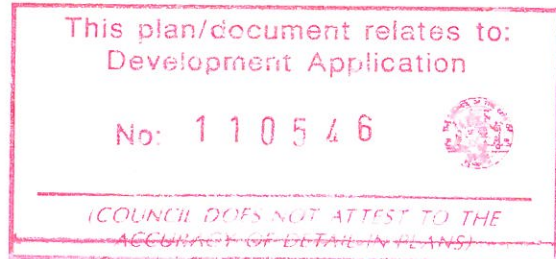




Shaping the Future



Werrington Subdivision
Cnr of French Street & Great Western Highway
Kingswood
Civil, Flooding & Stormwater Management Report

Prepared For:

Middle East Pty Ltd

Prepared By:
Cardno ITC
Level 7, 33 YORK STREET
SYDNEY NSW 2000
Tel: 612 9495 8100
Fax: 612 9495 8111

December 2011

DOCUMENT HISTORY

Issue No.	Revision No.	Date	No. of Pages	Comment
A	0	31.03.11	23	Preliminary Issue – Draft Only
A	1	14.04.11	63	Preliminary Issue – For Client Approval
A	2	18.04.11	63	Final Issue
A	3	21.04.11	74	Final Issue – includes Client comments
A	4	29.04.11	74	Final Issue – For submission to Council
A	5	18.05.11	74	Final Issue – For submission to Council
A	6	20.12.11	89	Revised Issue – For submission to Council

DOCUMENT APPROVAL:

Approved by: Sam Haddad Date: 20.12.2011
(Cardno ITC)

Approved by: _____ Date: _____
(Middle East Pty Ltd)

CONTENTS

1 EXECUTIVE SUMMARY	1
2 INTRODUCTION.....	2
2.1 <i>Brief.....</i>	2
2.2 <i>Report Structure</i>	3
2.3 <i>References</i>	3
3 GLOSSARY	5
4 PROJECT DESCRIPTION.....	6
4.1 <i>Site Location.....</i>	6
4.2 <i>Development Description.....</i>	7
4.3 <i>Site Investigation</i>	7
4.4 <i>Authorities Requirements.....</i>	7
5 STORMWATER MANAGEMENT.....	9
5.1 <i>General.....</i>	9
5.2 <i>Urban Drainage Design</i>	9
5.3 <i>On-Site Detention</i>	9
5.4 <i>Water Quality.....</i>	10
5.5 <i>Water Cycle Management Facilities Contributions.....</i>	11
6 FLOOD MANAGEMENT	12
6.1 <i>Description.....</i>	12
6.2 <i>Hydrological Modelling.....</i>	12
6.3 <i>Hydraulic Simulations</i>	14
7 CIVIL DESIGN	25
Appendix 1.....	26
<i>Rainfall Data.....</i>	26
Appendix 2.....	29
<i>Catchment Plan.....</i>	29
Appendix 3.....	31
<i>Results of the Hydrological Modelling.....</i>	31
Appendix 4.....	33
<i>Results of the Hydraulic Modelling</i>	33
Appendix 5.....	65
<i>Flood Extents Plan</i>	65
Appendix 6.....	67
<i>Design Drawings</i>	67
Appendix 7.....	80
<i>Authorities Correspondence</i>	80

1 EXECUTIVE SUMMARY

This document is a stormwater management and strategy report for the proposed Mixed-Use subdivision located at the corner of French Street and the Great Western Highway, in the suburb Kingswood.

This report assesses the following:-

1. The flooding impact;
2. The proposed strategy for the internal stormwater drainage; and
3. The road network design.

The report describes the proposed masterplan in general and the Stage 1 Development Application in specific.

The site is identified as the Werrington Mixed-Use Area. The site is divided into residential and employment zoning. The residential zone is subject to a Stage 1 Development Application and a Stage 2 planning proposal.

The site is located within the Werrington Creek Catchment Area. A watercourse (classified as Category 2) draining in a South-North direction bisects the site. The watercourse collects the runoff from a culvert crossing under the Great Western Highway. The watercourse terminates in a culvert under the Western Railway line.

A flood study for the watercourse has been prepared. The study assesses the existing and the proposed flooding scenarios following the development of the site. The impacts of the flooding on the development and vice versa are considered. The results of the simulations indicate that the proposed subdivision is outside the flood prone area and does not alter the flooding characteristics through the site.

Provisions are made for the internal drainage network servicing the proposed subdivision. The stormwater management involves the following aspects:-

- Urban drainage design to drain all the lots into the street drainage system. The design caters for a 10-year ARI storm event;
- Provision of On-Site Detention (OSD) systems to control the discharge flows from the site. The OSDs are provided in the shape of basins/ponds located in the drainage reserve; and
- Provision of water quality measures to control the quality of water discharging from the site to current industry standards and Council requirements (refer Table 3). These measures include water quality bio-retention ponds and gross pollutant traps. The ponds are combined with the OSD ponds;

The civil design is carried out in accordance with Council's DCP and technical guidelines. The designs are reflected in the long sections and the typical cross sections detailed in the design drawings. Reference is made to Appendix 6 for more details.

2 INTRODUCTION

2.1 Brief

Cardno ITC have been engaged by Middle East Pty Ltd (The Client) to prepare the subdivision civil design plans for the site at the corner of French Street and The Great Western Highway in Kingswood for the purpose of providing new residential lots.

The Client is proposing to submit a Masterplan for the site and concurrently a Stage 1 Development Application for new residential properties. The site is identified as the Werrington Mixed-Use Area and is controlled by a Development Control Plan prepared by Penrith City Council (PCC) and is known as the "Werrington Mixed-Use Area DCP".

The site is a large land previously owned and occupied by the Defence Forces. A watercourse draining in a South-North direction bisects the site. The watercourse is identified as Category 2 by Council and is located in a conservation area. The subdivision is proposed outside the conservation area.

Cardno ITC was commissioned to carry out the following tasks: -

- A flood study for the watercourse. The study involved hydrological and 1-D hydraulic simulations;
- The civil design of the road network; and
- The stormwater drainage design.

A site visit was undertaken on the 13th of January 2011 to familiarise with the site and the surrounding catchment and to determine opportunities and constraints.

Liaison with the relevant authorities was made including Council, Sydney Water, RTA, The Office of Nepean Hawkesbury and the Department of Water and Energy. Refer to Appendix 7 for copies of correspondence received from the relevant authorities.

This report was compiled to describe the tasks undertaken by Cardno ITC and to provide recommendations relating to the proposed subdivision. This report should be read in conjunction with the design drawings as listed below: -

- C100 – Title Sheet;
- C101 – Site Plan / Staging Plan;
- C200 – General Arrangement Plan;
- C201 – Cut & Fill Plan (not issued in the revised set of drawings);
- C300 – Road Longitudinal Sections – Road 1, 2, 3 & 5;
- C301 – Road Longitudinal Sections – Road 6, 7, 8 & 9 – Road Typical Sections;
- C400 – Stormwater Longitudinal Sections – Sheet 1 of 3;
- C401 – Stormwater Longitudinal Sections – Sheet 2 of 3;
- C402 – Stormwater Longitudinal Sections – Sheet 3 of 3;
- C500 – Details Sheet.

2.2 Report Structure

This report is structured as follows:-

- Section 1 – Executive Summary: this section summarises the tasks and the results of the design and analysis;
- Section 2 – Introduction: this section includes the preliminaries and the objectives of the report;
- Section 3 – Glossary: this section includes the definition of the terms used in the report;
- Section 4 – Project Description: this section describes the existing site, the proposed development and the requirements of the authorities;
- Section 5 – Stormwater Management: the design standards adopted for the internal stormwater are outlined in this section;
- Section 6 – Flood Management: this is the main core section of the report where the hydrology and the hydraulic simulations are detailed;
- Section 7 – Civil Design: the design standards relating to the road design, grading, and other civil components are included in this section; and
- Section 8 – Appendices: the documents referenced in this report are included in this section.

2.3 References

The following documents have been reviewed and checked against the site conditions.

1. Survey drawing ref. A734 prepared by Whelans In-Sites and dated 16/12/2002 detailing the site topography, contours and drainage structures;
2. Survey drawings ref. 3140DT rev. c1 prepared by Stratasurv and dated 19/04/2011 detailing specific areas of the site as requested by Cardno ITC;
3. Proposed subdivision and lots layout plan ref. 3140STAGE01 rev. a10 prepared by Stratasurv and dated 19/12/2011;
4. Proposed Master Plan Study and layout plan prepared by Tony Owen Partners;
5. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 29 July 2010;
6. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 8 September 2010;
7. Pre-DA meeting attended by Cardno ITC in Penrith City Council chambers on 01/03/2011;
8. Catchment Map for the watercourse received from Penrith City Council dated 18 January 2010;
9. Penrith City Council "Development Control Plan 2010", sections C3, C8, C10, C11 & C13;
10. Penrith City Council "Werrington Mixed-Use Area" DCP (effective 23 February 2007);
11. Penrith City Council "Guidelines For Engineering Works and Subdivisions and Developments", part 1 design & part 2 construction dated 20 May 1997;
12. Penrith City Council "WELL Precinct Development Contributions Plan 2008";
13. The NSW Government "Floodplain Development Manual" April 2005; and

14. "Australian Rainfall & Runoff" (AR&R 1997) by Engineers Australia.

3 GLOSSARY

Annual Exceedance Probability (AEP)

The chance of a flood of a given or a larger size occurring in any one year, usually expressed as a percentage.

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Average Recurrence Interval (ARI)

The long term average number of years between the occurrence of a flood as big as or larger than the selected event.

Catchment

The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

Flood

Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse.

Flood Liable Land

Land susceptible to flooding by the PMF.

Flood Planning Levels (FPLs)

Are the combinations of flood levels and freeboards selected for floodplain risk management purposes.

Freeboard

Is a factor of safety typically used in relation to the setting of floor levels.

Habitable Room

In industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to damage in the event of a flood.

Peak Discharge

The maximum discharge occurring during a flood event.

Probable Maximum Flood

PMF is the largest flood that could conceivably occur at a placation, usually estimated from probable maximum precipitation.

Probable Maximum Precipitation

PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year.

Runoff

The amount of rainfall which actually ends up as stream flow.

4 PROJECT DESCRIPTION

4.1 Site Location

The development site is located on the corner of French Street and The Great Western Highway in the suburb of Kingswood. Figure 1 below shows the location of the site.



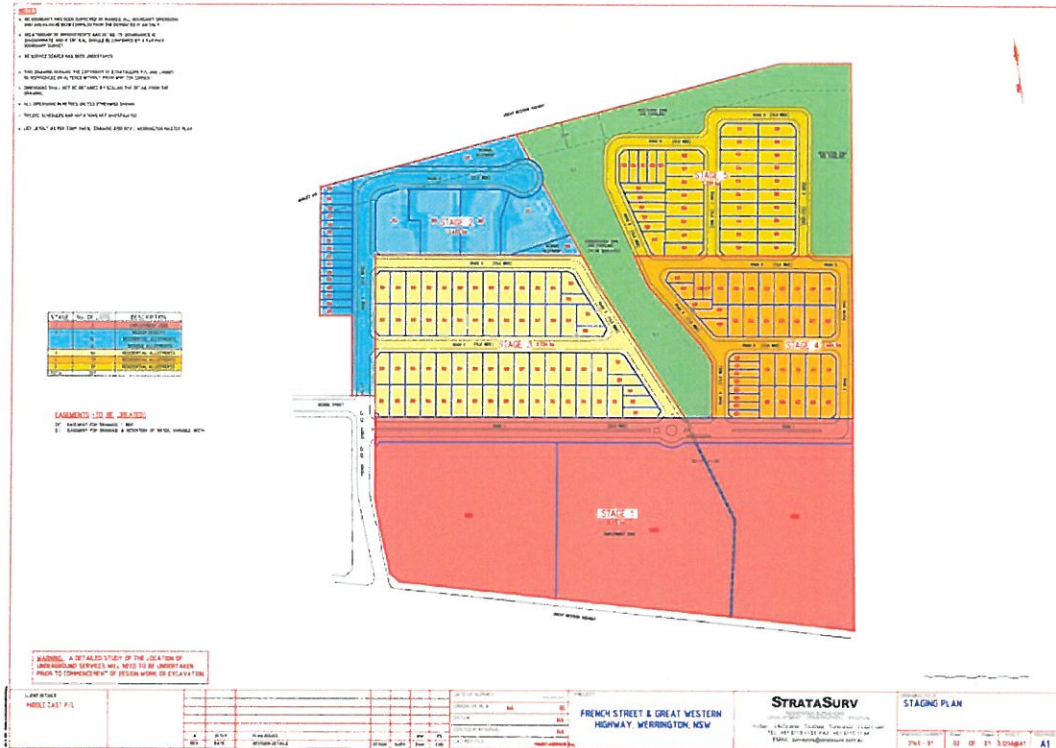
The overall site covers an area of 22.03ha (as per the survey) and is currently a vacant land. A watercourse draining a culvert system under the Great Western Highway bisects the site from south to north.

The watercourse starts from the southern boundary with the highway down to a culvert system under the railway line, which delimits the northern boundary of the site. The western boundary of the site is limited by French Street while the eastern boundary is bounded by adjoining properties and vacant land.

4.2 Development Description

The Client is proposing to subdivide the site, which is already zoned as Mixed-Use Area under Council's current DCP. The intent of the proposal is to provide a masterplan for the whole site and a development application for a Staged residential subdivision.

The layout of the proposed masterplan subdivision is shown below. The staging is also shown different colours as well.



4.3 Site Investigation

A site inspection was carried out by Cardno ITC to familiarise with the site and the surrounding catchment area.

The investigation covered the existing condition of the site, the existing ponds, the watercourse, the culverts under the Great Western Highway and the constructed road and the associated infrastructure. The culverts under the Great Western Railway could not be inspected due to overgrown vegetation in that area.

At the time of our inspection, the watercourse was dry. It is understood that the watercourse flows only during a rainfall event.

4.4 Authorities Requirements

4.4.1 Penrith City Council

The site is located in the Local Government Area of Penrith City Council (PCC). The requirements of PCC are summarised in this section.

The key requirements of PCC in relation to subdivision, flooding and stormwater management are as follows:-

- The watercourse traversing the site is classified as Category 2 and requires 20m core riparian corridor width and 10m vegetated setback on each side totaling an overall width of 40m. (Refer Table C3.3 of DCP 2010);
- 50% flow reduction in downstream pipe systems for partial blockage to be made;
- On-Site Detention is required for the proposed development. The OSDs should be located above the 5-year ARI flood level;
- Water quality requirements to Council's DCP will be required. Level 2 modeling is required because the site falls under the "Medium (10-50ha)" category; and
- The proposed ponds can be located within the drainage reserve as shown in the "Werrington Mixed Use Area" DCP.

4.4.2 Sydney Water

With respect to stormwater, Sydney Water has advised that it does not own any infrastructure in the area and would not have any requirements for stormwater management or flooding.

4.4.3 Office of Nepean and Hawkesbury

- The watercourse is a category 2 so it needs to have 20m riparian width each side of the top of bank of the watercourse;
- Enough space should be allowed for any water quality or quantity basins/structures; and
- Removal of any current works in the watercourse riparian area should be OK with adequate environmental protection, but will need a controlled activity approval. It is best to do this via an integrated development application.

5 STORMWATER MANAGEMENT

5.1 General

The stormwater management covers several aspects of the stormwater design. It includes the following: -

- Urban road drainage design;
- Inter-allotment drainage design for sites with lands that fall away from the street;
- On-Site Detention as requested by Council; and
- Water quality control.

These components are designed to address the requirements of the relevant authorities.

5.2 Urban Drainage Design

The pipe/pit system including the inter-allotment drainage are designed to cater for 10-year ARI storm event with overland flowpath provided for storms in excess of the design storm. The road drainage has been designed using the minor/major system approach with the piped network being the minor and the roads being the major. Refer to the IFD table included in Appendix 1 for rainfall intensity values adopted in the design.

The stormwater drainage will generally follow the natural gradient of the site. Ultimately, the discharge from the site will be maintained to the culverts under the railway line.

An impervious fraction of 0.80 has been adopted for the purpose of sizing the pipe system servicing the subdivision. The following runoff coefficients have been used: -

- $C_{20} = 0.83$; and
- $C_{100} = 0.95$.

The following times of concentration have been adhered to: -

- Minimum $t_c = 6$ minutes; and
- Maximum $t_c = 20$ minutes.

5.3 On-Site Detention

The On-Site Detention (OSD) basins have been sized using "DRAINS" software. The simulations ensured that the site discharge in all storms for the post-developed conditions does not exceed the pre-developed natural state of the site.

It is proposed to retain the existing pond servicing the employment zone and Road 1 (refer to design drawings for location and details). The pond has been constructed as part of the previous subdivision of the site.

Two additional OSD basins are proposed as part of this subdivision to control the runoff from the areas north of Road 1. Basin 1 has a capacity of 1746m³ and controls the runoff from the site area west of the conservation zone. Basin 2 has a capacity of 1014m³ and controls the runoff from the site area east of the conservation zone. Refer to General Arrangement Plan (DRG C200) for location of Basins 1 & 2.

The table on the following page summarises the results of the DRAINS model. The controlled peak flow from the On-Site Detention basins is equal or less than the existing peak flow in all storm events.

Table 1 Summary Results of Basin 1 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.64	1.67	0.63	0.63	0	995
20	1.19	2.37	1.07	0.71	0.36	1478
100	1.86	3.09	1.86	0.74	1.12	1746

Table 2 Summary Results of Basin 2 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.50	1.20	0.50	0.50	0	576
20	0.89	1.67	0.82	0.59	0.23	874
100	1.38	2.11	1.38	0.62	0.76	1014

5.4 Water Quality

To address the water quality requirements, the site's runoff will be treated prior to discharging into the railway culverts. It is proposed to use a treatment train approach to meet the water quality objectives.

The site is classified "Medium (10-50ha) under Council DCP 2010 Section C3 and hence a Level 2 (Actual Event Load) is required to assess the pollutants load from a storm event on a daily basis.

The following table summarises the requirements for pollution retention criteria as required by Council.

Table 3 Pollution Retention Criteria

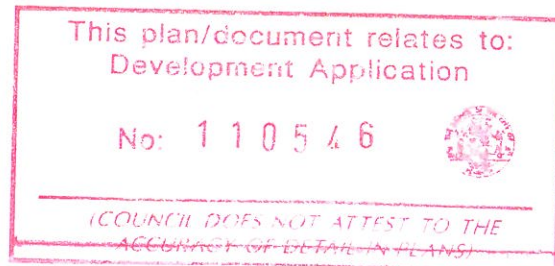
Pollutant	Description	Retention Criteria
Litter	All anthropogenic material (cans, bottles, wrapping, etc.)	70% of material \geq 5mm diameter
Coarse Sediment	Coarse sand (\geq 0.5mm)	80% of the load for particles \leq 0.5mm diameter
Nutrients	Total Phosphorus & total Nitrogen	45% retention of the load for each
Fine Particles	Fine sand (\geq 0.05mm)	50% of the load for particles \leq 0.1mm diameter
Free Oil & Grease	Free floating viscous liquids \geq 150 μ m that do not emulsify in aqueous solutions	90% of the load with no visible discharges

The treatment train approach adopted for the subdivision is described below.

- a. It is assumed that each lot will be fitted with an individual rainwater reuse tank in the future when the lots will be developed with residential single dwellings to respond to BASIX requirements;
- b. It is proposed to install gross pollutant traps in front of the OSD basins. The devices will be designed to capture litter, gross and fine sediments and hydrocarbons generated from the site to manufacturer's requirements. The gully pits in the streets will be fitted with trash baskets only if required by Council; and



Shaping the Future



Werrington Subdivision
Cnr of French Street & Great Western Highway
Kingswood
Civil, Flooding & Stormwater Management Report

Prepared For:

Middle East Pty Ltd

Prepared By:
Cardno ITC
Level 7, 33 YORK STREET
SYDNEY NSW 2000
Tel: 612 9495 8100
Fax: 612 9495 8111

December 2011

DOCUMENT HISTORY

Issue No.	Revision No.	Date	No. of Pages	Comment
A	0	31.03.11	23	Preliminary Issue – Draft Only
A	1	14.04.11	63	Preliminary Issue – For Client Approval
A	2	18.04.11	63	Final Issue
A	3	21.04.11	74	Final Issue – includes Client comments
A	4	29.04.11	74	Final Issue – For submission to Council
A	5	18.05.11	74	Final Issue – For submission to Council
A	6	20.12.11	89	Revised Issue – For submission to Council

DOCUMENT APPROVAL:

Approved by: Sam Haddad Date: 20.12.2011
(Cardno ITC)

Approved by: _____ Date: _____
(Middle East Pty Ltd)

CONTENTS

1 EXECUTIVE SUMMARY	1
2 INTRODUCTION.....	2
2.1 <i>Brief.....</i>	2
2.2 <i>Report Structure</i>	3
2.3 <i>References</i>	3
3 GLOSSARY	5
4 PROJECT DESCRIPTION.....	6
4.1 <i>Site Location.....</i>	6
4.2 <i>Development Description.....</i>	7
4.3 <i>Site Investigation</i>	7
4.4 <i>Authorities Requirements.....</i>	7
5 STORMWATER MANAGEMENT.....	9
5.1 <i>General.....</i>	9
5.2 <i>Urban Drainage Design</i>	9
5.3 <i>On-Site Detention</i>	9
5.4 <i>Water Quality.....</i>	10
5.5 <i>Water Cycle Management Facilities Contributions.....</i>	11
6 FLOOD MANAGEMENT	12
6.1 <i>Description.....</i>	12
6.2 <i>Hydrological Modelling.....</i>	12
6.3 <i>Hydraulic Simulations</i>	14
7 CIVIL DESIGN	25
Appendix 1	26
<i>Rainfall Data.....</i>	26
Appendix 2	29
<i>Catchment Plan.....</i>	29
Appendix 3	31
<i>Results of the Hydrological Modelling.....</i>	31
Appendix 4	33
<i>Results of the Hydraulic Modelling</i>	33
Appendix 5.....	65
<i>Flood Extents Plan</i>	65
Appendix 6.....	67
<i>Design Drawings</i>	67
Appendix 7	80
<i>Authorities Correspondence</i>	80

1 EXECUTIVE SUMMARY

This document is a stormwater management and strategy report for the proposed Mixed-Use subdivision located at the corner of French Street and the Great Western Highway, in the suburb Kingswood.

This report assesses the following:-

1. The flooding impact;
2. The proposed strategy for the internal stormwater drainage; and
3. The road network design.

The report describes the proposed masterplan in general and the Stage 1 Development Application in specific.

The site is identified as the Werrington Mixed-Use Area. The site is divided into residential and employment zoning. The residential zone is subject to a Stage 1 Development Application and a Stage 2 planning proposal.

The site is located within the Werrington Creek Catchment Area. A watercourse (classified as Category 2) draining in a South-North direction bisects the site. The watercourse collects the runoff from a culvert crossing under the Great Western Highway. The watercourse terminates in a culvert under the Western Railway line.

A flood study for the watercourse has been prepared. The study assesses the existing and the proposed flooding scenarios following the development of the site. The impacts of the flooding on the development and vice versa are considered. The results of the simulations indicate that the proposed subdivision is outside the flood prone area and does not alter the flooding characteristics through the site.

Provisions are made for the internal drainage network servicing the proposed subdivision. The stormwater management involves the following aspects:-

- Urban drainage design to drain all the lots into the street drainage system. The design caters for a 10-year ARI storm event;
- Provision of On-Site Detention (OSD) systems to control the discharge flows from the site. The OSDs are provided in the shape of basins/ponds located in the drainage reserve; and
- Provision of water quality measures to control the quality of water discharging from the site to current industry standards and Council requirements (refer Table 3). These measures include water quality bio-retention ponds and gross pollutant traps. The ponds are combined with the OSD ponds;

The civil design is carried out in accordance with Council's DCP and technical guidelines. The designs are reflected in the long sections and the typical cross sections detailed in the design drawings. Reference is made to Appendix 6 for more details.

2 INTRODUCTION

2.1 Brief

Cardno ITC have been engaged by Middle East Pty Ltd (The Client) to prepare the subdivision civil design plans for the site at the corner of French Street and The Great Western Highway in Kingswood for the purpose of providing new residential lots.

The Client is proposing to submit a Masterplan for the site and concurrently a Stage 1 Development Application for new residential properties. The site is identified as the Werrington Mixed-Use Area and is controlled by a Development Control Plan prepared by Penrith City Council (PCC) and is known as the "Werrington Mixed-Use Area DCP".

The site is a large land previously owned and occupied by the Defence Forces. A watercourse draining in a South-North direction bisects the site. The watercourse is identified as Category 2 by Council and is located in a conservation area. The subdivision is proposed outside the conservation area.

Cardno ITC was commissioned to carry out the following tasks: -

- A flood study for the watercourse. The study involved hydrological and 1-D hydraulic simulations;
- The civil design of the road network; and
- The stormwater drainage design.

A site visit was undertaken on the 13th of January 2011 to familiarise with the site and the surrounding catchment and to determine opportunities and constraints.

Liaison with the relevant authorities was made including Council, Sydney Water, RTA, The Office of Nepean Hawkesbury and the Department of Water and Energy. Refer to Appendix 7 for copies of correspondence received from the relevant authorities.

This report was compiled to describe the tasks undertaken by Cardno ITC and to provide recommendations relating to the proposed subdivision. This report should be read in conjunction with the design drawings as listed below: -

- C100 – Title Sheet;
- C101 – Site Plan / Staging Plan;
- C200 – General Arrangement Plan;
- C201 – Cut & Fill Plan (not issued in the revised set of drawings);
- C300 – Road Longitudinal Sections – Road 1, 2, 3 & 5;
- C301 – Road Longitudinal Sections – Road 6, 7, 8 & 9 – Road Typical Sections;
- C400 – Stormwater Longitudinal Sections – Sheet 1 of 3;
- C401 – Stormwater Longitudinal Sections – Sheet 2 of 3;
- C402 – Stormwater Longitudinal Sections – Sheet 3 of 3;
- C500 – Details Sheet.

2.2 Report Structure

This report is structured as follows:-

- Section 1 – Executive Summary: this section summarises the tasks and the results of the design and analysis;
- Section 2 – Introduction: this section includes the preliminaries and the objectives of the report;
- Section 3 – Glossary: this section includes the definition of the terms used in the report;
- Section 4 – Project Description: this section describes the existing site, the proposed development and the requirements of the authorities;
- Section 5 – Stormwater Management: the design standards adopted for the internal stormwater are outlined in this section;
- Section 6 – Flood Management: this is the main core section of the report where the hydrology and the hydraulic simulations are detailed;
- Section 7 – Civil Design: the design standards relating to the road design, grading, and other civil components are included in this section; and
- Section 8 – Appendices: the documents referenced in this report are included in this section.

2.3 References

The following documents have been reviewed and checked against the site conditions.

1. Survey drawing ref. A734 prepared by Whelans In-Sites and dated 16/12/2002 detailing the site topography, contours and drainage structures;
2. Survey drawings ref. 3140DT rev. c1 prepared by Stratasurv and dated 19/04/2011 detailing specific areas of the site as requested by Cardno ITC;
3. Proposed subdivision and lots layout plan ref. 3140STAGE01 rev. a10 prepared by Stratasurv and dated 19/12/2011;
4. Proposed Master Plan Study and layout plan prepared by Tony Owen Partners;
5. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 29 July 2010;
6. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 8 September 2010;
7. Pre-DA meeting attended by Cardno ITC in Penrith City Council chambers on 01/03/2011;
8. Catchment Map for the watercourse received from Penrith City Council dated 18 January 2010;
9. Penrith City Council "Development Control Plan 2010", sections C3, C8, C10, C11 & C13;
10. Penrith City Council "Werrington Mixed-Use Area" DCP (effective 23 February 2007);
11. Penrith City Council "Guidelines For Engineering Works and Subdivisions and Developments", part 1 design & part 2 construction dated 20 May 1997;
12. Penrith City Council "WELL Precinct Development Contributions Plan 2008";
13. The NSW Government "Floodplain Development Manual" April 2005; and

3 GLOSSARY

Annual Exceedance Probability (AEP)

The chance of a flood of a given or a larger size occurring in any one year, usually expressed as a percentage.

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Average Recurrence Interval (ARI)

The long term average number of years between the occurrence of a flood as big as or larger than the selected event.

Catchment

The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

Flood

Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse.

Flood Liable Land

Land susceptible to flooding by the PMF.

Flood Planning Levels (FPLs)

Are the combinations of flood levels and freeboards selected for floodplain risk management purposes.

Freeboard

Is a factor of safety typically used in relation to the setting of floor levels.

Habitable Room

In industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to damage in the event of a flood.

Peak Discharge

The maximum discharge occurring during a flood event.

Probable Maximum Flood

PMF is the largest flood that could conceivably occur at a location, usually estimated from probable maximum precipitation.

Probable Maximum Precipitation

PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year.

Runoff

The amount of rainfall which actually ends up as stream flow.

4 PROJECT DESCRIPTION

4.1 Site Location

The development site is located on the corner of French Street and The Great Western Highway in the suburb of Kingswood. Figure 1 below shows the location of the site.



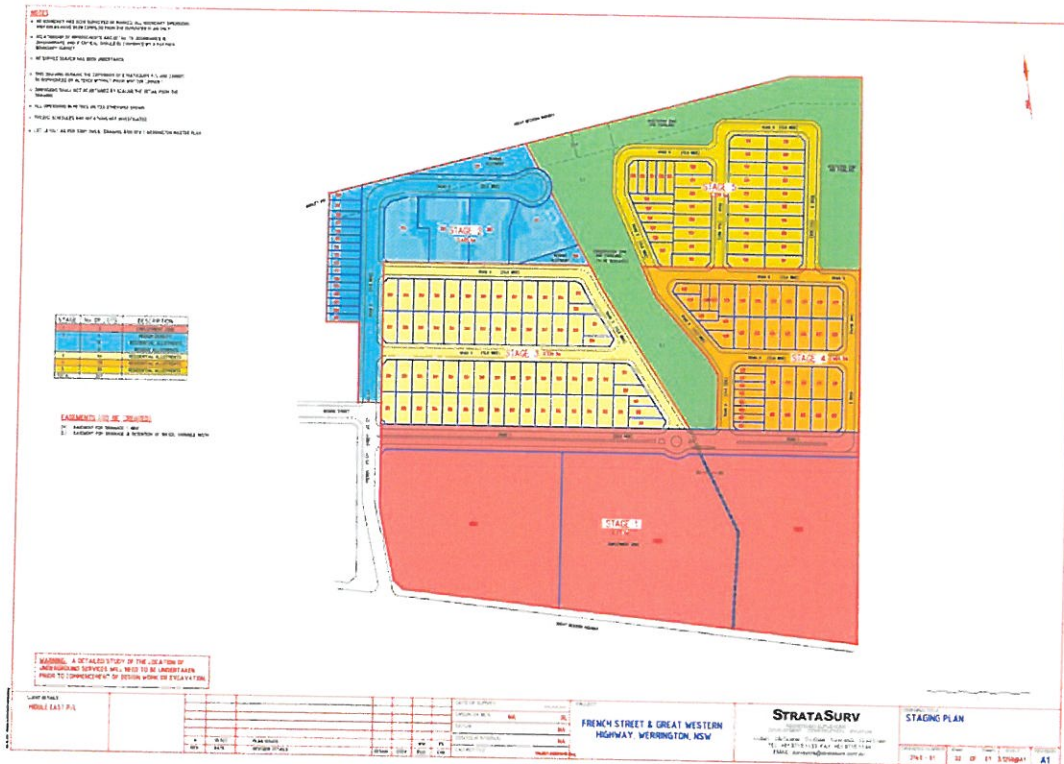
The overall site covers an area of 22.03ha (as per the survey) and is currently a vacant land. A watercourse draining a culvert system under the Great Western Highway bisects the site from south to north.

The watercourse starts from the southern boundary with the highway down to a culvert system under the railway line, which delimits the northern boundary of the site. The western boundary of the site is limited by French Street while the eastern boundary is bounded by adjoining properties and vacant land.

4.2 Development Description

The Client is proposing to subdivide the site, which is already zoned as Mixed-Use Area under Council's current DCP. The intent of the proposal is to provide a masterplan for the whole site and a development application for a Staged residential subdivision.

The layout of the proposed masterplan subdivision is shown below. The staging is also shown different colours as well.



4.3 Site Investigation

A site inspection was carried out by Cardno ITC to familiarise with the site and the surrounding catchment area.

The investigation covered the existing condition of the site, the existing ponds, the watercourse, the culverts under the Great Western Highway and the constructed road and the associated infrastructure. The culverts under the Great Western Railway could not be inspected due to overgrown vegetation in that area.

At the time of our inspection, the watercourse was dry. It is understood that the watercourse flows only during a rainfall event.

4.4 Authorities Requirements

4.4.1 Penrith City Council

The site is located in the Local Government Area of Penrith City Council (PCC). The requirements of PCC are summarised in this section.

The key requirements of PCC in relation to subdivision, flooding and stormwater management are as follows:-

- The watercourse traversing the site is classified as Category 2 and requires 20m core riparian corridor width and 10m vegetated setback on each side totaling an overall width of 40m. (Refer Table C3.3 of DCP 2010);
- 50% flow reduction in downstream pipe systems for partial blockage to be made;
- On-Site Detention is required for the proposed development. The OSDs should be located above the 5-year ARI flood level;
- Water quality requirements to Council's DCP will be required. Level 2 modeling is required because the site falls under the "Medium (10-50ha)" category; and
- The proposed ponds can be located within the drainage reserve as shown in the "Werrington Mixed Use Area" DCP.

4.4.2 Sydney Water

With respect to stormwater, Sydney Water has advised that it does not own any infrastructure in the area and would not have any requirements for stormwater management or flooding.

4.4.3 Office of Nepean and Hawkesbury

- The watercourse is a category 2 so it needs to have 20m riparian width each side of the top of bank of the watercourse;
- Enough space should be allowed for any water quality or quantity basins/structures; and
- Removal of any current works in the watercourse riparian area should be OK with adequate environmental protection, but will need a controlled activity approval. It is best to do this via an integrated development application.

5 STORMWATER MANAGEMENT

5.1 General

The stormwater management covers several aspects of the stormwater design. It includes the following: -

- Urban road drainage design;
- Inter-allotment drainage design for sites with lands that fall away from the street;
- On-Site Detention as requested by Council; and
- Water quality control.

These components are designed to address the requirements of the relevant authorities.

5.2 Urban Drainage Design

The pipe/pit system including the inter-allotment drainage are designed to cater for 10-year ARI storm event with overland flowpath provided for storms in excess of the design storm. The road drainage has been designed using the minor/major system approach with the piped network being the minor and the roads being the major. Refer to the IFD table included in Appendix 1 for rainfall intensity values adopted in the design.

The stormwater drainage will generally follow the natural gradient of the site. Ultimately, the discharge from the site will be maintained to the culverts under the railway line.

An impervious fraction of 0.80 has been adopted for the purpose of sizing the pipe system servicing the subdivision. The following runoff coefficients have been used: -

- $C_{20} = 0.83$; and
- $C_{100} = 0.95$.

The following times of concentration have been adhered to: -

- Minimum $t_c = 6$ minutes; and
- Maximum $t_c = 20$ minutes.

5.3 On-Site Detention

The On-Site Detention (OSD) basins have been sized using "DRAINS" software. The simulations ensured that the site discharge in all storms for the post-developed conditions does not exceed the pre-developed natural state of the site.

It is proposed to retain the existing pond servicing the employment zone and Road 1 (refer to design drawings for location and details). The pond has been constructed as part of the previous subdivision of the site.

Two additional OSD basins are proposed as part of this subdivision to control the runoff from the areas north of Road 1. Basin 1 has a capacity of 1746m³ and controls the runoff from the site area west of the conservation zone. Basin 2 has a capacity of 1014m³ and controls the runoff from the site area east of the conservation zone. Refer to General Arrangement Plan (DRG C200) for location of Basins 1 & 2.

The table on the following page summarises the results of the DRAINS model. The controlled peak flow from the On-Site Detention basins is equal or less than the existing peak flow in all storm events.

Table 1 Summary Results of Basin 1 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.64	1.67	0.63	0.63	0	995
20	1.19	2.37	1.07	0.71	0.36	1478
100	1.86	3.09	1.86	0.74	1.12	1746

Table 2 Summary Results of Basin 2 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.50	1.20	0.50	0.50	0	576
20	0.89	1.67	0.82	0.59	0.23	874
100	1.38	2.11	1.38	0.62	0.76	1014

5.4 Water Quality

To address the water quality requirements, the site's runoff will be treated prior to discharging into the railway culverts. It is proposed to use a treatment train approach to meet the water quality objectives.

The site is classified "Medium (10-50ha) under Council DCP 2010 Section C3 and hence a Level 2 (Actual Event Load) is required to assess the pollutants load from a storm event on a daily basis.

The following table summarises the requirements for pollution retention criteria as required by Council.

Table 3 Pollution Retention Criteria

Pollutant	Description	Retention Criteria
Litter	All anthropogenic material (cans, bottles, wrapping, etc.)	70% of material \geq 5mm diameter
Coarse Sediment	Coarse sand (\geq 0.5mm)	80% of the load for particles \leq 0.5mm diameter
Nutrients	Total Phosphorus & total Nitrogen	45% retention of the load for each
Fine Particles	Fine sand (\geq 0.05mm)	50% of the load for particles \leq 0.1mm diameter
Free Oil & Grease	Free floating viscous liquids \geq 150 μ m that do not emulsify in aqueous solutions	90% of the load with no visible discharges

The treatment train approach adopted for the subdivision is described below.

- It is assumed that each lot will be fitted with an individual rainwater reuse tank in the future when the lots will be developed with residential single dwellings to respond to BASIX requirements;
- It is proposed to install gross pollutant traps in front of the OSD basins. The devices will be designed to capture litter, gross and fine sediments and hydrocarbons generated from the site to manufacturer's requirements. The gully pits in the streets will be fitted with trash baskets only if required by Council; and

- c. Water quality bio-retention ponds are proposed in conjunction with the OSD basins. The basins will be underlain with a layer of fine material and a network of subsoil pipes. The purpose of the fine material is to treat the runoff from the 3-month storm through percolation. The runoff will be drained through the subsoil network and discharged into the stormwater system. The ponds could possibly have an extended depth as well to allow for more treatment volume and time.

The performance of the above treatment train measures will be verified against the criteria in Table 3 by calculations and real rainfall event simulations using "MUSIC" software in the advanced stages of the design development.

5.5 Water Cycle Management Facilities Contributions

Under the WELL Precinct Development Contributions Plan, there are contributions for the Water Cycle Management Facilities to be provided by the developer. The contributions for the Werrington Mixed Use Area are calculated as follows:-

Net Developable Area of the site for Stage 1 (for catchments) = 8.618ha;
Contributions per hectare = \$209,040.00. This includes for the land acquisition and the works for both wp8-r1 & wp8-r2 as noted in the DCP;

The Water Cycle Management Facilities Contributions are: $8.618 \times 209040 = \$1,801,506.72$.

6 FLOOD MANAGEMENT

6.1 Description

This section outlines the flooding requirements for the proposed subdivision due to the presence of the watercourse. For the purpose of the Master Plan submission, Cardno ITC have carried out a flood study to determine the impacts of the flooding if there are any.

The site is bisected by a watercourse traversing the site from the culverts under the Great Western Highway down to the culverts under the Railway Corridor. The area of the watercourse is considered a conservation zone and is potentially subject to flooding in major storm events.

The culverts are as follows:-

- Under the Great Western Highway: two box sections 1.86m wide and 1.25m high; and
- Under the Great Western Railway: one circular conduit 1.5m diameter.

Another minor overland flowpath enters the site from the eastern boundary and connects to the watercourse in the middle of the site.

The flood study is divided into two sections: hydrological and hydraulic simulations. These simulations respond to Council's requirements.

6.1.1 Hydrology

The hydrological analysis of the flood study identifies the characteristics of the catchment and determines the flood peak discharge through the site.

The rainfall intensities obtained from Council's Guidelines for Works and Subdivisions (1997) and included in Appendix 1, have been used in the hydrological "DRAINS" model prepared to simulate the runoff for the upstream catchment.

6.1.2 Hydraulic Simulations

The flood peak values derived from the hydrological analysis are used to assess the capacity of the watercourse to carry the flows and to determine the peak flood levels expected to be reached for each storm event.

The hydraulic simulations have been carried out using the 1-D software "HECRAS" as required by Council. The existing watercourse cross sectional area has been extracted from the detailed survey plan of the site and used to build the "HECRAS" model. The extent of the model is limited to the site boundaries.

6.2 Hydrological Modelling

A "DRAINS" model is built to replicate the catchment's hydrology and to estimate the peak flood discharges for any observed or synthetic storm. Parameters such as catchment area, impervious area and rainfall losses are used to describe the catchment response to a specific rainfall event in order to generate synthetic peak flood flows where required.

The catchment area was subdivided into several sub-catchments based on the topography and the outlet controls (i.e. location of culverts, roads blocking flows, direction of flows, etc.). Reference is made to Appendix 2 for the layout of the sub-catchments.

The catchment area extends into the Western Sydney University to the South. The impact of the ponds servicing the university has not been included in the simulations. These could have a retarding affect on the runoff and could potentially reduce the peak flood discharge into the site. The approach is rather conservative and could lead to higher flows through the site but is considered acceptable for the purpose of this study.

The catchment extends into adjoining properties to the east. This catchment has been included as a separate sub-catchment, which drains through a depression within the site and discharges into the watercourse.

The northern and western boundaries of the catchment are bounded by the railway corridor and French Street respectively. There are no external catchments in these directions.

The catchments are classified as follows:

- Catchment A (UWS) is mainly pervious and is assigned a retardance coefficient of 0.1;
- Catchment B (Employment zone of site) is assigned a retardance coefficient of 0.05;
- Catchment B1 (adjoining site to the east) is considered to be residential in the future and is assigned a retardance coefficient of 0.08; and
- Catchment C (residential zone of site) is assigned a retardance coefficient of 0.08.

The simulations were carried out for the 5, 20 & 100 year ARI storm events.

The table below shows the peak flood discharges through the sub-catchments.

Table 4 Summary Results of Hydrological Simulations

ARI (yrs)	Cat A Flow (m ³ /s)	Cat B Flow (m ³ /s)	Cat B1 Flow (m ³ /s)	Cat C Flow (m ³ /s)	Total Flow (m ³ /s)
5	1.67	2.29	0.66	0.50	3.87
20	2.63	3.53	1.02	0.78	5.68
100	3.89	4.89	1.47	1.19	7.91

The total flow indicated in the last column of the table does not equal the sum of the sub-catchment flows because of the partial areas effect.

6.2.1 Option A – Employment area rezoned to residential

This option considers the rezoning of the employment area of the site into residential. The purpose of this option is to determine the impact (if any) of such rezoning on the flood peak discharge into the watercourse.

The “DRAINS” model was re-configured with the retardance coefficient for the employment zone increased to 0.08.

The results of the simulations are included in the following table and compared with the results in Table 4 above.

Table 5 Summary Results of Modified Hydrological Simulations & Comparison with previous results

ARI (yrs)	Total Flow (m ³ /s)	Total Flow – Option A (m ³ /s)
5	3.87	3.97
20	5.68	6.07
100	7.91	8.55

It is obvious from the above results that the peak flood discharge into the watercourse increases if the rezoning occurs and this is due to the partial area effects within the catchment and the time of concentration for each sub-catchment. Option A was not considered in the following sections of this report or in the modelling.

6.3 Hydraulic Simulations

6.3.1 General

A "HECRAS" model was configured to simulate the existing watercourse crossing the site and to determine the flood levels across the site and to plot the water surface profile. The data included in the HECRAS model was extrapolated from Digital Terrain Model (DTM) created from the detailed survey of the site. Cross sections at 20m intervals were created from the DTM and exported into the HECRAS model as well.

A culvert program was used to estimate the flow rates for the unblocked and blocked (50%) culvert scenarios. This was used to determine the depth of blockages in the culverts to replicate a 50% blockage factor as required by Council.

The flood peak discharges derived from the "DRAINS" model were inserted in HECRAS model in the Steady Mode. A blockage factor of 50% is applied to the flows in the downstream culverts under the railway lines.

Manning's roughness coefficient of 0.035 was adopted for the main watercourse, with the banks having a higher roughness of 0.1.

For the purpose of the flood study, three (3) separate runs were performed to accurately simulate the different scenarios within the site. In summary, the runs are as follows: -

- **Plan "01 EXISTING"** – Existing site conditions (no blockages): this run simulates the existing site and watercourse conditions without any blockages applied to the upstream and downstream culverts;
- **Plan "02 EXG BL"** – Existing site conditions (with blockages): this run is similar to Plan 01 EXG with blockages applied to the upstream and downstream culverts to achieve 50% reduction in the piped flows;
- **Plan "03 PROPOSED"** – Proposed site (with blockages): this run simulates the proposed site with the subdivision layout with blockages applied to the upstream and downstream culverts.

6.3.2 Plan "01 EXISTING"

The cross sections at 20 metres intervals were included in the geometry file of HECRAS. This included the existing culverts under the Great Western Highway, the road through the site and the Great Western Railway.

The watercourse is labelled in HECRAS as follows: -

- Reach '1': segment of watercourse downstream of internal road and side overland flow from the east down to the culverts under the Railway corridor;
- Reach '2': segment of watercourse upstream of internal road up to the culverts under the Great Western Highway; and
- Reach 'side': Natural overland flowpath from the eastern boundary of the site.

The boundary conditions used for the purpose of the modelling are as follows: -

- Normal Depth upstream of the site. Normal depth of 1% is adopted as upstream boundary condition; and
- Normal Depth downstream of the site. Normal depth of 1% is adopted for the downstream boundary condition. This value is considered appropriate, as the Energy Slope in the downstream sections appear to be in the order of 0.5% to 1% depending on the storm event.

A summary of the results in Plan 01 for key sections is tabulated below. Reference should be made to Appendix 5 for the layout and the location of the sections. Detailed modelling results are included in Appendix 4.

Table 6 Summary Results of Plan "01 EXISTING" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)
side	of path	180	20-ARI	1.02	43.7	43.8	1.01
side	of path	180	100-ARI	1.47	43.7	43.82	1.12
side	of path	180	5 ARI	0.66	43.7	43.78	0.85
side	of path	100	20-ARI	1.02	41	41.1	1.74
side	of path	100	100-ARI	1.47	41	41.18	1.13
side	of path	100	5 ARI	0.66	41	41.08	1.6
side	of path	20	20-ARI	1.02	38.2	38.85	0.11
side	of path	20	100-ARI	1.47	38.2	38.93	0.13
side	of path	20	5 ARI	0.66	38.2	38.78	0.08
2	main us	574.81	20-ARI	2.63	43.9	44.43	1.02
2	main us	574.81	100-ARI	3.89	43.9	44.62	0.98
2	main us	574.81	5 ARI	1.67	43.9	44.24	1.15
2	main us	550				Culvert under Great Western Highway	
2	main us	534.27	20-ARI	2.63	42.81	43	1.17
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18
2	main us	534.27	5 ARI	1.67	42.81	42.95	1.33
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.12
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.26
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.95
2	main us	354.27	20-ARI	2.63	40	40.18	1.18
2	main us	354.27	100-ARI	3.89	40	40.23	1.3
2	main us	354.27	5 ARI	1.67	40	40.14	1.09
2	main us	330				Culvert under internal road	
2	main us	314.27	20-ARI	2.63	38.2	38.86	0.25
2	main us	314.27	100-ARI	3.89	38.2	38.94	0.31
2	main us	314.27	5 ARI	1.67	38.2	38.78	0.18

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
1	main ds	160	20-ARI	5.68	36.98	37.22	1.32	
1	main ds	160	100-ARI	7.91	36.98	37.27	1.44	
1	main ds	160	5 ARI	3.87	36.98	37.19	1.1	
1	main ds	40	20-ARI	5.68	35.33	36.19	0.15	
1	main ds	40	100-ARI	7.91	35.33	36.8	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.56	0.6	
1	main ds	7.76	20-ARI	5.68	33.84	36.18	0.18	
1	main ds	7.76	100-ARI	7.91	33.84	36.8	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.47	0.2	
1	main ds	5	Culvert under Railway Line					
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41	
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59	
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22	

The results in Table 6 above indicate that the culvert under the railway is not large enough to cope with the peak flood discharge in a 100-year ARI storm event, which overtops the railway line. This is obviously due to the limited capacity of the 1500mm pipe culvert under the existing site conditions.

The watercourse area upstream of the culvert becomes inundated and water is stored temporarily in that area until such time the storm magnitude has reduced and the culvert is capable of discharging the incoming flows.

6.3.3 Plan "02 EXG BL"

Plan 02 is similar to Plan 01 with blockages to the upstream and to the downstream culverts under the Great Western Highway and the Great Western Railway respectively added to the HECRAS model. The blockages are included in the culvert geometry file by applying blockages to the bottom depth of the culverts such that the flow is reduced by 50% as requested by Council.

This plan is prepared to simulate the impact of the downstream culvert blockage on the flood levels across the site.

This was achieved by incorporating the obstructions as follows: -

Section	Description	Depth Blocked (m)
550	GWH culverts	0.4
5	GWR culverts	0.3

The detailed results of the simulations are included in Appendix 4 for reference. A summary of the results outlining the flood levels in key cross sections of the existing creek is shown in Table 8 below.

Table 8 Summary Results of Plan "02 EXG BL" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
side	of path	180	20-ARI	1.02	43.7	43.8	1.01	
side	of path	180	100-ARI	1.47	43.7	43.82	1.12	
side	of path	180	5 ARI	0.66	43.7	43.78	0.85	
side	of path	100	20-ARI	1.02	41	41.1	1.74	
side	of path	100	100-ARI	1.47	41	41.18	1.13	
side	of path	100	5 ARI	0.66	41	41.08	1.6	
side	of path	20	20-ARI	1.02	38.2	38.85	0.11	
side	of path	20	100-ARI	1.47	38.2	38.93	0.13	
side	of path	20	5 ARI	0.66	38.2	38.78	0.08	
2	main us	574.81	20-ARI	2.63	43.9	44.87	0.42	
2	main us	574.81	100-ARI	3.89	43.9	45.06	0.47	
2	main us	574.81	5 ARI	1.67	43.9	44.7	0.36	
2	main us	550	Culvert under Great Western Highway					
2	main us	534.27	20-ARI	2.63	42.81	43.01	1.04	
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18	
2	main us	534.27	5 ARI	1.67	42.81	42.98	0.94	
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.12	
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.26	
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.95	
2	main us	354.27	20-ARI	2.63	40	40.21	1.17	
2	main us	354.27	100-ARI	3.89	40	40.25	1.26	
2	main us	354.27	5 ARI	1.67	40	40.16	1.05	
2	main us	330	Culvert under internal road					
2	main us	314.27	20-ARI	2.63	38.2	38.86	0.25	

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
2	main us	314.27	100-ARI	3.89	38.2	38.94	0.31	
2	main us	314.27	5 ARI	1.67	38.2	38.78	0.18	
1	main ds	160	20-ARI	5.68	36.98	37.22	1.32	
1	main ds	160	100-ARI	7.91	36.98	37.27	1.44	
1	main ds	160	5 ARI	3.87	36.98	37.19	1.1	
1	main ds	40	20-ARI	5.68	35.33	36.74	0.08	
1	main ds	40	100-ARI	7.91	35.33	36.84	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.79	0.22	
1	main ds	7.76	20-ARI	5.68	33.84	36.74	0.14	
1	main ds	7.76	100-ARI	7.91	33.84	36.84	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.79	0.16	
1	main ds	5	Culvert under Railway Line					
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41	
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59	
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22	

The results in Table 8 above indicate that the blockage in GWR culverts affect the flood level in the upstream sections closer to the culverts. The impact of the blockage is more significant for the minor storms as opposed to the major storms as outlined in the table below.

In summary, the water level before the culvert rises 550mm in the 20-year ARI, 40mm in the 100-year ARI and 230mm in the 5-year ARI due to the partial blockage of the culvert. (Refer River Station 7.76 in Table 9 below).

In this scenario, the peak discharge floods in a 20-year ARI storm event could potentially overtop the railway lines. However, the flood levels in a 20-year ARI storm event are still below the 100-year ARI storm event in the existing scenario (PLAN 01). This indicates that the 20-year flood level will not have an adverse impact on the proposed levels within the subdivision.

The increase in the 100-year flood levels is minimal and is still below the proposed levels within the subdivision.

Table 9 Comparison of Flood Level in Lower Sections of the watercourse

River Station	Profile	Plan	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)
60	20-ARI	Exist_b	5.68	35.49	36.74
60	20-ARI	Exist	5.68	35.49	36.19

River Station	Profile	Plan	Q Total (m ³ /s)	Min Ch EI (m)	W.S. Elevation (m)
60	100-ARI	Exist_b	7.91	35.49	36.84
60	100-ARI	Exist	7.91	35.49	36.8
60	5 ARI	Exist_b	3.87	35.49	35.8
60	5 ARI	Exist	3.87	35.49	35.69
40	20-ARI	Exist_b	5.68	35.33	36.74
40	20-ARI	Exist	5.68	35.33	36.19
40	100-ARI	Exist_b	7.91	35.33	36.84
40	100-ARI	Exist	7.91	35.33	36.8
40	5 ARI	Exist_b	3.87	35.33	35.79
40	5 ARI	Exist	3.87	35.33	35.56
7.76	20-ARI	Exist_b	5.68	33.84	36.74
7.76	20-ARI	Exist	5.68	33.84	36.18
7.76	100-ARI	Exist_b	7.91	33.84	36.84
7.76	100-ARI	Exist	7.91	33.84	36.80
7.76	5 ARI	Exist_b	3.87	33.84	35.79
7.76	5 ARI	Exist	3.87	33.84	35.47

5

Culvert under Railway Line

6.3.4 Plan "03 PROPOSED"

In Plan 03, the geometry file is amended to include the road levels on each side of the watercourse and to determine the impacts (if any) of these level changes on the flooding behaviour. The edges of the roads bounding the watercourse are included as levees in the model. In this case, the width of the flow is restricted to the width of the conservation zone (40m as a minimum).

The flow entering the site from the eastern boundary is diverted around the proposed subdivision and discharges directly into the culvert under the railway line. This is also reflected in this run.

The existing culvert under the internal road is removed and replaced with a proposed culvert under Road 1. The proposed culvert is similar to the existing culvert in shape and size and consists of three box sections 2.7m wide and 0.6m high.

The results of the simulations for Plan 03 are summarised in Table 10 below. Reference should be made to Appendix 4 for detailed results of the simulations.

Table 10 Summary Results of Plan "03 PROPOSED" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch EI (m)	W.S. Elevation (m)	Velocity Channel (m/s)
2	main us	574.81	20-ARI	2.63	43.9	44.87	0.42

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
2	main us	574.81	100-ARI	3.89	43.9	45.06	0.47	
2	main us	574.81	5 ARI	1.67	43.9	44.7	0.36	
2	main us	550	Culvert under Great Western Highway					
2	main us	534.27	20-ARI	2.63	42.81	43.01	1.1	
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18	
2	main us	534.27	5 ARI	1.67	42.81	42.98	0.93	
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.11	
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.28	
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.98	
2	main us	394.27	20-ARI	2.63	40.5	41.02	0.3	
2	main us	394.27	100-ARI	3.89	40.5	41.13	0.33	
2	main us	394.27	5 ARI	1.67	40.5	40.92	0.26	
2	main us	375	Proposed culvert under Road 1					
2	main us	314.27	20-ARI	2.63	38.2	38.83	0.27	
2	main us	314.27	100-ARI	3.89	38.2	38.9	0.34	
2	main us	314.27	5 ARI	1.67	38.2	38.76	0.2	
1	main ds	160	20-ARI	4.66	36.98	37.2	1.25	
1	main ds	160	100-ARI	6.44	36.98	37.24	1.37	
1	main ds	160	5 ARI	3.21	36.98	37.17	1.04	
1	main ds	40	20-ARI	5.68	35.33	36.74	0.08	
1	main ds	40	100-ARI	7.91	35.33	36.84	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.79	0.22	
1	main ds	7.76	20-ARI	5.68	33.84	36.74	0.14	
1	main ds	7.76	100-ARI	7.91	33.84	36.84	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.79	0.16	
1	main ds	5	Culvert under Railway Line					

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22

The results in Table 10 above indicate that the proposed subdivision does not impact on the flooding as there is no increase in flood levels along the watercourse.

This is demonstrated in Table 11 below, which compares the flood levels along the watercourse for all three plans described above.

The subdivision, as per the proposed lot layout, is not affected by flooding from the watercourse in all storm events up to and including the 100-year ARI storm event.

The proposed road network bounding the watercourse has a minimum finished surface level of RL37.00 at the lowest points, which is 160mm above the worst-case scenario flood level.

The proposed filling under Roads 3 & 6 adjoining the watercourse will not impact on the flooding behaviour and characteristics as outlined in Section 15 of Council's DCP 2010 Part C3. The results of the simulations indicate that all the criteria in that section of the DCP have been complied with.

The proposed residential lots are set at higher levels and will provide a minimum of 500mm freeboard above the 100-year ARI flood level.

