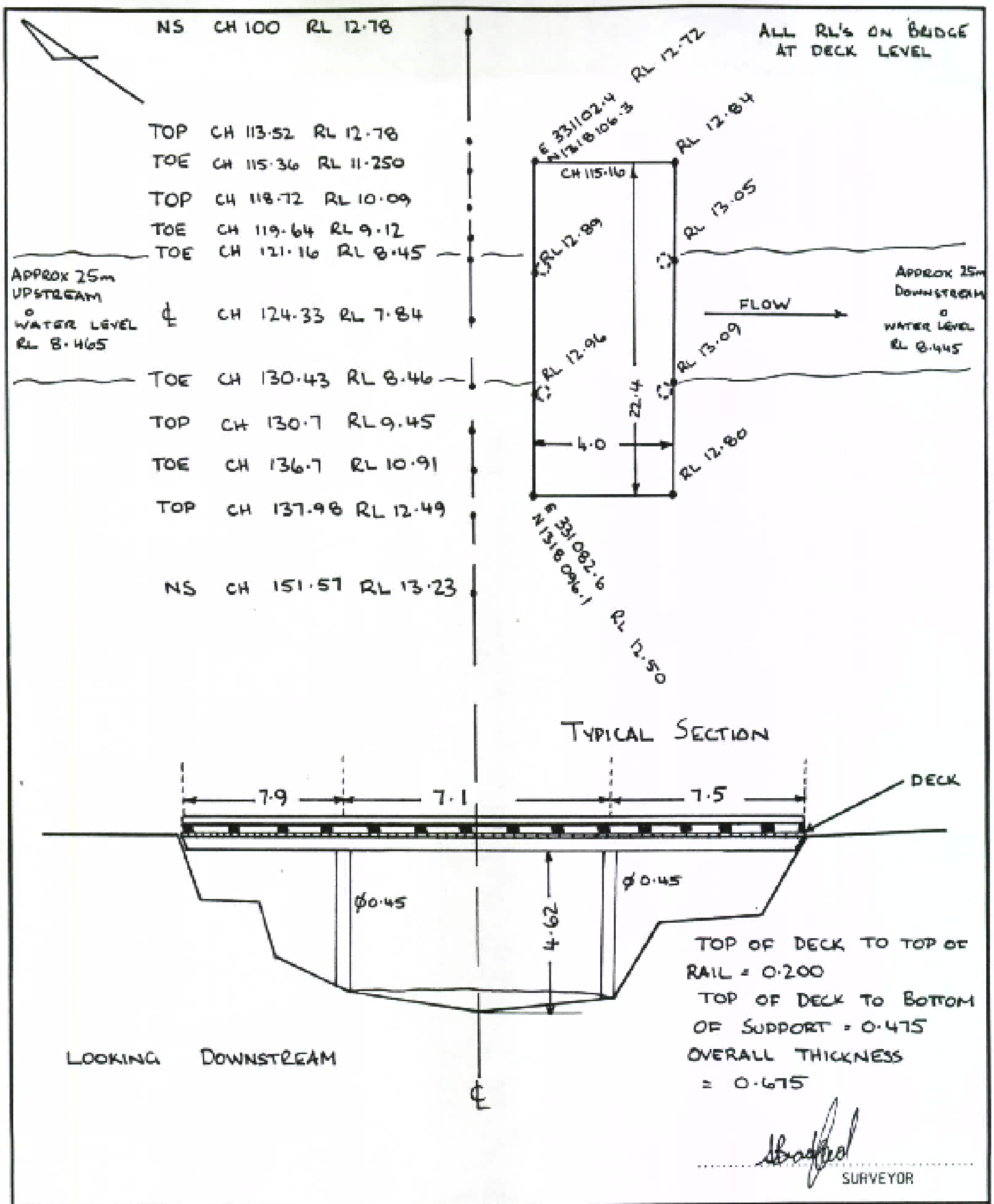
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888
DATE 13/8/97 · R.R. NOT TO SCALE · REF. 96/110	



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DATE: 11/8/97 | R.R.: NOT TO SCALE | REF.: 96/110

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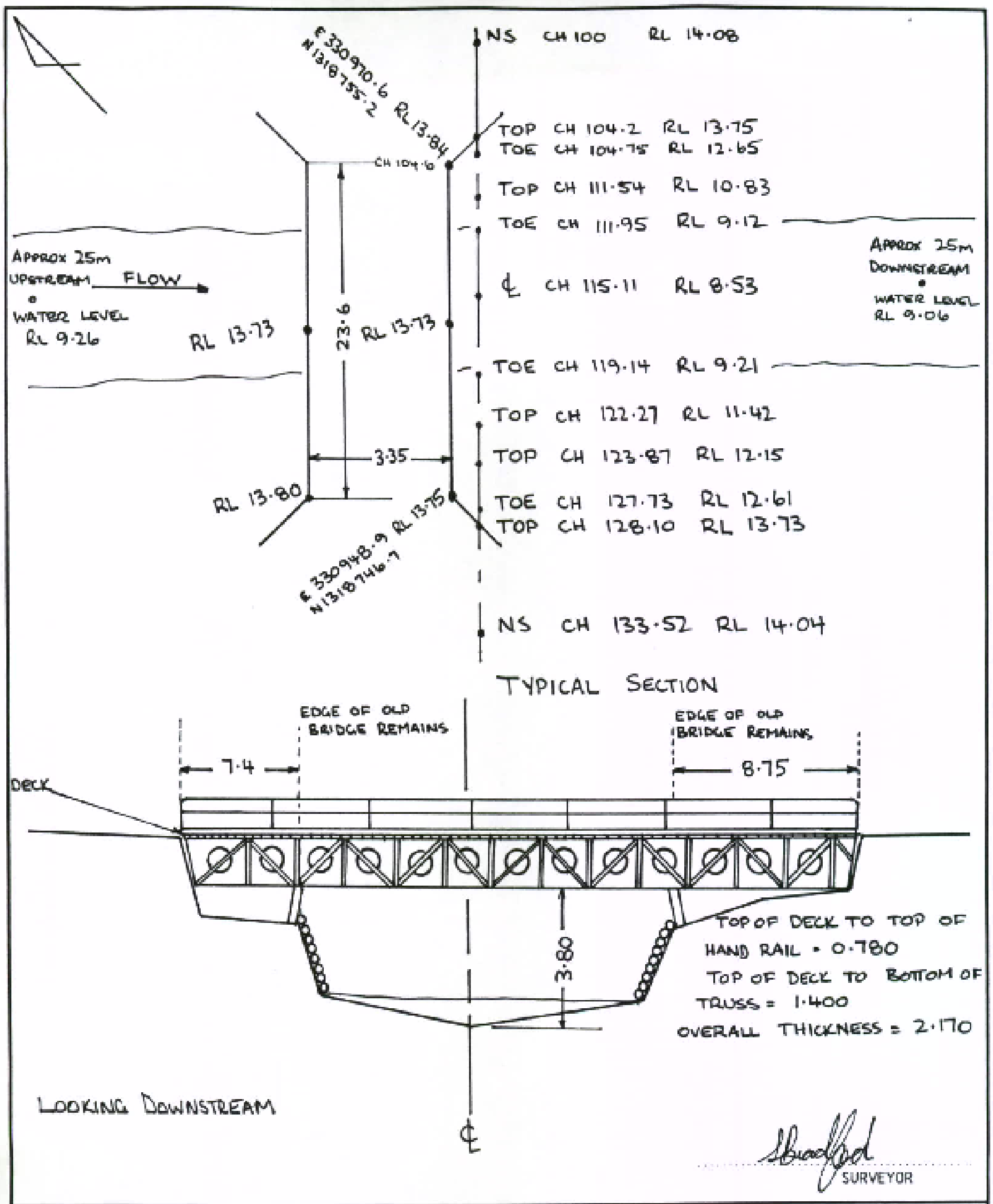

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DATE 7/8/97 | R.R. NOT TO SCALE | REF. 96/110

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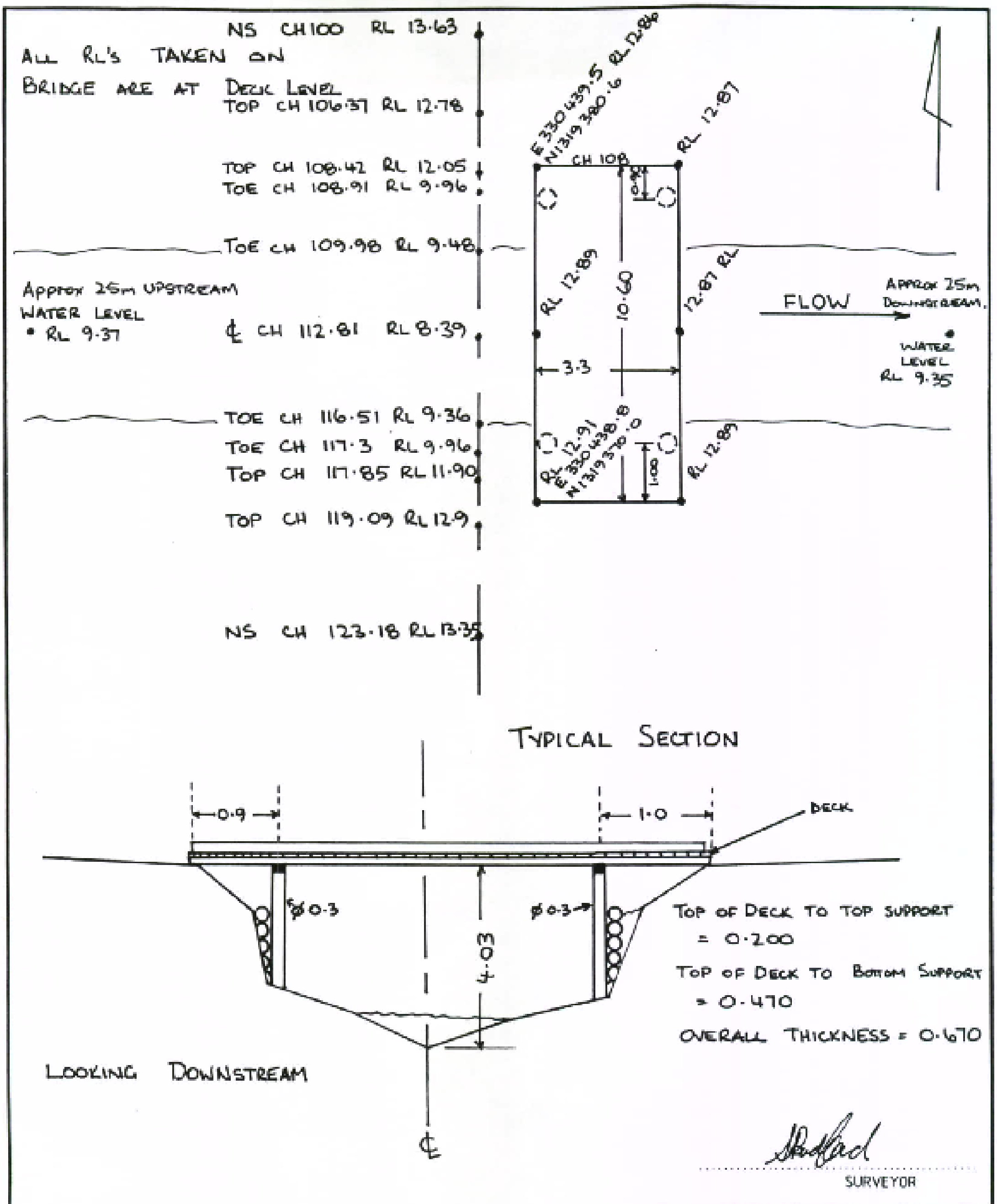

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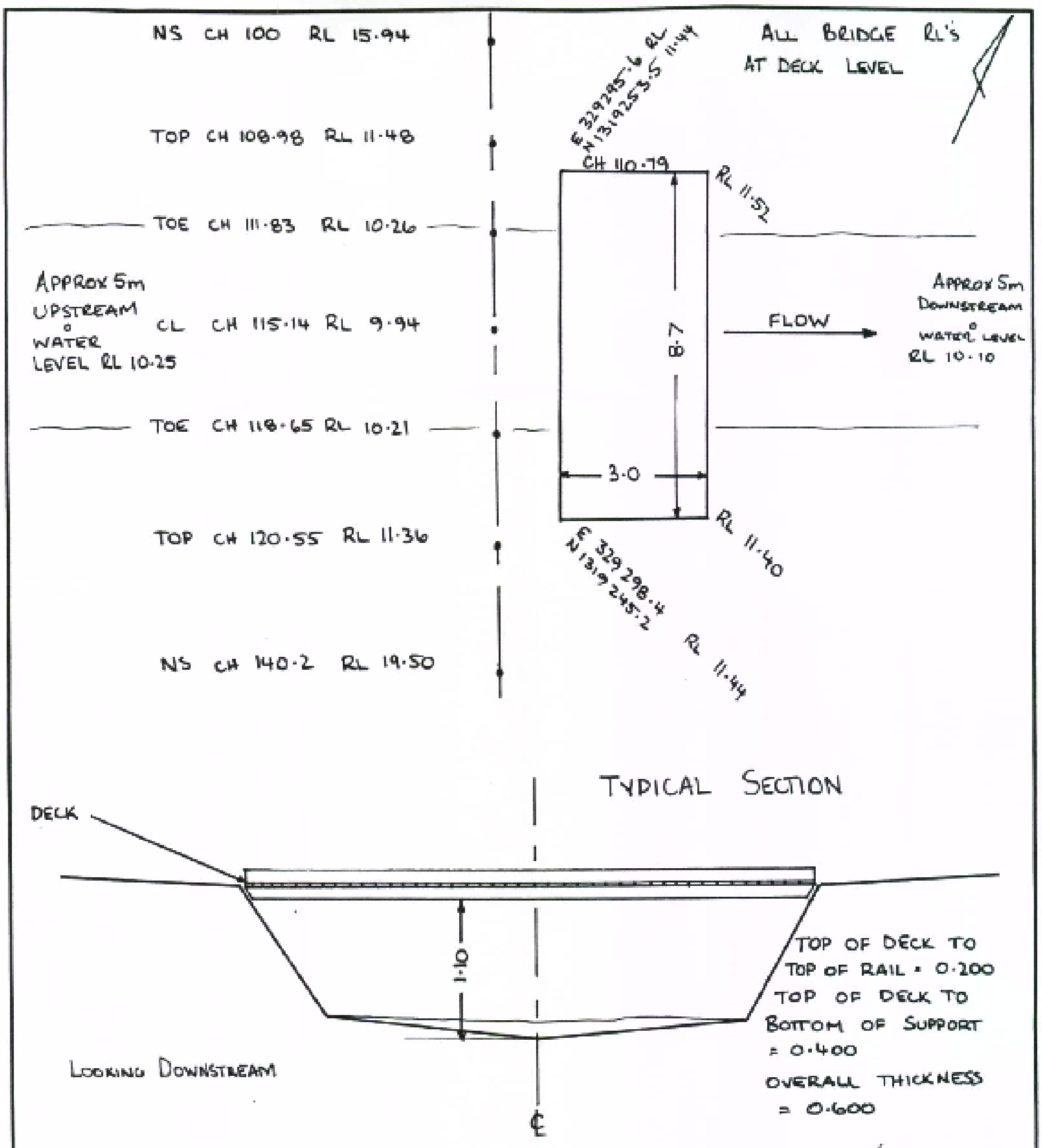

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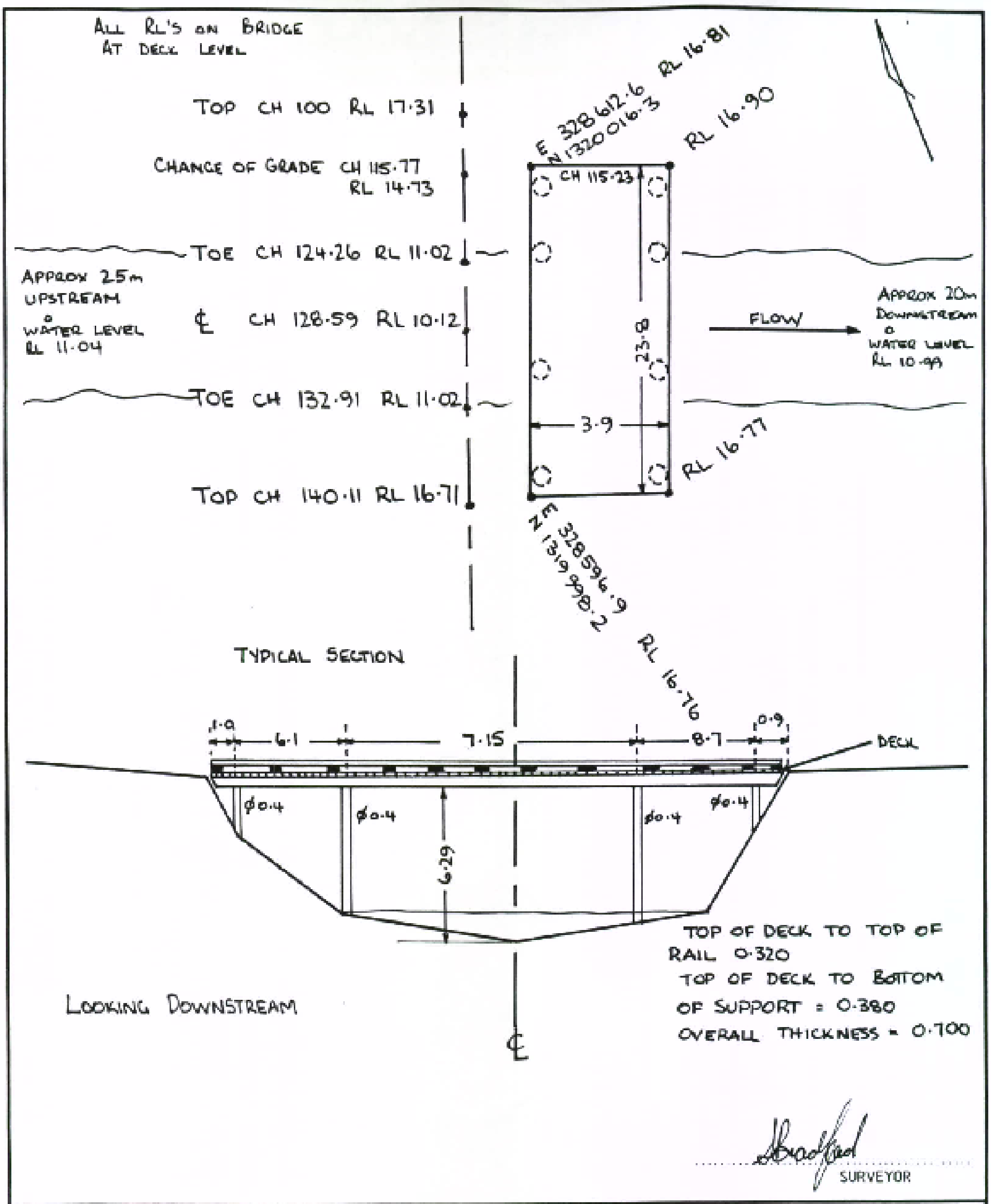
DATE 13/8/97 R.R. NOT TO SCALE REF. 96/110	



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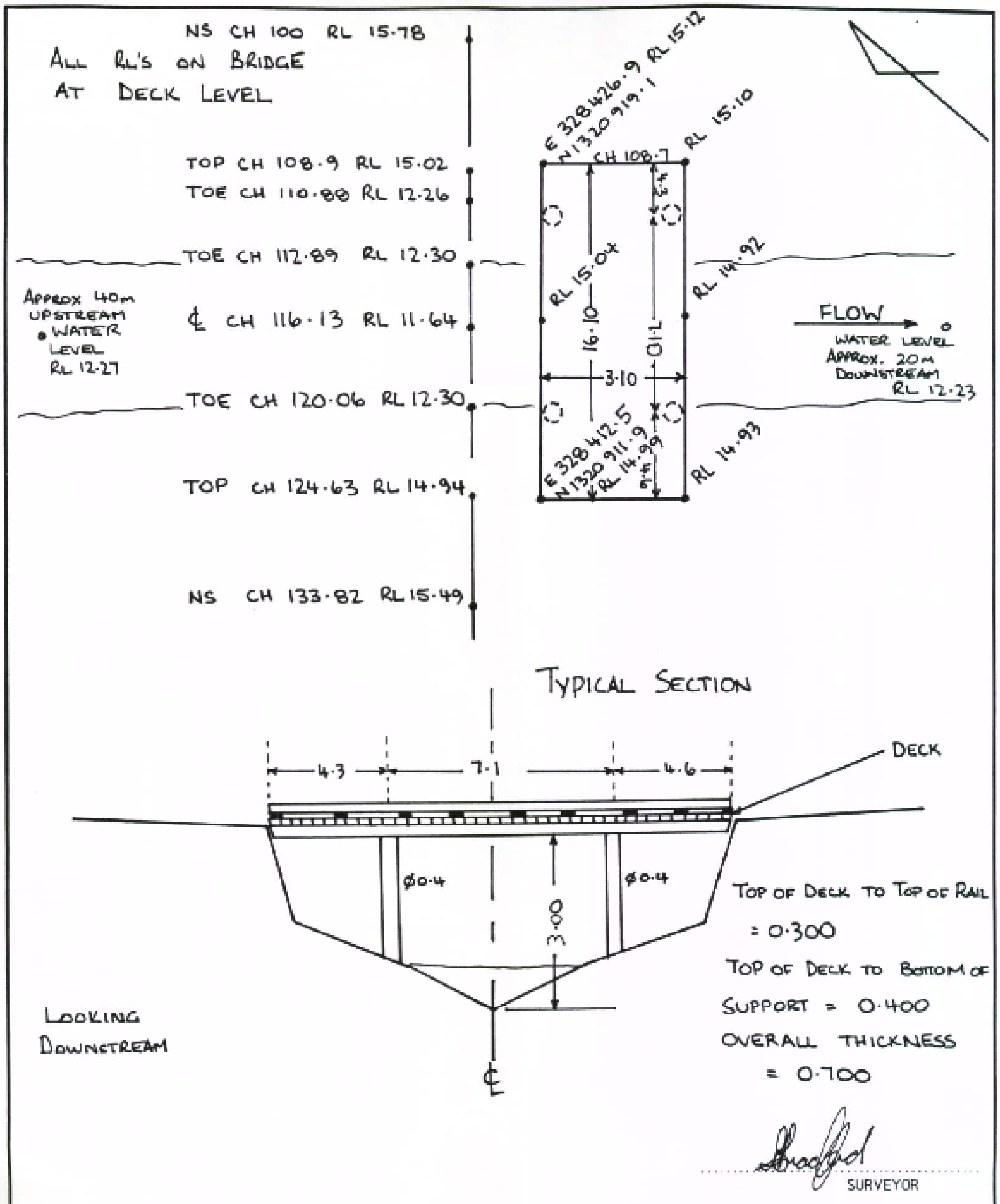

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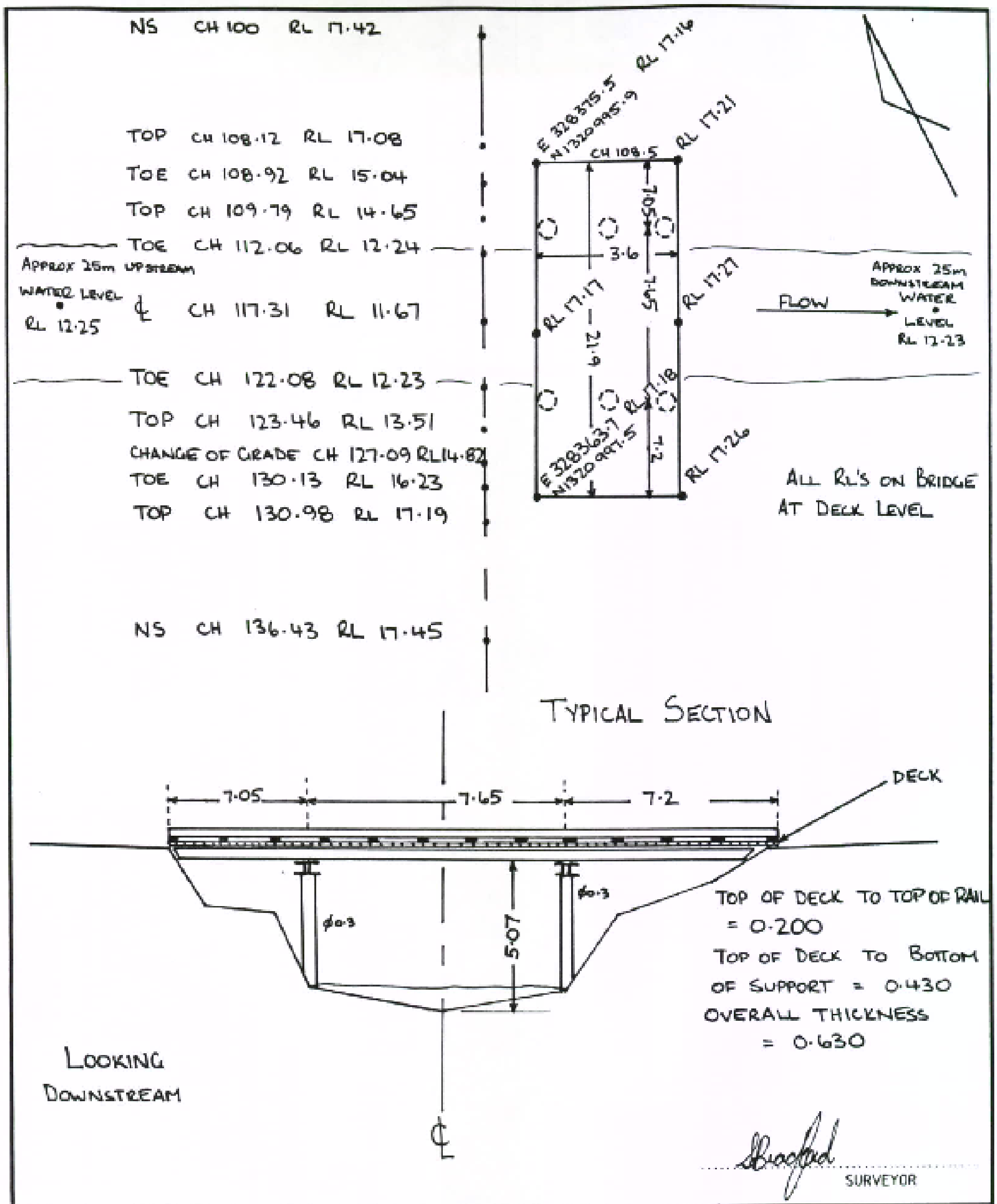

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PLAN: RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

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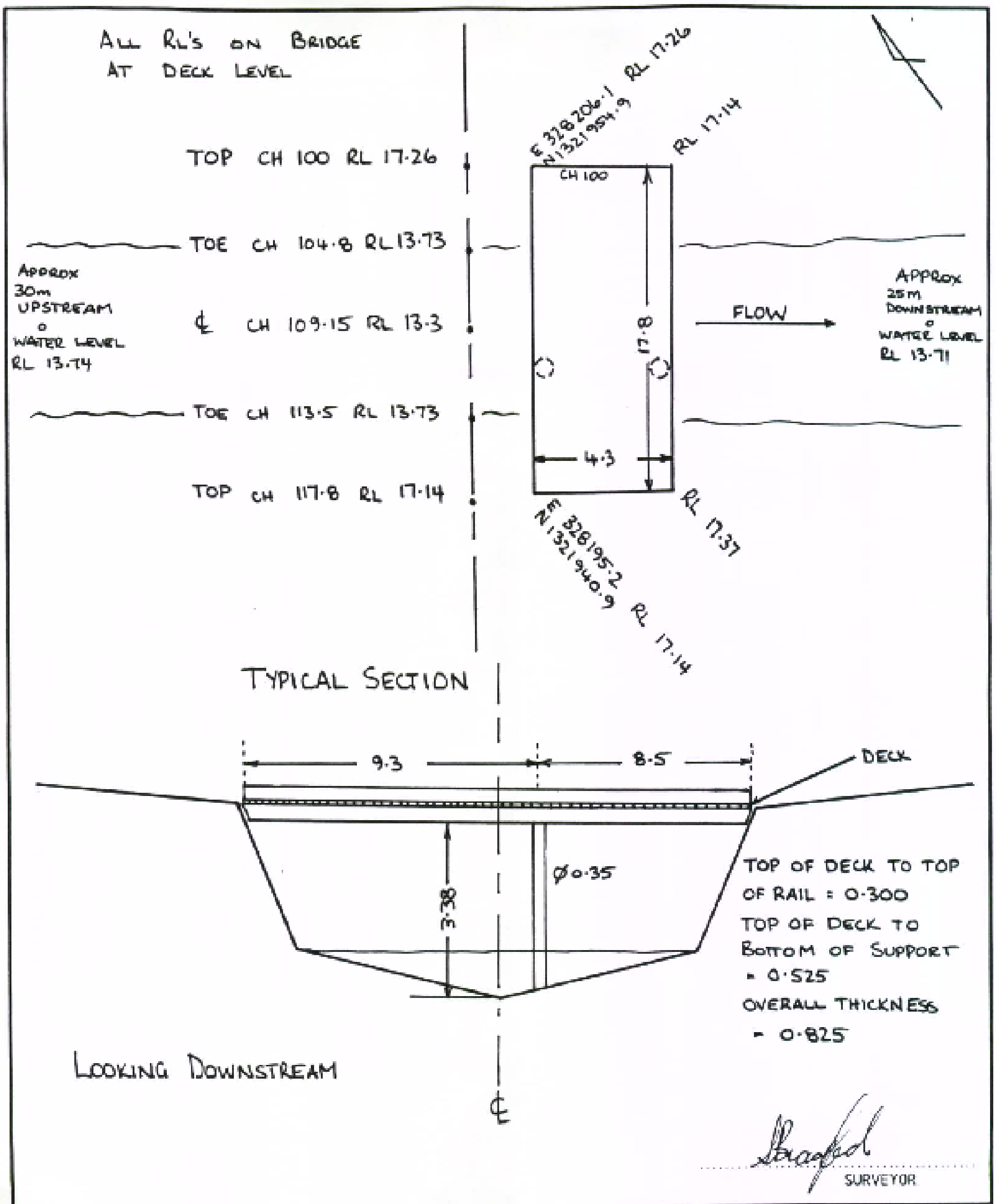

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DATE 13/8/97 | R.R. NOT TO SCALE | REF. 96/110

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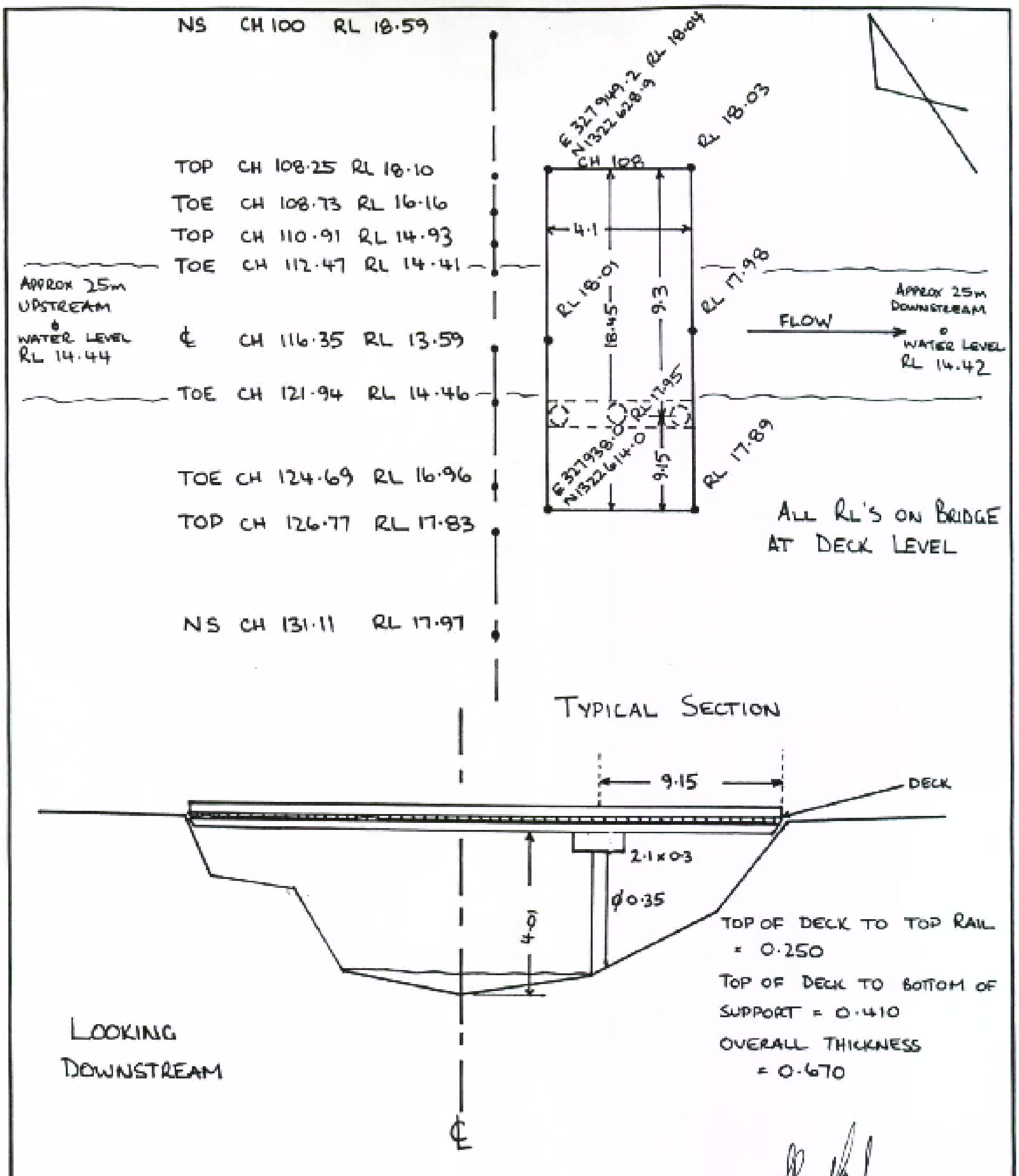

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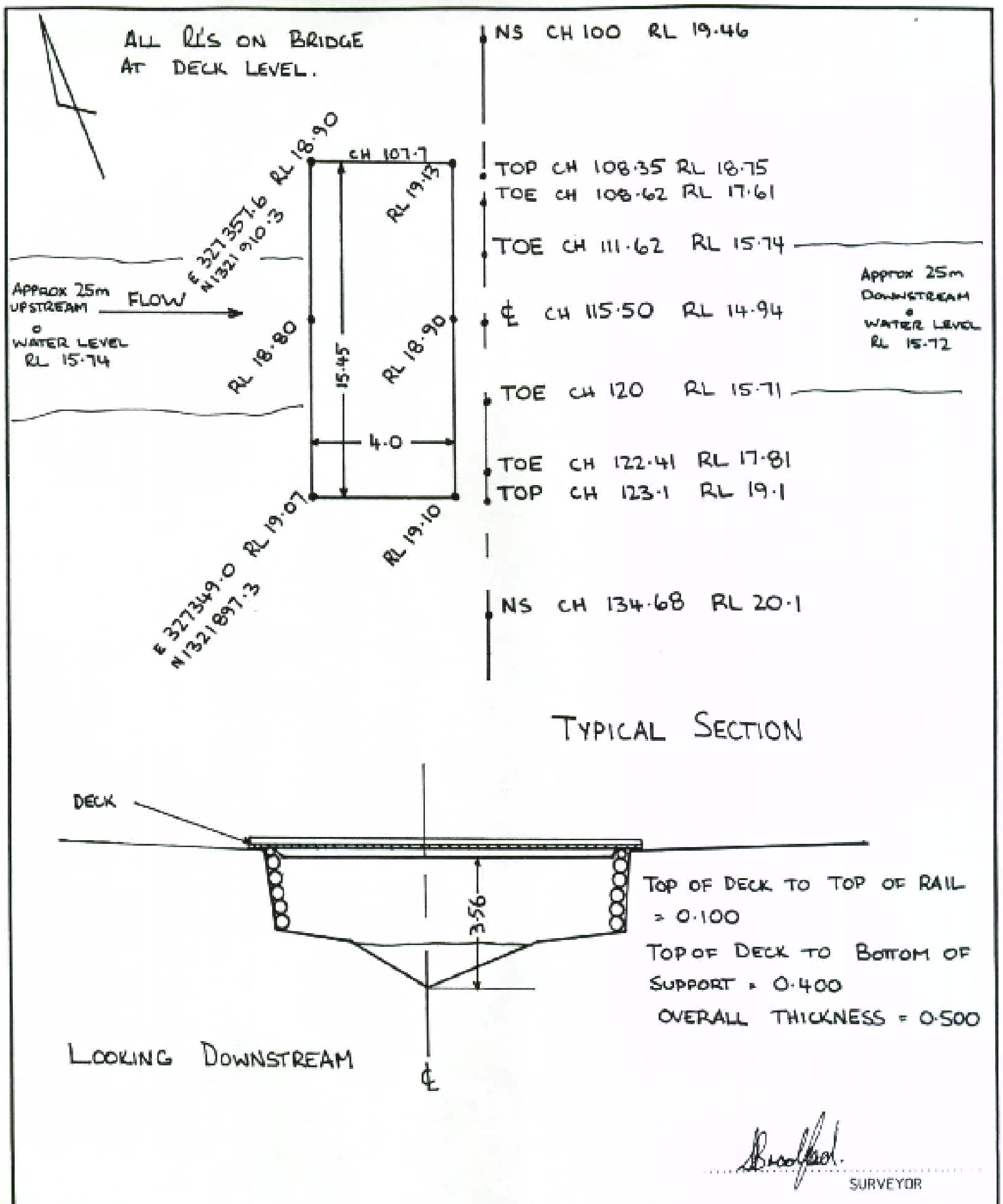
DATE 5/8/97 · R.R. NOT TO SCALE · REF. 96/110	



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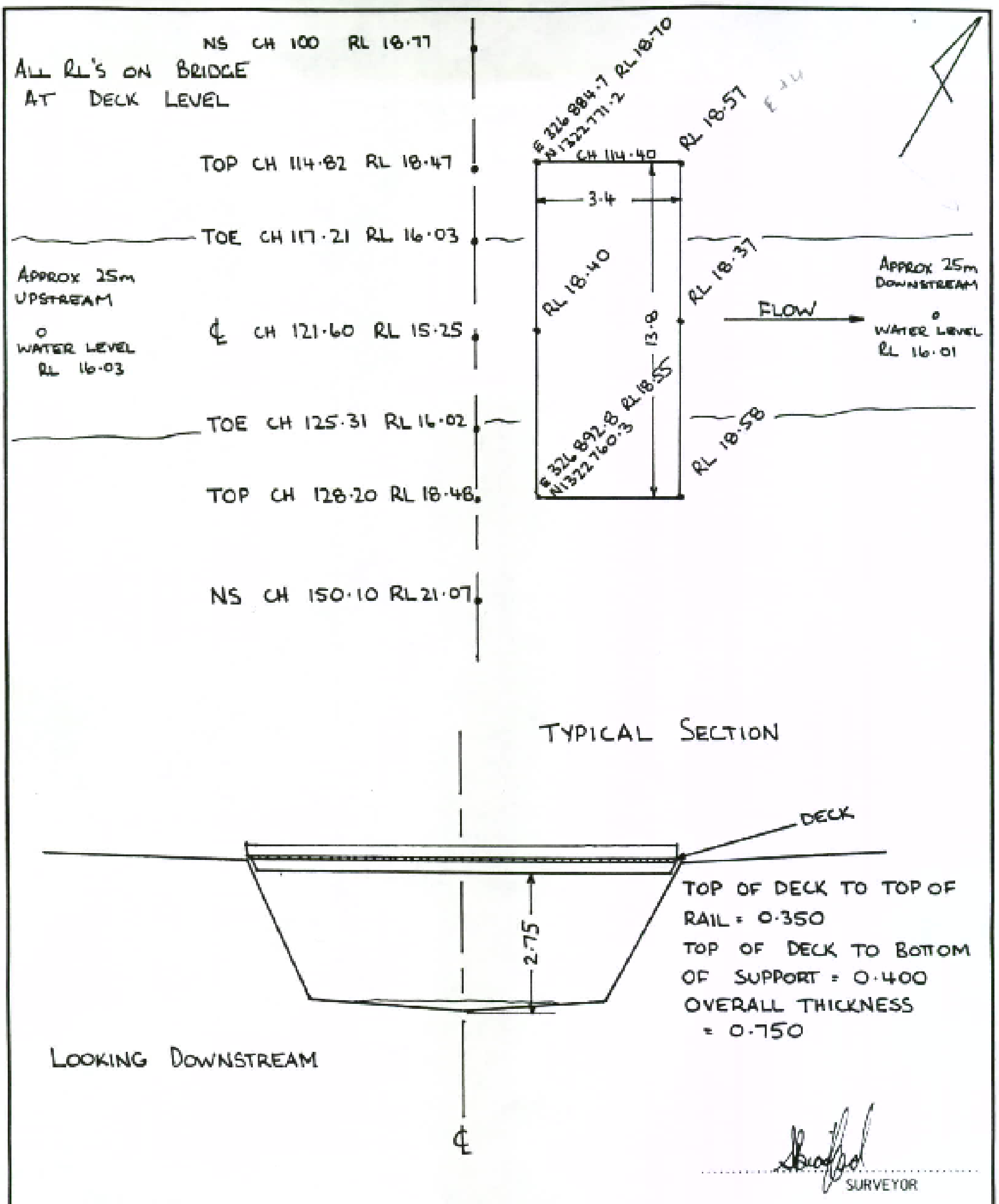

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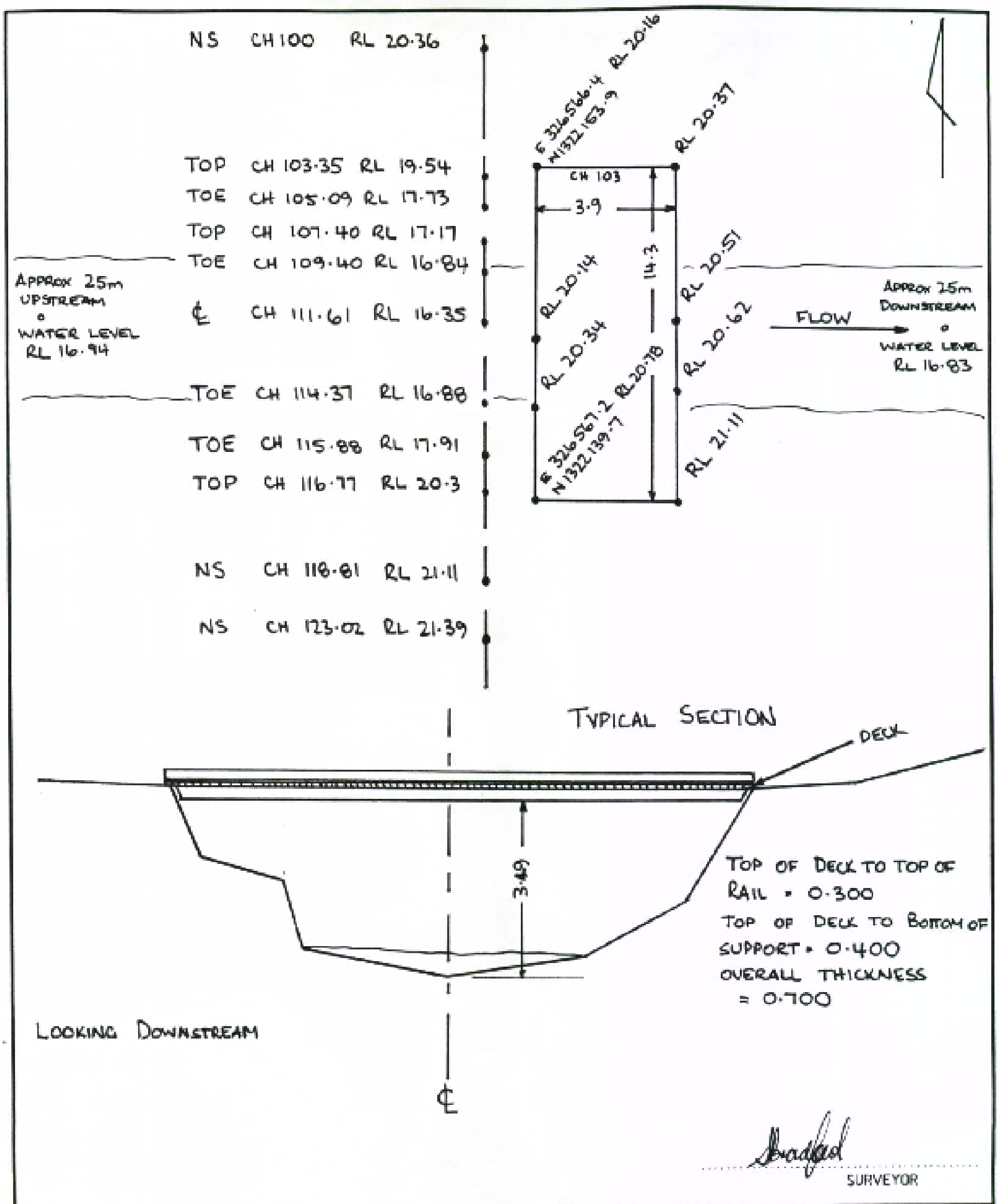

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7/8/97	NOT TO SCALE	96/110

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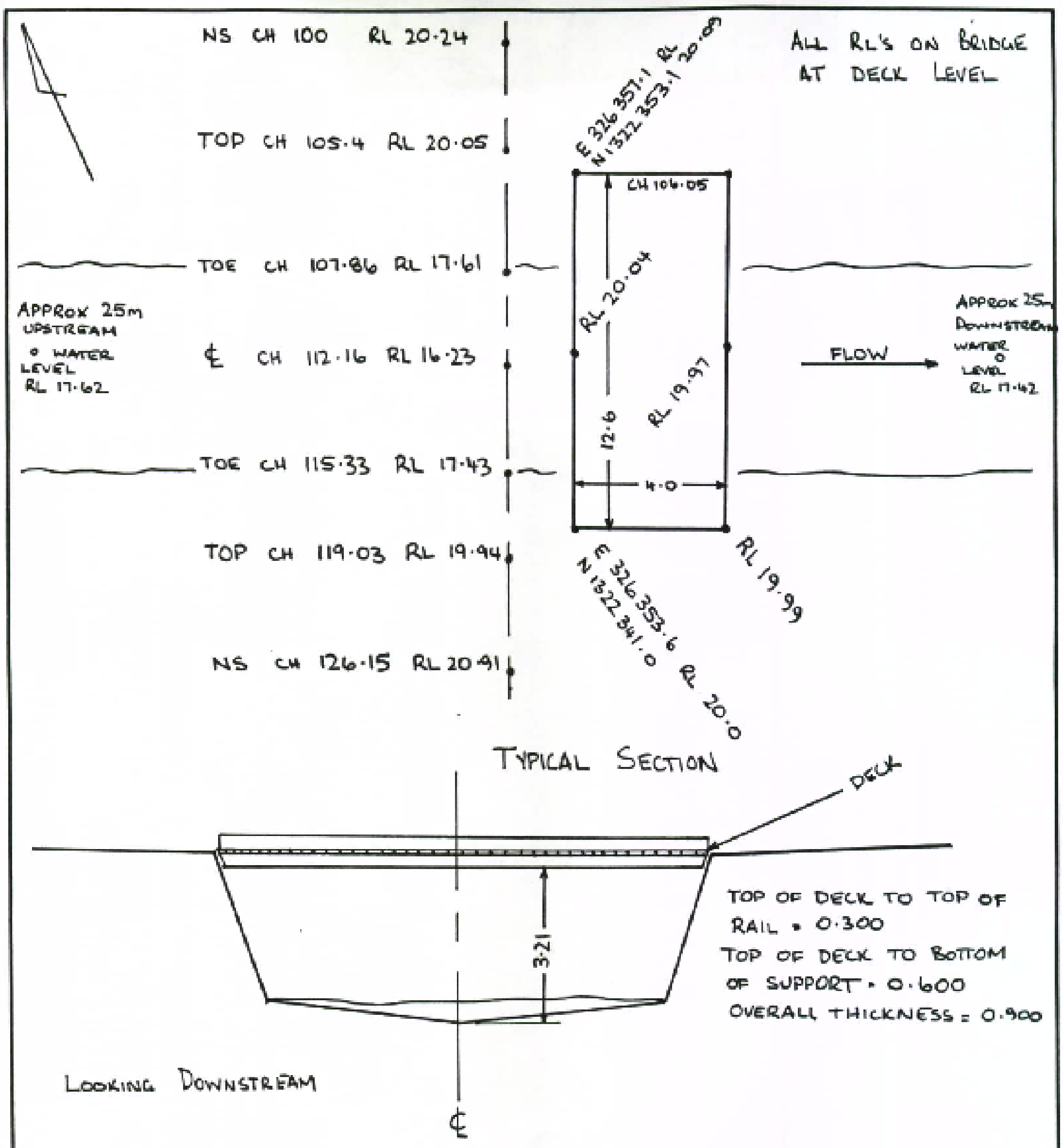
DX 7888



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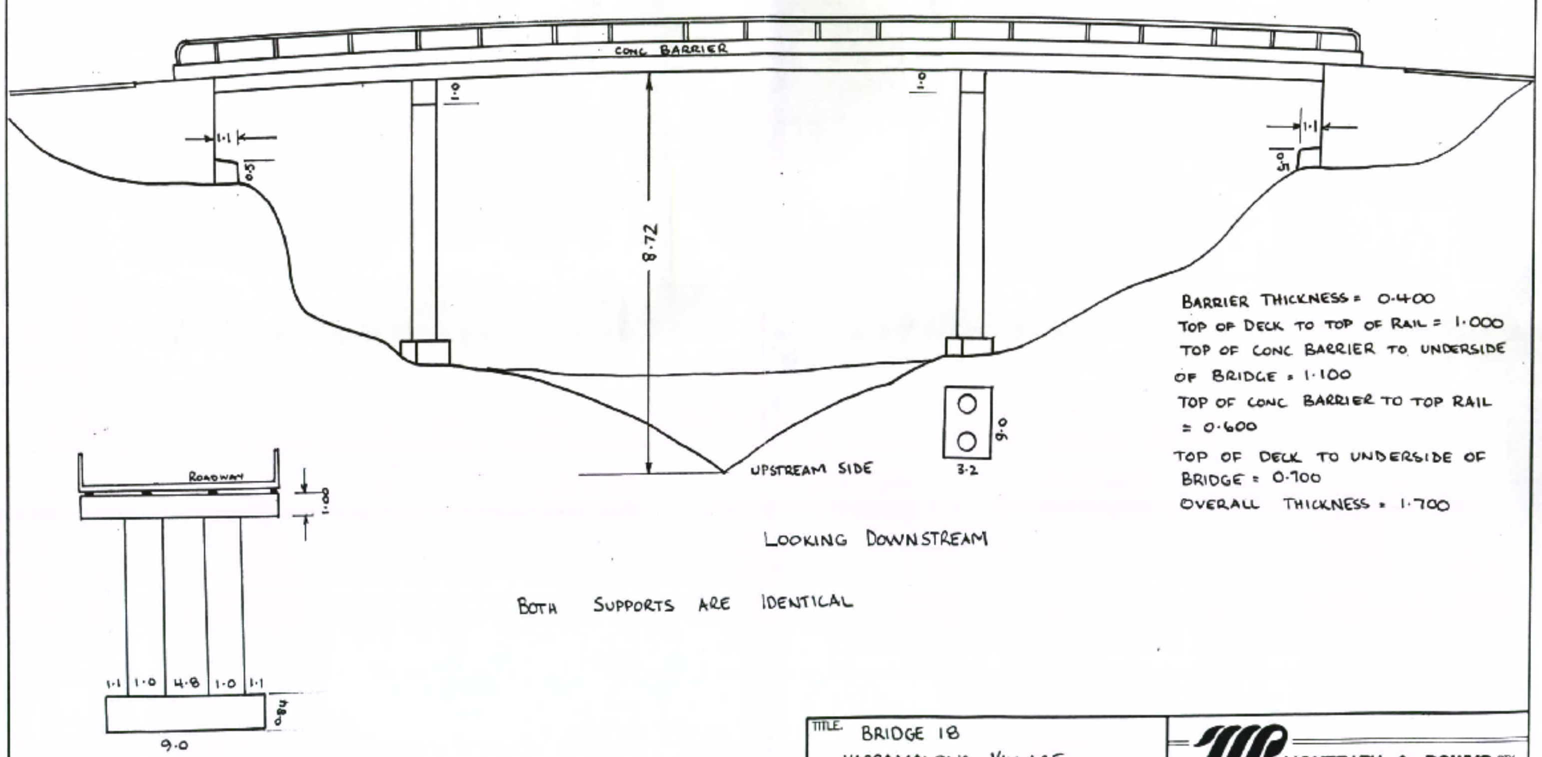
DATE 11/8/97 · R.R. NOT TO SCALE · REF. 96/110	



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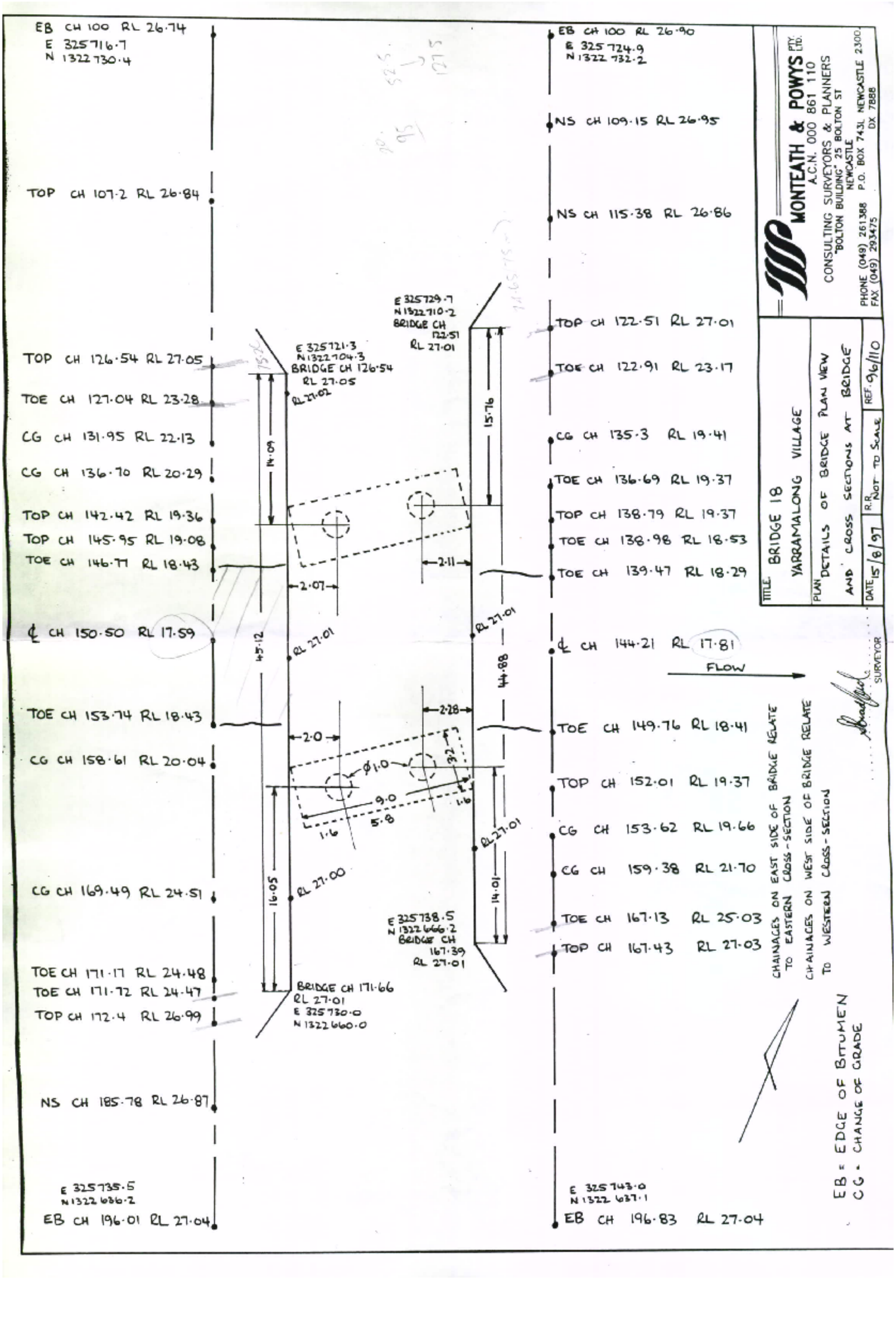
PLAN: CROSS - SECTION AND PROFILE OF SUPPORTS	
DATE: 15/8/9 · R.R.: NOT TO SCALE · REF: 96/110	

SURVEYOR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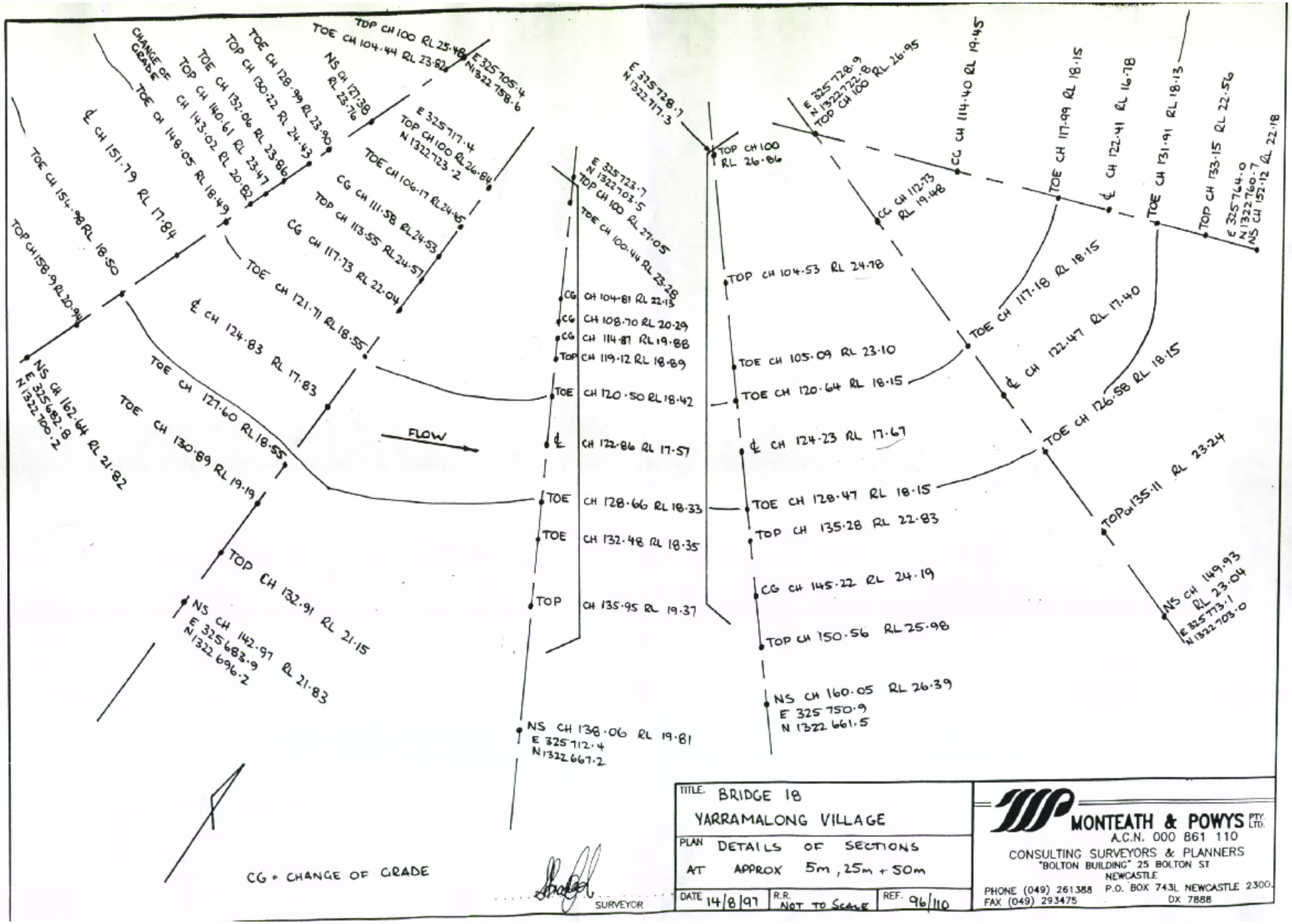
FAX (049) 293475 DX 7888
TITLE BRIDGE 18
YARRAMALONG VILLAGE
PLAN DETAILS OF BRIDGE PLAN VIEW
AND CROSS SECTIONS AT BRIDGE
DATE 15/8/97
R.R. NOT TO SCALE
REF. 96/110
SURVEYOR
CHAINAGES ON EAST SIDE OF BRIDGE RELATE TO EASTERN CROSS-SECTION
CHAINAGES ON WEST SIDE OF BRIDGE RELATE TO WESTERN CROSS-SECTION
EB = EDGE OF BITUMEN
CG = CHANGE OF GRADE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SURVEYOR
TITLE BRIDGE 18
YARRAMALONG VILLAGE
PLAN DETAILS OF SECTIONS
AT APPROX 5m, 25m + 50m
DATE 14/8/97
R.R. NOT TO SCALE
REF. 96/110
MONTEATH & POWYS PTY. LTD.
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CONSULTING SURVEYORS & PLANNERS
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PHONE (049) 261388 P.O. BOX 743L NEWCASTLE 2300
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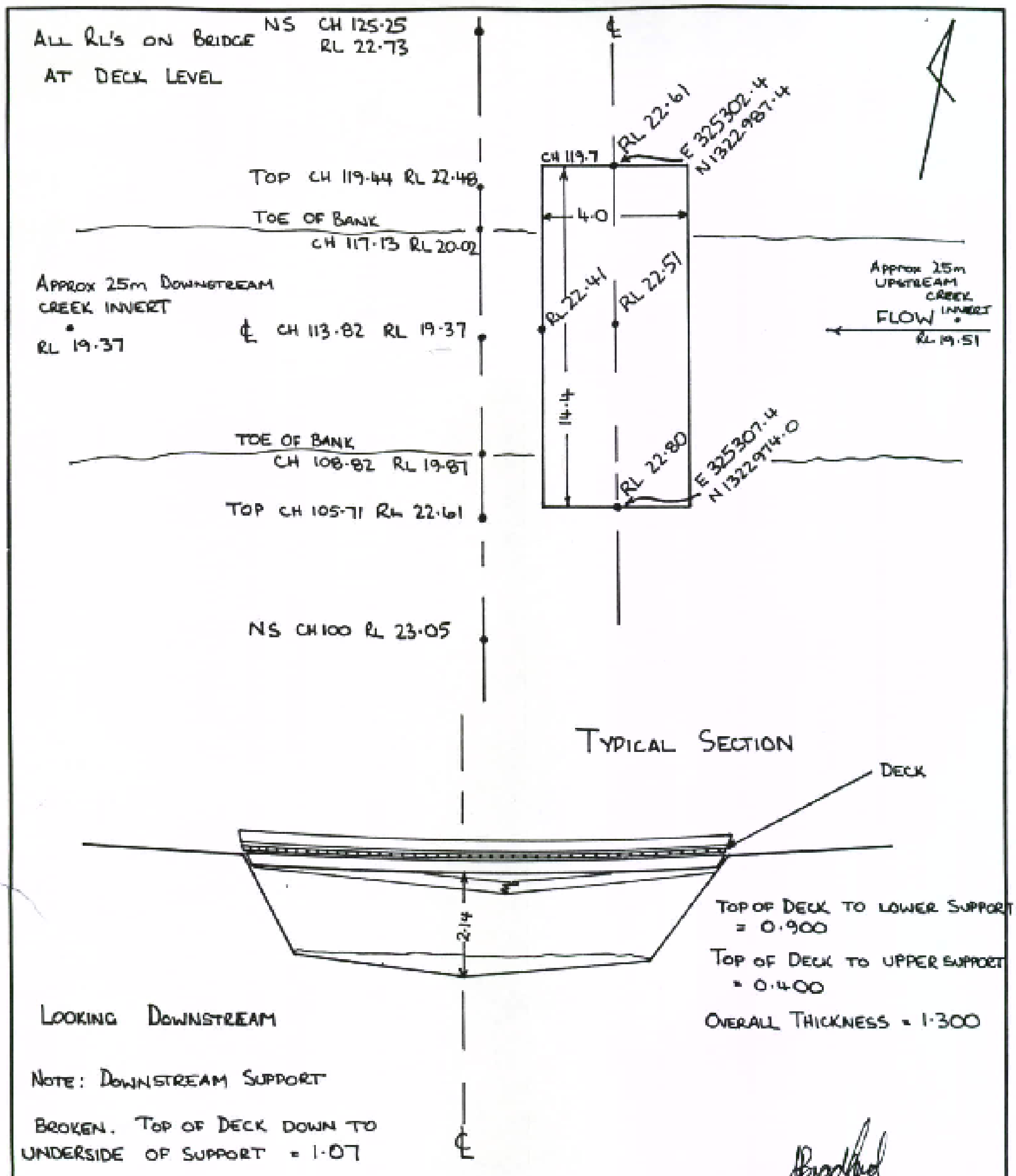

