Allans Creek Flood Study

Report Prepared For

Wollongong City Council

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Lawson and Treloar Pty Ltd
Level 2
910 Pacific Highway
Gordon NSW 2072
Australia

Telephone: 61 2 9499 3000
Facsimile: 61 2 9499 3033
Email: cltnsw@cardno.com.au

A.B.N. 55 001 882 873

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IMPORTANT INFORMATION

Due to the implementation of actions from the Allans Creek Floodplain Risk Management Plan and subsequent detailed investigations, this Flood Study has been updated to represent the current catchment conditions. These updates have resulted in two Addendum reports (Cardno Lawson Treloar, 2007, ref: R2346v2 and Cardno Lawson Treloar, 2009 ref: W4789v4), which supersedes a number of results presented in this study. It is therefore imperative that this Flood Study is read in conjunction with the Addendum reports. Peak water levels, flows and velocities presented in this report for some areas have been superseded and must be taken from the Addendum reports. Figures showing flood extents have also been superseded and must be read from the Addendum reports. It is the responsibility of the reader to ensure they have read the Addendum reports before using the presented data.

The areas impacted by the Addendum reports are shown on the following page.

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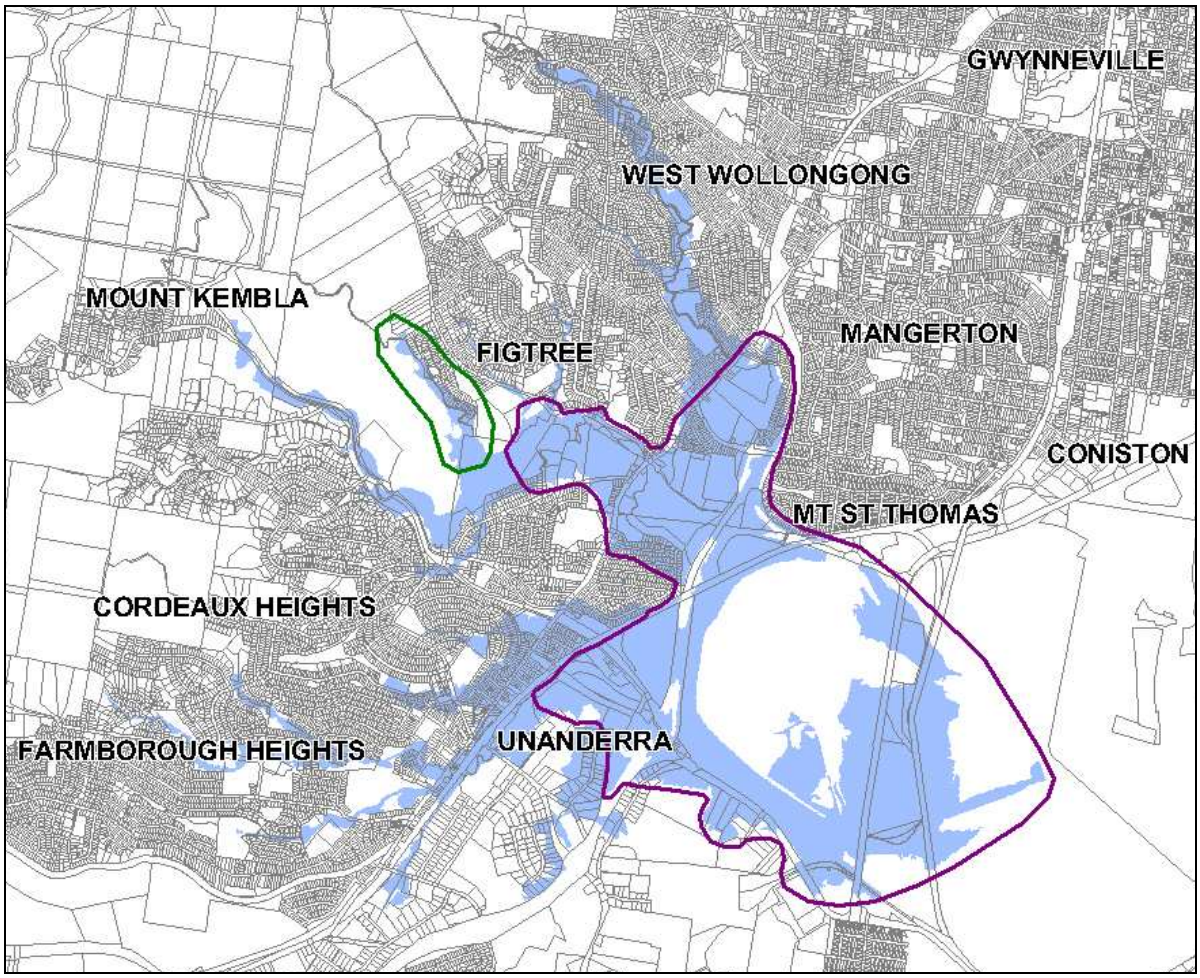
Area Impacted by Addendum 1 (Cardno Lawson Treloar, 2008, Ref: R2346v3) and Addendum 2 (Cardno Lawson Treloar, 2009, Ref: W4789v4)



	Updated Floodplain (PMF Extent)
	Area Impacted by Addendum 1
	Area Impacted by Addendum 2

NOTE: Flood levels, velocities and flows have been updated within the area shown above. Flood extents for the <u>entire floodplain</u> have been updated in Addendum 1, except for flood extents for the Darragh Drive area, which have been updated in Addendum 2.

FOREWORD

The State Government's Flood Policy is directed towards providing solutions to existing flood problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the policy, the management of flood liable land is the responsibility of Local Government. The State Government subsidises flood mitigation works to alleviate existing flooding problems and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government through the following sequential stages:

1. Formation of a Committee	Established by Council and includes community group representatives and State agency specialists.
2. Data Collection	Past data such as flood levels, rainfall records, land use, soil types etc.
3. Flood Study	Determines the nature and extent of the floodplain.
4. Floodplain Risk Management Study	Evaluates management options for the floodplain in respect of both existing and proposed development.
5. Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
6. Implementation of the Plan	Construction of flood mitigation works to protect existing development. Use of Environmental Planning Instruments to ensure new development is compatible with the flood hazard.

The Allans Creek Flood Study encapsulates both stages two and three of the management process for the Allans Creek Floodplain. This study has been prepared for Wollongong City Council by Lawson & Treloar Pty Ltd (now Cardno Lawson Treloar) to define the current flood behaviour and assist with later stages of the process leading to the preparation of a Floodplain Risk Management Plan.

EXECUTIVE SUMMARY

The Allans Creek catchment has an area of 42 square kilometres. The catchment lies to the south west of the Wollongong CBD and rises up to the Illawarra escarpment. The catchment is characterised by steep upper slopes with little development and a floodplain with a mix of residential, commercial and industrial development.

In the past, flooding in Allans Creek has caused property damage and posed a high hazard to the residents living in close proximity to the major drainage channels in the area. Additionally major transport links and local roads have been inundated by flood waters making evacuation difficult. Over the past decades, Allans Creek has experienced significant flood events including those in March 1975, March 1978, March 1983, October 1983, February 1984, June 1991, August 1998 and October 1999.

Flooding of developed areas within the catchment has been reasonably frequent in recent times. The rainfall characteristics of the Illawarra Escarpment, the steep channels and the high probability of culverts blocking during high discharge events exacerbate the flood behaviour of the area in comparison to other urban areas in New South Wales.

Accordingly, a flood study of Allans Creek catchment has been undertaken to define the nature and extent of flooding in the area for a range of design rainfall events. The study has been carried out for the existing catchment conditions.

The estimation of flooding behaviour was undertaken by developing two mathematical models to simulate the hydrologic and hydraulic aspects of flooding. The hydrological modelling package RAFTS was utilised to determine catchment runoff and for routing flows through the catchment. Predicted hydrographs from RAFTS were then input to the hydraulic model MIKE-11 for the determination of peak flood level, velocity and discharge for various design rainfall events. The design rainfall events investigated for this study were the 100, 50, 20, 10, 5 year average recurrence interval (ARI) events together with the Probable Maximum Flood (PMF).

The impact of variability of significant model parameters has been assessed by carrying out a sensitivity analysis. Hydraulic model parameters such as channel roughness, design flow hydrographs and design culvert blockage conditions have been assessed for sensitivity.

This study has produced flood behaviour information in both tabular, plan and longitudinal section forms that provide a management tool for the assessment of floodplain risk management options in the study area which will be carried out in the next stage of the floodplain management process.

GLOSSARY OF TERMS*

Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Australian Rainfall and Runoff (AR&R)	Engineers Australia publication pertaining to rainfall, runoff and flooding investigations in Australia.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as, or greater than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events. e.g. some roads may be designed to be overtopped in the 1 in 1 year or 100%AEP flood event.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain that causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river or drainage system.
Flood fringe	The remaining area of flood-prone land after floodway and flood storage areas have been defined.
Flood hazard	Potential risk to life and limb caused by flooding.
Flood-prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land. Floodplain Risk Management Plans encompass all flood-prone land, rather than being restricted to land subject to designated flood events.
Floodplain	Area of a river valley adjacent to the river channel, which is subject to inundation by the probable maximum flood event.

Floodplain management measures	The full range of techniques available to floodplain managers.
Floodplain management options	The measures which might be feasible for the management of a particular area.
Flood storages	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often, but not always, aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or significant increase in flood levels. Floodways are often, but not necessarily, areas of deeper flow or areas where higher velocities occur. As for flood storage areas, the extent and behaviour of floodways may change with flood severity. Areas that are benign for small floods may cater for much greater and more hazardous flows during larger floods. Hence, it is necessary to investigate a range of flood sizes before adopting a design flood event to define floodway areas.
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
High hazard	Possible danger to life and limb; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Integrated survey grid (ISG)	ISG is a global co-ordinate system based on a Transverse Mercator Projection. The globe is divided into a number of zones, with the true origin at the intersection of the Central Meridian and the Equator.
Low hazard	Should it be necessary, people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Mathematical/computer models	The mathematical representation of the physical processes involved in runoff and stream flow. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with rainfall, runoff, pipe and overland stream flow.
NPER	National Professional Engineers Register. Maintained by Engineers Australia.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The flood calculated to be the maximum that is likely to occur.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Annual Exceedence Probability.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Stormwater flooding	Inundation by local runoff. Stormwater flooding can be caused by local runoff exceeding the capacity of an urban stormwater drainage system or by the backwater effects of mainstream flooding causing the urban stormwater drainage system to overflow.
Topography	A surface which defines the ground level of a chosen area.

* Many terms in this Glossary have been derived or adapted from the NSW Government's *Floodplain Development Manual*, 2005.

LIST OF ABBREVIATIONS

AAD	Average Annual Damage
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AMG	Australian Mapping Grid
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
CMB	Catchment Management Board
DCP	Development Control Plan
DHI	Danish Hydraulics Institute
DIPNR	Department of Infrastructure, Planning and Natural Resources (now Department of Natural Resources and Department of Planning)
DLWC	Department of Land and Water Conservation (now Department of Natural Resources)
DNR	Department of Natural Resources
DPWS	Department of Public Works and Services (now Department of Commerce)
DUAP	Department of Urban Affairs and Planning (now Department of Planning)
EPA	Environmental Protection Authority (now Department of Environment and Conservation)
EPI	Environmental Planning Instrument
ESD	Ecologically Sustainable Development
FPL	Flood Planning Level
FRMC	Floodplain Risk Management Committee
FRMP	Floodplain Risk Management Plan
FRMS	Floodplain Risk Management Study
GIS	Geographic Information System
GSDM	Generalised Short Duration Method
ha	hectare
HAT	Highest Astronomical Tide

IEAust	Institution of Engineers, Australia (now referred to as Engineers Australia)
IFD	Intensity Frequency Duration
km	kilometres
km^2	Square kilometres
L&T	Lawson & Treloar
LAT	Lowest Astronomical Tide
LEP	Local Environment Plan
LGA	Local Government Area
LIC	Land Information Centre
m	metre
m^2	Square metres
m^3	Cubic metres
mAHD	Metres to Australian Height Datum
MHIs	Maximum Height Indicators
MHL	Manly Hydraulics Laboratory
MHWL	Mean High Water Level
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MIKE11	MIKE11 proprietary software package
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
mm	millimetre
m/s	metres per second
MSL	Mean Sea Level
NPWS	National Parks and Wildlife Service (now within the Department of Environment and Conservation)
NSW	New South Wales
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PWD	Public Works Department New South Wales

RAFTS	RAFTS proprietary software package
REP	Regional Environmental Plan
RTA	Roads and Traffic Authority
SCA	Sydney Catchment Authority
SCARM	Standing Committee on Agriculture and Resource Management
SEPP	State Environmental Planning Policy
SES	State Emergency Service
SRA	State Rail Authority (now RailCorp)
WBNM	Watershed Bounded Network Model
WCC	Wollongong City Council

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1. INTRODUCTION

1.1 Background

This report has been prepared by Lawson and Treloar (now Cardno Lawson Treloar) for Wollongong City Council to examine and define the flood behaviour of the Allans Creek floodplain. The study was originally commissioned as part of the revision of the existing flood study to assist with the preparation of the Floodplain Risk Management Study and Plan by Council in 1996. The revision to the Flood Study was presented in draft form to Council immediately prior to major flooding in August 1998. The catchment was subsequently subjected to major flooding again in October 1999.

During the time between and after the floods of August 1998 and October 1999, the study was suspended in order to gather all available data on the two floods and undertake some local studies to define specific flood behaviour on a smaller scale.

As a result, considerable revision has been undertaken to reschematise and recalibrate the models based on the information obtained from the two floods. Additionally, these floods identified the importance of culvert blockage in the assessment of flood behaviour in the catchment. Culvert Blockage (in accordance with Council's conduit blockage policy) has been incorporated into the assessments presented in this report.

1.2 Locality and Catchment Overview

Allans Creek is a partly developed catchment within the Wollongong City Council Local Government area. The catchment and study area are shown in Figure 1.1. The most prominent feature of the catchment is the Illawarra Escarpment, rising behind Wollongong up to Mount Kembla (534m) at its highest point. The sharp increase in elevation, with close proximity to the coast leads to intense orographic rainfall conditions within the catchment, resulting in high creek discharges for rare and extreme events.

Residential development is predominantly located in the middle to lower reaches of the catchment. The suburbs of Cordeaux Heights, Cringila, Farmborough Heights, Figtree, Mangerton, Mount Keira, Mount Kembla, Port Kembla North, Unanderra and West Wollongong are incorporated in the study area. Significant commercial and industrial areas are located in the lower portions of the catchment leading to Port Kembla Harbour which is the downstream boundary of the Creek system.

1.3 Floodplain Management Process

Flooding in Allans Creek has caused property damage and continues to pose a high hazard to some residents living within close proximity to the major creeks and drainage channels in the area. This has prompted Wollongong City Council, through the Allans Creek Floodplain Management Committee, to prepare a comprehensive Floodplain Risk Management Plan for the Allans Creek Floodplain. The staged movement toward the development of such a Plan is part of the NSW State

Government's program to manage major flood impacts and hazards in floodplains, in accordance with the Floodplain Development Manual (NSW Government, 2005).

One of the stages in the preparation of a Floodplain Risk Management Plan for Allans Creek is to undertake a detailed Flood Study for the catchment. Wollongong City Council commissioned Lawson and Treloar Pty Ltd (L&T) (now Cardno Lawson Treloar) to undertake this flood study to determine the flood behaviour for the 100, 50, 20, 10, 5 year ARI floods and Probable Maximum Flood (PMF). In accordance with these study objectives, the nature and extent of flooding through the estimation of design flood flows, levels and velocities has been determined.

1.4 Study Overview

The various components of the flood study can be grouped together in three stages:

- the collection of available historical rainfall and flood level data. Historical flood data was gathered through Council survey after the 1998 and 1999 flood events and an extensive resident survey. Literature was also available detailing flood levels and rainfall for other historic storms (Section 3).

- a full hydrologic investigation for the catchment using a hydrologic computer model (Section 4).

- the establishment of a hydraulic computer model of the major flowpaths in the catchment which was calibrated using the historical flood level data. The hydraulic model was then used with design rainfall conditions generating design hydrographs from the hydrologic model to simulate flood behaviour in the catchment (Section 5).

Presented as findings of this flood study are the envelope of peak flood levels for all ARI's and the PMF, the flood extents for all ARI's and the PMF flood profiles for all creek reaches examined (Sections 5, 6, 7 and 8).

2. STUDY OBJECTIVES AND METHODOLOGY

The objectives of the Flood Study were to:

- define existing flood behaviour for the mainstream flooding in the catchment.
- define design flood levels, velocities and flow distributions for the catchment.
- map the extent of flooding for the 100, 50, 20, 10 and 5 year ARI floods and the Probable Maximum Flood (PMF) for the catchment.

Two numerical modelling tools were developed:

- a hydrologic model to convert rainfall over the catchment into runoff. The hydrologic model combines rainfall information with local catchment characteristics to estimate runoff hydrographs throughout the catchment.
- a hydraulic model to convert the runoff hydrographs into water levels and velocities throughout the major drainage systems in the study area. The model simulates the hydraulic behaviour of the water within the study area by accounting for flow in the major channels as well as potential secondary flowpaths, which operate when the capacity of the channels is exceeded. It relies on boundary conditions, which include the runoff hydrographs produced by the hydrologic model and the appropriate downstream boundary.

In addition to the two numerical models, the Geographic Information System (GIS) *MapInfo Professional* was used in conjunction with the 12D digital terrain model software to evaluate flood extents.

3. DATA COMPILATION AND REVIEW

Data pertinent to flooding has been obtained from a number of sources and includes information required for input to both the hydrologic and hydraulic models. These data include:

- Council's land information
- ground survey commissioned for this study
- work as executed or design plans for various structures
- design information (eg *Australian Rainfall and Runoff*, 1999).

In addition to this, information required for the calibration of these models has also been obtained. These data include:

- historical rainfall data
- historical flood level data
- details of the proportion of blockage experienced at culverts throughout the catchment.

The data have been extracted from previous reports, data collection organisations or from Council's extensive database of flood information collated after the 1998 and 1999 flood events.

3.1 Previous Studies/Reports

A large volume of data existed for Allans Creek Catchment relating to flooding and development within the catchment. This data was used in the development and calibration of the hydraulic model.

A detailed list of all past reports/studies and additional input data is included in Section 10.

Specific reports that were found to have valuable reference data included:

- NSW Public Works South Coast Regional Office (July 1988). *Flooding of the Wollongong Area, 27th April - 1st May 1988*

- NSW Public Works South Coast Regional Office (November 1990). *Flooding of the Wollongong Area, 31st July - 3rd August 1990*

- NSW Public Works South Coast Regional Office (September 1991). *Flooding of the Wollongong Area, 6th June - 12th June 1991*

- NSW Public Works South Coast Regional Office (September 1991). *Wollongong Creeks, June 1991 Flood Levels Surveyed*

- NSW Public Works (June 1991) *Allans Creek Flood Study* Report No. PW89013. ISBN 073055175X.

- NSW Public Works (June 1991) *Allans Creek Flood Study - Compendium of Data.*

3.2 Land Information and Survey

3.2.1 Wollongong City Council Land Information

Wollongong City Council provided cadastral base information, contour files, land-use in the catchment (Local Environment Plan) and aerial photographs for use in both the hydrological and hydraulic modelling in digital format. The data was input to the *MapInfo Professional* GIS mapping package and used extensively for the study.

3.2.2 Allans Creek Flood Study (NSW public Works, 1991)

The survey information utilised in the NSW Public Works (1991A) study of Allans Creek considered only the lower reaches of the creek system. This survey was used as a basis of the sections in the downstream reaches of the study area.

3.2.3 Ground Survey Commissioned for this Study

Prior to undertaking further ground survey, the information listed above including reports on historical floods and available mapping (such as contour data and aerial photography), was reviewed in order to determine all possible flood flow paths. A major consideration of the model design was to locate the model cross sections in such a way as to reproduce all of the flow paths for major over-bank flooding up to and including the PMF.

Following this review, a brief was prepared for a registered surveyor to undertake a survey of the area to complement the existing information. This brief outlined the details and the methodology to survey the required hydraulic features of the catchment to enable definition of the flow channels, significant overland flood flow paths, culverts, bridges, weirs, detention basins and floodplain storage areas. This survey was undertaken by the Department of Public Works and Services (DPWS) in 1996.

Additional ground survey was obtained in 1999 (Council surveyors) to supplement the model in the American Creek area.

Due to the lapse in time from the original survey undertaken in 1996, a secondary survey was commissioned in 2003 to capture additional survey for flowpaths in the model, and to re-survey areas that had changed since the completion of the original survey.

These surveys were carried out by HATCH and Council Surveyors to Australian Height Datum. All level data provided in this report is based on this datum.

3.3 Historical Storm Rainfall Data

Historical storm events to be used for model calibration were identified from previous studies of the catchment and as required the 1998 and 1999 flood events were also

used for calibration. In all, four calibration events were identified each providing calibration data in different parts of the catchment. These are listed in Table 3.1.

Table 3.1: Calibration Events

Month	Year
February	1984
June	1991
August	1998
October	1999

Pluviograph data for the February 1984 storm was obtained from the Allans Creek Flood Study Compendium of Data (NSW Public Works, 1991B). Similarly, pluviograph data for the June 1991 storm was obtained from the report into flooding of the Wollongong Area on 6th to 12th June 1991 (NSW Public Works, 1991C).

Pluviograph data for the August 1998 and October 1999 storms was obtained from an array of sources. Data from the Bureau of Meteorology, Sydney Water, Department of Public Works and Services (Manly Hydraulics Laboratory) and Wollongong City Council data was utilised for the development of isohyetal charts and temporal patterns.

The location of the rainfall gauges used in model calibration for various years are shown in Figure 3.1.

3.4 Stream Gauges

The Department of Commerce operates a stage stream recorder on Byarong Creek. The gauge is located just upstream of the culverts under the F6 Freeway. This gauge was identified for use in the calibration of the 1998 and 1999 storm flood levels. However, the levels recorded by the stream gauge conflicted with the data associated with the hydraulic model set up. Photographic evidence of the 1998 flood showed that the channel just upstream of the F6 freeway was overtopped. The surveyed level of the top of bank showed that the water level would have to have reached a minimum level of 10.37 mAHD to overtop the banks, whereas the peak recording from the stream gauge was 8.4 mAHD. This discrepancy was not able to be resolved and as such the stream gauge was not used in the calibration of the hydraulic model.

Additionally, the gauge could not be used for calibration of the hydrological model for discharges of lesser storm events. This is due to the location of the gauge, just upstream of culverts that are known to block. The levels recorded by the gauge would therefore be subject to backwater effects. These backwater effects would cause variations in the stage discharge relationship developed for the gauge, and these would not be constant over time as the degree of blockage changed.

3.5 Recorded Flood Levels

3.5.1 1984 and 1991 Events

Flood level information for the 1984 flood was obtained from the Allans Creek Flood Study Compendium of Data (NSW Public Works, 1991B) and 1991 flood level information was obtained from the report into flooding of the Wollongong Area 6th to 12th June 1991 (NSW Public Works, 1991C). These reports detail historic flooding in the Wollongong area. A list of the recorded flood levels is included in Appendix A.

3.5.2 1998 and 1999 Events

Flood level data for the 1998 and 1999 storms was obtained from various sources. The primary source of information was the post-flood survey by Council of the peak water levels throughout the catchment. This data was supplemented by data from the Maximum Height Indicators (MHIs) installed throughout the catchment. It should be noted that not all MHIs were useful in the calibration process as some failed and others were overtopped.

Verification of flood levels was carried out by comparing the flood levels derived from the post-flood resident surveys for the 1998 storm. This involved extracting the depth of flooding above floor estimated by residents and using this in conjunction with the surveyed floor level for the particular property to develop a resident estimated peak water level for the property. An example of a response from Council's post-flood survey is included as Appendix B. Over 500 surveys from the Wollongong Local Government Area (LGA) were returned following the flood of 1998. Data from these surveys has been compiled into a central database for use in this and future studies.

A number of levels derived through the resident surveys were not used as a primary calibration source, as the depths are only estimates by the resident, and not measured. Additionally the surveyed floor level may not coincide with the point at which the resident recorded the peak above the floor flooding, as floor levels were generally surveyed at the front door, whereas flooding may have been reported over lower floor levels elsewhere in the house.

Detail of the nature of the storm events is given in Section 5.3.

4. CATCHMENT DESCRIPTION

4.1 General

The study area of Allans Creek encompasses several large creeks, all of which drain through Allans Creek into Port Kembla.

The Allans Creek catchment, on the south-western side of Wollongong, drains a catchment area of approximately 42km^2 from the Illawarra Range to the Port Kembla Inner Harbour. The western areas of the catchment near the Illawarra Escarpment are very steep and are predominantly forested. The middle reaches of the catchment are mainly rural with some forest and residential development, while closer to the coast the catchment floodplain is relatively flat with a blend of residential, industrial and commercial development. The Allans Creek catchment is shown in Figure 1.1.

Five main tributaries drain Allans Creek catchment:

- Byarong Creek (northern portion – Major Tributaries include Running Brook Creek and Ghost Creek)
- American Creek (central portion – tributaries include Branch Creek and Brandy and Water Creek)
- Charcoal Creek (southern portion - tributaries include Jenkins Creek)
- Allans Creek (southern – central portion and confluence of the tributaries)
- Unanderra Industrial Area Drains.

The result is a hydrologically complex system in the lower reaches, with the timing of the arrival of flows at different locations and the relative magnitude of flows resulting in complex flooding mechanisms.

Urban development in the catchment has altered a number of the waterways and floodplain areas considerably from their natural state. Flood flows in the urbanised lower parts of the catchment are complicated by over 70 bridge and culvert crossings. Filling of the floodplain and realignment and lining of some of the creek channels has also impacted on the original flow regime of the floodplain. Major transport links that traverse the floodplain are the F6 freeway, the Princes Highway the Illawarra Railway and the Cordeaux Coal Company Railway.

4.2 Existing Flood Behaviour

Flooding of Allans Creek is caused by a combination of geographic features of the catchment, along with development induced issues, causing a complex system of flow regimes and flooding mechanisms.

The characteristics that determine the existing flooding behaviour are detailed below.

4.2.1 Orographic Rainfall

The Illawarra Escarpment forms part of the Illawarra ranges. It is characterised by steep cliffs 200-300m high approximately 10km from the coast. The peak of the ranges is approximately 500 m high behind Wollongong. The steep rise in elevation

combined with the proximity to the coast generates unique localised meteorological effects. The orographic lifting of moist air masses generate intense rainfall bursts at the base of the escarpment that result in flash flooding of the catchment.

This rainfall mechanism is the major cause of flooding in the Allans Creek catchment.

4.2.2 Steep Rainfall Gradients

The orographic nature of the rainfall leads to highly variable localised rainfall throughout the catchment. In the lower reaches of the catchment the rainfall intensities are generally far lower than those recorded on the escarpment. This leads to differing flood mechanisms, and flood peak timing throughout the catchment. Creeks in the upper reaches of the catchment generally have a shorter critical duration, due to the high intensity bursts experienced as a result of the orographic effect, whereas the lower reaches have a longer critical storm duration in the order of six hours. This difference in critical storm duration is due to the greater catchment area contributing flows and the complex routing of the escarpment rainfall to the lower reaches.

An analysis of this phenomenon can be found in more detail in Little and Babister (1999) and Evans and Bewick (1999).

4.2.3 Steep Slopes in the Upper Catchment

The steep slopes in the upper catchment lead to faster response times in the upper catchments (ie the time to the peak flood level in an event is short). Steep catchment slopes result in short lead times for the flow to reach the main upper catchment waterways. Once floodwaters enter the main upper catchment waterways they also achieve high velocities up to 5.8 m/s due to the steep slopes of the creeks.

The lower reaches of the catchment have flatter subcatchments and flatter creek slopes, which lead to a longer time to reach the peak flood level.

The combination of the slope and distance gives the catchment complex hydrograph timing which requires the use of fully dynamic modelling systems to replicate the behaviour. The timing of all local hydrographs affects the flood levels in the lower reaches of the catchment, where the arrival of coincidental peak hydrographs from upstream catchments and local catchments can lead to elevated peak flood levels.

4.2.4 Lower Floodplain Areas

The lower reaches of the catchment form one large floodplain system.

The catchment below the Princes Highway forms a single broad floodplain area. Natural and artificial controls detain water in portions of the lower regions leading to widespread flooding. Major artificial hydraulic controls in this region are the Illawarra Railway, the F6 Freeway and its access ramps, and the Princes Highway.

4.2.5 Conduit Blockage

Conduit blockage (primarily culverts) has been shown to have a major effect on the flooding mechanisms of the catchment (Rigby and Silveri, 2001). Culvert blockages in both the 1998 and 1999 floods caused flood flow diversion resulting in new flood paths and increased damage within the floodplain. Critical culverts that were shown to block are the Princes Highway Culverts on all major crossings, Byarong Creek at The Avenue and the F6 Freeway, Byarong Creek at Koloona Avenue and Byarong Creek at Uralba Street.

Greater detail of culvert blockage effects and schematisation is given in Sections 6.3 and 7.2.

5. HYDROLOGICAL MODELLING

5.1 Model Selection and Development

Runoff hydrographs for the flood study were developed using the RAFTS rainfall/runoff-modelling package (XP Software, 1992). The subcatchment layout as used in the RAFTS model is shown in Figure 5.1.

The RAFTS model layout for the study was constructed by converting the Watershed Bounded Network Model (WBNM) hydrological model developed for the Allans Creek Flood Study (NSW Public Works, 1991A) into RAFTS format and adding the RAFTS model developed for the Unanderra Flood Study (WCC, 1994) together. This created a single model that encompassed the entire study area.

The combined model was then refined to ensure a homogeneous layout, with all sub-catchments being of approximately equal size. Sub-catchments were also adjusted to enable a seamless interfacing of the RAFTS model with the hydraulic model (MIKE11) (Section 6). The combined model subcatchments were further divided to account for different initial/continuing rainfall loss rates for pervious/impervious areas of the urban parts of the catchment (i.e. a split catchment modelling approach was adopted).

The RAFTS model has been developed using the split catchment approach to appropriately assess the behaviour of urban areas and allow future development scenarios to be easily incorporated and simulated. The split catchment approach assigns separate parameters for the developed and undeveloped areas of a sub-catchment, which essentially enables a flexible adjustment of the model parameters to incorporate urban development.

The combined hydrologic model has total catchment coverage that allows runoff hydrographs to be developed for the catchment through a single model. By encompassing the entire catchment in one model, issues relating to the relative timing of hydrographs flowing from the various tributary catchments have been eliminated.

A summary of the RAFTS data is provided in Table 5.1.

Table 5.1 RAFTS Subcatchment Data Summary

Catchment	Area (km^2)	Number of Subcatchments	Development Condition
American Creek	8.7	15	Partly Urban
Charcoal Creek	6.9	21	Partly Urban
Brandy & Water Creek	6.0	13	Rural
Byarong Creek	9.1	18	Partly Urban
Branch Creek	4.4	12	Partly Urban
Industrial Area	2.8	10	Industrial
Allans Lower Reaches	4.3	4	Industrial
Total	42.2	93	-

Lag times for routing accumulating catchment flows in the model were calculated on the basis of approximate stream velocities of 2.0 m/s for steep areas, 1.0 m/s for moderate slopes and 0.3 m/s for flat areas. These values are based on those reported in AR&R and have been applied to the specific topography of the subcatchment.

Important parameters used in the development of the RAFTS model are given below in Table 5.2.

Table 5.2 RAFTS Global Model Parameters

RAFTS Parameter	Forest	Urban Pervious Area	Urban Impervious Area
Catchment Manning's 'n'	0.1	0.025	0.015
Storage Delay Parameter, B	1.0	1.0	1.0
% Impervious	0	5	100

5.2 Model Calibration

As outlined in Section 3.4, there were no operational flow gauges available in the study area (Section 3.4 discusses the use of the existing Department of Commerce gauge) and hence the hydrological model could not be calibrated directly. A combined hydrology + hydraulics approach was adopted, where the hydraulic model was calibrated to measured peak flood levels with input from the hydrologic model, thus indirectly validating the results of the hydrologic model.

The results of the hydrologic model were checked in a direct sense by comparison with the Rational Method for rural catchments. The method is described in *Volume 1, Book 4* of *Australian Rainfall and Runoff* (IEAust, 1999). Three different sized areas were selected for the application of the Rational Method for the purposes of comparison:

- Area 1 is the entire catchment to the Port Kembla Rail Bridge
- Area 2 is American Creek catchment down to the Princes Highway Bridge, and
- Area 3 is Byarong Creek Catchment down to the Princes Highway Bridge.

Areas 2 and 3 were chosen as they represent creeks that are partly undeveloped, such that they would compare well to the rational method calculation results and would also represent large sub-catchments that contribute a large portion to the total flood flow.

Areas 1, 2 and 3 are shown in Figure 5.2. The comparison was made for various design flows with the results provided in Table 5.3.

The rational method calculations are included in Appendix C.

Table 5.3: Comparison of Peak Flow RAFTS Model and Rational Method Results

ARI	Location	Rational Method* (m^3/s)	RAFTS (m^3/s)	% Variation
100 year	AREA 1	750	897	16.4%
	AREA 2	381	495	23.0%
	AREA 3	190	231	17.7%
50 year	AREA 1	609	776	21.5%
	AREA 2	310	426	27.2%
	AREA 3	155	196	20.9%
20 year	AREA 1	465	629	26.1%
	AREA 2	235	340	30.9%
	AREA 3	118	155	23.9%
10 year	AREA 1	359	521	31.1%
	AREA 2	182	278	34.5%
	AREA 3	91	125	27.2%
5 year	AREA 1	279	436	36.0%
	AREA 2	141	228	38.2%
	AREA 3	71	101	29.7%
PMF*	AREA 1	1295	2206	41.3%
	AREA 2	745	1045	28.7%
	AREA 3	428	380	-12.6%

* The discharge for the PMF was not calculated using the Rational Method. The prediction equation derived by Nathan et al. (1994), as recommended in Book 6 of AR&R (I.E. Aust., 1999) was used to determine the peak flow. See Appendix C for details.

The results of the Rational Method Calculation comparison (Table 5.3) show that the RAFTS model predicts greater flow for all catchments and all ARI's by between 16 - 38%. This is reasonable as the rational method calculations used are for rural catchments, using the average 'East Coast Time of Concentration' formula as advised by AR&R (IEAust, 1999). As outlined earlier (Section 4.2), the response time of this catchment is shorter than the East Coast average, due to the steepness of the catchment. This leads to the use of lower than the actual time of concentration rainfall intensities for the calculation of catchment discharge. The partial urbanisation of the catchment, as incorporated in the RAFTS model will also lead to higher runoff than that estimated by the Rational Method. The estimate of the PMF discharge using regional relationships indicates that the discharge in Area 3 is slightly underestimated by the RAFTS modelling. This could be due to the long narrow nature of the catchment simulated in the RAFTS model. However, the extreme nature of the PMF and the uncertainties in its determination make this reasonably small variance acceptable for this one catchment. It should be noted that the total catchment flow is overestimated by the RAFTS model.

The hydrologic model is therefore assumed to provide reliable results that are conservative when compared to the Rational Method.

5.3 Historical Storm Event Modelling

Data for the historic storm events selected for modelling was compiled for the study for use in the calibration and verification process (Section 6.3). Rainfall isohyetal diagrams and temporal patterns for the four calibration storms are discussed in greater detail in Section 6.3.

The 1984 storm started at approximately 8pm on the 17th of February with rainfall ceasing at approximately 8pm on the 18th of February. During this 24 hour period 406.5mm was recorded at the Mount Keira pluviometer. The most intense period of the storm was from 8 am to 10 am on the 18th of February. Rainfall just south of the catchment near Dapto was shown to have an intensity close to that of the PMP.

The 1991 storm started on the 6th of June, however the most intense rainfall was recorded during the 10th of June, where 310.5mm of rainfall was recorded at Rixon's Pass. The rainfall period ended on the 12th of June.

The 1998 storm occurred on the 17th and 18th of August. The most intense period of the storm was from 7pm to 8pm on the 17th. Rainfall for this storm was most intense in the northern and upper reaches of the catchment. The rainfall period ended at approximately 9am on the 18th of August. For durations between 30 minutes and 6 hours the recurrence interval for pluviometers on the Illawarra escarpment were at or above the 100 year average recurrence interval (Evans and Bewick, 1999). The pluviometers in the lower reaches of the catchment recorded rainfalls of less than a 100 year ARI.

The 1999 storm occurred on the 23rd and 24th of October 1999, with the most intense period of rainfall occurring during the morning of the 24th. The heaviest rainfall was located over American and Byarong Creek catchments. Recorded rainfall totals for the storm were substantially lower than what is considered to be the 100 year ARI storm for the area as derived from AR&R (IEAust, 1999). The most intense 1 hour and 2 hour bursts of the October 1999 event were very close to a 20 year ARI intensity.

5.4 Design Rainfall

Design rainfall depths and temporal patterns for 100 year, 50 year, 20 year, 10 year and 5 year ARI events were developed using standard techniques provided in AR&R. Design storm rainfall intensities for the full range of storm frequencies and durations are presented in Table 5.4.

Owing to the relatively small area of the catchment, a uniform areal distribution reduction factor has been applied to the design storms in the hydrologic analysis. That is, no areal reduction factor has been applied to the intensities derived from AR&R as the catchment area is within the size requirements for application of the design storm intensities reported in AR&R. Application of an areal reduction factor would be applied in the case where only a single set of IFD intensities could be developed for a catchment that exceeded the sizing for which the design rainfall intensities were developed.

The Illawarra escarpment creates an intense difference in rainfall between the coast and the escarpment. For this reason it was not appropriate to use a single IFD curve for the entire catchment. Instead two IFD curves were used in modelling design rainfall, a more intense curve in the upper reaches of the catchment and a less intense relationship for the floodplain on the coast. This was possible as the design rainfall parameter maps within AR&R are sufficiently detailed for the Allans Creek catchment area.

The Probable Maximum Precipitation (PMP) intensities were estimated using the Generalised Short Duration Method (Bureau of Meteorology, 1994). Three rainfall intensities are presented in Table 5.4. The three values correspond to isohyets A, B and C defined for the spatial distribution of the PMP (Bureau of Meteorology, 1994).

Table 5.4 Design Rainfall Data (mm)

Frequency	Duration									
	30 min		1 hour		2 hour		3 hour		6 hour	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
100 yr ARI	167.3	140.1	124.5	101.2	85.8	68.6	68.7	54.3	46.8	36.4
50 yr ARI	149.1	126.5	110.0	90.9	75.6	61.3	60.4	48.4	41.1	32.2
20 yr ARI	125.5	108.6	91.4	77.4	62.5	51.8	49.8	40.7	33.7	26.9
10 yr ARI	107.6	94.8	77.5	67.1	52.8	44.6	42.0	34.9	28.3	22.9
5 yr ARI	93.8	84.5	66.7	59.3	45.2	39.0	35.9	30.4	24.1	19.8
PMP - A*	443.6		325.4		245.5		198.2		132	
PMP - B*	388.4		290.7		217.2		174.3		116.8	
PMP - C*	341.0		259.5		192.0		156.6		103.2	

Note: there is no upper and lower PMP intensity due to the spatial variability being taken into account by the PMP areas. A*, B* and C* denote the PMP region the rainfall depth applies to.

5.5 Design Temporal Patterns

Design temporal patterns used in the hydrologic modelling are those described in AR&R. The standard temporal pattern for Zone 1 – East Coast Australia were applied to the design rainfall intensities. For PMF the temporal pattern described by the Bureau of Meteorology (1994) was applied.

5.6 Design Flows

The design rainfall intensities developed (Table 5.4), were applied to the hydrologic model in order to predict design runoff hydrographs. The rainfall losses were assumed in accordance with the AR&R guidelines. Initial losses were modelled between 0 and 10mm, and the continuing loss values were between 0 and 2.5mm/h. Assuming conservative loss values is the means by which the design rainfall intensities were used to develop design hydrographs. Using this approach reduces the uncertainties in the process of catchment modelling that can lead to design rainfall estimation for a design event leading to a design flood of a different magnitude.

For PMF estimates, extremely low initial rainfall losses were assumed as per the recommendation of AR&R. Initial losses of 0 mm and continuing losses of 2.5 mm/h were assumed.

6. HYDRAULIC MODELLING

6.1 Establishment of Hydraulic Model

As described in Section 3, the hydraulic model was established from survey details of the channel cross section and floodplain along with details of hydraulic structures that form controls within the floodplain.

An hydraulic model was developed for the study using MIKE-11 version 2003 (SP1) (DHI, 2003). MIKE-11 is a dynamic hydraulic-routing model developed by the Danish Hydraulic Institute (DHI), which is widely used and has been shown to provide reliable, robust simulation of flood behaviour in urban and rural areas through a vast number of applications. The model has been tested over a period of many years in Australian rivers, creeks and urban systems. The wide variety of hydraulic structures which the model can handle (weirs, roads, levees, culverts, bridges etc) makes it a flexible and adaptable hydraulic analysis tool.

The model branch layout within MIKE11 was developed after a number of detailed site visits and thorough consideration of reports of historical floods, available mapping and additional survey. The model branch layout is shown in Figure 6.1.

A description of the creeks and the naming convention adopted in the model as well as the geographic name is provided below in Table 6.1.

Table 6.1 Model Nomenclature

Model Name	Geographic Name	Location
Allans Creek	Allans Creek	Flows into Port Kembla
American Creek	American Creek	Flows into Byarong Creek
Branch	Branch Creek	Flows into American Creek
Branch - Tributary	Unnamed	Flows into Branch Creek
Brandy & Water Creek	Brandy & Water Creek	Flows into American Creek
Brandy & Water Tributary	Unnamed	Flows into Brandy & Water Creek
Byarong Creek	Byarong Creek	Flows into American Creek
Charcoal	Charcoal	Flows into Highway Branch
Charcoal – Major Tributary	Charcoal	Flows into Charcoal Creek
Charcoal – Minor Tributary	Unnamed	Flows into Charcoal Creek
Cordo-Heights	Unnamed	Flows into American Creek
Freeway Branch	Unnamed	Flows into Allans Creek (lower)
Highway Branch	Unnamed	Flows into Allans Creek (lower)
Jenkins Creek	Jenkins Creek	Flows into Highway Branch
Running Brook	Running Brook	Flows into Byarong Creek
Unanderra Drain	Unnamed	Flows into American Creek

The location of cross sections in the model was determined by field inspection. Cross sections were located perpendicular to defined flow paths. The floodway cross sections were located so that flow controls on the floodplain could be modelled satisfactorily, with cross sections spaced to adequately represent variations in the drainage network of the floodplain. The location of cross sections in the model is shown in Figure 6.2. Full details of the model cross sections are shown in Appendix D.

All the major channels and flowpaths in the study area were modelled including those streets and parks in the floodplain which behave as active flowpaths in flood events. Areas such as the low-lying region from Arrow Avenue, through to Westfield at Figtree and The Avenue form complex inter-linked flowpaths. The flow regime in this area is essentially two-dimensional, and the model has been established in a quasi two-dimensional form with considerable attention to detail to ensure that the model accurately represented all the flow paths in the region.

Due to the quasi-2D nature of the model an understanding of the flow mechanisms is required to understand all of the cross section geometries. Many cross sections have what appear to be “vertical walls” that contain the flow on one bank. These “vertical walls” have been incorporated into the hydraulic model for a range of reasons. The primary reason for vertical walls is the “splitting” of a cross section to correctly model the conveyance in complex floodplain geometries. Where the cross section is “split” the cross section will be continued on a parallel branch sometimes with the same chainage, but a different branch name, this is shown schematically in Figure 6.3. A secondary reason for the inclusion of a vertical wall is the correct modelling of the front of buildings that would act to contain or obstruct flow. Generally not all flow will be contained by the buildings, as some flow will percolate through the building, into the building and in some cases through the yard. However, the assessment of the flow path from the site inspection has lead to the branch being modelled as “contained” by the front of the buildings. This effect is evident in Arrow Avenue (cross section 4024) and in Allans Creek in the upper reaches through the commercial area (Allans 4738). All cross sections have been checked that they appropriately represent the floodplain geometry up to the PMF. In most cases this required the cross section to extend beyond the PMF extent. However, in the case of the vertical walls, the cross section geometry was checked against the expected flow direction and hydraulic controls.

6.2 Downstream Model Boundary (Port Kembla Harbour)

A tidal boundary was developed for the downstream limit of the model. The tidal boundary used was an average tidal boundary that represented the mean high water level (MHWL) within Port Kembla. The tide was synchronised such that the peak of the high tide corresponded to the peak of the flood hydrograph at the downstream boundary for the critical duration in that reach. This is a conservative approach from a probabilistic perspective. The level with the greatest probability of occurring in Port Kembla is mean sea level (MSL, approximately 0 mAHD).

Recorded water levels for Port Kembla were used as the downstream boundary of the model for each of the calibration storms.

No storm induced ocean anomaly was included in the design tidal boundary prepared since, for example, the probability or recurrence interval of the 100 year ARI ocean level occurring at the same time as a 100 year ARI flood is much less than 100 years.

This assumption is similar to that adopted in the June 1991 Allans Creek Flood Study (NSW Public Works, 1991A). This report outlines details of a meteorological investigation which showed that the intense rainfalls that generate the peak discharges in Allans Creek are caused by upper air instability (thunderstorms) rather than intense low pressure systems. Generally peak ocean set up is caused by intense low pressure systems, and the wind fields generated by upper air instability (thunder) storms do not exist long enough to generate such elevated ocean levels.

6.3 Model Calibration

As outlined in Section 3.3, the storm events of February 1984, June 1991, August 1998 and October 1999 were used in the calibration of the hydraulic model. All storm durations were used for calibration purposes rather than for verification purposes as the data in each set had information for differing reaches of the system.

The primary calibration storm used was the 1998 storm, as this storm had the greatest number of data points and good records of rainfall data. The remaining storm events were then used to calibrate those reaches where data was not available from the 1998 storm and verify results for those reaches where there was commonality. Further details of each specific event are outlined below.

The calibrated Manning's n values used in the hydraulic model are shown in Appendix D for each of the cross sections used. The right hand scale and the minor line on each of the cross sections shows the Manning's n value at each location. A summary of the base Manning's n values used in the calibration process are provided in Table 6.2. These values were adjusted locally (where required) for the various land uses to achieve calibration.

Table 6.2 – Base Manning's n Values

Landuse	Base Manning's n Value
Dense Vegetation	0.15
Open Space	0.04
Roads/Paved Areas	0.02
Buildings/Urban Areas	0.15

Profiles of the peak water level and the recorded peak water level for each model reach with calibration data for the four calibration storms are shown in Appendix E.

6.3.1 Culvert Blockages

A major element of the calibration process was calibrating the catchment to the culvert blockages experienced for that particular rainfall event. No culvert blocked to the same degree for all calibration storms. Generally very high levels of blockage were experienced for the 1998 and 1999 storms with some blockages occurring during the 1991 storm and little evidence of blockage occurring for the 1984 storm.

In the storms where culverts blocked, many culverts blocked completely leading to the embankment above the culvert to act as a weir and in some cases water was diverted around the bridge or culvert. The water levels in the area upstream of the culvert and embankment were therefore elevated and caused worse flooding than if the culvert had been unblocked.

As such, each storm formed a portion of the calibration process. The model was calibrated for the physical factors, such as roughness, that are common to the catchment for all storms, followed by the storm-dependent element of culvert blockage. This ensured that the hydraulic model represented the actual physical condition, and no errors were made in attempting to calibrate the physical parameters to account for culvert blockage.

6.3.2 August 1998 Calibration

During the course of the study the catchment was flooded in August 1998. The severity of this flood lead to extensive survey of the peak flood levels reported by residents and indicated by debris marks throughout the catchment providing a good spread of reliable calibration data. Additionally the returned resident surveys were analysed to locate those properties that experienced over floor flooding. The surveyed floor level and reported over floor flood level were combined to give peak water level at the property.

In total there were 96 surveyed peak water level marks throughout the catchment including the peak levels recorded by the operational MHI's (Section 3.5.2). Returned resident surveys yielded a further 42 calibration points.

The rainfall recording facilities in the catchment were also greatly improved compared to the 1991 state, leading to greater accuracy in the temporal and spatial hydrological component of the calibration process.

In calibrating a flood model it is important to calibrate the model to a flood as close in rarity to the highest ARI to be modelled. This provides some certainty in the model calibration at the level of the highest flood mark, with flood levels above that mark being an extrapolation of the model calibration. As the 1998 flood was (in some reaches) close in flood level to the previously reported 100 year ARI flood it was important to calibrate the models to this event to achieve a higher level of certainty in rare to extreme flood events.

The isohyetal charts developed for the 1998 storm are presented in Figure 6.4. This figure was developed from available data from the rain gauges shown in Figure 3.1. The cumulative rainfall trace observed at the gauges used within the hydrologic modelling are shown in Figure 6.5.

The results of the final calibrated model, run with the August 1998 storm rainfall are shown in Appendix E. These figures are shown as a profile of the peak water level with the calibration points shown on the flood profile. Only those reaches with calibration points are shown.

6.3.3 February 1984 Calibration

The storm event of February 1984 was selected as details of recorded pluviometer data existed for the catchment, as well as recorded peak water levels throughout the catchment. Data was sourced from the Allans Creek Flood Study Compendium of Data (NSW Public Works, 1991B). The isohyetal chart developed for the compendium of data was applied to the RAFTS model, and the gauge specific temporal patterns applied to develop the calibration hydrological model. The applied NSW Public Works (1991B) isohyetal lines are shown in Figure 6.6 and the temporal pattern for the applied pluviometers is shown in Figure 6.7.

In total there were 29 calibration points recorded. These points were assigned a chainage in the model and are shown in Appendix E as profiles of the modelled calibration peak water level and the calibration points.

6.3.4 June 1991 Calibration

The Public Works Department undertook a study into the flooding of the Wollongong area from the 6th of June to the 12th of June in 1991 (NSW Public Works, 1991C). This study compiled recorded rainfall in the Wollongong area, as well as peak flood levels. The rainfall data presented in the NSW Public Works study was analysed and isohyetal lines developed for the Allans Creek catchment. The isohyetal lines are presented in Figure 6.8. The trace for the pluviometers used in the development of the hydrological model is presented in Figure 6.9.

In total there were 11 calibration points recorded that were useful for this study. These points were assigned a chainage in the model and are shown in Appendix E as profiles of the modelled calibration peak water level and the calibration points.

6.3.5 October 1999 Calibration

In 1999 the catchment was flooded again to a similar extent to the 1998 flood. However, the temporal pattern, and spatial variability over the catchment varied greatly from the 1998 storm. Generally, the storm was most intense over American and Byarong Creeks with close to 20 year ARI intensities for the shorter durations. The rainfall data sourced for this study was analysed and isohyetal lines developed for the Allans Creek catchment. The isohyetal lines are presented in Figure 6.10. The trace for the pluviometers used in the development of the hydrological model is presented in Figure 6.11.

A flood level survey was carried out after the 1999 storm. This data and data from the MHI's (Section 3.5.2) was used in the calibration of the hydraulic model.

In total there were 84 calibration points recorded that were suitable for use for calibration. These points were assigned a chainage in the model and are shown in Appendix E as profiles of both the modelled calibration peak water level and the calibration points.

6.3.6 Results of Calibration

The model was generally calibrated well. The most critical component of the calibration process was the determination of the culvert blockages that applied to each of the storms. The majority of the calibration points were located on or near to roads, and the ability to calibrate to these recorded levels was affected by the culvert blockage modelled.

Model roughness was the next most important parameter for model calibration. The adopted general roughness values (Table 6.2) were modified within the appropriate range for the particular land use.

Some calibration points were ruled out as they were either too high or too low for valid calibration. The levels that were too high were investigated and often found to be levels from local overland flow passing into the main streams. Assessment of these overland flow paths is not within the scope of this catchment wide flood study. The few levels that were too low were identified as they were often at or just above the surveyed creek invert at that location. These levels may have arisen from inaccuracies in the survey or in the definition of the peak water level mark from the resident survey.

7. DESIGN FLOOD ESTIMATION

7.1 General

The calibrated hydraulic model (Section 6) was used for design flood estimation. Design flood inflow hydrographs were obtained from the RAFTS model (Section 5). These hydrographs were applied to the hydraulic model, which represents the floodplain under current catchment conditions. A total of 65 inflow hydrographs were used in the hydraulic model.

The 30 minute, 1, 2, 3 and 6 hour design storm events were applied to the models in order to estimate the critical storm duration for different reaches in the floodplain.

Generally the shorter duration storms were critical in the upper reaches. The 30 minute, 1 hour and 2 hour were critical at different creeks in the upper reaches. The 1 and 2 hour durations were critical on the larger creeks. The longer durations of 3 and 6 hour were critical in the lower reaches where the timing of the various creeks was important to the peak flow and where the volume of the hydrograph determined the peak water level.

7.2 Design Culvert Blockage

Extensive consultation between Wollongong City Council, the Department of Natural Resources, Lawson and Treloar and other consultants preparing similar studies for adjacent areas, led to the development of a design blockage policy to be used in the modelling of peak water levels for design storms.

The policy adopted by Council to represent blockage throughout the catchment is as follows.

i. 100% blockage for structures with a major diagonal opening width of <6m

ii. 25% bottom up blockage for structures with a major diagonal width of >6m.

   For bridge structures involving piers or bracing, the major diagonal length is defined as the clear diagonal opening between piers/bracing, not the width of the channel at the cross section.

iii. 100% blockage for handrails over structures covered in (i) and for structures covered in (ii) when overtopping occurs.

iv. Culvert blockage criteria applies only to exceedence probabilities greater than 10 year ARI. That is, there are no culverts blocked in the determination of 10 and 20 year ARI flood levels.

The impact of blockage of any culvert/bridge in the catchment is manifold. The blockage causes an increase in the flood levels upstream of the culvert and a decrease downstream. Depending on the steepness of the creek, the impact of the culvert may or may not be transferred to a downstream culvert. For example, blocking the Koloona Avenue culvert would not have any significant impact on flood

levels at the Uralba Street Bridge. On the other hand, blocking The Avenue culverts on Byarong Creek would have an appreciable impact on flood levels at the Freeway culverts.

The blockage can also have significant impact on the timing of the hydrographs at the confluence of major creeks. This in turn can have either a beneficial impact if the timing of various hydrograph peaks are staggered or an adverse impact if the peaks coincide. Thus a number of culvert blockage combinations are possible, which may result in the coincidence of flood peaks at the confluence that may result in more adverse flooding conditions.

In addition, in the lower reaches of the creeks, a combination of blocked/unblocked culverts can have significant adverse impacts. For example, on Byarong Creek various blockage combinations for the Princes Highway Bridge, The Avenue culverts and the Freeway culverts will have different impacts.

There are a large number of blockage combinations for culverts and application of the Blockage Policy for all combinations would result in a very high number of model assessments. However, after careful review of the hydraulic behaviour of all the creeks in the catchment, eight different combinations of blockages were selected. The criterion for selection for these blockage scenarios was to establish the highest possible flood level primarily to ensure that the flood planning level is set accordingly.

Since cross-catchment flows occur only at few places in the Allans Creek catchment and the impact for a particular creek, upstream of the applied blockage, is isolated, it was possible to combine the blockage impact assessment for a number of creeks.

The following blockage scenarios were considered for design model runs for various ARI's and durations.

- DESIGN1: All culverts open, no blockage

- DESIGN2: All culverts blocked as per Blockage Policy

- DESIGN3: The Princes Highway is the first major hydraulic control for various creeks in the catchment. The following culverts/bridges were blocked as per the Blockage Policy to determine the impact of the Princes Highway.

    - Allans branch at Princes Highway
    - American Creek at Princes Highway
    - Byarong Creek at Princes Highway
    - Charcoal Creek at Princes Highway
    - Jenkins Creek at Princes Highway
    - Unanderra Drain at Princes Highway
    - Freeway branch at Coal Co. Railway

  The rest of the culverts were kept open.

- DESIGN4: Unanderra - Dapto railway line and the Freeway are the next major controls. Their impact along with the impact on some major tributaries was modelled. The following culvert/bridges were blocked:

  - Jenkins Creek at Railway
  - Charcoal Creek at Railway
  - Allans branch at Railway
  - Unanderra Drain at Railway
  - Freeway branch at Five Islands Road
  - Byarong Creek at The Avenue
  - Branch Tributary at O'Briens Road
  - Branch Creek at O'Briens Road
  - Cordeaux Heights branch at Gibson Road
  - American Creek at Cordeaux Road.

  The rest of the culverts were kept open.

- DESIGN5: This run established the impact of the Freeway on Byarong and American Creeks. It included the impact of other culverts as well. The following culverts/bridges were blocked:

  - Byarong Creek at Freeway
  - American Creek at Freeway
  - Highway branch at Berkeley Road
  - Freeway branch at Berkeley Road
  - Allans Creek at Blackman Parade

  The rest of the culverts were kept open.

- DESIGN6: This model run was a combination of various blockages, which were considered important. The following culverts/bridges were blocked:

  - Byarong Creek at Railway
  - Highway branch at Five Islands Road
  - Freeway branch at Freeway Ramp
  - Unanderra Drain at Freeway

  The rest of the culverts were kept open.

- DESIGN7: This run considered the impact of Freeway alone. The following culverts/bridges were blocked:

  - Freeway branch at Freeway
  - Highway branch at Freeway
  - Unanderra Drain at Freeway

  The rest of the culverts were kept open.

- DESIGN8: This run looked at blockages in Byarong creek and American Creek at the Freeway. Charcoal Creek was also included. The blocked culverts were:

  - Byarong Creek at Princes Highway
  - Byarong Creek at The Avenue
  - Byarong Creek at Freeway
  - American Creek at Freeway
  - Charcoal Creek at Tallegalla Street.

  The rest of the culverts were kept open.

7.3 Results

A summary of model results for predicted flood behaviour for all ARI's at each cross section is provided in Appendix F. The results include peak water level and the critical duration storm for which this peak level occurs for each model cross-section. Appendix G provides the peak flow at all bridge crossings and a few additional locations throughout the study area. Peak flows are reported for the fully blocked culvert case (Design 2) and the fully open case (Design 1). These results have been extracted such that the flow reported includes flow through, over and around each of the bridge structures across the full flood width. In some instances such as the F6 near Byarong and American Creeks the two creek systems combine and overtop the freeway at the sag between the two creeks. Where this is the case it is clearly noted in the description of the location in Appendix G.

The results are also provided as longitudinal profiles in Figures 7.1 to 7.14 of the major creeks in the floodplain. The flood profiles are provided for:

- Allans Creek (Figure 7.1)
- American Creek (Figure 7.2)
- Arrow Avenue (Figure 7.3)
- Branch Creek (Figure 7.4)
- Branch Tributary (Figure 7.5)
- Byarong Creek (Upper) (Figure 7.6)
- Charcoal Creek (Figure 7.7)
- Charcoal Creek Major Tributary (Figure 7.8)
- Cordo Heights (Figure 7.9)
- Freeway Branch (Figure 7.10)
- Highway Branch (Figure 7.11)
- Jenkins Creek (Figure 7.12)
- Running Brook Creek (Figure 7.13)
- Unanderra Drain (Figure 7.14).

Flood extents are provided for 100, 50, 20, 10, and 5 year ARI floods and PMF in Figures 7.15 through 7.20. It should be noted that the extents have been based on the surveyed information where available. Elsewhere, 2m LIC contour data has been used to map the extent. The extents have been prepared to provide a guide as to the extent of flooding and given the broad scale nature of the investigation should not be used for the assessment of flood extent on individual properties.

The results presented in Appendix F and Figures 7.1 to 7.20 represent the peak flood level at each location when all storm durations and blockage scenarios have been considered. Therefore the flood profiles represent the peak water level envelope.

Further discussion of the results can be found in Section 8.

7.4 Sensitivity Analysis

A sensitivity analysis was carried out to determine the range of uncertainty in the model results for the critical 100 year ARI design flood event. The following model parameters were tested for sensitivity:

- Channel roughness – Increased/Decreased by 20%
- Catchment runoff – Increased/Decreased by 20%
- Culvert blockage – Fully open compared to design blockage criteria.

Details of the approach and results of the sensitivity analysis can be found in Section 8.2.

8. DISCUSSION OF RESULTS

8.1 Flooding Behaviour

Flooding behaviour in the Allans Creek Catchment is complex and controlled by the mechanisms described in Section 5 of the report. In general culvert blockage is the dominant factor influencing flood behaviour.

Analysis of the results from the eight design-blockage scenarios indicates that not only is the percentage blocked critical, but the combination of blockages is also important. Both resident reports of flooding and the process of calibrating the model identified areas where the combination of blockages results in the elevation of the peak water level above the level that would be reached had all culverts been modelled as blocked simultaneously. This is because some blocked culverts impose a lesser storage effect than others, leading to flood waters propagating to the next blocked culvert. This becomes critical in the lower reaches of the catchment where backwater effects propagate further upstream and over a wider floodplain area. In this situation a blockage can result in a significant storage effect.

Generally the Princes Highway is the first major control on all branches. Specifically floodwaters in Byarong Creek are diverted via Arrow Avenue and onto the Princes Highway towards Figtree Westfield and ultimately towards Lysaght Oval. Likewise the culverts under the Avenue, once blocked, divert water towards Figtree Westfield and Lysaght Oval. The combination of these two flood waves worsens flooding in the lower Figtree area. Blockage of the culverts under the F6 Freeway also exacerbates flooding this region.

Blockage of the Princes Highway bridges on American, Charcoal and Jenkins Creeks has a measurable effect upstream, with the resulting backwater exacerbating peak flood levels. For example, the backwater drowns out the Tallegalla Street footbridge on Charcoal Creek, and on American Creek the backwater propagates upstream to Suttor Place.

Blockage of both the Byarong Creek and American Creek culverts under the F6 Freeway leads to the worst possible flooding combination for the region between the Princes Highway and the F6 Freeway. Flood flows are detained behind the Freeway, and are forced to flow downstream by overtopping the Freeway via the low point on the Freeway, near Lysaght Oval. The American Creek and Byarong Creek catchments form a large portion of the Allans Creek catchment and with the F6 Freeway culverts blocked, a significant amount of flow is forced over the Freeway leading to the likely closing of the Freeway during rare and extreme events.

A check was carried out as to the volume of the 100 year ARI hydrograph and the volume of available storage upstream of the F6. The results of this analysis showed that the available storage upstream of the F6 is approximately 2.04 million m^3, whereas the volume of the 100 year ARI 6 hour storm is approximately 6.92 million m^3. Thus the volume of the hydrograph in the 100 year ARI is more than three times the available storage area in the lower floodplain. Consequently these areas are expected to be substantially inundated where flows are detained (e.g. when culverts

block). This analysis validates the results of the modelling with the culverts fully blocked.

Blockage of the culverts under the Illawarra Rail Line at Charcoal Creek, Allans Creek, Jenkins Creek and Unanderra Drain all lead to overtopping of the railway line. In the north of the catchment the combined flow of American Creek and Byarong Creek overtop the railway line, even though the railway bridge is only blocked 25% under the design blockage criteria for spans greater than 6 m. This is due to the large amount of flow passing the bridge. In the south the railway is located either in a cutting or at the natural surface level and as such is exposed to overtopping by the creeks.

All culverts on Charcoal, Jenkins, Allans Creeks and Unanderra Drain are blocked 100% under the design blockage criteria.

A list of the overtopping durations and depths for the Princes Highway, Illawarra Rail line and the F6 Freeway for rare and extreme events is provided in Table 8.1.

Table 8.1 Major Transport Link Flooding

	Duration Overtopped at PMF (hrs)	Depth of flood over road/rail at PMF (m)	Duration Overtopped at 100 year ARI (hrs)	Depth of flood over road/rail at 100 year ARI (m)
Princes Highway				
Allans Creek	2	0.65	*	*
American Creek	9.5	3.17	8	1.69
Byarong Creek	5.5	1.19	4	0.88
Charcoal Creek	9	1.61	8	1.02
Jenkins Creek	7	1.13	4	0.89
Unanderra Drain	8	1.04	8	0.41
Illawarra Railway				
Jenkins Creek	7.5	1.20	4.5	0.97
Charcoal Creek	7.5	3.04	4.5	1.76
Allans Creek	3	0.81	*	*
Unanderra Drain	7	2.27	4.5	0.55
American Creek	2	0.38	-	-
F6 Freeway				
American/Byarong Creeks	8.5	3.43	8	2.17
Allans Creek/ Unanderra Drain	5.5	1.20	*	*
Freeway Trib Branch	5	0.67	3	0.36

* These roads are not overtopped immediately above the creek, however they are overtopped in the immediate area as shown in the flood extent mapping (Figures 7.15 and 7.20).
Note: The times provided are for the peak overtopping duration which may not coincide with the storm duration that yielded the peak overtopping depth.

A summary of flood behaviour at key locations within the catchment is provided in Table 8.2. The flood data presented is for the peak flood condition from either the open (unblocked) or closed (blocked) condition. For a full list of both the open and closed condition discharges at all crossings, see Appendix G.

Table 8.2 Flood Behaviour at Key Locations

Location	PMF			100 year ARI			50 year ARI			20 year ARI			10 year ARI			5 year ARI		
	H (m AHD)	Q (m^3/s)	V (m/s)	H (m AHD)	Q (m^3/s)	V (m/s)	H (m AHD)	Q (m^3/s)	V (m/s)	H (m AHD)	Q (m^3/s)	V (m/s)	H (m AHD)	Q (m^3/s)	V (m/s)	H (m AHD)	Q (m^3/s)	V (m/s)
Byarong Creek																		
U/S Koloona Ave	36.02	387	1.4	35.51	214	1.3	35.42	184	1.4	35.27	144	1.3	34.74	117	1.3	34.51	93	1.3
U/S Princes Hwy	17.61	448	0.7	17.11	210	0.5	17.03	177	0.5	16.90	138	0.5	16.06	111	0.4	15.85	91	0.4
U/S The Avenue	14.41	716	2.6	13.09	289	2.6	12.97	204	2.6	12.80	152	2.6	9.93	88	2.5	9.62	72	2.4
American Creek																		
U/S Princes Hwy	14.27	956	1.5	12.79	367	1.5	12.61	310	1.6	12.38	239	1.6	11.67	188	1.5	11.36	155	1.5
U/S Freeway*	13.81	1355	0.7	12.55	512	0.6	12.50	454	0.6	12.15	374	0.7	8.23	294	0.7	7.92	241	0.6
Jenkins Creek																		
U/S Princes Hwy	18.53	79	1.2	18.28	38	1.2	18.22	33	1.1	18.13	25	1.2	15.00	21	1.1	14.71	19	1.1
Charcoal Creek																		
U/S Blackman Pde	26.60	103	1.0	26.19	52	0.9	26.11	45	0.9	25.98	35	0.9	25.62	28	0.9	25.48	22	0.9
U/S Princes	17.46	360	1.7	16.88	124	1.4	16.80	96	1.4	16.71	74	1.5	15.04	58	1.4	14.48	47	1.4
Allans Creek																		
U/S Springhill Rd	10.43	1279	0.8	10.06	545	1.6	9.98	476	1.6	9.78	385	1.6	9.44	334	1.4	7.93	261	1.3

Note:
- H Flood Height (mAHD)
- Q Discharge (m^3/s)
- V Velocity (m/s)
- *American Creek flows reported at the Freeway include cross catchment flow from Byarong Creek

The complex nature of the flow mechanisms within the Allans Creek floodplain require detailed description for analysis. The quasi 2D nature of the model leads to complex flow distributions and peak water levels (Section 6.1). There are many long cross sections that have been split into two or three branches at local high points. These split points are important to determine the extent of flooding at lower ARI's. However, they are often inundated at the 100 year ARI and the PMF. This leads to differing flood levels at various locations on the long cross section between the individual branches. Refer to Figure 6.3 for an understanding of the quasi 2D nature of the split cross sections.

It is noted that a direct comparison between results from hydrological modelling (Section 5, Table 5.3) and hydraulic modelling (Table 8.2) cannot be made due to the nature of hydraulic controls within the catchment which are unaccounted for in the hydrological modelling.

The difference in water levels due to this phenomenon can be seen at Figtree along the Princes Highway, where the PMF peak water level drops along the length of the road, even though the cross sections join end to end. At these locations it is important to visualise the peak water level results, either over the creek centreline or at the centre of the cross section for overland branches. When using the results of the study to determine flood levels at a location adjoining one of the split cross sections it is important to visualise the longitudinal fall in water levels as continuous, rather than a step at the junction of the cross sections. Where site specific information is sought from the results presented it is advisable to be conservative in the assessment and to review the ground levels at the location of interest.

Caution should be used by consultants taking the results of this study and attempting to build a local model of a specific area of interest using the results of this study. The peak water level (Appendix F) does not always occur at the same time as the peak flow (Appendix G), and the fully dynamic nature of the model leads to dynamic behaviour of the flood storage behind blocked culverts. The timing of the peaks within the various creeks should also be considered with any local study.

In addition to the complexities of the model in timing of the hydrographs there are also the effects of flow diversion between catchments to consider. Flow diversions differ from overbank branches such as those on Byarong Creek at Whelan Avenue and Langson Place where flow breaks out from the creek and flows down a parallel flow path, such as a road, back into the same creek. Flow diversions are defined in this study as areas where flow breaks out of the creek and does not return to that creek system. Simple hydrological analysis will underestimate the magnitude of flow for the catchment receiving the diverted flow.

Diverted flow is likely to occur at the following locations:

- Charcoal Creek at Blackman Parade,
- Charcoal major Tributary at Blackman Parade,
- Byarong Creek from Arrow Avenue through to Cleverdon Avenue.

In the upper reaches of the catchment the effect of culvert blockage is generally localised and storage is small. That is, if a culvert is blocked, the associated increase in water level is localised. There is generally no significant impact on water level downstream of a blocked culvert, and the steep slopes and low deck height of bridges prevent the drowning out of structures upstream of a blocked culvert.

The exception to this case is Cordo-Heights Branch of the model where the blocked Coal-Company railway culvert creates a dam where water levels rise to the level of the rail embankment, drowning the culverts upstream. There is no secondary flow path in this location and the design blockage applied to this structure results in the culverts being blocked 100%.

In the upper catchment steep channel slopes lead to high channel velocities which causes the flood peaks to reach the lower catchment rapidly, with the combined flood hydrograph causing the worst flooding. This process is described in Section 4.2.

On the 'Allans Creek' model branch the flood profile (Figure 7.1) shows a large difference in the water level between the 100 year ARI and PMF envelopes in the lower reaches. This is due to the bridges acting as a series of hydraulic controls and causing a backwater that elevates the water level. For the 100 year ARI event, flow is able to pass under the structures, whereas for the PMF the peak flow of approximately 1200 m^3/s can not entirely pass under the bridge decks. The bridges cause a backwater to the level of the bridge deck, before any additional flow area is available, leading to a greater head loss at the structure.

This flood storage upstream of the structures within the model attenuates the peak flow past that structure. This can be seen by the difference in the flow from the RAFTS model (Table 5.3) and the Mike11 model results (Table 8.2) at the same location. Large volumes of water are held behind the F6 Freeway in the Unanderra Industrial Area and in the floodplain areas upstream of the F6 near the Figtree Caravan Park.

The 'Highway' and 'Freeway' branches of the model also show a large difference in the 100 year ARI and PMF flood levels (Figures 7.10 and 7.11). This is also caused by the backwater effect of culverts and bridges in the lower reaches of the model. The Highway and Freeway branches store large volumes of flow. The peak flood discharge is only mildly attenuated by the storage as the storage capacity is filled by the early part of the hydrograph. The effect of the storage can be seen in the decrease in flow from American Creek to Allans Creek in Table 8.2.

The flat slopes of the lower catchment lead to several structures being drowned out by floodwaters. In these instances the culvert/bridge no longer acts as the control as the culvert downstream generally exerts a greater control on flood levels.

8.2 Model Sensitivity Effects

The expected variability in the model results was tested by carrying out a number of sensitivity analyses (Section 7.4). The sensitivity of various parameters requires

careful consideration, as this will define the likely range that can be expected in the behaviour of the design flood. The sensitivity of the hydraulic model peak water levels to catchment runoff, channel roughness and culvert blockage was investigated.

8.2.1 Channel Roughness

Channel roughness sensitivity was investigated by increasing and decreasing the channel roughness by 20%. This involved changing the local channel roughness values used in the final calibrated model and re-running the model with all other parameters unchanged for the 100 year ARI 2 hour storm event.

Channel roughness was shown to be most sensitive on those creeks with high calibrated roughness. The greatest change in water levels resulting from the change in roughness was in the upper reaches of the catchment with a maximum variation of +1.39/-2.4 m. These areas generally had high roughness (as derived though the calibration process), which leads to the high variation in Manning's 'n' and ensuing change in water levels. Changes in water level also occurred in the lower reaches where the change in timing of the peak led to changes in peak water levels.

Calibration in these areas was good and showed that the concurrence of timing of the various creeks was good. Therefore, given the high degree of certainty in the reaches with high calibrated roughness and the ensuing high sensitivity to roughness, it is concluded that the model is insensitive to errors in roughness estimation.

8.2.2 Catchment Runoff

The sensitivity of the model to variations in catchment runoff was investigated by increasing and decreasing the runoff hydrograph size by 20%. All other calibrated parameters were unchanged in the model assessment.

Catchment runoff was shown to be most sensitive in the lower reaches of the catchment upstream of the major controls of the Princes Highway, The Illawarra Railway and the F6 Freeway. The peak variation in water level is +1.54/-1.21 m. These high variations are recorded in the various branches in the Unanderra industrial area, where undersized culverts and depressed areas produced elevated water levels under normal conditions. This effect is accentuated by the additional flow and eased by the reduced flow.

The average change in water depth across the catchment for the change in catchment runoff is +0.20/-0.22 m. This shows that the catchment is sensitive to errors in hydrological inputs. However, in the reaches where the greatest sensitivity was shown, good calibration was achieved. In the lower reaches of the catchment, where the greatest sensitivity to catchment runoff is shown, the peak water levels are sensitive to the particular design blockage scenario used. This indicates that culvert blockage is the critical factor in peak water level determination. The effect of culvert blockage drowns out the effect of catchment runoff variation in the lower reaches where culvert blockage has its greatest impact on water levels.

8.2.3 Culvert Blockage

Culvert blockage sensitivity was assessed by comparing the catchment with all culverts fully open to that when the design blockage policy is applied. This analysis indicated that culvert blockage had the greatest potential impact on flood levels. The range of variation in peak water level is +2.92/-0.13 m, with an average change across the catchment of 0.3 m.

Sensitivity to culvert blockage is high, as some culvert/bridge structures and the associated road/railway act as a dam when blocked. The impact of 100% blockage of a culvert/bridge causes floodwaters to fill the area behind the culvert/bridge before they overtop the road/railway.

Although the model is sensitive to culvert blockage it is important to recognise the importance of the application of the design blockage policy. Without the policy, all culverts would be unblocked leading to design flood levels for the 100 year ARI storm which in some locations are considerably lower than that of the calibrated 1998 and 1999 floods, even though these floods generally were lower than a 100 year ARI (Section 5.3). In brief, a less than 100 year ARI design storm (with blockage) would lead to higher than 100 year ARI design flood levels (without blockage). This means many residents would already have experienced flood levels well above what would become a false design planning level.

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11. QUALIFICATIONS

This report has been prepared for Wollongong City Council to define the nature and extent of flooding in the Allans Creek floodplain. The report defines the flooding behaviour for the major flow paths in the catchment.

The investigation and modelling procedures adopted for this study follow current best practice and considerable care has been applied to the preparation of the results. However, model set-up and calibration depends on the quality of data available and there will always be some uncertainties. The flow regime and the flow control structures are very complicated and can only be represented by schematised model layouts.

Hence there will be an unknown level of uncertainty in the results and this should be borne in mind in their application.

The results of the study are based on the following assumptions/conditions:

- Design flood extents are approximate between cross sections of the model. Where surveyed levels are not available, flood extents are based on the 2m LIC contour data provided by Council and the interpolation of model results.
- The local pit and pipe stormwater drainage system is not modelled.

Study results should not be used for purposes other than those for which they were prepared.

APPENDIX A

LIST OF RECORDED FLOOD LEVELS

APPENDIX B

EXAMPLE OF RESPONSE FROM COUNCIL'S POST-FLOOD SURVEY

APPENDIX C

RATIONAL METHOD CALCULATIONS

APPENDIX D

MODEL CROSS SECTIONS

APPENDIX E

CALIBRATION DETAILS AND PROFILES 1984, 1991, 1998 AND 1999 STORMS

APPENDIX F
SUMMARY OF HYDRAULIC MODEL RESULTS

IMPORTANT INFORMATION

Due to the implementation of actions from the Allans Creek Floodplain Risk Management Plan and subsequent detailed investigations, this Flood Study has been updated to represent the current catchment conditions. These updates have resulted in two Addendum reports (Cardno Lawson Treloar, 2007, ref: R2346v2 and Cardno Lawson Treloar, 2009 ref: W4789v4), which supersedes a number of results presented in this study. It is therefore imperative that this Flood Study is read in conjunction with the Addendum reports. Peak water levels, flows and velocities presented in this report for some areas have been superseded and must be taken from the Addendum reports. Figures showing flood extents have also been superseded and must be read from the Addendum reports. It is the responsibility of the reader to ensure they have read the Addendum reports before using the presented data.