HEC-RAS (Continued)

River	Reach	River Sta	Profile	Plan	O Total (m ³ /s)	Min Ch El (m)	WS Elev (m)	Crit WS (m)	EG Elev (m)	EG Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Fr. d/s # Chl
2	main us	374.27	5 ARI	Exist	1.67	40.74	40.51	40.48	40.54	0.011979	0.74	2.24	19.35	0.70
2	main us	354.27	20-ARI	Exist b	2.63	40.00	40.21	40.21	40.27	0.023688	1.17	2.25	16.44	1.01
2	main us	354.27	20-ARI	Proposed	2.63	40.00	40.21	40.21	40.27	0.023676	1.17	2.25	16.43	1.01
2	main us	354.27	100-ARI	Exist b	3.89	40.00	40.25	40.25	40.33	0.021856	1.26	3.10	15.06	1.00
2	main us	354.27	100-ARI	Proposed	3.89	40.00	40.25	40.25	40.33	0.022372	1.27	3.07	16.99	1.01
2	main us	354.27	5 ARI	Exist b	1.67	40.00	40.16	40.16	40.22	0.021963	1.06	1.68	14.74	1.00
2	main us	354.27	5 ARI	Proposed	1.67	40.00	40.16	40.16	40.22	0.024805	1.04	1.60	14.27	0.99
2	main us	354.27	5 ARI	Exist	1.67	40.00	40.16	40.16	40.22	0.024362	1.04	1.61	14.29	0.99
2	main us	330		Culvert										
2	main us	314.27	20-ARI	Exist b	2.63	38.20	38.66	38.41	38.56	0.000184	0.27	10.64	21.80	0.11
2	main us	314.27	20-ARI	Proposed	2.63	38.20	38.63	38.41	38.53	0.000222	0.27	9.92	20.49	0.12
2	main us	314.27	100-ARI	Exist b	3.89	38.20	38.94	38.46	38.95	0.000254	0.31	12.43	20.80	0.11
2	main us	314.27	100-ARI	Proposed	3.89	38.20	38.90	38.45	38.91	0.000322	0.34	11.47	21.54	0.15
2	main us	314.27	5 ARI	Exist b	1.67	38.20	38.78	38.37	38.75	0.000122	0.18	9.05	20.69	0.09
2	main us	314.27	5 ARI	Proposed	1.67	38.20	38.76	38.37	38.76	0.000147	0.20	8.51	19.82	0.10
2	main us	314.27	5 ARI	Exist	1.67	38.20	38.78	38.37	38.78	0.000122	0.18	9.05	20.69	0.09
2	main us	294.27	20-ARI	Exist b	2.63	38.20	38.66	38.43	38.61	0.000163	0.23	11.58	21.35	0.10
2	main us	294.27	20-ARI	Proposed	2.63	38.20	38.62	38.43	38.61	0.000204	0.24	10.74	20.82	0.11
2	main us	294.27	100-ARI	Exist b	3.89	38.20	38.94	38.46	38.94	0.000163	0.23	11.56	23.35	0.10
2	main us	294.27	100-ARI	Proposed	3.89	38.20	38.94	38.46	38.94	0.000221	0.26	13.51	24.11	0.12
2	main us	294.27	5 ARI	Exist b	1.67	38.20	38.78	38.37	38.75	0.000108	0.17	9.80	22.51	0.09
2	main us	294.27	5 ARI	Proposed	1.67	38.20	38.75	38.37	38.75	0.000132	0.18	9.19	21.26	0.09
2	main us	294.27	5 ARI	Exist	1.67	38.20	38.78	38.37	38.78	0.000108	0.17	9.80	22.51	0.09
2	main us	274.27	20-ARI	Exist b	2.63	38.20	38.66	38.41	38.66	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	20-ARI	Proposed	2.63	38.20	38.62	38.41	38.62	0.000241	0.25	10.44	24.31	0.12
2	main us	274.27	100-ARI	Exist b	3.89	38.20	38.93	38.46	38.94	0.000254	0.29	13.42	27.25	0.13
2	main us	274.27	100-ARI	Proposed	3.89	38.20	38.89	38.45	38.89	0.000335	0.32	12.20	25.56	0.15
2	main us	274.27	5 ARI	Exist b	1.67	38.20	38.78	38.36	38.78	0.000128	0.18	9.50	23.59	0.09
2	main us	274.27	5 ARI	Proposed	1.67	38.20	38.75	38.36	38.75	0.000157	0.19	8.84	23.02	0.10
2	main us	274.27	5 ARI	Exist	1.67	38.20	38.78	38.36	38.78	0.000128	0.18	9.50	23.58	0.09
1	main ds	240.00	20-ARI	Exist b	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.56	0.97
1	main ds	240.00	20-ARI	Proposed	4.66	38.50	38.70	38.70	38.90	0.021614	1.38	3.38	18.13	1.07
1	main ds	240.00	100-ARI	Exist b	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.56	0.97
1	main ds	240.00	100-ARI	Proposed	4.44	38.50	38.75	38.75	38.92	0.019683	1.61	4.90	19.13	1.02
1	main ds	240.00	5 ARI	Exist b	3.21	38.50	38.69	38.69	38.92	0.019683	1.51	4.90	19.13	1.02
1	main ds	240.00	5 ARI	Proposed	3.21	38.50	38.69	38.69	38.77	0.020375	1.26	3.07	17.88	0.97
1	main ds	240.00	5 ARI	Exist	3.21	38.50	38.66	38.66	38.74	0.022633	1.22	2.88	17.54	1.00
1	main ds	220.00	20-ARI	Exist b	5.68	38.00	38.36	38.17	38.39	0.037413	0.67	8.43	25.77	0.37
1	main ds	220.00	20-ARI	Proposed	4.66	38.00	38.32	38.17	38.34	0.040484	0.63	7.37	24.81	0.31
1	main ds	220.00	100-ARI	Exist b	7.91	38.00	38.44	38.23	38.47	0.002315	0.75	10.54	26.02	0.38
1	main ds	220.00	100-ARI	Proposed	6.44	38.00	38.39	38.21	38.42	0.002380	0.70	9.17	25.51	0.37
1	main ds	220.00	5 ARI	Exist b	3.21	38.00	38.36	38.15	38.46	0.002623	0.78	10.13	25.67	0.40
1	main ds	220.00	5 ARI	Proposed	3.21	38.00	38.36	38.15	38.30	0.002452	0.69	6.58	24.46	0.38
1	main ds	220.00	5 ARI	Exist	3.21	38.00	38.36	38.15	38.27	0.002471	0.65	5.84	24.14	0.36
1	main ds	200.00	20-ARI	Exist b	5.68	37.68	38.17	38.17	38.28	0.010700	1.53	3.72	16.07	1.01
1	main ds	200.00	20-ARI	Proposed	4.66	37.68	38.14	38.14	38.25	0.021619	1.45	3.19	15.46	1.03
1	main ds	200.00	100-ARI	Exist b	7.91	37.68	38.24	38.24	38.35	0.011811	1.52	4.81	17.56	0.93
1	main ds	200.00	100-ARI	Proposed	6.44	37.68	38.19	38.19	38.32	0.019797	1.58	4.07	16.42	1.01
1	main ds	200.00	5 ARI	Exist b	3.21	37.68	38.12	38.12	38.36	0.016808	1.57	5.78	26.60	0.95
1	main ds	200.00	5 ARI	Proposed	3.21	37.68	38.12	38.12	38.21	0.021536	1.37	2.82	15.08	1.01
1	main ds	200.00	5 ARI	Exist	3.21	37.68	38.09	38.09	38.13	0.022453	1.30	2.46	14.61	1.01
1	main ds	180.00	20-ARI	Exist b	5.68	37.32	37.54	37.57	37.66	0.042707	1.54	3.69	27.83	1.35
1	main ds	180.00	20-ARI	Proposed	4.66	37.32	37.57	37.55	37.62	0.012889	0.69	4.72	26.08	0.77
1	main ds	180.00	100-ARI	Exist b	7.91	37.32	37.56	37.61	37.73	0.042023	1.80	4.39	27.93	1.45
1	main ds	180.00	100-ARI	Proposed	6.44	37.32	37.55	37.58	37.68	0.044190	1.63	3.94	27.74	1.39
1	main ds	180.00	5 ARI	Exist b	3.21	37.32	37.54	37.54	37.73	0.046136	1.79	4.41	27.95	1.44
1	main ds	180.00	5 ARI	Proposed	3.21	37.32	37.53	37.53	37.60	0.040177	1.30	2.97	27.32	1.26
1	main ds	160.00	20-ARI	Exist b	5.68	36.98	37.22	37.22	37.31	0.023068	1.32	4.30	25.62	1.03
1	main ds	160.00	20-ARI	Proposed	4.66	36.98	37.20	37.20	37.26	0.023917	1.25	3.72	24.67	1.03
1	main ds	160.00	100-ARI	Exist b	7.91	36.98	37.27	37.27	37.37	0.021289	1.44	5.48	26.84	1.02
1	main ds	160.00	100-ARI	Proposed	6.44	36.98	37.24	37.24	37.33	0.022133	1.37	4.70	26.04	1.03
1	main ds	160.00	5 ARI	Exist b	3.21	36.98	37.19	37.19	37.37	0.021289	1.44	5.48	26.84	1.02
1	main ds	160.00	5 ARI	Proposed	3.21	36.98	37.19	37.19	37.25	0.019368	1.10	3.53	24.37	0.92
1	main ds	140.00	20-ARI	Exist b	5.68	36.50	36.83	36.79	36.88	0.011018	1.02	5.57	27.98	0.73
1	main ds	140.00	20-ARI	Proposed	4.66	36.50	36.82	36.76	36.80	0.009147	0.90	5.19	27.45	0.66
1	main ds	140.00	100-ARI	Exist b	7.91	36.50	36.89	36.89	36.97	0.022913	1.41	6.03	29.72	1.14

HEC-RAS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total (m ³ /s)	Min Ch El (m)	W ₂ Elev (m)	Crit WS (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Ch
1	main ds	140.00	100-ARI	Exist_b	7.91	36.50	36.91	36.82	36.95	0.007771	1.01	7.82	30.83	0.64
1	main ds	140.00	100-ARI	Proposed	6.44	36.50	36.89	36.8	36.93	0.006001	0.87	7.43	30.25	0.65
1	main ds	140.00	100-ARI	Exist	7.71	36.50	36.89	36.83	36.95	0.009181	1.07	7.39	30.21	0.63
1	main ds	140.00	5-ARI	Exist_b	3.87	36.50	36.74	36.74	36.81	0.023920	1.15	3.25	23.19	1.02
1	main ds	140.00	5-ARI	Proposed	3.21	36.50	36.72	36.72	36.79	0.024562	1.14	2.92	21.89	1.01
1	main ds	140.00	5-ARI	Exist	3.97	36.50	36.74	36.74	36.81	0.023980	1.15	3.25	23.19	1.02
1	main ds	120.00	20-ARI	Exist_b	5.68	36.03	36.75	36.39	36.75	0.000541	0.91	15.69	30.81	0.19
1	main ds	120.00	20-ARI	Proposed	4.56	36.03	36.75	36.35	36.75	0.000356	0.90	15.62	37.84	0.15
1	main ds	120.00	20-ARI	Exist	5.68	36.03	36.51	36.39	36.54	0.004370	0.75	7.47	28.17	0.40
1	main ds	120.00	100-ARI	Exist_b	7.91	36.03	36.85	36.44	36.86	0.000512	0.40	18.79	41.16	0.19
1	main ds	120.00	100-ARI	Proposed	6.44	36.03	36.85	36.40	36.86	0.000325	0.33	18.51	37.89	0.15
1	main ds	120.00	100-ARI	Exist	7.91	36.03	36.82	36.44	36.82	0.000630	0.43	18.57	41.15	0.19
1	main ds	120.00	5-ARI	Exist_b	3.87	36.03	36.41	36.33	36.47	0.004382	0.70	5.54	24.85	0.47
1	main ds	120.00	5-ARI	Proposed	3.21	36.03	36.41	36.31	36.44	0.004408	0.67	4.80	22.97	0.47
1	main ds	120.00	5-ARI	Exist	3.97	36.03	36.44	36.30	36.47	0.004366	0.70	5.54	24.85	0.47
1	main ds	100.00	20-ARI	Exist_b	5.68	36.00	36.75	36.30	36.75	0.000387	0.95	16.38	33.74	0.16
1	main ds	100.00	20-ARI	Proposed	4.66	36.00	36.74	36.26	36.75	0.000244	0.90	15.60	28.18	0.13
1	main ds	100.00	20-ARI	Exist	5.93	36.00	36.41	36.30	36.45	0.005169	0.86	6.59	24.15	0.53
1	main ds	100.00	100-ARI	Exist_b	7.91	36.00	36.81	36.35	36.85	0.000428	0.40	19.72	36.78	0.17
1	main ds	100.00	100-ARI	Proposed	5.44	36.00	36.85	36.31	36.85	0.000270	0.35	18.52	28.61	0.14
1	main ds	100.00	100-ARI	Exist	7.91	36.00	36.81	36.35	36.82	0.000517	0.43	18.60	36.01	0.19
1	main ds	100.00	5-ARI	Exist_b	3.87	36.00	36.34	36.24	36.37	0.004950	0.72	5.04	21.43	0.50
1	main ds	100.00	5-ARI	Proposed	3.21	36.00	36.31	36.22	36.34	0.005185	0.74	4.35	20.26	0.51
1	main ds	100.00	5-ARI	Exist	3.97	36.00	36.34	36.24	36.37	0.005029	0.77	5.03	21.40	0.51
1	main ds	80.00	20-ARI	Exist_b	5.68	35.74	36.74	36.17	36.75	0.000249	0.37	24.45	57.31	0.14
1	main ds	80.00	20-ARI	Proposed	4.65	35.74	36.74	36.14	36.74	0.000173	0.31	23.32	53.05	0.11
1	main ds	80.00	20-ARI	Exist	5.68	35.74	36.23	36.17	36.31	0.009731	1.25	4.57	17.10	0.73
1	main ds	80.00	100-ARI	Exist_b	7.91	35.74	36.83	36.23	36.84	0.000300	0.44	29.91	57.43	0.15
1	main ds	80.00	100-ARI	Proposed	6.44	35.74	36.84	36.19	36.85	0.000200	0.37	28.75	51.05	0.13
1	main ds	80.00	100-ARI	Exist	7.91	35.74	36.80	36.23	36.81	0.000352	0.47	28.00	57.39	0.17
1	main ds	80.00	5-ARI	Exist_b	3.87	35.74	36.10	36.10	36.21	0.020670	1.43	2.70	13.13	1.01
1	main ds	80.00	5-ARI	Proposed	3.21	35.74	36.08	36.08	36.17	0.020479	1.34	2.39	12.63	0.99
1	main ds	80.00	5-ARI	Exist	3.97	35.74	36.10	36.10	36.21	0.020820	1.43	2.70	13.13	1.01
1	main ds	60.00	20-ARI	Exist_b	5.68	35.49	36.74	35.88	36.74	0.000011	0.10	63.81	63.56	0.03
1	main ds	60.00	20-ARI	Proposed	4.66	35.49	36.74	35.66	36.74	0.000007	0.08	63.83	63.56	0.02
1	main ds	60.00	20-ARI	Exist	5.93	35.49	36.19	35.68	36.19	0.000121	0.21	28.77	61.09	0.09
1	main ds	60.00	100-ARI	Exist_b	7.91	35.49	36.84	35.72	36.84	0.000016	0.12	68.90	63.56	0.04
1	main ds	60.00	100-ARI	Proposed	6.44	35.49	36.84	35.68	36.84	0.000010	0.10	70.37	63.56	0.03
1	main ds	60.00	100-ARI	Exist	7.91	35.49	36.80	35.72	36.80	0.000017	0.13	67.80	63.56	0.04
1	main ds	60.00	5-ARI	Exist_b	3.87	35.49	36.80	35.64	36.81	0.001507	0.42	9.13	38.53	0.29
1	main ds	60.00	5-ARI	Proposed	3.21	35.49	36.80	35.50	36.81	0.001074	0.39	9.01	38.53	0.28
1	main ds	60.00	5-ARI	Exist	3.97	35.49	36.69	35.64	36.72	0.001600	0.75	5.17	31.40	0.50
1	main ds	40.00	20-ARI	Exist_b	5.68	35.33	36.74	35.54	36.74	0.000006	0.08	76.64	61.79	0.02
1	main ds	40.00	20-ARI	Proposed	5.68	35.33	36.74	35.53	36.74	0.000006	0.08	76.64	61.79	0.02
1	main ds	40.00	20-ARI	Exist	5.68	35.33	36.19	35.54	36.19	0.000041	0.15	42.39	61.79	0.06
1	main ds	40.00	100-ARI	Exist_b	7.91	35.33	36.84	35.57	36.84	0.000009	0.11	82.57	61.79	0.03
1	main ds	40.00	100-ARI	Proposed	7.91	35.33	36.84	35.56	36.84	0.000009	0.11	83.02	61.79	0.03
1	main ds	40.00	100-ARI	Exist	7.91	35.33	36.80	35.57	36.80	0.000010	0.11	80.52	61.79	0.03
1	main ds	40.00	5-ARI	Exist_b	3.87	35.33	36.79	35.51	36.79	0.000240	0.22	18.89	55.42	0.12
1	main ds	40.00	5-ARI	Proposed	3.87	35.33	36.79	35.51	36.79	0.000240	0.22	18.89	55.42	0.12
1	main ds	40.00	5-ARI	Exist	3.97	35.33	36.56	35.51	36.58	0.006815	0.50	6.66	50.79	0.50
1	main ds	7.76	20-ARI	Exist_b	5.68	33.84	36.74	34.24	36.74	0.000017	0.14	60.26	32.64	0.03
1	main ds	7.76	20-ARI	Proposed	5.59	33.84	36.74	34.24	36.74	0.000007	0.14	60.27	32.64	0.03
1	main ds	7.76	20-ARI	Exist	5.68	33.84	36.18	34.24	36.19	0.000017	0.18	42.15	32.64	0.04
1	main ds	7.76	100-ARI	Exist_b	7.91	33.84	36.84	34.32	36.84	0.000012	0.18	63.97	32.64	0.03
1	main ds	7.76	100-ARI	Proposed	7.91	33.84	36.84	34.31	36.84	0.000012	0.18	63.51	32.64	0.03
1	main ds	7.76	100-ARI	Exist	7.91	33.84	36.80	34.32	36.80	0.000012	0.18	62.79	32.64	0.04
1	main ds	7.76	5-ARI	Exist_b	3.87	33.84	35.79	34.17	35.79	0.000017	0.18	29.19	32.64	0.04
1	main ds	7.76	5-ARI	Proposed	3.87	33.84	35.79	34.17	35.79	0.000018	0.18	29.19	32.64	0.04
1	main ds	7.76	5-ARI	Exist	3.97	33.84	35.47	34.17	35.47	0.000017	0.20	19.44	30.19	0.08
1	main ds	5		Culvert										
1	main ds	2	20-ARI	Exist_b	5.68	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.78
1	main ds	2	20-ARI	Proposed	5.59	33.63	34.09	34.02	34.19	0.010002	1.41	4.03	11.41	0.78
1	main ds	2	20-ARI	Exist	5.68	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.78
1	main ds	2	100-ARI	Exist_b	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.98	11.71	0.78
1	main ds	2	100-ARI	Proposed	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.98	11.71	0.78
1	main ds	2	100-ARI	Exist	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.98	11.71	0.78
1	main ds	2	5-ARI	Exist_b	3.87	33.63	34.01	33.95	34.09	0.010012	1.22	3.18	11.27	0.73
1	main ds	2	5-ARI	Proposed	3.87	33.63	34.01	33.96	34.09	0.010014	1.22	3.18	11.27	0.73
1	main ds	2	5-ARI	Exist	3.97	33.63	34.01	33.96	34.09	0.010012	1.22	3.18	11.27	0.73

In our opinion, there is no need to carry out works within the watercourse to improve the flooding situation in the watercourse. Refer to Appendix 4 for detailed results of the simulations.

7 CIVIL DESIGN

The civil design undertaken for the proposed subdivision includes the road design, the cut and fill and other civil details required to ensure that the development is feasible at this conceptual stage.

The design is carried out in accordance with Council's DCP 2010 and the "Guidelines for Engineering Works for Subdivisions and Developments".

The subdivision is divided into two stages. Stage 1 covers a total of 123 lots and is submitted for Development Application and Stage 2 covers 35 lots for planning approval.

There is a total of nine (9) separate roads within the subdivision. Roads 1 & 2 are collector roads and Roads 3 to 9 are local roads.

Road 1 is proposed with a landscaping median in the middle as requested by the Client. Road 2 is the continuation of French Street into the subdivision.

The road network configuration is outlined in below.

Table 12 Road configuration

Road	Road Reserve (m)	Width of Travel Lane Both Directions (m)	Verge Width (m)	Parking Lane (m)	Concrete Pathway 1.5m wide	Median (m)
1	23.6	7	2 x 4.8	2 x 2.5	Both sides	2.0
2	21.6	7	2 x 4.8	2 x 2.5	Both sides	0
3 to 9	15.6	3	2 x 3.8	2 x 2.5	Both sides	0

Both Roads 1 & 2 have a widened concrete shared pedestrian path and cycleway with a total width of 2.5m to one side only. Reference is made to the traffic and the planning reports for details on the pedestrian and cycleway strategies.

Reference is made to Appendix 6 which includes all the design drawings for the proposed subdivision.

APPENDIX 1

Rainfall Data

IFD Table

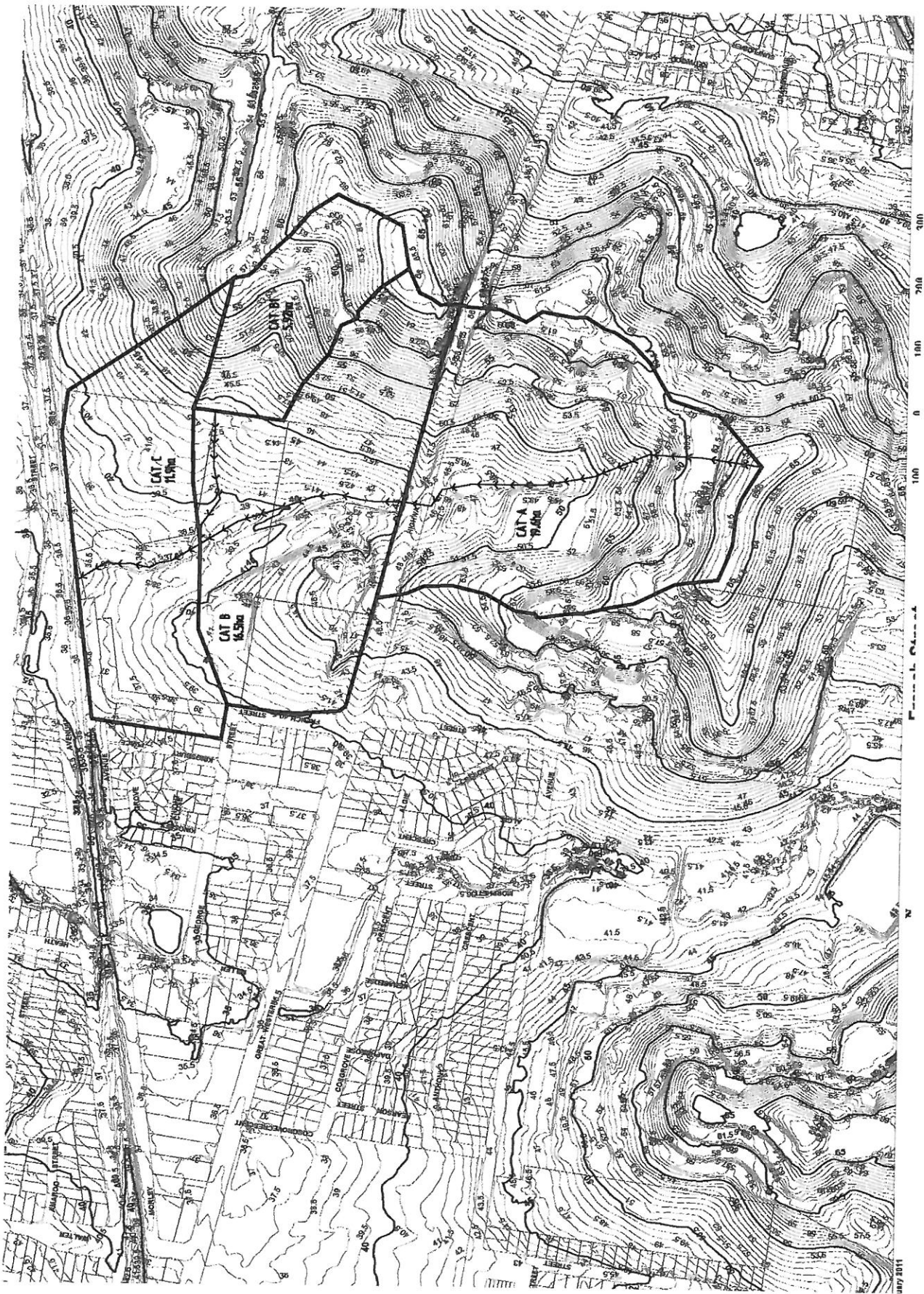
BUREAU OF METEOROLOGY INTENSITY COEFFICIENTS FOR PENRITH							
Period	A	B	C	D	E	F	G
1	3.1235	-0.5793	-0.0202	0.00945	-0.001209	-0.0004600	0.0000687
2	3.3820	-0.5790	-0.0208	0.00914	-0.001066	-0.0004188	0.0000614
5	3.6470	-0.5792	-0.0236	0.00780	-0.000288	-0.0002227	0.0000085
10	3.7766	-0.5793	-0.0252	0.00707	0.000155	-0.0001137	-0.0000215
20	3.9242	-0.5799	-0.0260	0.00683	0.000358	-0.0000630	-0.0000344
50	4.0911	-0.5795	-0.0274	0.00590	0.000772	0.0000646	-0.0000663
100	4.2024	-0.5800	-0.0280	0.00570	0.000942	0.0001046	-0.0000765

RETURN PERIOD (YEARS)							
Time	1	2	5	10	20	50	100
hr min	1	2	5	10	20	50	100
0 6	69.5	90.0	117.7	134.2	155.6	184.2	206.1
0 7	65.6	84.9	111.1	126.6	146.9	173.8	194.5
0 8	62.3	80.6	105.4	120.1	139.3	164.9	184.5
0 9	59.4	76.9	100.5	114.5	132.8	157.1	175.8
0 10	56.9	73.6	96.1	109.5	127.0	150.2	168.0
0 11	54.6	70.7	92.3	105.1	121.9	144.1	161.2
0 12	52.6	68.1	88.8	101.1	117.2	138.6	155.0
0 13	50.7	65.7	85.6	97.5	113.1	133.6	149.4
0 14	49.1	63.5	82.8	94.2	109.3	129.1	144.4
0 15	47.5	61.5	80.2	91.2	105.8	125.0	139.7
0 16	46.1	59.7	77.7	88.5	102.6	121.2	135.5
0 17	44.8	58.0	75.5	85.9	99.6	117.7	131.6
0 18	43.6	56.4	73.4	83.6	96.9	114.4	128.0
0 19	42.4	54.9	71.5	81.4	94.3	111.4	124.6
0 20	41.4	53.5	69.7	79.3	92.0	108.6	121.4
0 22	39.4	51.0	66.4	75.6	87.6	103.5	115.7
0 24	37.7	48.8	63.6	72.3	83.8	99.0	110.7
0 26	36.2	46.8	61.0	69.4	80.4	95.0	106.2
0 28	34.8	45.0	58.6	66.7	77.3	91.3	102.1
0 30	33.5	43.4	56.5	64.3	74.6	88.0	98.4
0 35	30.8	39.9	52.0	59.2	68.6	81.0	90.6
0 40	28.6	37.1	48.3	55.0	63.7	75.3	84.2
0 45	26.8	34.7	45.2	51.5	59.7	70.5	78.8
0 50	25.2	32.7	42.6	48.5	56.2	66.4	74.2
0 55	23.9	30.9	40.3	45.9	53.2	62.9	70.3
1 00	22.7	29.4	38.4	43.7	50.6	59.8	66.8

Time hr min	RETURN PERIOD (YEARS)						
	1	2	5	10	20	50	100
1 00	22.7	29.4	38.4	43.7	50.6	59.8	66.8
1 30	17.9	23.2	30.2	34.4	39.9	47.1	52.6
2 00	15.1	19.6	25.4	28.9	33.5	39.6	44.2
2 30	13.2	17.1	22.2	25.3	29.3	34.5	38.6
3 00	11.9	15.3	19.9	22.6	26.2	30.9	34.5
3 30	10.8	14.0	18.1	20.6	23.8	28.1	31.4
4 00	10.0	12.9	16.7	19.0	22.0	25.9	28.9
4 30	9.3	12.0	15.6	17.7	20.4	24.1	26.9
5 00	8.7	11.3	14.6	16.5	19.2	22.6	25.2
5 30	8.2	10.7	13.8	15.6	18.1	21.3	23.8
6 00	7.8	10.1	13.1	14.8	17.2	20.2	22.5
8 00	6.6	8.5	10.9	12.3	14.1	16.5	18.3
10 00	5.7	7.4	9.5	10.7	12.3	14.4	15.9
12 00	5.1	6.6	8.5	9.5	11.0	12.8	14.2
18 00	3.9	5.1	6.6	7.5	8.6	10.2	11.4
24 00	3.2	4.2	5.5	6.3	7.3	8.6	9.6
36 00	2.4	3.2	4.2	4.9	5.7	6.8	7.6
48 00	2.0	2.6	3.5	4.0	4.7	5.7	6.4
60 00	1.7	2.2	3.0	3.4	4.1	4.9	5.5
72 00	1.4	1.9	2.6	3.0	3.6	4.3	4.9

APPENDIX 2

Catchment Plan



APPENDIX 3

Results of the Hydrological Modelling

DATA SHEET

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%)	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough
CATA	A	19.6	50	50	0	1	5	0	569	569	569	3.8	3.8	3.8	0.1	0.1	0.1
Cat B	B	16.5	50	50	0	1	5	0	398	398	398	7	7	7	0.05	0.05	0.05
Cat C	C	11.9	50	50	0	1	5	0	1846	1846	1846	1.16	1.16	1.16	0.08	0.08	0.08
Cat B1	B1	5.92	50	50	0	1	5	0	419	419	419	5.3	5.3	5.3	0.08	0.08	0.08

RESULTS SHEET 1 - 5 YEAR ARI

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	1.672	1.192	0.481	49.61	53.61	48.61	AR&R 5 year. 1 hour storm. average 38.4 mm/h. Zone 1
Cat B	2.288	1.673	0.627	18.79	22.79	17.79	AR&R 5 year. 25 minutes storm. average 62 mm/h. Zone 1
Cat C	0.498	0.354	0.145	161.31	165.31	160.31	AR&R 5 year. 3 hours storm. average 19.8 mm/h. Zone 1
Cat B1	0.659	0.47	0.199	30.98	34.98	29.98	AR&R 5 year. 45 minutes storm. average 45.3 mm/h. Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	1.672	2.875	1.576	0.509	1.41	4.38	2.77	AR&R 5 year. 1 hour storm. average 38.4 mm/h. Zone 1
OF B	3.477	3.875	1.185	0.6	1.45	8	2.42	AR&R 5 year. 1.5 hours storm. average 30.2 mm/h. Zone 1
OF C	3.875	3.875	0.256	0.152	0.21	34.44	1.35	AR&R 5 year. 1 hour storm. average 38.4 mm/h. Zone 1
OF B1	0.659	0.659	0.424	0.06	0.07	15.94	1.23	AR&R 5 year. 45 minutes storm. average 45.3 mm/h. Zone 1

Run Log for 20100127 run at 20:14:53 on 13/4/2011

RESULTS SHEET 2 - 20 YEAR ARI
SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	2.632	1.716	0.941	44.4	48.4		43.4 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
Cat B	3.526	2.381	1.233	16.91	20.91		15.91 AR&R 20 year, 25 minutes storm, average 82 mm/h, Zone 1
Cat C	0.778	0.502	0.279	144.98	148.98		143.98 AR&R 20 year, 3 hours storm, average 25.9 mm/h, Zone 1
Cat B1	1.018	0.658	0.396	29.59	33.59		28.59 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	2.632	4.147	1.576	0.6	1.56	8		2.59 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF B	5.018	5.683	1.185	0.6	2.13	8		3.55 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF C	5.683	5.683	0.256	0.177	0.27	39.47		1.5 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF B1	1.018	1.018	0.424	0.071	0.1	18.28		1.38 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1

Run Log for 20100127 run at 20:06:47 on 13/4/2011

RESULTS SHEET 3 - 100 YEAR ARI
SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	3.895	2.379	1.608	39.91	43.91		38.91 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
Cat B	4.891	3.2	2.03	15.2	19.2		14.2 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1
Cat C	1.189	0.727	0.463	117.79	121.79		116.79 AR&R 100 year, 2 hours storm, average 43.7 mm/h, Zone 1
Cat B1	1.466	0.938	0.55	22.1	26.1		21.1 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	3.895	5.553	1.622	0.6	2.08	8		3.47 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF B	6.886	7.911	1.91	0.6	2.97	8		4.95 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF C	7.911	7.911	7.665	0.203	0.33	44.5		1.63 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF B1	1.466	1.466	12.688	0.083	0.13	20.61		1.52 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1

Run Log for 20100127 run at 20:10:40 on 13/4/2011

APPENDIX 4

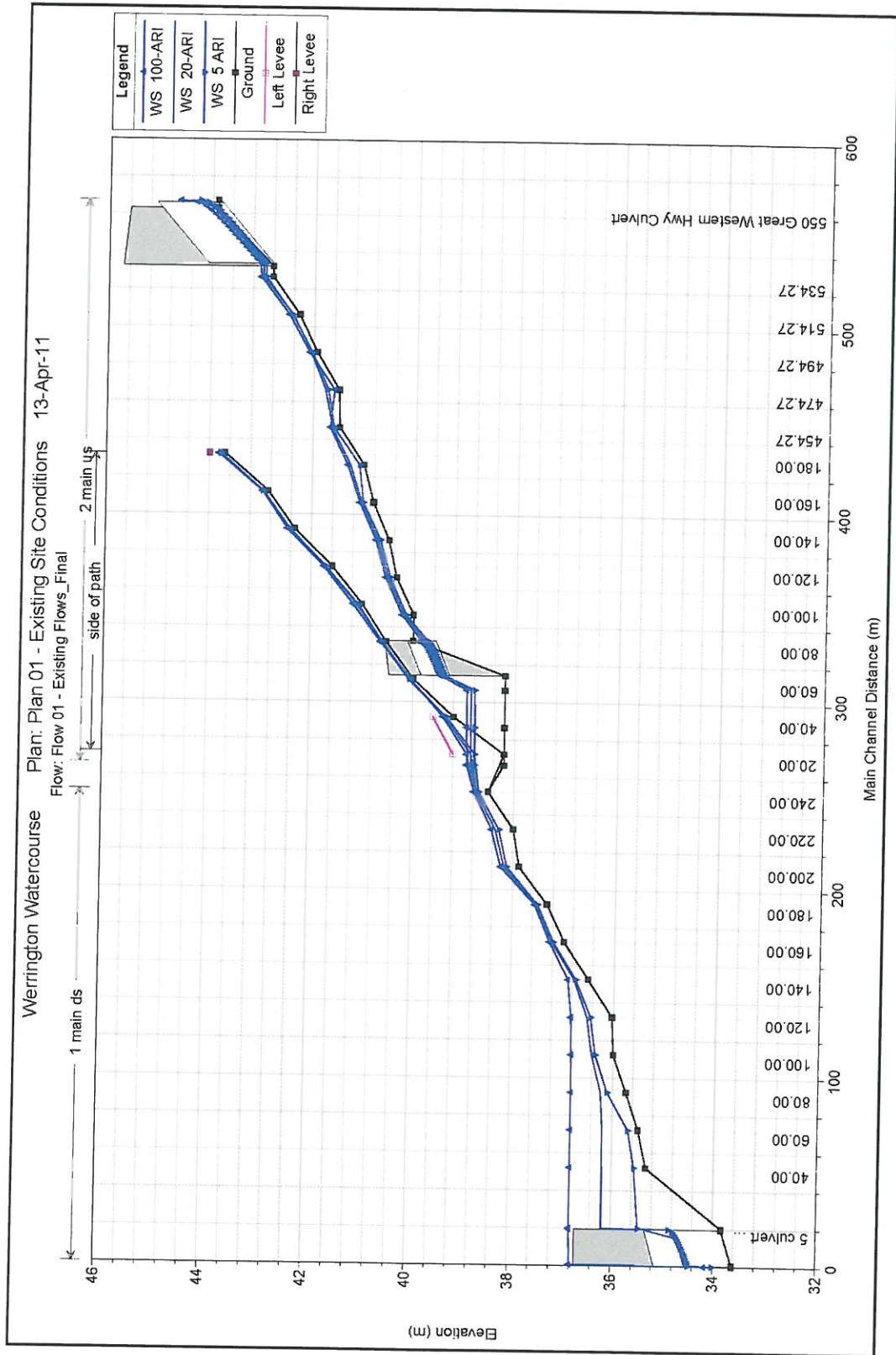
Results of the Hydraulic Modelling

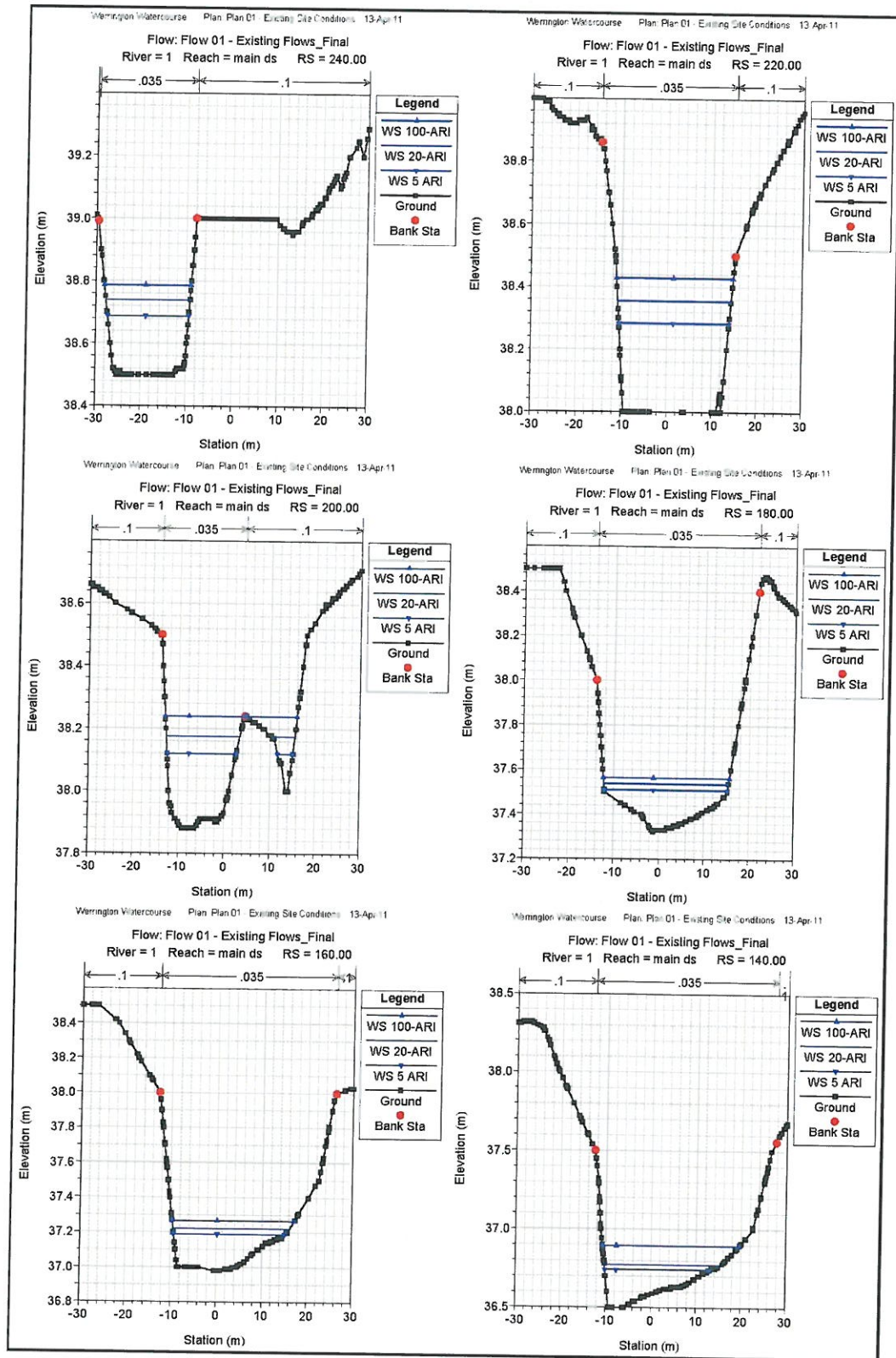
Plan 01 – Existing Site Conditions

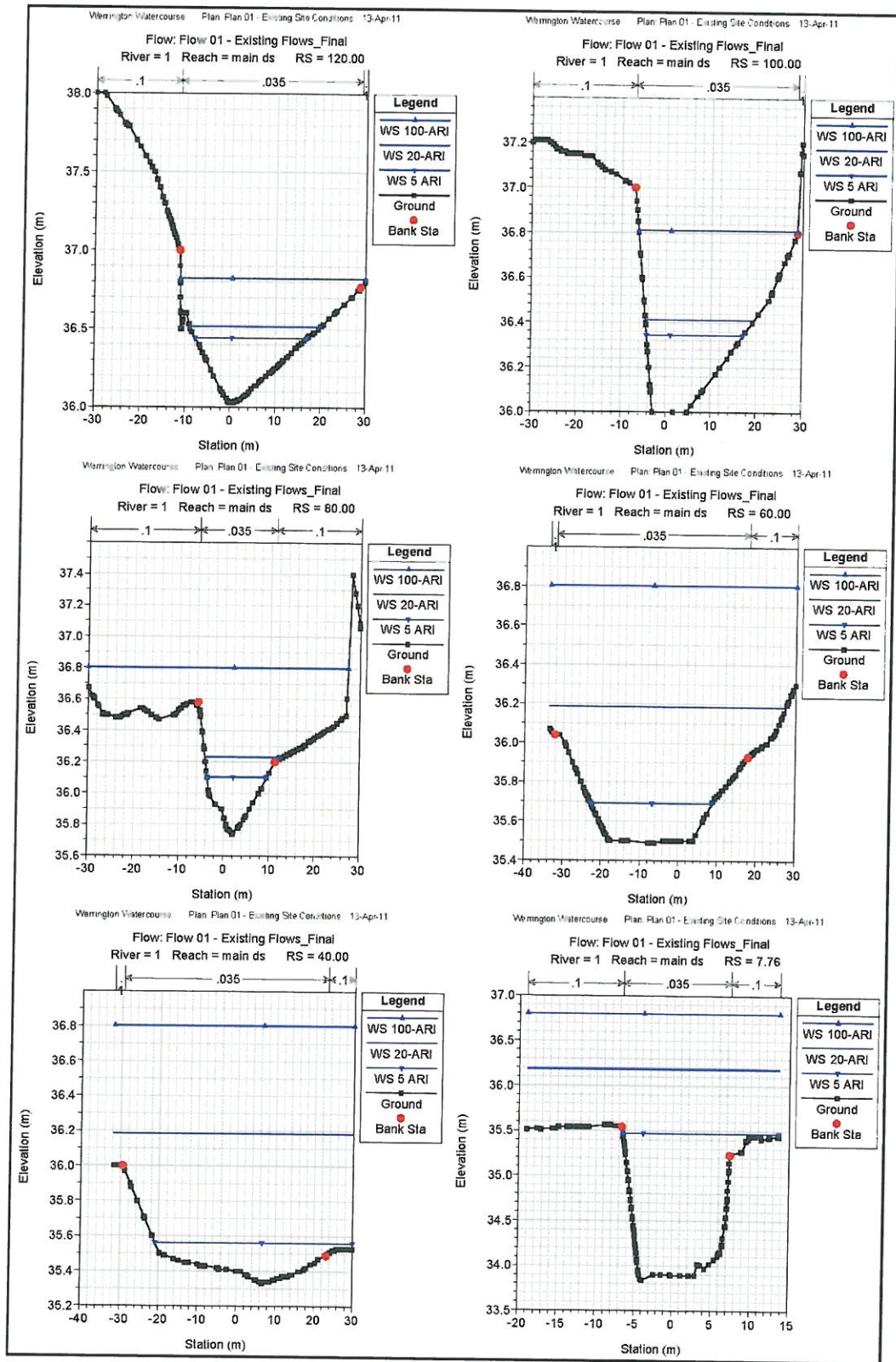
HEC-RAS Plan Exist													
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Cnt W S (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnt (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Ch
side	of path	180.00	20-ARI	1.02	43.70	43.80	43.80	43.84	0.033056	1.01	1.95	21.62	1.10
side	of path	180.00	100-ARI	1.47	43.70	43.82	43.82	43.87	0.029524	1.12	2.07	22.11	1.06
side	of path	180.00	5-ARI	0.66	43.70	43.78	43.78	43.81	0.032113	0.65	1.15	20.99	1.07
side	of path	160.00	20-ARI	1.02	42.85	42.95	42.96	42.90	0.025542	0.95	1.66	22.84	0.98
side	of path	160.00	100-ARI	1.47	42.85	42.88	42.88	42.94	0.025861	1.17	1.65	21.80	1.42
side	of path	160.00	5-ARI	0.66	42.85	42.94	42.94	42.97	0.028026	0.78	1.25	21.82	0.90
side	of path	140.00	20-ARI	1.02	42.23	42.44	42.44	42.48	0.025632	0.99	1.38	16.75	1.00
side	of path	140.00	100-ARI	1.47	42.23	42.47	42.47	42.52	0.023921	1.11	1.87	20.96	1.00
side	of path	140.00	5-ARI	0.66	42.33	42.42	42.42	42.45	0.030139	0.88	0.95	15.66	1.03
side	of path	120.00	20-ARI	1.02	41.59	41.73	41.75	41.81	0.042454	1.31	0.90	12.70	1.26
side	of path	120.00	100-ARI	1.47	41.59	41.76	41.78	41.85	0.042575	1.39	1.19	14.41	1.31
side	of path	120.00	5-ARI	0.66	41.59	41.71	41.72	41.76	0.038812	0.79	0.68	10.21	1.16
side	of path	100.00	20-ARI	1.02	41.00	41.10	41.15	41.26	0.028322	1.74	0.60	9.51	2.10
side	of path	100.00	100-ARI	1.47	41.00	41.18	41.18	41.24	0.021523	1.13	1.47	13.91	0.96
side	of path	100.00	5-ARI	0.66	41.00	41.08	41.12	41.21	0.055390	1.60	0.41	8.18	2.21
side	of path	80.00	20-ARI	1.02	40.53	40.69	40.69	40.67	0.024681	0.94	1.20	15.15	0.97
side	of path	80.00	100-ARI	1.47	40.53	40.64	40.65	40.71	0.031756	1.17	1.45	15.73	1.12
side	of path	80.00	5-ARI	0.66	40.53	40.60	40.60	40.64	0.028087	0.72	0.86	12.39	0.98
side	of path	60.00	20-ARI	1.02	39.99	40.08	40.08	40.12	0.030685	0.93	1.20	17.95	1.04
side	of path	60.00	100-ARI	1.47	39.99	40.04	40.10	40.45	0.066560	2.83	0.52	15.52	4.85
side	of path	60.00	5-ARI	0.66	39.99	40.07	40.07	40.09	0.026187	0.72	0.95	16.93	0.96
side	of path	40.00	20-ARI	1.02	39.20	39.37	39.37	39.43	0.022936	1.04	0.98	8.31	0.97
side	of path	40.00	100-ARI	1.47	39.20	39.41	39.41	39.48	0.021666	1.15	1.27	8.81	0.97
side	of path	40.00	5-ARI	0.66	39.20	39.34	39.34	39.38	0.026393	0.93	0.71	7.82	0.99
side	of path	20.00	20-ARI	1.02	38.20	38.85	38.30	38.85	0.070055	0.11	0.58	19.50	0.05
side	of path	20.00	100-ARI	1.47	38.20	38.93	38.34	38.93	0.000045	0.13	11.30	20.50	0.06
side	of path	20.00	5-ARI	0.66	38.20	38.76	38.29	38.76	0.030023	0.68	8.25	16.55	0.04
2	main us	574.81	20-ARI	2.63	43.90	44.43	44.27	44.48	0.004472	1.02	2.98	6.26	0.51
2	main us	574.81	100-ARI	3.89	43.90	44.62	44.35	44.67	0.005315	0.98	3.95	7.98	0.40
2	main us	574.81	5-ARI	1.67	43.90	44.24	44.19	44.31	0.018523	1.15	1.46	5.82	0.72
2	main us	550											
2	main us	534.27	20-ARI	2.63	42.81	43.00	43.01	43.07	0.033853	1.17	2.25	21.50	1.15
2	main us	534.27	100-ARI	3.89	42.81	43.05	43.05	43.12	0.027667	1.19	3.30	23.71	1.01
2	main us	534.27	5-ARI	1.67	42.81	42.95	42.98	43.04	0.030359	1.38	1.26	17.16	1.96
2	main us	514.27	20-ARI	2.63	42.29	42.41	42.44	42.50	0.026273	1.33	1.97	24.47	1.50
2	main us	514.27	100-ARI	3.89	42.29	42.49	42.47	42.53	0.016709	0.96	4.06	30.73	0.84
2	main us	514.27	5-ARI	1.67	42.29	42.43	42.41	42.45	0.018215	0.73	2.30	25.60	0.78
2	main us	494.27	20-ARI	2.63	41.94	42.05	42.05	42.10	0.021122	0.88	3.69	28.20	1.01
2	main us	494.27	100-ARI	3.89	41.94	42.08	42.08	42.15	0.024264	1.10	2.54	26.79	1.00
2	main us	494.27	5-ARI	1.67	41.94	42.03	42.03	42.07	0.024463	0.80	2.10	27.81	0.93
2	main us	474.27	20-ARI	2.63	41.50	41.77	41.64	41.78	0.002546	0.83	4.94	21.92	0.36
2	main us	474.27	100-ARI	3.89	41.50	41.59	41.68	42.00	0.011494	2.15	1.37	16.07	3.31
2	main us	474.27	5-ARI	1.67	41.50	41.71	41.61	41.72	0.027366	0.44	3.75	20.83	0.73
2	main us	454.27	20-ARI	2.63	41.48	41.63	41.63	41.69	0.023154	1.12	2.35	18.03	0.98
2	main us	454.27	100-ARI	3.89	41.48	41.66	41.66	41.75	0.022100	1.26	2.08	18.91	1.00
2	main us	454.27	5-ARI	1.67	41.48	41.59	41.59	41.64	0.023349	0.95	1.78	17.25	0.95
2	main us	434.27	20-ARI	2.63	41.00	41.26	41.19	41.30	0.026036	0.83	3.18	14.75	0.51
2	main us	434.27	100-ARI	3.89	41.00	41.32	41.24	41.37	0.007624	0.79	3.95	15.84	0.63
2	main us	434.27	5-ARI	1.67	41.00	41.09	41.14	41.28	0.040734	1.93	0.85	11.24	2.23
2	main us	414.27	20-ARI	2.63	40.81	41.04	41.04	41.10	0.022608	1.08	2.70	27.40	0.97
2	main us	414.27	100-ARI	3.89	40.81	41.07	41.07	41.15	0.021789	1.22	2.89	28.42	0.98
2	main us	414.27	5-ARI	1.67	40.81	41.01	41.00	41.05	0.023516	0.93	1.33	26.44	0.95
2	main us	394.27	20-ARI	2.63	40.40	40.71	40.67	40.75	0.011156	0.90	3.52	21.32	0.71
2	main us	394.27	100-ARI	3.89	40.40	40.75	40.71	40.80	0.012100	1.05	4.48	26.13	0.76
2	main us	394.27	5-ARI	1.67	40.40	40.66	40.63	40.69	0.011982	0.80	2.53	19.35	0.71
2	main us	374.27	20-ARI	2.63	40.34	40.51	40.42	40.51	0.005055	0.87	4.40	23.60	0.63
2	main us	374.27	100-ARI	3.89	40.34	40.56	40.46	40.58	0.009888	0.80	5.60	27.41	0.66
2	main us	374.27	5-ARI	1.67	40.34	40.46	40.38	40.48	0.008488	0.54	3.32	23.15	0.59
2	main us	354.27	20-ARI	2.63	40.00	40.18	40.18	40.25	0.027335	1.18	2.83	19.81	1.07
2	main us	354.27	100-ARI	3.89	40.00	40.23	40.23	40.30	0.026141	1.30	3.51	22.18	1.07
2	main us	354.27	5-ARI	1.67	40.00	40.14	40.14	40.20	0.031242	1.03	1.84	17.38	1.10
2	main us	330											
2	main us	314.27	20-ARI	2.63	38.20	38.86	38.41	38.86	0.000184	0.25	10.44	20.80	0.11
2	main us	314.27	100-ARI	3.89	38.20	38.94	38.46	38.95	0.000251	0.31	12.40	21.55	0.12
2	main us	314.27	5-ARI	1.67	38.20	38.78	38.37	38.76	0.000122	0.18	9.05	20.03	0.08
2	main us	294.27	20-ARI	2.63	38.20	38.86	38.43	38.86	0.000163	0.23	11.56	20.35	0.10
2	main us	294.27	100-ARI	3.89	38.20	38.94	38.46	38.94	0.000221	0.29	12.51	24.11	0.12

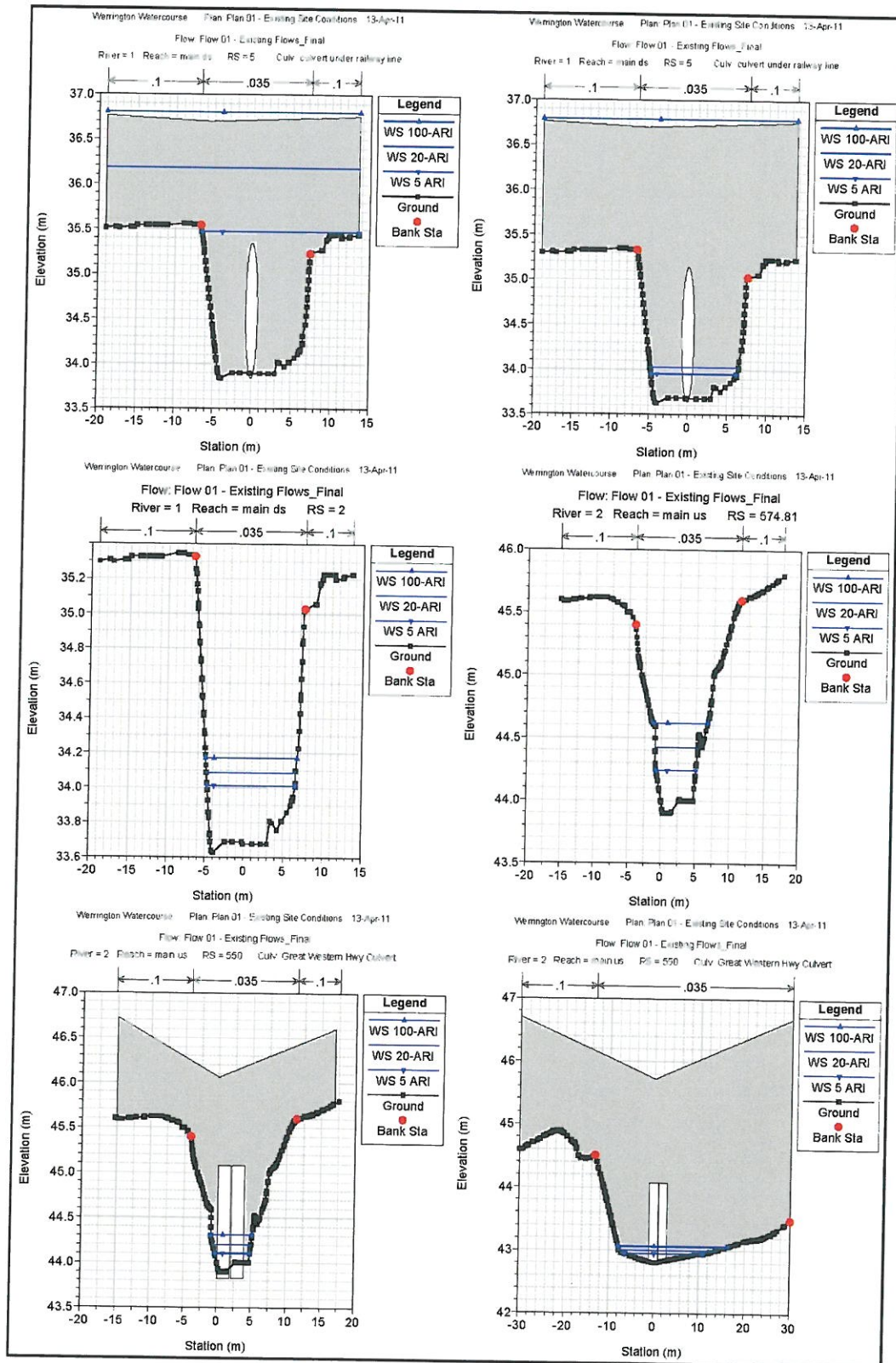
HEC-RAS Plan Exist (Continued)

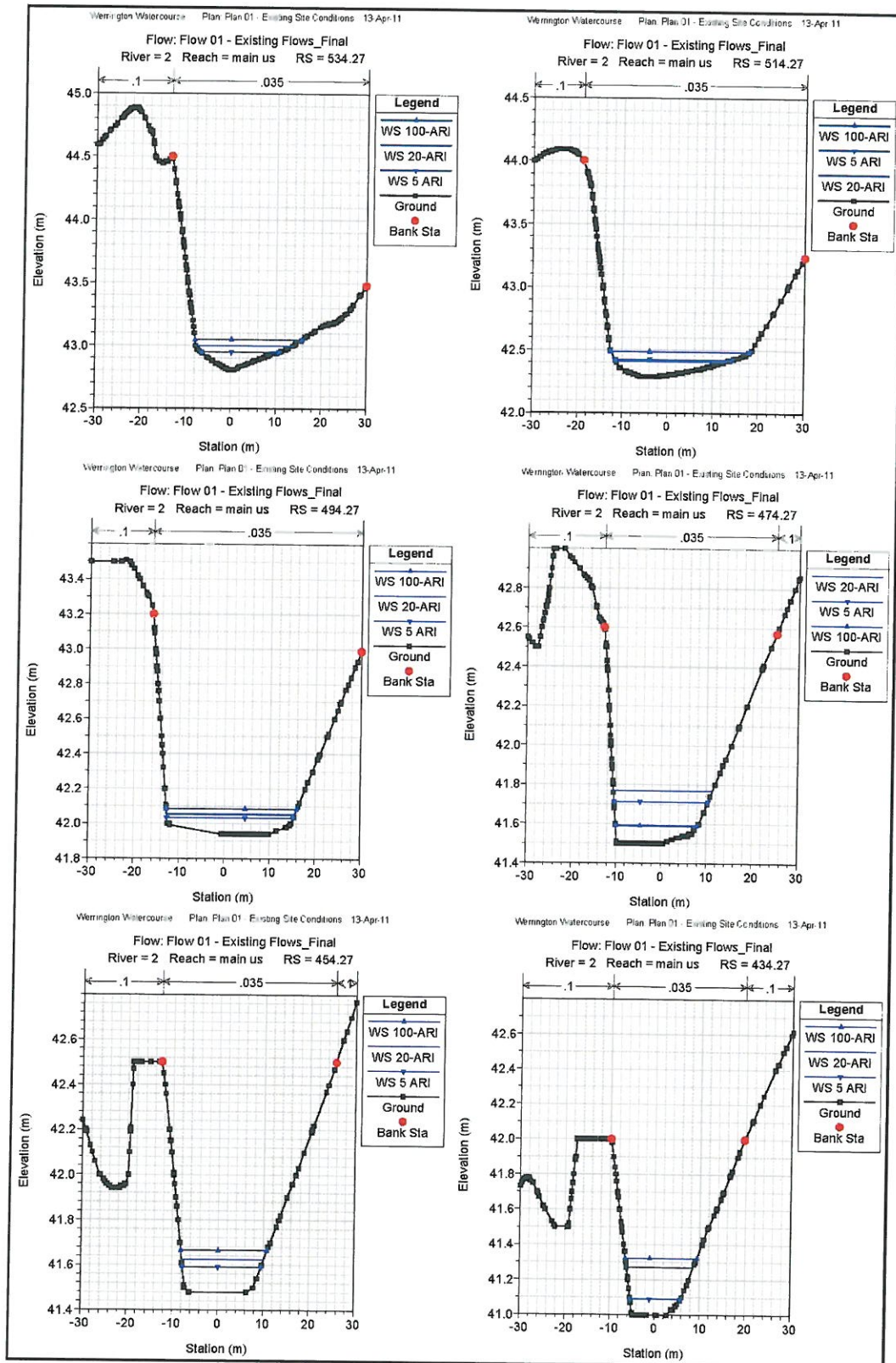
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crt W.S (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
2	main us	294.27	5ARI	1.07	38.20	38.79	38.79	38.79	0.000109	0.17	9.60	22.51	0.08
2	main us	274.27	20-ARI	2.63	38.20	38.85	38.41	38.85	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	100-ARI	3.89	38.20	38.91	38.46	38.94	0.000254	0.29	13.42	27.25	0.13
2	main us	274.27	5ARI	1.97	38.20	38.78	38.36	38.78	0.000128	0.18	9.50	23.58	0.09
1	main ds	240.00	20-ARI	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.58	0.97
1	main ds	240.00	100-ARI	7.91	38.50	38.79	38.79	38.92	0.019883	1.61	4.90	19.13	1.02
1	main ds	240.00	5ARI	3.87	38.50	38.69	38.69	38.77	0.020375	1.26	3.07	17.88	0.67
1	main ds	220.00	20-ARI	5.68	38.00	38.37	38.19	38.38	0.002568	0.89	8.27	25.17	0.38
1	main ds	220.00	100-ARI	7.91	38.00	38.43	38.23	38.46	0.002623	0.78	10.13	26.87	0.40
1	main ds	220.00	5ARI	3.87	38.00	38.28	38.15	38.30	0.002539	0.59	6.51	24.43	0.37
1	main ds	200.00	20-ARI	5.68	37.68	38.17	38.17	38.28	0.018892	1.48	4.17	21.16	0.99
1	main ds	200.00	100-ARI	7.91	37.68	38.24	38.24	38.36	0.019008	1.57	5.78	23.60	0.91
1	main ds	200.00	5ARI	3.87	37.68	38.12	38.12	38.21	0.019397	1.32	3.11	18.59	0.96
1	main ds	180.00	20-ARI	5.68	37.32	37.54	37.57	37.66	0.042895	1.54	3.88	27.63	1.35
1	main ds	180.00	100-ARI	7.91	37.32	37.56	37.61	37.73	0.046136	1.79	4.41	27.95	1.44
1	main ds	180.00	5ARI	3.87	37.32	37.51	37.53	37.60	0.042218	1.32	2.93	27.33	1.29
1	main ds	160.00	20-ARI	5.68	36.98	37.22	37.22	37.31	0.023068	1.32	4.30	28.62	1.13
1	main ds	160.00	100-ARI	7.91	36.98	37.27	37.27	37.37	0.021269	1.44	5.48	26.84	1.02
1	main ds	160.00	5ARI	3.87	36.98	37.19	37.18	37.25	0.019788	1.10	3.73	24.37	0.92
1	main ds	140.00	20-ARI	5.68	36.50	36.77	36.79	36.87	0.028913	1.41	4.03	35.72	1.14
1	main ds	140.00	100-ARI	7.91	36.50	36.89	36.83	36.95	0.009486	1.07	7.39	30.21	0.69
1	main ds	140.00	5ARI	3.87	36.50	36.74	36.74	36.81	0.023960	1.19	3.35	23.19	1.02
1	main ds	120.00	20-ARI	5.68	36.03	36.51	36.39	36.54	0.004370	0.76	7.47	29.17	0.48
1	main ds	120.00	100-ARI	7.91	36.03	36.82	36.44	36.83	0.000630	0.49	18.77	41.15	0.29
1	main ds	120.00	5ARI	3.87	36.03	36.44	36.53	36.47	0.004388	0.70	5.54	24.65	0.47
1	main ds	100.00	20-ARI	5.68	36.00	36.41	36.20	36.45	0.005169	0.86	6.59	24.15	0.53
1	main ds	100.00	100-ARI	7.91	36.00	36.81	36.35	36.82	0.000517	0.43	18.60	35.06	0.19
1	main ds	100.00	5ARI	3.87	36.00	36.34	36.24	36.37	0.005029	0.77	5.03	21.40	0.51
1	main ds	80.00	20-ARI	5.68	35.74	36.29	36.17	36.31	0.009731	1.28	4.57	11.10	0.73
1	main ds	80.00	100-ARI	7.91	35.74	36.60	36.23	36.81	0.000352	0.47	28.00	57.39	0.17
1	main ds	80.00	5ARI	3.87	35.74	36.10	36.10	36.21	0.020820	1.43	2.70	13.13	1.01
1	main ds	60.00	20-ARI	5.68	35.49	36.19	35.68	36.19	0.000121	0.21	33.77	61.09	0.09
1	main ds	60.00	100-ARI	7.91	35.49	36.57	35.72	36.80	0.000017	0.13	67.80	63.56	0.04
1	main ds	60.00	5ARI	3.87	35.49	35.68	35.64	35.72	0.007600	0.75	5.17	31.40	0.59
1	main ds	40.00	20-ARI	5.68	35.33	36.19	35.54	36.19	0.000041	0.15	42.39	61.79	0.06
1	main ds	40.00	100-ARI	7.91	35.33	36.80	35.67	36.80	0.000010	0.11	80.23	61.79	0.03
1	main ds	40.00	5ARI	3.87	35.33	35.55	35.51	35.58	0.005815	0.60	6.66	50.99	0.50
1	main ds	7.76	20-ARI	5.68	33.84	36.18	34.14	36.19	0.000017	0.18	42.15	30.84	0.04
1	main ds	7.76	100-ARI	7.91	33.84	36.00	34.02	36.80	0.000011	0.18	62.28	30.84	0.04
1	main ds	7.76	5ARI	3.87	33.84	35.47	34.17	35.47	0.000037	0.20	19.64	20.19	0.06
1	main ds	5		Current									
1	main ds	2	20-ARI	5.68	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.76
1	main ds	2	100-ARI	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.98	11.71	0.73
1	main ds	2	5ARI	3.87	33.63	34.01	33.95	34.03	0.010012	1.22	3.18	11.27	0.73