SURVEYOR

TITLE. BRIDGE No. 19
RMB 1392

PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE	R.R.	REF.
5/8/97	NOT TO SCALE	96/110

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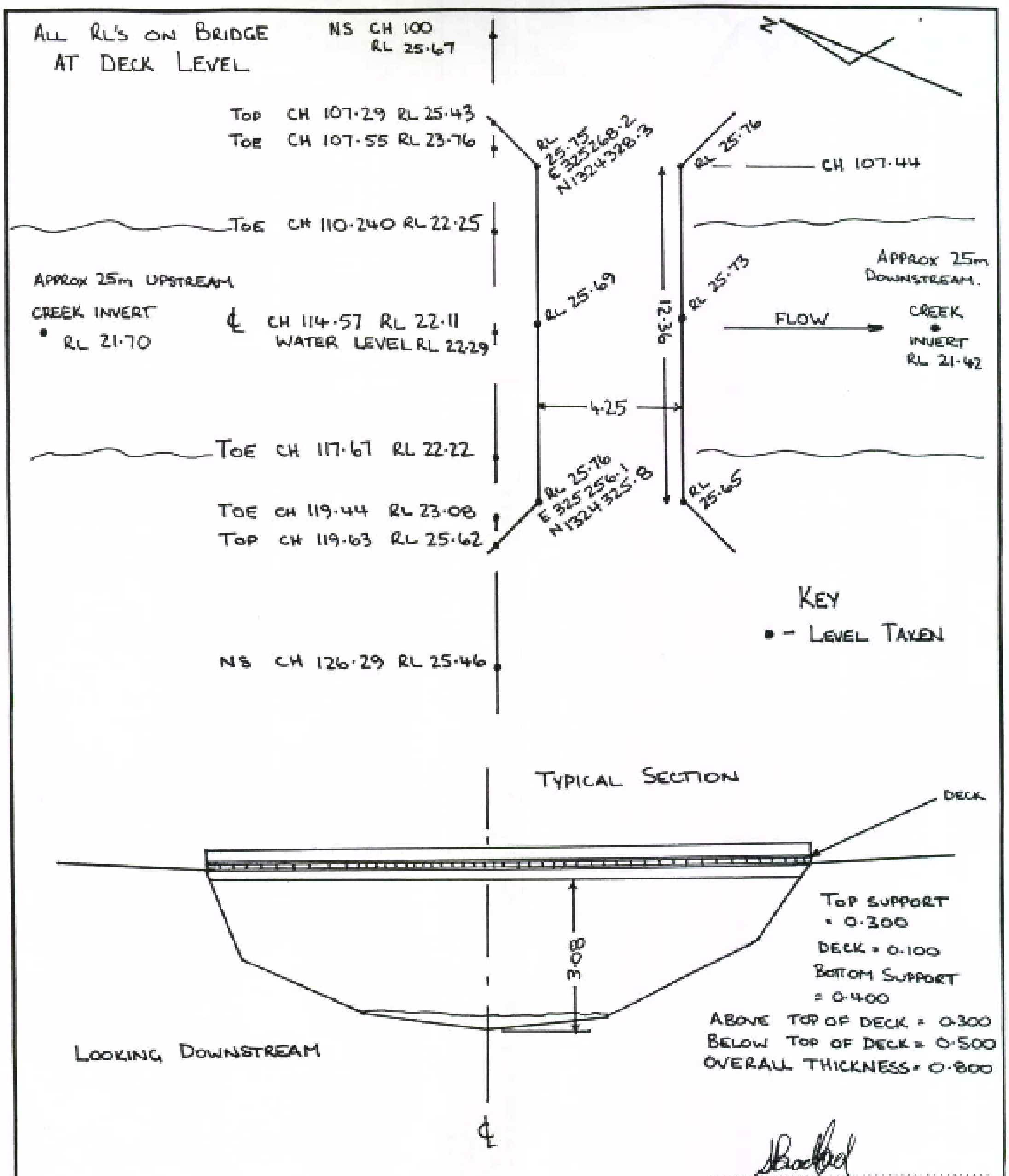
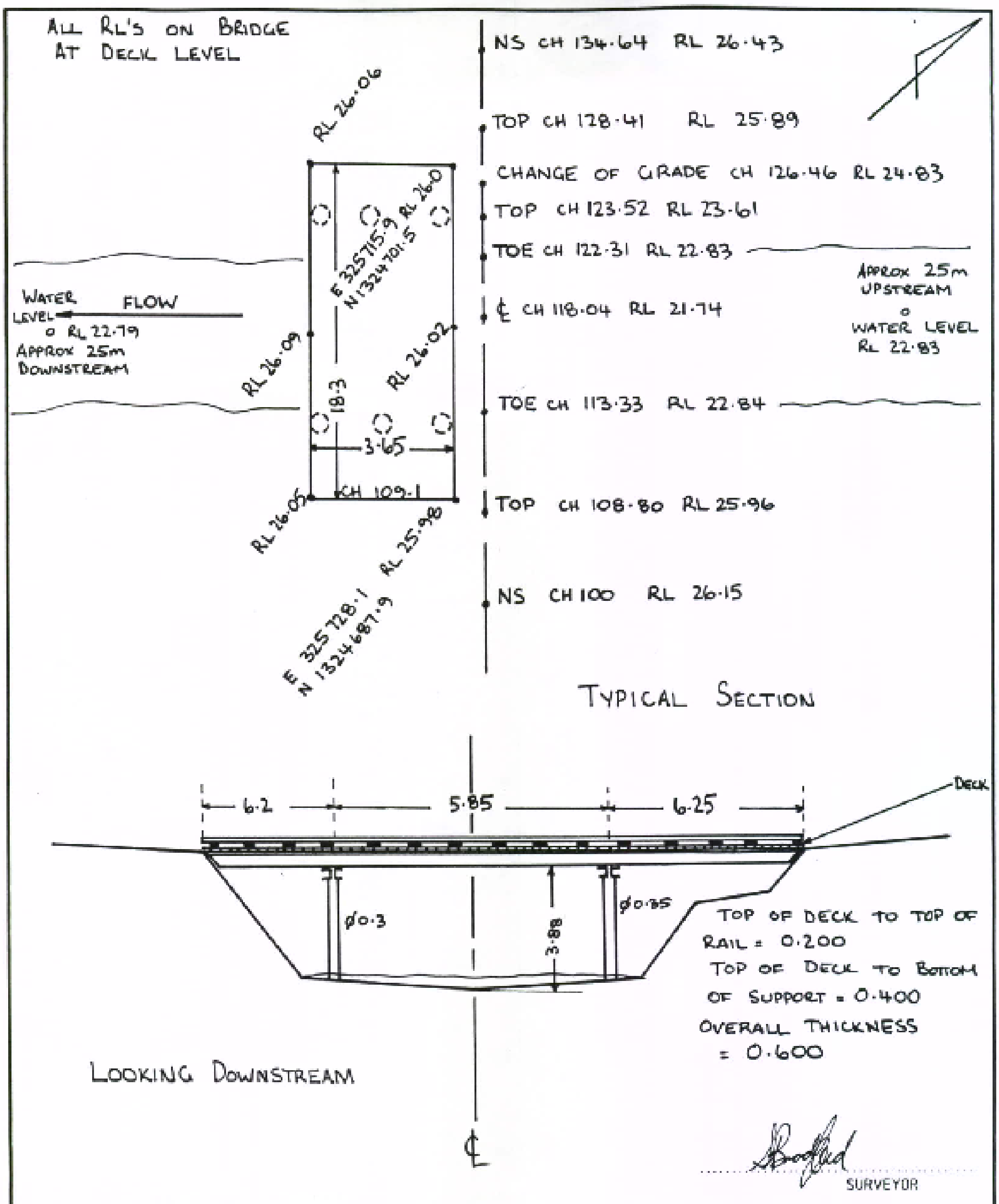
DX 7888

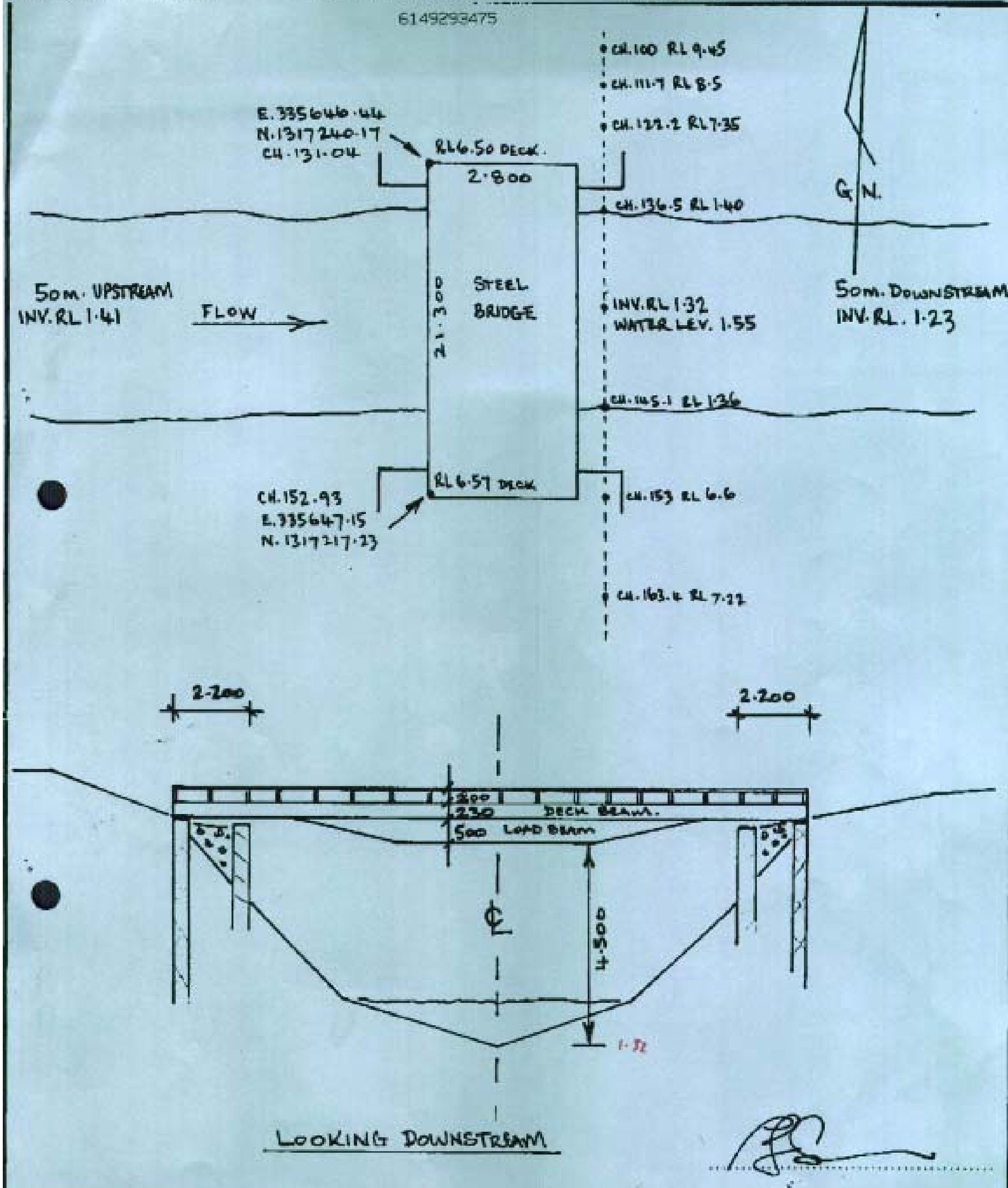


SURVEYOR

TITLE: BRIDGE No. 20 BUNNING CREEK ROAD	MONTEATH & POWYS PTY. LTD. A.C.N. 000 881 110
PLAN: RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE
DATE: 29/7/97 — R.R. NOT TO SCALE — REF. 96/110	PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888

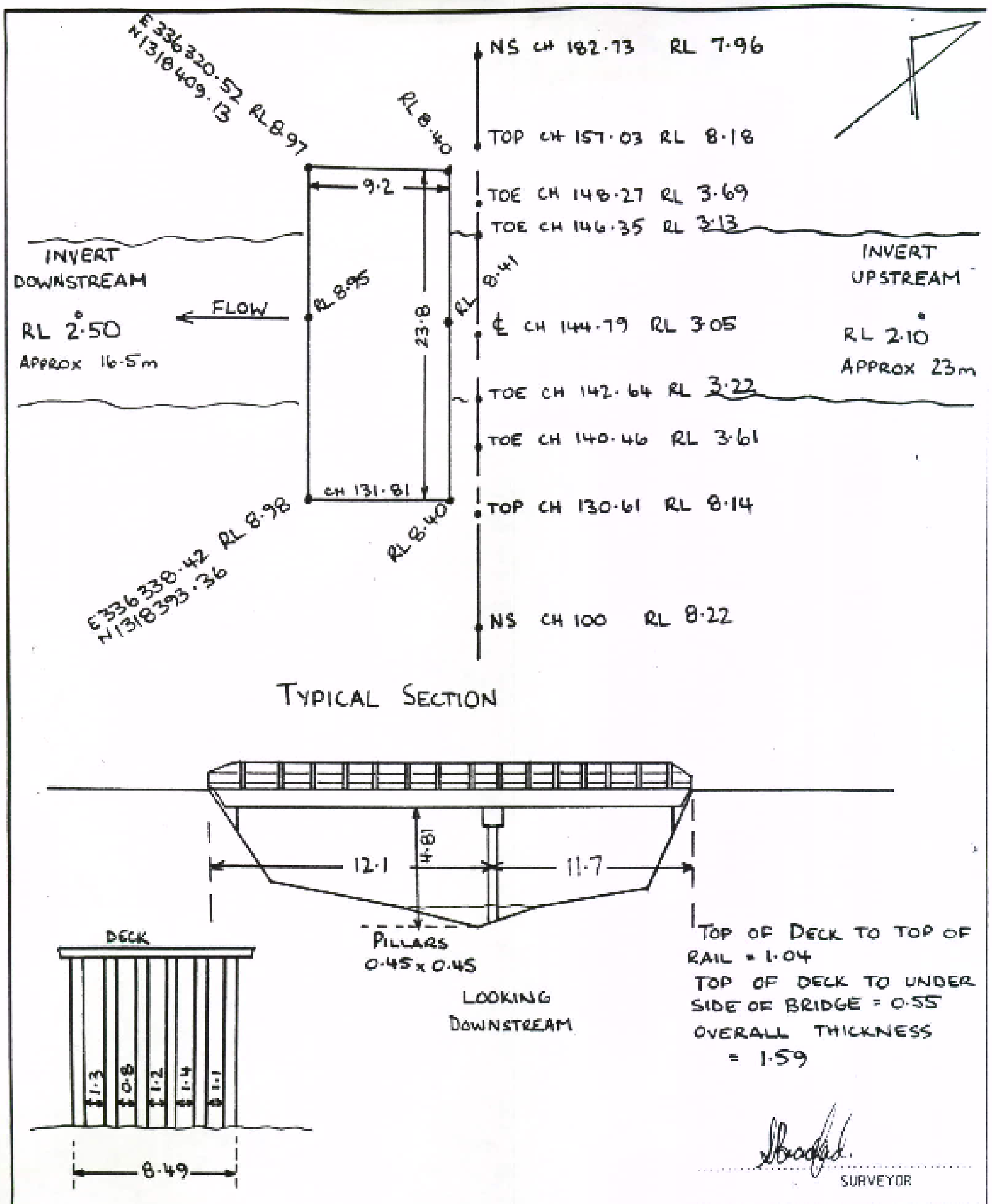


TITLE. BRIDGE 21 RMB 1428	MONTEATH & POWYS PTY. LTD. A.C.N. 000 861 110 CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE PHONE (049) 261388 P.O. BOX 743L NEWCASTLE 2300 FAX (049) 293475 DX 7888
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	
DATE 7/8/97	R.R. NOT TO SCALE	REF. 96/110	

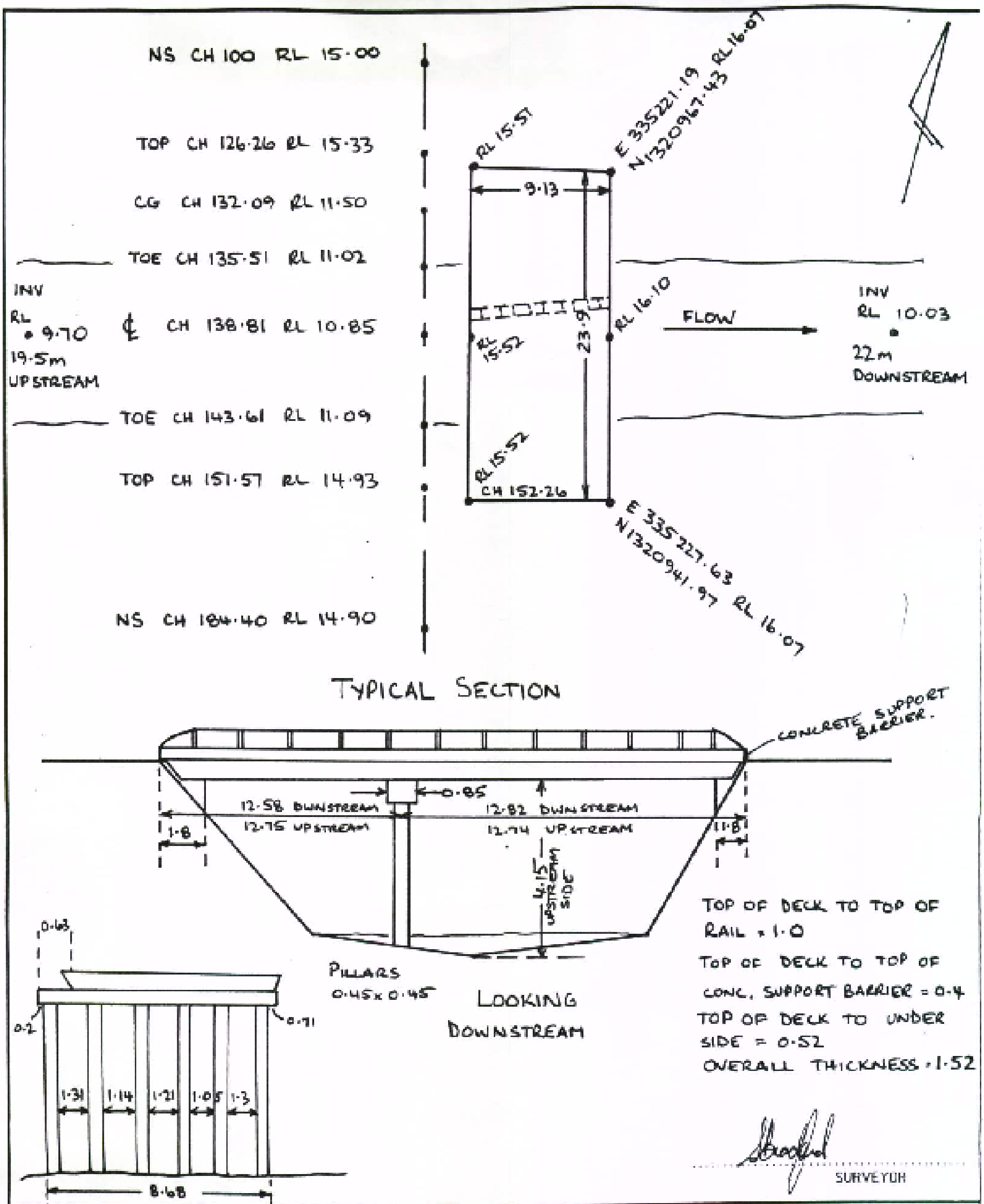


TITLE. BRIDGE N°. 22 TURFMASTERS.	MONTEATH & POWYS PTY. LTD. A.C.N. 000 881 110
PLAN A.H.D. HEIGHTS AND I.S.G. LOCATION OF BRIDGE SHOWING TYPICAL SECTION.	CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE
DATE 14/11/97 R.R. NOT TO SCALE REF. 96110	PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888

SURVEY DATE.



TITLE. BRIDGE 'A' JILLIBY ROAD	MONTEATH & POWYS PTY LTD. A.C.N. 000 861 110
PLAN RL VALUES + DIMENSIONS OF BRIDGE + TYPICAL SECTION	CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE
DATE 18/9/97 R.R. NOT TO SCALE REF. 96/110	PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300 DX 7866



SURVEYOR

TITLE: BRIDGE 'B'
JILLIBY ROAD

PLAN: RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE: 18/9/97 | R.R.: NOT TO SCALE | REF: 96/110

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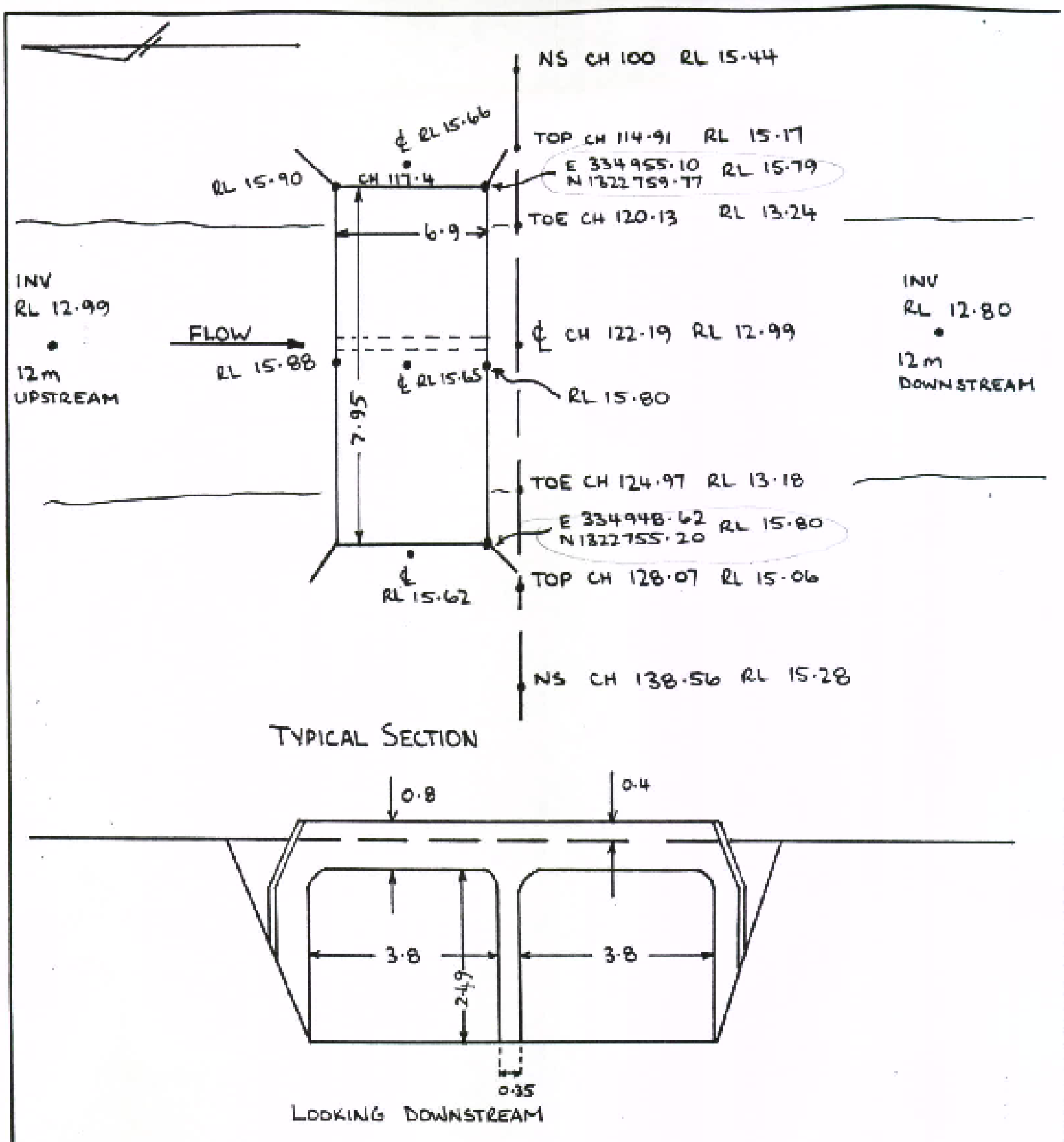
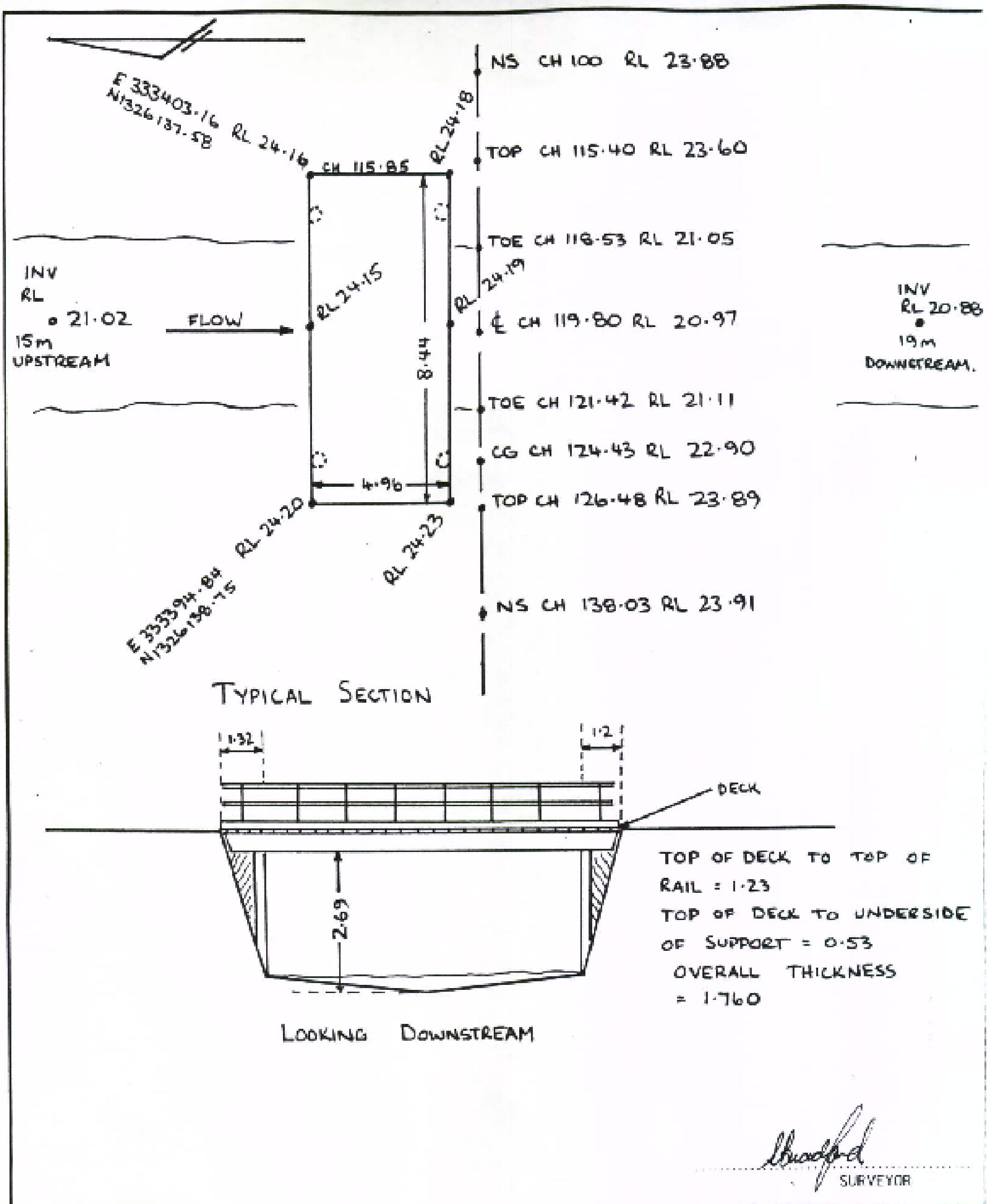
FAX (049) 293475
P.O. BOX 743L NEWCASTLE 2300
DX 7888



SURVEYOR

TITLE. BRIDGE 'C' DURREN ROAD	MONTEATH & POWYS PTY. LTD. A.C.N. 000 861 110 CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	
DATE 18/9/97 — R.R. NOT TO SCALE — REF. 96/110	



TITLE: BRIDGE 'D'
MANDALONG ROAD

PLAN: RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE: 18/9/97 | R.P. NOT TO SCALE | REF 96/110

MONTEATH & POWYS PTY. LTD.
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NEWCASTLE
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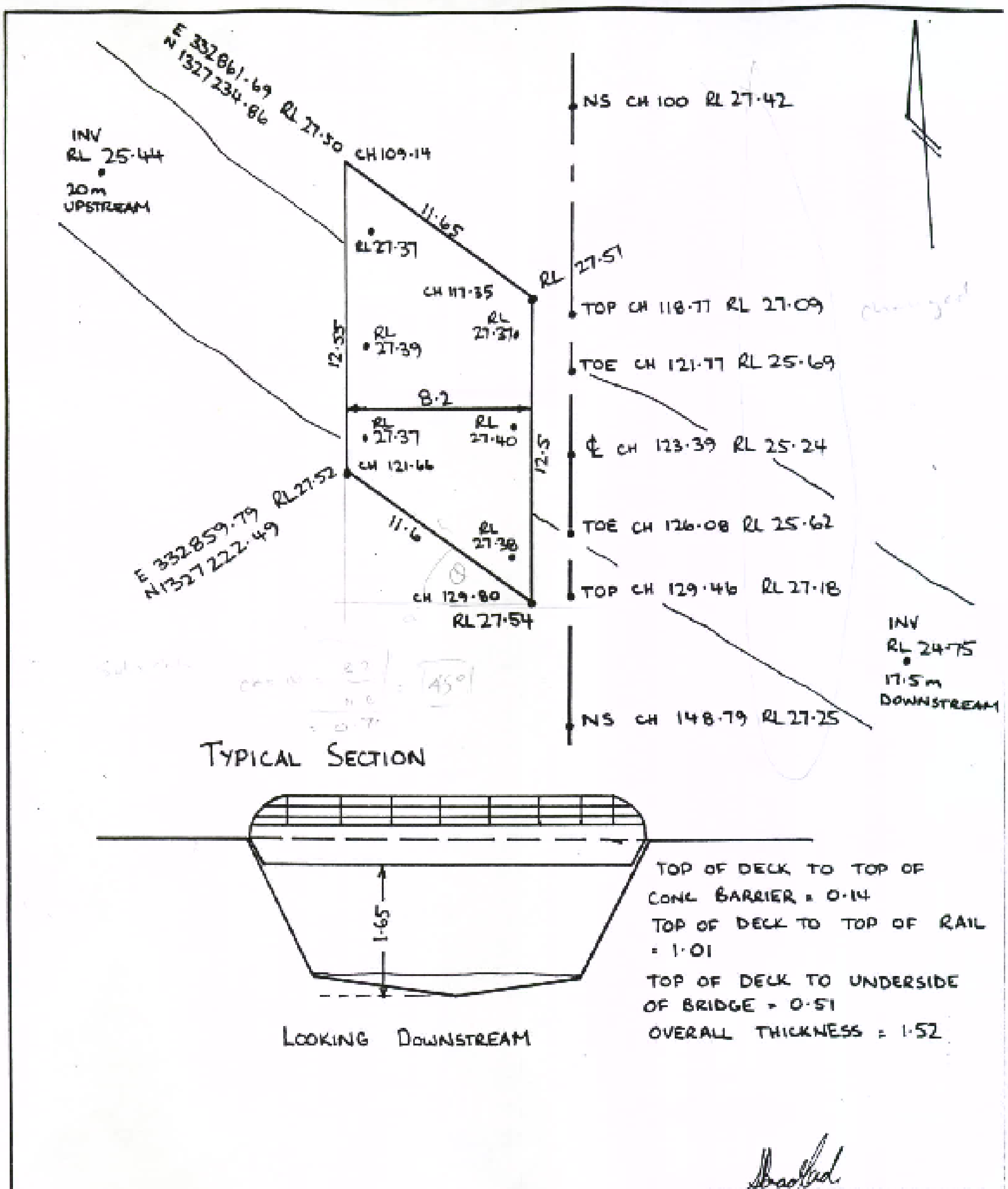
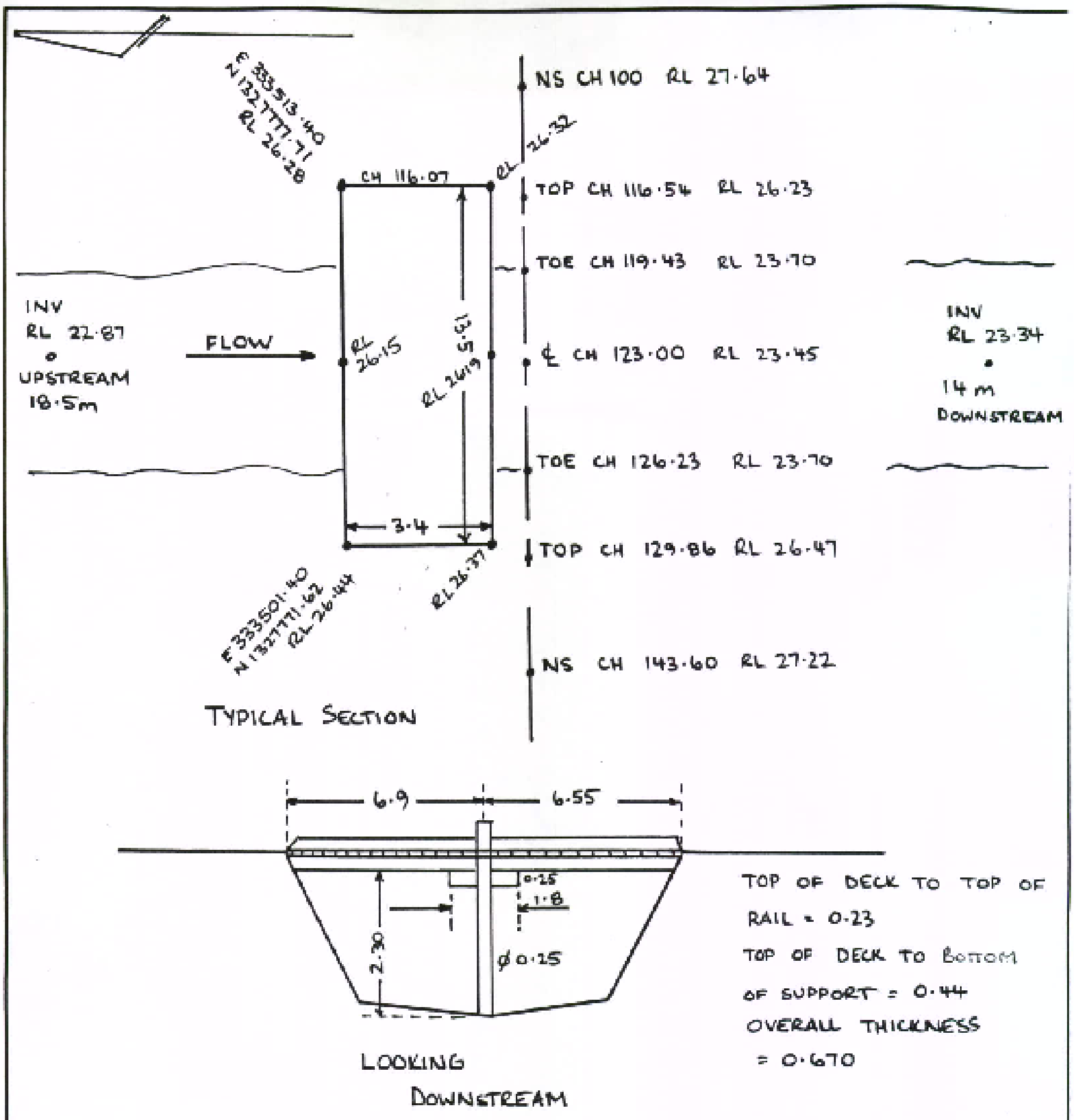
FAX (049) 293475
P.O. BOX 743L NEWCASTLE 2300.
DX 7888



SURVEYOR

TITLE. BRIDGE 'E' JILLIBY ROAD	MONTEATH & POWYS PTY. LTD. A.C.N. 000 861 110 CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300 DX 7888
DATE 18/4/97 · R.R. NOT TO SCALE · REF. 96/110	



SURVEYOR

TITLE: BRIDGE 'F'
HITCHCOCK LANE

PLAN: RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE 18/9/97 | A.B. NOT TO SCALE | REF. 96/110

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FAX (049) 293475
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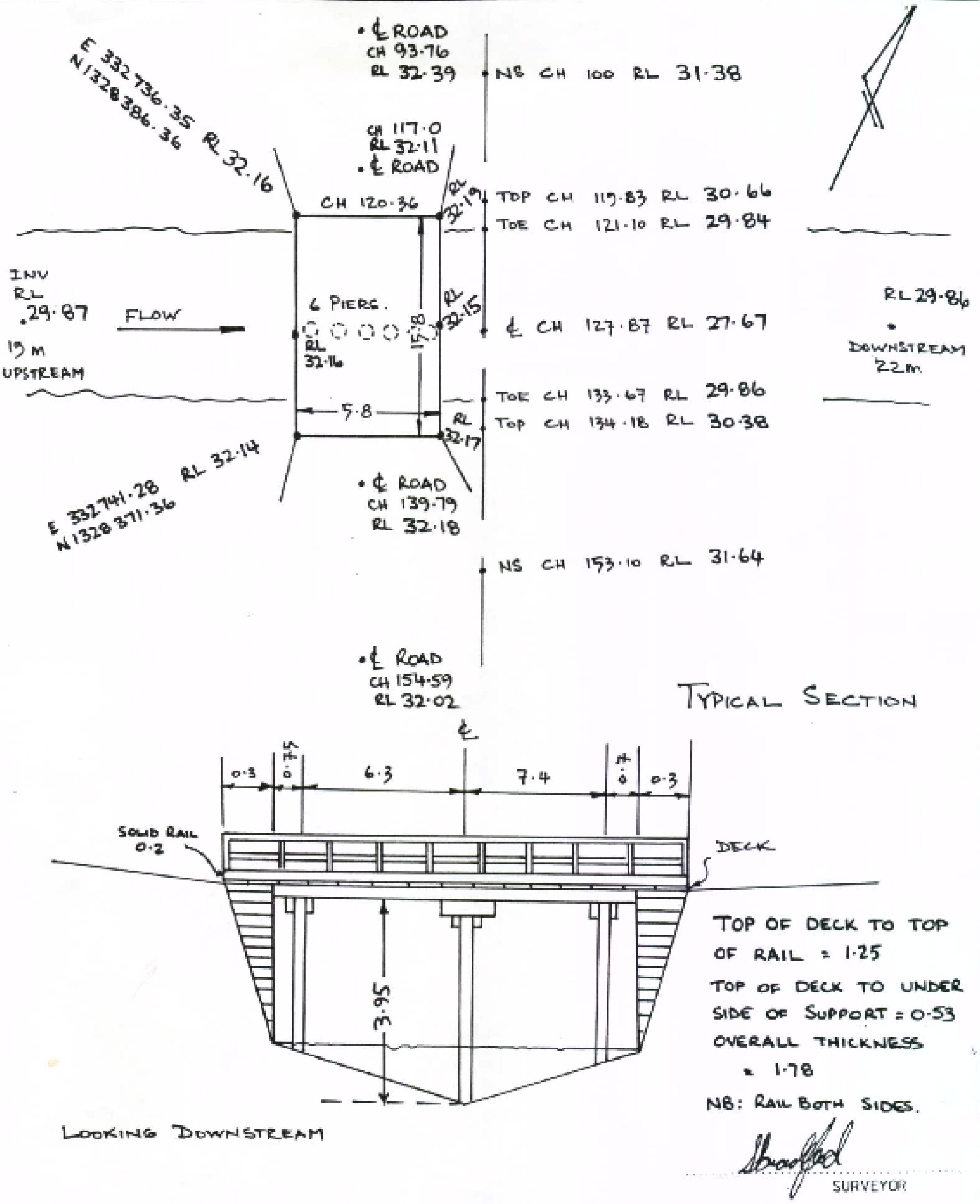
DX 7888



TITLE. BRIDGE "G"
JILLIBY ROAD

PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE 18/9/97 | R.R. NOT TO SCALE | REF. 96/110

MONTEATH & POWYS PTY. LTD.
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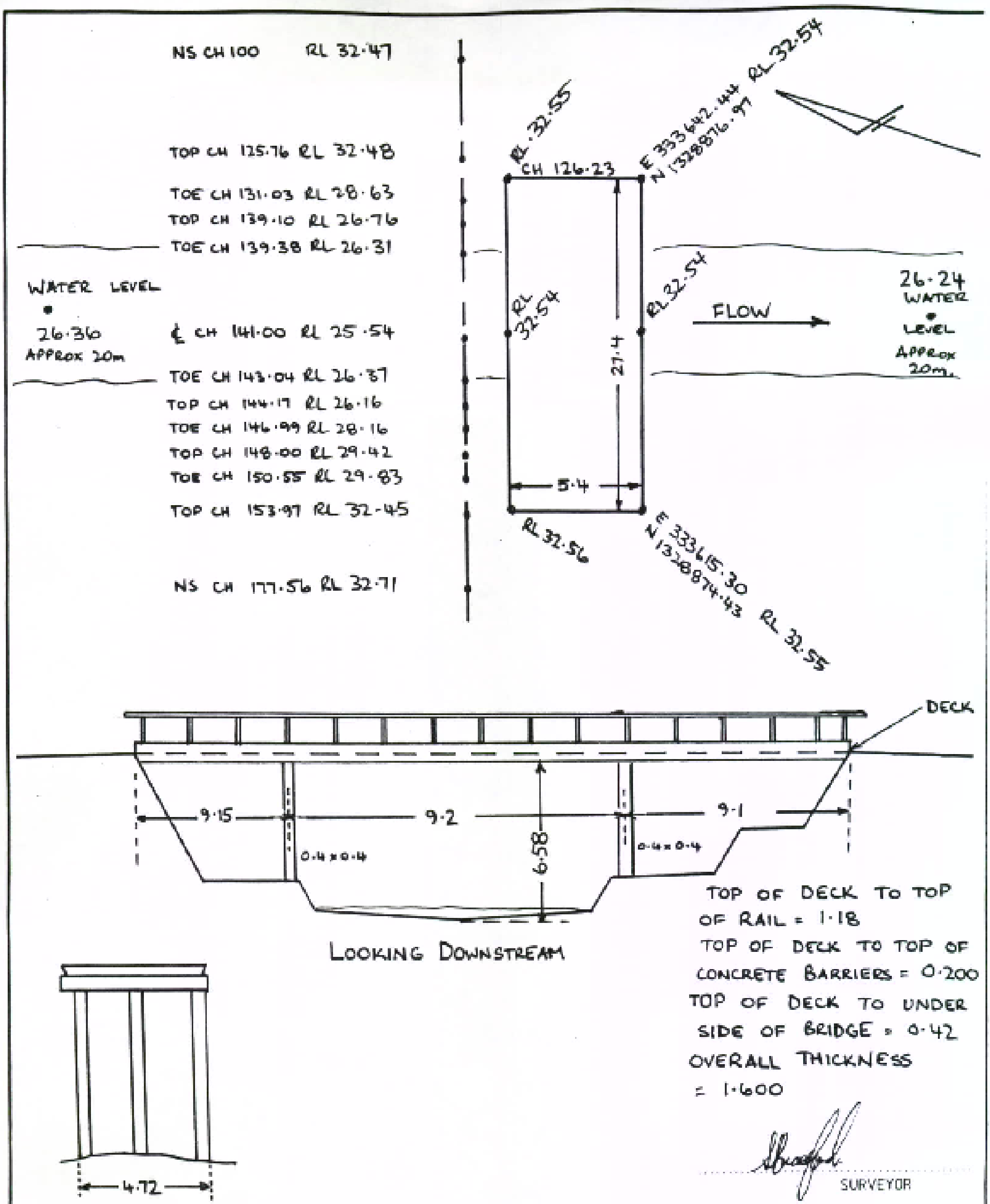
DX 7888



TITLE. BRIDGE 'H'
JILLIBY ROAD

PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE 22/9/97 | R.R. NOT TO SCALE | REF. 96/110

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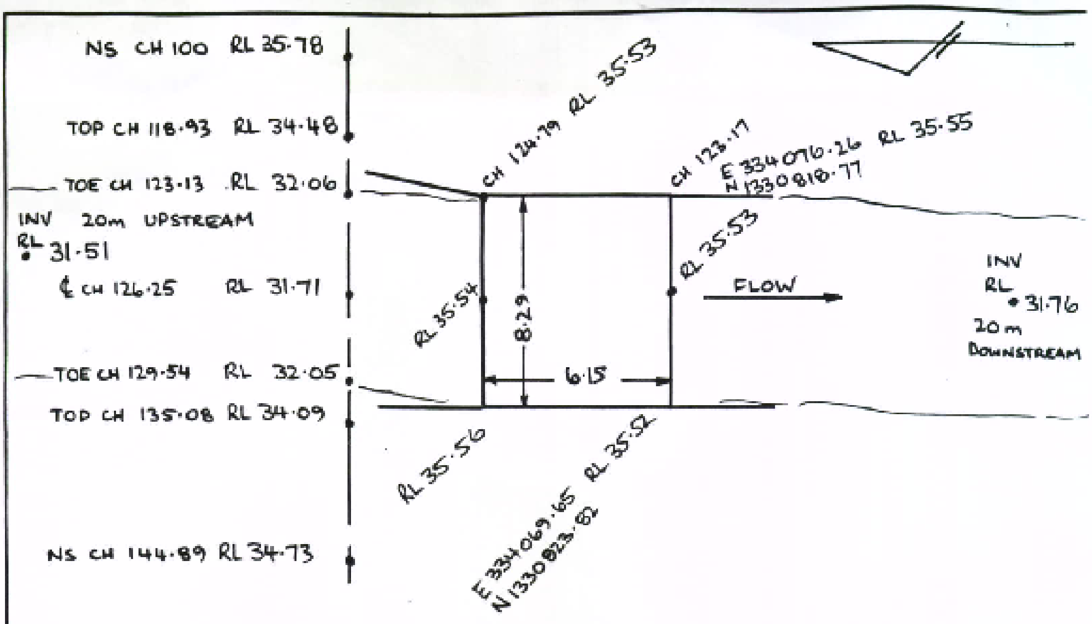
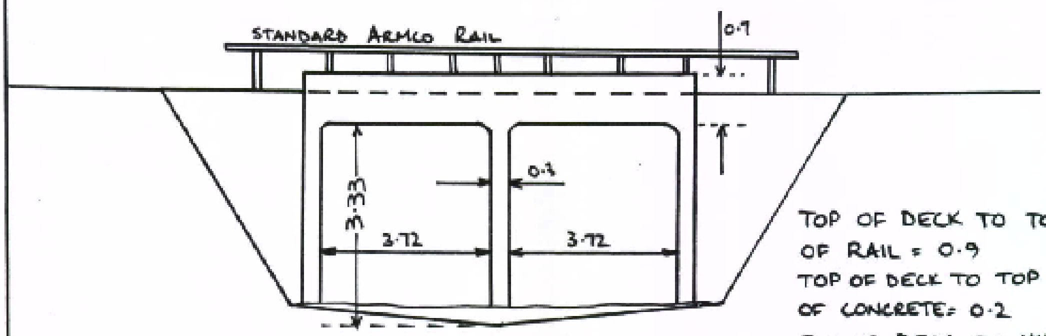
DX 7888



TYPICAL SECTION



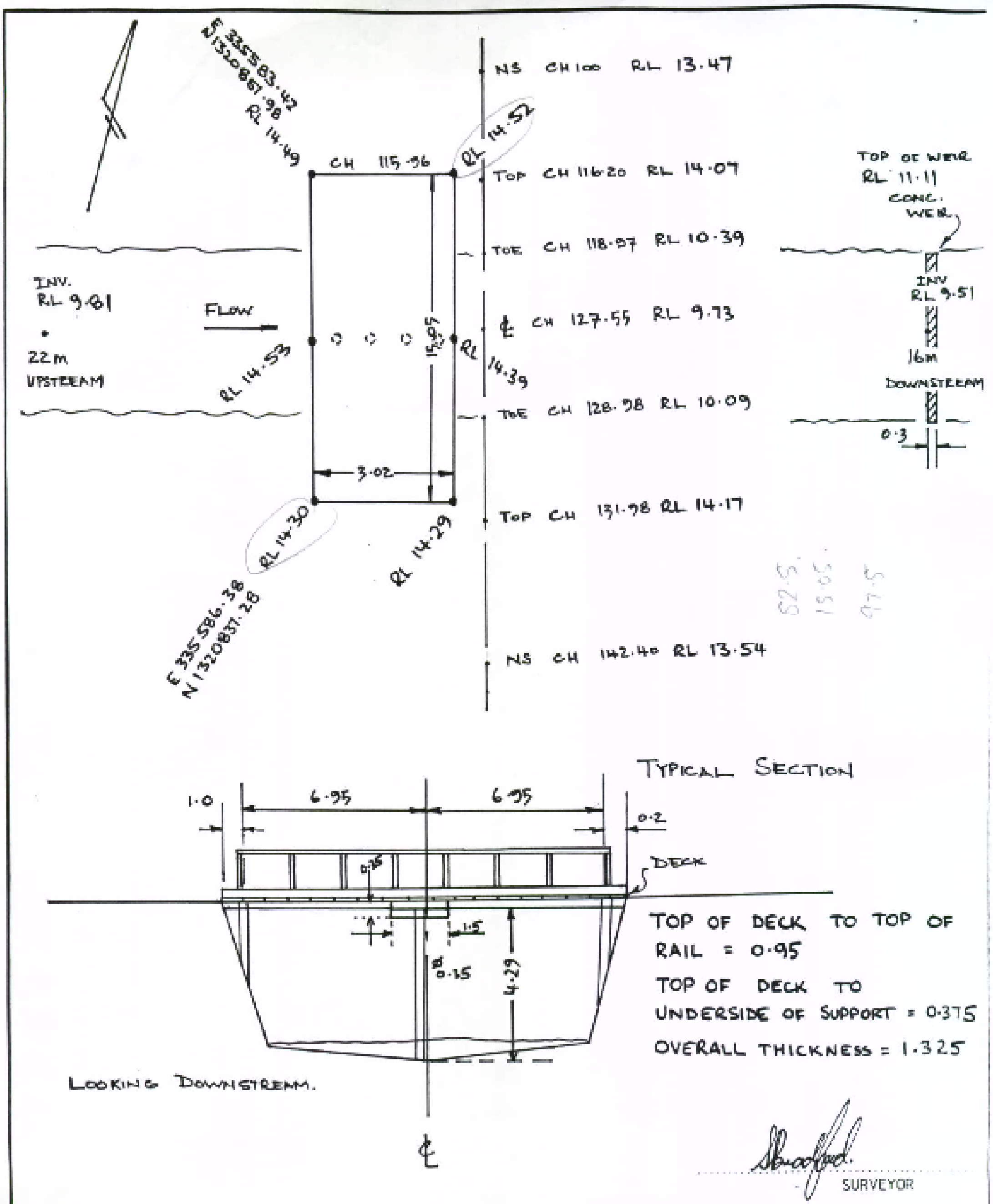
LOOKING DOWNSTREAM

TOP OF DECK TO TOP OF RAIL = 0·9
TOP OF DECK TO TOP OF CONCRETE = 0·2
TOP OF DECK TO UNDER SIDE = 0·5
OVERALL THICKNESS = 1·4

85·8
90
94 2

SURVEYOR

TITLE. BRIDGE 'J' JILLIBY ROAD	MONTEATH & POWYS PTY. LTD. A.C.N. 000 861 110
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE
DATE 18/9/97 · R.R. NOT TO SCALE · REF. 96/110	PHONE (049) 261398 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300. DX 7888



TITLE. BRIDGE 'K'
MILHAM PROPERTY

PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION

DATE 18/9/97 | R.R. NOT TO SCALE | REF. 96/110

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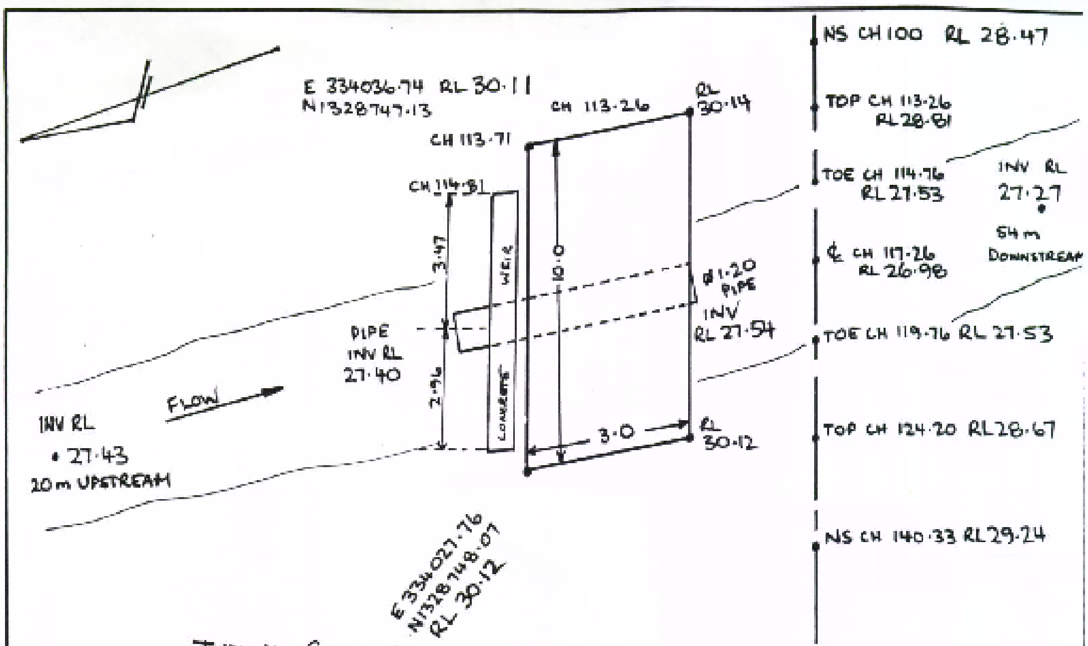
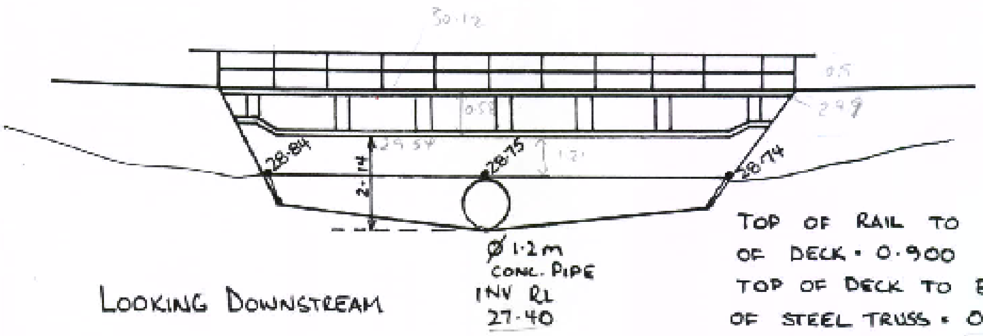
FAX (049) 293475
P.O. BOX 743L NEWCASTLE 2300
DX 7866



TYPICAL SECTION



LOOKING DOWNSTREAM

TOP OF RAIL TO TOP OF DECK = 0.900
TOP OF DECK TO BOTTOM OF STEEL TRUSS = 0.580
OVER ALL THICKNESS = 1.48
TOP OF DECK TO TOP OF WEIR = 1.36

SURVEYOR

TITLE. BRIDGE 'L' PRIVATE PROPERTY OFF JILLIBY ROAD NEAR BRIDGE 'H'	MONTEATH & POWYS PTY LTD. A.C.N. 000 861 110 CONSULTING SURVEYORS & PLANNERS "BOLTON BUILDING" 25 BOLTON ST NEWCASTLE PHONE (049) 261388 FAX (049) 293475 P.O. BOX 743L NEWCASTLE 2300 DX 7888
PLAN RL VALUES AND DIMENSIONS OF BRIDGE + TYPICAL SECTION	
DATE 22/9/97 · R.R. NOT TO SCALE · REF. 96/110	

Annex B

Design Rainfall

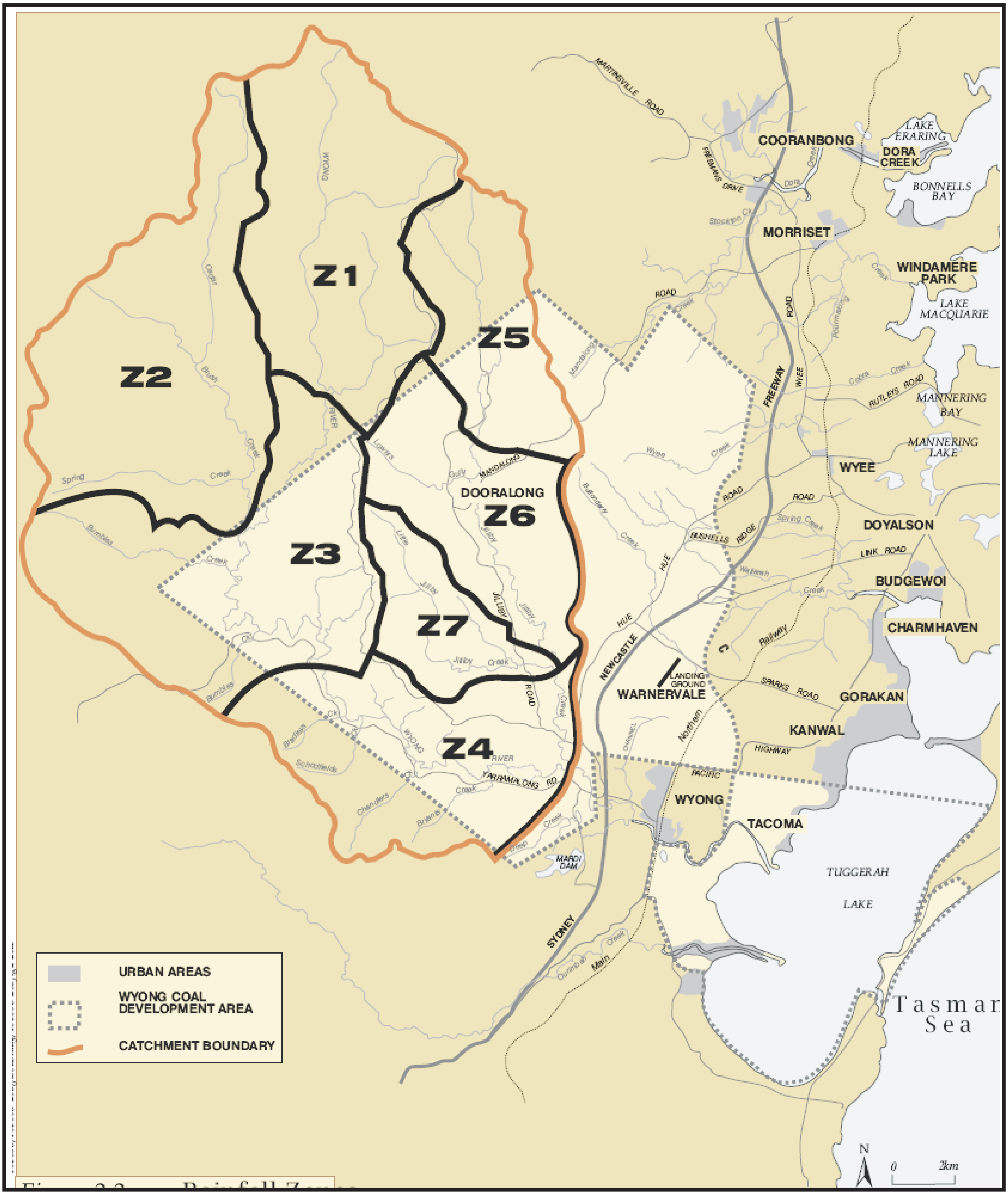


Figure B.1

Rainfall Zones

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project Flood Impact Assessment		
Drawing No:	0044971s_GIS19	Suffix No:	R1
Date Rev:	10/02/09	Drawing size:	A4
Drawn by:	JS	Reviewed by:	SO
Source:	-		
Scale:	Refer to Scale Bar		

N

Environmental Resources Management Australia Pty Ltd
53 Bonville Avenue, Thornton, NSW 2322
Telephone +61 2 4964 2150

ERM

Suffix	Revisions	Date	Init
R0	Preliminary Issue	04-06-08	JS
R1		10-02-09	JD

Table B.1 RAINFALL INTENSITIES FOR DESIGN STORM

AEP	Duration	Rainfall Intensity (mm/h)							
(%)	(hours)	Z1	Z1	Z3	Z4	Z5	Z6	Z7	Z8
1	24	13.5	13.9	14.4	14.1	13.8	14.4	14.6	13.7
	36	10.6	11.0	11.4	11.0	10.7	11.3	11.5	10.7
	48	8.80	9.20	9.54	9.15	8.88	9.35	9.60	8.83
	72	6.75	7.13	7.44	7.05	6.80	7.25	7.50	6.73
2	24	12.2	12.4	12.4	12.2	12.2	12.4	12.5	12.0
	36	9.61	9.78	9.83	9.57	9.56	9.72	9.84	9.39
	48	8.05	8.23	8.26	8.00	7.98	8.13	8.24	7.84
	72	6.15	6.33	6.34	6.10	6.08	6.20	6.30	5.97
5	24	10.2	10.3	10.4	10.2	10.2	10.4	10.5	10.1
	36	7.99	8.16	8.36	8.19	7.96	8.28	8.56	7.87
	48	6.69	6.85	6.90	6.71	6.64	6.79	6.90	6.57
	72	5.11	5.27	5.29	5.11	5.05	5.18	5.27	4.99
10	24	8.63	8.80	8.93	8.78	8.63	8.85	9.00	8.60
	36	6.78	6.95	7.04	6.88	6.76	6.94	7.07	6.73
	48	5.67	5.83	5.89	5.74	5.64	5.79	5.90	5.61
	72	4.32	4.47	4.50	4.36	4.29	4.41	4.49	4.26
20	24	7.44	7.61	7.76	7.65	7.45	7.68	7.84	7.48
	36	5.84	6.00	6.11	5.99	5.83	6.02	6.14	5.85
	48	4.88	5.03	5.11	4.99	4.86	5.02	5.12	4.87
	72	3.72	3.85	3.89	3.78	3.69	3.81	3.89	3.69

Notes: 1. *Z1-Z8 refers to the Rainfall Zones 1 to 8 used in the XP-RAFTS model to represent distributed rainfall depth across the catchment.*

2. *ARI is Average Recurrence Interval of the design storm*

Annex C

Observed Flood Marks

Table C.1 FLOOD HEIGHTS OBSERVED BY RESIDENTS

Station	Year	RL (mAHD)	Description
1A(a)	1964	18.48	RMB 197 Yarramalong Rd
1A(a)	1977	NS	RMB 197 Yarramalong Rd
1A(b)	1985	17.39	RMB 197 Yarramalong Rd (Base of orange tree)
1A(c)	1985	16.47	Near RMB 1198 50m east of tree
1A(d)	1985	16.76	Intersection of RMB 1194 "New Dawn" driveway and Yarramalong Rd
1B(a)	1985	15.15	Rear of Community Hall (base of pier nearest Wyong Creek)
1B(b)	1985	15.46	Intersection "Yarramalong Park" driveway and Yarramalong Rd
1D(a)	1985	17.09	Driveway RMB 1216
1D(b)	1985	15.26	Edge of bitumen near flood marker
1D(b)	1985	17.30	Edge of bitumen near power pole
1D(c)	1985	17.71	Edge of bitumen near driveway.
1D(d)	1985	18.07	Ground level at fourth post
3A	1998	30.02	Frog Lodge, Dooralong Rd (ground level at star picket)
6B	1990	10.06	Little Jilliby Rd (Mike Cambell's house) top of wire fence
6C(a)	1990	15.86	Cnr Jilliby Rd and Durren Rd
6C(b)(i)	1990	16.02	Corner of Jilliby Rd and Durren Rd (edge of bitumen of Jilliby Rd)
6C(b)(ii)	1990	15.93	Corner of Jilliby Rd and Durren Rd (edge of Bitumen of Jilliby Rd)
6D(a)	1990	17.89	"Grey Gums" (Driveway and Little Jilliby Rd)
6D(b)	1990	18.54	"Grey Gums" (Edge of Bitumen opposite gap in trees)
8B(b)	1964	10.31	Porter's Rail Bridge (mark on power pole, believed to be 1964 flood)
8A(a)	1989	8.72	Cnr of Wattagan Forrest Drive and Jilliby Rd (Stay Pole)
8A(b)	1989	8.62	Cnr of Wattagan Forrest Drive and Jilliby Rd (power pole)
8A(c)	1989	9.49	Cnr of Wattagan Forrest Drive and Jilliby Rd (top of large stump)
8B(a)	1989	9.20	Cnr of Wattagan Forrest Drive and Jilliby Rd (House corner)
8C	1989	8.46	"Fatheringham" property, top of flood plain.
10A (a)	1992	30.44	RMB 1437 Bunning Creek Road at base of small tree adjacent to power pole
11A (a)	1992	NS	Ravensdale Road at base of cattleyard closest to the creek.
12A (a)	1963	28.59	1429A Yarramalong Road, mark engraved on shed support
12A (b)	1964	28.82	1429A Yarramalong Road, mark engraved on shed support
12A (c)	1977	28.91	1429A Yarramalong Road, mark engraved on shed support
12A (d)	1978	29.04	1429A Yarramalong Road, mark engraved on shed support
13A (a)	1985	35.87	1550 Yarramalong Road at mark on entry steps.