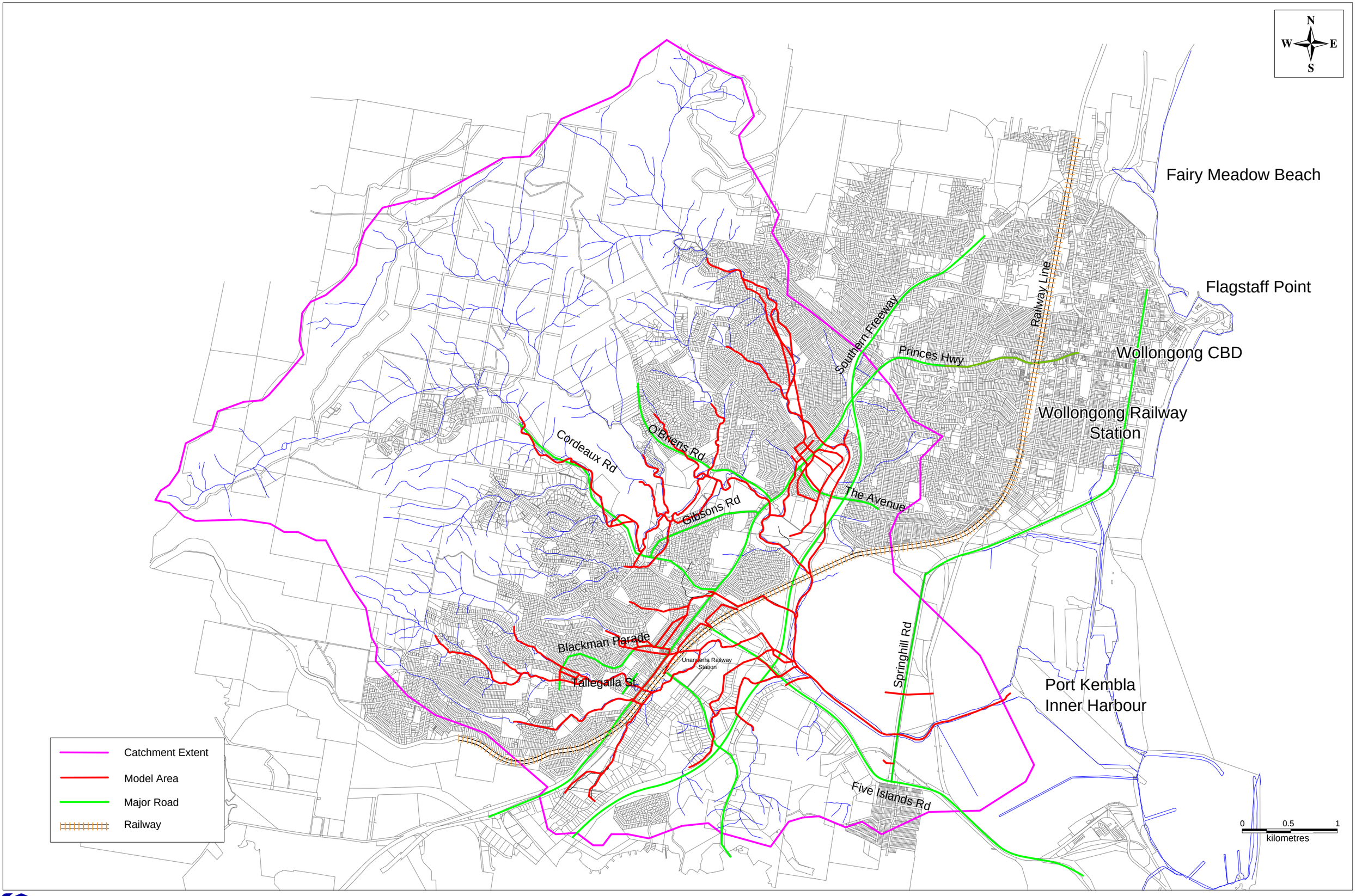
APPENDIX G

SUMMARY OF FLOW RESULTS AT BRIDGES

Report Prepared For
Wollongong City Council

Allans Creek Flood Study

Report J1946/R1986
September, 2006



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Allans Creek Flood Study

FIGURE 1.1
Catchment Study Area

J1946/Figures 2006/Flood Study Figures V6\Figure 1.1 Catchment.Wor

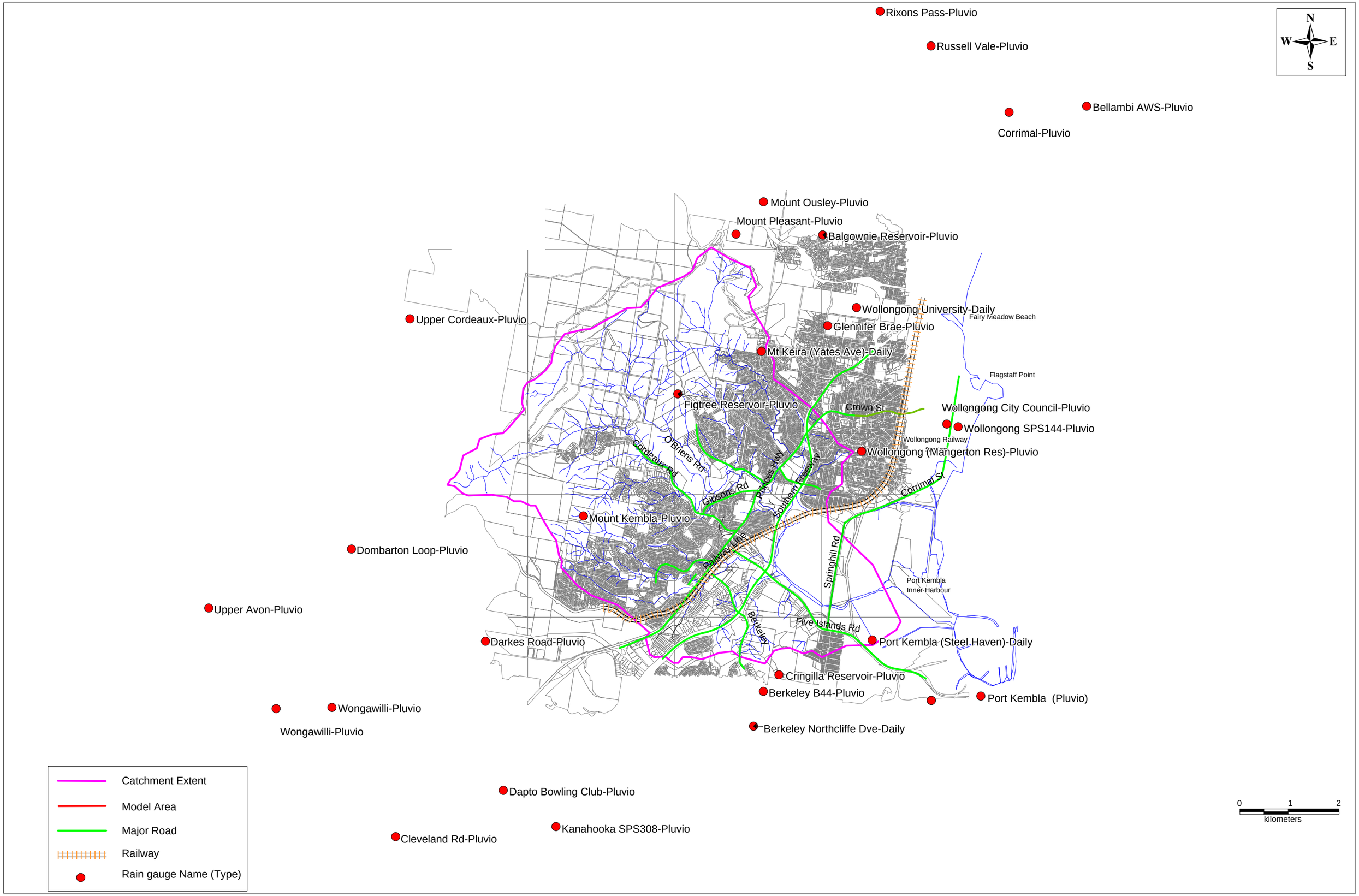

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FIGURE 3.1
Rain Gauge Locations

J1946\Figures 2006\Flood Study Figures V6\Figure3.1 Raingauge.Wor

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FIGURE 5.1
RAFTS Sub-Catchments

J1946/Figures 2006/Flood Study Figures V6\Figure 5.1 Rafts.Wor

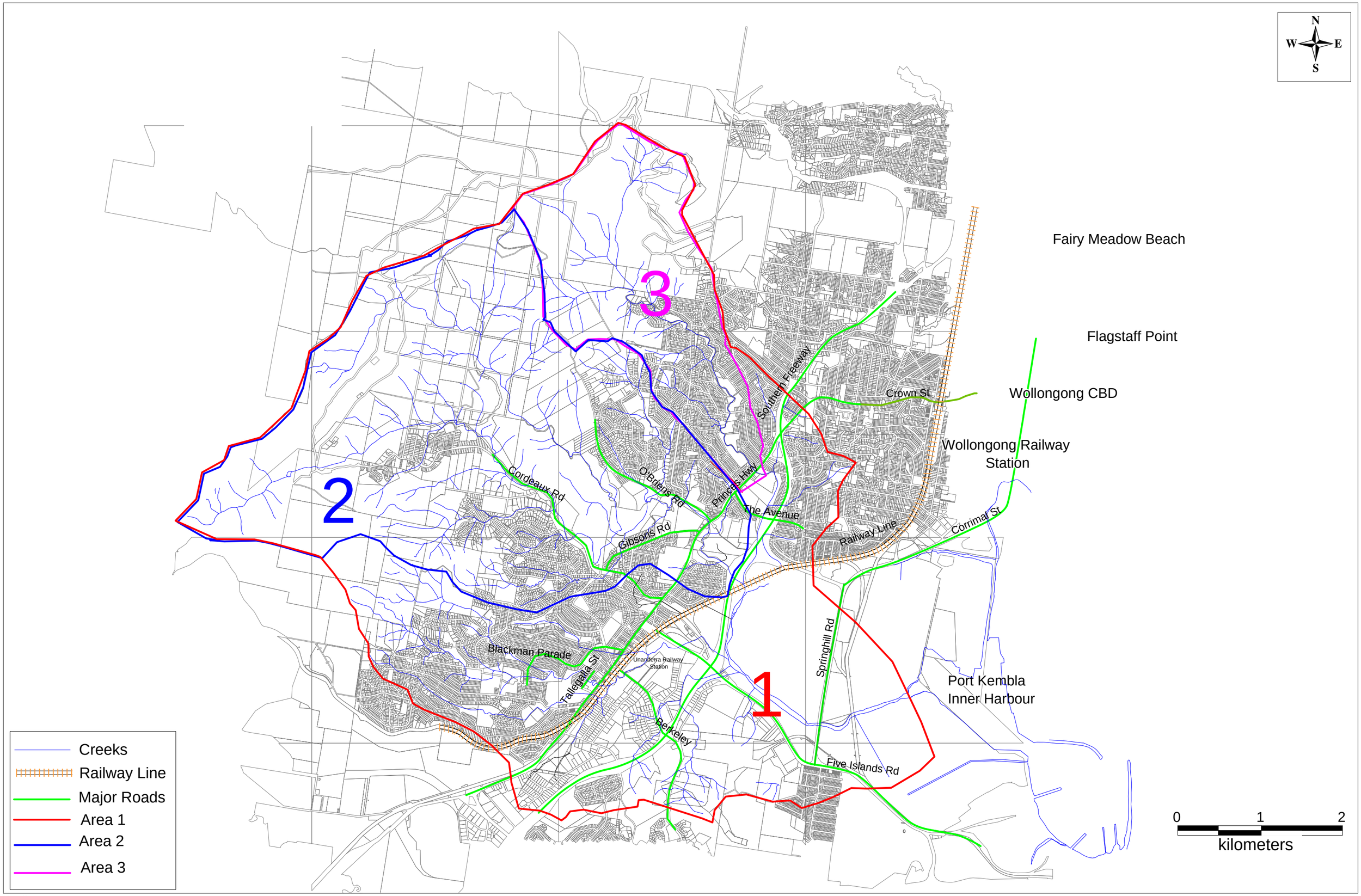

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FIGURE 5.2
Rational Method Areas

J1946/Figures 2006/Flood Study Figures V6\Figure 5.2 Rational method.Wor

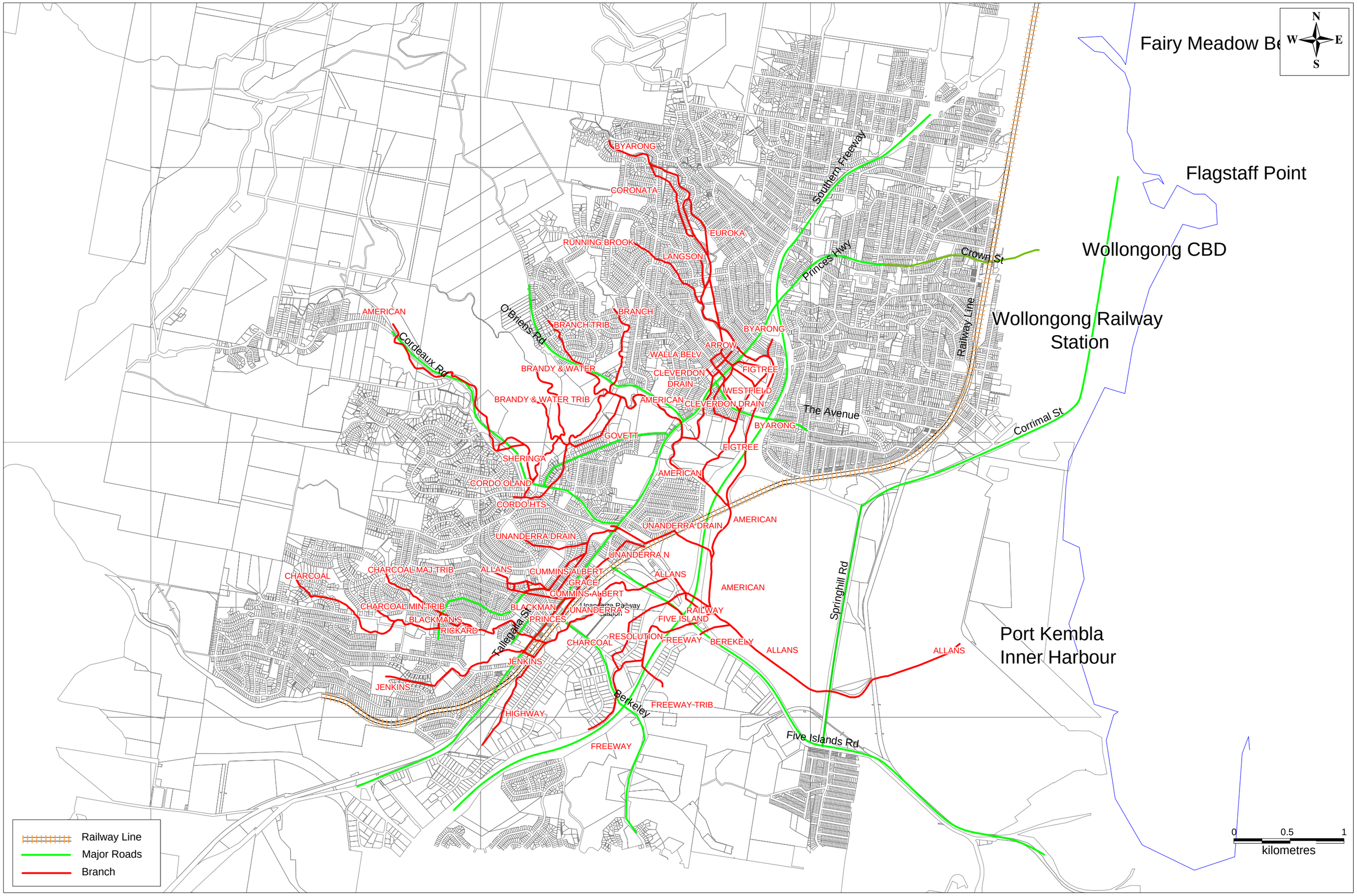

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FIGURE 6.1
Branch Layout

J1946/Figures 2006/Flood Study Figures V6\Figure 6.1 Branch layout.Wor

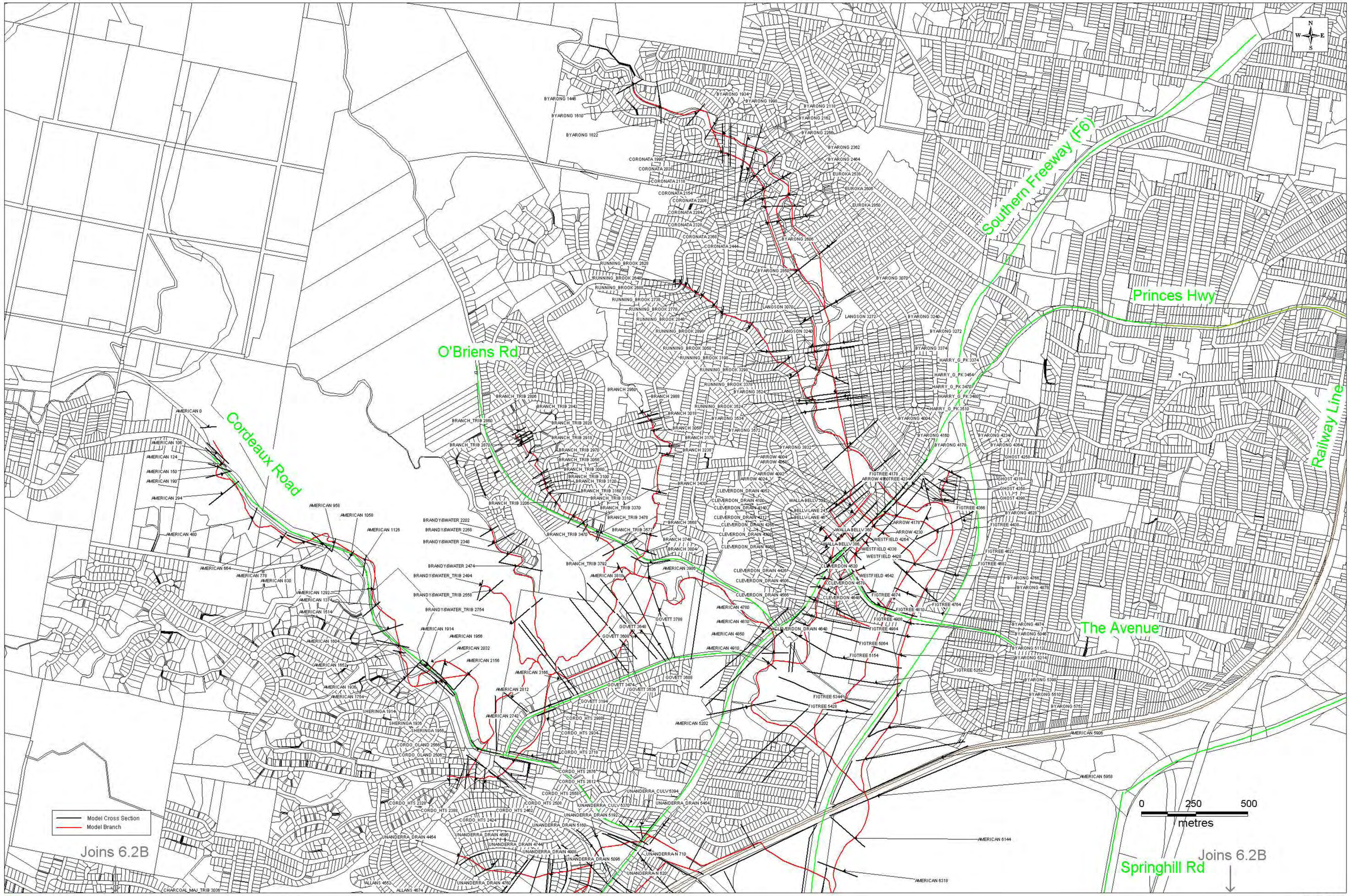

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FIGURE 6.2A
CROSS SECTION LAYOUT

J1946/Figures 2006/Flood Study Figures V6\Figure 6.2 Cross section layout.Wor

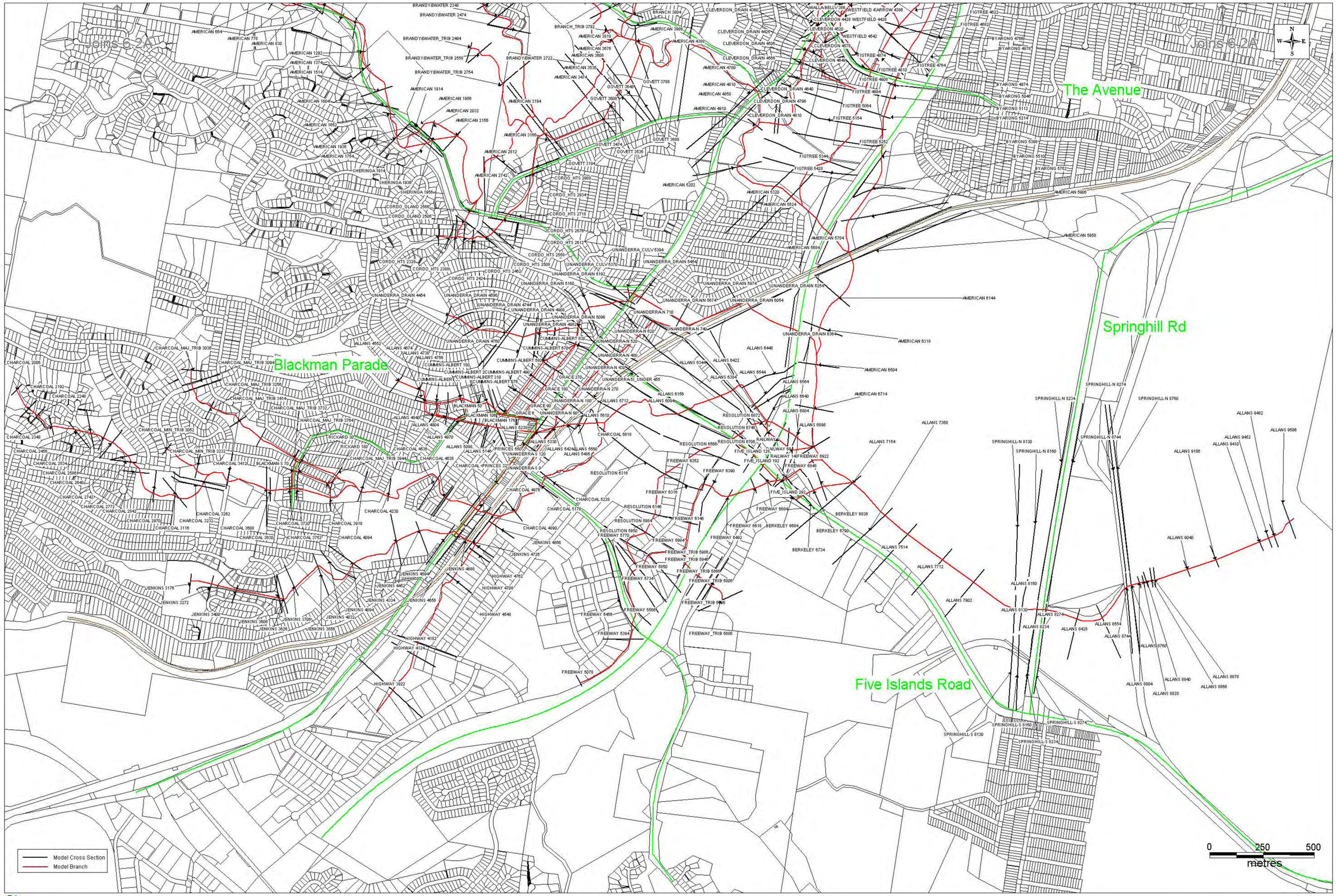

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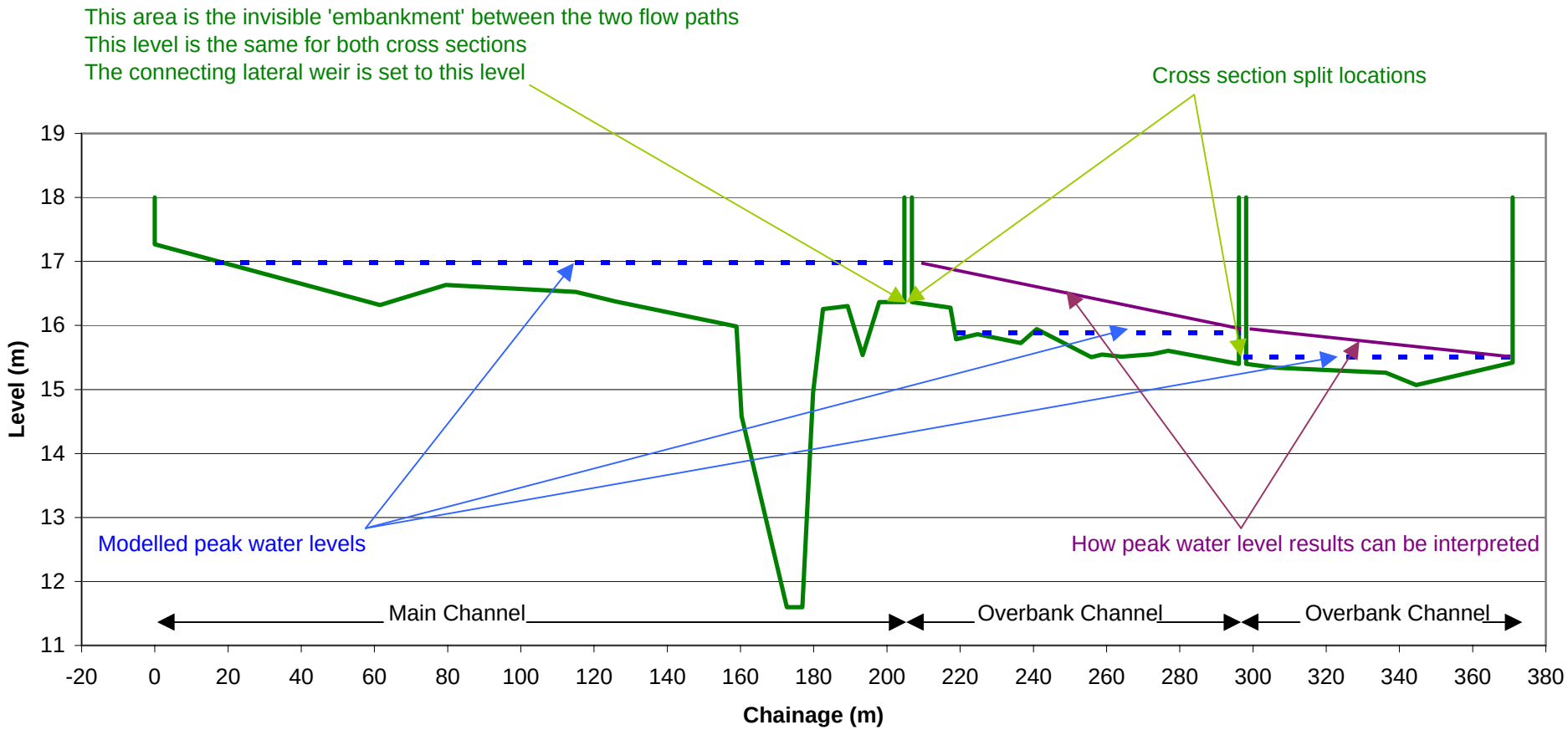
FIGURE 6.2B
CROSS SECTION LAYOUT

J1946/Figures 2006/Flood Study Figures V6/Figure 6.2 Cross section layout.Wor

Quasi 2D cross section split (looking downstream)



Location of cross section split was defined by observing local flow paths during the site inspection and from the available survey

Model incorporates a lateral weir at the location of splits

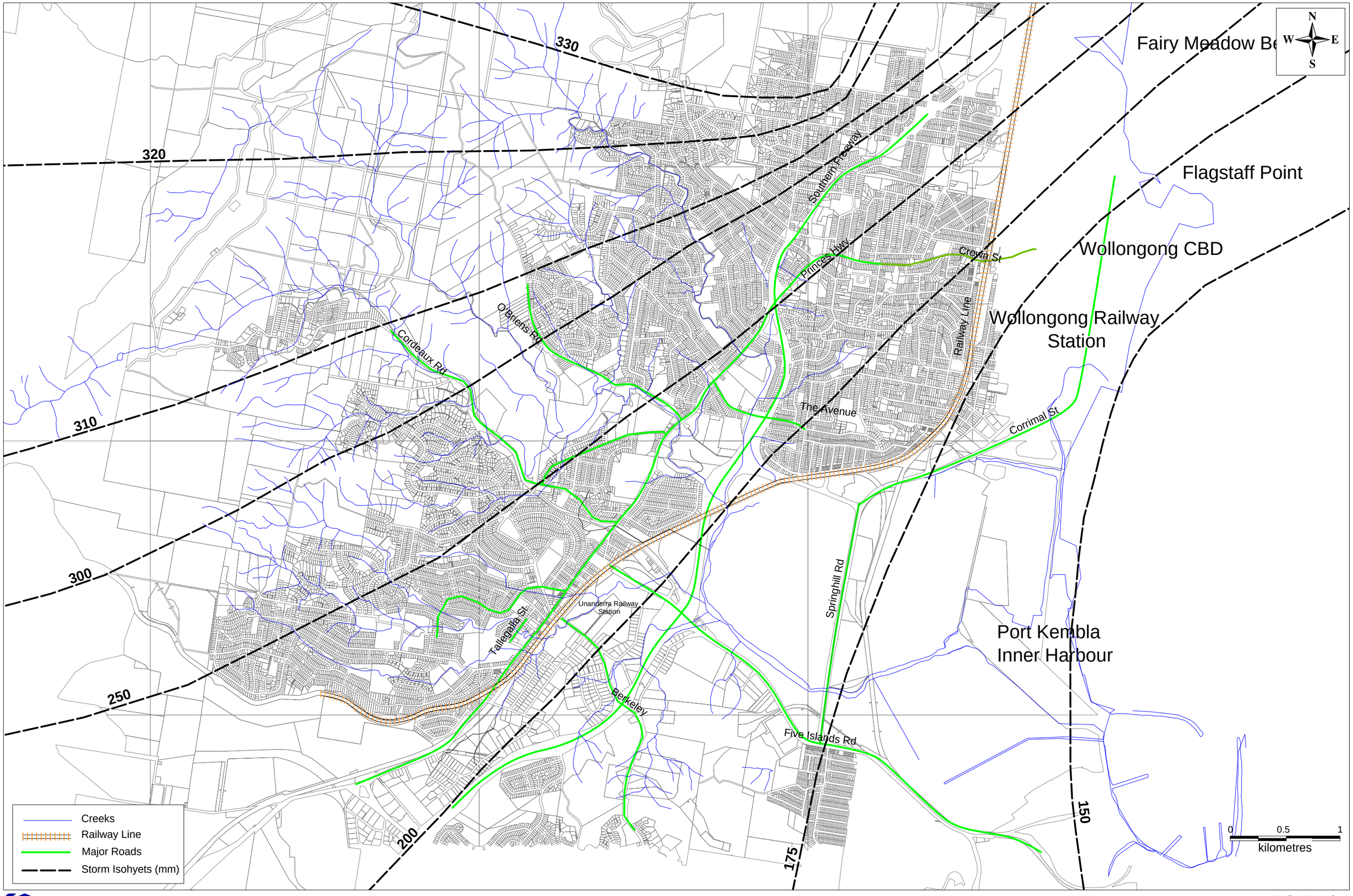


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FIGURE 6.4
August 1998 Storm Isohyets

J1946/Figures 2006/Flood Study Figures V6\Figure 6.4 Aug 98 Isohyets.Wor

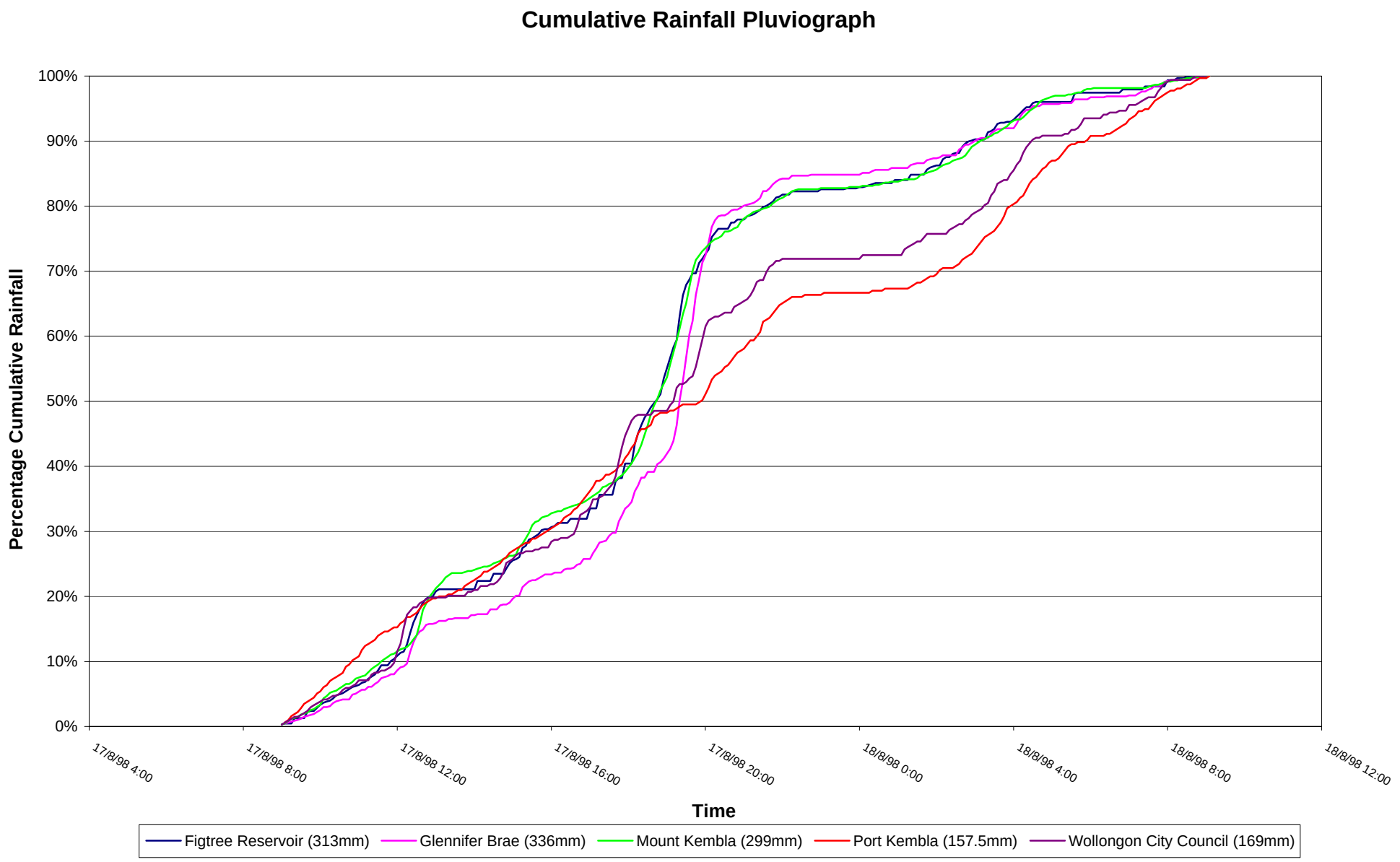

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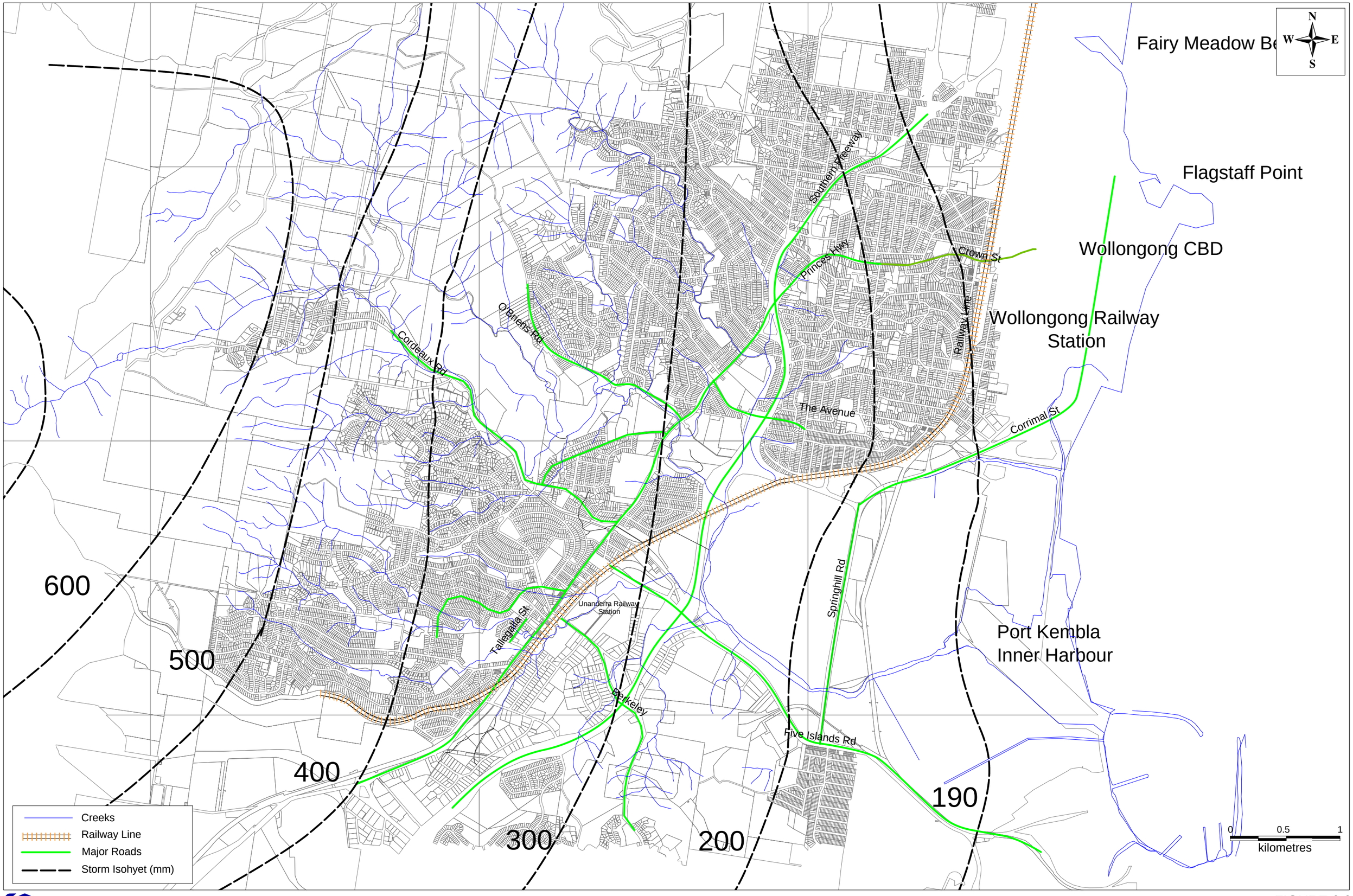
FIGURE 6.5

Cumulative Rainfall Pluviograph - August 1998

J1946\Figures 2006\Flood Study Figures V6\Figure 6.5 - 1998 pluvio.xls



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1 September 2006

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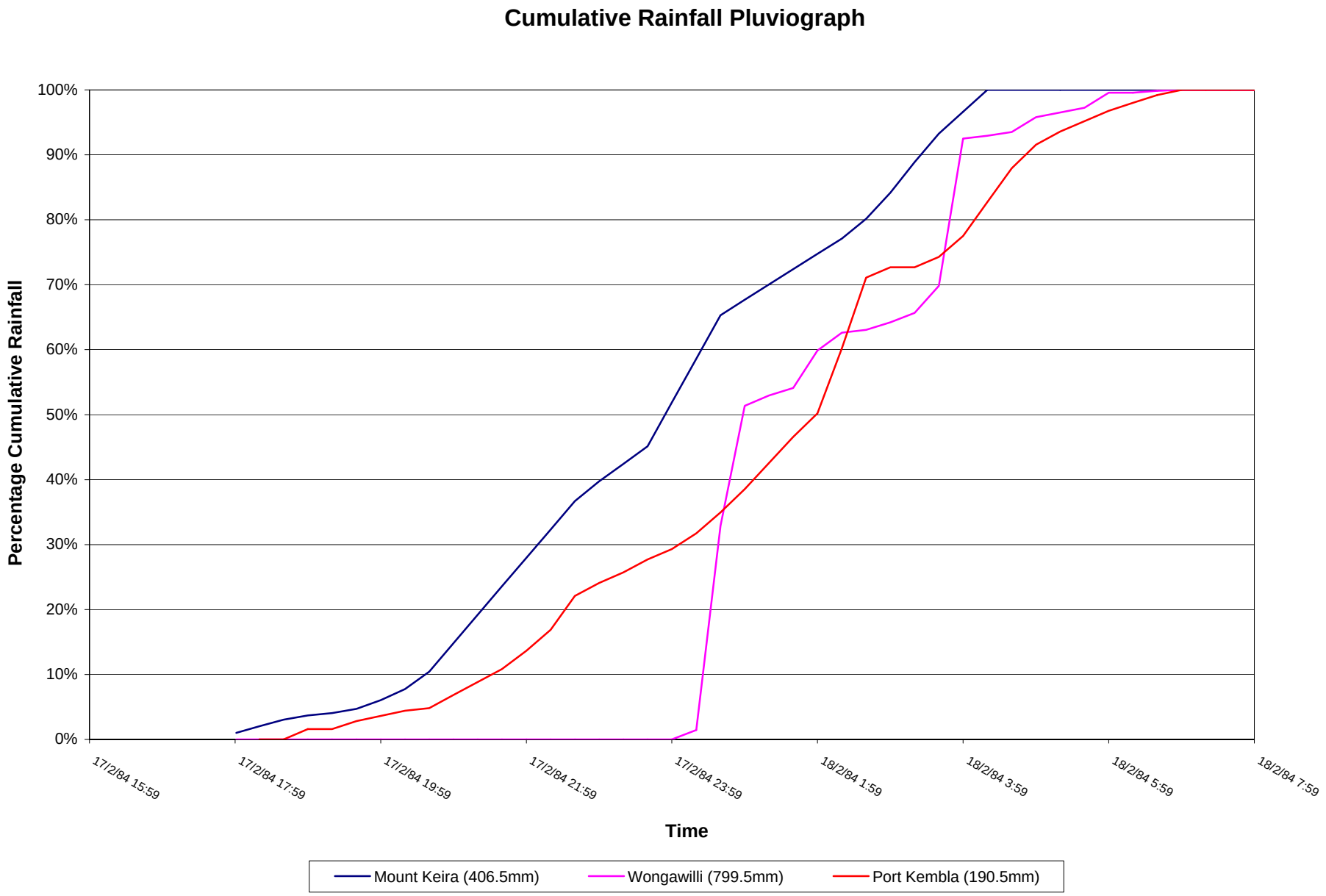
FIGURE 6.6
February 1984 Storm Isohyets

J1946/Figures 2006/Flood Study Figures V6\Figure 6.6 Feb 84 Isohyets.Wor



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1 September 2006

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FIGURE 6.7
Cumulative Rainfall Pluviograph - February 1984
Jobs\J1946\Figures 2006\Flood Study Figures V6\Figure 6.7 - 1984 pluvio.xls

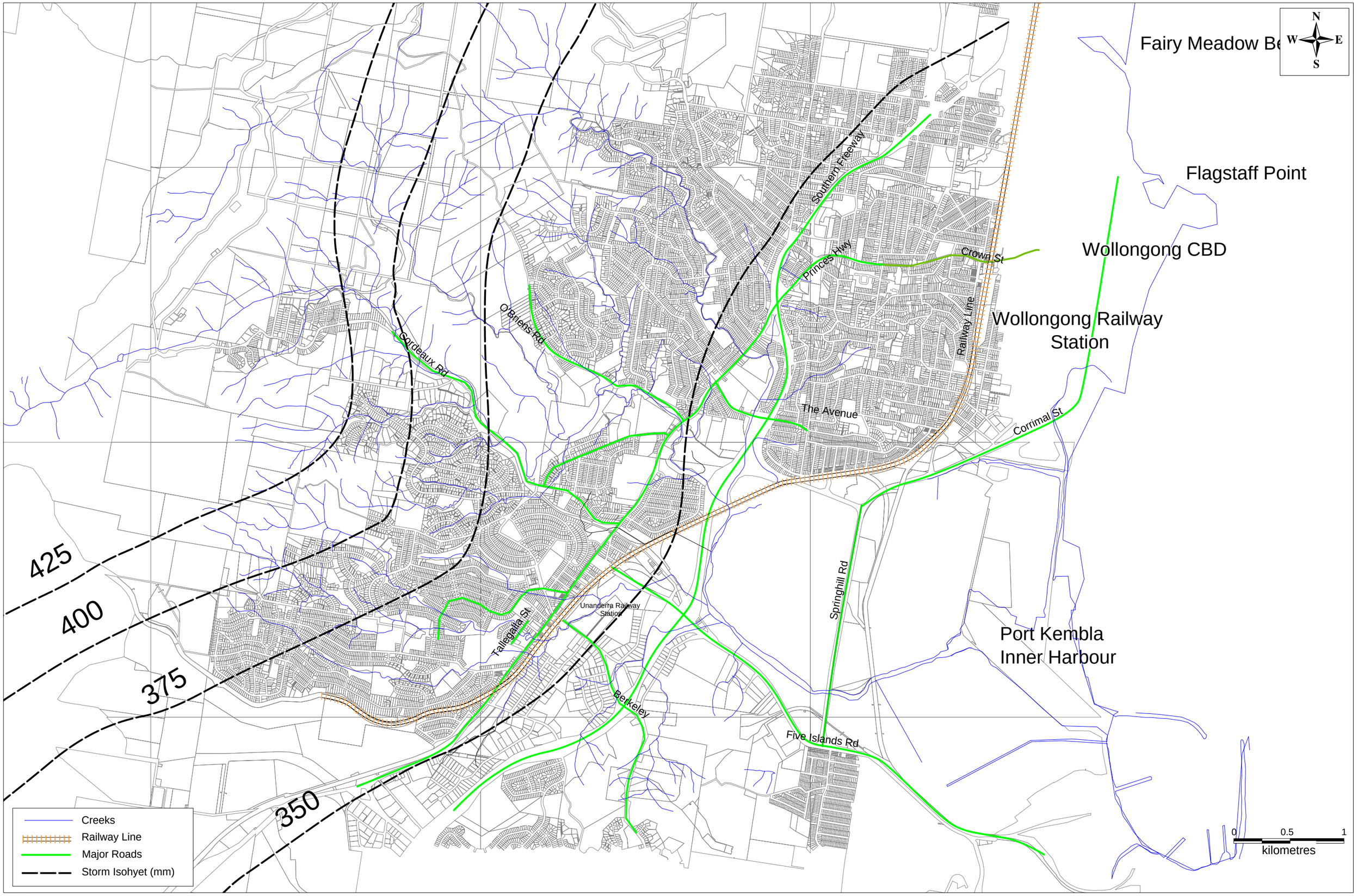

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FIGURE 6.8
June 1991 Storm Isohyets

J1946/Figures 2006/Flood Study Figures V6\Figure 6.8 June 91 Isohyets.Wor

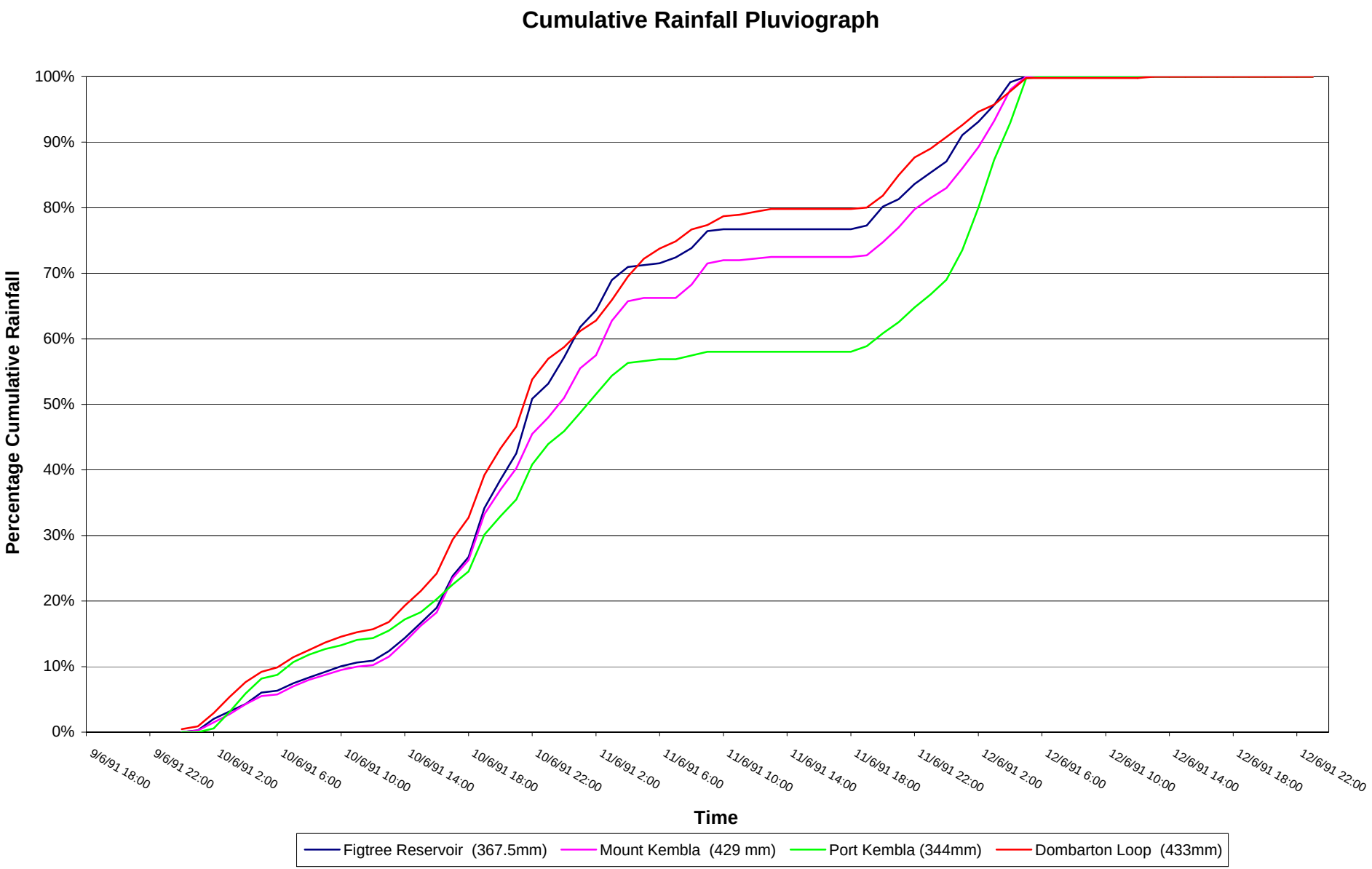

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FIGURE 6.9

Cumulative Rainfall Pluviograph - June 1991

J1946\Figures 2006\Flood Study Figures V6\Figure 6.9 - 1991 pluvio.xls

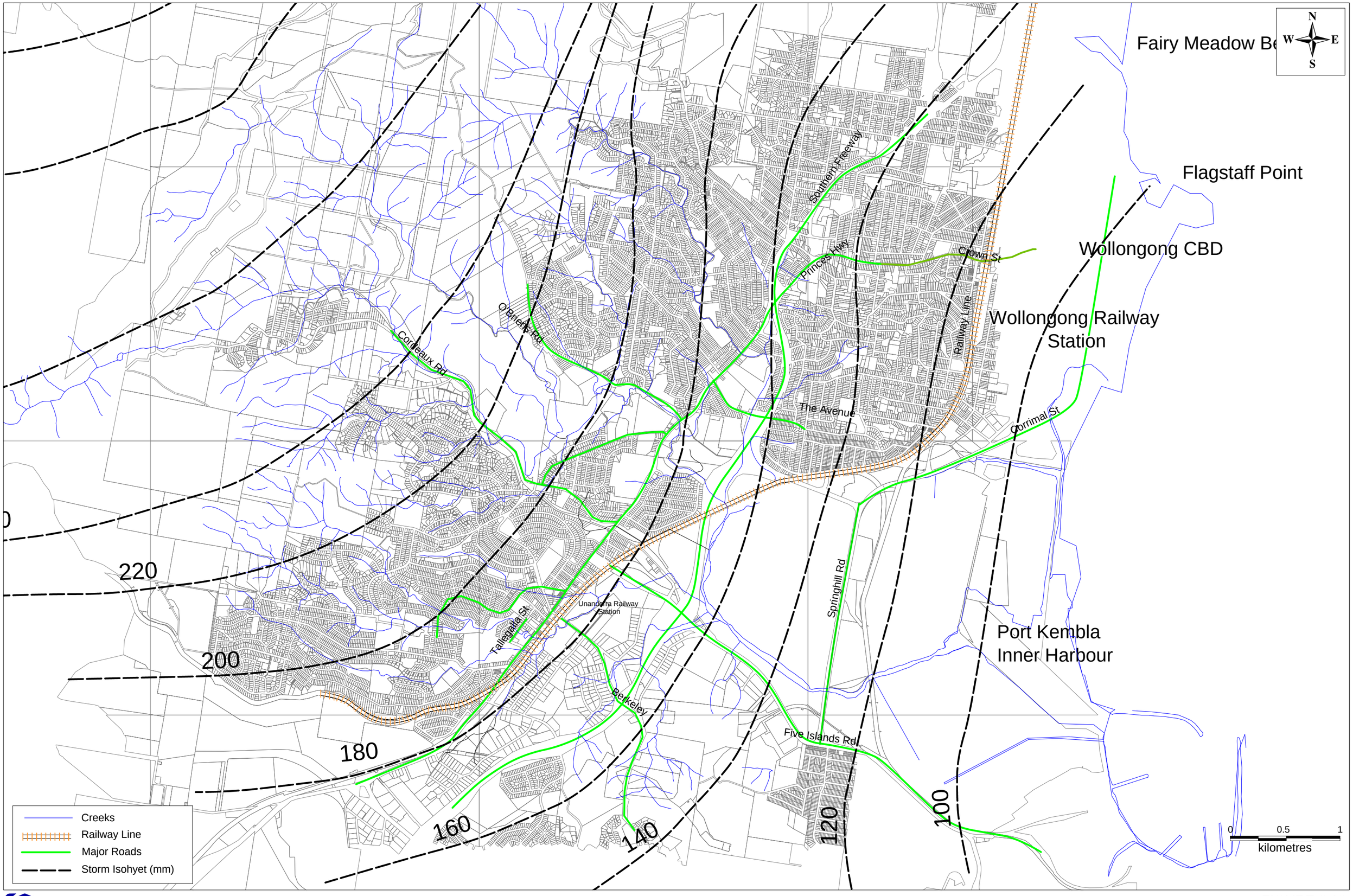

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FIGURE 6.10
October 1999 Storm Isohyets

J1946/Figures 2006/Flood Study Figures V6\Figure 6.10 Oct 99 Isohyets.Wor

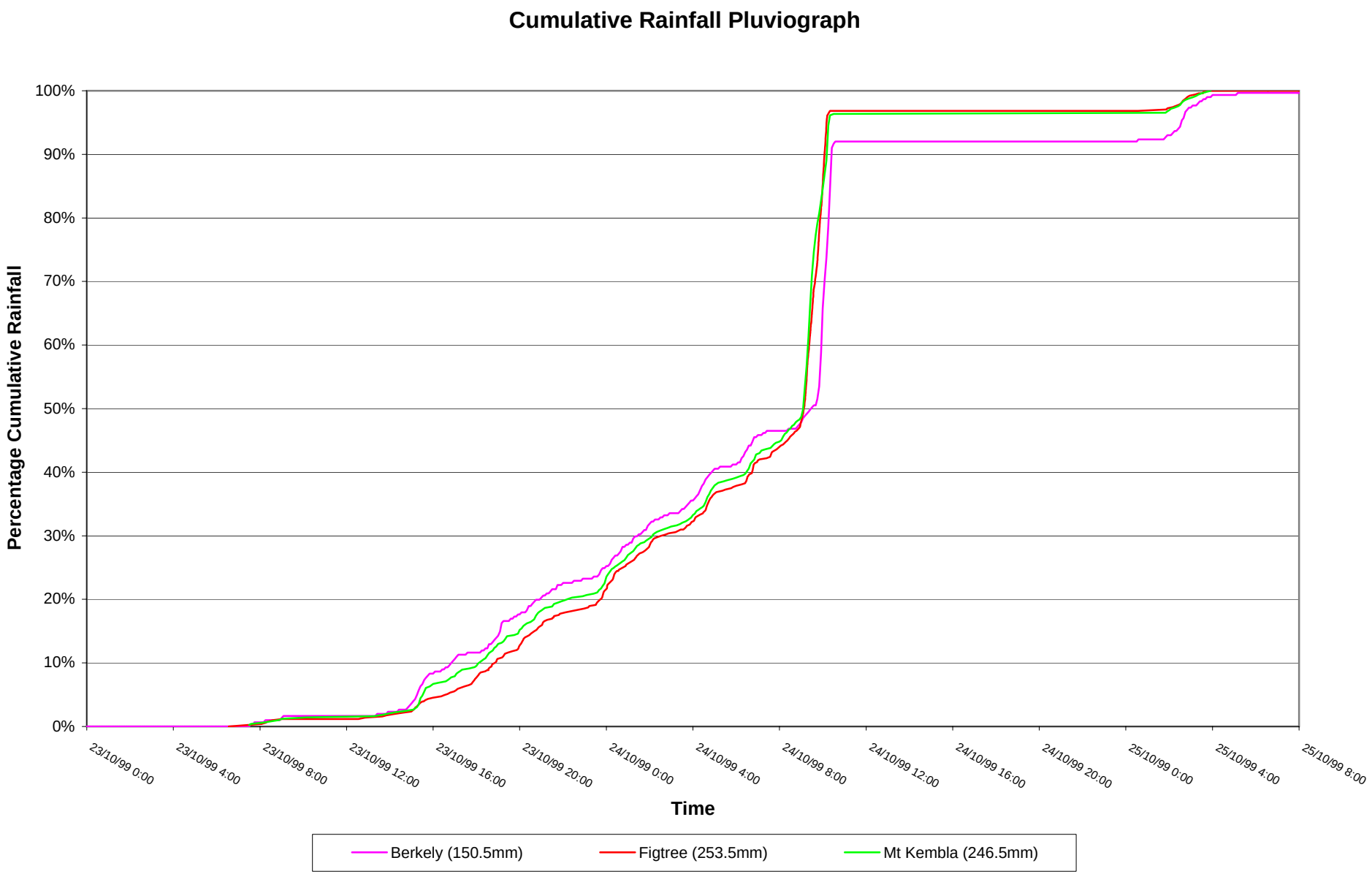

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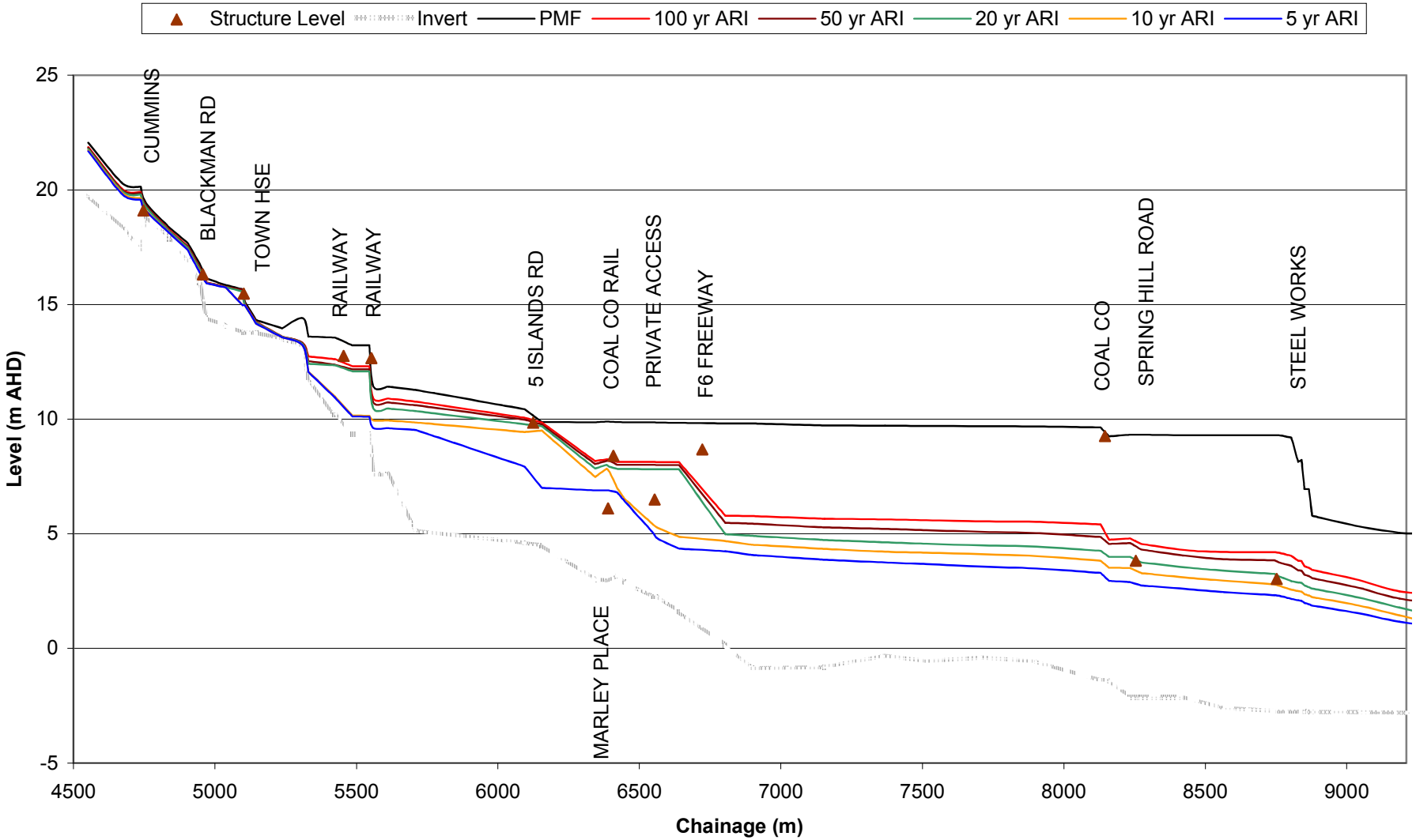
FIGURE 6.11

Cumulative Rainfall Pluviograph - October 1999

Allans Creek Flood Study J1946\Figures 2006\Flood Study Figures V6\Figure 6.11 - 1999 pluvio.xls\Pluvio 1999

Flood Profile Allans Creek



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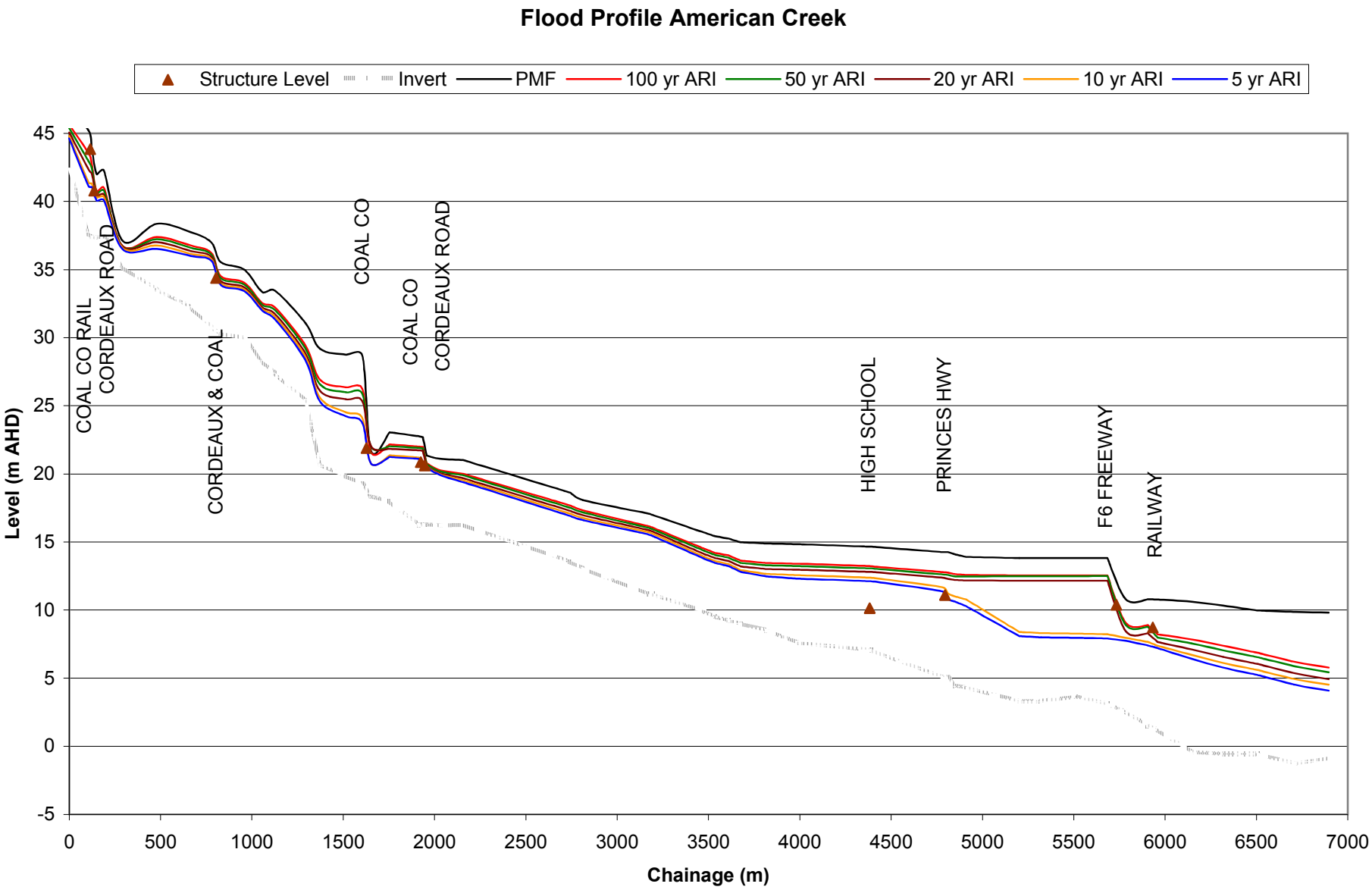
Allans Creek Flood Study

FIGURE 7.1
DESIGN FLOOD LEVEL PROFILES - ALLANS CREEK
J1946/Figures 2006/Flood
Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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1 September 2006

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FIGURE 7.2
DESIGN FLOOD LEVEL PROFILES - AMERICAN CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

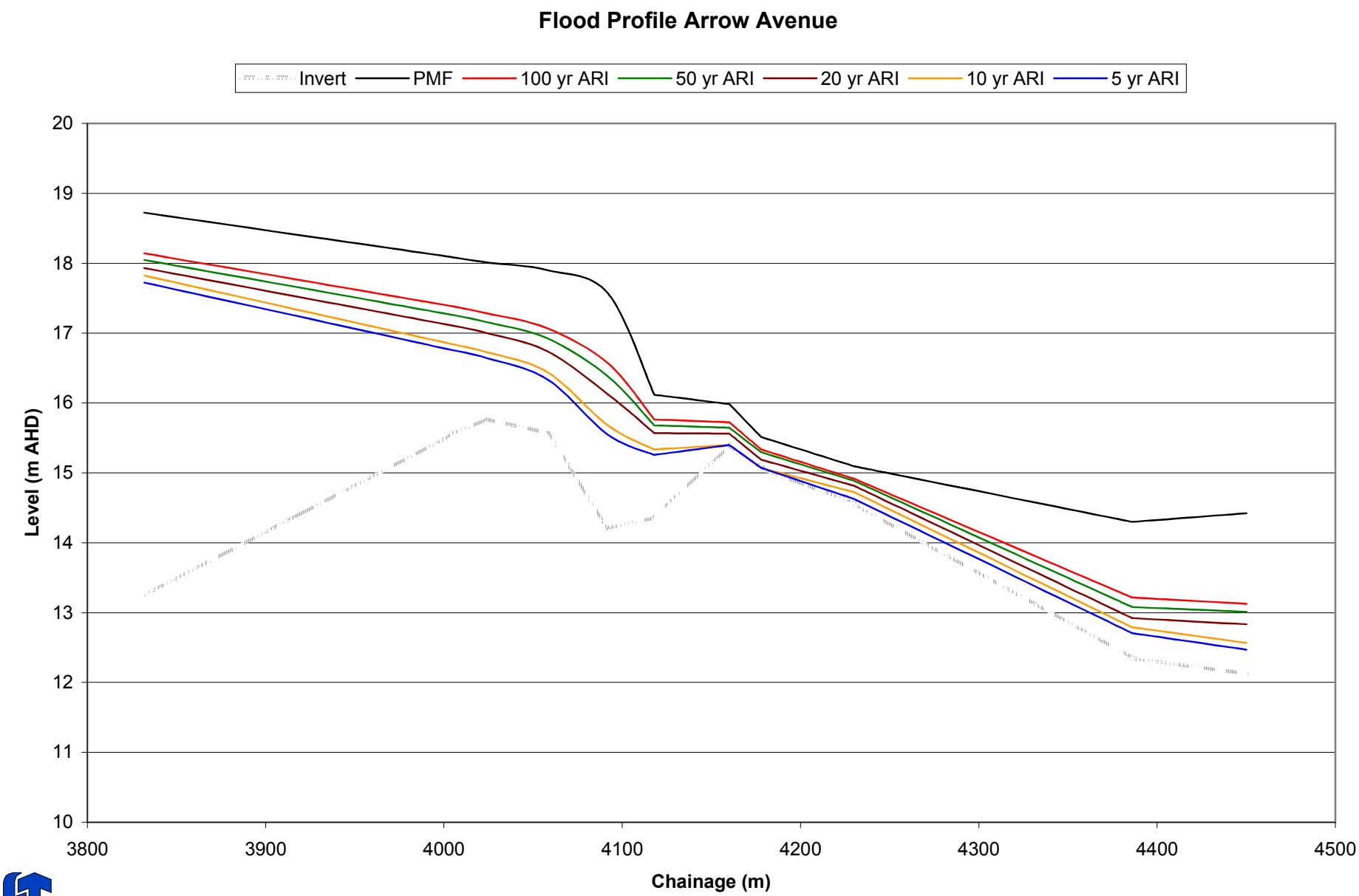

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FIGURE 7.3
DESIGN FLOOD LEVEL PROFILES - ARROW AVENUE
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

Flood Profile Branch Creek

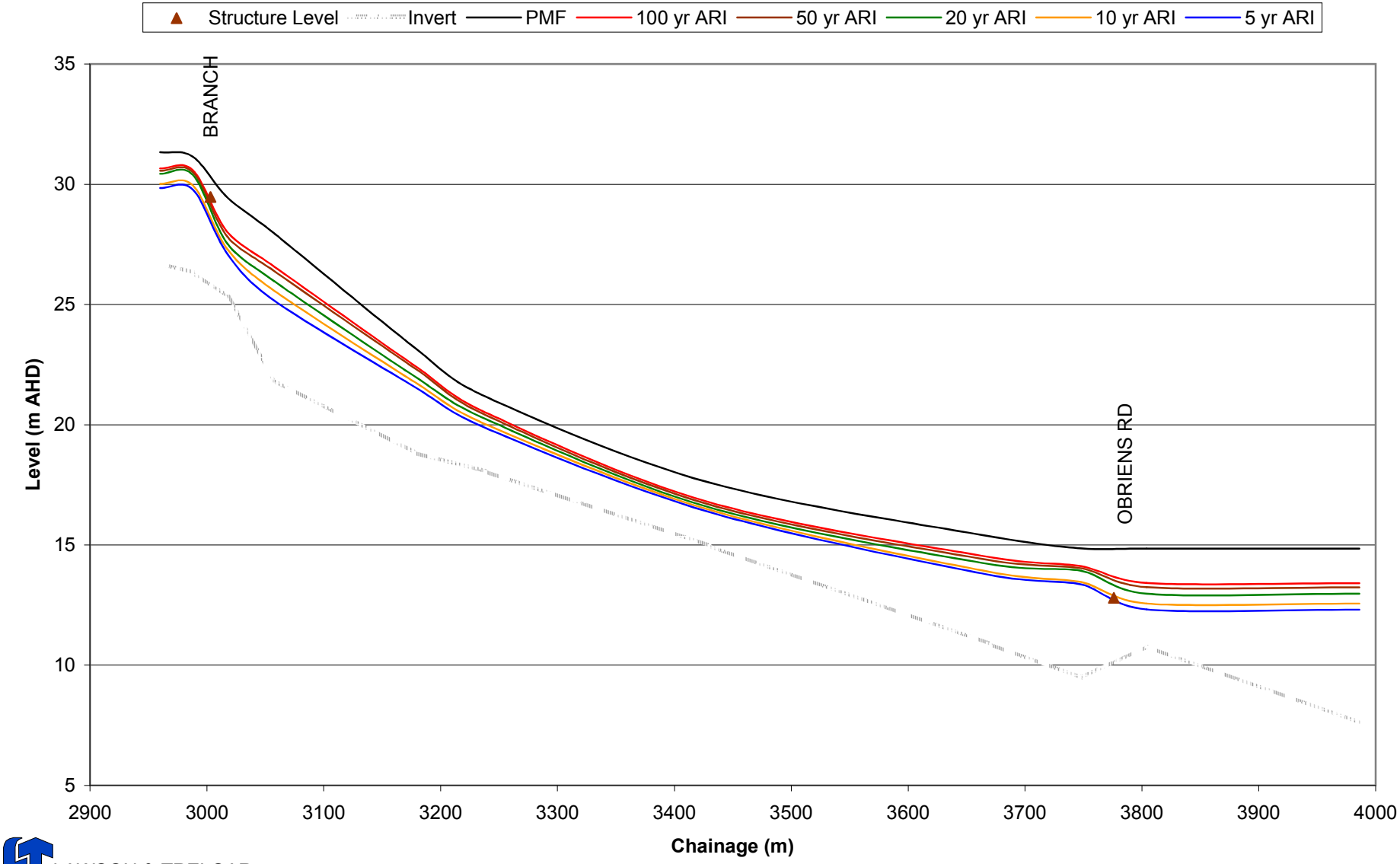

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FIGURE 7.4
DESIGN FLOOD LEVEL PROFILES - BRANCH CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

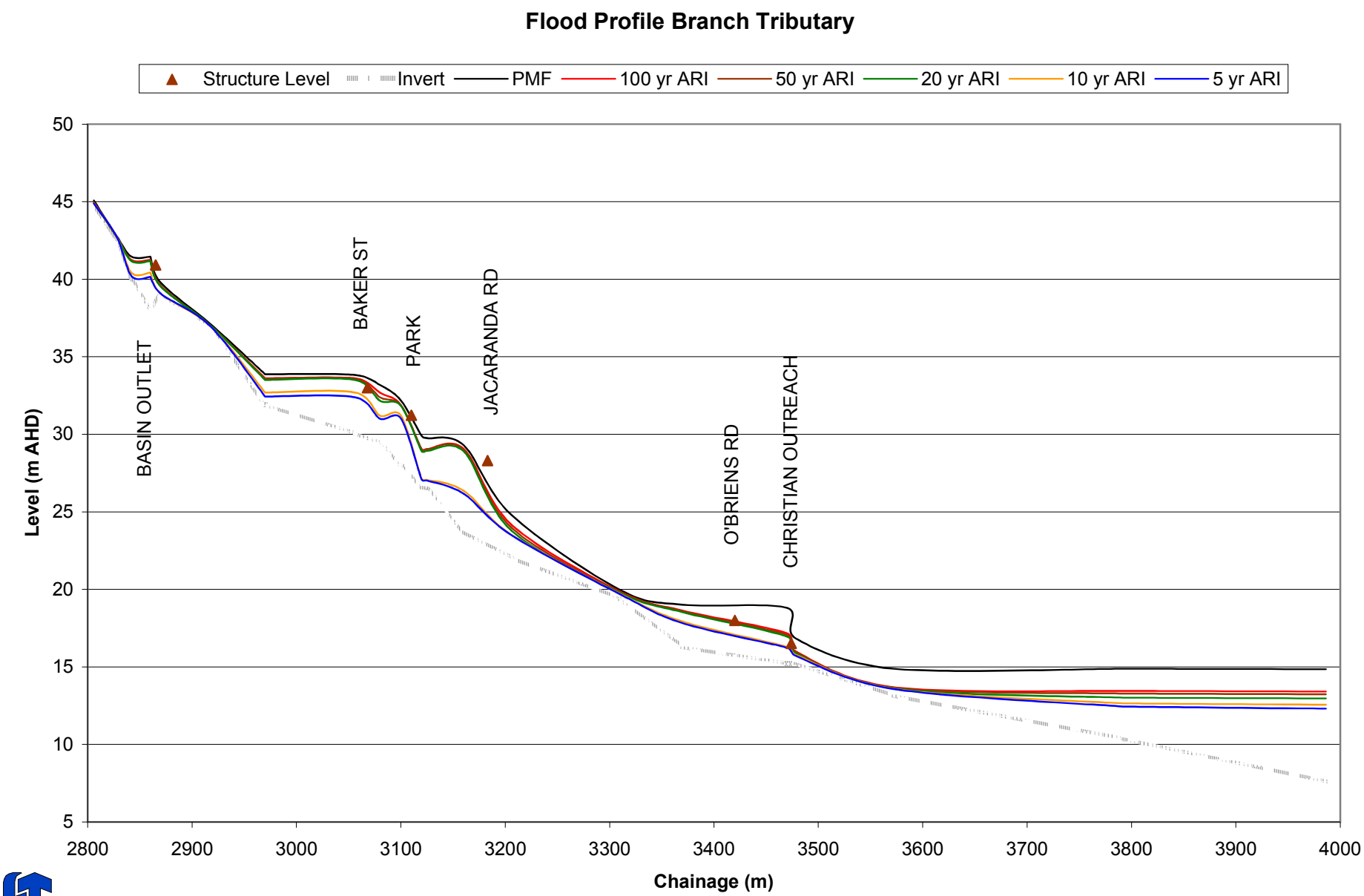

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FIGURE 7.5
DESIGN FLOOD LEVEL PROFILES - BRANCH TRIBUTARY
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

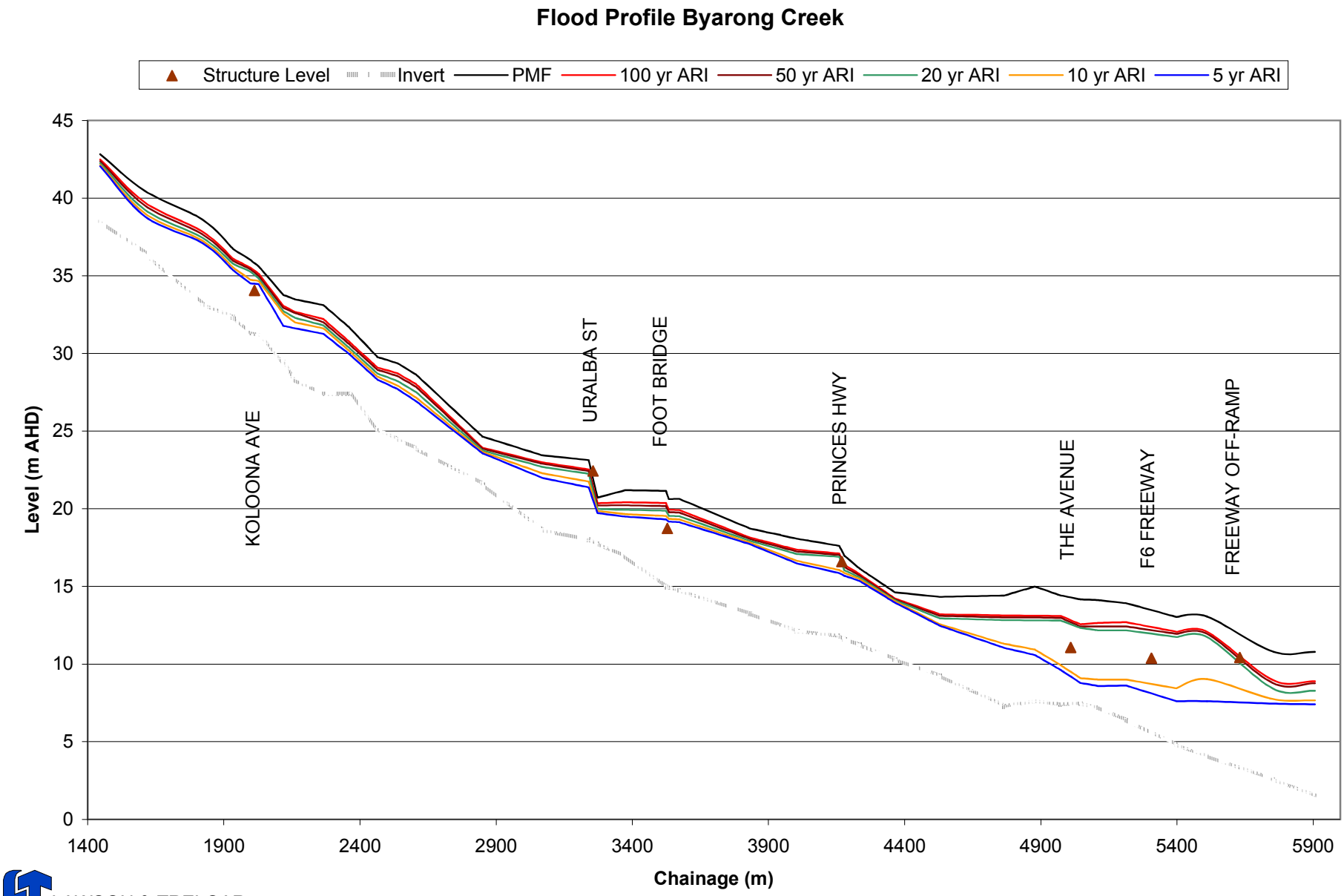

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FIGURE 7.6
DESIGN FLOOD LEVEL PROFILES - BYARONG CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