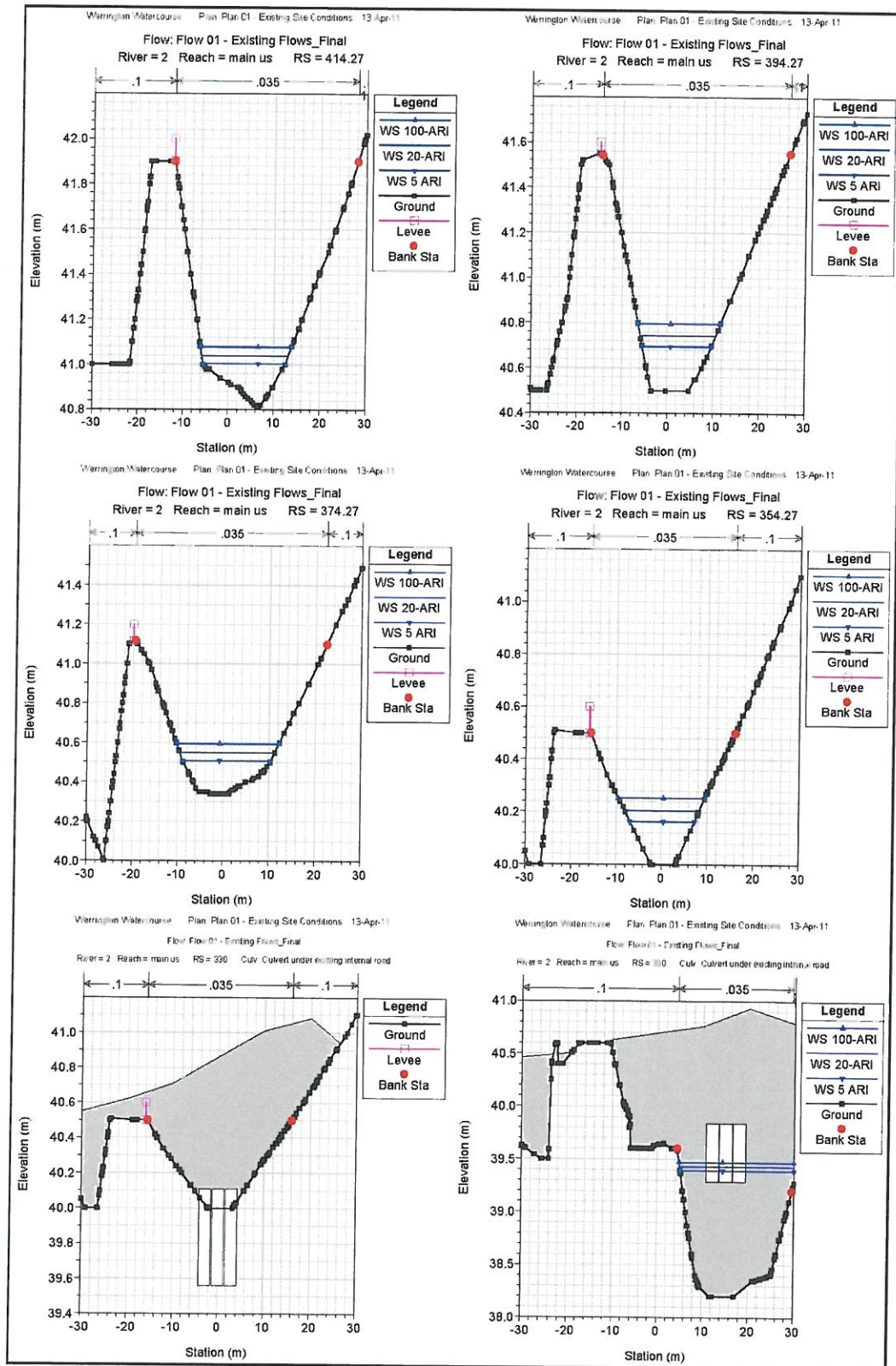


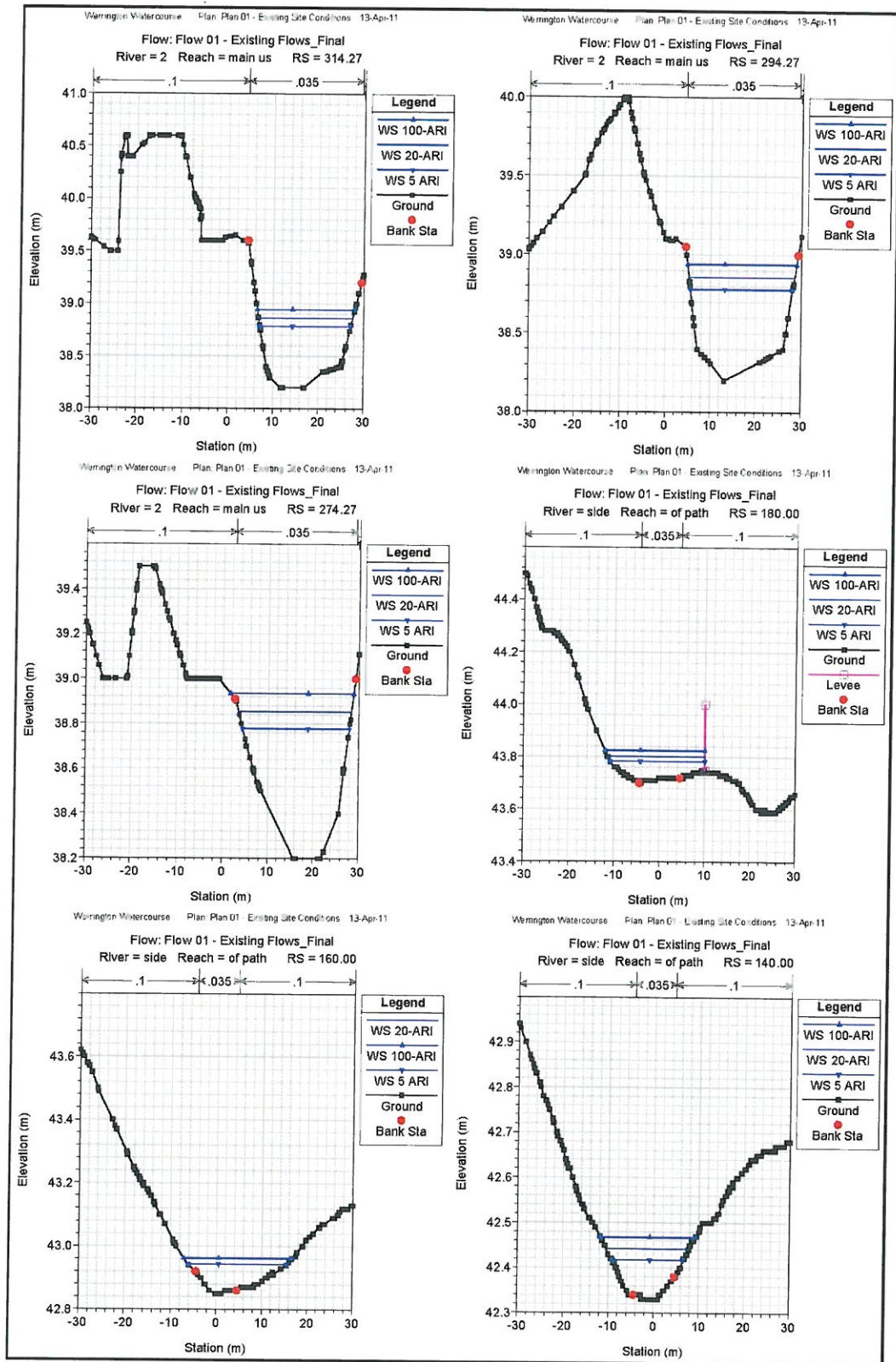


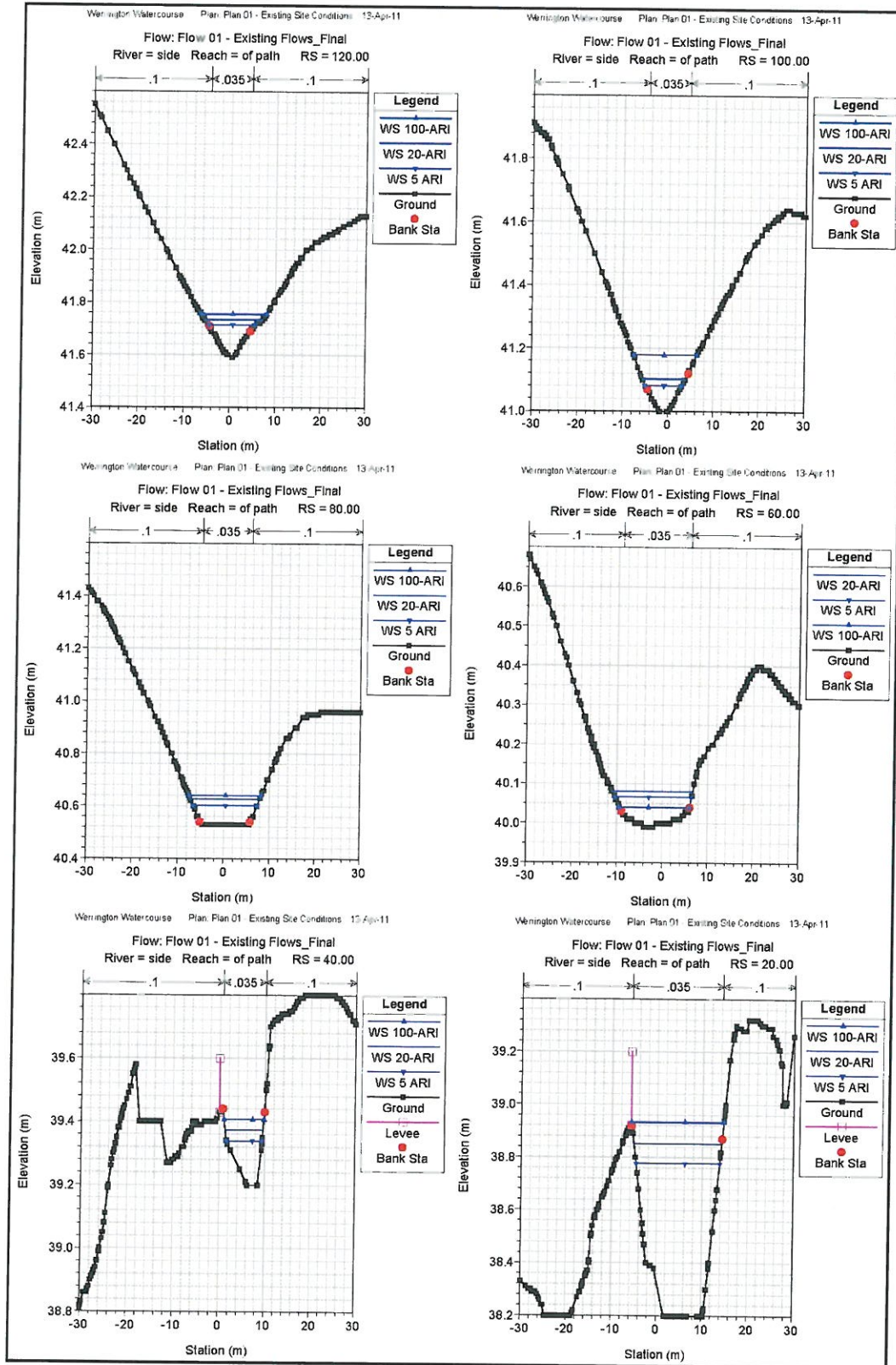










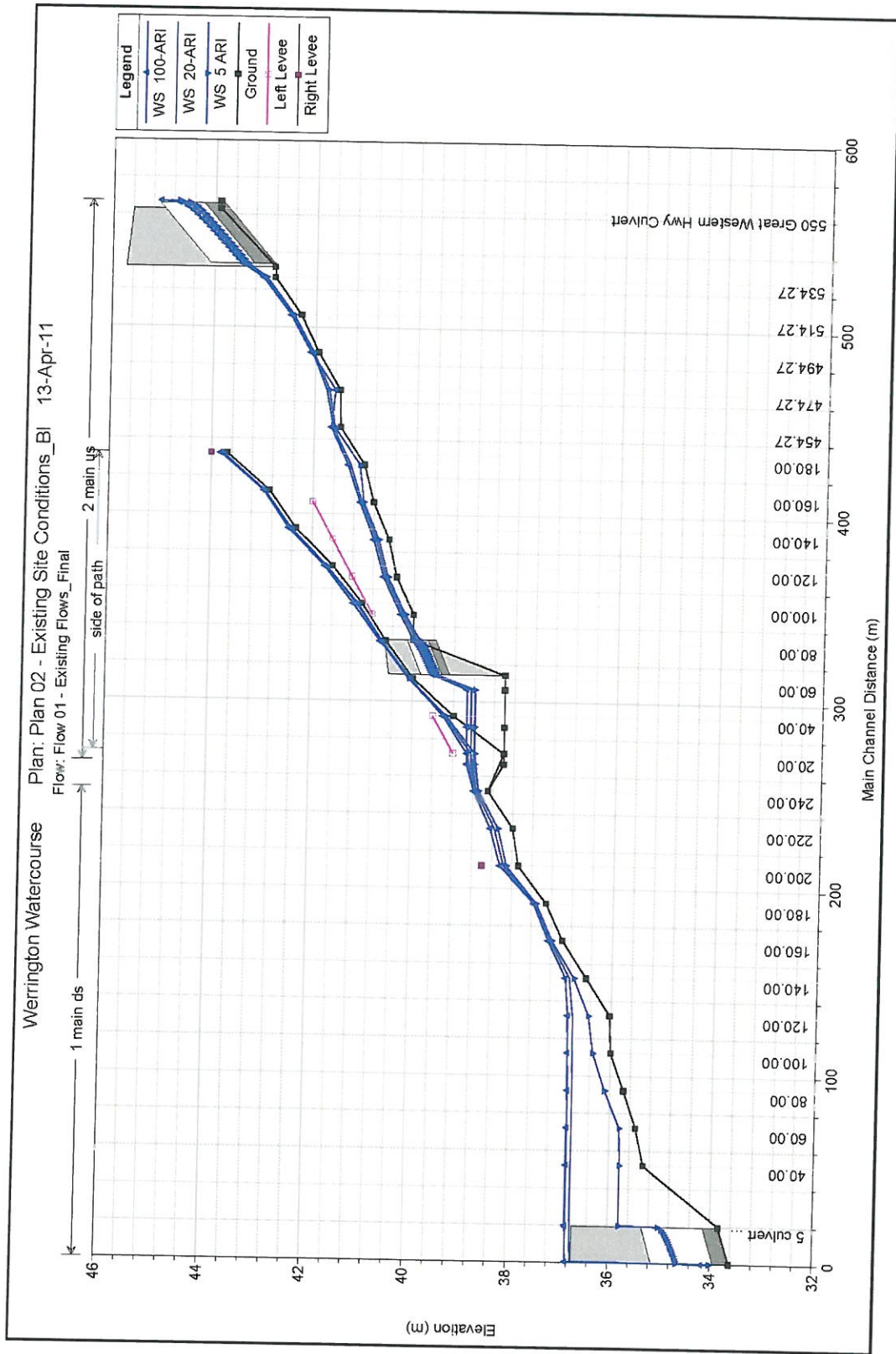


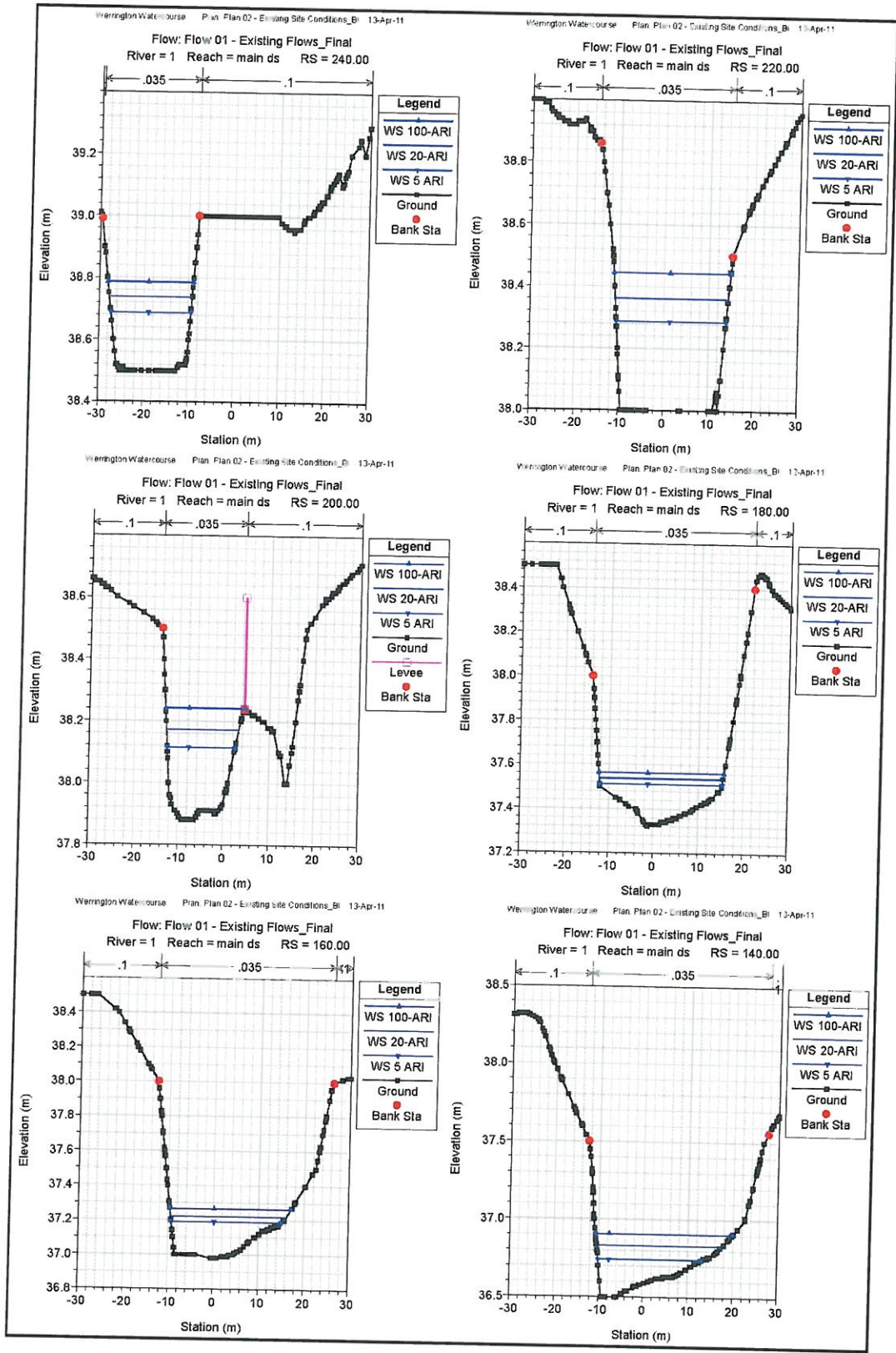
Plan 02 – Existing Site Conditions with Culvert Blockage

HEC-RAS Plan Exist_b													
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Ch
side	of path	180.00	20-ARI	1.02	43.70	43.80	43.80	43.64	0.033056	1.01	1.56	21.62	1.10
side	of path	180.00	100-ARI	1.47	43.70	43.82	43.82	43.67	0.029324	1.11	1.97	22.11	1.08
side	of path	180.00	5-ARI	0.66	43.70	43.78	43.78	43.97	0.032113	0.85	1.18	20.99	1.04
side	of path	160.00	20-ARI	1.02	42.85	42.96	42.96	43.00	0.025542	0.95	1.66	23.84	0.98
side	of path	160.00	100-ARI	1.47	42.85	42.96	42.98	43.04	0.053661	1.37	1.65	23.80	1.42
side	of path	160.00	5-ARI	0.66	42.85	42.94	42.94	42.97	0.023024	0.70	1.25	21.82	0.90
side	of path	140.00	20-ARI	1.02	42.33	42.44	42.44	42.49	0.025832	0.99	1.36	18.35	1.00
side	of path	140.00	100-ARI	1.47	42.33	42.47	42.47	42.52	0.023821	1.11	1.87	20.96	1.00
side	of path	140.00	5-ARI	0.66	42.33	42.42	42.42	42.45	0.030199	0.80	0.95	15.86	1.03
side	of path	120.00	20-ARI	1.02	41.59	41.73	41.73	41.81	0.042654	1.21	0.90	12.70	1.26
side	of path	120.00	100-ARI	1.47	41.59	41.75	41.78	41.85	0.042375	1.39	1.17	14.41	1.31
side	of path	120.00	5-ARI	0.66	41.59	41.71	41.72	41.76	0.028912	0.99	0.68	10.21	1.16
side	of path	100.00	20-ARI	1.02	41.00	41.10	41.15	41.20	0.128362	1.74	0.50	9.51	2.10
side	of path	100.00	100-ARI	1.47	41.00	41.18	41.18	41.24	0.021223	1.13	1.45	13.91	0.96
side	of path	100.00	5-ARI	0.66	41.00	41.08	41.12	41.21	0.115390	1.60	0.41	8.16	2.21
side	of path	80.00	20-ARI	1.02	40.53	40.63	40.63	40.67	0.024601	0.94	1.23	15.11	0.97
side	of path	80.00	100-ARI	1.47	40.53	40.64	40.65	40.71	0.031756	1.17	1.45	15.73	1.12
side	of path	80.00	5-ARI	0.66	40.53	40.60	40.60	40.64	0.028097	0.94	0.90	13.95	0.94
side	of path	60.00	20-ARI	1.02	39.99	40.08	40.08	40.12	0.030663	0.89	1.20	17.95	1.04
side	of path	60.00	100-ARI	1.47	39.99	40.04	40.10	40.45	0.065950	2.83	0.92	15.62	4.85
side	of path	60.00	5-ARI	0.66	39.99	40.07	40.07	40.09	0.026187	0.72	0.45	16.91	0.93
side	of path	40.00	20-ARI	1.02	39.20	39.37	39.37	39.42	0.022938	1.04	0.90	8.31	0.97
side	of path	40.00	100-ARI	1.47	39.20	39.41	39.41	39.48	0.021666	1.16	1.27	8.81	0.97
side	of path	40.00	5-ARI	0.66	39.20	39.34	39.34	39.38	0.026393	0.93	0.71	7.62	0.99
side	of path	20.00	20-ARI	1.02	38.20	38.25	38.30	38.35	0.000005	0.11	9.66	19.50	0.05
side	of path	20.00	100-ARI	1.47	38.20	38.53	38.54	38.93	0.000045	0.13	11.90	20.50	0.06
side	of path	20.00	5-ARI	0.66	38.20	38.78	38.78	38.78	0.000023	0.09	6.25	18.55	0.04
2	main us	574.81	20-ARI	2.63	43.90	44.87	44.27	44.88	0.000440	0.42	6.21	9.77	0.17
2	main us	574.81	100-ARI	3.89	43.90	45.06	44.35	45.07	0.000468	0.47	8.20	11.46	0.18
2	main us	574.81	5-ARI	1.67	43.90	44.70	44.19	44.71	0.000402	0.36	4.66	8.81	0.16
2	main us	550											
2	main us	534.27	20-ARI	2.63	42.81	43.01	43.01	43.07	0.024004	1.04	2.92	22.06	0.98
2	main us	534.27	100-ARI	3.89	42.81	43.05	43.05	43.11	0.013667	1.18	3.30	23.71	1.01
2	main us	534.27	5-ARI	1.67	42.81	42.98	42.98	43.02	0.026987	0.94	1.77	19.76	1.00
2	main us	514.27	20-ARI	2.63	42.29	42.46	42.44	42.49	0.015172	0.81	1.24	28.35	0.78
2	main us	514.27	100-ARI	3.89	42.29	42.49	42.47	42.53	0.016709	0.86	4.06	30.73	0.84
2	main us	514.27	5-ARI	1.67	42.29	42.43	42.41	42.45	0.016219	0.73	2.30	25.88	0.78
2	main us	494.27	20-ARI	2.63	41.94	42.05	42.05	42.10	0.011122	0.98	1.65	28.70	1.01
2	main us	494.27	100-ARI	3.89	41.94	42.09	42.08	42.15	0.024264	1.10	3.54	28.79	1.00
2	main us	494.27	5-ARI	1.67	41.94	42.03	42.03	42.07	0.014463	0.80	2.10	27.61	0.93
2	main us	474.27	20-ARI	2.63	41.50	41.77	41.64	41.78	0.002940	0.73	4.94	21.93	0.76
2	main us	474.27	100-ARI	3.89	41.50	41.59	41.68	42.00	0.011484	2.95	1.37	16.07	3.31
2	main us	474.27	5-ARI	1.67	41.50	41.71	41.61	41.70	0.002969	0.44	1.76	20.83	0.73
2	main us	454.27	20-ARI	2.63	41.48	41.63	41.63	41.69	0.023154	1.11	2.15	18.03	0.99
2	main us	454.27	100-ARI	3.89	41.48	41.66	41.66	41.75	0.021400	1.26	3.06	18.91	1.00
2	main us	454.27	5-ARI	1.67	41.48	41.59	41.59	41.64	0.023349	0.95	1.76	17.26	0.95
2	main us	434.27	20-ARI	2.63	41.00	41.27	41.19	41.30	0.006198	0.81	1.24	14.86	0.55
2	main us	434.27	100-ARI	3.89	41.00	41.32	41.24	41.37	0.007124	0.96	4.04	15.95	0.61
2	main us	434.27	5-ARI	1.67	41.00	41.09	41.14	41.28	0.010754	1.33	0.95	11.24	2.23
2	main us	414.27	20-ARI	2.63	40.81	41.04	41.04	41.10	0.023363	1.10	2.39	18.95	0.99
2	main us	414.27	100-ARI	3.89	40.81	41.08	41.08	41.15	0.021805	1.23	3.15	19.90	0.99
2	main us	414.27	5-ARI	1.67	40.81	41.00	41.00	41.05	0.024782	0.95	1.75	18.12	0.98
2	main us	394.27	20-ARI	2.63	40.50	40.74	40.68	40.78	0.008523	0.86	3.07	16.55	0.94
2	main us	394.27	100-ARI	3.89	40.50	40.80	40.73	40.84	0.008848	0.98	2.97	18.02	0.67
2	main us	394.27	5-ARI	1.67	40.50	40.70	40.64	40.72	0.007748	0.72	2.32	15.09	0.58
2	main us	374.27	20-ARI	2.63	40.34	40.55	40.52	40.58	0.011601	0.86	3.06	20.76	0.71
2	main us	374.27	100-ARI	3.89	40.34	40.59	40.55	40.64	0.011236	0.83	4.03	22.41	0.73
2	main us	374.27	5-ARI	1.67	40.34	40.51	40.48	40.54	0.011894	0.74	2.25	19.34	0.39
2	main us	354.27	20-ARI	2.63	40.00	40.21	40.21	40.27	0.013688	1.11	2.25	16.44	1.01
2	main us	354.27	100-ARI	3.89	40.00	40.35	40.25	40.35	0.021856	1.26	3.10	19.06	1.00
2	main us	354.27	5-ARI	1.67	40.00	40.16	40.16	40.22	0.024966	1.05	1.99	14.24	1.00
2	main us	330											
2	main us	314.27	20-ARI	2.63	38.20	38.86	38.41	38.86	0.000184	0.25	10.64	20.80	0.11
2	main us	314.27	100-ARI	3.89	38.20	38.94	38.46	38.95	0.000254	0.31	12.40	21.55	0.13
2	main us	314.27	5-ARI	1.67	38.20	38.78	38.37	38.78	0.000122	0.18	9.05	20.09	0.04
2	main us	294.27	20-ARI	2.63	38.20	38.66	38.43	38.86	0.000163	0.23	11.56	23.35	0.10
2	main us	294.27	100-ARI	3.89	38.20	38.94	38.41	38.94	0.000221	0.29	13.51	24.11	0.12

HEC-RAS Plan Exhibit (Continued)

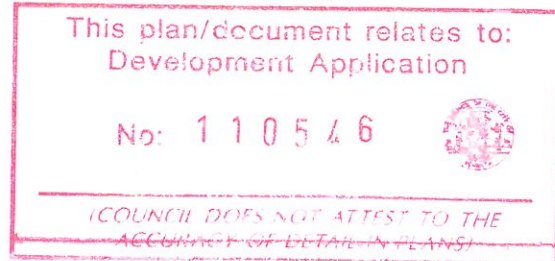
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W S Elev (m)	Cut W S (m)	E G Elev (m)	E G Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
2	main us	294.27	5 ARI	1.67	36.20	38.78	39.33	39.78	0.000108	0.17	0.80	22.51	0.08
2	main us	274.27	20-ARI	3.53	36.20	38.85	39.41	39.86	0.000190	0.22	11.33	24.95	0.11
2	main us	274.27	100-ARI	3.69	36.20	38.93	39.48	39.94	0.000254	0.25	13.42	27.25	0.13
2	main us	274.27	5 ARI	1.67	36.20	38.78	39.36	39.70	0.000128	0.18	9.50	23.58	0.08
1	main ds	240.00	20-ARI	5.68	36.50	36.74	36.74	36.84	0.019099	1.42	4.01	18.59	0.97
1	main ds	240.00	100-ARI	7.91	36.50	36.79	36.79	36.92	0.019622	1.61	4.90	19.13	1.02
1	main ds	240.00	5 ARI	3.87	36.50	36.69	36.69	36.77	0.020076	1.26	3.07	17.89	0.97
1	main ds	220.00	20-ARI	5.68	36.00	36.36	36.19	36.38	0.020413	0.67	6.43	25.23	0.37
1	main ds	220.00	100-ARI	7.91	36.00	36.44	36.33	36.47	0.020755	0.75	15.54	26.02	0.36
1	main ds	220.00	5 ARI	3.87	36.00	36.29	36.15	36.30	0.020452	0.89	6.58	24.46	0.36
1	main ds	200.00	20-ARI	5.68	37.88	36.17	36.17	36.39	0.020120	1.53	3.72	16.07	1.01
1	main ds	200.00	100-ARI	7.91	37.88	36.24	36.24	36.36	0.017781	1.62	4.87	17.55	0.98
1	main ds	200.00	5 ARI	3.87	37.88	36.12	36.12	36.21	0.021204	1.37	2.82	15.08	1.01
1	main ds	180.00	20-ARI	5.68	37.32	37.54	37.57	37.66	0.042707	1.54	3.69	27.63	1.35
1	main ds	180.00	100-ARI	7.91	37.32	37.56	37.61	37.73	0.047023	1.90	4.39	27.93	1.40
1	main ds	180.00	5 ARI	3.87	37.32	37.53	37.60	37.60	0.040177	1.30	3.97	27.85	1.20
1	main ds	160.00	20-ARI	5.68	36.98	37.22	37.22	37.31	0.020788	1.22	4.10	26.62	1.05
1	main ds	160.00	100-ARI	7.91	36.98	37.27	37.27	37.37	0.021529	1.44	5.48	26.84	1.02
1	main ds	160.00	5 ARI	3.87	36.98	37.19	37.18	37.25	0.019328	1.10	3.53	24.57	0.92
1	main ds	140.00	20-ARI	5.68	36.50	36.33	36.79	36.86	0.011018	1.02	5.57	27.93	0.77
1	main ds	140.00	100-ARI	7.91	36.50	36.31	36.83	36.96	0.007771	1.01	7.82	30.63	0.64
1	main ds	140.00	5 ARI	3.87	36.50	36.74	36.74	36.71	0.023960	1.19	3.25	23.19	1.02
1	main ds	120.00	20-ARI	5.68	36.03	36.75	36.89	36.76	0.000541	0.16	10.85	39.91	0.18
1	main ds	120.00	100-ARI	7.91	36.03	36.85	36.44	36.86	0.000512	0.40	15.79	41.19	0.18
1	main ds	120.00	5 ARI	3.87	36.03	36.44	36.33	36.47	0.004392	0.70	5.54	24.65	0.47
1	main ds	100.00	20-ARI	5.68	36.03	36.76	36.30	36.75	0.000327	0.25	10.38	22.74	0.16
1	main ds	100.00	100-ARI	7.91	36.03	36.84	36.35	36.85	0.000428	0.40	19.72	35.23	0.17
1	main ds	100.00	5 ARI	3.87	36.03	36.34	36.24	36.37	0.004980	0.77	5.04	21.43	0.50
1	main ds	80.00	20-ARI	5.68	35.74	36.74	36.17	36.75	0.000249	0.27	24.45	57.31	0.14
1	main ds	80.00	100-ARI	7.91	35.74	36.83	36.23	36.84	0.000300	0.44	29.81	57.43	0.15
1	main ds	80.00	5 ARI	3.87	35.74	36.10	36.10	36.21	0.020670	1.43	2.70	13.13	1.01
1	main ds	60.00	20-ARI	5.68	35.49	36.74	35.68	36.74	0.000011	0.10	65.81	63.56	0.02
1	main ds	60.00	100-ARI	7.91	35.49	36.84	35.72	36.84	0.000016	0.12	60.90	63.53	0.04
1	main ds	60.00	5 ARI	3.87	35.49	35.80	35.64	35.81	0.001507	0.42	9.13	38.63	0.28
1	main ds	40.00	20-ARI	5.68	35.33	36.74	35.54	36.74	0.000006	0.08	76.64	61.79	0.02
1	main ds	40.00	100-ARI	7.91	35.33	36.84	35.57	36.84	0.000009	0.11	82.57	61.79	0.03
1	main ds	40.00	5 ARI	3.87	35.33	35.79	35.51	35.74	0.000240	0.22	18.89	55.42	0.12
1	main ds	7.76	20-ARI	5.68	33.84	36.74	34.24	36.74	0.000007	0.14	60.26	32.64	0.03
1	main ds	7.76	100-ARI	7.91	33.84	36.84	34.32	36.54	0.000012	0.18	63.37	32.64	0.01
1	main ds	7.76	5 ARI	3.87	33.84	35.79	34.17	35.79	0.000017	0.16	28.19	32.64	0.04
1	main ds	5	Convent										
1	main ds	2	20-ARI	5.68	33.63	34.09	34.03	34.13	0.010001	1.41	4.90	11.41	0.76
1	main ds	2	100-ARI	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.98	11.71	0.78
1	main ds	2	5 ARI	3.87	33.63	34.01	33.95	34.06	0.010012	1.22	3.18	11.27	0.73







Shaping the Future



Werrington Subdivision
Cnr of French Street & Great Western Highway
Kingswood
Civil, Flooding & Stormwater Management Report

Prepared For:

Middle East Pty Ltd

Prepared By:
Cardno ITC

Level 7, 33 YORK STREET
SYDNEY NSW 2000
Tel: 612 9495 8100
Fax: 612 9495 8111

December 2011

DOCUMENT HISTORY

Issue No.	Revision No.	Date	No. of Pages	Comment
A	0	31.03.11	23	Preliminary Issue – Draft Only
A	1	14.04.11	63	Preliminary Issue – For Client Approval
A	2	18.04.11	63	Final Issue
A	3	21.04.11	74	Final Issue – includes Client comments
A	4	29.04.11	74	Final Issue – For submission to Council
A	5	18.05.11	74	Final Issue – For submission to Council
A	6	20.12.11	89	Revised Issue – For submission to Council

DOCUMENT APPROVAL:

Approved by: Sam Haddad Date: 20.12.2011
(Cardno ITC)

Approved by: _____ Date: _____
(Middle East Pty Ltd)

CONTENTS

1 EXECUTIVE SUMMARY	1
2 INTRODUCTION.....	2
2.1 Brief.....	2
2.2 Report Structure	3
2.3 References.....	3
3 GLOSSARY	5
4 PROJECT DESCRIPTION.....	6
4.1 Site Location.....	6
4.2 Development Description.....	7
4.3 Site Investigation	7
4.4 Authorities Requirements.....	7
5 STORMWATER MANAGEMENT.....	9
5.1 General.....	9
5.2 Urban Drainage Design	9
5.3 On-Site Detention	9
5.4 Water Quality.....	10
5.5 Water Cycle Management Facilities Contributions.....	11
6 FLOOD MANAGEMENT	12
6.1 Description.....	12
6.2 Hydrological Modelling.....	12
6.3 Hydraulic Simulations	14
7 CIVIL DESIGN	25
Appendix 1	26
<i>Rainfall Data.....</i>	<i>26</i>
Appendix 2	29
<i>Catchment Plan.....</i>	<i>29</i>
Appendix 3	31
<i>Results of the Hydrological Modelling.....</i>	<i>31</i>
Appendix 4	33
<i>Results of the Hydraulic Modelling</i>	<i>33</i>
Appendix 5	65
<i>Flood Extents Plan</i>	<i>65</i>
Appendix 6	67
<i>Design Drawings</i>	<i>67</i>
Appendix 7	80
<i>Authorities Correspondence</i>	<i>80</i>

1 EXECUTIVE SUMMARY

This document is a stormwater management and strategy report for the proposed Mixed-Use subdivision located at the corner of French Street and the Great Western Highway, in the suburb Kingswood.

This report assesses the following:-

1. The flooding impact;
2. The proposed strategy for the internal stormwater drainage; and
3. The road network design.

The report describes the proposed masterplan in general and the Stage 1 Development Application in specific.

The site is identified as the Werrington Mixed-Use Area. The site is divided into residential and employment zoning. The residential zone is subject to a Stage 1 Development Application and a Stage 2 planning proposal.

The site is located within the Werrington Creek Catchment Area. A watercourse (classified as Category 2) draining in a South-North direction bisects the site. The watercourse collects the runoff from a culvert crossing under the Great Western Highway. The watercourse terminates in a culvert under the Western Railway line.

A flood study for the watercourse has been prepared. The study assesses the existing and the proposed flooding scenarios following the development of the site. The impacts of the flooding on the development and vice versa are considered. The results of the simulations indicate that the proposed subdivision is outside the flood prone area and does not alter the flooding characteristics through the site.

Provisions are made for the internal drainage network servicing the proposed subdivision. The stormwater management involves the following aspects:-

- Urban drainage design to drain all the lots into the street drainage system. The design caters for a 10-year ARI storm event;
- Provision of On-Site Detention (OSD) systems to control the discharge flows from the site. The OSDs are provided in the shape of basins/ponds located in the drainage reserve; and
- Provision of water quality measures to control the quality of water discharging from the site to current industry standards and Council requirements (refer Table 3). These measures include water quality bio-retention ponds and gross pollutant traps. The ponds are combined with the OSD ponds;

The civil design is carried out in accordance with Council's DCP and technical guidelines. The designs are reflected in the long sections and the typical cross sections detailed in the design drawings. Reference is made to Appendix 6 for more details.

2 INTRODUCTION

2.1 Brief

Cardno ITC have been engaged by Middle East Pty Ltd (The Client) to prepare the subdivision civil design plans for the site at the corner of French Street and The Great Western Highway in Kingswood for the purpose of providing new residential lots.

The Client is proposing to submit a Masterplan for the site and concurrently a Stage 1 Development Application for new residential properties. The site is identified as the Werrington Mixed-Use Area and is controlled by a Development Control Plan prepared by Penrith City Council (PCC) and is known as the "Werrington Mixed-Use Area DCP".

The site is a large land previously owned and occupied by the Defence Forces. A watercourse draining in a South-North direction bisects the site. The watercourse is identified as Category 2 by Council and is located in a conservation area. The subdivision is proposed outside the conservation area.

Cardno ITC was commissioned to carry out the following tasks: -

- A flood study for the watercourse. The study involved hydrological and 1-D hydraulic simulations;
- The civil design of the road network; and
- The stormwater drainage design.

A site visit was undertaken on the 13th of January 2011 to familiarise with the site and the surrounding catchment and to determine opportunities and constraints.

Liaison with the relevant authorities was made including Council, Sydney Water, RTA, The Office of Nepean Hawkesbury and the Department of Water and Energy. Refer to Appendix 7 for copies of correspondence received from the relevant authorities.

This report was compiled to describe the tasks undertaken by Cardno ITC and to provide recommendations relating to the proposed subdivision. This report should be read in conjunction with the design drawings as listed below: -

- C100 – Title Sheet;
- C101 – Site Plan / Staging Plan;
- C200 – General Arrangement Plan;
- C201 – Cut & Fill Plan (not issued in the revised set of drawings);
- C300 – Road Longitudinal Sections – Road 1, 2, 3 & 5;
- C301 – Road Longitudinal Sections – Road 6, 7, 8 & 9 – Road Typical Sections;
- C400 – Stormwater Longitudinal Sections – Sheet 1 of 3;
- C401 – Stormwater Longitudinal Sections – Sheet 2 of 3;
- C402 – Stormwater Longitudinal Sections – Sheet 3 of 3;
- C500 – Details Sheet.

2.2 Report Structure

This report is structured as follows:-

- Section 1 – Executive Summary: this section summarises the tasks and the results of the design and analysis;
- Section 2 – Introduction: this section includes the preliminaries and the objectives of the report;
- Section 3 – Glossary: this section includes the definition of the terms used in the report;
- Section 4 – Project Description: this section describes the existing site, the proposed development and the requirements of the authorities;
- Section 5 – Stormwater Management: the design standards adopted for the internal stormwater are outlined in this section;
- Section 6 – Flood Management: this is the main core section of the report where the hydrology and the hydraulic simulations are detailed;
- Section 7 – Civil Design: the design standards relating to the road design, grading, and other civil components are included in this section; and
- Section 8 – Appendices: the documents referenced in this report are included in this section.

2.3 References

The following documents have been reviewed and checked against the site conditions.

1. Survey drawing ref. A734 prepared by Whelans In-Sites and dated 16/12/2002 detailing the site topography, contours and drainage structures;
2. Survey drawings ref. 3140DT rev. c1 prepared by Stratasurv and dated 19/04/2011 detailing specific areas of the site as requested by Cardno ITC;
3. Proposed subdivision and lots layout plan ref. 3140STAGE01 rev. a10 prepared by Stratasurv and dated 19/12/2011;
4. Proposed Master Plan Study and layout plan prepared by Tony Owen Partners;
5. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 29 July 2010;
6. Pre-DA meeting notes prepared by Penrith City Council reference PL 10/0089 dated 8 September 2010;
7. Pre-DA meeting attended by Cardno ITC in Penrith City Council chambers on 01/03/2011;
8. Catchment Map for the watercourse received from Penrith City Council dated 18 January 2010;
9. Penrith City Council "Development Control Plan 2010", sections C3, C8, C10, C11 & C13;
10. Penrith City Council "Werrington Mixed-Use Area" DCP (effective 23 February 2007);
11. Penrith City Council "Guidelines For Engineering Works and Subdivisions and Developments", part 1 design & part 2 construction dated 20 May 1997;
12. Penrith City Council "WELL Precinct Development Contributions Plan 2008";
13. The NSW Government "Floodplain Development Manual" April 2005; and

14. "Australian Rainfall & Runoff" (AR&R 1997) by Engineers Australia.

3 GLOSSARY

Annual Exceedance Probability (AEP)

The chance of a flood of a given or a larger size occurring in any one year, usually expressed as a percentage.

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Average Recurrence Interval (ARI)

The long term average number of years between the occurrence of a flood as big as or larger than the selected event.

Catchment

The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

Flood

Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse.

Flood Liable Land

Land susceptible to flooding by the PMF.

Flood Planning Levels (FPLs)

Are the combinations of flood levels and freeboards selected for floodplain risk management purposes.

Freeboard

Is a factor of safety typically used in relation to the setting of floor levels.

Habitable Room

In industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to damage in the event of a flood.

Peak Discharge

The maximum discharge occurring during a flood event.

Probable Maximum Flood

PMF is the largest flood that could conceivably occur at a location, usually estimated from probable maximum precipitation.

Probable Maximum Precipitation

PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year.

Runoff

The amount of rainfall which actually ends up as stream flow.

4 PROJECT DESCRIPTION

4.1 Site Location

The development site is located on the corner of French Street and The Great Western Highway in the suburb of Kingswood. Figure 1 below shows the location of the site.



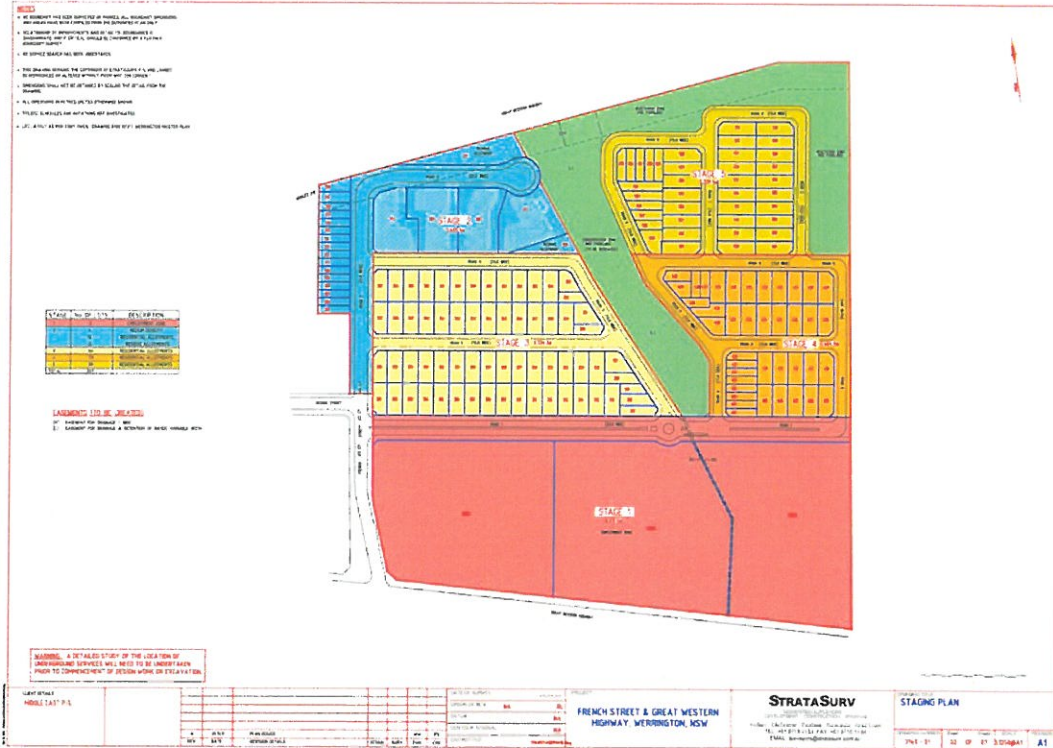
The overall site covers an area of 22.03ha (as per the survey) and is currently a vacant land. A watercourse draining a culvert system under the Great Western Highway bisects the site from south to north.

The watercourse starts from the southern boundary with the highway down to a culvert system under the railway line, which delimits the northern boundary of the site. The western boundary of the site is limited by French Street while the eastern boundary is bounded by adjoining properties and vacant land.

4.2 Development Description

The Client is proposing to subdivide the site, which is already zoned as Mixed-Use Area under Council's current DCP. The intent of the proposal is to provide a masterplan for the whole site and a development application for a Staged residential subdivision.

The layout of the proposed masterplan subdivision is shown below. The staging is also shown different colours as well.



4.3 Site Investigation

A site inspection was carried out by Cardno ITC to familiarise with the site and the surrounding catchment area.

The investigation covered the existing condition of the site, the existing ponds, the watercourse, the culverts under the Great Western Highway and the constructed road and the associated infrastructure. The culverts under the Great Western Railway could not be inspected due to overgrown vegetation in that area.

At the time of our inspection, the watercourse was dry. It is understood that the watercourse flows only during a rainfall event.

4.4 Authorities Requirements

4.4.1 Penrith City Council

The site is located in the Local Government Area of Penrith City Council (PCC). The requirements of PCC are summarised in this section.

The key requirements of PCC in relation to subdivision, flooding and stormwater management are as follows:-

- The watercourse traversing the site is classified as Category 2 and requires 20m core riparian corridor width and 10m vegetated setback on each side totaling an overall width of 40m. (Refer Table C3.3 of DCP 2010);
- 50% flow reduction in downstream pipe systems for partial blockage to be made;
- On-Site Detention is required for the proposed development. The OSDs should be located above the 5-year ARI flood level;
- Water quality requirements to Council's DCP will be required. Level 2 modeling is required because the site falls under the "Medium (10-50ha)" category; and
- The proposed ponds can be located within the drainage reserve as shown in the "Werrington Mixed Use Area" DCP.

4.4.2 Sydney Water

With respect to stormwater, Sydney Water has advised that it does not own any infrastructure in the area and would not have any requirements for stormwater management or flooding.

4.4.3 Office of Nepean and Hawkesbury

- The watercourse is a category 2 so it needs to have 20m riparian width each side of the top of bank of the watercourse;
- Enough space should be allowed for any water quality or quantity basins/structures; and
- Removal of any current works in the watercourse riparian area should be OK with adequate environmental protection, but will need a controlled activity approval. It is best to do this via an integrated development application.

5 STORMWATER MANAGEMENT

5.1 General

The stormwater management covers several aspects of the stormwater design. It includes the following: -

- Urban road drainage design;
- Inter-allotment drainage design for sites with lands that fall away from the street;
- On-Site Detention as requested by Council; and
- Water quality control.

These components are designed to address the requirements of the relevant authorities.

5.2 Urban Drainage Design

The pipe/pit system including the inter-allotment drainage are designed to cater for 10-year ARI storm event with overland flowpath provided for storms in excess of the design storm. The road drainage has been designed using the minor/major system approach with the piped network being the minor and the roads being the major. Refer to the IFD table included in Appendix 1 for rainfall intensity values adopted in the design.

The stormwater drainage will generally follow the natural gradient of the site. Ultimately, the discharge from the site will be maintained to the culverts under the railway line.

An impervious fraction of 0.80 has been adopted for the purpose of sizing the pipe system servicing the subdivision. The following runoff coefficients have been used: -

- $C_{20} = 0.83$; and
- $C_{100} = 0.95$.

The following times of concentration have been adhered to: -

- Minimum $t_c = 6$ minutes; and
- Maximum $t_c = 20$ minutes.

5.3 On-Site Detention

The On-Site Detention (OSD) basins have been sized using "DRAINS" software. The simulations ensured that the site discharge in all storms for the post-developed conditions does not exceed the pre-developed natural state of the site.

It is proposed to retain the existing pond servicing the employment zone and Road 1 (refer to design drawings for location and details). The pond has been constructed as part of the previous subdivision of the site.

Two additional OSD basins are proposed as part of this subdivision to control the runoff from the areas north of Road 1. Basin 1 has a capacity of 1746m³ and controls the runoff from the site area west of the conservation zone. Basin 2 has a capacity of 1014m³ and controls the runoff from the site area east of the conservation zone. Refer to General Arrangement Plan (DRG C200) for location of Basins 1 & 2.

The table on the following page summarises the results of the DRAINS model. The controlled peak flow from the On-Site Detention basins is equal or less than the existing peak flow in all storm events.

Table 1 Summary Results of Basin 1 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.64	1.67	0.63	0.63	0	995
20	1.19	2.37	1.07	0.71	0.36	1478
100	1.86	3.09	1.86	0.74	1.12	1746

Table 2 Summary Results of Basin 2 Sizing

ARI (yrs)	Existing Peak Flow (m ³ /s)	Uncontrolled Peak Flow (m ³ /s)	Controlled Peak Flow (m ³ /s)	Piped Flow (m ³ /s)	Spillway Flow (m ³ /s)	OSD Volume (m ³)
5	0.50	1.20	0.50	0.50	0	576
20	0.89	1.67	0.82	0.59	0.23	874
100	1.38	2.11	1.38	0.62	0.76	1014

5.4 Water Quality

To address the water quality requirements, the site's runoff will be treated prior to discharging into the railway culverts. It is proposed to use a treatment train approach to meet the water quality objectives.

The site is classified "Medium (10-50ha) under Council DCP 2010 Section C3 and hence a Level 2 (Actual Event Load) is required to assess the pollutants load from a storm event on a daily basis.

The following table summarises the requirements for pollution retention criteria as required by Council.

Table 3 Pollution Retention Criteria

Pollutant	Description	Retention Criteria
Litter	All anthropogenic material (cans, bottles, wrapping, etc.)	70% of material \geq 5mm diameter
Coarse Sediment	Coarse sand (\geq 0.5mm)	80% of the load for particles \leq 0.5mm diameter
Nutrients	Total Phosphorus & total Nitrogen	45% retention of the load for each
Fine Particles	Fine sand (\geq 0.05mm)	50% of the load for particles \leq 0.1mm diameter
Free Oil & Grease	Free floating viscous liquids \geq 150 μ m that do not emulsify in aqueous solutions	90% of the load with no visible discharges

The treatment train approach adopted for the subdivision is described below.

- It is assumed that each lot will be fitted with an individual rainwater reuse tank in the future when the lots will be developed with residential single dwellings to respond to BASIX requirements;
- It is proposed to install gross pollutant traps in front of the OSD basins. The devices will be designed to capture litter, gross and fine sediments and hydrocarbons generated from the site to manufacturer's requirements. The gully pits in the streets will be fitted with trash baskets only if required by Council; and

- c. Water quality bio-retention ponds are proposed in conjunction with the OSD basins. The basins will be underlain with a layer of fine material and a network of subsoil pipes. The purpose of the fine material is to treat the runoff from the 3-month storm through percolation. The runoff will be drained through the subsoil network and discharged into the stormwater system. The ponds could possibly have an extended depth as well to allow for more treatment volume and time.

The performance of the above treatment train measures will be verified against the criteria in Table 3 by calculations and real rainfall event simulations using "MUSIC" software in the advanced stages of the design development.

5.5 Water Cycle Management Facilities Contributions

Under the WELL Precinct Development Contributions Plan, there are contributions for the Water Cycle Management Facilities to be provided by the developer. The contributions for the Werrington Mixed Use Area are calculated as follows:-

Net Developable Area of the site for Stage 1 (for catchments) = 8.618ha;
Contributions per hectare = \$209,040.00. This includes for the land acquisition and the works for both wp8-r1 & wp8-r2 as noted in the DCP;

The Water Cycle Management Facilities Contributions are: $8.618 \times 209040 = \$1,801,506.72$.

6 FLOOD MANAGEMENT

6.1 Description

This section outlines the flooding requirements for the proposed subdivision due to the presence of the watercourse. For the purpose of the Master Plan submission, Cardno ITC have carried out a flood study to determine the impacts of the flooding if there are any.

The site is bisected by a watercourse traversing the site from the culverts under the Great Western Highway down to the culverts under the Railway Corridor. The area of the watercourse is considered a conservation zone and is potentially subject to flooding in major storm events.

The culverts are as follows:-

- Under the Great Western Highway: two box sections 1.86m wide and 1.25m high; and
- Under the Great Western Railway: one circular conduit 1.5m diameter.

Another minor overland flowpath enters the site from the eastern boundary and connects to the watercourse in the middle of the site.

The flood study is divided into two sections: hydrological and hydraulic simulations. These simulations respond to Council's requirements.

6.1.1 Hydrology

The hydrological analysis of the flood study identifies the characteristics of the catchment and determines the flood peak discharge through the site.

The rainfall intensities obtained from Council's Guidelines for Works and Subdivisions (1997) and included in Appendix 1, have been used in the hydrological "DRAINS" model prepared to simulate the runoff for the upstream catchment.

6.1.2 Hydraulic Simulations

The flood peak values derived from the hydrological analysis are used to assess the capacity of the watercourse to carry the flows and to determine the peak flood levels expected to be reached for each storm event.

The hydraulic simulations have been carried out using the 1-D software "HECRAS" as required by Council. The existing watercourse cross sectional area has been extracted from the detailed survey plan of the site and used to build the "HECRAS" model. The extent of the model is limited to the site boundaries.

6.2 Hydrological Modelling

A "DRAINS" model is built to replicate the catchment's hydrology and to estimate the peak flood discharges for any observed or synthetic storm. Parameters such as catchment area, impervious area and rainfall losses are used to describe the catchment response to a specific rainfall event in order to generate synthetic peak flood flows where required.

The catchment area was subdivided into several sub-catchments based on the topography and the outlet controls (i.e. location of culverts, roads blocking flows, direction of flows, etc.). Reference is made to Appendix 2 for the layout of the sub-catchments.

The catchment area extends into the Western Sydney University to the South. The impact of the ponds servicing the university has not been included in the simulations. These could have a retarding affect on the runoff and could potentially reduce the peak flood discharge into the site. The approach is rather conservative and could lead to higher flows through the site but is considered acceptable for the purpose of this study.

The catchment extends into adjoining properties to the east. This catchment has been included as a separate sub-catchment, which drains through a depression within the site and discharges into the watercourse.

The northern and western boundaries of the catchment are bounded by the railway corridor and French Street respectively. There are no external catchments in these directions.

The catchments are classified as follows:

- Catchment A (UWS) is mainly pervious and is assigned a retardance coefficient of 0.1;
- Catchment B (Employment zone of site) is assigned a retardance coefficient of 0.05;
- Catchment B1 (adjoining site to the east) is considered to be residential in the future and is assigned a retardance coefficient of 0.08; and
- Catchment C (residential zone of site) is assigned a retardance coefficient of 0.08.

The simulations were carried out for the 5, 20 & 100 year ARI storm events.

The table below shows the peak flood discharges through the sub-catchments.

Table 4 Summary Results of Hydrological Simulations

ARI (yrs)	Cat A Flow (m ³ /s)	Cat B Flow (m ³ /s)	Cat B1 Flow (m ³ /s)	Cat C Flow (m ³ /s)	Total Flow (m ³ /s)
5	1.67	2.29	0.66	0.50	3.87
20	2.63	3.53	1.02	0.78	5.68
100	3.89	4.89	1.47	1.19	7.91

The total flow indicated in the last column of the table does not equal the sum of the sub-catchment flows because of the partial areas effect.

6.2.1 Option A – Employment area rezoned to residential

This option considers the rezoning of the employment area of the site into residential. The purpose of this option is to determine the impact (if any) of such rezoning on the flood peak discharge into the watercourse.

The “DRAINS” model was re-configured with the retardance coefficient for the employment zone increased to 0.08.

The results of the simulations are included in the following table and compared with the results in Table 4 above.

Table 5 Summary Results of Modified Hydrological Simulations & Comparison with previous results

ARI (yrs)	Total Flow (m ³ /s)	Total Flow – Option A (m ³ /s)
5	3.87	3.97
20	5.68	6.07
100	7.91	8.55

It is obvious from the above results that the peak flood discharge into the watercourse increases if the rezoning occurs and this is due to the partial area effects within the catchment and the time of concentration for each sub-catchment. Option A was not considered in the following sections of this report or in the modelling.

6.3 Hydraulic Simulations

6.3.1 General

A "HECRAS" model was configured to simulate the existing watercourse crossing the site and to determine the flood levels across the site and to plot the water surface profile. The data included in the HECRAS model was extrapolated from Digital Terrain Model (DTM) created from the detailed survey of the site. Cross sections at 20m intervals were created from the DTM and exported into the HECRAS model as well.

A culvert program was used to estimate the flow rates for the unblocked and blocked (50%) culvert scenarios. This was used to determine the depth of blockages in the culverts to replicate a 50% blockage factor as required by Council.

The flood peak discharges derived from the "DRAINS" model were inserted in HECRAS model in the Steady Mode. A blockage factor of 50% is applied to the flows in the downstream culverts under the railway lines.

Manning's roughness coefficient of 0.035 was adopted for the main watercourse, with the banks having a higher roughness of 0.1.

For the purpose of the flood study, three (3) separate runs were performed to accurately simulate the different scenarios within the site. In summary, the runs are as follows: -

- **Plan "01 EXISTING"** – Existing site conditions (no blockages): this run simulates the existing site and watercourse conditions without any blockages applied to the upstream and downstream culverts;
- **Plan "02 EXG BL"** – Existing site conditions (with blockages): this run is similar to Plan 01 EXG with blockages applied to the upstream and downstream culverts to achieve 50% reduction in the piped flows;
- **Plan "03 PROPOSED"** – Proposed site (with blockages): this run simulates the proposed site with the subdivision layout with blockages applied to the upstream and downstream culverts.

6.3.2 Plan "01 EXISTING"

The cross sections at 20 metres intervals were included in the geometry file of HECRAS. This included the existing culverts under the Great Western Highway, the road through the site and the Great Western Railway.

The watercourse is labelled in HECRAS as follows: -

- Reach '1': segment of watercourse downstream of internal road and side overland flow from the east down to the culverts under the Railway corridor;
- Reach '2': segment of watercourse upstream of internal road up to the culverts under the Great Western Highway; and
- Reach 'side': Natural overland flowpath from the eastern boundary of the site.

The boundary conditions used for the purpose of the modelling are as follows: -

- Normal Depth upstream of the site. Normal depth of 1% is adopted as upstream boundary condition; and
- Normal Depth downstream of the site. Normal depth of 1% is adopted for the downstream boundary condition. This value is considered appropriate, as the Energy Slope in the downstream sections appear to be in the order of 0.5% to 1% depending on the storm event.

A summary of the results in Plan 01 for key sections is tabulated below. Reference should be made to Appendix 5 for the layout and the location of the sections. Detailed modelling results are included in Appendix 4.

Table 6 Summary Results of Plan "01 EXISTING" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
side	of path	180	20-ARI	1.02	43.7	43.8	1.01	
side	of path	180	100-ARI	1.47	43.7	43.82	1.12	
side	of path	180	5 ARI	0.66	43.7	43.78	0.85	
side	of path	100	20-ARI	1.02	41	41.1	1.74	
side	of path	100	100-ARI	1.47	41	41.18	1.13	
side	of path	100	5 ARI	0.66	41	41.08	1.6	
side	of path	20	20-ARI	1.02	38.2	38.85	0.11	
side	of path	20	100-ARI	1.47	38.2	38.93	0.13	
side	of path	20	5 ARI	0.66	38.2	38.78	0.08	
2	main us	574.81	20-ARI	2.63	43.9	44.43	1.02	
2	main us	574.81	100-ARI	3.89	43.9	44.62	0.98	
2	main us	574.81	5 ARI	1.67	43.9	44.24	1.15	
2	main us	550	Culvert under Great Western Highway					
2	main us	534.27	20-ARI	2.63	42.81	43	1.17	
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18	
2	main us	534.27	5 ARI	1.67	42.81	42.95	1.33	
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.12	
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.26	
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.95	
2	main us	354.27	20-ARI	2.63	40	40.18	1.18	
2	main us	354.27	100-ARI	3.89	40	40.23	1.3	
2	main us	354.27	5 ARI	1.67	40	40.14	1.09	
2	main us	330	Culvert under internal road					
2	main us	314.27	20-ARI	2.63	38.2	38.86	0.25	
2	main us	314.27	100-ARI	3.89	38.2	38.94	0.31	
2	main us	314.27	5 ARI	1.67	38.2	38.78	0.18	

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
1	main ds	160	20-ARI	5.68	36.98	37.22	1.32	
1	main ds	160	100-ARI	7.91	36.98	37.27	1.44	
1	main ds	160	5 ARI	3.87	36.98	37.19	1.1	
1	main ds	40	20-ARI	5.68	35.33	36.19	0.15	
1	main ds	40	100-ARI	7.91	35.33	36.8	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.56	0.6	
1	main ds	7.76	20-ARI	5.68	33.84	36.18	0.18	
1	main ds	7.76	100-ARI	7.91	33.84	36.8	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.47	0.2	
1	main ds	5	Culvert under Railway Line					
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41	
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59	
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22	

The results in Table 6 above indicate that the culvert under the railway is not large enough to cope with the peak flood discharge in a 100-year ARI storm event, which overtops the railway line. This is obviously due to the limited capacity of the 1500mm pipe culvert under the existing site conditions.

The watercourse area upstream of the culvert becomes inundated and water is stored temporarily in that area until such time the storm magnitude has reduced and the culvert is capable of discharging the incoming flows.

6.3.3 Plan "02 EXG BL"

Plan 02 is similar to Plan 01 with blockages to the upstream and to the downstream culverts under the Great Western Highway and the Great Western Railway respectively added to the HECRAS model. The blockages are included in the culvert geometry file by applying blockages to the bottom depth of the culverts such that the flow is reduced by 50% as requested by Council.

This plan is prepared to simulate the impact of the downstream culvert blockage on the flood levels across the site.

This was achieved by incorporating the obstructions as follows: -

Section	Description	Depth Blocked (m)
550	GWH culverts	0.4
5	GWR culverts	0.3

The detailed results of the simulations are included in Appendix 4 for reference. A summary of the results outlining the flood levels in key cross sections of the existing creek is shown in Table 8 below.

Table 8 Summary Results of Plan "02 EXG BL" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
side	of path	180	20-ARI	1.02	43.7	43.8	1.01	
side	of path	180	100-ARI	1.47	43.7	43.82	1.12	
side	of path	180	5 ARI	0.66	43.7	43.78	0.85	
side	of path	100	20-ARI	1.02	41	41.1	1.74	
side	of path	100	100-ARI	1.47	41	41.18	1.13	
side	of path	100	5 ARI	0.66	41	41.08	1.6	
side	of path	20	20-ARI	1.02	38.2	38.85	0.11	
side	of path	20	100-ARI	1.47	38.2	38.93	0.13	
side	of path	20	5 ARI	0.66	38.2	38.78	0.08	
2	main us	574.81	20-ARI	2.63	43.9	44.87	0.42	
2	main us	574.81	100-ARI	3.89	43.9	45.06	0.47	
2	main us	574.81	5 ARI	1.67	43.9	44.7	0.36	
2	main us	550	Culvert under Great Western Highway					
2	main us	534.27	20-ARI	2.63	42.81	43.01	1.04	
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18	
2	main us	534.27	5 ARI	1.67	42.81	42.98	0.94	
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.12	
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.26	
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.95	
2	main us	354.27	20-ARI	2.63	40	40.21	1.17	
2	main us	354.27	100-ARI	3.89	40	40.25	1.26	
2	main us	354.27	5 ARI	1.67	40	40.16	1.05	
2	main us	330	Culvert under internal road					
2	main us	314.27	20-ARI	2.63	38.2	38.86	0.25	

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
2	main us	314.27	100-ARI	3.89	38.2	38.94	0.31	
2	main us	314.27	5 ARI	1.67	38.2	38.78	0.18	
1	main ds	160	20-ARI	5.68	36.98	37.22	1.32	
1	main ds	160	100-ARI	7.91	36.98	37.27	1.44	
1	main ds	160	5 ARI	3.87	36.98	37.19	1.1	
1	main ds	40	20-ARI	5.68	35.33	36.74	0.08	
1	main ds	40	100-ARI	7.91	35.33	36.84	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.79	0.22	
1	main ds	7.76	20-ARI	5.68	33.84	36.74	0.14	
1	main ds	7.76	100-ARI	7.91	33.84	36.84	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.79	0.16	
1	main ds	5	Culvert under Railway Line					
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41	
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59	
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22	

The results in Table 8 above indicate that the blockage in GWR culverts affect the flood level in the upstream sections closer to the culverts. The impact of the blockage is more significant for the minor storms as opposed to the major storms as outlined in the table below.

In summary, the water level before the culvert rises 550mm in the 20-year ARI, 40mm in the 100-year ARI and 230mm in the 5-year ARI due to the partial blockage of the culvert. (Refer River Station 7.76 in Table 9 below).

In this scenario, the peak discharge floods in a 20-year ARI storm event could potentially overtop the railway lines. However, the flood levels in a 20-year ARI storm event are still below the 100-year ARI storm event in the existing scenario (PLAN 01). This indicates that the 20-year flood level will not have an adverse impact on the proposed levels within the subdivision.

The increase in the 100-year flood levels is minimal and is still below the proposed levels within the subdivision.

Table 9 Comparison of Flood Level in Lower Sections of the watercourse

River Station	Profile	Plan	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)
60	20-ARI	Exist_b	5.68	35.49	36.74
60	20-ARI	Exist	5.68	35.49	36.19

River Station	Profile	Plan	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)
60	100-ARI	Exist_b	7.91	35.49	36.84
60	100-ARI	Exist	7.91	35.49	36.8
60	5 ARI	Exist_b	3.87	35.49	35.8
60	5 ARI	Exist	3.87	35.49	35.69
40	20-ARI	Exist_b	5.68	35.33	36.74
40	20-ARI	Exist	5.68	35.33	36.19
40	100-ARI	Exist_b	7.91	35.33	36.84
40	100-ARI	Exist	7.91	35.33	36.8
40	5 ARI	Exist_b	3.87	35.33	35.79
40	5 ARI	Exist	3.87	35.33	35.56
7.76	20-ARI	Exist_b	5.68	33.84	36.74
7.76	20-ARI	Exist	5.68	33.84	36.18
7.76	100-ARI	Exist_b	7.91	33.84	36.84
7.76	100-ARI	Exist	7.91	33.84	36.80
7.76	5 ARI	Exist_b	3.87	33.84	35.79
7.76	5 ARI	Exist	3.87	33.84	35.47

5

Culvert under Railway Line

6.3.4 Plan "03 PROPOSED"

In Plan 03, the geometry file is amended to include the road levels on each side of the watercourse and to determine the impacts (if any) of these level changes on the flooding behaviour. The edges of the roads bounding the watercourse are included as levees in the model. In this case, the width of the flow is restricted to the width of the conservation zone (40m as a minimum).

The flow entering the site from the eastern boundary is diverted around the proposed subdivision and discharges directly into the culvert under the railway line. This is also reflected in this run.

The existing culvert under the internal road is removed and replaced with a proposed culvert under Road 1. The proposed culvert is similar to the existing culvert in shape and size and consists of three box sections 2.7m wide and 0.6m high.

The results of the simulations for Plan 03 are summarised in Table 10 below. Reference should be made to Appendix 4 for detailed results of the simulations.

Table 10 Summary Results of Plan "03 PROPOSED" at Key Sections

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)
2	main us	574.81	20-ARI	2.63	43.9	44.87	0.42

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)	
2	main us	574.81	100-ARI	3.89	43.9	45.06	0.47	
2	main us	574.81	5 ARI	1.67	43.9	44.7	0.36	
2	main us	550	Culvert under Great Western Highway					
2	main us	534.27	20-ARI	2.63	42.81	43.01	1.1	
2	main us	534.27	100-ARI	3.89	42.81	43.05	1.18	
2	main us	534.27	5 ARI	1.67	42.81	42.98	0.93	
2	main us	454.27	20-ARI	2.63	41.48	41.63	1.11	
2	main us	454.27	100-ARI	3.89	41.48	41.66	1.28	
2	main us	454.27	5 ARI	1.67	41.48	41.59	0.98	
2	main us	394.27	20-ARI	2.63	40.5	41.02	0.3	
2	main us	394.27	100-ARI	3.89	40.5	41.13	0.33	
2	main us	394.27	5 ARI	1.67	40.5	40.92	0.26	
2	main us	375	Proposed culvert under Road 1					
2	main us	314.27	20-ARI	2.63	38.2	38.83	0.27	
2	main us	314.27	100-ARI	3.89	38.2	38.9	0.34	
2	main us	314.27	5 ARI	1.67	38.2	38.76	0.2	
1	main ds	160	20-ARI	4.66	36.98	37.2	1.25	
1	main ds	160	100-ARI	6.44	36.98	37.24	1.37	
1	main ds	160	5 ARI	3.21	36.98	37.17	1.04	
1	main ds	40	20-ARI	5.68	35.33	36.74	0.08	
1	main ds	40	100-ARI	7.91	35.33	36.84	0.11	
1	main ds	40	5 ARI	3.87	35.33	35.79	0.22	
1	main ds	7.76	20-ARI	5.68	33.84	36.74	0.14	
1	main ds	7.76	100-ARI	7.91	33.84	36.84	0.18	
1	main ds	7.76	5 ARI	3.87	33.84	35.79	0.16	
1	main ds	5	Culvert under Railway Line					

River	Reach	River Station	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elevation (m)	Velocity Channel (m/s)
1	main ds	2	20-ARI	5.68	33.63	34.09	1.41
1	main ds	2	100-ARI	7.91	33.63	34.17	1.59
1	main ds	2	5 ARI	3.87	33.63	34.01	1.22

The results in Table 10 above indicate that the proposed subdivision does not impact on the flooding as there is no increase in flood levels along the watercourse.

This is demonstrated in Table 11 below, which compares the flood levels along the watercourse for all three plans described above.

The subdivision, as per the proposed lot layout, is not affected by flooding from the watercourse in all storm events up to and including the 100-year ARI storm event.

The proposed road network bounding the watercourse has a minimum finished surface level of RL37.00 at the lowest points, which is 160mm above the worst-case scenario flood level.

The proposed filling under Roads 3 & 6 adjoining the watercourse will not impact on the flooding behaviour and characteristics as outlined in Section 15 of Council's DCP 2010 Part C3. The results of the simulations indicate that all the criteria in that section of the DCP have been complied with.

The proposed residential lots are set at higher levels and will provide a minimum of 500mm freeboard above the 100-year ARI flood level.