Source: *Historical flood marks were obtained by consulting the public in Yarramalong and Dooralong Valleys.*
m AHD - metres, Australian Height Datum
YARR - Yarramalong Valley
Chainage - distance along the river branch in metres
DOOR - Dooralong Valley
NS – abbreviates not surveyed.

Table C.2 FLOOD HEIGHTS FOR HISTORICAL STORMS OBTAINED FROM UPPER WYONG RIVER FLOOD STUDY

Station	Year	RL (mAHD)	Description
8	1989	6.60	Yarramalong Road (collies waterhole) Ti -tree opposite flood height marker
11	1989	9.67	Watagan Road mark on p.pole and gate of house opposite
12	1964	10.10	Dunks lane approx floor level of old house(Fotheringham) put fire out in open fireplace (Bill Daniels) see G.Bisset survey
13	1990	9.68	Dooralong Road bottom of rail "grey gums"
14	1989	16.11	Durren Road G.L.Stake 200m south of Smiths Lane
14	1992	16.41	Durren Road G.L.Stake 200m south of Smiths Lane
15	1989	25.14	Mandalong Road bridge notch in sapling R.H.S. Approx 1.5m above ground
16	1989	24.14	Mandalong Road 600m above ground--gate lot 144
17	1989	36.79	Lemon Tree 50m west of bridge base of p.pole L.H.S.
18	1989	12.19	Yarramalong Road plastic on p.pole S.W.corner Lauffs Lane(maybe old flood mark)
19	1989	11.71	Yarramalong Road 100m west Lauffs Lane top rail on wooden gate north side of road
20	1989	12.69	Kidmans Lane axe cut E.H.S. in gum 1.5 above ground
21	1989	12.14	Kidmans Lane near "Lyons" 100mm above base of strut
21	1992	12.37	Kidmans Lane near "Lyons" 100mm above base of strut
22	1949	12.53	Kidmans Lane house R.H.S. end of lane ground level at back steps
23	1989	14.30	Chandlers Lane top wire on fence 2nd p.pole from Yarramalong Road R.H.S
24	1989	15.72	Yarramalong Road "Wyong Creek Hall"1st p.pole past 1st wire up
25	1989	17.32	Boyds Lane 500m down base stake L.H.S
26	1989	18.29	Yarramalong Road take near loading ramp RMB 1216 (gears)
26	1992	18.19	Yarramalong Road take near loading ramp RMB 1216 (gears)
27	1989	18.28	Yarramalong Road old gate opposite "Gleneagles" top of top rail
28	1989	19.20	Yarramalong Road bottom 3rd wire (gap)on gate
29	1989	17.92	Yarramalong Road base of gum in Paddock 100m west of horse yard (old milk can shed) Yarramalong
30	1989	23.77	Yarramalong road edge of seal 90 of stake 30m west of "Robinvale" gate

Table C.2 FLOOD HEIGHTS FOR HISTORICAL STORMS OBTAINED FROM UPPER WYONG RIVER FLOOD STUDY *(Contd)*

Station	**Year**	**RL (m AHD)**	**Description**
30	1992	23.37	Yarramalong road edge of seal 90 of stake 30m west of "Robinvale" gate
31	1989	27.56	Binga Longa Road Cl. Opposite letterbox no 7 "Jones"
33	1990	28.03	Bunning Creek Road dumpy 200m L.H.S from Yarramalong Rd
33	1992	27.53	Bunning Creek Road dumpy 200m L.H.S from Yarramalong Rd
34	1989	20.66	Stints Lane stake 500m down L.H.S

Source: Department of Public Works (Feb 1988) Upper Wyong River Flood Study

m AHD - metres, Australian Height Datum

YARR - Yarramalong Valley

DOOR - Dooralong Valley

Chainage - distance along the river branch in kilometres

Ppole – Power Pole

Annex D

Hydrologic Modelling Parameters

Table D.1 XP-RAFTS SUB-CATCHMENT PARAMETERS - YARRAMALONG AND DOORALONG VALLEY

Subcatchment ID	Area (hectares)	Slope (%)
1_10	2908	4.1
1_20	2044	2.6
3_10	1455	3.2
1_21D	0.001	1.0
1_30	1666	2.2
4_10	3195	2.9
4_20	4015	1.6
1_31D	0.001	1.0
1_40	2359	2.8
1_42	1131	4.2
1_44	623	4.5
1_50	1381	2.4
1_52	691	4.4
1_54	817	3.5
1_60	1316	2.9
1_62	798	3.8
1_70	558	3.1
2_10	1558	4.6
2_12	456	4.4
11_02	102	4.9
11_04	562	3.3
2_20	518	3.4
17_10	556	4.7
2_21D	0.001	1.0
2_30	258	3.9
18_10	580	3.7
2_31D	0.001	1.0
12_02	114	4.7
12_04	164	2.6
2_32D	0.001	1.0
13_02	114	5.3
13_04	214	2.3

Table D.2 XP-RAFTS SUB-CATCHMENT PARAMETERS - YARRAMALONG AND DOORALONG VALLEY

Subcatchment ID	Area (hectares)	Slope (%)
2_33D	0.001	1.0
2_34	391	3.9
2_36	749	3.3
14_02	168	2.7
14_04	313	1.2
2_37D	0.001	1.0
5_10	1093	2.8
5_12	267	4.0
5_14	236	3.6
15_02	331	3.8
5_15D	0.001	1.0
5_20	95	0.8
2_38D	0.001	1.0
2_40	307	2.2
2_50	852	2.3
1_72D	0.001	1.0
1_80	250	1.1

Notes: ID relates to node identity used in the XP-RAFTS model

Table D.3 ARBM RAINFALL INFILTRATION MODEL PARAMETERS - YARRAMALONG AND DOORALONG VALLEY

Storage Capacities	**Abbreviation**	**Value**	
Impervious Zone	CAPIMP	0.6	
Interception Zone	ISC	2.0	
Depression Storage Zone	DSc	2.0	
Upper Soil	USC	16.5	
Lower Soil	LSC	250.0	
Initial Storage Capacities		**Initial wetness 60%**	**Initial wetness 100%**
Impervious Zone	CAPIMP(init)	0.35	0.6
Interception Zone	ISC(init)	1.2	2
Depression Storage Zone	DSC(init)	1.2	2
Upper Soil	USC(init)	10.0	16.5
Lower Soil	LSC(init)	150.0	250
Groundwater	GS	0.0	0.0
Infiltration			
Dry Sorptivity, Upper Soil	SO	10.0	
Hydraulic Conductivity, Upper Soil	Ko	0.42	
Lower Soil Drainage Factor	LDF	0.05	
Groundwater recession factor, constant rate	KG	0.94	
Groundwater recession factor, variable rate	GN	1.0	
Evapotranspiration			
Proportion of rainfall intercepted by vegetation		0.7	
Maximum potential evapotranspiration, upper soil	UH	10.0	
Maximum potential evapotranspiration, lower soil	LH	10.0	
Proportion of evapotranspiration from upper soil zone	ER	0.7	
Ratio of potential evaporation from A class pan		0.7	

Notes: XP-RAFTS model used initial wetnesses of both 60% and 100%.

Table D.3 XP-RAFTS SUB-CATCHMENT PARAMETERS - HUE HUE CATCHMENT

Node	Total Area (ha)	Sub Area 1 (ha)	Sub Area 2 (ha)	Slope (%)	Imp SA1 (%)	Imp SA2 (%)	Pern SA1	Pern SA2
H1.000	89.47	89.47		6.5			0.100	
H1.020	112.58	112.58		3			0.100	
H2.000	50.29	50.29		3.7			0.085	
H1.03j	0.00	0.00		0.2			0.025	
H1.040	47.73	47.73		4.9	2		0.075	
H3.000	53.79	53.79		6	5		0.065	
H1.05j	0.00	0.00		0.2			0.025	
H1.060	33.14	33.14		5.1	5		0.065	
H4.000	23.35	23.35		3.8	7		0.060	
H5.000	25.36	22.06	3.30	4.5		100	0.060	0.018
H1.080	54.53	54.53		3.1	5		0.065	
H6.000	44.51	39.17	5.34	7.8		100	0.060	0.018
H7.000	34.31	29.85	4.46	8.5		100	0.055	0.018
H1.09j	0.00	0.00		0.2			0.025	
H1.10	55.29	46.44	8.85	5.6		100	0.050	0.018
H8.000	42.76	38.48	4.28	6.3		100	0.060	0.018
H1.11j	0.00	0.00		0.2			0.025	
H10.00	37.15	31.95	5.20	3.2		100	0.050	0.018
H1.120	66.03	56.79	9.24	2.9		100	0.050	0.018
H9.00	50.64	42.54	8.10	5.4		100	0.065	0.018
H1.13j	0.00	0.00		0.2			0.025	
out	0.00	0.00		0.2			0.025	

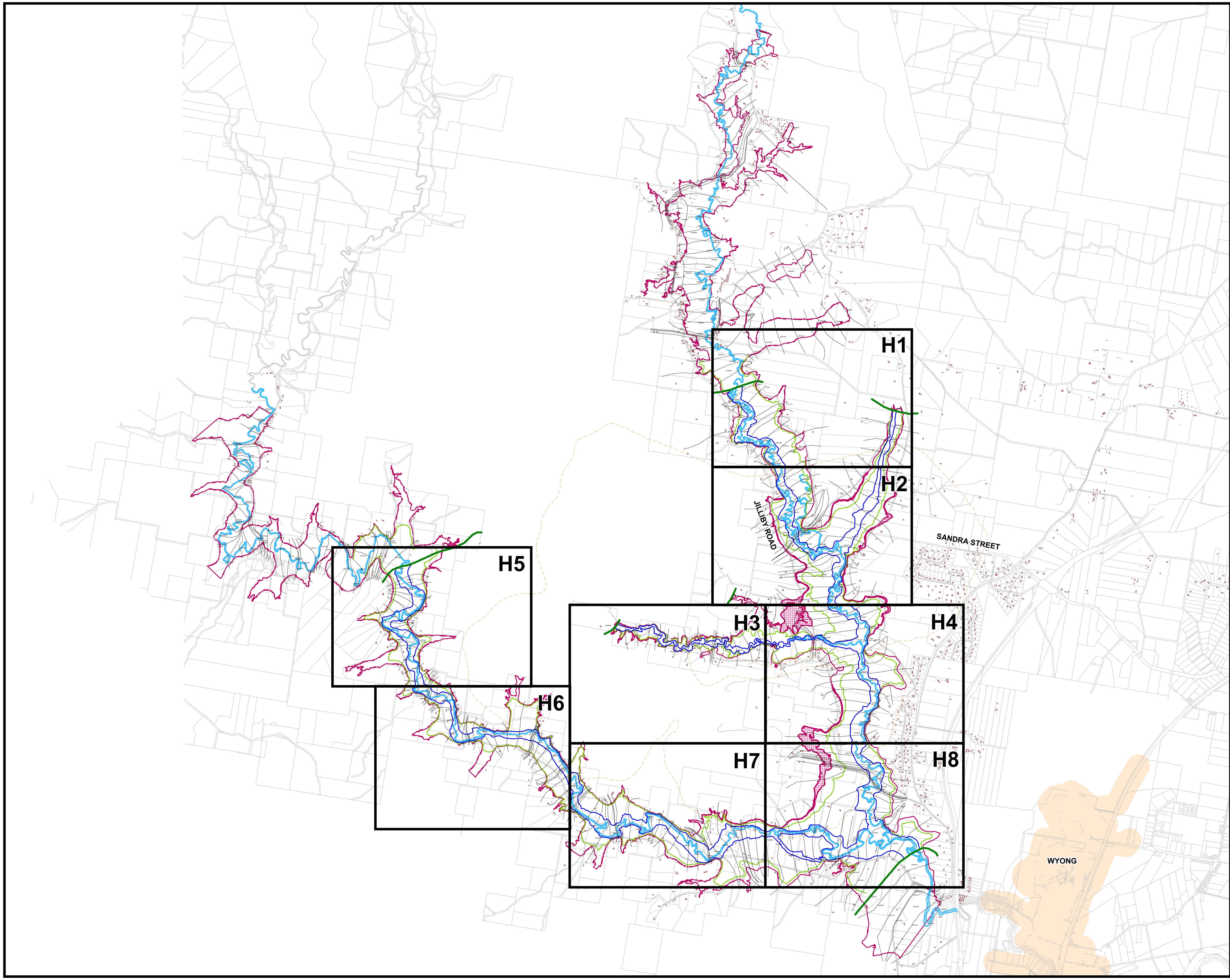
Table D.4 ARBM RAINFALL INFILTRATION MODEL PARAMETERS – HUE HUE CATCHMENT

Storage Capacities	**Abbreviation**	**Value**	
Impervious Zone	CAPIMP	0.6	
Interception Zone	ISC	2.0	
Depression Storage Zone	DSC	2.0	
Upper Soil	USC	16.5	
Lower Soil	LSC	250.0	
Initial Storage Capacities		**Initial wetness 80%**	**Initial wetness 100%**
Impervious Zone	CAPIMP(init)	0.46	0.6
Interception Zone	ISC(init)	1.62	2
Depression Storage Zone	DSC(init)	1.6	2
Upper Soil	USC(init)	13.33	16.5
Lower Soil	LSC(init)	200.0	250
Groundwater	GS	0.0	0.0
Infiltration			
Dry Sorptivity, Upper Soil	SO	10.0	
Hydraulic Conductivity, Upper Soil	Ko	0.42	
Lower Soil Drainage Factor	LDF	0.05	
Groundwater recession factor, constant rate	KG	0.94	
Groundwater recession factor, variable rate	GN	1.0	
Evapotranspiration			
Proportion of rainfall intercepted by vegetation		0.7	
Maximum potential evapotranspiration, upper soil	UH	10.0	
Maximum potential evapotranspiration, lower soil	LH	10.0	
Proportion of evapotranspiration from upper soil zone	ER	0.7	
Ratio of potential evaporation from A class pan		0.7	

Notes: XP-RAFTS model used initial wetnesses of 100% used in sensitivity analysis.

Annex E

MIKE 11 Model Layout



Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.0

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Annex E Index Sheet

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_GIS10
Date:	15.05.2007
Drawing Size:	A3
Drawn By:	DH
Reviewed By:	GH
Source:	-
Scale:	Refer to Scale Bar

N

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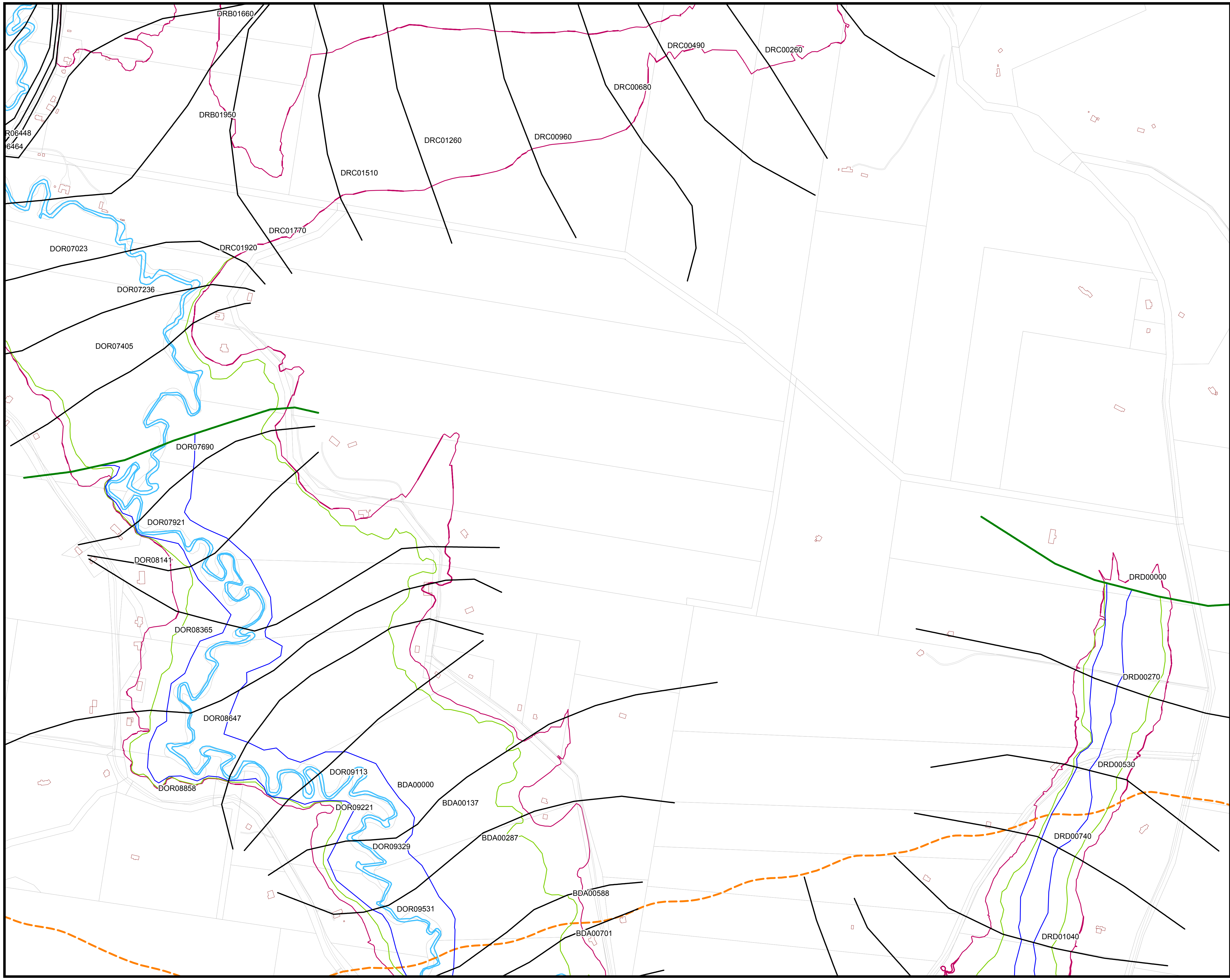

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.1

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E1

Client: Wyong Areas Coal Joint Venture
Project: Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No: 0044971_GIS11
Date Rev: 10.02.2009 Drawing Size: A3
Drawn By: DH Reviewed By: GH
Source: -
Scale: Refer to Scale Bar

0 100 200m

N

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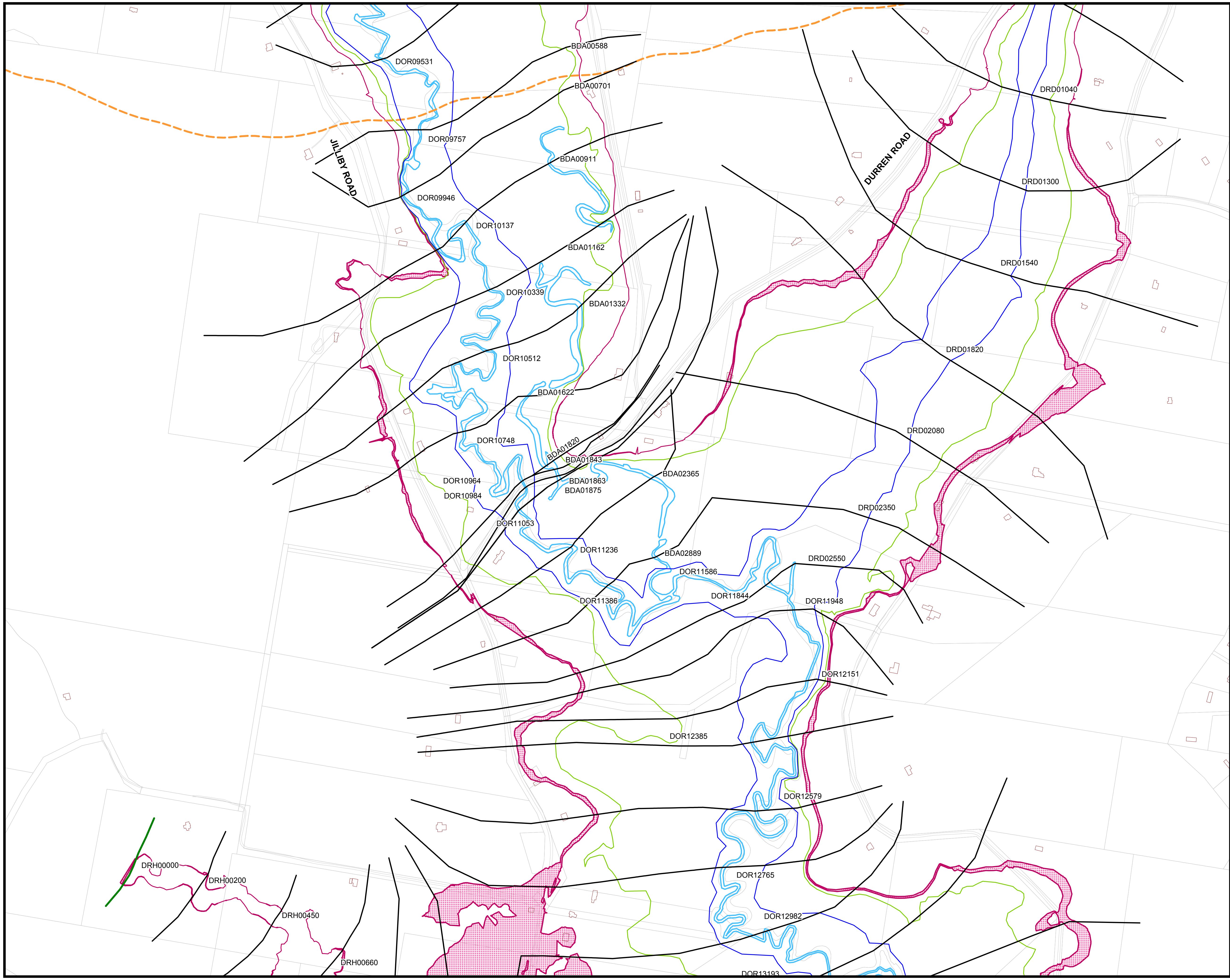

Figure E.2

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E2

Client: Wyong Areas Coal Joint Venture
Project: Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No: 0044971_GIS12
Date Rev: 10.02.2009 Drawing Size: A3
Drawn By: DH Reviewed By: GH
Source: -
Scale: Refer to Scale Bar

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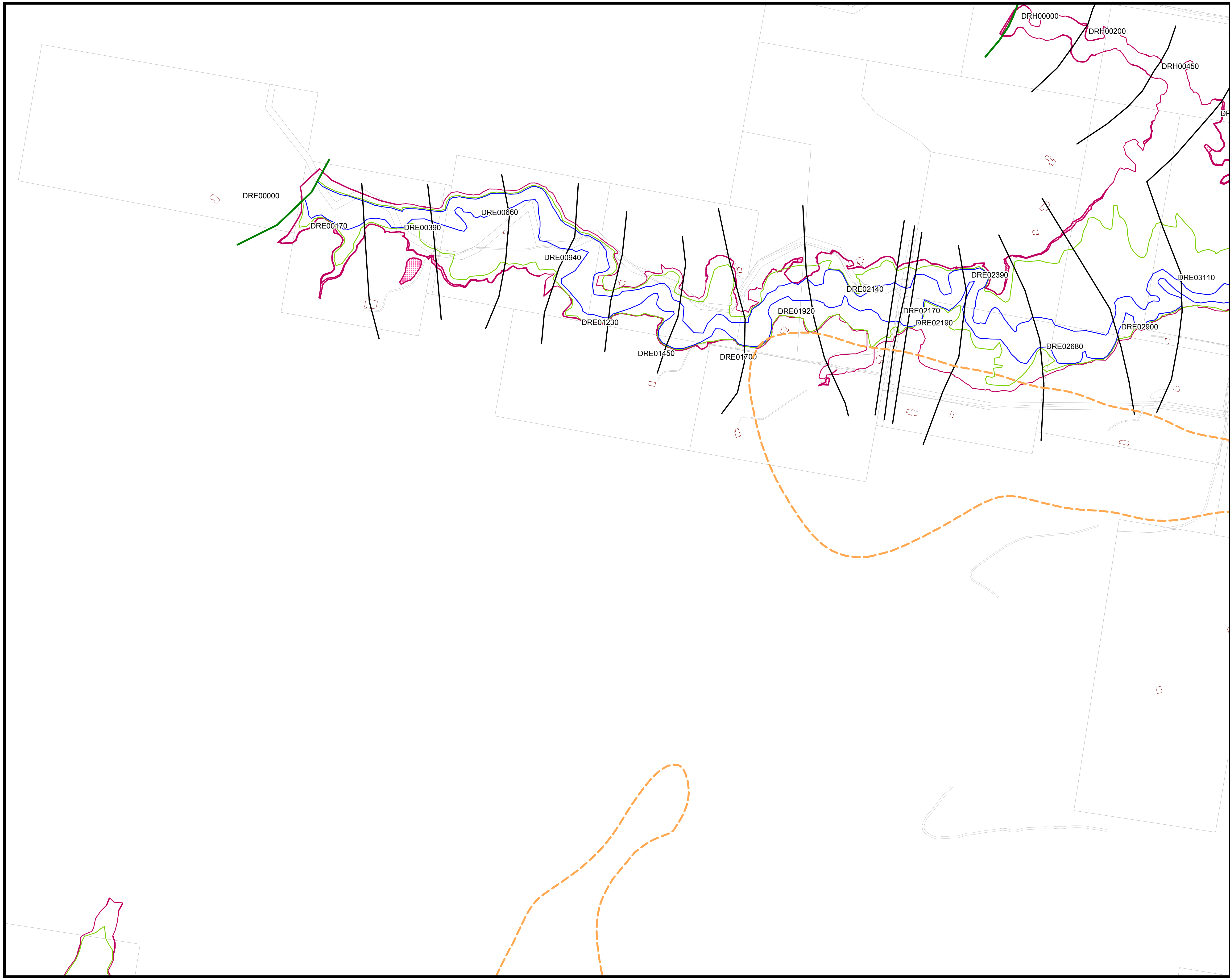

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.3

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E3

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS13		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
Scale:	Refer to Scale Bar		

N

0 100 200m

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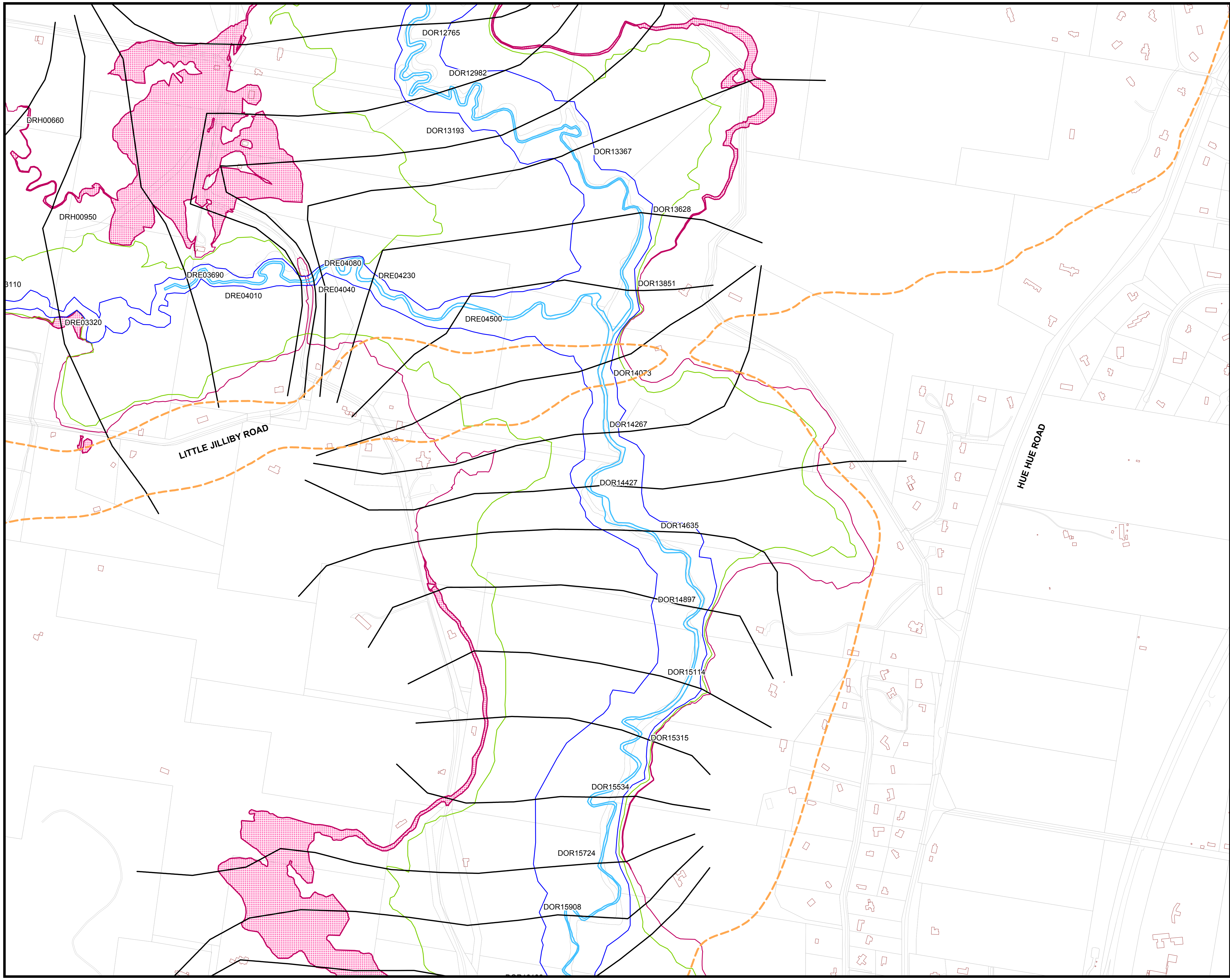

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.4

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E4

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_GIS14
Date Rev:	10.02.2009 Drawing Size: A3
Drawn By:	DH Reviewed By: GH
Source:	-
Scale:	Refer to Scale Bar

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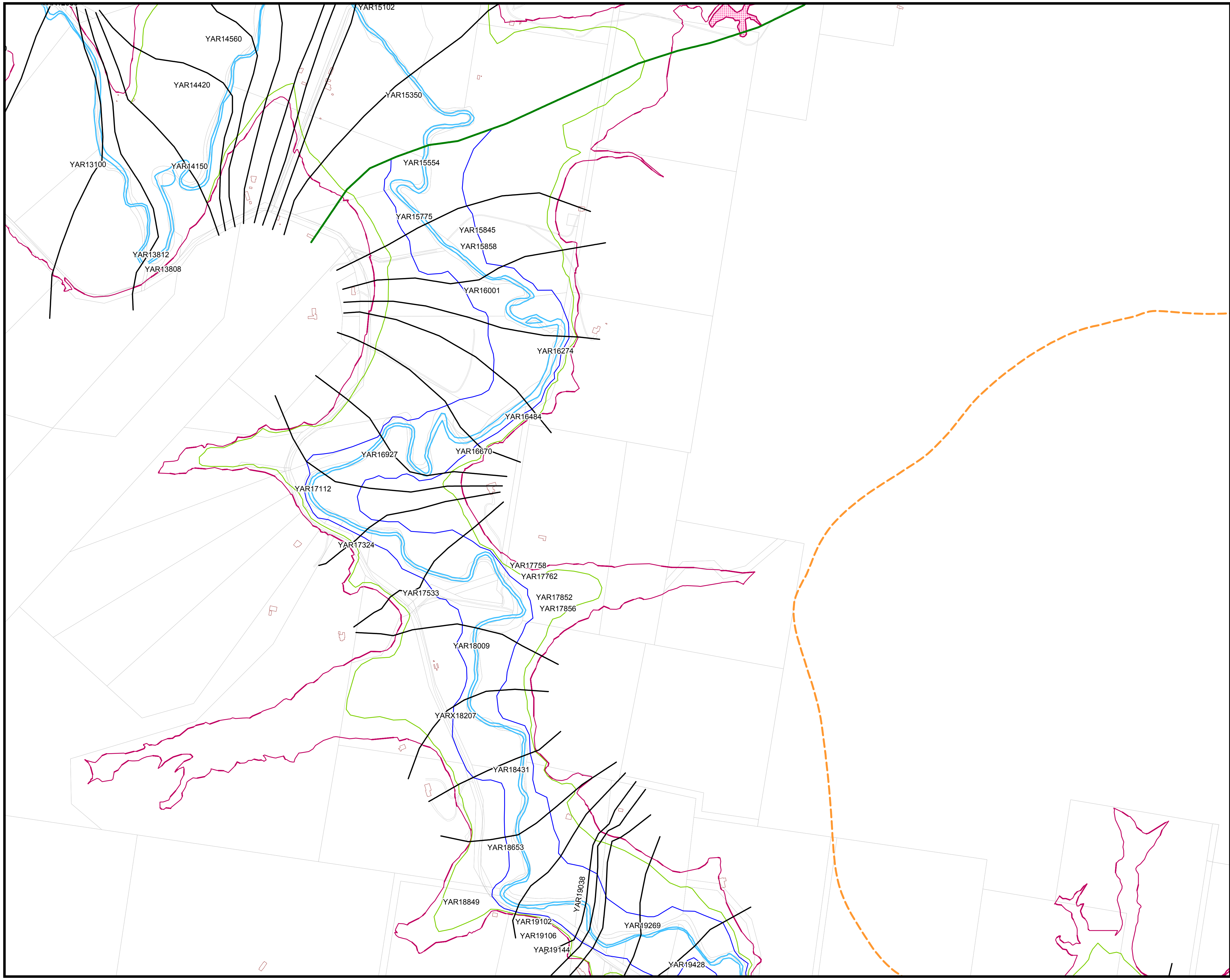

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.5

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E5

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_GIS15
Date Rev:	10.02.2009 Drawing Size: A3
Drawn By:	DH Reviewed By: GH
Source:	-
Scale:	Refer to Scale Bar

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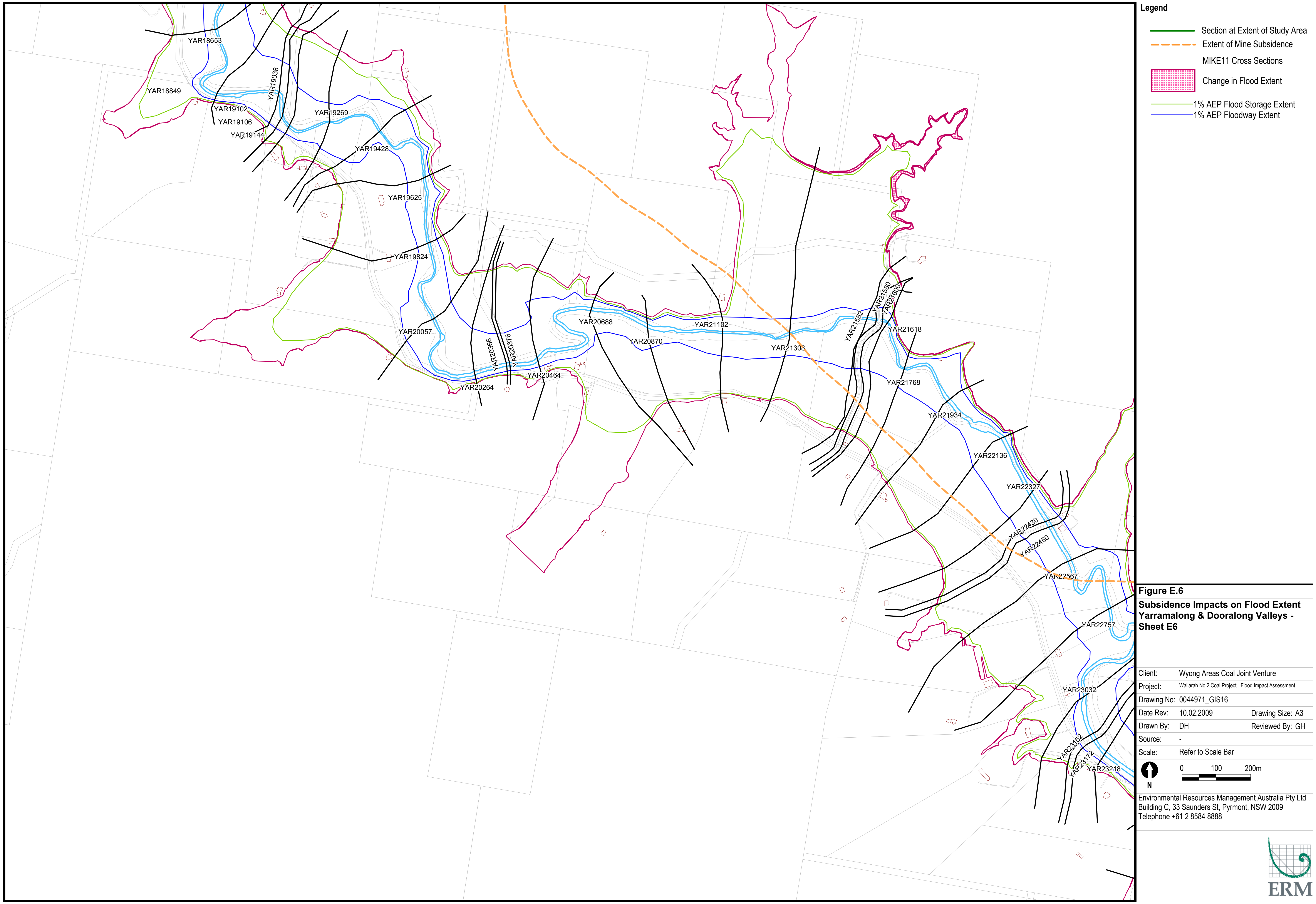

Figure E.6

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E6

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS16		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
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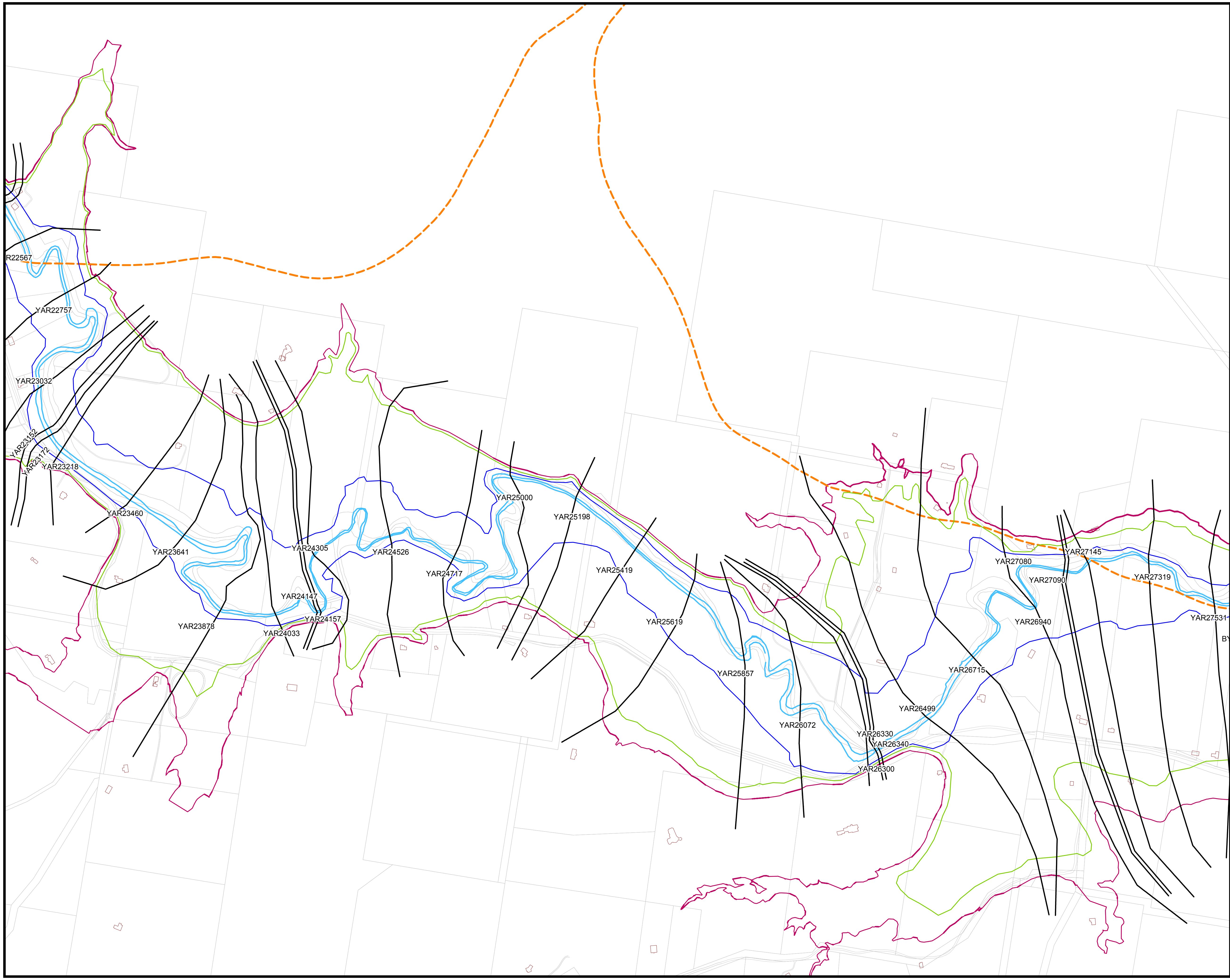

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.7

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E7

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS17		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
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0 100 200m

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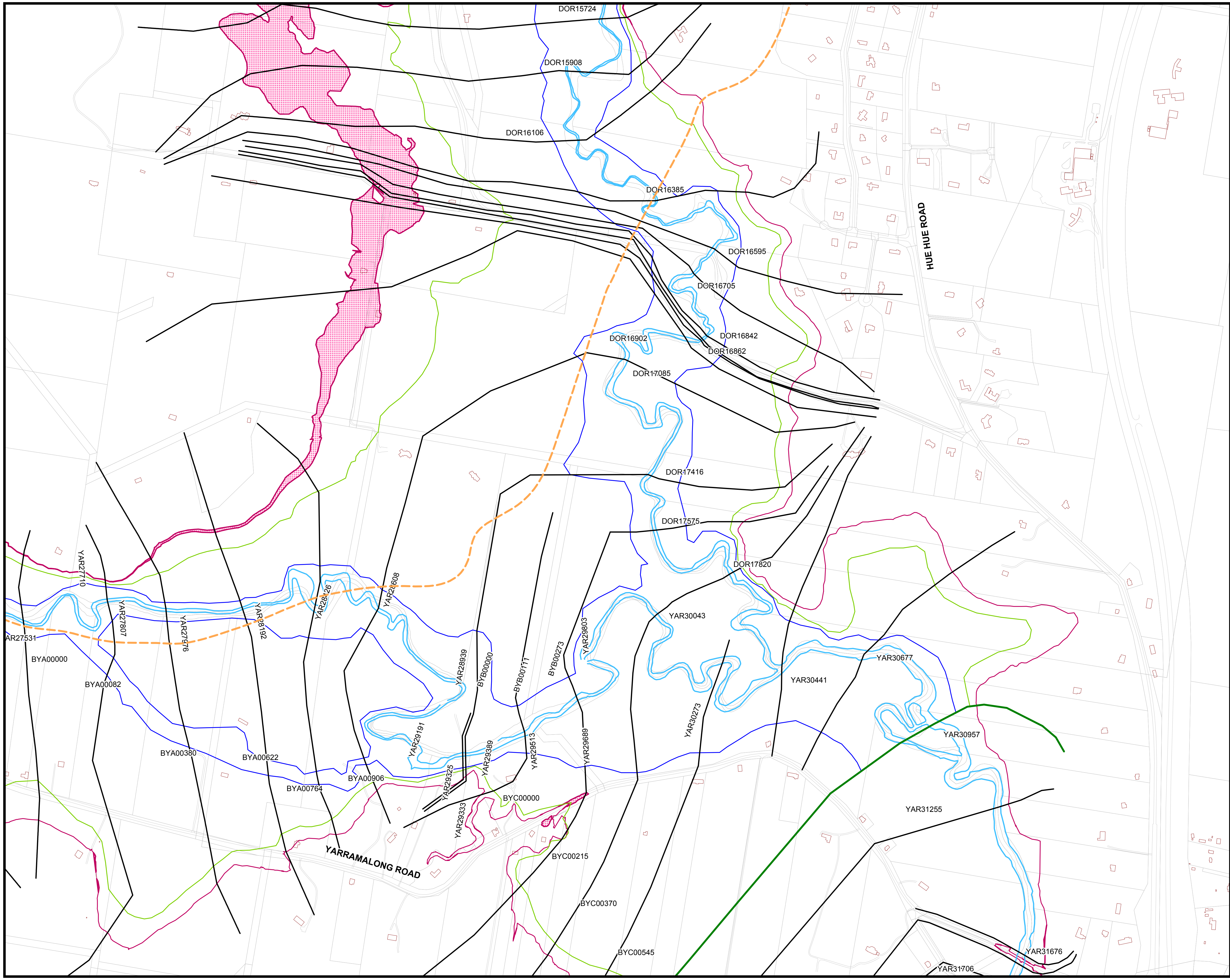

Legend

- Section at Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent

Figure E.8

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E8

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS18		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
Scale:	Refer to Scale Bar		

N

0 100 200m

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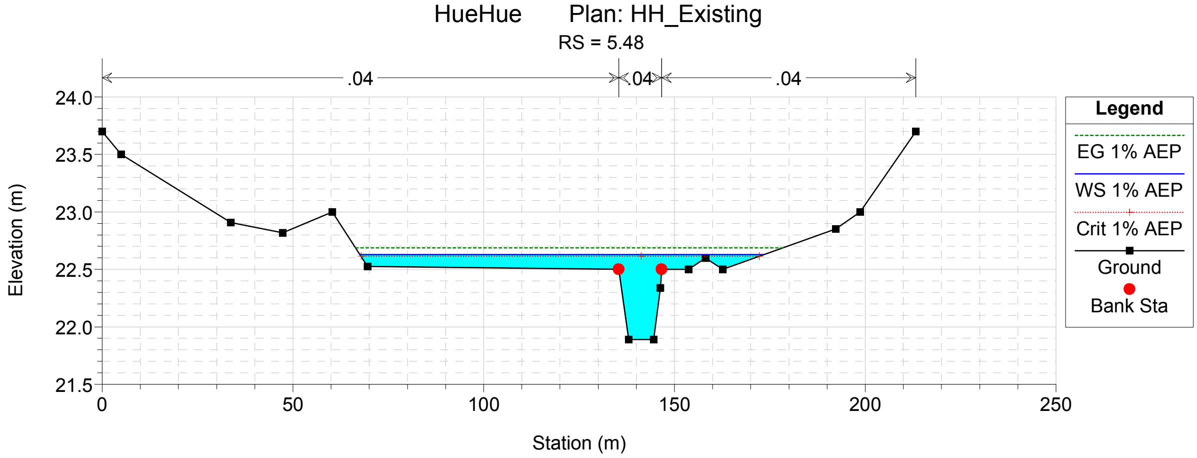
Annex F