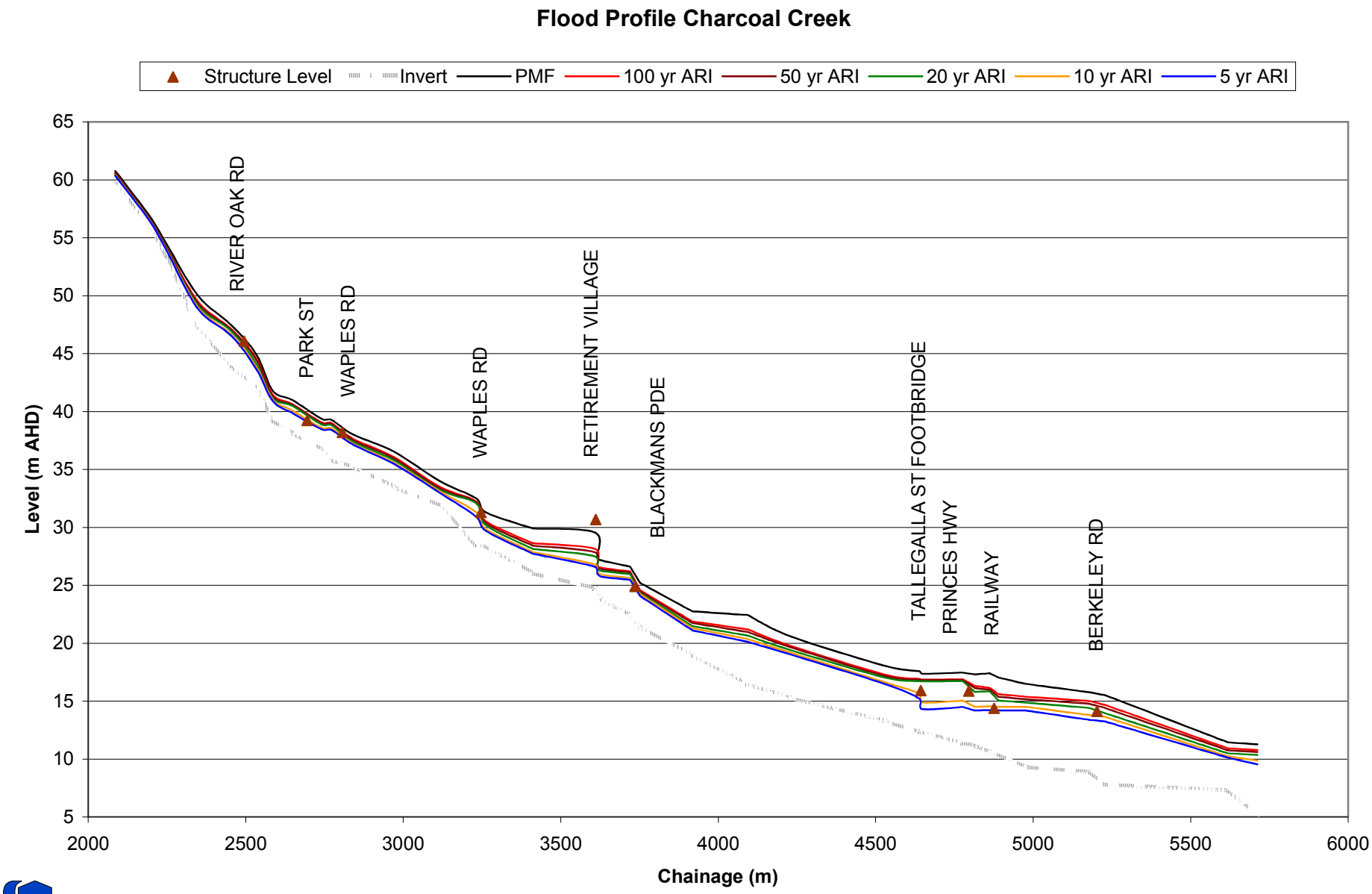

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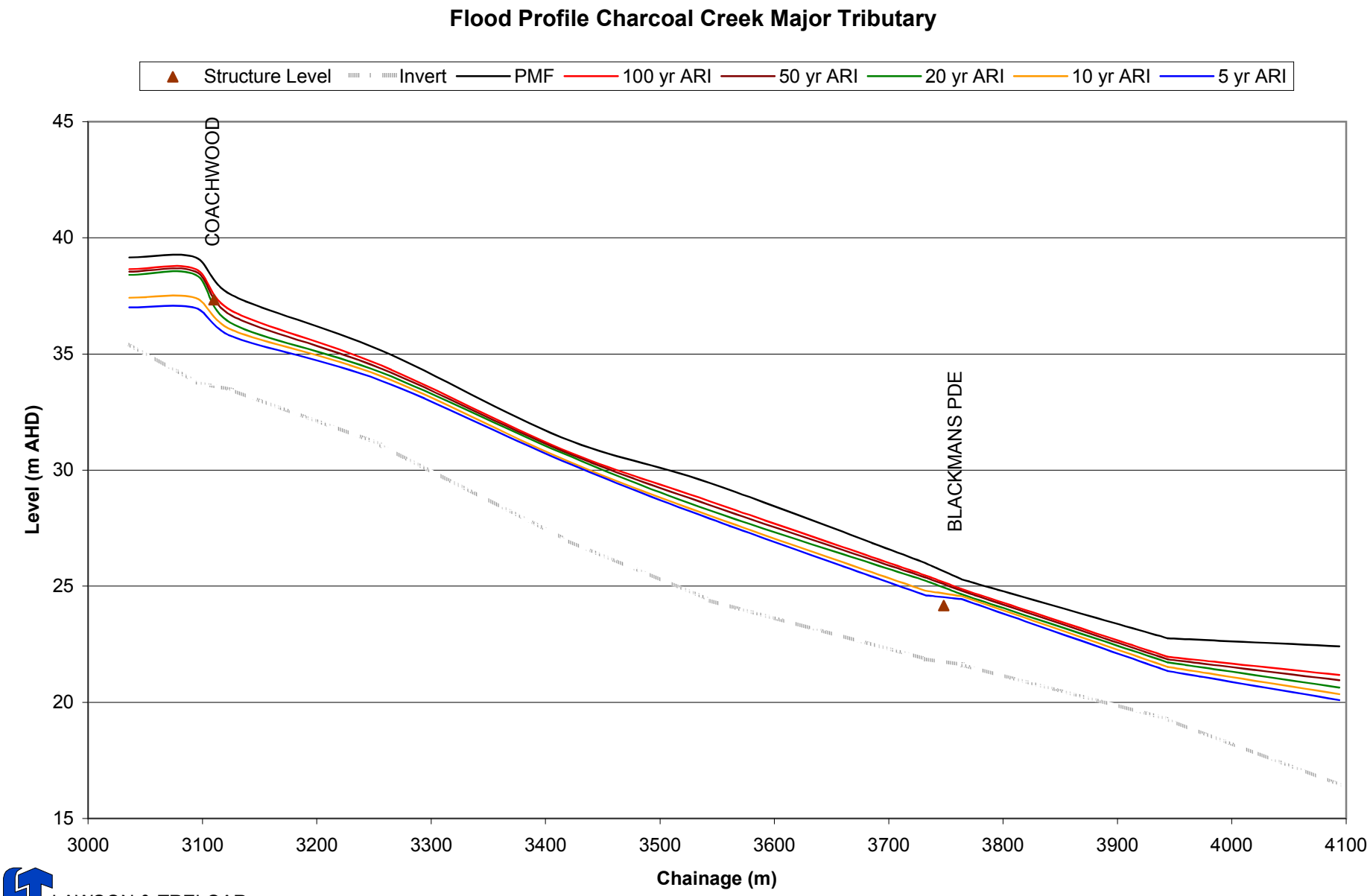
FIGURE 7.7
DESIGN FLOOD LEVEL PROFILES - CHARCOAL CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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1 September 2006

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FIGURE 7.8
DESIGN FLOOD LEVEL PROFILES - CHARCOAL CREEK MAJOR TRIBUTARY
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

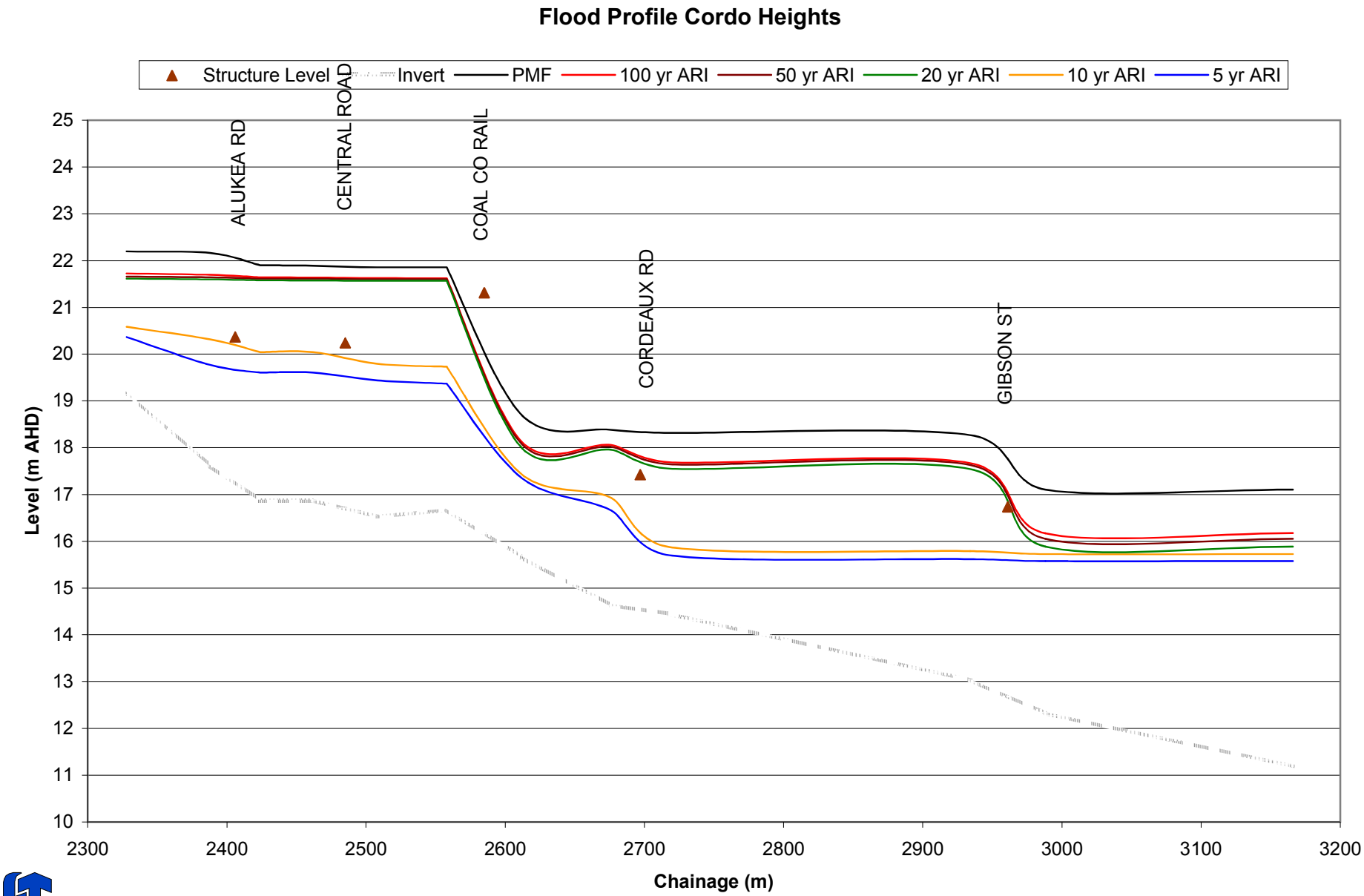

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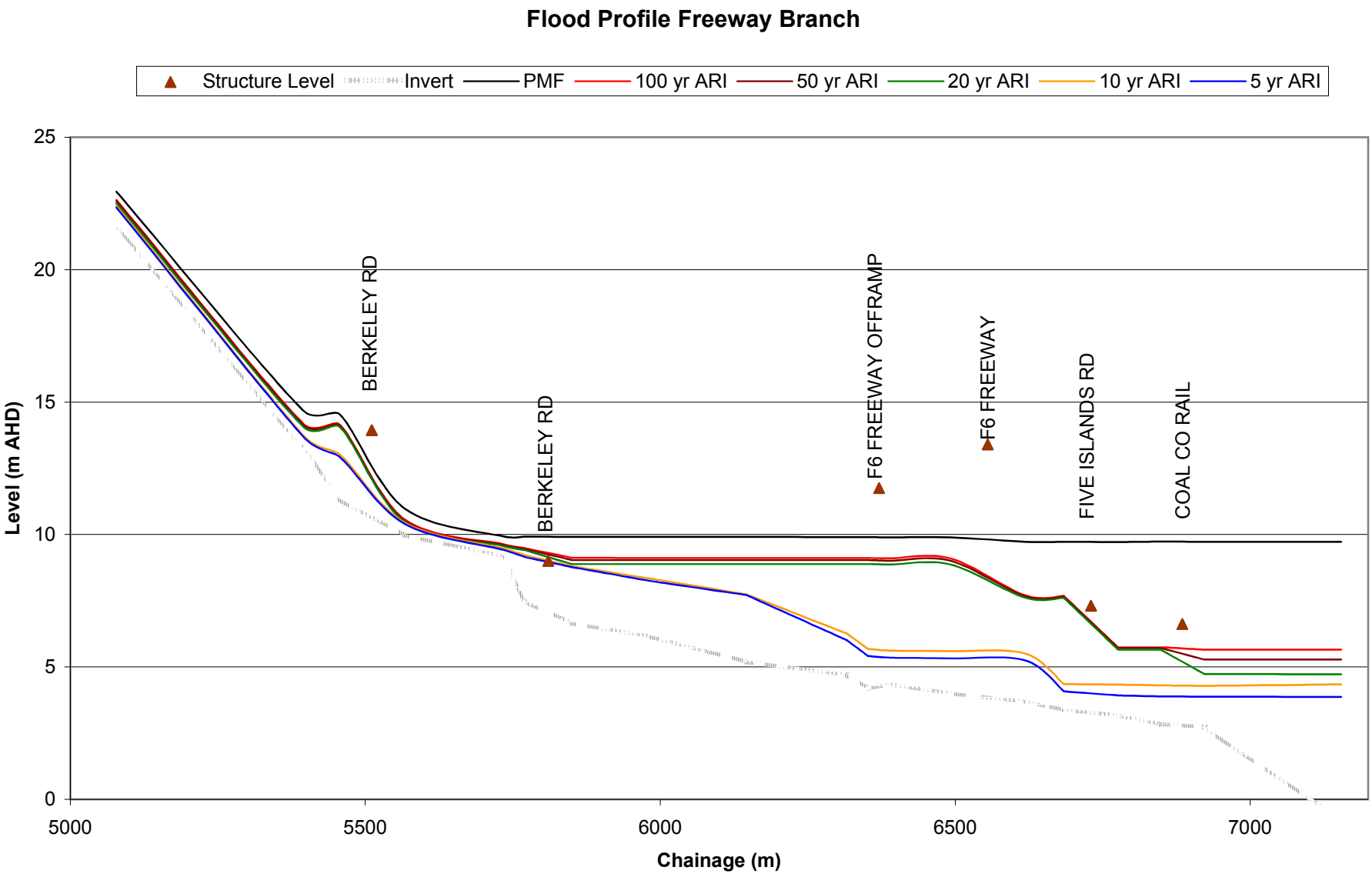
FIGURE 7.9
DESIGN FLOOD LEVEL PROFILES - CORDO HEIGHTS
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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1 September 2006

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FIGURE 7.10
DESIGN FLOOD LEVEL PROFILES - FREEWAY BRANCH
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

Flood Profile Highway Branch

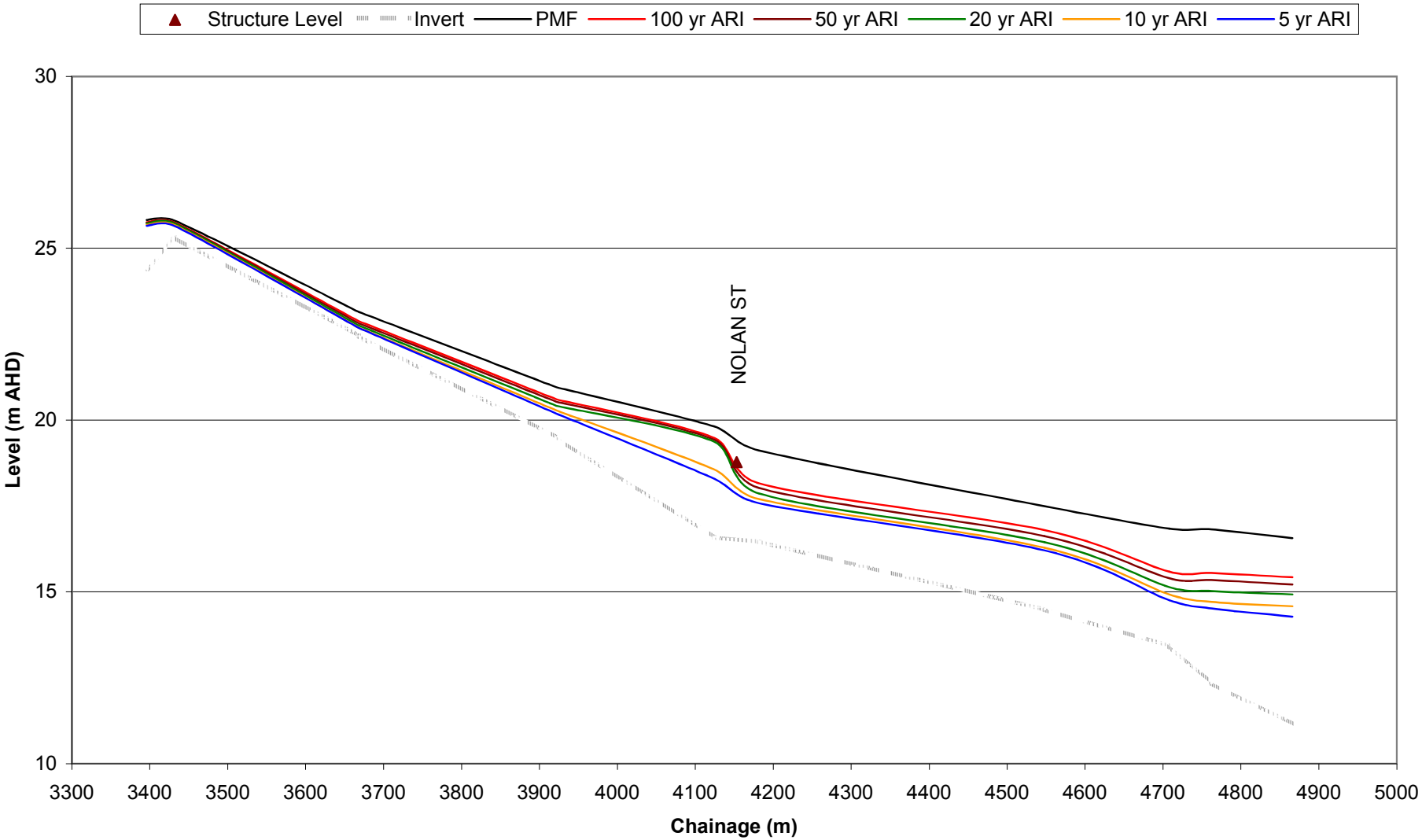

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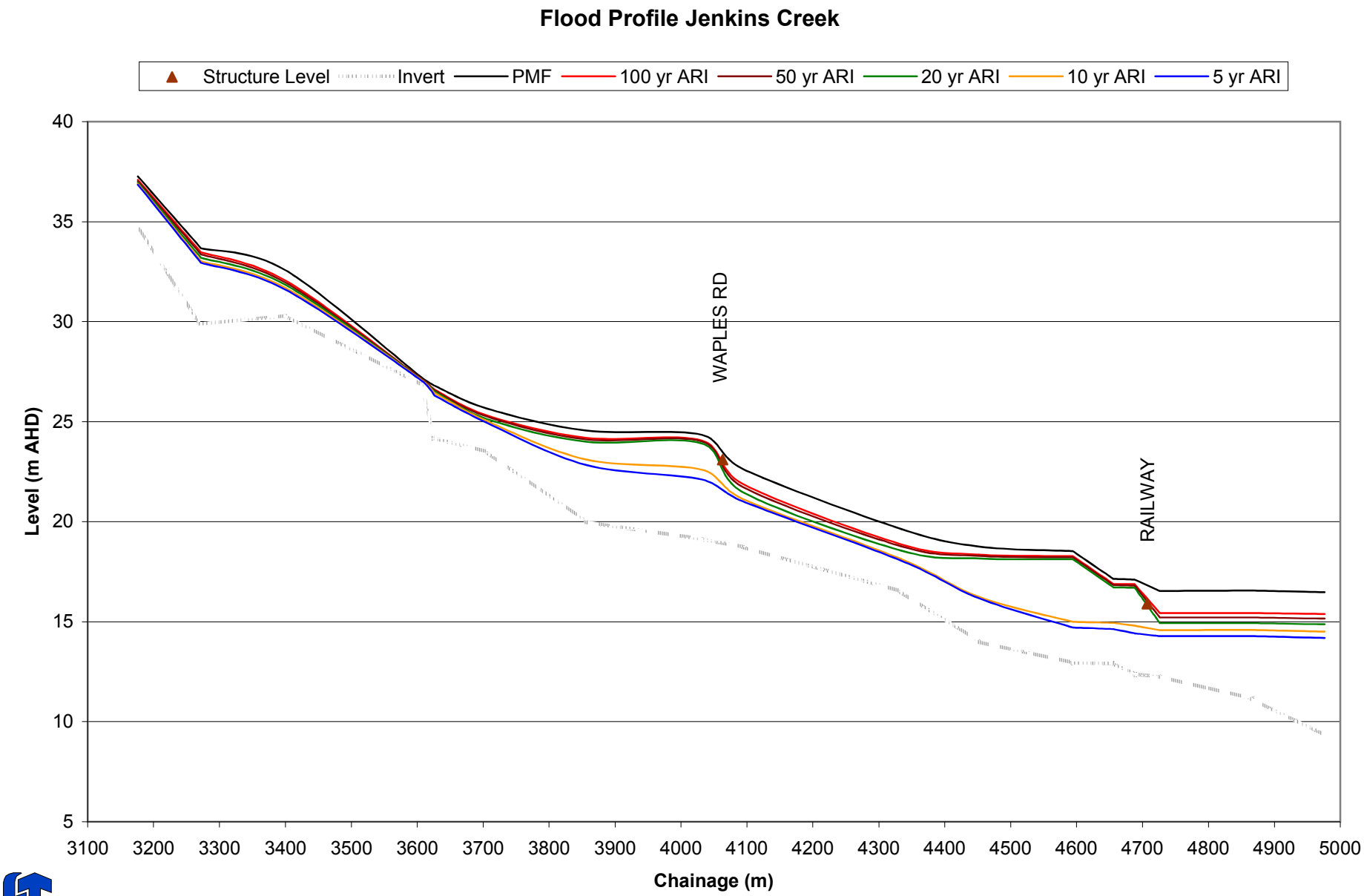
FIGURE 7.11
DESIGN FLOOD LEVEL PROFILES - HIGHWAY BRANCH
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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1 September 2006

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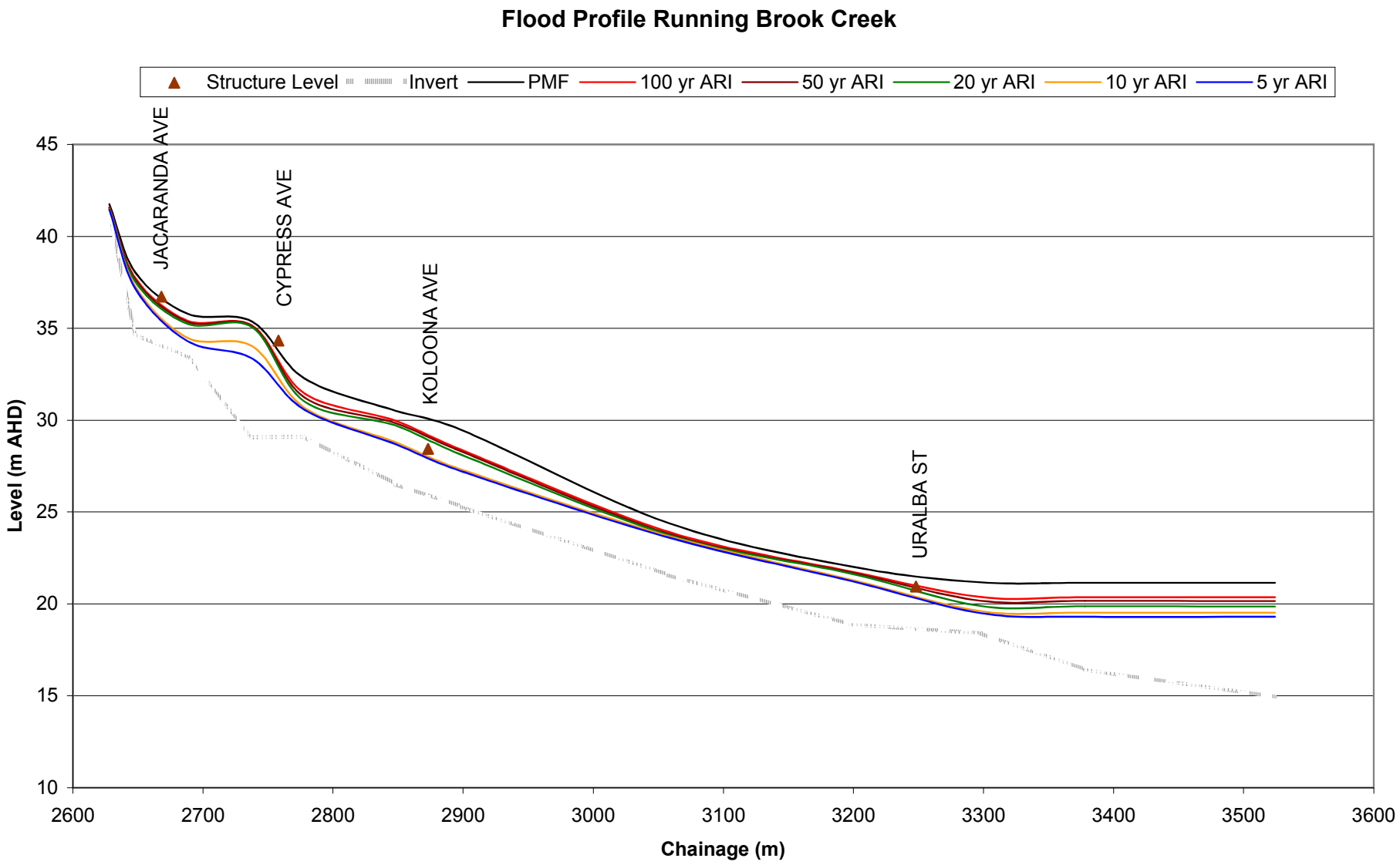
FIGURE 7.12
DESIGN FLOOD LEVEL PROFILES - JENKINS CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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1 September 2006

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FIGURE 7.13
DESIGN FLOOD LEVEL PROFILES - RUNNING BROOK CREEK
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls

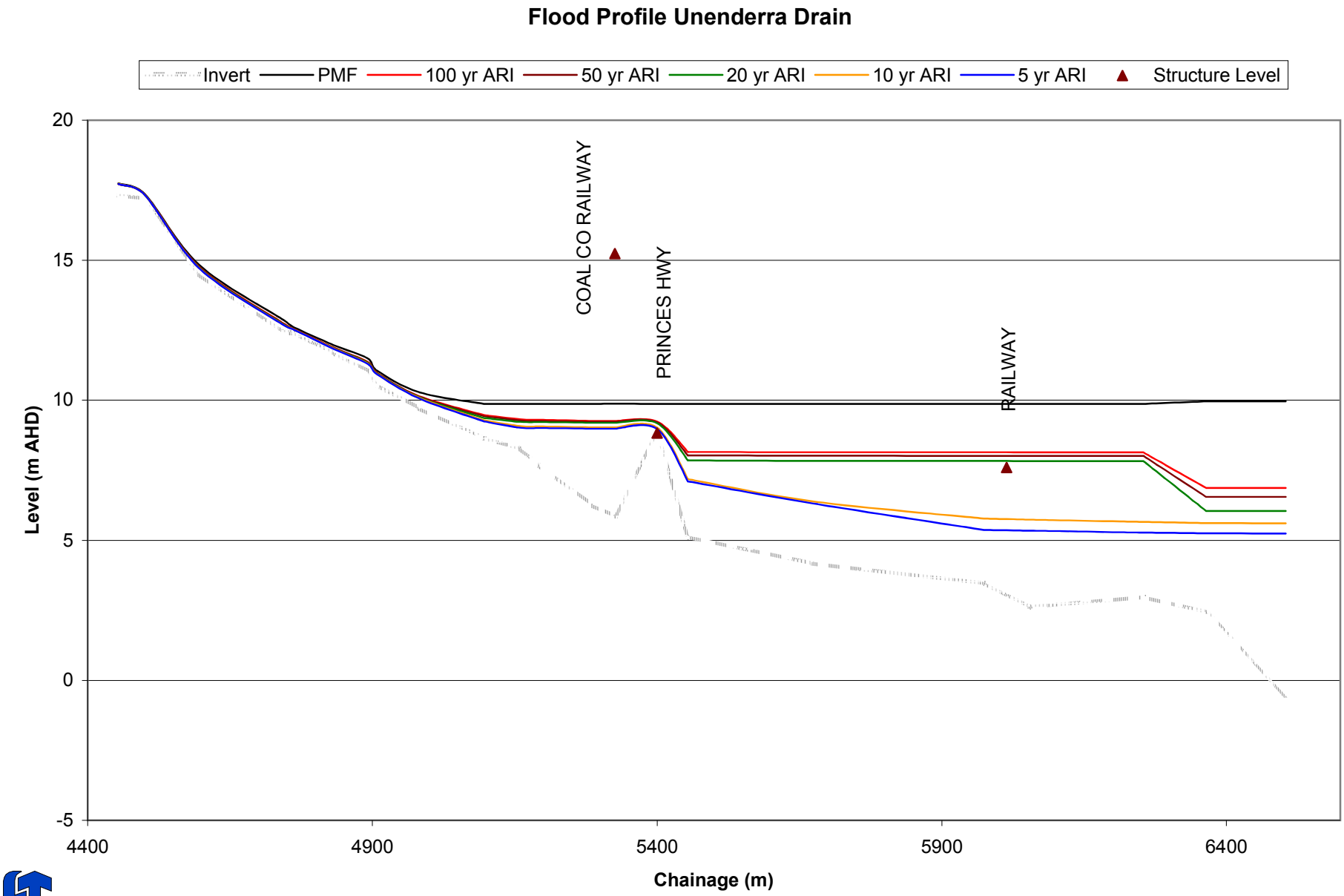

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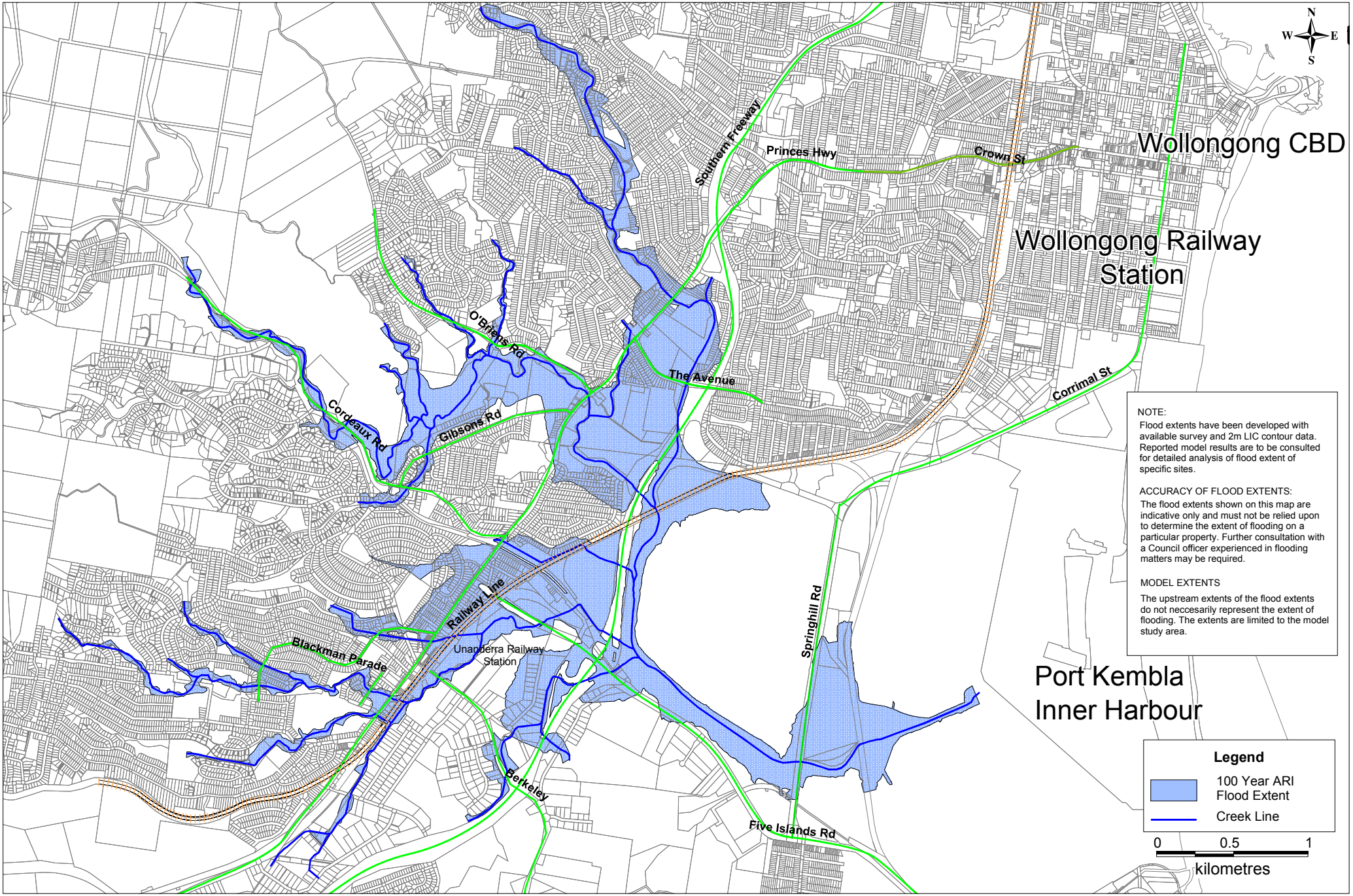
FIGURE 7.14
DESIGN FLOOD LEVEL PROFILES - UNANDERRA DRAIN
J1946/Figures 2006/Flood Study Figures V6/Figures 7.1-7.14 - Flood Profiles.xls



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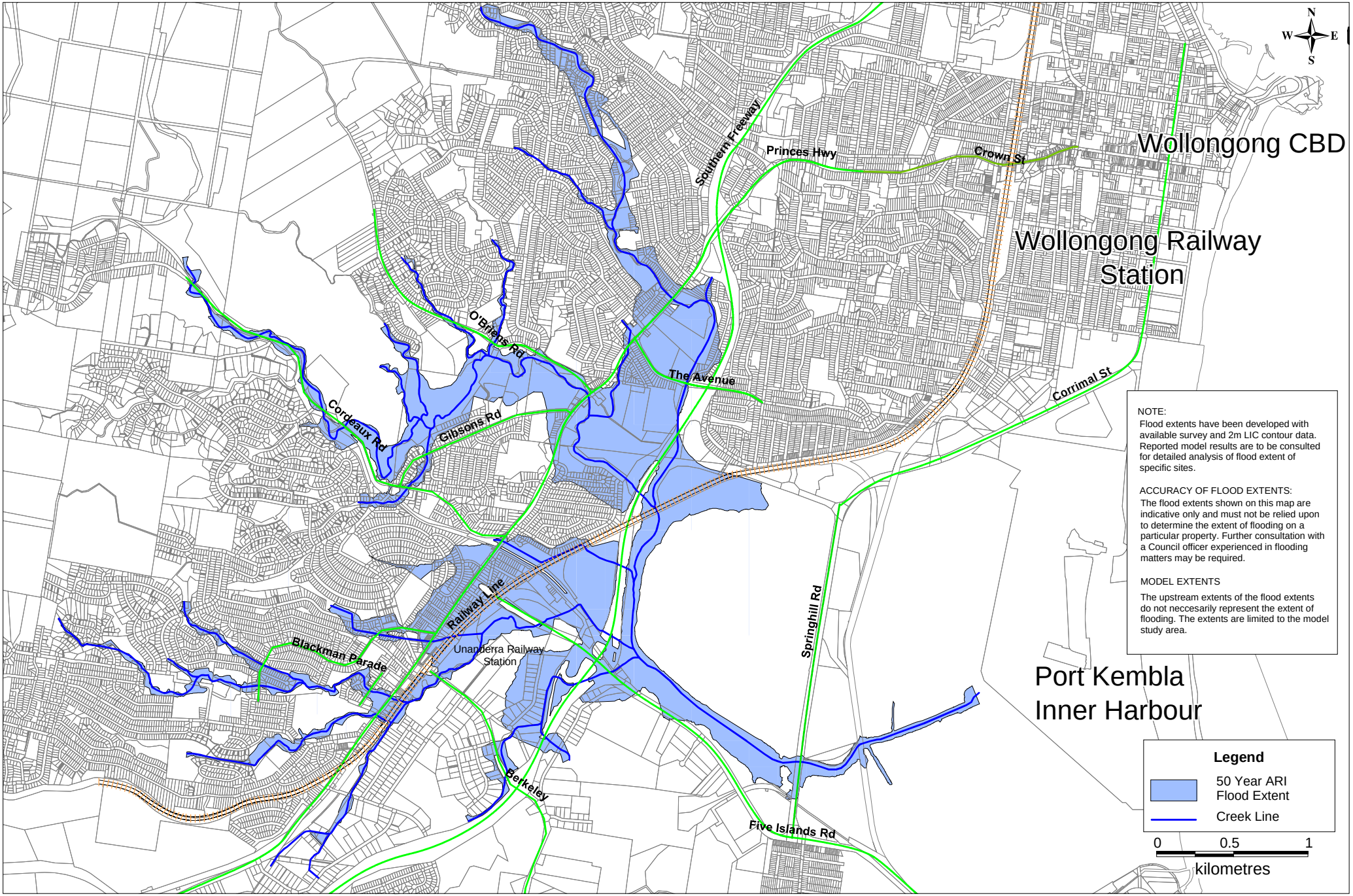
1 September 2006

Allans Creek Flood Study

FIGURE 7.15
100 YEAR ARI FLOOD EXTENT

J1946/Figures 2006/Flood Study Figures V6\Figure 7.15 100yr Extent.Wor



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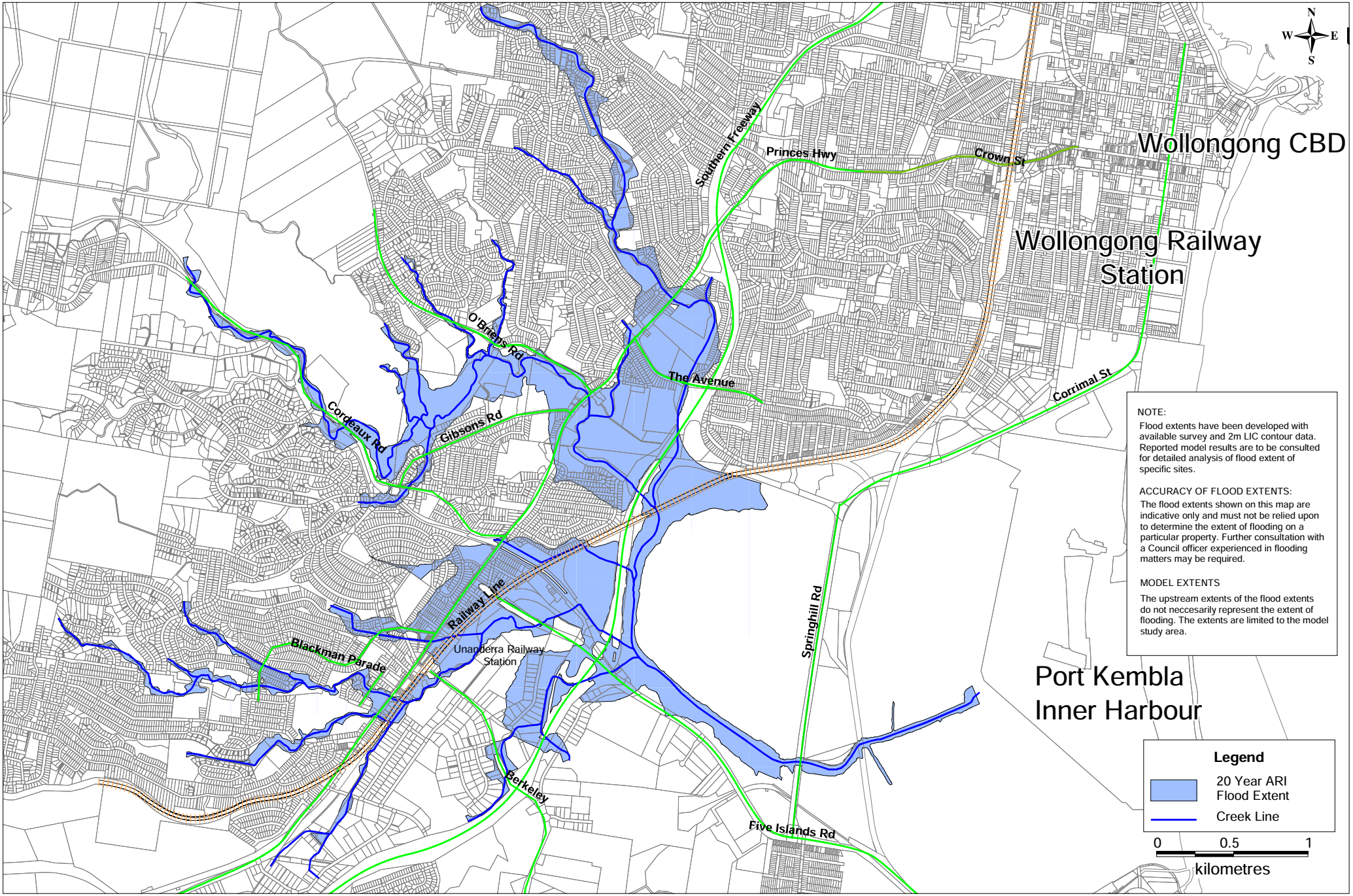
1 September 2006

Allans Creek Flood Study

FIGURE 7.16
50 YEAR ARI FLOOD EXTENT

J1946/Figures 2006/Flood Study Figures V6\Figure 7.16 50yr Extent.Wor



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1 September 2006

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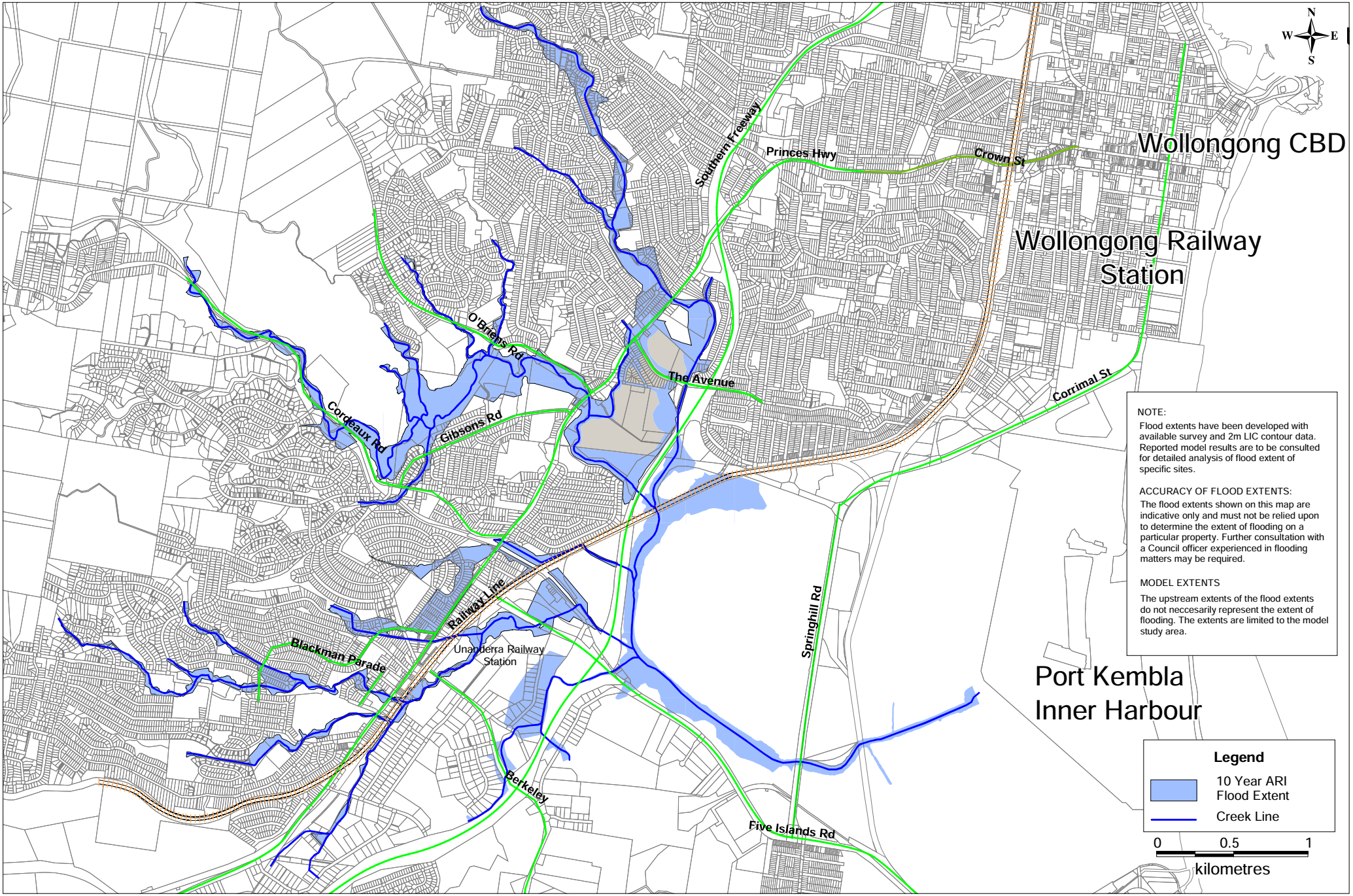
FIGURE 7.17
20 YEAR ARI FLOOD EXTENT

J1946/Figures 2006/Flood Study Figures V6\Figure 7.17 20yr Extent.Wor



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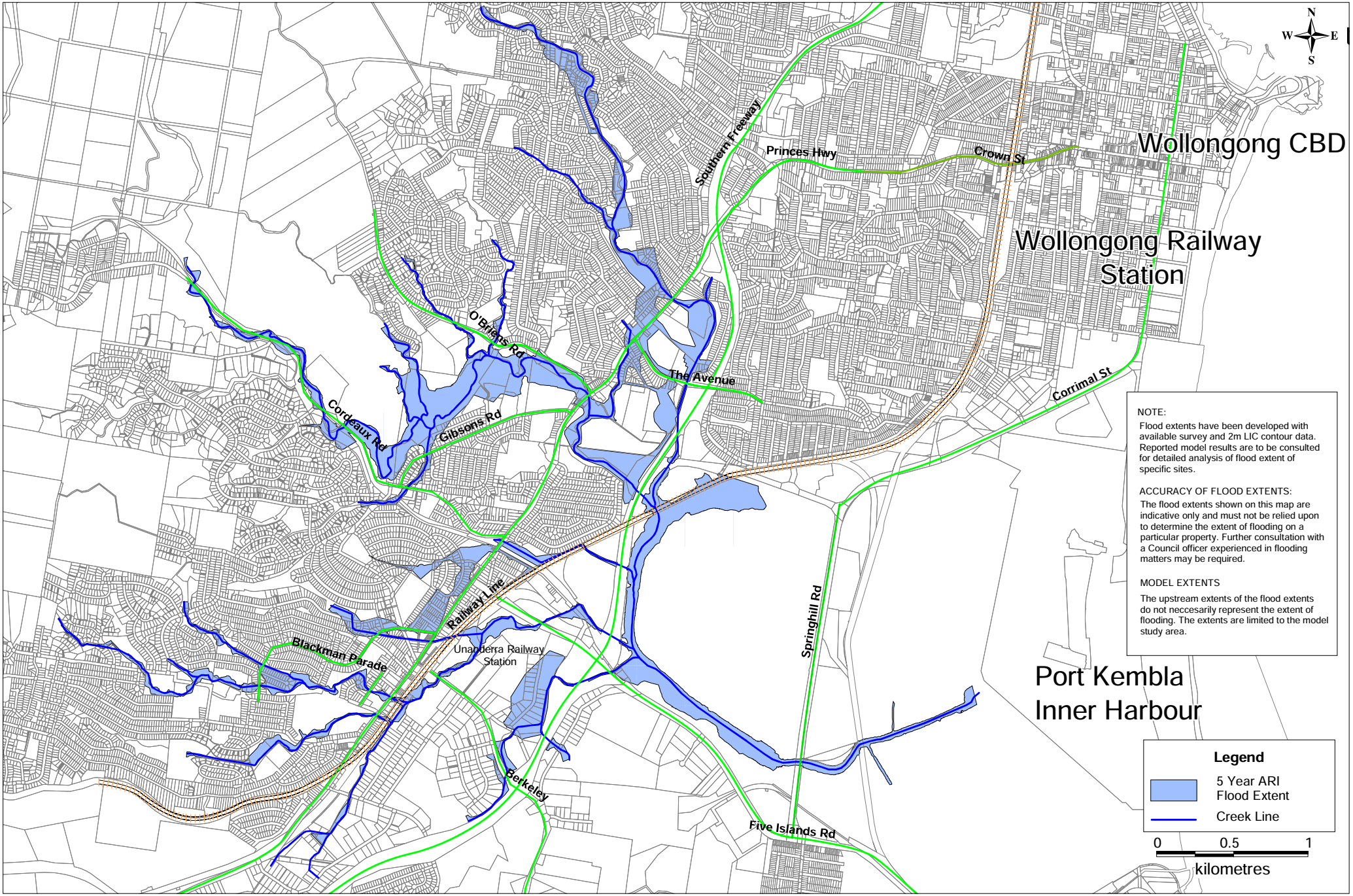
1 September 2006

Allans Creek Flood Study

FIGURE 7.18
10 YEAR ARI FLOOD EXTENT

J1946/Figures 2006/Flood Study Figures V6\Figure 7.18 10yr Extent.Wor

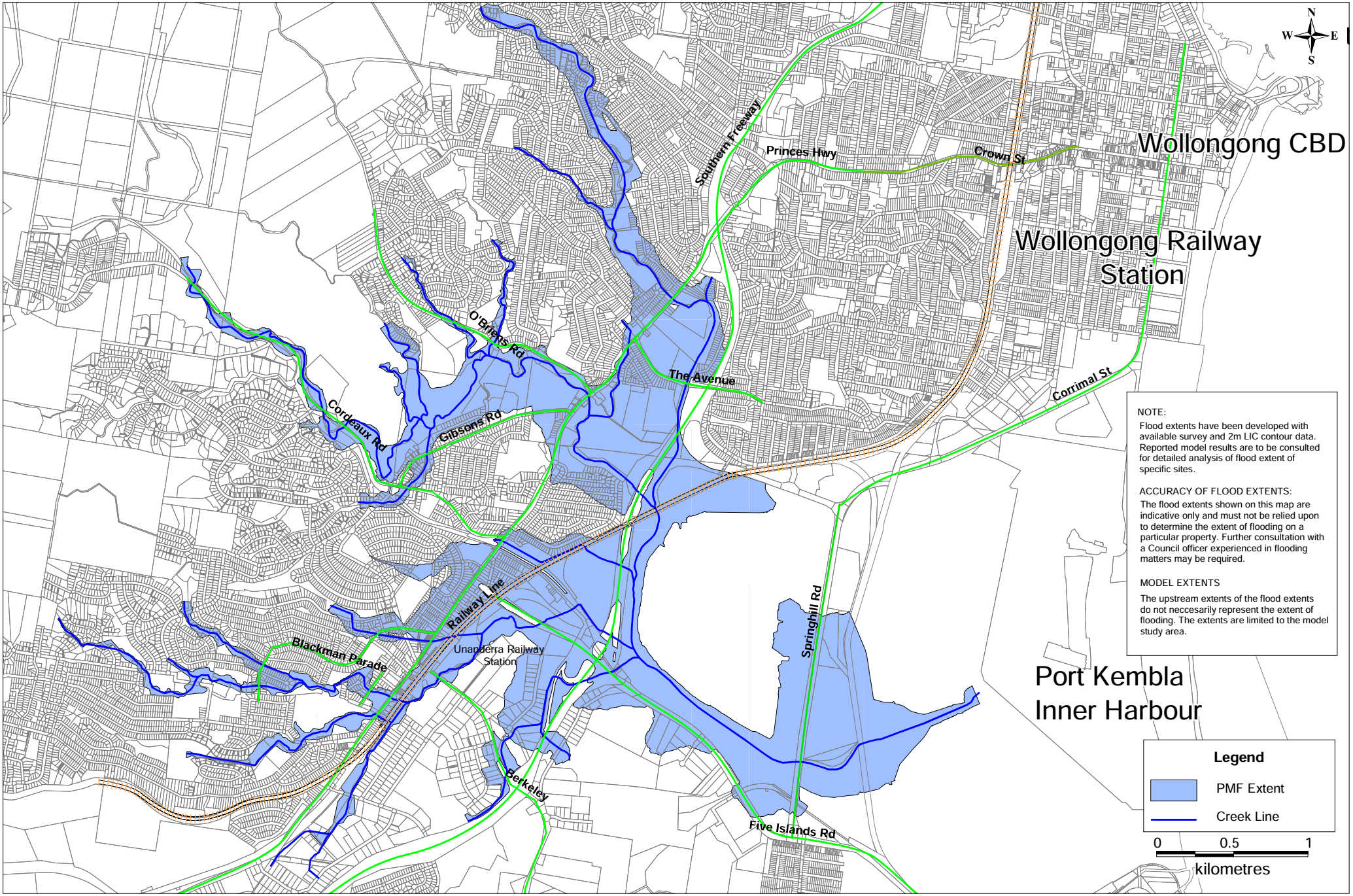


LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE 7.19
5 YEAR ARI FLOOD EXTENT

J1946/Figures 2006/Flood Study Figures V6\Figure 7.19 5yr Extent.Wor



LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE 7.20
PMF EXTENT
J1946/Figures 2006/Flood Study Figures V6\Figure 7.20 PMF Extent.Wor

APPENDIX A - LIST OF RECORDED FLOOD LEVELS

1999 Recorded Flood Level		
Branch	**Chainage (m)**	**Water Level (mAHD)**
ALLANS	4186	14.325
ALLANS	5146	14.962
ALLANS	4749.64	19.32
AMERICAN	3149.37	15.91
AMERICAN	3168.13	15.89
AMERICAN	4017.51	13.2
AMERICAN	4781.82	11.88
AMERICAN	4815.75	11.01
AMERICAN	4846.1	11.04
AMERICAN	5609.37	10
AMERICAN	5628.49	9.1
ARROW	3904	16.98
ARROW	4010	16.4
ARROW	4024	16.39
ARROW	4039	16.15
ARROW	4039	16.19
ARROW	4082	15.44
ARROW	4118	15.425
BRANCH	3758.36	13.77
BRANCH	3797.35	13.62
BRANCH TRIB	3053.59	33.42
BRANCH TRIB	3059.33	33.44
BRANCH TRIB	3369.38	18.66
BYARONG	1939.67	35.13
BYARONG	1999.1	34.375
BYARONG	2062.88	33.02
BYARONG	2591.53	27.47
BYARONG	3283.13	21.115
BYARONG	3320.2	20.565
BYARONG	3647.22	18.65
BYARONG	3917.02	16.98
BYARONG	3980.2	16.753
BYARONG	4146.15	15.22
BYARONG	4396.71	13.93
BYARONG	4791.49	12.08
BYARONG	4794.07	12.035
BYARONG	4800.87	12
BYARONG	4830.81	12.09
BYARONG	4849.89	11.625
BYARONG	4861.45	11.62
BYARONG	4878.91	11.87
BYARONG	4894.36	10.925
BYARONG	4898.41	11.13
BYARONG	5194.34	10.51
CHARCOAL	3729.42	25.87
CHARCOAL	4644.27	16.385
CHARCOAL	4824.66	16.225
CLEVERDON	4697.08	11
CLEVERDON DRAIN	4797.84	11.04
CLEVERDON_DRAIN	4166.34	14.155
CLEVERDON DRAIN	4804.7	11.2
CORDO HTS	2485.84	20.62
CUMMINS-ALBERT	73.55	18.474

APPENDIX A - LIST OF RECORDED FLOOD LEVELS

1999 Recorded Flood Level		
Branch	**Chainage (m)**	**Water Level (mAHD)**
CUMMINS-ALBERT	312.723	15.24
CUMMINS-ALBERT	328.111	13.824
CUMMINS-ALBERT	670	11.51
FIGTREE	5183.35	10.165
FIGTREE	5279.57	11.1
GHOST	4396.71	13.93
GOVETT	3262.7	15.51
GOVETT	3293.76	15.53
GOVETT	3309.8	15.15
GOVETT	3608.92	13.72
GOVETT	3613.12	13.86
GOVETT	3635.09	13.87
GOVETT	3691.96	13.4
GOVETT	4017.51	13.2
JENKINS	3681.87	25.65
JENKINS	3837.49	22.9
JENKINS	4063.73	22.75
JENKINS	4624.5	15.99
LANGSON	3117.28	22.015
RUNNING BROOK	2864.55	28.94
RUNNING BROOK	3187.9	21.295
RUNNING BROOK	3246.71	21.155
UNANDERRA DRAIN	3165.64	9.511
UNANDERRA DRAIN	5012.41	9.6
UNANDERRA DRAIN	5101.02	9.67
UNANDERRA DRAIN	5116	9.65

WOLLONGONG
City of Diversity

Brand

- JAN 85 1977

STORM SURVEY

Your response to this questionnaire will help Wollongong City Council investigate stormwater problems throughout the city. Indicate your responses by either writing in the spaces provided or placing a tick in the most appropriate box. Please note: questionnaire is printed on both sides.

1. Name or Business/Organisation _____

   Address _____
   Street Number Street

   FIGTREE _____ Postcode 2525
   Suburb

2. How long have you lived in/or owned the above property? 13+ years

3. What type of development is on the property?
   - [x] Residential
   - [ ] Commercial (please specify) _____
   - [ ] Other (please specify) _____

4. What is your status with regard to the property?
   - [x] Owner residing
   - [ ] Owner conducting business
   - [ ] Owner not residing nor conducting business at property
   - [ ] Tenant only
   - [ ] Secretary or Body Corporate
   - [ ] Other (please specify) _____

5. Did the property suffer stormwater damage on 17 August 1998?
   - [ ] No
   - [x] Yes

   If you answered NO, go to question 19.

6. At what speed did the water travel?
   - [ ] Stationary
   - [ ] Walking pace
   - [x] Running
   - [ ] Other (please specify) _____

7. Were you aware of any potential stormwater problems affecting the property prior to 17 August 1998?
   - [x] No
   - [ ] Yes

8. Have you experienced previous stormwater problems at this property?
   - [x] No
   - [ ] Yes

9. How many people were at the property when it was affected by stormwater? 3

10. Were people evacuated from the property?
- [x] No
- [ ] Yes

If you answered NO, go to question 12.

11. How long was it before you returned home? _____ hours

12. Who provided you with assistance during the storm?
- [ ] No one
- [x] State Emergency Service (SES)
- [ ] Police
- [ ] Fire brigade
- [ ] Other (please specify) _____

13. After the storm, did you approach any organisations for help (eg. Department of Community Services)?
- [x] No
- [ ] Yes (please specify) _____

14. Has the storm affected the health of anyone in your household?
- [x] No
- [ ] Yes (please specify) _____

15. Was the stormwater damage covered by insurance?
- [ ] No
- [x] Yes eventually

16. Please indicate the time and money spent on the clean up process (only).

A. RESIDENTIAL PROPERTY

Internal

Hours 5 - getting rid of water in house.

Cost _____

External

Hours _____

Cost _____

Other (please specify) _____

Hours _____

Cost _____

If a residential property, go to question 19.

B. COMMERCIAL PROPERTY

Hours _____

Cost of salaries _____

Cost of materials _____

17. How much trading time was lost due to the storm? _____ days

18. What would be the estimated cost of lost sales? _____

19. Do you have any photographs, videos or other information about stormwater problems in your area that would be available for viewing by Wollongong City Council?

☑ No

☐ Yes Contact name _____

Telephone number _____

Best time to call _____

20. If you have any suggestions for resolving the stormwater or drainage problems in your area, list them below.

* The storm water drain became blocked once unblocked the water ~~di~~ resided

21. What parts of the property were affected by stormwater and to what depth?

☑ Grounds Depth _____ cm - Half of clothesline * underwater in backya
- Only the top of the letterbox could be seen in frontya

☑ Garage/Shed Depth 30 cm

☐ Building Depth _____ cm above floor level

☐ Other (please specify) _____ Depth _____ cm

22. Draw a sketch map below of the property showing where the stormwater came in and exited. Also indicate, if possible, the depth of water and any other relevant details.

Please complete the attached house or commercial damage survey report

WOLLONGONG CITY COUNCIL
HOUSE DAMAGE SURVEY

Please fill in the following details of the property

Age of the house 13 years

Construction material of house

- ☐ Double brick
- ☑ Brick veneer
- ☐ Timber
- ☐ Cladding
- ☐ Other (please specify) _____

Number of habitable storeys

- ☐ One
- ☑ Two
- ☐ Three or more

Number of bedrooms

- ☐ One
- ☐ Two
- ☑ Three
- ☐ Four or more

STRUCTURAL DAMAGE		
Area	Description of Damage	Estimated Cost
Foundations		
External walls		
Internal walls		
Floors		
Doors/Windows		
Built-ins		
Other		

INTERNAL DAMAGE			
Room	Damaged Items	Description of Damage	Estimated Cost
Kitchen	Appliances		
	Furniture		
	Food		
	Floor coverings		
Dining	Appliances		
	Furniture		
	Floor coverings		
Lounge/Living	Appliances	Gas heater damaged	$850-
	Furniture		
	Floor coverings		

INTERNAL DAMAGE CONTINUED			
Room	Damaged Items	Description of Damage	Estimated Cost
Bedrooms	Appliances		
	Bed base and linen		
	Clothing		
	Floor coverings		
	Furniture		
Bath/Toilets	Appliances		
	Floor coverings		
	Other		
Laundry	Appliances		
	Floor coverings		
	Other		
Other	~~Garage~~	~~Tools~~	

EXTERNAL DAMAGE			
Area	Damaged Items	Description of Damage	Estimated Cost
Garage/Workshop*	Power Tools / 2 lawn mowers		$4000
Motor vehicle (include make and model)			
Storage*			
Gardens			
Fences			
Other			

**including equipment, etc. stored inside.*

If a motor vehicle was damaged, was it:

- ❑ Privately owned
- ❑ Company owned
- ❑ Government owned
- ❑ Commercial owned
- ❑ Other (please specify) _____

If you have any additional comments, please list them below.

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR ASSISTANCE

Please return your completed questionnaire to:

Post: Reply Paid 119
Wollongong City Council
Locked Bag 8821
South Coast Mail Centre NSW 2521
(Please note: NO STAMP IS REQUIRED)

or

Telephone: 4227 7666
A Council officer will call in
and collect the questionnaire

WOLLONGONG CITY COUNCIL
COMMERCIAL DAMAGE SURVEY

Please fill in the following details of the property

Type of business _____

Age of building _____ years

Construction material of

- Foundations _____
- Walls (internal) _____
- Walls (external) _____
- Floor covering _____

Measurement of floor area _____ m^2

Number of storeys

- ❑ One
- ❑ Two
- ❑ Three or more

STRUCTURAL DAMAGE		
Area	Description of Damage	Estimated Cost
Foundations		
External walls		
Internal walls		
Floors		
Doors/Windows		
Built-ins		
Other		

DAMAGE TO FITTINGS/PLANT EQUIPMENT ETC		
Items	Description of Damage	Estimated Cost

APPENDIX C
RATIONAL METHOD CALCULATIONS

ARI	Area #	Area (km^2)	TC (h)	TC (min)	I (mm/h)	C_{10}	FF_y	C_y	Q(m^3/s)
100 YR	1	42.2	3.15	189.1	46.6	1	1.37	1.37	750
	2	17.22	2.24	134.5	58	1	1.37	1.37	381
	3	7	1.59	95.5	71	1	1.37	1.37	190
50 YR	1	42.2	3.15	189.1	41.7	1	1.25	1.25	609
	2	17.22	2.24	134.5	52	1	1.25	1.25	310
	3	7	1.59	95.5	64	1	1.25	1.25	155
20 YR	1	42.2	3.15	189.1	35.4	1	1.12	1.12	465
	2	17.22	2.24	134.5	43.9	1	1.12	1.12	235
	3	7	1.59	95.5	54	1	1.12	1.12	118
10 YR	1	42.2	3.15	189.1	30.6	1	1	1.00	359
	2	17.22	2.24	134.5	38	1	1	1.00	182
	3	7	1.59	95.5	47	1	1	1.00	91
5 YR	1	42.2	3.15	189.1	27	1	0.88	0.88	279
	2	17.22	2.24	134.5	33.4	1	0.88	0.88	141
	3	7	1.59	95.5	41.3	1	0.88	0.88	71
PMF	1	42.2	3.15	189.1	160	-	-	-	1294.5
	2	17.22	2.24	134.5	207	-	-	-	745.29
	3	7	1.59	95.5	259	-	-	-	428.06

$TC(hours) = 0.76*A^{0.38}$ (A in km^2)

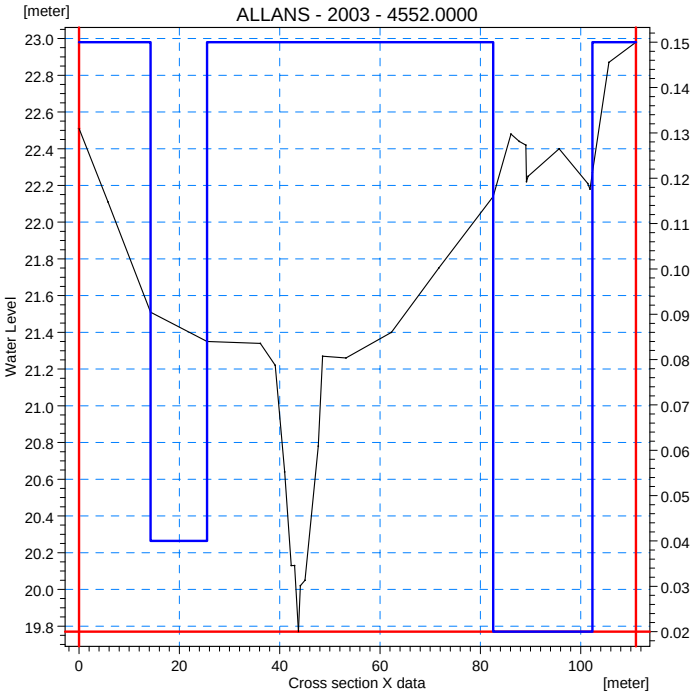
$FF_{100} = 2.57-0.588*I_{12,50}/I_{12,2}$