Table 11 Flood Levels Comparison Table for Plans 01, 02 & 03

HC	R/S	Event	Reach	Event Sta	Profile	Plan	U Total (m³/s)	Min Ch El (m)	WS Elev (m)	Out WS (m)	EG Elev (m)	EG Slope (m/s)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)	Froude # Out
2	main us	574.01	20-ARI	Exist b	2.02	43.50	44.07	44.27	44.00	0.000440	0.42	5.24	9.77	0.17		
2	main us	574.01	20-ARI	Proposed	2.02	43.50	44.07	44.27	44.00	0.000440	0.42	6.21	9.77	0.17		
2	main us	574.81	30-ARI	Exist b	2.02	43.50	44.41	44.47	44.48	0.001847	1.17	4.98	8.36	0.16		
2	main us	574.81	100-ARI	Exist b	2.02	43.50	45.18	44.98	45.17	0.001458	1.17	8.81	11.48	0.16		
2	main us	574.01	100-ARI	Proposed	2.02	43.50	45.05	44.35	47.07	0.000450	0.47	5.20	11.48	0.16		
2	main us	574.81	100-ARI	Exist	2.02	43.50	44.62	44.35	44.67	0.003150	0.96	3.95	7.98	0.45		
2	main us	574.81	5-ARI	Exist b	1.67	43.48	44.70	44.71	44.71	0.001247	1.15	4.86	8.81	0.16		
2	main us	574.81	5-ARI	Proposed	1.67	43.48	44.70	44.71	44.71	0.001247	1.15	4.86	8.81	0.16		
2	main us	574.81	5-ARI	Exist	1.67	43.48	44.70	44.71	44.71	0.001247	1.15	1.46	5.82	0.73		
2	main us	550														
2	main us	534.27	20-ARI	Exist b	2.63	42.87	43.31	43.01	43.07	0.004204	1.04	2.62	22.98	0.98		
2	main us	534.27	20-ARI	Proposed	2.63	42.87	43.31	43.01	43.07	0.004204	1.10	2.29	21.87	1.06		
2	main us	534.27	20-ARI	Exist	2.63	42.87	43.00	43.01	43.02	0.011853	1.17	2.26	21.92	1.15		
2	main us	534.27	100-ARI	Exist b	2.06	42.15	43.05	43.05	43.12	0.023527	1.10	3.20	22.71	1.01		
2	main us	534.27	100-ARI	Proposed	2.06	42.15	43.05	43.05	43.12	0.023437	1.18	3.21	22.72	1.01		
2	main us	534.27	100-ARI	Exist	2.69	42.87	43.06	43.05	43.11	0.012881	1.18	3.20	22.71	1.01		
2	main us	534.27	5-ARI	Exist b	1.67	42.87	42.90	42.90	42.92	0.026207	0.84	1.77	19.76	1.00		
2	main us	534.27	5-ARI	Proposed	1.67	42.87	42.90	42.90	42.92	0.026212	0.92	1.79	19.79	0.99		
2	main us	534.27	5-ARI	Exist	1.67	42.87	42.96	42.96	43.04	0.010529	1.12	1.26	17.16	1.56		
2	main us	514.27	20-ARI	Exist b	2.63	42.28	42.46	42.44	42.48	0.015172	0.81	2.24	26.32	0.70		
2	main us	514.27	20-ARI	Proposed	2.63	42.28	42.46	42.44	42.48	0.015076	0.82	2.29	26.81	0.78		
2	main us	514.27	30-ARI	Exist	2.63	42.29	42.41	42.44	42.48	0.016567	1.15	1.97	24.47	1.40		
2	main us	514.27	100-ARI	Exist b	2.69	42.29	42.49	42.47	42.49	0.016798	1.18	4.18	31.72	0.84		
2	main us	514.27	100-ARI	Proposed	2.08	42.28	42.49	42.47	42.50	0.015650	0.96	4.07	30.74	0.84		
2	main us	514.27	100-ARI	Exist	2.69	42.29	42.49	42.47	42.53	0.018720	0.96	4.16	30.73	0.84		
2	main us	514.27	5-ARI	Exist b	1.67	42.29	42.41	42.41	42.45	0.018115	1.12	2.41	26.89	1.29		
2	main us	514.27	5-ARI	Proposed	1.67	42.29	42.41	42.41	42.45	0.018998	0.70	2.37	26.16	0.76		
2	main us	514.27	5-ARI	Exist	1.67	42.29	42.47	42.41	42.45	0.016215	0.72	2.30	25.88	0.78		
2	main us	494.27	30-ARI	Exist b	2.63	41.94	42.05	42.05	42.10	0.027122	0.94	2.68	28.27	1.01		
2	main us	494.27	30-ARI	Proposed	2.63	41.94	42.05	42.05	42.10	0.028292	1.00	2.66	28.17	1.05		
2	main us	494.27	30-ARI	Exist	2.63	41.94	42.05	42.05	42.10	0.027122	0.98	2.68	28.27	1.01		
2	main us	494.27	100-ARI	Exist b	2.69	41.94	42.08	42.08	42.15	0.034584	1.10	1.84	26.73	1.09		
2	main us	494.27	100-ARI	Proposed	2.09	41.94	42.07	42.08	42.15	0.024451	1.10	2.52	26.73	1.00		
2	main us	494.27	100-ARI	Exist	2.09	41.94	42.07	42.10	42.15	0.024254	1.10	3.24	26.73	1.00		
2	main us	494.27	5-ARI	Exist b	1.67	41.94	42.03	42.07	42.07	0.024613	0.80	2.10	27.91	0.93		
2	main us	494.27	5-ARI	Proposed	1.67	41.94	42.04	42.04	42.07	0.024613	0.80	2.10	27.91	0.93		
2	main us	494.27	5-ARI	Exist	1.67	41.94	42.03	42.03	42.07	0.024452	0.90	2.10	27.91	0.93		
2	main us	474.27	20-ARI	Exist b	2.63	41.50	41.77	41.64	41.76	0.009540	0.91	4.94	21.93	0.96		
2	main us	474.27	20-ARI	Proposed	2.63	41.50	41.77	41.64	41.76	0.009540	0.91	4.94	21.93	0.96		
2	main us	474.27	20-ARI	Exist	2.63	41.50	41.77	41.64	41.76	0.009540	0.91	4.94	21.93	0.96		
2	main us	474.27	100-ARI	Exist b	2.69	41.50	41.69	41.68	42.00	0.311454	2.65	1.37	16.07	3.31		
2	main us	474.27	100-ARI	Proposed	2.69	41.50	41.69	41.68	41.98	0.146881	1.16	6.28	25.89	1.48		
2	main us	474.27	100-ARI	Exist	2.69	41.50	41.69	41.68	42.00	0.311454	2.65	1.37	16.07	3.31		
2	main us	474.27	5-ARI	Exist b	1.67	41.60	41.71	41.61	41.72	0.002369	0.41	3.76	20.83	0.33		
2	main us	474.27	5-ARI	Proposed	1.67	41.60	41.71	41.61	41.72	0.002448	0.42	3.72	20.80	0.34		
2	main us	474.27	5-ARI	Exist	1.67	41.60	41.71	41.61	41.72	0.002669	0.44	3.78	20.83	0.33		
2	main us	454.27	20-ARI	Exist b	2.69	41.48	41.63	41.63	41.63	0.022164	1.12	2.55	16.02	0.99		
2	main us	454.27	20-ARI	Proposed	2.69	41.48	41.63	41.63	41.63	0.022730	1.11	2.37	16.02	0.98		
2	main us	454.27	20-ARI	Exist	2.69	41.48	41.63	41.63	41.63	0.022164	1.12	2.55	16.02	0.99		
2	main us	454.27	100-ARI	Exist b	2.09	41.48	41.66	41.66	41.75	0.022130	1.26	2.20	13.91	1.00		
2	main us	454.27	100-ARI	Proposed	2.09	41.48	41.66	41.66	41.75	0.022783	1.29	2.05	16.68	1.01		
2	main us	454.27	100-ARI	Exist	2.69	41.48	41.66	41.66	41.75	0.025700	1.28	2.05	16.91	1.00		
2	main us	454.27	5-ARI	Exist b	1.67	41.40	41.59	41.59	41.64	0.022349	0.95	1.70	17.26	0.95		
2	main us	454.27	5-ARI	Proposed	1.67	41.40	41.59	41.59	41.64	0.022876	0.90	1.70	17.10	1.00		
2	main us	454.27	5-ARI	Exist	1.67	41.40	41.59	41.59	41.64	0.023049	0.95	1.76	17.26	0.95		
2	main us	434.27	20-ARI	Exist b	2.02	41.00	41.27	41.19	41.20	0.006160	0.81	2.23	14.02	0.50		
2	main us	434.27	20-ARI	Proposed	2.02	41.00	41.27	41.19	41.29	0.005532	0.91	2.20	14.42	0.64		
2	main us	434.27	30-ARI	Exist	2.64	41.00	41.27	41.19	41.41	0.011848	1.18	1.74	14.88	0.64		
2	main us	434.27	100-ARI	Exist b	2.69	41.00	41.24	41.24	41.37	0.009443	0.98	4.14	15.88	0.81		
2	main us	434.27	100-ARI	Proposed	2.09	41.00	41.24	41.24	41.37	0.009443	1.00	2.66	15.88	0.81		
2	main us	434.27	100-ARI	Exist	2.69	41.00	41.24	41.24	41.37	0.009443	0.98	4.14	15.88	0.81		
2	main us	434.27	5-ARI	Exist b	1.67	41.00	41.14	41.14	41.26	0.018734	1.14	1.18	11.24	2.23		
2	main us	434.27	5-ARI	Proposed	1.67	41.00	41.17	41.14	41.30	0.018646	0.88	1.65	11.63	3.13		
2	main us	434.27	5-ARI	Exist	1.67	41.00	41.07	41.14	41.28	0.018734	1.14	0.86	11.24	2.23		
2	main us	414.27	30-ARI	Exist b	2.63	40.87	41.14	41.14	41.18	0.023966	1.18	2.38	16.45	0.94		
2	main us	414.27	30-ARI	Proposed	2.63	40.87	41.08	41.11	41.12	0.016207	0.79	1.77	16.71	0.67		
2	main us	414.27	30-ARI	Exist	2.63	40.87	41.04	41.14	41.10	0.023363	1.10	2.29	16.96	0.99		
2	main us	414.27	100-ARI	Exist b	2.69	40.87	41.08	41.08	41.15	0.021605	1.23	3.16	19.76	0.99		
2	main us	414.27	100-ARI	Proposed	2.06	40.87	41.17	41.00	41.20	0.005107	0.76	4.10	27.71	0.51		
2	main us	414.27	100-ARI	Exist	2.09	40.87	41.00	41.00	41.15	0.021003	1.23	3.16	19.93	0.99		
2	main us	414.27	5-ARI	Exist b	1.67	40.81	41.00	41.00	41.05	0.024782	0.95	1.75	18.12	0.98		
2	main us	414.27	5-ARI	Proposed	1.67	40.81	41.00	41.00	41.08	0.012435	0.78	2.19	18.71	0.71		
2	main us	414.27	5-ARI	Exist	1.67	40.81	41.00	41.00	41.05	0.024808	0.95	1.75	18.12	0.98		
2	main us	394.27	20-ARI	Exist b	2.02	40.80	40.74	40.69	40.79	0.009523	0.98	3.07	16.55	0.64		
2	main us	394.27	20-ARI	Proposed	2.02	40.80	40.74	40.69	40.84	0.011438	0.88	3.78	14.87	0.78		
2	main us	394.27	20-ARI													

HEC-RAS (Continued)

River	Reach	River Sta	Profile	Plan	O Total (m ³ /s)	Min Ch El (m)	WS Elev (m)	Crit WS (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
2	main us	374.27	5 ARI	Exist	1.67	40.24	40.51	40.46	40.54	0.011979	0.74	2.24	19.33	0.70
2	main us	354.27	20-ARI	Exist_b	2.63	40.00	40.21	40.21	40.27	0.023686	1.17	2.25	16.44	1.01
2	main us	354.27	20-ARI	Proposed	2.63	40.00	40.21	40.21	40.27	0.023676	1.17	2.25	16.43	1.01
2	main us	354.27	20-ARI	Exist	2.63	40.00	40.21	40.21	40.27	0.023676	1.17	2.25	16.44	1.01
2	main us	354.27	100-ARI	Exist_b	3.89	40.00	40.25	40.25	40.33	0.021855	1.26	3.10	19.06	1.00
2	main us	354.27	100-ARI	Proposed	3.89	40.00	40.25	40.25	40.33	0.022372	1.27	3.07	18.99	1.01
2	main us	354.27	100-ARI	Exist	3.89	40.00	40.25	40.25	40.33	0.022176	1.26	3.08	19.02	1.00
2	main us	354.27	5-ARI	Exist_b	1.67	40.00	40.16	40.16	40.22	0.019666	1.05	1.59	14.74	1.00
2	main us	354.27	5-ARI	Proposed	1.67	40.00	40.16	40.16	40.22	0.024605	1.04	1.60	14.27	0.99
2	main us	354.27	5-ARI	Exist	1.67	40.00	40.16	40.16	40.22	0.024392	1.04	1.61	14.29	0.99
2	main us	330												
2	main us	314.27	20-ARI	Exist_b	2.63	38.20	38.86	38.41	38.86	0.003184	0.25	10.64	20.80	0.11
2	main us	314.27	20-ARI	Proposed	2.63	38.20	38.83	38.41	38.83	0.002238	0.27	9.92	20.49	0.12
2	main us	314.27	20-ARI	Exist	2.63	38.20	38.86	38.41	38.86	0.000184	0.25	10.64	20.80	0.11
2	main us	314.27	100-ARI	Exist_b	3.89	38.20	38.94	38.46	38.95	0.000254	0.31	12.40	21.56	0.13
2	main us	314.27	100-ARI	Proposed	3.89	38.20	38.90	38.45	38.91	0.000322	0.34	11.47	21.16	0.15
2	main us	314.27	100-ARI	Exist	3.89	38.20	38.94	38.46	38.95	0.000254	0.31	12.40	21.56	0.13
2	main us	314.27	5-ARI	Exist_b	1.67	38.20	38.78	38.37	38.78	0.000122	0.18	9.05	20.09	0.09
2	main us	314.27	5-ARI	Proposed	1.67	38.20	38.76	38.37	38.76	0.000147	0.20	8.51	19.83	0.10
2	main us	314.27	5-ARI	Exist	1.67	38.20	38.78	38.37	38.78	0.000122	0.18	9.05	20.09	0.09
2	main us	294.27	20-ARI	Exist_b	2.63	38.20	38.86	38.45	38.86	0.001163	0.23	11.56	23.35	0.13
2	main us	294.27	20-ARI	Proposed	2.63	38.20	38.82	38.43	38.82	0.000004	0.24	10.74	23.02	0.11
2	main us	294.27	20-ARI	Exist	2.63	38.20	38.86	38.43	38.86	0.000163	0.23	11.56	23.35	0.13
2	main us	294.27	100-ARI	Exist_b	3.89	38.20	38.94	38.46	38.94	0.000221	0.29	13.51	24.11	0.12
2	main us	294.27	100-ARI	Proposed	3.89	38.20	38.89	38.45	38.90	0.000305	0.31	12.44	23.70	0.14
2	main us	294.27	100-ARI	Exist	3.89	38.20	38.94	38.46	38.94	0.000221	0.29	13.51	24.11	0.12
2	main us	294.27	5-ARI	Exist_b	1.67	38.20	38.78	38.39	38.78	0.000108	0.17	9.80	22.51	0.09
2	main us	294.27	5-ARI	Proposed	1.67	38.20	38.75	38.39	38.75	0.000132	0.18	9.19	22.26	0.09
2	main us	294.27	5-ARI	Exist	1.67	38.20	38.78	38.39	38.78	0.000108	0.17	9.80	22.51	0.09
2	main us	274.27	20-ARI	Exist_b	2.63	38.20	38.85	38.41	38.86	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	20-ARI	Proposed	2.63	38.20	38.82	38.41	38.82	0.000241	0.25	10.44	24.31	0.12
2	main us	274.27	20-ARI	Exist	2.63	38.20	38.85	38.41	38.86	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	100-ARI	Exist_b	3.89	38.20	38.93	38.46	38.94	0.000254	0.29	13.47	27.25	0.13
2	main us	274.27	100-ARI	Proposed	3.89	38.20	38.89	38.45	38.90	0.000335	0.32	12.40	26.56	0.15
2	main us	274.27	100-ARI	Exist	3.89	38.20	38.93	38.46	38.94	0.000254	0.29	13.47	27.25	0.13
2	main us	274.27	5-ARI	Exist_b	1.67	38.20	38.78	38.36	38.78	0.000128	0.19	9.50	22.58	0.09
2	main us	274.27	5-ARI	Proposed	1.67	38.20	38.75	38.36	38.75	0.000157	0.19	8.84	22.02	0.10
2	main us	274.27	5-ARI	Exist	1.67	38.20	38.78	38.36	38.78	0.000128	0.19	9.50	22.58	0.09
1	main ds	240.00	20-ARI	Exist_b	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.56	0.97
1	main ds	240.00	20-ARI	Proposed	4.66	38.50	38.70	38.70	38.80	0.021844	1.38	3.38	18.13	1.02
1	main ds	240.00	20-ARI	Exist	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.56	0.97
1	main ds	240.00	100-ARI	Exist_b	7.91	38.50	38.79	38.79	38.92	0.019683	1.61	4.90	19.13	1.02
1	main ds	240.00	100-ARI	Proposed	6.44	38.50	38.75	38.74	38.87	0.020011	1.61	4.28	18.75	1.01
1	main ds	240.00	100-ARI	Exist	7.91	38.50	38.79	38.74	38.87	0.020011	1.61	4.28	18.75	1.01
1	main ds	240.00	5-ARI	Exist_b	3.87	38.50	38.69	38.79	38.92	0.019683	1.61	4.90	19.13	1.02
1	main ds	240.00	5-ARI	Proposed	3.21	38.50	38.66	38.79	38.92	0.020375	1.25	3.07	17.68	0.97
1	main ds	240.00	5-ARI	Exist	3.87	38.50	38.69	38.79	38.92	0.020375	1.25	3.07	17.68	0.97
1	main ds	220.00	20-ARI	Exist_b	5.68	38.00	38.36	38.19	38.38	0.003413	0.67	8.43	25.27	0.37
1	main ds	220.00	20-ARI	Proposed	4.66	38.00	38.32	38.17	38.34	0.004884	0.63	7.77	24.81	0.37
1	main ds	220.00	20-ARI	Exist	5.68	38.00	38.36	38.19	38.36	0.002658	0.59	8.27	25.17	0.38
1	main ds	220.00	100-ARI	Exist_b	7.91	38.00	38.44	38.23	38.47	0.002315	0.75	10.54	26.02	0.38
1	main ds	220.00	100-ARI	Proposed	6.44	38.00	38.39	38.21	38.42	0.002380	0.70	9.17	25.51	0.37
1	main ds	220.00	100-ARI	Exist	7.91	38.00	38.43	38.23	38.46	0.002623	0.76	10.13	25.87	0.40
1	main ds	220.00	5-ARI	Exist_b	3.87	38.00	38.79	38.15	38.30	0.004652	1.69	5.99	24.48	0.35
1	main ds	220.00	5-ARI	Proposed	3.21	38.00	38.75	38.13	38.27	0.004711	1.55	5.84	24.14	0.36
1	main ds	220.00	5-ARI	Exist	3.87	38.00	38.79	38.15	38.30	0.002639	0.59	6.51	24.43	0.37
1	main ds	200.00	20-ARI	Exist_b	5.68	37.80	38.17	38.17	38.29	0.002020	1.53	3.72	16.07	1.01
1	main ds	200.00	20-ARI	Proposed	4.66	37.80	38.14	38.14	38.25	0.021618	1.46	3.19	15.48	1.03
1	main ds	200.00	20-ARI	Exist	5.68	37.80	38.17	38.17	38.29	0.019362	1.48	4.17	21.16	0.98
1	main ds	200.00	100-ARI	Exist_b	7.91	37.80	38.21	38.24	38.36	0.017781	1.53	4.81	17.55	0.99
1	main ds	200.00	100-ARI	Proposed	6.44	37.80	38.19	38.19	38.32	0.019787	1.58	4.07	16.45	1.01
1	main ds	200.00	100-ARI	Exist	7.91	37.80	38.24	38.24	38.36	0.019808	1.57	4.78	16.60	0.95
1	main ds	200.00	5-ARI	Exist_b	3.87	37.80	38.12	38.12	38.21	0.021636	1.37	2.82	15.08	1.01
1	main ds	200.00	5-ARI	Proposed	3.21	37.80	38.09	38.09	38.18	0.022453	1.30	2.46	14.61	1.01
1	main ds	200.00	5-ARI	Exist	3.87	37.80	38.12	38.12	38.21	0.019387	1.32	3.11	16.59	0.98
1	main ds	180.00	20-ARI	Exist_b	5.68	37.32	37.54	37.57	37.57	0.042707	1.54	3.69	27.62	1.35
1	main ds	180.00	20-ARI	Proposed	4.66	37.32	37.57	37.55	37.57	0.012888	0.99	4.72	26.08	0.77
1	main ds	180.00	20-ARI	Exist	5.68	37.32	37.54	37.57	37.57	0.012886	1.54	3.68	27.63	1.35
1	main ds	180.00	100-ARI	Exist_b	7.91	37.32	37.56	37.61	37.73	0.047023	1.63	4.39	27.93	1.45
1	main ds	180.00	100-ARI	Proposed	6.44	37.32	37.56	37.40	37.59	0.044180	1.63	3.94	27.74	1.38
1	main ds	180.00	100-ARI	Exist	7.91	37.32	37.56	37.61	37.73	0.046136	1.79	4.41	27.95	1.44
1	main ds	180.00	5-ARI	Exist_b	3.87	37.32	37.51	37.53	37.60	0.040177	1.30	2.97	27.36	1.26
1	main ds	180.00	5-ARI	Proposed	3.21	37.32	37.53	37.52	37.57	0.014861	0.89	3.59	27.59	0.79
1	main ds	180.00	5-ARI	Exist	3.87	37.32	37.51	37.53	37.60	0.042218	1.32	2.93		

HEC-RAS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total (m³/s)	Min Ch El (m)	WS Elev (m)	Crit WS (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)	Freude # Chl
1	main ds	140.00	100-ARI	Exist_b	7.91	36.50	36.91	36.83	36.95	0.007771	1.01	7.52	30.63	0.64
1	main ds	140.00	100-ARI	Proposed	6.44	36.50	36.89	36.81	36.93	0.006001	0.87	7.43	30.25	0.65
1	main ds	140.00	100-ARI	Exist_b	7.91	36.50	36.89	36.81	36.95	0.009185	1.07	7.39	30.21	0.69
1	main ds	140.00	5-ARI	Exist_b	3.87	36.50	36.74	36.74	36.81	0.023980	1.19	3.25	23.19	1.02
1	main ds	140.00	5-ARI	Proposed	3.21	36.50	36.72	36.72	36.79	0.024582	1.14	2.62	21.93	1.01
1	main ds	140.00	5-ARI	Exist_b	3.87	36.50	36.74	36.74	36.91	0.023980	1.19	3.25	23.19	1.02
1	main ds	120.00	20-ARI	Exist_b	5.68	36.03	36.75	36.37	36.75	0.000541	0.96	15.85	39.01	0.19
1	main ds	120.00	20-ARI	Proposed	4.66	36.03	36.75	36.35	36.75	0.000356	0.96	15.62	37.64	0.25
1	main ds	120.00	20-ARI	Exist_b	5.68	36.03	36.51	36.39	36.54	0.004370	0.76	7.47	29.17	0.48
1	main ds	120.00	100-ARI	Exist_b	7.91	36.03	36.85	36.44	36.86	0.000512	0.40	19.79	41.15	0.18
1	main ds	120.00	100-ARI	Proposed	6.44	36.03	36.85	36.40	36.86	0.000325	0.52	19.51	37.69	0.25
1	main ds	120.00	100-ARI	Exist_b	7.91	36.03	36.82	36.44	36.83	0.000370	0.43	19.57	41.15	0.20
1	main ds	120.00	5-ARI	Exist_b	3.87	36.03	36.74	36.33	36.47	0.004387	0.70	5.54	24.65	0.47
1	main ds	120.00	5-ARI	Proposed	3.21	36.03	36.41	36.31	36.44	0.004403	0.67	4.89	22.97	0.47
1	main ds	120.00	5-ARI	Exist_b	3.87	36.03	36.44	36.33	36.47	0.004386	0.70	5.54	24.65	0.47
1	main ds	100.00	20-ARI	Exist_b	5.68	36.00	36.75	36.30	36.75	0.000387	0.95	16.39	33.74	0.16
1	main ds	100.00	20-ARI	Proposed	4.66	36.00	36.74	36.26	36.75	0.000244	0.90	15.60	28.19	0.13
1	main ds	100.00	20-ARI	Exist_b	5.53	36.00	36.41	36.30	36.45	0.005169	0.86	6.51	24.15	0.63
1	main ds	100.00	100-ARI	Exist_b	7.91	36.00	36.84	36.35	36.85	0.000478	0.40	19.72	35.20	0.17
1	main ds	100.00	100-ARI	Proposed	6.44	36.00	36.85	36.31	36.85	0.000270	0.36	18.52	29.52	0.14
1	main ds	100.00	100-ARI	Exist_b	7.91	36.00	36.81	36.35	36.82	0.000517	0.45	19.60	35.90	0.19
1	main ds	100.00	5-ARI	Exist_b	3.87	36.00	36.34	36.24	36.37	0.004900	0.77	5.04	21.43	0.50
1	main ds	100.00	5-ARI	Proposed	3.21	36.00	36.31	36.21	36.34	0.005185	0.74	4.35	20.26	0.51
1	main ds	100.00	5-ARI	Exist_b	3.87	36.00	36.34	36.24	36.37	0.005029	0.77	5.03	21.40	0.51
1	main ds	80.00	20-ARI	Exist_b	5.68	35.74	36.74	36.17	36.75	0.000249	0.97	24.45	57.31	0.14
1	main ds	80.00	20-ARI	Proposed	4.66	35.74	36.74	36.14	36.74	0.000173	0.91	23.32	53.26	0.11
1	main ds	80.00	20-ARI	Exist_b	5.68	35.74	36.23	36.17	36.31	0.009731	1.25	4.57	17.10	0.73
1	main ds	80.00	100-ARI	Exist_b	7.91	35.74	36.83	36.28	36.84	0.000300	0.44	29.91	57.43	0.15
1	main ds	80.00	100-ARI	Proposed	6.44	35.74	36.84	36.19	36.85	0.000200	0.57	28.75	53.26	0.13
1	main ds	80.00	100-ARI	Exist_b	7.91	35.74	36.60	36.23	36.81	0.000352	0.47	28.00	57.39	0.17
1	main ds	80.00	5-ARI	Exist_b	3.87	35.74	36.10	36.10	36.21	0.020620	1.43	2.70	13.13	1.01
1	main ds	80.00	5-ARI	Proposed	3.21	35.74	36.08	36.08	36.17	0.020408	1.34	2.39	12.63	0.99
1	main ds	80.00	5-ARI	Exist_b	3.87	35.74	36.10	36.10	36.21	0.020920	1.43	2.70	13.13	1.01
1	main ds	60.00	20-ARI	Exist_b	5.68	35.49	36.74	35.68	36.74	0.000011	0.10	63.81	63.56	0.01
1	main ds	60.00	20-ARI	Proposed	4.66	35.49	36.74	35.66	36.74	0.000007	0.08	63.63	63.56	0.02
1	main ds	60.00	20-ARI	Exist_b	5.68	35.49	36.19	35.68	36.19	0.001211	0.21	28.77	61.09	0.08
1	main ds	60.00	100-ARI	Exist_b	7.91	35.49	36.84	35.72	36.84	0.000016	0.13	69.30	63.56	0.04
1	main ds	60.00	100-ARI	Proposed	6.44	35.49	36.84	35.69	36.84	0.000010	0.10	70.37	63.56	0.03
1	main ds	60.00	100-ARI	Exist_b	7.91	35.49	36.80	35.72	36.80	0.000017	0.13	67.80	63.56	0.04
1	main ds	60.00	5-ARI	Exist_b	3.87	35.49	35.80	35.64	35.81	0.061507	0.42	9.13	35.53	0.28
1	main ds	60.00	5-ARI	Proposed	3.21	35.49	35.60	35.62	35.81	0.061074	0.36	9.02	38.43	0.23
1	main ds	60.00	5-ARI	Exist_b	3.87	35.49	35.69	35.64	35.72	0.067800	0.45	5.17	31.40	0.69
1	main ds	40.00	20-ARI	Exist_b	5.68	35.33	36.74	35.54	36.74	0.000000	0.08	76.64	61.79	0.02
1	main ds	40.00	20-ARI	Proposed	5.68	35.33	36.74	35.53	36.74	0.000000	0.08	76.66	61.79	0.02
1	main ds	40.00	20-ARI	Exist_b	5.00	35.33	36.19	35.64	36.19	0.000341	0.17	42.39	61.79	0.06
1	main ds	40.00	100-ARI	Exist_b	7.91	35.33	36.84	35.57	36.84	0.000009	0.11	82.57	61.79	0.03
1	main ds	40.00	100-ARI	Proposed	7.91	35.33	36.84	35.56	36.84	0.000007	0.11	83.02	61.79	0.03
1	main ds	40.00	100-ARI	Exist_b	7.91	35.33	36.80	35.57	36.80	0.000010	0.11	80.52	61.79	0.03
1	main ds	40.00	5-ARI	Exist_b	3.87	35.33	36.79	35.51	35.79	0.000240	0.23	18.89	55.42	0.12
1	main ds	40.00	5-ARI	Proposed	3.87	35.33	36.79	35.51	35.79	0.000240	0.23	18.99	55.42	0.12
1	main ds	40.00	5-ARI	Exist_b	3.87	35.33	35.56	35.51	35.68	0.006815	0.60	5.56	50.99	0.50
1	main ds	7.76	20-ARI	Exist_b	5.68	33.84	36.74	34.24	36.74	0.000007	0.14	60.26	32.64	0.03
1	main ds	7.76	20-ARI	Proposed	5.68	33.84	36.74	34.24	36.74	0.000007	0.14	60.27	32.64	0.03
1	main ds	7.76	20-ARI	Exist_b	5.68	33.84	36.18	34.24	36.19	0.000017	0.18	42.15	32.64	0.04
1	main ds	7.76	100-ARI	Exist_b	7.91	33.84	36.84	34.32	36.84	0.000012	0.16	63.37	32.64	0.03
1	main ds	7.76	100-ARI	Proposed	7.91	33.84	36.84	34.31	36.84	0.000012	0.16	63.61	32.64	0.02
1	main ds	7.76	100-ARI	Exist_b	7.91	33.84	36.80	34.32	36.80	0.000012	0.16	62.29	32.64	0.04
1	main ds	7.76	5-ARI	Exist_b	3.87	33.84	35.79	34.17	35.79	0.000017	0.16	29.19	32.64	0.04
1	main ds	7.76	5-ARI	Proposed	3.87	33.84	35.79	34.17	35.79	0.000018	0.16	29.19	32.64	0.04
1	main ds	7.76	5-ARI	Exist_b	3.87	33.84	35.47	34.17	35.47	0.000037	0.20	19.64	20.19	0.00
1	main ds	5		Culvert										
1	main ds	2	20-ARI	Exist_b	5.88	33.63	34.09	34.05	34.19	0.010001	1.41	4.03	11.41	0.76
1	main ds	2	20-ARI	Proposed	5.88	33.63	34.09	34.02	34.19	0.010002	1.41	4.03	11.41	0.75
1	main ds	2	20-ARI	Exist_b	5.88	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.75
1	main ds	2	100-ARI	Exist_b	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.99	11.71	0.78
1	main ds	2	100-ARI	Proposed	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.99	11.71	0.78
1	main ds	2	100-ARI	Exist_b	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.99	11.71	0.78
1	main ds	2	5-ARI	Exist_b	3.87	33.63	34.01	33.95	34.09	0.010012	1.22	3.18	11.27	0.73
1	main ds	2	5-ARI	Proposed	3.87	33.63	34.01	33.96	34.09	0.010014	1.22	3.18	11.27	0.73
1	main ds	2	5-ARI	Exist_b	3.87	33.63	34.01	33.95	34.09	0.010012	1.22	3.18	11.27	0.73

In our opinion, there is no need to carry out works within the watercourse to improve the flooding situation in the watercourse. Refer to Appendix 4 for detailed results of the simulations.

7 CIVIL DESIGN

The civil design undertaken for the proposed subdivision includes the road design, the cut and fill and other civil details required to ensure that the development is feasible at this conceptual stage.

The design is carried out in accordance with Council's DCP 2010 and the "Guidelines for Engineering Works for Subdivisions and Developments".

The subdivision is divided into two stages. Stage 1 covers a total of 123 lots and is submitted for Development Application and Stage 2 covers 35 lots for planning approval.

There is a total of nine (9) separate roads within the subdivision. Roads 1 & 2 are collector roads and Roads 3 to 9 are local roads.

Road 1 is proposed with a landscaping median in the middle as requested by the Client. Road 2 is the continuation of French Street into the subdivision.

The road network configuration is outlined in below.

Table 12 Road configuration

Road	Road Reserve (m)	Width of Travel Lane Both Directions (m)	Verge Width (m)	Parking Lane (m)	Concrete Pathway 1.5m wide	Median (m)
1	23.6	7	2 x 4.8	2 x 2.5	Both sides	2.0
2	21.6	7	2 x 4.8	2 x 2.5	Both sides	0
3 to 9	15.6	3	2 x 3.8	2 x 2.5	Both sides	0

Both Roads 1 & 2 have a widened concrete shared pedestrian path and cycleway with a total width of 2.5m to one side only. Reference is made to the traffic and the planning reports for details on the pedestrian and cycleway strategies.

Reference is made to Appendix 6 which includes all the design drawings for the proposed subdivision.

APPENDIX 1

Rainfall Data

IFD Table

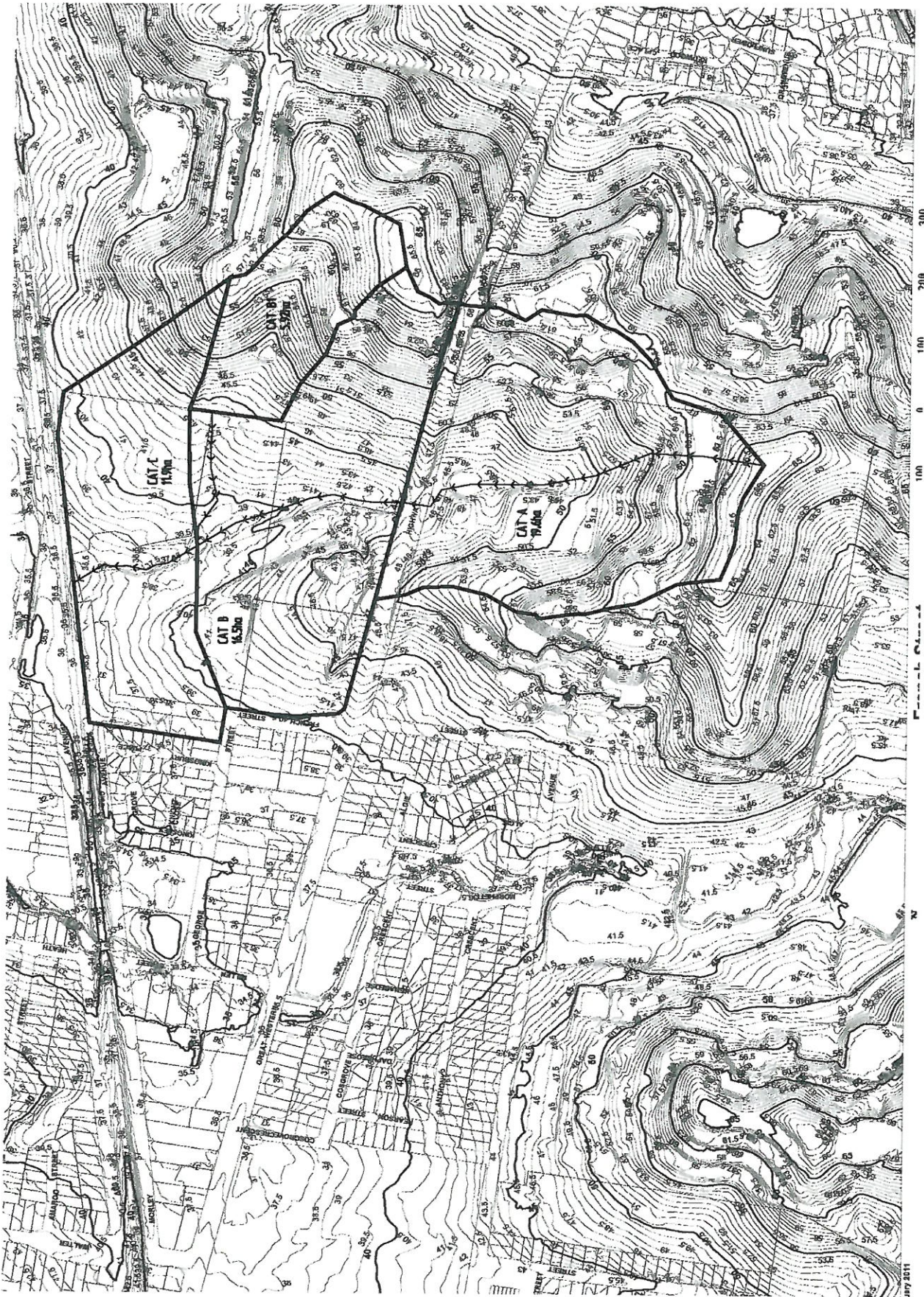
BUREAU OF METEOROLOGY INTENSITY COEFFICIENTS FOR PENRITH							
Period	A	B	C	D	E	F	G
1	3.1235	-0.5793	-0.0202	0.00945	-0.001209	-0.0004600	0.0000687
2	3.3820	-0.5790	-0.0208	0.00914	-0.001066	-0.0004188	0.0000614
5	3.6470	-0.5792	-0.0236	0.00780	-0.000288	-0.0002227	0.0000085
10	3.7766	-0.5793	-0.0252	0.00707	0.000155	-0.0001137	-0.0000215
20	3.9242	-0.5799	-0.0260	0.00683	0.000358	-0.0000630	-0.0000344
50	4.0911	-0.5795	-0.0274	0.00590	0.000772	0.0000646	-0.0000663
100	4.2024	-0.5800	-0.0280	0.00570	0.000942	0.0001046	-0.0000765

RETURN PERIOD (YEARS)							
Time	1	2	5	10	20	50	100
hr min	1	2	5	10	20	50	100
0 6	69.5	90.0	117.7	134.2	155.6	184.2	206.1
0 7	65.6	84.9	111.1	126.6	146.9	173.8	194.5
0 8	62.3	80.6	105.4	120.1	139.3	164.9	184.5
0 9	59.4	76.9	100.5	114.5	132.8	157.1	175.8
0 10	56.9	73.6	96.1	109.5	127.0	150.2	168.0
0 11	54.6	70.7	92.3	105.1	121.9	144.1	161.2
0 12	52.6	68.1	88.8	101.1	117.2	138.6	155.0
0 13	50.7	65.7	85.6	97.5	113.1	133.6	149.4
0 14	49.1	63.5	82.8	94.2	109.3	129.1	144.4
0 15	47.5	61.5	80.2	91.2	105.8	125.0	139.7
0 16	46.1	59.7	77.7	88.5	102.6	121.2	135.5
0 17	44.8	58.0	75.5	85.9	99.6	117.7	131.6
0 18	43.6	56.4	73.4	83.6	96.9	114.4	128.0
0 19	42.4	54.9	71.5	81.4	94.3	111.4	124.6
0 20	41.4	53.5	69.7	79.3	92.0	108.6	121.4
0 22	39.4	51.0	66.4	75.6	87.6	103.5	115.7
0 24	37.7	48.8	63.6	72.3	83.8	99.0	110.7
0 26	36.2	46.8	61.0	69.4	80.4	95.0	106.2
0 28	34.8	45.0	58.6	66.7	77.3	91.3	102.1
0 30	33.5	43.4	56.5	64.3	74.6	88.0	98.4
0 35	30.8	39.9	52.0	59.2	68.6	81.0	90.6
0 40	28.6	37.1	48.3	55.0	63.7	75.3	84.2
0 45	26.8	34.7	45.2	51.5	59.7	70.5	78.8
0 50	25.2	32.7	42.6	48.5	56.2	66.4	74.2
0 55	23.9	30.9	40.3	45.9	53.2	62.9	70.3
1 00	22.7	29.4	38.4	43.7	50.6	59.8	66.8

Time hr min	RETURN PERIOD (YEARS)						
	1	2	5	10	20	50	100
1 00	22.7	29.4	38.4	43.7	50.6	59.8	66.8
1 30	17.9	23.2	30.2	34.4	39.9	47.1	52.6
2 00	15.1	19.6	25.4	28.9	33.5	39.6	44.2
2 30	13.2	17.1	22.2	25.3	29.3	34.5	38.6
3 00	11.9	15.3	19.9	22.6	26.2	30.9	34.5
3 30	10.8	14.0	18.1	20.6	23.8	28.1	31.4
4 00	10.0	12.9	16.7	19.0	22.0	25.9	28.9
4 30	9.3	12.0	15.6	17.7	20.4	24.1	26.9
5 00	8.7	11.3	14.6	16.6	19.2	22.6	25.2
5 30	8.2	10.7	13.8	15.6	18.1	21.3	23.8
6 00	7.8	10.1	13.1	14.8	17.2	20.2	22.5
8 00	6.6	8.5	10.9	12.3	14.1	16.5	18.3
10 00	5.7	7.4	9.5	10.7	12.3	14.4	15.9
12 00	5.1	6.6	8.5	9.5	11.0	12.8	14.2
18 00	3.9	5.1	6.6	7.5	8.6	10.2	11.4
24 00	3.2	4.2	5.5	6.3	7.3	8.6	9.6
36 00	2.4	3.2	4.2	4.9	5.7	6.8	7.6
48 00	2.0	2.6	3.5	4.0	4.7	5.7	6.4
60 00	1.7	2.2	3.0	3.4	4.1	4.9	5.5
72 00	1.4	1.9	2.6	3.0	3.6	4.3	4.9

APPENDIX 2

Catchment Plan



APPENDIX 3

Results of the Hydrological Modelling

DATA SHEET

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%)	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough
CATA	A	19.6	50	50	0	1	5	0	569	569	569	3.8	3.8	3.8	0.1	0.1	0.1
Cat B	B	16.5	50	50	0	1	5	0	398	398	398	7	7	7	0.05	0.05	0.05
Cat C	C	11.9	50	50	0	1	5	0	1846	1846	1846	1.16	1.16	1.16	0.08	0.08	0.08
Cat B1	B1	5.92	50	50	0	1	5	0	419	419	419	5.3	5.3	5.3	0.08	0.08	0.08

RESULTS SHEET 1 - 5 YEAR ARI

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	1.672	1.192	0.481	49.61	53.61	48.61	AR&R 5 year, 1 hour storm, average 38.4 mm/h, Zone 1
Cat B	2.288	1.673	0.627	18.79	22.79	17.79	AR&R 5 year, 25 minutes storm, average 62 mm/h, Zone 1
Cat C	0.488	0.354	0.145	161.31	165.31	160.31	AR&R 5 year, 3 hours storm, average 19.8 mm/h, Zone 1
Cat B1	0.658	0.47	0.199	30.98	34.98	29.98	AR&R 5 year, 45 minutes storm, average 45.3 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	1.672	2.875	1.576	0.509	1.41	4.38	2.77	AR&R 5 year, 1 hour storm, average 38.4 mm/h, Zone 1
OF B	3.477	3.875	1.185	0.6	1.45	8	2.42	AR&R 5 year, 1.5 hours storm, average 30.2 mm/h, Zone 1
OF C	3.875	3.875	0.256	0.152	0.21	34.44	1.35	AR&R 5 year, 1 hour storm, average 38.4 mm/h, Zone 1
OF B1	0.658	0.659	0.424	0.06	0.07	15.94	1.23	AR&R 5 year, 45 minutes storm, average 45.3 mm/h, Zone 1

Run Log for 20100127 run at 20:14:53 on 13/4/2011

RESULTS SHEET 2 - 20 YEAR ARI

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	2.632	1.716	0.941	44.4	48.4		43.4 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
Cat B	3.526	2.381	1.233	16.91	20.91		15.91 AR&R 20 year, 25 minutes storm, average 82 mm/h, Zone 1
Cat C	0.778	0.502	0.279	144.98	148.98		143.98 AR&R 20 year, 3 hours storm, average 25.9 mm/h, Zone 1
Cat B1	1.018	0.658	0.396	29.59	33.59		28.59 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	2.632	4.147	1.576	0.6	1.56		8	2.59 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF B	5.018	5.683	1.185	0.6	2.13		8	3.55 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF C	5.683	5.683	0.256	0.177	0.27	39.47		1.5 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1
OF B1	1.018	1.018	0.424	0.071	0.1	18.28		1.38 AR&R 20 year, 1 hour storm, average 51 mm/h, Zone 1

Run Log for 20100127 run at 20:06:47 on 13/4/2011

RESULTS SHEET 3 - 100 YEAR ARI

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT A	3.895	2.379	1.608	39.91	43.91		38.91 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
Cat B	4.891	3.2	2.03	15.2	19.2		14.2 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1
Cat C	1.189	0.727	0.463	117.79	121.79		116.79 AR&R 100 year, 2 hours storm, average 43.7 mm/h, Zone 1
Cat B1	1.466	0.938	0.55	22.1	26.1		21.1 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF A	3.895	5.553	1.622	0.6	2.08		8	3.47 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF B	6.886	7.911	1.91	0.6	2.97		8	4.95 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF C	7.911	7.911	7.665	0.203	0.33	44.5		1.63 AR&R 100 year, 1 hour storm, average 67 mm/h, Zone 1
OF B1	1.466	1.466	12.688	0.083	0.13	20.61		1.52 AR&R 100 year, 25 minutes storm, average 109 mm/h, Zone 1

Run Log for 20100127 run at 20:10:40 on 13/4/2011

APPENDIX 4

Results of the Hydraulic Modelling

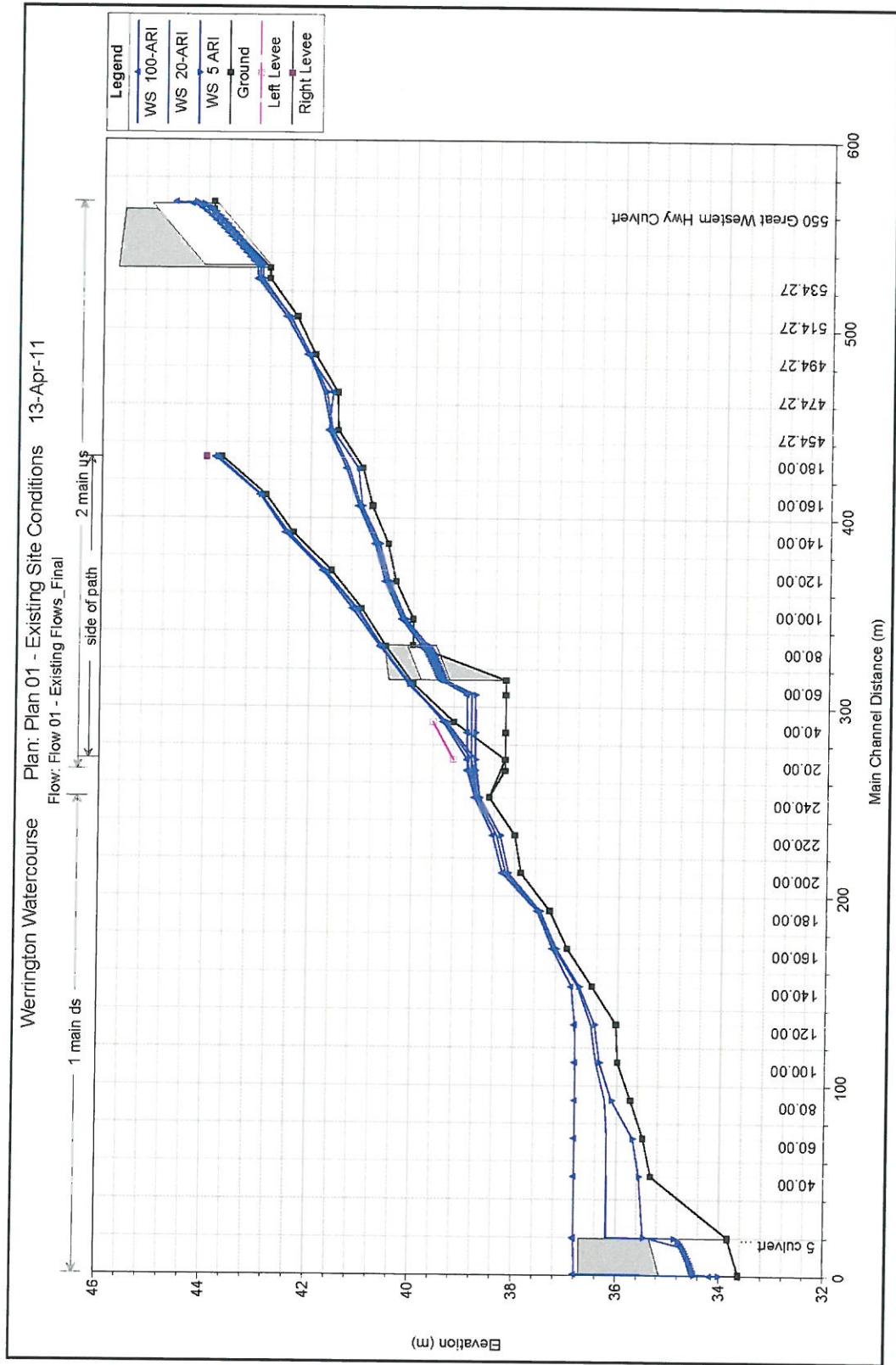
Plan 01 – Existing Site Conditions

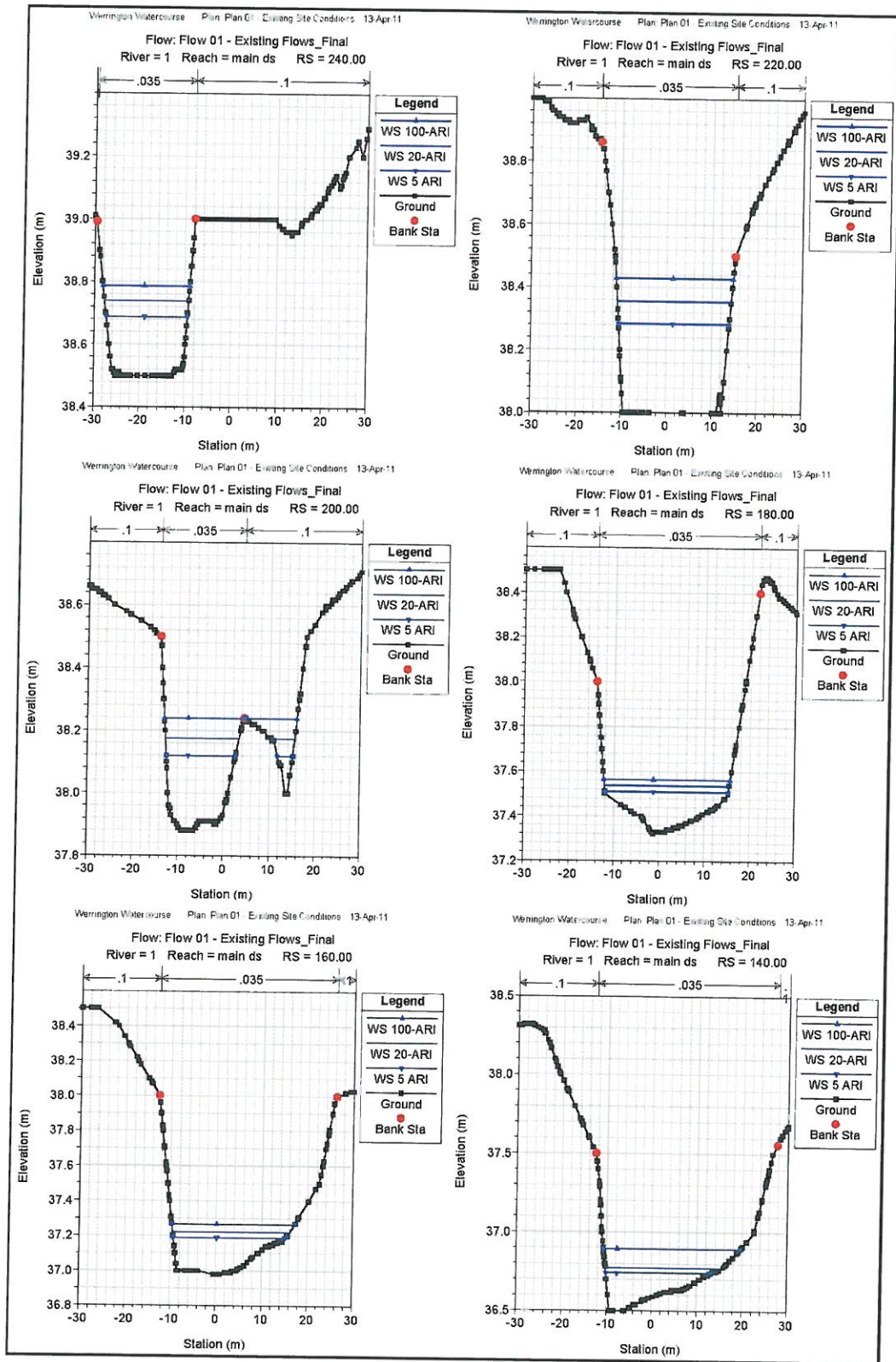
HEC-RAS Plan Exist

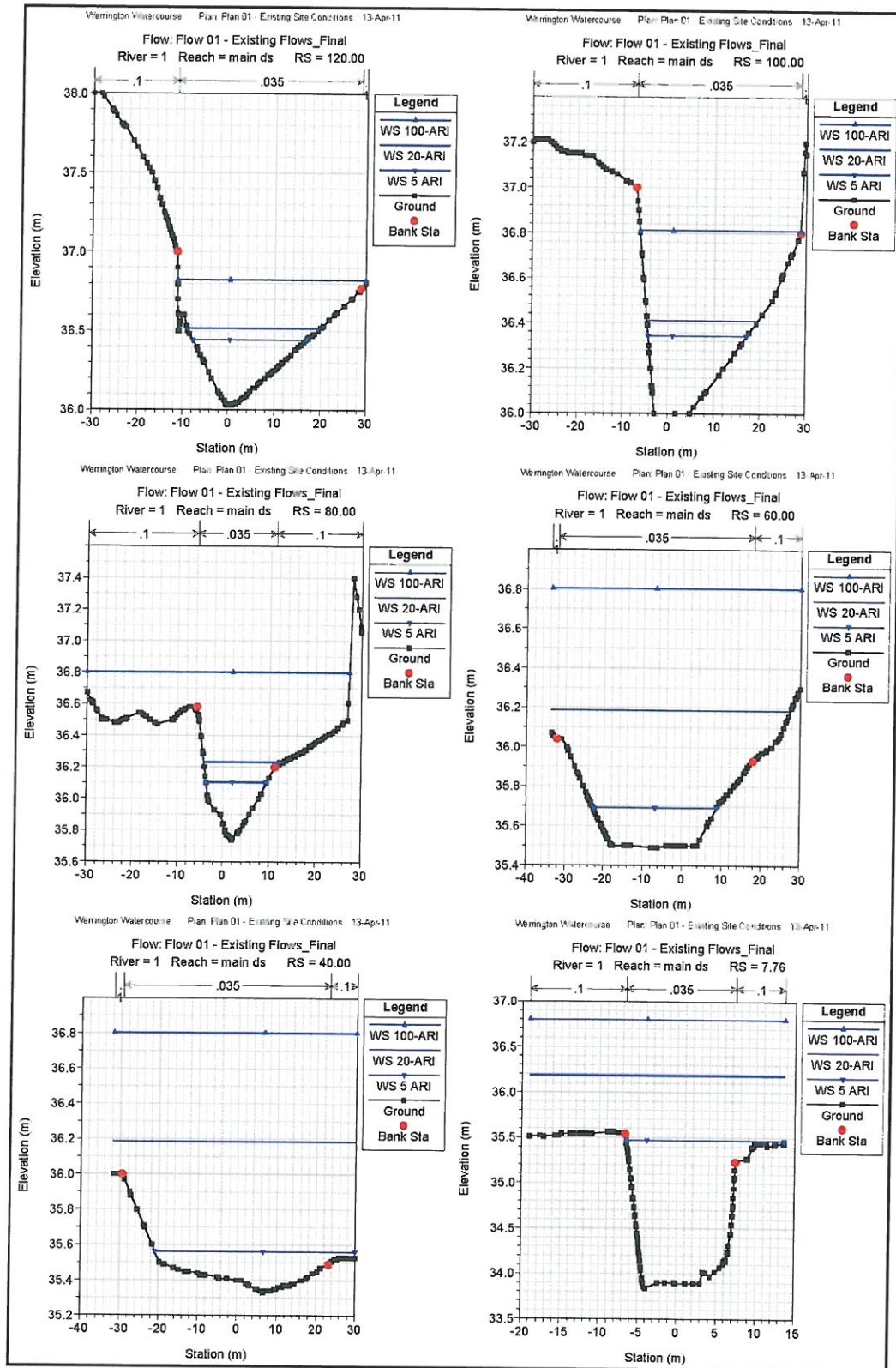
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W S Elev (m)	Cnt W S (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Cntl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Ctl
side	of path	180.00	20-ARI	1.02	43.70	43.80	43.80	43.84	0.033096	1.01	1.56	21.62	1.10
side	of path	180.00	100-ARI	1.47	43.70	43.82	43.82	43.87	0.029624	1.12	2.07	22.11	1.04
side	of path	180.00	5-ARI	0.65	43.70	43.78	43.78	43.81	0.032113	0.85	1.13	20.99	1.04
side	of path	160.00	20-ARI	1.02	42.85	42.96	42.96	43.00	0.035542	0.95	1.56	20.84	0.98
side	of path	160.00	100-ARI	1.47	42.85	42.96	42.96	43.04	0.051561	1.37	1.65	21.80	1.43
side	of path	160.00	5-ARI	0.66	42.85	42.94	42.94	42.97	0.023026	0.78	1.25	21.82	0.90
side	of path	140.00	20-ARI	1.02	42.33	42.44	42.44	42.49	0.025832	0.99	1.38	18.35	1.00
side	of path	140.00	100-ARI	1.47	42.33	42.47	42.47	42.52	0.023921	1.11	1.87	20.96	1.00
side	of path	140.00	5-ARI	0.66	42.33	42.42	42.42	42.45	0.030135	0.89	0.95	15.65	1.03
side	of path	120.00	20-ARI	1.02	41.59	41.73	41.73	41.81	0.042454	1.21	0.90	12.70	1.26
side	of path	120.00	100-ARI	1.47	41.59	41.75	41.75	41.85	0.042575	1.39	1.19	14.41	1.31
side	of path	120.00	5-ARI	0.66	41.59	41.71	41.72	41.76	0.038822	0.99	0.68	10.21	1.16
side	of path	100.00	20-ARI	1.02	41.00	41.10	41.10	41.26	0.120362	1.74	0.63	9.11	2.10
side	of path	100.00	100-ARI	1.47	41.00	41.16	41.16	41.24	0.021523	1.13	1.49	15.91	0.96
side	of path	100.00	5-ARI	0.66	41.00	41.06	41.12	41.21	0.155390	1.60	0.41	8.18	2.21
side	of path	80.00	20-ARI	1.02	40.53	40.63	40.63	40.67	0.024601	0.94	1.29	15.18	0.97
side	of path	80.00	100-ARI	1.47	40.53	40.64	40.65	40.71	0.031756	1.17	1.45	15.73	1.12
side	of path	80.00	5-ARI	0.66	40.53	40.60	40.60	40.64	0.020097	0.82	0.83	13.99	0.96
side	of path	60.00	20-ARI	1.02	39.99	40.06	40.08	40.12	0.050693	0.93	1.20	17.95	1.04
side	of path	60.00	100-ARI	1.47	39.99	40.04	40.10	40.45	0.036550	2.83	0.52	15.52	4.85
side	of path	60.00	5-ARI	0.66	39.99	40.07	40.07	40.09	0.026187	0.72	0.85	16.93	0.93
side	of path	40.00	20-ARI	1.02	39.20	39.37	39.37	39.43	0.022938	1.04	0.98	8.31	0.97
side	of path	40.00	100-ARI	1.47	39.20	39.41	39.41	39.46	0.021668	1.15	1.27	8.81	0.97
side	of path	40.00	5-ARI	0.66	39.20	39.34	39.34	39.38	0.026393	0.93	0.71	7.82	0.98
side	of path	20.00	20-ARI	1.02	38.20	38.85	38.90	38.95	0.000095	0.11	0.68	17.50	0.05
side	of path	20.00	100-ARI	1.47	38.20	39.93	39.34	38.93	0.000049	0.19	11.30	20.50	0.06
side	of path	20.00	5-ARI	0.66	38.20	39.78	38.28	38.78	0.000023	0.05	8.25	18.55	0.04
2	main us	574.81	20-ARI	2.63	43.00	44.43	44.27	44.48	0.004472	1.03	2.58	6.33	0.51
2	main us	574.81	100-ARI	3.89	43.90	44.62	44.35	44.67	0.003315	0.98	3.95	7.98	0.45
2	main us	574.81	5-ARI	1.67	43.90	44.24	44.19	44.31	0.010523	1.15	1.46	5.82	0.75
2	main us	550	Curvert										
2	main us	534.27	20-ARI	2.63	42.81	43.00	43.01	43.07	0.033883	1.17	2.25	21.50	1.15
2	main us	534.27	100-ARI	3.89	42.81	43.05	43.05	43.12	0.039667	1.18	3.53	22.71	1.01
2	main us	534.27	5-ARI	1.67	42.81	42.95	42.98	43.04	0.070339	1.39	1.35	17.16	1.06
2	main us	514.27	20-ARI	2.63	42.29	42.41	42.44	42.50	0.062573	1.33	1.97	24.47	1.50
2	main us	514.27	100-ARI	3.89	42.29	42.49	42.47	42.51	0.016709	0.96	4.06	30.73	0.84
2	main us	514.27	5-ARI	1.67	42.29	42.43	42.41	42.45	0.016215	0.73	2.30	29.88	0.78
2	main us	494.27	20-ARI	2.63	41.94	42.05	42.05	42.10	0.021122	0.38	2.63	26.20	1.01
2	main us	494.27	100-ARI	3.89	41.94	42.08	42.08	42.15	0.024261	1.10	3.54	26.79	1.00
2	main us	494.27	5-ARI	1.67	41.94	42.03	42.03	42.07	0.024463	0.80	2.10	27.81	0.93
2	main us	474.27	20-ARI	2.63	41.50	41.77	41.64	41.78	0.002546	0.53	4.94	21.92	0.36
2	main us	474.27	100-ARI	3.89	41.50	41.59	41.68	42.00	0.311894	2.85	1.37	12.07	3.31
2	main us	474.27	5-ARI	1.67	41.50	41.71	41.61	41.71	0.007366	0.44	3.76	20.83	0.33
2	main us	454.27	20-ARI	2.63	41.48	41.63	41.63	41.69	0.023154	1.12	2.33	18.03	0.98
2	main us	454.27	100-ARI	3.89	41.48	41.66	41.66	41.72	0.022100	1.26	3.08	18.91	1.00
2	main us	454.27	5-ARI	1.67	41.48	41.59	41.59	41.64	0.024349	0.95	1.75	17.25	0.95
2	main us	434.27	20-ARI	2.63	41.00	41.26	41.19	41.30	0.006656	0.33	3.16	14.75	0.47
2	main us	434.27	100-ARI	3.89	41.00	41.32	41.24	41.37	0.007634	0.99	3.95	16.81	0.63
2	main us	434.27	5-ARI	1.67	41.00	41.09	41.14	41.28	0.140734	1.93	0.86	11.24	2.20
2	main us	414.27	20-ARI	2.63	40.81	41.04	41.04	41.10	0.022606	1.08	2.70	27.40	0.97
2	main us	414.27	100-ARI	3.89	40.81	41.07	41.07	41.15	0.021789	1.22	3.69	28.42	0.99
2	main us	414.27	5-ARI	1.67	40.81	41.01	41.00	41.05	0.023516	0.93	1.63	26.44	0.98
2	main us	394.27	20-ARI	2.63	40.50	40.71	40.67	40.75	0.011156	0.90	3.57	21.92	0.71
2	main us	394.27	100-ARI	3.89	40.50	40.75	40.71	40.80	0.012106	1.05	4.47	22.13	0.76
2	main us	394.27	5-ARI	1.67	40.50	40.66	40.63	40.69	0.011962	0.60	2.53	19.58	0.71
2	main us	374.27	20-ARI	2.63	40.34	40.51	40.42	40.53	0.009865	0.67	4.43	25.60	0.82
2	main us	374.27	100-ARI	3.89	40.34	40.55	40.45	40.58	0.009888	0.80	5.80	27.41	0.66
2	main us	374.27	5-ARI	1.67	40.34	40.46	40.38	40.48	0.009488	0.54	3.33	23.15	0.99
2	main us	354.27	20-ARI	2.63	40.00	40.18	40.18	40.25	0.027385	1.18	2.43	18.81	1.07
2	main us	354.27	100-ARI	3.89	40.00	40.23	40.23	40.30	0.076141	1.30	3.51	22.18	1.07
2	main us	354.27	5-ARI	1.67	40.00	40.14	40.14	40.20	0.031242	1.09	1.84	17.33	1.10
2	main us	330	Curvert										
2	main us	314.27	20-ARI	2.63	38.20	38.86	38.41	38.86	0.000184	0.35	10.64	20.80	0.11
2	main us	314.27	100-ARI	3.89	38.20	38.94	38.46	38.95	0.000254	0.31	12.40	21.55	0.13
2	main us	314.27	5-ARI	1.67	38.20	38.78	38.37	38.76	0.000122	0.19	9.05	20.08	0.08
2	main us	294.27	20-ARI	2.63	38.20	38.86	38.43	38.86	0.000163	0.23	11.56	23.95	0.10
2	main us	294.27	100-ARI	3.89	38.20	38.94	38.46	38.94	0.000221	0.29	13.51	24.11	0.12

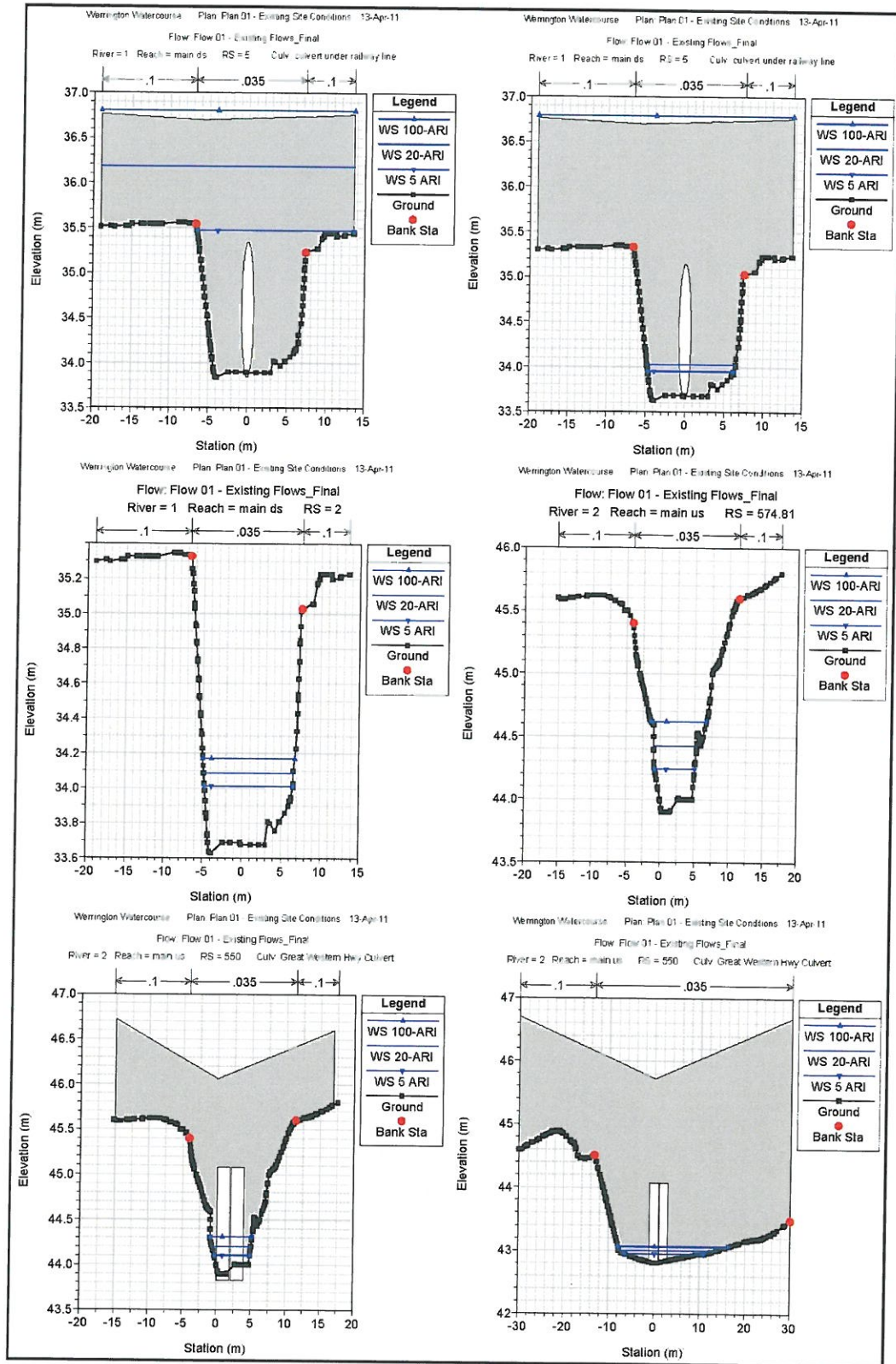
HEC-RAS Plan E-011 (Continued)