HEC-RAS Cross Section Details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Elevation (m)
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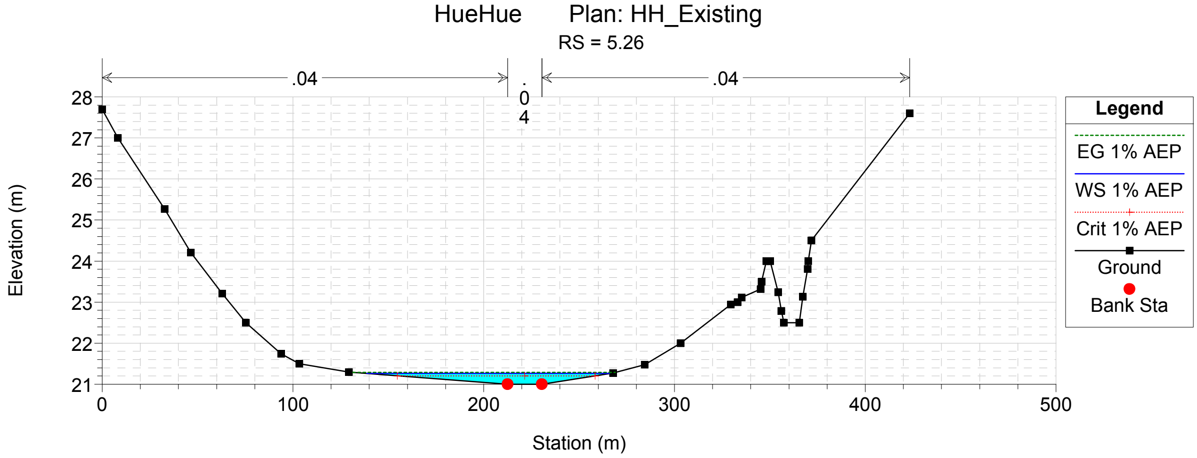
23.5
23.0
22.5
22.0
21.5
0
50
100
150
200
250
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 5.26
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.04
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26
25
24
23
22
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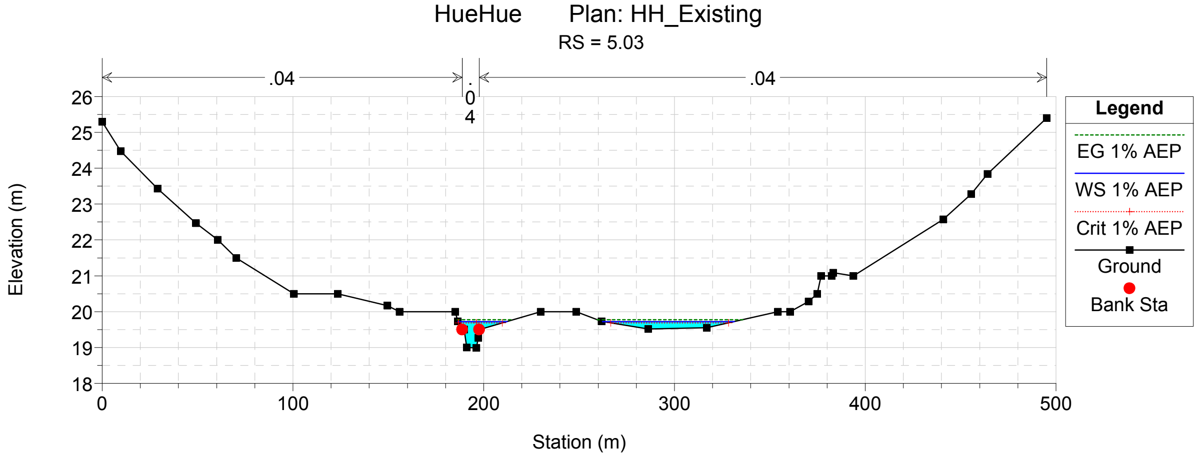
200
300
400
500
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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.04
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25
24
23
22
21
20
19
18
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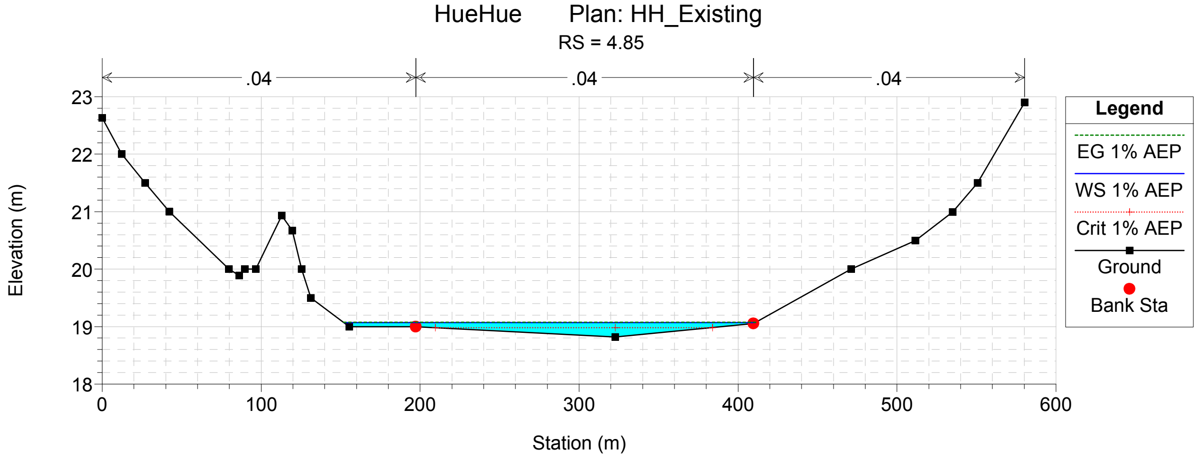
100
200
300
400
500
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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21
20
19
18
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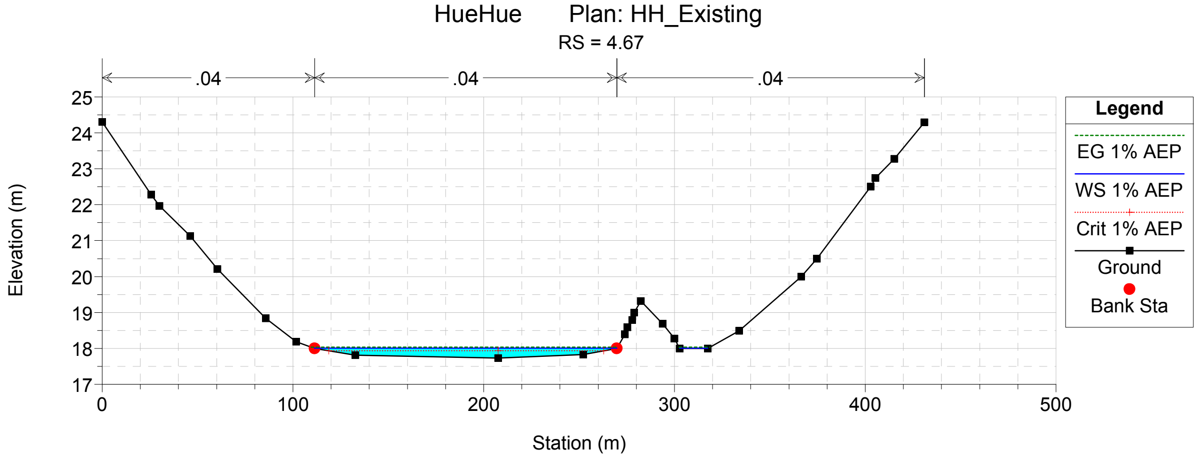
100
200
300
400
500
600
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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Elevation (m)
Station (m)
Legend
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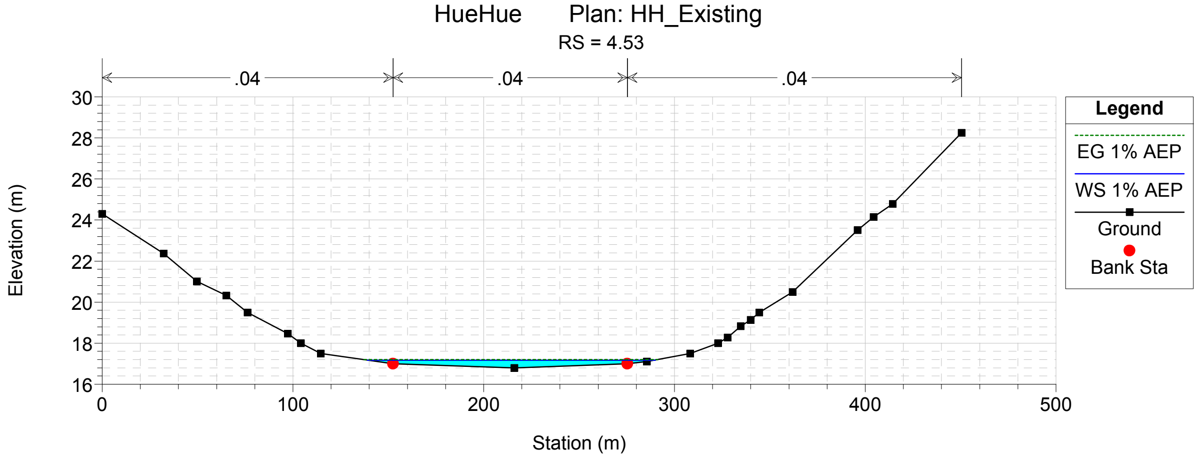
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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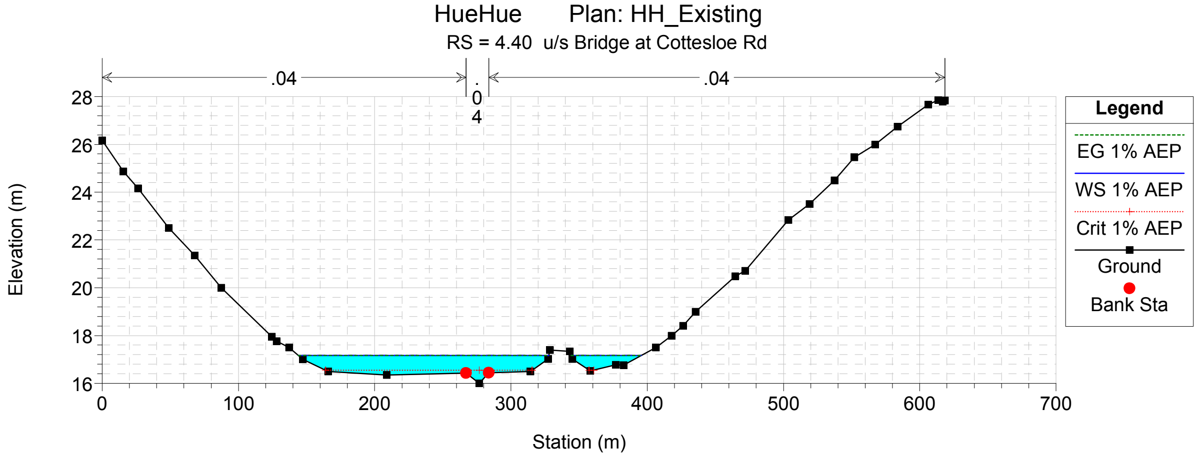
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta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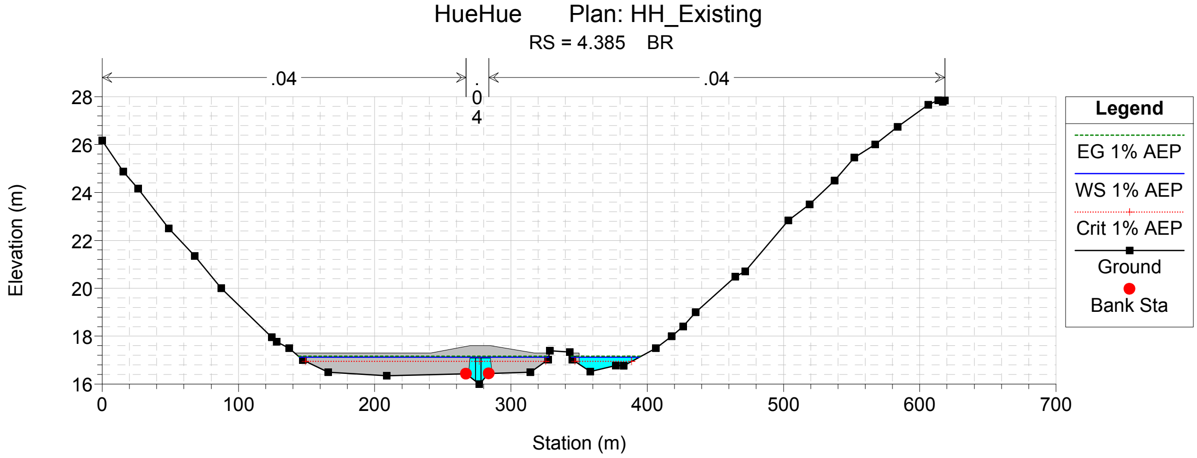
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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Elevation (m)
Station (m)
Legend
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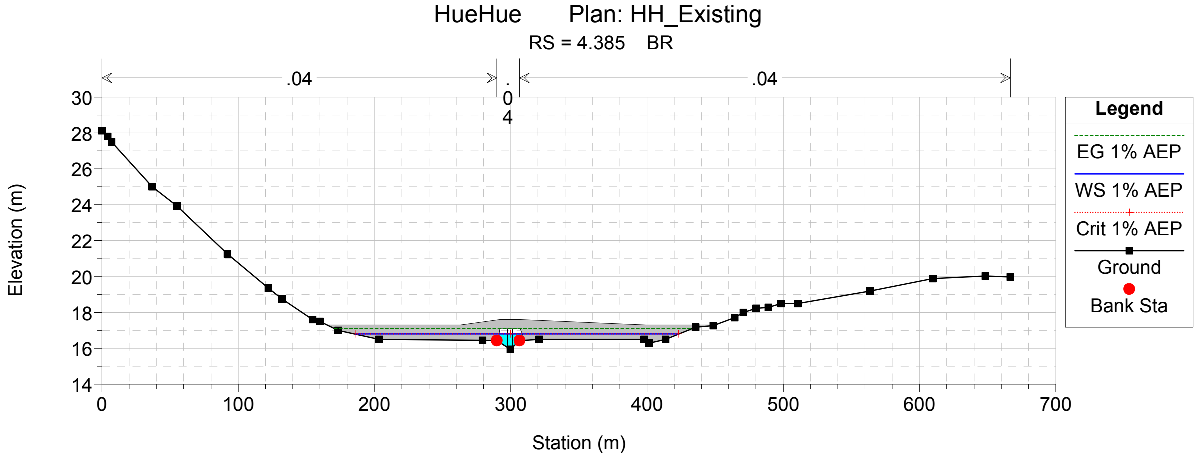
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 4.385 BR
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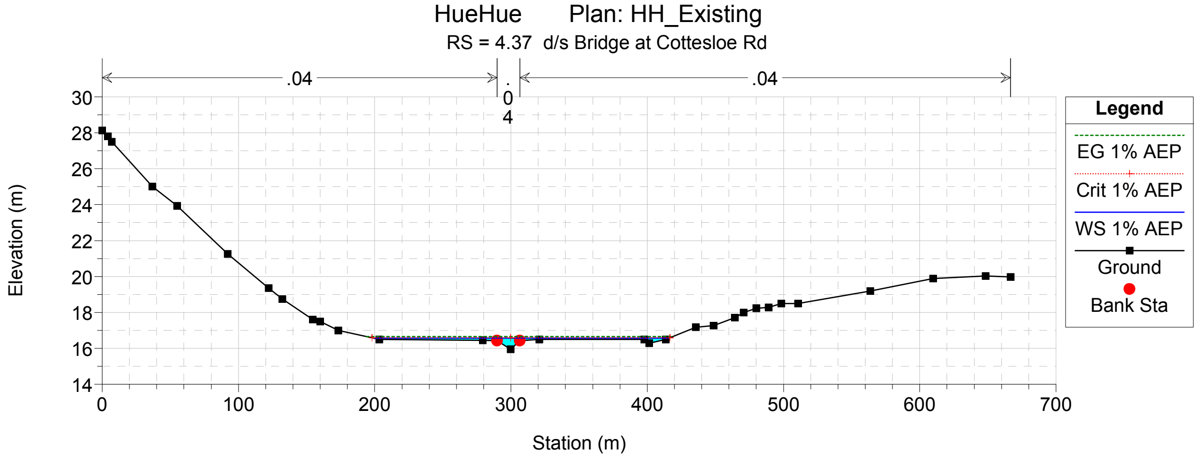
.04
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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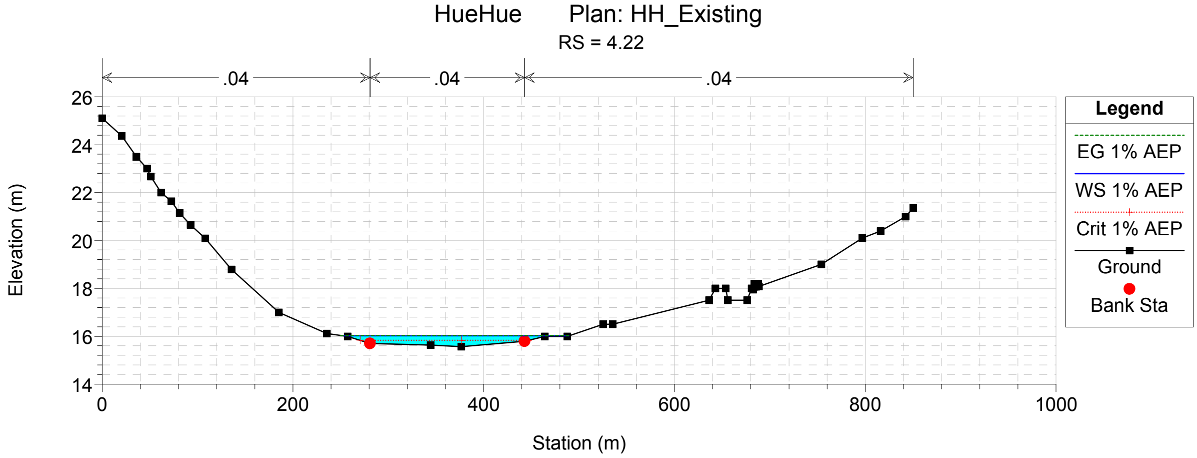
Elevation (m)
Station (m)
Legend
EG 1% AEP
Crit 1% AEP
WS 1% AEP
Ground
Bank Sta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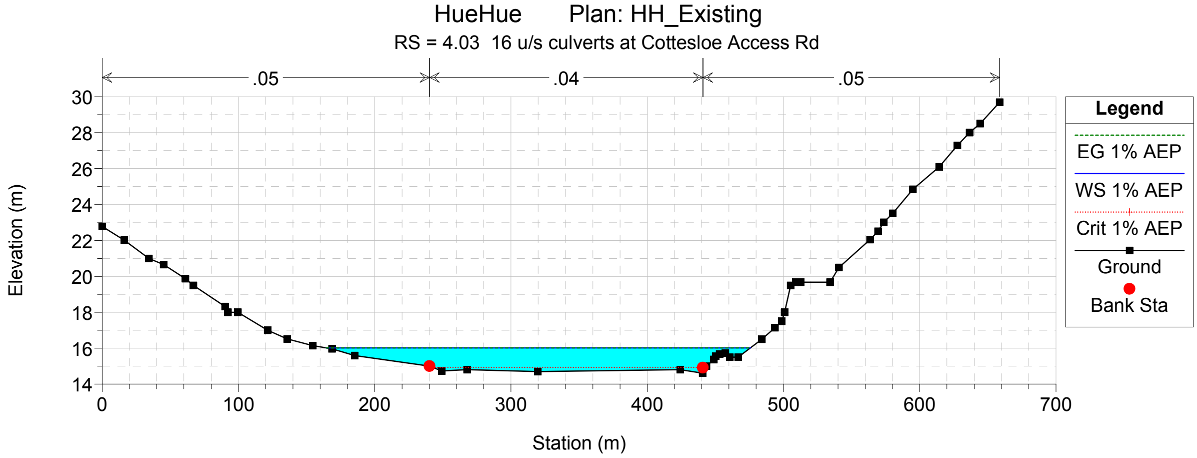
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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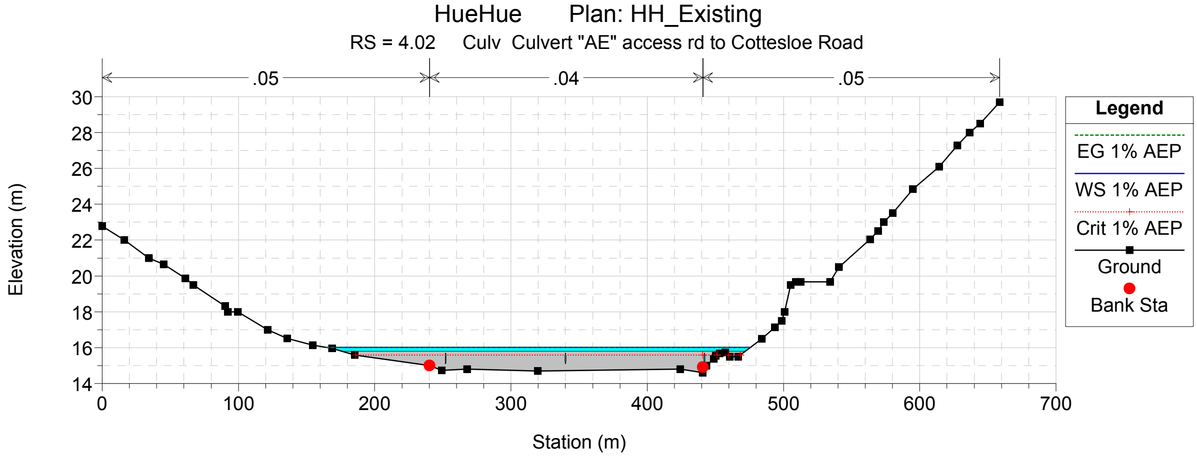
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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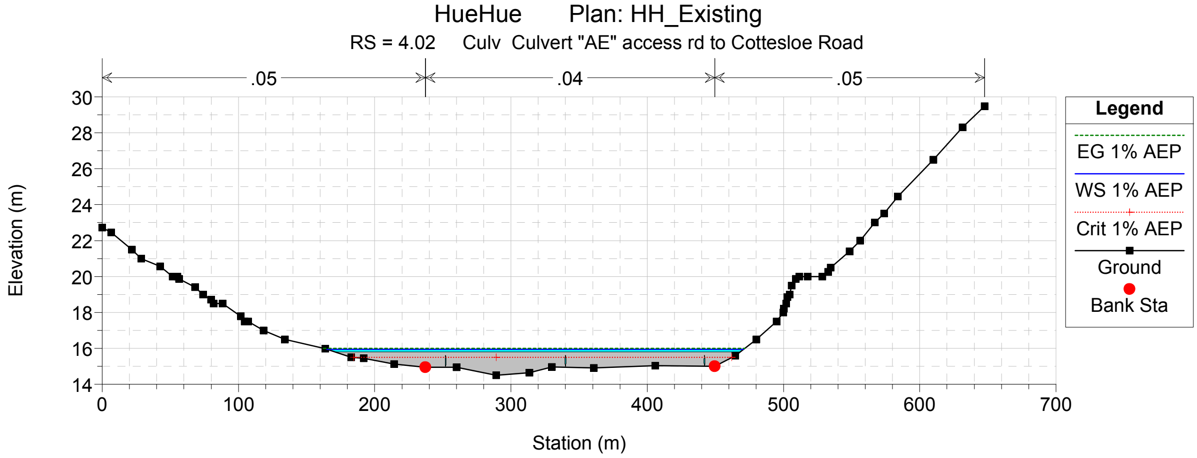
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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RS = 4.02 Culv Culvert "AE" access rd to Cottesloe Road
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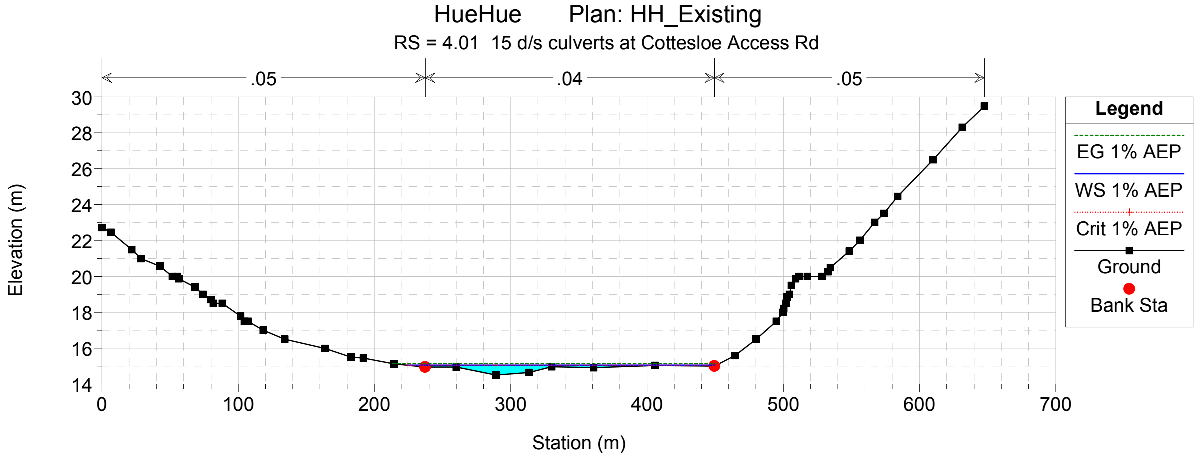
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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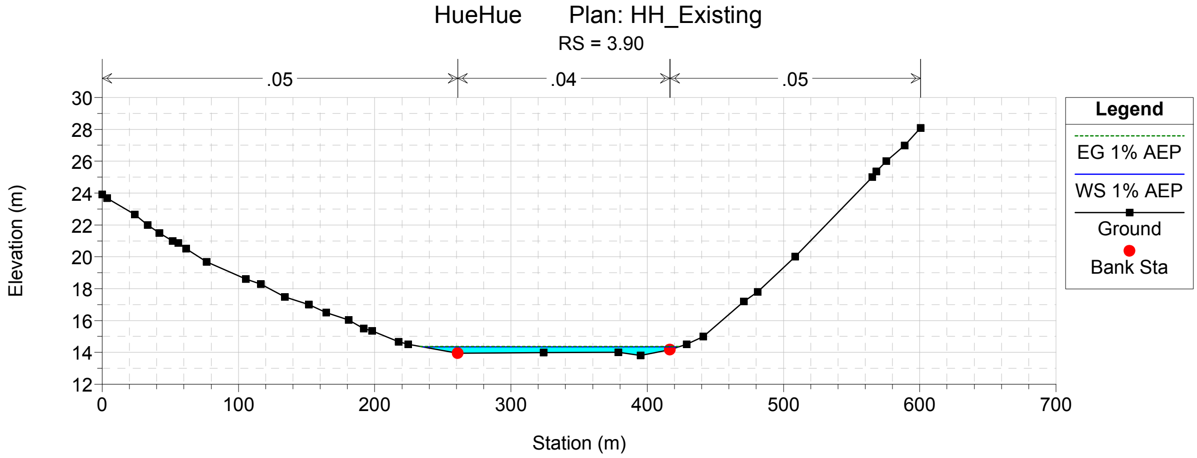
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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.04
.05
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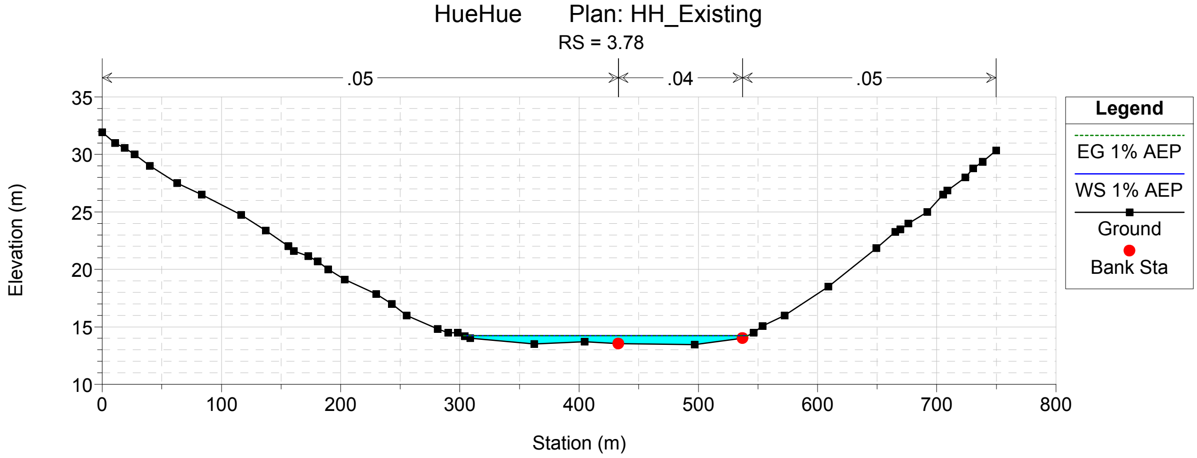
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
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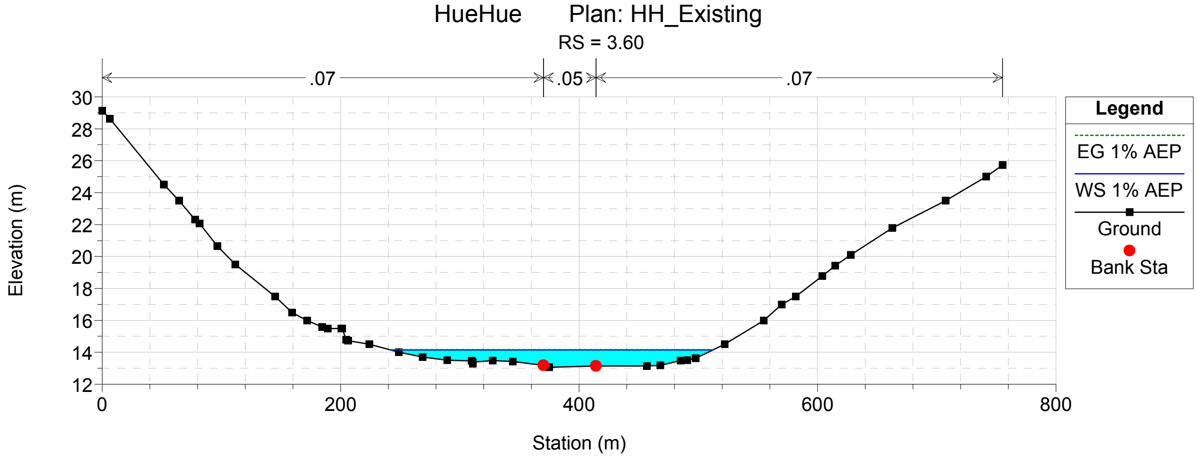
.05
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 3.60
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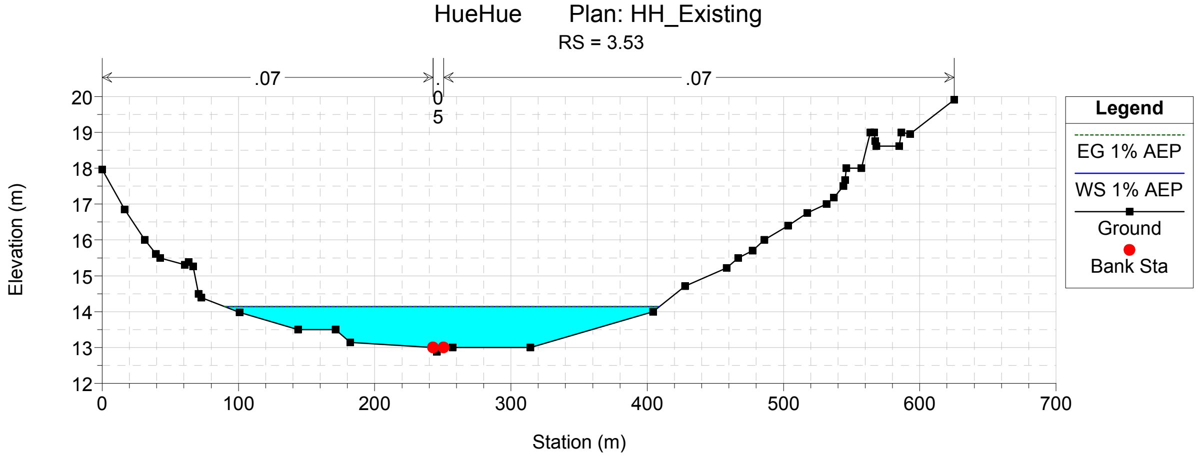
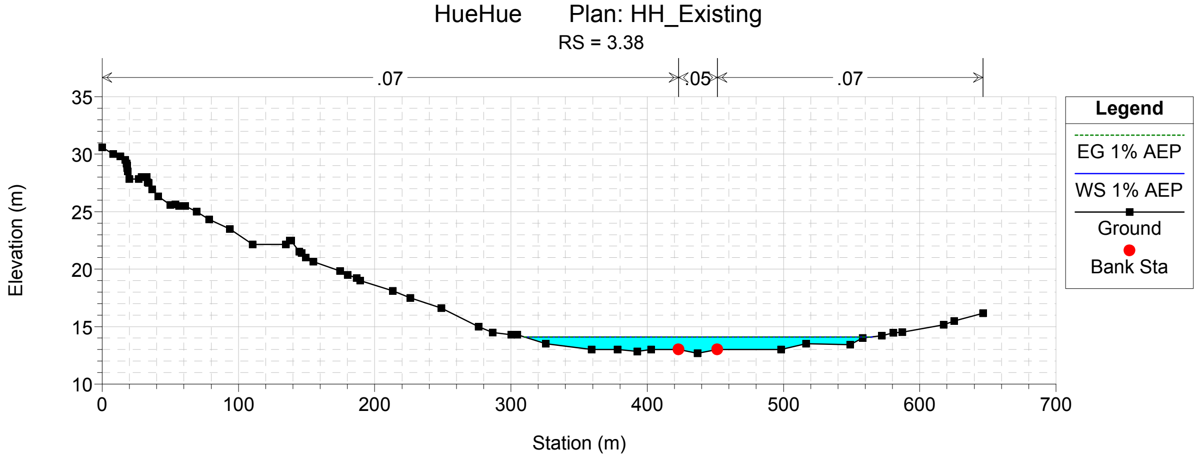
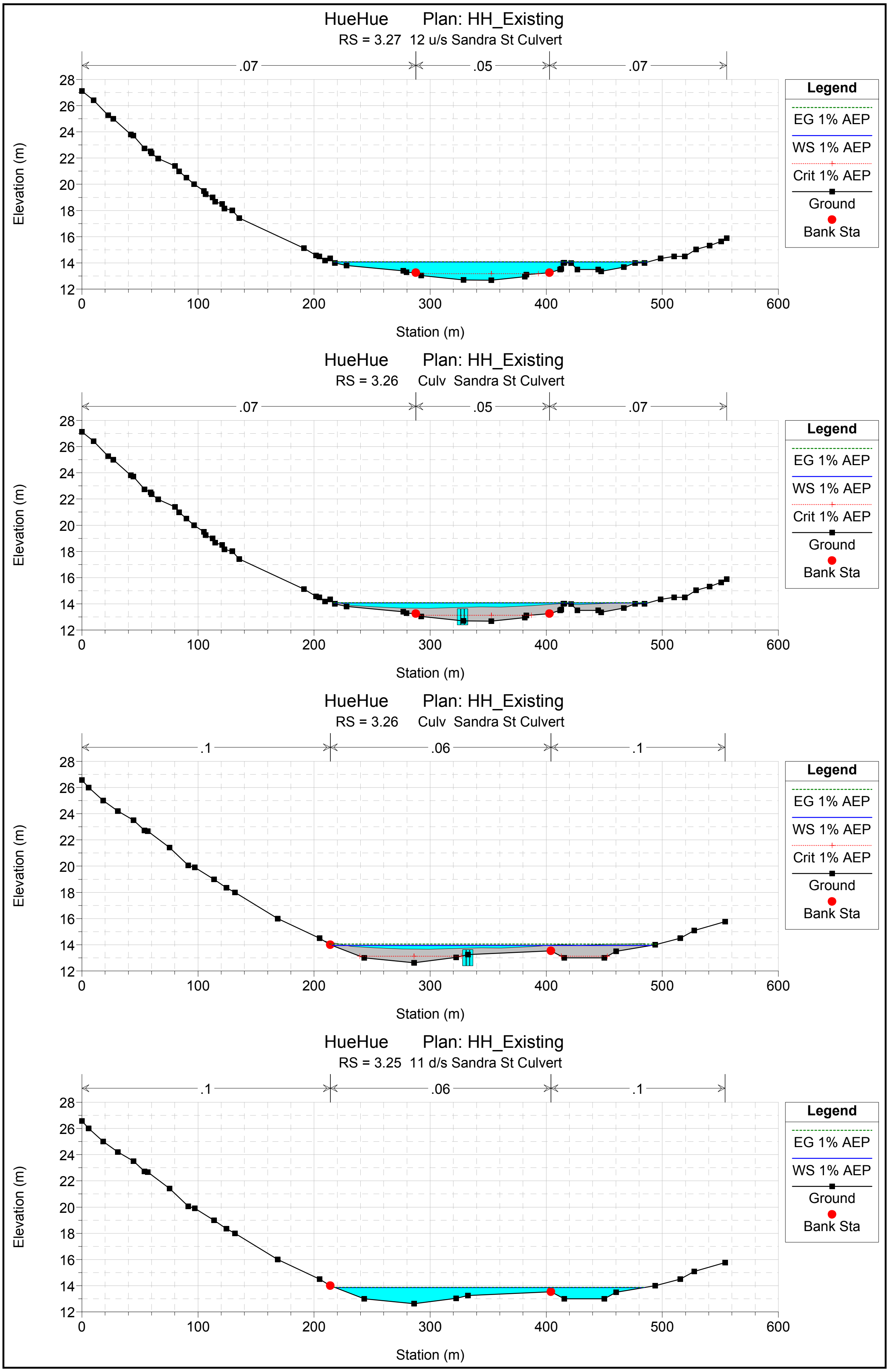
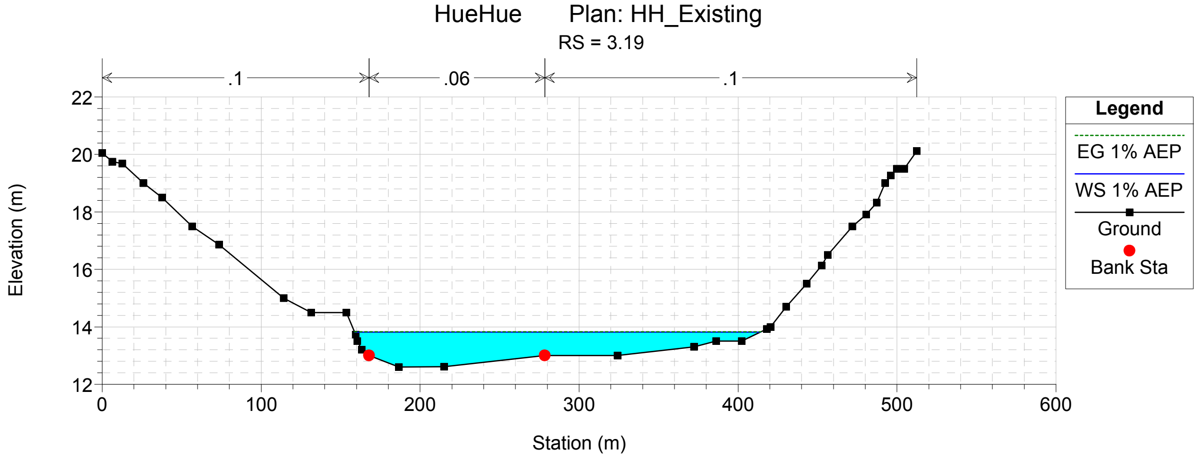
.05
.07
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

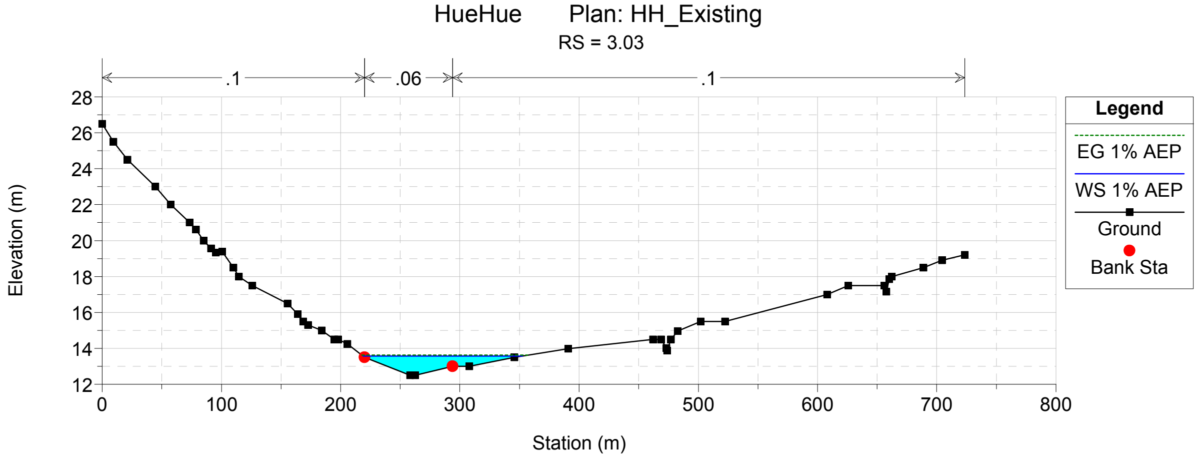

HueHue Plan: HH_Existing
RS = 3.53
.07
.05
.07
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

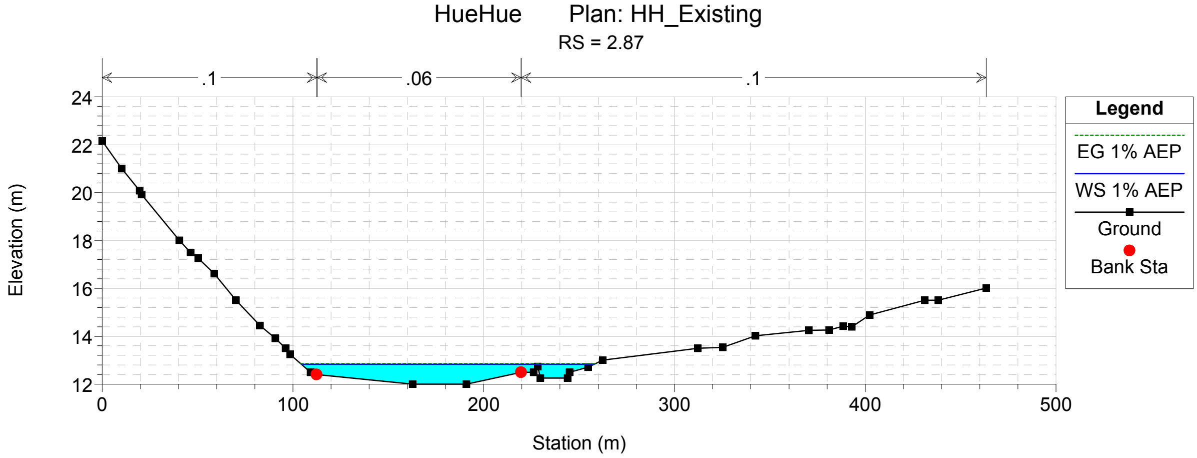

HueHue Plan: HH_Existing
RS = 3.38
.07
.05
.07
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

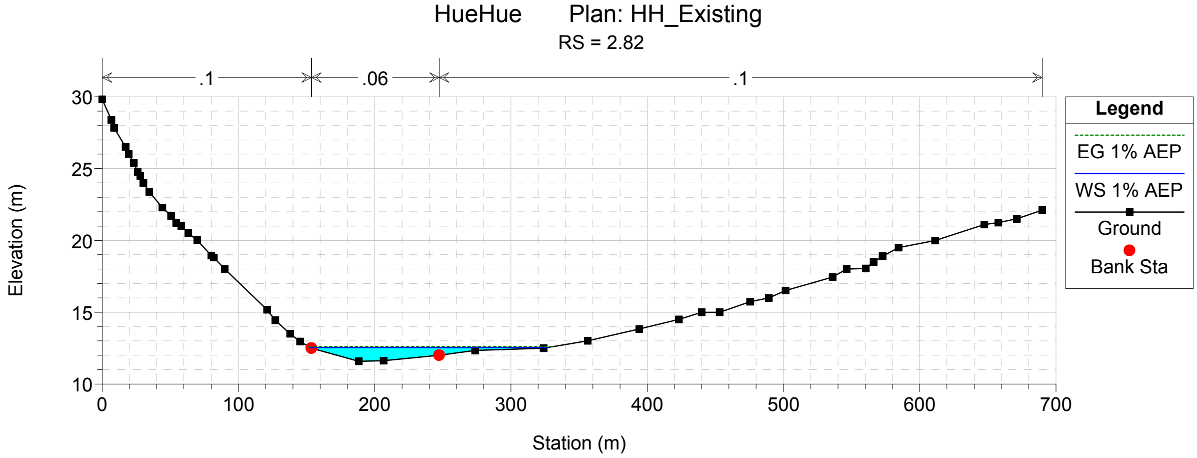


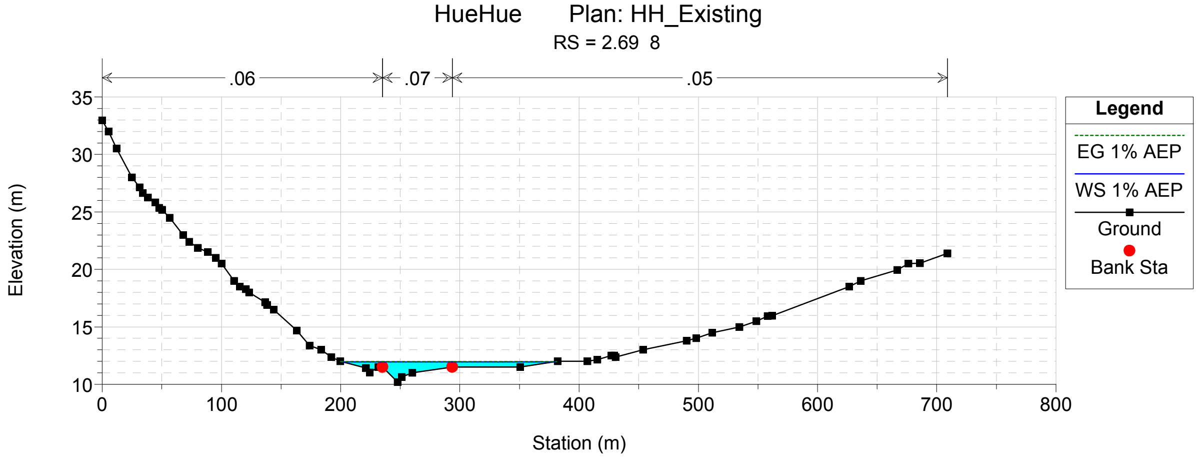
HueHue Plan: HH_Existing
RS = 3.27 12 u/s Sandra St Culvert
.07
.05
.07
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
HueHue Plan: HH_Existing
RS = 3.26 Culv Sandra St Culvert
.07
.05
.07
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
HueHue Plan: HH_Existing
RS = 3.26 Culv Sandra St Culvert
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
HueHue Plan: HH_Existing
RS = 3.25 11 d/s Sandra St Culvert
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

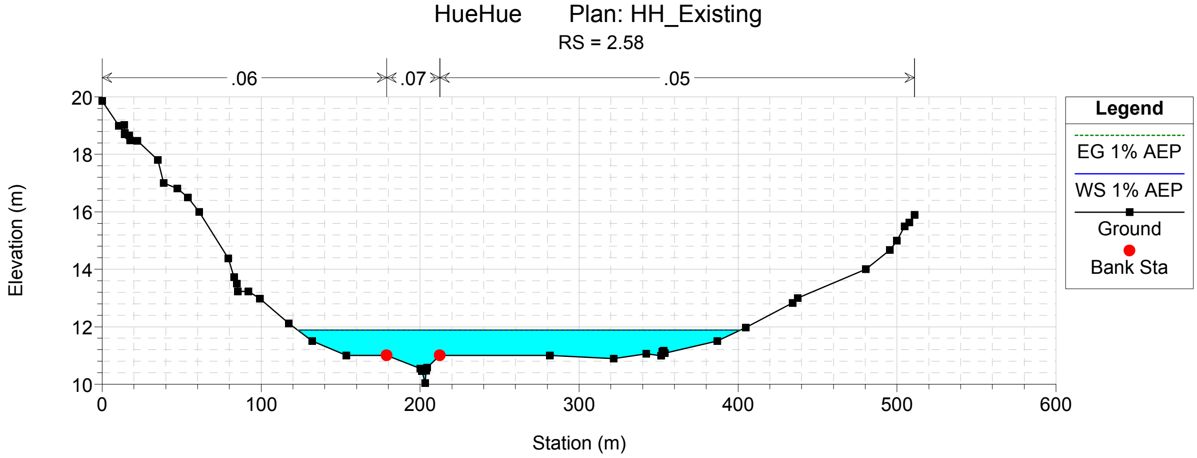

HueHue Plan: HH_Existing
RS = 3.19
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

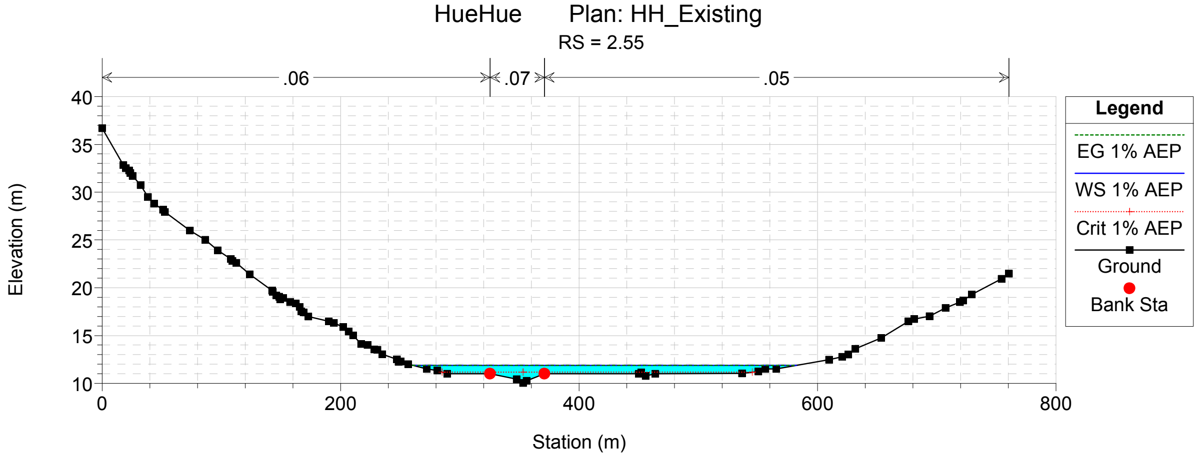

HueHue Plan: HH_Existing
RS = 3.03
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

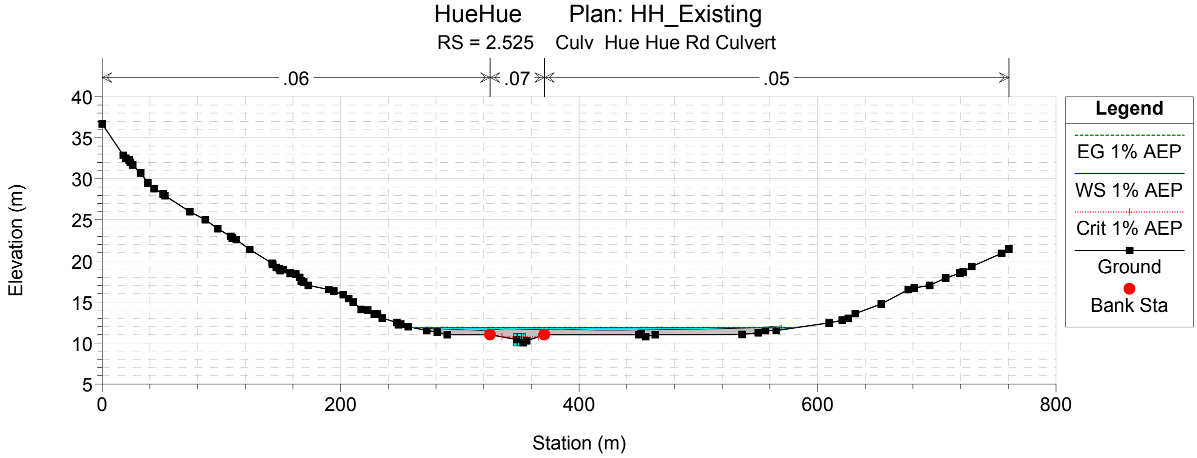

HueHue Plan: HH_Existing
RS = 2.87
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

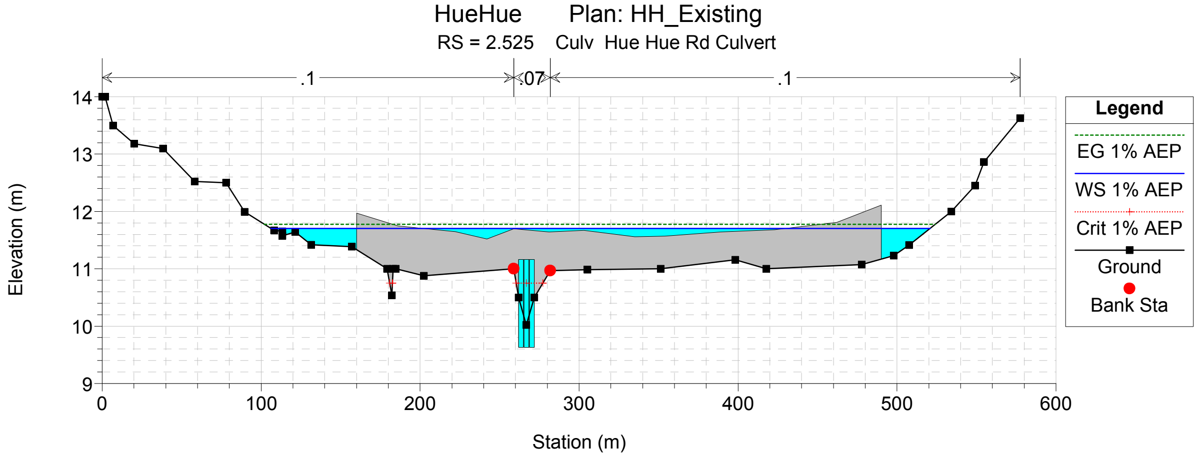

HueHue Plan: HH_Existing
RS = 2.82
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 2.69 8
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

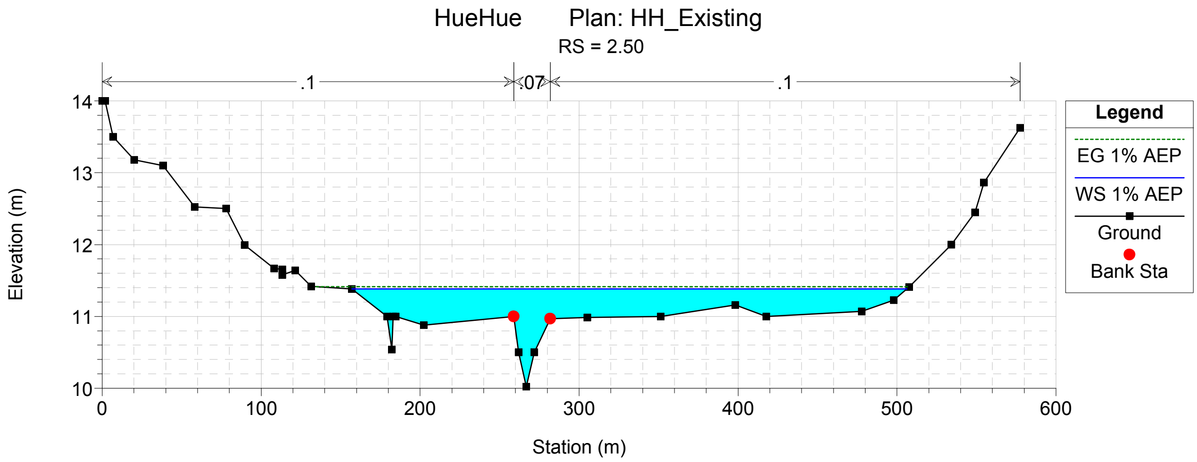

HueHue Plan: HH_Existing
RS = 2.58
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 2.55
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

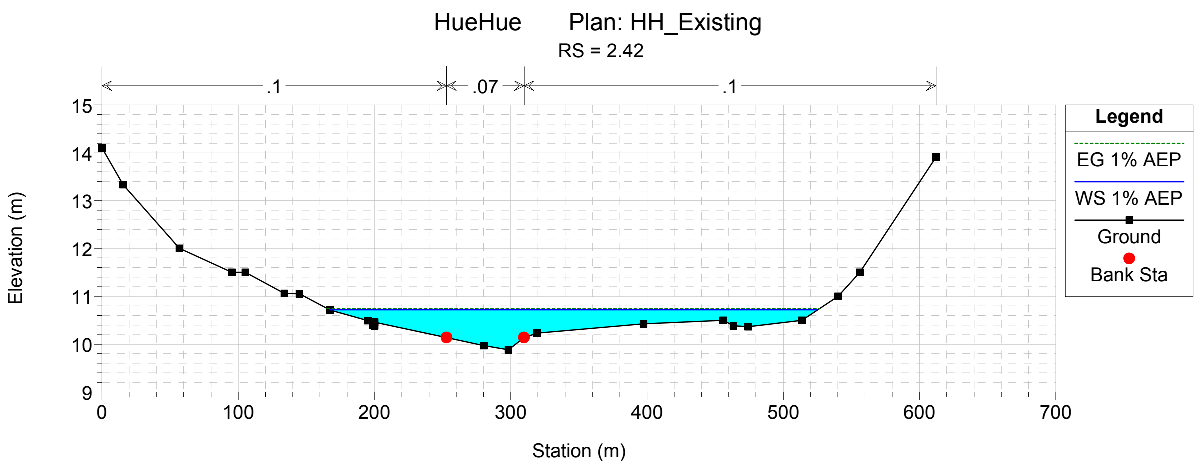

HueHue Plan: HH_Existing
RS = 2.525 Culv Hue Hue Rd Culvert
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta



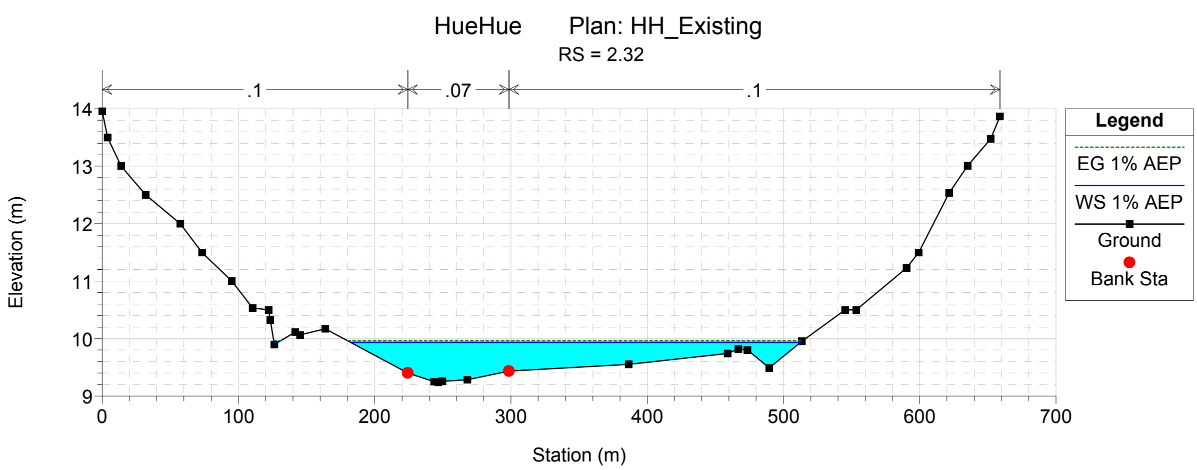
HueHue Plan: HH_Existing
RS = 2.525 Culv Hue Hue Rd Culvert
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)



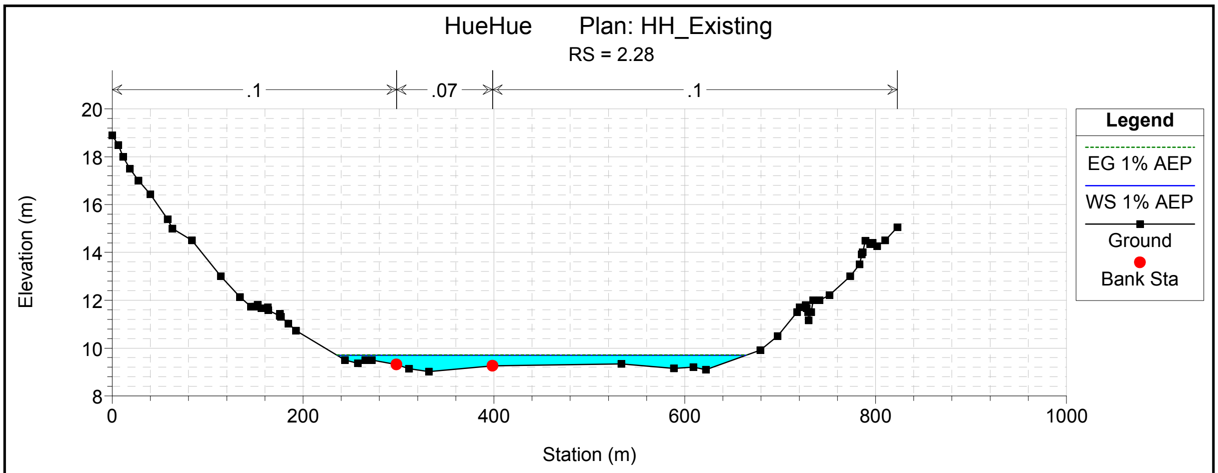
HueHue Plan: HH_Existing
RS = 2.50
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

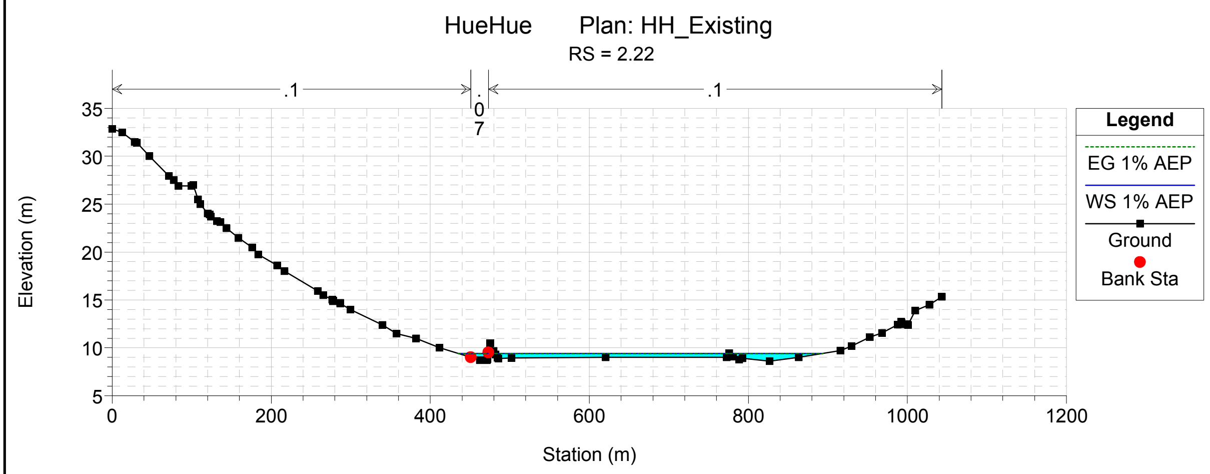


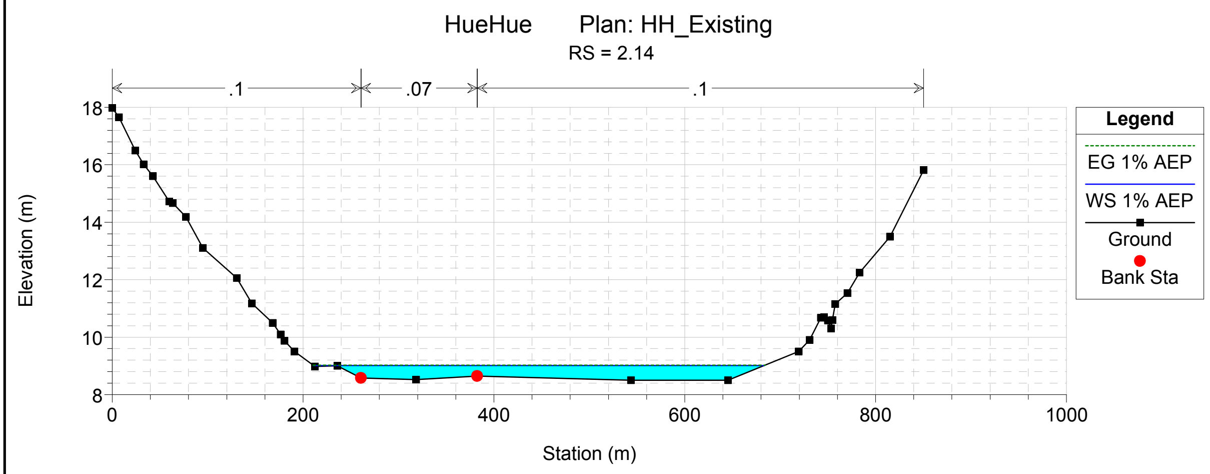
HueHue Plan: HH_Existing
RS = 2.42
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

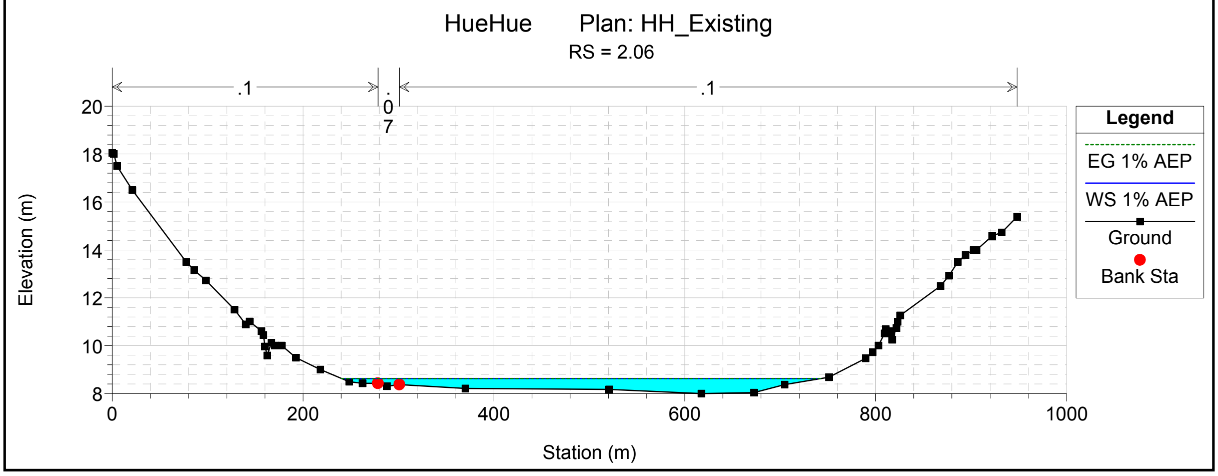


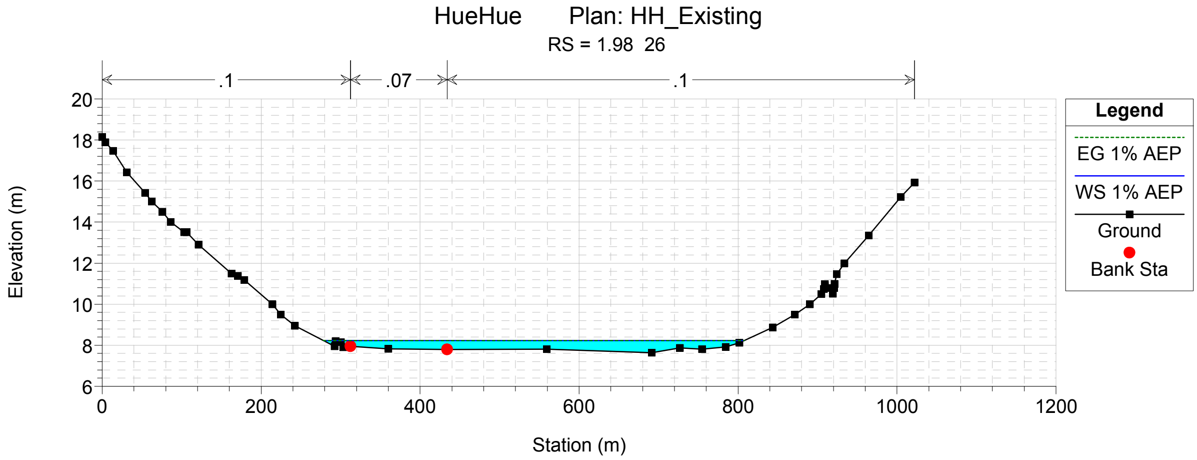
HueHue Plan: HH_Existing
RS = 2.32
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