$FF_{50} = 1.99-0.366*I_{12,50}/I_{12,2}$

$C_y = C_{10}*FFy$

$Q(m^3/s) = C*I(m/s)*A(m^2)$

$Q_{PMP}(m^3/s) = Q_{PMF}(m^3/s) = 129.1*A(km^2)^{0.616}$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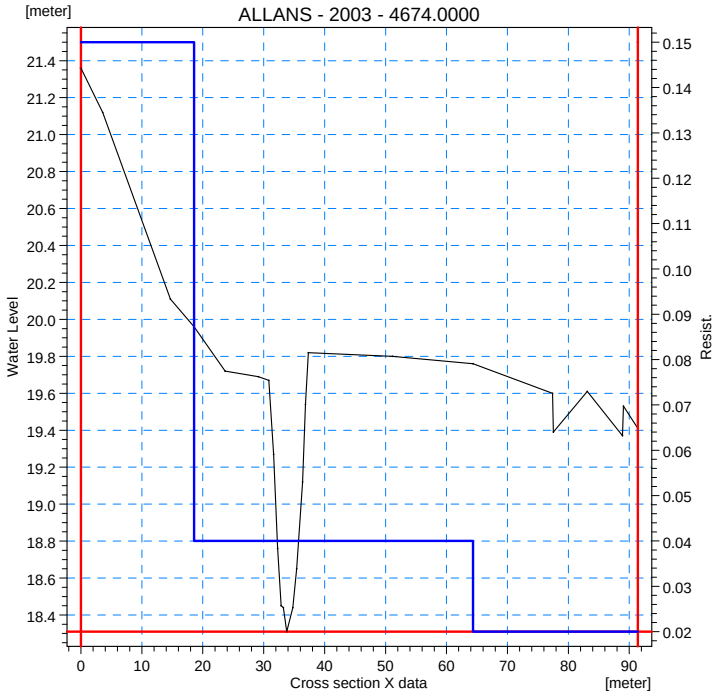
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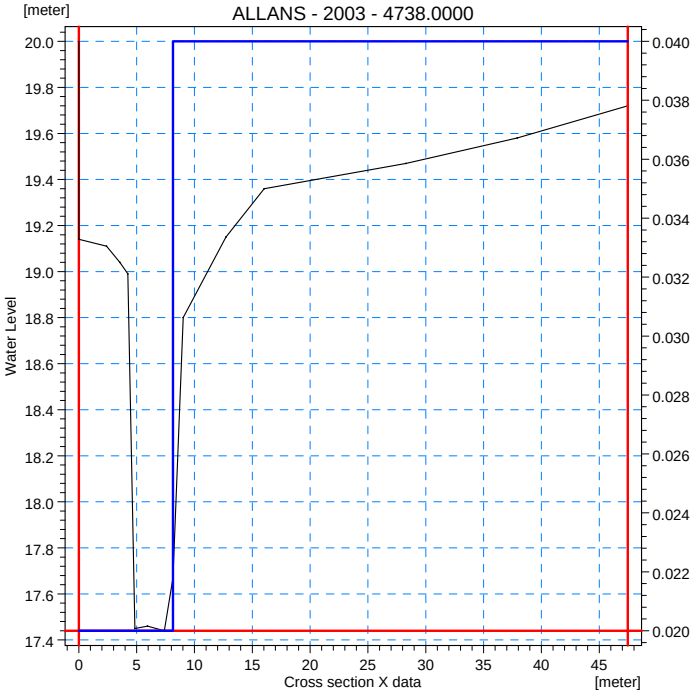
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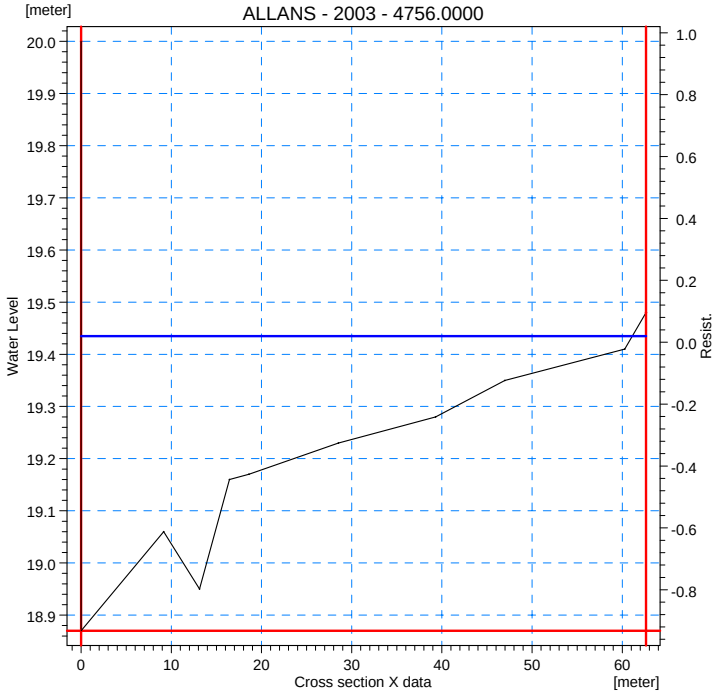
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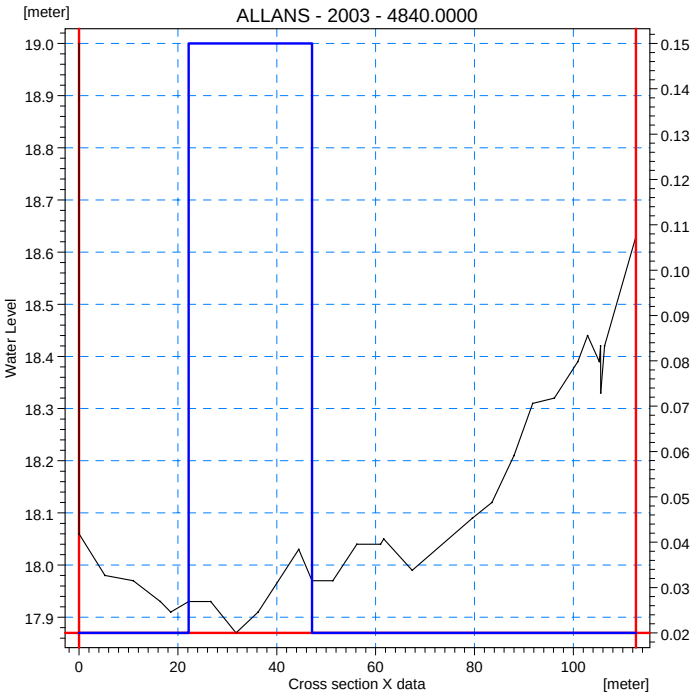
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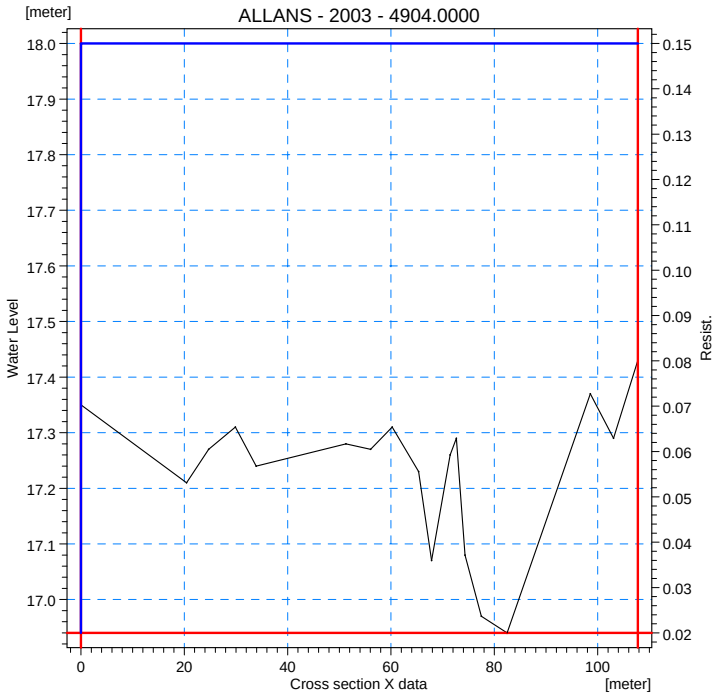
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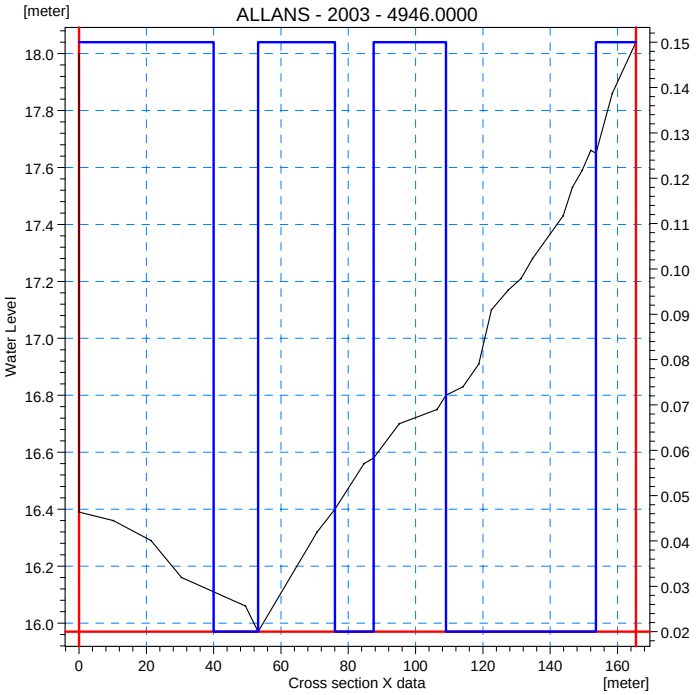
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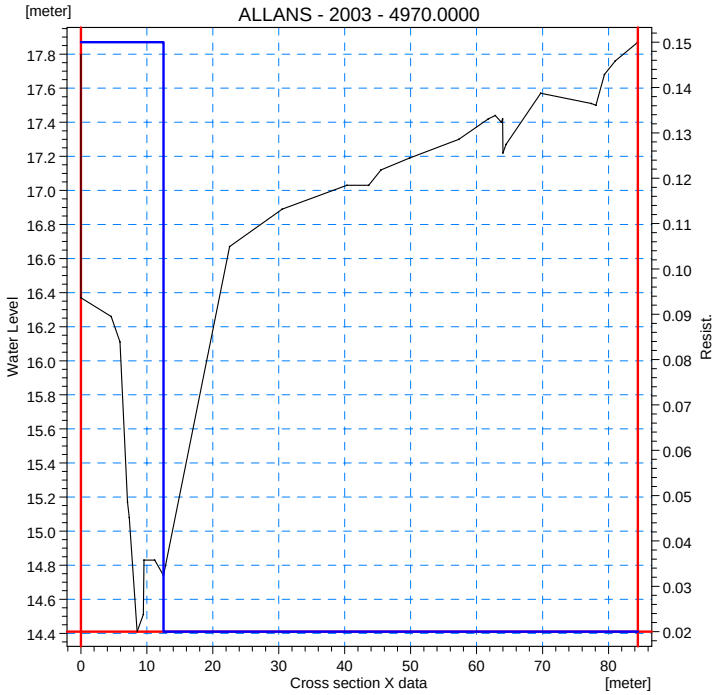
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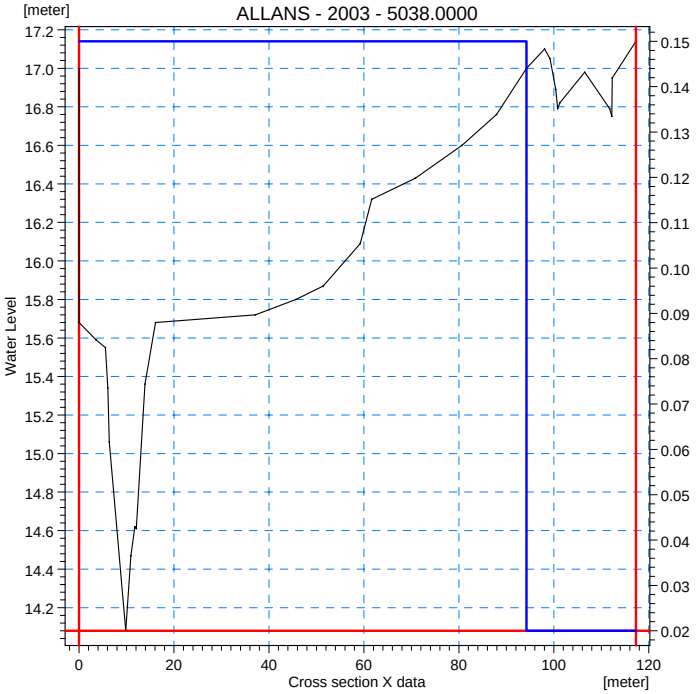
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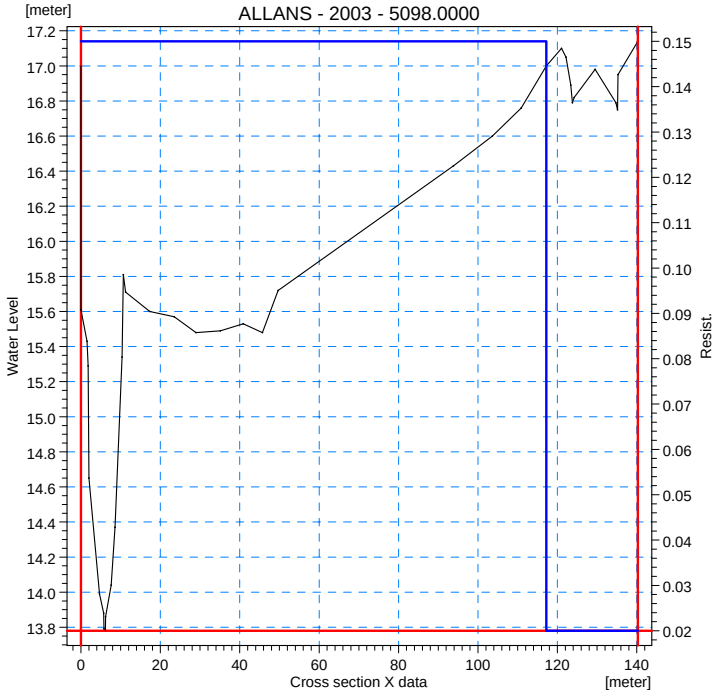
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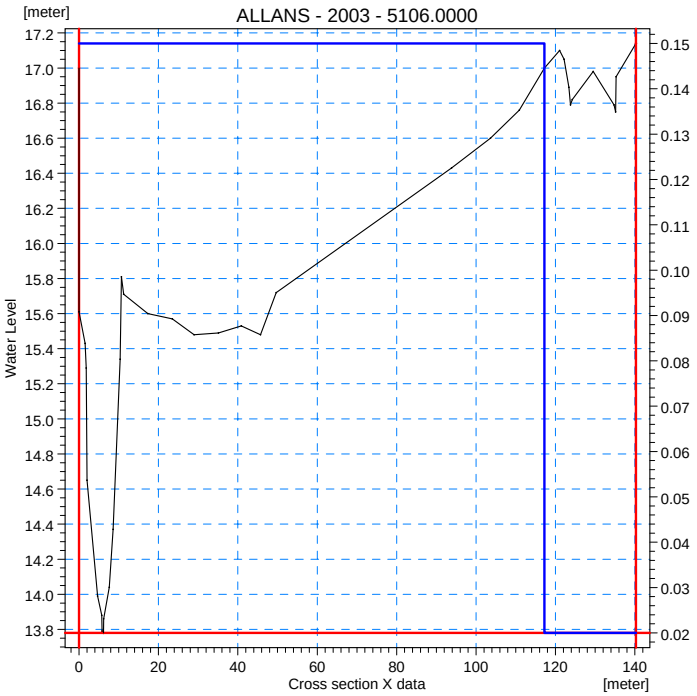
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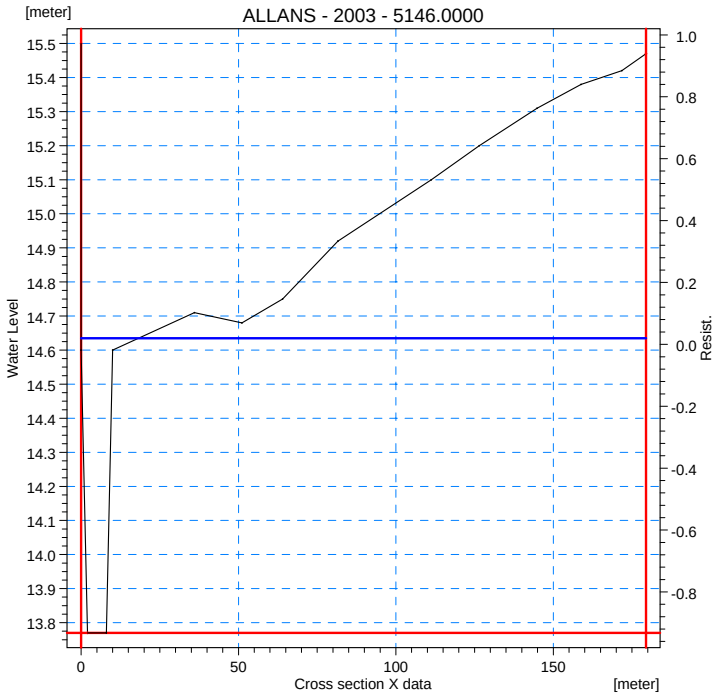
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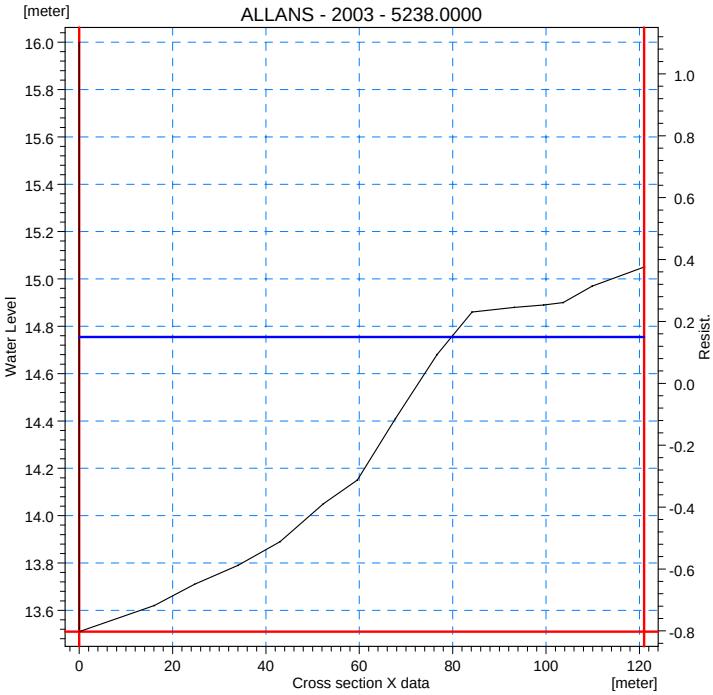
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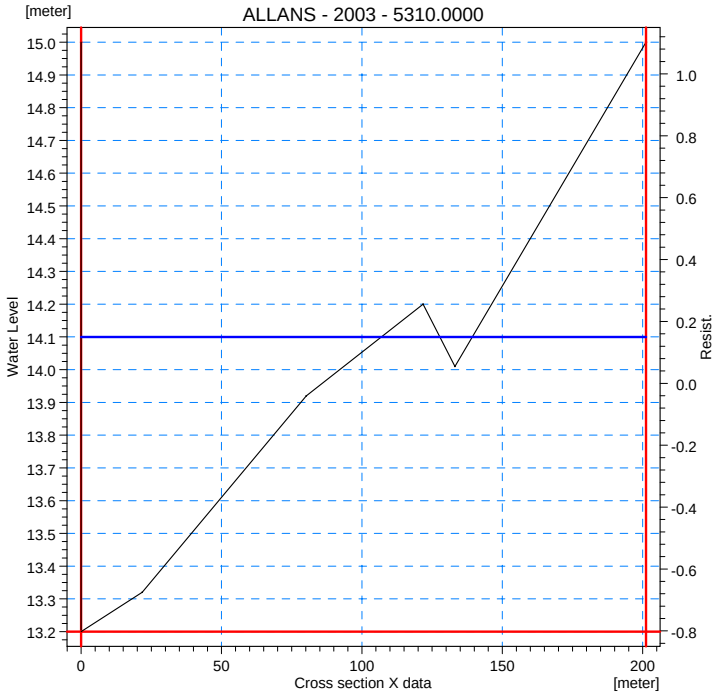
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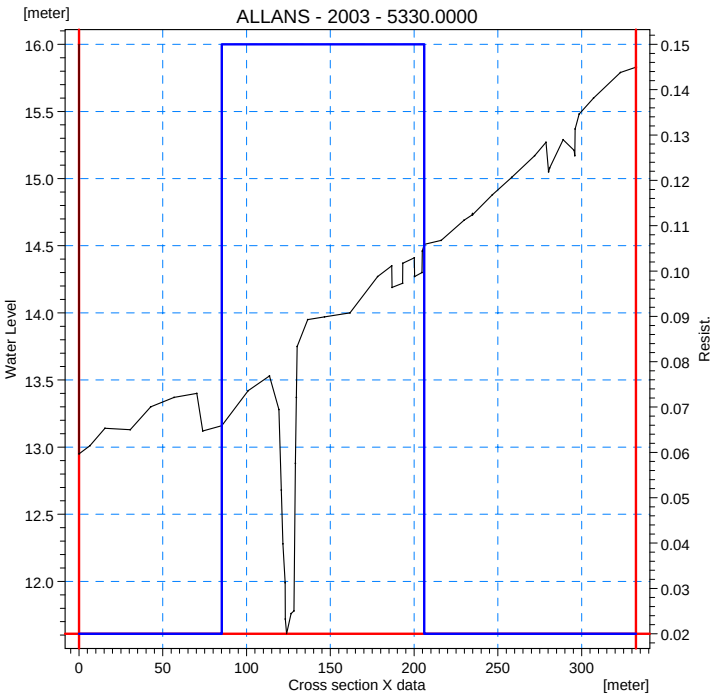
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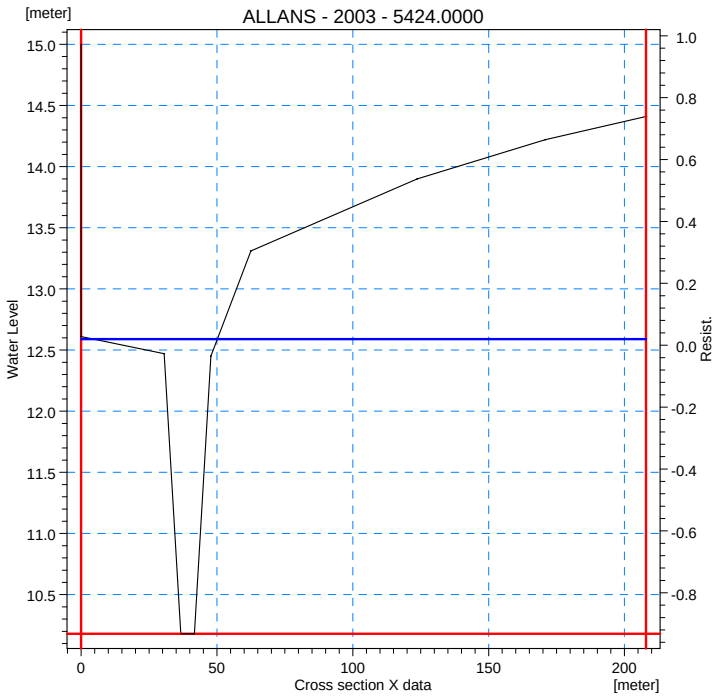
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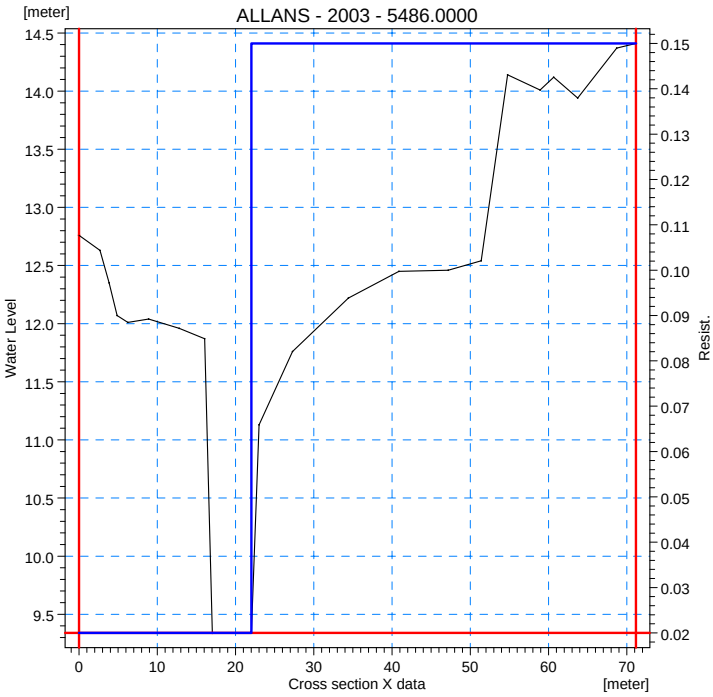
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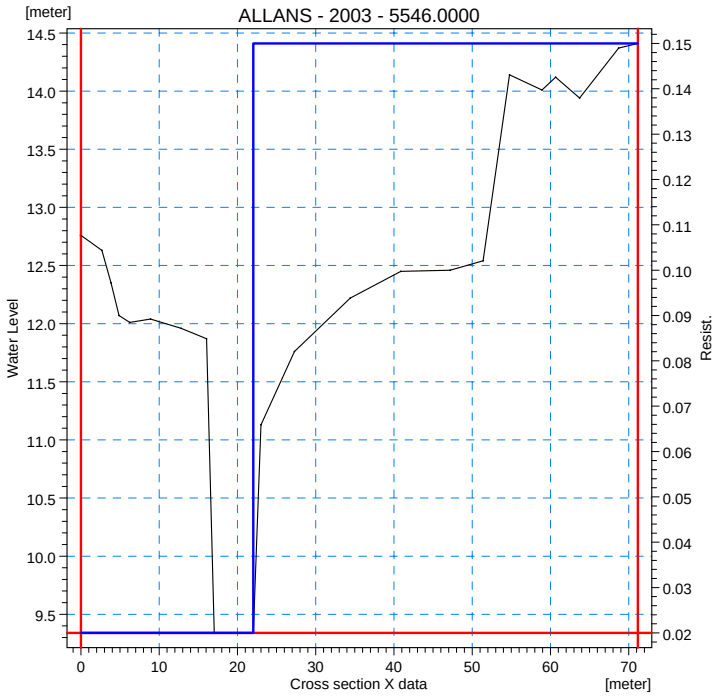
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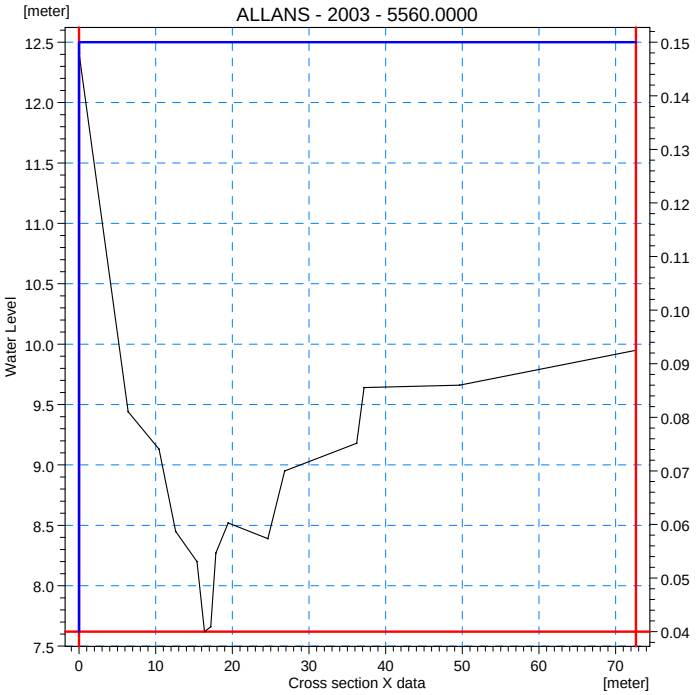
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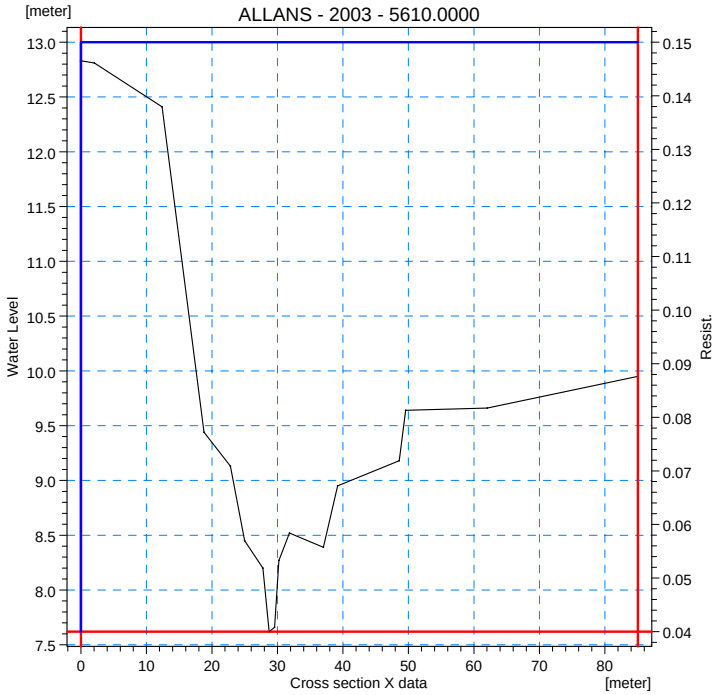
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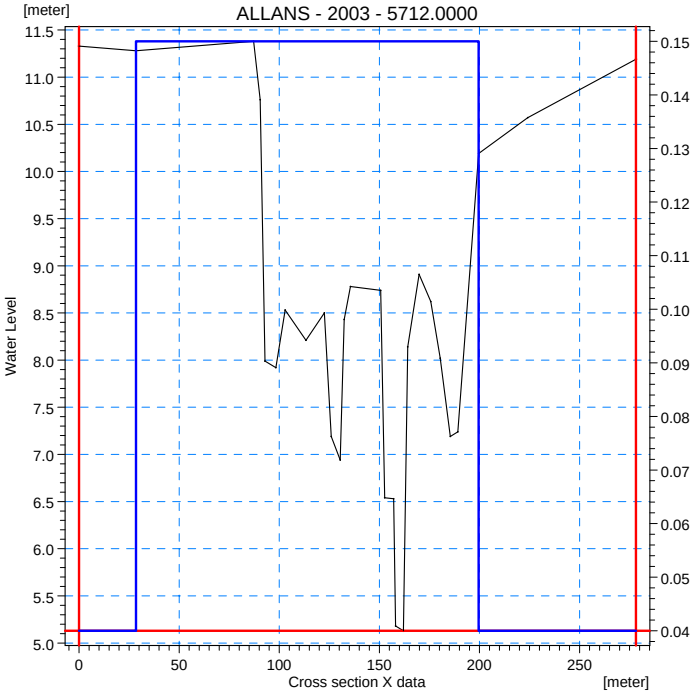
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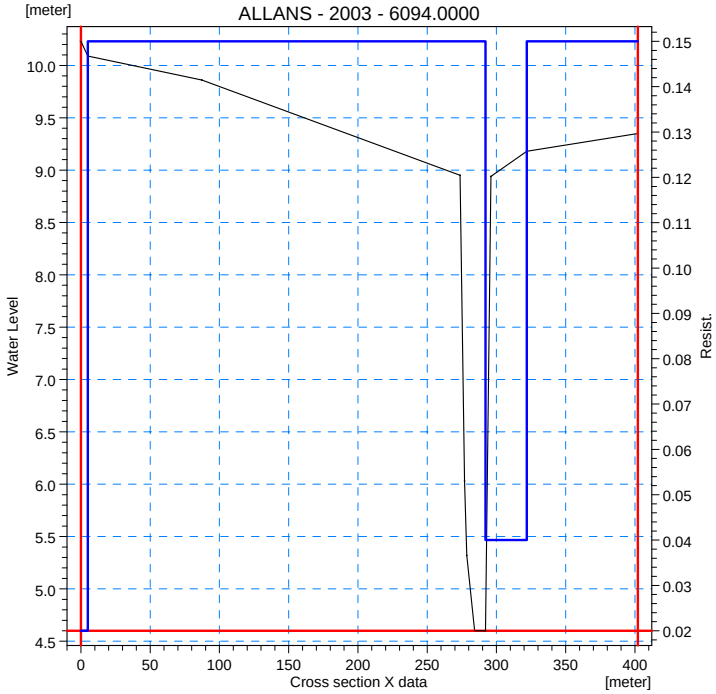
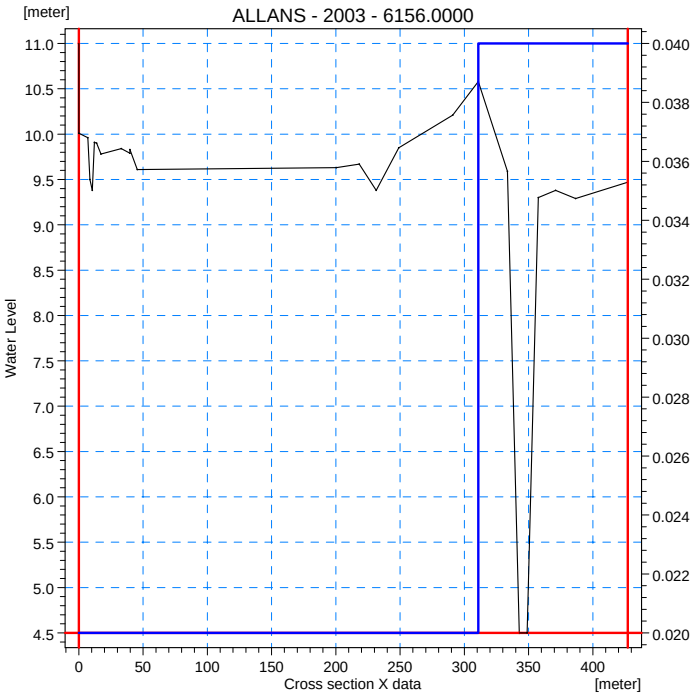
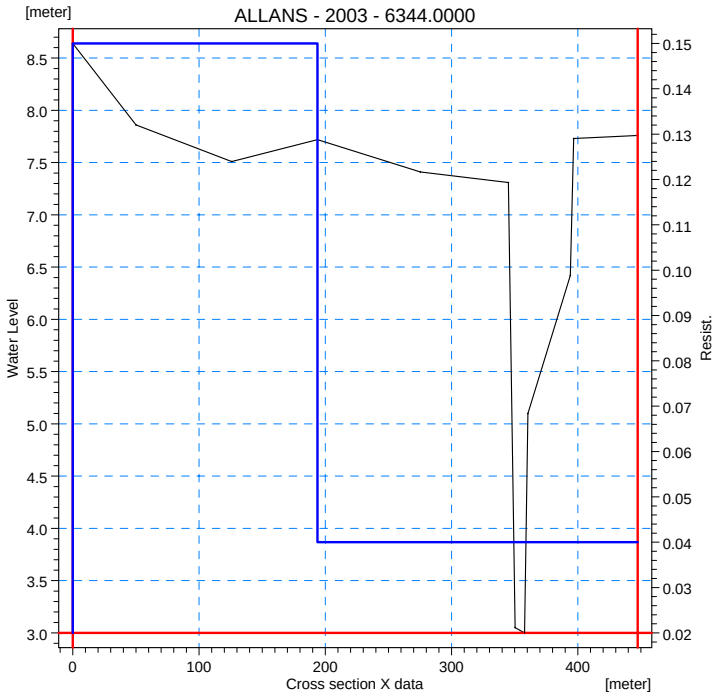

ALLANS - 2003 - 6094.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6156.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6344.0000
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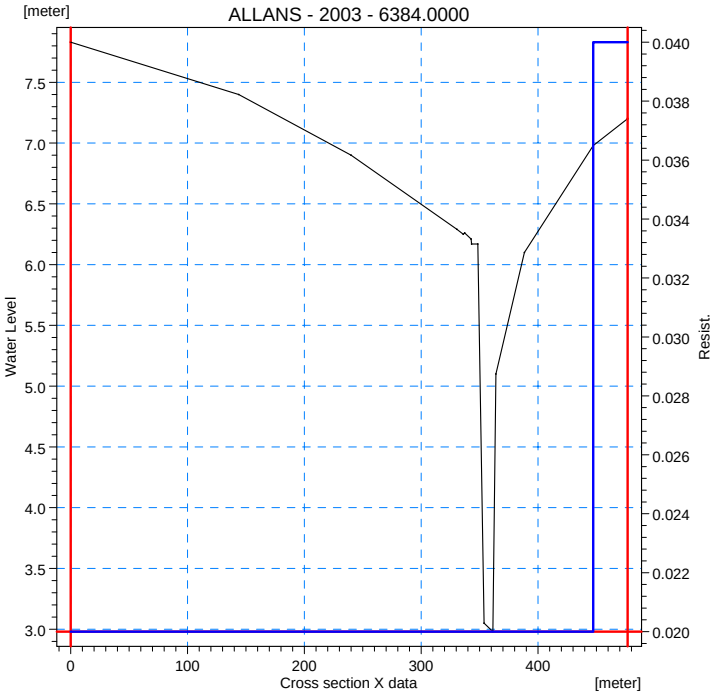
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6384.0000
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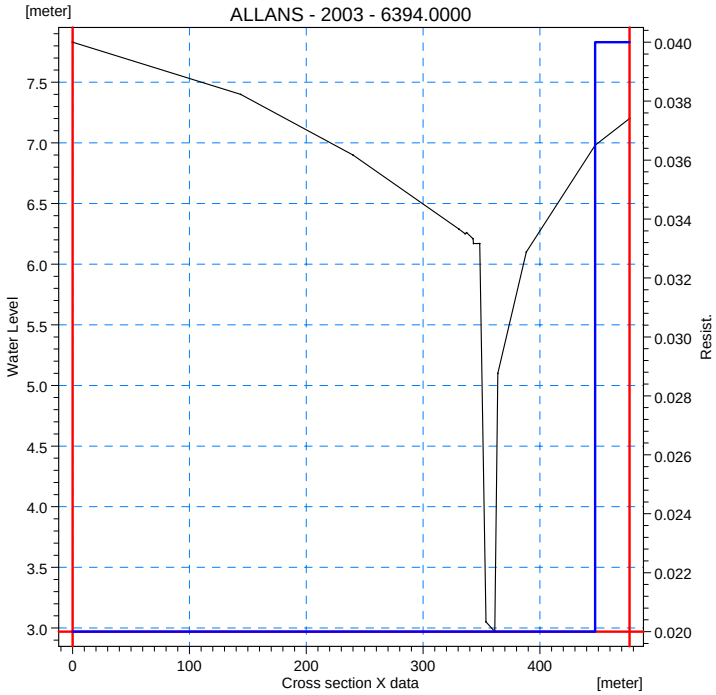
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6394.0000
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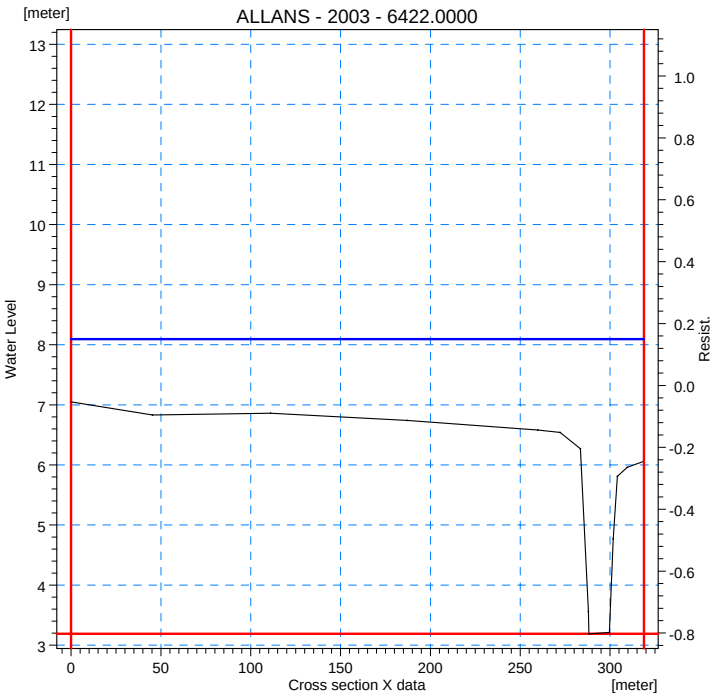
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6422.0000
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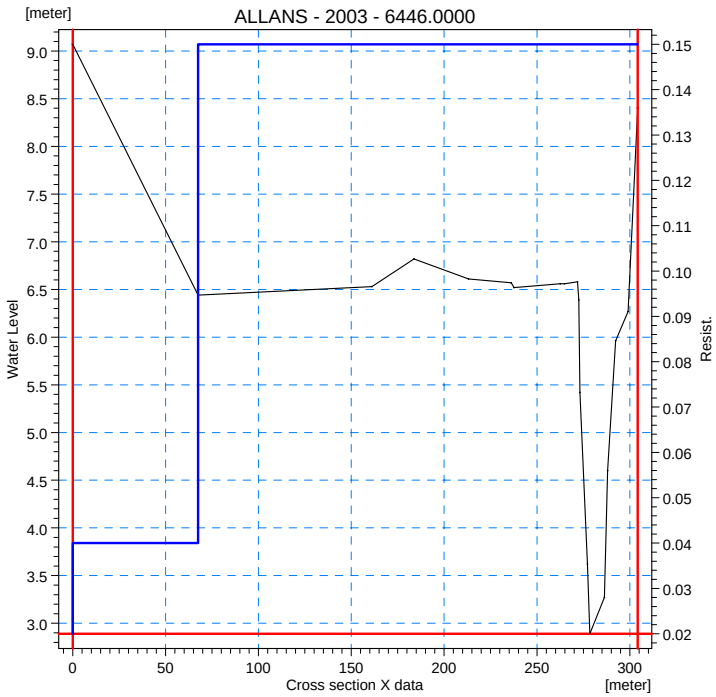
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6446.0000
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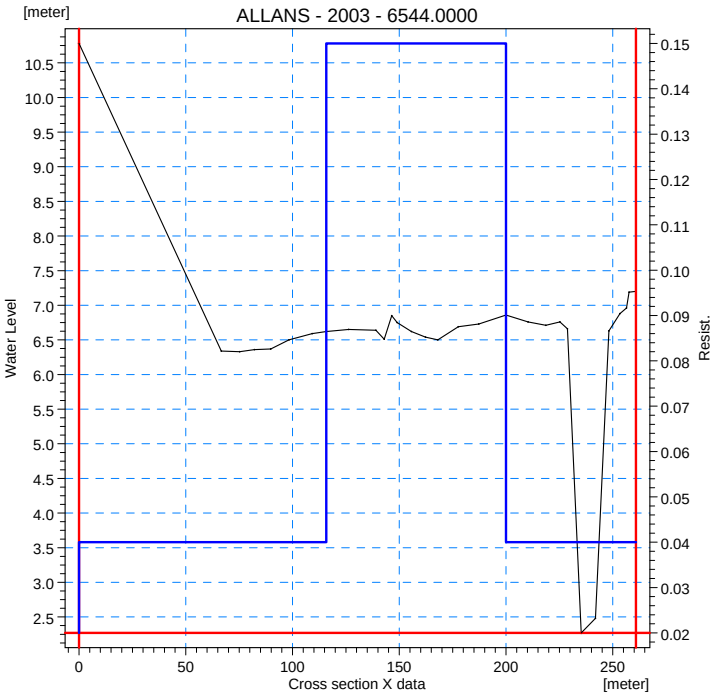
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6544.0000
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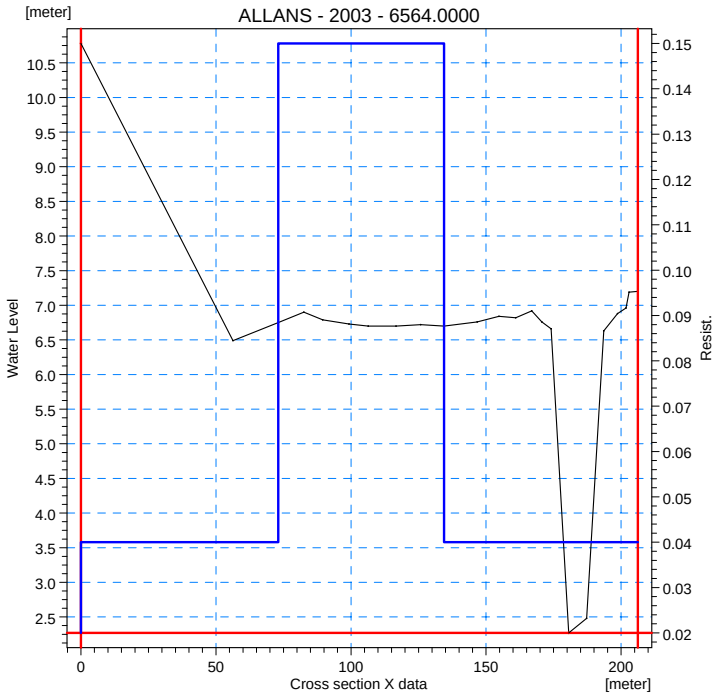
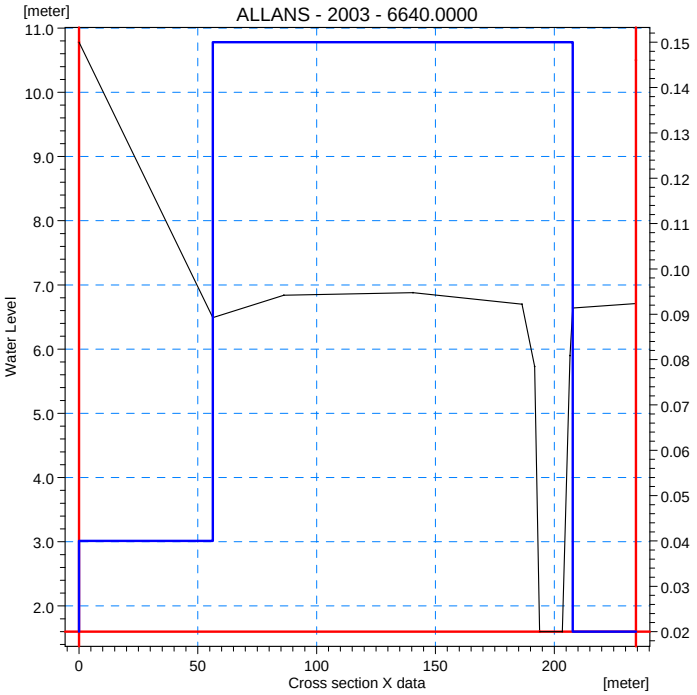
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6564.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6640.0000
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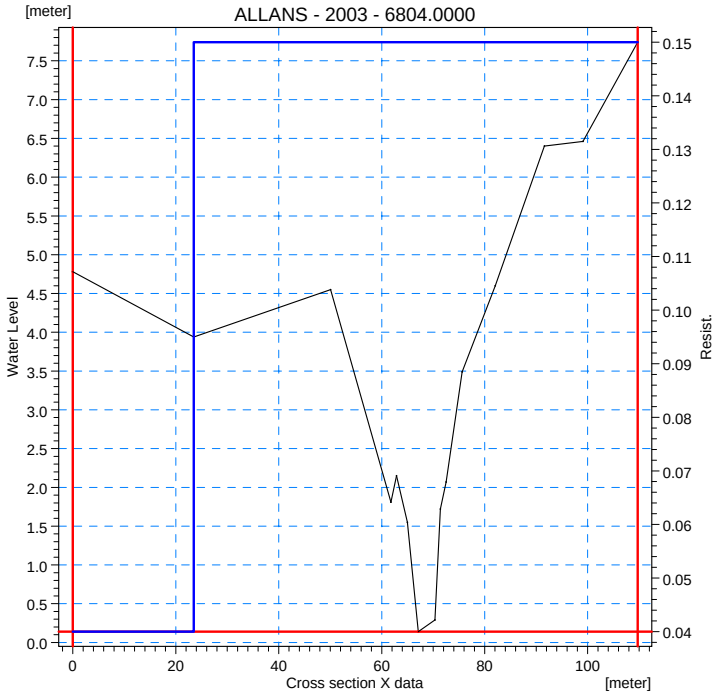
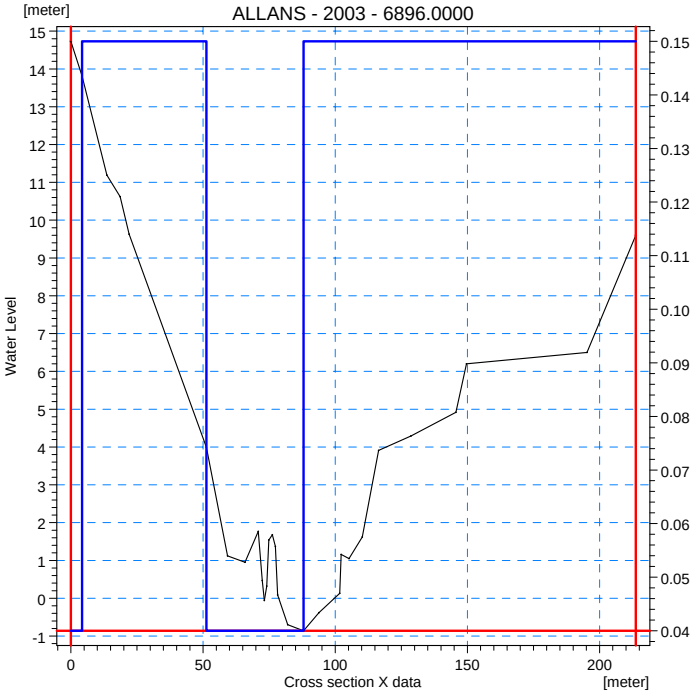
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6804.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 6896.0000
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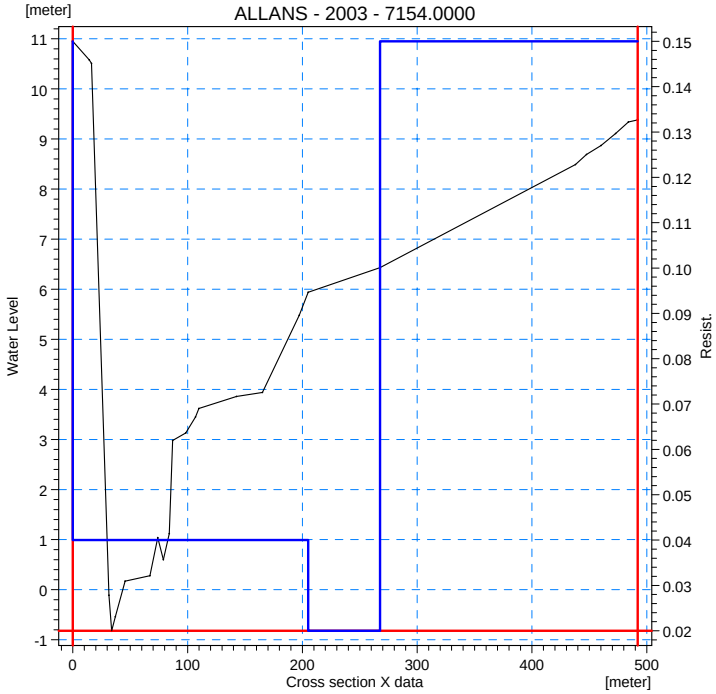
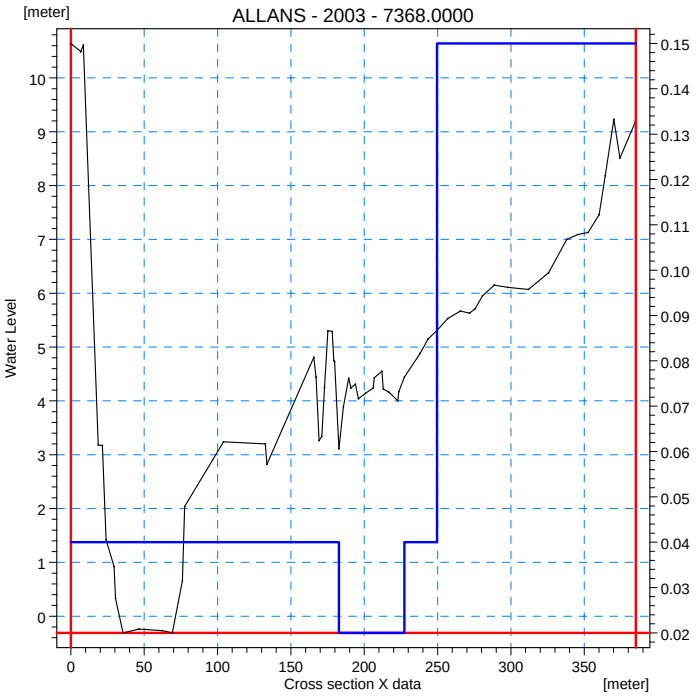
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 7154.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 7368.0000
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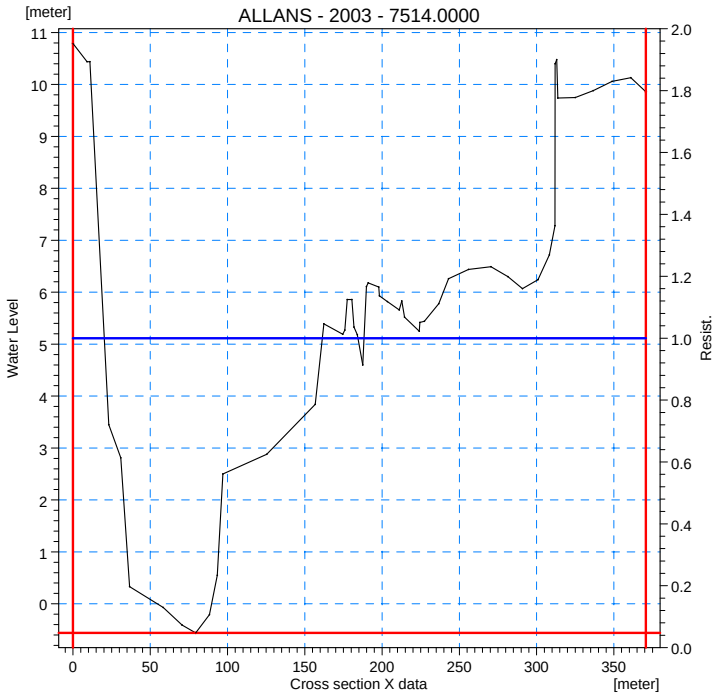
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 7514.0000
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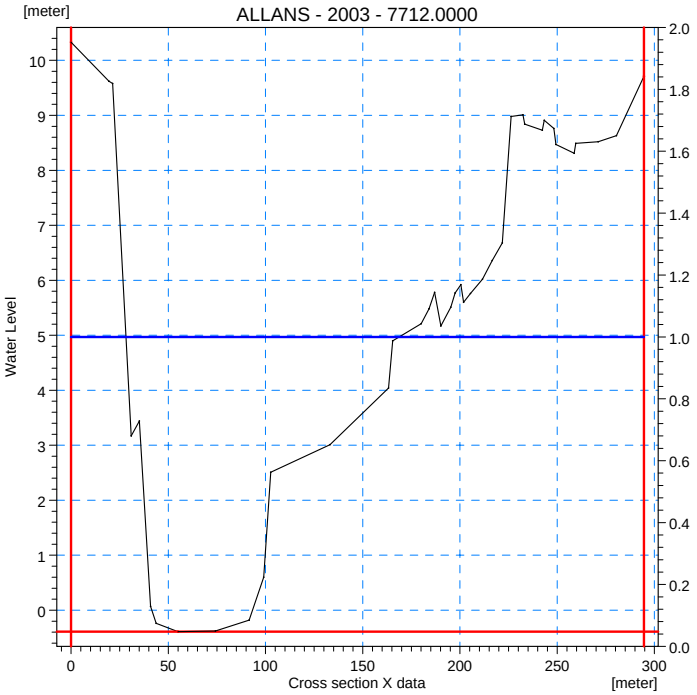
Water Level
Resist.
Cross section X data
[meter]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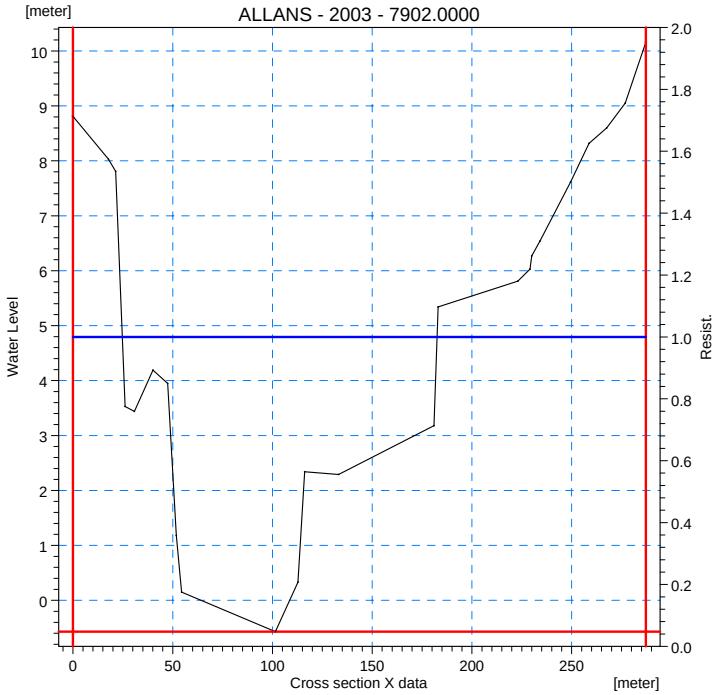
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 7902.0000
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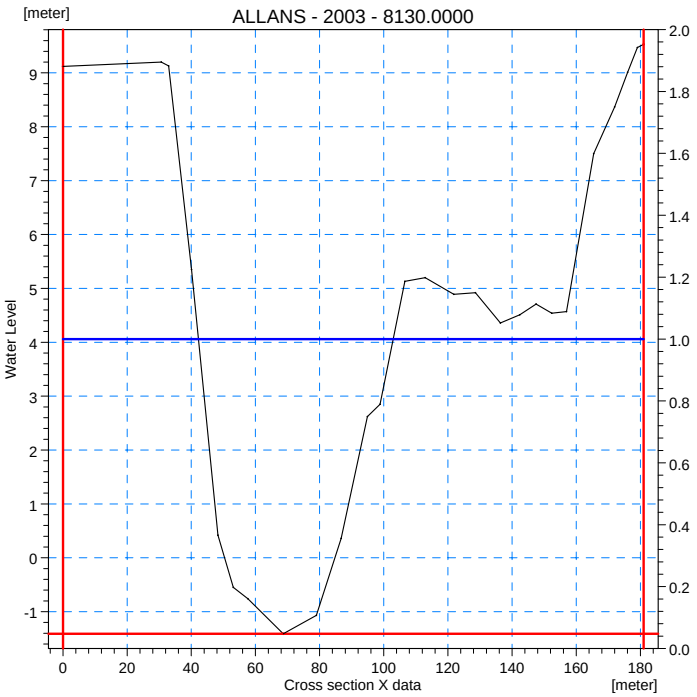
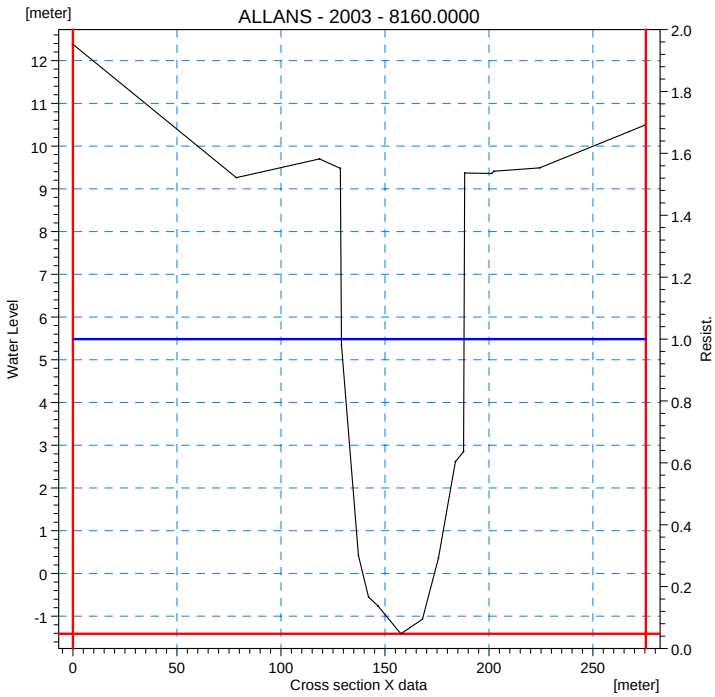
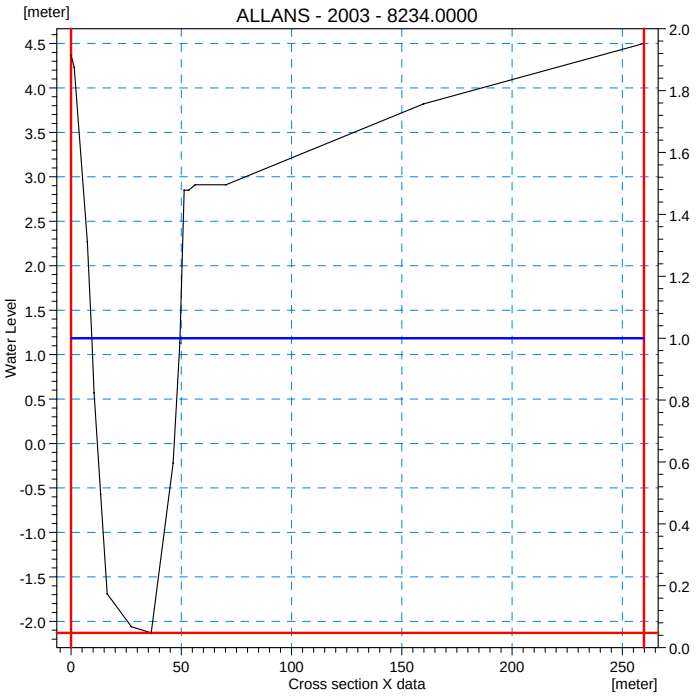
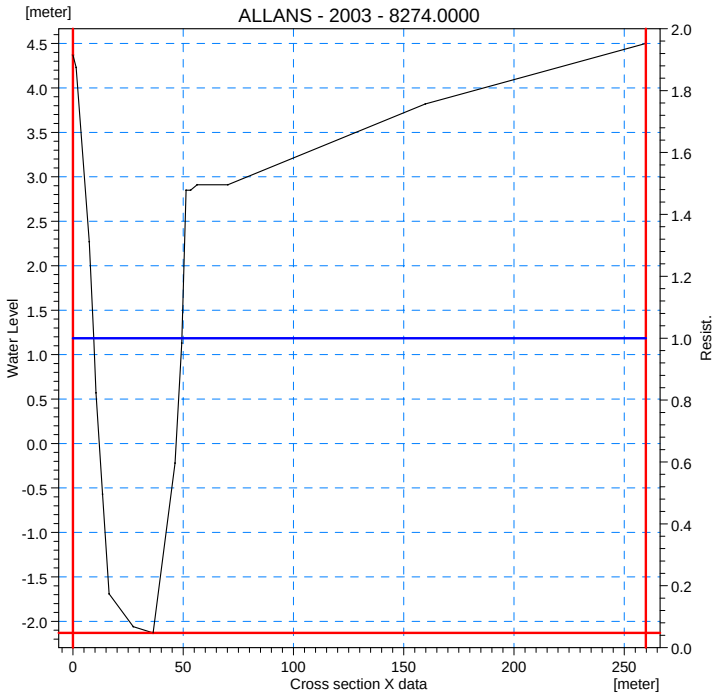
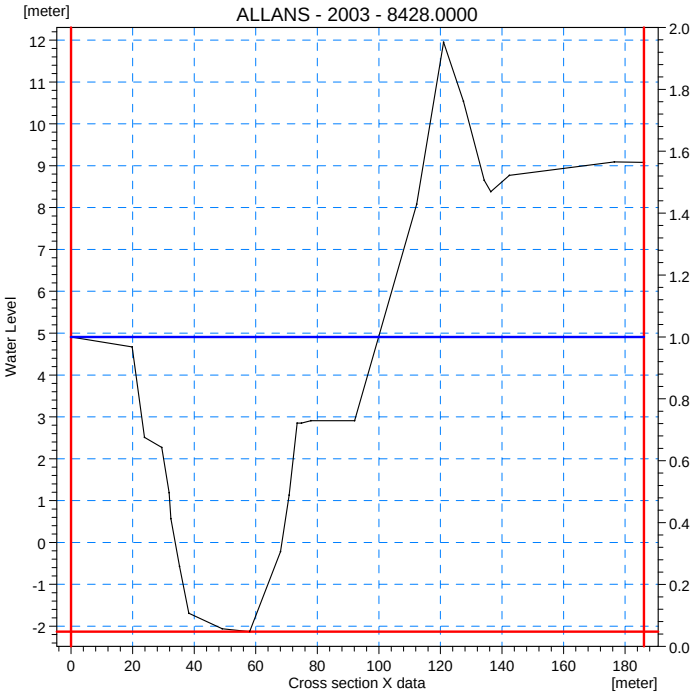
Water Level
Resist.
Cross section X data
[meter]

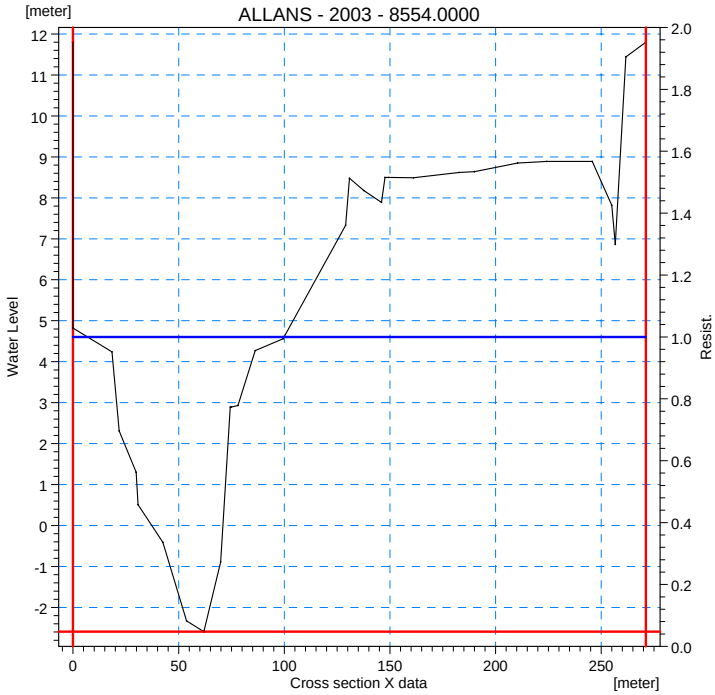

ALLANS - 2003 - 8130.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8234.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8274.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8428.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8554.0000
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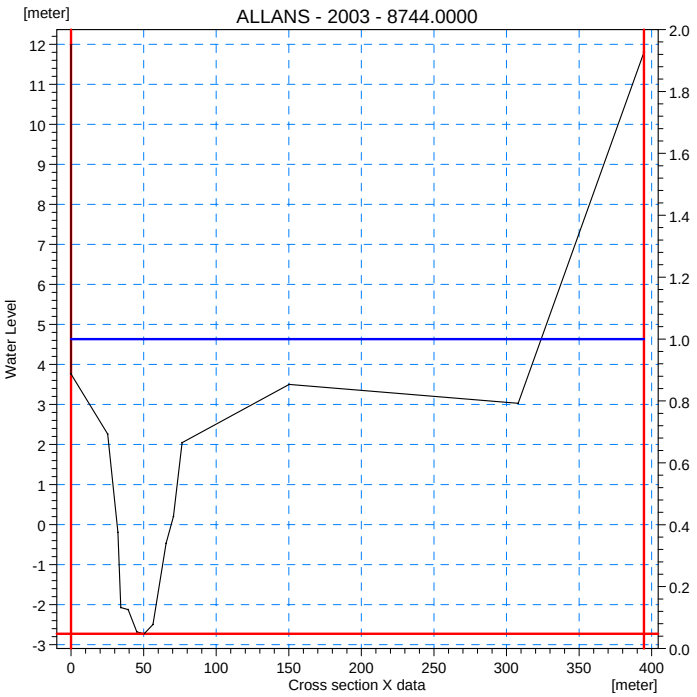
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8744.0000
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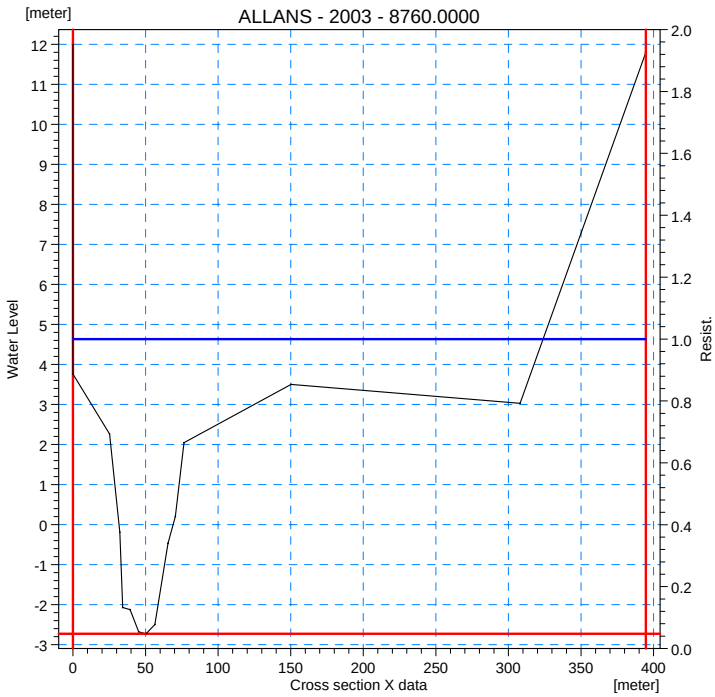
Water Level
Resist.
Cross section X data
[meter]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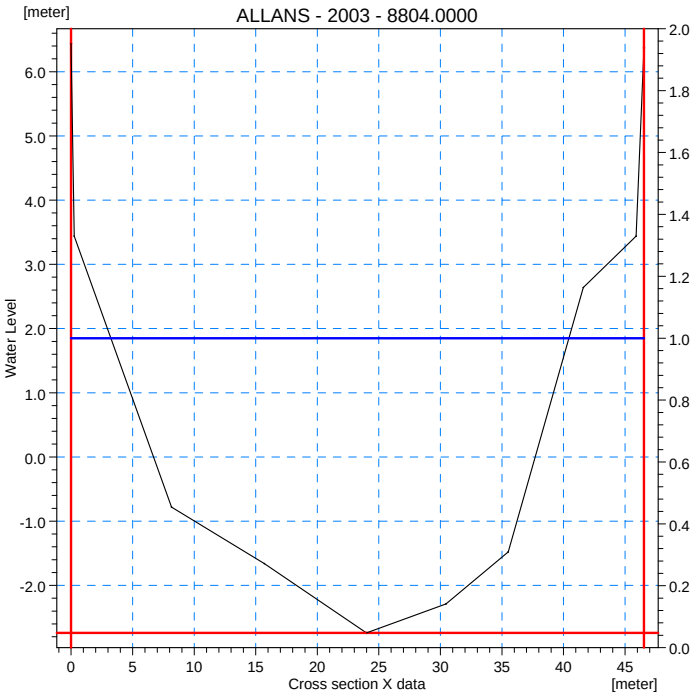
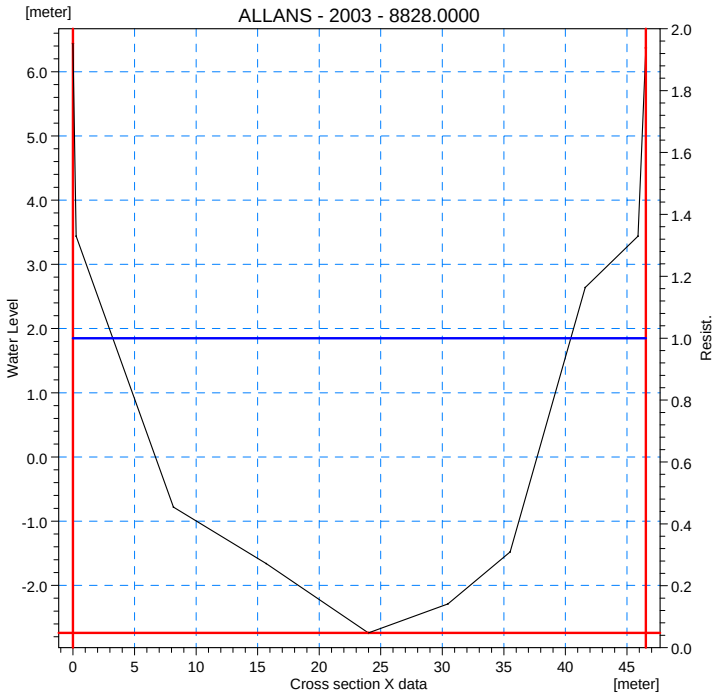
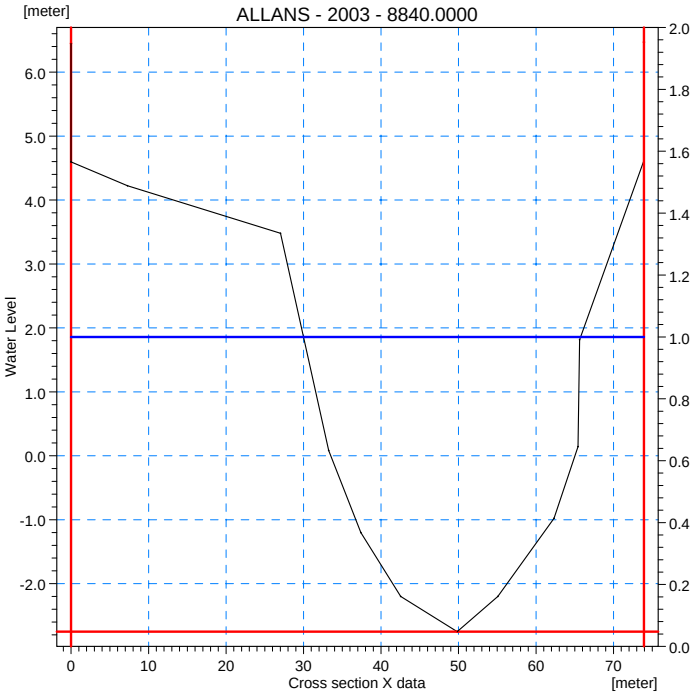
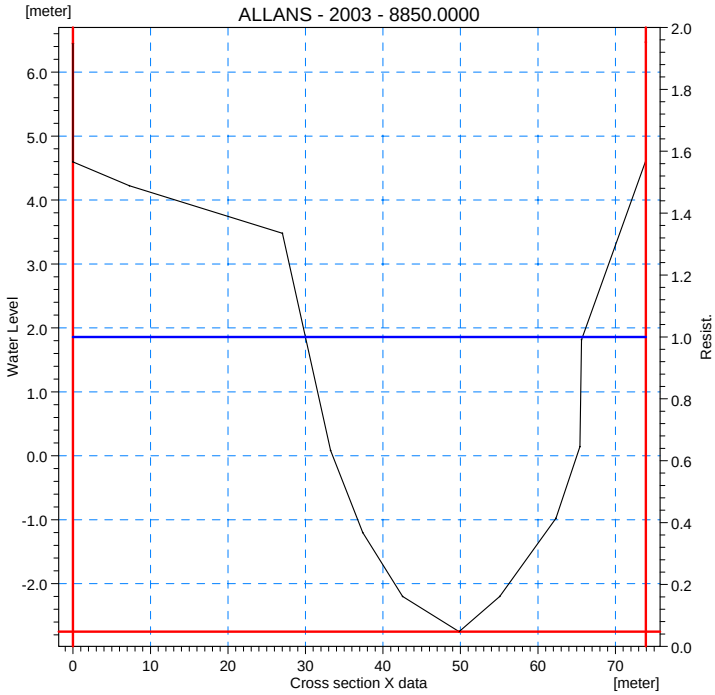
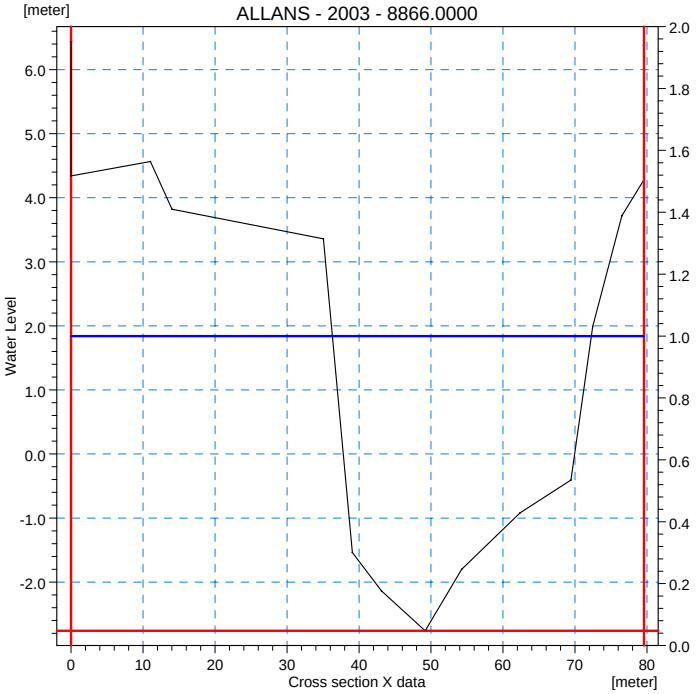
Water Level
Resist.
Cross section X data
[meter]

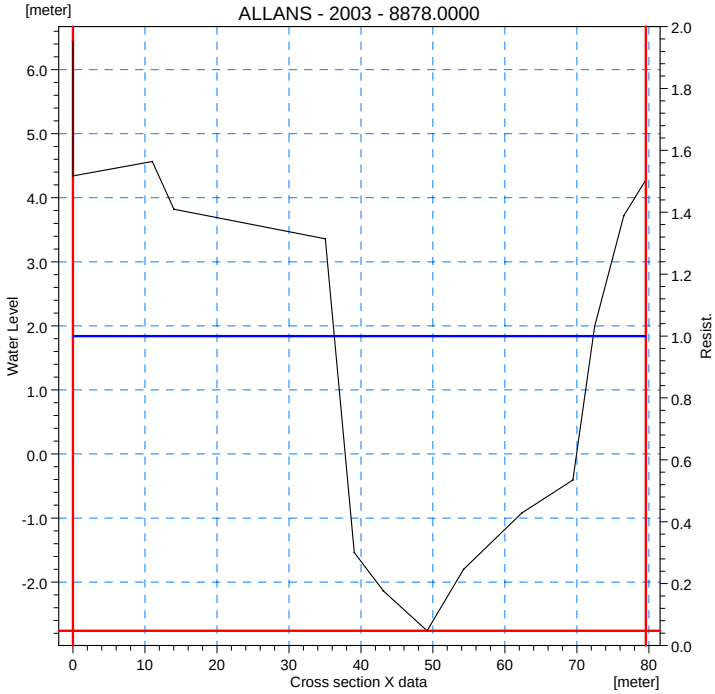

ALLANS - 2003 - 8804.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8828.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8840.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8850.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 8866.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]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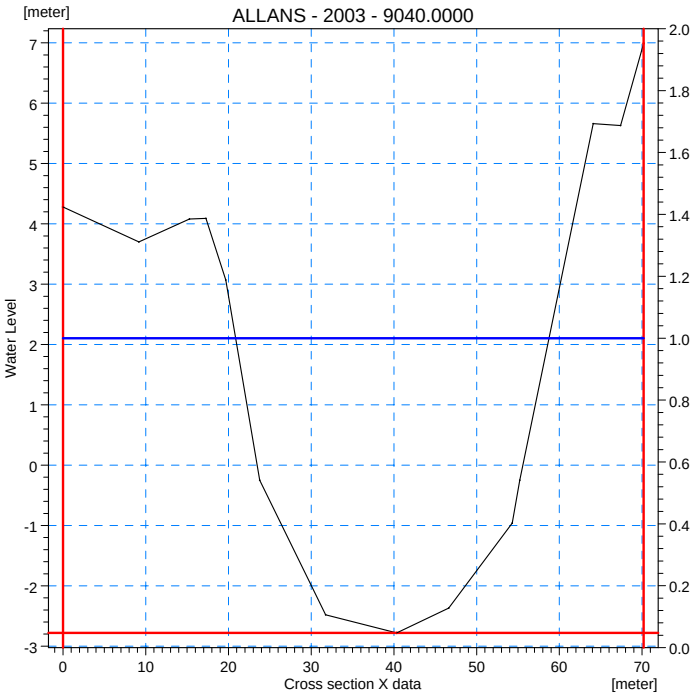
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 9040.0000
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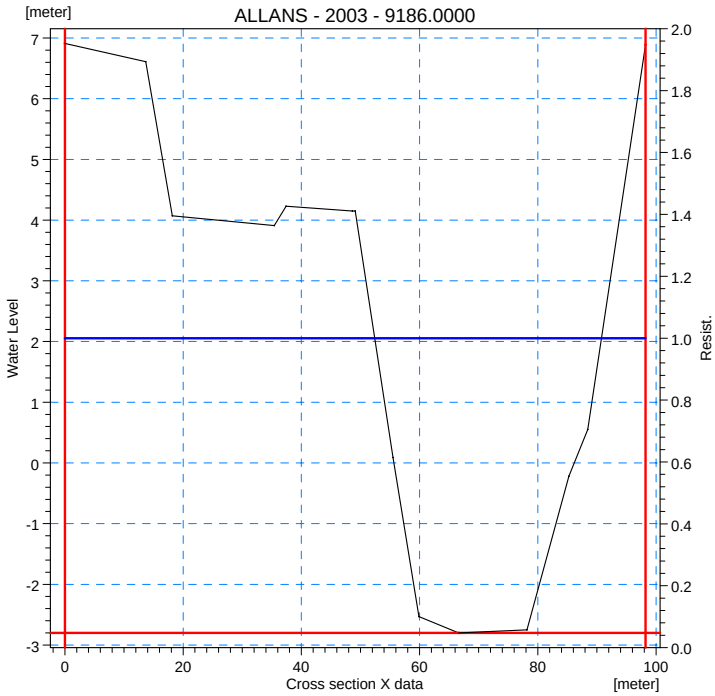
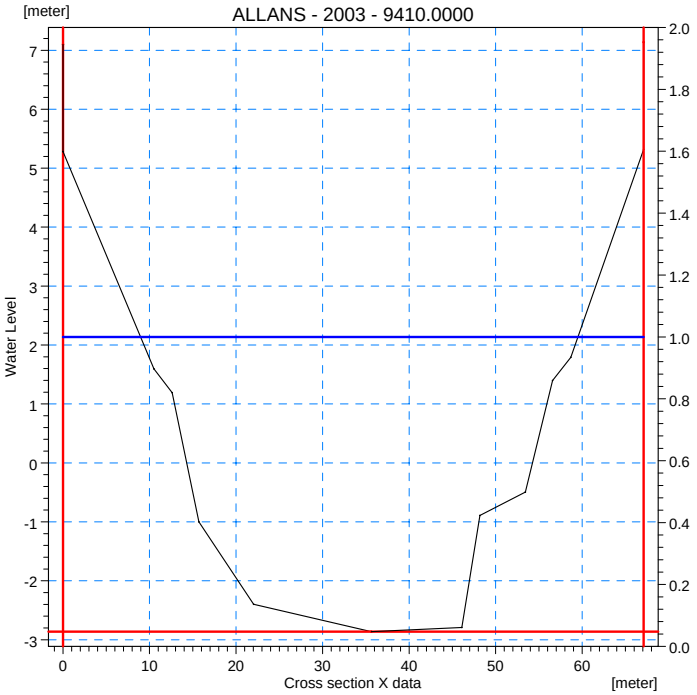
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 9186.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 9410.0000
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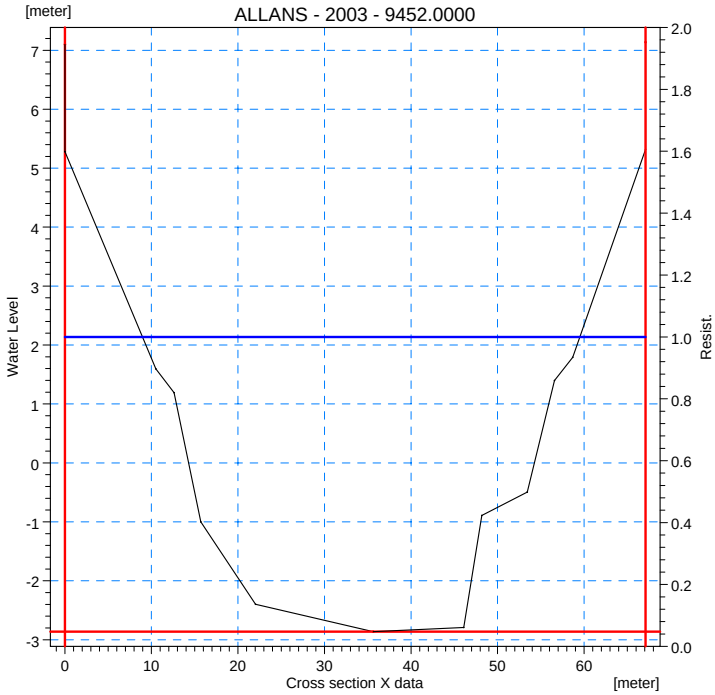
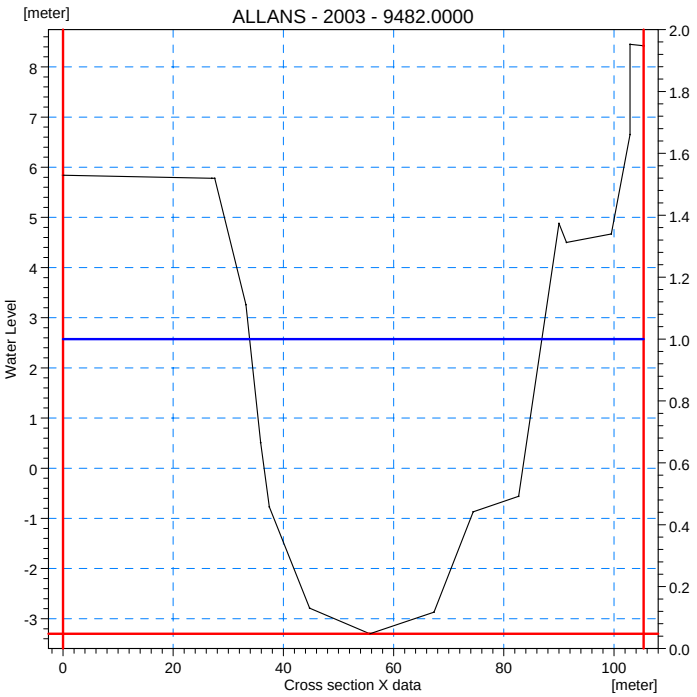
Water Level
Resist.
Cross section X data
[meter]