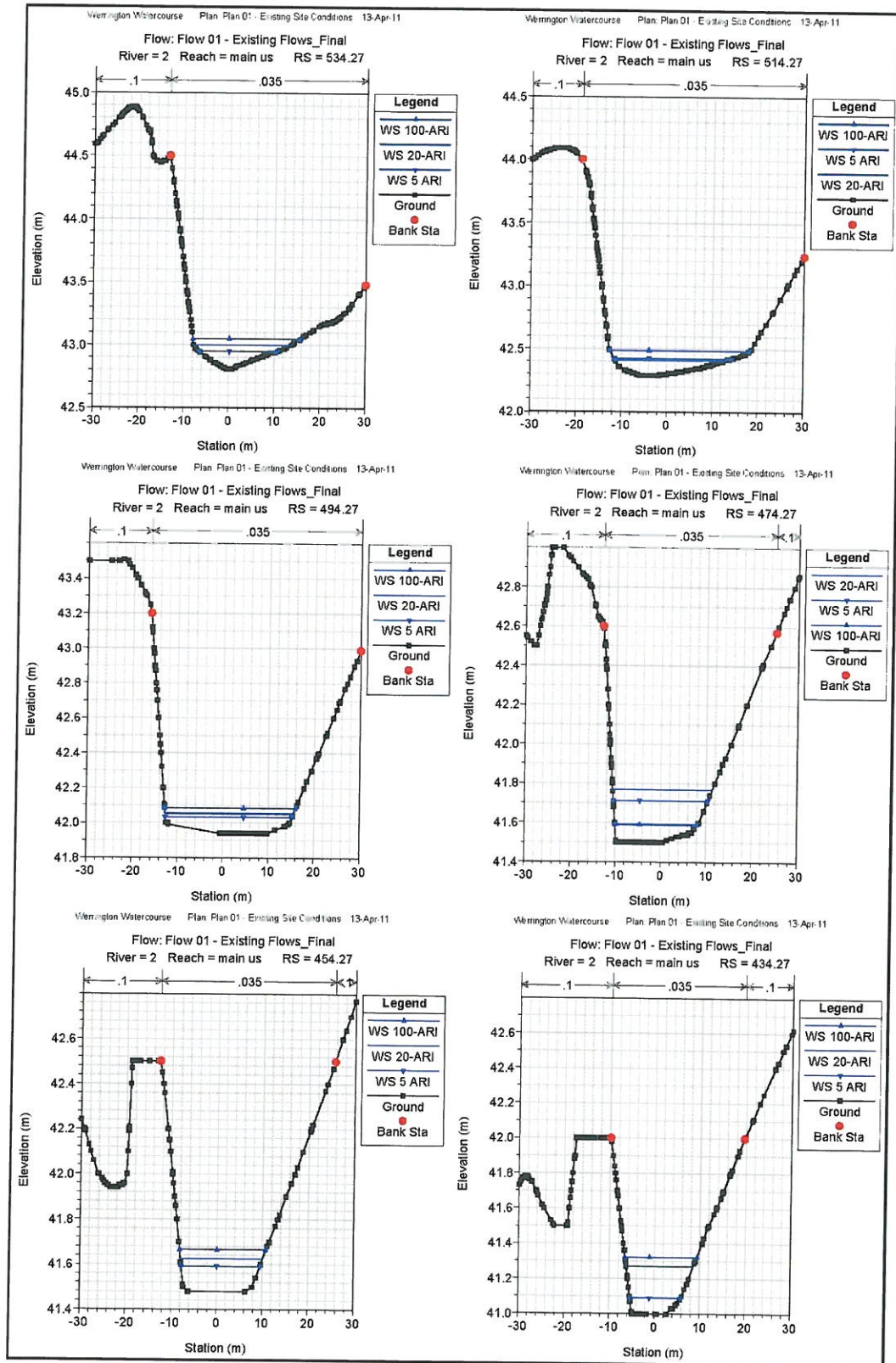
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W/S Elev (m)	Crit W/S (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
2	main us	294.27	5 ARI	1.67	38.20	38.73	38.33	38.78	0.000106	0.17	9.80	22.51	0.08
2	main us	274.27	20-ARI	2.73	38.20	38.85	38.41	38.86	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	100-ARI	3.89	38.20	38.93	38.46	38.94	0.000254	0.29	13.42	27.25	0.13
2	main us	274.27	5 ARI	1.67	38.20	38.78	38.36	38.78	0.000128	0.18	9.50	23.58	0.09
1	main ds	240.00	20-ARI	5.68	38.50	38.74	38.74	38.84	0.019099	1.42	4.01	18.59	0.51
1	main ds	240.00	100-ARI	7.91	38.50	38.79	38.79	38.92	0.019833	1.61	4.90	19.13	1.02
1	main ds	240.00	5 ARI	3.87	38.50	38.59	38.69	38.77	0.020375	1.26	3.07	17.88	0.47
1	main ds	220.00	20-ARI	5.48	38.00	38.75	38.19	38.38	0.002568	0.69	8.27	25.17	0.38
1	main ds	220.00	100-ARI	7.51	38.00	38.43	38.23	38.43	0.002623	0.76	10.15	25.87	0.40
1	main ds	220.00	5 ARI	3.92	38.00	38.26	38.15	38.20	0.002339	0.59	6.51	24.43	0.37
1	main ds	200.00	20-ARI	5.68	37.88	38.17	38.17	38.28	0.018892	1.48	4.17	21.16	0.58
1	main ds	200.00	100-ARI	7.91	37.88	38.24	38.24	38.36	0.016808	1.57	5.78	28.60	0.95
1	main ds	200.00	5 ARI	3.87	37.88	38.12	38.12	38.21	0.019387	1.32	3.11	18.59	0.56
1	main ds	180.00	20-ARI	5.68	37.32	37.51	37.27	37.66	0.042865	1.54	3.88	27.53	1.25
1	main ds	180.00	100-ARI	7.91	37.32	37.56	37.61	37.73	0.046136	1.76	4.41	27.95	1.44
1	main ds	180.00	5 ARI	3.87	37.32	37.51	37.53	37.60	0.042219	1.32	2.95	27.33	1.29
1	main ds	160.00	20-ARI	5.68	36.98	37.22	37.22	37.31	0.023068	1.32	4.30	25.52	1.03
1	main ds	160.00	100-ARI	7.91	36.98	37.27	37.27	37.37	0.021269	1.44	5.48	26.84	1.02
1	main ds	160.00	5 ARI	3.87	36.98	37.19	37.18	37.25	0.019758	1.10	3.74	24.37	0.92
1	main ds	140.00	20-ARI	5.68	36.50	36.77	36.79	36.87	0.028913	1.41	4.03	25.72	1.14
1	main ds	140.00	100-ARI	7.91	36.50	36.89	36.83	36.95	0.009186	1.07	7.28	30.21	0.69
1	main ds	140.00	5 ARI	3.87	36.50	36.74	36.74	36.81	0.023980	1.19	3.25	23.19	1.02
1	main ds	120.00	20-ARI	5.68	36.02	36.51	36.50	36.54	0.004370	0.76	7.47	29.17	0.48
1	main ds	120.00	100-ARI	7.91	36.02	36.81	36.44	36.83	0.007630	0.43	18.57	41.15	0.20
1	main ds	120.00	5 ARI	3.87	36.02	36.44	36.33	36.47	0.004386	0.70	5.54	24.65	0.47
1	main ds	100.00	20-ARI	5.68	36.00	36.41	36.40	36.45	0.003163	0.86	6.59	24.15	0.51
1	main ds	100.00	100-ARI	7.91	36.00	36.81	36.35	36.82	0.000517	0.43	18.60	35.06	0.19
1	main ds	100.00	5 ARI	3.87	36.00	36.74	36.24	36.37	0.005029	0.77	5.03	21.40	0.51
1	main ds	80.00	20-ARI	5.68	35.74	36.23	36.17	36.31	0.009731	1.25	4.57	17.10	0.73
1	main ds	80.00	100-ARI	7.91	35.74	36.80	36.13	36.81	0.000352	0.47	28.00	37.39	0.17
1	main ds	80.00	5 ARI	3.87	35.74	36.10	36.10	36.21	0.020820	1.43	2.70	13.13	1.61
1	main ds	60.00	20-ARI	5.68	35.49	36.19	35.68	35.19	0.000121	0.21	33.77	61.09	0.09
1	main ds	60.00	100-ARI	7.91	35.49	36.80	35.72	36.80	0.000017	0.13	67.80	63.56	0.04
1	main ds	60.00	5 ARI	3.87	35.49	35.64	35.64	35.72	0.007800	0.26	5.17	31.40	0.59
1	main ds	40.00	20-ARI	5.68	35.33	36.19	35.54	36.19	0.000041	0.15	42.39	61.79	0.04
1	main ds	40.00	100-ARI	7.91	35.33	36.80	35.67	36.80	0.000010	0.11	80.53	61.79	0.03
1	main ds	40.00	5 ARI	3.87	35.33	35.56	35.51	35.58	0.005815	0.60	6.66	50.99	0.20
1	main ds	7.76	20-ARI	5.00	33.44	34.18	34.24	34.19	0.000017	0.16	43.15	32.54	0.04
1	main ds	7.76	100-ARI	7.91	33.44	36.80	34.51	36.80	0.000012	0.18	62.29	32.64	0.04
1	main ds	7.76	5 ARI	3.87	33.44	35.47	34.17	35.47	0.000037	0.20	19.64	20.19	0.06
1	main ds	5		0									
			0	0									
1	main ds	2	20-ARI	5.36	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.76
1	main ds	2	100-ARI	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.96	11.71	0.78
1	main ds	2	5 ARI	3.87	33.63	34.01	33.95	34.08	0.010012	1.27	3.18	11.27	0.73

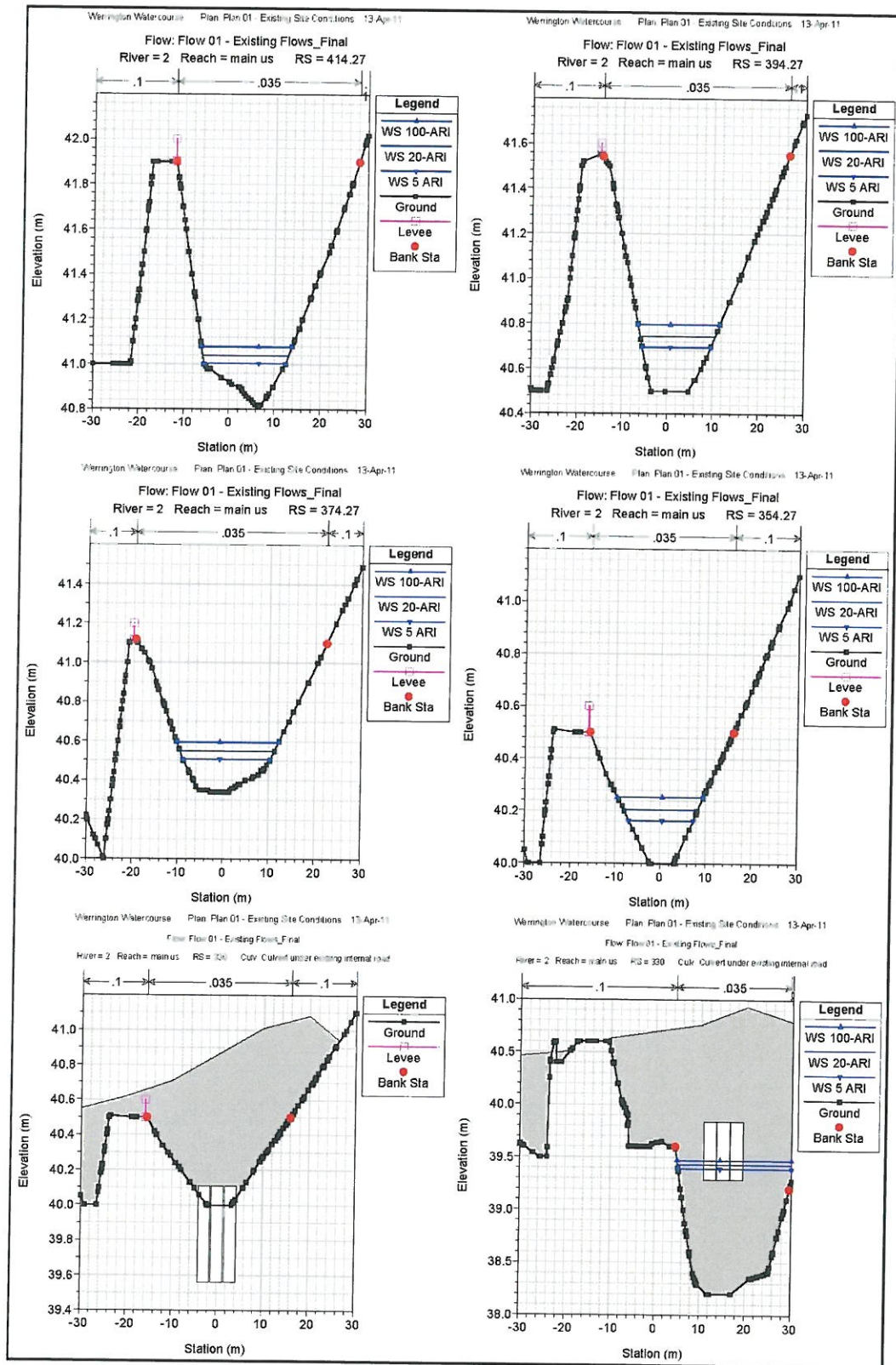


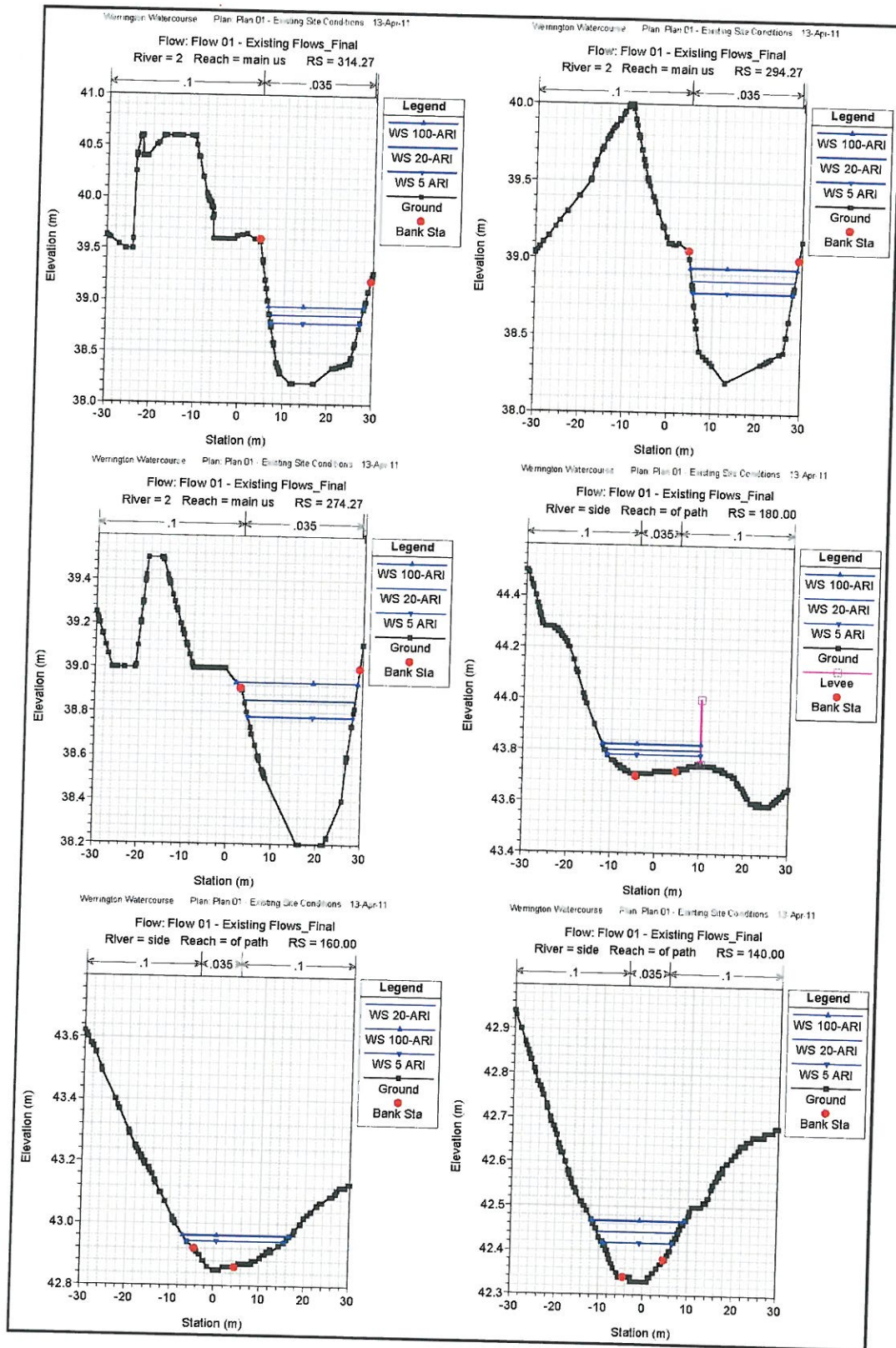


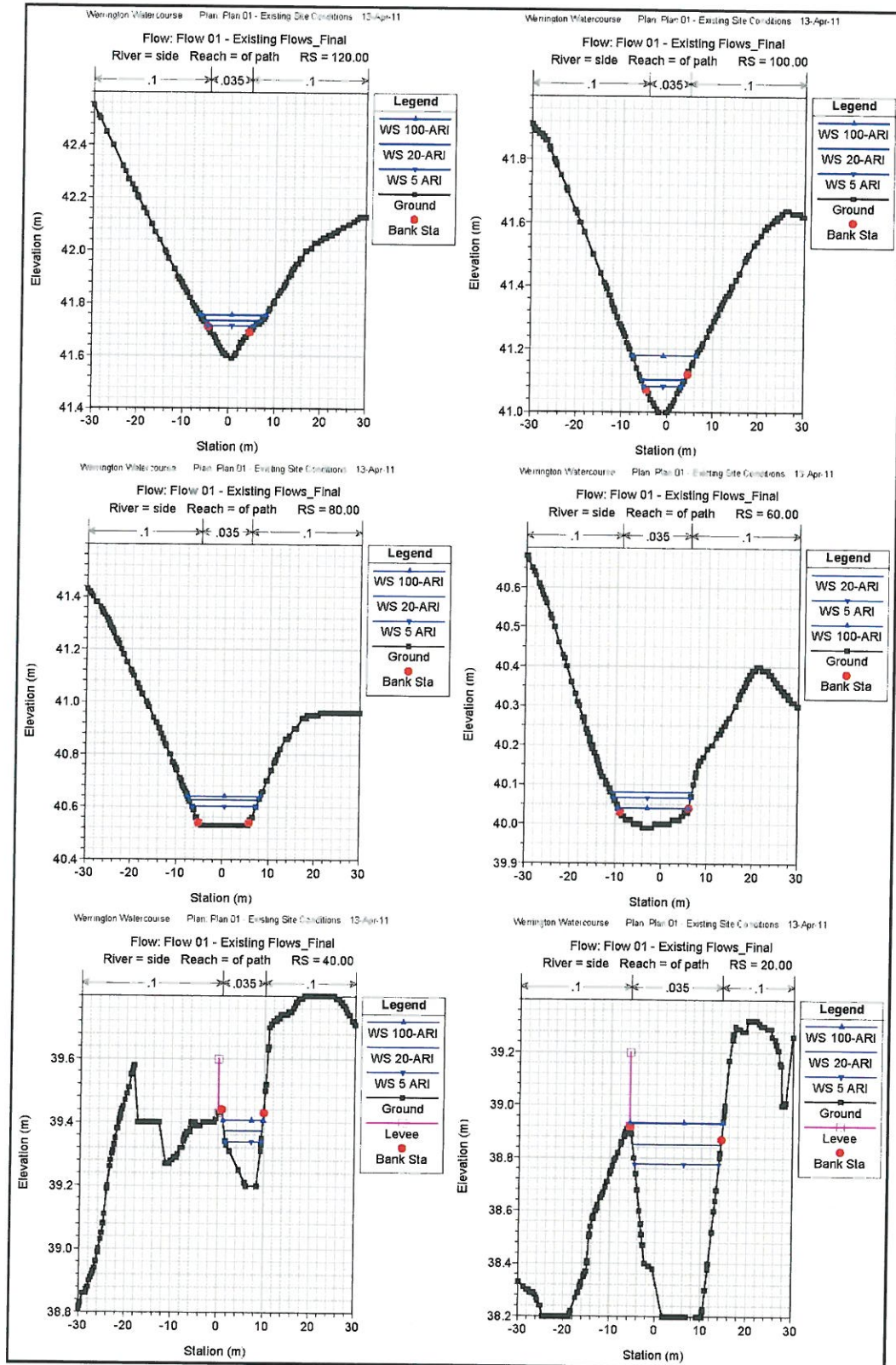










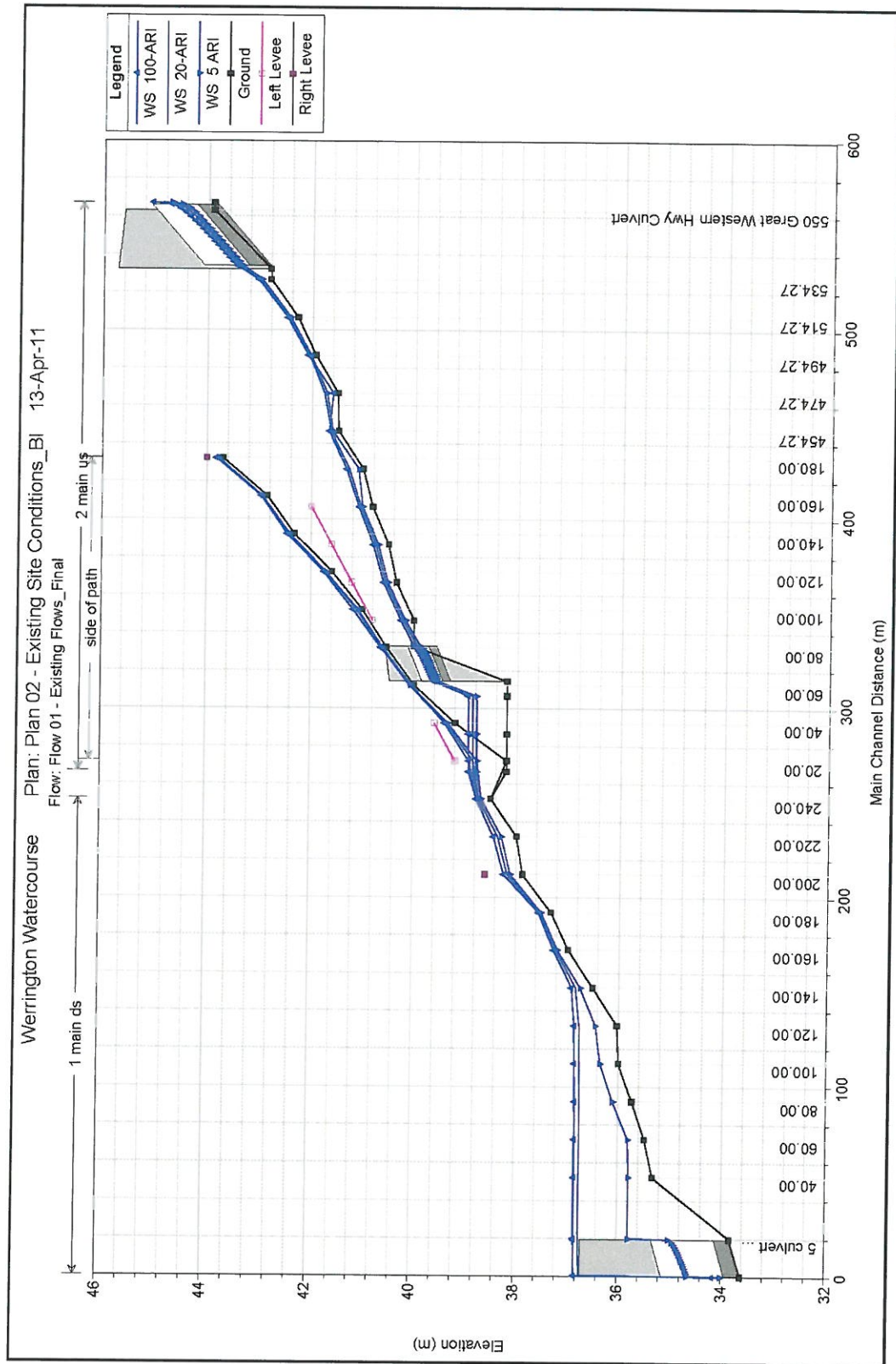


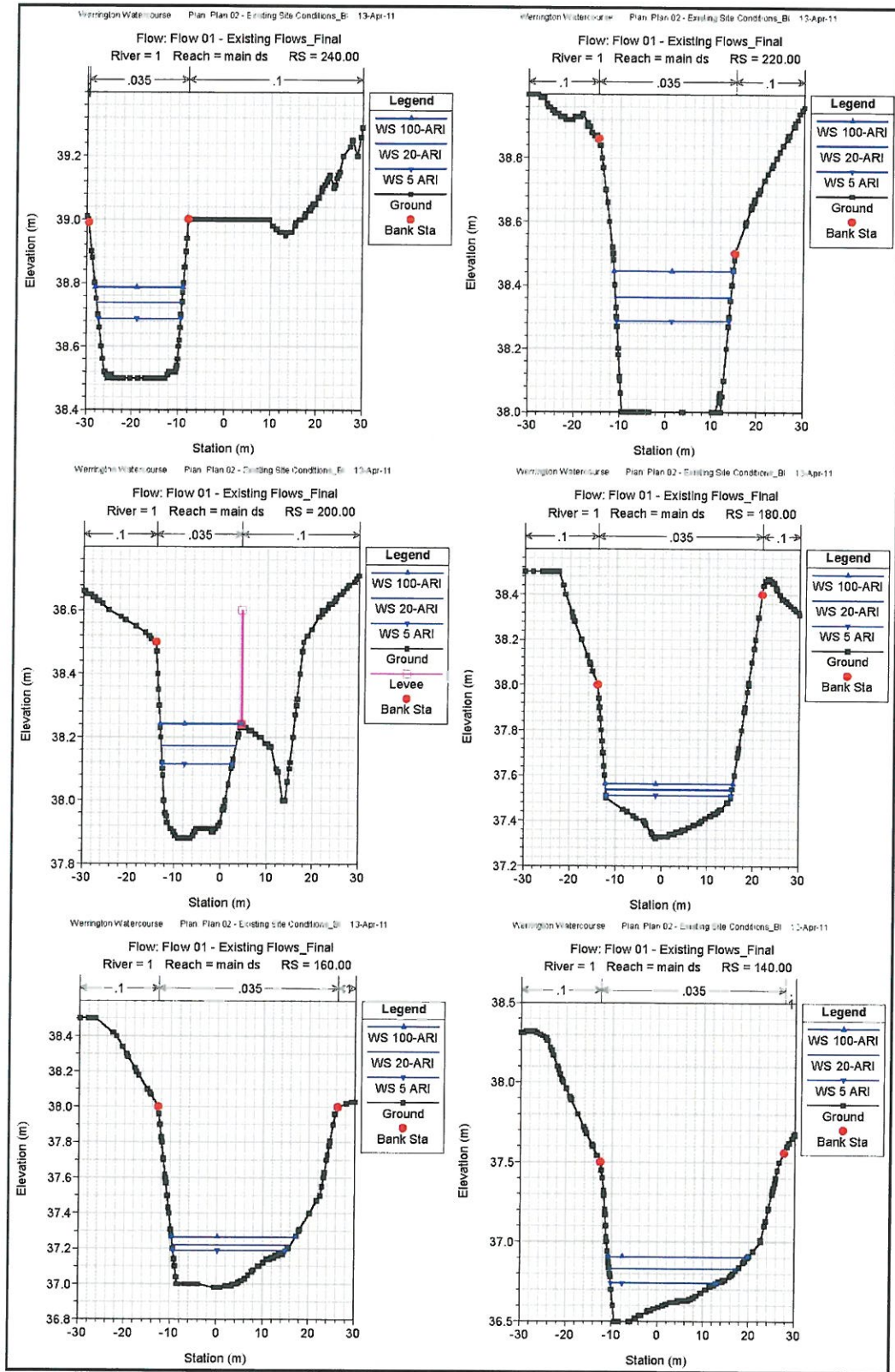
Plan 02 – Existing Site Conditions with Culvert Blockage

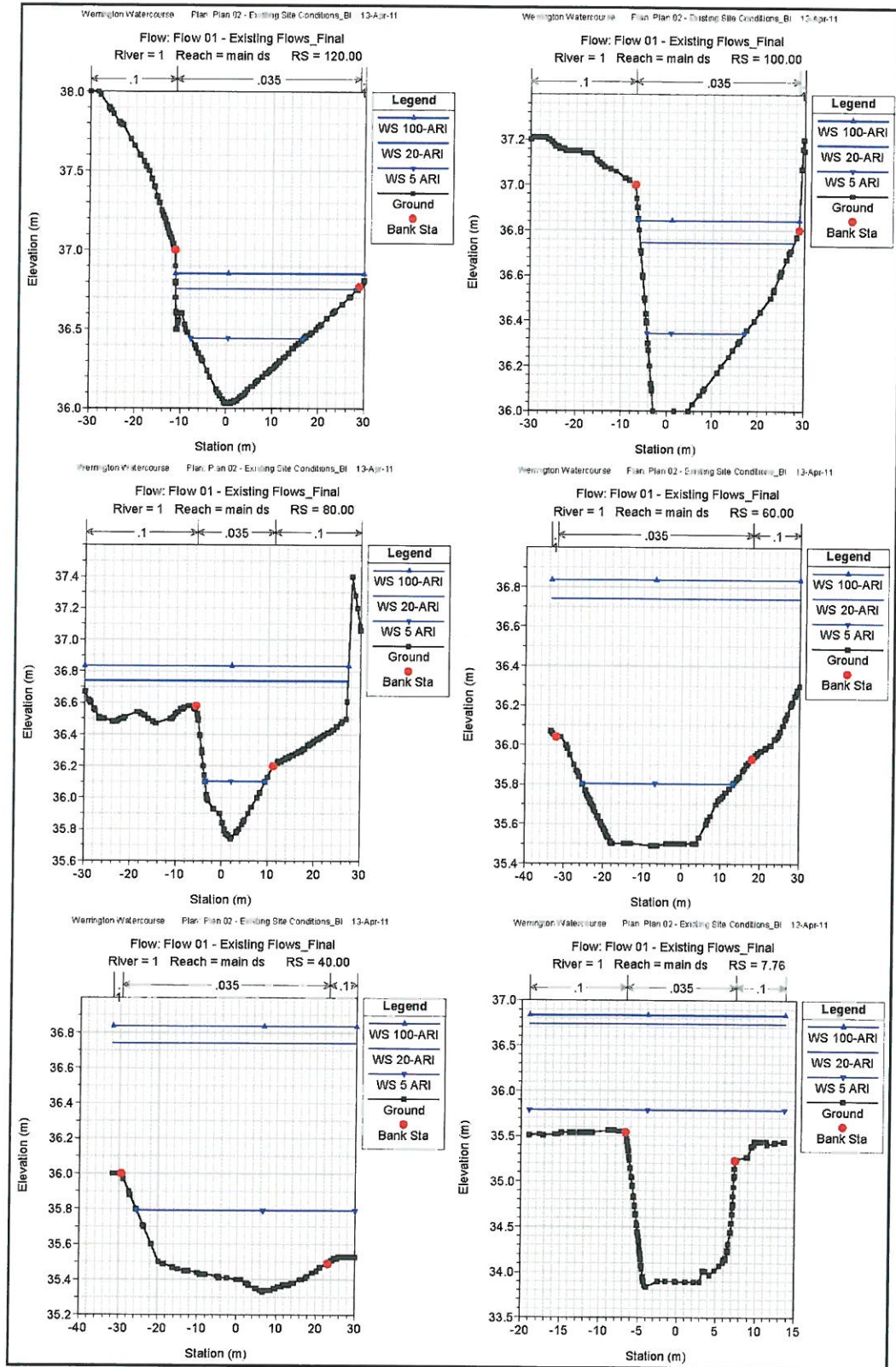
HEC-RAS Plan Exist.b													
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
side	of path	180.00	20-ARI	1.02	43.70	43.80	43.80	43.84	0.039056	1.01	1.56	21.62	1.10
side	of path	180.00	100-ARI	1.47	43.70	43.82	43.82	43.97	0.039524	1.13	2.07	22.11	1.08
side	of path	180.00	5-ARI	0.66	43.70	43.78	43.78	42.91	0.032113	0.85	1.16	20.95	1.04
side	of path	160.00	20-ARI	1.02	42.85	42.96	42.96	43.00	0.025642	0.95	1.66	23.84	0.98
side	of path	160.00	100-ARI	1.47	42.85	42.96	42.96	43.74	0.053661	1.97	1.65	23.80	1.43
side	of path	160.00	5-ARI	0.66	42.85	42.94	42.94	42.97	0.023026	0.78	1.25	21.82	0.90
side	of path	140.00	20-ARI	1.02	42.33	42.44	42.44	42.49	0.025692	0.99	1.36	18.35	1.00
side	of path	140.00	100-ARI	1.47	42.33	42.47	42.47	42.52	0.027491	1.11	1.87	20.96	1.00
side	of path	140.00	5-ARI	0.66	42.33	42.42	42.42	42.45	0.030139	0.88	0.95	15.66	1.03
side	of path	120.00	20-ARI	1.02	41.59	41.73	41.73	41.81	0.042454	1.21	0.90	12.70	1.26
side	of path	120.00	100-ARI	1.47	41.59	41.75	41.78	41.85	0.042575	1.39	1.19	14.41	1.31
side	of path	120.00	5-ARI	0.66	41.59	41.71	41.72	41.76	0.032812	0.94	0.66	10.21	1.16
side	of path	100.00	20-ARI	1.02	41.00	41.10	41.15	41.26	0.128362	1.74	0.40	5.51	2.10
side	of path	100.00	100-ARI	1.47	41.00	41.18	41.18	41.24	0.021523	1.13	1.49	13.91	0.96
side	of path	100.00	5-ARI	0.66	41.00	41.08	41.12	41.21	0.155390	1.60	0.41	8.16	2.21
side	of path	80.00	20-ARI	1.02	40.53	40.63	40.63	40.67	0.024601	0.94	1.20	15.16	0.97
side	of path	80.00	100-ARI	1.47	40.53	40.64	40.65	40.71	0.031796	1.17	1.45	15.72	1.12
side	of path	80.00	5-ARI	0.66	40.53	40.60	40.60	40.64	0.021067	0.82	0.86	10.99	0.98
side	of path	60.00	20-ARI	1.02	39.99	40.06	40.06	40.10	0.030693	0.89	1.20	17.95	1.04
side	of path	60.00	100-ARI	1.47	39.99	40.04	40.10	40.45	0.066550	2.83	0.52	15.50	4.85
side	of path	60.00	5-ARI	0.66	39.99	40.07	40.07	40.09	0.026167	0.72	0.95	16.82	0.93
side	of path	40.00	20-ARI	1.02	39.20	39.37	39.37	39.43	0.022938	1.04	0.98	8.31	0.97
side	of path	40.00	100-ARI	1.47	39.20	39.41	39.41	39.46	0.021666	1.16	1.27	8.81	0.97
side	of path	40.00	5-ARI	0.66	39.20	39.34	39.34	39.36	0.026393	0.83	0.71	7.62	0.99
side	of path	20.00	20-ARI	1.02	38.20	38.65	38.65	38.85	0.000035	0.11	9.68	19.50	0.05
side	of path	20.00	100-ARI	1.47	38.20	38.69	38.34	38.93	0.000043	0.13	11.30	20.50	0.06
side	of path	20.00	5-ARI	0.66	38.20	38.78	38.28	38.78	0.000023	0.08	8.25	18.55	0.04
2	main us	574.81	20-ARI	2.63	43.90	44.87	44.27	44.86	0.000440	0.42	6.21	9.77	0.17
2	main us	574.81	100-ARI	3.89	43.90	45.06	44.35	45.07	0.000468	0.47	8.20	11.46	0.18
2	main us	574.81	5-ARI	1.67	43.90	44.70	44.19	44.71	0.000402	0.35	4.66	8.81	0.16
2	main us	550											
				Culvert									
2	main us	534.27	20-ARI	2.63	42.81	43.01	43.01	43.07	0.024004	1.04	2.52	22.06	0.98
2	main us	534.27	100-ARI	3.89	42.81	43.15	43.05	43.12	0.023967	1.15	3.30	23.71	1.01
2	main us	534.27	5-ARI	1.67	42.81	42.98	42.98	43.02	0.026987	0.94	1.77	19.76	1.00
2	main us	514.27	20-ARI	2.63	42.29	42.46	42.46	42.49	0.015172	0.81	3.24	29.35	0.78
2	main us	514.27	100-ARI	3.89	42.29	42.49	42.47	42.53	0.016709	0.96	4.06	30.73	0.84
2	main us	514.27	5-ARI	1.67	42.29	42.43	42.41	42.45	0.016215	0.73	2.30	25.68	0.78
2	main us	494.27	20-ARI	2.63	41.94	42.05	42.05	42.10	0.027122	0.98	3.66	28.35	1.01
2	main us	494.27	100-ARI	3.89	41.94	42.28	42.08	42.15	0.024264	1.10	3.54	28.75	1.00
2	main us	494.27	5-ARI	1.67	41.94	42.03	42.03	42.07	0.024463	0.80	2.10	27.81	0.93
2	main us	474.27	20-ARI	2.63	41.50	41.77	41.64	41.78	0.032740	0.93	4.94	21.93	0.76
2	main us	474.27	100-ARI	3.89	41.50	41.59	41.69	42.00	0.311484	2.35	1.37	16.07	3.31
2	main us	474.27	5-ARI	1.67	41.50	41.71	41.61	41.72	0.002369	0.44	3.76	20.83	0.93
2	main us	454.27	20-ARI	2.63	41.48	41.63	41.63	41.65	0.021154	1.12	2.33	18.03	0.99
2	main us	454.27	100-ARI	3.89	41.48	41.66	41.66	41.75	0.022100	1.25	3.08	15.91	1.00
2	main us	454.27	5-ARI	1.67	41.48	41.59	41.59	41.64	0.013349	0.65	1.16	12.26	0.85
2	main us	434.27	20-ARI	2.63	41.00	41.27	41.19	41.30	0.006158	0.81	3.24	14.86	0.55
2	main us	434.27	100-ARI	3.89	41.00	41.32	41.24	41.37	0.007124	0.86	4.04	15.95	0.61
2	main us	434.27	5-ARI	1.67	41.00	41.09	41.14	41.28	0.010754	1.19	0.86	11.34	2.23
2	main us	414.27	20-ARI	2.63	40.81	41.04	41.04	41.10	0.023363	1.10	2.38	18.96	0.99
2	main us	414.27	100-ARI	3.89	40.81	41.09	41.09	41.15	0.021805	1.23	3.15	19.90	0.99
2	main us	414.27	5-ARI	1.67	40.81	41.00	41.00	41.05	0.024982	0.95	1.75	18.12	0.98
2	main us	394.27	20-ARI	2.63	40.50	40.74	40.68	40.78	0.008523	0.85	2.07	16.55	0.84
2	main us	394.27	100-ARI	3.89	40.50	40.80	40.73	40.84	0.008948	0.98	2.97	18.02	0.87
2	main us	394.27	5-ARI	1.67	40.50	40.70	40.64	40.72	0.007748	0.72	2.32	15.09	0.59
2	main us	374.27	20-ARI	2.63	40.34	40.55	40.52	40.59	0.011601	0.86	3.06	20.76	0.71
2	main us	374.27	100-ARI	3.89	40.34	40.59	40.55	40.64	0.011236	0.96	4.03	22.41	0.73
2	main us	374.27	5-ARI	1.67	40.34	40.51	40.48	40.54	0.011834	0.74	2.25	15.34	0.68
2	main us	354.27	20-ARI	2.63	40.00	40.21	40.21	40.27	0.023689	1.11	2.25	16.44	1.01
2	main us	354.27	100-ARI	3.89	40.00	40.25	40.25	40.31	0.021856	1.23	3.10	19.06	1.00
2	main us	354.27	5-ARI	1.67	40.00	40.16	40.16	40.22	0.024966	1.05	1.59	14.34	1.00
2	main us	330											
				Culvert									
2	main us	314.27	20-ARI	2.63	38.20	38.66	38.41	38.66	0.000184	0.25	10.64	20.80	0.11
2	main us	314.27	100-ARI	3.89	38.20	38.64	38.46	38.95	0.000254	0.31	12.40	21.55	0.13
2	main us	314.27	5-ARI	1.67	38.20	38.78	38.37	38.78	0.000123	0.18	9.05	20.09	0.09
2	main us	294.27	20-ARI	2.63	38.20	38.66	38.43	38.94	0.000163	0.23	11.56	23.35	0.10
2	main us	294.27	100-ARI	3.89	38.20	38.64	38.45	38.94	0.000221	0.29	13.51	24.11	0.12

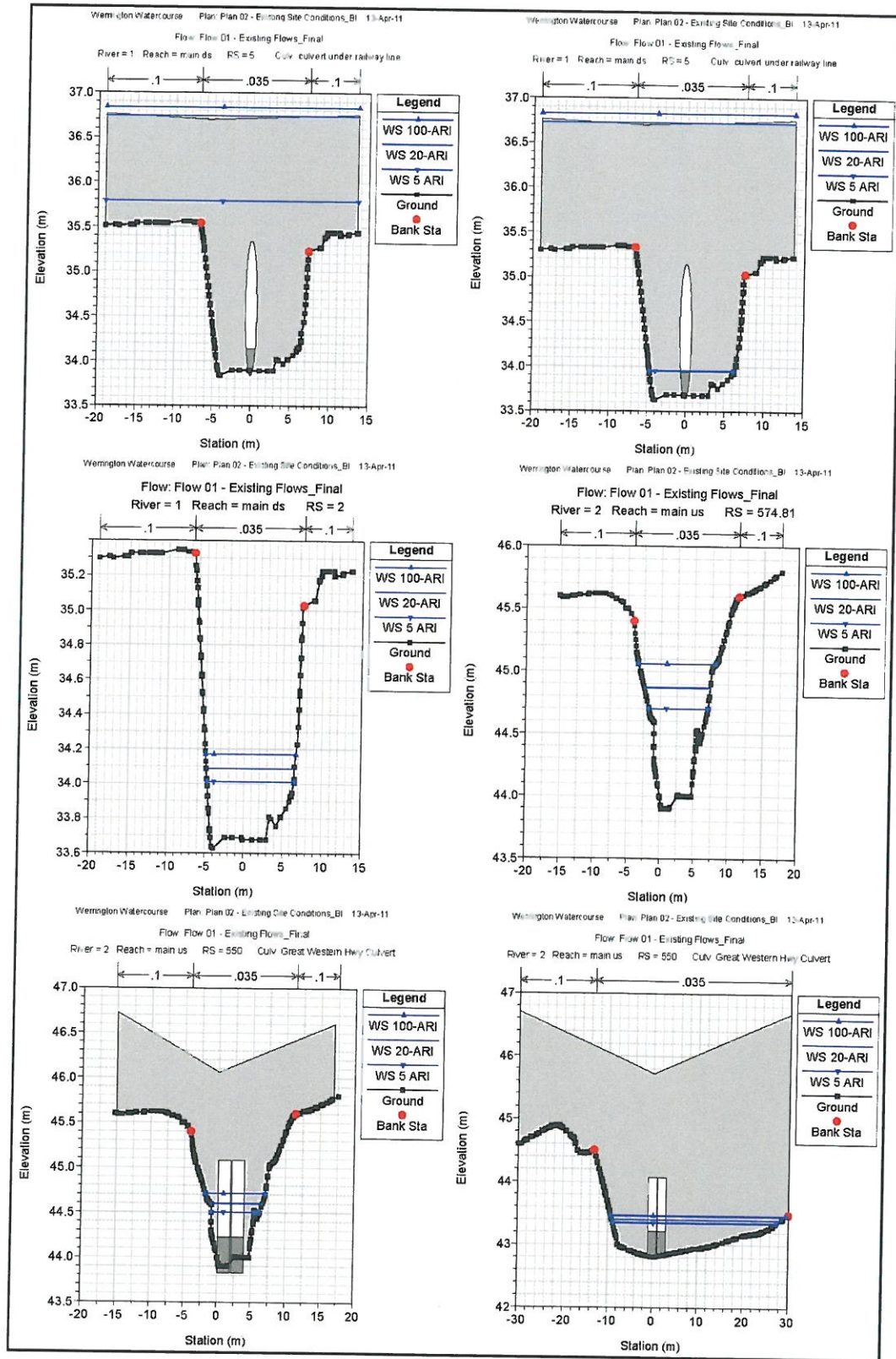
HEC-RAS Plan E list b (Continued)

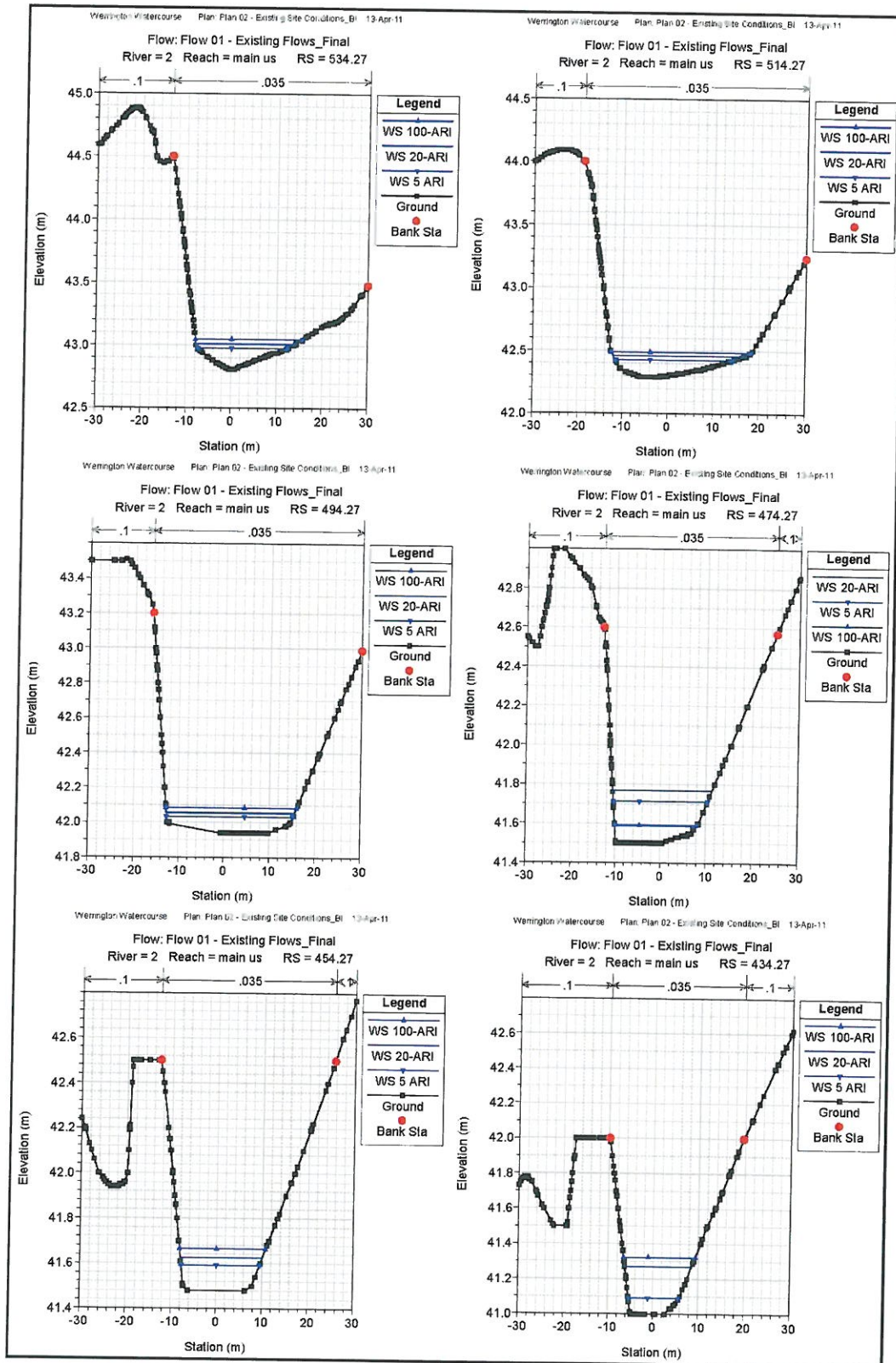
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W S Elev (m)	Cnt W S (m)	E G Elev (m)	E G Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
2	main us	294.27	5 ARI	1.67	36.20	36.78	33.39	38.76	0.000108	0.17	0.50	22.51	0.06
2	main us	274.27	20-ARI	2.53	36.20	36.85	38.41	38.86	0.000190	0.23	11.33	24.95	0.11
2	main us	274.27	100-ARI	3.89	36.20	36.13	38.85	38.94	0.000254	0.25	13.43	27.25	0.13
2	main us	274.27	5 ARI	1.67	36.20	36.78	38.35	38.76	0.000128	0.18	9.50	23.83	0.06
1	main ds	240.00	20-ARI	5.68	36.50	36.74	38.74	38.84	0.019094	1.42	4.01	18.59	0.97
1	main ds	240.00	100-ARI	7.91	36.50	36.79	38.77	38.92	0.019663	1.61	4.90	19.13	1.02
1	main ds	240.00	5 ARI	3.87	36.50	36.69	38.69	38.77	0.020376	1.26	3.01	17.63	0.91
1	main ds	220.00	20-ARI	5.68	36.00	36.36	38.19	38.39	0.002413	0.67	6.43	25.23	0.37
1	main ds	220.00	100-ARI	7.91	36.00	36.44	38.23	38.47	0.002315	0.75	10.54	26.12	0.38
1	main ds	220.00	5 ARI	3.87	36.00	36.29	38.15	38.30	0.002452	0.59	6.58	24.45	0.36
1	main ds	200.00	20-ARI	5.68	37.83	38.17	38.17	38.29	0.000220	1.53	3.72	16.07	1.01
1	main ds	200.00	100-ARI	7.91	37.88	38.24	38.24	38.36	0.017791	1.62	4.87	17.55	0.98
1	main ds	200.00	5 ARI	3.87	37.88	38.12	38.12	38.21	0.021526	1.37	2.82	15.08	1.01
1	main ds	180.00	20-ARI	5.68	37.32	37.54	37.57	37.66	0.042707	1.54	3.69	27.63	1.35
1	main ds	180.00	100-ARI	7.91	37.82	37.56	37.61	37.75	0.047023	1.60	4.39	27.93	1.45
1	main ds	180.00	5 ARI	3.87	37.32	37.51	37.53	37.60	0.040177	1.30	2.97	27.35	1.26
1	main ds	160.00	20-ARI	5.68	36.98	37.20	37.22	37.31	0.023668	1.31	4.30	26.62	1.03
1	main ds	160.00	100-ARI	7.91	36.98	37.27	37.27	37.37	0.021289	1.44	5.18	26.84	1.02
1	main ds	160.00	5 ARI	3.87	36.98	37.19	37.18	37.25	0.019358	1.10	6.53	24.37	0.92
1	main ds	140.00	20-ARI	5.68	36.50	36.83	36.79	36.88	0.011018	1.02	5.57	27.98	0.73
1	main ds	140.00	100-ARI	7.91	36.50	36.91	36.83	36.96	0.007771	1.01	7.92	30.63	0.64
1	main ds	140.00	5 ARI	3.87	36.50	36.74	36.74	36.81	0.023980	1.19	3.25	25.18	1.02
1	main ds	120.00	20-ARI	5.68	36.03	36.15	36.39	36.76	0.000541	0.36	15.35	39.81	0.18
1	main ds	120.00	100-ARI	7.91	36.03	36.85	36.44	36.86	0.000512	0.40	19.79	41.16	0.18
1	main ds	120.00	5 ARI	3.87	36.03	36.44	36.33	36.47	0.004352	0.70	5.54	24.65	0.47
1	main ds	100.00	20-ARI	5.68	36.00	36.75	36.30	36.75	0.000367	0.35	16.38	33.74	0.15
1	main ds	100.00	100-ARI	7.91	36.00	36.84	36.35	36.95	0.000428	0.40	19.72	35.20	0.17
1	main ds	100.00	5 ARI	3.87	36.00	36.34	35.24	36.37	0.004980	0.77	5.04	21.42	0.50
1	main ds	80.00	20-ARI	5.68	35.74	36.74	36.17	36.75	0.000249	0.37	24.45	57.31	0.14
1	main ds	80.00	100-ARI	7.91	35.74	36.83	36.23	36.84	0.000300	0.44	29.91	57.43	0.15
1	main ds	80.00	5 ARI	3.87	35.74	36.10	36.10	36.21	0.020650	1.43	2.70	13.13	1.01
1	main ds	60.00	20-ARI	5.00	35.48	36.74	35.68	36.74	0.000011	0.10	63.81	63.56	0.01
1	main ds	60.00	100-ARI	7.91	35.49	36.84	35.72	36.84	0.000016	0.13	69.90	63.56	0.04
1	main ds	60.00	5 ARI	3.87	35.49	35.90	35.64	35.81	0.001507	0.42	9.19	38.63	0.28
1	main ds	40.00	20-ARI	5.68	35.83	36.74	35.54	36.74	0.000006	0.08	76.64	61.79	0.02
1	main ds	40.00	100-ARI	7.91	35.83	36.84	35.57	36.84	0.000009	0.11	82.67	61.79	0.03
1	main ds	40.00	5 ARI	3.87	35.83	35.79	35.51	35.79	0.000340	0.22	18.85	56.47	0.12
1	main ds	7.76	20-ARI	5.68	33.84	36.74	34.24	36.74	0.000007	0.14	60.26	32.64	0.03
1	main ds	7.76	100-ARI	7.91	33.84	36.84	34.32	36.84	0.000012	0.18	63.37	32.64	0.01
1	main ds	7.76	5 ARI	3.87	33.84	35.79	34.17	35.79	0.000017	0.16	20.19	32.64	0.04
1	main ds	5											
			Culvert										
1	main ds	2	20-ARI	5.68	33.63	34.09	34.03	34.19	0.010001	1.41	4.03	11.41	0.76
1	main ds	2	100-ARI	7.91	33.63	34.17	34.10	34.30	0.010002	1.59	4.96	11.71	0.78
1	main ds	2	5 ARI	3.87	33.63	34.01	33.95	34.09	0.010012	1.22	3.18	11.27	0.73