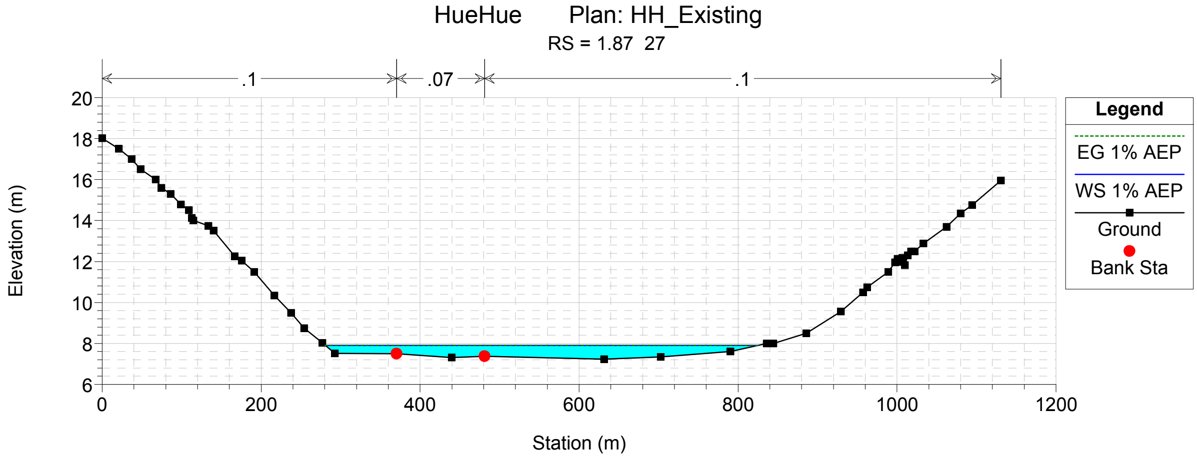

HueHue Plan: HH_Existing
RS = 2.28
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
20
18
16
14
12
10
8
0
200
400
600
800
1000

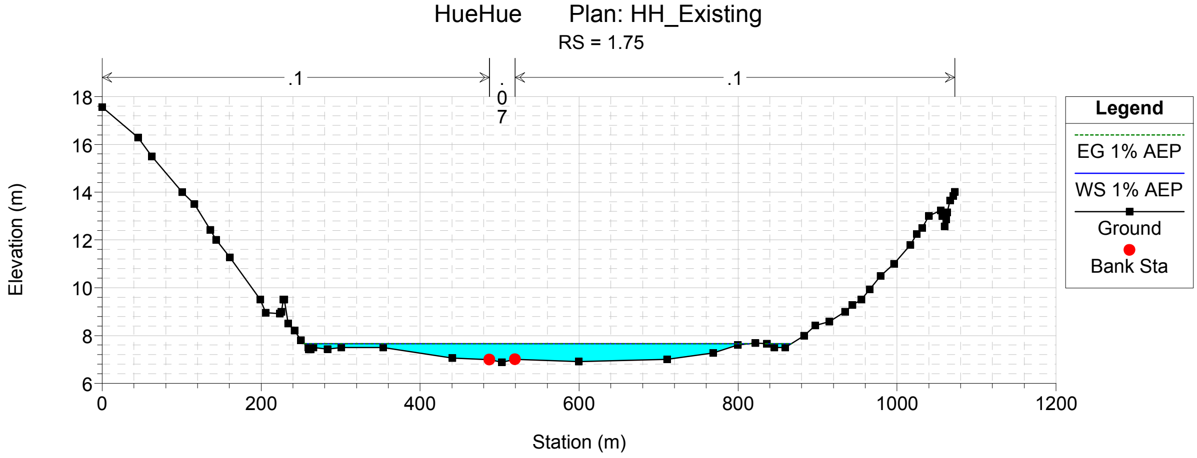

HueHue Plan: HH_Existing
RS = 2.22
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
35
30
25
20
15
10
5
0
200
400
600
800
1000
1200

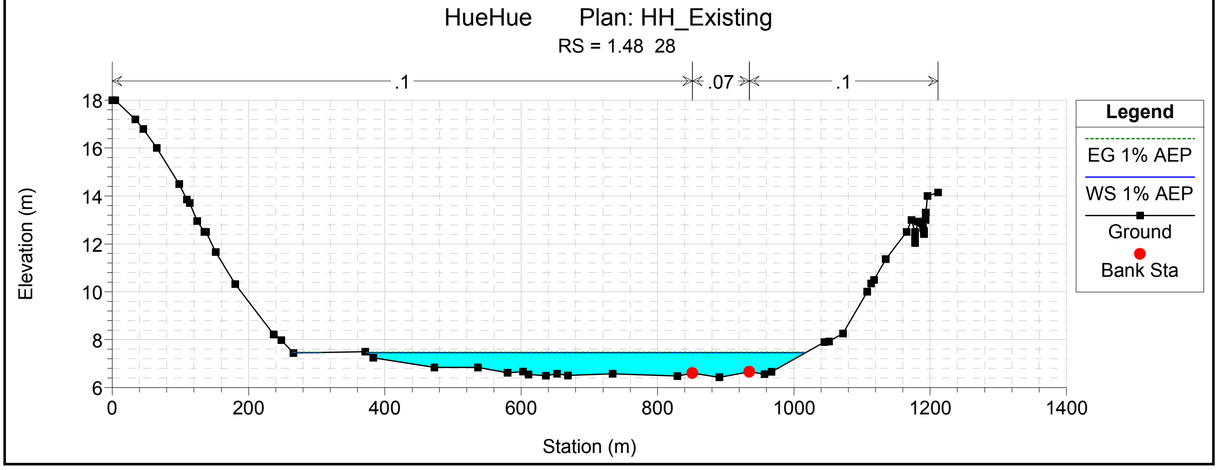

HueHue Plan: HH_Existing
RS = 2.14
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
18
16
14
12
10
8
0
200
400
600
800
1000


HueHue Plan: HH_Existing
RS = 2.06
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
20
18
16
14
12
10
8
0
200
400
600
800
1000


HueHue Plan: HH_Existing
RS = 1.98 26
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

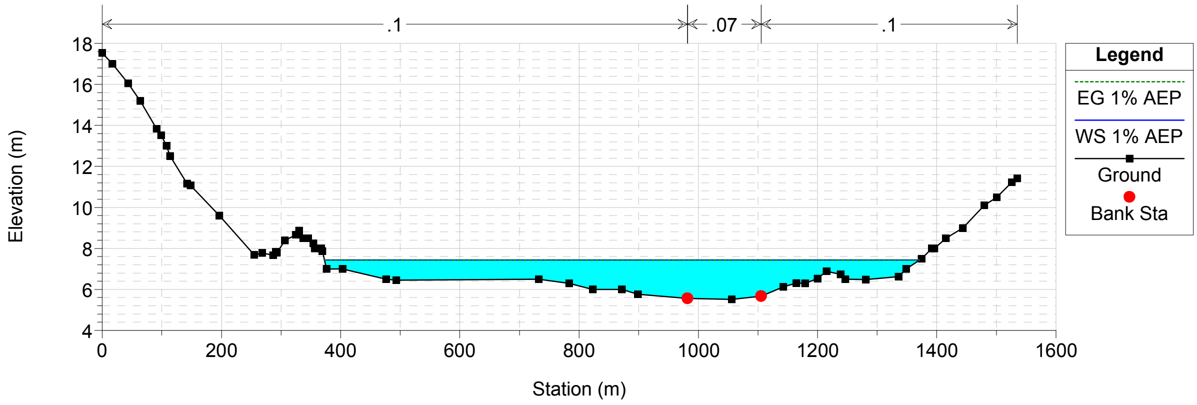

HueHue Plan: HH_Existing
RS = 1.87 27
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 1.75
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 1.48 28
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

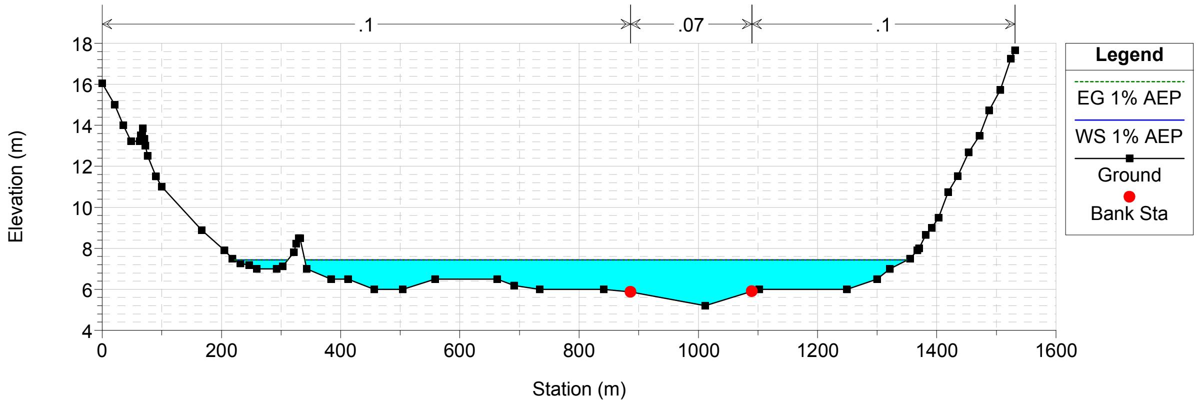
HueHue Plan: HH_Existing

RS = 1.13



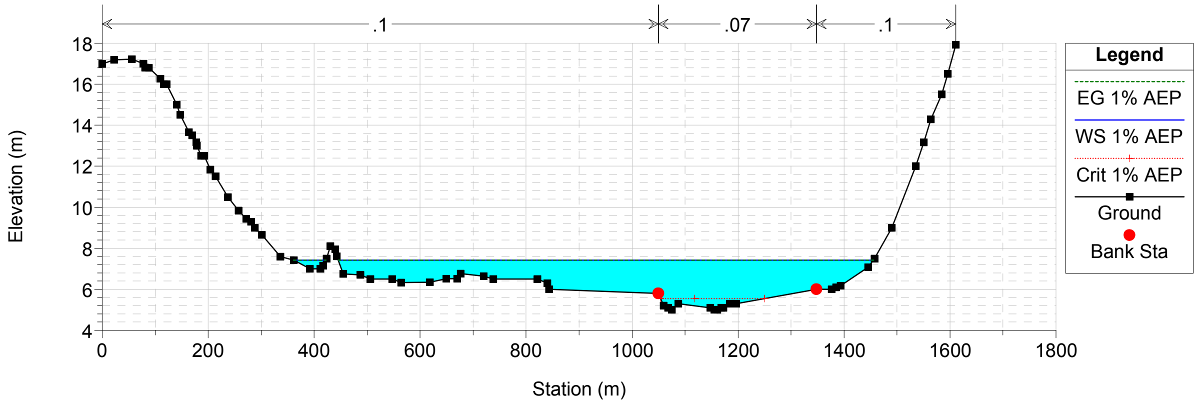
HueHue Plan: HH_Existing

RS = 1.04



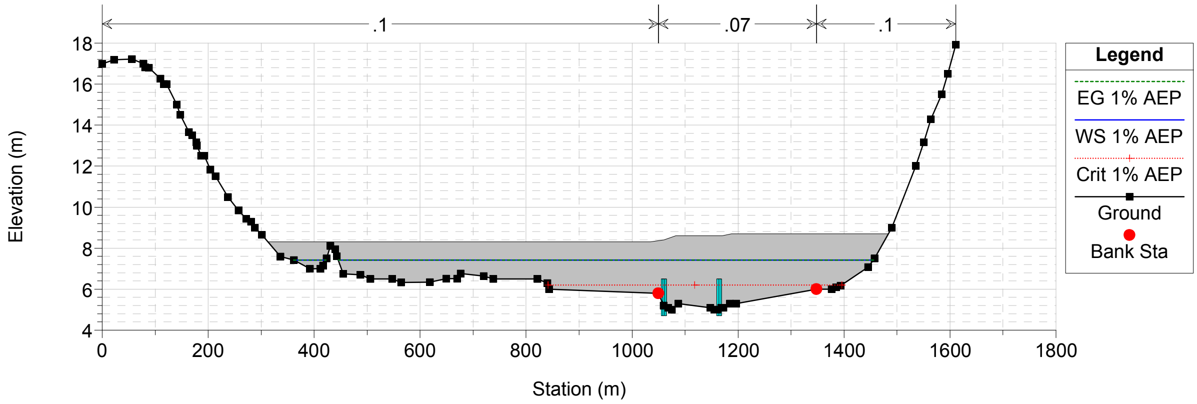
HueHue Plan: HH_Existing

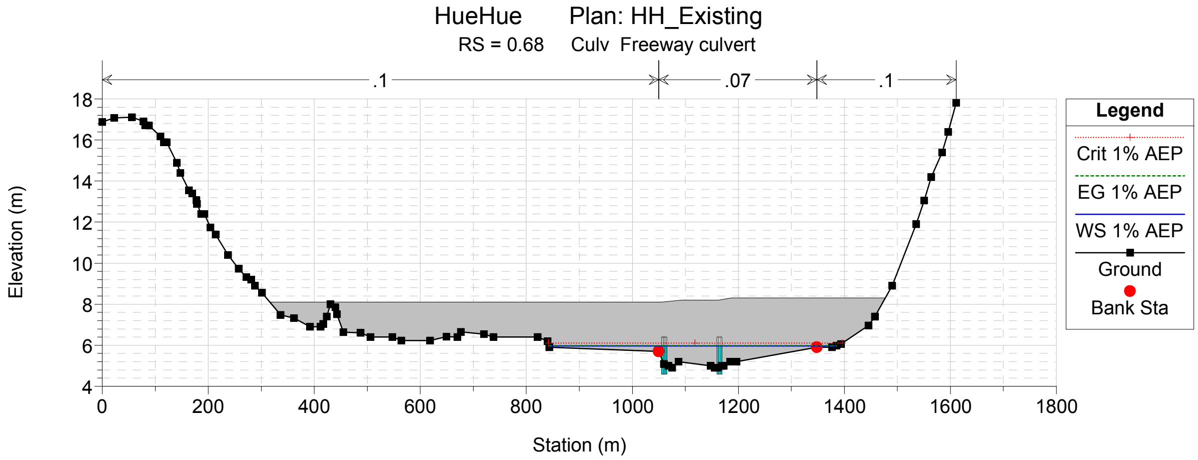
RS = 1 1 u/s freeway culverts

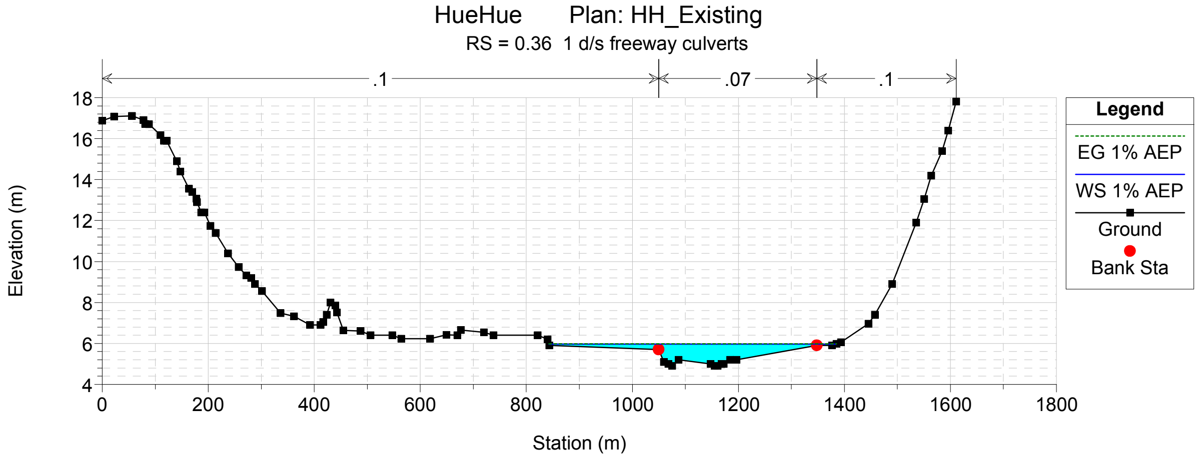


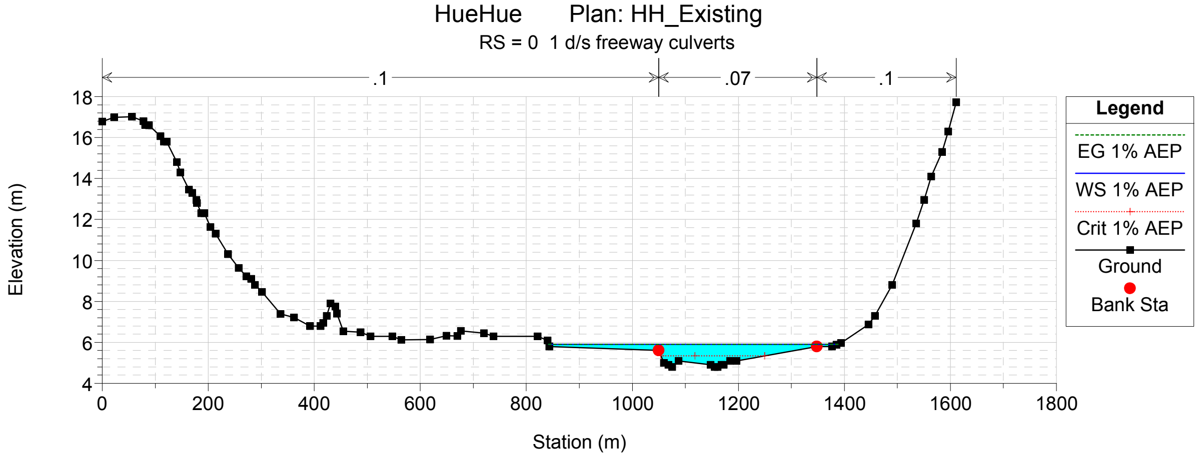
HueHue Plan: HH_Existing

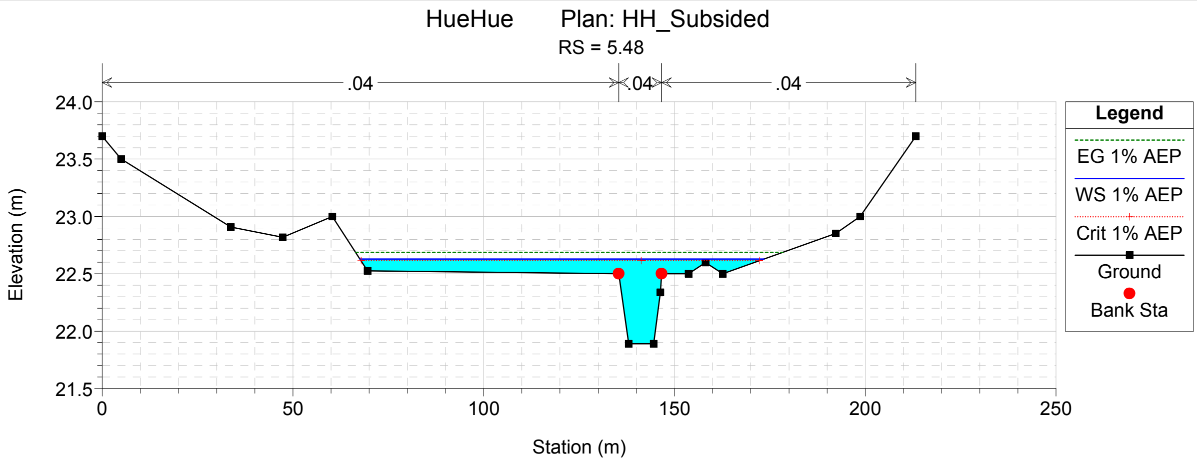
RS = 0.68 Culv Freeway culvert



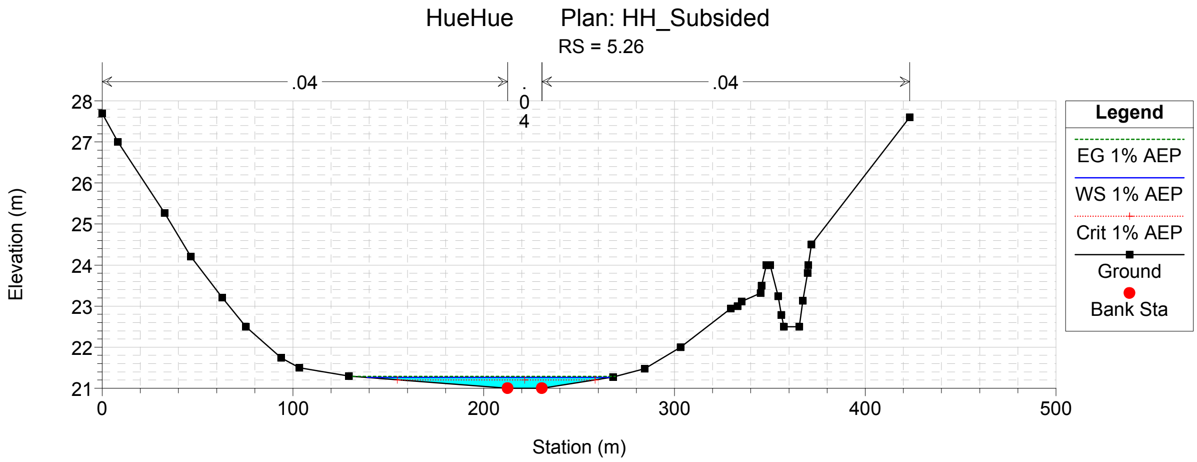

HueHue Plan: HH_Existing
RS = 0.68 Culv Freeway culvert
.1
.07
.1
Elevation (m)
Station (m)
Legend
Crit 1% AEP
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Existing
RS = 0.36 1 d/s freeway culverts
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

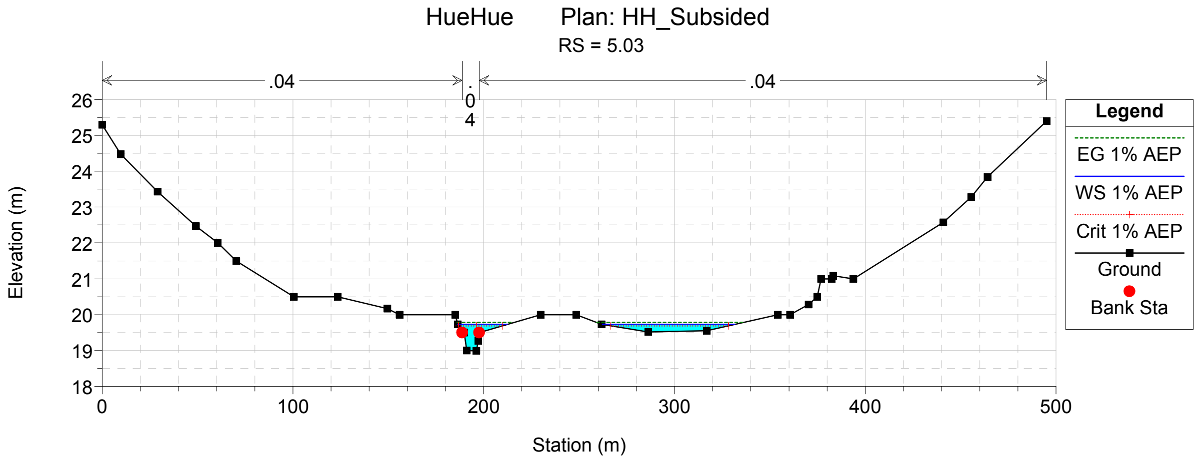

HueHue Plan: HH_Existing
RS = 0 1 d/s freeway culverts
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta



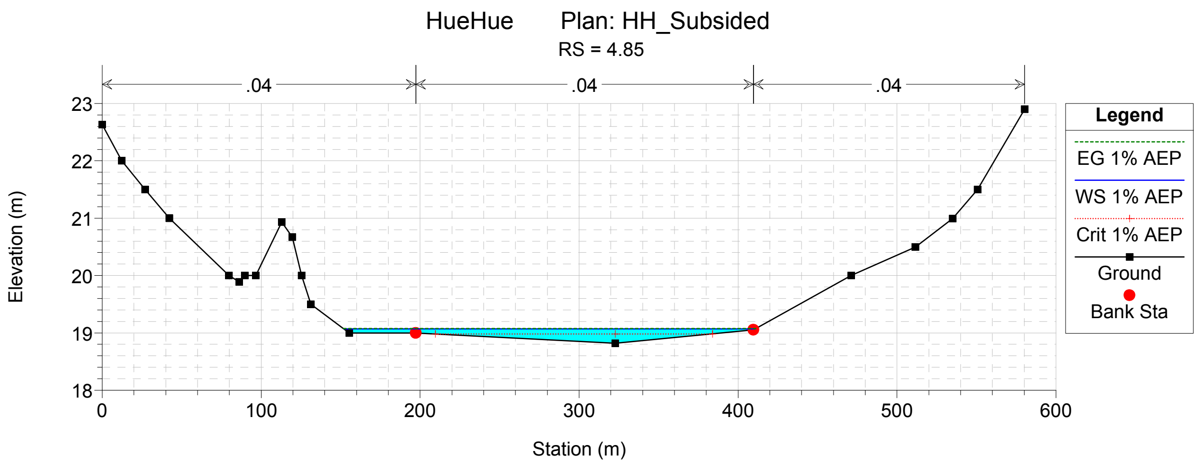
HueHue Plan: HH_Subsided
RS = 5.48
.04
.04
.04
Elevation (m)
Station (m)
24.0
23.5
23.0
22.5
22.0
21.5
0
50
100
150
200
250
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta



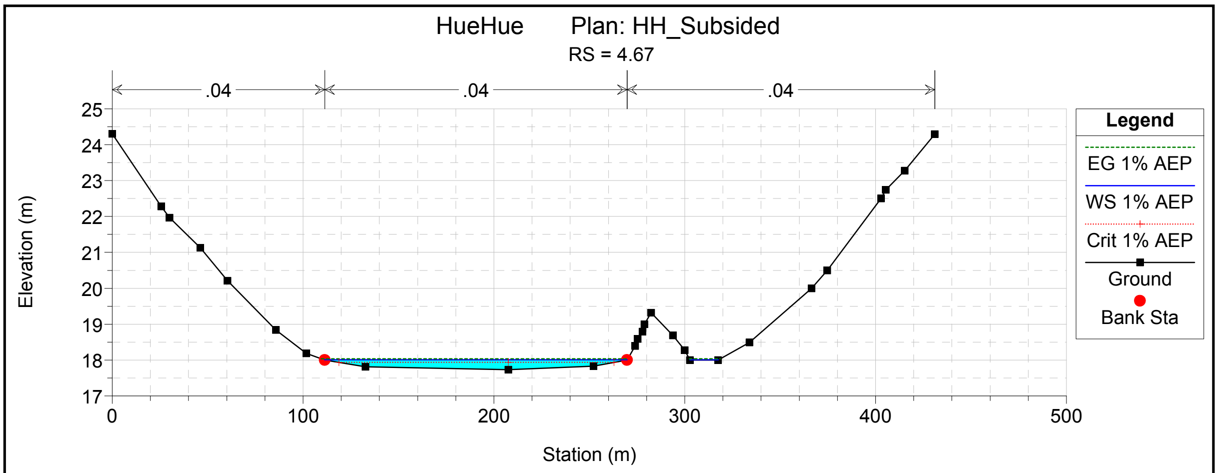
HueHue Plan: HH_Subsided
RS = 5.26
.04
.
0
4
.04
Elevation (m)
Station (m)
28
27
26
25
24
23
22
21
0
100
200
300
400
500
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

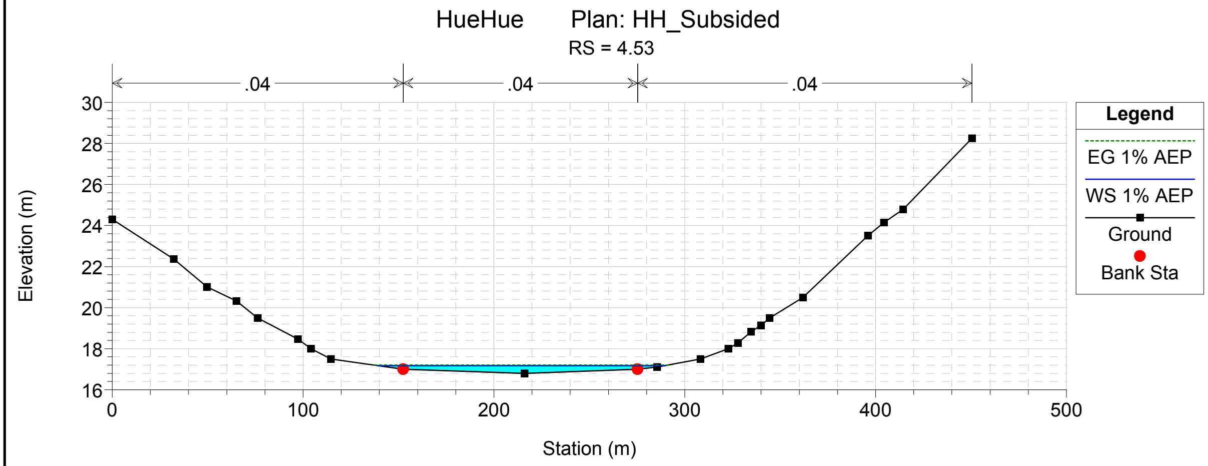


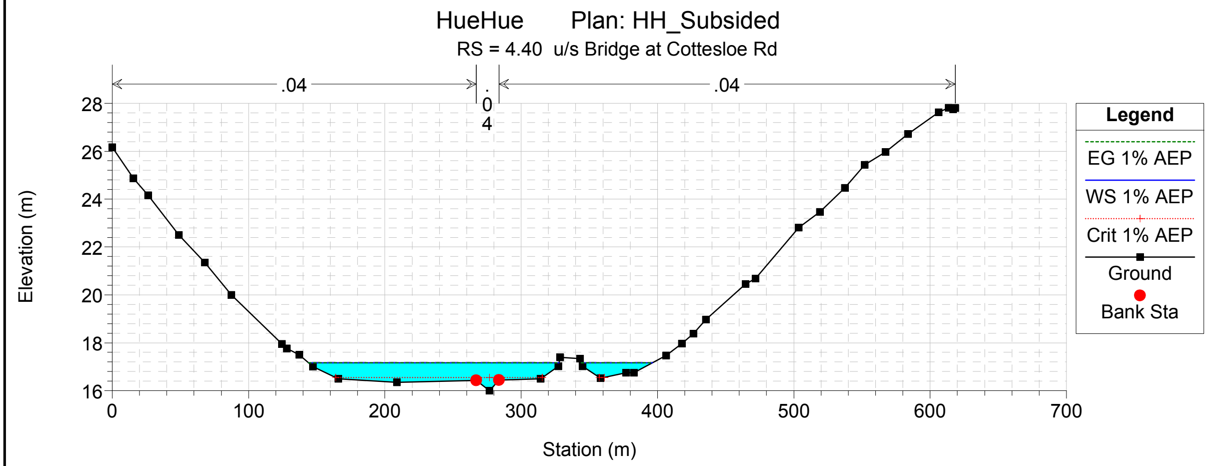
HueHue Plan: HH_Subsided
RS = 5.03
.04
.
0
4
.04
Elevation (m)
Station (m)
26
25
24
23
22
21
20
19
18
0
100
200
300
400
500
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

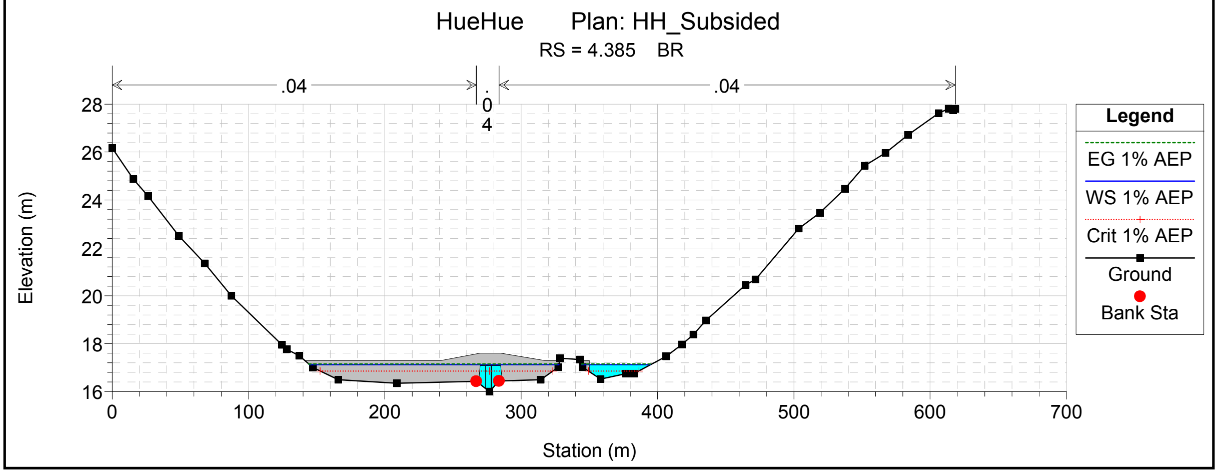


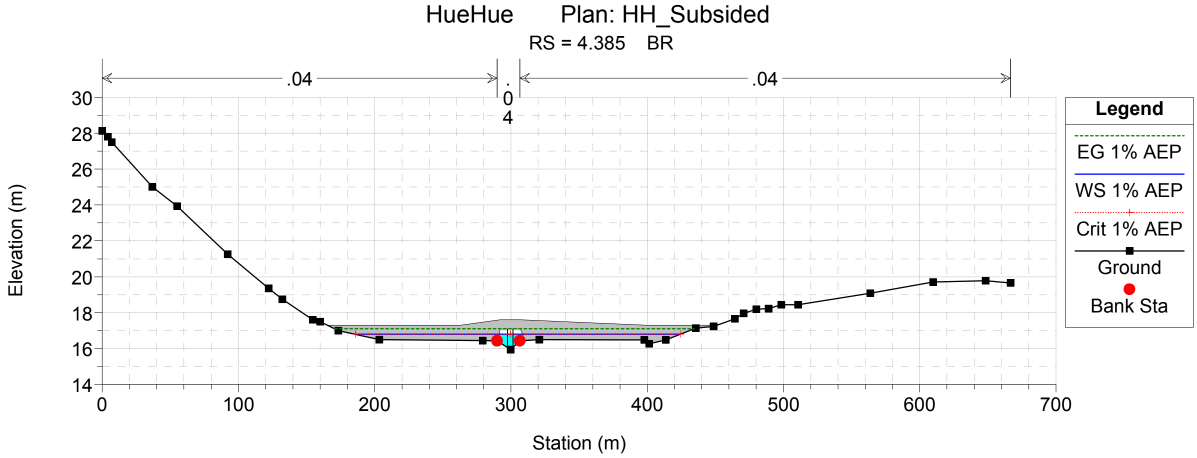
HueHue Plan: HH_Subsided
RS = 4.85
.04
.04
.04
Elevation (m)
Station (m)
23
22
21
20
19
18
0
100
200
300
400
500
600
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

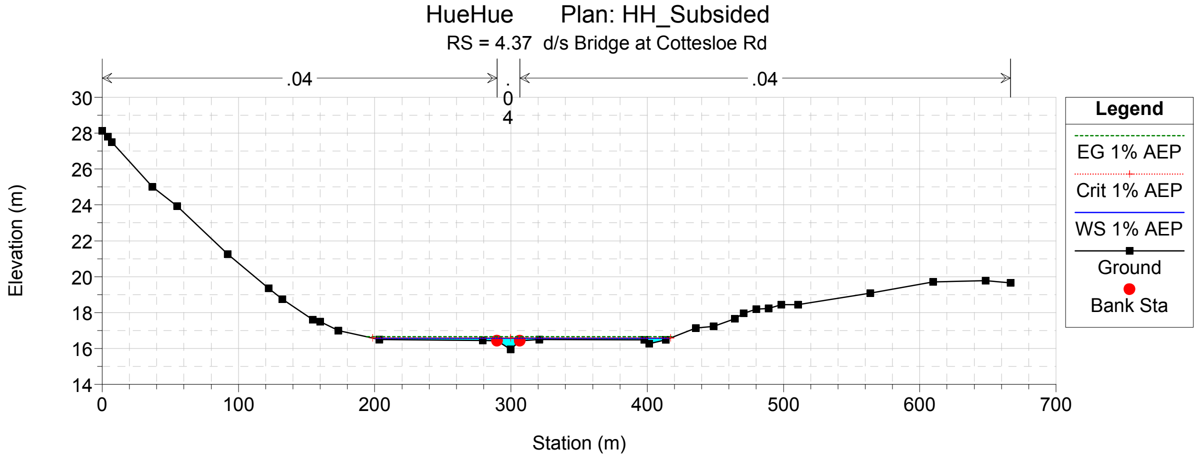

HueHue Plan: HH_Subsided
RS = 4.67
.04
.04
.04
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

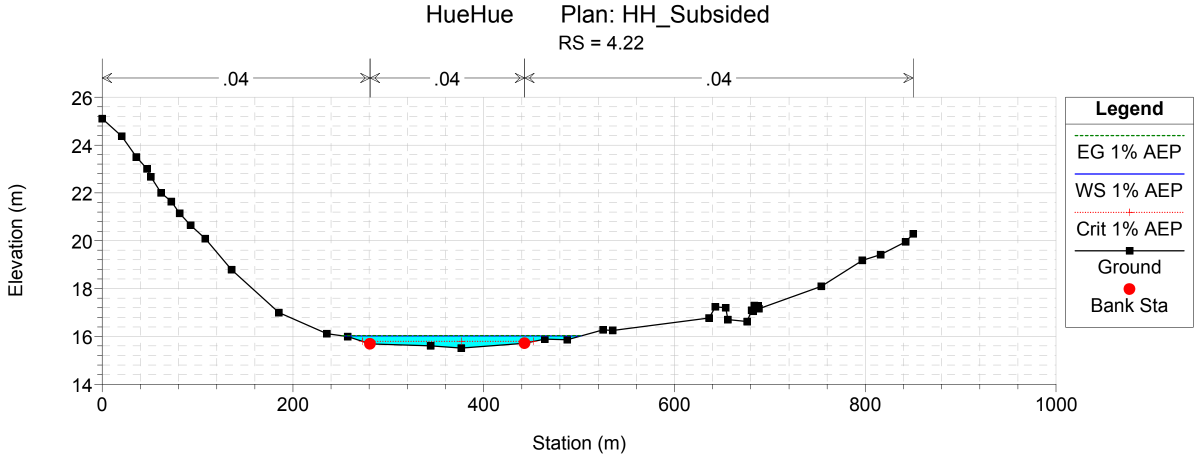

HueHue Plan: HH_Subsided
RS = 4.53
.04
.04
.04
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

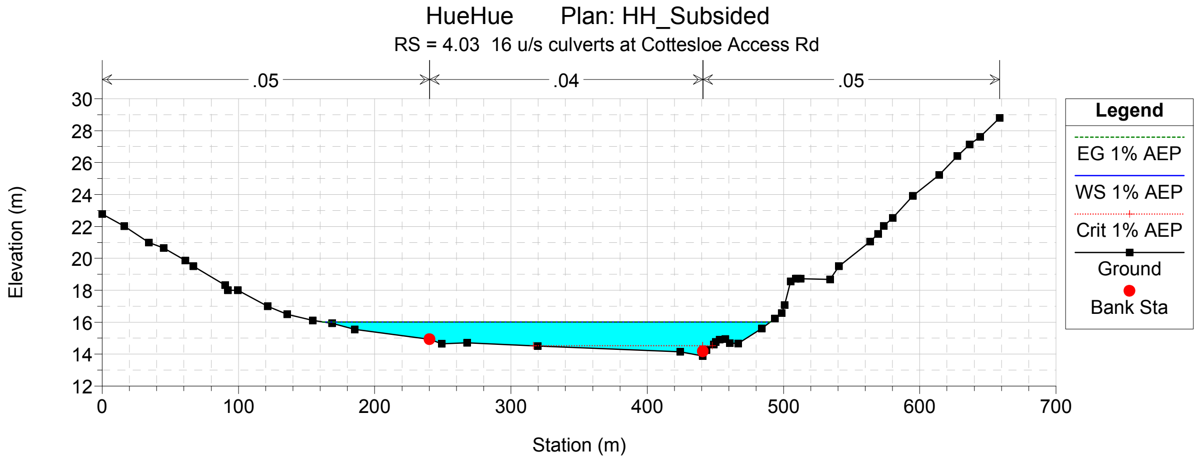

HueHue Plan: HH_Subsided
RS = 4.40 u/s Bridge at Cottesloe Rd
.04
.04
.04
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

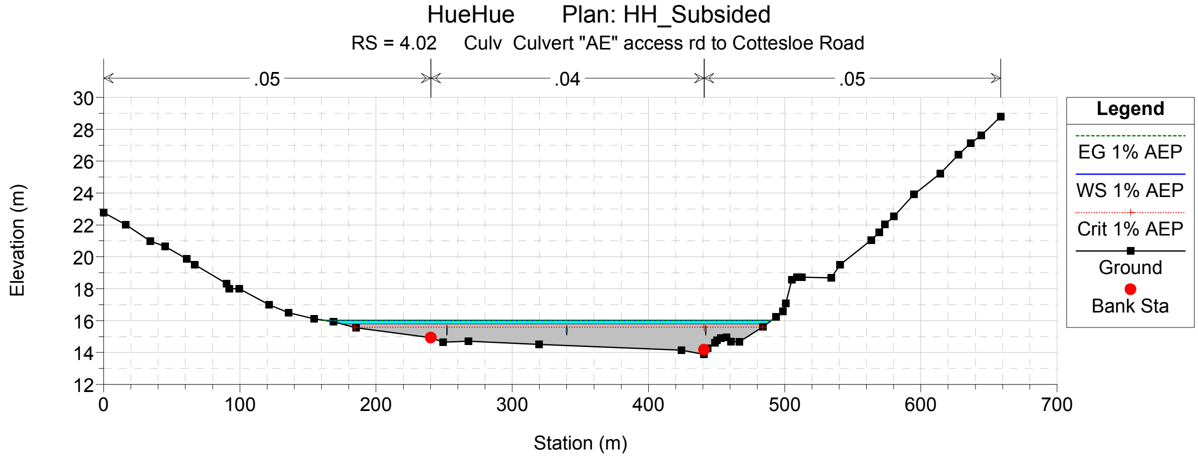

HueHue Plan: HH_Subsided
RS = 4.385 BR
.04
.04
.04
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

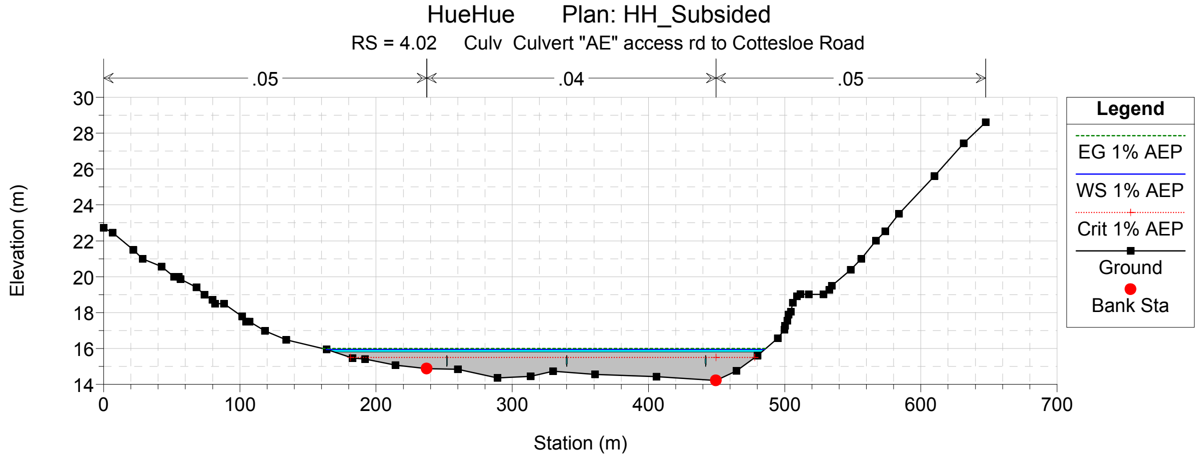

HueHue Plan: HH_Subsided
RS = 4.385 BR
.04
.04
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

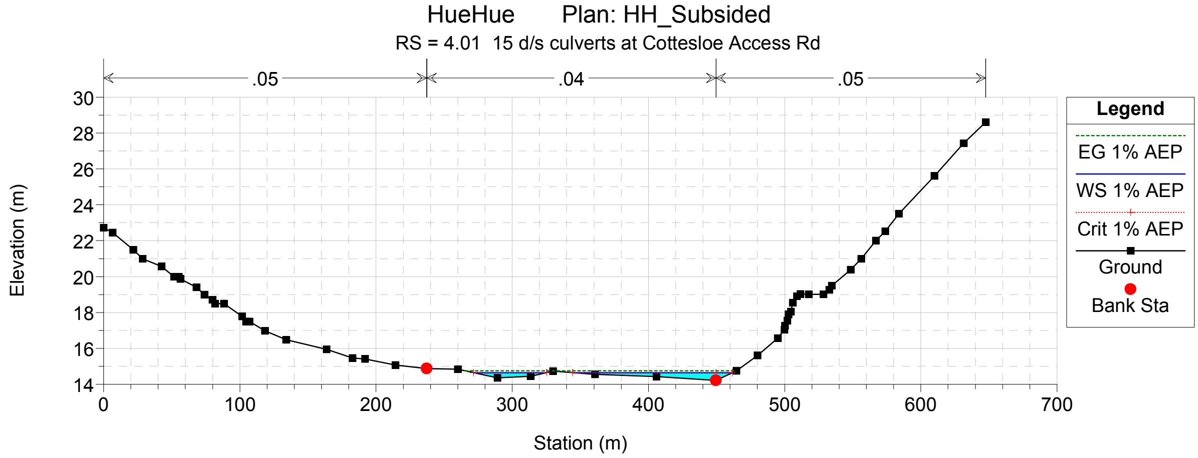

HueHue Plan: HH_Subsided
RS = 4.37 d/s Bridge at Cottesloe Rd
.04
.04
Legend
EG 1% AEP
Crit 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

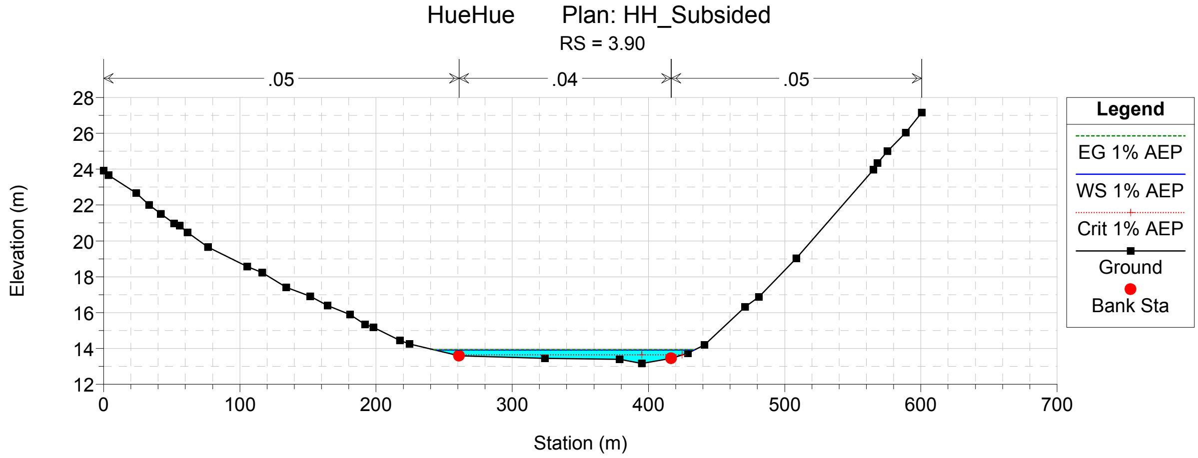

HueHue Plan: HH_Subsided
RS = 4.22
.04
.04
.04
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

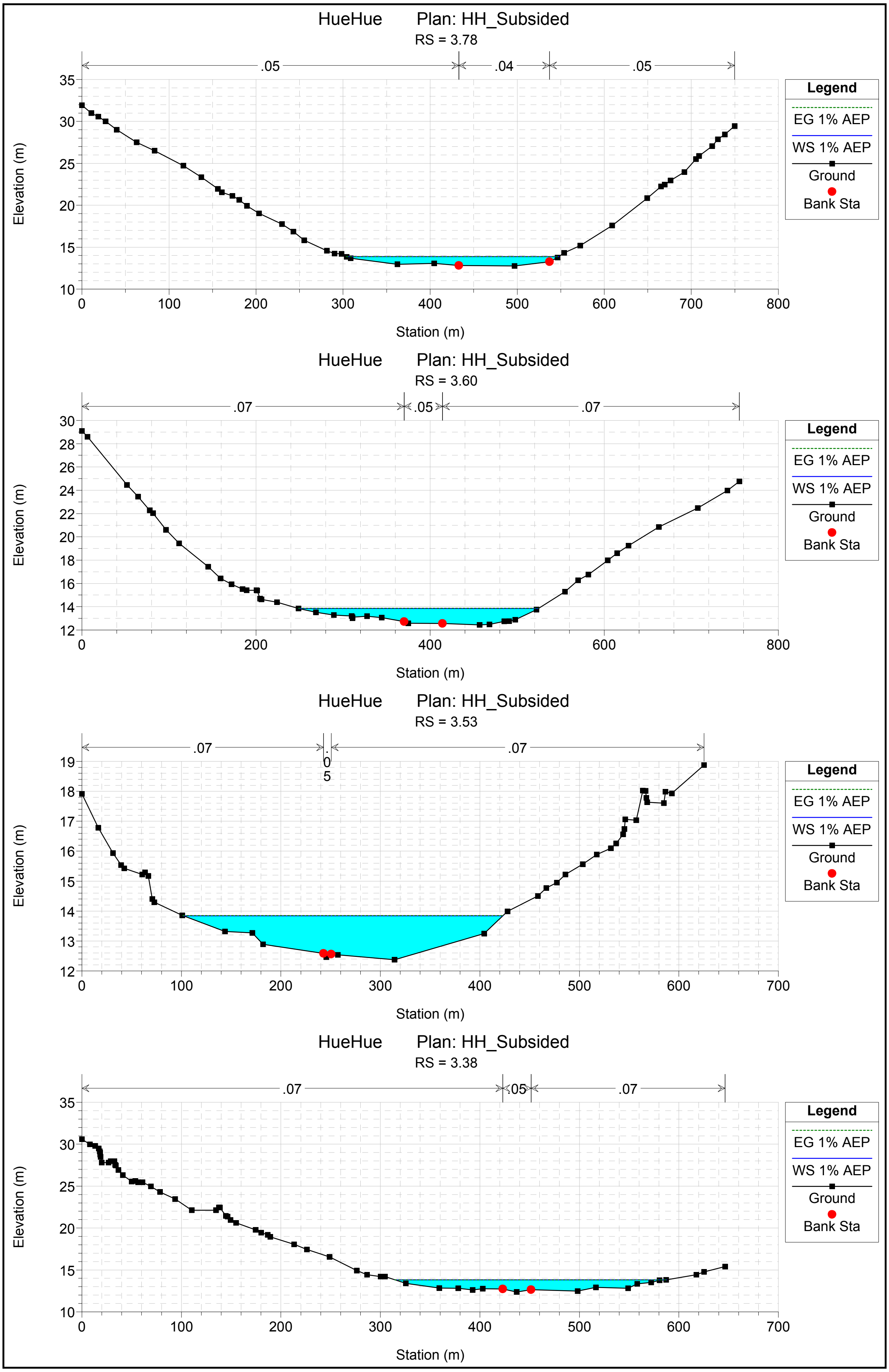

HueHue Plan: HH_Subsided
RS = 4.03 16 u/s culverts at Cottesloe Access Rd
.05
.04
.05
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

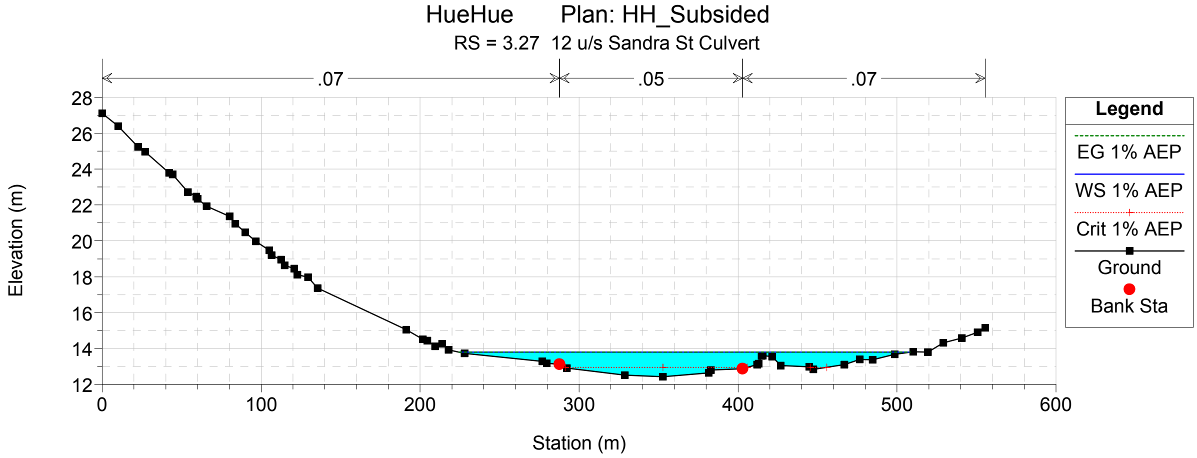

HueHue Plan: HH_Subsided
RS = 4.02 Culv Culvert "AE" access rd to Cottesloe Road
.05
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

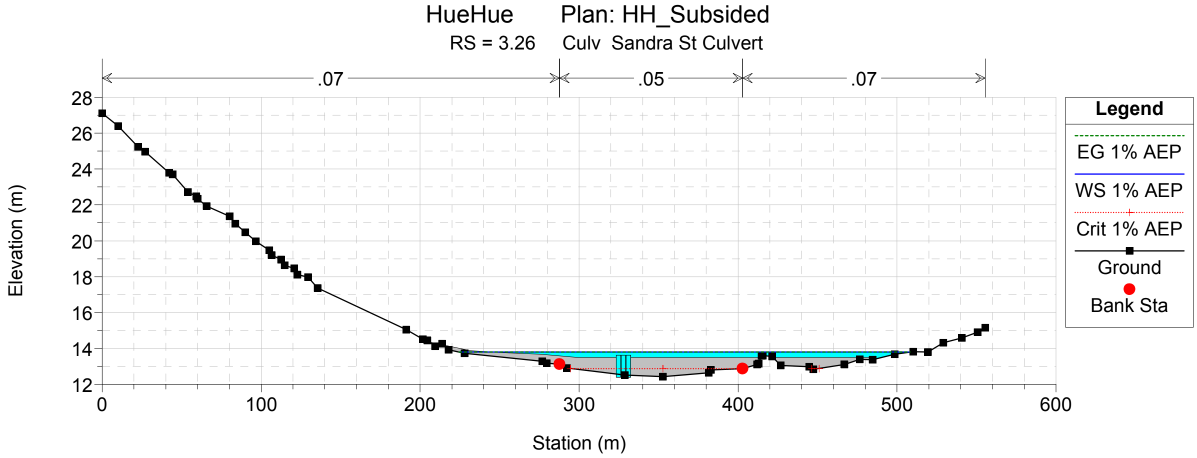

HueHue Plan: HH_Subsided
RS = 4.02 Culv Culvert "AE" access rd to Cottesloe Road
.05
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

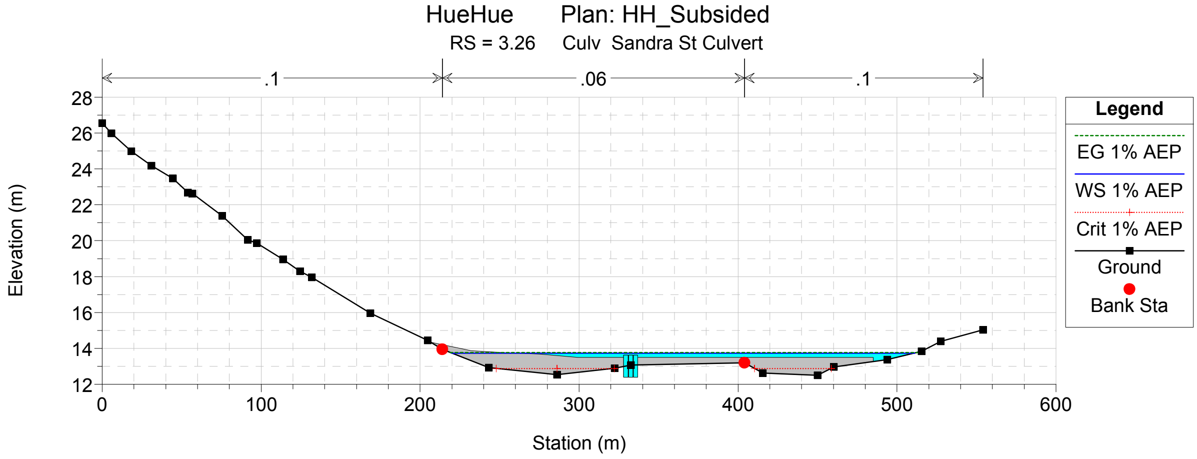

HueHue Plan: HH_Subsided
RS = 4.01 15 d/s culverts at Cottesloe Access Rd
.05
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

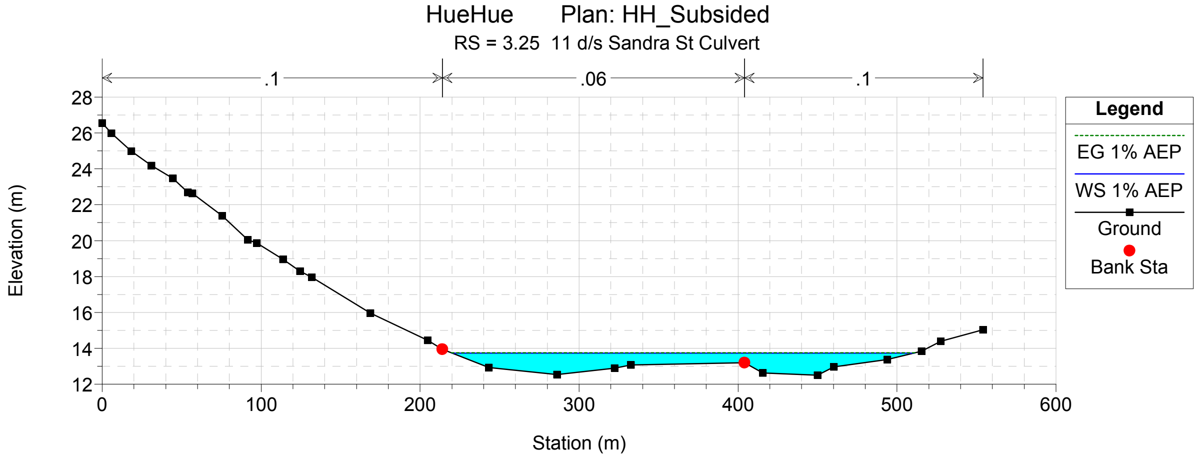

HueHue Plan: HH_Subsided
RS = 3.90
.05
.04
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

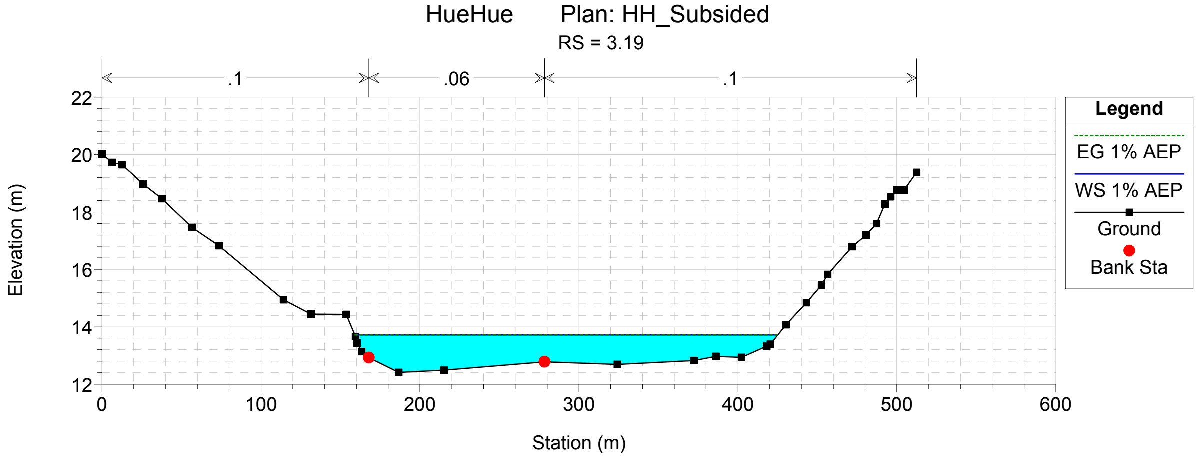

HueHue Plan: HH_Subsided
RS = 3.78
.05
.04
.05
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
HueHue Plan: HH_Subsided
RS = 3.60
.07
.05
.07
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
HueHue Plan: HH_Subsided
RS = 3.53
.07
.05
.07
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
HueHue Plan: HH_Subsided
RS = 3.38
.07
.05
.07
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

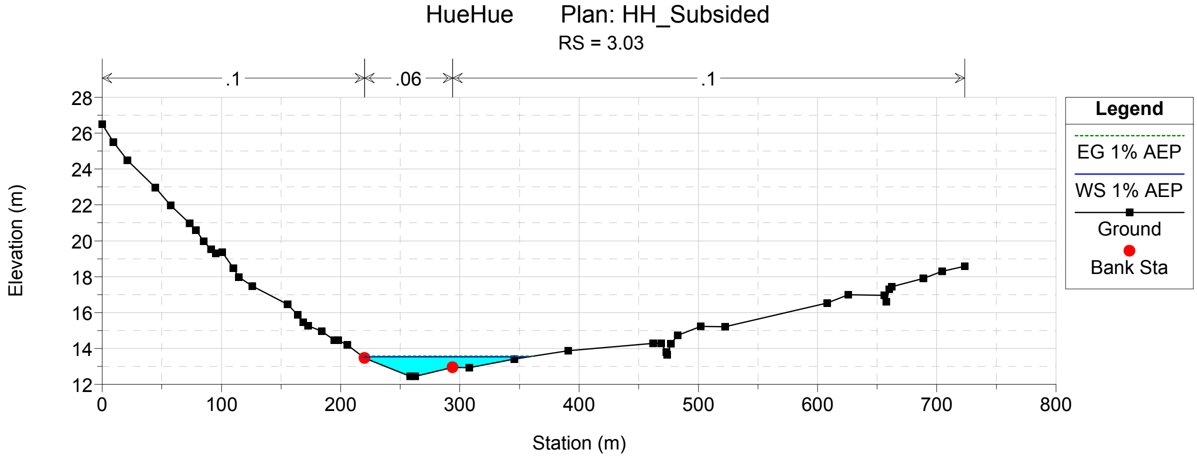

HueHue Plan: HH_Subsided
RS = 3.27 12 u/s Sandra St Culvert
.07
.05
.07
Elevation (m)
Station (m)
28
26
24
22
20
18
16
14
12
0
100
200
300
400
500
600
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