ALLANS - 2003 - 9452.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]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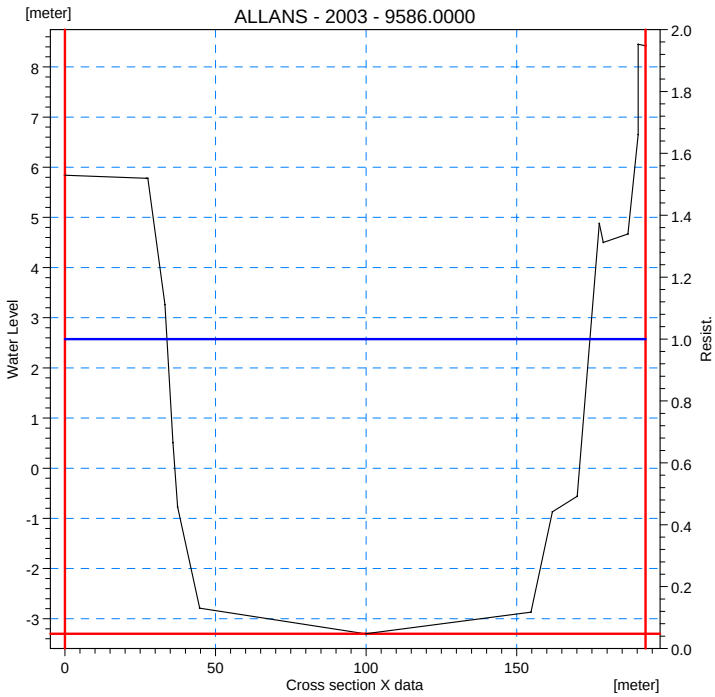
Water Level
Resist.
Cross section X data
[meter]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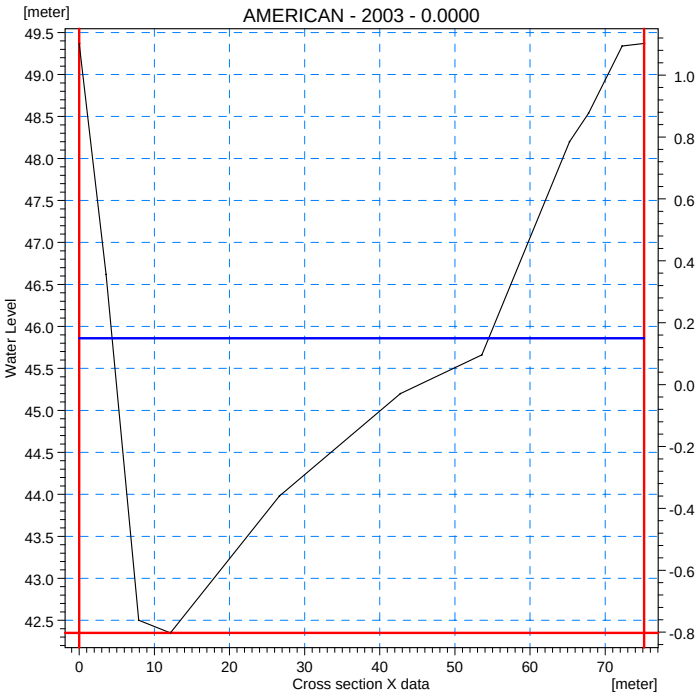
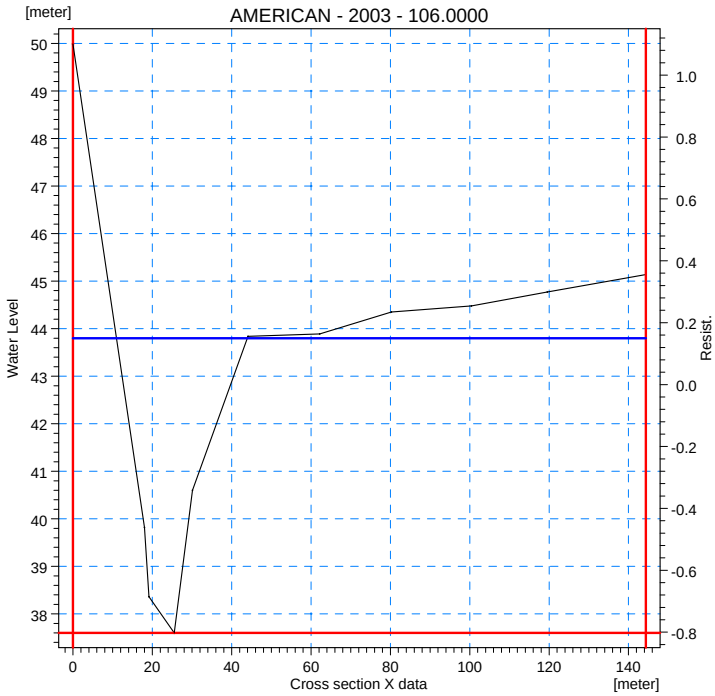
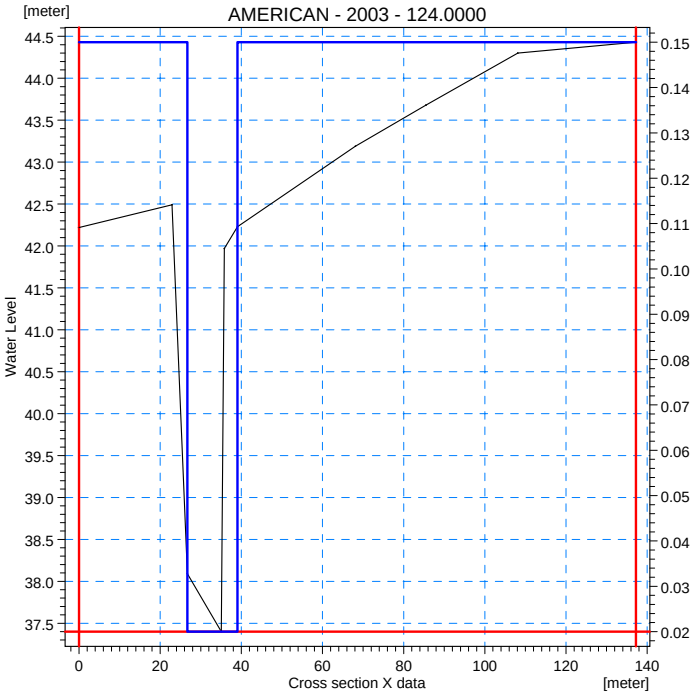
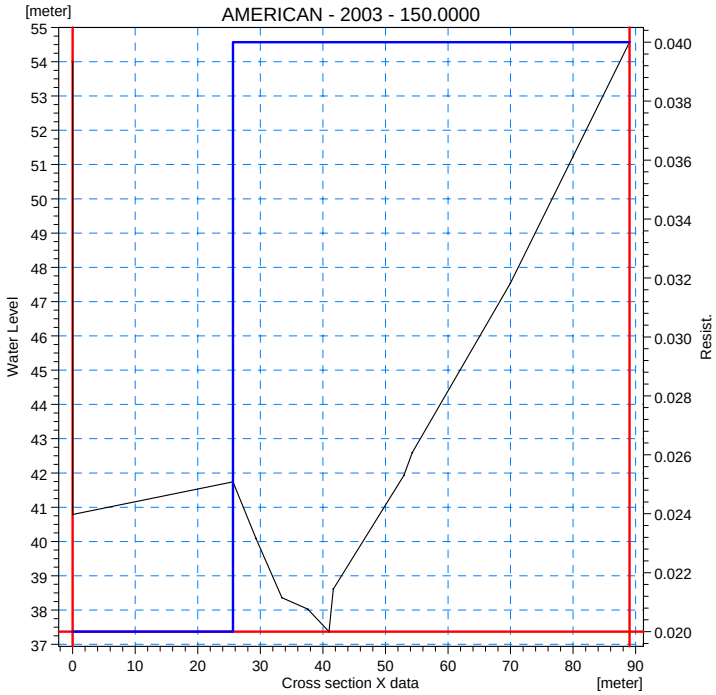
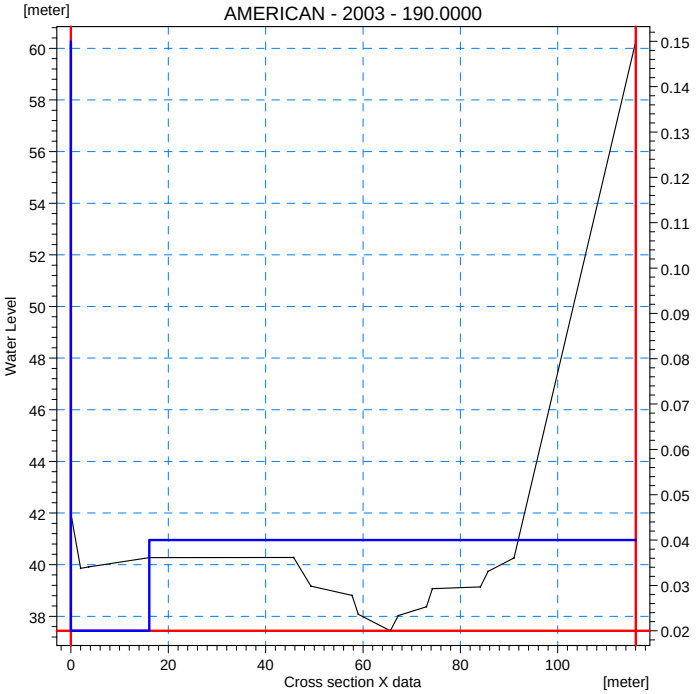
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 106.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 124.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 150.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 190.0000
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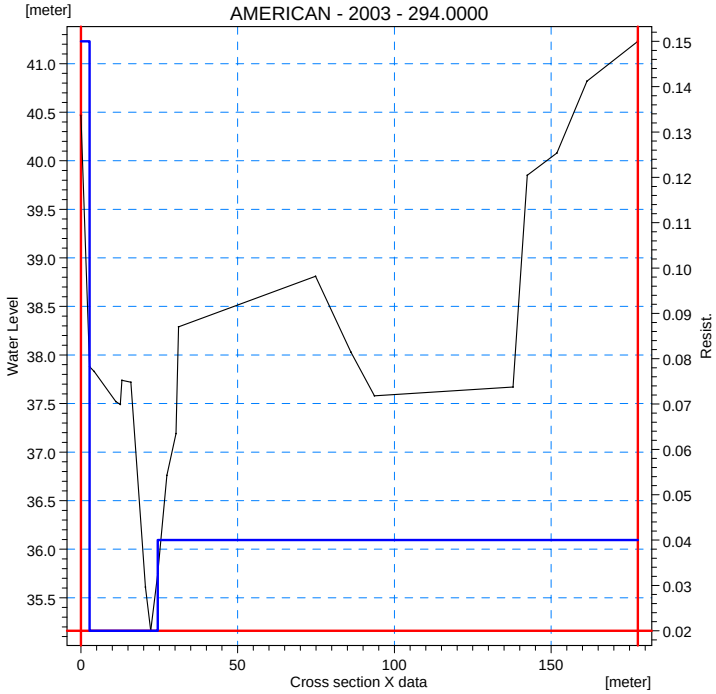
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 294.0000
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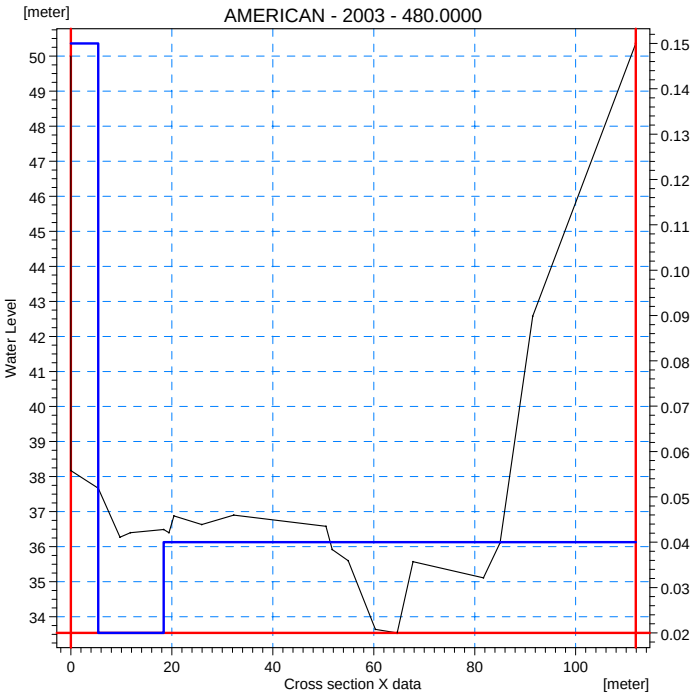
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 480.0000
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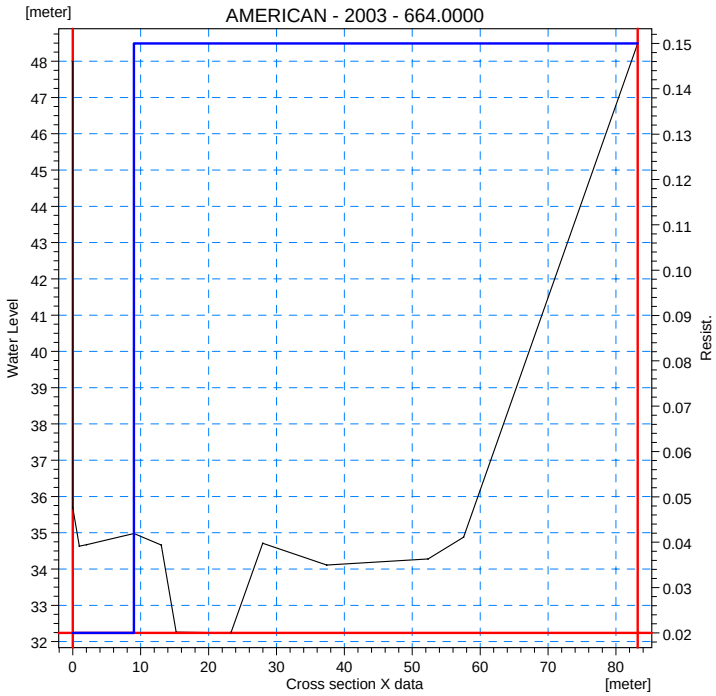
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 664.0000
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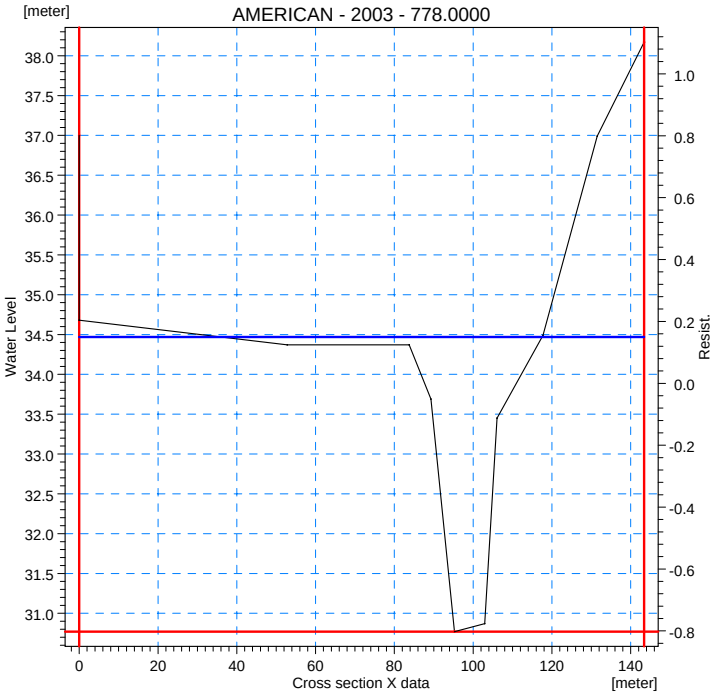
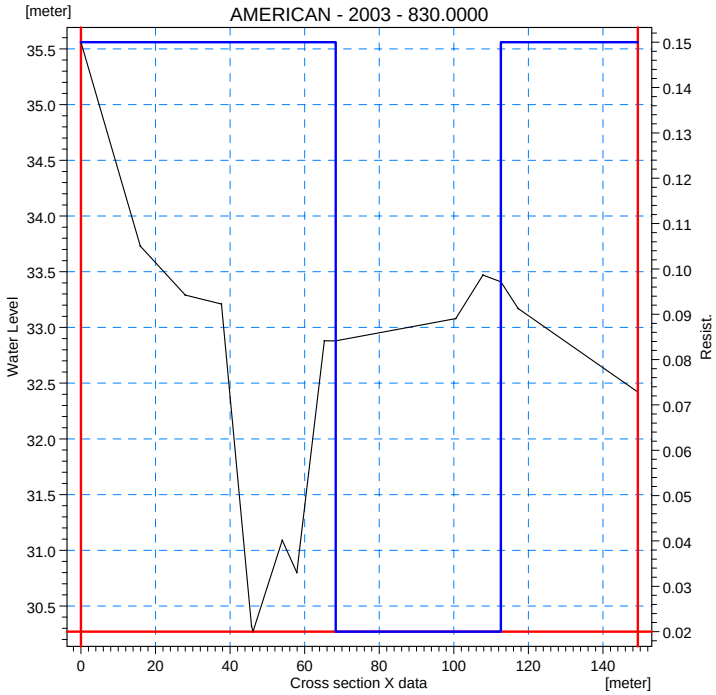
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 778.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 830.0000
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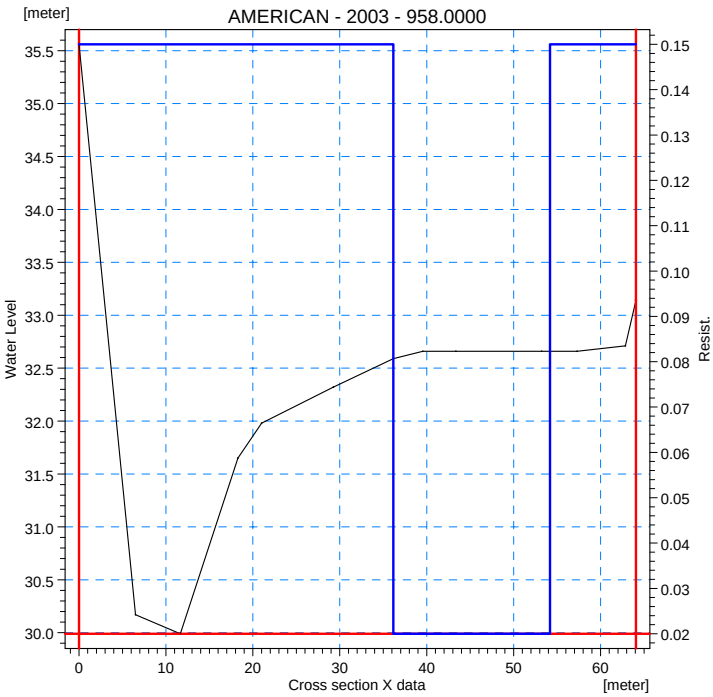
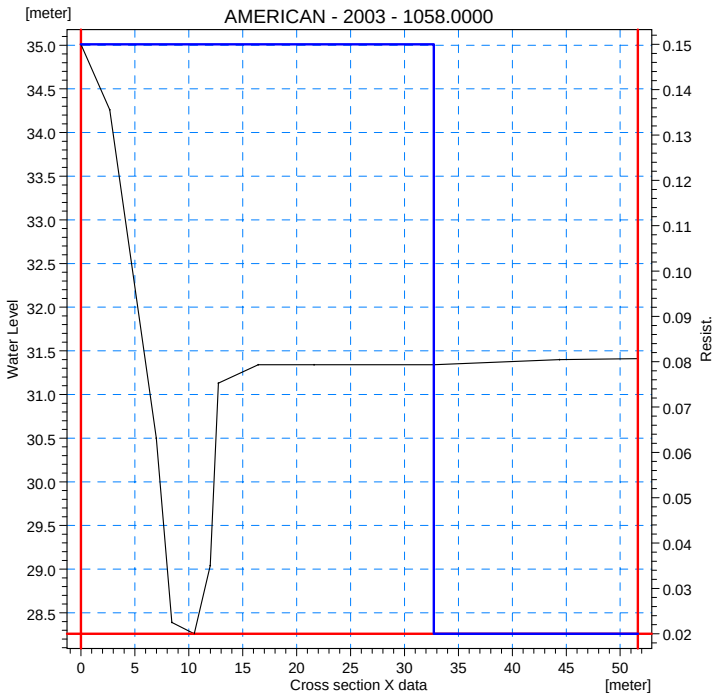
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 958.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 1058.0000
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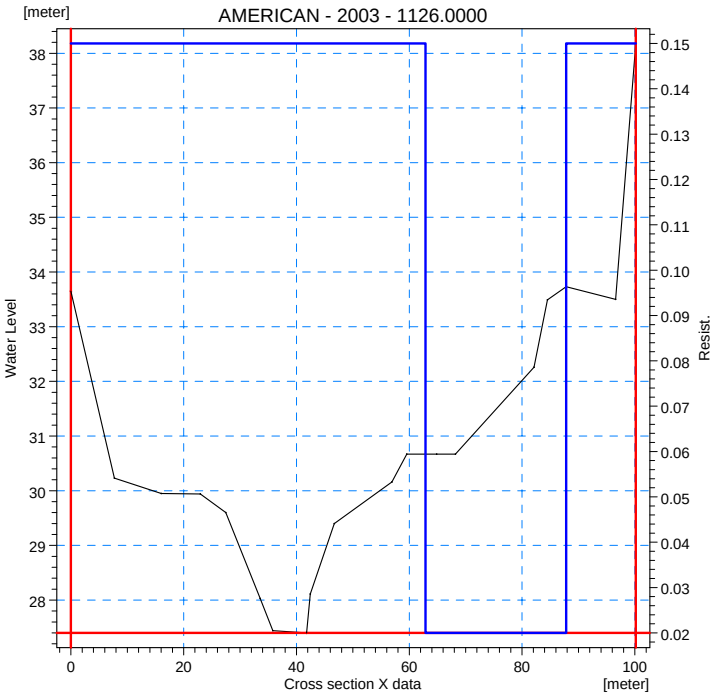
Water Level
Resist.
Cross section X data
[meter]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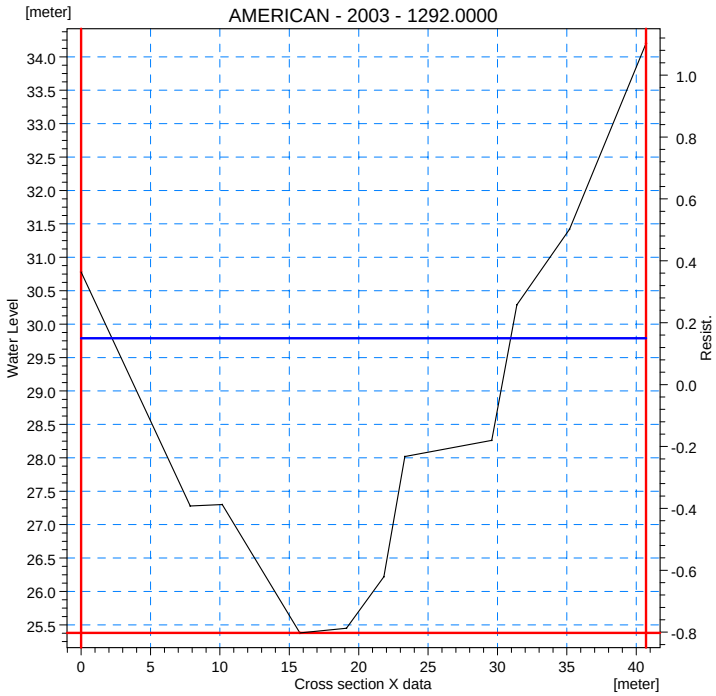
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 1292.0000
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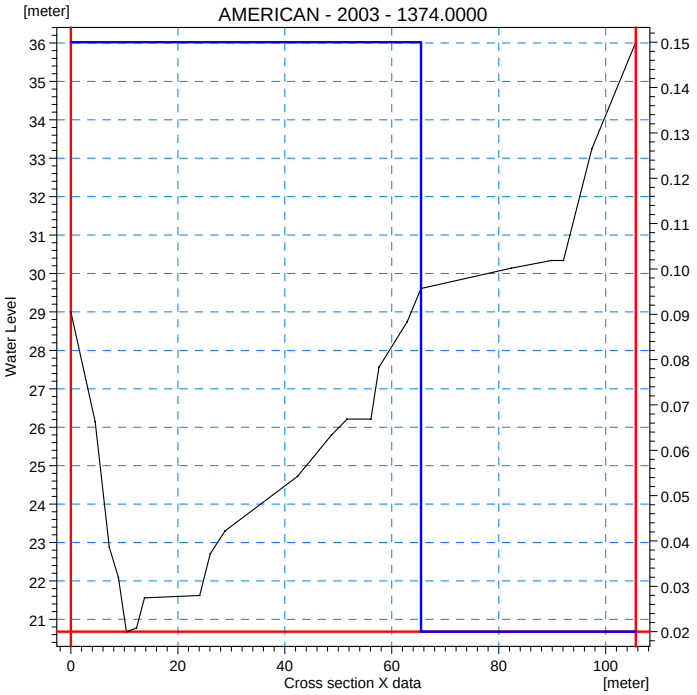
Water Level
Resist.
Cross section X data
[meter]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Water Level
Resist.
Cross section X data
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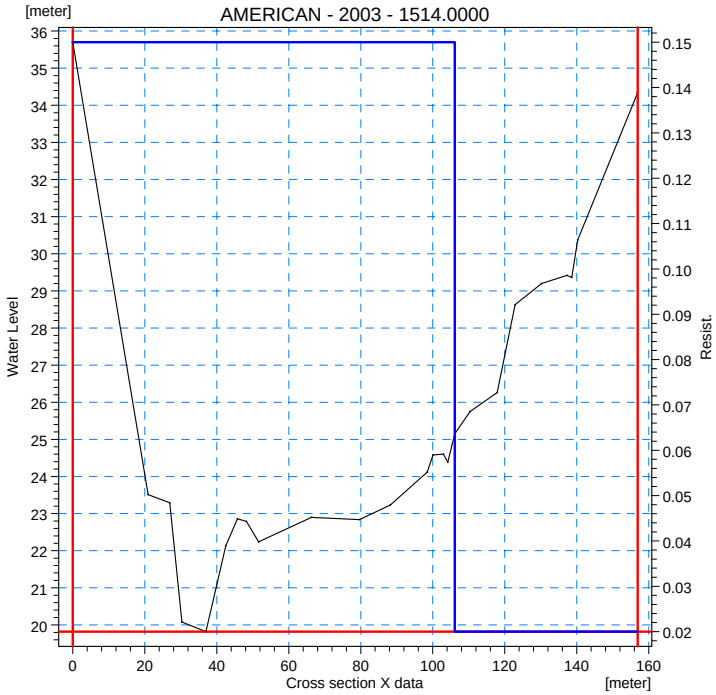
AMERICAN - 2003 - 1514.0000
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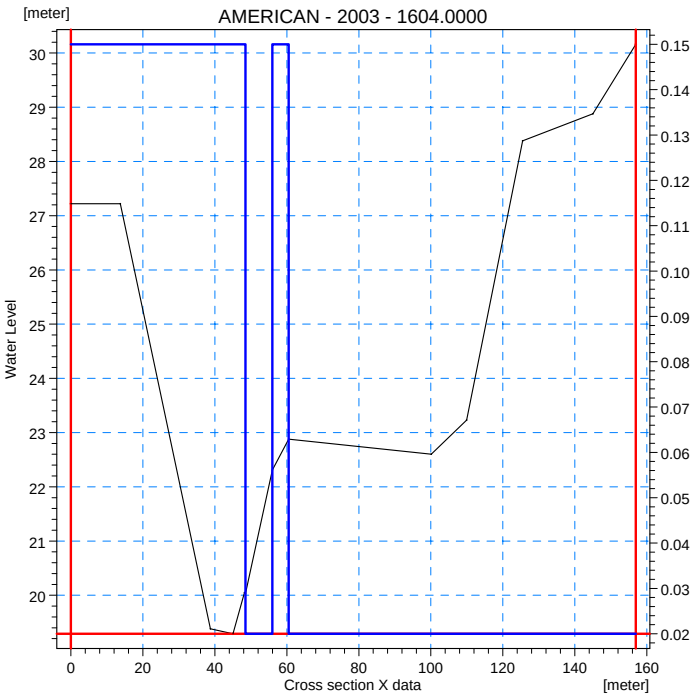
Water Level
Resist.
Cross section X data
[meter]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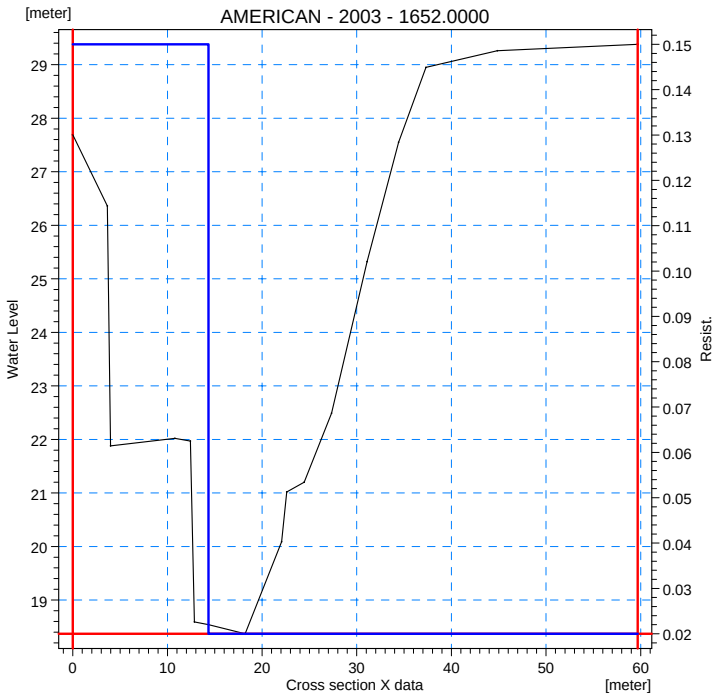
Water Level
Resist.
Cross section X data
[meter]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Water Level
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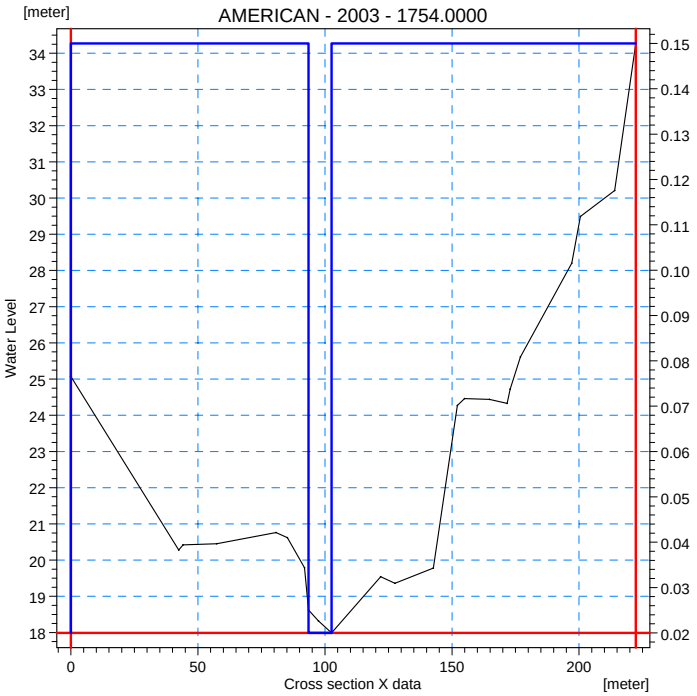
Cross section X data
[meter]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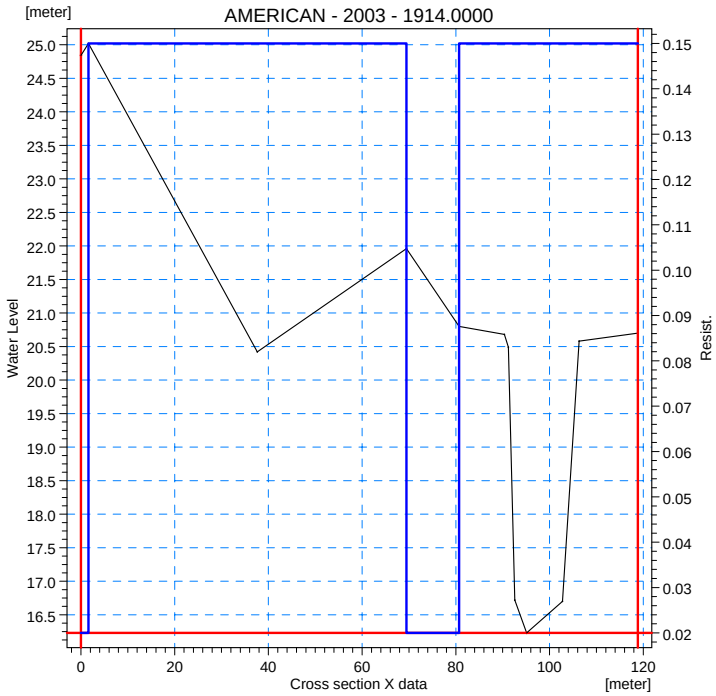
Water Level
Resist.
Cross section X data
[meter]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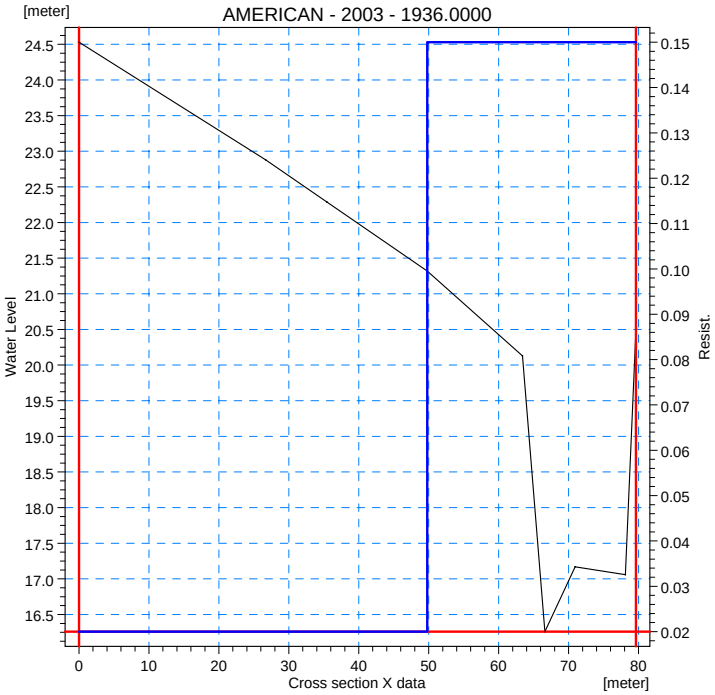
Water Level
Resist.
Cross section X data
[meter]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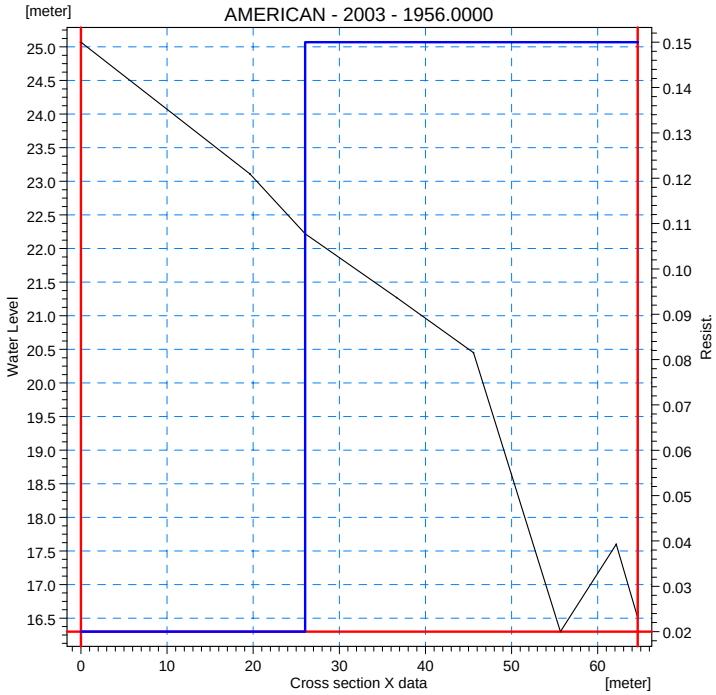
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 1956.0000
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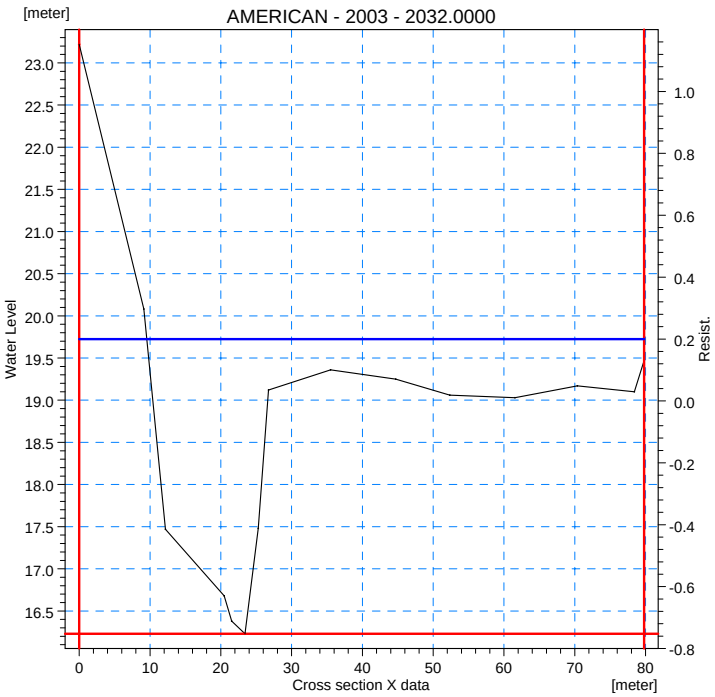
Water Level
Resist.
Cross section X data
[meter]


AMERICAN - 2003 - 2032.0000
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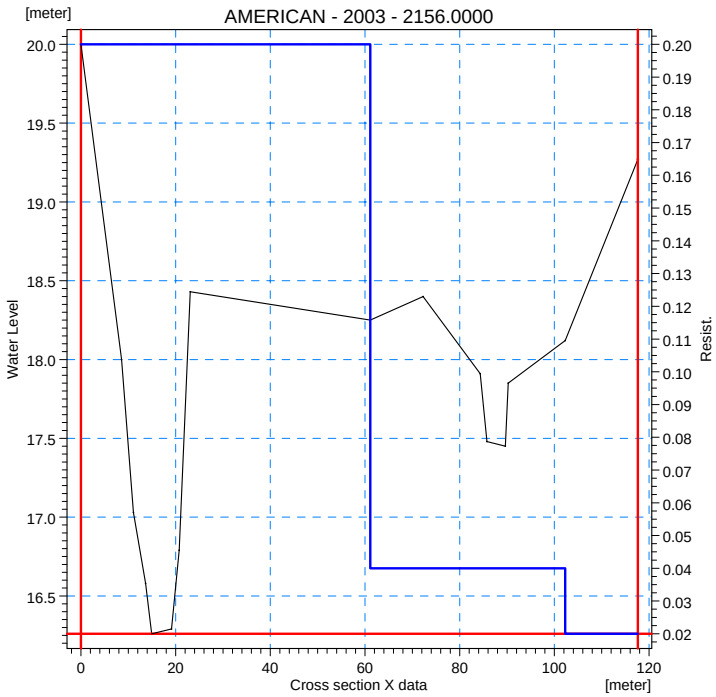
Water Level
Resist.
Cross section X data
[meter]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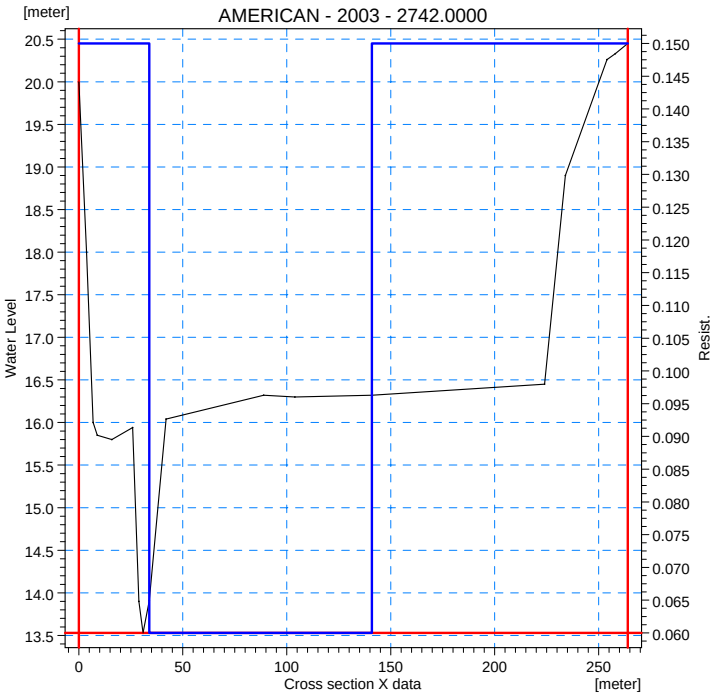
Water Level
Resist.
Cross section X data
[meter]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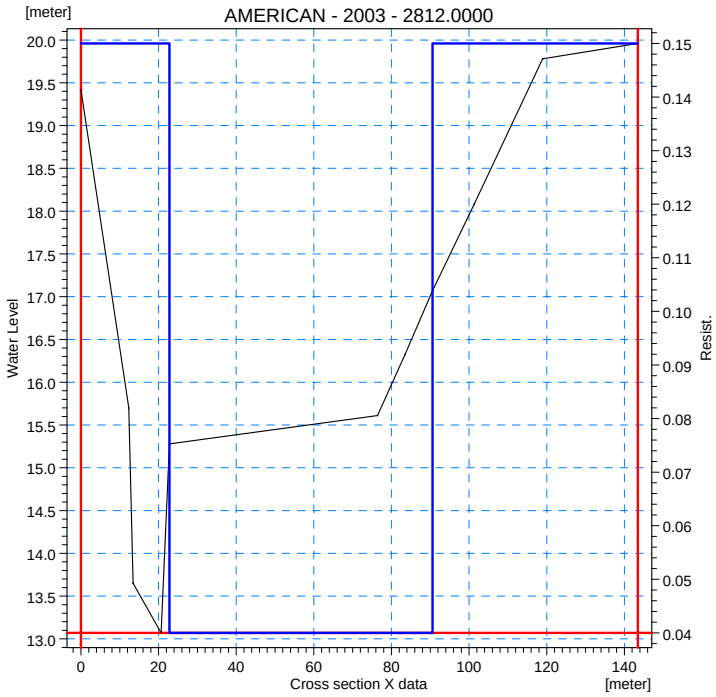
Water Level
Resist.
Cross section X data
[meter]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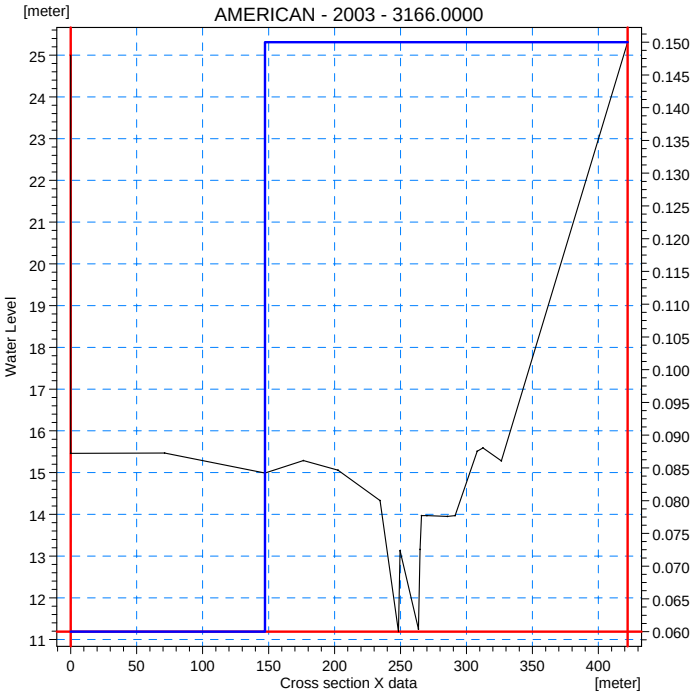
Resist.
Cross section X data
[meter]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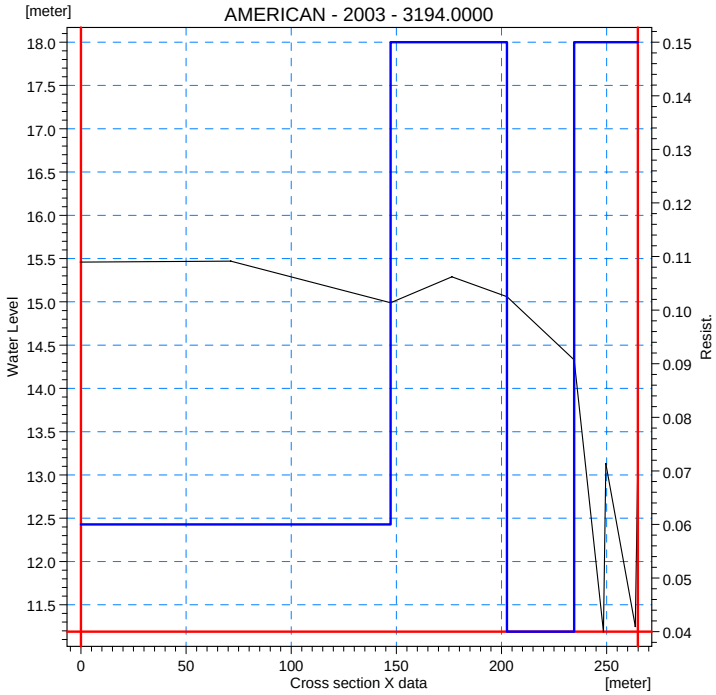
Water Level
Resist.
Cross section X data
[meter]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Water Level
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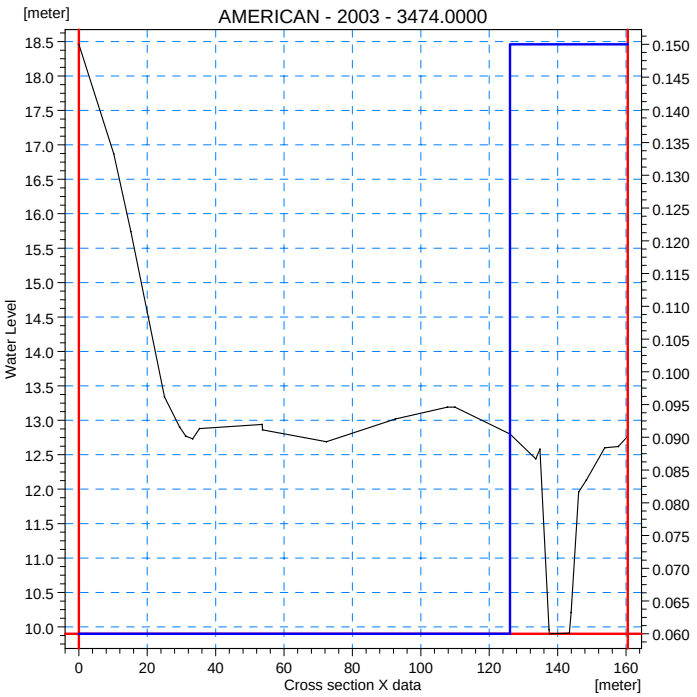
Cross section X data
[meter]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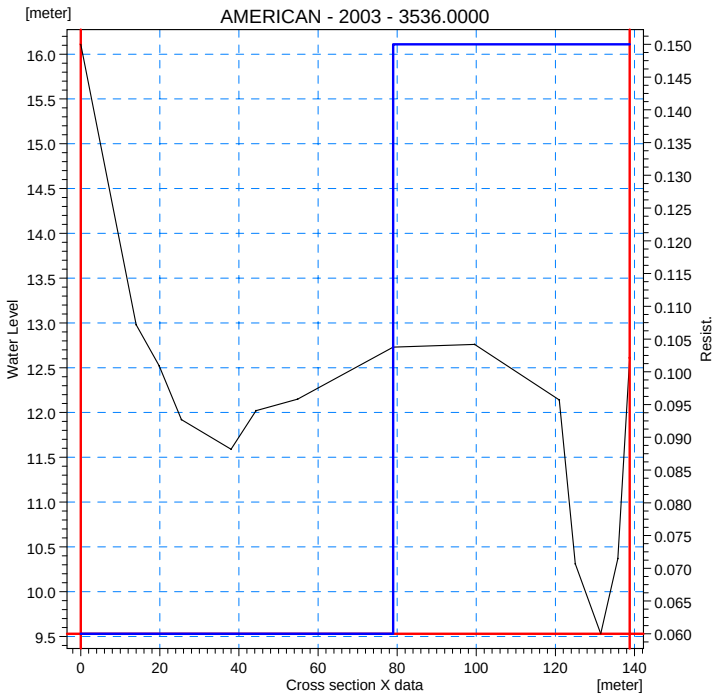
Water Level
Resist.
Cross section X data
[meter]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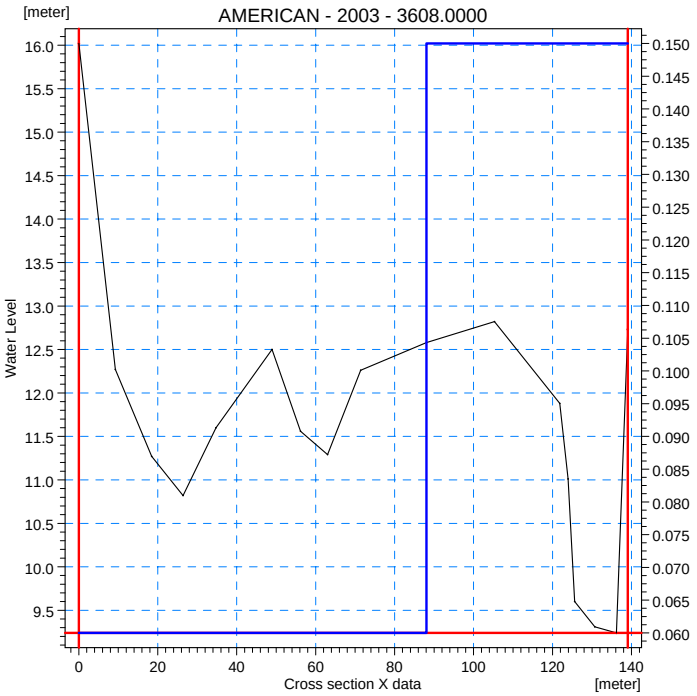
[meter]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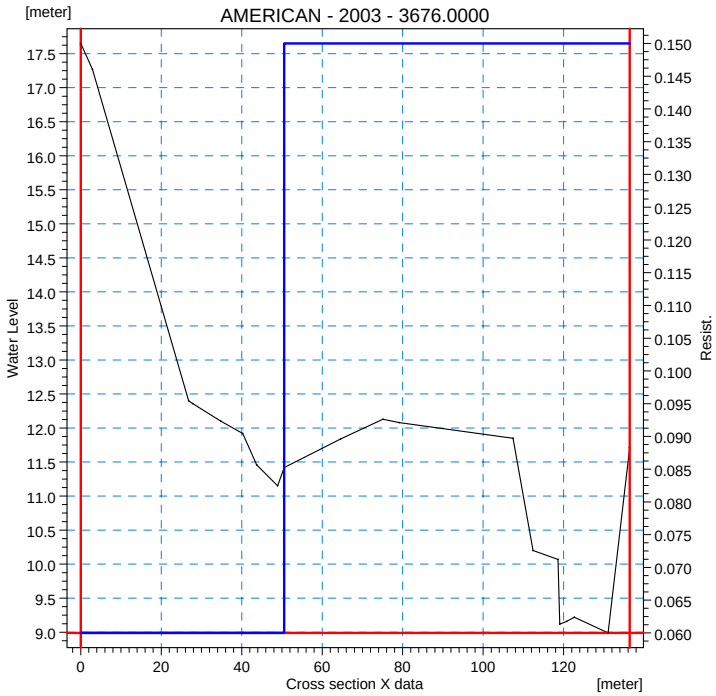
Water Level
Resist.
Cross section X data
[meter]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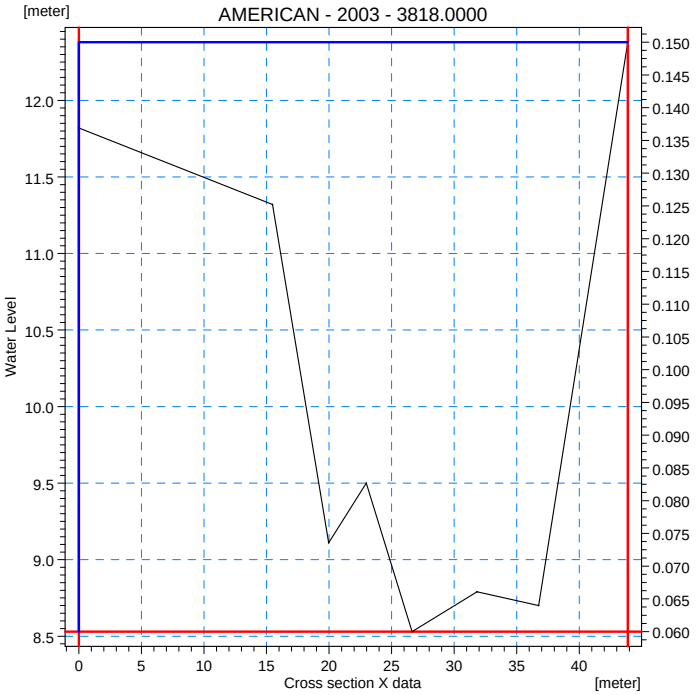
Water Level
Resist.
Cross section X data
[meter]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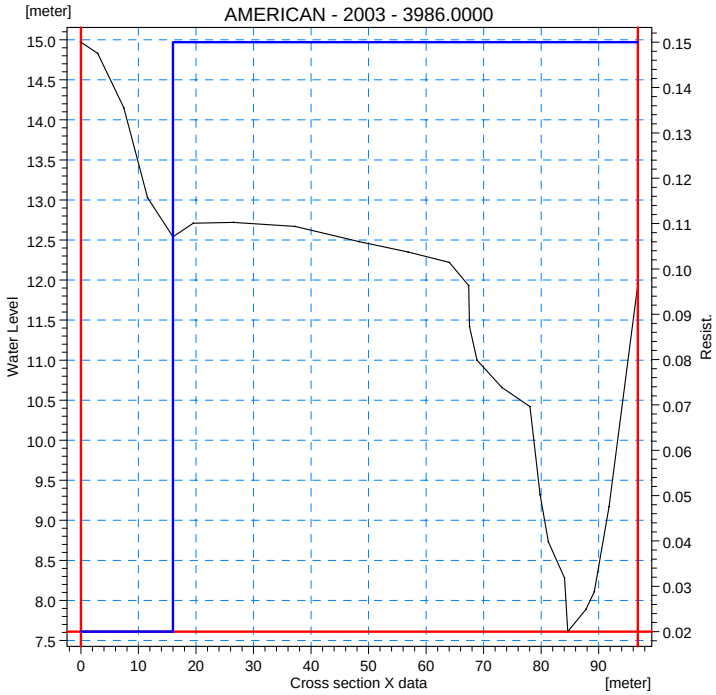
Water Level
Resist.
Cross section X data
[meter]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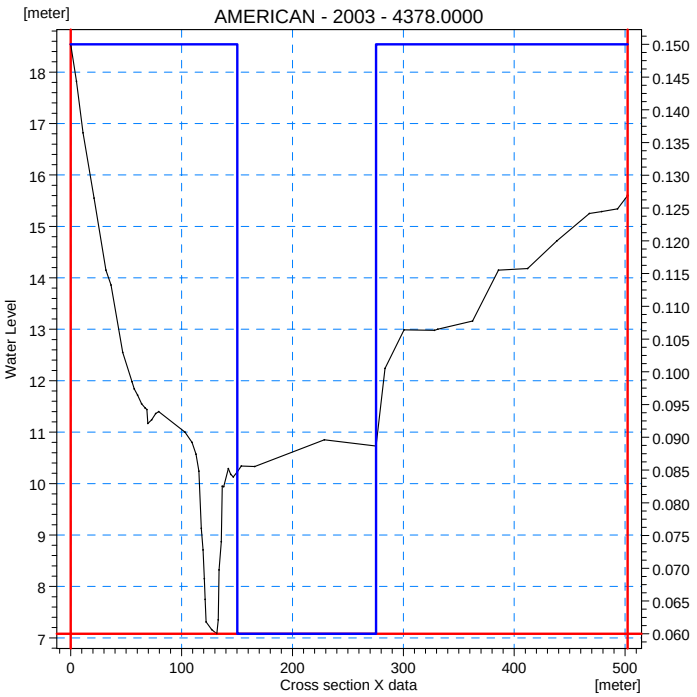
Resist.
Cross section X data
[meter]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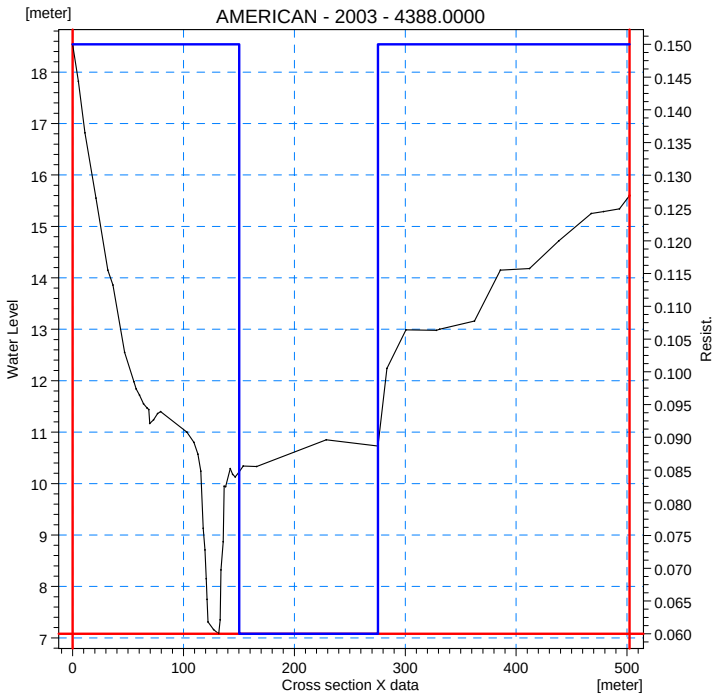
Water Level
Resist.
Cross section X data
[meter]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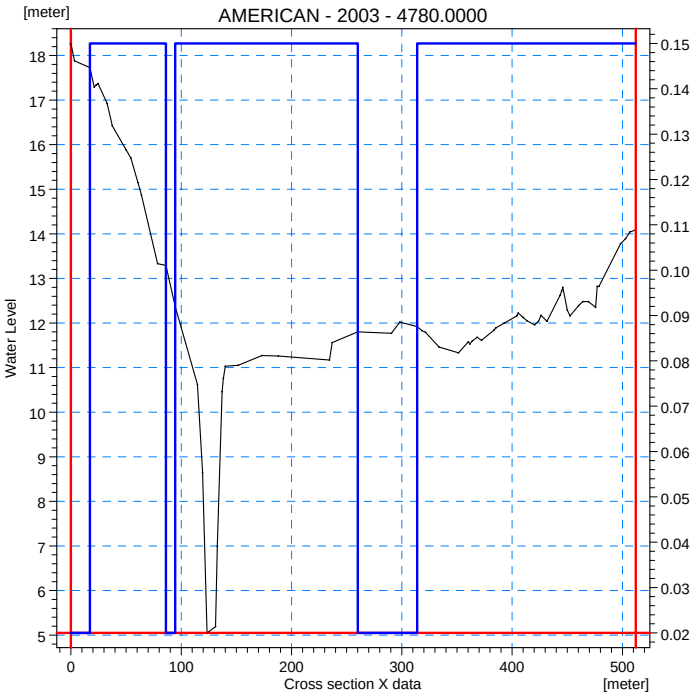
Resist.
Cross section X data
[meter]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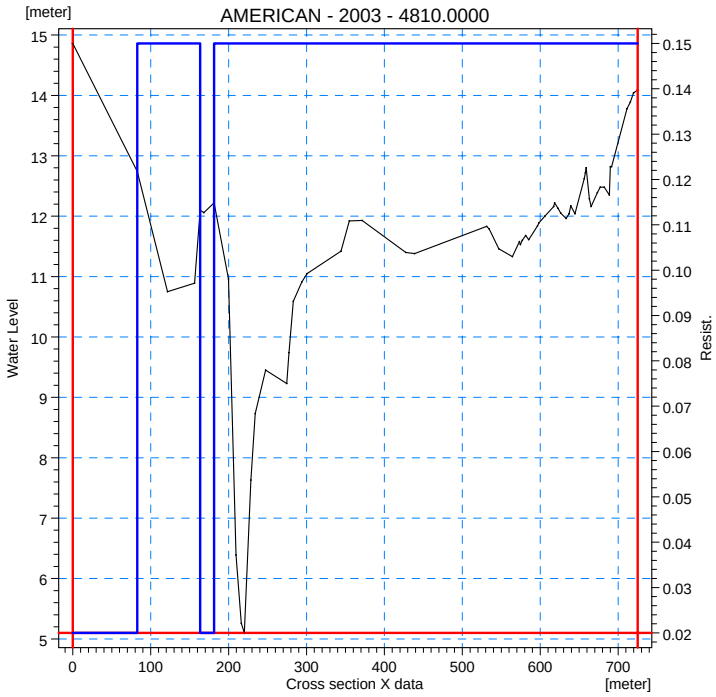
Water Level
Resist.
Cross section X data
[meter]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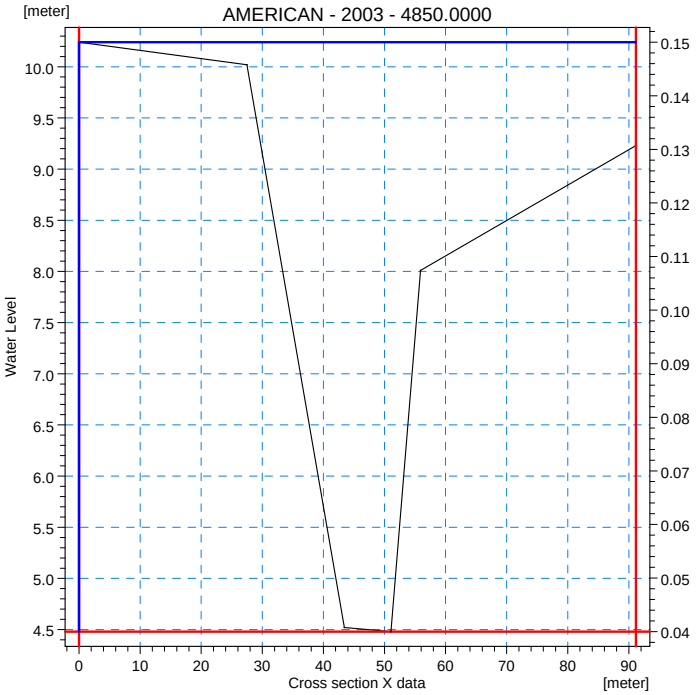
Water Level
Resist.
Cross section X data
[meter]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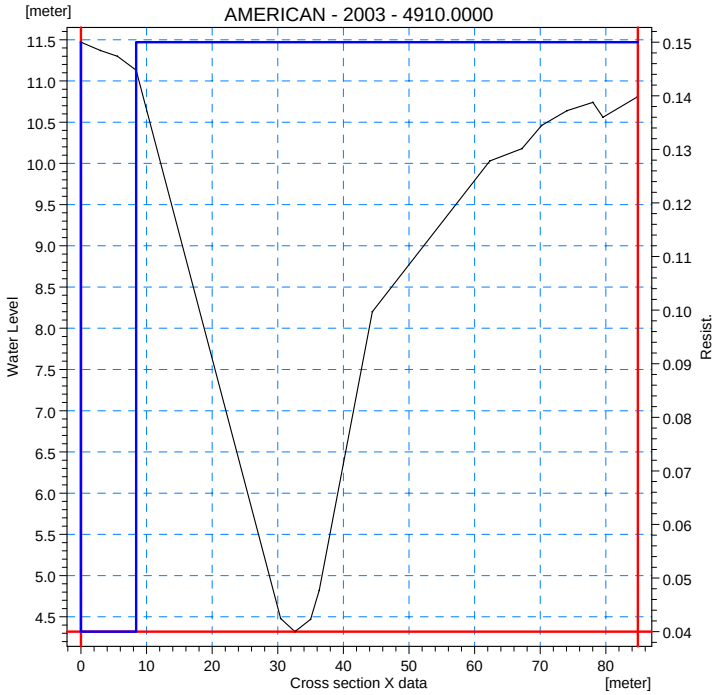
Water Level
Resist.
Cross section X data
[meter]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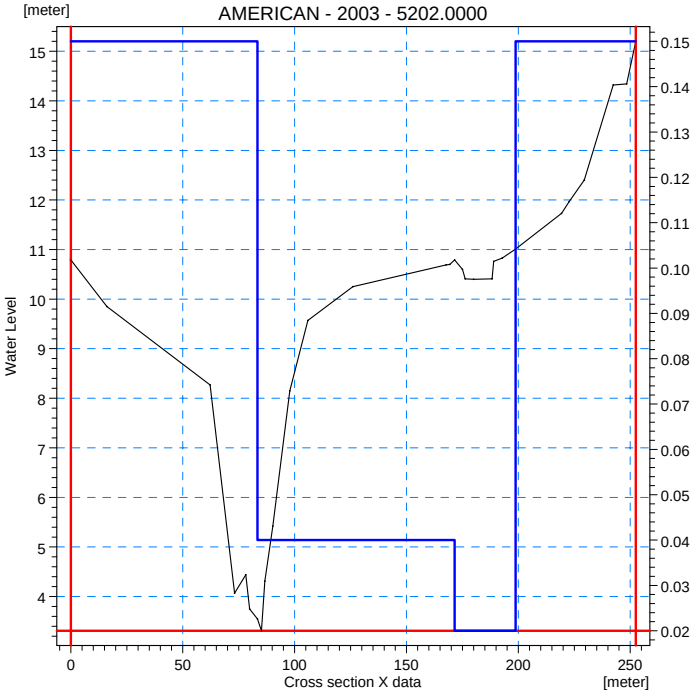
Resist.
Cross section X data
[meter]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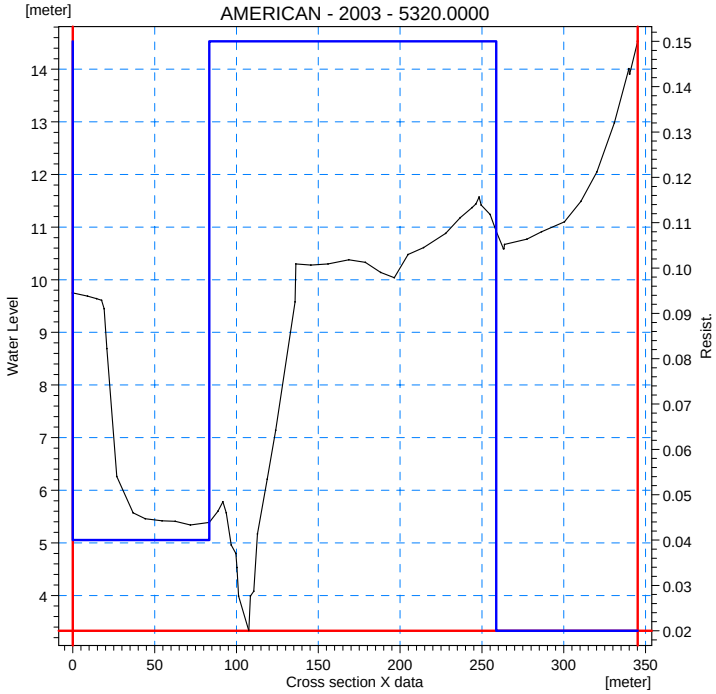
Water Level
Resist.
Cross section X data
[meter]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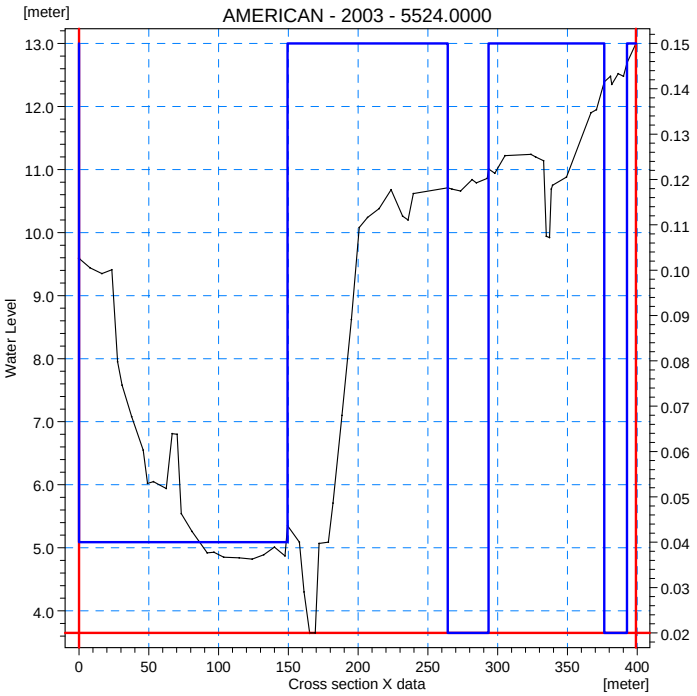
Water Level
Resist.
Cross section X data
[meter]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Water Level
Resist.
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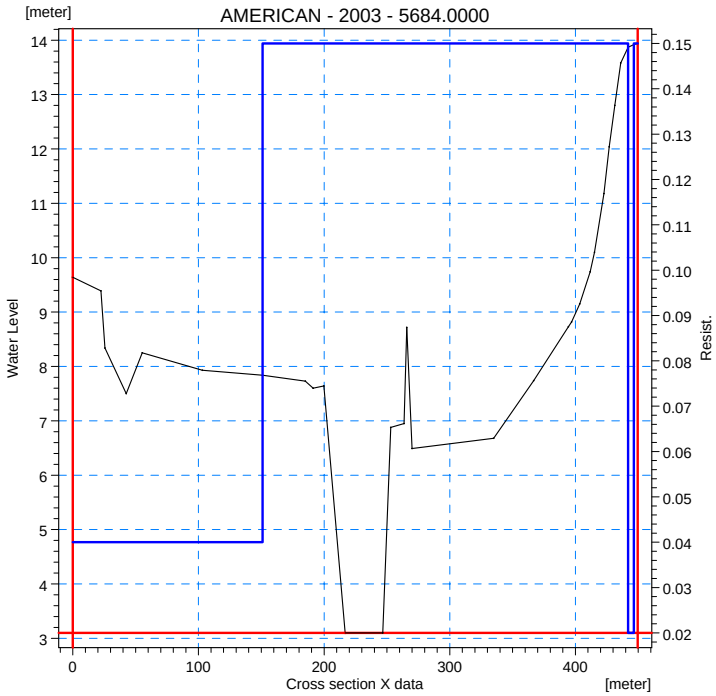
[meter]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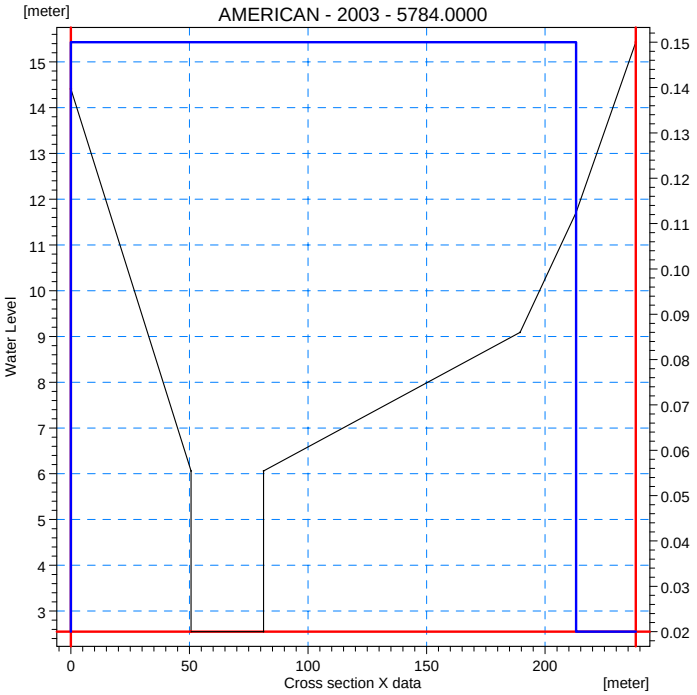
Water Level
Resist.
Cross section X data
[meter]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Resist.
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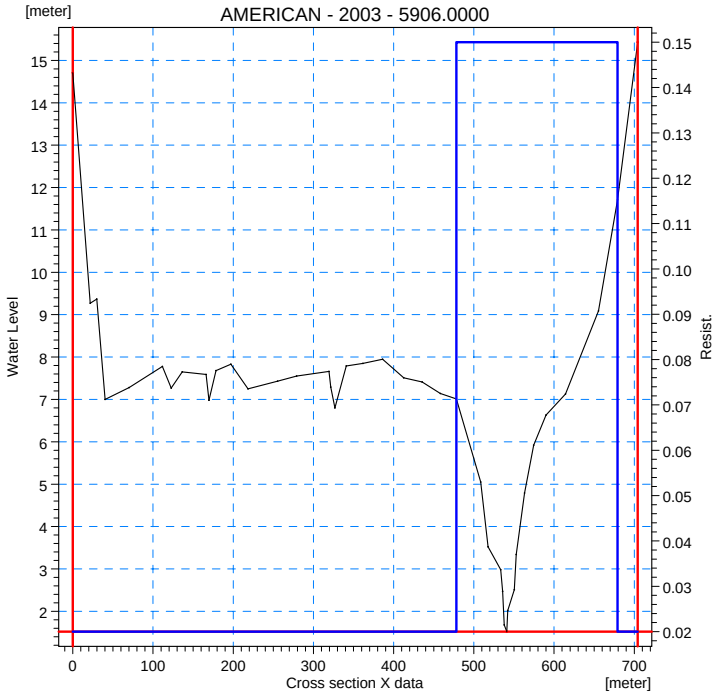
[meter]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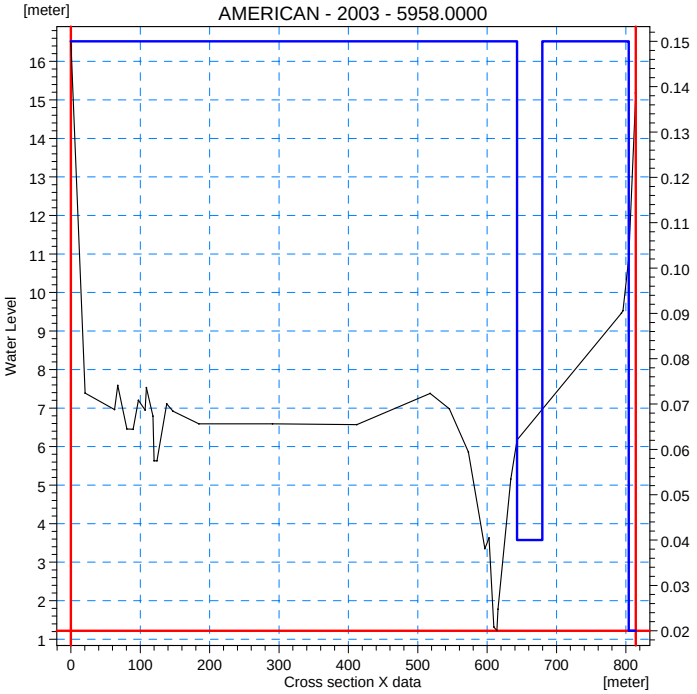
Water Level
Resist.
Cross section X data
[meter]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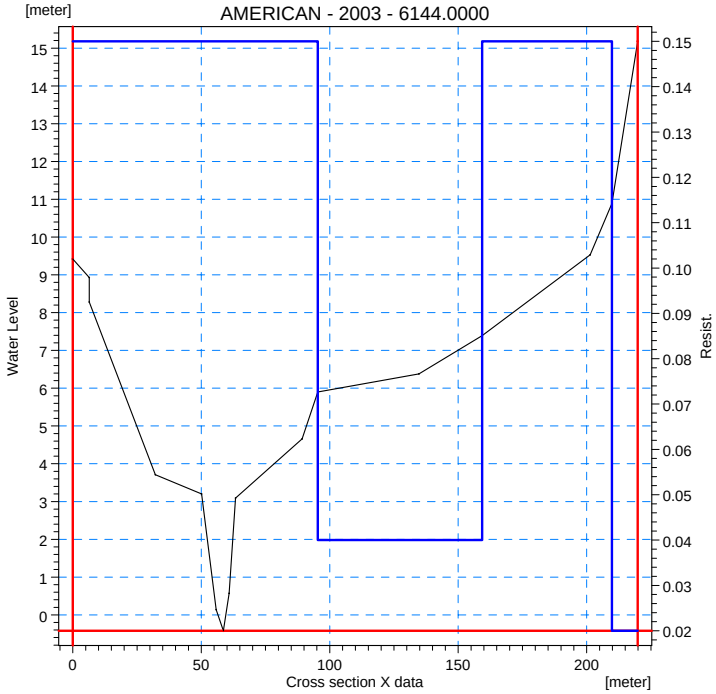
Water Level
Resist.
Cross section X data
[meter]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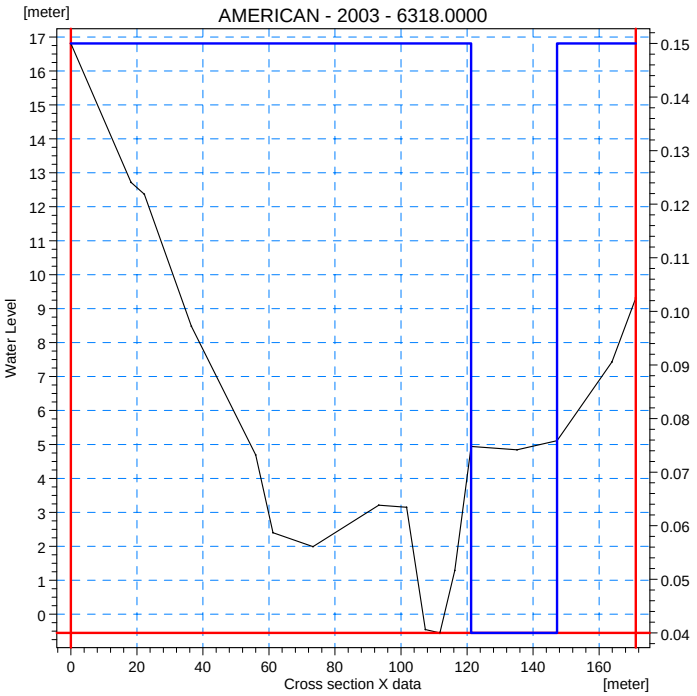
Water Level
Resist.
Cross section X data
[meter]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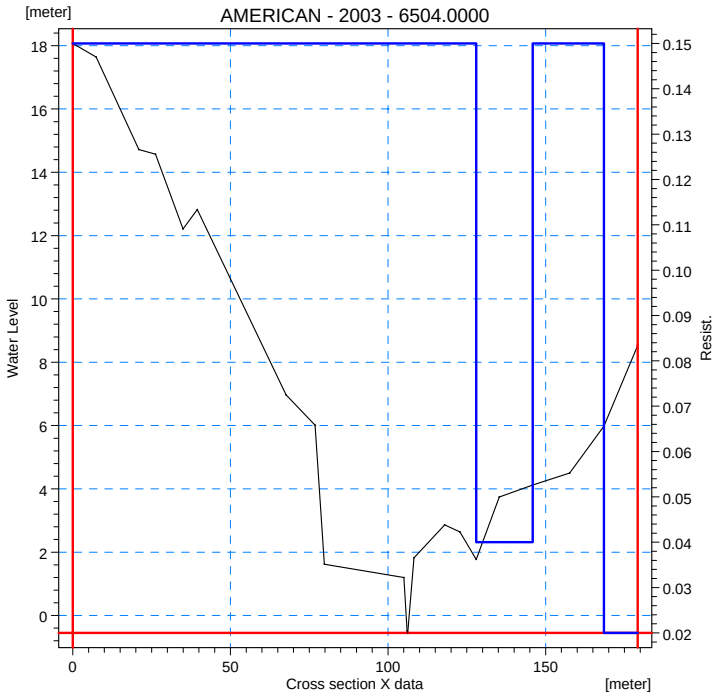
Water Level
Resist.
Cross section X data
[meter]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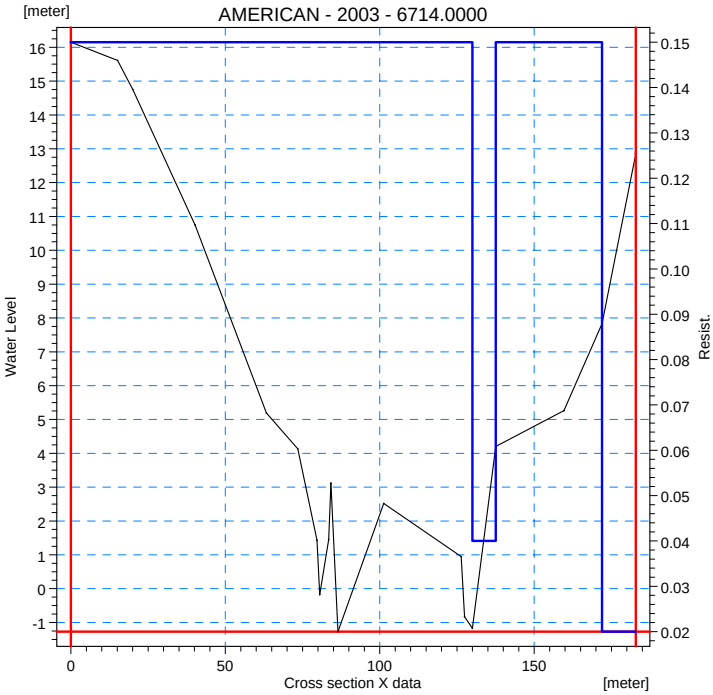
Water Level
Resist.
Cross section X data
[meter]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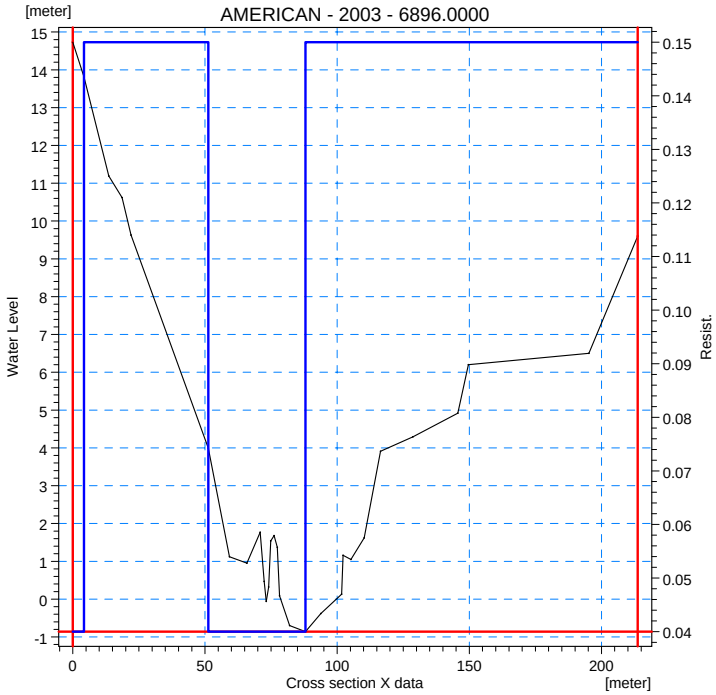
Water Level
Resist.
Cross section X data
[meter]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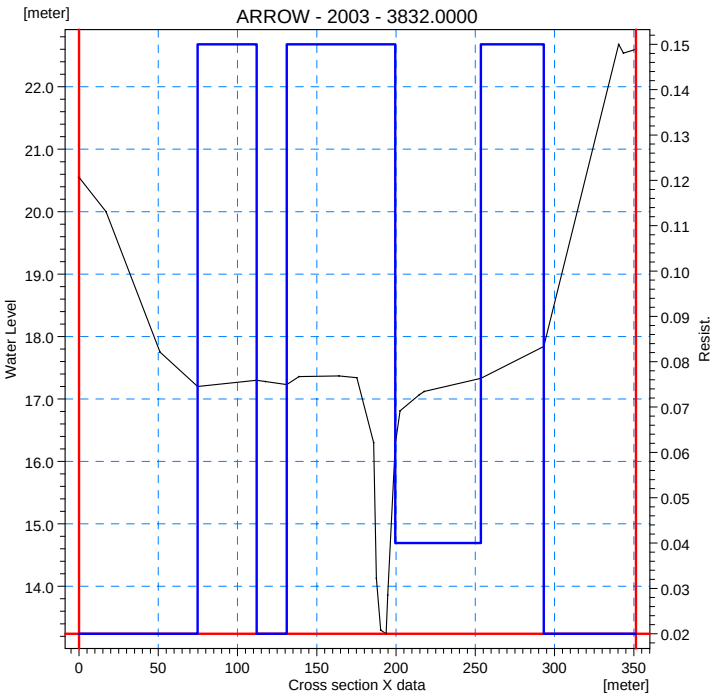
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 3832.0000
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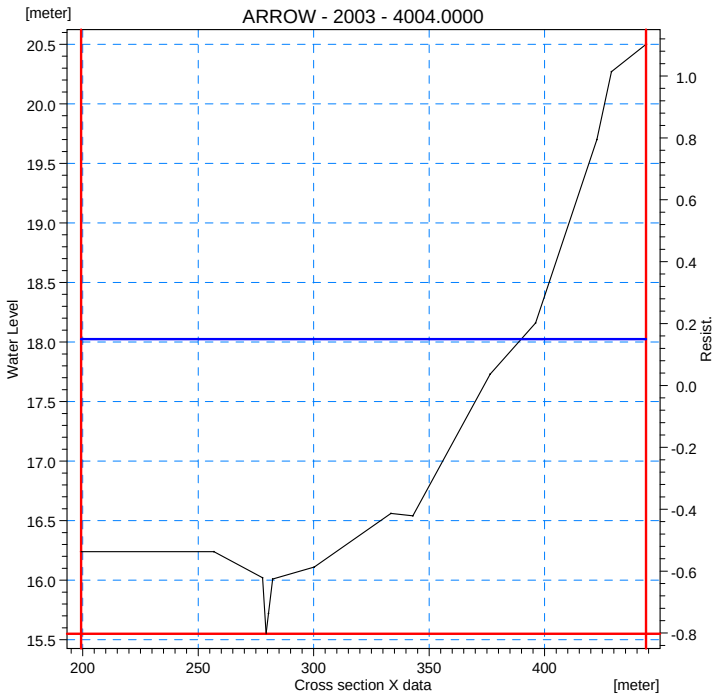
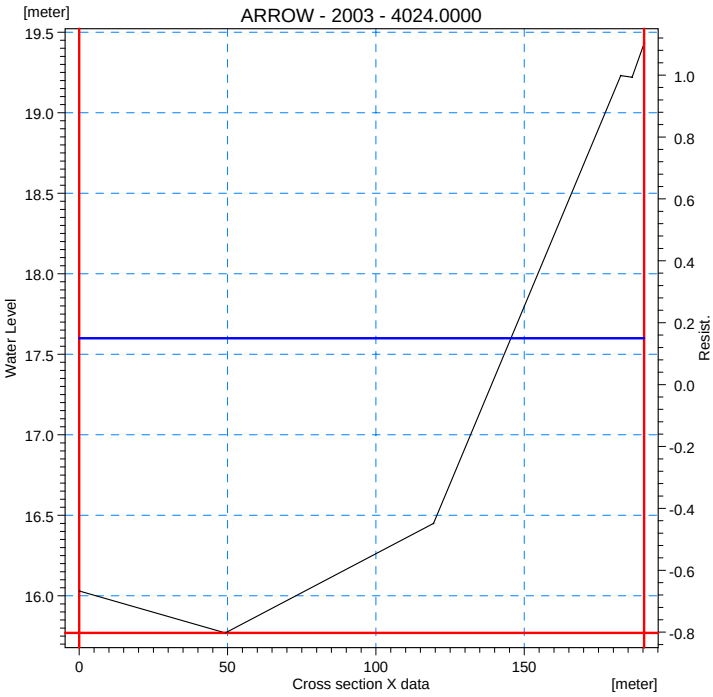
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4004.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4024.0000
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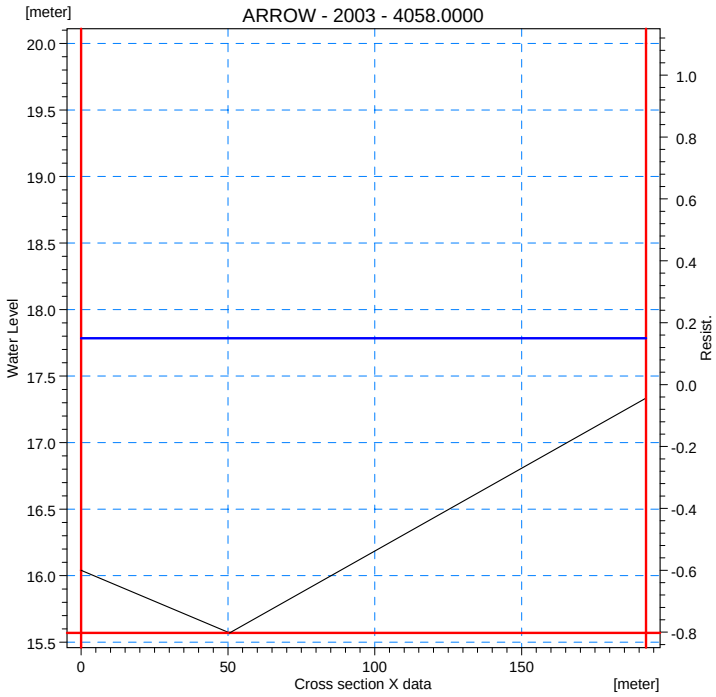
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4058.0000
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Water Level
Resist.
Cross section X data
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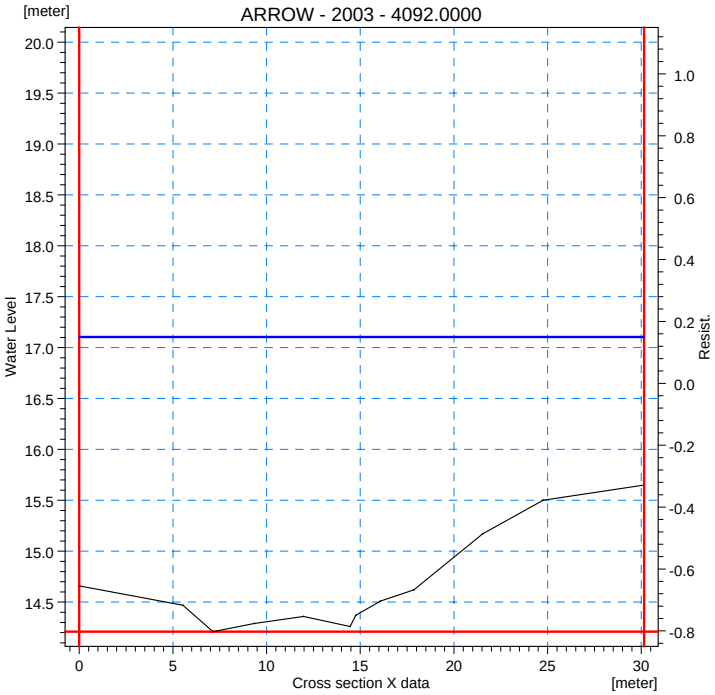
ARROW - 2003 - 4092.0000
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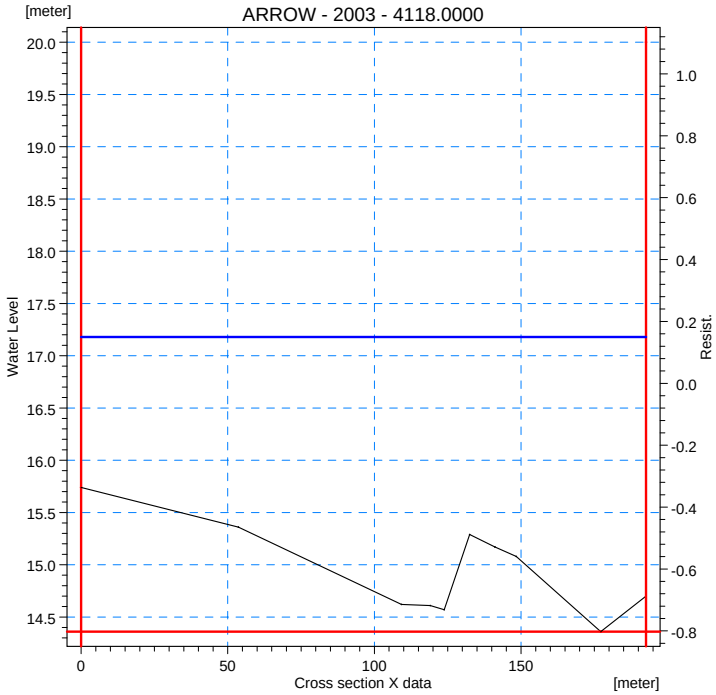
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4118.0000
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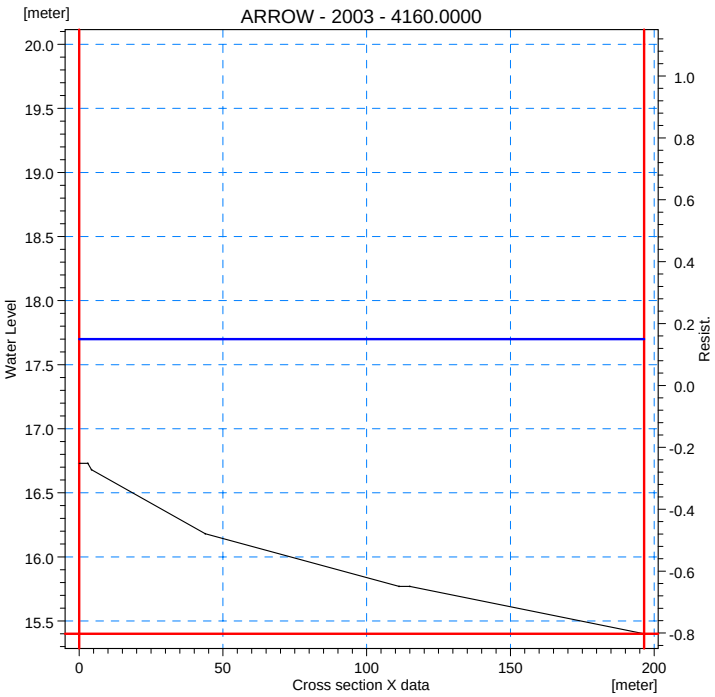
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4160.0000
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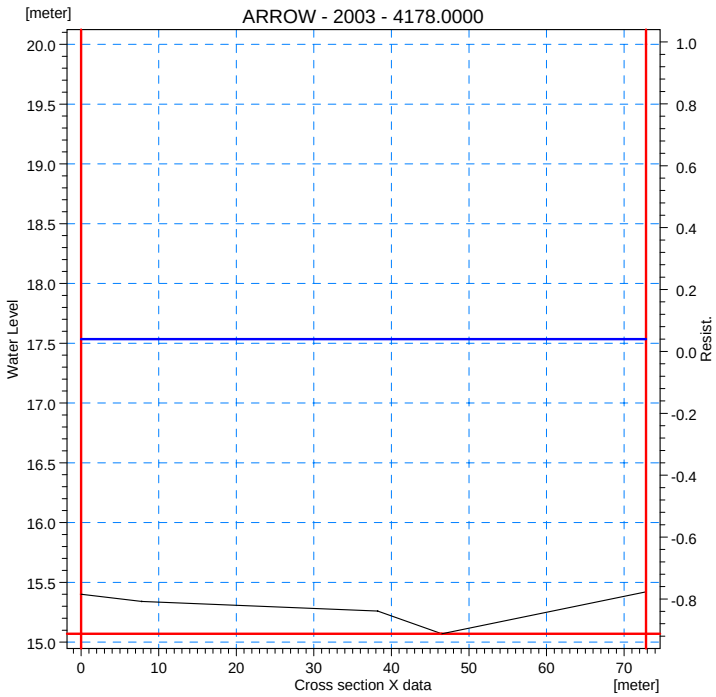
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4178.0000
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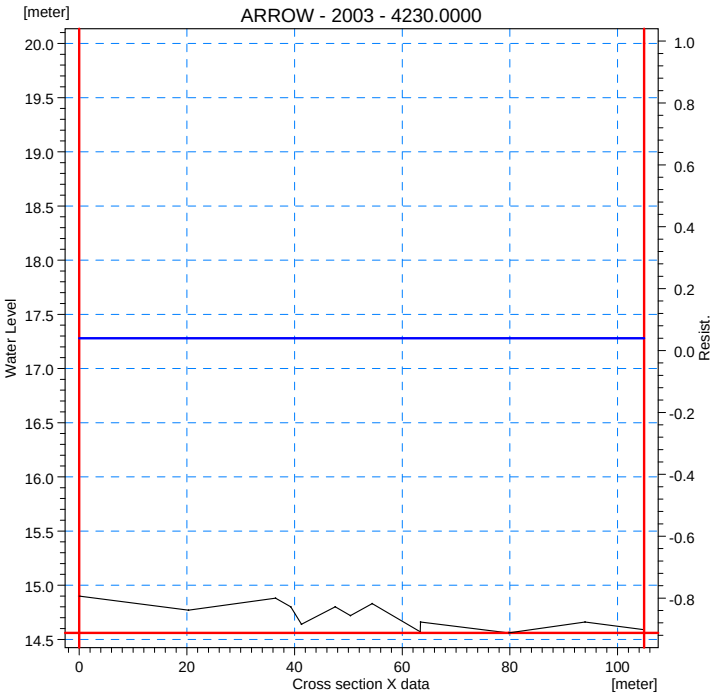
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4230.0000
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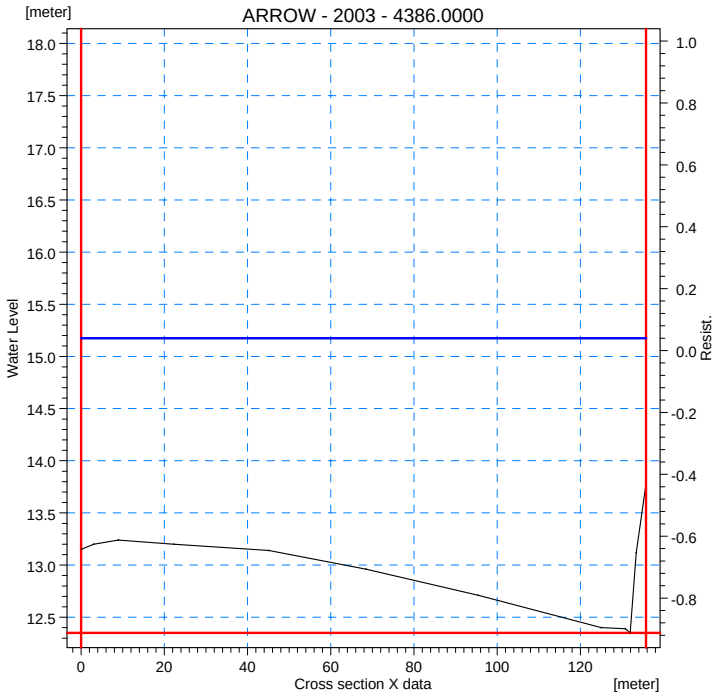
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4386.0000
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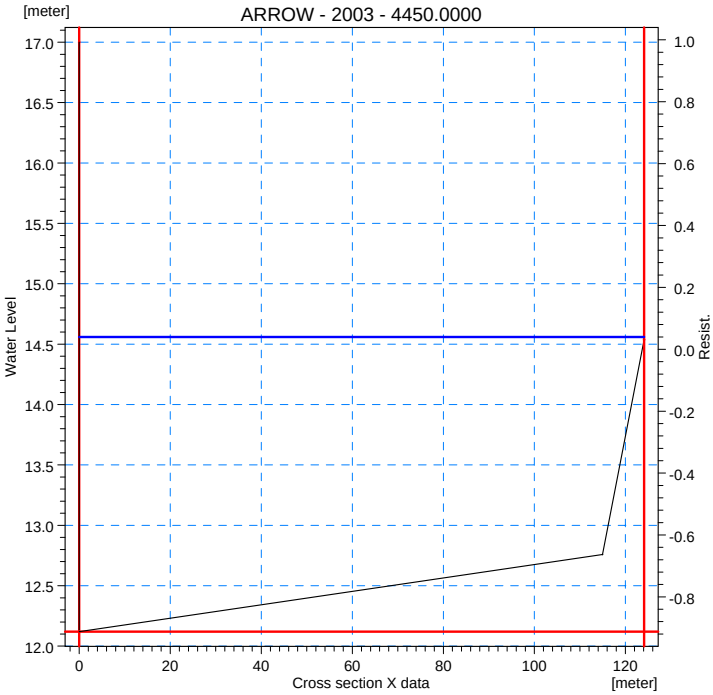
Water Level
Resist.
Cross section X data
[meter]