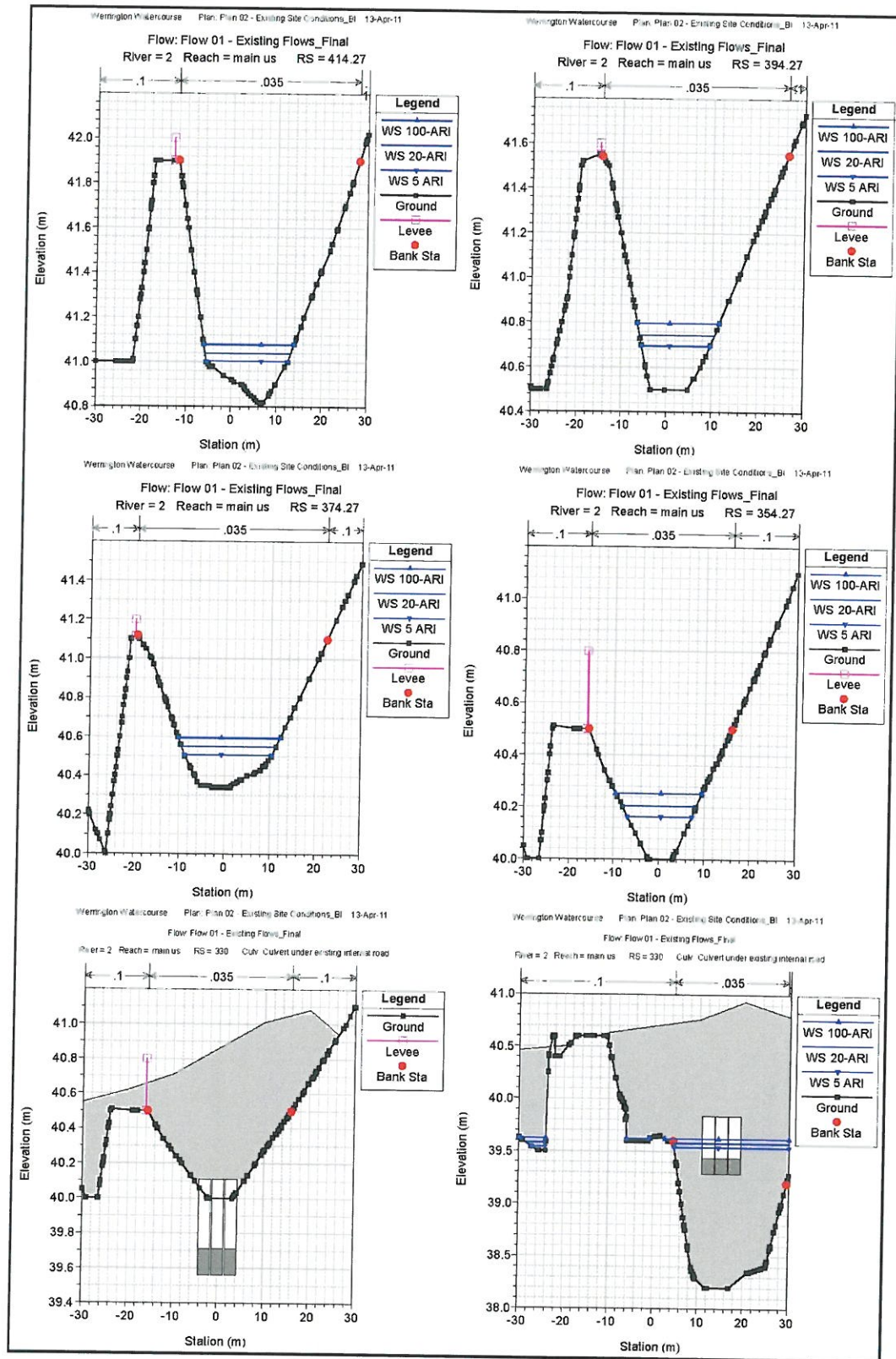


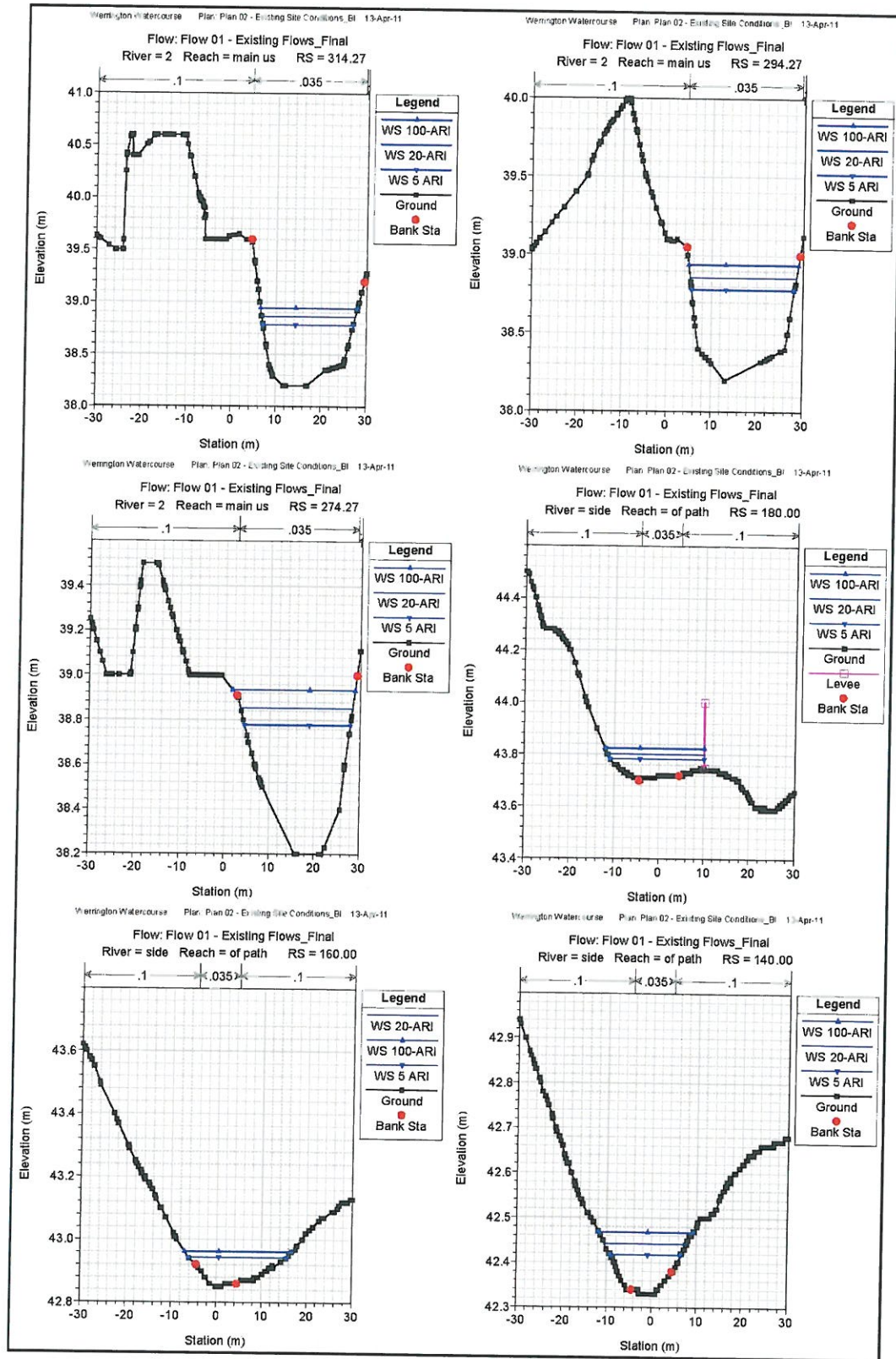


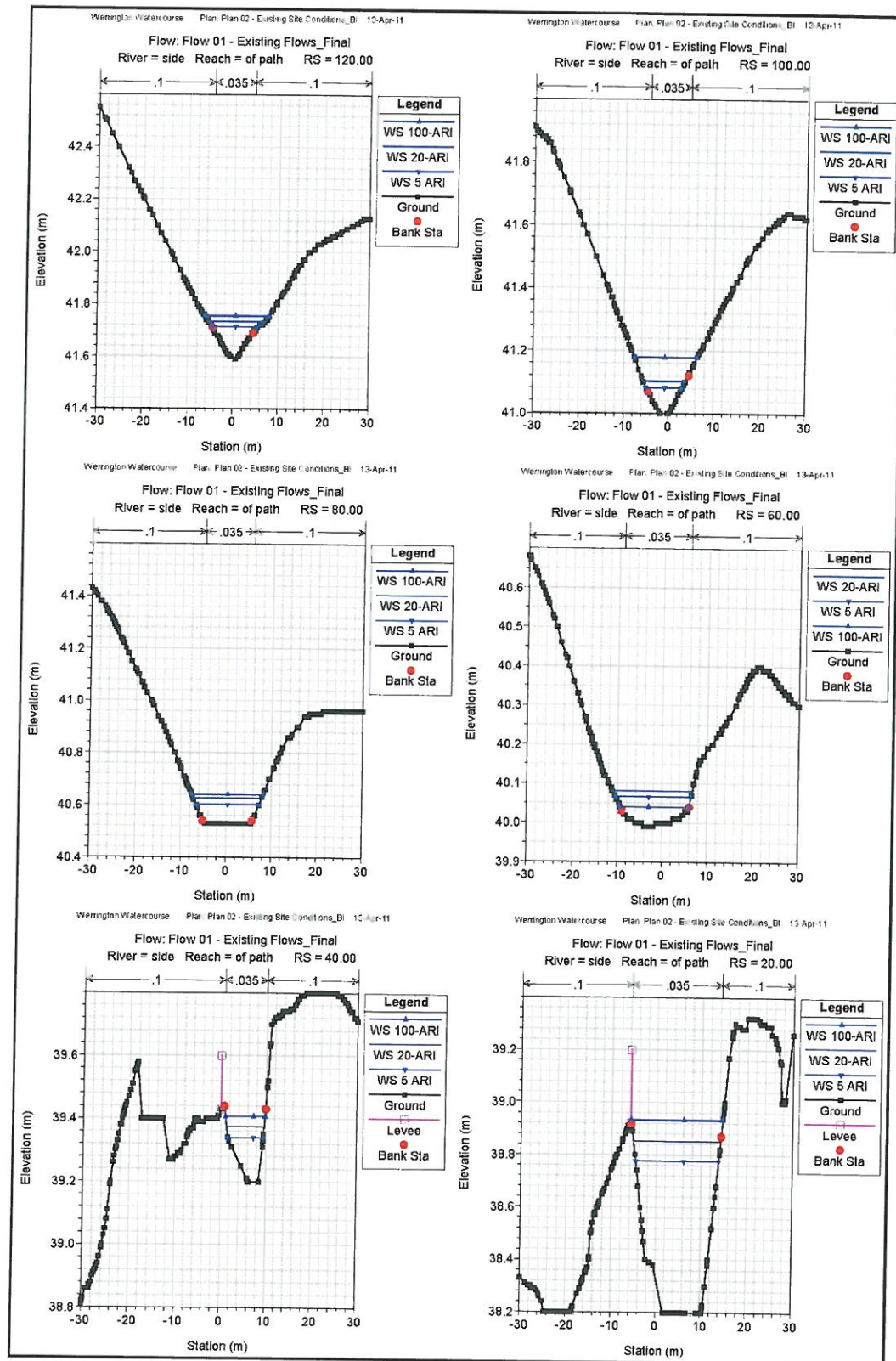








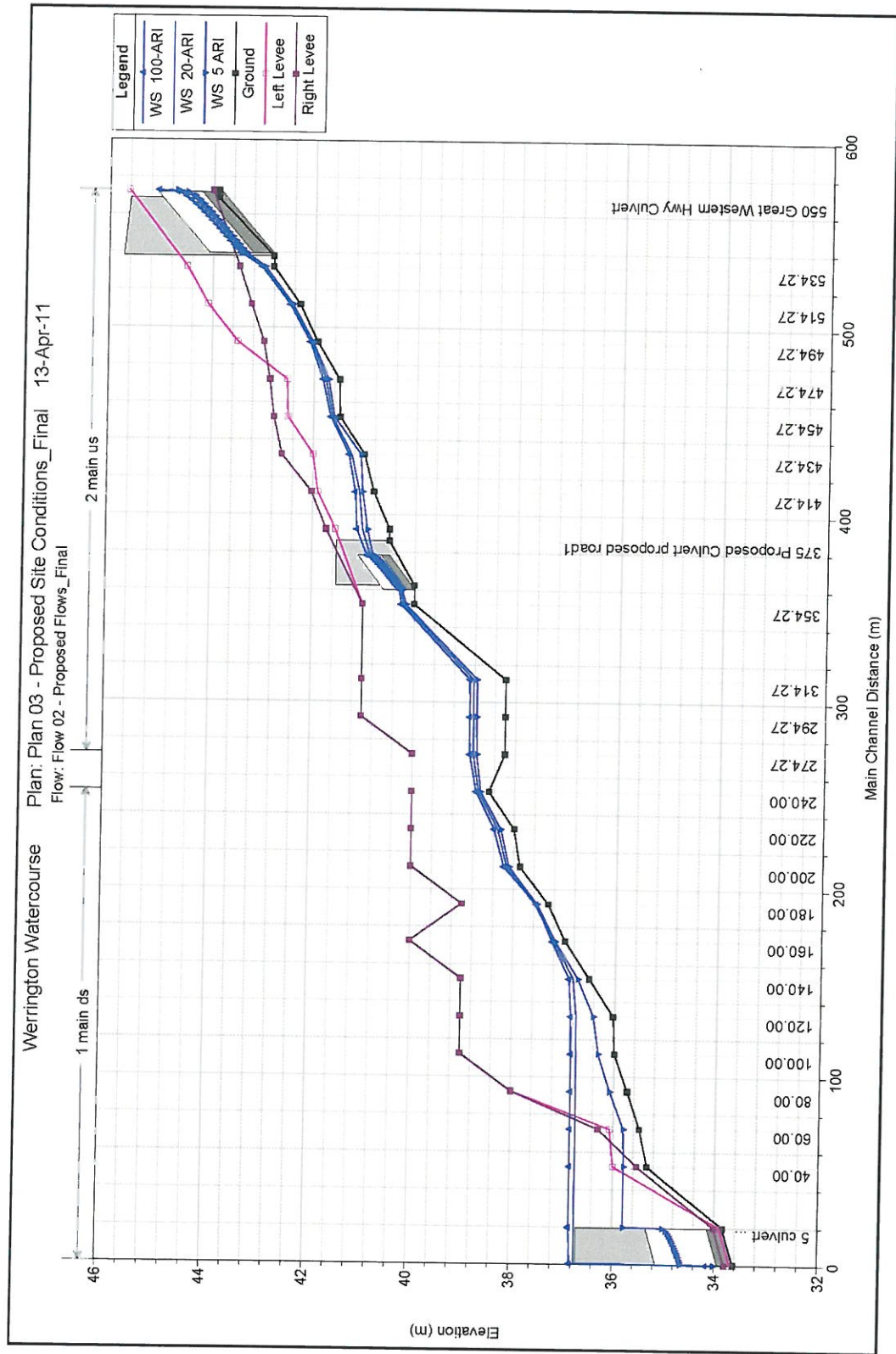


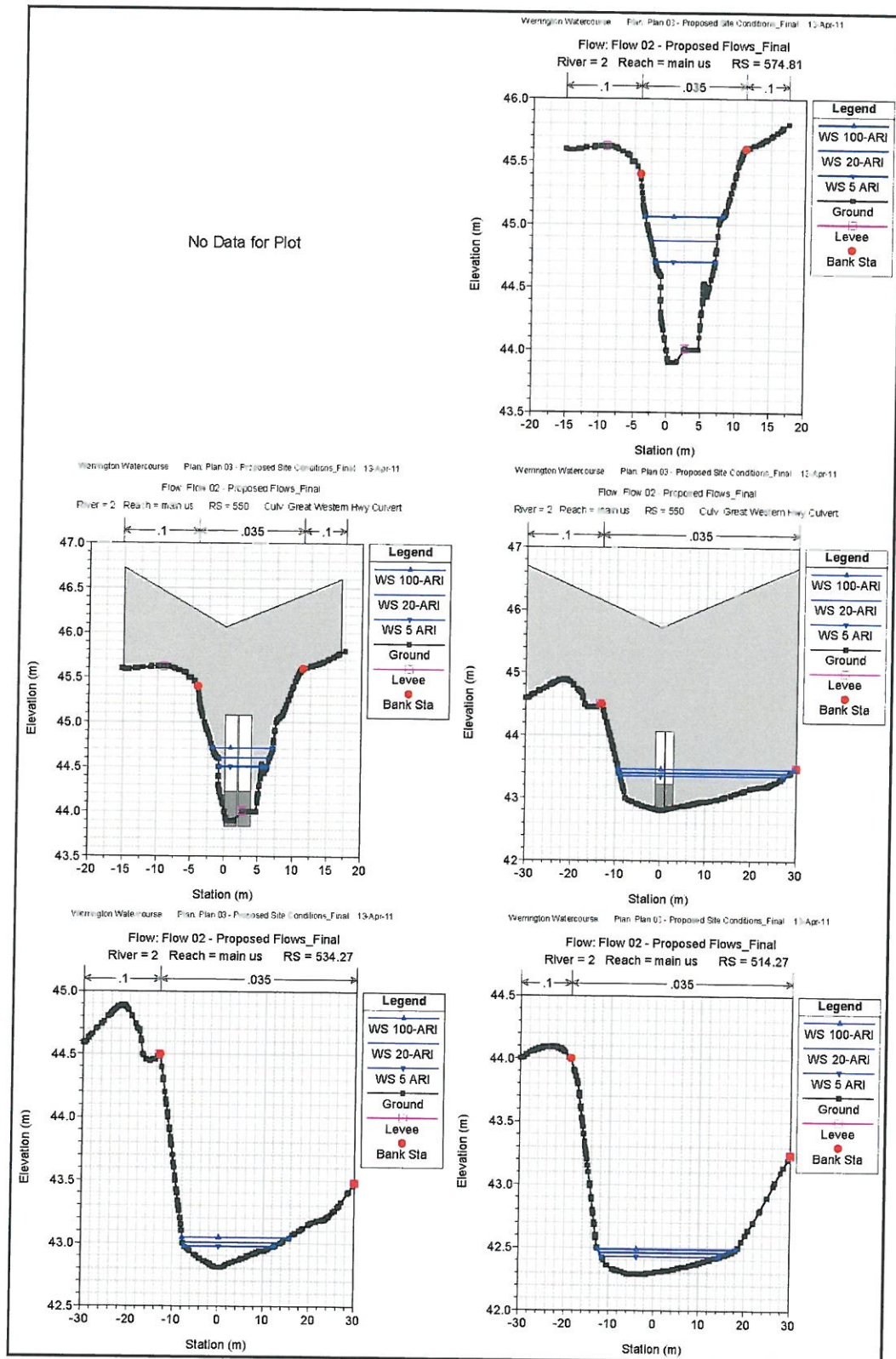


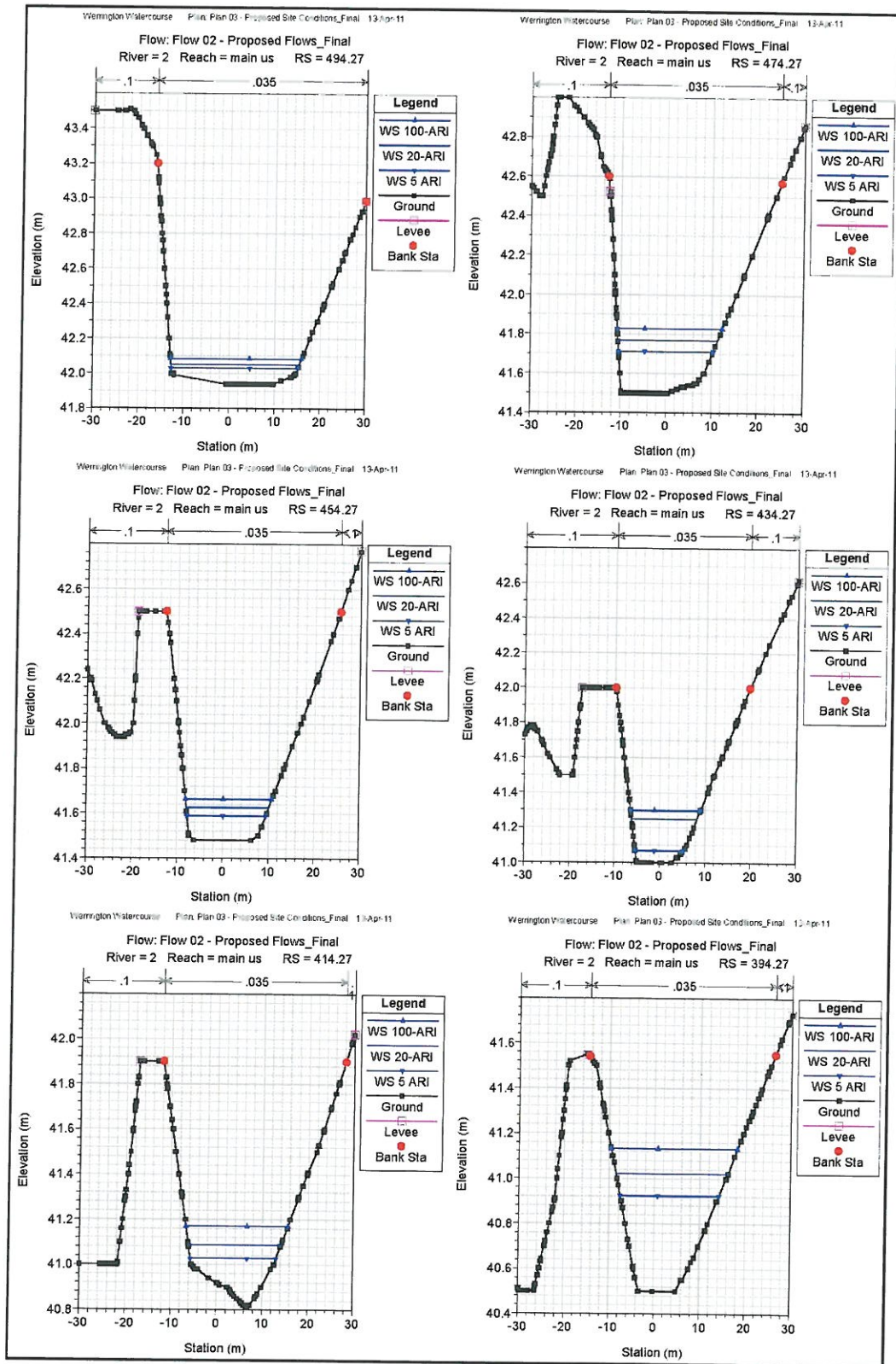
Plan 03 – Proposed Site Conditions with Culvert Blockage

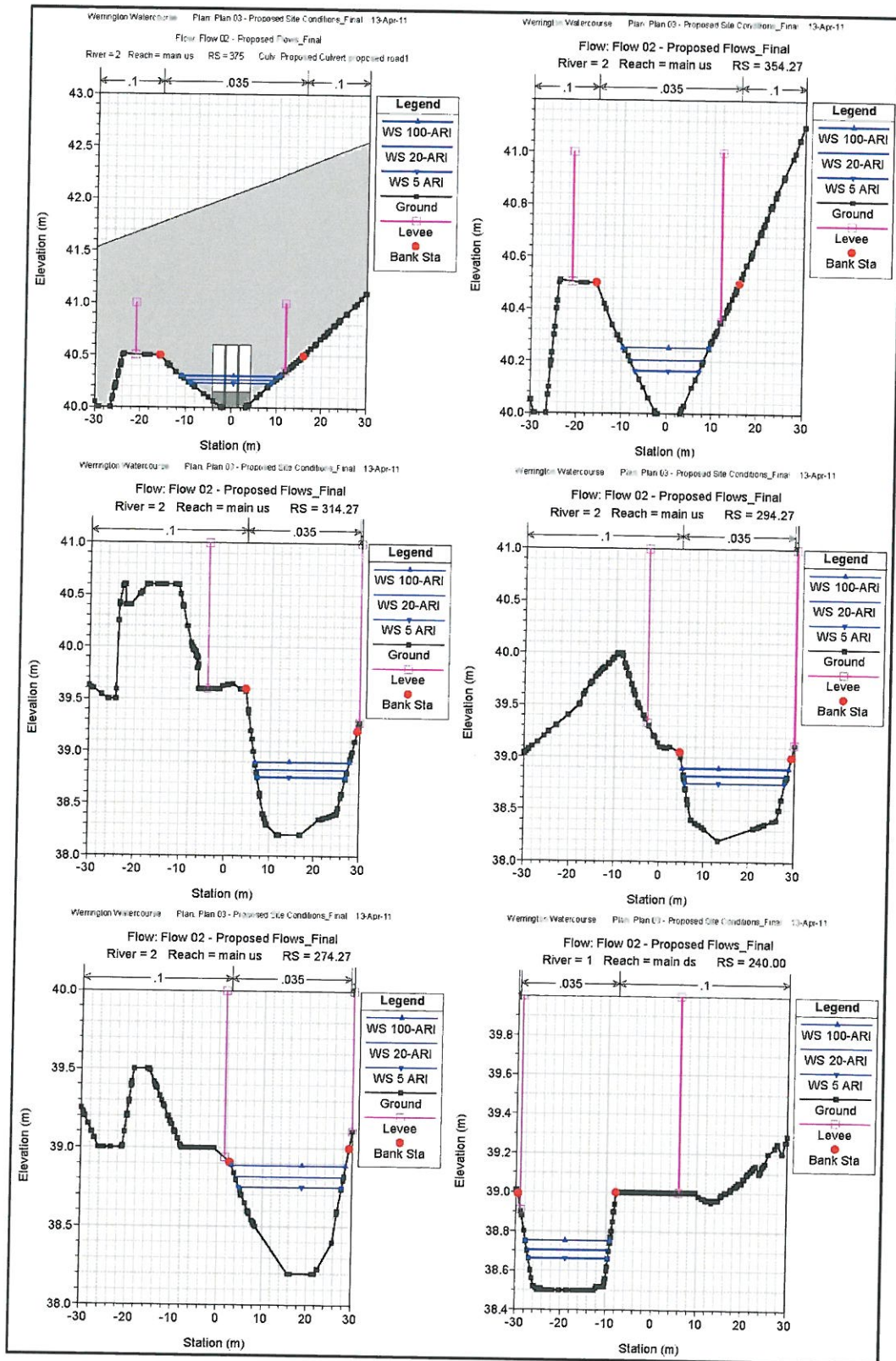
HEC-RAS Plan Proposed

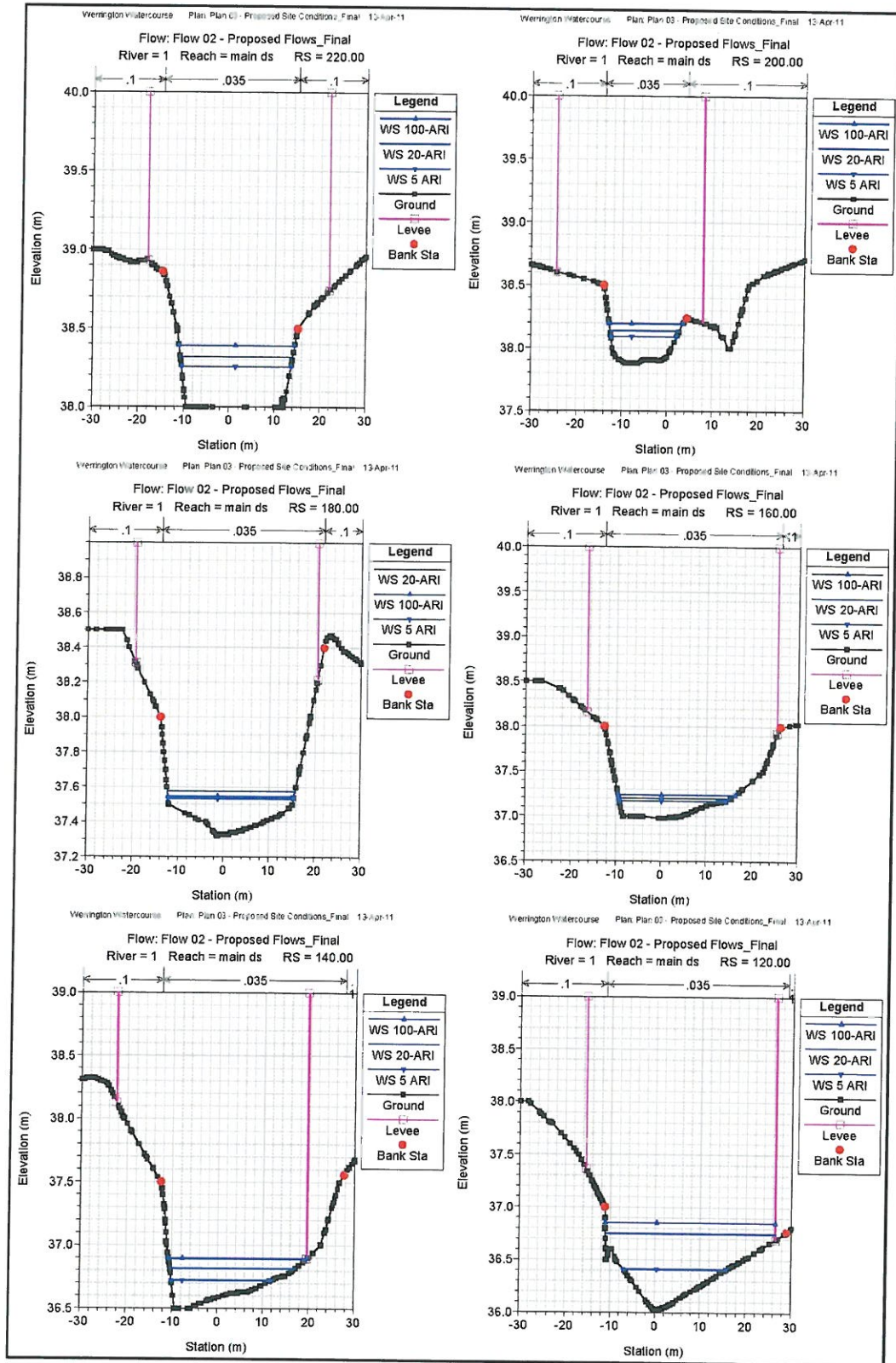
River	Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S (m)	E.G. Elev (m)	E.G. Slope (mm)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Ch
2	main us	574.81	20-ARI	2.63	43.90	44.67	44.27	44.95	0.000440	0.42	6.21	9.77	0.17
2	main us	574.81	100-ARI	3.89	41.90	45.06	44.35	45.07	0.000463	0.47	8.20	11.46	0.16
2	main us	574.81	5-ARI	1.67	43.90	44.70	44.19	44.7	0.000403	0.36	4.66	8.61	0.16
2	main us	550											
2	main us	534.27	20-ARI	2.63	42.91	43.01	43.01	43.07	0.026345	1.10	2.39	21.83	1.06
2	main us	534.27	100-ARI	3.89	41.91	43.05	43.05	43.12	0.023487	1.18	2.31	23.72	1.01
2	main us	534.27	5-ARI	1.67	42.81	42.98	42.98	43.02	0.026372	0.93	1.78	19.79	0.99
2	main us	514.27	20-ARI	2.63	42.29	42.46	42.44	42.49	0.015075	0.82	3.23	26.81	0.78
2	main us	514.27	100-ARI	3.89	42.29	42.49	42.47	42.53	0.016690	0.96	4.07	30.14	0.84
2	main us	514.27	5-ARI	1.67	42.29	42.40	42.41	42.45	0.014898	0.75	2.37	26.18	0.75
2	main us	494.27	20-ARI	2.63	41.94	42.05	42.05	42.10	0.029393	1.00	2.82	26.15	1.05
2	main us	494.27	100-ARI	3.89	41.94	42.08	42.08	42.15	0.024451	1.10	2.53	26.78	1.00
2	main us	494.27	5-ARI	1.67	41.94	42.09	42.09	42.07	0.028303	0.85	2.90	27.76	0.99
2	main us	474.27	20-ARI	2.63	41.90	41.77	41.64	41.78	0.002568	0.53	4.82	21.91	0.36
2	main us	474.27	100-ARI	3.89	41.90	41.63	41.68	41.85	0.002680	0.52	6.29	23.16	0.38
2	main us	474.27	5-ARI	1.67	41.90	41.71	41.61	41.72	0.002448	0.45	3.73	20.80	0.34
2	main us	454.27	20-ARI	2.63	41.48	41.63	41.63	41.69	0.022730	1.11	2.37	18.05	0.98
2	main us	454.27	100-ARI	3.89	41.48	41.66	41.66	41.75	0.022783	1.28	3.05	18.88	1.00
2	main us	454.27	5-ARI	1.67	41.48	41.59	41.59	41.64	0.019975	0.98	1.70	17.18	1.00
2	main us	434.27	20-ARI	2.63	41.00	41.25	41.19	41.23	0.008932	0.81	2.80	14.42	0.64
2	main us	434.27	100-ARI	3.89	41.00	41.50	41.24	41.36	0.009413	1.06	3.16	15.74	0.70
2	main us	434.27	5-ARI	1.67	41.00	41.07	41.14	41.43	0.035496	2.68	0.82	10.63	3.93
2	main us	414.27	20-ARI	2.63	40.81	41.09	41.04	41.12	0.038406	0.79	3.39	20.14	0.62
2	main us	414.27	100-ARI	3.89	40.81	41.17	41.08	41.20	0.035107	0.76	5.10	22.31	0.51
2	main us	414.27	5-ARI	1.67	40.81	41.03	41.00	41.06	0.012395	0.76	2.13	18.70	0.71
2	main us	394.27	20-ARI	2.63	40.50	41.02	40.69	41.05	0.000139	0.10	8.76	24.67	0.16
2	main us	394.27	100-ARI	3.89	40.50	41.13	40.73	41.14	0.000435	0.33	11.67	27.84	0.16
2	main us	394.27	5-ARI	1.67	40.50	40.92	40.64	40.95	0.000402	0.25	6.52	21.77	0.15
2	main us	375											
2	main us	354.27	20-ARI	2.63	40.00	40.21	40.21	40.27	0.023876	1.17	2.25	16.87	1.01
2	main us	354.27	100-ARI	3.89	40.00	40.25	40.25	40.33	0.022372	1.27	3.07	18.99	1.01
2	main us	354.27	5-ARI	1.67	40.00	40.16	40.16	40.22	0.024605	1.04	1.60	14.27	0.99
2	main us	314.27	20-ARI	2.63	38.70	38.83	38.41	38.83	0.000228	0.27	9.07	20.49	0.12
2	main us	314.27	100-ARI	3.89	38.20	38.90	38.45	38.81	0.000322	0.34	11.47	21.16	0.15
2	main us	314.27	5-ARI	1.67	38.20	38.76	38.37	38.76	0.000117	0.20	8.51	19.60	0.10
2	main us	294.27	20-ARI	2.63	38.20	38.82	38.43	38.81	0.000204	0.24	10.74	20.02	0.11
2	main us	294.27	100-ARI	3.89	38.20	38.99	38.46	38.90	0.000285	0.31	12.44	23.70	0.14
2	main us	294.27	5-ARI	1.67	38.20	38.75	38.39	38.73	0.000132	0.18	9.19	22.38	0.09
2	main us	274.27	20-ARI	2.63	38.20	38.82	38.41	38.82	0.000241	0.25	10.44	24.31	0.12
2	main us	274.27	100-ARI	3.89	38.20	38.99	38.45	38.89	0.000335	0.32	12.20	27.36	0.15
2	main us	274.27	5-ARI	1.67	38.20	38.75	38.35	38.73	0.000157	0.19	8.84	22.02	0.10
1	main ds	240.00	20-ARI	4.66	36.90	38.70	38.70	38.80	0.021844	1.38	3.38	16.13	1.02
1	main ds	240.00	100-ARI	6.44	36.90	38.75	38.75	38.87	0.020011	1.51	4.28	18.75	1.01
1	main ds	240.00	5-ARI	3.21	38.50	38.66	38.66	38.74	0.022630	1.22	2.94	17.54	1.00
1	main ds	220.00	20-ARI	4.66	36.00	38.32	38.17	38.34	0.002484	0.53	7.37	24.81	0.37
1	main ds	220.00	100-ARI	6.44	36.00	38.39	38.21	38.42	0.001380	0.70	9.17	25.51	0.37
1	main ds	220.00	5-ARI	3.21	38.00	38.26	38.19	38.27	0.000471	0.55	5.84	24.14	0.36
1	main ds	200.00	20-ARI	4.66	37.88	38.14	38.14	38.25	0.021618	1.46	3.19	15.46	1.03
1	main ds	200.00	100-ARI	6.44	37.88	38.19	38.19	38.32	0.019797	1.58	4.07	16.45	1.01
1	main ds	200.00	5-ARI	3.21	37.88	38.09	38.09	38.18	0.022453	1.30	2.48	14.61	1.01
1	main ds	180.00	20-ARI	4.66	37.32	37.57	37.55	37.63	0.012889	0.89	4.72	26.08	0.77
1	main ds	180.00	100-ARI	6.44	37.32	37.55	37.58	37.66	0.044190	1.63	3.94	27.74	1.38
1	main ds	180.00	5-ARI	3.21	37.32	37.53	37.52	37.57	0.014889	0.69	3.59	27.59	0.75
1	main ds	160.00	20-ARI	4.66	36.98	37.20	37.20	37.28	0.003917	1.25	3.72	24.67	1.03
1	main ds	160.00	100-ARI	6.44	36.98	37.24	37.24	37.31	0.002833	1.37	4.70	26.04	1.03
1	main ds	160.00	5-ARI	3.21	36.98	37.17	37.15	37.23	0.020195	1.04	3.08	21.66	0.92
1	main ds	140.00	20-ARI	4.66	36.50	36.82	36.76	36.86	0.009147	0.90	5.19	27.45	0.68
1	main ds	140.00	100-ARI	6.44	36.50	36.89	36.81	36.87	0.006001	0.87	7.43	30.25	0.56
1	main ds	140.00	5-ARI	3.21	36.50	36.72	36.72	36.79	0.024582	1.14	2.02	21.93	1.01
1	main ds	120.00	20-ARI	4.66	36.03	36.75	36.35	36.75	0.003656	0.30	15.61	37.64	0.15
1	main ds	120.00	100-ARI	6.44	36.03	36.85	36.40	36.86	0.000326	0.33	19.51	37.68	0.15
1	main ds	120.00	5-ARI	3.21	36.03	36.41	36.31	36.44	0.004408	0.67	4.80	22.97	0.47
1	main ds	100.00	20-ARI	4.66	36.00	36.74	36.26	36.75	0.000244	0.30	15.60	28.16	0.13
1	main ds	100.00	100-ARI	6.44	36.00	36.85	36.31	36.85	0.000270	0.35	18.52	28.62	0.14
1	main ds	100.00	5-ARI	3.21	36.00	36.31	36.21	36.31	0.005185	0.74	4.35	20.76	0.51
1	main ds	80.00	20-ARI	4.66	35.74	36.74	36.14	36.74	0.000173	0.31	22.32	53.05	0.11
1	main ds	80.00	100-ARI	6.44	35.74	36.84	36.19	36.85	0.000200	0.37	26.75	53.05	0.13

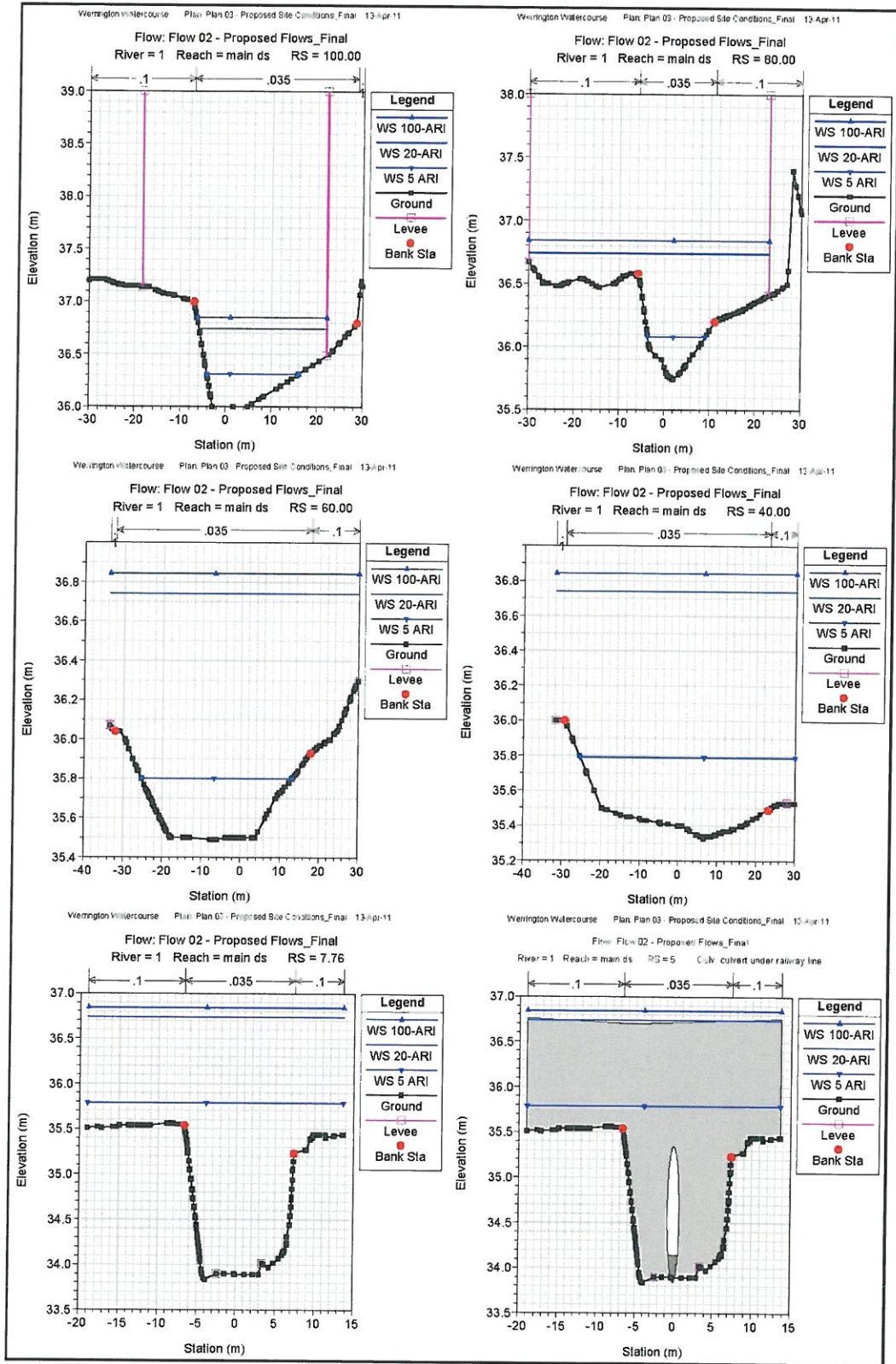


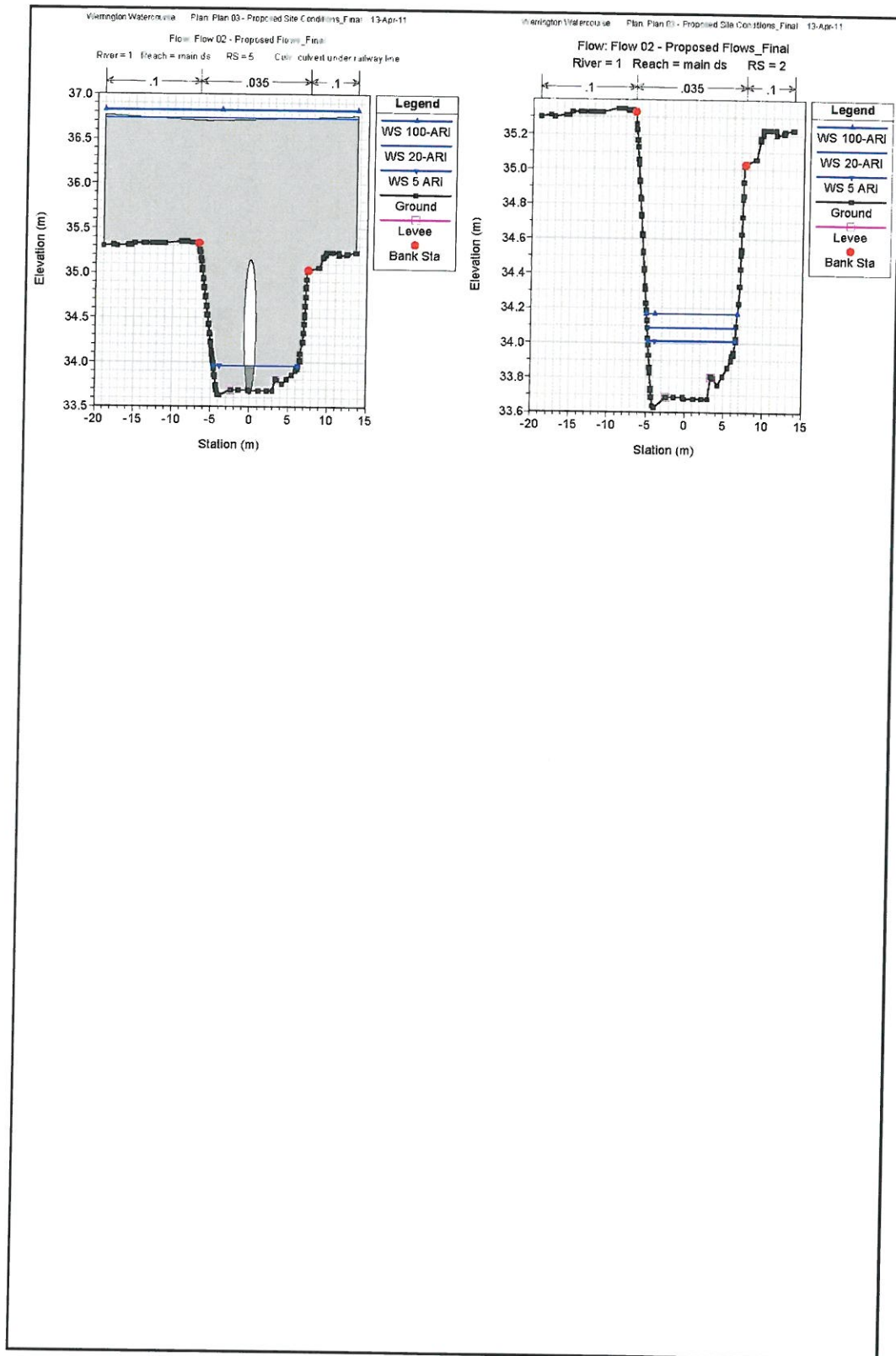






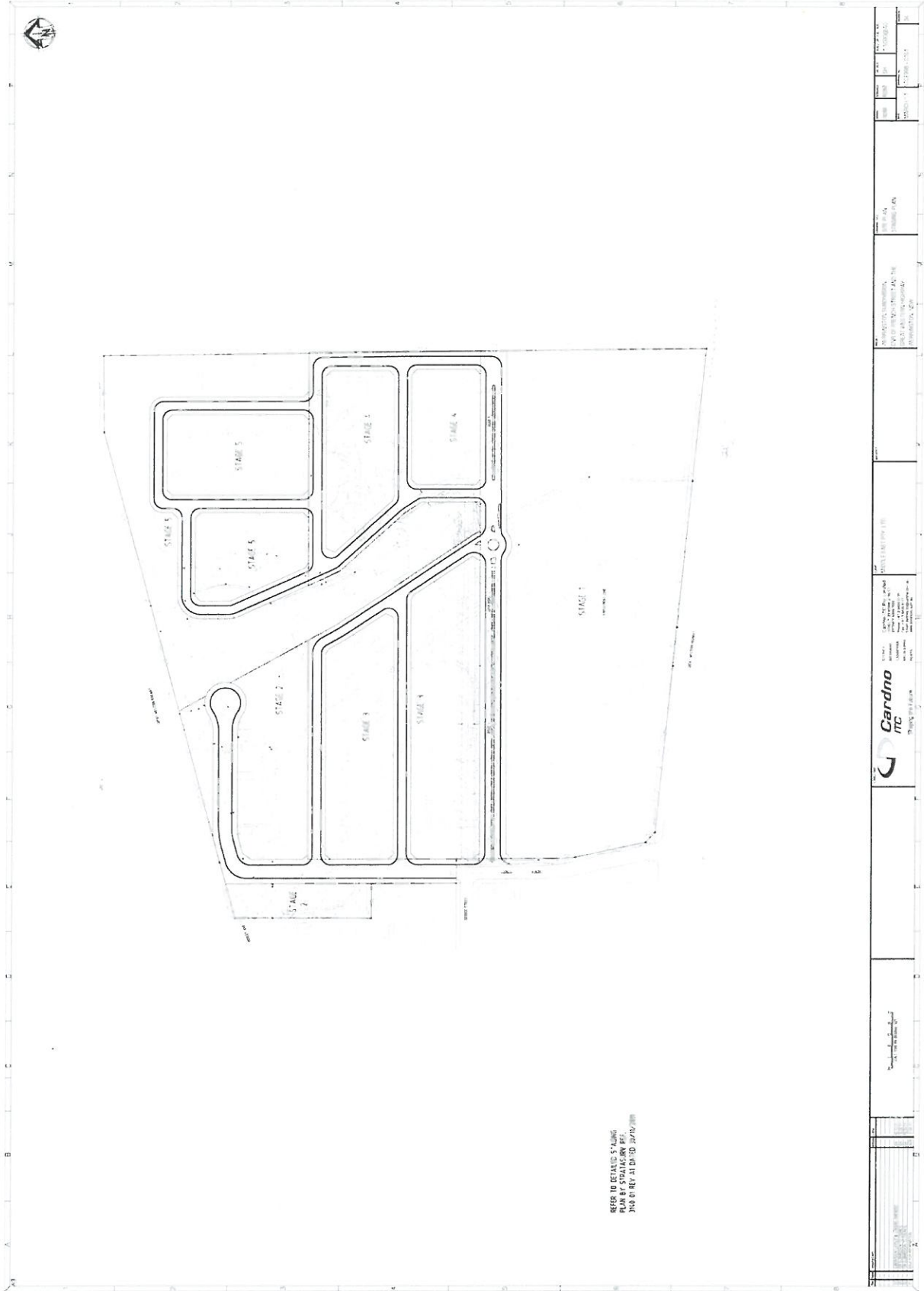


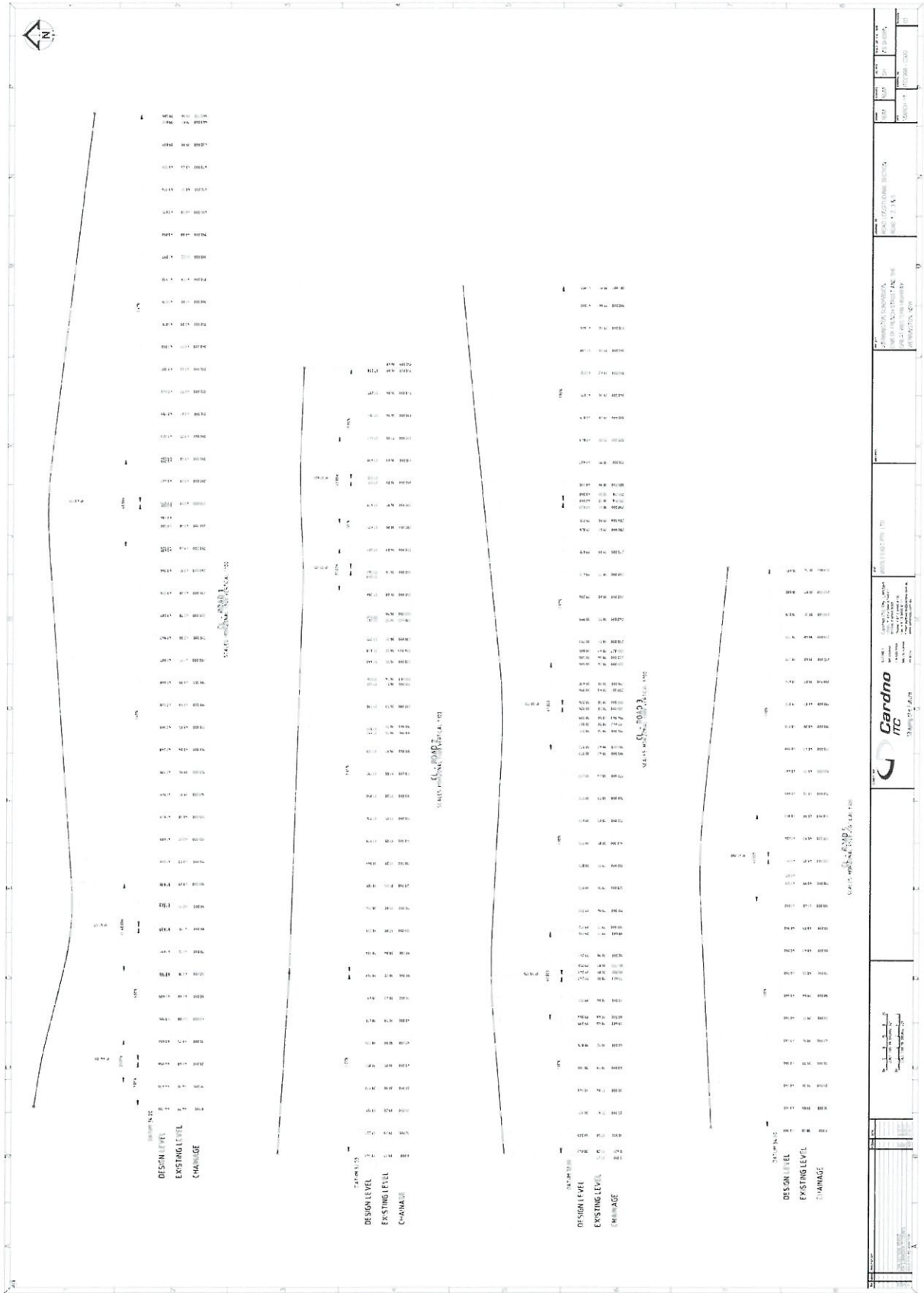


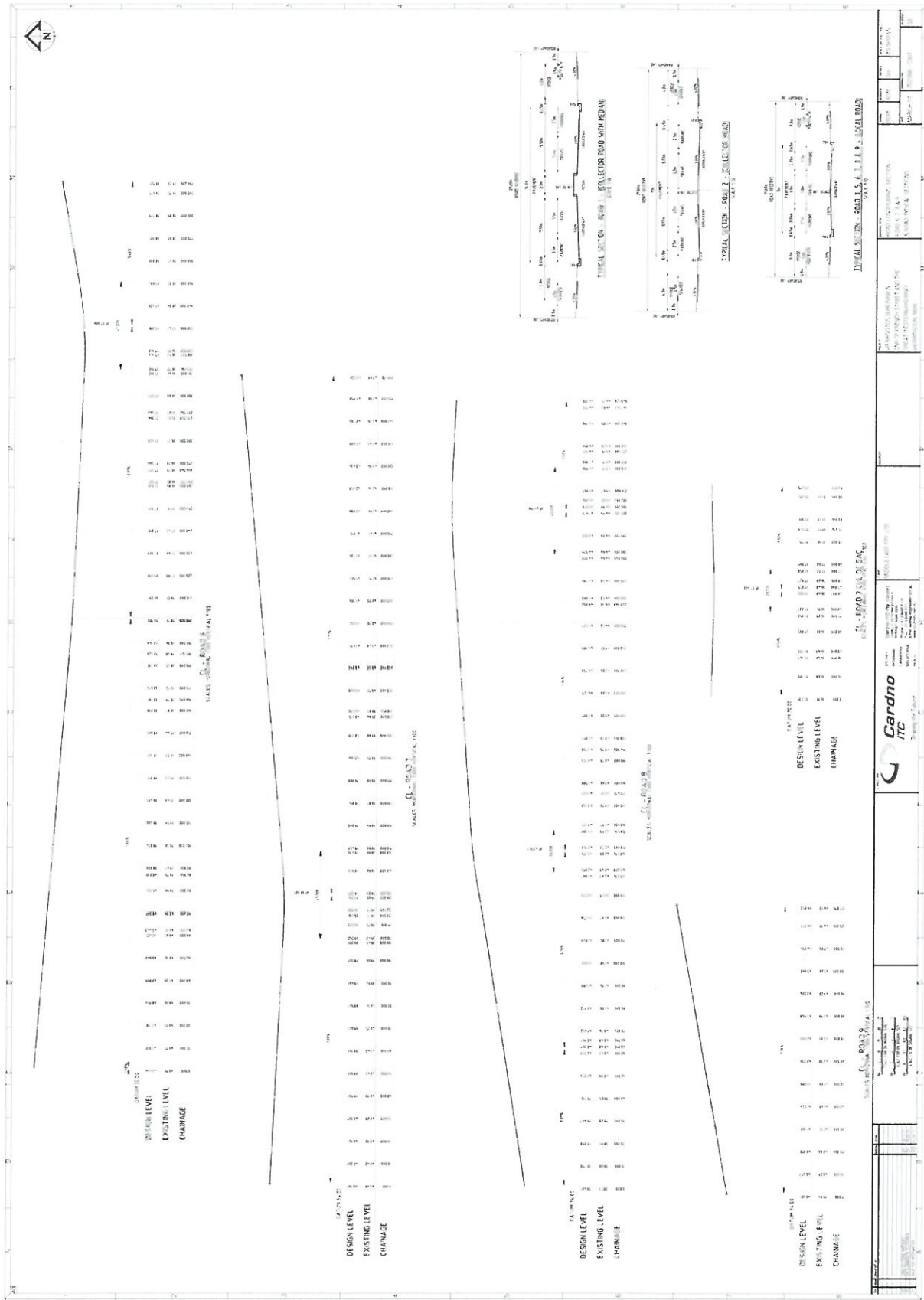


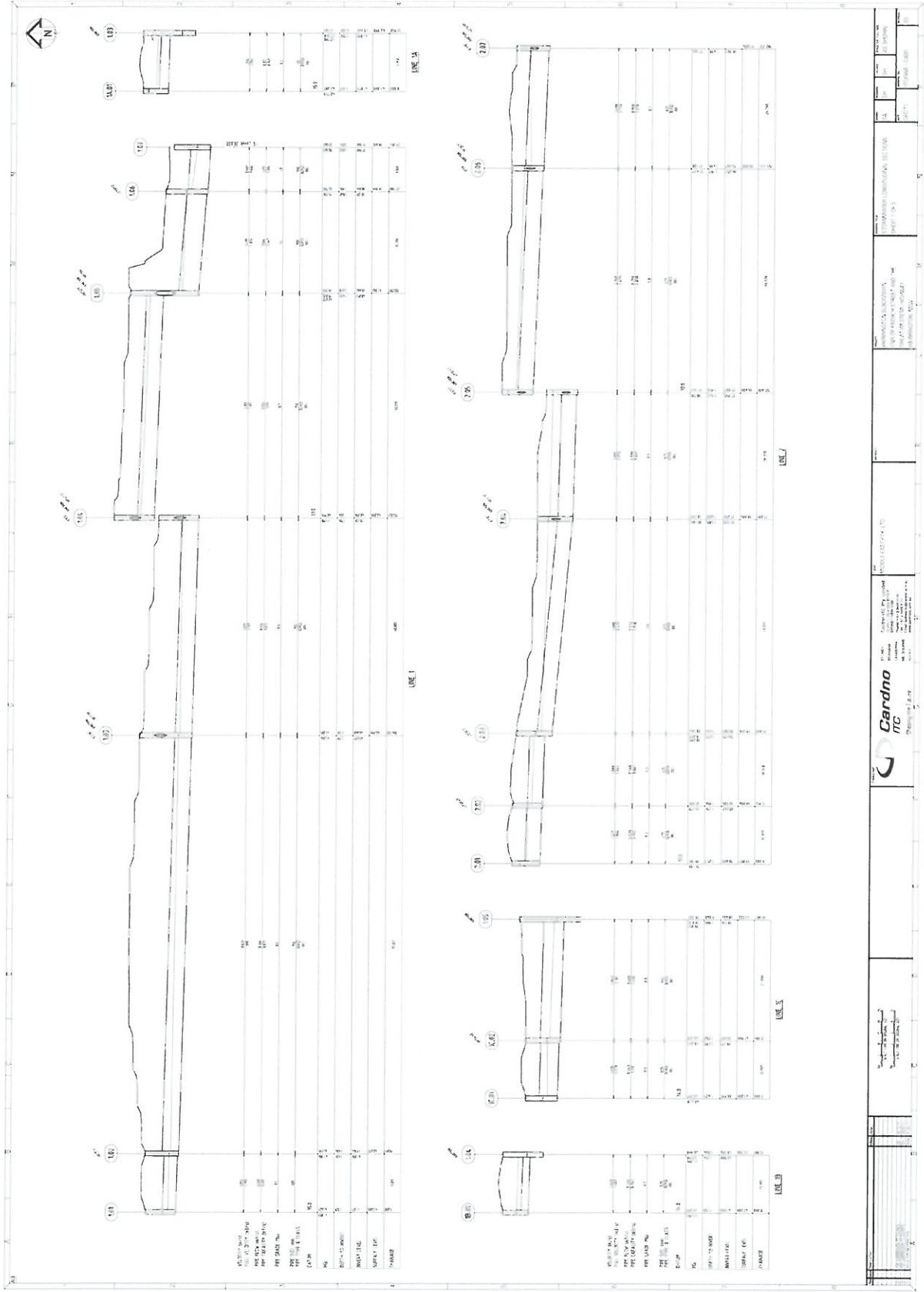
APPENDIX 6

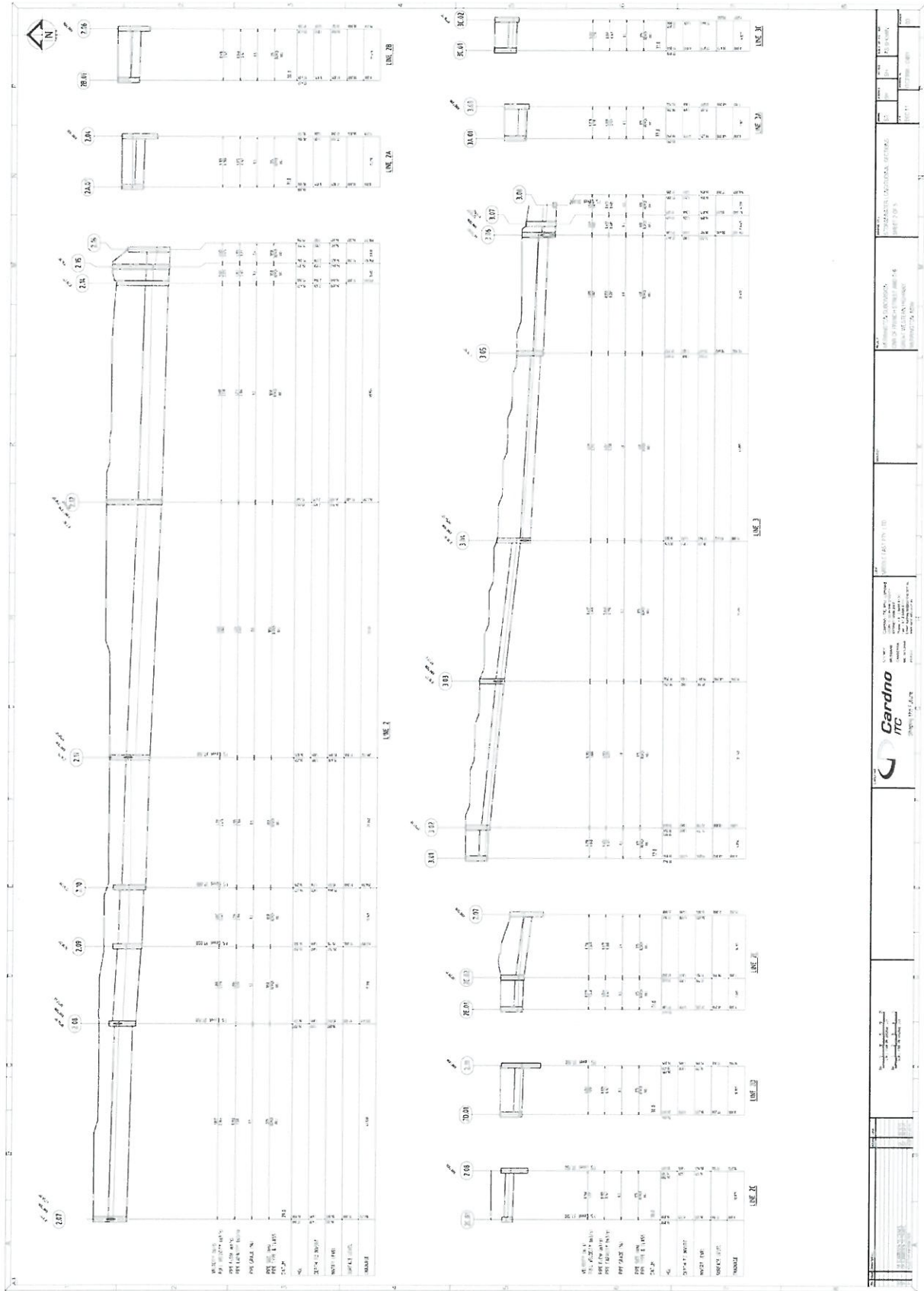
Design Drawings

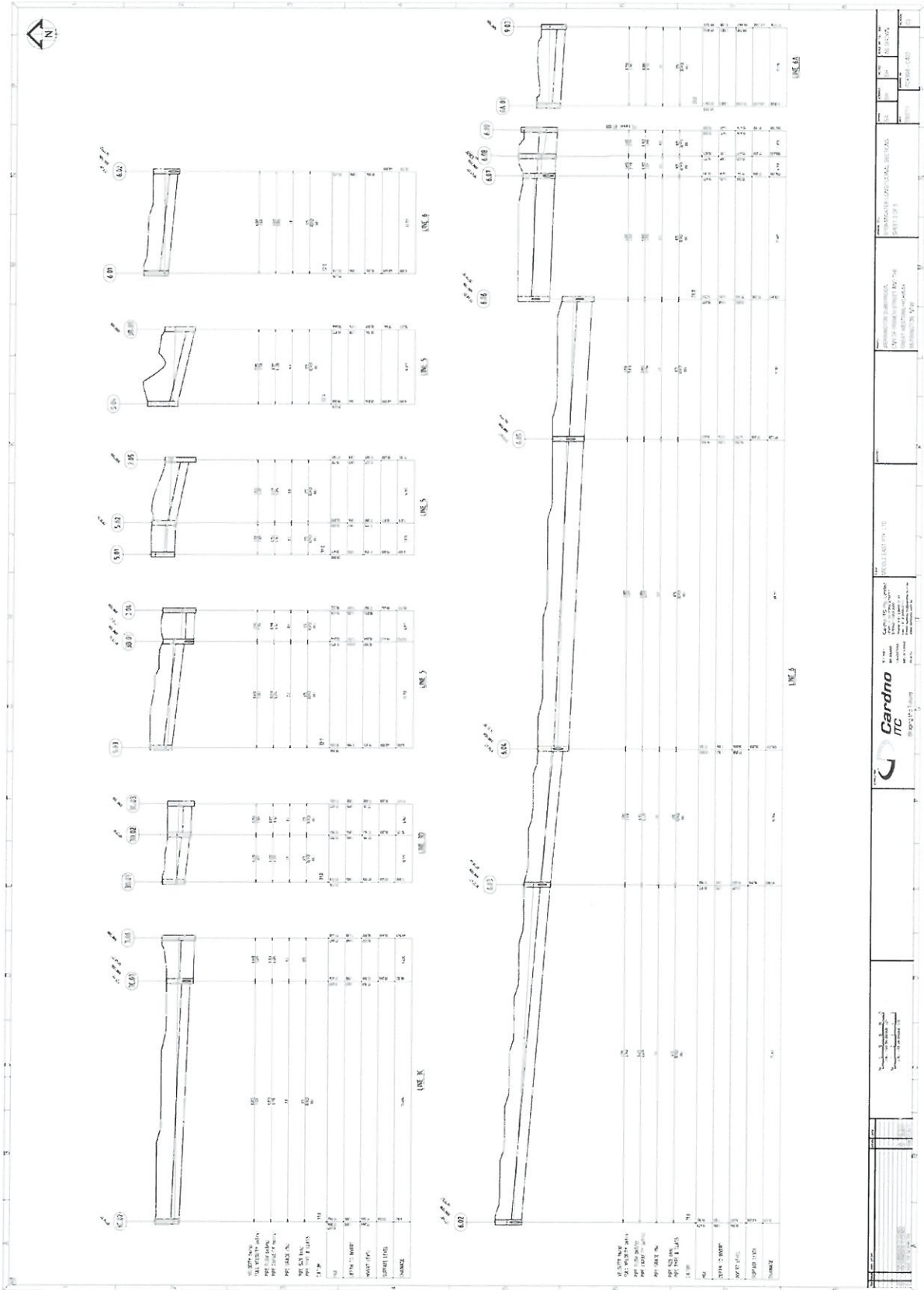


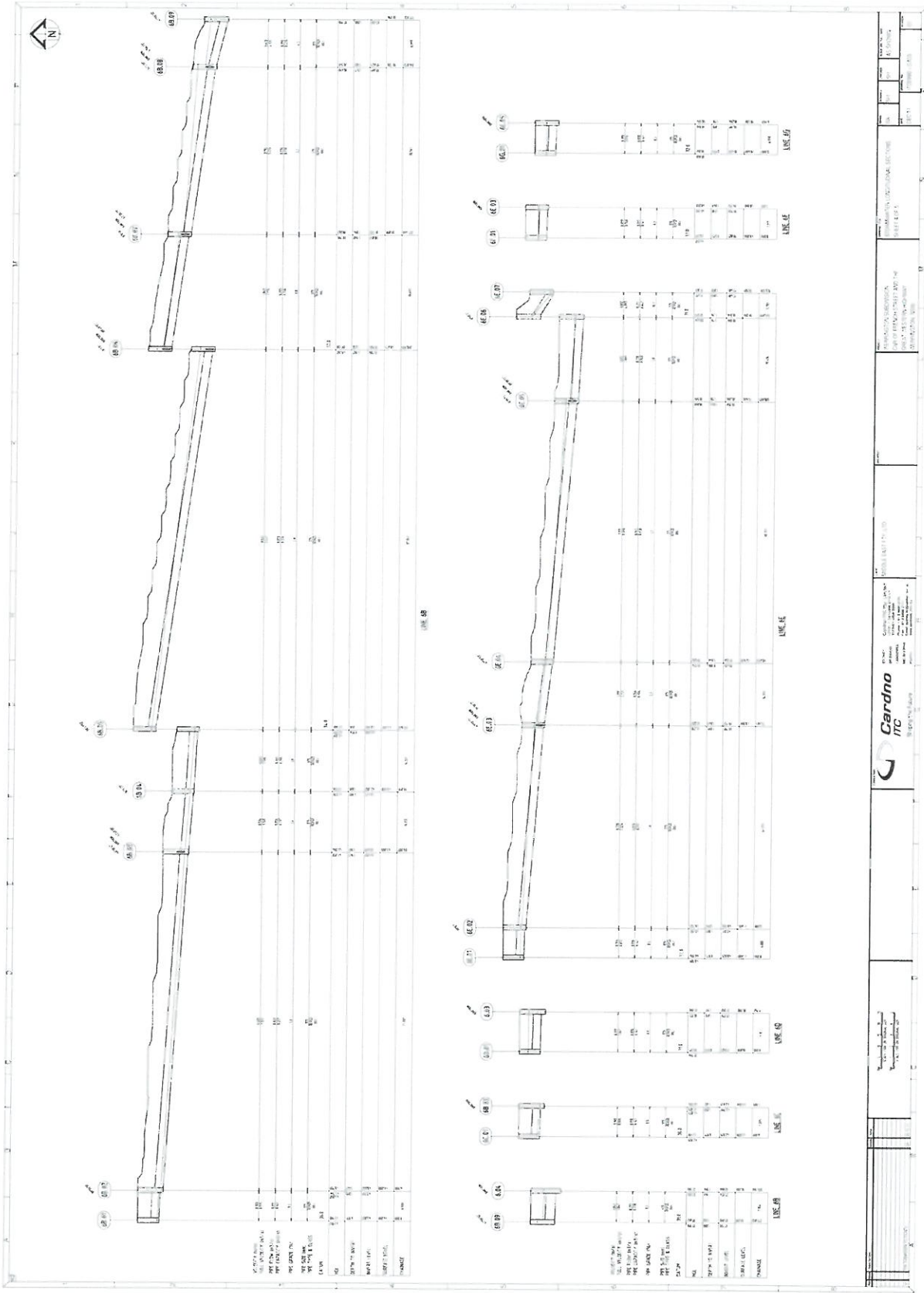


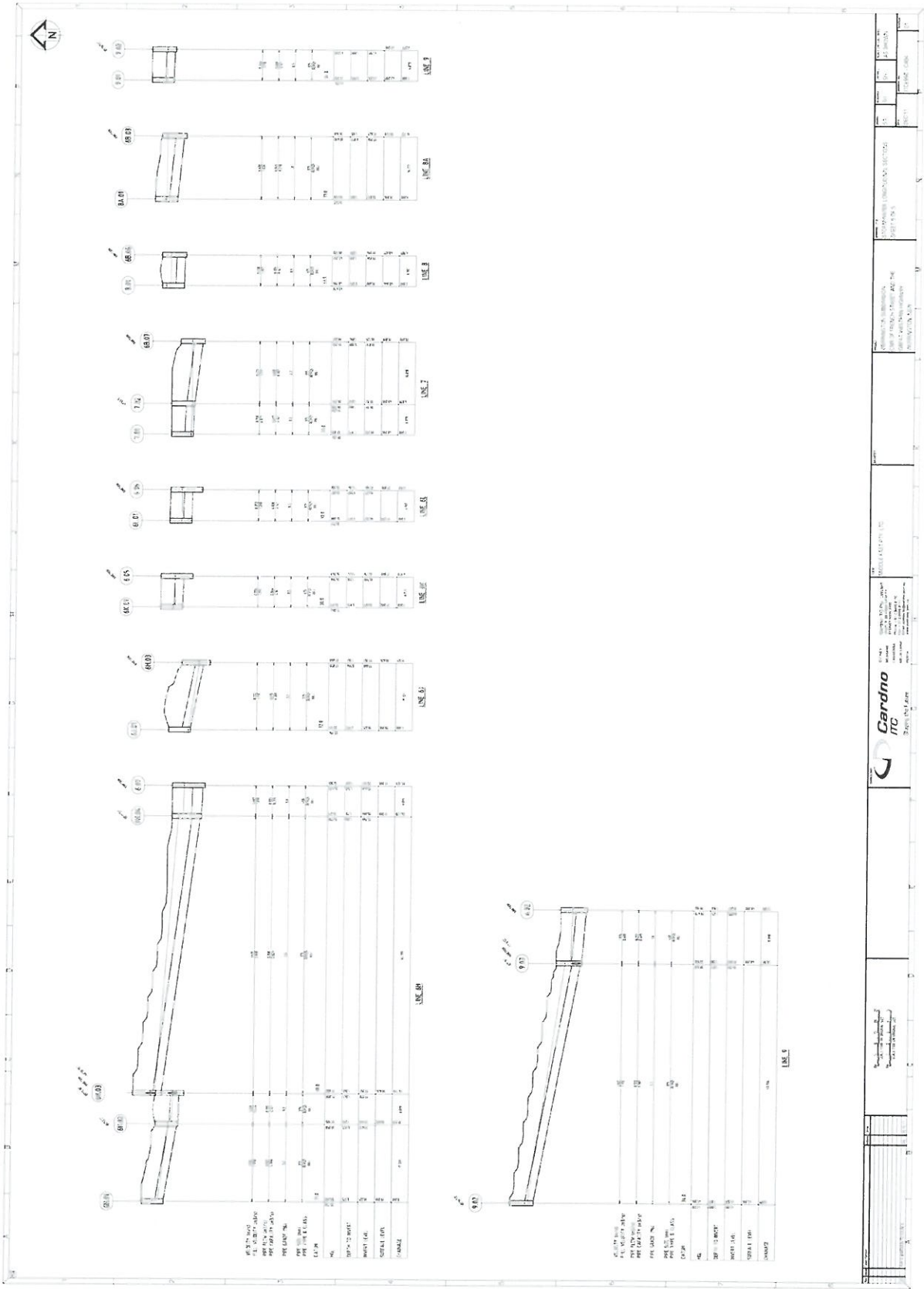






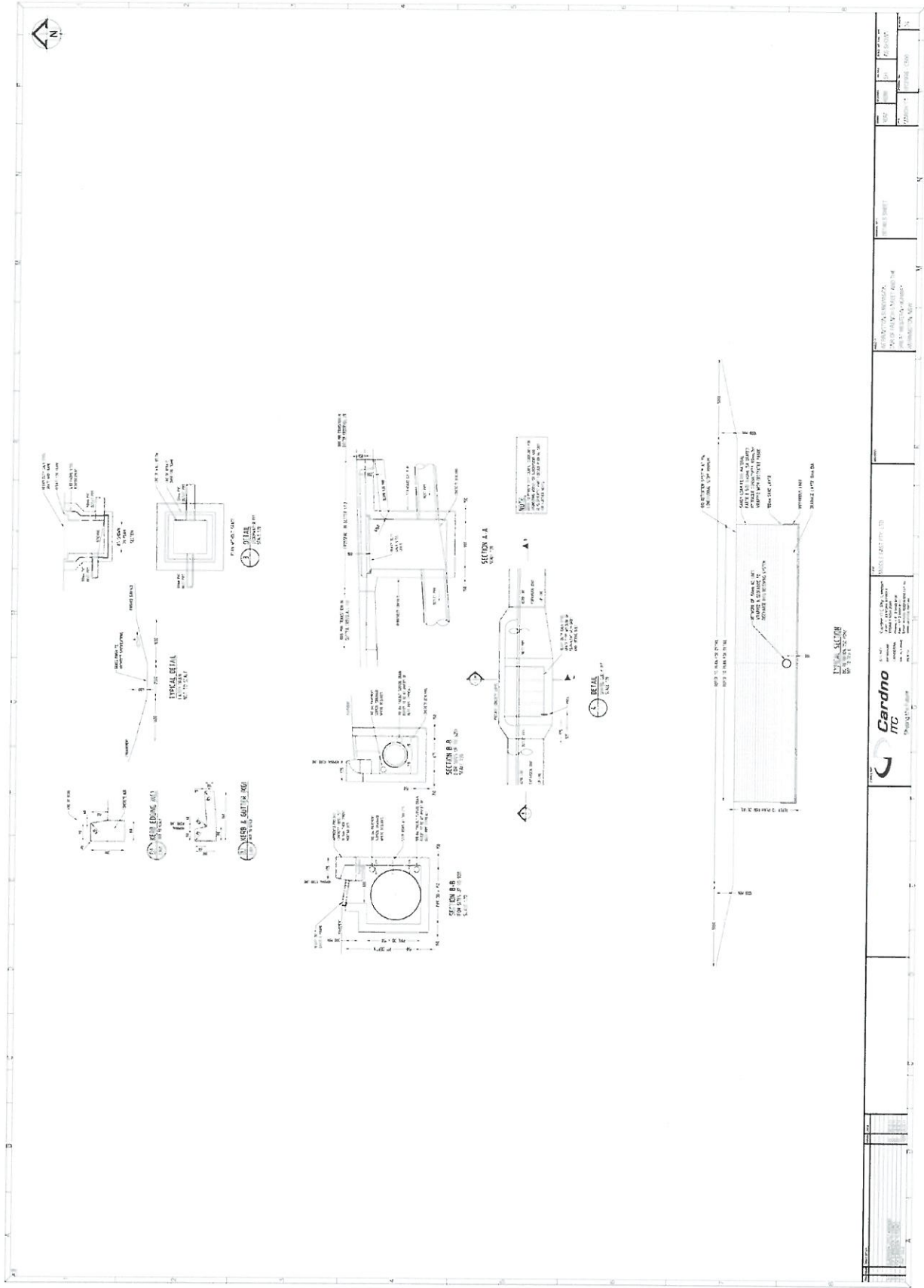






Project: French Street & Great Western Highway
 Drawing: CIVIL - FLOODING & STORMWATER MANAGEMENT
 Revision: A6

Cardno ITC
 100 St Johns Street, Perth WA 6000
 Ph: (08) 9447 1000
 Fax: (08) 9447 1001
 Email: info@cardno.com.au



APPENDIX 7

Authorities Correspondence

Office of Hawkesbury and Nepean

From: Greg Brady [mailto:Greg.Brady@ohn.nsw.gov.au] **Sent:** Tuesday, 25 January 2011 9:21 AM **To:** Sam Haddad (Cardno ITC) **Subject:** Re: Werrington Subdivision masterplan (Office ref:10erm11-74)

Hi Sam,

I've had the time now to have a quick look at the Werrington Kingswood site plans you supplied.