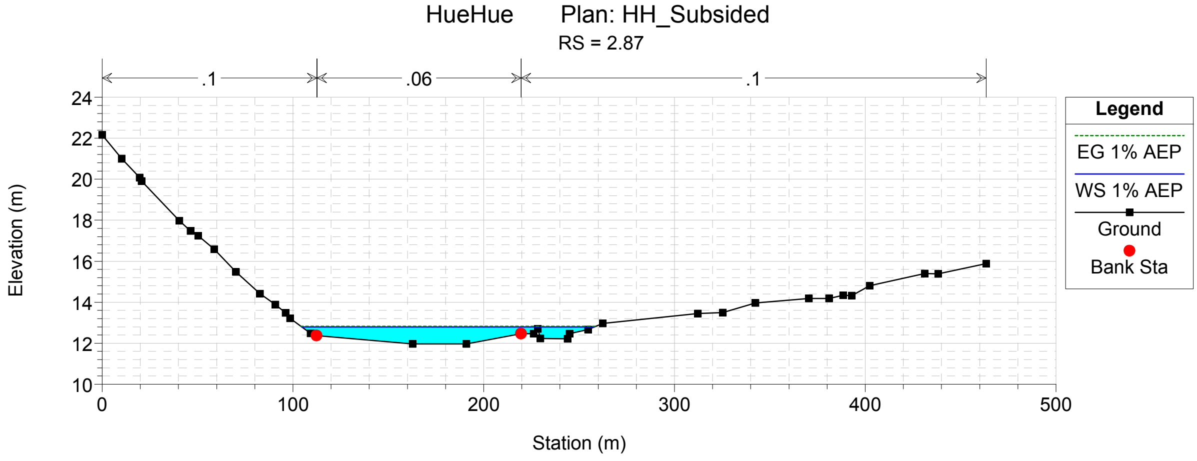

HueHue Plan: HH_Subsided
RS = 3.26 Culv Sandra St Culvert
.07
.05
.07
Elevation (m)
Station (m)
28
26
24
22
20
18
16
14
12
0
100
200
300
400
500
600
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

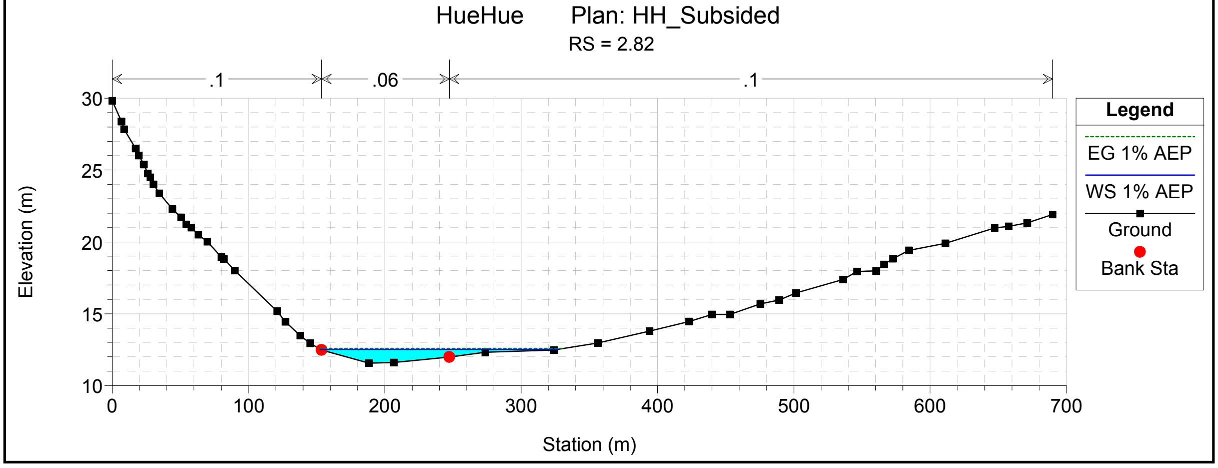

HueHue Plan: HH_Subsided
RS = 3.26 Culv Sandra St Culvert
.1
.06
.1
Elevation (m)
Station (m)
28
26
24
22
20
18
16
14
12
0
100
200
300
400
500
600
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

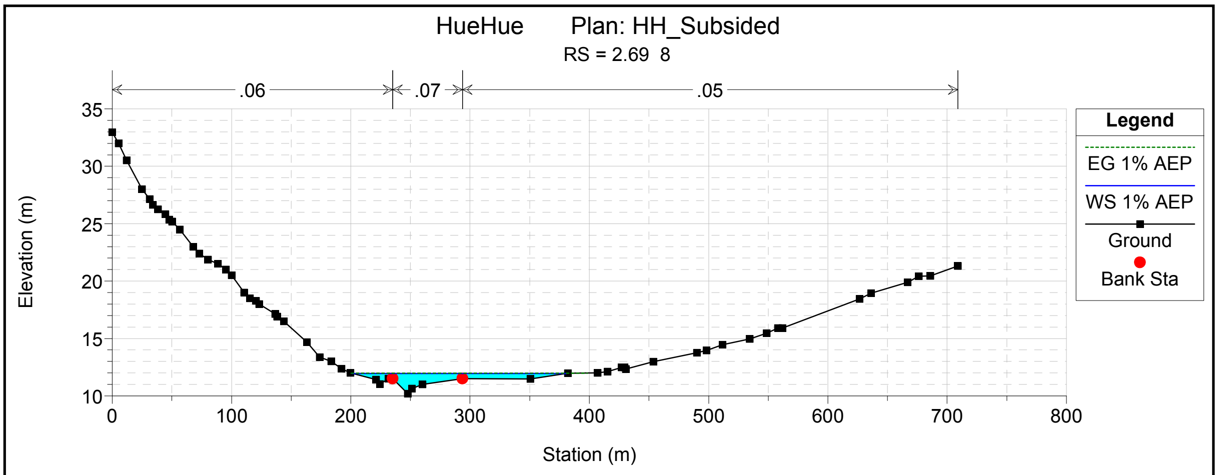

HueHue Plan: HH_Subsided
RS = 3.25 11 d/s Sandra St Culvert
.1
.06
.1
Elevation (m)
Station (m)
28
26
24
22
20
18
16
14
12
0
100
200
300
400
500
600
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

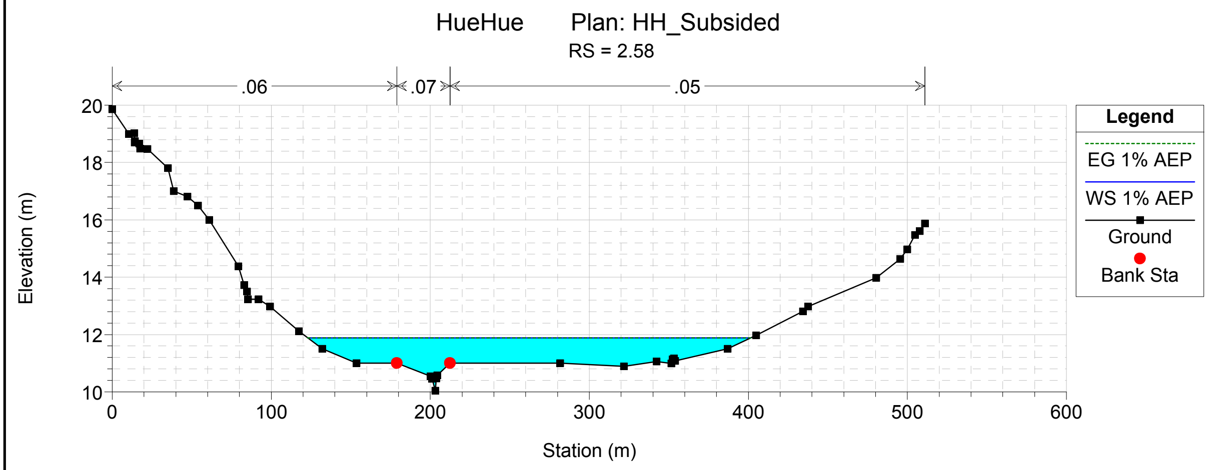

HueHue Plan: HH_Subsided
RS = 3.19
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

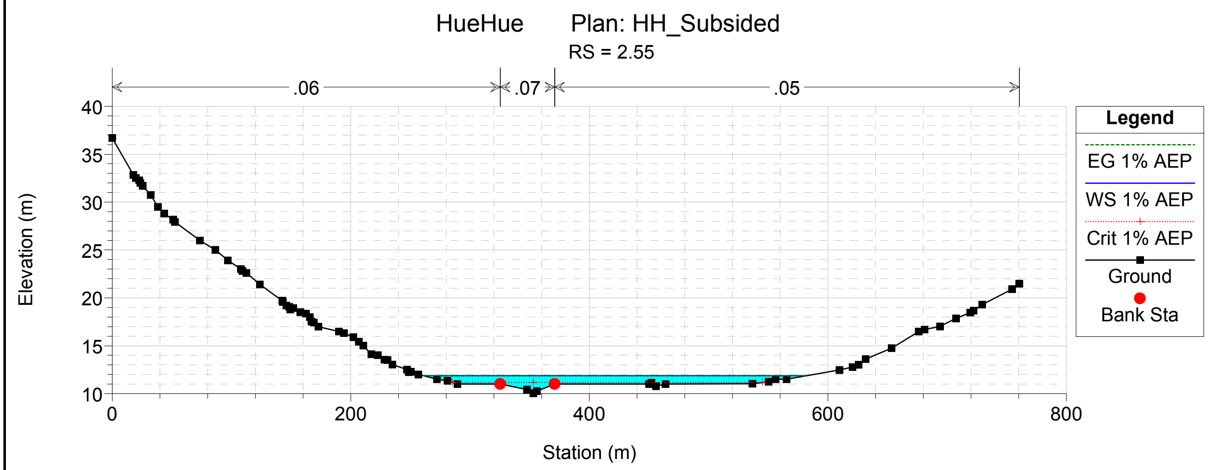

HueHue Plan: HH_Subsided
RS = 3.03
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

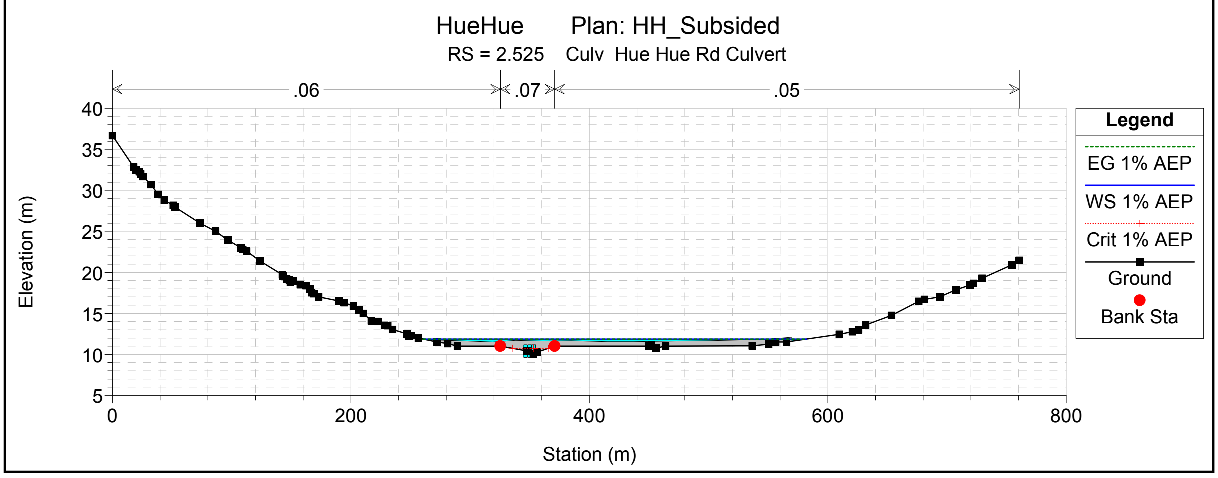

HueHue Plan: HH_Subsided
RS = 2.87
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

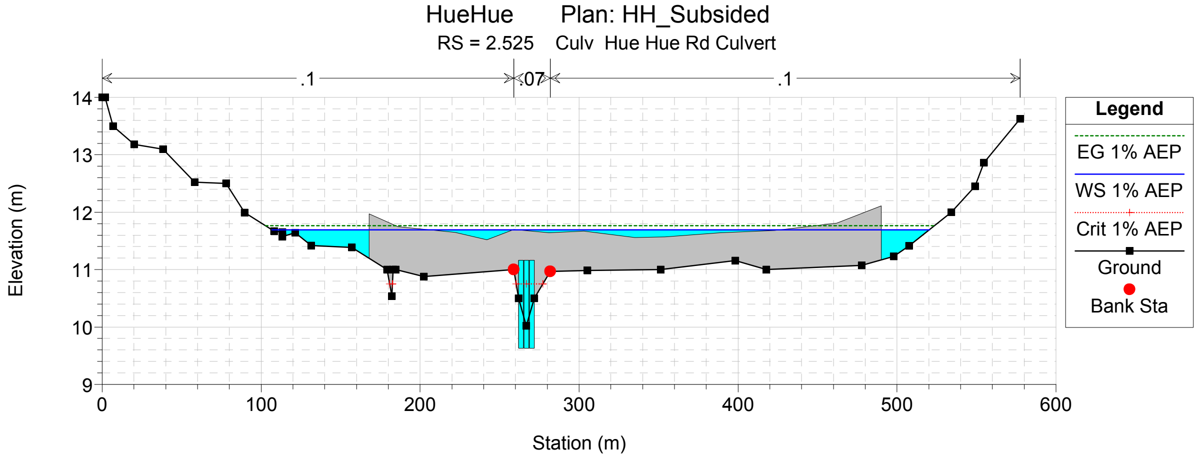

HueHue Plan: HH_Subsided
RS = 2.82
.1
.06
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

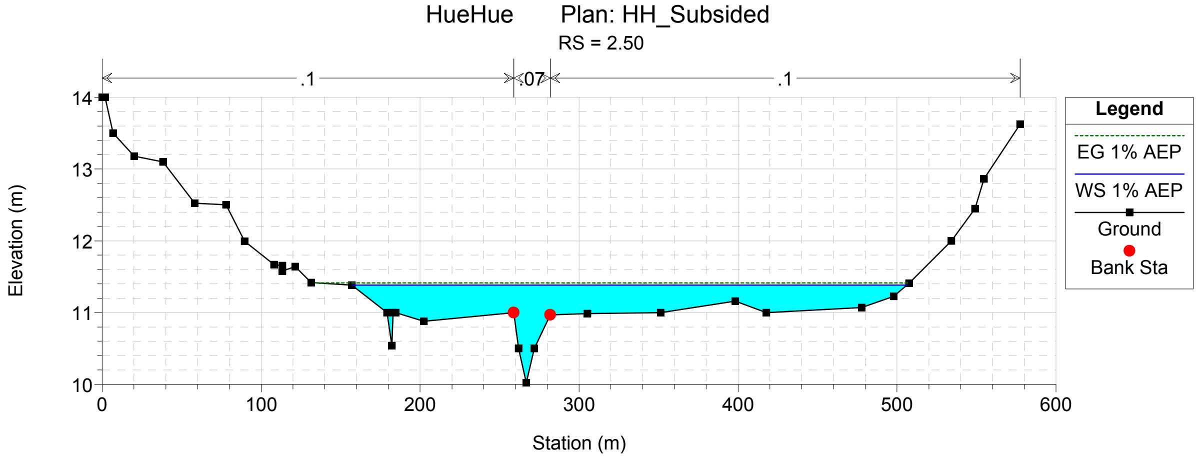

HueHue Plan: HH_Subsided
RS = 2.69 8
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

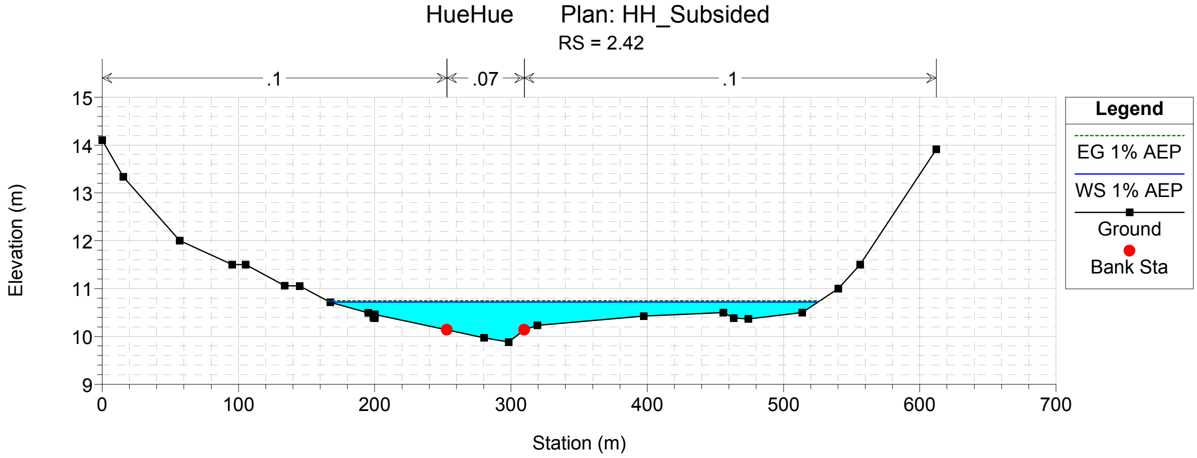

HueHue Plan: HH_Subsided
RS = 2.58
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

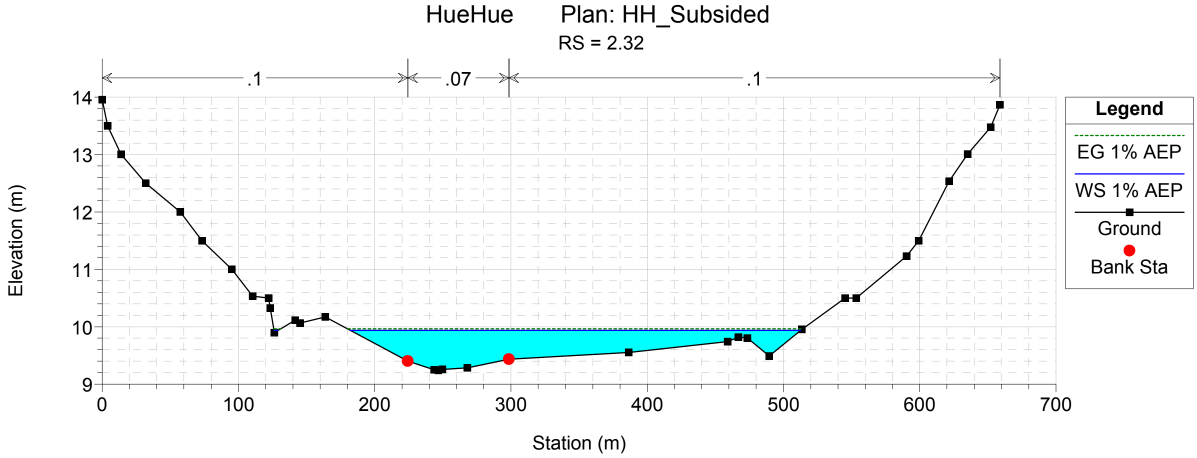

HueHue Plan: HH_Subsided
RS = 2.55
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

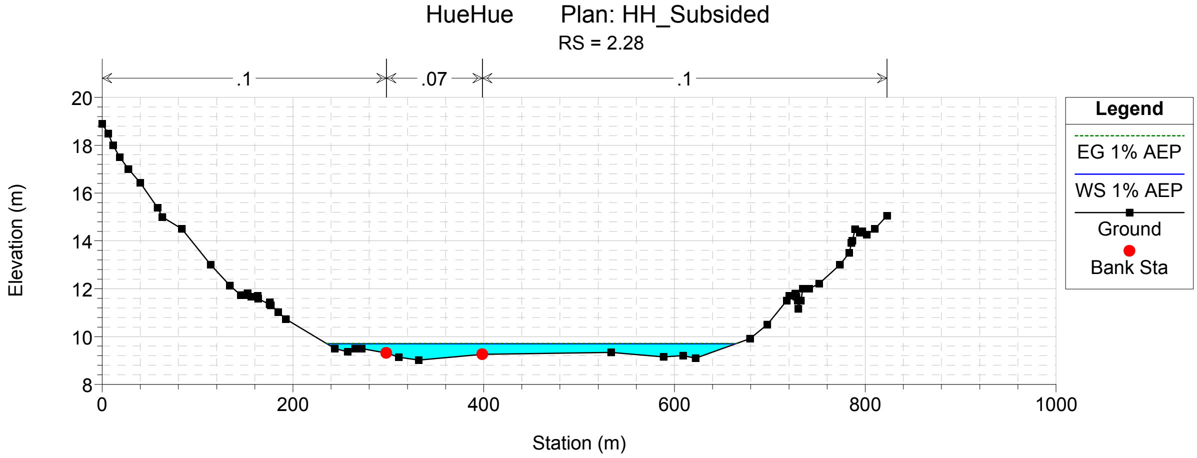

HueHue Plan: HH_Subsided
RS = 2.525 Culv Hue Hue Rd Culvert
.06
.07
.05
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

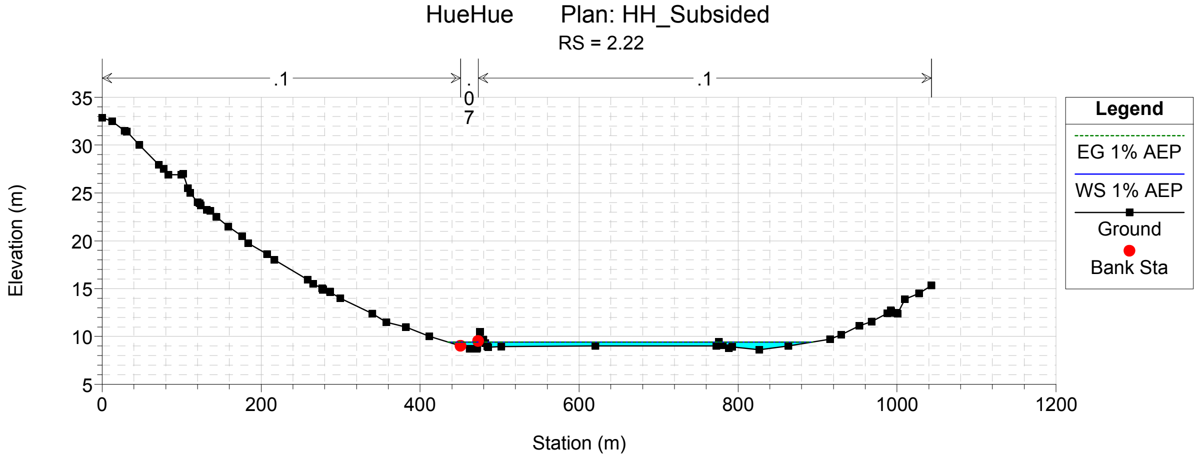

HueHue Plan: HH_Subsided
RS = 2.525 Culv Hue Hue Rd Culvert
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

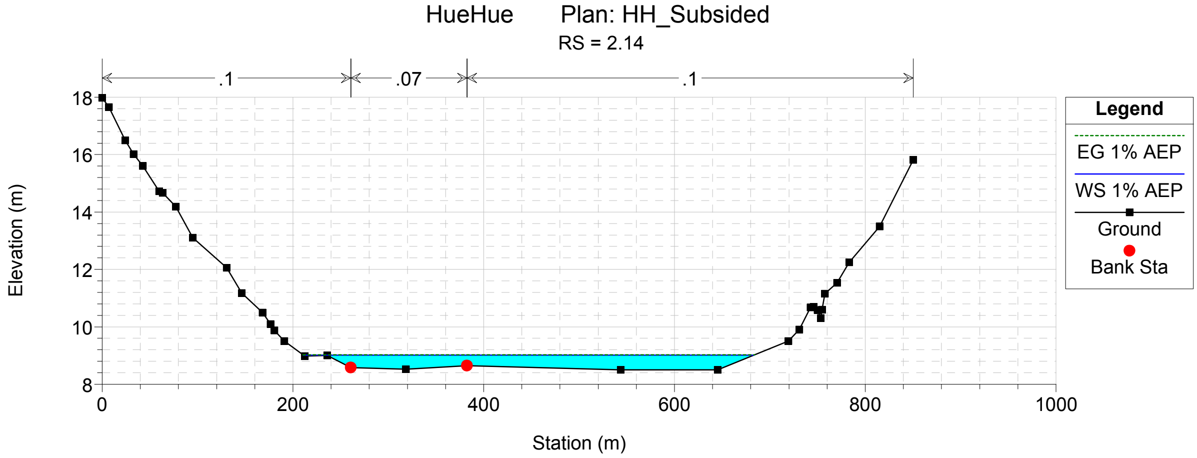

HueHue Plan: HH_Subsided
RS = 2.50
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

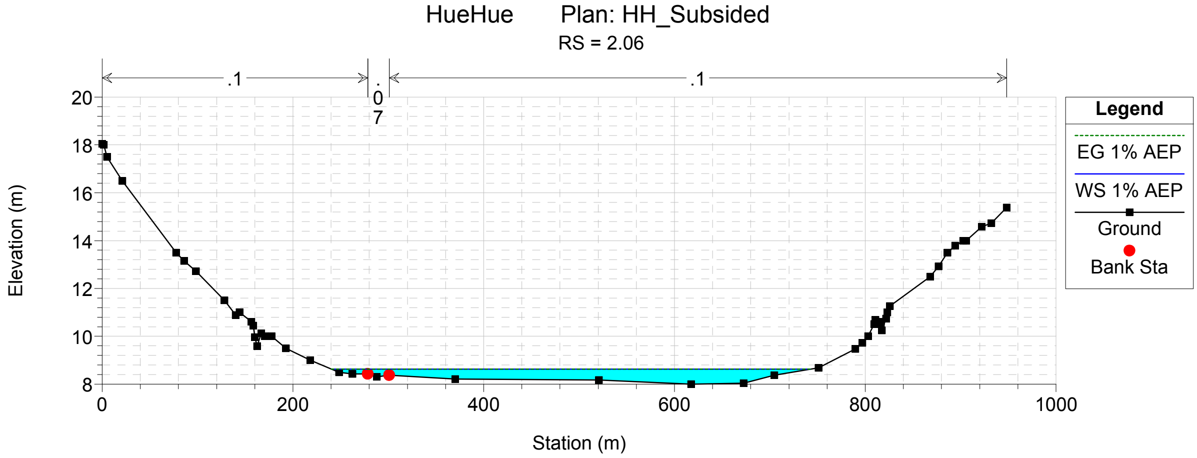

HueHue Plan: HH_Subsided
RS = 2.42
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

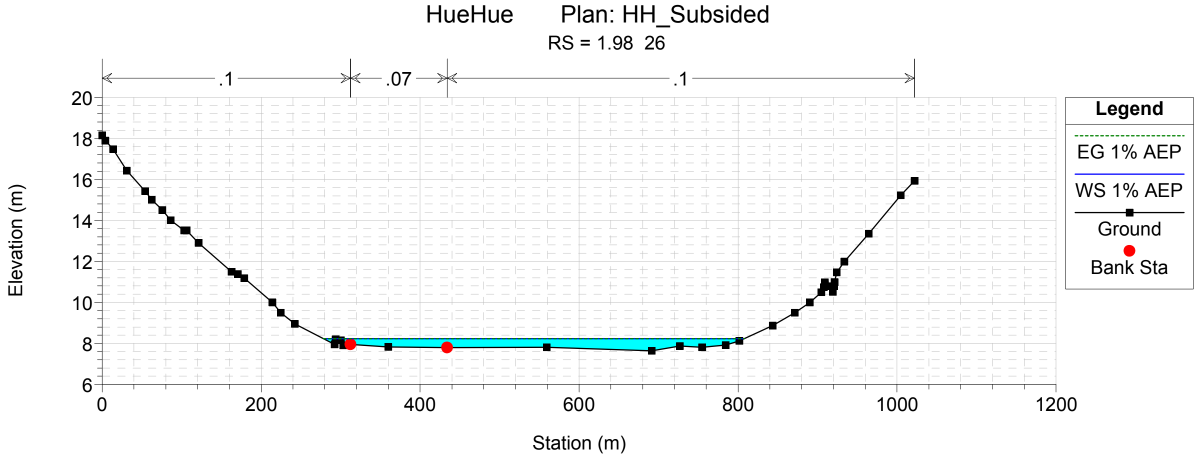

HueHue Plan: HH_Subsided
RS = 2.32
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

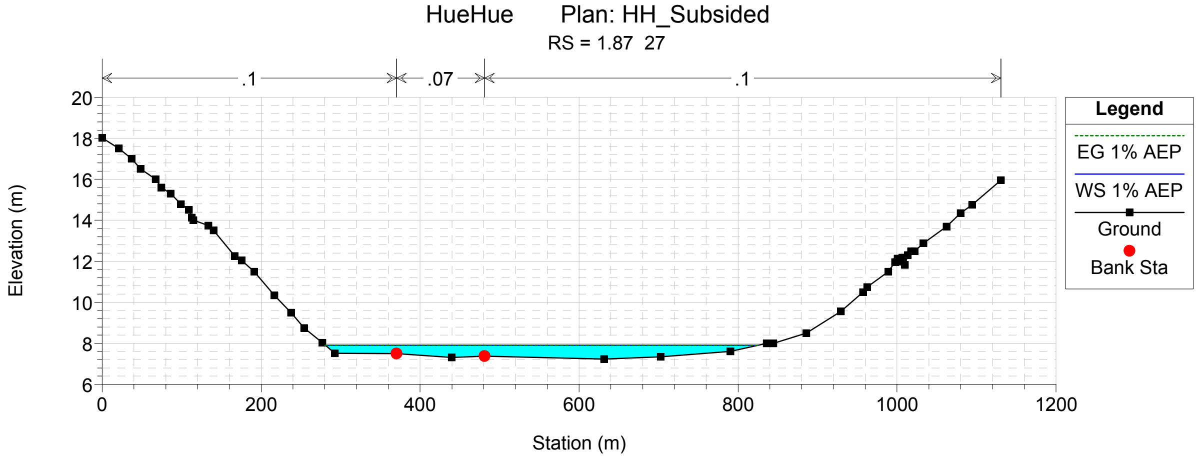

HueHue Plan: HH_Subsided
RS = 2.28
.1
.07
.1
Elevation (m)
20
18
16
14
12
10
8
0
200
400
600
800
1000
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

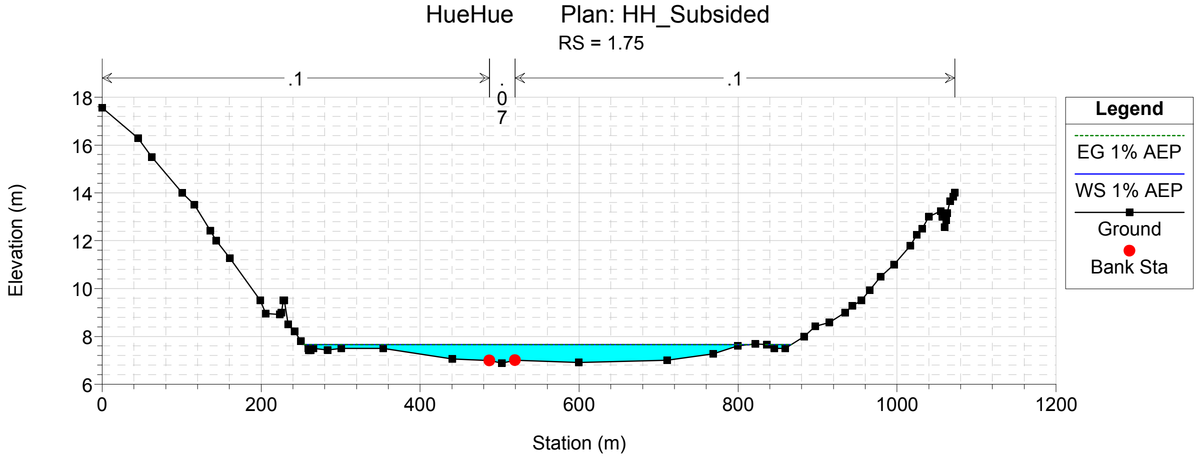

HueHue Plan: HH_Subsided
RS = 2.22
.1
.07
.1
Elevation (m)
35
30
25
20
15
10
5
0
200
400
600
800
1000
1200
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

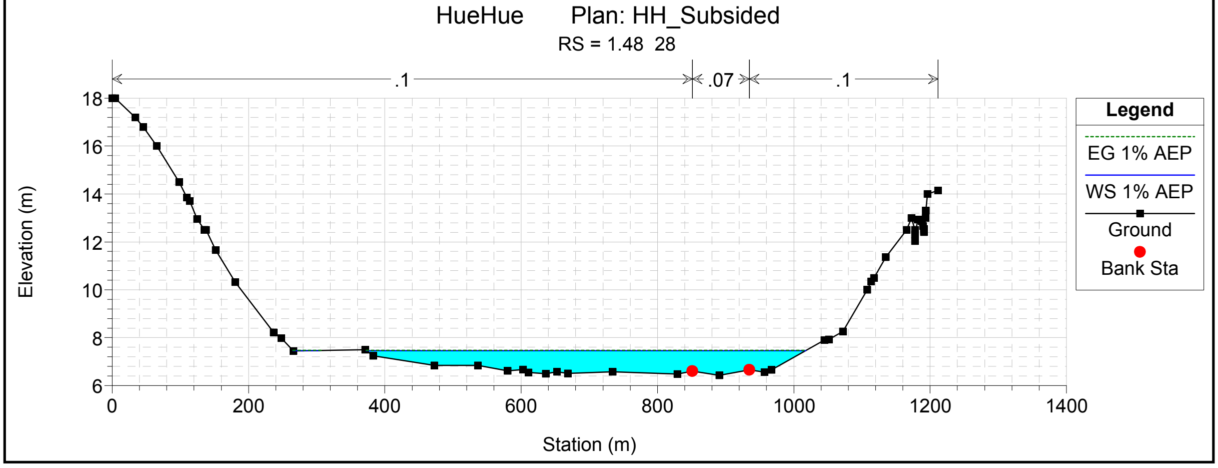

HueHue Plan: HH_Subsided
RS = 2.14
.1
.07
.1
Elevation (m)
18
16
14
12
10
8
0
200
400
600
800
1000
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

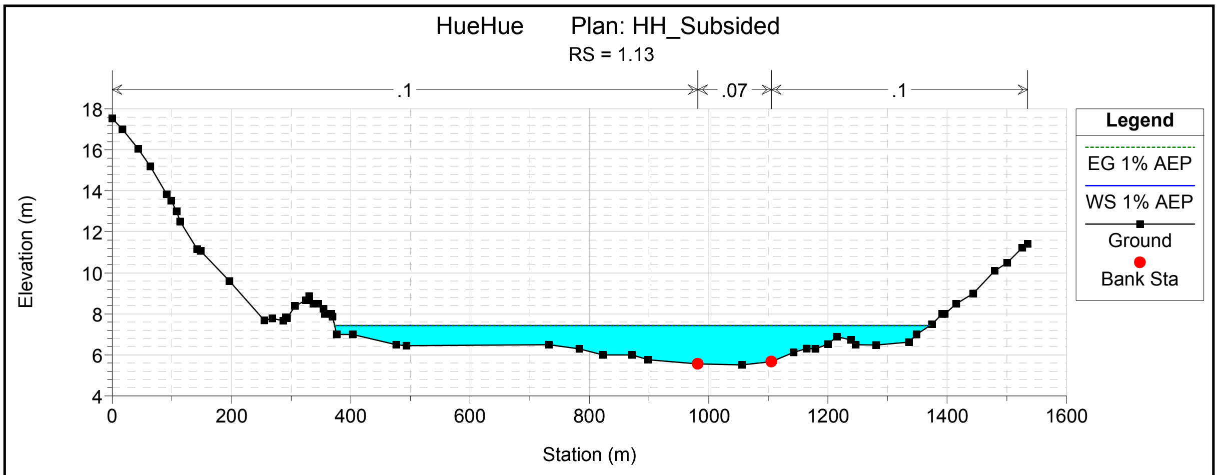

HueHue Plan: HH_Subsided
RS = 2.06
.1
.07
.1
Elevation (m)
20
18
16
14
12
10
8
0
200
400
600
800
1000
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

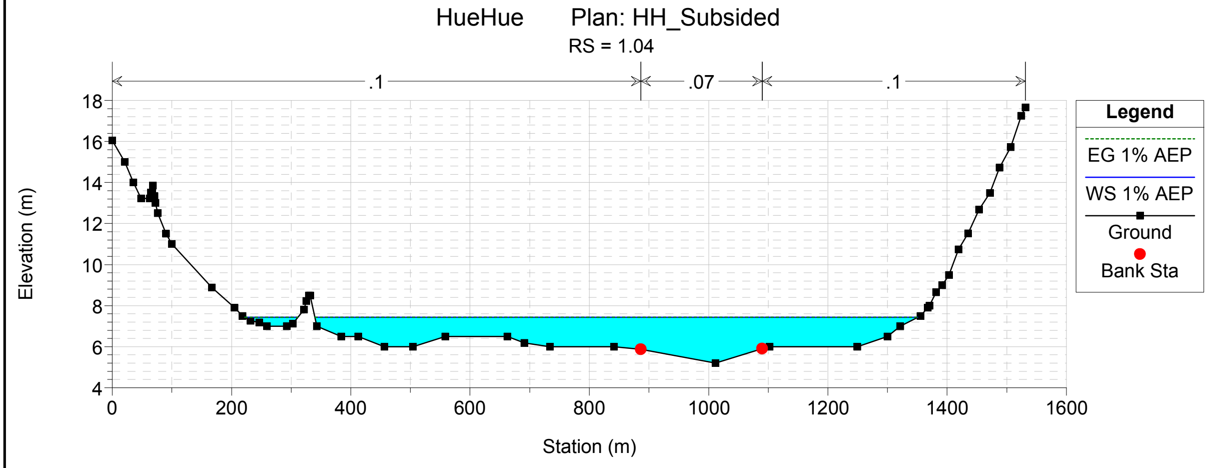

HueHue Plan: HH_Subsided
RS = 1.98 26
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
20
18
16
14
12
10
8
6
0
200
400
600
800
1000
1200

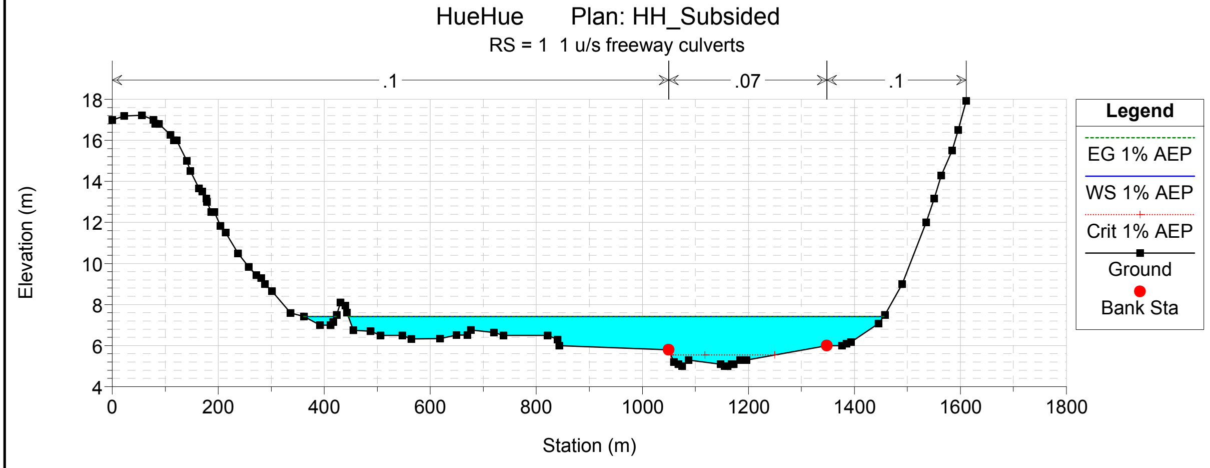

HueHue Plan: HH_Subsided
RS = 1.87 27
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
20
18
16
14
12
10
8
6
0
200
400
600
800
1000
1200

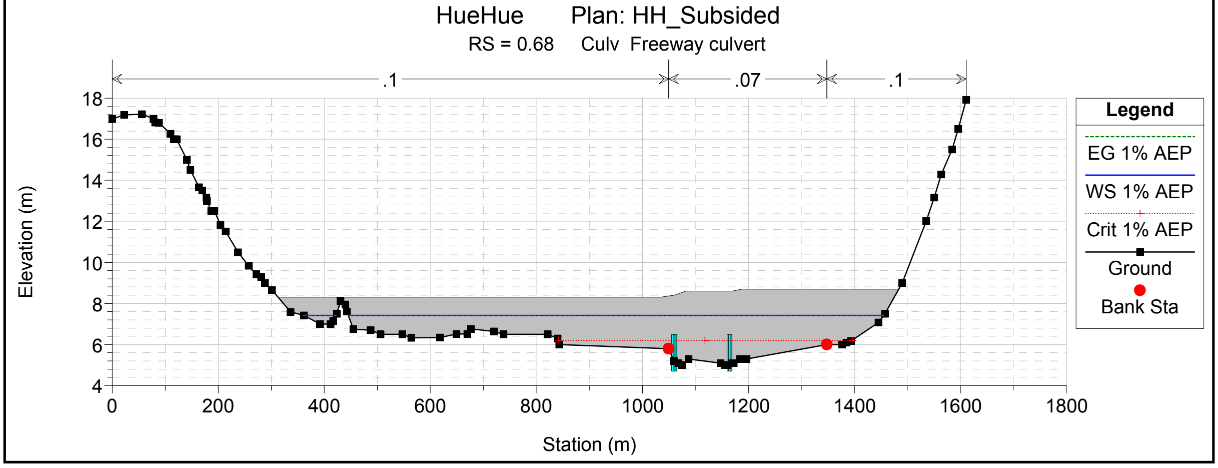

HueHue Plan: HH_Subsided
RS = 1.75
.1
.
0
7
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
18
16
14
12
10
8
6
0
200
400
600
800
1000
1200

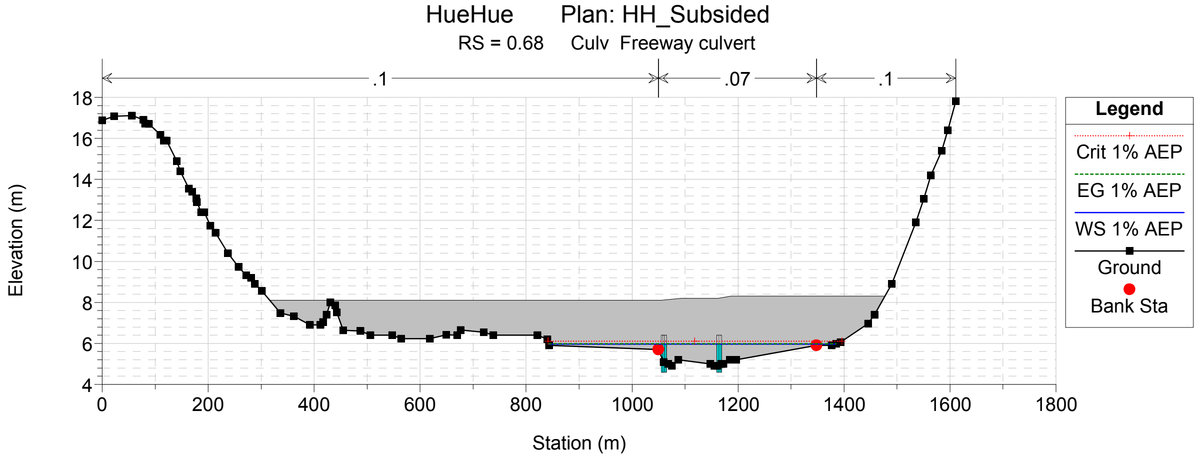

HueHue Plan: HH_Subsided
RS = 1.48 28
.1
.07
.1
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
18
16
14
12
10
8
6
0
200
400
600
800
1000
1200
1400

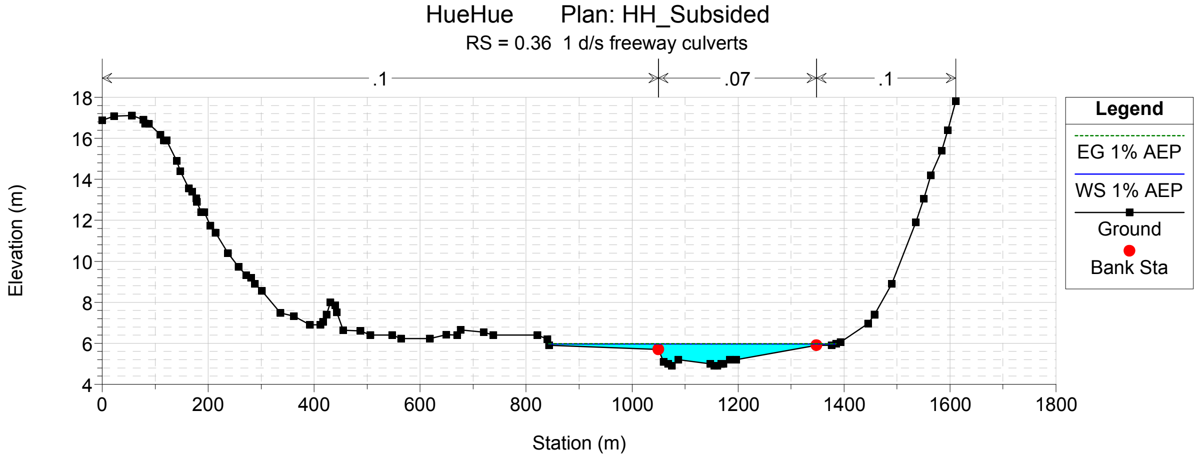

HueHue Plan: HH_Subsided
RS = 1.13
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta

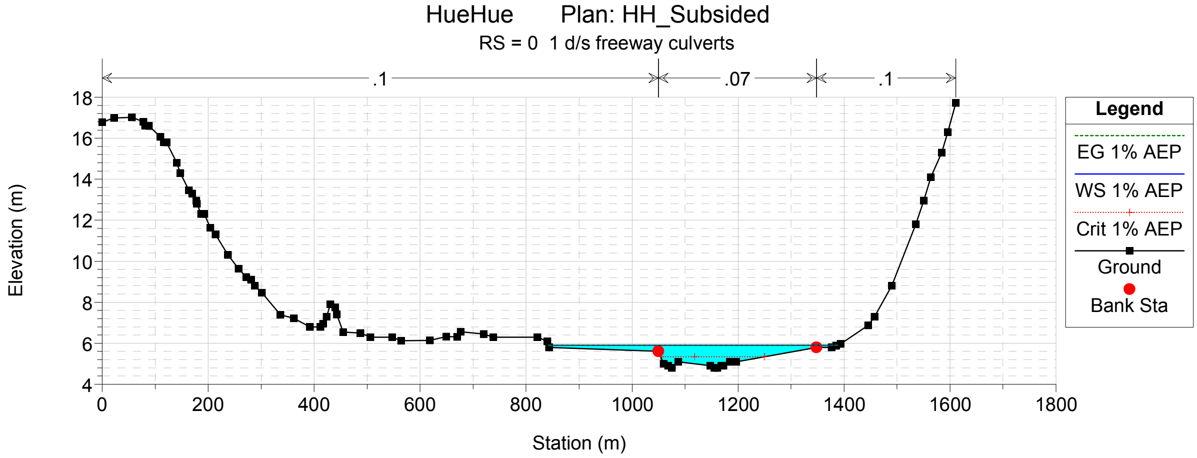

HueHue Plan: HH_Subsided
RS = 1.04
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Subsided
RS = 1 1 u/s freeway culverts
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Subsided
RS = 0.68 Culv Freeway culvert
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Subsided
RS = 0.68 Culv Freeway culvert
.1
.07
.1
Elevation (m)
Station (m)
Legend
Crit 1% AEP
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Subsided
RS = 0.36 1 d/s freeway culverts
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Ground
Bank Sta


HueHue Plan: HH_Subsided
RS = 0 1 d/s freeway culverts
.1
.07
.1
Elevation (m)
Station (m)
Legend
EG 1% AEP
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

Annex G

HEC-RAS Input Parameters

Details of Structures – Hue Hue Creek

Location	Type Dimensions	Length	Roughness	Kentry	Kexit
Access Road of Cottesloe Road	Bridge (15m length) 3 spans	3m			
Access Road of Cottesloe Road	Culvert (3 x 600 dia)	11m	0.018	0.5	1.0
Sandra Street	Box Culvert (3 x 2750 x 1200)	10m	0.018	0.5	1.0
Hue – Hue Road	Box Culvert (3 x 3000 x 1500)	11m	0.018	0.5	1.0
Sydney Newcastle Freeway	Box Culvert (6 x 3000 x 1800)	49m	0.018	0.5	1.0

1. Culvert dimensions in mm
2. Roughness Values expressed as Mannings co-efficients

Annex H

MIKE 11 Modelling Results

Table H.1 Existing and Subsided Flood Levels and Depths: 1% AEP

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	4138	31.55	31.55	0.00	9.73	9.73	0.00
YARR	4388	31.35	31.35	0.00	9.61	9.61	0.00
YARR	4392	31.28	31.28	0.00	9.54	9.54	0.00
YARR	4770	31.10	31.10	0.00	9.47	9.47	0.00
YARR	5440	30.85	30.85	0.00	9.24	9.24	0.00
YARR	5460	30.79	30.79	0.00	9.18	9.18	0.00
YARR	5670	30.70	30.70	0.00	9.09	9.09	0.00
YARR	6050	30.60	30.60	0.00	8.99	8.99	0.00
YARR	6330	30.55	30.55	0.00	9.40	9.40	0.00
YARR	6610	30.47	30.47	0.00	9.77	9.77	0.00
YARR	6690	30.41	30.41	0.00	9.84	9.84	0.00
YARR	7190	30.14	30.14	0.00	9.97	9.97	0.00
YARR	7430	29.95	29.95	0.00	9.97	9.97	0.00
YARR	7680	29.72	29.72	0.00	9.94	9.94	0.00
YARR	7960	29.46	29.46	0.00	9.90	9.90	0.00
YARR	8198	29.22	29.22	0.00	9.85	9.85	0.00
YARR	8202	29.13	29.13	0.00	9.76	9.76	0.00
YARR	8400	28.90	28.90	0.00	9.66	9.66	0.00
YARR	8720	28.60	28.60	0.00	9.54	9.54	0.00
YARR	8940	28.40	28.40	0.00	9.61	9.61	0.00
YARR	9300	28.22	28.22	0.00	9.70	9.70	0.00
YARR	9655	28.08	28.08	0.00	9.89	9.89	0.00
YARR	10000	27.88	27.88	0.00	9.79	9.79	0.00
YARR	10230	27.76	27.76	0.00	10.13	10.13	0.00
YARR	10285	27.72	27.72	0.00	10.05	10.05	0.00
YARR	10295	27.47	27.47	0.00	9.80	9.80	0.00
YARR	10330	27.43	27.43	0.00	9.90	9.90	0.00
YARR	10600	27.07	27.07	0.00	9.82	9.82	0.00
YARR	10870	26.71	26.71	0.00	9.73	9.73	0.00
YARR	11200	26.59	26.59	0.00	9.95	9.95	0.00
YARR	11410	26.54	26.54	0.00	10.12	10.12	0.00
YARR	11598	26.49	26.49	0.00	10.26	10.26	0.00
YARR	11602	26.44	26.44	0.00	10.21	10.21	0.00
YARR	11620	26.43	26.43	0.00	10.22	10.22	0.00
YARR	11820	26.34	26.34	0.00	10.32	10.32	0.00
YARR	11838	26.34	26.34	0.00	10.34	10.34	0.00
YARR	11842	26.28	26.28	0.00	10.28	10.28	0.00
YARR	12100	26.08	26.08	0.00	10.30	10.30	0.00
YARR	12470	25.67	25.67	0.00	10.21	10.21	0.00
YARR	12690	25.56	25.56	0.00	10.26	10.26	0.00
YARR	12708	25.55	25.55	0.00	10.30	10.30	0.00
YARR	12712	25.49	25.49	0.00	10.24	10.24	0.00
YARR	12950	25.28	25.28	0.00	10.06	10.06	0.00
YARR	13100	25.18	25.18	0.00	10.04	10.04	0.00
YARR	13808	24.91	24.91	0.00	9.97	9.97	0.00
YARR	13812	24.87	24.87	0.00	9.93	9.93	0.00
YARR	14150	24.64	24.64	0.00	10.06	10.06	0.00
YARR	14420	24.32	24.32	0.00	9.92	9.92	0.00
YARR	14560	24.28	24.28	0.00	10.12	10.12	0.00
YARR	14790	24.20	24.20	0.00	10.29	10.29	0.00
YARR	15000	23.94	23.94	0.00	10.25	10.25	0.00
YARR	15030	23.86	23.86	0.00	10.20	10.20	0.00
YARR	15090	23.77	23.77	0.00	10.18	10.18	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	15110	23.70	23.70	0.00	10.11	10.11	0.00
YARR	15350	23.61	23.61	0.00	10.09	10.09	0.00
YARR	15554	23.59	23.59	0.00	10.17	10.17	0.00
YARR	15775	23.55	23.55	0.00	10.23	10.23	0.00
YARR	15845	23.54	23.54	0.00	10.24	10.24	0.00
YARR	15858	23.50	23.49	0.00	10.20	10.19	0.00
YARR	16001	23.48	23.47	0.00	10.28	10.27	0.00
YARR	16274	23.42	23.41	0.00	10.43	10.42	0.00
YARR	16484	23.36	23.36	0.00	10.56	10.56	0.00
YARR	16670	23.30	23.30	0.00	10.65	10.65	0.00
YARR	16927	23.18	23.18	0.00	10.78	10.78	0.00
YARR	17122	23.12	23.11	0.00	10.87	10.86	0.01
YARR	17324	23.02	23.01	0.01	10.97	10.96	0.01
YARR	17533	22.85	22.84	0.01	10.96	10.95	0.01
YARR	17758	22.77	22.76	0.01	11.10	11.09	0.01
YARR	17762	22.70	22.70	0.01	11.03	11.03	0.01
YARR	17852	22.69	22.69	0.01	11.05	11.05	0.01
YARR	17856	22.65	22.65	0.01	11.01	11.01	0.01
YARR	18009	22.64	22.63	0.01	11.17	11.16	0.01
YARR	18207	22.60	22.60	0.01	11.36	11.36	0.01
YARR	18431	22.51	22.50	0.01	11.55	11.54	0.01
YARR	18653	22.38	22.37	0.01	11.67	11.66	0.01
YARR	18894	22.17	22.16	0.01	11.80	11.79	0.01
YARR	19038	22.04	22.03	0.01	11.89	11.88	0.01
YARR	19100	22.01	22.00	0.01	11.89	11.88	0.01
YARR	19110	21.94	21.93	0.01	11.82	11.81	0.01
YARR	19144	21.91	21.90	0.01	11.80	11.79	0.01
YARR	19269	21.83	21.81	0.01	11.73	11.71	0.01
YARR	19428	21.76	21.74	0.01	11.67	11.65	0.01
YARR	19625	21.60	21.58	0.02	11.74	11.72	0.01
YARR	19824	21.30	21.28	0.02	11.49	11.47	0.02
YARR	20057	21.09	21.07	0.02	11.28	11.26	0.02
YARR	20264	20.85	20.83	0.02	11.04	11.02	0.02
YARR	20366	20.68	20.65	0.03	10.98	10.94	0.04
YARR	20376	20.59	20.55	0.04	10.89	10.84	0.05
YARR	20464	20.49	20.45	0.04	10.78	10.74	0.04
YARR	20688	20.41	20.37	0.04	11.05	11.01	0.04
YARR	20870	20.27	20.22	0.05	10.94	10.89	0.05
YARR	21102	19.68	19.61	0.07	10.75	10.56	0.19
YARR	21308	19.58	19.50	0.08	10.83	10.77	0.06
YARR	21552	19.53	19.45	0.08	11.10	11.03	0.06
YARR	21580	19.51	19.43	0.08	10.97	11.03	0.06
YARR	21600	19.46	19.39	0.07	10.93	11.01	0.08
YARR	21618	19.45	19.38	0.07	11.06	11.00	0.06
YARR	21768	19.34	19.27	0.07	10.90	10.92	0.03
YARR	21934	19.11	19.05	0.07	10.82	10.87	0.05
YARR	22136	18.86	18.85	0.02	10.60	10.73	0.13
YARR	22327	18.69	18.69	0.01	10.43	10.53	0.11
YARR	22430	18.63	18.64	0.01	10.28	10.35	0.07
YARR	22450	18.56	18.57	0.00	9.97	10.04	0.07
YARR	22567	18.50	18.51	0.00	10.24	10.28	0.04
YARR	22757	18.38	18.38	0.00	10.29	10.30	0.01
YARR	23032	18.14	18.14	0.01	10.25	10.05	0.19
YARR	23152	18.01	18.02	0.01	9.93	9.15	0.78

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	23172	17.93	17.93	0.00	9.85	9.85	0.00
YARR	23218	17.86	17.87	0.00	10.16	9.97	0.20
YARR	23460	17.67	17.67	0.00	10.17	10.17	0.00
YARR	23641	17.60	17.60	0.00	10.30	10.30	0.00
YARR	23878	17.51	17.51	0.00	10.49	10.49	0.00
YARR	24033	17.44	17.44	0.00	10.23	10.23	0.00
YARR	24147	17.40	17.40	0.00	10.39	10.39	0.00
YARR	24157	17.35	17.35	0.00	10.40	10.40	0.00
YARR	24305	17.28	17.28	0.00	10.54	10.54	0.00
YARR	24526	17.18	17.18	0.00	10.78	10.78	0.00
YARR	24717	17.09	17.09	0.00	10.85	10.85	0.00
YARR	25000	16.89	16.89	0.00	11.09	11.09	0.00
YARR	25198	16.61	16.61	0.00	10.98	10.98	0.00
YARR	25419	16.18	16.18	0.00	10.74	10.74	0.00
YARR	25619	15.92	15.92	0.00	10.66	10.66	0.00
YARR	25857	15.78	15.78	0.00	10.52	10.52	0.00
YARR	26072	15.61	15.61	0.00	10.85	10.85	0.00
YARR	26300	15.11	15.10	0.00	10.43	10.42	0.00
YARR	26330	14.94	14.94	0.00	10.27	10.27	0.00
YARR	26340	14.86	14.86	0.00	10.19	10.19	0.00
YARR	26499	14.53	14.52	0.01	10.32	10.31	0.01
YARR	26715	14.47	14.46	0.01	10.34	10.33	0.01
YARR	26940	14.39	14.38	0.01	10.64	10.38	0.26
YARR	27080	14.17	14.16	0.01	10.62	10.17	0.45
YARR	27090	14.12	14.11	0.01	10.57	10.12	0.45
YARR	27145	14.02	14.01	0.01	10.57	10.15	0.42
YARR	27319	13.75	13.74	0.01	10.47	10.03	0.44
YARR	27531	13.43	13.41	0.01	10.38	10.10	0.28
YARR	27710	12.80	12.79	0.01	9.92	9.71	0.21
YARR	27807	12.67	12.66	0.01	9.89	9.72	0.18
YARR	27976	12.41	12.39	0.02	9.80	9.55	0.25
YARR	28192	12.31	12.29	0.02	9.92	9.56	0.36
YARR	28426	12.24	12.24	0.00	10.10	10.11	0.01
YARR	28608	12.14	12.15	0.02	10.18	9.60	0.57
YARR	28939	12.07	12.08	0.01	10.09	9.79	0.31
YARR	29191	12.25	12.24	0.02	10.26	10.14	0.13
YARR	29325	11.98	11.97	0.01	9.98	9.97	0.01
YARR	29333	11.95	11.94	0.01	9.95	9.94	0.01
YARR	29389	11.81	11.80	0.01	10.03	10.02	0.01
YARR	29513	11.61	11.60	0.01	10.33	10.32	0.01
YARR	29689	11.57	11.57	0.01	10.29	10.29	0.01
YARR	29803	11.57	11.56	0.01	10.45	10.45	0.01
YARR	30043	10.47	10.44	0.04	9.71	9.68	0.03
YARR	30273	10.18	10.13	0.05	9.52	9.47	0.05
YARR	30441	10.15	10.09	0.06	9.49	9.43	0.06
YARR	30677	9.39	9.34	0.05	8.73	8.68	0.05
YARR	30957	9.07	9.03	0.05	9.71	9.67	0.05
YARR	31255	8.91	8.87	0.04	8.41	8.37	0.04
YARR	31676	8.42	8.37	0.05	9.91	9.86	0.05
YARR	31706	8.16	8.11	0.04	9.74	9.69	0.04
YARR	31777	8.04	8.00	0.04	8.84	8.80	0.04
YARR	31989	7.92	7.91	0.01	8.72	8.71	0.01
YARR	32264	7.91	7.91	0.01	8.76	8.75	0.01
YARR	32574	7.90	7.90	0.00	8.80	8.80	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR	0	38.27	38.27	0.00	3.33	3.33	0.00
DOOR	280	37.79	37.79	0.00	3.69	3.69	0.00
DOOR	520	37.44	37.44	0.00	4.07	4.07	0.00
DOOR	707	37.02	37.02	0.00	5.31	5.31	0.00
DOOR	713	37.00	37.00	0.00	5.29	5.29	0.00
DOOR	770	36.89	36.89	0.00	5.25	5.25	0.00
DOOR	810	36.69	36.69	0.00	5.15	5.15	0.00
DOOR	1190	35.93	35.93	0.00	5.61	5.61	0.00
DOOR	1440	35.62	35.62	0.00	5.96	5.96	0.00
DOOR	1650	34.79	34.79	0.00	5.76	5.76	0.00
DOOR	1880	33.94	33.94	0.00	5.47	5.47	0.00
DOOR	2100	33.17	33.17	0.00	5.26	5.26	0.00
DOOR	2330	32.75	32.75	0.00	5.48	5.48	0.00
DOOR	2540	32.38	32.38	0.00	5.67	5.67	0.00
DOOR	2810	31.68	31.68	0.00	5.63	5.63	0.00
DOOR	2970	31.45	31.45	0.00	5.84	5.84	0.00
DOOR	2995	31.41	31.41	0.00	5.87	5.87	0.00
DOOR	3001	31.20	31.20	0.00	5.66	5.66	0.00
DOOR	3056	31.05	31.05	0.00	5.59	5.59	0.00
DOOR	3356	30.46	30.46	0.00	3.85	3.85	0.00
DOOR	3576	30.43	30.43	0.00	5.82	5.82	0.00
DOOR	3821	30.34	30.34	0.00	6.08	6.08	0.00
DOOR	4035	29.68	29.68	0.00	5.74	5.74	0.00
DOOR	4090	29.30	29.30	0.00	5.46	5.46	0.00
DOOR	4261	28.79	28.79	0.00	5.26	5.26	0.00
DOOR	4310	28.57	28.57	0.00	5.12	5.12	0.00
DOOR	4314	28.52	28.52	0.00	5.08	5.08	0.00
DOOR	4454	28.00	28.00	0.00	4.69	4.69	0.00
DOOR	4660	27.56	27.56	0.00	4.46	4.46	0.00
DOOR	4860	27.38	27.38	0.00	4.47	4.47	0.00
DOOR	5179	27.18	27.18	0.00	4.66	4.66	0.00
DOOR	5360	26.68	26.68	0.00	4.45	4.45	0.00
DOOR	5461	26.43	26.43	0.00	4.33	4.33	0.00
DOOR	5691	25.90	25.90	0.00	4.03	4.03	0.00
DOOR	5913	25.56	25.56	0.00	3.90	3.90	0.00
DOOR	6091	25.43	25.43	0.00	4.07	4.07	0.00
DOOR	6404	25.15	25.15	0.00	4.14	4.14	0.00
DOOR	6448	25.09	25.09	0.00	5.12	5.12	0.00
DOOR	6464	24.50	24.50	0.00	4.53	4.53	0.00
DOOR	6490	24.34	24.34	0.00	3.42	3.42	0.00
DOOR	6677	23.92	23.92	0.00	3.32	3.32	0.00
DOOR	7023	23.61	23.61	0.00	2.91	2.91	0.00
DOOR	7236	23.31	23.31	0.00	3.57	3.57	0.00
DOOR	7405	23.12	23.12	0.00	3.56	3.56	0.00
DOOR	7690	22.78	22.79	0.00	3.84	3.85	0.00
DOOR	7921	22.37	22.37	0.00	3.82	3.82	0.00
DOOR	8141	21.68	21.69	0.01	3.49	3.50	0.01
DOOR	8365	21.33	21.34	0.02	3.53	3.54	0.02
DOOR	8647	20.94	20.95	0.02	3.71	3.72	0.02
DOOR	8858	20.51	20.50	0.00	3.72	3.71	0.00
DOOR	9113	20.09	20.08	0.01	3.64	3.63	0.01
DOOR	9221	19.60	19.57	0.03	3.45	3.42	0.03
DOOR	9329	19.48	19.44	0.04	3.62	3.58	0.04
DOOR	9531	19.24	19.16	0.08	3.72	3.64	0.08