ARROW - 2003 - 4450.0000
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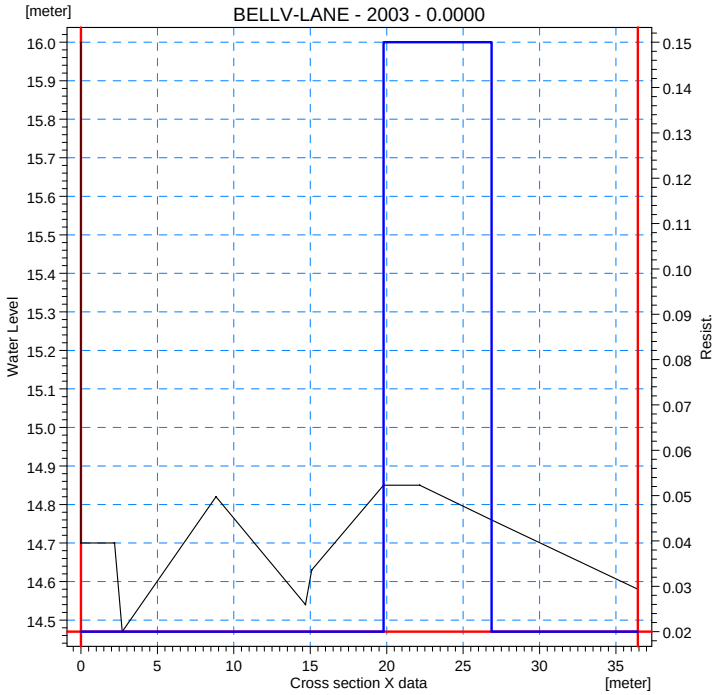
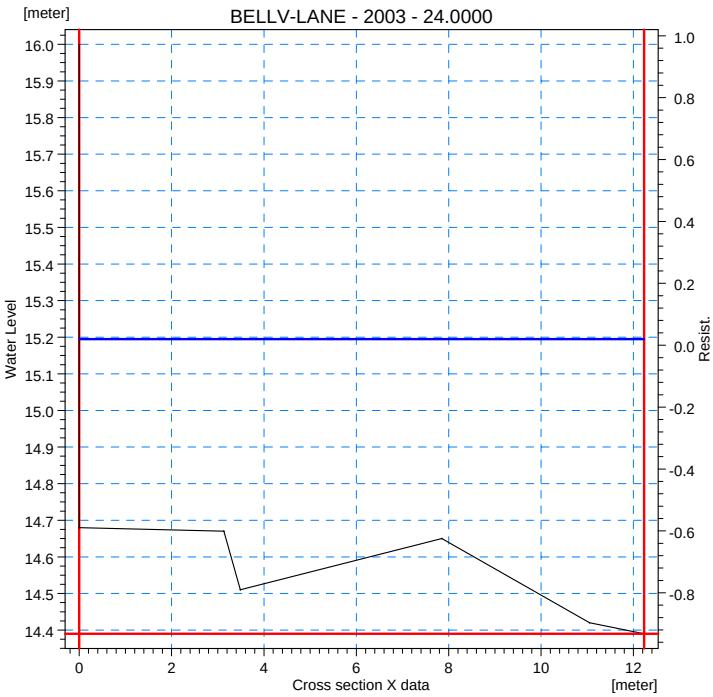
Resist.
Cross section X data
[meter]


BELLV-LANE - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BELLV-LANE - 2003 - 24.0000
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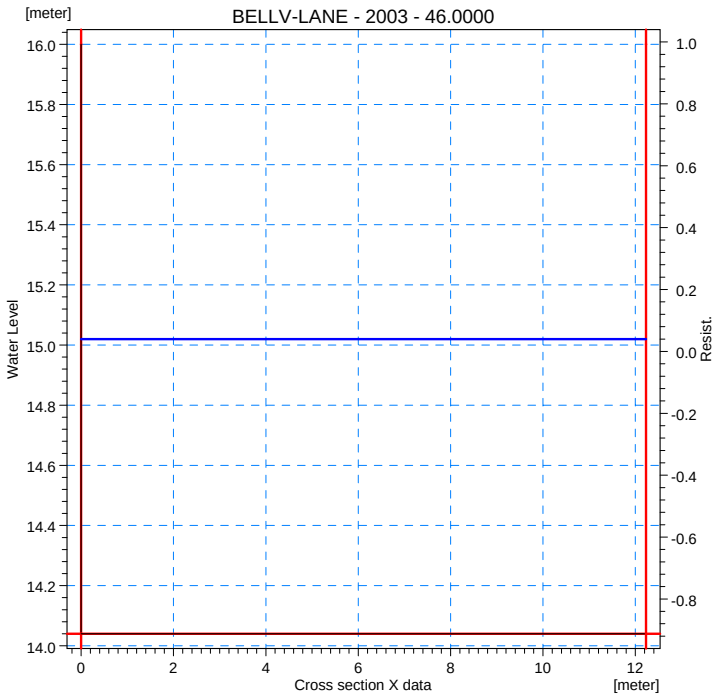
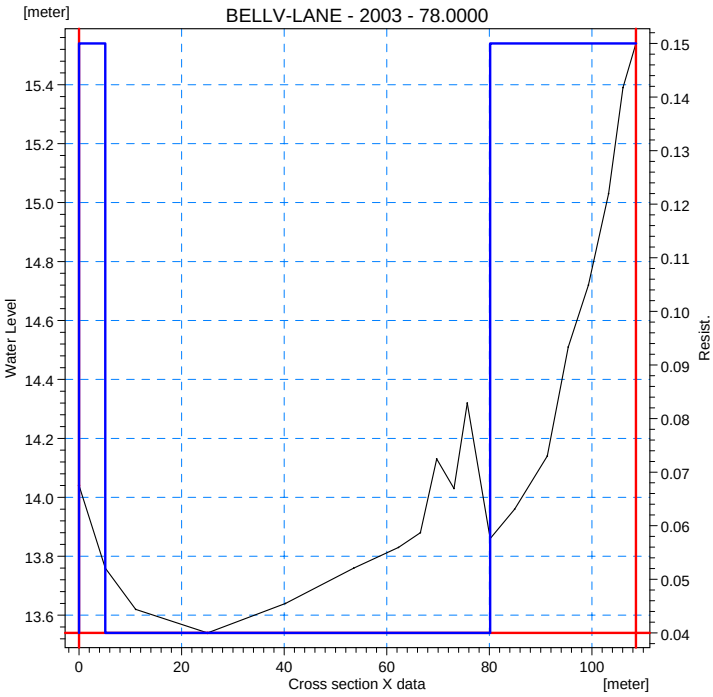
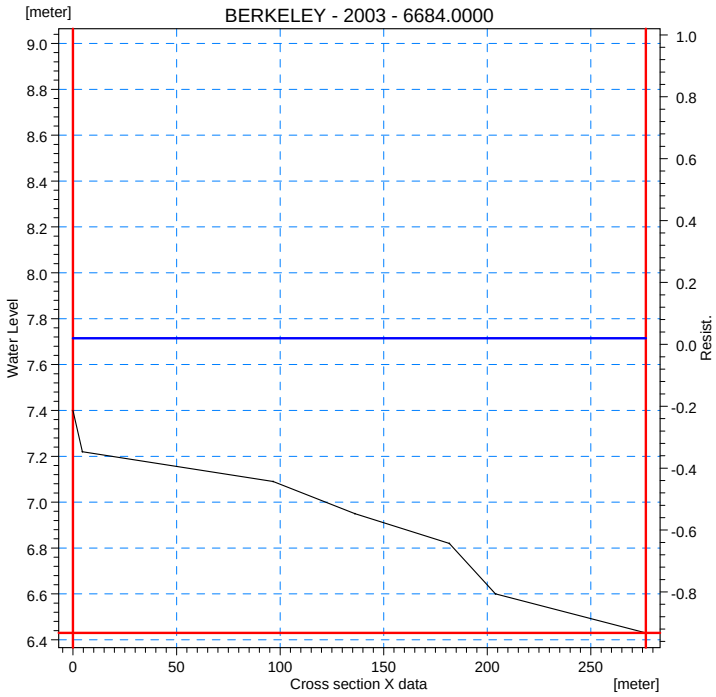
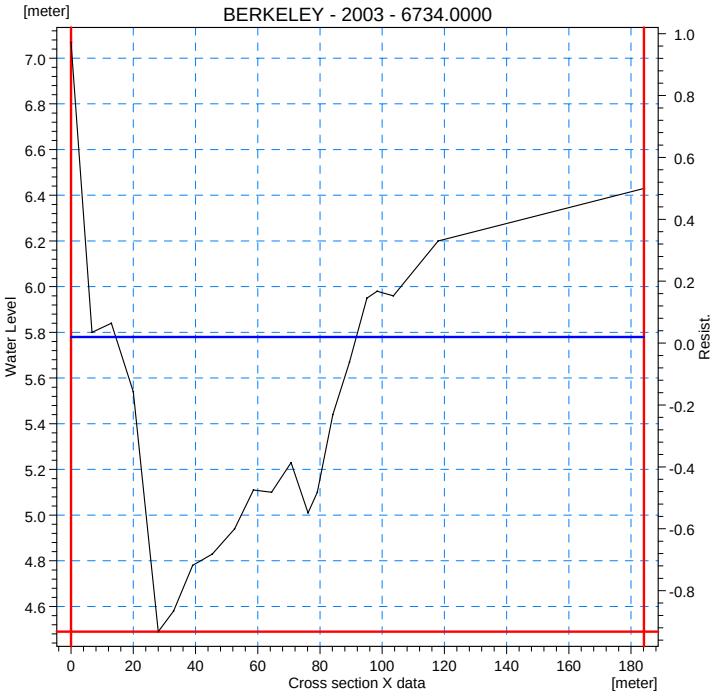
Water Level
Resist.
Cross section X data
[meter]


BELLV-LANE - 2003 - 46.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BELLV-LANE - 2003 - 78.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BERKELEY - 2003 - 6684.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BERKELEY - 2003 - 6734.0000
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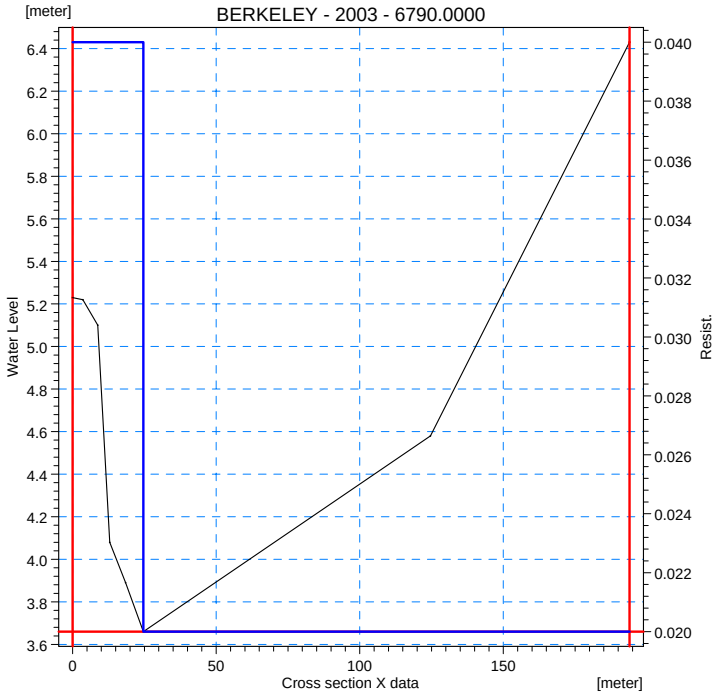
Water Level
Resist.
Cross section X data
[meter]


BERKELEY - 2003 - 6790.0000
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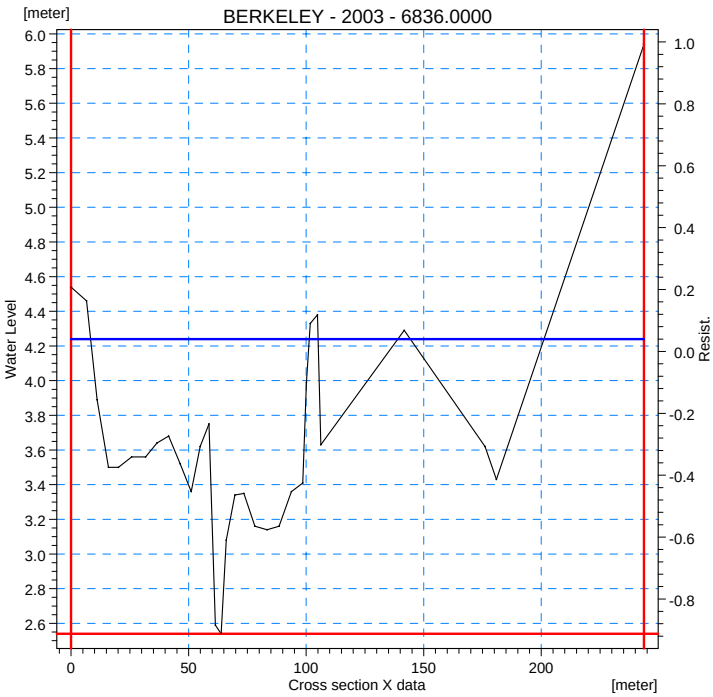
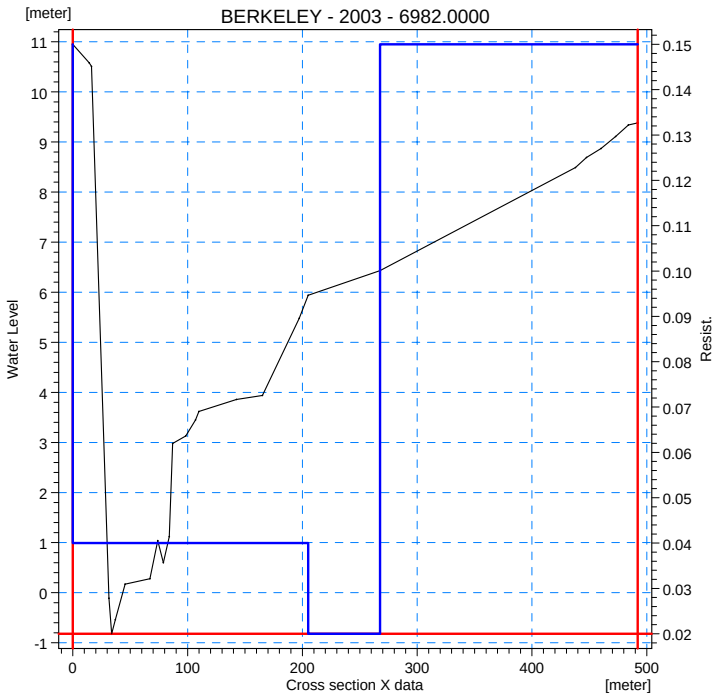
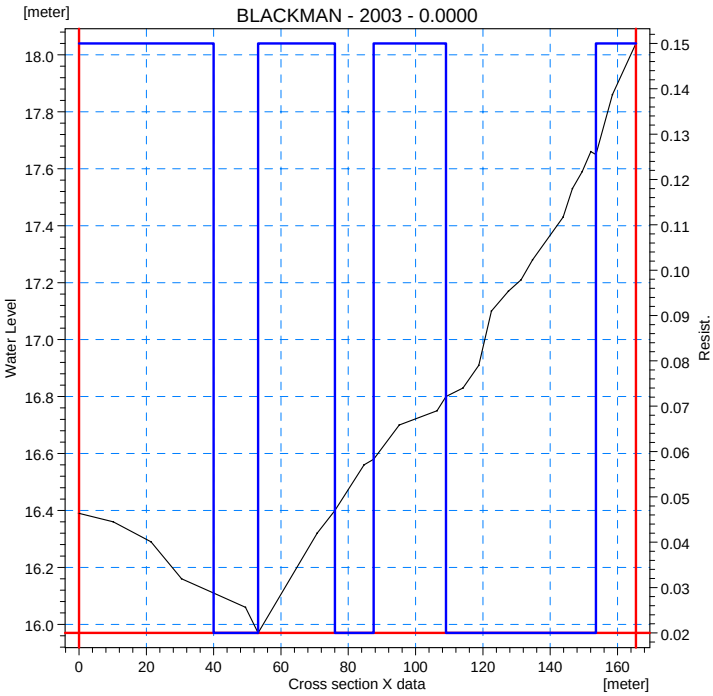
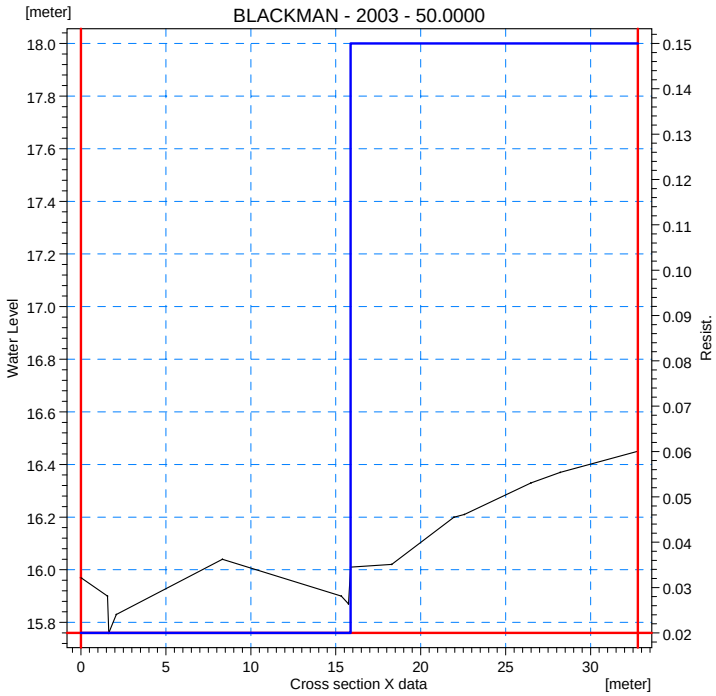
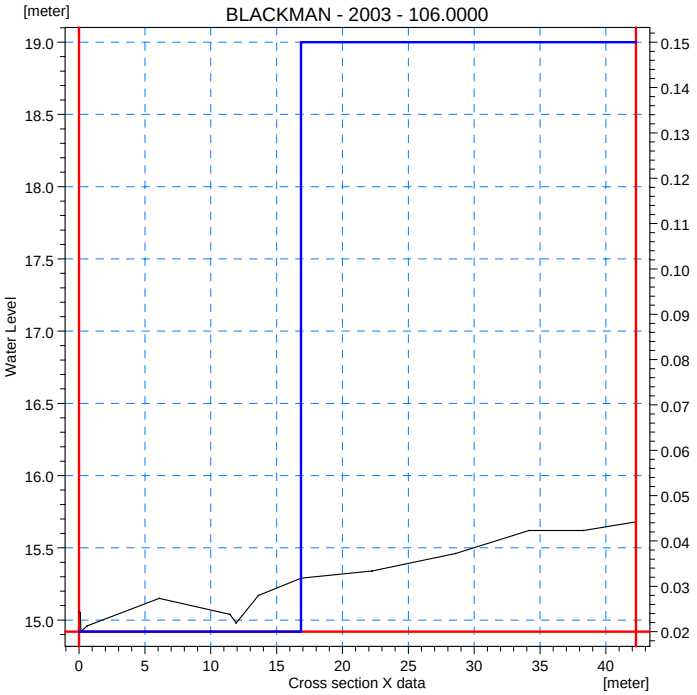
Water Level
Resist.
Cross section X data
[meter]

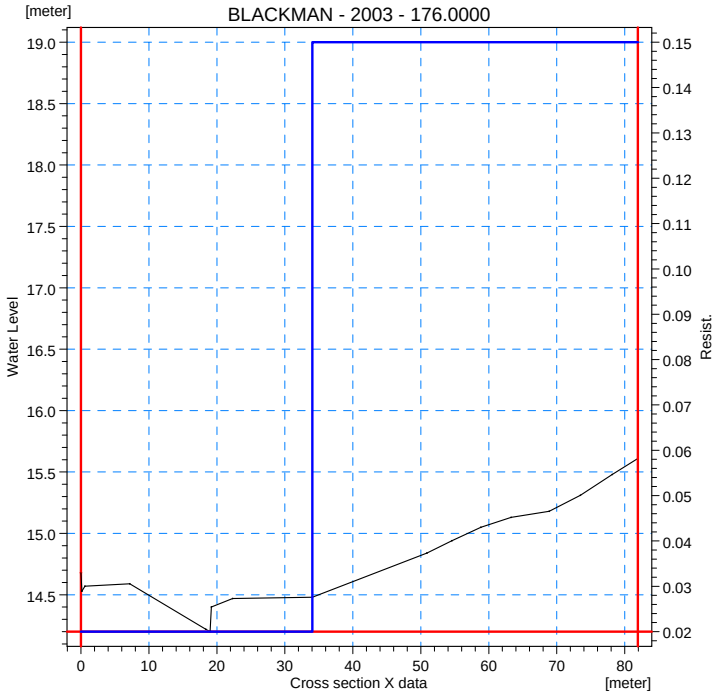

BERKELEY - 2003 - 6836.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

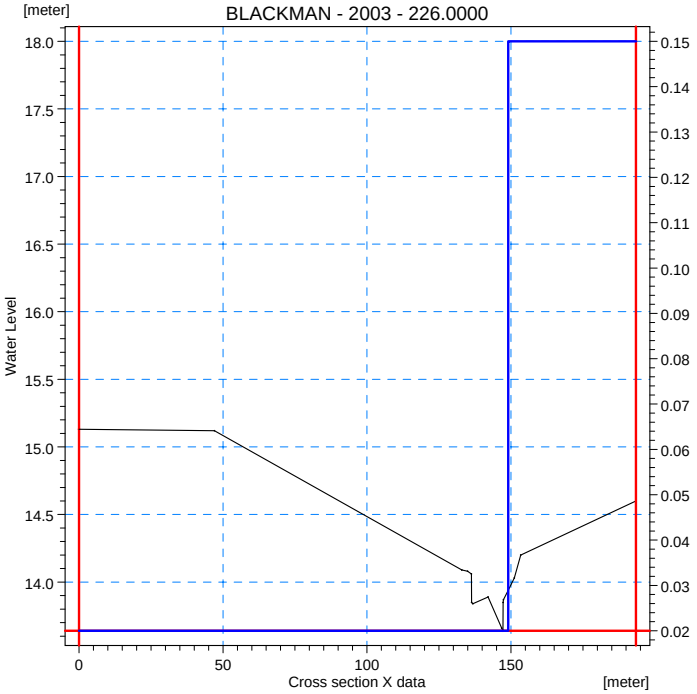

BERKELEY - 2003 - 6982.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BLACKMAN - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BLACKMAN - 2003 - 50.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BLACKMAN - 2003 - 106.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BLACKMAN - 2003 - 176.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BLACKMAN - 2003 - 226.0000
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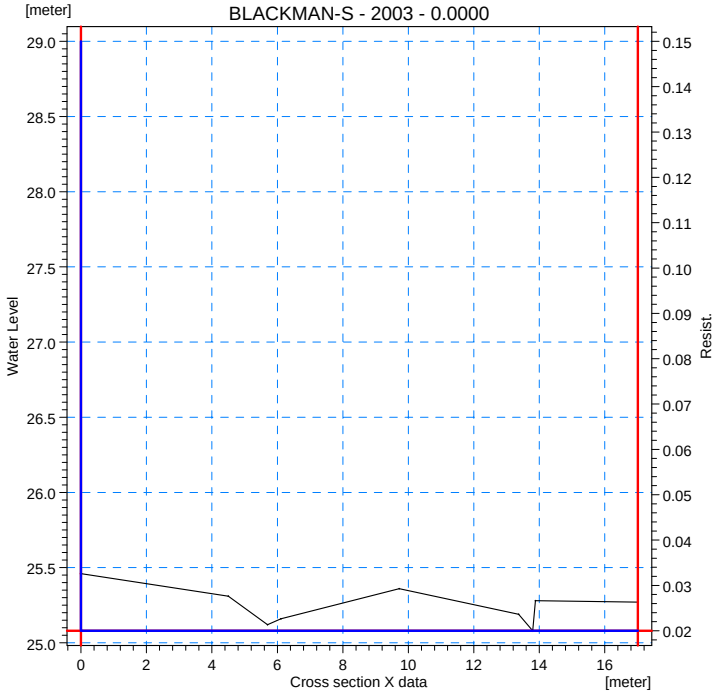
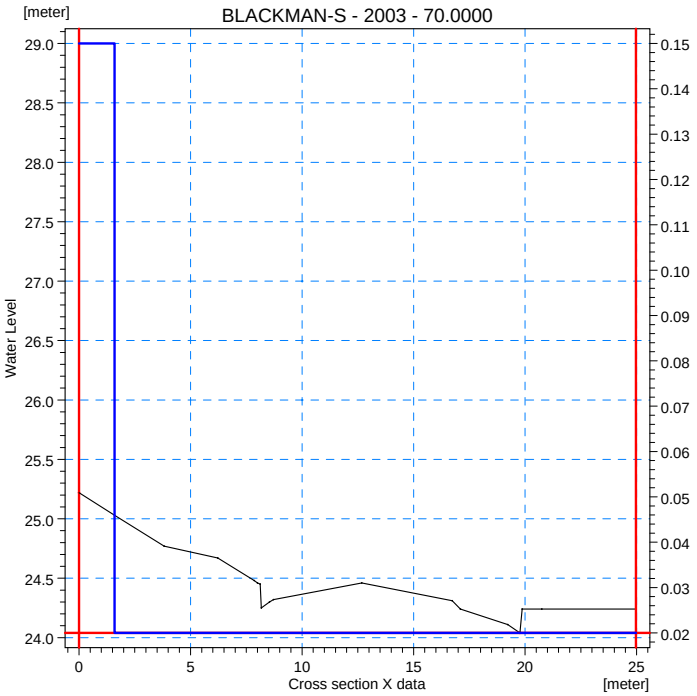
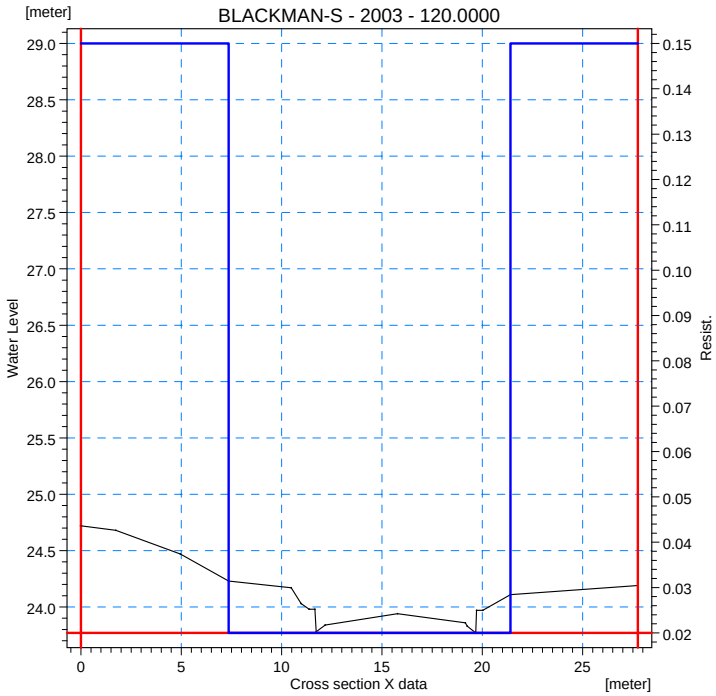
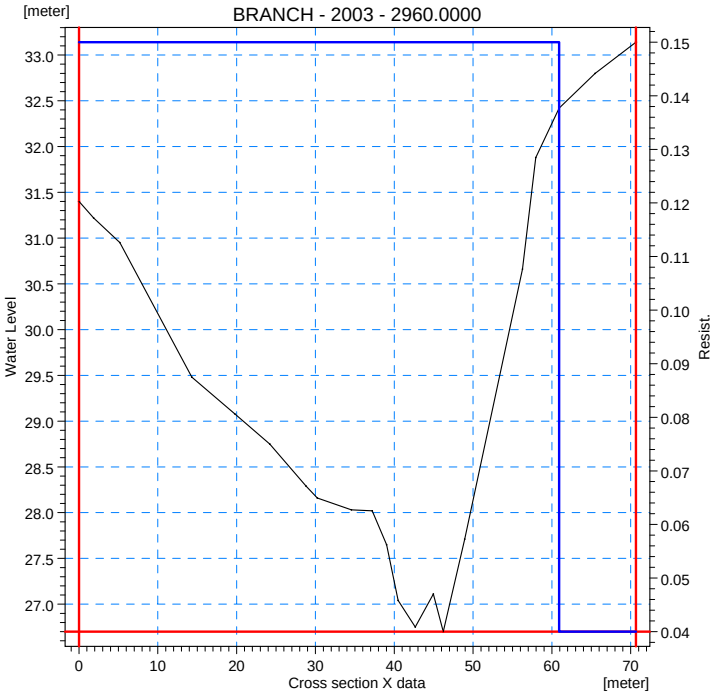
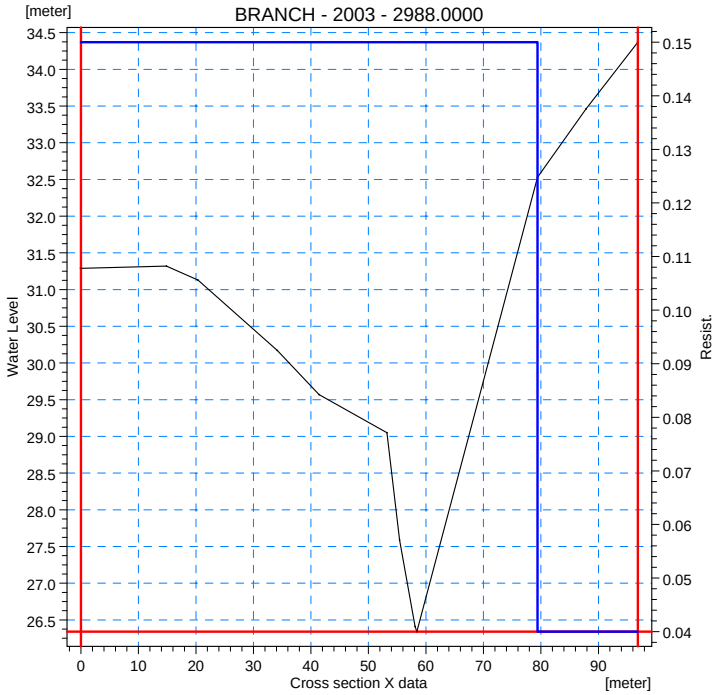
Water Level
Resist.
Cross section X data
[meter]

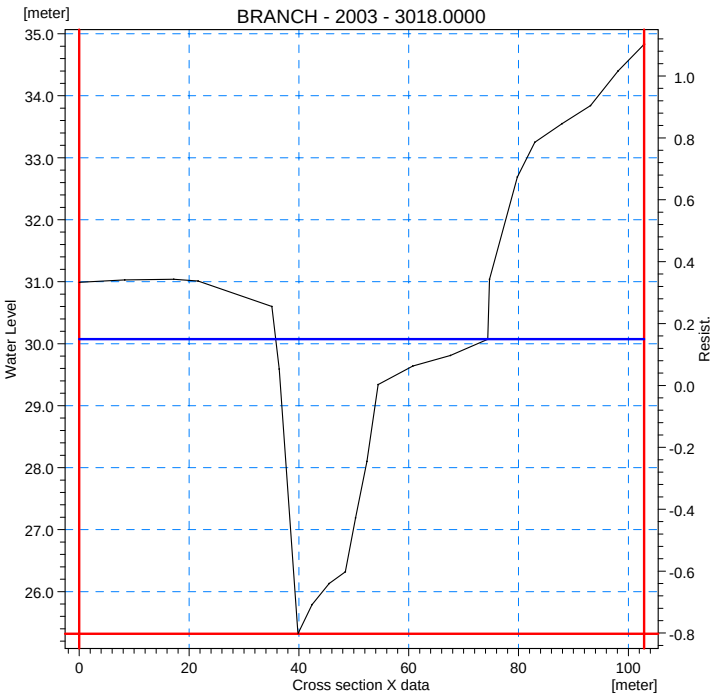

BLACKMAN-S - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

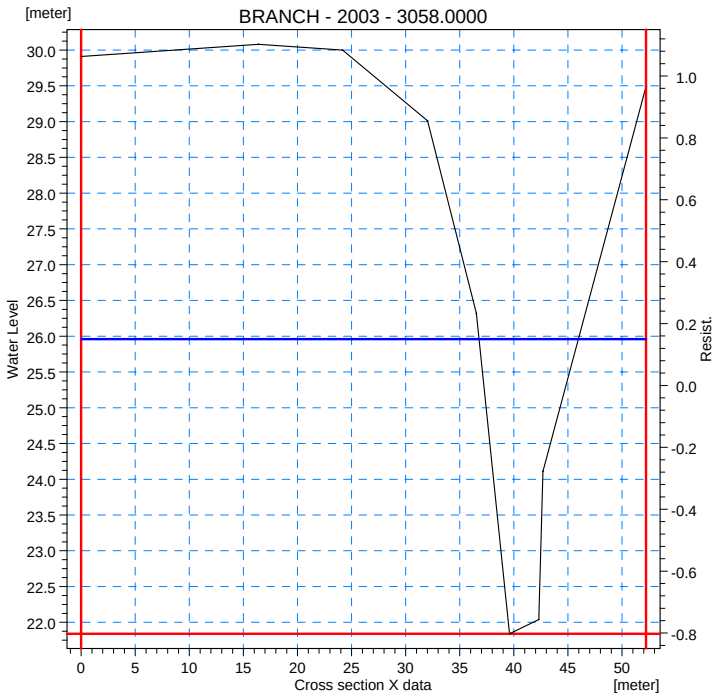

BLACKMAN-S - 2003 - 70.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

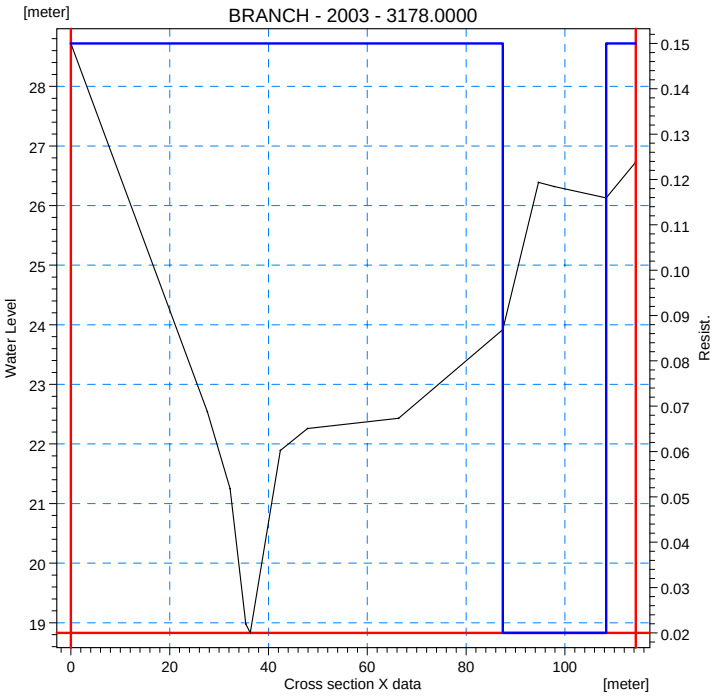

BLACKMAN-S - 2003 - 120.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 2960.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 2988.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3018.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3058.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3178.0000
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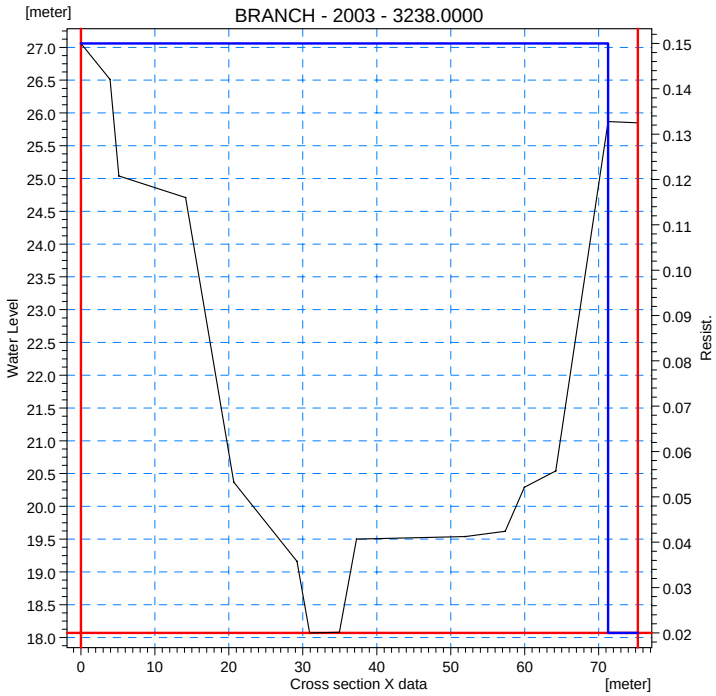
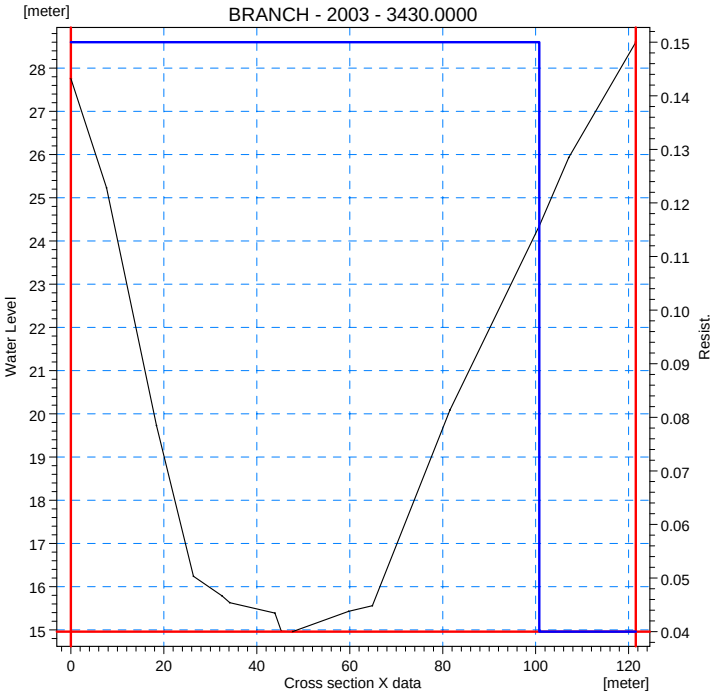
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3238.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3430.0000
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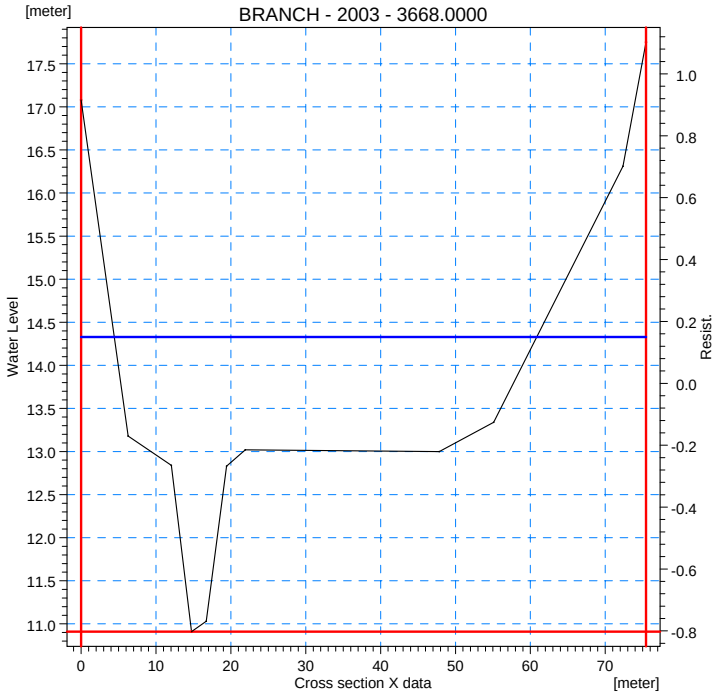
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3668.0000
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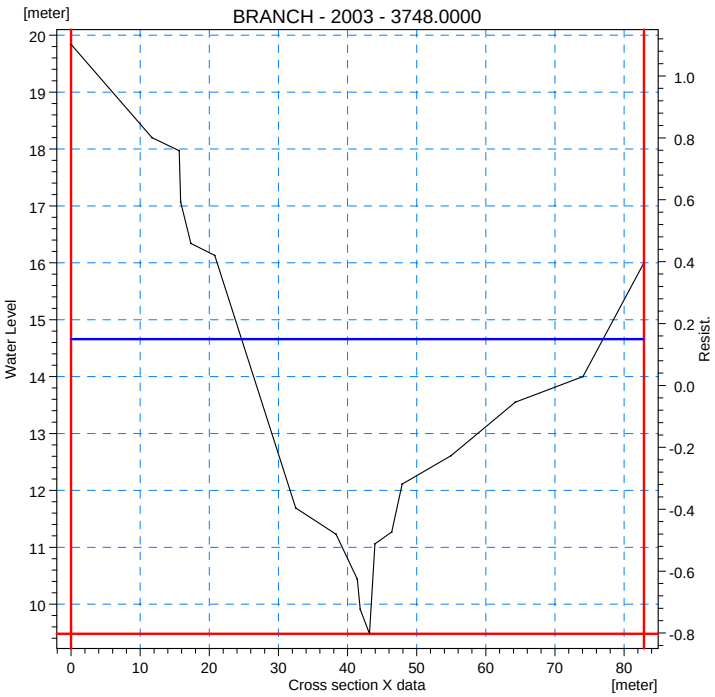
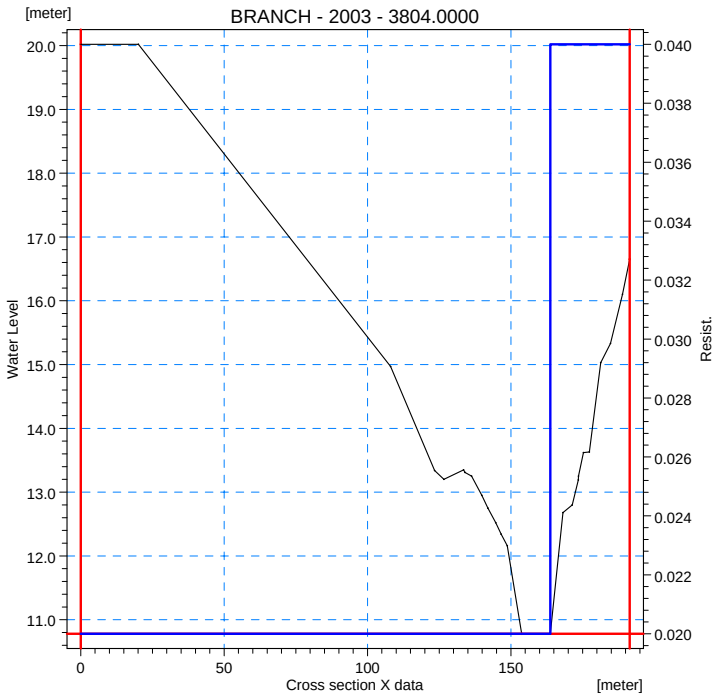
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3748.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3804.0000
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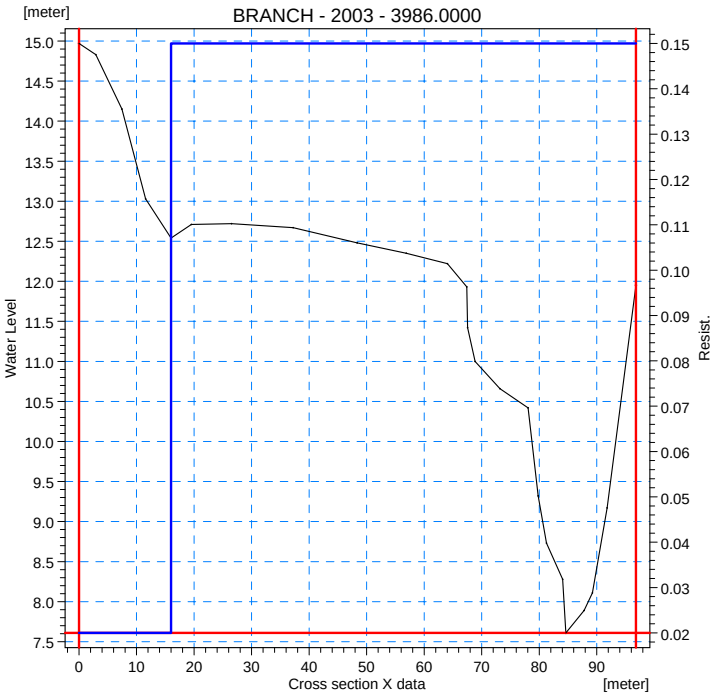
Water Level
Resist.
Cross section X data
[meter]


BRANCH - 2003 - 3986.0000
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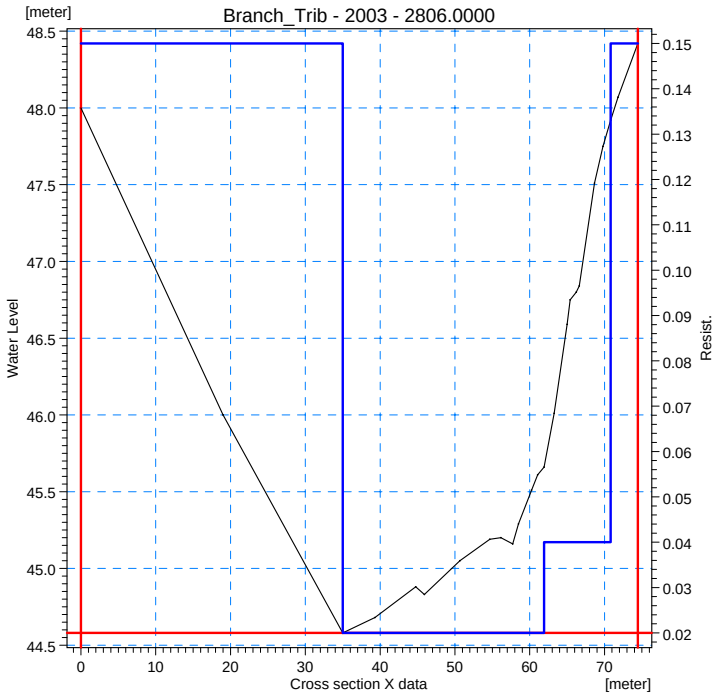
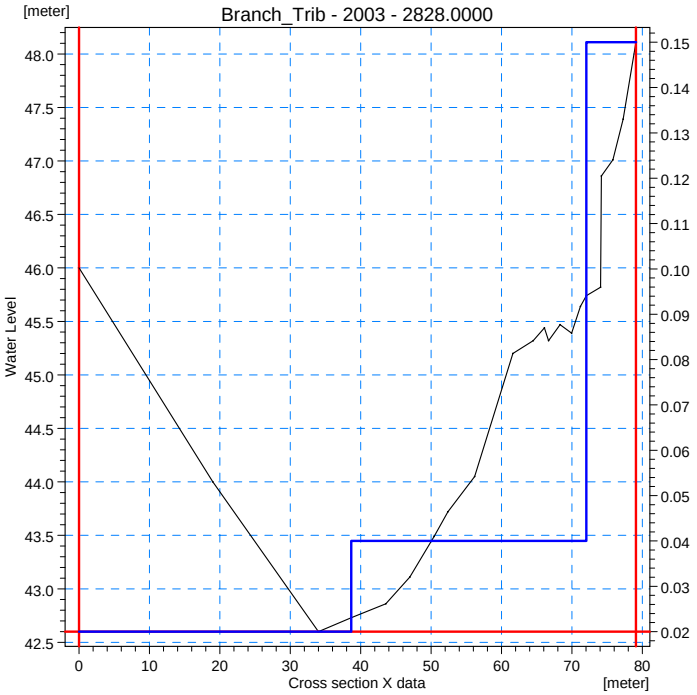
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2806.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2828.0000
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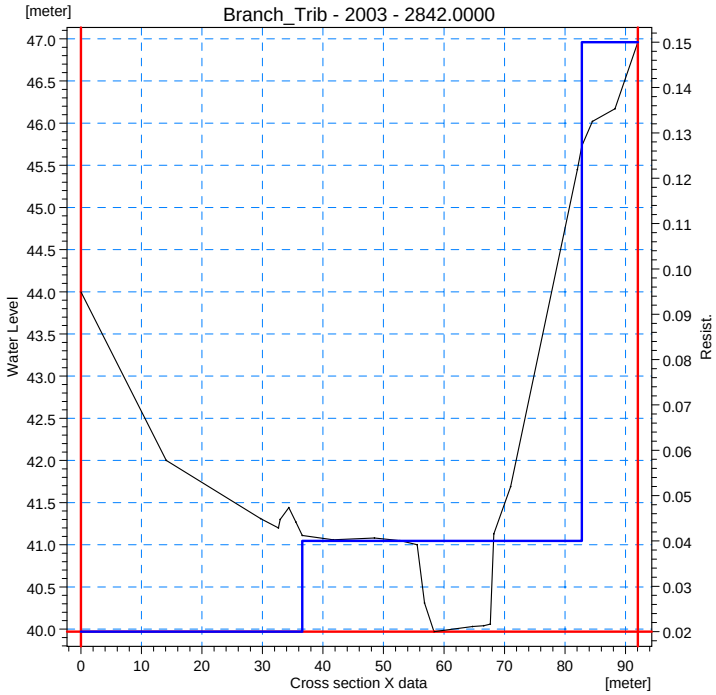
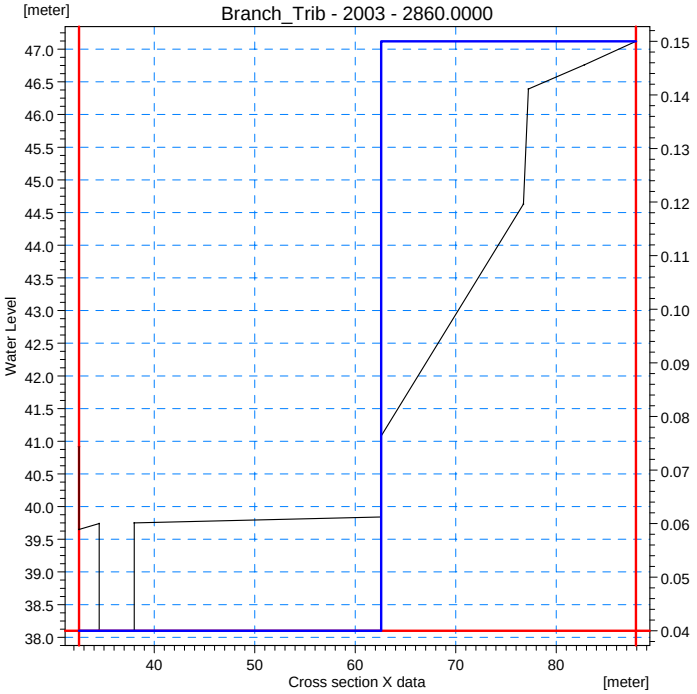
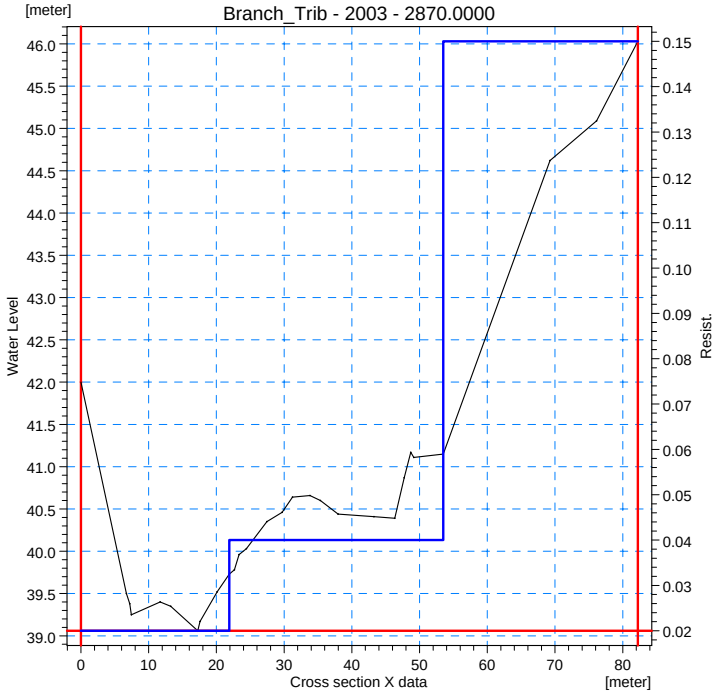
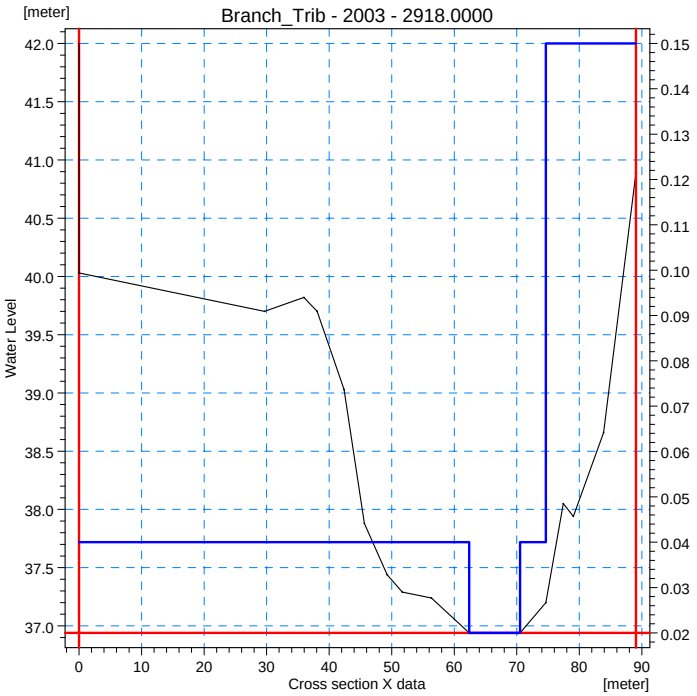
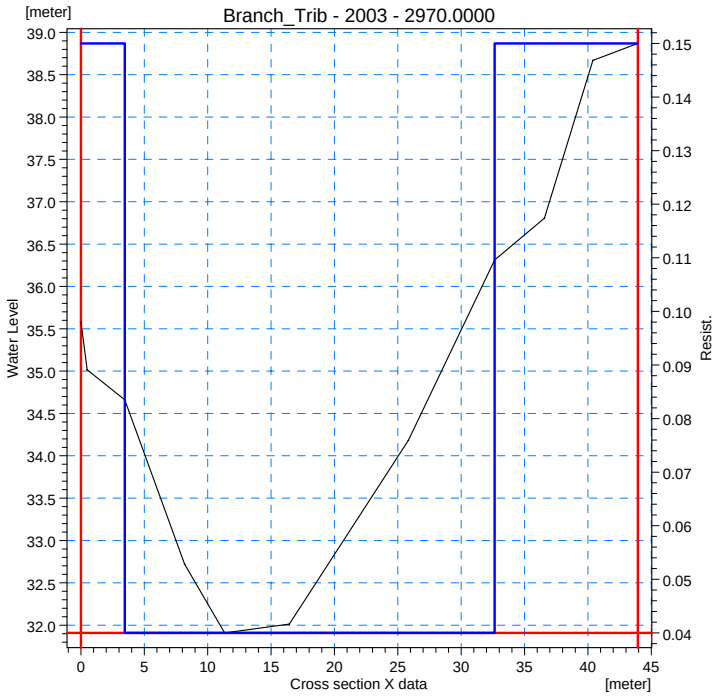
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2842.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2860.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2870.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2918.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 2970.0000
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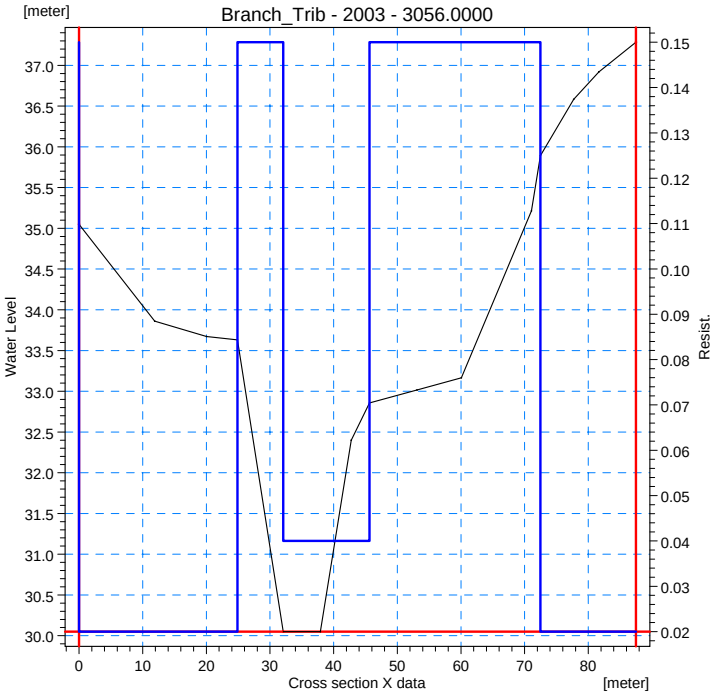
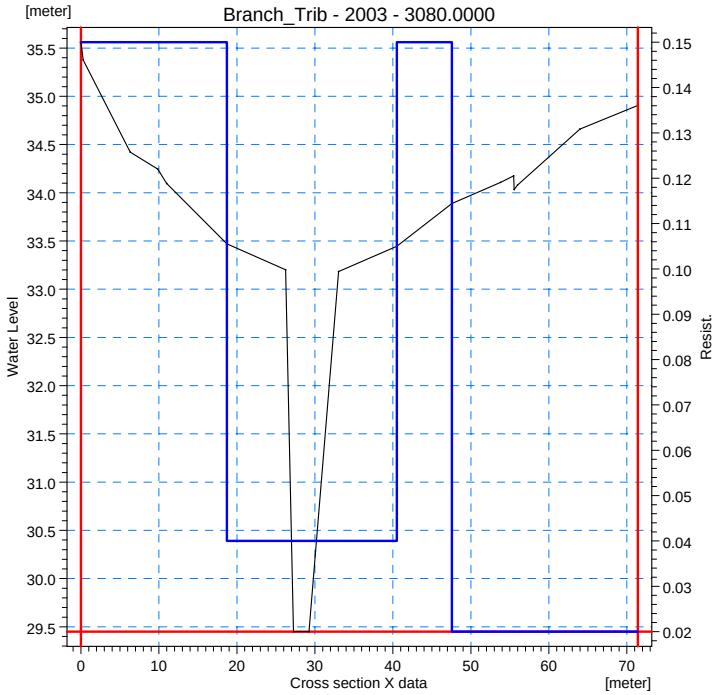
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3056.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3080.0000
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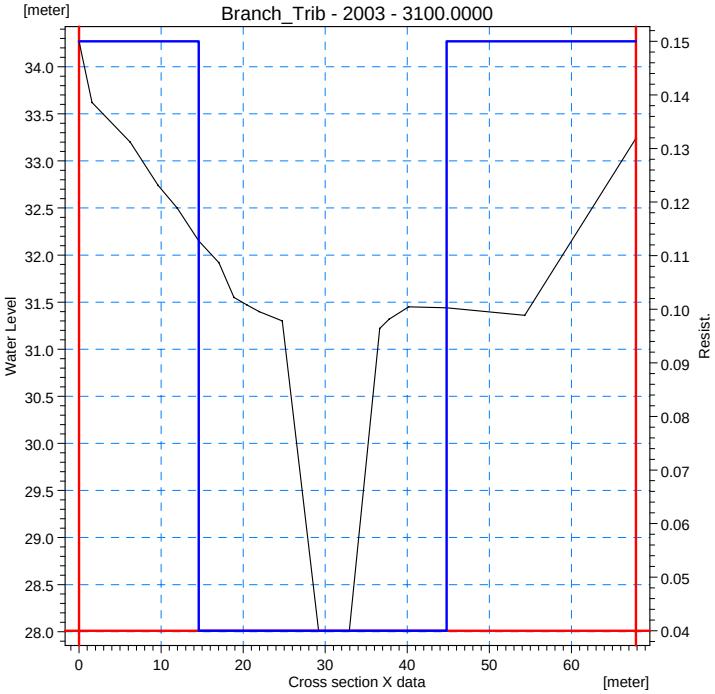
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3100.0000
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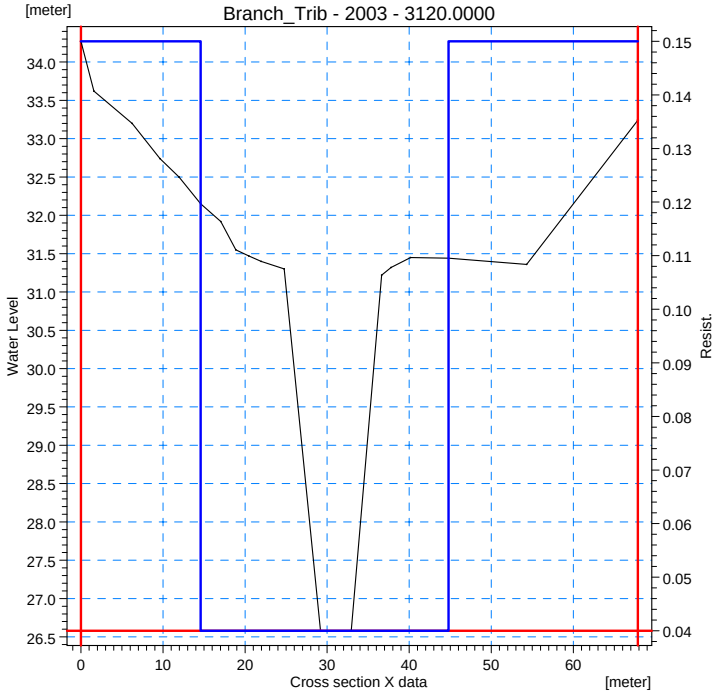
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3120.0000
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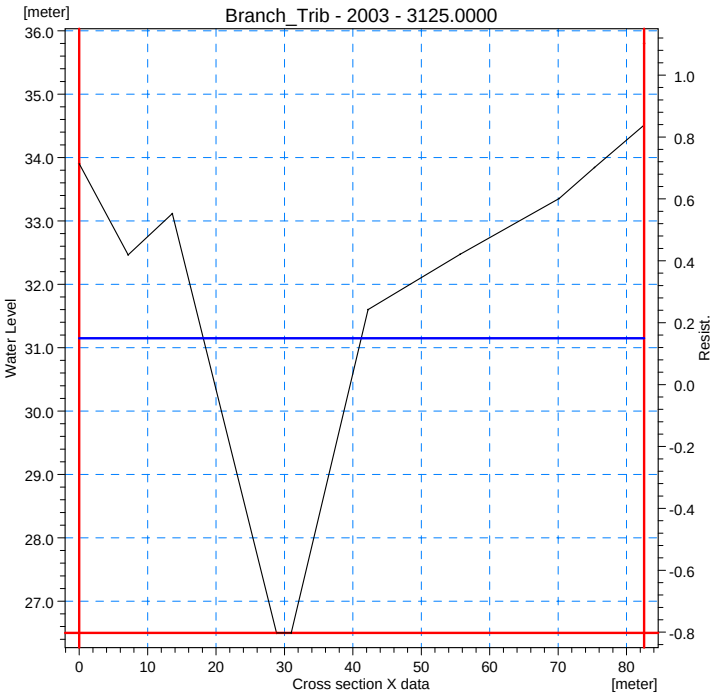
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3125.0000
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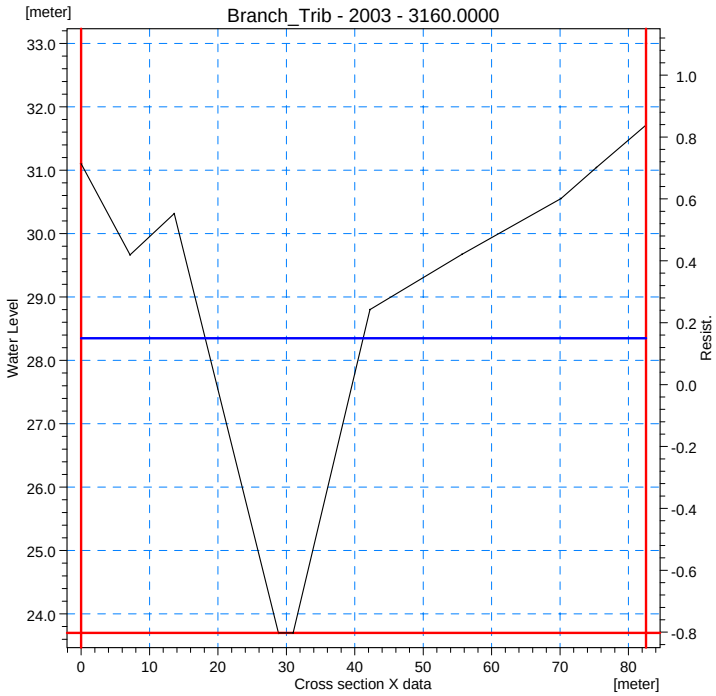
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3160.0000
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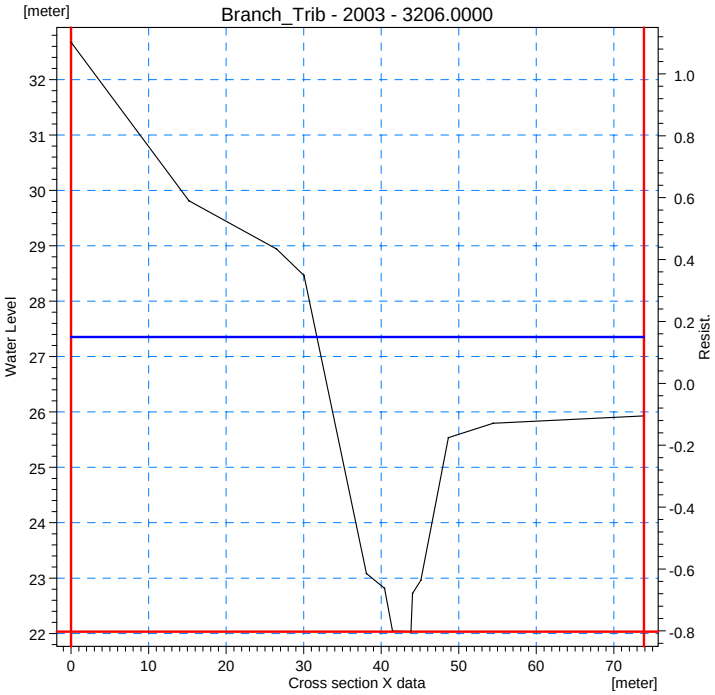
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3206.0000
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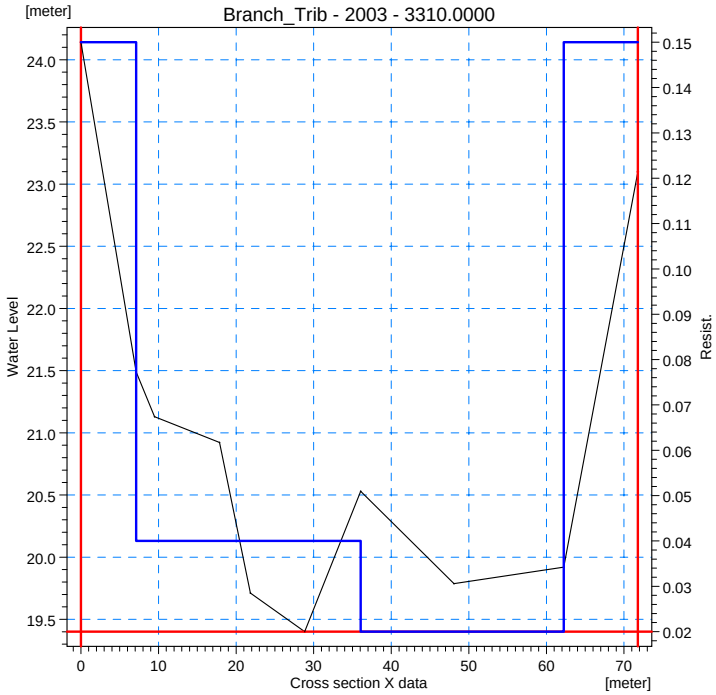
Water Level
Resist.
Cross section X data
[meter]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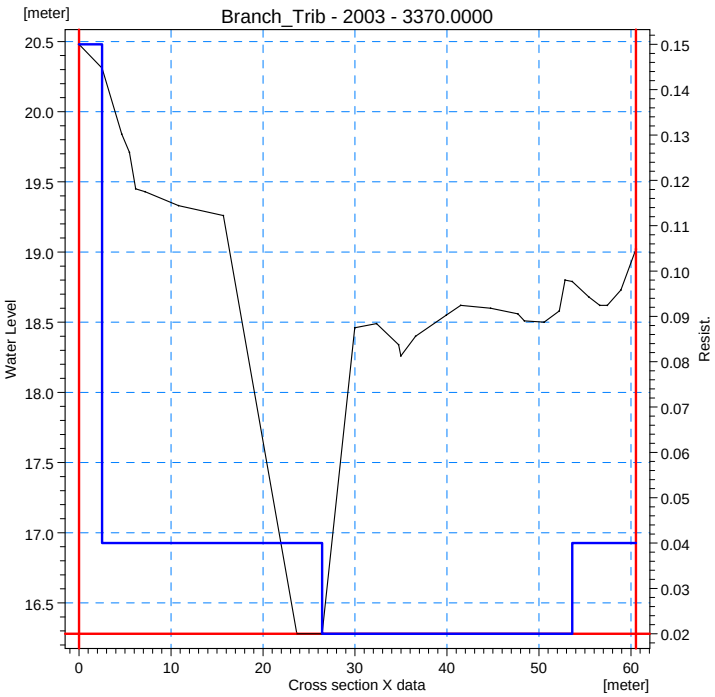
Water Level
Resist.
Cross section X data
[meter]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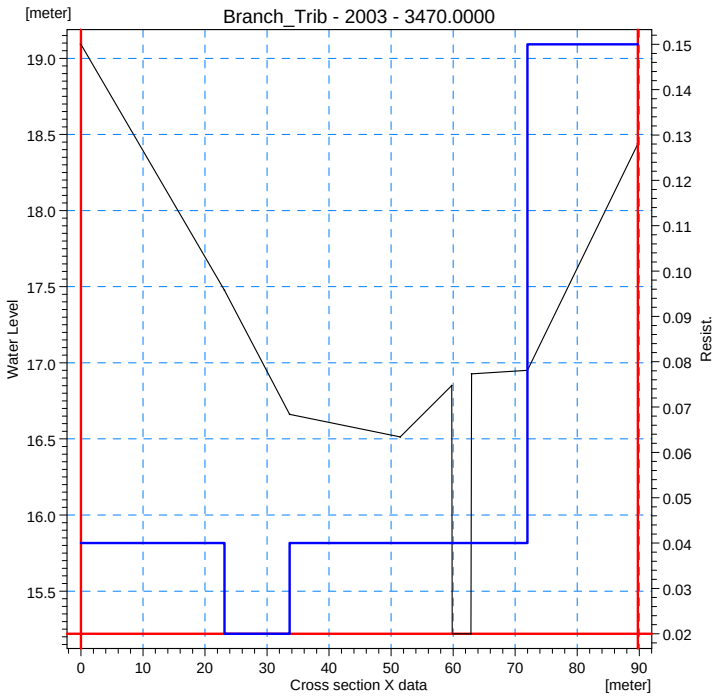
Water Level
Resist.
Cross section X data
[meter]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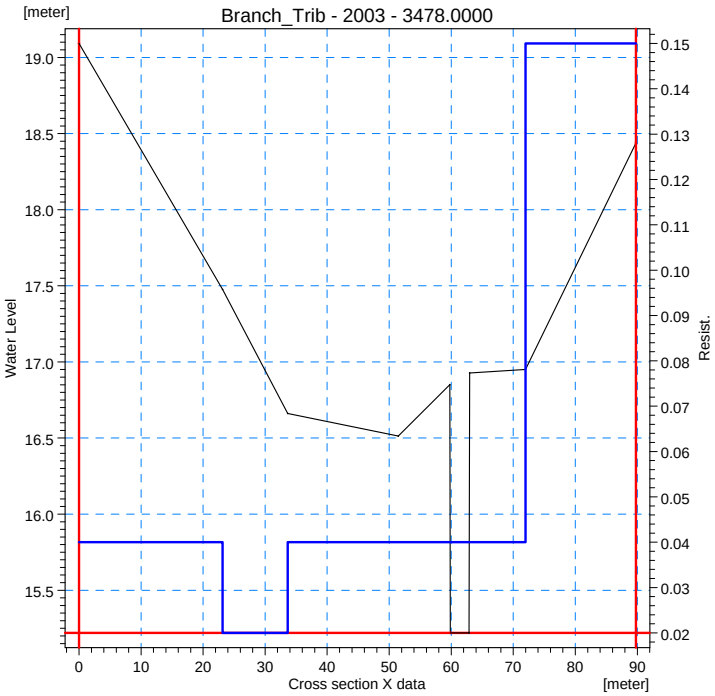
Water Level
Resist.
Cross section X data
[meter]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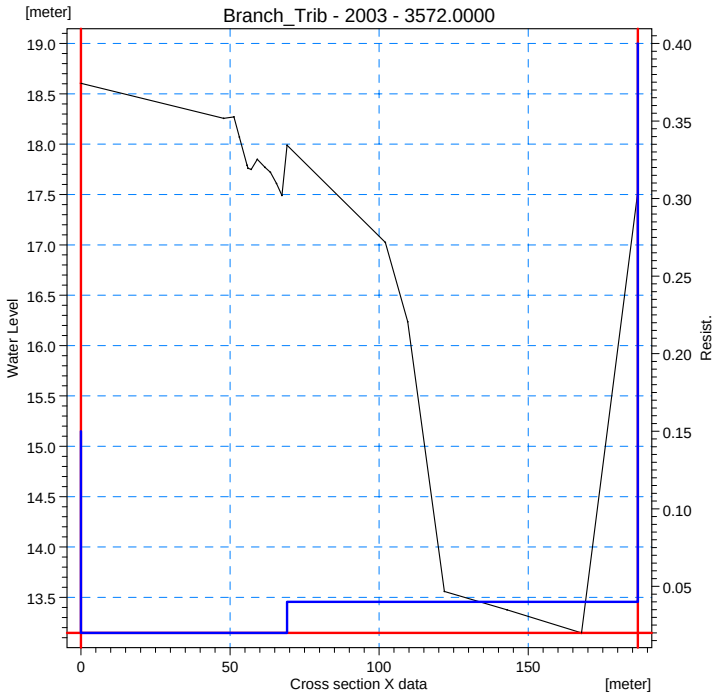
Water Level
Resist.
Cross section X data
[meter]