In principle I think it is close to the Offices requirements. However the following is needed:

- (1). The watercourse is a category 2 so it needs to have 20m riparian width each side of the top of bank of the watercourse.
- (2). It is unclear where the watercourse goes under the rail line. Currently it looks like it flows along the line towards the west (to Morley Av??). This needs to be clearer. If it actually goes under the rail line in a direct line (or east which you are protecting) then this is not an issue.
- (3). It would appear that you have not left space for any water quality or quantity basins/structures. These should not be in the riparian area.
- (4). I understand that there may be a new railway station, is this still occurring as that may impact upon the watercourse and the footprint of the development?
- (4). Removal of any current works in the watercourse riparian area should be OK with adequate environmental protection, but will need a controlled activity approval. It is best to do this via integrated development.

I suggest you modify the masterplan to address issues (1) to (3) above and then we can give an in-principle support.

Regards Greg

Greg Brady Natural Resource Officer Office of Hawkesbury Nepean
Level 4, 2-6 Station Street
(PO Box 323)
PENRITH NSW 2751
Phone direct 4729 8134
Phone general 4729 8138 Fax 4729 8141
Visit our new website at www.ohn.nsw.gov.au

Penrith City Council



Our Ref: PL 10/0089
Contact: Schandel Jefferys
Telephone: (02) 4732 8125

29 July 2010

Demlan Constructions Pty Ltd
Angus MacInnes
7 Charles Street
PARRAMATTA NSW 2150

Dear Angus

**Pre-Lodgement Meeting
Cnr French and Great Western Highway Kingswood**

We welcome your initiative to commence your project in Penrith Local Government Area.

Thank you for participating in Council's pre-lodgement meeting on 20 July 2010. We consider that the pre-lodgement process will assist in determination of your proposal. The attached advice will assist you in preparing your development application.

Further to our most recent meeting, Council officers would like to confirm that the preferred approach to this subdivision is to proceed with an application once the Stage 2 Local Environmental Plan (LEP) has been gazetted. The proposals discussed at the pre-lodgement meeting present some permissibility issues which are likely to be resolved under the Stage 2 LEP. Proceeding under the current planning controls may not result in the best planning outcome.

Council provides competitive services in *Certification of Development*. If you need to enquire about *Construction Certificates* and *Principal Certifying Authority* matters please contact Colin Wood, Building Approvals Co-ordinator on (02) 4732 8083.

If you require any further assistance regarding the attached advice please contact me on (02) 4732 8125.

Yours faithfully

Schandel Jefferys
Principal Planner



**** Please note: the attached advice is to assist you with your development proposal. It is not a full assessment of the proposal. Council's full assessment and determination can only be made after lodgement of the development application. The applicant is responsible to address all Council's requirements if a development application is lodged.*

Tel: (02) 4732 7777 • Fax: (02) 4732 7958 • Civic Centre, 601 High Street, Penrith NSW 2750
DX 8917 Penrith • PO Box 60, Penrith NSW 2751 • Email: penrith@penrith.nsw.gov.au

Pre – Lodgement Advice	
Date of Issue	29 July 2010
Pre- Lodgement Number	PL 10/0089
Proponent	Demlan Constructions Pty Ltd
Proposal	Proposed masterplan comprising residential subdivision, employment land, road network, transport interchange and drainage/conservation corridor.
Address	Lot 50, 55, 58, 57 and 56 DP 1069025 Lot 50 French Street Werrington
Development Type	Integrated Development
Permissibility	<p>The land is partly zoned 5A Special Uses, 10A Mixed Use – Residential and 10B Special Uses – Employment under Penrith Local Environmental Plan (LEP) 1998 Urban Land. The land is to be included in Council's Stage 2 LEP 2010.</p> <p>Residential subdivision is not permitted in the 10B and 5A zones. Components of the proposal would not be permitted under current zoning regulations.</p> <p>Sydney Regional Environmental Plan 20 (Hawkesbury Nepean River) and Penrith Development Control Plan 2007 – Werrington Mixed Use Area apply to the land.</p>
Site Constraints	<p>The site is affected by:</p> <ul style="list-style-type: none"> • drainage easement • services easement • water supply easement • bushfire prone • covenant.
General Requirements	<p>The Statement of Environmental Effects must include:</p> <ul style="list-style-type: none"> • a detailed description of the proposal • consideration of relevant statutory provisions, particularly, section 79C of the Environmental Planning and Assessment Act 1979 • consideration of other relevant matters listed on the <i>Application Information Sheet</i> attached with this advice • a detailed assessment of the key issues specified below.
Key Issues	<p>Proposed Future Railway Station</p> <p>As discussed at the pre-lodgement meeting the state government has placed plans for a future railway station on</p>

	<p>hold. The design should be amended to reflect this change as a transport interchange is no longer required.</p> <p>Well Precinct and strategic issues</p> <ul style="list-style-type: none"> • The university precinct is currently working on a Masterplan. The site forms part of the Well Precinct. It is envisaged that the site will form part of a larger high tech development precinct or a small business park. • The zones will be translated into the new LEP template zones however, the exact zones have not yet been determined. • Council would not support rezoning employment land to residential. • Consideration may be given to reduce densities across the site as a result of the station interchange not proceeding. <p>Subdivision design</p> <ul style="list-style-type: none"> • Proposed future residential development along the Great Western Highway is not supported. This part of the site will form part of the future small business park or high tech park and therefore residential development on the eastern side of the vegetation corridor would sever this land use pattern and is not suitable. • The residential development along the Great Western Highway is also not supported due to the low level of residential amenity for this land resulting mainly from potential noise impacts. • Back fences along any areas of open space are not desirable. Dwelling design is to allow passive surveillance of open space. • The application is to demonstrate how the subdivision layout has been designed to consider how each lot can be developed for residential purposes. This is to include setbacks, private open space, aspect, car parking and landscaping. This is particularly relevant on sloping land • The subdivision layout is to provide land that can be developed in future with minimal need for cut and fill. <p>Local Environmental Plan (LEP) and Permissibility</p> <ul style="list-style-type: none"> • The proposal is to comply with all relevant requirements of LEP 1998 Urban Land and the statement of environmental effects submitted with any development application will need to provide details of compliance.
--	--

WERRINGTON SUBDIVISION CNR FRENCH STREET AND THE GREAT WESTERN HIGHWAY, WERRINGTON NSW

DA SUBMISSION & MASTER PLAN

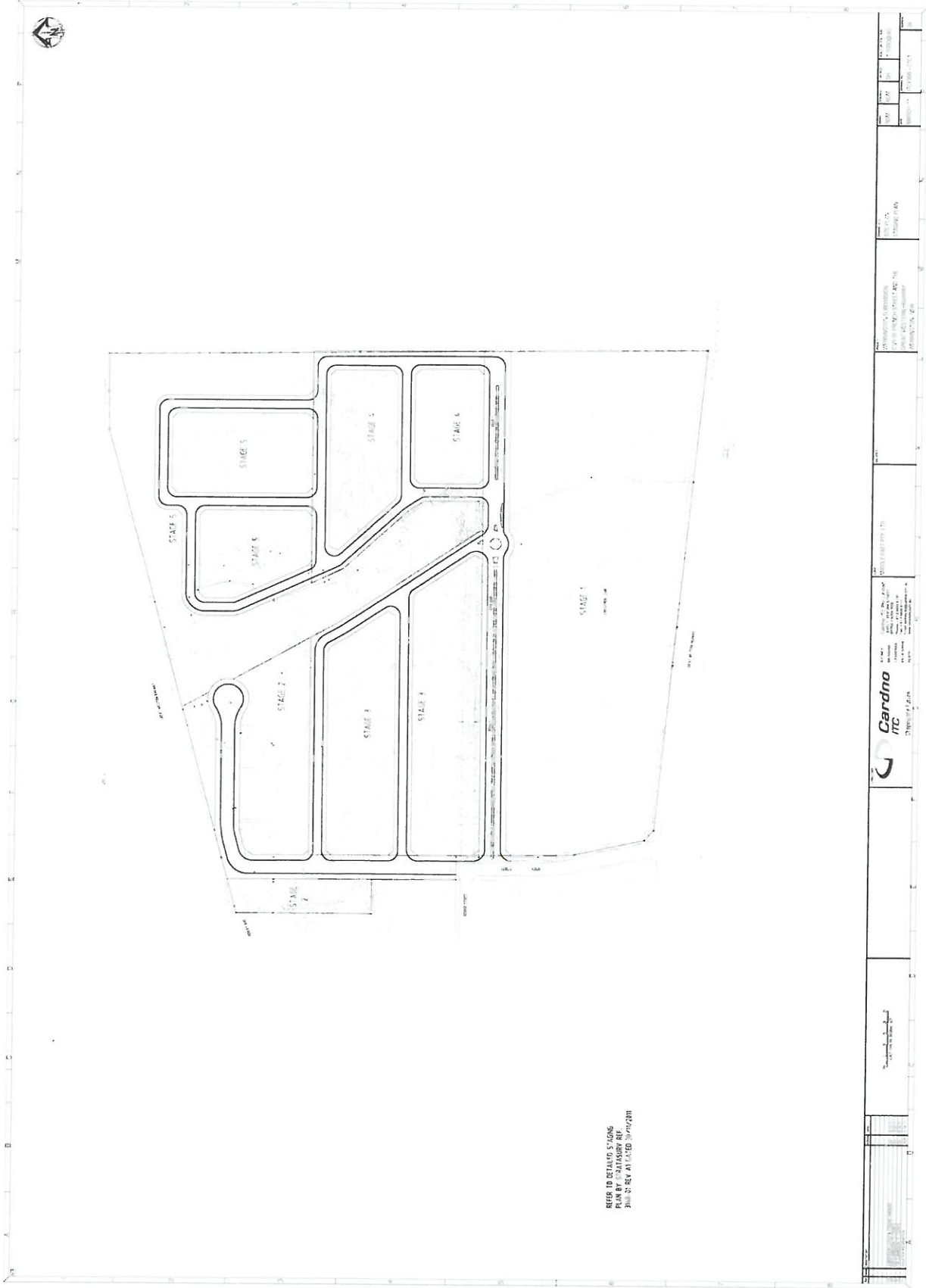


DRAWING REVISION TABLE

NO.	DATE	REVISION
01	12/11/2021	ISSUE FOR PERMIT
02	02/01/2022	ISSUE FOR PERMIT
03	02/01/2022	ISSUE FOR PERMIT
04	02/01/2022	ISSUE FOR PERMIT
05	02/01/2022	ISSUE FOR PERMIT
06	02/01/2022	ISSUE FOR PERMIT
07	02/01/2022	ISSUE FOR PERMIT
08	02/01/2022	ISSUE FOR PERMIT
09	02/01/2022	ISSUE FOR PERMIT
10	02/01/2022	ISSUE FOR PERMIT
11	02/01/2022	ISSUE FOR PERMIT
12	02/01/2022	ISSUE FOR PERMIT
13	02/01/2022	ISSUE FOR PERMIT
14	02/01/2022	ISSUE FOR PERMIT
15	02/01/2022	ISSUE FOR PERMIT
16	02/01/2022	ISSUE FOR PERMIT
17	02/01/2022	ISSUE FOR PERMIT
18	02/01/2022	ISSUE FOR PERMIT
19	02/01/2022	ISSUE FOR PERMIT
20	02/01/2022	ISSUE FOR PERMIT
21	02/01/2022	ISSUE FOR PERMIT
22	02/01/2022	ISSUE FOR PERMIT
23	02/01/2022	ISSUE FOR PERMIT
24	02/01/2022	ISSUE FOR PERMIT
25	02/01/2022	ISSUE FOR PERMIT
26	02/01/2022	ISSUE FOR PERMIT
27	02/01/2022	ISSUE FOR PERMIT
28	02/01/2022	ISSUE FOR PERMIT
29	02/01/2022	ISSUE FOR PERMIT
30	02/01/2022	ISSUE FOR PERMIT
31	02/01/2022	ISSUE FOR PERMIT
32	02/01/2022	ISSUE FOR PERMIT
33	02/01/2022	ISSUE FOR PERMIT
34	02/01/2022	ISSUE FOR PERMIT
35	02/01/2022	ISSUE FOR PERMIT
36	02/01/2022	ISSUE FOR PERMIT
37	02/01/2022	ISSUE FOR PERMIT
38	02/01/2022	ISSUE FOR PERMIT
39	02/01/2022	ISSUE FOR PERMIT
40	02/01/2022	ISSUE FOR PERMIT
41	02/01/2022	ISSUE FOR PERMIT
42	02/01/2022	ISSUE FOR PERMIT
43	02/01/2022	ISSUE FOR PERMIT
44	02/01/2022	ISSUE FOR PERMIT
45	02/01/2022	ISSUE FOR PERMIT
46	02/01/2022	ISSUE FOR PERMIT
47	02/01/2022	ISSUE FOR PERMIT
48	02/01/2022	ISSUE FOR PERMIT
49	02/01/2022	ISSUE FOR PERMIT
50	02/01/2022	ISSUE FOR PERMIT

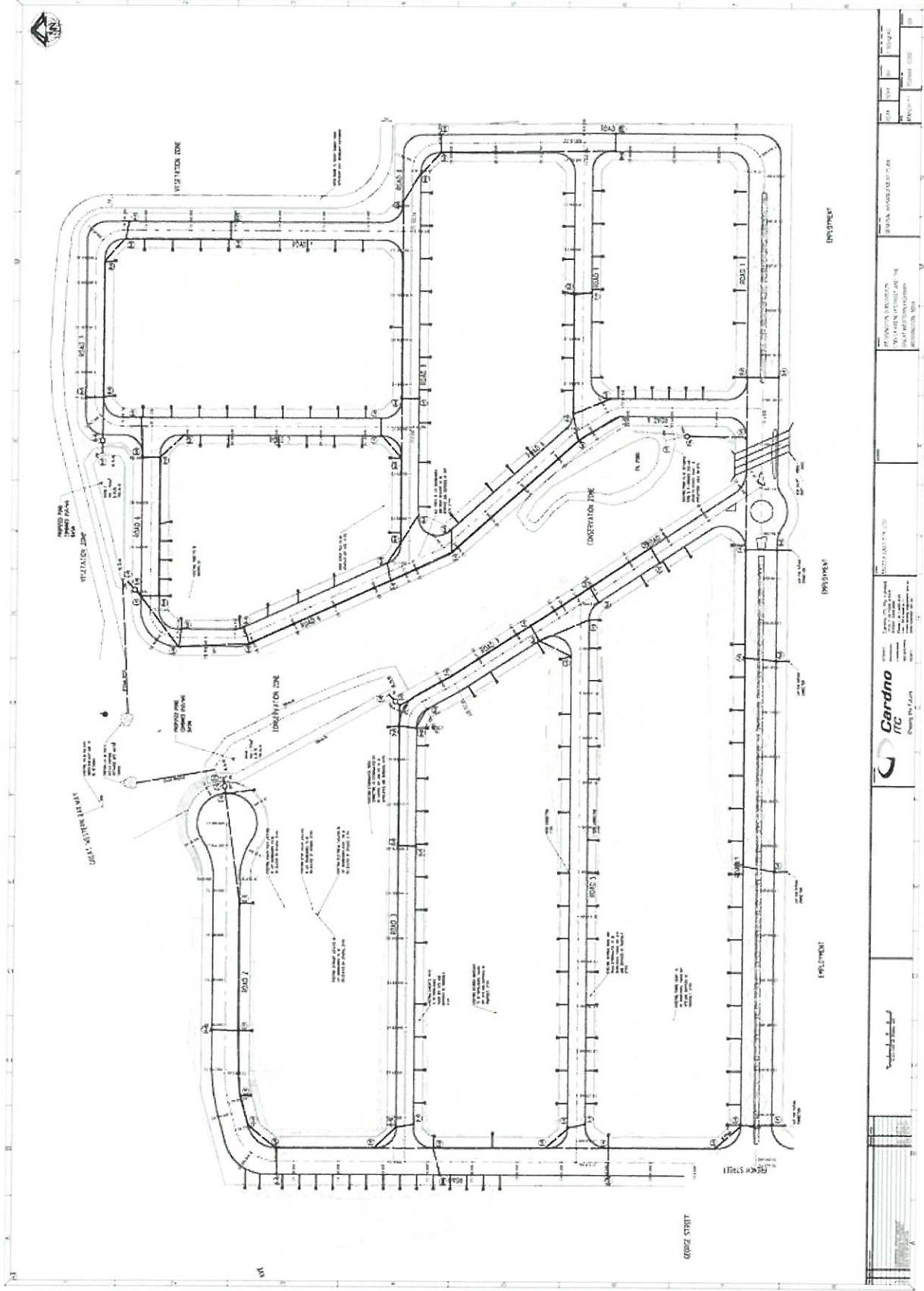


<p>Project Name: Werrington Subdivision</p> <p>Client: [Name]</p> <p>Site No: [Number]</p> <p>Scale: 1:500</p> <p>Author: [Name]</p> <p>Check: [Name]</p> <p>Drawn: [Name]</p> <p>Project No: [Number]</p> <p>Sheet No: [Number]</p> <p>Total Sheets: [Number]</p>	<p>DATE: 02/01/2022</p> <p>TIME: 10:00 AM</p> <p>PROJECT: Werrington Subdivision</p> <p>SHEET: 01 OF 01</p> <p>SCALE: 1:500</p> <p>AUTHOR: [Name]</p> <p>CHECK: [Name]</p> <p>DRAWN: [Name]</p> <p>PROJECT NO: [Number]</p> <p>SHEET NO: [Number]</p> <p>TOTAL SHEETS: [Number]</p>
--	---

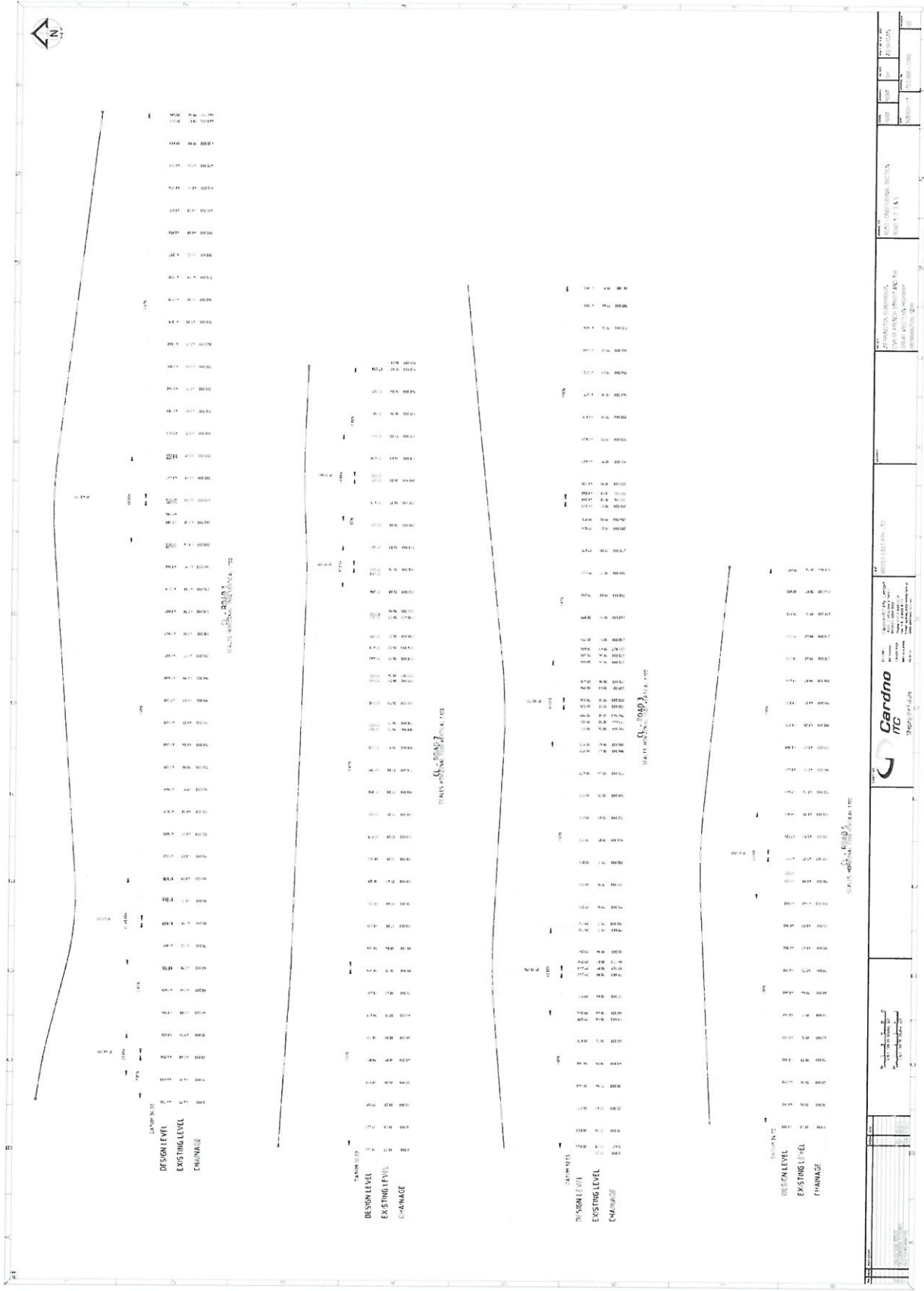


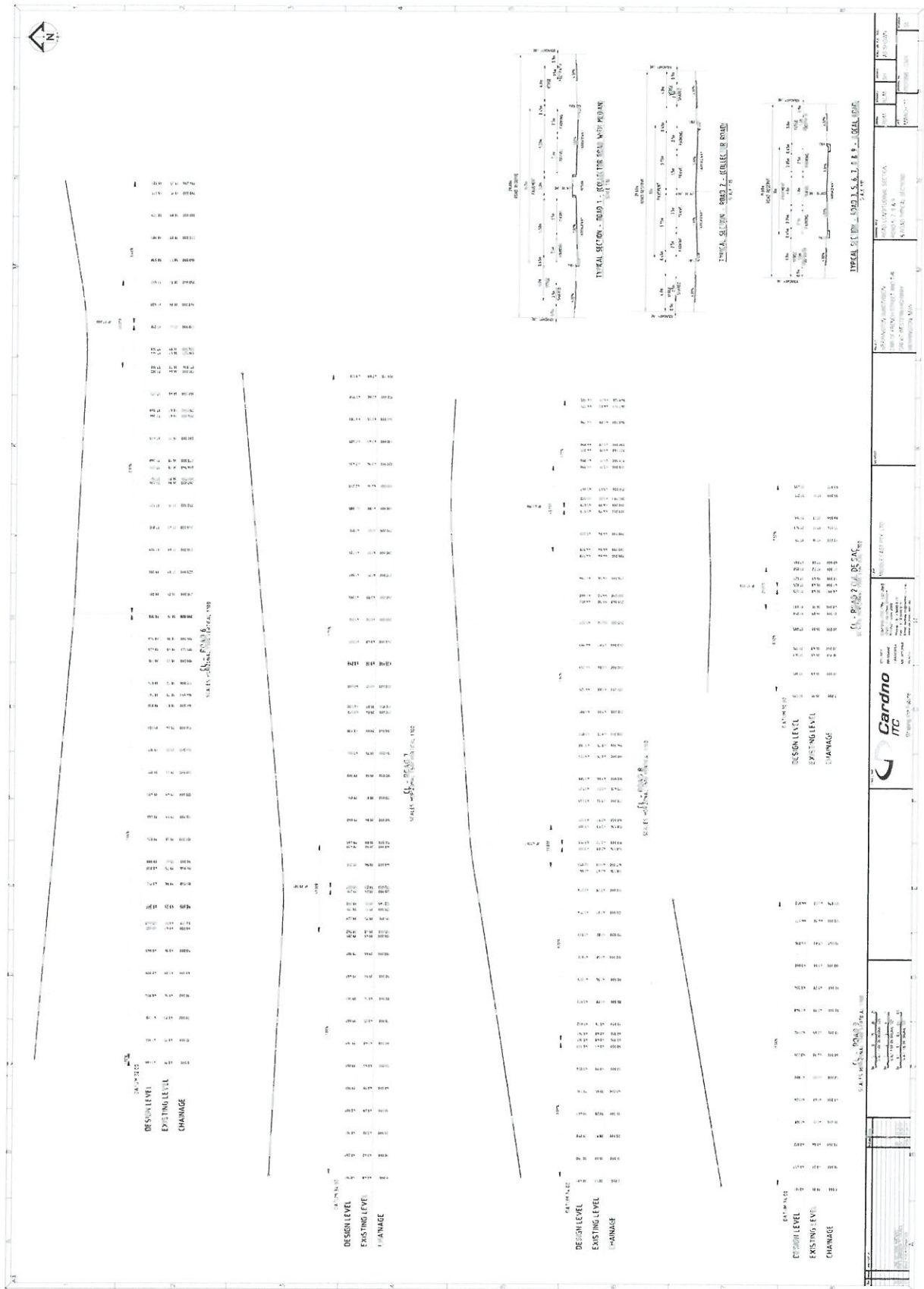
REFER TO DETAILED STAGING
PLAN BY ANTISDRW REF
JMS/STP AT 10/05/2020

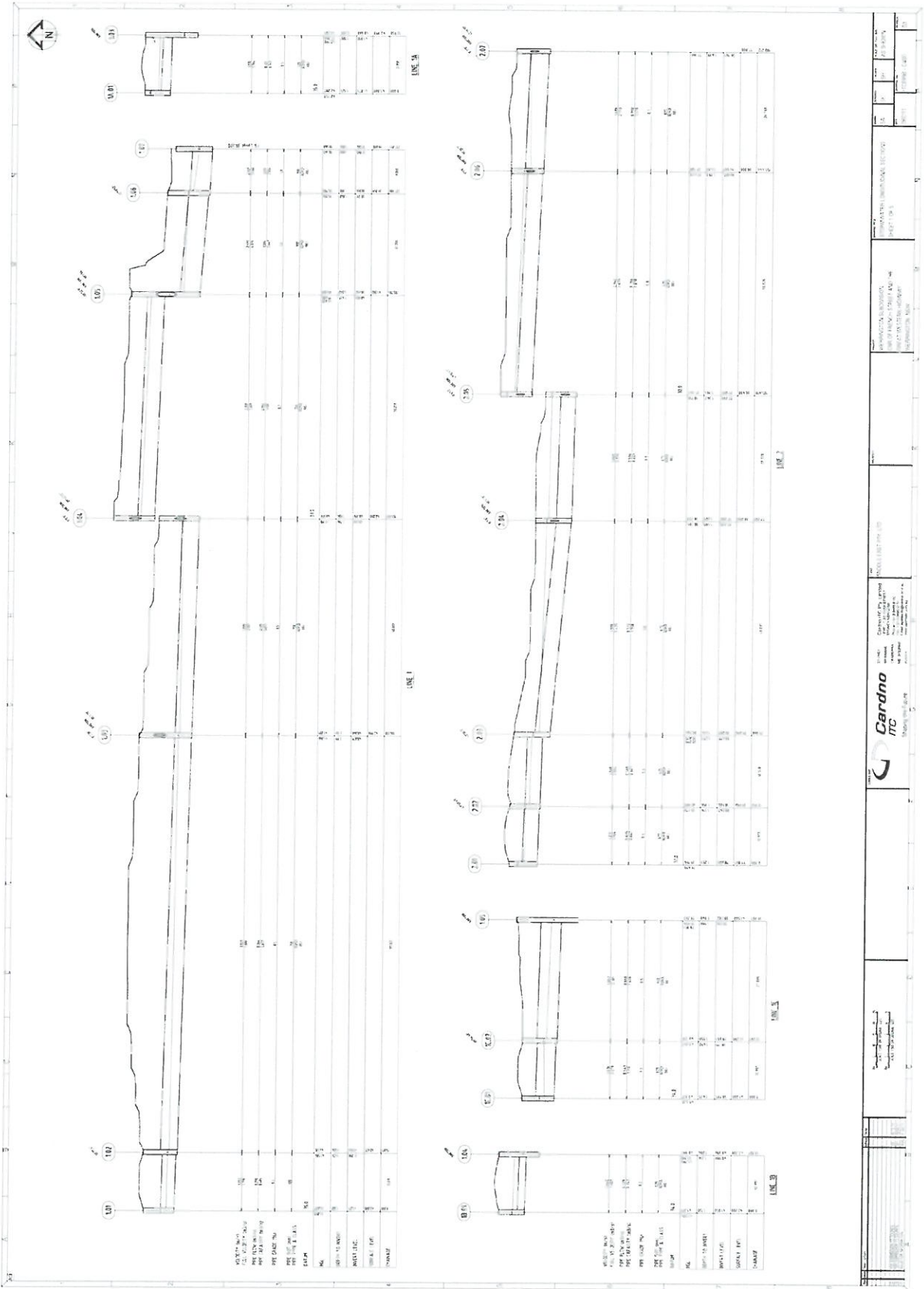
<p>Cardno ITC 2700017212</p>	<p>PROJECT NO: 2700017212 PROJECT NAME: FRENCH STREET & GREAT WESTERN HIGHWAY DRAWING NO: 2700017212-069</p>	<p>DATE: 31/05/2021 DRAWN BY: JMS/STP CHECKED BY: JMS/STP APPROVED BY: JMS/STP</p>	<p>SCALE: 1:1000 SHEET NO: 69 OF 70</p>
---	--	--	---

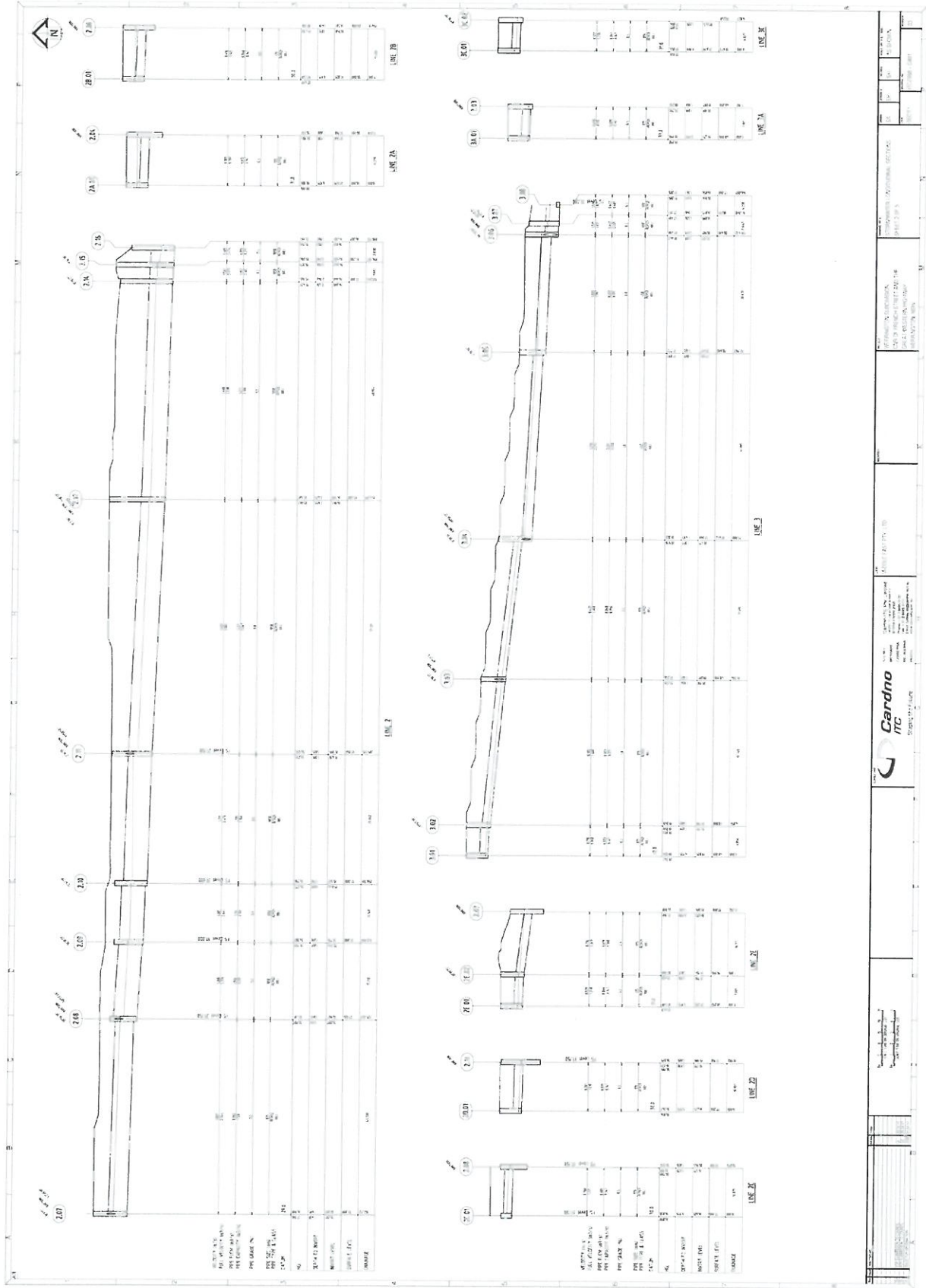


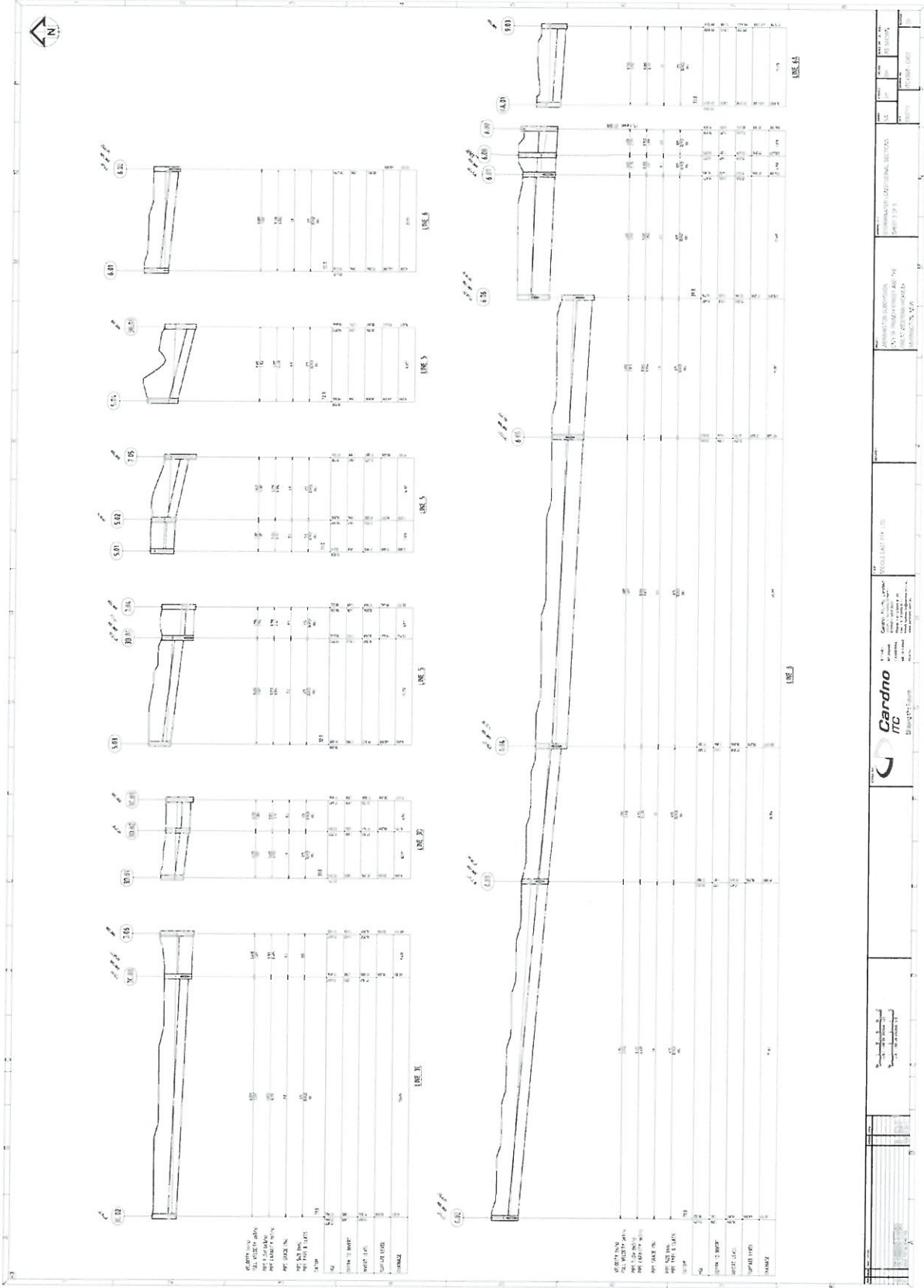
<p>Cardno ITC Planning and Design</p>		<p>PROJECT: FRENCH STREET & GREAT WESTERN HIGHWAY SHEET: 70 OF 70 DATE: 31/05/2021</p>	
<p>DESIGNED BY: [Name] CHECKED BY: [Name] APPROVED BY: [Name]</p>		<p>CLIENT: [Name] PROJECT NO: [Number]</p>	

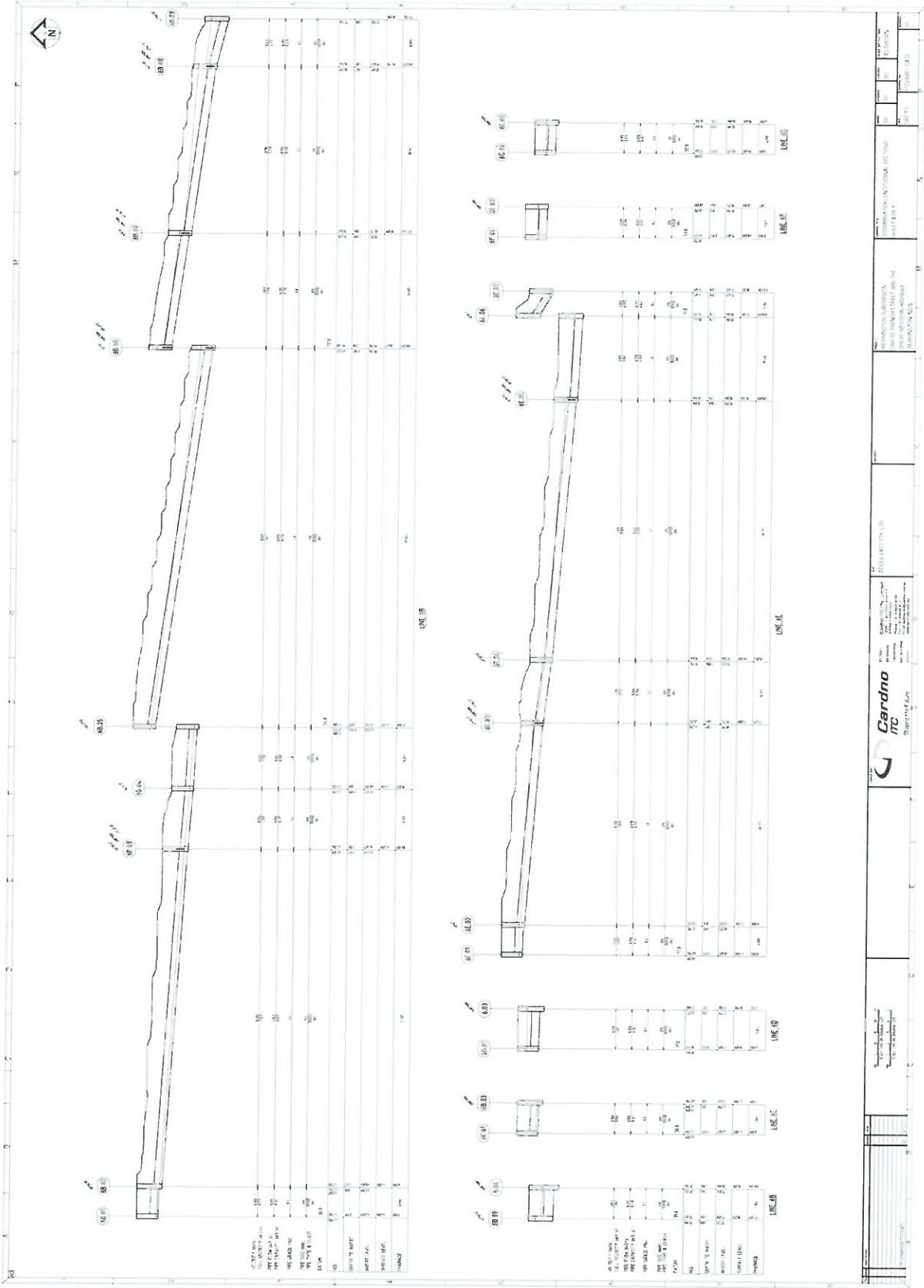


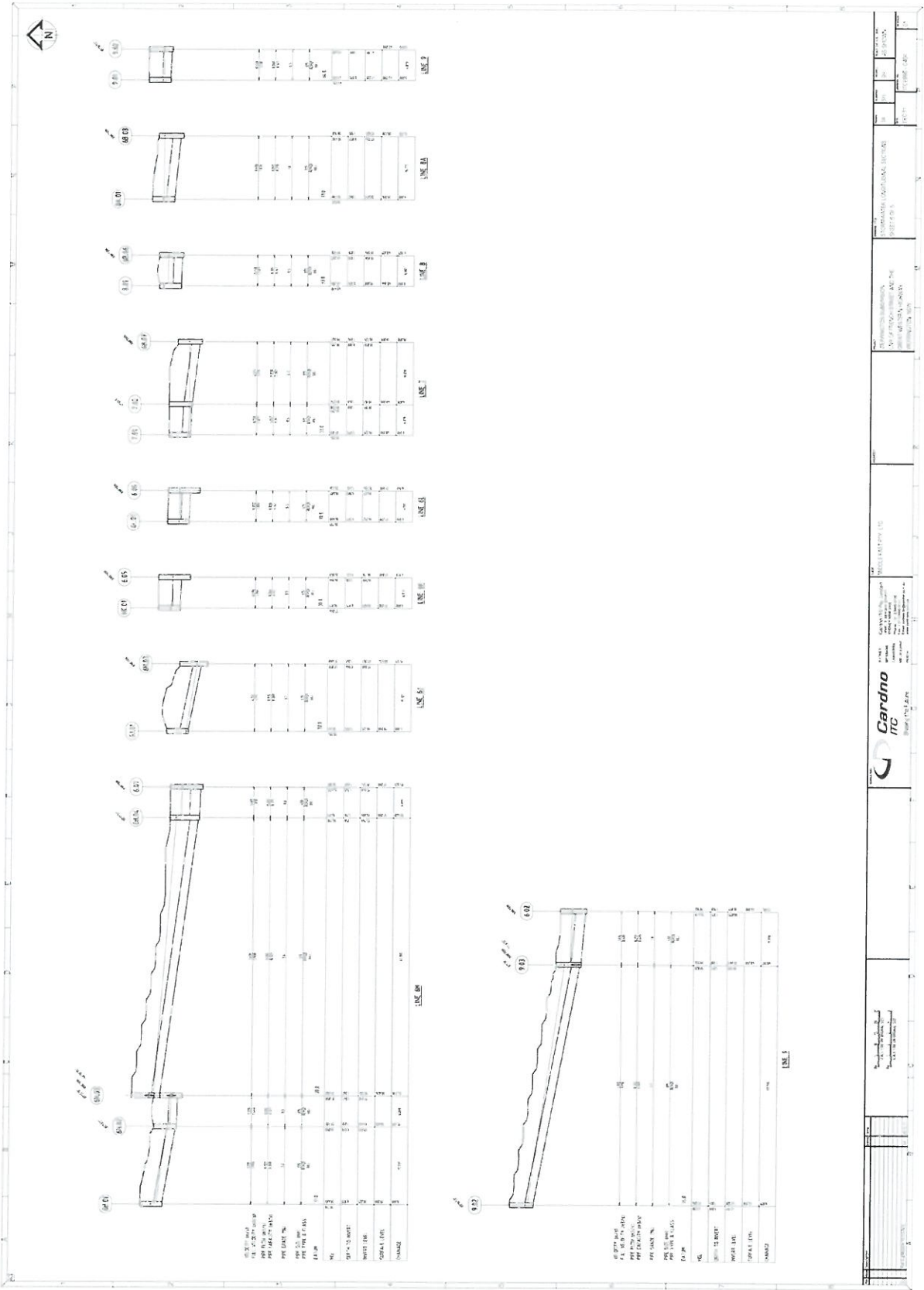


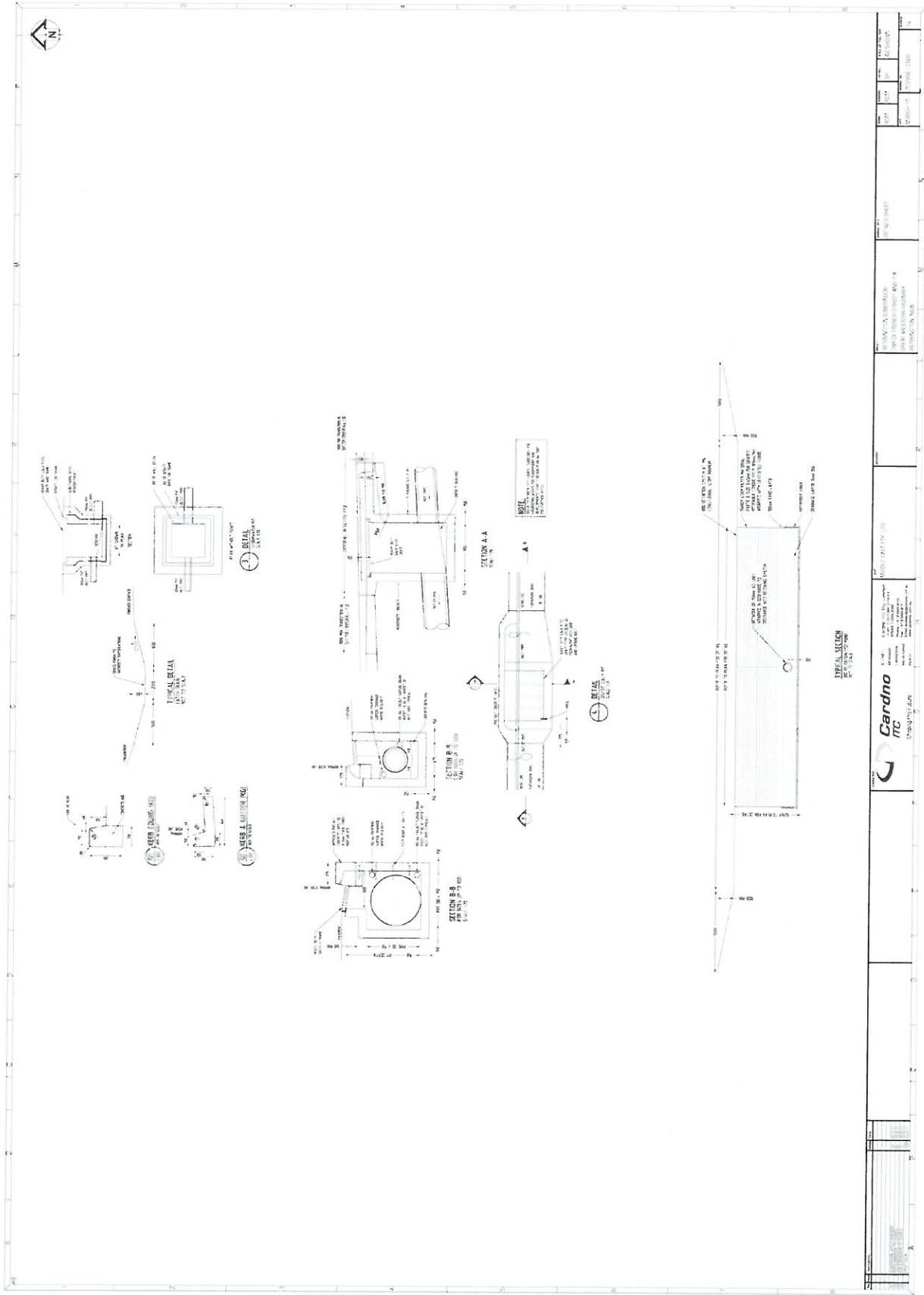












APPENDIX 7

Authorities Correspondence

Office of Hawkesbury and Nepean

From: Greg Brady [mailto:Greg.Brady@ohn.nsw.gov.au] **Sent:** Tuesday, 25 January 2011 9:21 AM **To:** Sam Haddad (Cardno ITC) **Subject:** Re: Werrington Subdivision masterplan (Office ref:10erm11-74)

Hi Sam,

I've had the time now to have a quick look at the Werrington Kingswood site plans you supplied.

In principle I think it is close to the Offices requirements. However the following is needed:

- (1). The watercourse is a category 2 so it needs to have 20m riparian width each side of the top of bank of the watercourse.
- (2). It is unclear where the watercourse goes under the rail line. Currently it looks like it flows along the line towards the west (to Morley Av??). This needs to be clearer. If it actually goes under the rail line in a direct line (or east which you are protecting) then this is not an issue.
- (3). It would appear that you have not left space for any water quality or quantity basins/structures. These should not be in the riparian area.
- (4). I understand that there may be a new railway station, is this still occurring as that may impact upon the watercourse and the footprint of the development?
- (4). Removal of any current works in the watercourse riparian area should be OK with adequate environmental protection, but will need a controlled activity approval. It is best to do this via integrated development.

I suggest you modify the masterplan to address issues (1) to (3) above and then we can give an in-principle support.

Regards Greg

Greg Brady Natural Resource Officer Office of Hawkesbury Nepean
Level 4, 2-6 Station Street
(PO Box 323)
PENRITH NSW 2751
Phone direct 4729 8134
Phone general 4729 8138 Fax 4729 8141
Visit our new website at www.ohn.nsw.gov.au

Penrith City Council



Our Ref: PL 10/0089
Contact: Schandel Jefferys
Telephone: (02) 4732 8125

29 July 2010

Demlan Constructions Pty Ltd
Angus MacInnes
7 Charles Street
PARRAMATTA NSW 2150

Dear Angus

Pre-Lodgement Meeting
Cnr French and Great Western Highway Kingswood

We welcome your initiative to commence your project in Penrith Local Government Area.


Thank you for participating in Council's pre-lodgement meeting on 20 July 2010. We consider that the pre-lodgement process will assist in determination of your proposal. The attached advice will assist you in preparing your development application

Further to our most recent meeting, Council officers would like to confirm that the preferred approach to this subdivision is to proceed with an application once the Stage 2 Local Environmental Plan (LEP) has been gazetted. The proposals discussed at the pre-lodgement meeting present some permissibility issues which are likely to be resolved under the Stage 2 LEP. Proceeding under the current planning controls may not result in the best planning outcome.

Council provides competitive services in *Certification of Development*. If you need to enquire about *Construction Certificates* and *Principal Certifying Authority* matters please contact Colin Wood, Building Approvals Co-ordinator on (02) 4732 8083.

If you require any further assistance regarding the attached advice please contact me on (02) 4732 8125.

Yours faithfully


Schandel Jefferys
Principal Planner

**** Please note: the attached advice is to assist you with your development proposal. It is not a full assessment of the proposal. Council's full assessment and determination can only be made after lodgement of the development application. The applicant is responsible to address all Council's requirements if a development application is lodged.*

Tel: (02) 4732 7777 • Fax: (02) 4732 7958 • Civic Centre, 601 High Street, Penrith NSW 2750
BX 9047, Penrith • PO Box 60, Penrith NSW 2751 • Email: penrith@penrithcitycouncil.nsw.gov.au

Pre – Lodgement Advice	
Date of Issue	29 July 2010
Pre- Lodgement Number	PL 10/0089
Proponent	Demlan Constructions Pty Ltd
Proposal	Proposed masterplan comprising residential subdivision, employment land, road network, transport interchange and drainage/conservation corridor.
Address	Lot 50, 55, 58, 57 and 56 DP 1069025 Lot 50 French Street Werrington
Development Type	Integrated Development
Permissibility	<p>The land is partly zoned 5A Special Uses, 10A Mixed Use – Residential and 10B Special Uses – Employment under Penrith Local Environmental Plan (LEP) 1998 Urban Land. The land is to be included in Council's Stage 2 LEP 2010.</p> <p>Residential subdivision is not permitted in the 10B and 5A zones. Components of the proposal would not be permitted under current zoning regulations.</p> <p>Sydney Regional Environmental Plan 20 (Hawkesbury Nepean River) and Penrith Development Control Plan 2007 – Werrington Mixed Use Area apply to the land.</p>
Site Constraints	<p>The site is affected by:</p> <ul style="list-style-type: none"> • drainage easement • services easement • water supply easement • bushfire prone • covenant.
General Requirements	<p>The Statement of Environmental Effects must include:</p> <ul style="list-style-type: none"> • a detailed description of the proposal • consideration of relevant statutory provisions, particularly, section 79C of the Environmental Planning and Assessment Act 1979 • consideration of other relevant matters listed on the <i>Application Information Sheet</i> attached with this advice • a detailed assessment of the key issues specified below.
Key Issues	<p>Proposed Future Railway Station</p> <p>As discussed at the pre-lodgement meeting the state government has placed plans for a future railway station on</p>

	<p>hold. The design should be amended to reflect this change as a transport interchange is no longer required.</p> <p>Well Precinct and strategic issues</p> <ul style="list-style-type: none"> • The university precinct is currently working on a Masterplan. The site forms part of the Well Precinct. It is envisaged that the site will form part of a larger high tech development precinct or a small business park. • The zones will be translated into the new I.E.P template zones however, the exact zones have not yet been determined. • Council would not support rezoning employment land to residential. • Consideration may be given to reduce densities across the site as a result of the station interchange not proceeding. <p>Subdivision design</p> <ul style="list-style-type: none"> • Proposed future residential development along the Great Western Highway is not supported. This part of the site will form part of the future small business park or high tech park and therefore residential development on the eastern side of the vegetation corridor would sever this land use pattern and is not suitable. • The residential development along the Great Western Highway is also not supported due to the low level of residential amenity for this land resulting mainly from potential noise impacts. • Back fences along any areas of open space are not desirable. Dwelling design is to allow passive surveillance of open space. • The application is to demonstrate how the subdivision layout has been designed to consider how each lot can be developed for residential purposes. This is to include setbacks, private open space, aspect, car parking and landscaping. This is particularly relevant on sloping land • The subdivision layout is to provide land that can be developed in future with minimal need for cut and fill. <p>Local Environmental Plan (LEP) and Permissibility</p> <ul style="list-style-type: none"> • The proposal is to comply with all relevant requirements of LEP 1998 Urban Land and the statement of environmental effects submitted with any development application will need to provide details of compliance.
--	--

	<ul style="list-style-type: none"> • This land is to be included in the Stage 2 LEP and therefore if the proposal is to progress before this is gazetted the proposal would need to be amended to address the issue of permissibility. • At the pre-lodgement meeting the proponent said that they would like to move forward with this proposal under the current planning controls. Although this is not the preferred approach by Council it could be considered with an overall Masterplan for the site then staging. Consideration will need to be given so that development proposed at the initial stage does not preclude the site's development opportunities in future. <p>Road hierarchy and layout Council does not support the use of cul-de-sacs in the proposed layout as this minimises permeability of the site and is inconsistent with the requirements in the DCP.</p> <p>Urban Design Review Panel The application may need to be presented to an Urban Design Review Panel meeting and it is preferred that this occur before the application is lodged.</p> <p>Diversity of housing type Consideration is to be given to increasing the housing diversity proposed.</p> <p>Engineering comments</p> <ul style="list-style-type: none"> • The road layout and pattern should comply with the indicative layout included in the DCP. • Roads are to provide connectivity to main roads. • Intersection geometry is to comply with Ausroads (sight distances and angles) • Water quality treatment will be required in accordance with the DCP. • On-site detention is required. Post development flows are to match pre development flows which is in accordance with the DCP. • The site is affected by overland flows and this is to be accommodated within the development. • It appears that work (i.e. roads and drainage) has been carried out on site and Council does not have any records of approvals for this work. Were construction works inspected? Are there details available for the pavement thickness and design, drainage system capacity as well as compliance with council's standards.
--	---

	<p>Traffic</p> <ul style="list-style-type: none">• A traffic assessment is required to be submitted with the development application addressing any potential impact. This assessment should provide details of whether the proposed development will result in the need for intersection or road upgrades.• Service vehicles for the employment land should not travel through the residential areas.• Pedestrian and cycle way connectivity to and within the site is to comply with the DCP requirements.• A deceleration lane along the Great Western Highway may be required, subject to discussions with the RTA.• Concurrence from the RTA will be required. <p>Development control plan (DCP)</p> <ul style="list-style-type: none">• The proposal is to comply with all relevant requirements of the Werrington Mixed-Use Area DCP.• The proposal will need to be supported by a Masterplan, please refer to the DCP for specific requirements. <p>Other matters</p> <ul style="list-style-type: none">• An application would need to address the requirements of SEPP 55 with regard to remediation of land.• A geotechnical report is required.• A salinity report is required.• Council cannot grant consent to development unless adequate support services and utilities are or will be available to the site within a reasonable time. <p>Section 94 Contributions</p> <p>Section 94 Contributions will be applied to this proposal. The relevant developer contribution plans are:</p> <ul style="list-style-type: none">• Cultural Facilities• District Open Space• WELL Precinct 2008 <p>Please note that as the NSW Government has currently placed a \$20,000 cap on developer contributions, Penrith City Council is currently seeking legal advice on this matter as discussed at the pre-lodgement meeting.</p>
--	--

References	Technical and Policy Guidelines, which may be relevant to the proposal are included in the attached list.
Consultation	Prior to lodgement of the development application you must consult with relevant government authorities, service providers, community groups and affected landowners. In particular you may need to consult with: <ul style="list-style-type: none"> • Energy Provider • Rural Fire Service • Sydney Water.
Application Form and Information Required	The attached application form must be completed and submitted to Penrith City Council. Notes on Page 3 and matrix on Page 4 of this form provides further clarification of information, which is required to be submitted with the application.
Fees	Please call Development Services Department's Administrative Support on (02) 4732 7991 to enquire about fees and charges.



Schandel Jefferys
Principal Planner

References – Technical and Policy Guidelines

Aspect	Policy / Methodology
Flora and Fauna	<ul style="list-style-type: none"> • Draft <i>Guidelines for Threatened Species Assessment</i> - Department of Environment and Conservation (DEC) • <i>Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities (DEC)</i>
Noise	<ul style="list-style-type: none"> • <i>NSW Industrial Noise Policy (DEC)</i> • <i>Environmental Criteria for Road Traffic Noise (DEC)</i> • <i>Environmental Control Manual (DEC)</i>
Air Quality	<ul style="list-style-type: none"> • <i>Approved Methods for Modelling and Assessment of Air Pollutants in NSW (DEC)</i>
Traffic	<ul style="list-style-type: none"> • <i>Guide to Traffic Generating Developments and Road Design Guide</i> - Roads and Traffic Authority (RTA) • Relevant Australian Standards
Waste	<ul style="list-style-type: none"> • <i>On-site Sewage Management and Greywater Reuse Policy</i> - Penrith City Council (PCC) • <i>Waste Management Plan (PCC)</i>
Flood Liable Land	<ul style="list-style-type: none"> • <i>Interim Policy for Development of Flood Liable Land (PCC)</i>
Bushfire	<ul style="list-style-type: none"> • <i>Planning for Bushfire Protection Guidelines</i> - NSW Rural Fire Service



Our Ref: DA11/0546
Contact: Robert Craig
Telephone: (02) 4732 7593

7 July 2011

Middle East Pty Ltd
Level 2, 7 Charles Street
PARRAMATTA NSW 2150

Attention: Ron Pomeroy

Dear Mr Pomeroy,

Development Application No. DA11/0546
Torrens Title Subdivision x 123 Residential Lots, 1 Drainage/Open Space Reserve,
2 Residue Lots & Public Roads
Lots 50-58 DP 1069025, 731-769 Great Western Highway (corner French Street), Werrington

I refer to the recent meeting held on 5 July 2011 regarding the subject development proposal which was attended by Council officers as well as Mr Angus MacInnes and Mr Charlie Demian from Demian Constructions.

Following the discussions at this meeting and following further assessment of your Development Application, I wish to advise that the following matters have arisen for your consideration and action.

Density of Residential Development

1. As previously advised, the *Werrington Mixed-Use Area Development Control Plan* (the DCP) establishes a residential density target of 30 dwellings per hectare for the site. After taking into consideration the likely timing and delivery of the train station proposed adjacent to the site, you are advised that Council officers are willing to consider a variation from this residential density requirement. In this regard, a residential density of between 20 and 25 dwellings per hectare may be appropriate for the site. Please note that details shall be submitted demonstrating how the development will meet the demand for local housing needs in terms of density and dwelling typologies.

Design of Development

2. The design of the development shall deliver a layout and structure (i.e. road widths, lot sizes and configuration, public open space, etc) which facilitates the re-development of the land in the vicinity of the proposed train station to higher-density forms of housing and a range of other uses once the station is delivered. The land identified as a future transport interchange and commuter car park in the DCP shall be set aside as a residue allotment.

Local Park

3. Consideration will be given to the proposed inclusion of the required local park in the central riparian corridor. However, it is noted that the DCP requires the park to provide meaningful passive and active recreation opportunities. The information submitted to date does not demonstrate the park will provide meaningful passive and active recreation opportunities.

Section 94 Contributions

4. The application of Section 94 contributions to the proposal is currently under assessment by

Tel: (02) 4732 7777 • Fax: (02) 4732 7958 • Civic Centre, 601 High Street, Penrith NSW 2750
DX 8017, Penrith • PO Box 60, Penrith NSW 2751 • E-mail: pencit@penrithcity.nsw.gov.au

Council's Developer Contributions Project Coordinator. Although Council officers' position on this matter will not be finalised until the modified development proposal is submitted, it should be noted that Council resolved the following at its Ordinary Meeting on 27 June 2011 in relation to the application of Section 94 contributions in the WELL (Werrington Enterprise, Living and Learning) Precinct:

- a. Development contributions up to \$30,000 per lot will be applied and directed to recreation, community, administration and selected road facilities identified in the WELL, District Open Space and Cultural Facilities Development Contributions Plans.
- b. Conditions imposed on development consents will require proponents to provide all required drainage works.
- c. Conditions imposed on development consents will require proponents to provide all public roads.

Other Matters

5. The NSW Office of Water has advised Council that the information submitted with the application is insufficient. A copy of the Office of Water's letter is attached for your information. It will be necessary for the additional information requested in the letter to be submitted to Council for referral to the Office of Water.
6. RailCorp has advised Council that the information submitted with the application is insufficient. A copy of RailCorp's letter is attached for your information. It will be necessary for the additional information requested in the letter to be submitted to Council for referral to RailCorp.
7. Road 1 shall be re-aligned to match the alignment of George Street and to form a four-way intersection with French Street in accordance with the DCP. Details of the intended management of this intersection, including pedestrian access and safety, shall also be submitted.
8. The width of the median in Road 1 shall be increased to accommodate the proposed median landscaping in accordance with RTA guidelines. In addition, concern is raised regarding the potential for vehicles to undertake unauthorised U-turn movements at the eastern end of this median.
9. The size, configuration and dimensions of each corner allotment, in particular Lot 18 and Lot 105, shall be reviewed and amended to accommodate a suitable dwelling building envelope. In this regard, each allotment shall be capable of containing a rectangle suitable for building purposes measuring 10m by 12m or 8m x 15m, behind the building line.