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR	9757	18.77	18.54	0.23	3.66	3.46	0.20
DOOR	9946	18.48	18.08	0.40	3.73	3.60	0.12
DOOR	10137	18.06	17.20	0.86	3.58	3.74	0.16
DOOR	10339	17.53	16.25	1.29	3.36	3.44	0.08
DOOR	10512	17.35	16.04	1.31	2.61	2.47	0.14
DOOR	10748	17.04	15.76	1.28	2.84	2.86	0.02
DOOR	10964	16.48	15.27	1.22	3.53	3.67	0.13
DOOR	10984	16.48	15.26	1.22	3.53	3.66	0.13
DOOR	11053	16.40	15.18	1.21	3.38	3.46	0.09
DOOR	11236	15.88	14.71	1.17	2.86	2.98	0.12
DOOR	11386	15.43	14.36	1.07	2.41	2.44	0.03
DOOR	11586	15.29	14.30	0.99	2.96	3.15	0.19
DOOR	11844	15.00	14.21	0.79	3.56	4.06	0.50
DOOR	11948	14.94	14.20	0.75	3.64	4.03	0.39
DOOR	12151	14.74	14.13	0.61	3.94	4.68	0.74
DOOR	12385	14.57	14.08	0.48	4.27	4.93	0.66
DOOR	12579	14.46	14.05	0.41	4.66	5.60	0.93
DOOR	12765	14.37	14.03	0.34	5.07	6.02	0.95
DOOR	12982	14.28	14.01	0.27	5.18	6.05	0.87
DOOR	13193	14.23	13.99	0.23	5.35	6.31	0.96
DOOR	13367	14.21	13.99	0.22	5.71	6.79	1.08
DOOR	13628	14.16	13.98	0.18	5.96	6.77	0.81
DOOR	13851	14.03	13.91	0.12	5.83	5.80	0.03
DOOR	14073	13.67	13.56	0.12	5.98	5.89	0.10
DOOR	14267	12.98	12.61	0.37	5.80	5.51	0.28
DOOR	14427	12.63	11.87	0.76	5.82	5.31	0.51
DOOR	14635	12.53	11.71	0.82	5.82	6.01	0.19
DOOR	14897	12.35	11.57	0.78	5.64	5.43	0.21
DOOR	15114	12.08	11.47	0.62	5.66	5.47	0.19
DOOR	15315	11.89	11.41	0.48	5.67	5.88	0.21
DOOR	15534	11.73	11.36	0.37	5.62	6.17	0.55
DOOR	15724	11.64	11.34	0.31	5.64	5.84	0.20
DOOR	15908	11.57	11.32	0.25	6.65	6.67	0.02
DOOR	16106	11.46	11.27	0.19	6.76	6.66	0.10
DOOR	16385	11.24	11.13	0.11	7.11	7.01	0.09
DOOR	16595	11.15	11.05	0.09	7.40	7.30	0.09
DOOR	16705	11.12	11.03	0.09	7.37	7.28	0.09
DOOR	16842	11.10	11.01	0.09	7.75	7.66	0.09
DOOR	16862	11.09	11.00	0.09	7.18	7.95	0.77
DOOR	16902	11.09	11.00	0.09	7.74	7.65	0.09
DOOR	17085	11.07	10.98	0.09	8.19	8.11	0.09
DOOR	17416	10.98	10.89	0.09	9.40	9.31	0.09
DOOR	17575	10.86	10.78	0.09	9.49	9.41	0.09
DOOR	17820	10.15	10.09	0.06	9.49	9.43	0.06
DOOR_A	0	36.37	36.37	0.00	1.37	1.37	0.00
DOOR_A	260	35.26	35.26	0.00	2.01	2.01	0.00
DOOR_A	540	32.95	32.95	0.00	0.97	0.97	0.00
DOOR_A	870	31.50	31.50	0.00	1.18	1.18	0.00
DOOR_A	1120	31.18	31.18	0.00	2.73	2.73	0.00
DOOR_A	1330	30.82	30.82	0.00	3.08	3.08	0.00
DOOR_A	1478	30.62	30.62	0.00	3.64	3.64	0.00
DOOR_A	1482	30.61	30.61	0.00	3.63	3.63	0.00
DOOR_A	1560	30.56	30.56	0.00	3.76	3.76	0.00
DOOR_A	2100	30.43	30.43	0.00	4.22	4.22	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_B	0	32.20	32.20	0.00	0.52	0.52	0.00
DOOR_B	230	29.85	29.85	0.00	0.50	0.50	0.00
DOOR_B	500	27.87	27.87	0.00	0.56	0.56	0.00
DOOR_B	760	26.08	26.08	0.00	0.26	0.26	0.00
DOOR_B	1010	23.63	23.63	0.00	1.99	1.99	0.00
DOOR_B	1270	23.62	23.62	0.00	1.98	1.98	0.00
DOOR_B	1570	23.62	23.62	0.00	1.98	1.98	0.00
DOOR_B	1660	23.61	23.61	0.00	1.97	1.97	0.00
DOOR_B	1950	23.61	23.61	0.00	2.91	2.91	0.00
DOOR_C	0	28.67	28.67	0.00	0.64	0.64	0.00
DOOR_C	260	26.84	26.84	0.00	0.36	0.36	0.00
DOOR_C	490	25.41	25.41	0.00	0.33	0.33	0.00
DOOR_C	680	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	960	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1260	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1510	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1780	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1920	23.31	23.31	0.00	3.57	3.57	0.00
DOOR_D	0	21.10	21.10	0.00	0.79	0.79	0.00
DOOR_D	270	19.40	19.40	0.00	0.97	0.97	0.00
DOOR_D	530	18.55	18.56	0.01	0.55	0.56	0.02
DOOR_D	740	17.27	17.11	0.16	0.85	0.76	0.09
DOOR_D	1040	15.27	14.25	1.03	0.83	0.93	0.10
DOOR_D	1300	14.96	14.21	0.76	2.22	2.75	0.53
DOOR_D	1540	14.96	14.21	0.76	2.88	3.52	0.64
DOOR_D	1820	14.96	14.21	0.76	3.55	4.23	0.68
DOOR_D	2080	14.96	14.21	0.76	3.64	4.33	0.68
DOOR_D	2350	14.96	14.21	0.76	3.64	4.12	0.48
DOOR_D	2550	14.94	14.20	0.75	3.65	4.10	0.45
DOOR_E	0	30.26	30.21	0.05	5.92	5.96	0.04
DOOR_E	170	29.72	29.67	0.05	5.51	5.56	0.04
DOOR_E	390	29.31	29.23	0.08	5.16	5.14	0.02
DOOR_E	660	28.67	28.58	0.09	4.09	4.06	0.03
DOOR_E	940	27.64	27.51	0.13	4.05	3.98	0.07
DOOR_E	1230	26.00	25.88	0.12	3.72	3.74	0.02
DOOR_E	1450	24.80	24.75	0.06	3.97	3.98	0.01
DOOR_E	1700	24.22	24.17	0.04	4.15	4.13	0.02
DOOR_E	1920	23.41	23.36	0.06	3.71	3.70	0.01
DOOR_E	2140	22.19	22.10	0.09	3.86	3.84	0.02
DOOR_E	2170	21.87	21.76	0.10	3.77	3.73	0.03
DOOR_E	2190	21.75	21.64	0.10	3.88	3.82	0.06
DOOR_E	2390	21.26	21.15	0.11	3.71	3.78	0.07
DOOR_E	2680	20.35	20.17	0.17	3.22	3.12	0.10
DOOR_E	2900	19.43	18.80	0.63	3.28	2.79	0.48
DOOR_E	3110	18.54	17.67	0.87	4.15	3.97	0.18
DOOR_E	3320	17.23	16.82	0.41	3.99	4.46	0.47
DOOR_E	3690	16.44	16.02	0.41	4.26	4.10	0.15
DOOR_E	4010	15.20	15.00	0.20	3.70	3.58	0.13
DOOR_E	4040	15.15	14.94	0.22	4.02	3.89	0.13
DOOR_E	4080	14.76	14.55	0.21	4.06	3.94	0.12
DOOR_E	4230	14.18	13.97	0.21	3.48	3.34	0.13
DOOR_E	4500	13.67	13.56	0.12	3.96	3.94	0.02
DOOR_F	0	28.20	28.20	0.00	1.84	1.84	0.00
DOOR_F	180	27.31	27.31	0.00	1.98	1.98	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_F	185	27.31	27.31	0.00	2.06	2.06	0.00
DOOR_F	203	27.28	27.28	0.00	2.03	2.03	0.00
DOOR_F	210	27.26	27.26	0.00	1.87	1.87	0.00
DOOR_F	370	27.18	27.18	0.00	2.94	2.94	0.00
DOOR_G	0	31.66	31.66	0.00	3.39	3.39	0.00
DOOR_G	120	31.45	31.45	0.00	3.69	3.69	0.00
DOOR_G	137	31.36	31.36	0.00	3.69	3.69	0.00
DOOR_G	143	31.23	31.23	0.00	3.56	3.56	0.00
DOOR_G	160	30.97	30.97	0.00	3.39	3.39	0.00
DOOR_G	400	30.19	30.19	0.00	3.63	3.63	0.00
DOOR_G	600	29.78	29.78	0.00	3.22	3.22	0.00
DOOR_G	900	29.30	29.30	0.00	2.99	2.99	0.00
DOOR_H	0	23.67	21.82	1.85	1.71	1.79	0.08
DOOR_H	200	22.61	21.04	1.58	1.72	1.82	0.10
DOOR_H	450	21.28	19.86	1.41	1.90	1.89	0.00
DOOR_H	660	19.73	18.48	1.25	1.66	1.71	0.05
DOOR_H	950	16.44	16.02	0.41	0.12	0.90	0.78

Table H.1 Existing and Subsided Flood Levels and Depths: 1% AEP

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	4138	31.55	31.55	0.00	9.73	9.73	0.00
YARR	4388	31.35	31.35	0.00	9.61	9.61	0.00
YARR	4392	31.28	31.28	0.00	9.54	9.54	0.00
YARR	4770	31.10	31.10	0.00	9.47	9.47	0.00
YARR	5440	30.85	30.85	0.00	9.24	9.24	0.00
YARR	5460	30.79	30.79	0.00	9.18	9.18	0.00
YARR	5670	30.70	30.70	0.00	9.09	9.09	0.00
YARR	6050	30.60	30.60	0.00	8.99	8.99	0.00
YARR	6330	30.55	30.55	0.00	9.40	9.40	0.00
YARR	6610	30.47	30.47	0.00	9.77	9.77	0.00
YARR	6690	30.41	30.41	0.00	9.84	9.84	0.00
YARR	7190	30.14	30.14	0.00	9.97	9.97	0.00
YARR	7430	29.95	29.95	0.00	9.97	9.97	0.00
YARR	7680	29.72	29.72	0.00	9.94	9.94	0.00
YARR	7960	29.46	29.46	0.00	9.90	9.90	0.00
YARR	8198	29.22	29.22	0.00	9.85	9.85	0.00
YARR	8202	29.13	29.13	0.00	9.76	9.76	0.00
YARR	8400	28.90	28.90	0.00	9.66	9.66	0.00
YARR	8720	28.60	28.60	0.00	9.54	9.54	0.00
YARR	8940	28.40	28.40	0.00	9.61	9.61	0.00
YARR	9300	28.22	28.22	0.00	9.70	9.70	0.00
YARR	9655	28.08	28.08	0.00	9.89	9.89	0.00
YARR	10000	27.88	27.88	0.00	9.79	9.79	0.00
YARR	10230	27.76	27.76	0.00	10.13	10.13	0.00
YARR	10285	27.72	27.72	0.00	10.05	10.05	0.00
YARR	10295	27.47	27.47	0.00	9.80	9.80	0.00
YARR	10330	27.43	27.43	0.00	9.90	9.90	0.00
YARR	10600	27.07	27.07	0.00	9.82	9.82	0.00
YARR	10870	26.71	26.71	0.00	9.73	9.73	0.00
YARR	11200	26.59	26.59	0.00	9.95	9.95	0.00
YARR	11410	26.54	26.54	0.00	10.12	10.12	0.00
YARR	11598	26.49	26.49	0.00	10.26	10.26	0.00
YARR	11602	26.44	26.44	0.00	10.21	10.21	0.00
YARR	11620	26.43	26.43	0.00	10.22	10.22	0.00
YARR	11820	26.34	26.34	0.00	10.32	10.32	0.00
YARR	11838	26.34	26.34	0.00	10.34	10.34	0.00
YARR	11842	26.28	26.28	0.00	10.28	10.28	0.00
YARR	12100	26.08	26.08	0.00	10.30	10.30	0.00
YARR	12470	25.67	25.67	0.00	10.21	10.21	0.00
YARR	12690	25.56	25.56	0.00	10.26	10.26	0.00
YARR	12708	25.55	25.55	0.00	10.30	10.30	0.00
YARR	12712	25.49	25.49	0.00	10.24	10.24	0.00
YARR	12950	25.28	25.28	0.00	10.06	10.06	0.00
YARR	13100	25.18	25.18	0.00	10.04	10.04	0.00
YARR	13808	24.91	24.91	0.00	9.97	9.97	0.00
YARR	13812	24.87	24.87	0.00	9.93	9.93	0.00
YARR	14150	24.64	24.64	0.00	10.06	10.06	0.00
YARR	14420	24.32	24.32	0.00	9.92	9.92	0.00
YARR	14560	24.28	24.28	0.00	10.12	10.12	0.00
YARR	14790	24.20	24.20	0.00	10.29	10.29	0.00
YARR	15000	23.94	23.94	0.00	10.25	10.25	0.00
YARR	15030	23.86	23.86	0.00	10.20	10.20	0.00
YARR	15090	23.77	23.77	0.00	10.18	10.18	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	15110	23.70	23.70	0.00	10.11	10.11	0.00
YARR	15350	23.61	23.61	0.00	10.09	10.09	0.00
YARR	15554	23.59	23.59	0.00	10.17	10.17	0.00
YARR	15775	23.55	23.55	0.00	10.23	10.23	0.00
YARR	15845	23.54	23.54	0.00	10.24	10.24	0.00
YARR	15858	23.50	23.49	0.00	10.20	10.19	0.00
YARR	16001	23.48	23.47	0.00	10.28	10.27	0.00
YARR	16274	23.42	23.41	0.00	10.43	10.42	0.00
YARR	16484	23.36	23.36	0.00	10.56	10.56	0.00
YARR	16670	23.30	23.30	0.00	10.65	10.65	0.00
YARR	16927	23.18	23.18	0.00	10.78	10.78	0.00
YARR	17122	23.12	23.11	0.00	10.87	10.86	0.01
YARR	17324	23.02	23.01	0.01	10.97	10.96	0.01
YARR	17533	22.85	22.84	0.01	10.96	10.95	0.01
YARR	17758	22.77	22.76	0.01	11.10	11.09	0.01
YARR	17762	22.70	22.70	0.01	11.03	11.03	0.01
YARR	17852	22.69	22.69	0.01	11.05	11.05	0.01
YARR	17856	22.65	22.65	0.01	11.01	11.01	0.01
YARR	18009	22.64	22.63	0.01	11.17	11.16	0.01
YARR	18207	22.60	22.60	0.01	11.36	11.36	0.01
YARR	18431	22.51	22.50	0.01	11.55	11.54	0.01
YARR	18653	22.38	22.37	0.01	11.67	11.66	0.01
YARR	18894	22.17	22.16	0.01	11.80	11.79	0.01
YARR	19038	22.04	22.03	0.01	11.89	11.88	0.01
YARR	19100	22.01	22.00	0.01	11.89	11.88	0.01
YARR	19110	21.94	21.93	0.01	11.82	11.81	0.01
YARR	19144	21.91	21.90	0.01	11.80	11.79	0.01
YARR	19269	21.83	21.81	0.01	11.73	11.71	0.01
YARR	19428	21.76	21.74	0.01	11.67	11.65	0.01
YARR	19625	21.60	21.58	0.02	11.74	11.72	0.01
YARR	19824	21.30	21.28	0.02	11.49	11.47	0.02
YARR	20057	21.09	21.07	0.02	11.28	11.26	0.02
YARR	20264	20.85	20.83	0.02	11.04	11.02	0.02
YARR	20366	20.68	20.65	0.03	10.98	10.94	0.04
YARR	20376	20.59	20.55	0.04	10.89	10.84	0.05
YARR	20464	20.49	20.45	0.04	10.78	10.74	0.04
YARR	20688	20.41	20.37	0.04	11.05	11.01	0.04
YARR	20870	20.27	20.22	0.05	10.94	10.89	0.05
YARR	21102	19.68	19.61	0.07	10.75	10.56	0.19
YARR	21308	19.58	19.50	0.08	10.83	10.77	0.06
YARR	21552	19.53	19.45	0.08	11.10	11.03	0.06
YARR	21580	19.51	19.43	0.08	10.97	11.03	0.06
YARR	21600	19.46	19.39	0.07	10.93	11.01	0.08
YARR	21618	19.45	19.38	0.07	11.06	11.00	0.06
YARR	21768	19.34	19.27	0.07	10.90	10.92	0.03
YARR	21934	19.11	19.05	0.07	10.82	10.87	0.05
YARR	22136	18.86	18.85	0.02	10.60	10.73	0.13
YARR	22327	18.69	18.69	0.01	10.43	10.53	0.11
YARR	22430	18.63	18.64	0.01	10.28	10.35	0.07
YARR	22450	18.56	18.57	0.00	9.97	10.04	0.07
YARR	22567	18.50	18.51	0.00	10.24	10.28	0.04
YARR	22757	18.38	18.38	0.00	10.29	10.30	0.01
YARR	23032	18.14	18.14	0.01	10.25	10.05	0.19
YARR	23152	18.01	18.02	0.01	9.93	9.15	0.78

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	23172	17.93	17.93	0.00	9.85	9.85	0.00
YARR	23218	17.86	17.87	0.00	10.16	9.97	0.20
YARR	23460	17.67	17.67	0.00	10.17	10.17	0.00
YARR	23641	17.60	17.60	0.00	10.30	10.30	0.00
YARR	23878	17.51	17.51	0.00	10.49	10.49	0.00
YARR	24033	17.44	17.44	0.00	10.23	10.23	0.00
YARR	24147	17.40	17.40	0.00	10.39	10.39	0.00
YARR	24157	17.35	17.35	0.00	10.40	10.40	0.00
YARR	24305	17.28	17.28	0.00	10.54	10.54	0.00
YARR	24526	17.18	17.18	0.00	10.78	10.78	0.00
YARR	24717	17.09	17.09	0.00	10.85	10.85	0.00
YARR	25000	16.89	16.89	0.00	11.09	11.09	0.00
YARR	25198	16.61	16.61	0.00	10.98	10.98	0.00
YARR	25419	16.18	16.18	0.00	10.74	10.74	0.00
YARR	25619	15.92	15.92	0.00	10.66	10.66	0.00
YARR	25857	15.78	15.78	0.00	10.52	10.52	0.00
YARR	26072	15.61	15.61	0.00	10.85	10.85	0.00
YARR	26300	15.11	15.10	0.00	10.43	10.42	0.00
YARR	26330	14.94	14.94	0.00	10.27	10.27	0.00
YARR	26340	14.86	14.86	0.00	10.19	10.19	0.00
YARR	26499	14.53	14.52	0.01	10.32	10.31	0.01
YARR	26715	14.47	14.46	0.01	10.34	10.33	0.01
YARR	26940	14.39	14.38	0.01	10.64	10.38	0.26
YARR	27080	14.17	14.16	0.01	10.62	10.17	0.45
YARR	27090	14.12	14.11	0.01	10.57	10.12	0.45
YARR	27145	14.02	14.01	0.01	10.57	10.15	0.42
YARR	27319	13.75	13.74	0.01	10.47	10.03	0.44
YARR	27531	13.43	13.41	0.01	10.38	10.10	0.28
YARR	27710	12.80	12.79	0.01	9.92	9.71	0.21
YARR	27807	12.67	12.66	0.01	9.89	9.72	0.18
YARR	27976	12.41	12.39	0.02	9.80	9.55	0.25
YARR	28192	12.31	12.29	0.02	9.92	9.56	0.36
YARR	28426	12.24	12.24	0.00	10.10	10.11	0.01
YARR	28608	12.14	12.15	0.02	10.18	9.60	0.57
YARR	28939	12.07	12.08	0.01	10.09	9.79	0.31
YARR	29191	12.25	12.24	0.02	10.26	10.14	0.13
YARR	29325	11.98	11.97	0.01	9.98	9.97	0.01
YARR	29333	11.95	11.94	0.01	9.95	9.94	0.01
YARR	29389	11.81	11.80	0.01	10.03	10.02	0.01
YARR	29513	11.61	11.60	0.01	10.33	10.32	0.01
YARR	29689	11.57	11.57	0.01	10.29	10.29	0.01
YARR	29803	11.57	11.56	0.01	10.45	10.45	0.01
YARR	30043	10.47	10.44	0.04	9.71	9.68	0.03
YARR	30273	10.18	10.13	0.05	9.52	9.47	0.05
YARR	30441	10.15	10.09	0.06	9.49	9.43	0.06
YARR	30677	9.39	9.34	0.05	8.73	8.68	0.05
YARR	30957	9.07	9.03	0.05	9.71	9.67	0.05
YARR	31255	8.91	8.87	0.04	8.41	8.37	0.04
YARR	31676	8.42	8.37	0.05	9.91	9.86	0.05
YARR	31706	8.16	8.11	0.04	9.74	9.69	0.04
YARR	31777	8.04	8.00	0.04	8.84	8.80	0.04
YARR	31989	7.92	7.91	0.01	8.72	8.71	0.01
YARR	32264	7.91	7.91	0.01	8.76	8.75	0.01
YARR	32574	7.90	7.90	0.00	8.80	8.80	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR	0	38.27	38.27	0.00	3.33	3.33	0.00
DOOR	280	37.79	37.79	0.00	3.69	3.69	0.00
DOOR	520	37.44	37.44	0.00	4.07	4.07	0.00
DOOR	707	37.02	37.02	0.00	5.31	5.31	0.00
DOOR	713	37.00	37.00	0.00	5.29	5.29	0.00
DOOR	770	36.89	36.89	0.00	5.25	5.25	0.00
DOOR	810	36.69	36.69	0.00	5.15	5.15	0.00
DOOR	1190	35.93	35.93	0.00	5.61	5.61	0.00
DOOR	1440	35.62	35.62	0.00	5.96	5.96	0.00
DOOR	1650	34.79	34.79	0.00	5.76	5.76	0.00
DOOR	1880	33.94	33.94	0.00	5.47	5.47	0.00
DOOR	2100	33.17	33.17	0.00	5.26	5.26	0.00
DOOR	2330	32.75	32.75	0.00	5.48	5.48	0.00
DOOR	2540	32.38	32.38	0.00	5.67	5.67	0.00
DOOR	2810	31.68	31.68	0.00	5.63	5.63	0.00
DOOR	2970	31.45	31.45	0.00	5.84	5.84	0.00
DOOR	2995	31.41	31.41	0.00	5.87	5.87	0.00
DOOR	3001	31.20	31.20	0.00	5.66	5.66	0.00
DOOR	3056	31.05	31.05	0.00	5.59	5.59	0.00
DOOR	3356	30.46	30.46	0.00	3.85	3.85	0.00
DOOR	3576	30.43	30.43	0.00	5.82	5.82	0.00
DOOR	3821	30.34	30.34	0.00	6.08	6.08	0.00
DOOR	4035	29.68	29.68	0.00	5.74	5.74	0.00
DOOR	4090	29.30	29.30	0.00	5.46	5.46	0.00
DOOR	4261	28.79	28.79	0.00	5.26	5.26	0.00
DOOR	4310	28.57	28.57	0.00	5.12	5.12	0.00
DOOR	4314	28.52	28.52	0.00	5.08	5.08	0.00
DOOR	4454	28.00	28.00	0.00	4.69	4.69	0.00
DOOR	4660	27.56	27.56	0.00	4.46	4.46	0.00
DOOR	4860	27.38	27.38	0.00	4.47	4.47	0.00
DOOR	5179	27.18	27.18	0.00	4.66	4.66	0.00
DOOR	5360	26.68	26.68	0.00	4.45	4.45	0.00
DOOR	5461	26.43	26.43	0.00	4.33	4.33	0.00
DOOR	5691	25.90	25.90	0.00	4.03	4.03	0.00
DOOR	5913	25.56	25.56	0.00	3.90	3.90	0.00
DOOR	6091	25.43	25.43	0.00	4.07	4.07	0.00
DOOR	6404	25.15	25.15	0.00	4.14	4.14	0.00
DOOR	6448	25.09	25.09	0.00	5.12	5.12	0.00
DOOR	6464	24.50	24.50	0.00	4.53	4.53	0.00
DOOR	6490	24.34	24.34	0.00	3.42	3.42	0.00
DOOR	6677	23.92	23.92	0.00	3.32	3.32	0.00
DOOR	7023	23.61	23.61	0.00	2.91	2.91	0.00
DOOR	7236	23.31	23.31	0.00	3.57	3.57	0.00
DOOR	7405	23.12	23.12	0.00	3.56	3.56	0.00
DOOR	7690	22.78	22.79	0.00	3.84	3.85	0.00
DOOR	7921	22.37	22.37	0.00	3.82	3.82	0.00
DOOR	8141	21.68	21.69	0.01	3.49	3.50	0.01
DOOR	8365	21.33	21.34	0.02	3.53	3.54	0.02
DOOR	8647	20.94	20.95	0.02	3.71	3.72	0.02
DOOR	8858	20.51	20.50	0.00	3.72	3.71	0.00
DOOR	9113	20.09	20.08	0.01	3.64	3.63	0.01
DOOR	9221	19.60	19.57	0.03	3.45	3.42	0.03
DOOR	9329	19.48	19.44	0.04	3.62	3.58	0.04
DOOR	9531	19.24	19.16	0.08	3.72	3.64	0.08

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR	9757	18.77	18.54	0.23	3.66	3.46	0.20
DOOR	9946	18.48	18.08	0.40	3.73	3.60	0.12
DOOR	10137	18.06	17.20	0.86	3.58	3.74	0.16
DOOR	10339	17.53	16.25	1.29	3.36	3.44	0.08
DOOR	10512	17.35	16.04	1.31	2.61	2.47	0.14
DOOR	10748	17.04	15.76	1.28	2.84	2.86	0.02
DOOR	10964	16.48	15.27	1.22	3.53	3.67	0.13
DOOR	10984	16.48	15.26	1.22	3.53	3.66	0.13
DOOR	11053	16.40	15.18	1.21	3.38	3.46	0.09
DOOR	11236	15.88	14.71	1.17	2.86	2.98	0.12
DOOR	11386	15.43	14.36	1.07	2.41	2.44	0.03
DOOR	11586	15.29	14.30	0.99	2.96	3.15	0.19
DOOR	11844	15.00	14.21	0.79	3.56	4.06	0.50
DOOR	11948	14.94	14.20	0.75	3.64	4.03	0.39
DOOR	12151	14.74	14.13	0.61	3.94	4.68	0.74
DOOR	12385	14.57	14.08	0.48	4.27	4.93	0.66
DOOR	12579	14.46	14.05	0.41	4.66	5.60	0.93
DOOR	12765	14.37	14.03	0.34	5.07	6.02	0.95
DOOR	12982	14.28	14.01	0.27	5.18	6.05	0.87
DOOR	13193	14.23	13.99	0.23	5.35	6.31	0.96
DOOR	13367	14.21	13.99	0.22	5.71	6.79	1.08
DOOR	13628	14.16	13.98	0.18	5.96	6.77	0.81
DOOR	13851	14.03	13.91	0.12	5.83	5.80	0.03
DOOR	14073	13.67	13.56	0.12	5.98	5.89	0.10
DOOR	14267	12.98	12.61	0.37	5.80	5.51	0.28
DOOR	14427	12.63	11.87	0.76	5.82	5.31	0.51
DOOR	14635	12.53	11.71	0.82	5.82	6.01	0.19
DOOR	14897	12.35	11.57	0.78	5.64	5.43	0.21
DOOR	15114	12.08	11.47	0.62	5.66	5.47	0.19
DOOR	15315	11.89	11.41	0.48	5.67	5.88	0.21
DOOR	15534	11.73	11.36	0.37	5.62	6.17	0.55
DOOR	15724	11.64	11.34	0.31	5.64	5.84	0.20
DOOR	15908	11.57	11.32	0.25	6.65	6.67	0.02
DOOR	16106	11.46	11.27	0.19	6.76	6.66	0.10
DOOR	16385	11.24	11.13	0.11	7.11	7.01	0.09
DOOR	16595	11.15	11.05	0.09	7.40	7.30	0.09
DOOR	16705	11.12	11.03	0.09	7.37	7.28	0.09
DOOR	16842	11.10	11.01	0.09	7.75	7.66	0.09
DOOR	16862	11.09	11.00	0.09	7.18	7.95	0.77
DOOR	16902	11.09	11.00	0.09	7.74	7.65	0.09
DOOR	17085	11.07	10.98	0.09	8.19	8.11	0.09
DOOR	17416	10.98	10.89	0.09	9.40	9.31	0.09
DOOR	17575	10.86	10.78	0.09	9.49	9.41	0.09
DOOR	17820	10.15	10.09	0.06	9.49	9.43	0.06
DOOR_A	0	36.37	36.37	0.00	1.37	1.37	0.00
DOOR_A	260	35.26	35.26	0.00	2.01	2.01	0.00
DOOR_A	540	32.95	32.95	0.00	0.97	0.97	0.00
DOOR_A	870	31.50	31.50	0.00	1.18	1.18	0.00
DOOR_A	1120	31.18	31.18	0.00	2.73	2.73	0.00
DOOR_A	1330	30.82	30.82	0.00	3.08	3.08	0.00
DOOR_A	1478	30.62	30.62	0.00	3.64	3.64	0.00
DOOR_A	1482	30.61	30.61	0.00	3.63	3.63	0.00
DOOR_A	1560	30.56	30.56	0.00	3.76	3.76	0.00
DOOR_A	2100	30.43	30.43	0.00	4.22	4.22	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_B	0	32.20	32.20	0.00	0.52	0.52	0.00
DOOR_B	230	29.85	29.85	0.00	0.50	0.50	0.00
DOOR_B	500	27.87	27.87	0.00	0.56	0.56	0.00
DOOR_B	760	26.08	26.08	0.00	0.26	0.26	0.00
DOOR_B	1010	23.63	23.63	0.00	1.99	1.99	0.00
DOOR_B	1270	23.62	23.62	0.00	1.98	1.98	0.00
DOOR_B	1570	23.62	23.62	0.00	1.98	1.98	0.00
DOOR_B	1660	23.61	23.61	0.00	1.97	1.97	0.00
DOOR_B	1950	23.61	23.61	0.00	2.91	2.91	0.00
DOOR_C	0	28.67	28.67	0.00	0.64	0.64	0.00
DOOR_C	260	26.84	26.84	0.00	0.36	0.36	0.00
DOOR_C	490	25.41	25.41	0.00	0.33	0.33	0.00
DOOR_C	680	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	960	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1260	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1510	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1780	23.32	23.32	0.00	2.86	2.86	0.00
DOOR_C	1920	23.31	23.31	0.00	3.57	3.57	0.00
DOOR_D	0	21.10	21.10	0.00	0.79	0.79	0.00
DOOR_D	270	19.40	19.40	0.00	0.97	0.97	0.00
DOOR_D	530	18.55	18.56	0.01	0.55	0.56	0.02
DOOR_D	740	17.27	17.11	0.16	0.85	0.76	0.09
DOOR_D	1040	15.27	14.25	1.03	0.83	0.93	0.10
DOOR_D	1300	14.96	14.21	0.76	2.22	2.75	0.53
DOOR_D	1540	14.96	14.21	0.76	2.88	3.52	0.64
DOOR_D	1820	14.96	14.21	0.76	3.55	4.23	0.68
DOOR_D	2080	14.96	14.21	0.76	3.64	4.33	0.68
DOOR_D	2350	14.96	14.21	0.76	3.64	4.12	0.48
DOOR_D	2550	14.94	14.20	0.75	3.65	4.10	0.45
DOOR_E	0	30.26	30.21	0.05	5.92	5.96	0.04
DOOR_E	170	29.72	29.67	0.05	5.51	5.56	0.04
DOOR_E	390	29.31	29.23	0.08	5.16	5.14	0.02
DOOR_E	660	28.67	28.58	0.09	4.09	4.06	0.03
DOOR_E	940	27.64	27.51	0.13	4.05	3.98	0.07
DOOR_E	1230	26.00	25.88	0.12	3.72	3.74	0.02
DOOR_E	1450	24.80	24.75	0.06	3.97	3.98	0.01
DOOR_E	1700	24.22	24.17	0.04	4.15	4.13	0.02
DOOR_E	1920	23.41	23.36	0.06	3.71	3.70	0.01
DOOR_E	2140	22.19	22.10	0.09	3.86	3.84	0.02
DOOR_E	2170	21.87	21.76	0.10	3.77	3.73	0.03
DOOR_E	2190	21.75	21.64	0.10	3.88	3.82	0.06
DOOR_E	2390	21.26	21.15	0.11	3.71	3.78	0.07
DOOR_E	2680	20.35	20.17	0.17	3.22	3.12	0.10
DOOR_E	2900	19.43	18.80	0.63	3.28	2.79	0.48
DOOR_E	3110	18.54	17.67	0.87	4.15	3.97	0.18
DOOR_E	3320	17.23	16.82	0.41	3.99	4.46	0.47
DOOR_E	3690	16.44	16.02	0.41	4.26	4.10	0.15
DOOR_E	4010	15.20	15.00	0.20	3.70	3.58	0.13
DOOR_E	4040	15.15	14.94	0.22	4.02	3.89	0.13
DOOR_E	4080	14.76	14.55	0.21	4.06	3.94	0.12
DOOR_E	4230	14.18	13.97	0.21	3.48	3.34	0.13
DOOR_E	4500	13.67	13.56	0.12	3.96	3.94	0.02
DOOR_F	0	28.20	28.20	0.00	1.84	1.84	0.00
DOOR_F	180	27.31	27.31	0.00	1.98	1.98	0.00

River	Chainage	Water Surface Level (mAHD)			Depth (m)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_F	185	27.31	27.31	0.00	2.06	2.06	0.00
DOOR_F	203	27.28	27.28	0.00	2.03	2.03	0.00
DOOR_F	210	27.26	27.26	0.00	1.87	1.87	0.00
DOOR_F	370	27.18	27.18	0.00	2.94	2.94	0.00
DOOR_G	0	31.66	31.66	0.00	3.39	3.39	0.00
DOOR_G	120	31.45	31.45	0.00	3.69	3.69	0.00
DOOR_G	137	31.36	31.36	0.00	3.69	3.69	0.00
DOOR_G	143	31.23	31.23	0.00	3.56	3.56	0.00
DOOR_G	160	30.97	30.97	0.00	3.39	3.39	0.00
DOOR_G	400	30.19	30.19	0.00	3.63	3.63	0.00
DOOR_G	600	29.78	29.78	0.00	3.22	3.22	0.00
DOOR_G	900	29.30	29.30	0.00	2.99	2.99	0.00
DOOR_H	0	23.67	21.82	1.85	1.71	1.79	0.08
DOOR_H	200	22.61	21.04	1.58	1.72	1.82	0.10
DOOR_H	450	21.28	19.86	1.41	1.90	1.89	0.00
DOOR_H	660	19.73	18.48	1.25	1.66	1.71	0.05
DOOR_H	950	16.44	16.02	0.41	0.12	0.90	0.78

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
YARR	4138	29.50	29.50	0.00
YARR	4388	29.30	29.30	0.00
YARR	4392	29.25	29.25	0.00
YARR	4770	29.07	29.07	0.00
YARR	5440	28.88	28.88	0.00
YARR	5460	28.83	28.84	0.00
YARR	5670	28.75	28.75	0.00
YARR	6050	28.65	28.65	0.00
YARR	6330	28.62	28.62	0.00
YARR	6610	28.57	28.57	0.00
YARR	6690	28.54	28.54	0.00
YARR	7190	28.30	28.30	0.00
YARR	7430	28.12	28.12	0.00
YARR	7680	27.92	27.92	0.00
YARR	7960	27.69	27.69	0.00
YARR	8198	27.43	27.43	0.00
YARR	8202	27.37	27.37	0.00
YARR	8400	27.16	27.16	0.00
YARR	8720	26.83	26.83	0.00
YARR	8940	26.62	26.62	0.00
YARR	9300	26.44	26.45	0.00
YARR	9655	26.32	26.32	0.00
YARR	10000	26.16	26.16	0.00
YARR	10230	26.09	26.09	0.00
YARR	10285	26.07	26.07	0.00
YARR	10295	25.82	25.83	0.00
YARR	10330	25.79	25.79	0.00
YARR	10600	25.39	25.39	0.00
YARR	10870	24.82	24.82	0.00
YARR	11200	24.66	24.66	0.00
YARR	11410	24.62	24.62	0.00
YARR	11598	24.59	24.59	0.00
YARR	11602	24.56	24.56	0.00
YARR	11620	24.55	24.55	0.00
YARR	11820	24.50	24.50	0.00
YARR	11838	24.49	24.49	0.00
YARR	11842	24.45	24.45	0.00
YARR	12100	24.27	24.27	0.00
YARR	12470	23.54	23.54	0.00
YARR	12690	23.43	23.43	0.00
YARR	12708	23.42	23.42	0.00
YARR	12712	23.38	23.38	0.00
YARR	12950	23.24	23.24	0.00
YARR	13100	23.17	23.17	0.00
YARR	13808	22.88	22.88	0.00
YARR	13812	22.85	22.85	0.00
YARR	14150	22.67	22.67	0.00
YARR	14420	22.17	22.17	0.00
YARR	14560	22.10	22.10	0.00
YARR	14790	21.99	22.00	0.00
YARR	15000	21.71	21.71	0.00
YARR	15030	21.61	21.61	0.00

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
YARR	15090	21.48	21.48	0.00
YARR	15110	21.41	21.41	0.00
YARR	15350	21.29	21.29	0.00
YARR	15554	21.25	21.25	0.00
YARR	15775	21.20	21.20	0.00
YARR	15845	21.19	21.19	0.00
YARR	15858	21.16	21.16	0.00
YARR	16001	21.14	21.14	0.00
YARR	16274	21.07	21.07	0.00
YARR	16484	20.97	20.97	0.00
YARR	16670	20.90	20.90	0.00
YARR	16927	20.74	20.74	0.00
YARR	17122	20.64	20.64	0.00
YARR	17324	20.53	20.53	0.00
YARR	17533	20.25	20.24	0.00
YARR	17758	20.17	20.17	0.00
YARR	17762	20.13	20.12	0.00
YARR	17852	20.12	20.11	0.00
YARR	17856	20.09	20.09	0.00
YARR	18009	20.08	20.08	0.00
YARR	18207	20.06	20.06	0.00
YARR	18431	20.00	20.00	0.00
YARR	18653	19.90	19.89	0.00
YARR	18894	19.71	19.70	0.00
YARR	19038	19.59	19.58	0.01
YARR	19100	19.55	19.54	0.01
YARR	19110	19.49	19.48	0.01
YARR	19144	19.47	19.46	0.01
YARR	19269	19.41	19.40	0.01
YARR	19428	19.37	19.36	0.01
YARR	19625	19.28	19.28	0.01
YARR	19824	19.04	19.02	0.01
YARR	20057	18.88	18.87	0.01
YARR	20264	18.67	18.66	0.02
YARR	20366	18.44	18.41	0.02
YARR	20376	18.37	18.35	0.02
YARR	20464	18.28	18.26	0.02
YARR	20688	18.22	18.20	0.02
YARR	20870	18.13	18.10	0.03
YARR	21102	17.53	17.47	0.07
YARR	21308	17.43	17.35	0.07
YARR	21552	17.38	17.31	0.07
YARR	21580	17.37	17.30	0.07
YARR	21600	17.34	17.28	0.06
YARR	21618	17.34	17.28	0.06
YARR	21768	17.27	17.22	0.06
YARR	21934	17.08	17.03	0.06
YARR	22136	16.78	16.77	0.01
YARR	22327	16.60	16.61	0.01
YARR	22430	16.53	16.55	0.02
YARR	22450	16.49	16.50	0.00
YARR	22567	16.43	16.44	0.01

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
YARR	22757	16.33	16.34	0.01
YARR	23032	16.13	16.14	0.01
YARR	23152	16.00	16.01	0.01
YARR	23172	15.94	15.94	0.00
YARR	23218	15.85	15.85	0.00
YARR	23460	15.64	15.64	0.00
YARR	23641	15.57	15.57	0.00
YARR	23878	15.40	15.40	0.00
YARR	24033	15.27	15.27	0.00
YARR	24147	15.21	15.20	0.00
YARR	24157	15.14	15.14	0.00
YARR	24305	15.04	15.04	0.00
YARR	24526	14.89	14.89	0.00
YARR	24717	14.80	14.79	0.00
YARR	25000	14.64	14.63	0.00
YARR	25198	14.42	14.41	0.00
YARR	25419	14.04	14.04	0.00
YARR	25619	13.83	13.83	0.00
YARR	25857	13.72	13.72	0.00
YARR	26072	13.61	13.61	0.00
YARR	26300	13.26	13.26	0.00
YARR	26330	13.10	13.10	0.00
YARR	26340	13.03	13.03	0.00
YARR	26499	12.66	12.65	0.01
YARR	26715	12.60	12.60	0.01
YARR	26940	12.55	12.54	0.01
YARR	27080	12.38	12.37	0.01
YARR	27090	12.34	12.33	0.01
YARR	27145	12.25	12.24	0.01
YARR	27319	12.00	11.98	0.01
YARR	27531	11.66	11.65	0.02
YARR	27710	11.13	11.11	0.01
YARR	27807	11.03	11.01	0.02
YARR	27976	10.63	10.61	0.02
YARR	28192	10.46	10.44	0.02
YARR	28426	10.36	10.35	0.01
YARR	28608	10.29	10.29	0.00
YARR	28939	10.26	10.26	0.00
YARR	29191	10.45	10.43	0.02
YARR	29325	10.36	10.35	0.01
YARR	29333	10.34	10.34	0.01
YARR	29389	10.31	10.31	0.01
YARR	29513	10.25	10.25	0.00
YARR	29689	10.23	10.23	0.00
YARR	29803	10.23	10.23	0.00
YARR	30043	9.09	9.07	0.02
YARR	30273	8.49	8.45	0.04
YARR	30441	8.39	8.34	0.05
YARR	30677	7.68	7.63	0.05
YARR	30957	7.36	7.30	0.05
YARR	31255	7.22	7.16	0.05
YARR	31676	6.96	6.94	0.02

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
YARR	31706	6.92	6.91	0.01
YARR	31777	6.92	6.90	0.01
YARR	31989	6.91	6.90	0.00
YARR	32264	6.90	6.90	0.00
YARR	32574	6.90	6.90	0.00
DOOR	0	37.72	37.72	0.00
DOOR	280	37.17	37.17	0.00
DOOR	520	36.79	36.79	0.00
DOOR	707	36.38	36.38	0.00
DOOR	713	36.33	36.33	0.00
DOOR	770	36.25	36.25	0.00
DOOR	810	36.03	36.03	0.00
DOOR	1190	35.25	35.25	0.00
DOOR	1440	34.89	34.89	0.00
DOOR	1650	34.02	34.02	0.00
DOOR	1880	33.39	33.39	0.00
DOOR	2100	32.57	32.58	0.00
DOOR	2330	31.95	31.95	0.00
DOOR	2540	31.66	31.66	0.00
DOOR	2810	30.86	30.86	0.00
DOOR	2970	30.43	30.43	0.00
DOOR	2995	30.24	30.24	0.00
DOOR	3001	30.15	30.15	0.00
DOOR	3056	29.96	29.96	0.00
DOOR	3356	29.59	29.59	0.00
DOOR	3576	29.56	29.56	0.00
DOOR	3821	29.48	29.49	0.00
DOOR	4035	29.06	29.06	0.00
DOOR	4090	28.82	28.82	0.00
DOOR	4261	28.35	28.35	0.00
DOOR	4310	28.15	28.15	0.00
DOOR	4314	28.13	28.13	0.00
DOOR	4454	27.55	27.55	0.00
DOOR	4660	26.91	26.91	0.00
DOOR	4860	26.74	26.74	0.00
DOOR	5179	26.61	26.61	0.00
DOOR	5360	26.06	26.06	0.00
DOOR	5461	25.77	25.77	0.00
DOOR	5691	25.23	25.23	0.00
DOOR	5913	24.92	24.92	0.00
DOOR	6091	24.85	24.85	0.00
DOOR	6404	24.70	24.70	0.00
DOOR	6448	24.67	24.67	0.00
DOOR	6464	24.01	24.01	0.00
DOOR	6490	23.81	23.81	0.00
DOOR	6677	23.22	23.22	0.00
DOOR	7023	22.88	22.89	0.00
DOOR	7236	22.51	22.51	0.00
DOOR	7405	22.36	22.36	0.00
DOOR	7690	22.10	22.10	0.00
DOOR	7921	21.73	21.73	0.00
DOOR	8141	20.89	20.89	0.00

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
DOOR	8365	20.35	20.36	0.02
DOOR	8647	20.00	20.01	0.01
DOOR	8858	19.79	19.79	0.00
DOOR	9113	19.43	19.43	0.00
DOOR	9221	18.88	18.87	0.00
DOOR	9329	18.76	18.75	0.01
DOOR	9531	18.56	18.54	0.03
DOOR	9757	18.09	17.92	0.16
DOOR	9946	17.82	17.51	0.30
DOOR	10137	17.43	16.69	0.74
DOOR	10339	16.84	15.58	1.26
DOOR	10512	16.59	15.30	1.29
DOOR	10748	16.31	15.04	1.27
DOOR	10964	15.74	14.54	1.21
DOOR	10984	15.74	14.53	1.22
DOOR	11053	15.68	14.46	1.22
DOOR	11236	15.24	14.03	1.21
DOOR	11386	14.70	13.56	1.14
DOOR	11586	14.55	13.37	1.18
DOOR	11844	14.10	12.92	1.18
DOOR	11948	14.01	12.85	1.17
DOOR	12151	13.72	12.73	0.99
DOOR	12385	13.40	12.66	0.74
DOOR	12579	13.24	12.64	0.60
DOOR	12765	13.11	12.62	0.49
DOOR	12982	13.02	12.61	0.41
DOOR	13193	12.98	12.61	0.38
DOOR	13367	12.97	12.60	0.36
DOOR	13628	12.94	12.60	0.34
DOOR	13851	12.86	12.57	0.29
DOOR	14073	12.54	12.22	0.32
DOOR	14267	11.81	11.20	0.61
DOOR	14427	11.48	10.53	0.95
DOOR	14635	11.42	10.39	1.04
DOOR	14897	11.31	10.24	1.07
DOOR	15114	10.80	9.75	1.05
DOOR	15315	10.31	9.55	0.76
DOOR	15534	10.01	9.50	0.51
DOOR	15724	9.86	9.49	0.38
DOOR	15908	9.76	9.47	0.30
DOOR	16106	9.63	9.41	0.21
DOOR	16385	9.15	9.06	0.08
DOOR	16595	9.03	8.95	0.07
DOOR	16705	9.00	8.93	0.07
DOOR	16842	8.98	8.91	0.07
DOOR	16862	8.97	8.90	0.07
DOOR	16902	8.97	8.89	0.07
DOOR	17085	8.95	8.88	0.07
DOOR	17416	8.87	8.80	0.07
DOOR	17575	8.79	8.72	0.07
DOOR	17820	8.39	8.34	0.05
DOOR_A	0	36.00	36.00	0.00

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
DOOR_A	260	34.97	34.97	0.00
DOOR_A	540	32.64	32.64	0.00
DOOR_A	870	30.94	30.94	0.00
DOOR_A	1120	30.56	30.56	0.00
DOOR_A	1330	30.27	30.27	0.00
DOOR_A	1478	29.83	29.83	0.00
DOOR_A	1482	29.81	29.81	0.00
DOOR_A	1560	29.68	29.68	0.00
DOOR_A	2100	29.56	29.56	0.00
DOOR_B	0	32.09	32.09	0.00
DOOR_B	230	29.73	29.73	0.00
DOOR_B	500	27.72	27.72	0.00
DOOR_B	760	26.01	26.01	0.00
DOOR_B	1010	22.89	22.89	0.00
DOOR_B	1270	22.89	22.89	0.00
DOOR_B	1570	22.89	22.89	0.00
DOOR_B	1660	22.89	22.89	0.00
DOOR_B	1950	22.88	22.89	0.00
DOOR_C	0	28.29	28.55	0.26
DOOR_C	260	26.73	26.73	0.00
DOOR_C	490	25.31	25.31	0.00
DOOR_C	680	22.51	22.52	0.00
DOOR_C	960	22.51	22.52	0.00
DOOR_C	1260	22.51	22.52	0.00
DOOR_C	1510	22.51	22.52	0.00
DOOR_C	1780	22.51	22.52	0.00
DOOR_C	1920	22.51	22.51	0.00
DOOR_D	0	20.92	20.92	0.00
DOOR_D	270	19.21	19.21	0.01
DOOR_D	530	18.36	18.36	0.01
DOOR_D	740	16.94	16.81	0.14
DOOR_D	1040	15.10	14.03	1.08
DOOR_D	1300	14.03	12.85	1.18
DOOR_D	1540	14.03	12.85	1.18
DOOR_D	1820	14.03	12.85	1.18
DOOR_D	2080	14.03	12.85	1.18
DOOR_D	2350	14.03	12.85	1.18
DOOR_D	2550	14.01	12.85	1.17
DOOR_E	0	29.26	29.18	0.09
DOOR_E	170	28.75	28.66	0.09
DOOR_E	390	28.45	28.37	0.08
DOOR_E	660	27.99	27.91	0.07
DOOR_E	940	26.91	26.81	0.10
DOOR_E	1230	25.12	25.00	0.12
DOOR_E	1450	24.11	24.05	0.06
DOOR_E	1700	23.63	23.59	0.04
DOOR_E	1920	22.98	22.93	0.05
DOOR_E	2140	21.83	21.73	0.09
DOOR_E	2170	21.33	21.22	0.11
DOOR_E	2190	21.15	21.04	0.11
DOOR_E	2390	20.74	20.60	0.14
DOOR_E	2680	20.07	19.83	0.24

Table H.2 Existing and Subsided Flood Levels: 20% AEP

River	Chainage	Water Surface Level (mAHD)		
		Existing	Subsided	Difference
DOOR_E	2900	19.11	18.26	0.85
DOOR_E	3110	18.17	17.30	0.87
DOOR_E	3320	16.81	16.55	0.27
DOOR_E	3690	16.08	15.75	0.34
DOOR_E	4010	14.85	14.74	0.11
DOOR_E	4040	14.74	14.56	0.18
DOOR_E	4080	14.39	14.13	0.25
DOOR_E	4230	13.68	13.42	0.26
DOOR_E	4500	12.54	12.22	0.32
DOOR_F	0	27.91	27.91	0.00
DOOR_F	180	27.09	27.09	0.00
DOOR_F	185	27.08	27.08	0.00
DOOR_F	203	27.05	27.05	0.00
DOOR_F	210	26.98	26.97	0.00
DOOR_F	370	26.61	26.61	0.00
DOOR_G	0	31.23	31.23	0.00
DOOR_G	120	30.99	30.99	0.00
DOOR_G	137	30.92	30.92	0.00
DOOR_G	143	30.86	30.86	0.00
DOOR_G	160	30.71	30.72	0.00
DOOR_G	400	29.88	29.88	0.00
DOOR_G	600	29.47	29.47	0.00
DOOR_G	900	28.82	28.82	0.00
DOOR_H	0	23.30	21.44	1.86
DOOR_H	200	22.12	20.55	1.57
DOOR_H	450	21.04	19.64	1.41
DOOR_H	660	19.58	18.33	1.25
DOOR_H	950	16.08	15.75	0.34

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	4138	0.728	0.728	0	0.628	0.628	0
YARR	4388	0.753	0.753	0	0.656	0.656	0
YARR	4392	0.78	0.78	0	0.688	0.688	0
YARR	4770	0.909	0.909	0	0.83	0.83	0
YARR	5440	0.793	0.793	0	0.7	0.7	0
YARR	5460	0.592	0.592	0	0.504	0.504	0
YARR	5670	0.498	0.498	0	0.417	0.417	0
YARR	6050	0.572	0.572	0	0.476	0.476	0
YARR	6330	0.695	0.695	0	0.708	0.708	0
YARR	6610	1.338	1.338	0	1.392	1.392	0
YARR	6690	0.714	0.714	0	0.734	0.734	0
YARR	7190	0.579	0.579	0	0.502	0.502	0
YARR	7430	0.554	0.554	0	0.578	0.578	0
YARR	7680	0.526	0.526	0	0.482	0.482	0
YARR	7960	0.501	0.501	0	0.421	0.421	0
YARR	8198	0.487	0.487	0	0.388	0.388	0
YARR	8202	0.475	0.475	0	0.375	0.375	0
YARR	8400	0.552	0.552	0	0.438	0.438	0
YARR	8720	0.66	0.66	0	0.528	0.528	0
YARR	8940	0.748	0.748	0	0.601	0.601	0
YARR	9300	0.862	0.862	0	0.697	0.697	0
YARR	9655	0.702	0.702	0	0.585	0.585	0
YARR	10000	0.592	0.592	0	0.503	0.503	0
YARR	10230	0.696	0.696	0	0.592	0.592	0
YARR	10285	0.845	0.845	0	0.719	0.719	0
YARR	10295	0.833	0.833	0	0.689	0.689	0
YARR	10330	0.821	0.821	0	0.661	0.661	0
YARR	10600	0.855	0.855	0	0.705	0.705	0
YARR	10870	0.89	0.89	0	0.756	0.756	0
YARR	11200	0.851	0.851	0	0.72	0.72	0
YARR	11410	0.815	0.815	0	0.688	0.688	0
YARR	11598	1.057	1.057	0	0.936	0.936	0
YARR	11602	0.833	0.833	0	0.704	0.704	0
YARR	11620	0.87	0.87	0	0.744	0.744	0
YARR	11820	0.91	0.91	0	0.79	0.79	0
YARR	11838	0.793	0.793	0	0.706	0.706	0
YARR	11842	0.727	0.727	0	0.657	0.657	0
YARR	12100	0.749	0.749	0	0.677	0.677	0
YARR	12470	0.753	0.753	0	0.679	0.679	0
YARR	12690	0.607	0.607	0	0.533	0.533	0
YARR	12708	0.507	0.507	0	0.435	0.435	0
YARR	12712	0.559	0.559	0	0.475	0.475	0
YARR	12950	0.626	0.626	0	0.56	0.56	0
YARR	13100	0.685	0.685	0	0.58	0.58	0
YARR	13808	0.836	0.836	0	0.844	0.844	0
YARR	13812	0.703	0.703	0	0.607	0.607	0
YARR	14150	0.657	0.657	0	0.522	0.522	0
YARR	14420	0.695	0.695	0	0.553	0.553	0
YARR	14560	0.737	0.737	0	0.631	0.631	0
YARR	14790	2.747	2.747	0	2.708	2.708	0
YARR	15000	0.776	0.776	0	0.654	0.654	0
YARR	15030	0.83	0.83	0	0.704	0.704	0

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	15090	0.894	0.894	0	0.801	0.801	0
YARR	15110	0.967	0.967	0	0.89	0.89	0
YARR	15350	1.053	1.053	0	1.042	1.042	0
YARR	15554	0.969	0.969	0	0.993	0.993	0
YARR	15775	0.912	0.912	0	0.961	0.961	0
YARR	15845	0.581	0.581	0	0.58	0.58	0
YARR	15858	0.429	0.429	0	0.384	0.384	0
YARR	16001	0.46	0.46	0	0.387	0.387	0
YARR	16274	0.503	0.503	0	0.417	0.417	0
YARR	16484	0.53	0.53	0	0.433	0.433	0
YARR	16670	0.552	0.552	0	0.447	0.447	0
YARR	16927	0.7	0.7	0	0.673	0.673	0
YARR	17122	0.558	0.558	0	0.452	0.452	0
YARR	17324	0.562	0.562	0	0.456	0.456	0
YARR	17533	0.566	0.566	0	0.46	0.46	0
YARR	17758	0.6	0.6	0	0.495	0.495	0
YARR	17762	0.64	0.64	0	0.536	0.536	0
YARR	17852	0.62	0.62	0	0.535	0.535	0
YARR	17856	0.601	0.601	0	0.537	0.537	0
YARR	18009	0.957	0.957	0	0.916	0.916	0
YARR	18207	0.611	0.611	0	0.547	0.547	0
YARR	18431	0.711	0.711	0	0.648	0.648	0
YARR	18653	0.851	0.851	0	0.808	0.808	0
YARR	18894	0.703	0.703	0	0.659	0.659	0
YARR	19038	0.598	0.598	0	0.546	0.546	0
YARR	19100	0.64	0.64	0	0.581	0.581	0
YARR	19110	0.69	0.69	0	0.622	0.622	0
YARR	19144	0.664	0.664	0	0.601	0.601	0
YARR	19269	0.644	0.644	0	0.582	0.582	0
YARR	19428	1.198	1.198	0	1.347	1.347	0
YARR	19625	0.658	0.658	0	0.607	0.607	0
YARR	19824	0.864	0.864	0	0.738	0.738	0
YARR	20057	1.28	1.28	0	1.018	1.018	0
YARR	20264	0.819	0.819	0	0.711	0.711	0
YARR	20366	0.6	0.6	0	0.562	0.562	0
YARR	20376	0.516	0.516	0	0.432	0.432	0
YARR	20464	0.452	0.452	0	0.363	0.363	0
YARR	20688	1.007	1.007	0	0.954	0.954	0
YARR	20870	0.456	0.456	0	0.367	0.367	0
YARR	21102	0.656	0.656	0	0.553	0.553	0
YARR	21308	1.221	1.221	0	1.152	1.152	0
YARR	21552	0.753	0.753	0	0.728	0.728	0
YARR	21580	0.555	0.555	0	0.541	0.541	0
YARR	21600	0.462	0.462	0	0.444	0.444	0
YARR	21618	0.503	0.503	0	0.502	0.502	0
YARR	21768	0.505	0.505	0	0.46	0.46	0
YARR	21934	0.668	0.668	0	0.614	0.614	0
YARR	22136	0.857	0.857	0	0.782	0.782	0
YARR	22327	1.214	1.214	0	1.083	1.083	0
YARR	22430	1.226	1.226	0	1.106	1.106	0
YARR	22450	1.237	1.237	0	1.132	1.132	0
YARR	22567	1.069	1.069	0	1.046	1.046	0