Branch_Trib - 2003 - 3572.0000
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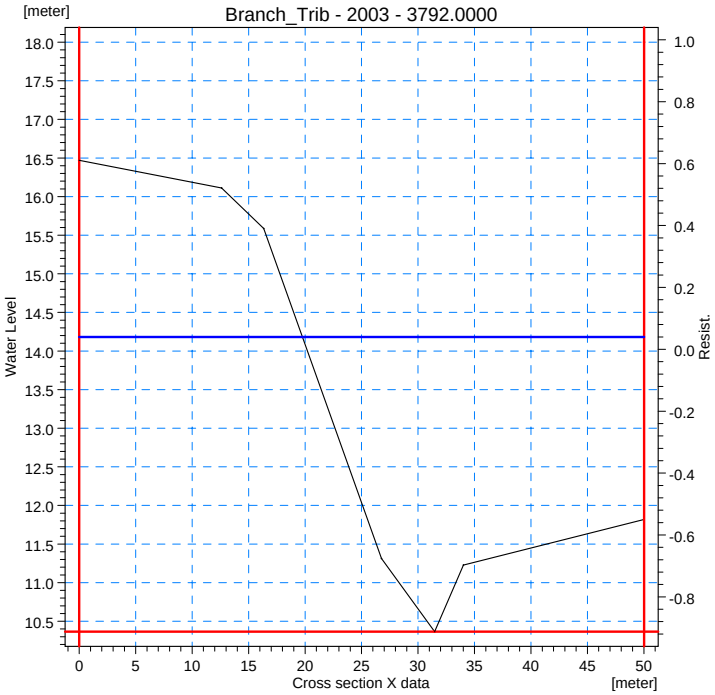
Water Level
Resist.
Cross section X data
[meter]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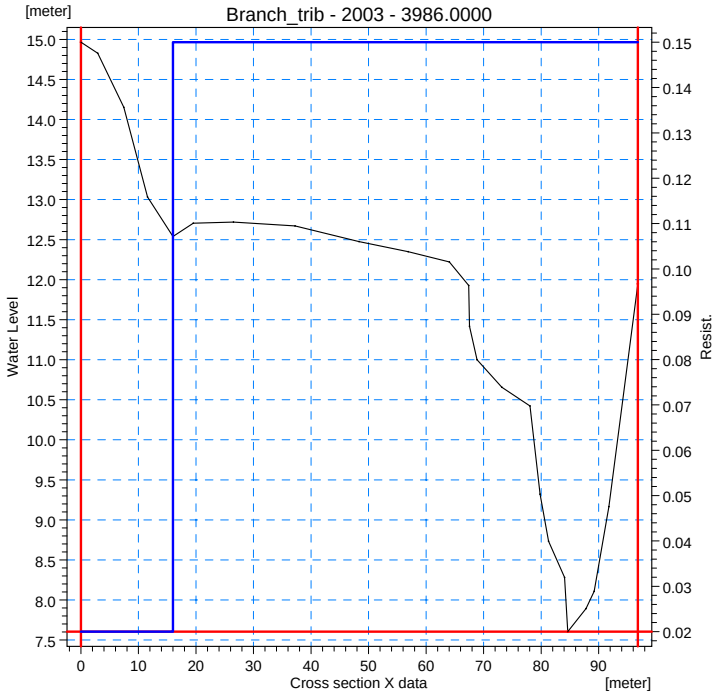
Water Level
Resist.
Cross section X data
[meter]


Branch_trib - 2003 - 3986.0000
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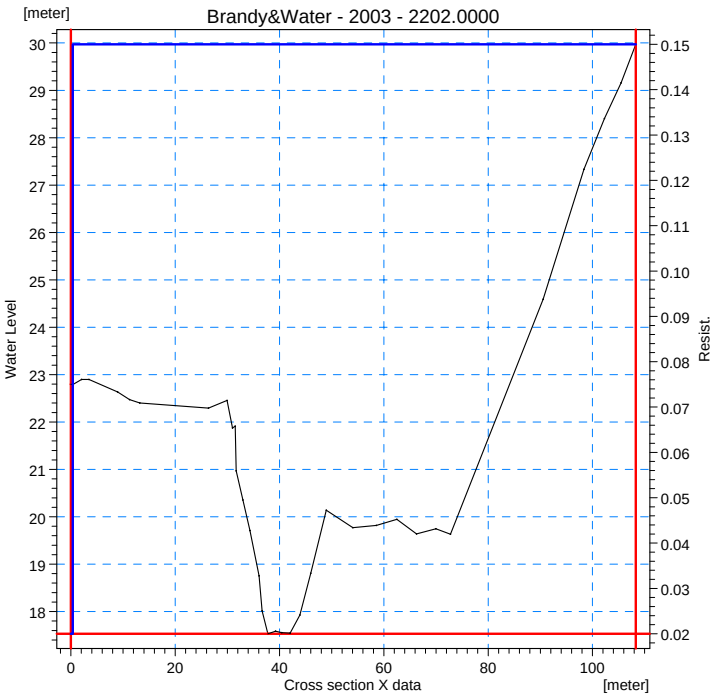
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 2202.0000
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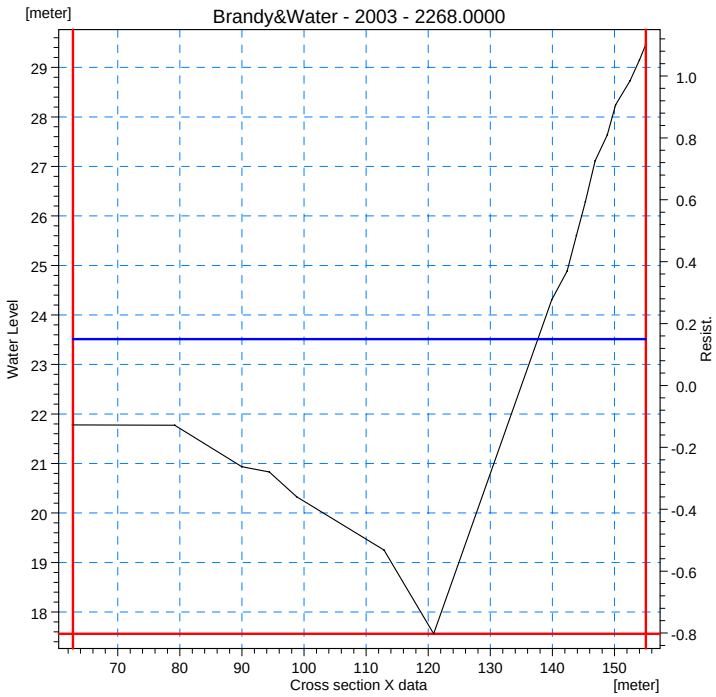
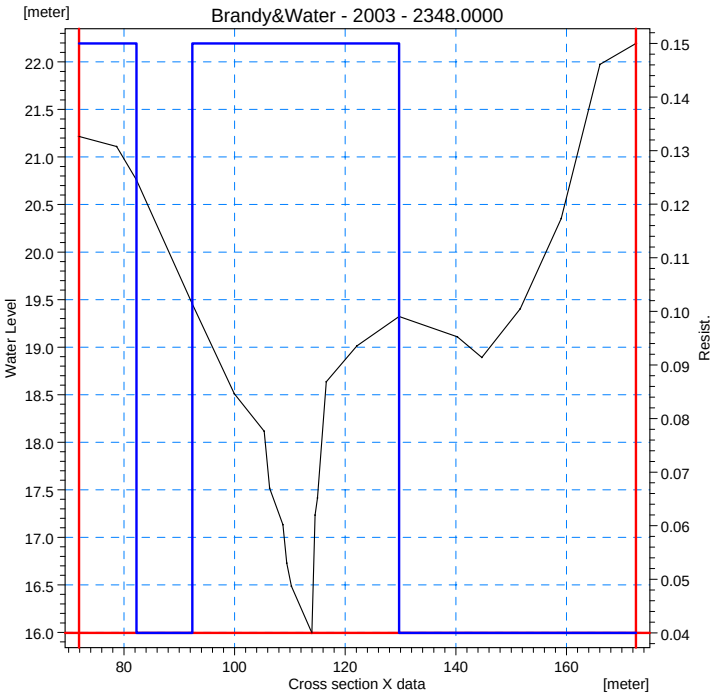
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 2268.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 2348.0000
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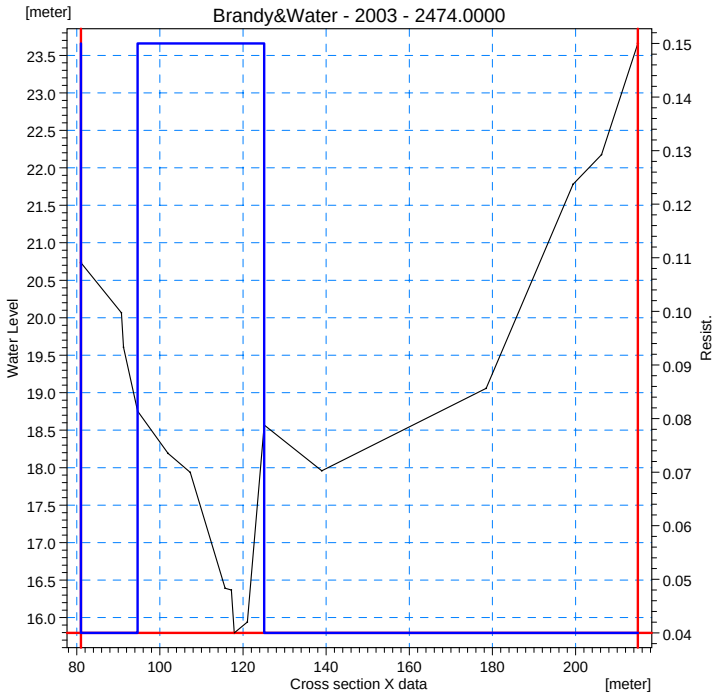
Resist.
Cross section X data
[meter]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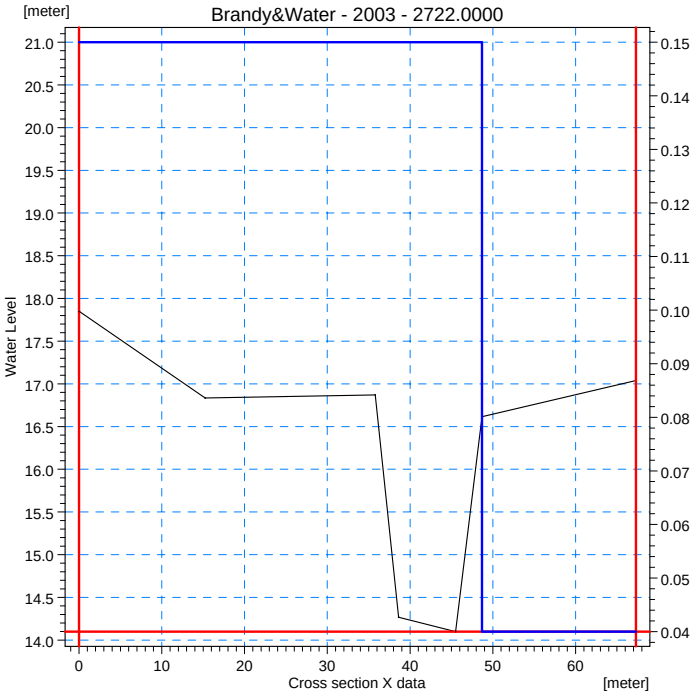
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 2722.0000
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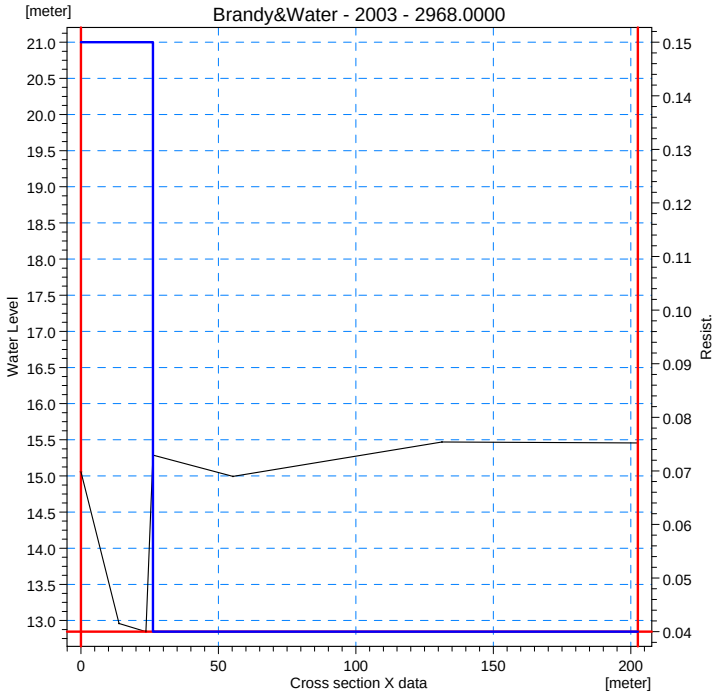
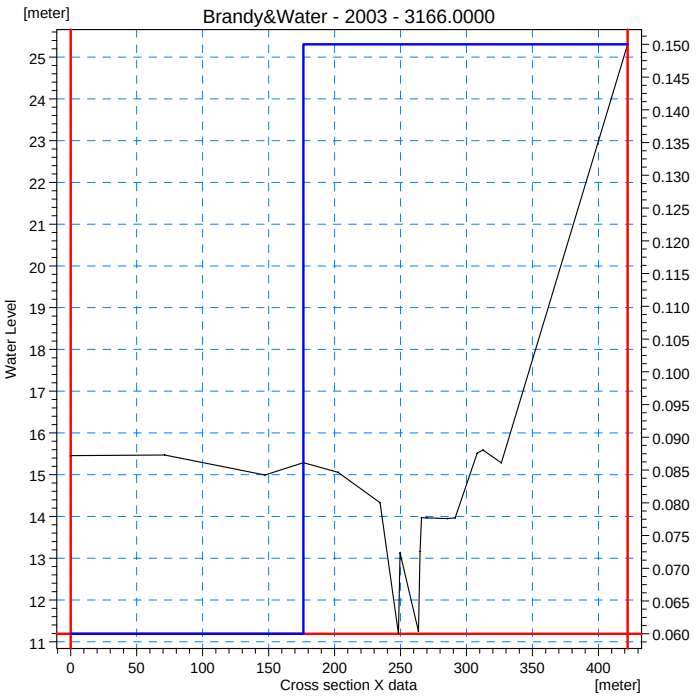
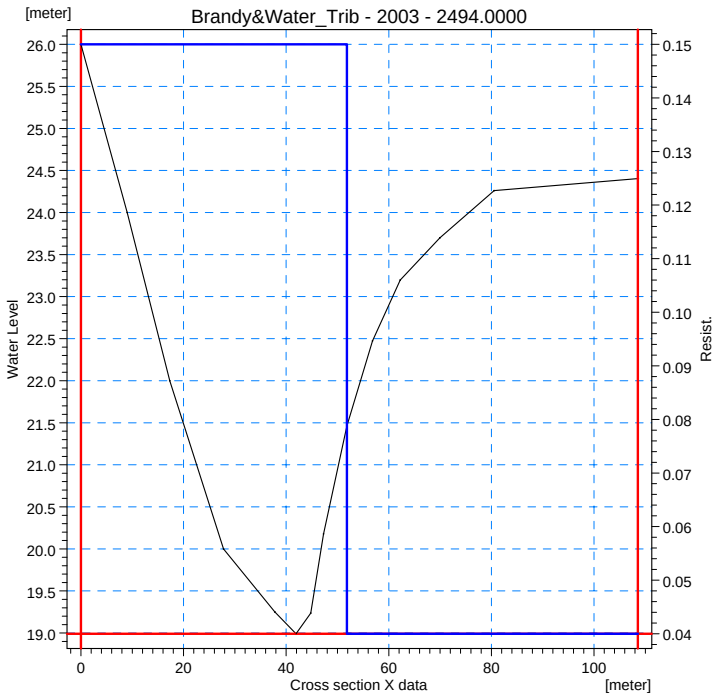
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 2968.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water - 2003 - 3166.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water_Trib - 2003 - 2494.0000
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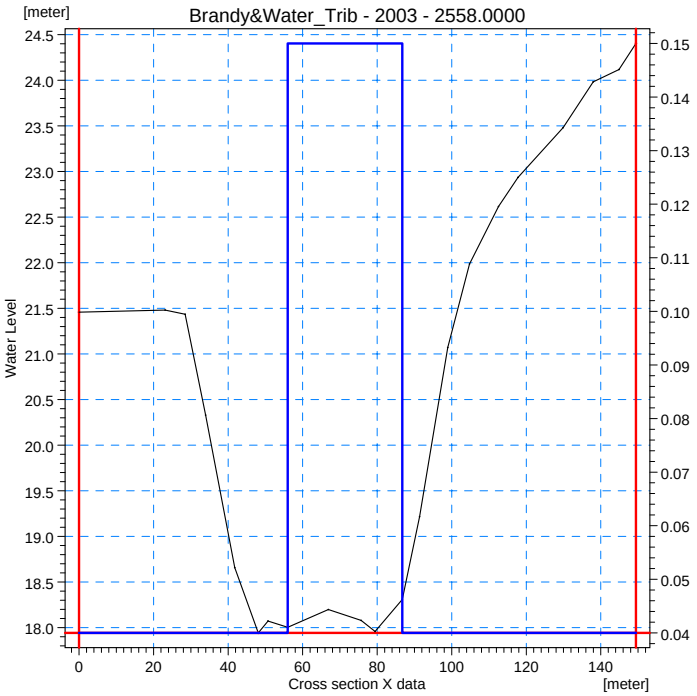
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water_Trib - 2003 - 2558.0000
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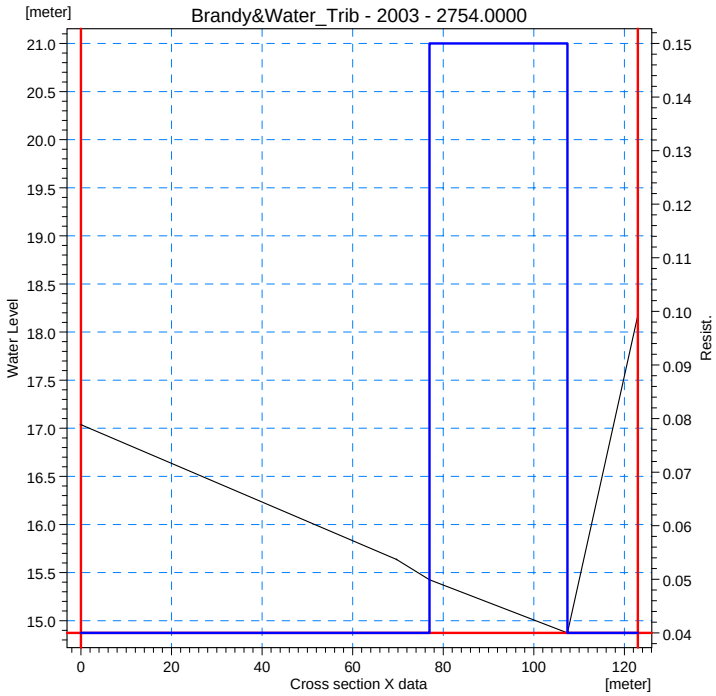
Water Level
Resist.
Cross section X data
[meter]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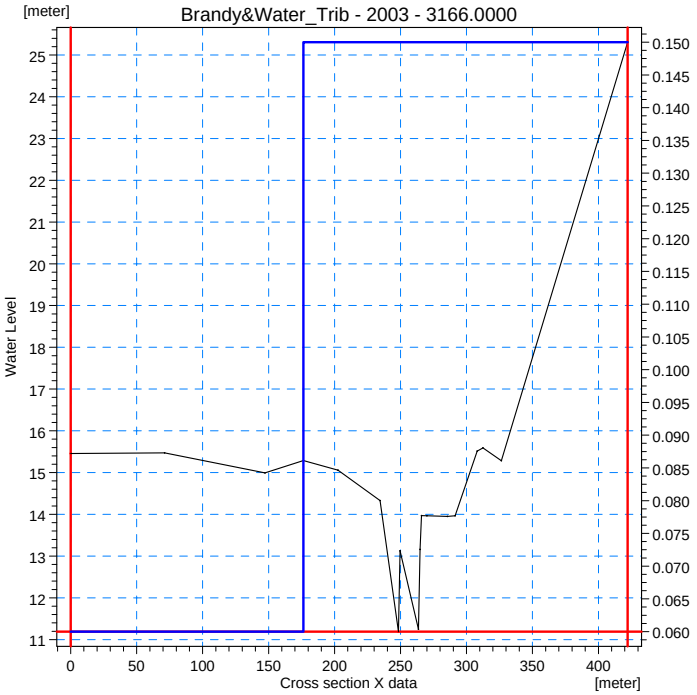
Water Level
Resist.
Cross section X data
[meter]


Brandy&Water_Trib - 2003 - 3166.0000
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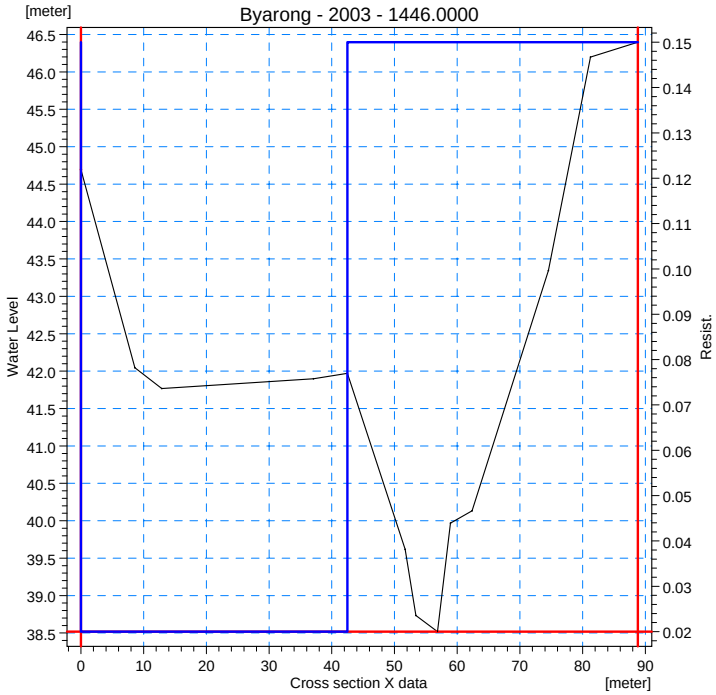
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 1446.0000
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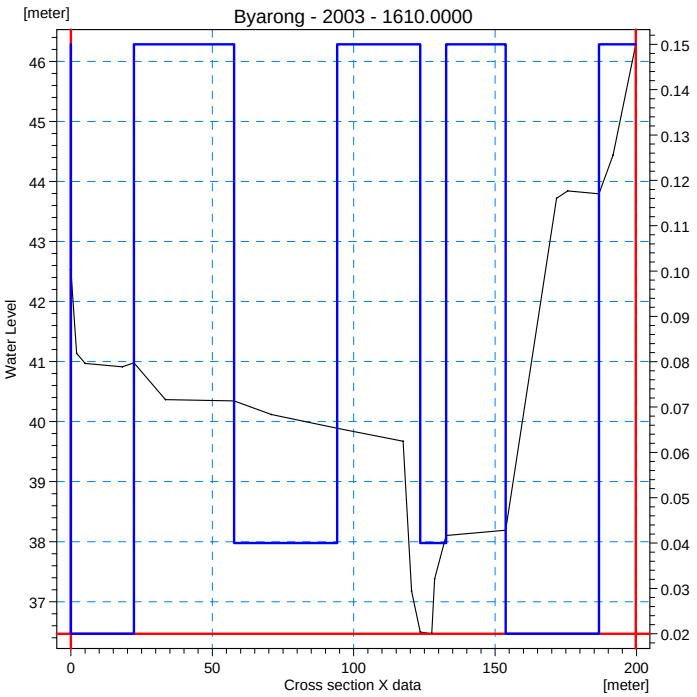
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 1610.0000
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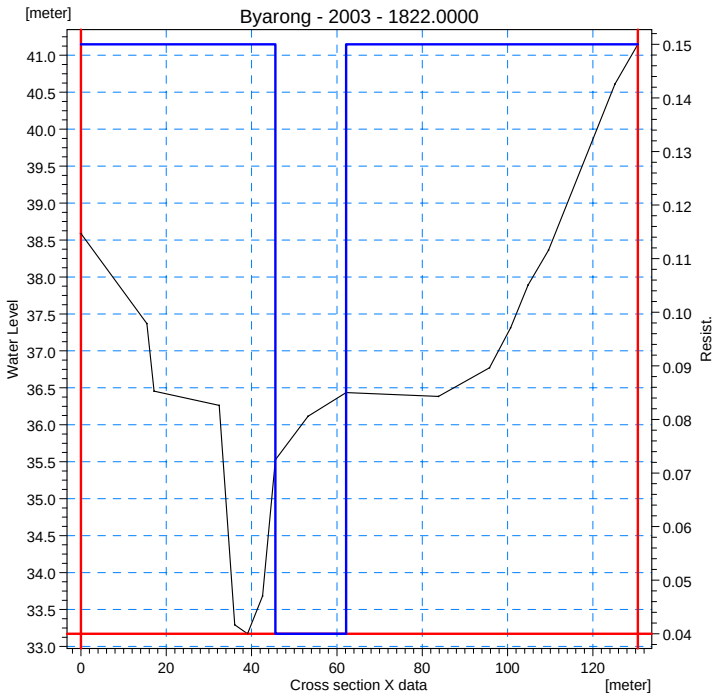
Water Level
Resist.
Cross section X data
[meter]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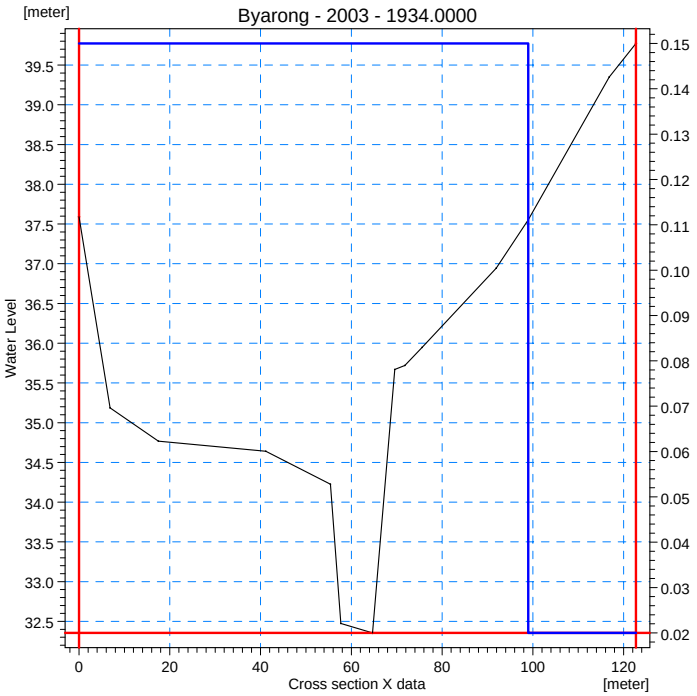
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 1934.0000
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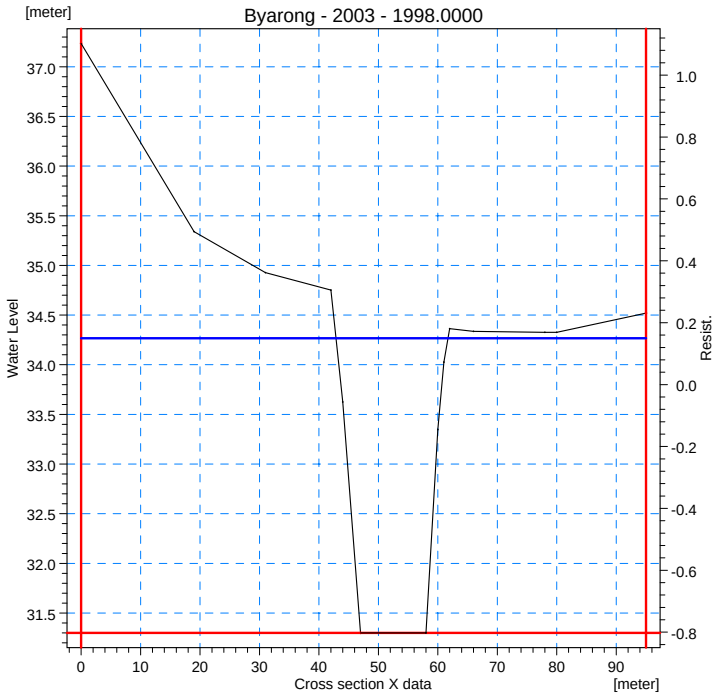
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 1998.0000
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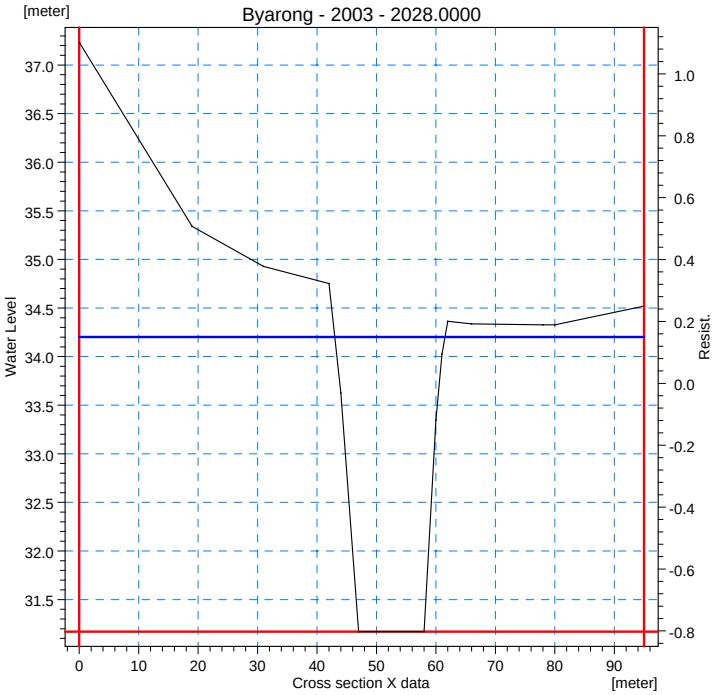
Water Level
Resist.
Cross section X data
[meter]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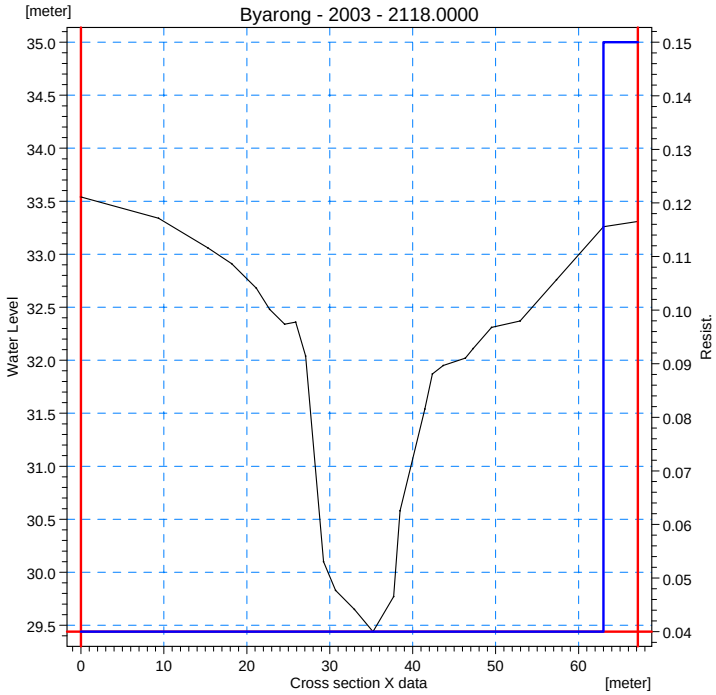
Cross section X data
[meter]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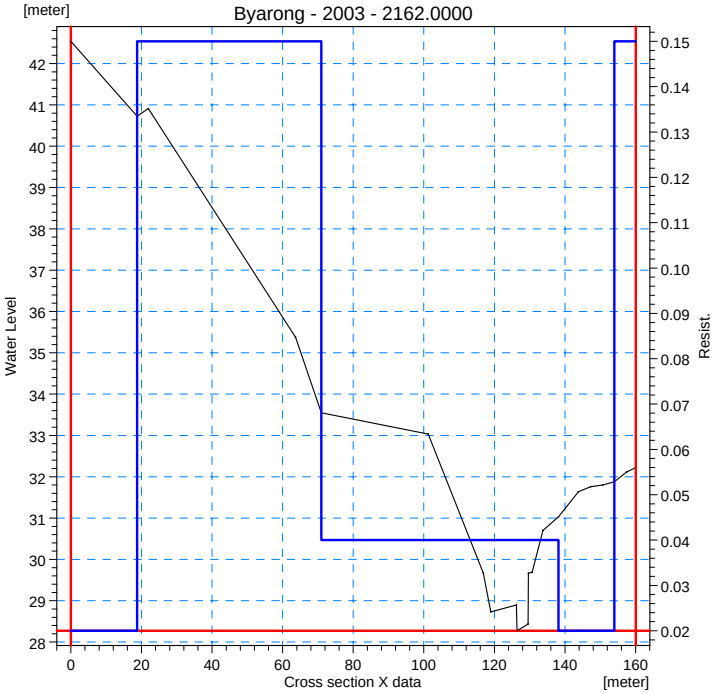
[meter]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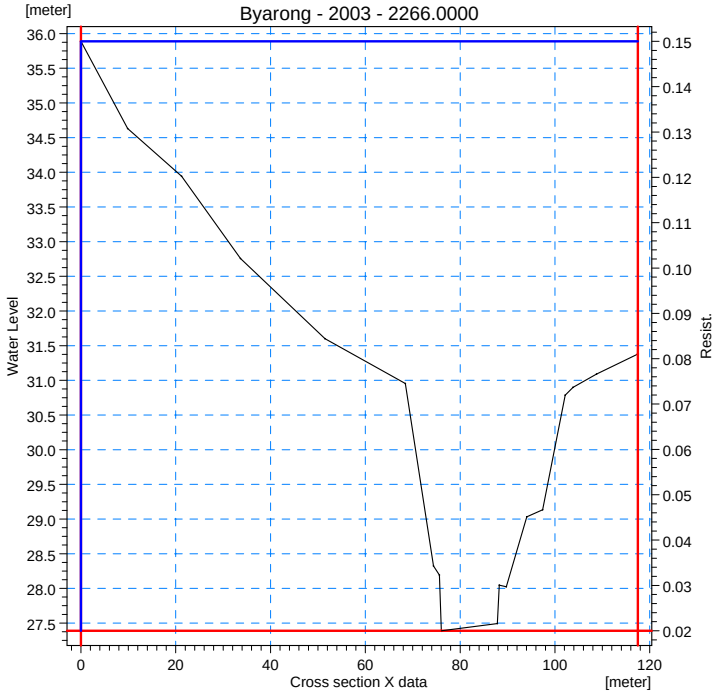
Cross section X data
[meter]


Byarong - 2003 - 2266.0000
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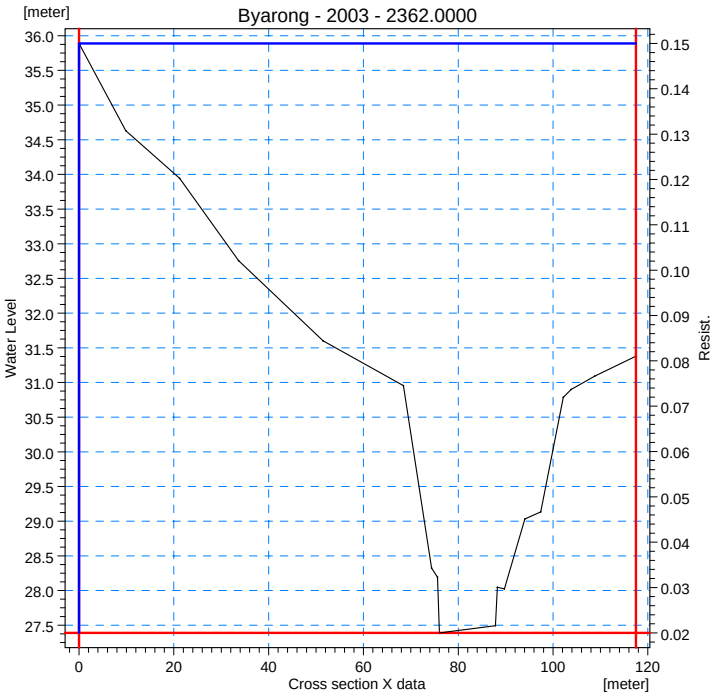
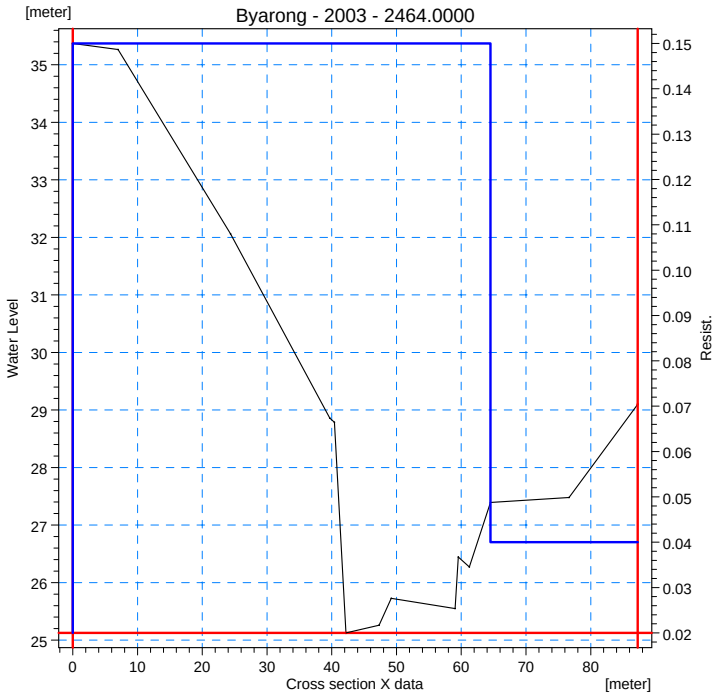
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 2362.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]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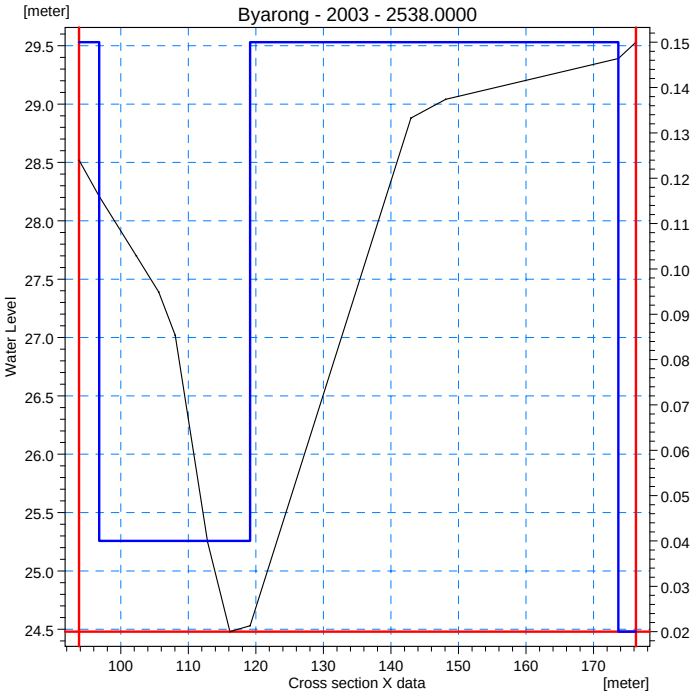
Cross section X data
[meter]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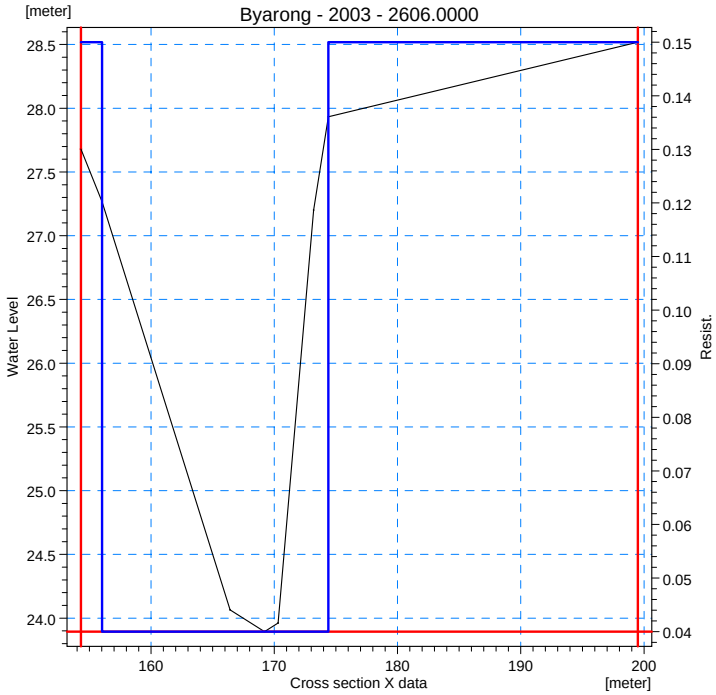
[meter]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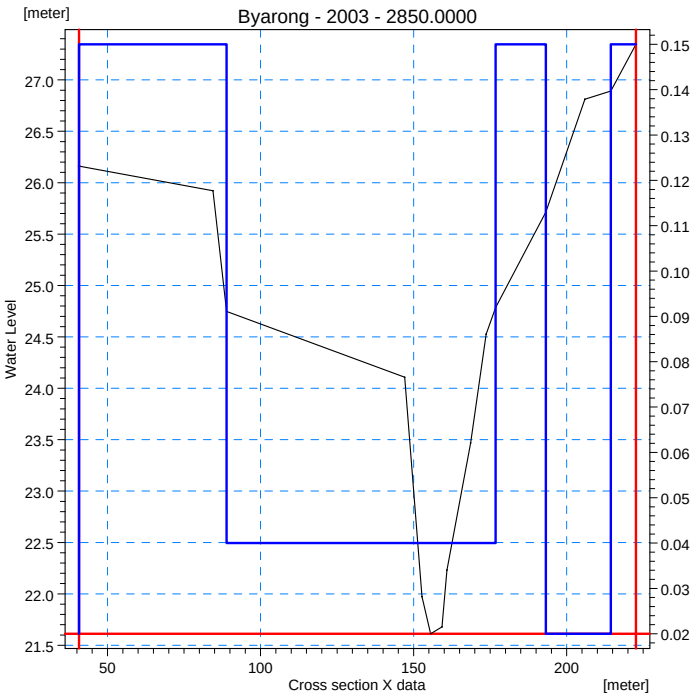
Cross section X data
[meter]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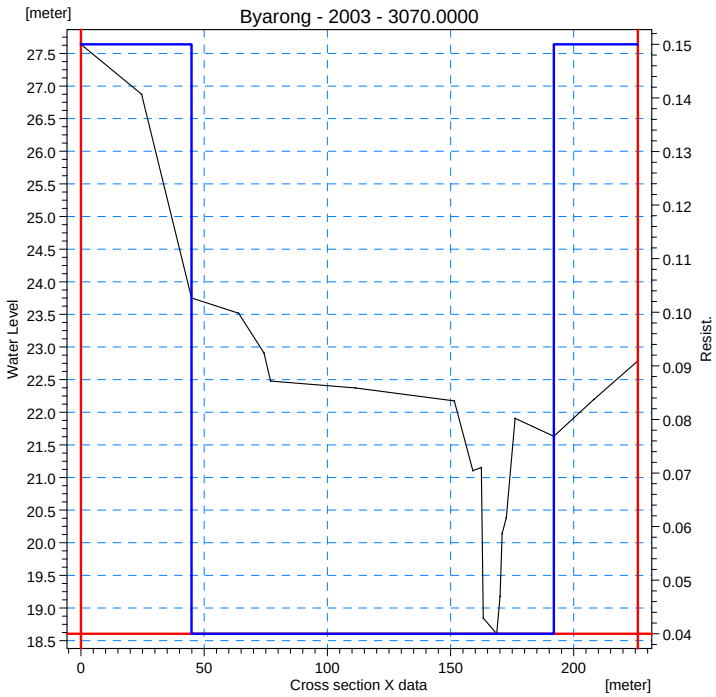
Water Level
Resist.
Cross section X data
[meter]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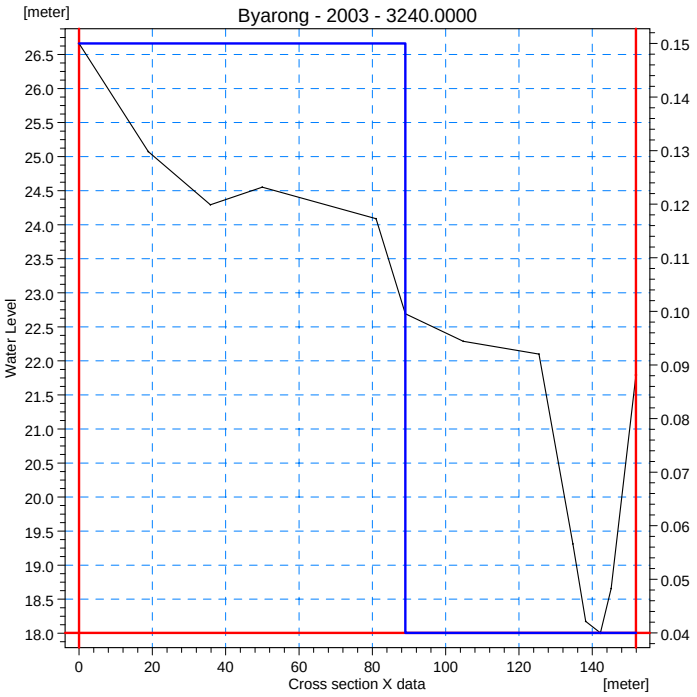
Water Level
Resist.
Cross section X data
[meter]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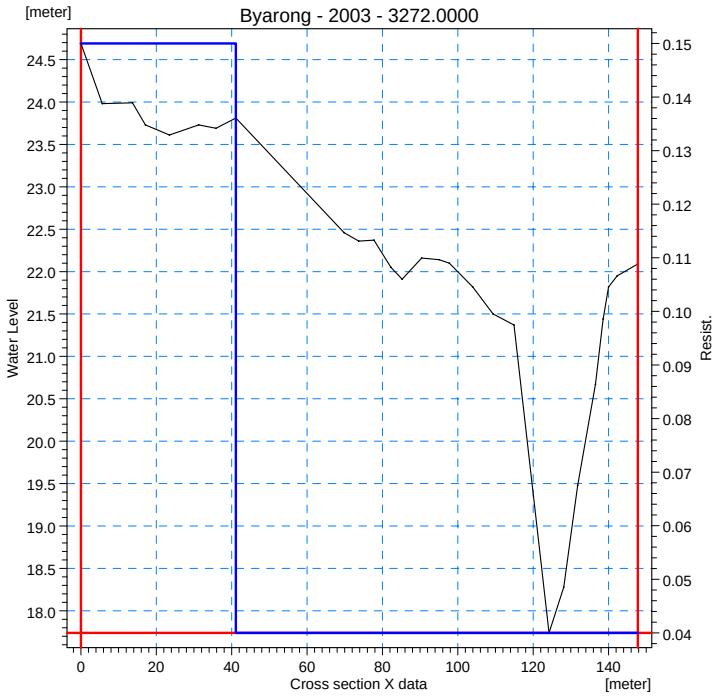
Water Level
Resist.
Cross section X data
[meter]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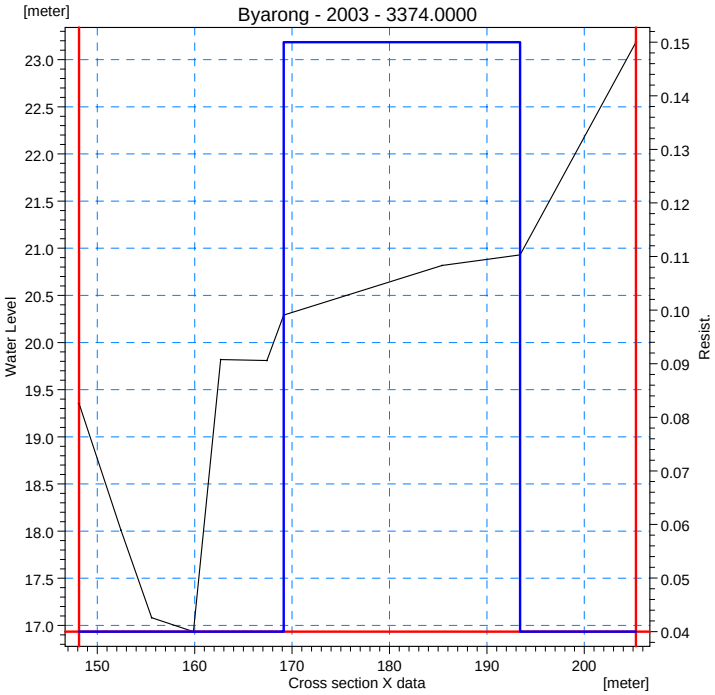
Water Level
Resist.
Cross section X data
[meter]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Water Level
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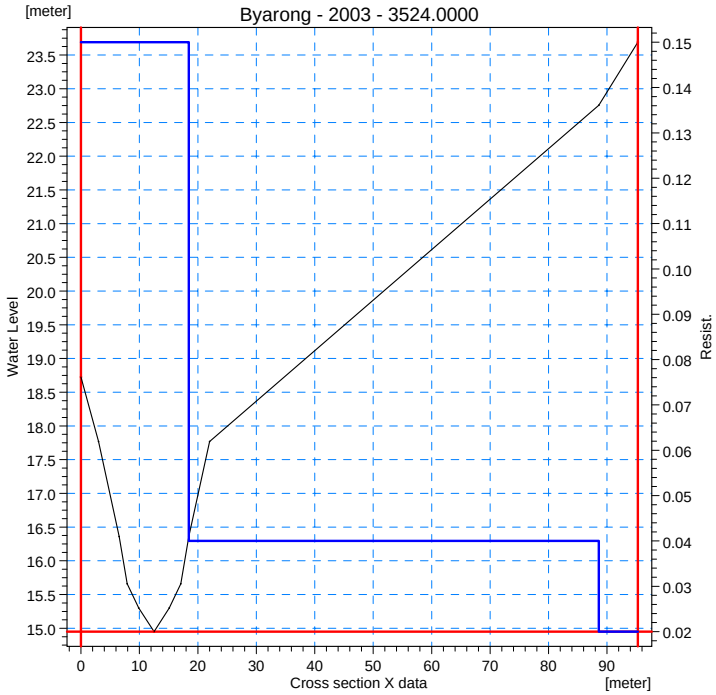
Cross section X data
[meter]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Water Level
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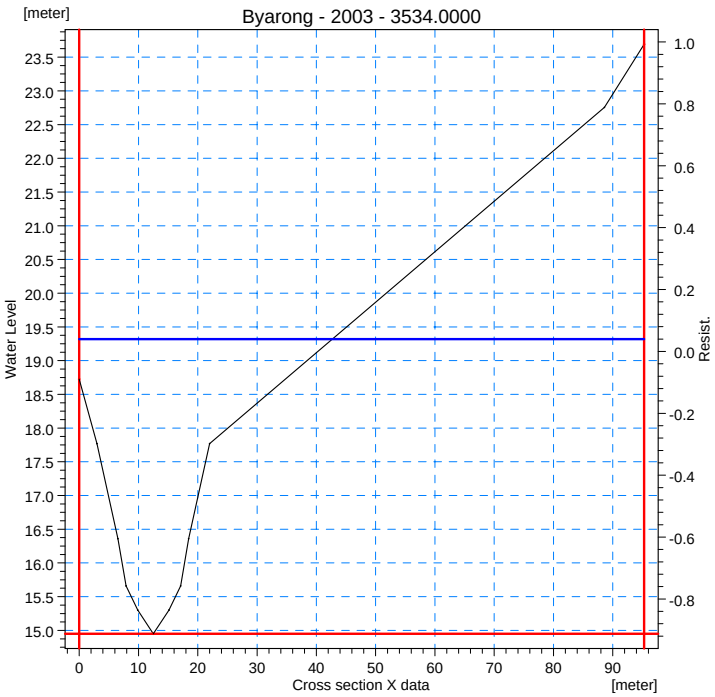
Cross section X data
[meter]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Cross section X data
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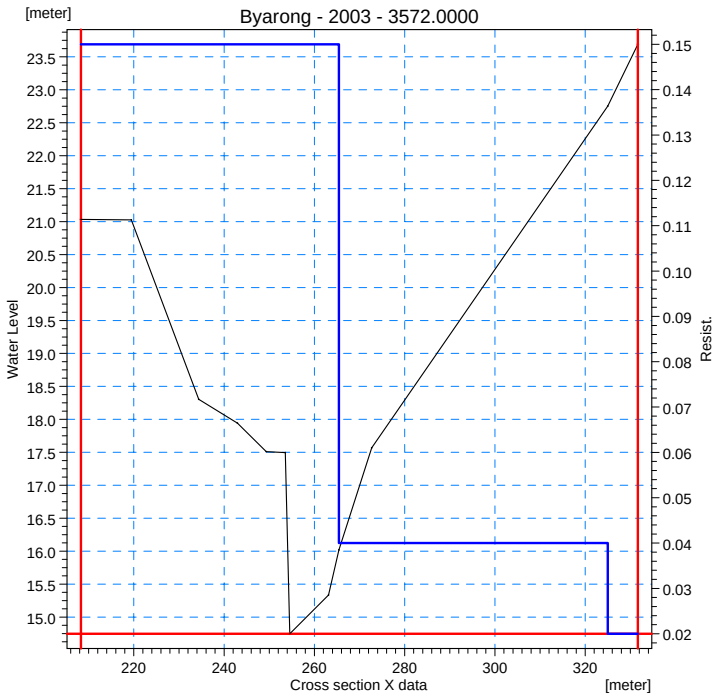
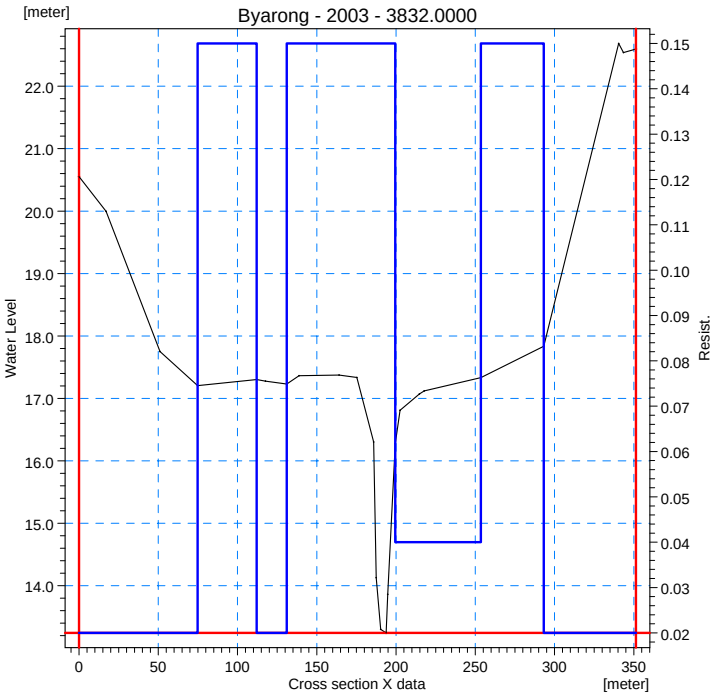

Byarong - 2003 - 3572.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 3832.0000
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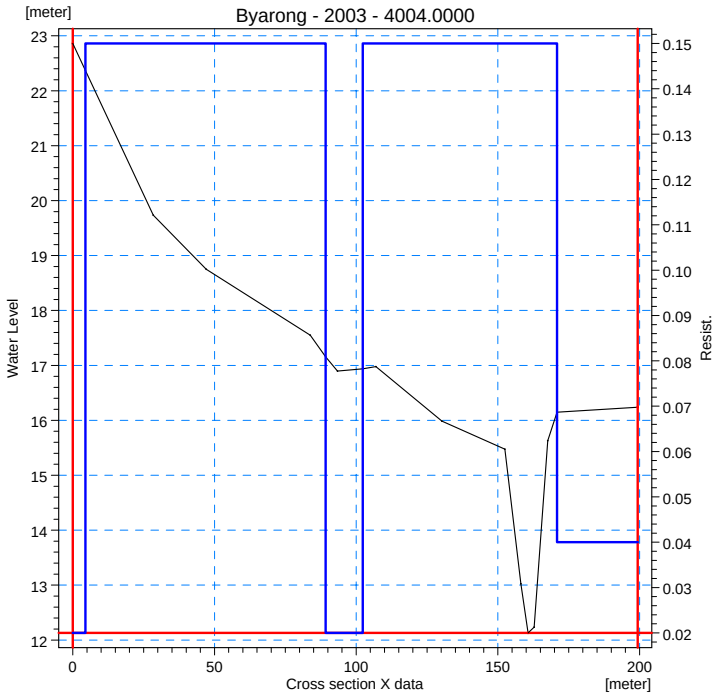
Water Level
Resist.
Cross section X data
[meter]


Byarong - 2003 - 4004.0000
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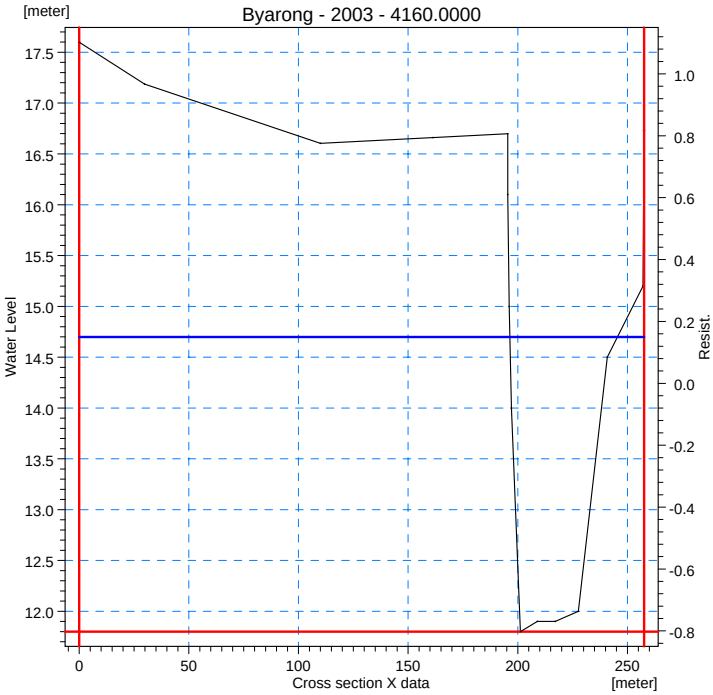
Water Level
Resist.
Cross section X data
[meter]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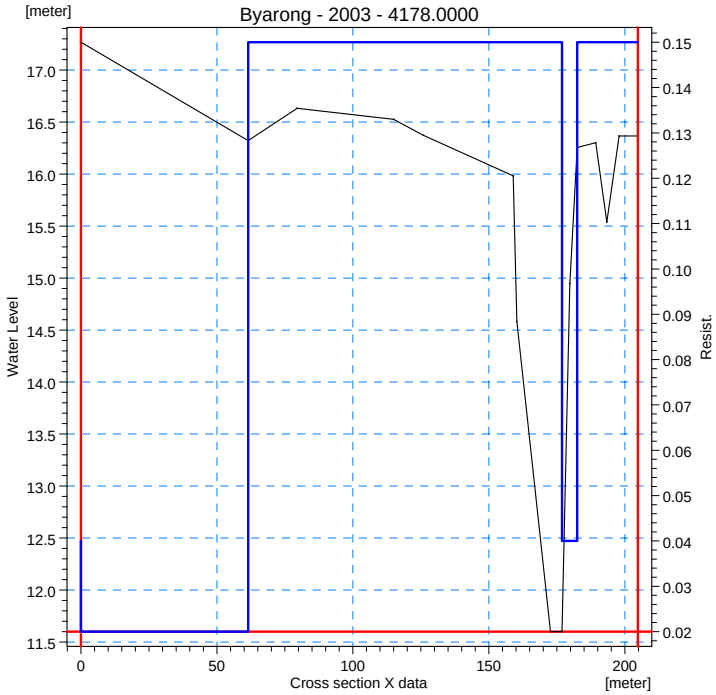
Resist.
Cross section X data
[meter]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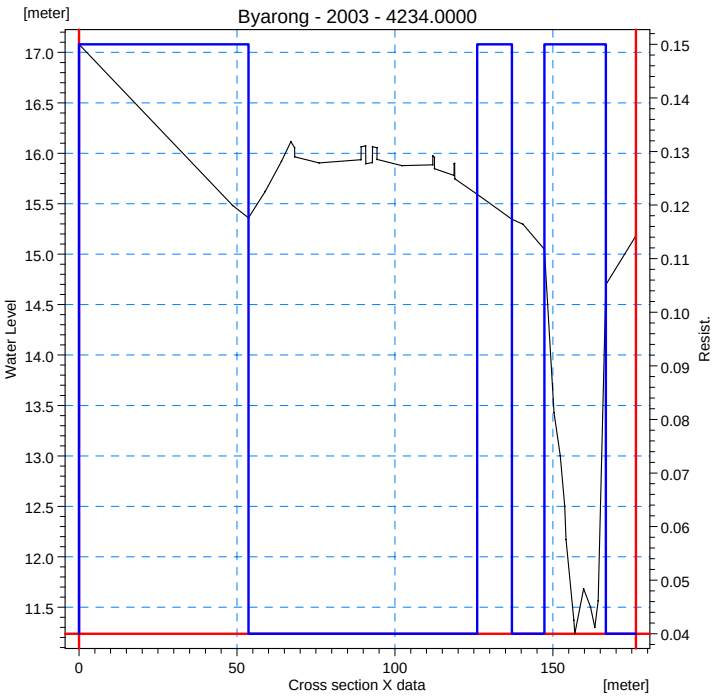
Resist.
Cross section X data
[meter]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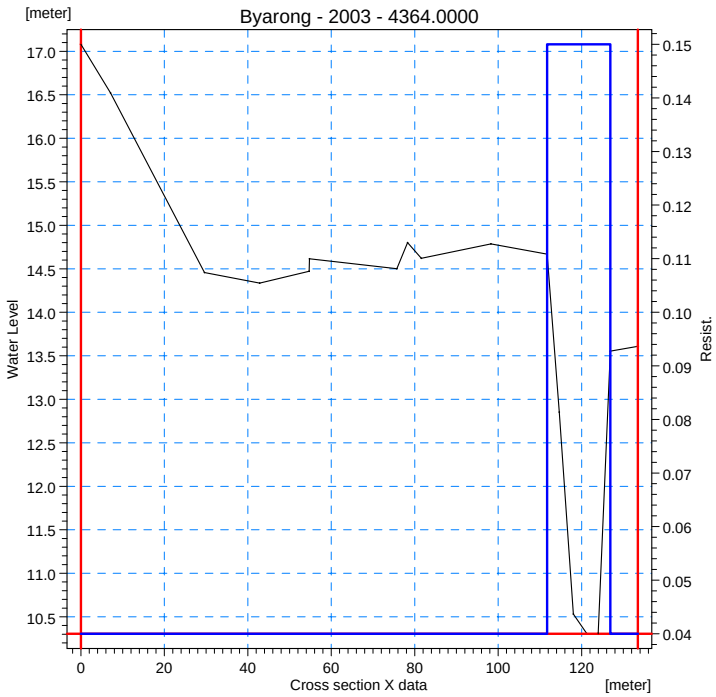
Resist.
Cross section X data
[meter]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Resist.
Cross section X data
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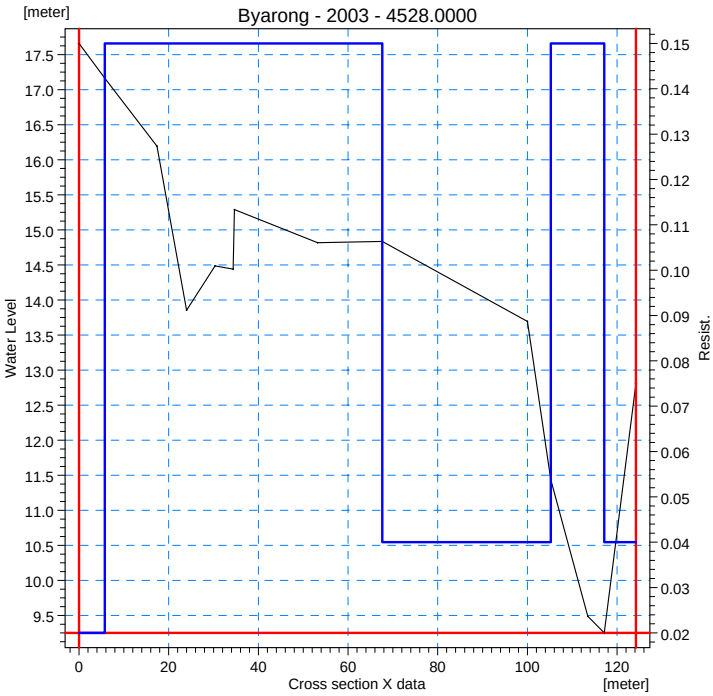
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Cross section X data
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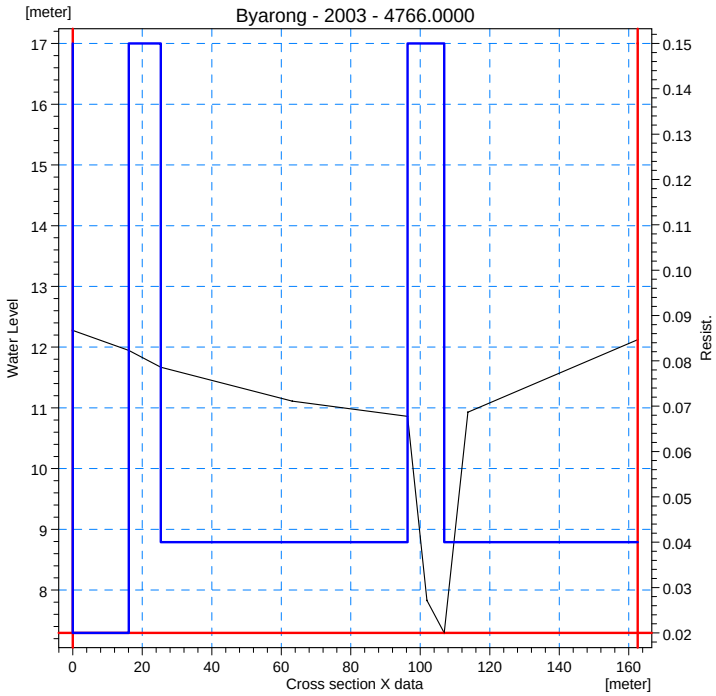
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Resist.
Cross section X data
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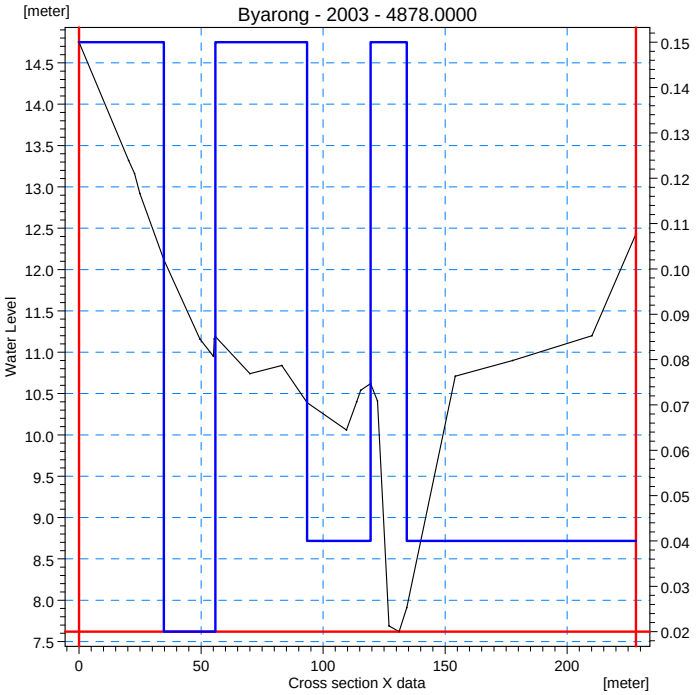
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Cross section X data
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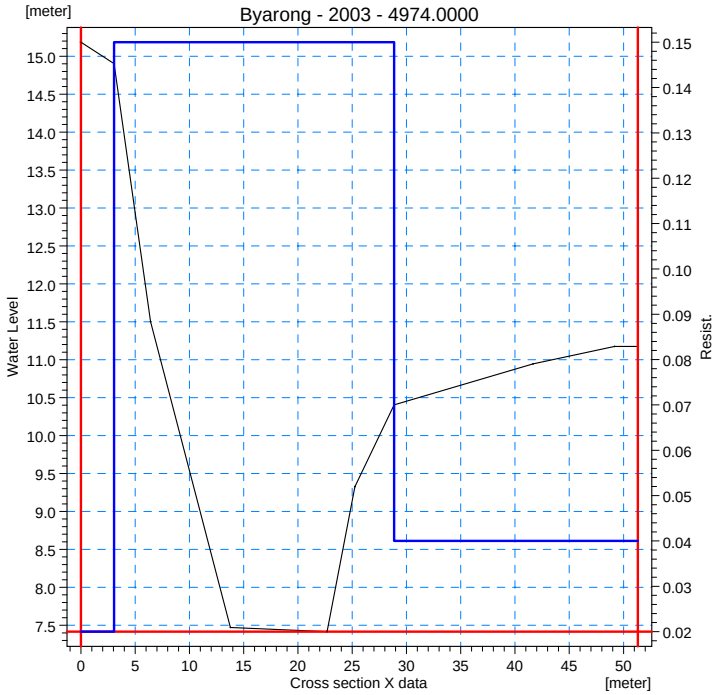
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Resist.
Cross section X data
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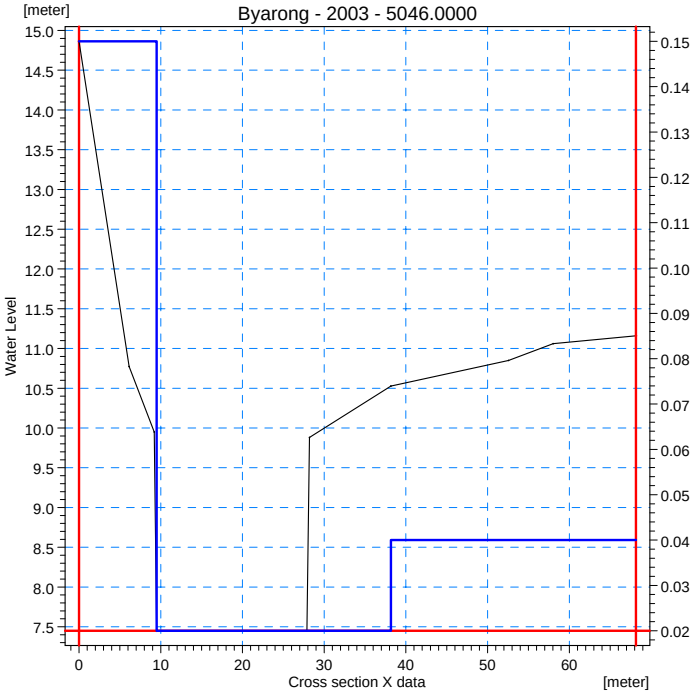
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Resist.
Cross section X data
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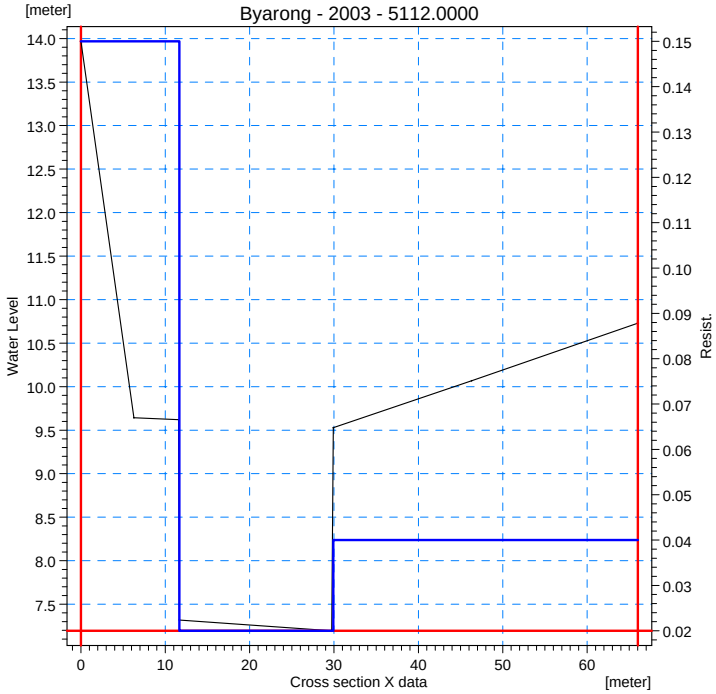
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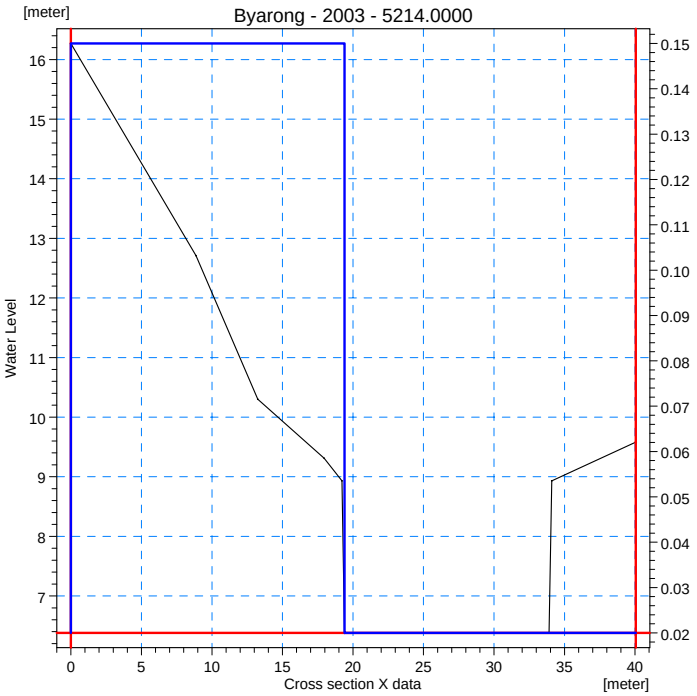
Water Level
Resist.
Cross section X data
[meter]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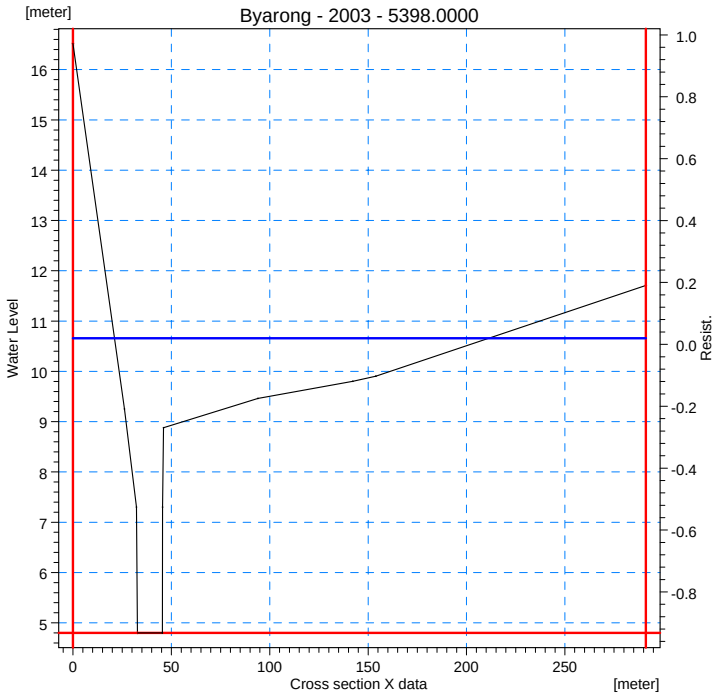
Water Level
Resist.
Cross section X data
[meter]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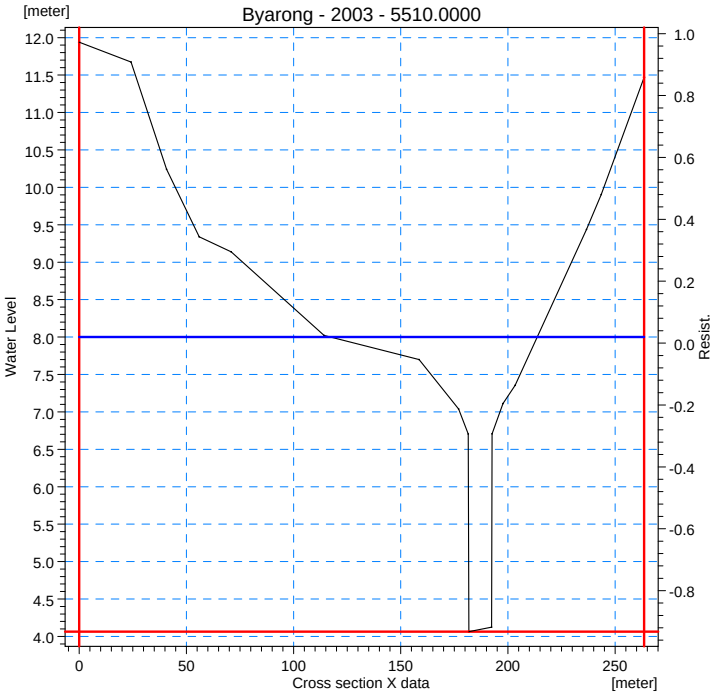
Resist.
Cross section X data
[meter]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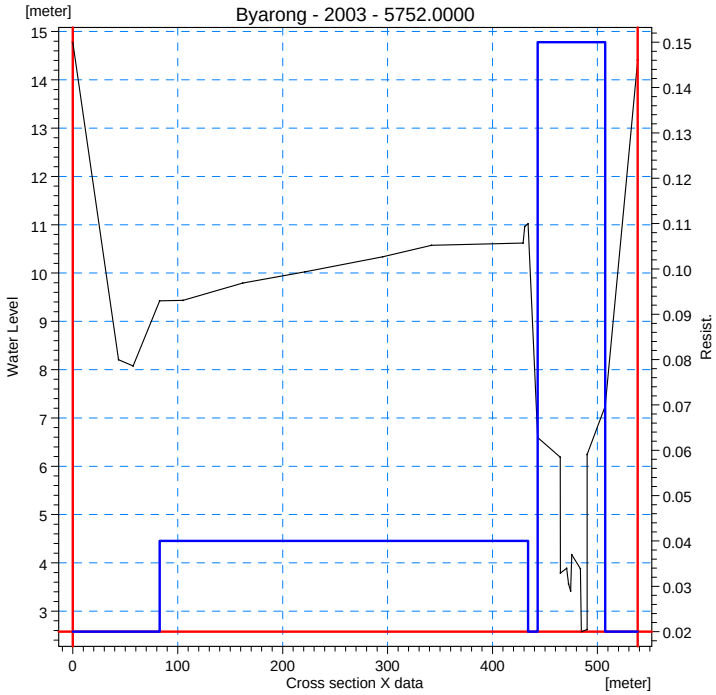
Water Level
Resist.
Cross section X data
[meter]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Resist.
Cross section X data
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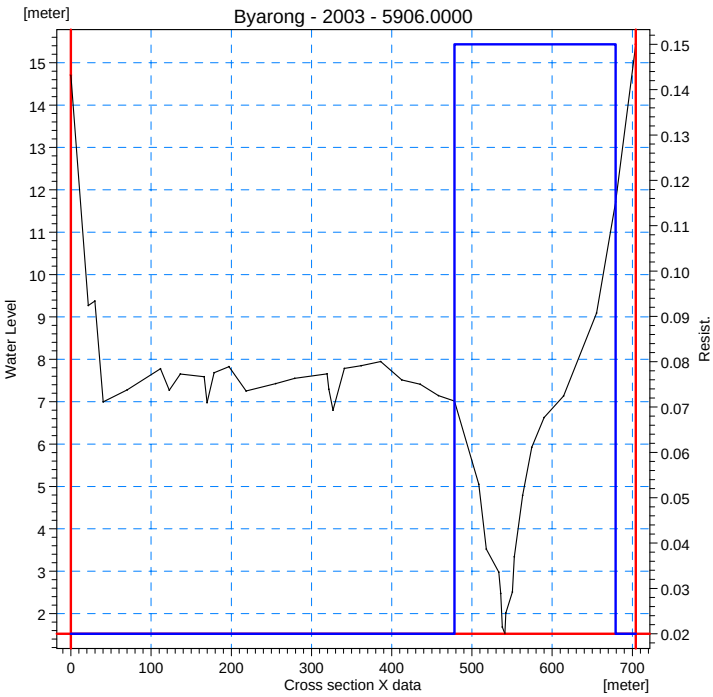
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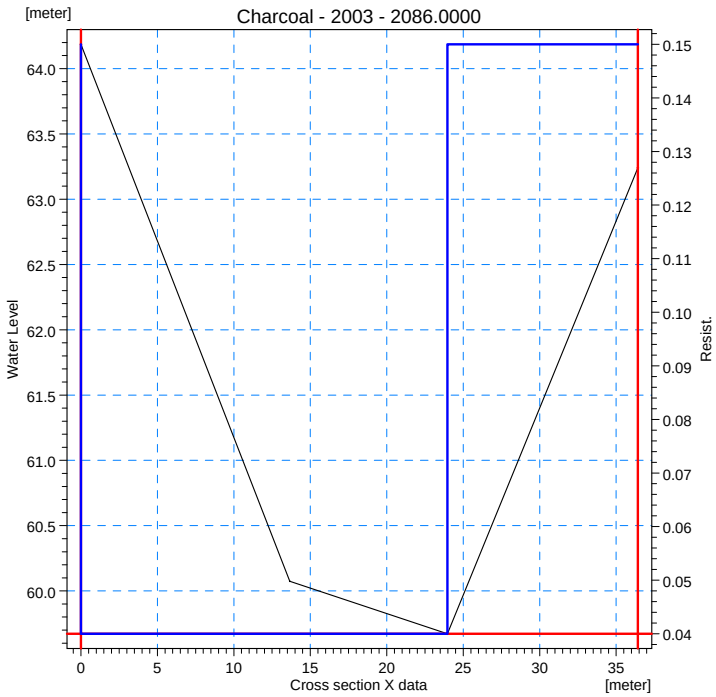
Cross section X data
[meter]