In addition to the matters raised in this letter, it is requested that responses be provided to the matters raised in Council's previous letter dated 10 June 2011. Please note that following further advice from external state government authorities or other departments of Council, additional information or further plan amendments may be requested.

Please be advised that the "stop the clock" provisions of the *Environmental Planning and Assessment Act 1979* continue to apply to the application.

Should you have any queries regarding this matter, please contact me on (02) 4732 7593.

Yours faithfully,



Robert Craig
Senior Environmental Planner



WERRINGTON SUBDIVISION CNR FRENCH STREET AND THE GREAT WESTERN HIGHWAY, WERRINGTON NSW

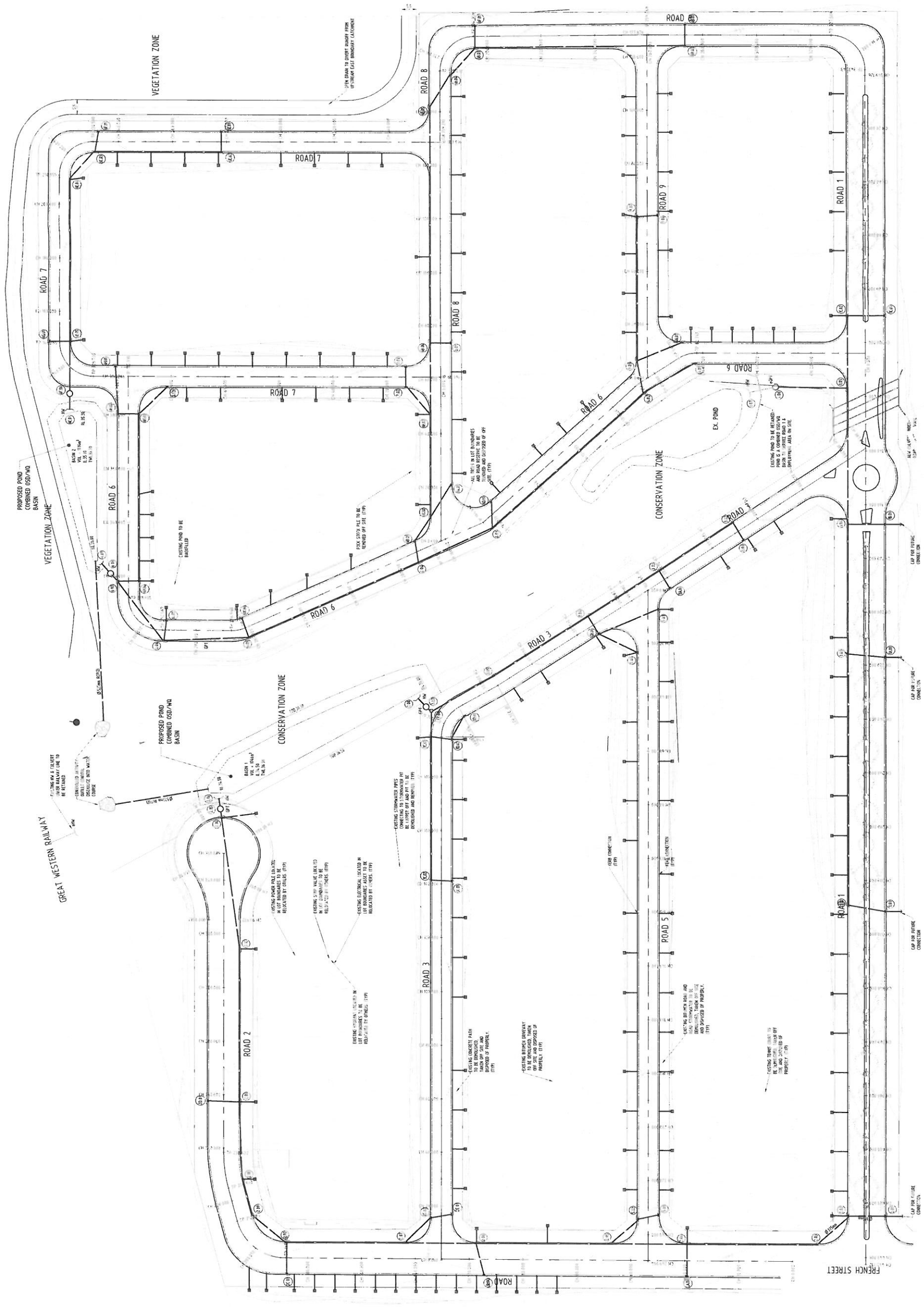
DA SUBMISSION & MASTER PLAN



NO.	REVISION
001	THIS SHEET
002	SITE PLAN & STAGING PLAN
003	GENERAL DRAINAGE PLAN
004	CONCRETE DRIVEWAY
005	ROAD LAYOUT PLAN
006	ROAD LAYOUT PLAN
007	ROAD LAYOUT PLAN
008	ROAD LAYOUT PLAN
009	ROAD LAYOUT PLAN
010	ROAD LAYOUT PLAN
011	ROAD LAYOUT PLAN
012	ROAD LAYOUT PLAN
013	ROAD LAYOUT PLAN
014	ROAD LAYOUT PLAN
015	ROAD LAYOUT PLAN
016	ROAD LAYOUT PLAN
017	ROAD LAYOUT PLAN
018	ROAD LAYOUT PLAN
019	ROAD LAYOUT PLAN
020	ROAD LAYOUT PLAN
021	ROAD LAYOUT PLAN
022	ROAD LAYOUT PLAN
023	ROAD LAYOUT PLAN
024	ROAD LAYOUT PLAN
025	ROAD LAYOUT PLAN
026	ROAD LAYOUT PLAN
027	ROAD LAYOUT PLAN
028	ROAD LAYOUT PLAN
029	ROAD LAYOUT PLAN
030	ROAD LAYOUT PLAN
031	ROAD LAYOUT PLAN
032	ROAD LAYOUT PLAN
033	ROAD LAYOUT PLAN
034	ROAD LAYOUT PLAN
035	ROAD LAYOUT PLAN
036	ROAD LAYOUT PLAN
037	ROAD LAYOUT PLAN
038	ROAD LAYOUT PLAN
039	ROAD LAYOUT PLAN
040	ROAD LAYOUT PLAN
041	ROAD LAYOUT PLAN
042	ROAD LAYOUT PLAN
043	ROAD LAYOUT PLAN
044	ROAD LAYOUT PLAN
045	ROAD LAYOUT PLAN
046	ROAD LAYOUT PLAN
047	ROAD LAYOUT PLAN
048	ROAD LAYOUT PLAN
049	ROAD LAYOUT PLAN
050	ROAD LAYOUT PLAN



	Cardno ITC <small>Shaping the Future</small>	<small>STONEY RIDGE MELBOURNE VIC 3048</small> Cardno ITC <small>Shaping the Future</small>	<small>LEVEL 7, 25 YORK STREET MELBOURNE VIC 3000 Phone: +61 3 9488 8100 Fax: +61 3 9488 8111 www.cardno.com.au</small> Cardno ITC Pty. Limited <small>MIDDLE EAST PTY. LTD.</small>	<small>WERRINGTON SUBDIVISION CNR OF FRENCH STREET AND THE GREAT WESTERN HIGHWAY WERRINGTON, NSW</small>	<small>DATE: 11/03/2011</small> <small>TIME: 11:00 AM</small> <small>PROJECT NO: ITCCERS - C100</small> <small>DATE: MARCH '11</small> <small>SCALE: NTS</small>	<small>NO. 03</small>
--	--	--	---	--	--	-----------------------



EMPLOYMENT

EMPLOYMENT

EMPLOYMENT

DATE	15/03/20
BY	SH
CHKD	MM
APP'D	MM
DATE	15/03/20
BY	SH
CHKD	MM
APP'D	MM

PROJECT NO: 11CE998 - C200
 DATE: MARCH 11

GENERAL ARRANGEMENT PLAN
 WERRINGTON SUBDIVISION
 CNR OF FRENCH STREET AND THE
 GREAT WESTERN HIGHWAY
 WERRINGTON, NSW

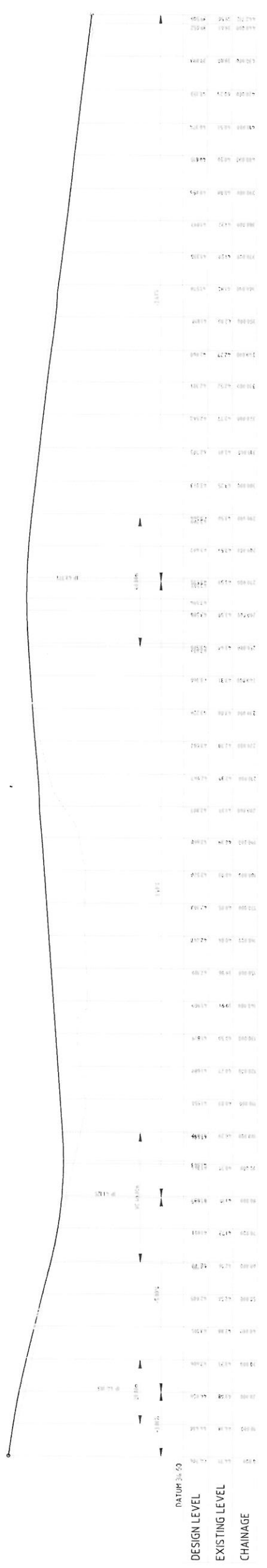
CLIENT: MIDDLE EAST PTY. LTD.
 DESIGNER: Cardno ITC Pty. Limited
 10/100 NEWCASTLE STREET
 SYDNEY NSW 2000
 PHONE: +61 2 955 1000
 FAX: +61 2 955 1001
 EMAIL: sydney@cardno.com.au
 WEBSITE: www.cardno.com.au



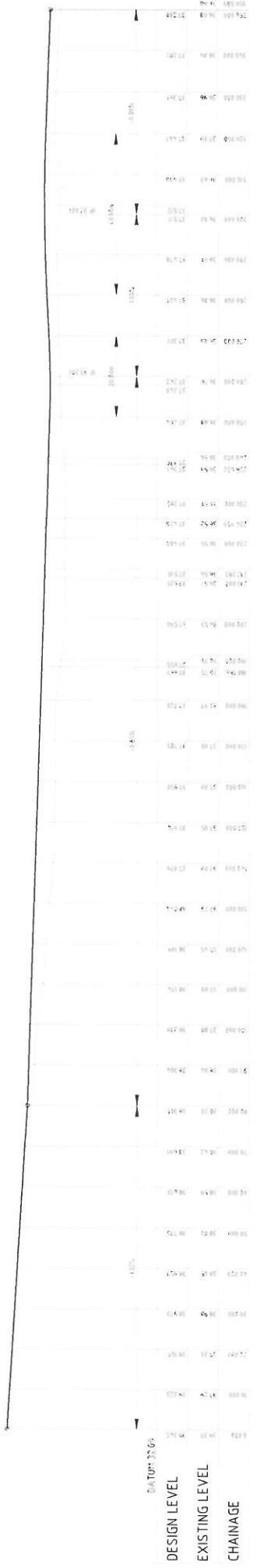
SYDNEY
 BRISBANE
 CANBERRA
 MELBOURNE
 PERTH

NO.	REV.	DATE	BY	CHKD	APP'D
1					
2					
3					
4					
5					

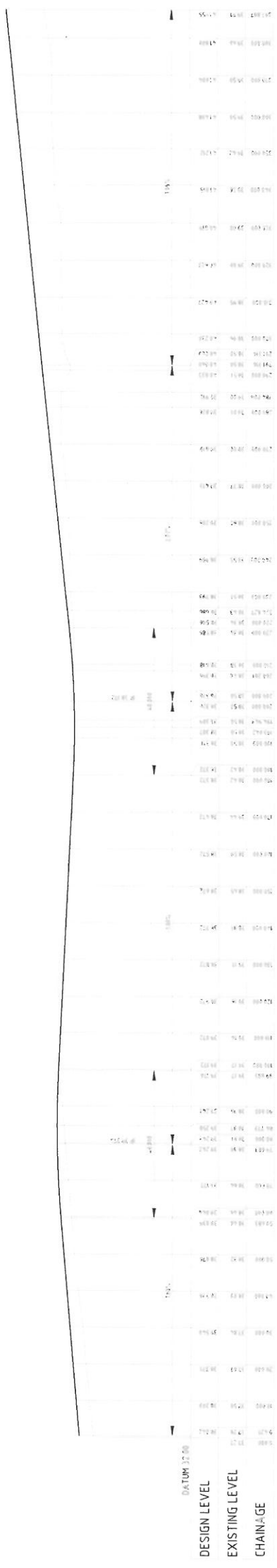
DATE	15/03/20
BY	SH
CHKD	MM
APP'D	MM



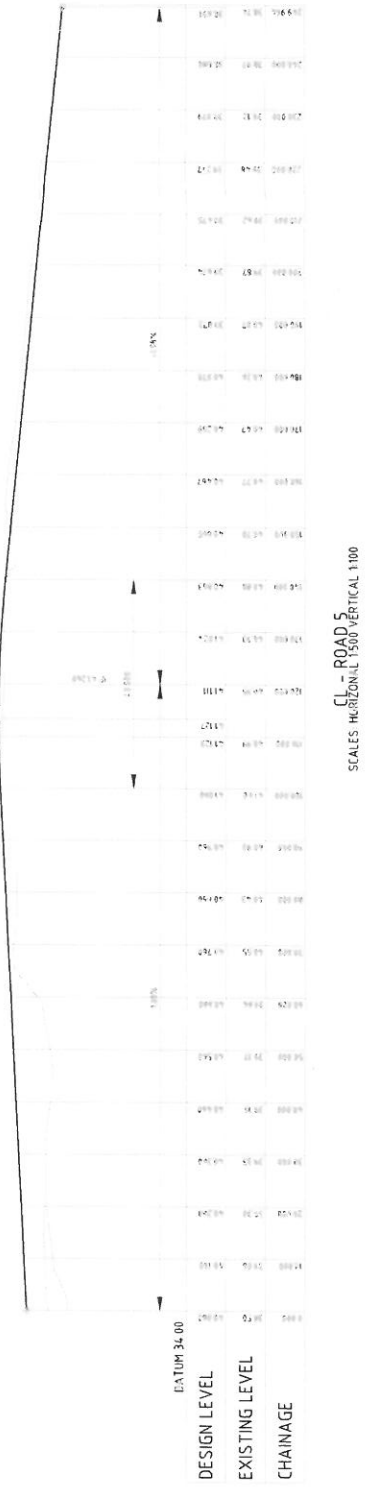
CL - ROAD 1
SCALE: HORIZONTAL 1:500 VERTICAL 1:100



CL - ROAD 2
SCALE: HORIZONTAL 1:500 VERTICAL 1:100



CL - ROAD 3
SCALE: HORIZONTAL 1:500 VERTICAL 1:100



CL - ROAD 5
SCALE: HORIZONTAL 1:500 VERTICAL 1:100

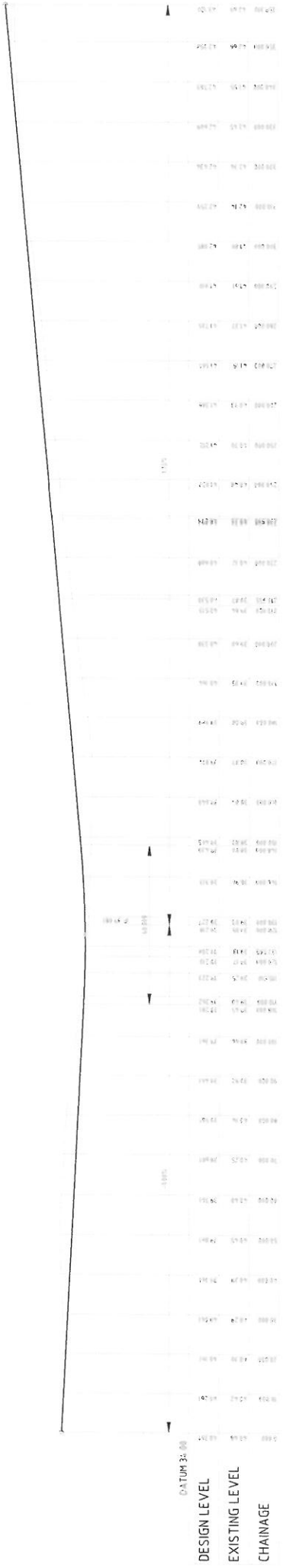
PROJECT	WERRINGTON SUBMISSION CNR OF FRENCH STREET AND THE GREAT WESTERN HIGHWAY WERRINGTON, NSW
DATE	MARCH 11
SCALE	AS SHOWN
PROJECT NO.	ITCE998 - C300
DATE	03

DESIGNER	MIDDLE EAST PTY. LTD.
ENGINEER	Cardno ITC Pty. Limited 170/171 FRENCH STREET WERRINGTON NSW 2030 Phone: +61 2 9665 1100 Fax: +61 2 9665 1101 Email: info@cardno.com.au www.cardno.com.au
PROJECT NO.	ITCE998 - C300
DATE	03

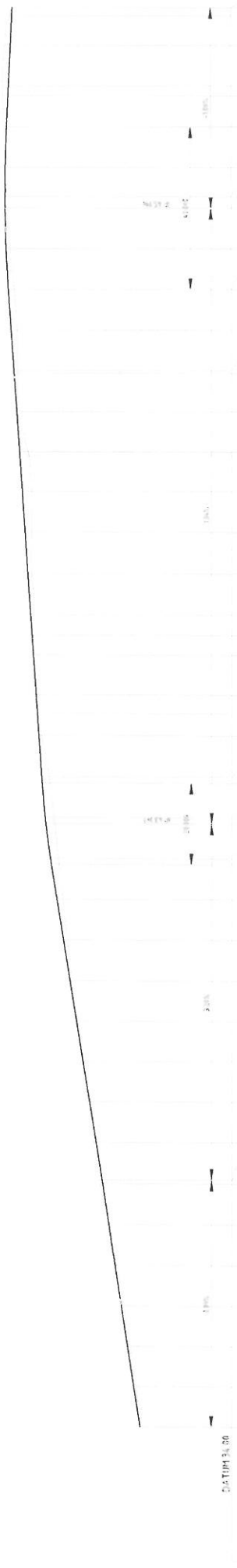
SCALE	1:500
SCALE	1:500
SCALE	1:500
SCALE	1:500



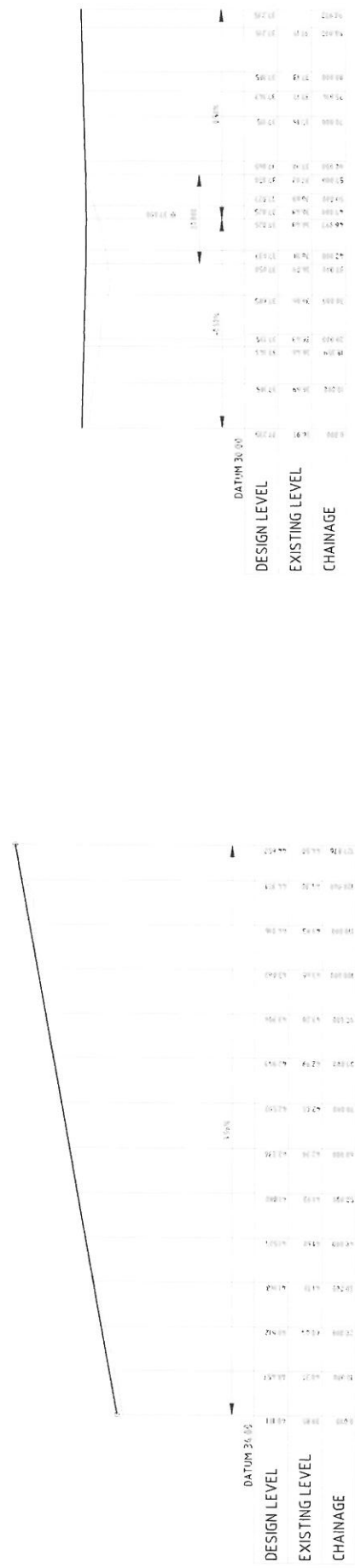
CL - ROAD 6
SCALES HORIZONTAL 1:500 VERTICAL 1:100



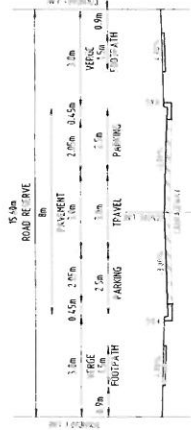
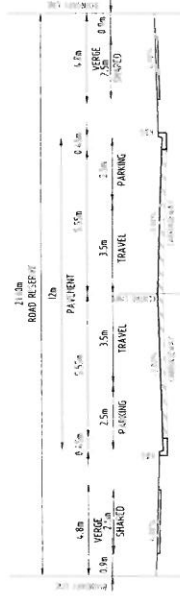
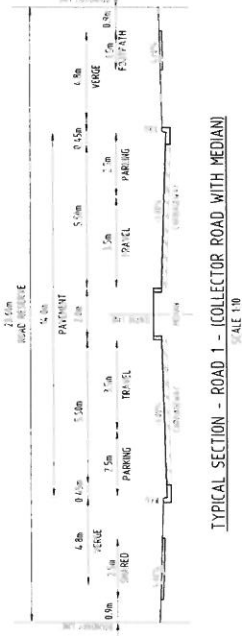
CL - ROAD 7
SCALES HORIZONTAL 1:500 VERTICAL 1:100



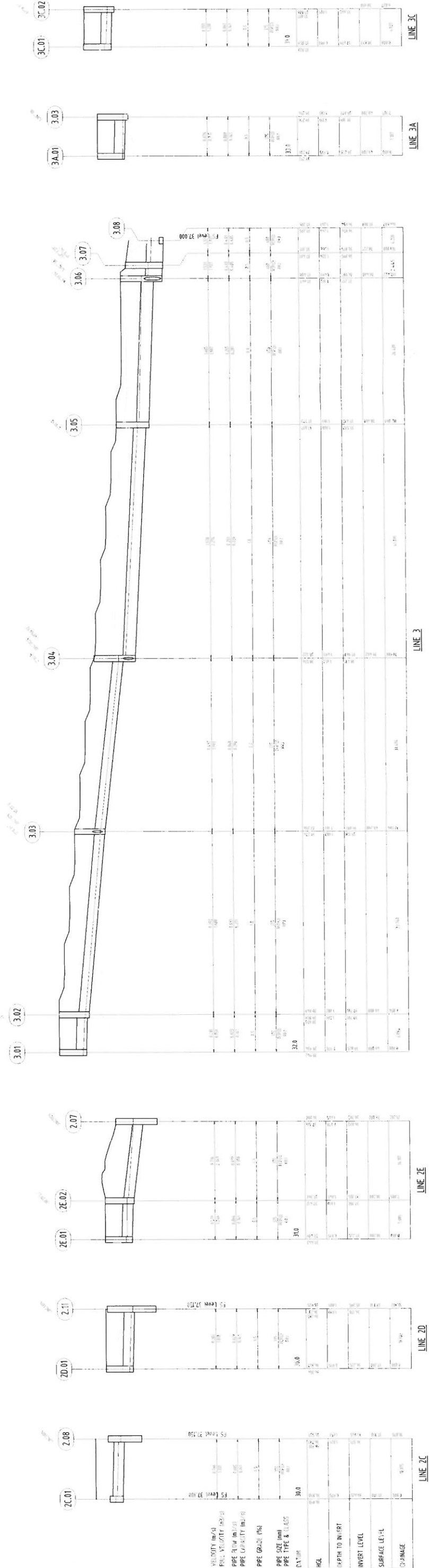
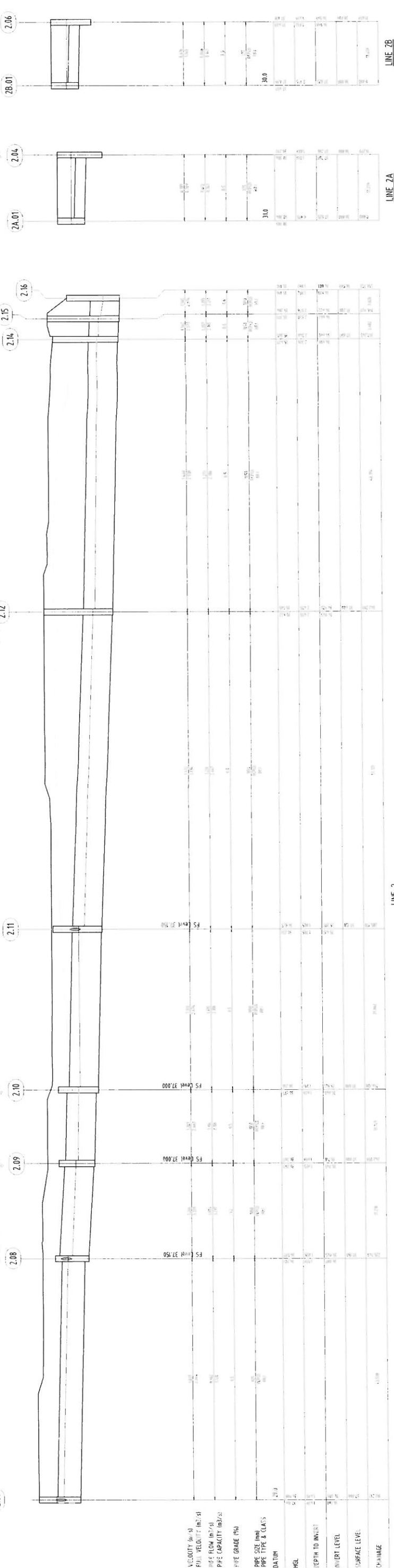
CL - ROAD 8
SCALES HORIZONTAL 1:500 VERTICAL 1:100



CL - ROAD 9
SCALES HORIZONTAL 1:500 VERTICAL 1:100



 Shaping the Future		Cardno ITC Pty. Limited 100/102 WILKINSON STREET PERTH, WESTERN AUSTRALIA 6000 Phone: +61 8 9468 8100 Fax: +61 8 9468 8101 www.cardno.com.au		MIDDLE EAST PTY. LTD 100/102 WILKINSON STREET PERTH, WESTERN AUSTRALIA 6000		ROAD LONGITUDINAL SECTION - ROAD 6, 7, 8 & 9 & ROAD TYPICAL SECTIONS		DATE: MARCH 11 PROJECT: WERRINGTON SUBDIVISION CNR OF FRENCH STREET AND THE GREAT WESTERN HIGHWAY WERRINGTON, NSW	DRAWN: SH CHECKED: RM PROJECT NO: ITC998 - CS01 SHEET NO: 03
------------------------	--	---	--	---	--	--	--	---	---



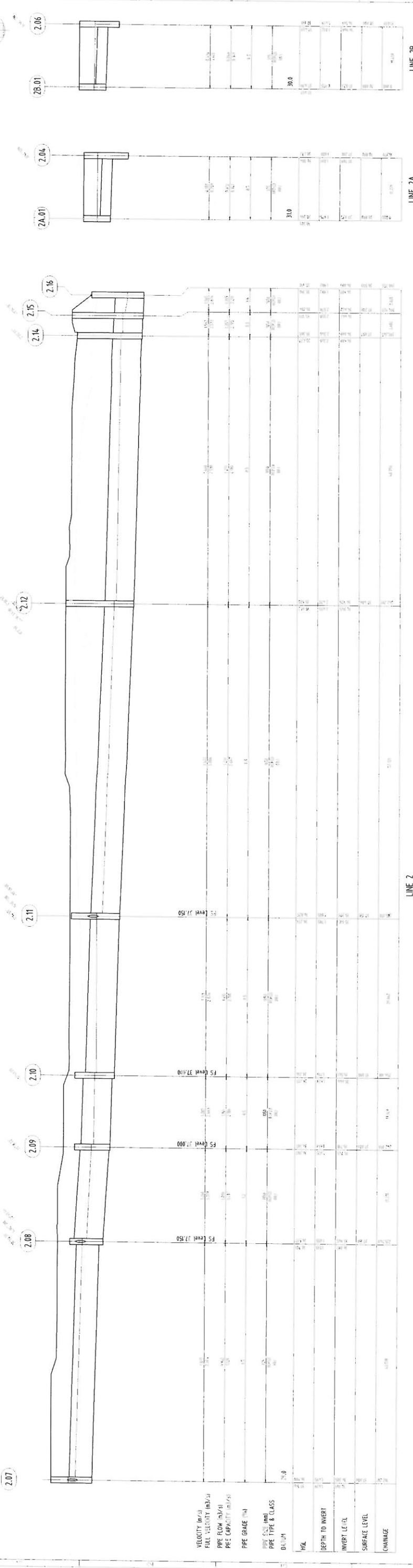
Cardno ITC
 Shaping the Future
 Sydney, Brisbane, Canberra, Melbourne, Perth
 Cardno ITC Pty. Limited
 37/38 Street
 Sydney, NSW 2000
 Phone: +61 2 9488 5100
 Email: sales@cardno.com.au
 www.cardno.com.au

MIDDLE EAST PTY. LTD.

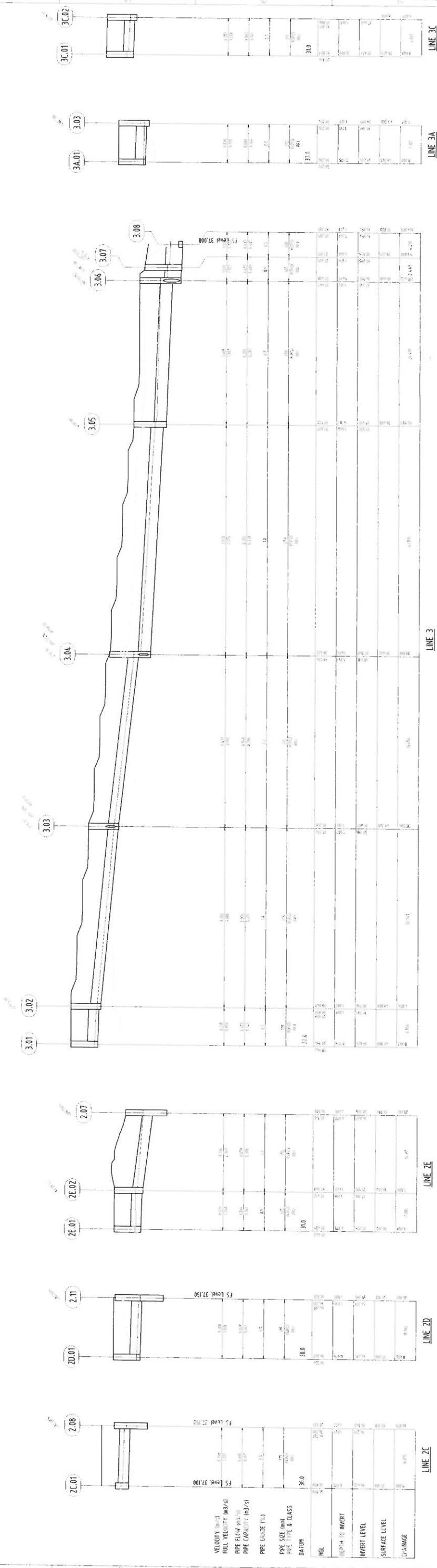
WERRINGTON SUBDIVISION
CHURCH OF FRENCH STREET AND THE
GREAT WESTERN HIGHWAY
WERRINGTON, NSW

STORMWATER LONGITUDINAL SECTIONS
SHEET 2 OF 5

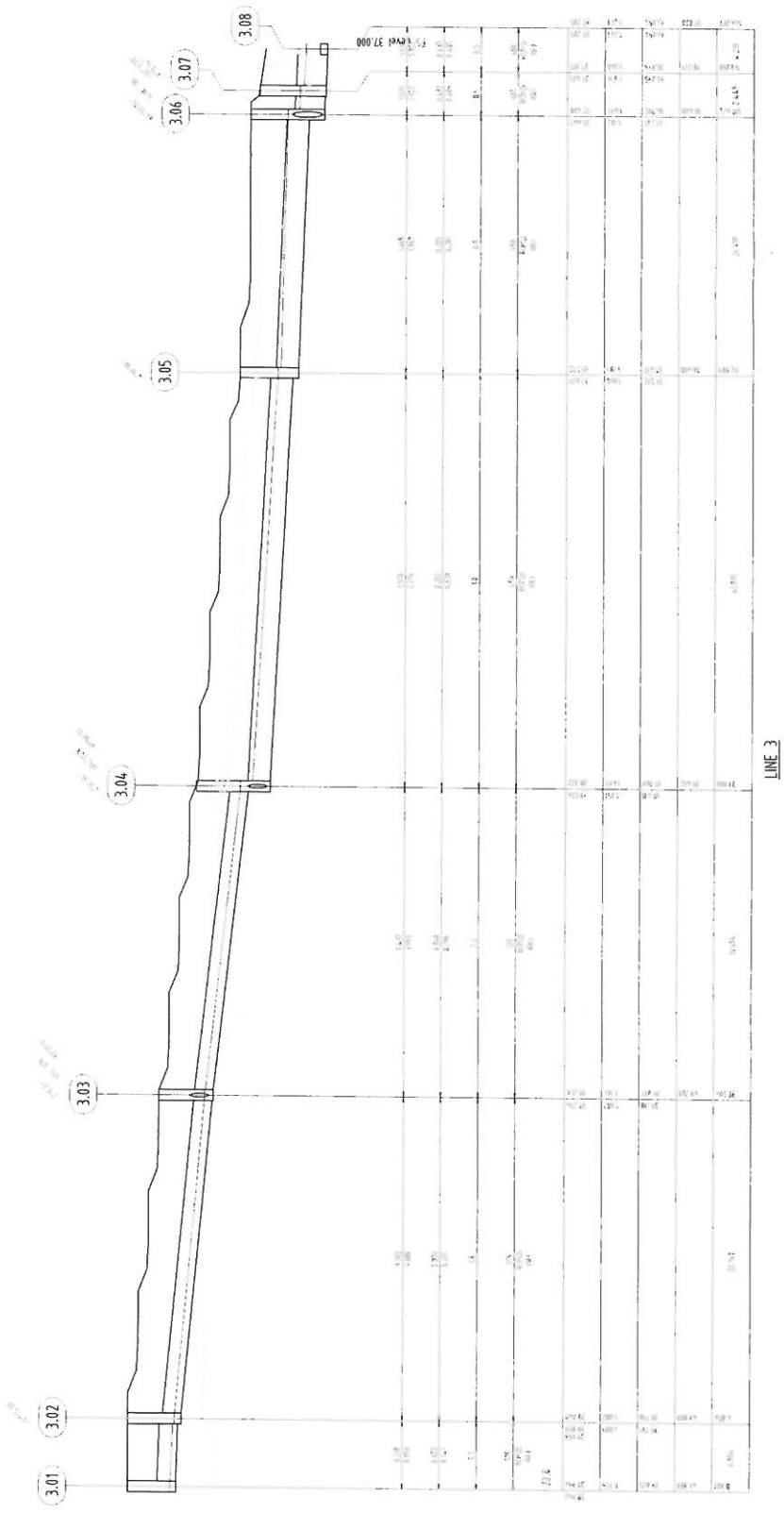
AS SHOWN
 SA SH SH
 DEC'11
 ITC/999 - C401
 03



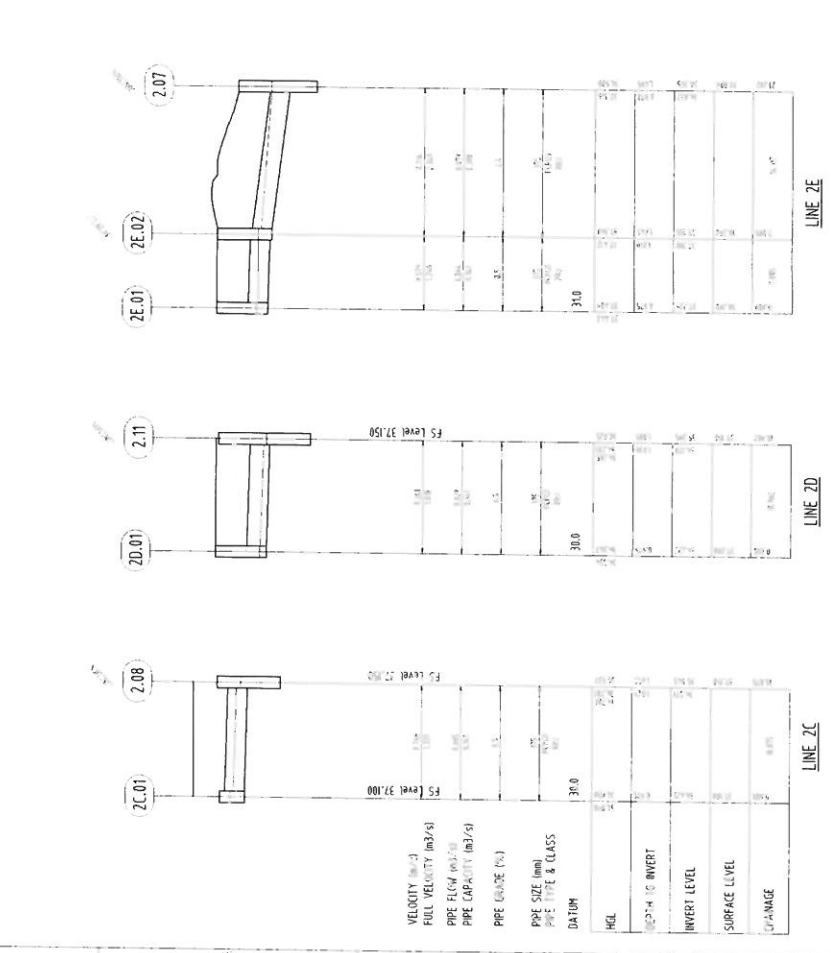
LINE 2A



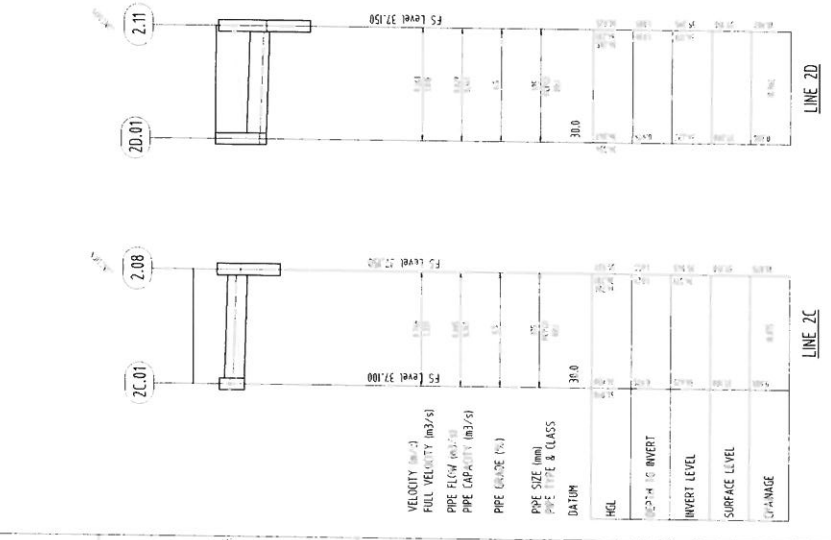
LINE 2B



LINE 2C



LINE 2D



LINE 2E



LINE 3

LINE 3A

LINE 3B

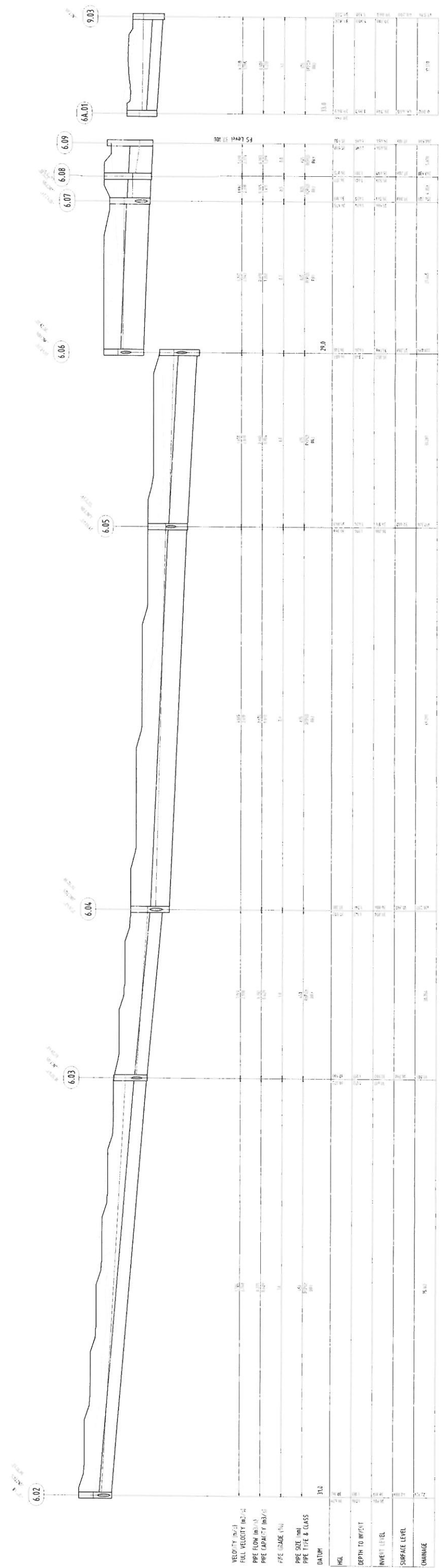
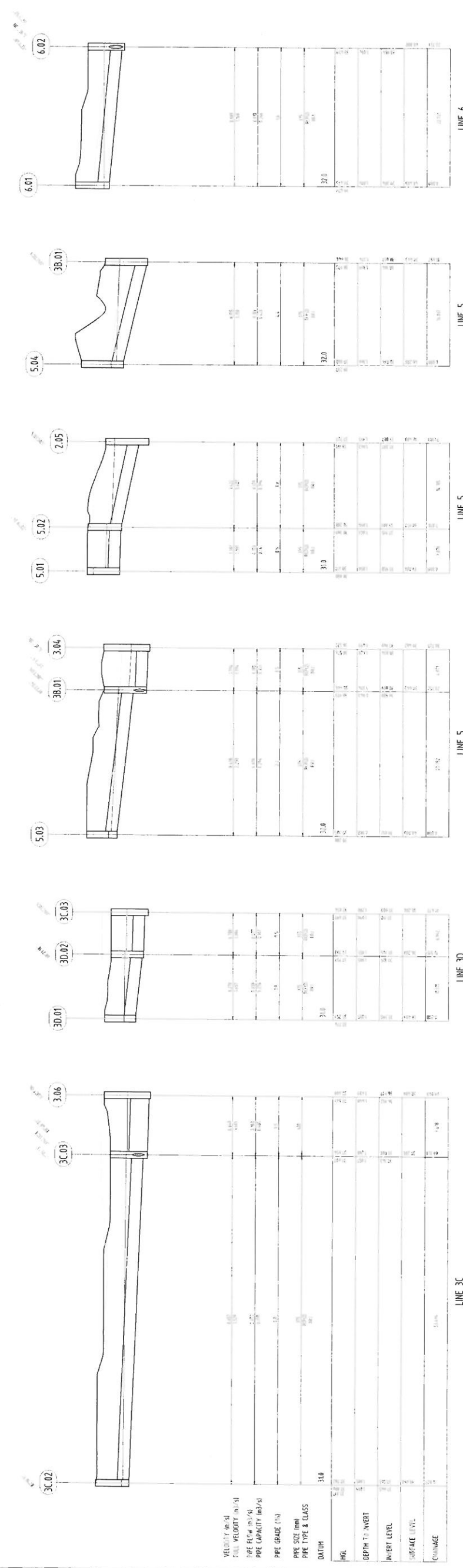
LINE 3C

Cardno ITC Pty. Limited
 100/100 STONEY RIDGE ROAD
 SYDNEY NSW 2000
 Australia
 Phone: +61 2 9661 1100
 Email: sales@cardno.com.au
 www.cardno.com.au

STONEY RIDGE
 WERRINGTON SUBDIVISION
 CNR OF FRENCH STREET AND THE
 GREAT WESTERN HIGHWAY
 WERRINGTON, NSW

MIDDLE EAST PTY. LTD.

PROJECT NO: 17000000000000000000
 SHEET NO: 01
 DATE: 31/05/2021



STORMWATER LONGITUDINAL SECTIONS
SHEET 3 OF 5

WERRINGTON SUBDIVISION
CNR OF FRENCH STREET AND THE
GREAT WESTERN HIGHWAY
WERRINGTON, NSW

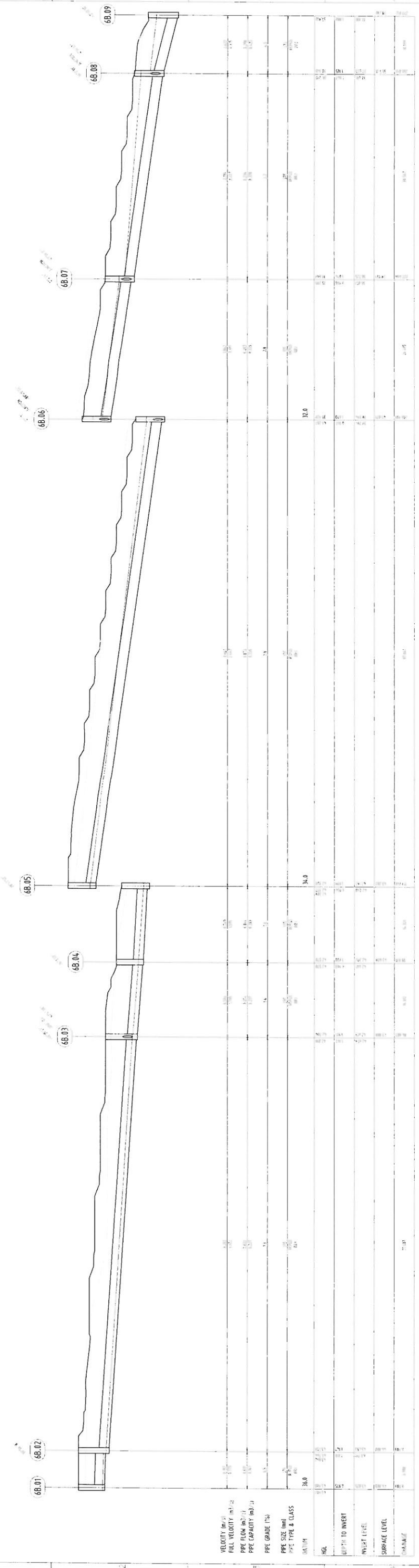
MIDDLE EAST PTY. LTD

Cardno ITC
Shaping the Future

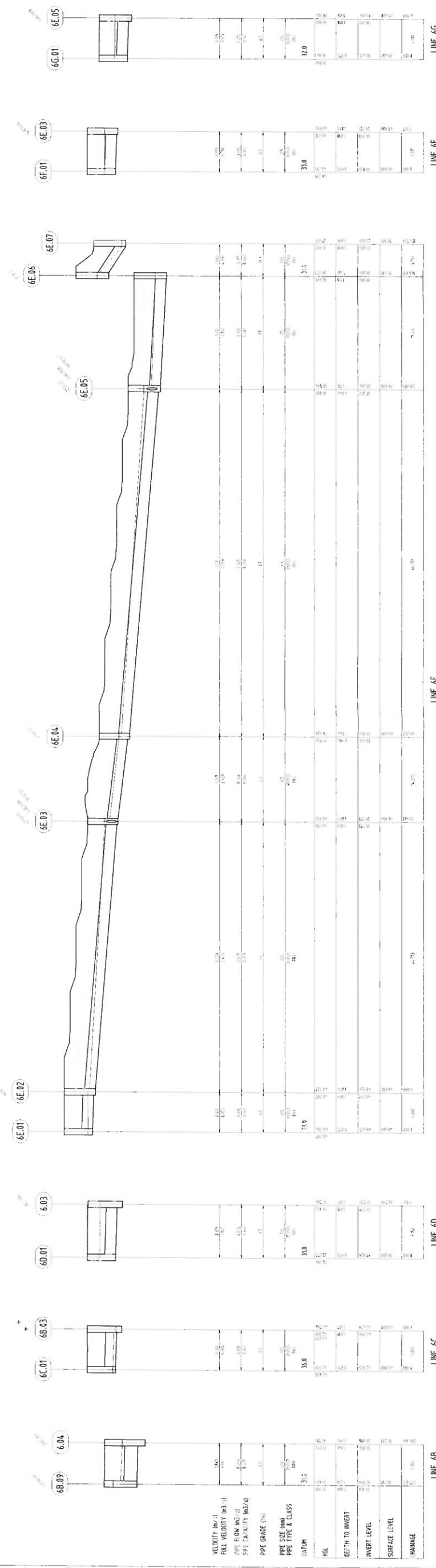
Cardno ITC Pty. Limited
Level 7, 100 York Street
Sydney NSW 2000
AUSTRALIA
Phone: +61 2 9439 8111
www.cardno.com.au

DATE: 31/05/2021
TIME: 10:00 AM
SCALE: 1:100

SA SH SH AS SHOWN
DEC11 ITC998-C402 03



LINE 68



LINE 66

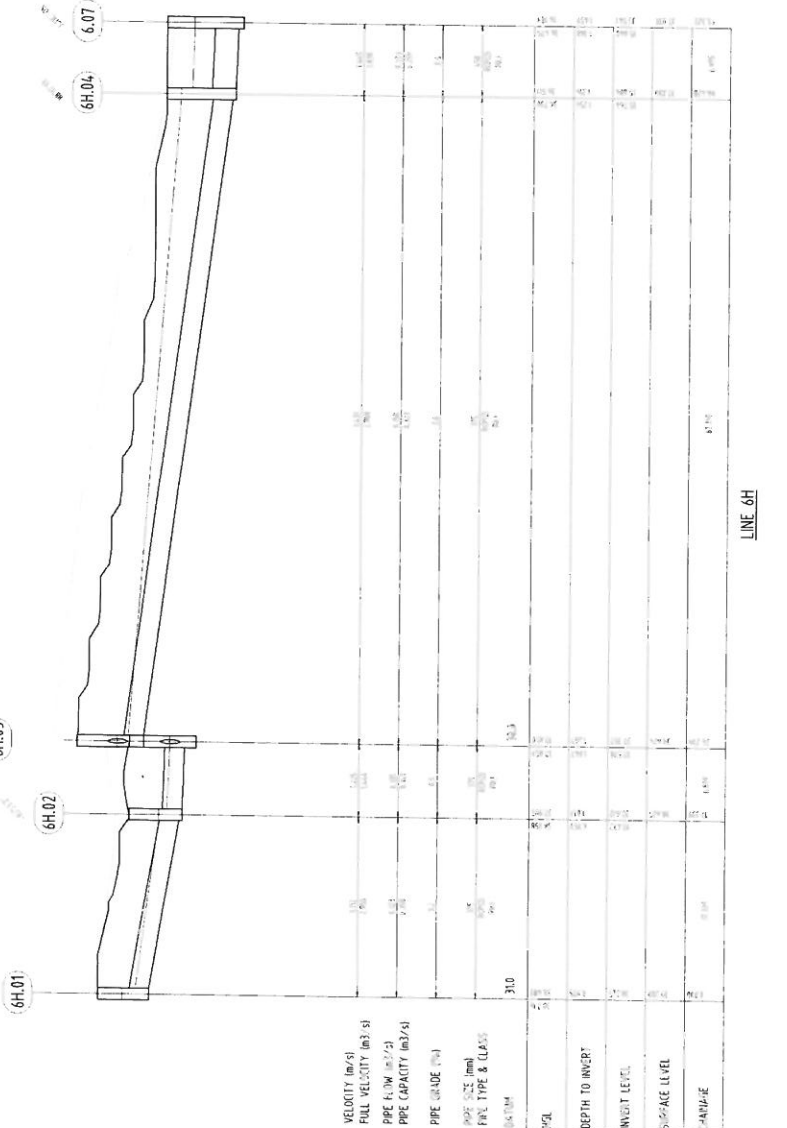
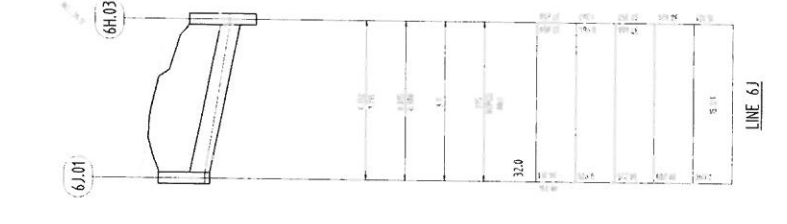
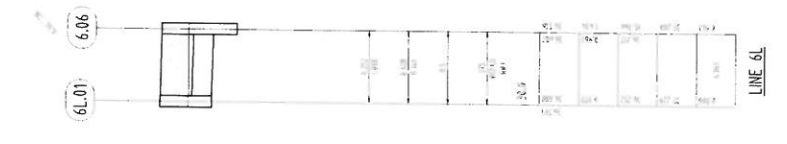
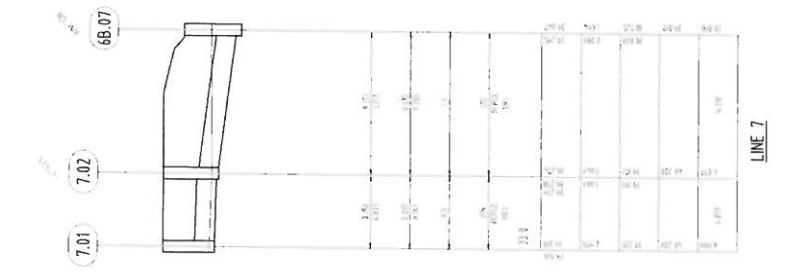
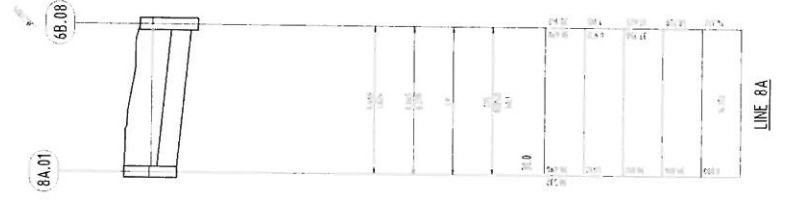
WERRINGTON SUBDIVISION
CHS OF FRENCH STREET AND THE
GREAT WESTERN HIGHWAY
WERRINGTON, NSW

STOPWATER LONGITUDINAL SECTIONS
SHEET 4 OF 5

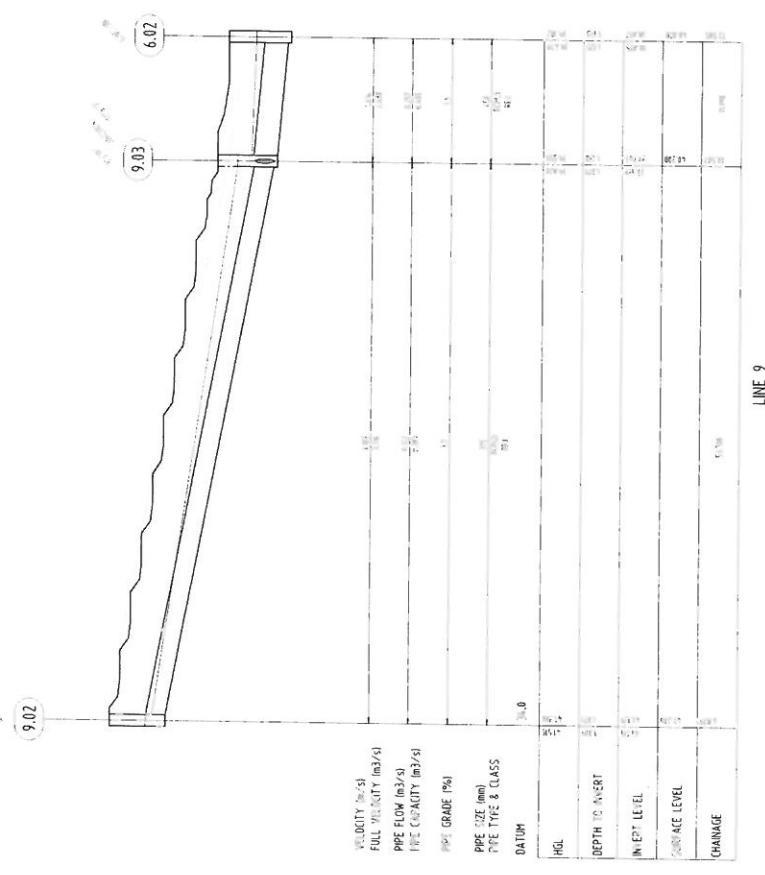
DATE: DEC11
PROJECT: ITCE008 - C403
STATUS: AS SHOWN

Cardno ITC Pty. Limited
LEVEL 7, 20 YORK STREET
SYDNEY NSW 2000
AUSTRALIA
Phone: +61 2 9492 8111
www.cardno.com.au

MIDDLE EAST PTY. LTD.



VELOCITY (m/s)	
FULL VELOCITY (m/s)	
PIPE FLOW (m ³ /s)	
PIPE CAPACITY (m ³ /s)	
PIPE GRADE (%)	
PIPE SIZE (mm)	310
PIPE TYPE & CLASS	
DATE	
INLET	
DEPTH TO INVERT	
INLET LEVEL	
SURFACE LEVEL	
GAINAGE	



VELOCITY (m/s)	
FULL VELOCITY (m/s)	
PIPE FLOW (m ³ /s)	
PIPE CAPACITY (m ³ /s)	
PIPE GRADE (%)	
PIPE SIZE (mm)	340
PIPE TYPE & CLASS	
DATE	
INLET	
DEPTH TO INVERT	
INLET LEVEL	
SURFACE LEVEL	
GAINAGE	

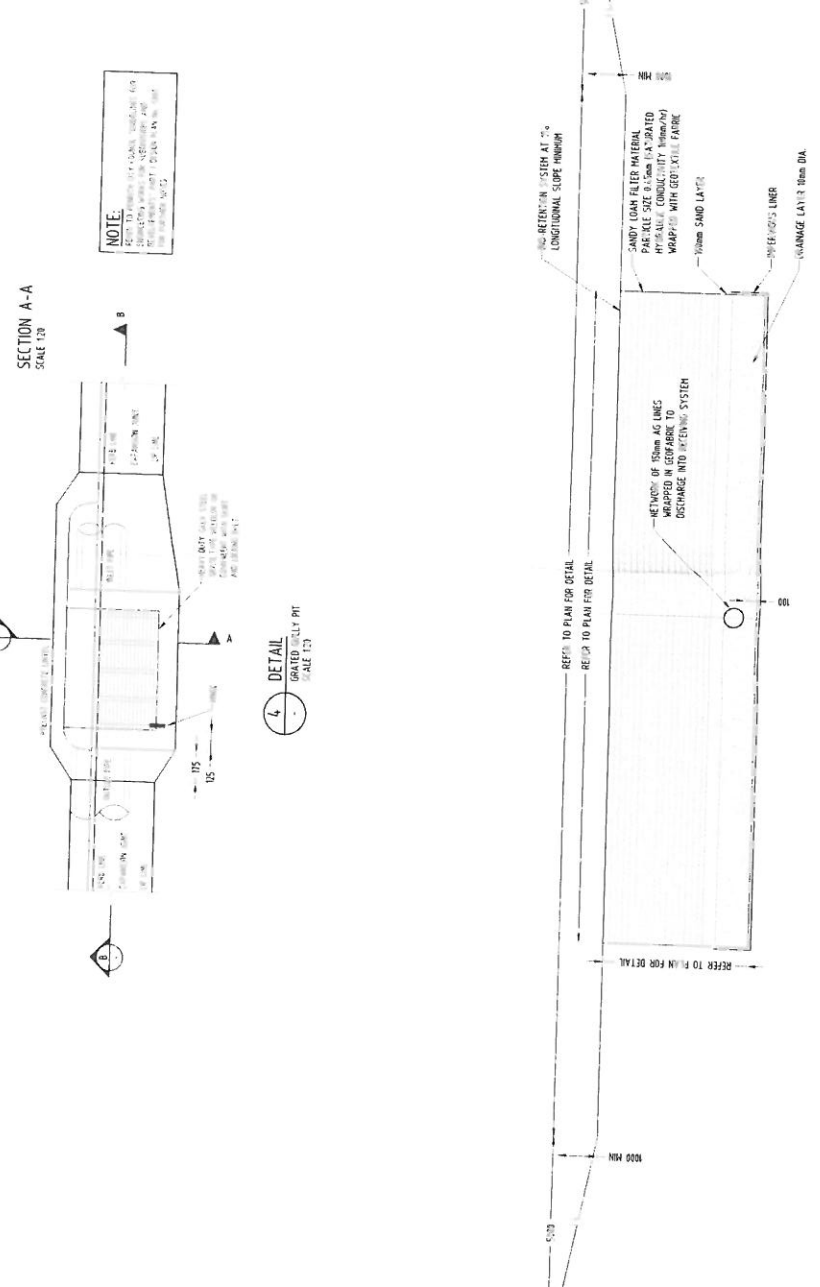
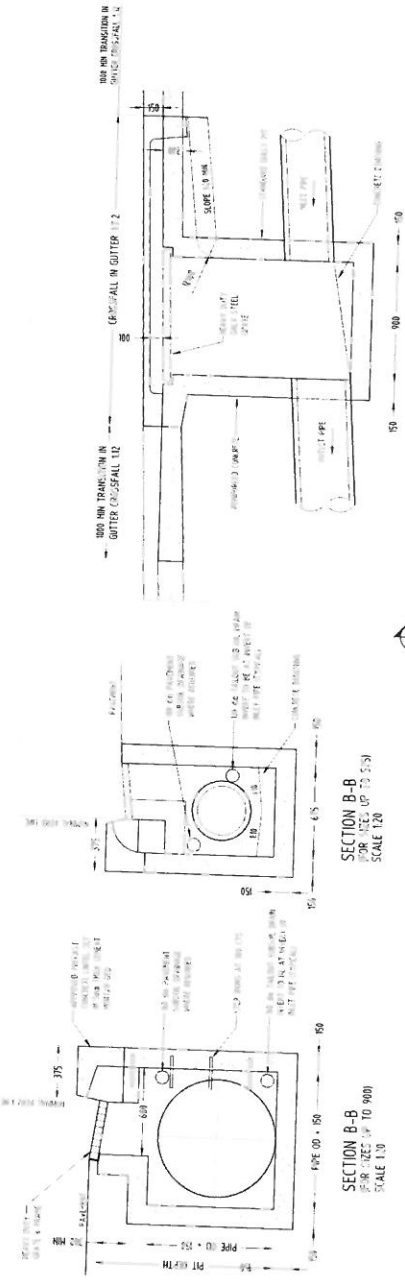
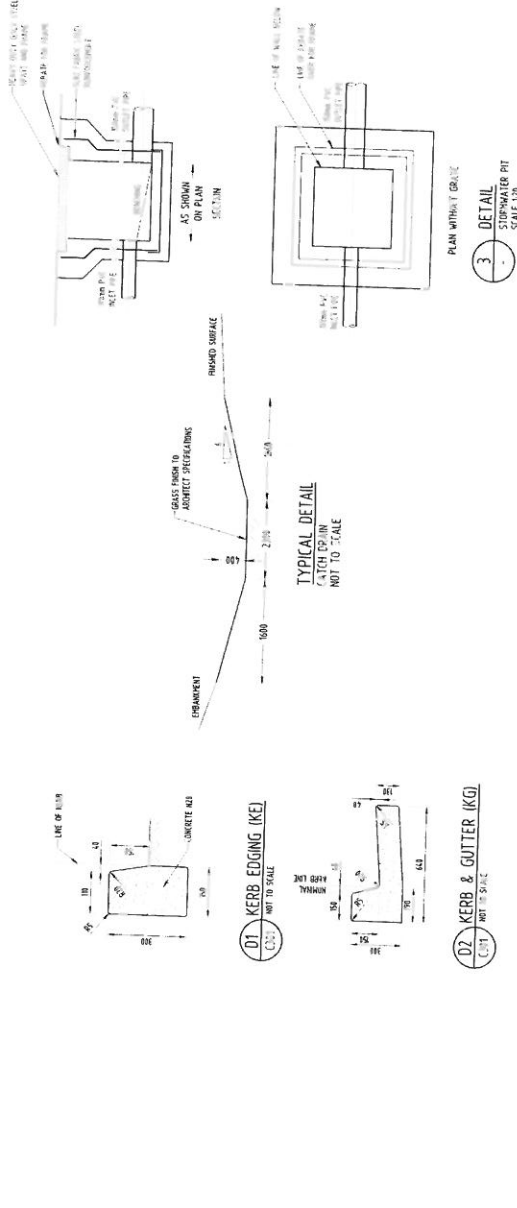
Cardno ITC
Shaping the Future

Cardno ITC Pty Limited
100 Pitt Street
Sydney NSW 2000
Australia
Phone: +61 2 9238 1111
www.cardno.com.au

WERRINGTON SUBDIVISION
CNR OF FRENCH STREET AND THE
GREAT WESTERN HIGHWAY
WERRINGTON, NSW

DATE: DEC-11
PROJECT: ITC6988 - C404
SHEET: 01

STORMWATER LONGITUDINAL SECTIONS
SHEET 5 OF 5





This plan/document relates to:
Development Application
No: 10546
YOU WILL NOT ATTEST TO THE
ACCURACY OF THIS INFORMATION

VEGETATION ZONE

CONSERVATION ZONE

EMPLOYMENT

EMPLOYMENT

EMPLOYMENT

GREAT WESTERN RAILWAY

MORLEY AVE

GEORGE STREET

LEGEND

 CUT
 FILL

<p>Cardno ITC Pty. Limited LEVEL 1, 33 YORK STREET SYDNEY NSW 2000 Phone: +61 2 9433 8300 Fax: +61 2 9433 8111 www.cardno.com.au</p>	<p>CLIENT MIDDLE EAST PTY. LTD.</p>	<p>PROJECT WERRINGTON SUBDIVISION CNR OF FRENCH STREET AND THE GREAT WESTERN HIGHWAY WERRINGTON, NSW</p>	<p>DATE MARCH 11</p>	<p>SCALE OF FULL SIZE 1:500@A0</p>
<p>STATIONING BRISBANE CANBERRA MELBOURNE PERTH</p>	<p>DATE 31/05/2021</p>	<p>DATE 31/05/2021</p>	<p>DATE 31/05/2021</p>	<p>DATE 31/05/2021</p>