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	22757	0.991	0.991	0	0.97	0.97	0
YARR	23032	1.178	1.178	0	1.159	1.159	0
YARR	23152	1.031	1.031	0	1.006	1.006	0
YARR	23172	0.575	0.575	0	0.552	0.552	0
YARR	23218	0.406	0.406	0	0.373	0.373	0
YARR	23460	0.379	0.379	0	0.364	0.364	0
YARR	23641	0.355	0.355	0	0.353	0.353	0
YARR	23878	0.384	0.384	0	0.367	0.367	0
YARR	24033	0.46	0.46	0	0.415	0.415	0
YARR	24147	0.463	0.463	0	0.411	0.411	0
YARR	24157	0.453	0.453	0	0.401	0.401	0
YARR	24305	0.944	0.944	0	0.977	0.977	0
YARR	24526	0.458	0.459	0.001	0.407	0.407	0
YARR	24717	0.442	0.442	0	0.39	0.39	0
YARR	25000	0.426	0.426	0	0.374	0.374	0
YARR	25198	0.482	0.482	0	0.437	0.437	0
YARR	25419	0.557	0.557	0	0.532	0.532	0
YARR	25619	0.515	0.515	0	0.474	0.474	0
YARR	25857	0.481	0.481	0	0.429	0.429	0
YARR	26072	0.526	0.526	0	0.471	0.471	0
YARR	26300	0.581	0.581	0	0.523	0.523	0
YARR	26330	0.601	0.601	0	0.551	0.551	0
YARR	26340	0.623	0.623	0	0.599	0.599	0
YARR	26499	0.464	0.464	0	0.423	0.423	0
YARR	26715	0.369	0.369	0	0.325	0.325	0
YARR	26940	0.494	0.494	0	0.456	0.456	0
YARR	27080	0.825	0.825	0	0.796	0.796	0
YARR	27090	0.685	0.686	0.001	0.659	0.659	0
YARR	27145	0.615	0.615	0	0.56	0.561	0.001
YARR	27319	0.604	0.605	0.001	0.545	0.546	0.001
YARR	27531	0.594	0.596	0.002	0.523	0.524	0.001
YARR	27710	1.217	1.221	0.004	1.247	1.266	0.019
YARR	27807	0.601	0.602	0.001	0.543	0.544	0.001
YARR	27976	0.475	0.476	0.001	0.389	0.389	0
YARR	28192	0.393	0.393	0	0.309	0.309	0
YARR	28426	0.591	0.592	0.001	0.527	0.526	0.001
YARR	28608	0.395	0.396	0.001	0.311	0.312	0.001
YARR	28939	0.407	0.408	0.001	0.318	0.318	0
YARR	29191	0.42	0.421	0.001	0.326	0.326	0
YARR	29325	0.472	0.472	0	0.365	0.366	0.001
YARR	29333	0.538	0.539	0.001	0.417	0.417	0
YARR	29389	0.634	0.634	0	0.493	0.493	0
YARR	29513	0.77	0.771	0.001	0.603	0.604	0.001
YARR	29689	0.712	0.714	0.002	0.574	0.574	0
YARR	29803	0.662	0.664	0.002	0.546	0.547	0.001
YARR	30043	0.705	0.707	0.002	0.582	0.583	0.001
YARR	30273	0.755	0.756	0.001	0.653	0.653	0
YARR	30441	0.731	0.732	0.001	0.584	0.585	0.001
YARR	30677	0.717	0.717	0	0.555	0.556	0.001
YARR	30957	0.675	0.677	0.002	0.572	0.573	0.001
YARR	31255	0.656	0.658	0.002	0.685	0.69	0.005
YARR	31676	1.136	1.139	0.003	1.174	1.18	0.006

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
YARR	31706	0.683	0.685	0.002	0.731	0.736	0.005
YARR	31777	0.663	0.664	0.001	0.683	0.687	0.004
YARR	31989	0.68	0.681	0.001	0.638	0.641	0.003
YARR	32264	0.619	0.62	0.001	0.482	0.483	0.001
YARR	32574	0.569	0.57	0.001	0.435	0.436	0.001
DOOR	0	0.543	0.544	0.001	0.409	0.409	0
DOOR	280	0.519	0.52	0.001	0.385	0.386	0.001
DOOR	520	0.638	0.64	0.002	0.491	0.492	0.001
DOOR	707	0.828	0.831	0.003	0.677	0.679	0.002
DOOR	713	0.748	0.751	0.003	0.617	0.619	0.002
DOOR	770	0.682	0.685	0.003	0.566	0.568	0.002
DOOR	810	0.72	0.724	0.004	0.581	0.583	0.002
DOOR	1190	0.763	0.768	0.005	0.598	0.601	0.003
DOOR	1440	0.808	0.814	0.006	0.661	0.665	0.004
DOOR	1650	0.859	0.865	0.006	0.776	0.778	0.002
DOOR	1880	0.9	0.907	0.007	0.801	0.805	0.004
DOOR	2100	0.946	0.953	0.007	0.837	0.84	0.003
DOOR	2330	0.971	0.979	0.008	0.993	0.994	0.001
DOOR	2540	0.932	0.939	0.007	0.808	0.811	0.003
DOOR	2810	0.828	0.835	0.007	0.672	0.678	0.006
DOOR	2970	0.745	0.751	0.006	0.58	0.585	0.005
DOOR	2995	0.541	0.545	0.004	0.42	0.424	0.004
DOOR	3001	0.424	0.428	0.004	0.329	0.332	0.003
DOOR	3056	0.612	0.618	0.006	0.488	0.492	0.004
DOOR	3356	1.102	1.115	0.013	0.944	0.956	0.012
DOOR	3576	1.129	1.149	0.02	0.968	0.985	0.017
DOOR	3821	1.159	1.185	0.026	0.993	1.015	0.022
DOOR	4035	0.536	0.537	0.001	0.448	0.447	0.001
DOOR	4090	0.348	0.346	0.002	0.287	0.285	0.002
DOOR	4261	0.394	0.392	0.002	0.327	0.324	0.003
DOOR	4310	0.455	0.453	0.002	0.379	0.377	0.002
DOOR	4314	0.504	0.501	0.003	0.423	0.42	0.003
DOOR	4454	0.565	0.561	0.004	0.479	0.475	0.004
DOOR	4660	0.796	0.805	0.009	0.798	0.807	0.009
DOOR	4860	0.561	0.558	0.003	0.461	0.456	0.005
DOOR	5179	0.558	0.546	0.012	0.441	0.433	0.008
DOOR	5360	0.554	0.534	0.02	0.424	0.412	0.012
DOOR	5461	0.663	0.65	0.013	0.514	0.505	0.009
DOOR	5691	0.827	0.828	0.001	0.652	0.655	0.003
DOOR	5913	0.827	0.828	0.001	0.679	0.682	0.003
DOOR	6091	0.826	0.83	0.004	0.708	0.71	0.002
DOOR	6404	0.774	0.715	0.059	0.668	0.622	0.046
DOOR	6448	0.728	0.627	0.101	0.631	0.554	0.077
DOOR	6464	0.704	0.652	0.052	0.591	0.551	0.04
DOOR	6490	0.689	0.687	0.002	0.562	0.557	0.005
DOOR	6677	0.604	0.601	0.003	0.511	0.506	0.005
DOOR	7023	0.535	0.532	0.003	0.468	0.464	0.004
DOOR	7236	0.843	0.84	0.003	0.835	0.852	0.017
DOOR	7405	0.628	0.622	0.006	0.539	0.537	0.002
DOOR	7690	0.57	0.567	0.003	0.477	0.475	0.002
DOOR	7921	0.521	0.52	0.001	0.427	0.425	0.002
DOOR	8141	0.573	0.571	0.002	0.468	0.467	0.001

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage (m)	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
		Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR	8365	0.646	0.645	0.001	0.523	0.524	0.001
DOOR	8647	0.607	0.606	0.001	0.495	0.496	0.001
DOOR	8858	0.561	0.561	0	0.461	0.462	0.001
DOOR	9113	0.637	0.639	0.002	0.54	0.54	0
DOOR	9221	0.739	0.743	0.004	0.651	0.652	0.001
DOOR	9329	0.984	0.849	0.135	0.938	0.941	0.003
DOOR	9531	0.79	0.792	0.002	0.703	0.707	0.004
DOOR	9757	0.81	0.811	0.001	0.719	0.723	0.004
DOOR	9946	0.831	0.831	0	0.735	0.739	0.004
DOOR	10137	0.684	0.685	0.001	0.567	0.567	0
DOOR	10339	0.589	0.592	0.003	0.463	0.465	0.002
DOOR	10512	0.53	0.531	0.001	0.451	0.45	0.001
DOOR	10748	0.493	0.494	0.001	0.537	0.55	0.013
DOOR	10964	0.476	0.477	0.001	0.444	0.445	0.001
DOOR	10984	0.469	0.468	0.001	0.456	0.455	0.001
DOOR	11053	0.464	0.466	0.002	0.444	0.443	0.001
DOOR	11236	0.48	0.479	0.001	0.434	0.434	0
DOOR	11386	0.447	0.448	0.001	0.396	0.397	0.001
DOOR	11586	0.419	0.42	0.001	0.364	0.364	0
DOOR	11844	1.616	1.66	0.044	1.344	1.4	0.056
DOOR	11948	0.438	0.438	0	0.455	0.451	0.004
DOOR	12151	0.453	0.454	0.001	0.424	0.422	0.002
DOOR	12385	0.469	0.469	0	0.449	0.452	0.003
DOOR	12579	0.457	0.457	0	0.44	0.451	0.011
DOOR	12765	0.456	0.466	0.01	0.474	0.49	0.016
DOOR	12982	0.461	0.463	0.002	0.414	0.418	0.004
DOOR	13193	0.488	0.488	0	0.386	0.387	0.001
DOOR	13367	0.545	0.545	0	0.431	0.431	0
DOOR	13628	0.618	0.618	0	0.488	0.488	0
DOOR	13851	0.68	0.68	0	0.542	0.542	0
DOOR	14073	0.758	0.758	0	0.61	0.61	0
DOOR	14267	0.778	0.778	0	0.622	0.622	0
DOOR	14427	0.8	0.8	0	0.635	0.635	0
DOOR	14635	0.612	0.612	0	0.479	0.479	0
DOOR	14897	0.496	0.496	0	0.384	0.384	0
DOOR	15114	0.435	0.435	0	0.336	0.336	0
DOOR	15315	0.387	0.387	0	0.298	0.298	0
DOOR	15534	0.458	0.458	0	0.354	0.355	0.001
DOOR	15724	0.56	0.56	0	0.438	0.438	0
DOOR	15908	0.653	0.654	0.001	0.54	0.54	0
DOOR	16106	0.802	0.802	0	0.708	0.709	0.001
DOOR	16385	0.839	0.838	0.001	0.754	0.756	0.002
DOOR	16595	0.882	0.882	0	0.806	0.808	0.002
DOOR	16705	1.028	1.03	0.002	0.971	0.973	0.002
DOOR	16842	0.918	0.918	0	0.84	0.843	0.003
DOOR	16862	0.486	0.489	0.003	0.487	0.492	0.005
DOOR	16902	0.323	0.326	0.003	0.335	0.339	0.004
DOOR	17085	0.264	0.264	0	0.219	0.219	0
DOOR	17416	0.223	0.223	0	0.174	0.174	0
DOOR	17575	0.289	0.29	0.001	0.226	0.227	0.001
DOOR	17820	0.414	0.416	0.002	0.326	0.328	0.002
DOOR_A	0	0.466	0.468	0.002	0.377	0.379	0.002

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

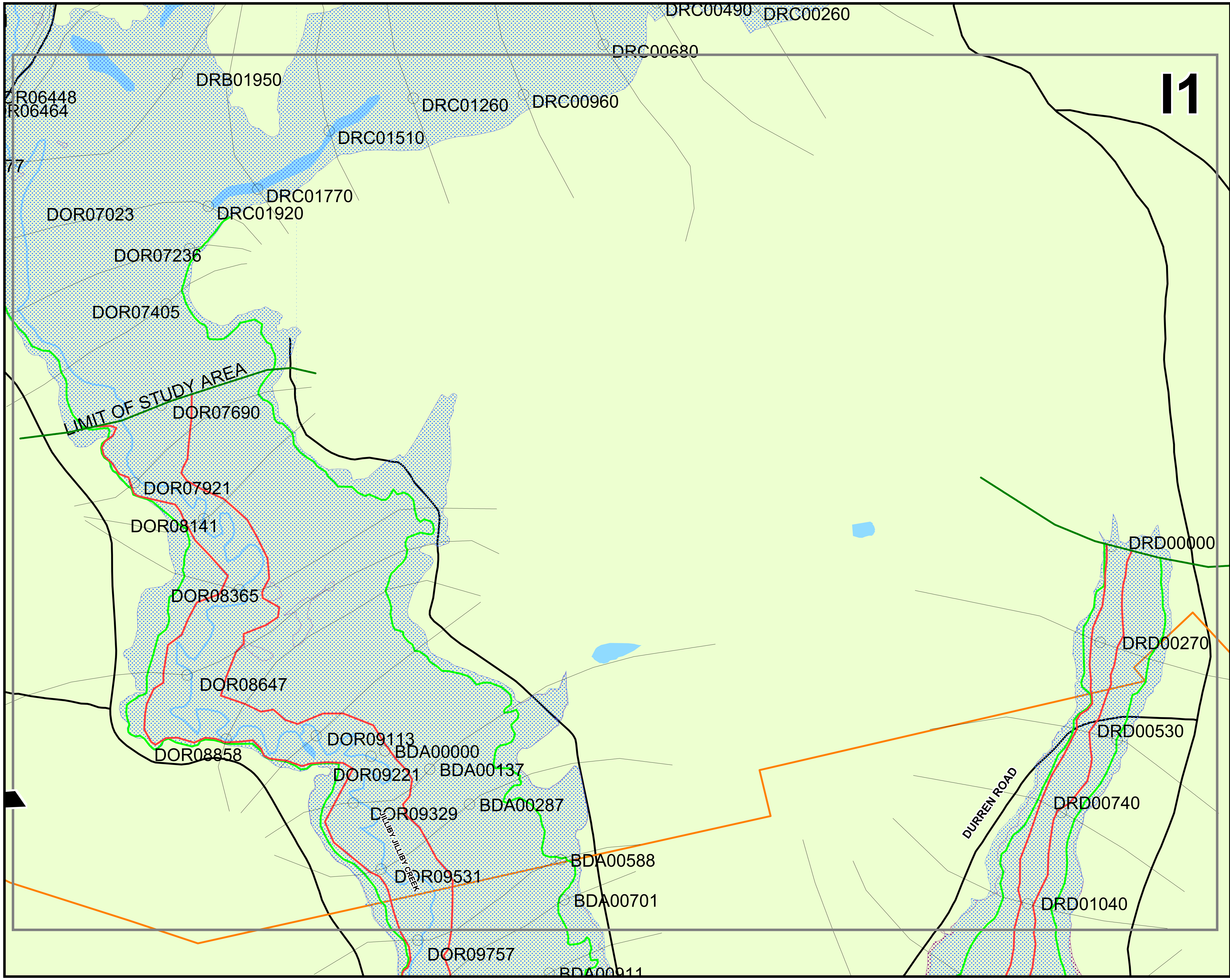
River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_A	260	0.53	0.532	0.002	0.444	0.447	0.003
DOOR_A	540	0.728	0.732	0.004	0.644	0.66	0.016
DOOR_A	870	0.539	0.54	0.001	0.456	0.458	0.002
DOOR_A	1120	0.513	0.515	0.002	0.433	0.434	0.001
DOOR_A	1330	0.489	0.492	0.003	0.411	0.413	0.002
DOOR_A	1478	0.465	0.467	0.002	0.385	0.387	0.002
DOOR_A	1482	0.443	0.444	0.001	0.363	0.364	0.001
DOOR_A	1560	0.443	0.443	0	0.371	0.371	0
DOOR_A	2100	0.444	0.443	0.001	0.379	0.378	0.001
DOOR_B	0	0.626	0.624	0.002	0.513	0.512	0.001
DOOR_B	230	1.065	1.059	0.006	0.798	0.792	0.006
DOOR_B	500	0.277	0.281	0.004	0.223	0.227	0.004
DOOR_B	760	0.313	0.317	0.004	0.254	0.258	0.004
DOOR_B	1010	0.36	0.365	0.005	0.295	0.301	0.006
DOOR_B	1270	0.415	0.423	0.008	0.369	0.376	0.007
DOOR_B	1570	0.543	0.554	0.011	0.51	0.51	0
DOOR_B	1660	0.298	0.303	0.005	0.317	0.322	0.005
DOOR_B	1950	0.303	0.31	0.007	0.334	0.339	0.005
DOOR_C	0	0.309	0.317	0.008	0.357	0.362	0.005
DOOR_C	260	0.352	0.342	0.01	0.357	0.362	0.005
DOOR_C	490	0.186	0.178	0.008	0.149	0.145	0.004
DOOR_C	680	0.125	0.123	0.002	0.1	0.1	0
DOOR_C	960	0.262	0.243	0.019	0.211	0.199	0.012
DOOR_C	1260	0.247	0.24	0.007	0.204	0.199	0.005
DOOR_C	1510	0.237	0.241	0.004	0.199	0.201	0.002
DOOR_C	1780	0.119	0.124	0.005	0.096	0.099	0.003
DOOR_C	1920	0.164	0.17	0.006	0.133	0.136	0.003
DOOR_D	0	0.279	0.286	0.007	0.222	0.219	0.003
DOOR_D	270	0.144	0.144	0	0.145	0.142	0.003
DOOR_D	530	0.164	0.166	0.002	0.168	0.166	0.002
DOOR_D	740	0.209	0.217	0.008	0.215	0.217	0.002
DOOR_D	1040	0.349	0.339	0.01	0.244	0.241	0.003
DOOR_D	1300	0.387	0.38	0.007	0.3	0.296	0.004
DOOR_D	1540	0.436	0.433	0.003	0.391	0.387	0.004
DOOR_D	1820	0.512	0.511	0.001	0.4	0.394	0.006
DOOR_D	2080	0.451	0.447	0.004	0.418	0.411	0.007
DOOR_D	2350	0.431	0.428	0.003	0.312	0.307	0.005
DOOR_D	2550	0.413	0.41	0.003	0.26	0.252	0.008
DOOR_E	0	0.334	0.333	0.001	0.26	0.252	0.008
DOOR_E	170	0.374	0.372	0.002	0.25	0.244	0.006
DOOR_E	390	0.425	0.422	0.003	0.251	0.244	0.007
DOOR_E	660	0.251	0.244	0.007	0.251	0.244	0.007
DOOR_E	940	0.255	0.247	0.008	0.254	0.247	0.007
DOOR_E	1230	0.258	0.25	0.008	0.258	0.25	0.008
DOOR_E	1450	0.258	0.25	0.008	0.258	0.25	0.008
DOOR_E	1700	0.27	0.26	0.01	0.269	0.26	0.009
DOOR_E	1920	0.282	0.271	0.011	0.282	0.271	0.011
DOOR_E	2140	0.65	0.651	0.001	0.507	0.507	0
DOOR_E	2170	0.627	0.633	0.006	0.528	0.531	0.003
DOOR_E	2190	0.665	0.653	0.012	0.66	0.649	0.011
DOOR_E	2390	0.665	0.653	0.012	0.66	0.649	0.011
DOOR_E	2680	0.333	0.34	0.007	0.282	0.292	0.01

Table H.3 Existing and Post Mining Flood Velocities 1% AEP and 20% AEP

River	Chainage	Peak Velocity 1% AEP (m/s)			Peak Velocity 20% AEP (m/s)		
	(m)	Existing	Subsided	Difference	Existing	Subsided	Difference
DOOR_E	2900	0.275	0.28	0.005	0.216	0.222	0.006
DOOR_E	3110	0.141	0.148	0.007	0.139	0.139	0
DOOR_E	3320	0.162	0.157	0.005	0.161	0.156	0.005
DOOR_E	3690	0.192	0.186	0.006	0.19	0.185	0.005
DOOR_E	4010	0.574	0.566	0.008	0.442	0.435	0.007
DOOR_E	4040	0.487	0.481	0.006	0.383	0.377	0.006
DOOR_E	4080	0.422	0.418	0.004	0.348	0.35	0.002
DOOR_E	4230	0.433	0.427	0.006	0.326	0.32	0.006
DOOR_E	4500	0.444	0.436	0.008	0.314	0.307	0.007
DOOR_F	0	0.392	0.387	0.005	0.297	0.292	0.005
DOOR_F	180	0.49	0.484	0.006	0.379	0.374	0.005
DOOR_F	185	0.872	0.874	0.002	0.87	0.873	0.003
DOOR_F	203	0.872	0.874	0.002	0.87	0.873	0.003
DOOR_F	210	0.777	0.782	0.005	0.755	0.76	0.005
DOOR_F	370	1.257	1.264	0.007	1.114	1.136	0.022
DOOR_G	0	2.247	2.228	0.019	1.757	1.746	0.011
DOOR_G	120	1.243	1.254	0.011	1.036	1.062	0.026
DOOR_G	137	1.243	1.254	0.011	1.036	1.062	0.026
DOOR_G	143	1.057	1.066	0.009	0.867	0.881	0.014
DOOR_G	160	0.92	0.928	0.008	0.748	0.758	0.01
DOOR_G	400	0.92	0.928	0.008	0.748	0.758	0.01
DOOR_G	600	0.9	0.909	0.009	0.714	0.735	0.021
DOOR_G	900	0.886	0.895	0.009	0.698	0.721	0.023
DOOR_H	0	0.801	0.814	0.013	0.676	0.695	0.019
DOOR_H	200	0.756	0.77	0.014	0.628	0.651	0.023
DOOR_H	450	0.72	0.735	0.015	0.634	0.663	0.029
DOOR_H	660	0.939	0.925	0.014	0.675	0.693	0.018
DOOR_H	950	1.114	1.141	0.027	0.977	1.01	0.033

Annex I

Flood Hazard Analysis



Legend

- Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Section
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure: I1

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Inset 1

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS11		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	-
Source:	-		
Scale:	Refer to Scale Bar		

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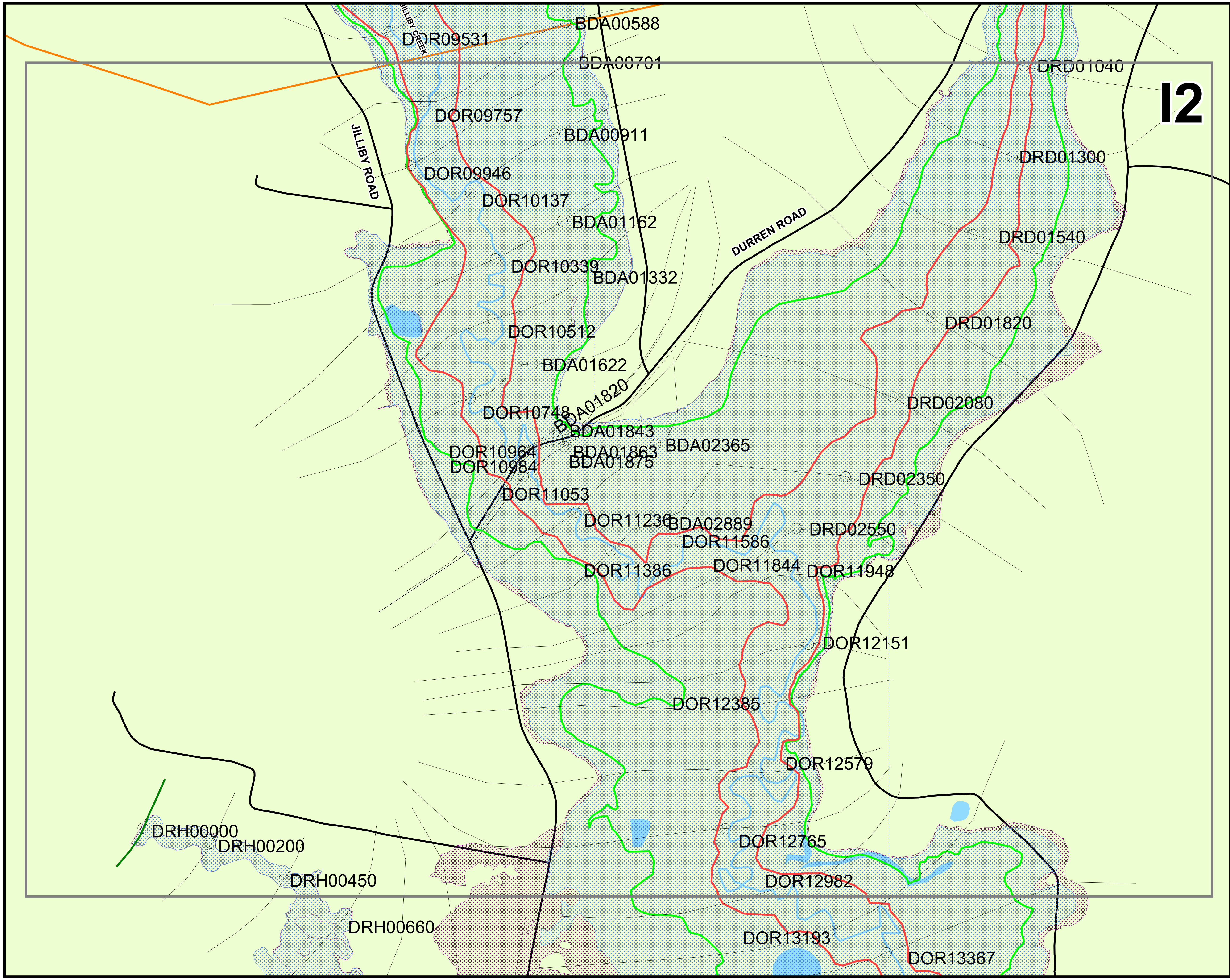
ERM



Legend

- Extent of Study Area
- Extent of Mine Subsidence
- MIKE11 Cross Section
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure: I2

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Inset 2

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_GIS12		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	-
Source:	-		
Scale:	Refer to Scale Bar		

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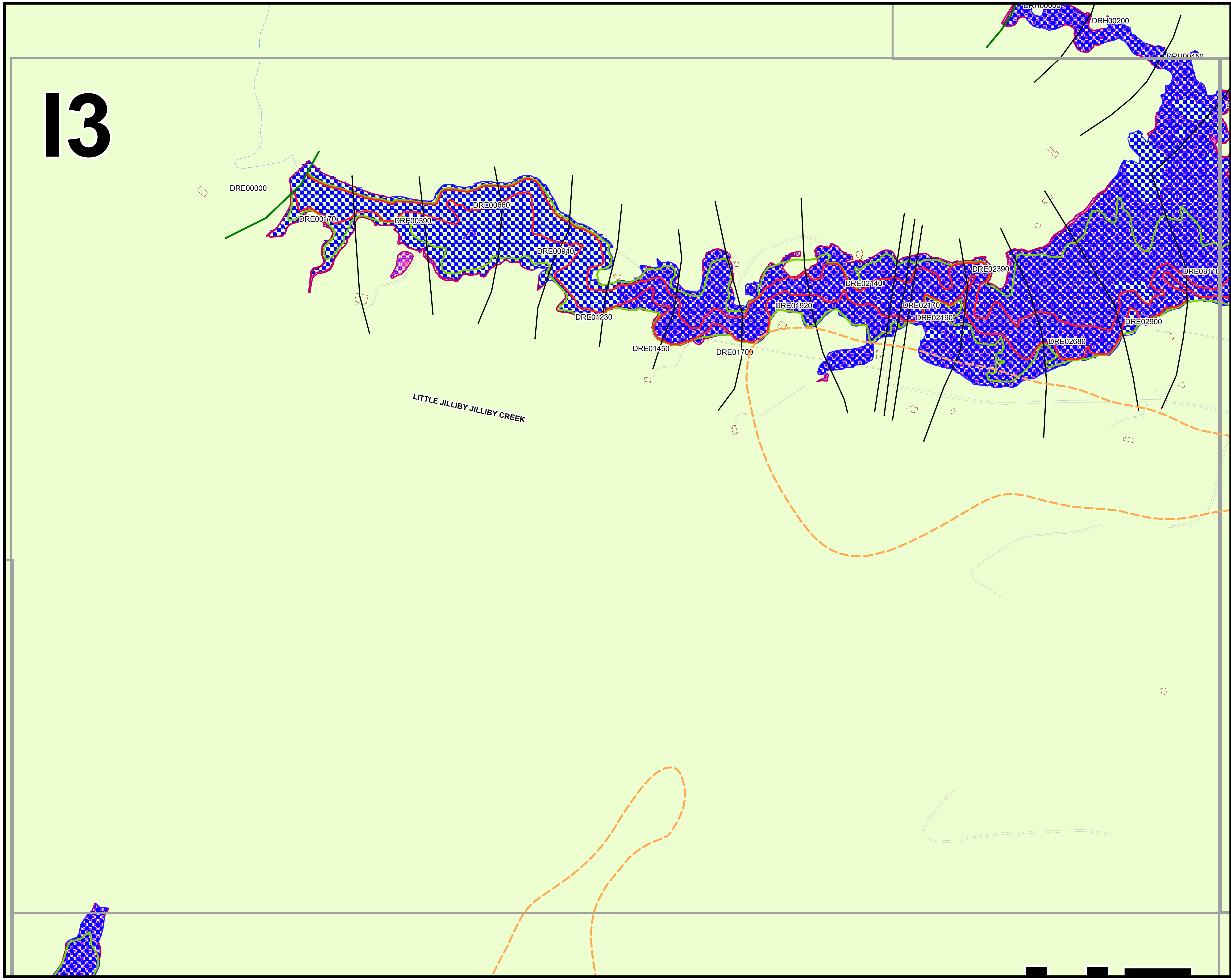

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.3

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet E3

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_I_GIS13		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
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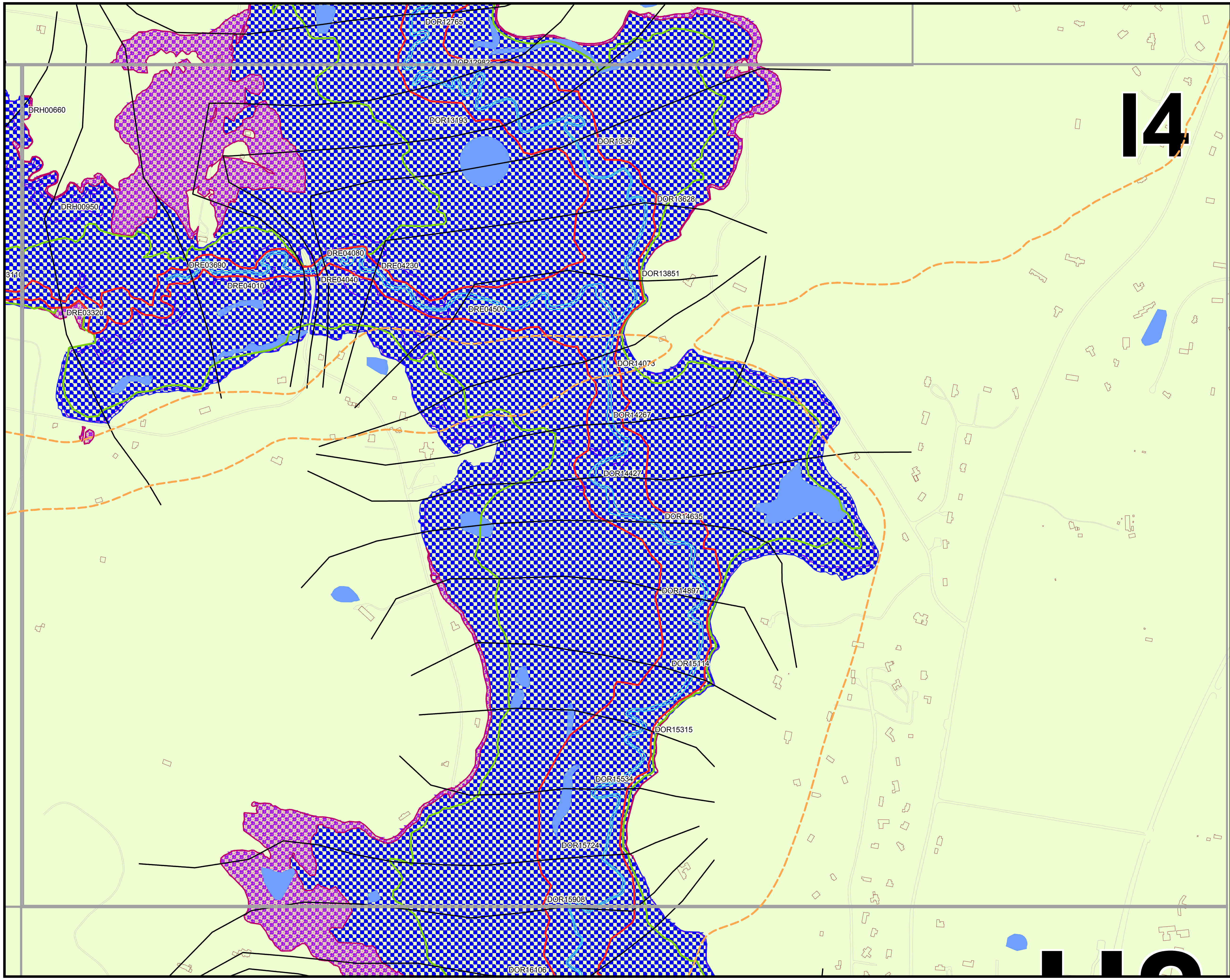

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.4

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet I4

Client:	Wyong Areas Coal Joint Venture		
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment		
Drawing No:	0044971_I_GIS14		
Date Rev:	10.02.2009	Drawing Size:	A3
Drawn By:	DH	Reviewed By:	GH
Source:	-		
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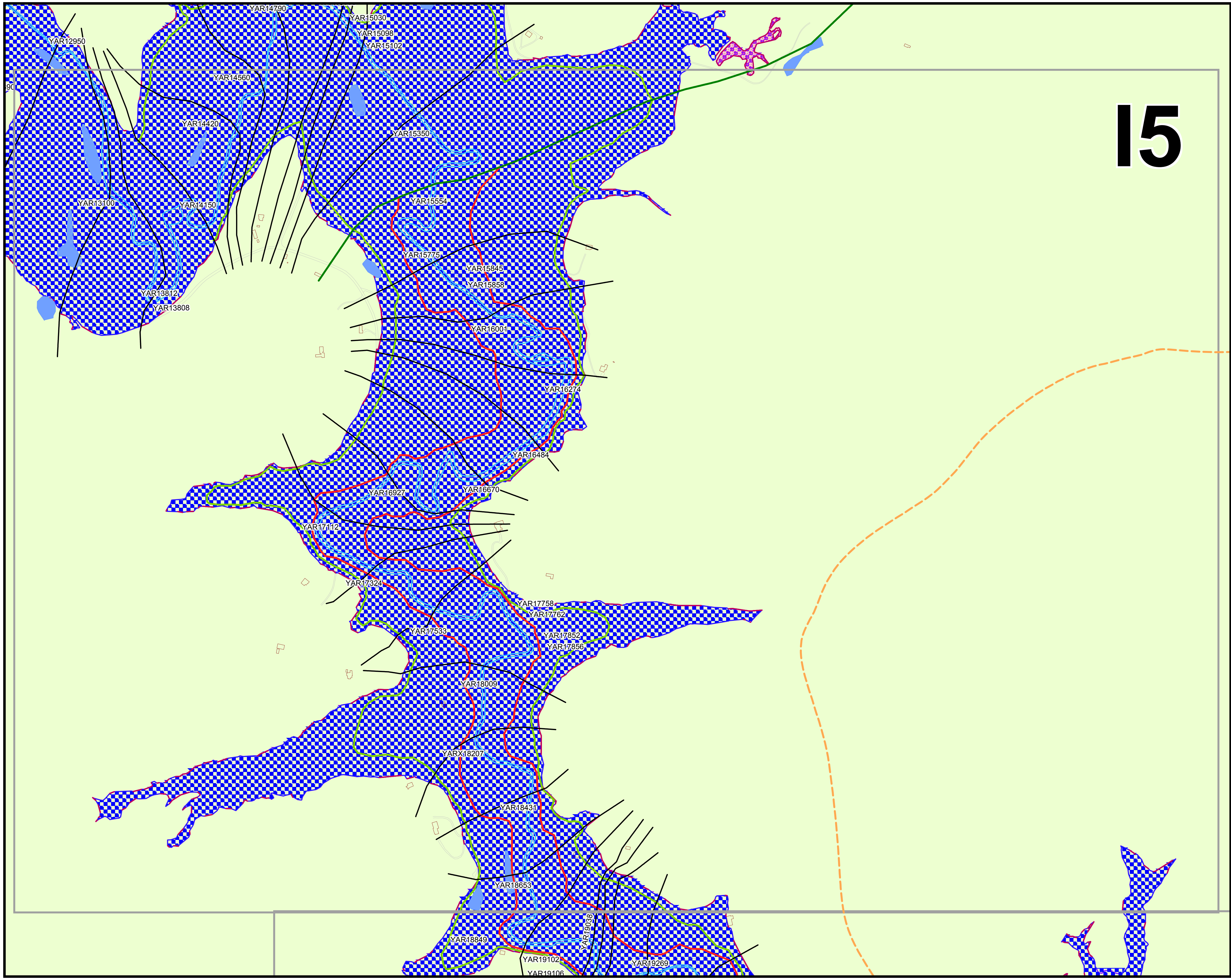

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.5

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet I5

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_I_GIS15
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Drawn By:	DH — Reviewed By: GH
Source:	-
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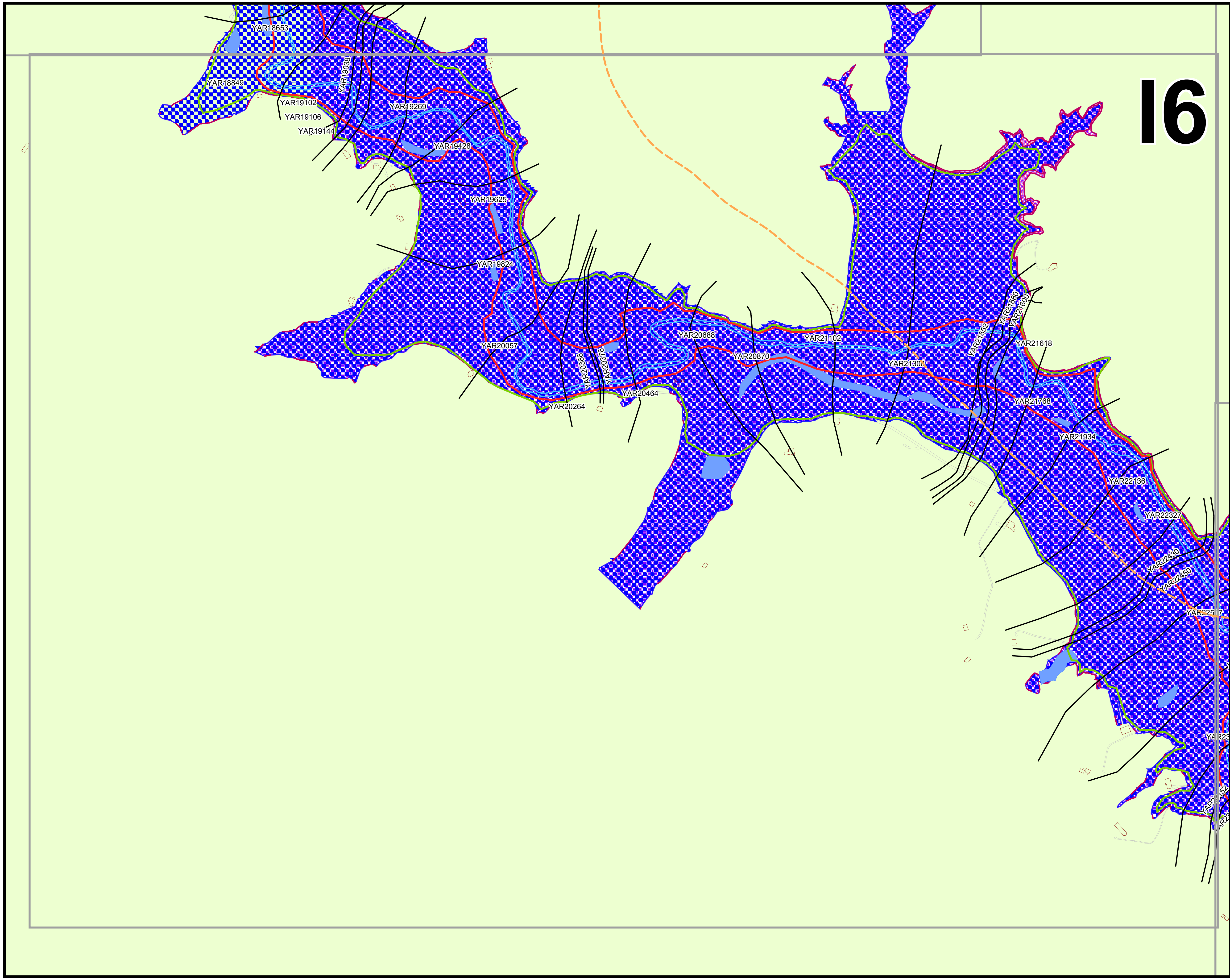

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.6

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet I6

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_I_GIS16
Date Rev:	10.02.2009 Drawing Size: A3
Drawn By:	DH Reviewed By: GH
Source:	-
Scale:	Refer to Scale Bar

N

0 100 200m

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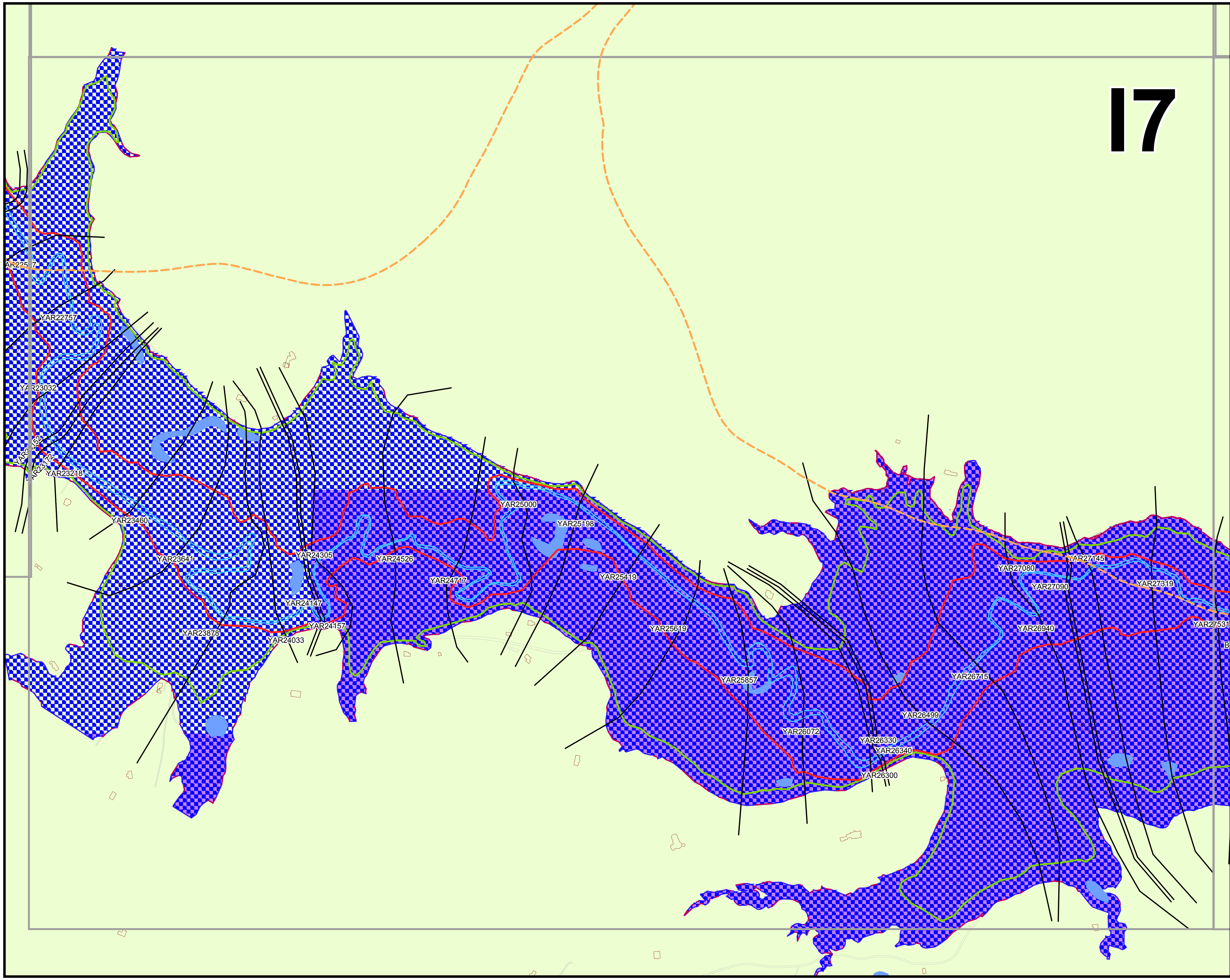

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.7

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet I7

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_I_GIS17
Date:	15.05.2007 Drawing Size: A3
Drawn By:	DH Reviewed By: GH
Source:	-
Scale:	Refer to Scale Bar

N 0 100 200m

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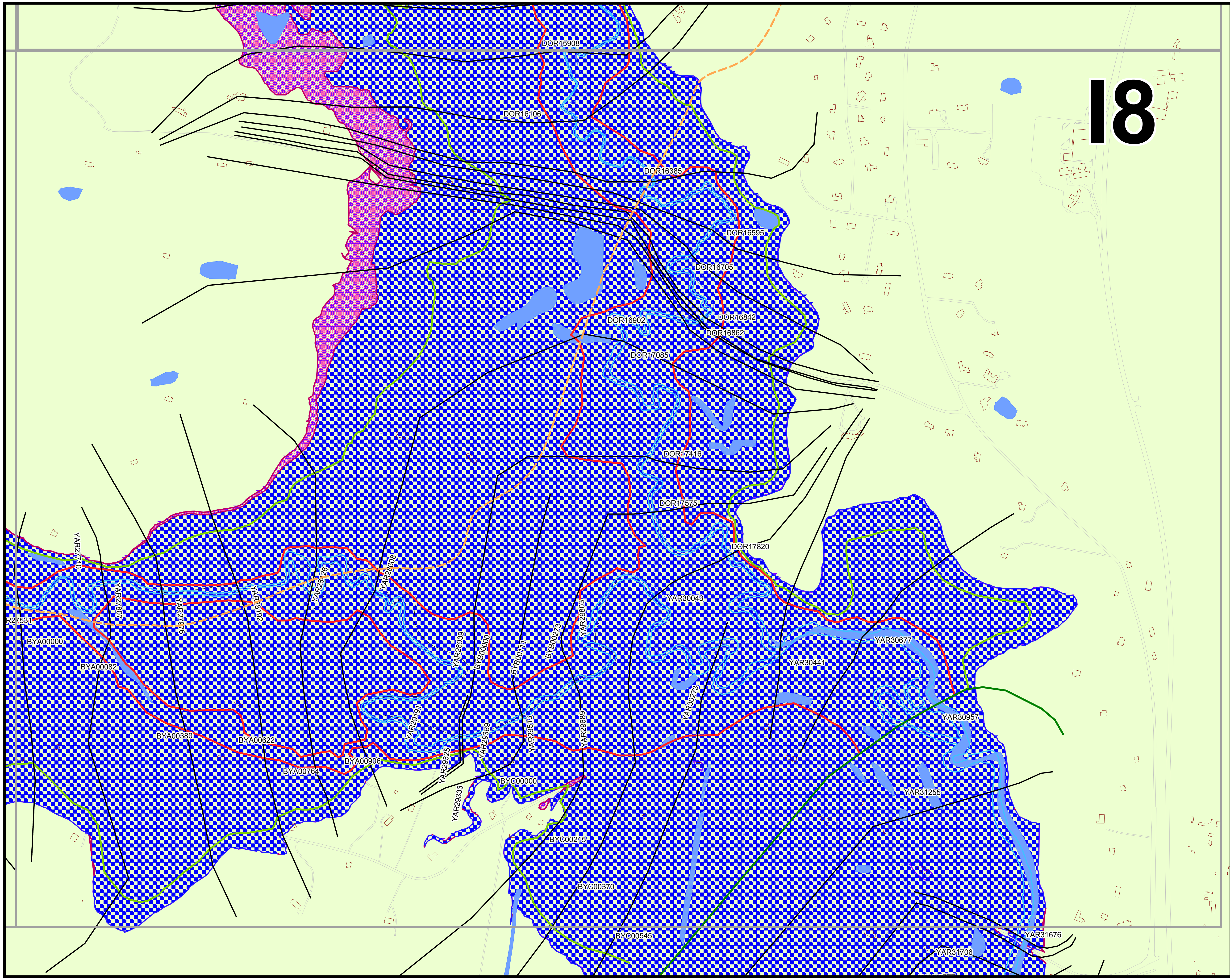

Legend

- Section at Extent of Study Area
- Extent of mine Subsidence
- MIKE11 Cross Sections
- Change in Flood Extent
- 1% AEP Flood Storage Extent
- 1% AEP Floodway Extent
- Existing 1% AEP Flood Extent
- Subsided 1% AEP Flood Extent

Figure I.8

Subsidence Impacts on Flood Extent Yarramalong & Dooralong Valleys - Sheet I8

Client:	Wyong Areas Coal Joint Venture
Project:	Wallarah No.2 Coal Project - Flood Impact Assessment
Drawing No:	0044971_I_GIS18
Date:	15.05.2007 Drawing Size: A3
Drawn By:	DH Reviewed By: GH
Source:	-
Scale:	Refer to Scale Bar

N 0 100 200m

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Annex J

HEC-RAS Modelling Results

HEC-RAS River: HueHue Reach: 1 Profile: 1% AEP

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	5.48	1% AEP	HH_Existing	12.80	21.89	22.63	22.61	22.69	0.005011	1.27	16.92	105.86	0.52
1	5.48	1% AEP	HH_Subsided	12.80	21.89	22.63	22.61	22.69	0.004979	1.27	16.97	105.91	0.51
1	5.26	1% AEP	HH_Existing	12.80	21.00	21.26	21.21	21.29	0.008245	0.93	19.06	127.19	0.58
1	5.26	1% AEP	HH_Subsided	12.80	21.00	21.26	21.21	21.29	0.008317	0.93	18.99	126.99	0.58
1	5.03	1% AEP	HH_Existing	12.80	18.99	19.73	19.69	19.78	0.005577	1.32	17.00	94.90	0.54
1	5.03	1% AEP	HH_Subsided	12.80	18.99	19.73	19.69	19.78	0.005521	1.31	17.08	95.12	0.54
1	4.85	1% AEP	HH_Existing	12.80	18.82	19.07	18.98	19.08	0.002973	0.38	34.65	258.66	0.32
1	4.85	1% AEP	HH_Subsided	12.80	18.82	19.07	18.98	19.08	0.002997	0.38	34.57	258.62	0.32
1	4.67	1% AEP	HH_Existing	24.80	17.73	18.00	17.93	18.04	0.008909	0.80	31.16	173.43	0.57
1	4.67	1% AEP	HH_Subsided	24.80	17.73	18.00	17.93	18.04	0.008847	0.80	31.23	173.47	0.57
1	4.53	1% AEP	HH_Existing	24.80	16.80	17.18		17.20	0.004297	0.70	36.86	150.92	0.42
1	4.53	1% AEP	HH_Subsided	24.80	16.80	17.18		17.20	0.004355	0.70	36.70	150.78	0.43
1	4.40	1% AEP	HH_Existing	24.80	16.00	17.16	16.55	17.16	0.000081	0.22	146.25	235.08	0.07
1	4.40	1% AEP	HH_Subsided	24.80	16.00	17.16	16.55	17.16	0.000081	0.22	146.63	235.76	0.07
1	4.385			Bridge									
1	4.37	1% AEP	HH_Existing	24.80	15.95	16.57	16.59	16.66	0.019411	1.82	24.85	216.40	0.94
1	4.37	1% AEP	HH_Subsided	24.80	15.95	16.56	16.58	16.65	0.020026	1.83	24.74	216.65	0.96
1	4.22	1% AEP	HH_Existing	36.80	15.56	16.02	15.83	16.04	0.002240	0.60	65.36	235.69	0.32
1	4.22	1% AEP	HH_Subsided	36.80	15.52	16.02	15.79	16.03	0.001389	0.51	78.66	248.20	0.26
1	4.03	1% AEP	HH_Existing	47.90	14.61	16.01	14.94	16.01	0.000034	0.17	312.73	311.24	0.05
1	4.03	1% AEP	HH_Subsided	47.90	13.88	16.02	14.53	16.02	0.000014	0.13	418.05	328.64	0.03
1	4.02			Culvert									
1	4.01	1% AEP	HH_Existing	47.90	14.50	15.05	15.05	15.14	0.029661	1.32	36.75	226.95	1.02
1	4.01	1% AEP	HH_Subsided	47.90	14.21	14.65	14.65	14.75	0.028007	1.42	34.09	170.97	1.02
1	3.90	1% AEP	HH_Existing	47.90	13.81	14.34		14.37	0.003902	0.80	62.56	187.43	0.42
1	3.90	1% AEP	HH_Subsided	47.90	13.16	13.91	13.64	13.93	0.001581	0.61	82.10	189.91	0.28
1	3.78	1% AEP	HH_Existing	47.90	13.47	14.22		14.23	0.000507	0.42	135.53	237.94	0.17
1	3.78	1% AEP	HH_Subsided	47.90	12.75	13.88		13.88	0.000133	0.29	201.51	244.18	0.09
1	3.60	1% AEP	HH_Existing	47.90	13.06	14.15		14.16	0.000304	0.36	204.22	271.07	0.11
1	3.60	1% AEP	HH_Subsided	47.90	12.56	13.85		13.86	0.000149	0.29	251.54	275.31	0.08
1	3.53	1% AEP	HH_Existing	47.90	12.88	14.14		14.14	0.000241	0.35	248.48	318.95	0.10
1	3.53	1% AEP	HH_Subsided	47.90	12.46	13.85		13.85	0.000129	0.27	298.31	321.53	0.08
1	3.38	1% AEP	HH_Existing	47.90	12.68	14.10		14.11	0.000196	0.33	233.43	255.37	0.09
1	3.38	1% AEP	HH_Subsided	47.90	12.37	13.82		13.83	0.000163	0.30	254.60	273.24	0.09
1	3.27	1% AEP	HH_Existing	61.50	12.67	14.07	13.17	14.08	0.000282	0.38	206.36	270.78	0.11
1	3.27	1% AEP	HH_Subsided	61.50	12.44	13.79	12.95	13.80	0.000297	0.38	210.29	282.95	0.11
1	3.26			Culvert									
1	3.25	1% AEP	HH_Existing	61.50	12.62	13.86		13.87	0.000841	0.39	180.83	266.32	0.15
1	3.25	1% AEP	HH_Subsided	61.50	12.54	13.74		13.74	0.000534	0.32	223.70	291.15	0.12
1	3.19	1% AEP	HH_Existing	61.50	12.60	13.82		13.83	0.000528	0.40	205.28	255.35	0.12
1	3.19	1% AEP	HH_Subsided	61.50	12.41	13.71		13.72	0.000334	0.33	252.87	266.05	0.10
1	3.03	1% AEP	HH_Existing	61.50	12.50	13.57		13.62	0.006027	1.03	72.68	133.66	0.39
1	3.03	1% AEP	HH_Subsided	61.50	12.45	13.53		13.57	0.005752	1.01	74.85	137.92	0.38
1	2.87	1% AEP	HH_Existing	61.50	12.00	12.83		12.86	0.003862	0.79	87.44	153.25	0.31
1	2.87	1% AEP	HH_Subsided	61.50	11.97	12.80		12.83	0.003806	0.79	88.02	153.56	0.31
1	2.82	1% AEP	HH_Existing	71.40	11.58	12.55		12.60	0.006402	1.04	80.71	174.14	0.40
1	2.82	1% AEP	HH_Subsided	71.40	11.56	12.53		12.58	0.006200	1.03	81.96	174.95	0.39
1	2.69	1% AEP	HH_Existing	71.40	10.20	11.96		11.99	0.003523	0.80	100.88	178.49	0.27
1	2.69	1% AEP	HH_Subsided	71.40	10.20	11.96		11.99	0.003427	0.79	102.03	179.79	0.26
1	2.58	1% AEP	HH_Existing	71.40	10.05	11.88		11.89	0.000383	0.31	225.96	278.53	0.09
1	2.58	1% AEP	HH_Subsided	71.40	10.05	11.88		11.89	0.000383	0.31	225.96	278.53	0.09
1	2.55	1% AEP	HH_Existing	78.40	10.05	11.87	11.17	11.88	0.000333	0.31	265.64	321.71	0.09
1	2.55	1% AEP	HH_Subsided	78.40	10.05	11.87	11.17	11.88	0.000333	0.31	265.64	321.71	0.09
1	2.525			Culvert									
1	2.50	1% AEP	HH_Existing	78.40	10.02	11.38		11.41	0.009224	1.23	133.35	349.03	0.43
1	2.50	1% AEP	HH_Subsided	78.40	10.02	11.38		11.41	0.009224	1.23	133.35	349.03	0.43
1	2.42	1% AEP	HH_Existing	78.40	9.88	10.72		10.75	0.007502	0.99	135.85	358.10	0.37
1	2.42	1% AEP	HH_Subsided	78.40	9.88	10.72		10.75	0.007502	0.99	135.85	358.10	0.37
1	2.32	1% AEP	HH_Existing	78.40	9.24	9.93		9.96	0.008287	0.94	128.32	333.11	0.38
1	2.32	1% AEP	HH_Subsided	78.40	9.24	9.93		9.96	0.008287	0.94	128.32	333.11	0.38

HEC-RAS River: HueHue Reach: 1 Profile: 1% AEP (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	2.28	1% AEP	HH_Existing	84.30	9.02	9.70		9.71	0.004718	0.67	182.23	428.26	0.28
1	2.28	1% AEP	HH_Subsided	84.30	9.02	9.70		9.71	0.004718	0.67	182.23	428.26	0.28
1	2.22	1% AEP	HH_Existing	84.30	8.70	9.40		9.41	0.005401	0.75	192.17	448.51	0.31
1	2.22	1% AEP	HH_Subsided	84.30	8.70	9.40		9.41	0.005401	0.75	192.17	448.51	0.31
1	2.14	1% AEP	HH_Existing	84.30	8.53	9.02		9.03	0.004514	0.56	195.00	472.56	0.27
1	2.14	1% AEP	HH_Subsided	84.30	8.53	9.02		9.03	0.004514	0.56	195.00	472.56	0.27
1	2.06	1% AEP	HH_Existing	84.30	8.31	8.62		8.63	0.005462	0.44	202.35	501.55	0.27
1	2.06	1% AEP	HH_Subsided	84.30	8.31	8.62		8.63	0.005462	0.44	202.35	501.55	0.27
1	1.98	1% AEP	HH_Existing	84.30	7.80	8.22		8.23	0.004356	0.50	212.32	528.87	0.26
1	1.98	1% AEP	HH_Subsided	84.30	7.80	8.22		8.23	0.004356	0.50	212.32	528.87	0.26
1	1.87	1% AEP	HH_Existing	84.30	7.31	7.91		7.91	0.002092	0.42	268.05	544.29	0.19
1	1.87	1% AEP	HH_Subsided	84.30	7.31	7.91		7.91	0.002092	0.42	268.05	544.29	0.19
1	1.75	1% AEP	HH_Existing	84.30	6.88	7.66		7.66	0.002050	0.52	277.74	589.68	0.20
1	1.75	1% AEP	HH_Subsided	84.30	6.88	7.66		7.66	0.002050	0.52	277.74	589.68	0.20
1	1.48	1% AEP	HH_Existing	84.30	6.42	7.46		7.47	0.000372	0.26	485.88	684.08	0.09
1	1.48	1% AEP	HH_Subsided	84.30	6.42	7.46		7.47	0.000372	0.26	485.88	684.08	0.09
1	1.13	1% AEP	HH_Existing	104.30	5.52	7.43		7.43	0.000052	0.16	1145.58	998.04	0.04
1	1.13	1% AEP	HH_Subsided	104.30	5.52	7.43		7.43	0.000052	0.16	1145.58	998.04	0.04
1	1.04	1% AEP	HH_Existing	104.30	5.20	7.43		7.43	0.000030	0.12	1362.36	1098.90	0.03
1	1.04	1% AEP	HH_Subsided	104.30	5.20	7.43		7.43	0.000030	0.12	1362.36	1098.90	0.03
1	1	1% AEP	HH_Existing	104.30	5.00	7.43	5.55	7.43	0.000023	0.11	1395.41	1070.79	0.02
1	1	1% AEP	HH_Subsided	104.30	5.00	7.43	5.55	7.43	0.000023	0.11	1395.41	1070.79	0.02
1	0.68			Culvert									
1	0.36	1% AEP	HH_Existing	104.30	4.90	5.97		5.99	0.002252	0.51	232.28	541.32	0.20
1	0.36	1% AEP	HH_Subsided	104.30	4.90	5.97		5.99	0.002252	0.51	232.28	541.32	0.20
1	0	1% AEP	HH_Existing	104.30	4.80	5.90	5.35	5.91	0.001925	0.48	246.95	544.41	0.19
1	0	1% AEP	HH_Subsided	104.30	4.80	5.90	5.35	5.91	0.001925	0.48	246.95	544.41	0.19

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