Charcoal - 2003 - 2086.0000
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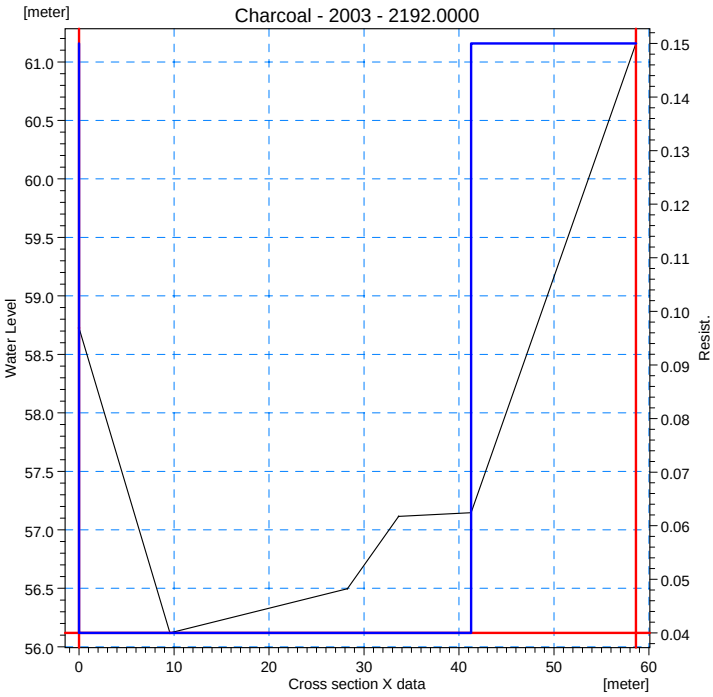
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 2192.0000
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Water Level
Resist.
Cross section X data
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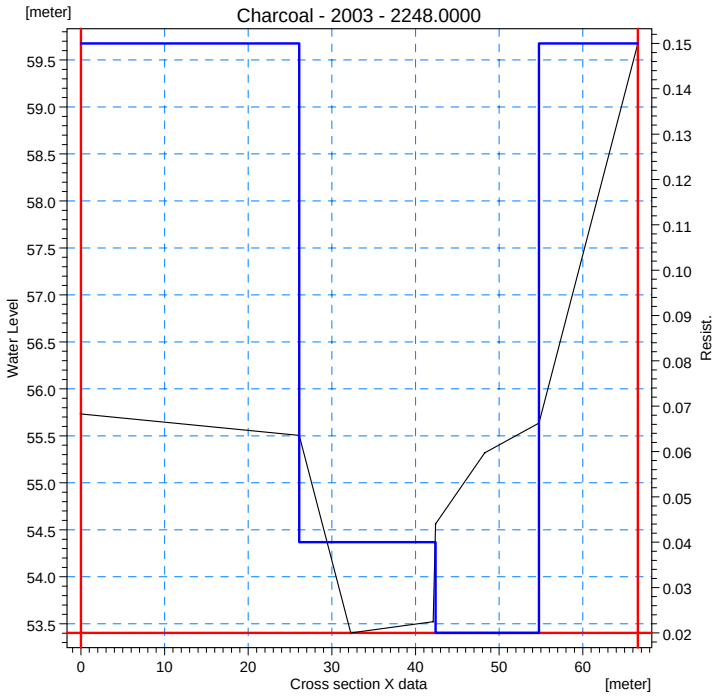
Charcoal - 2003 - 2248.0000
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Water Level
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Cross section X data
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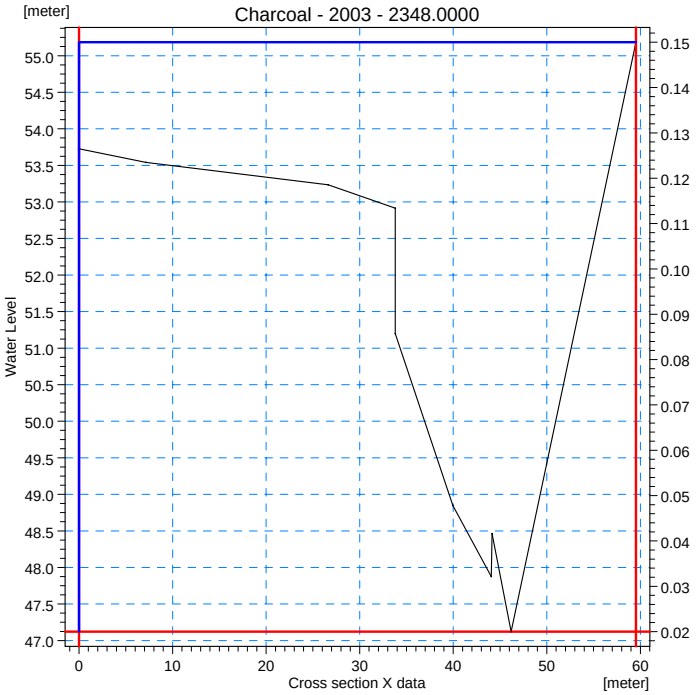
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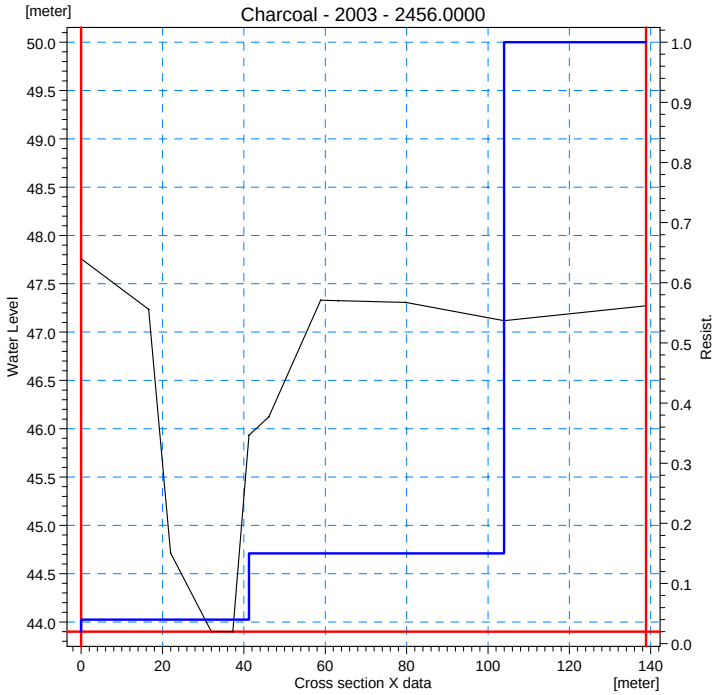
Charcoal - 2003 - 2456.0000
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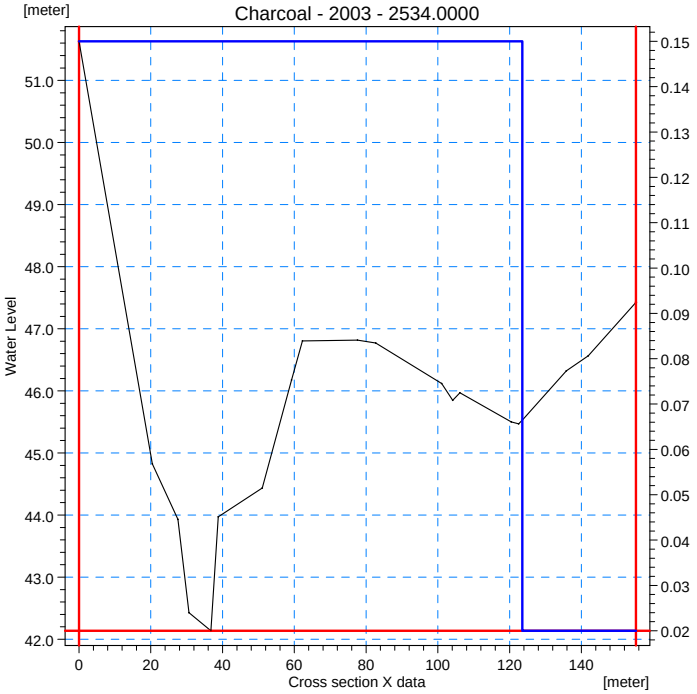
Cross section X data
[meter]


Charcoal - 2003 - 2534.0000
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Water Level
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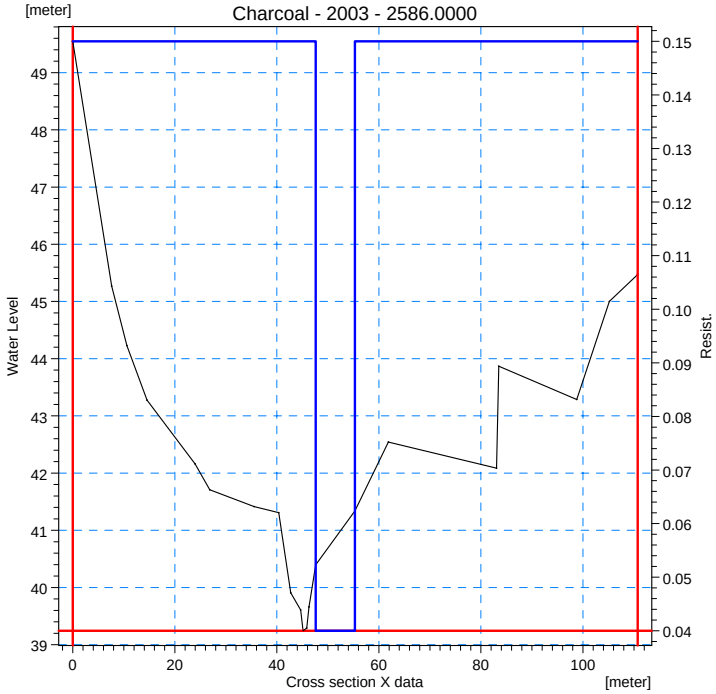
Cross section X data
[meter]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Cross section X data
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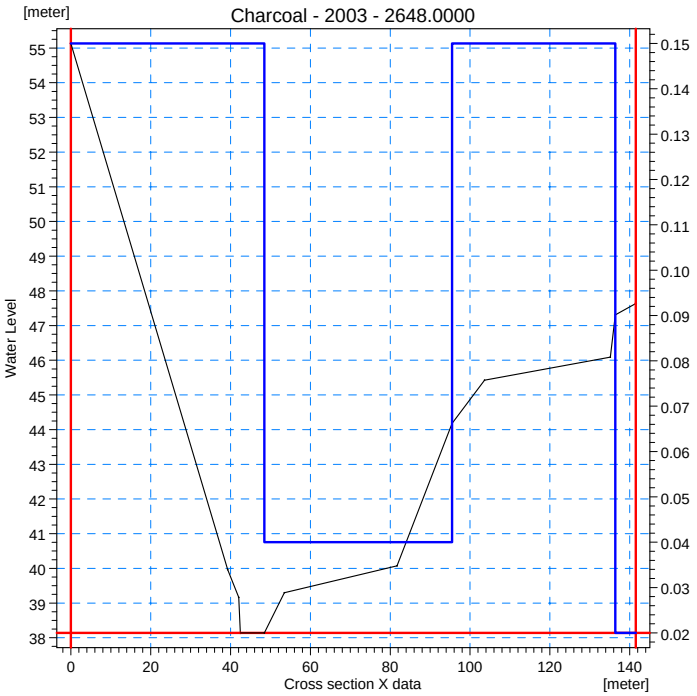
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Cross section X data
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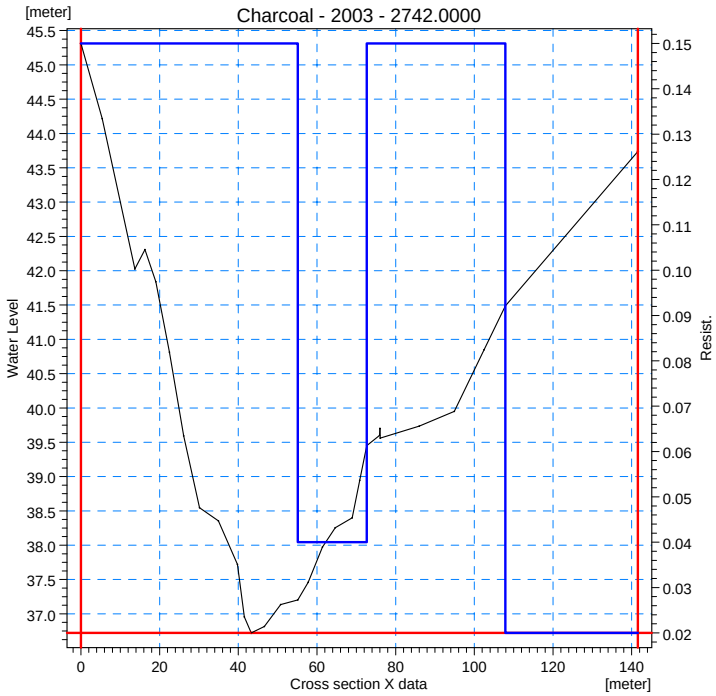
Charcoal - 2003 - 2742.0000
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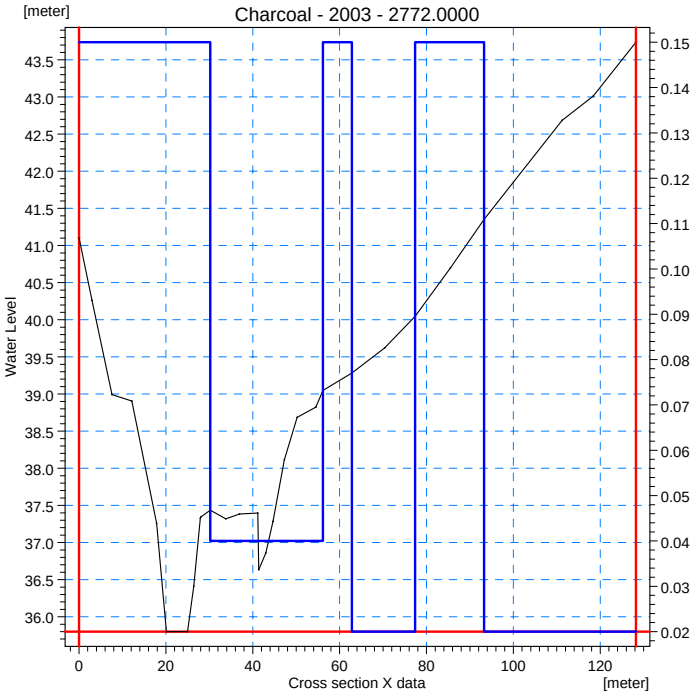
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 2772.0000
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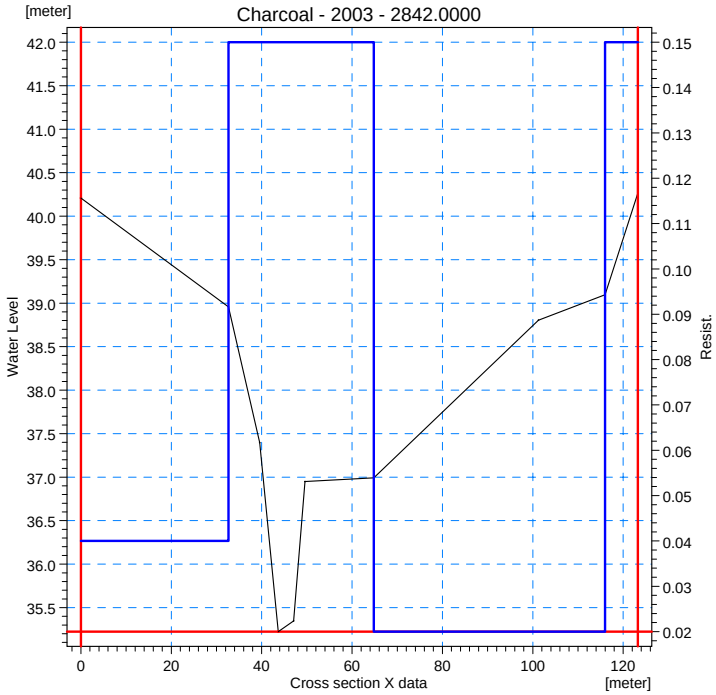
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 2842.0000
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Resist.
Cross section X data
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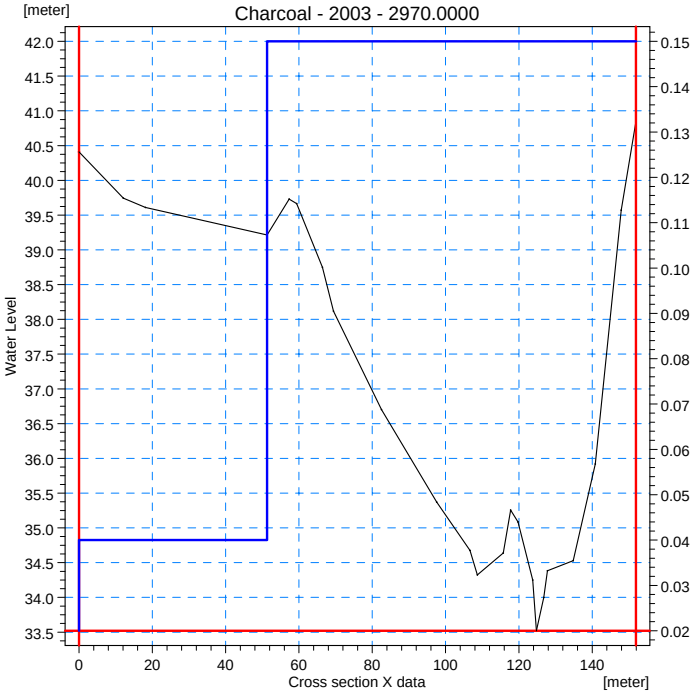
Charcoal - 2003 - 2970.0000
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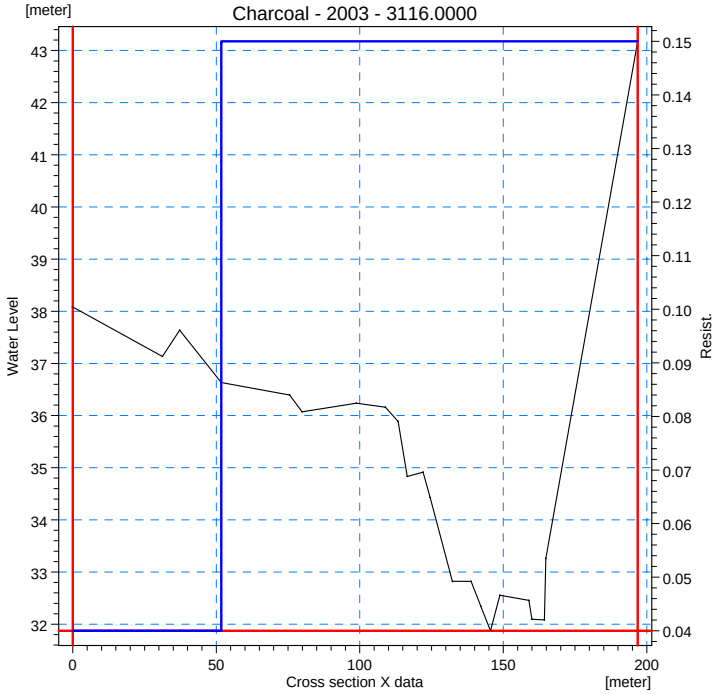
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 3116.0000
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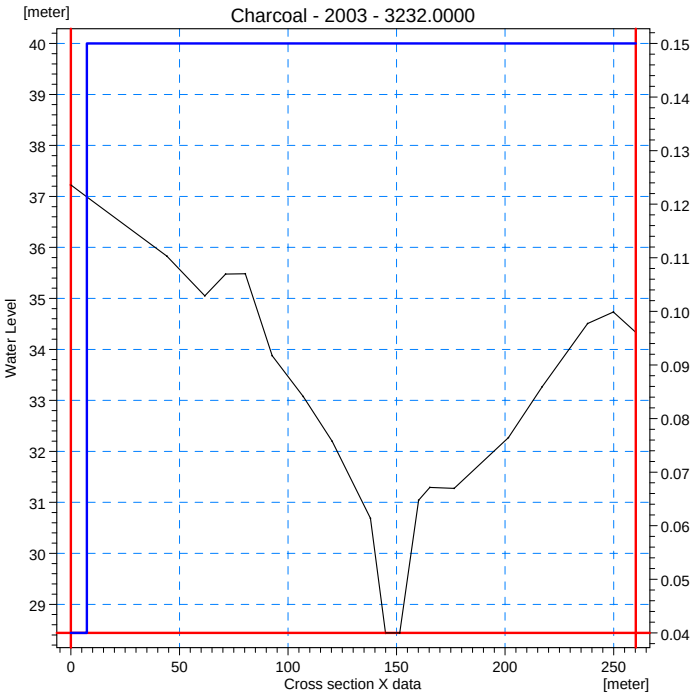
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 3232.0000
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Water Level
Resist.
Cross section X data
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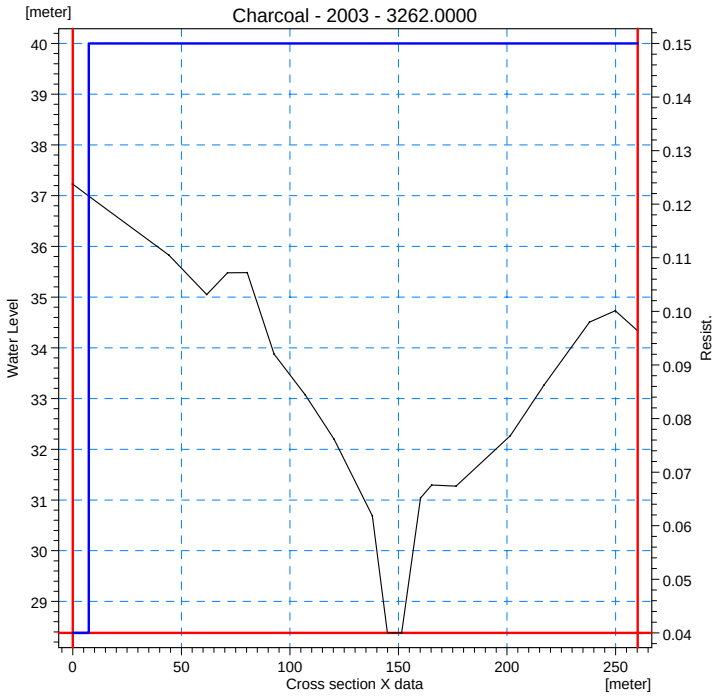
Charcoal - 2003 - 3262.0000
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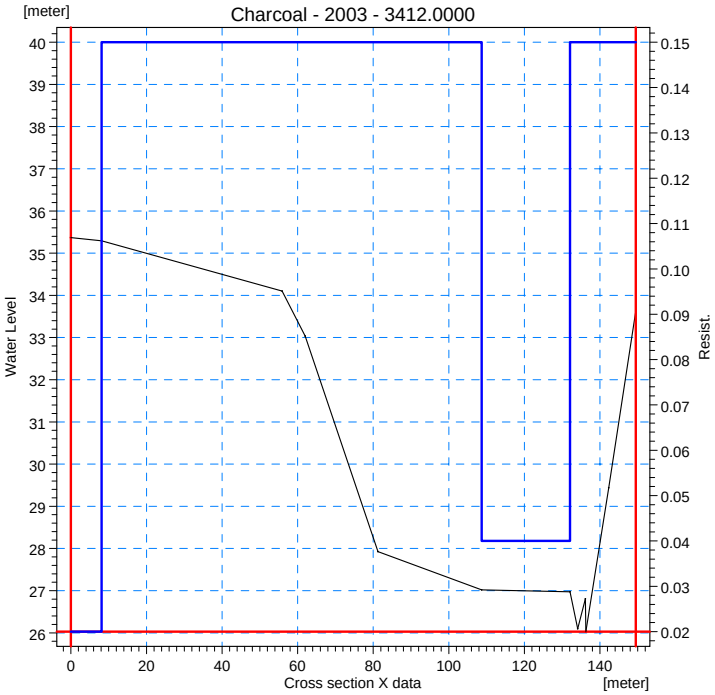
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 3412.0000
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Water Level
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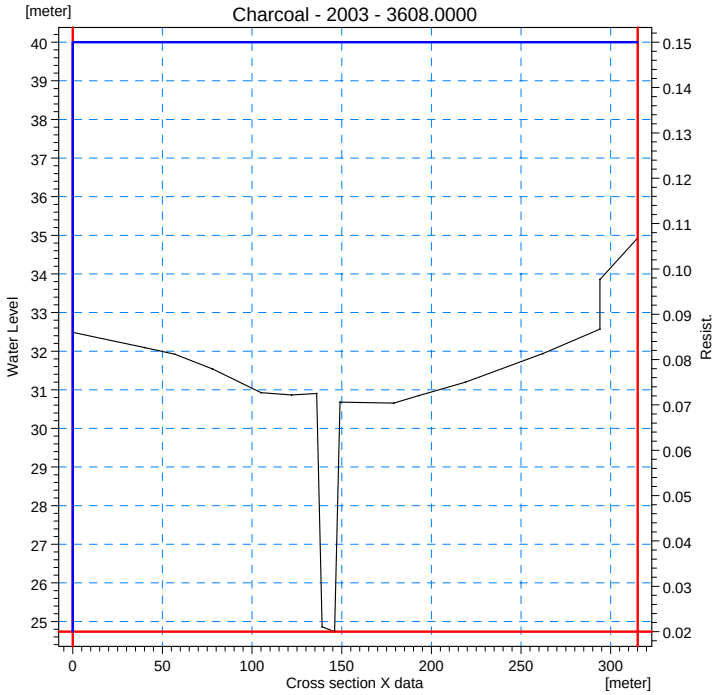
Cross section X data
[meter]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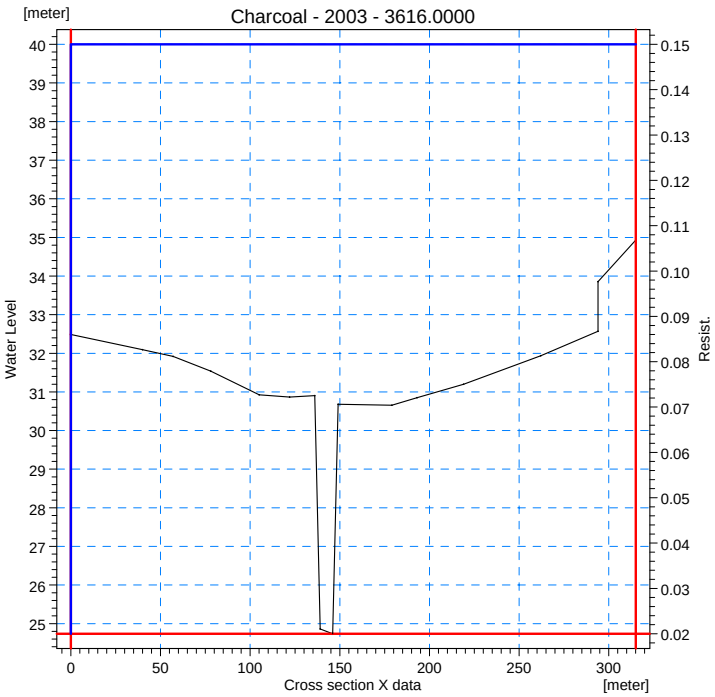
Resist.
Cross section X data
[meter]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Resist.
Cross section X data
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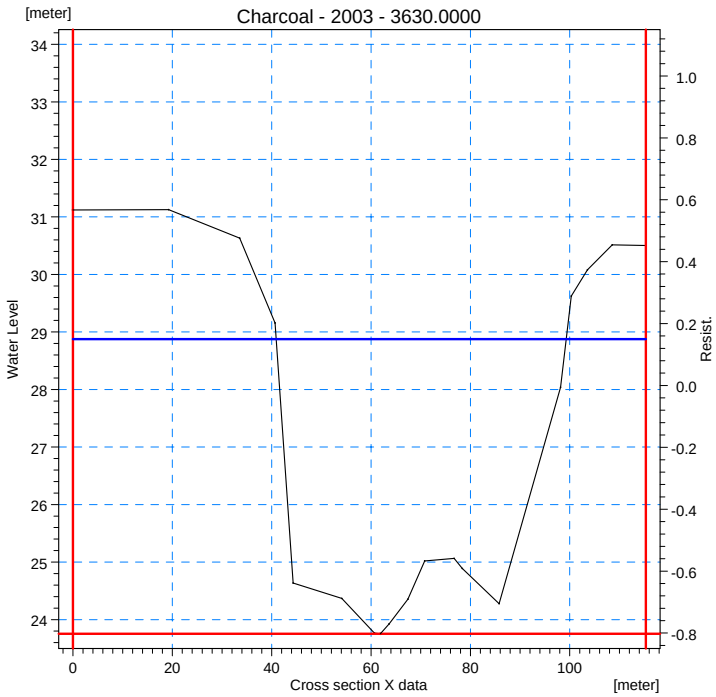
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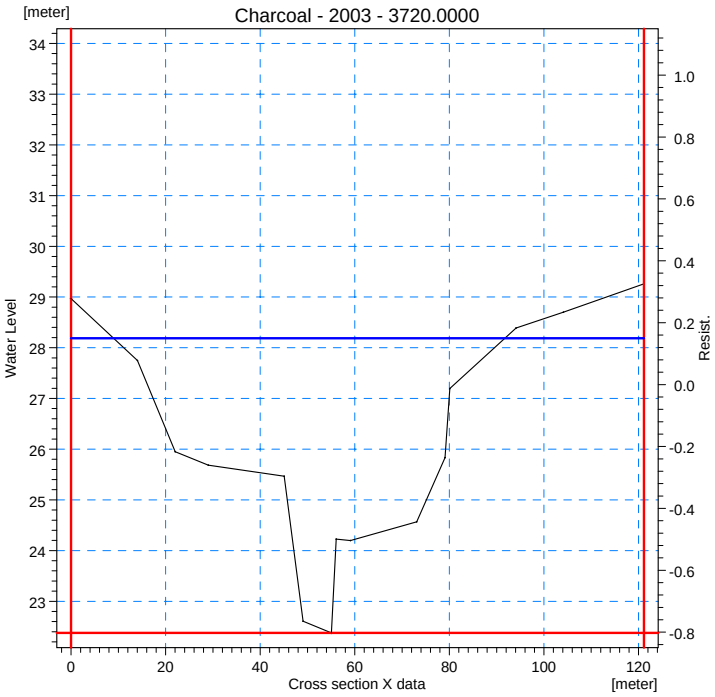
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 3720.0000
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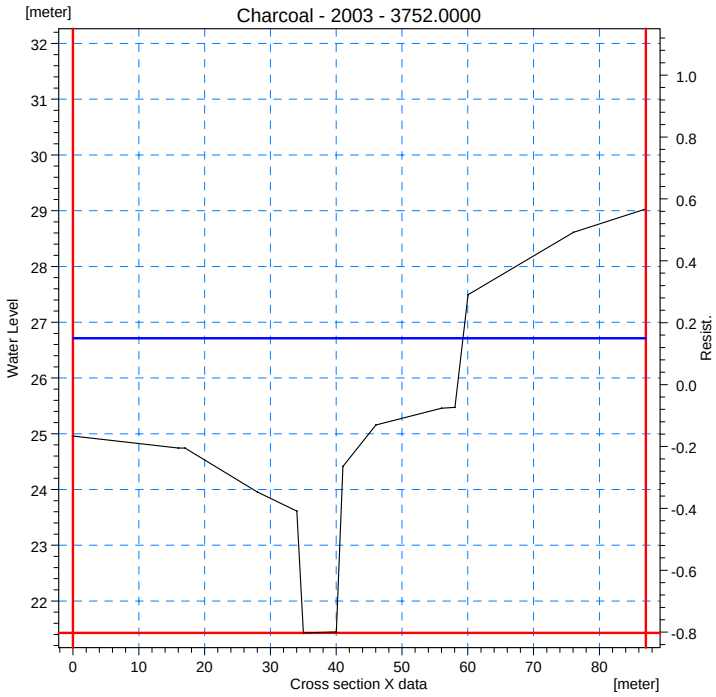
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Water Level
Resist.
Cross section X data
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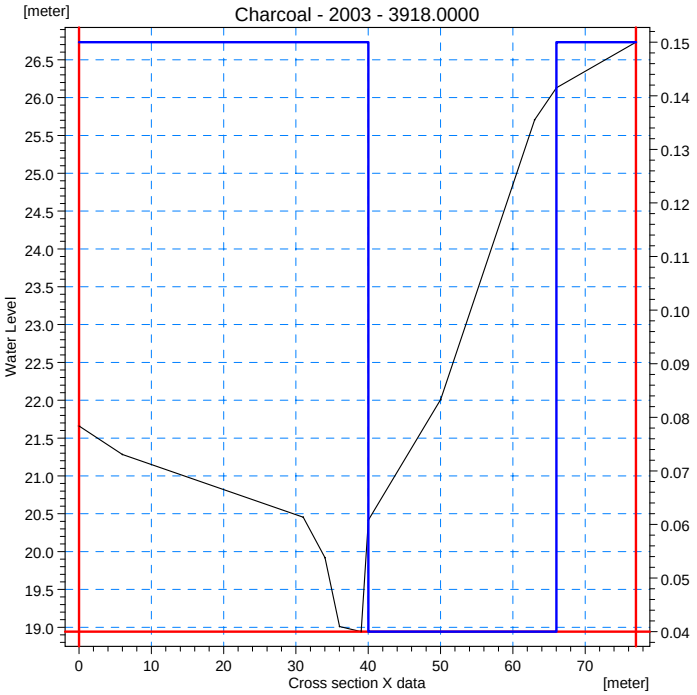
Charcoal - 2003 - 3918.0000
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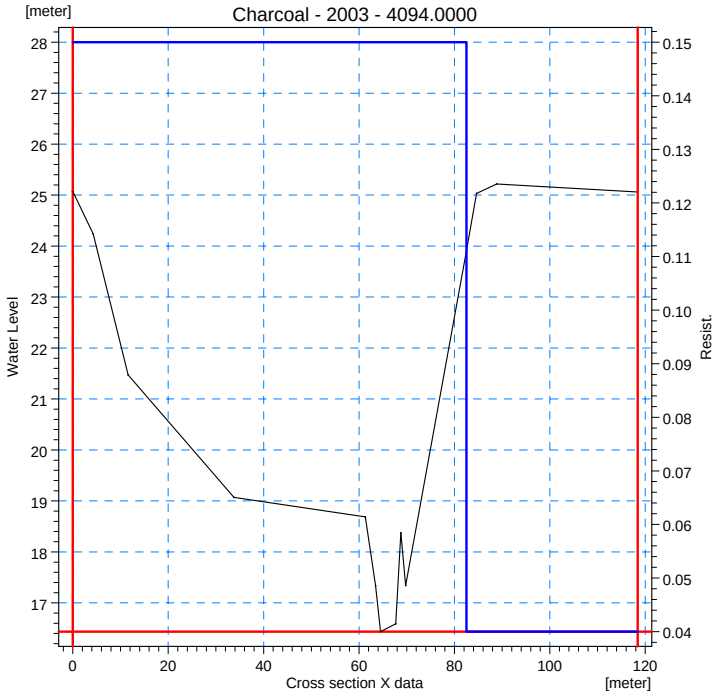
Cross section X data
[meter]


Charcoal - 2003 - 4094.0000
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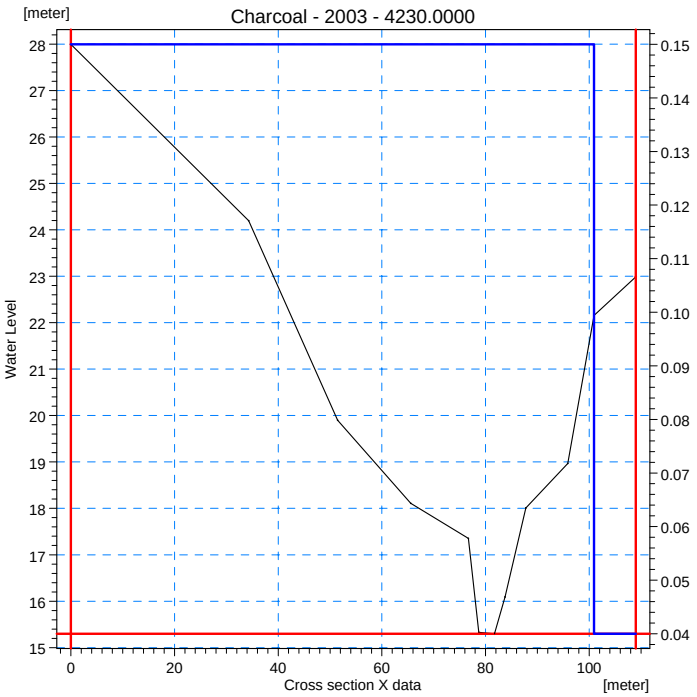
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4230.0000
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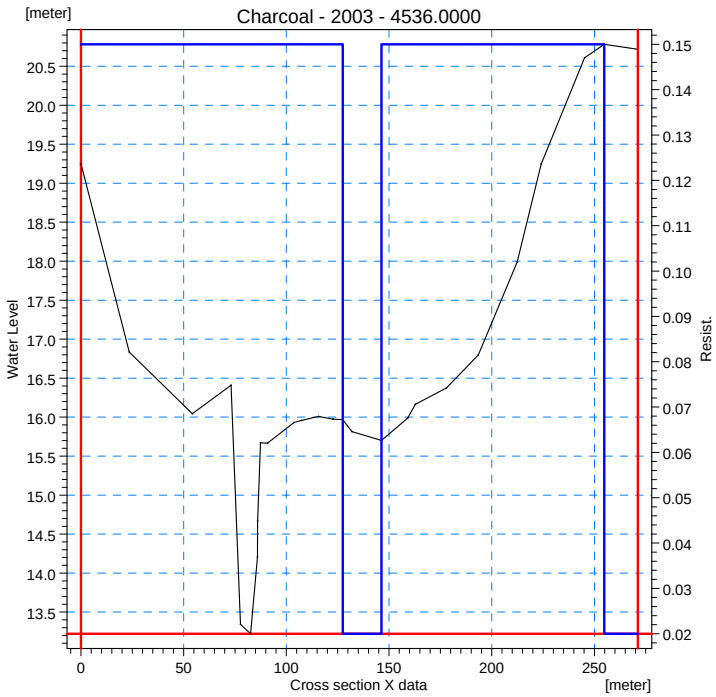
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4536.0000
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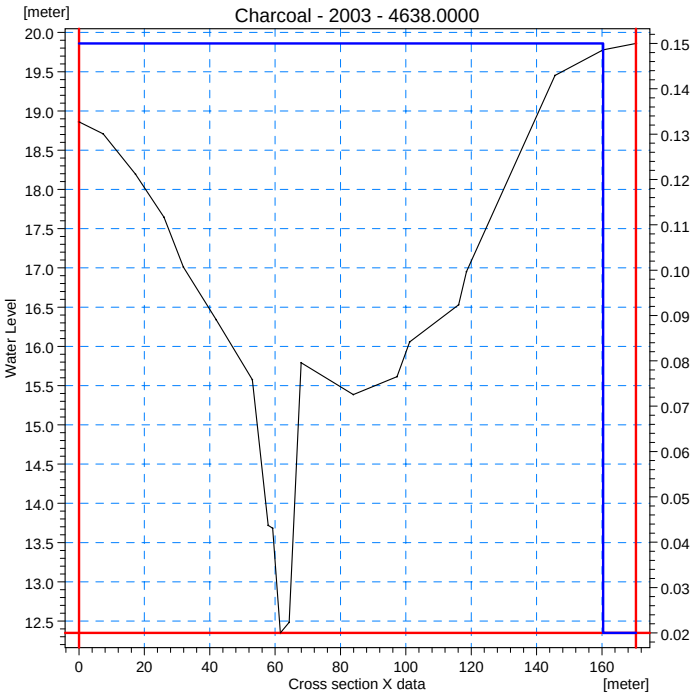
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4638.0000
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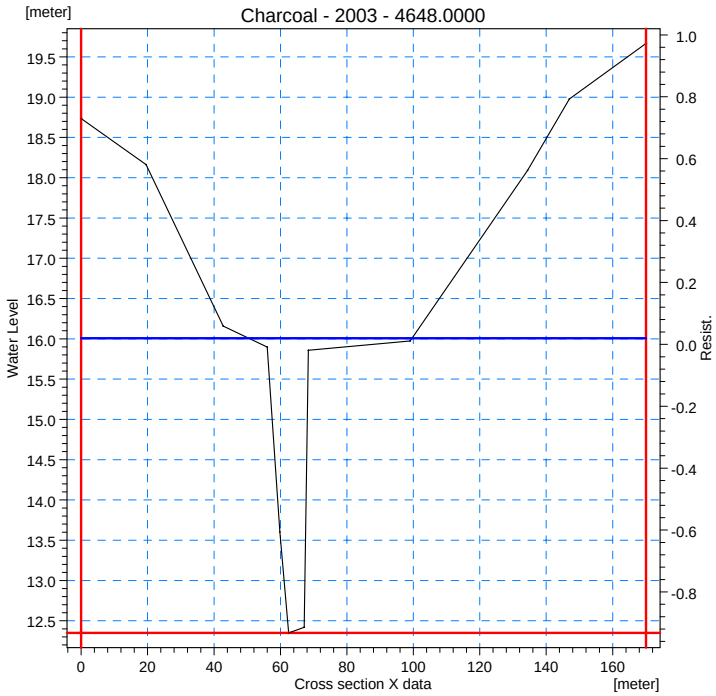
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4648.0000
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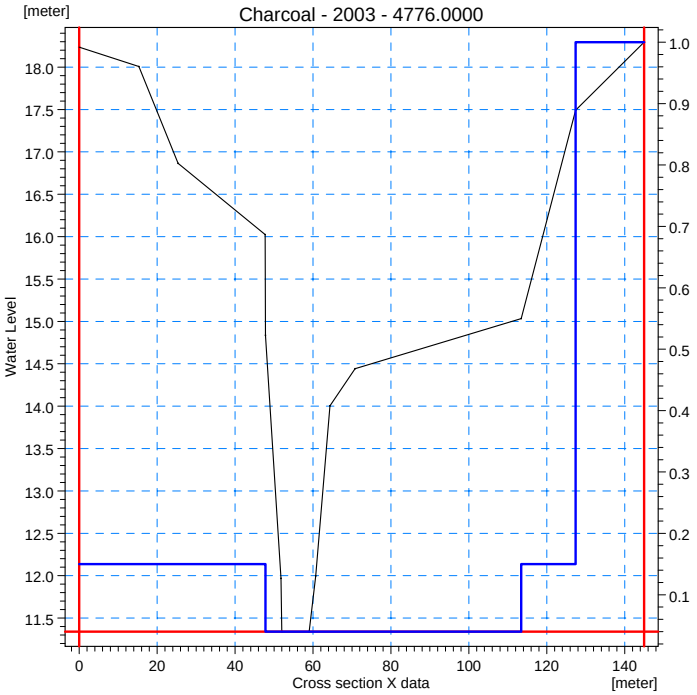
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4776.0000
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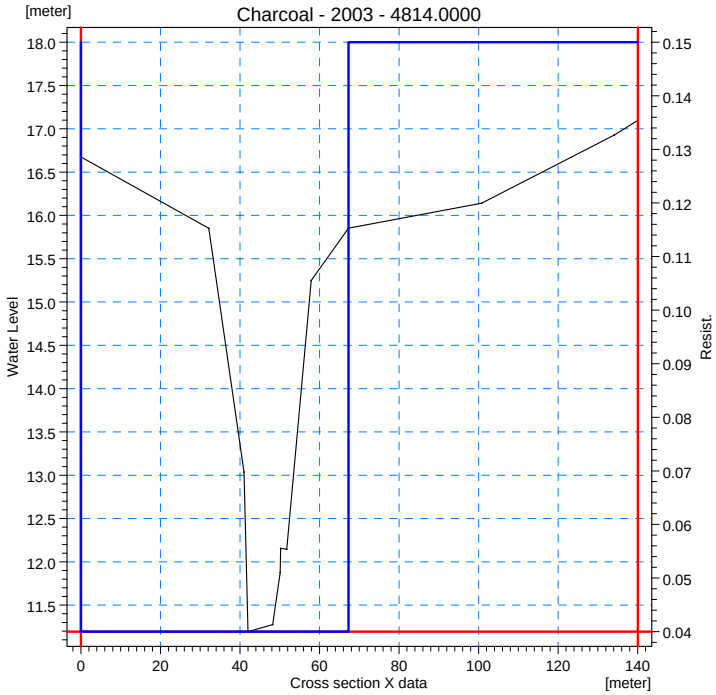
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4814.0000
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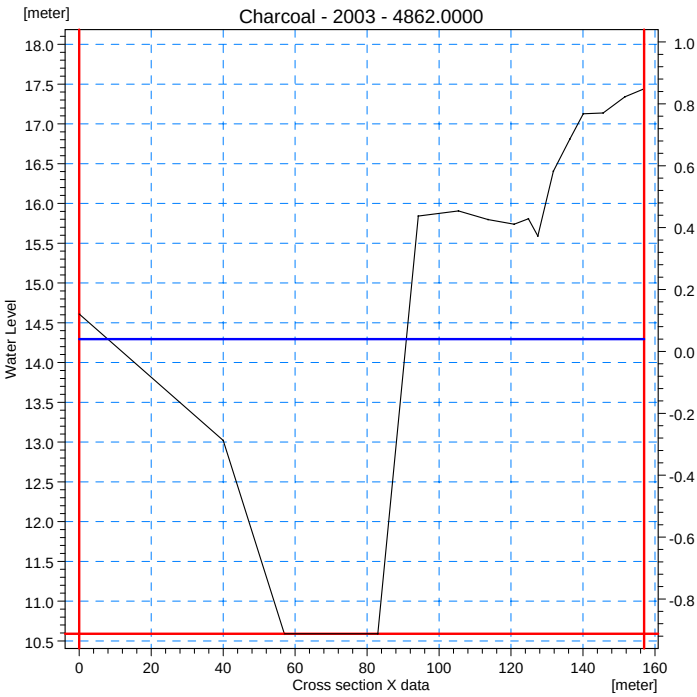
Water Level
Resist.
Cross section X data
[meter]


Charcoal - 2003 - 4862.0000
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Water Level
Resist.
Cross section X data
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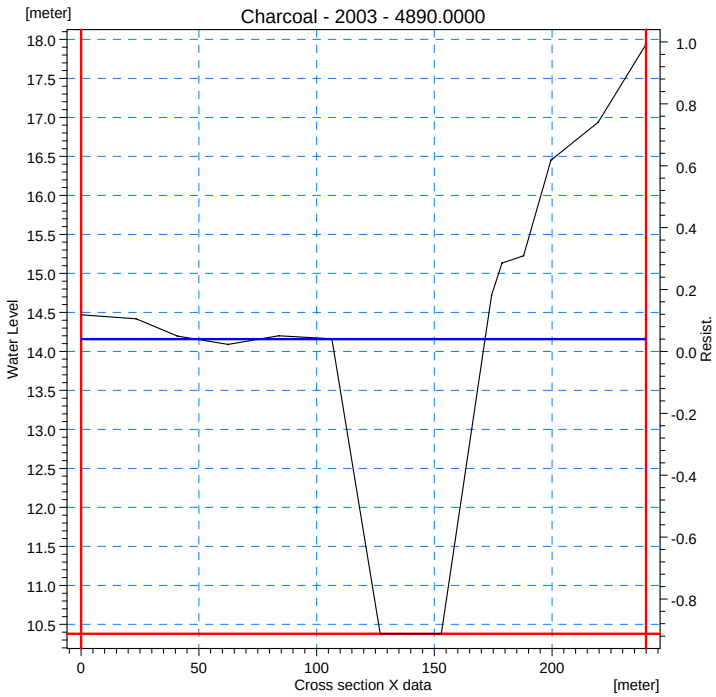
Charcoal - 2003 - 4890.0000
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Cross section X data
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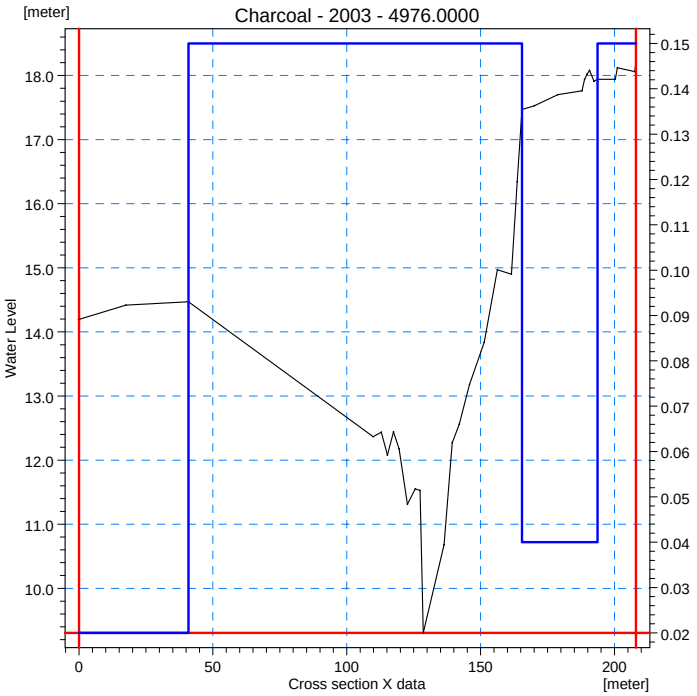
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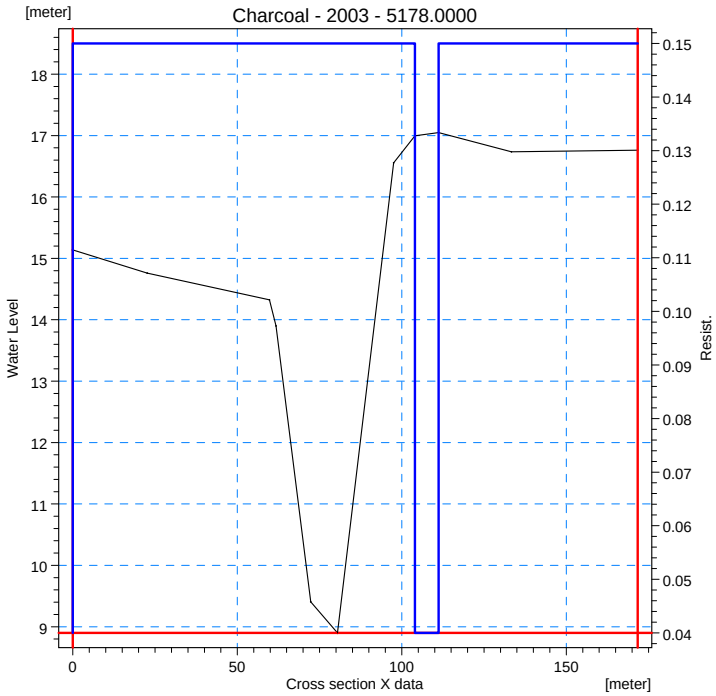
Cross section X data
[meter]


Charcoal - 2003 - 5178.0000
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Cross section X data
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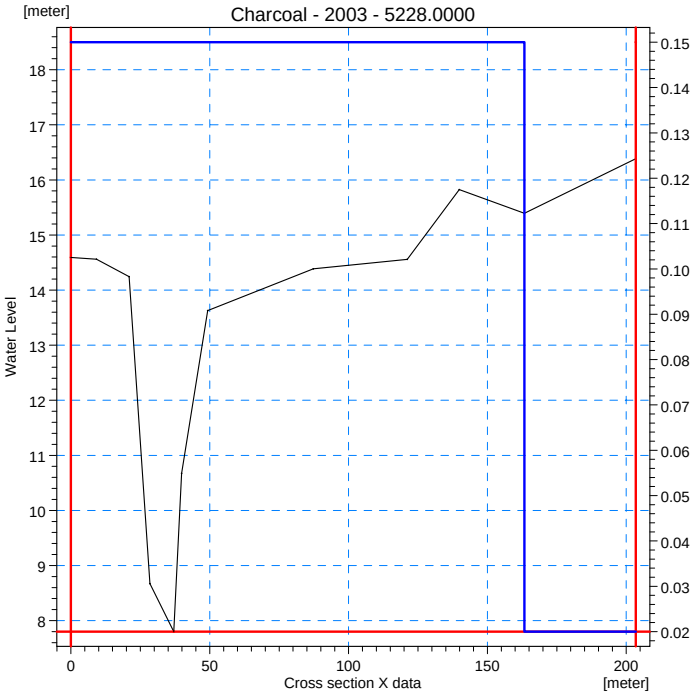
Charcoal - 2003 - 5228.0000
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Resist.
Cross section X data
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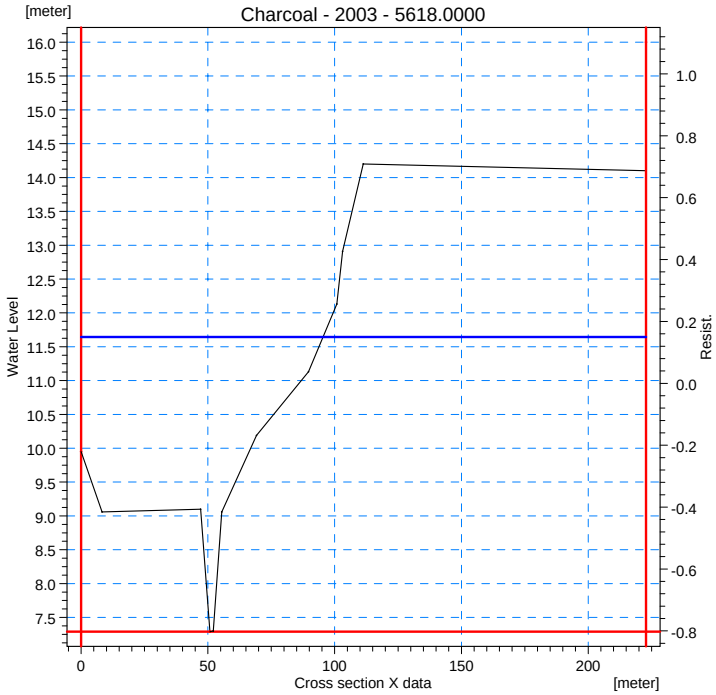
Charcoal - 2003 - 5618.0000
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Cross section X data
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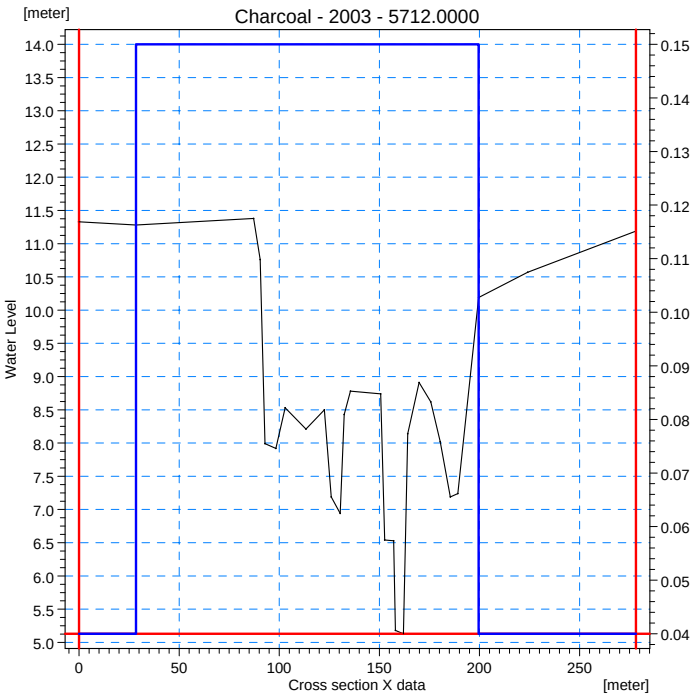
Charcoal - 2003 - 5712.0000
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Cross section X data
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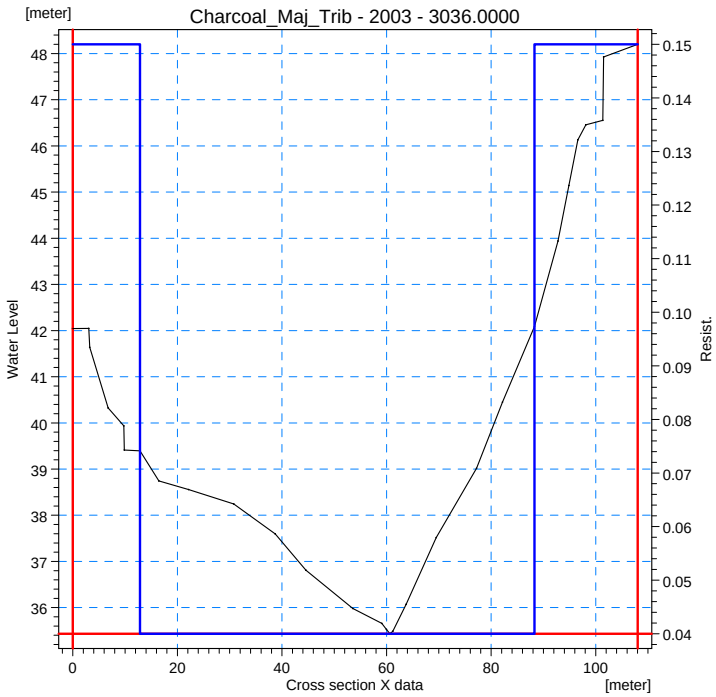
Charcoal_Maj_Trib - 2003 - 3036.0000
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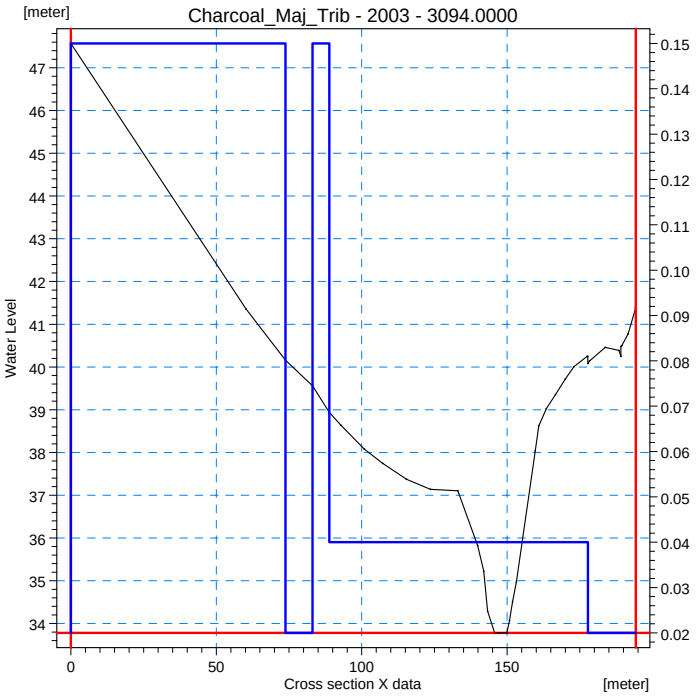
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3094.0000
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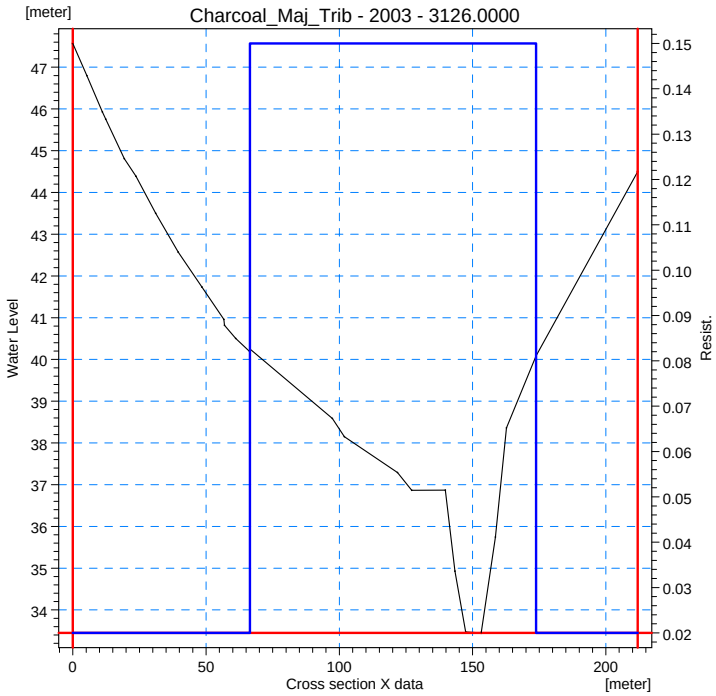
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3126.0000
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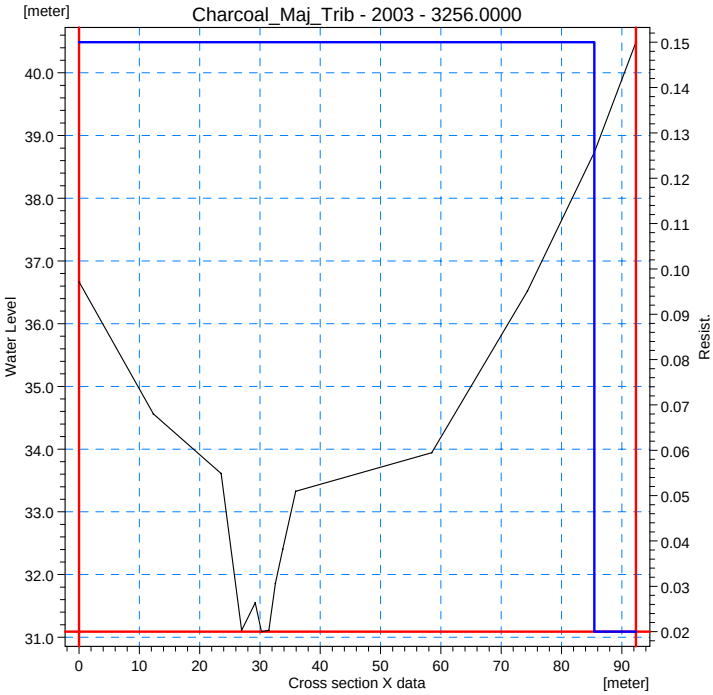
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3256.0000
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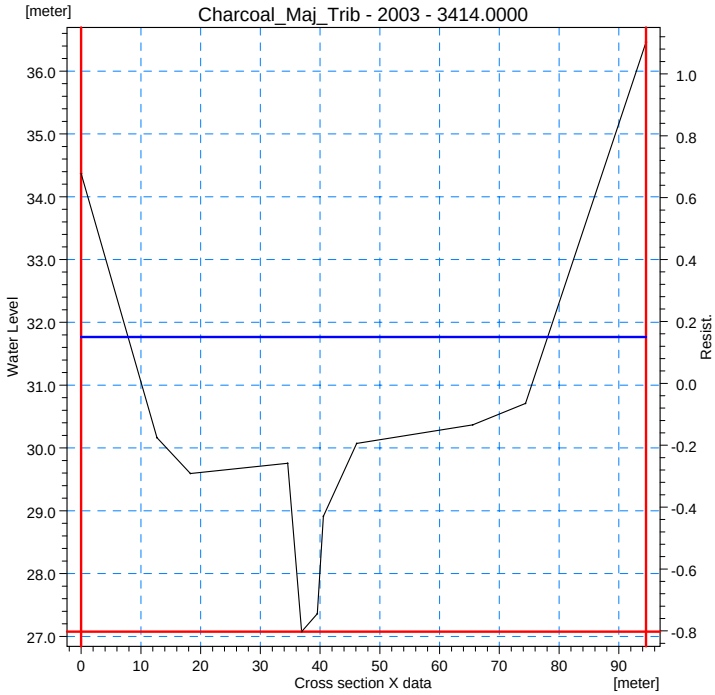
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3414.0000
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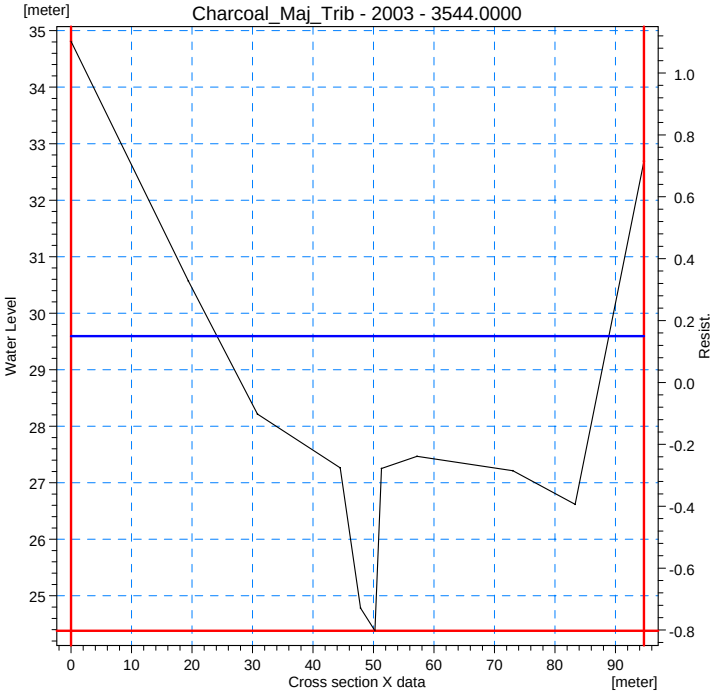
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3544.0000
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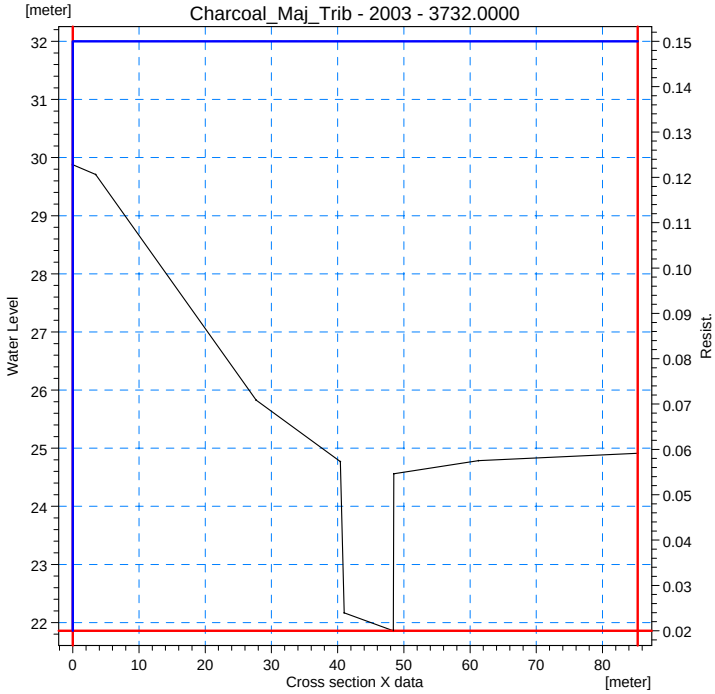
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3732.0000
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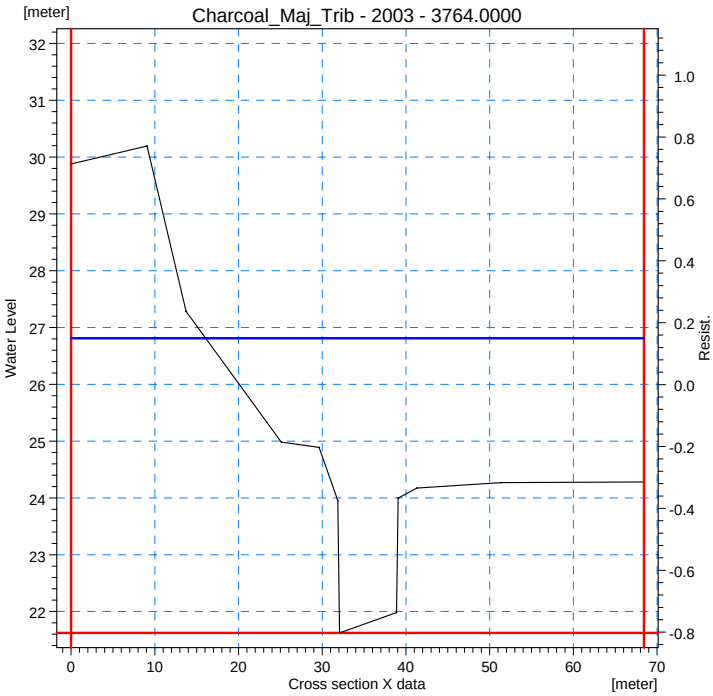
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3764.0000
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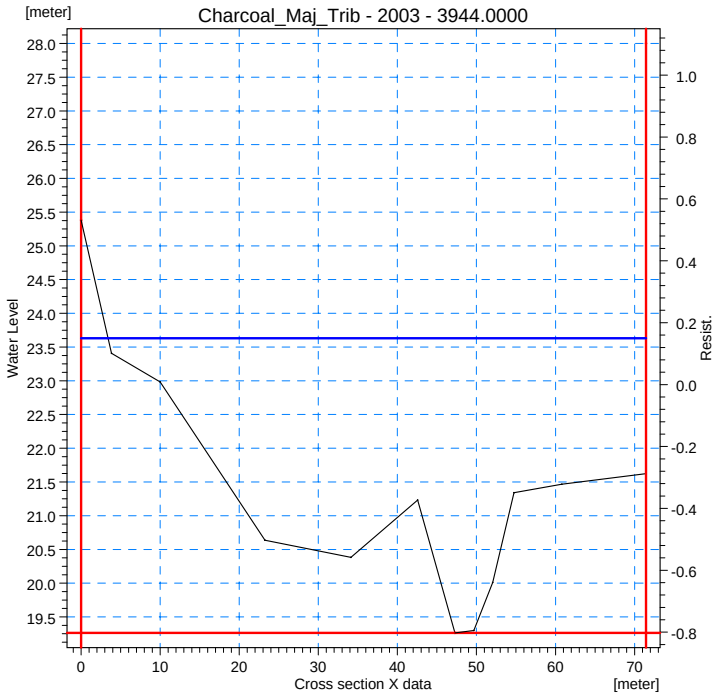
Resist.
Cross section X data
[meter]


Charcoal_Maj_Trib - 2003 - 3944.0000
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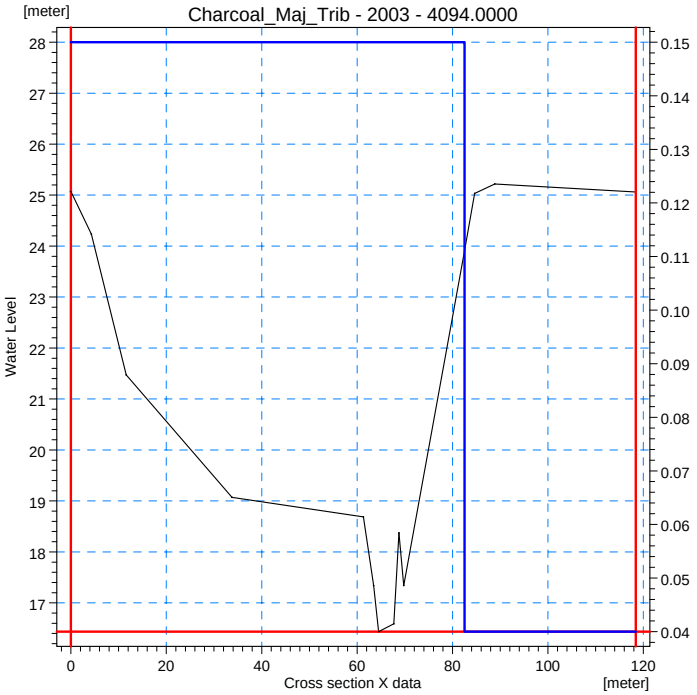
Resist.
Cross section X data
[meter]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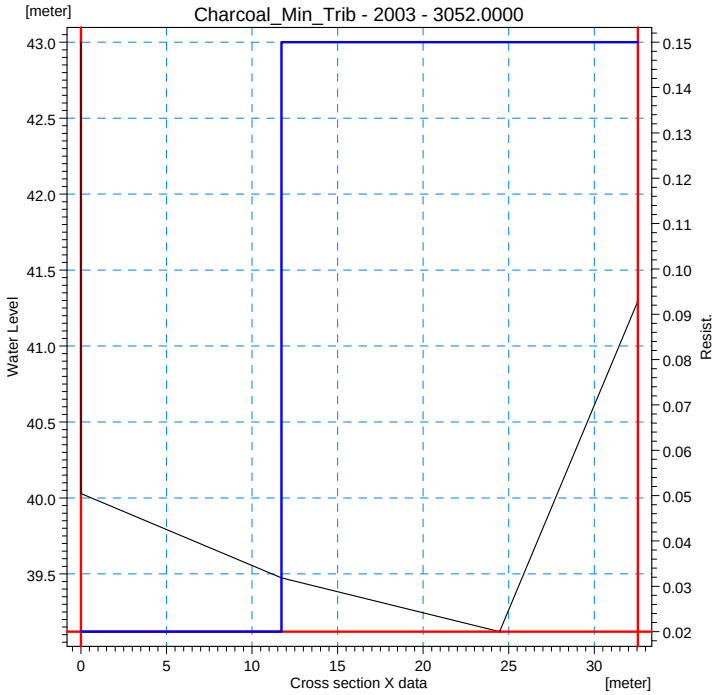
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Min_Trib - 2003 - 3052.0000
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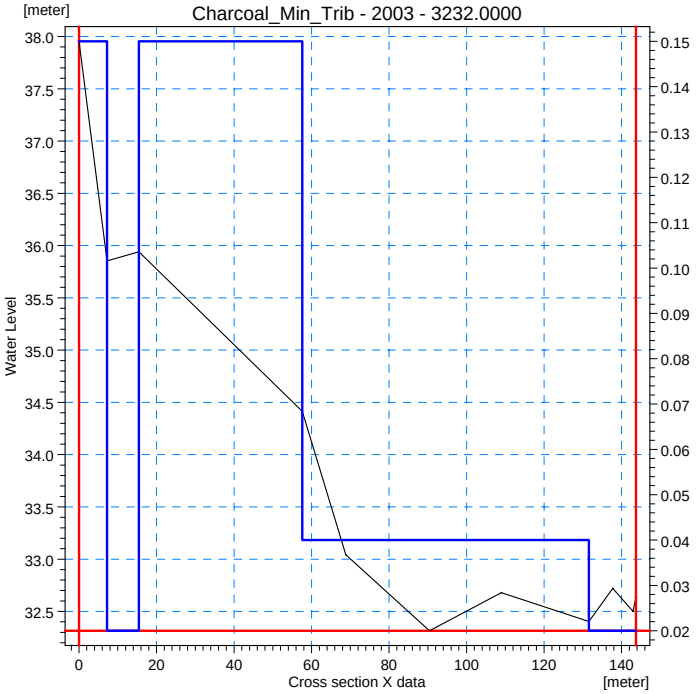
Resist.
Cross section X data
[meter]


Charcoal_Min_Trib - 2003 - 3232.0000
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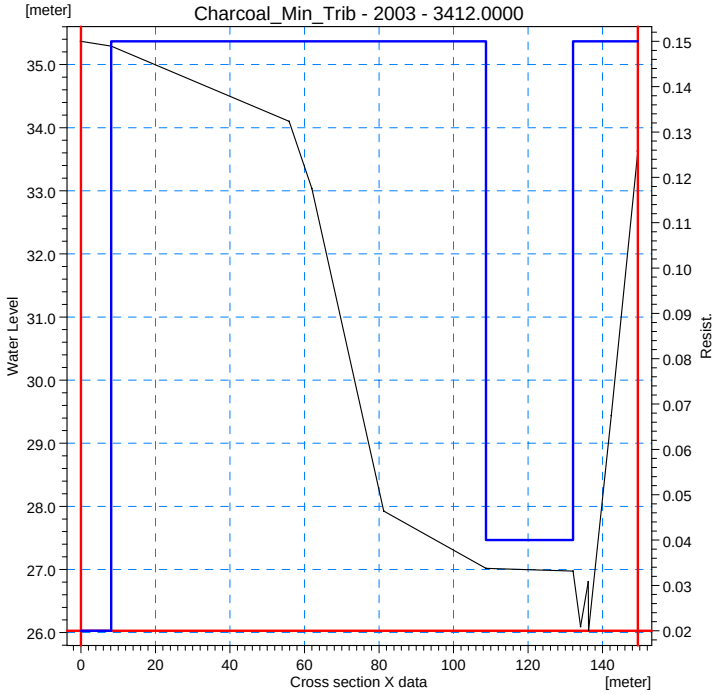
Water Level
Resist.
Cross section X data
[meter]


Charcoal_Min_Trib - 2003 - 3412.0000
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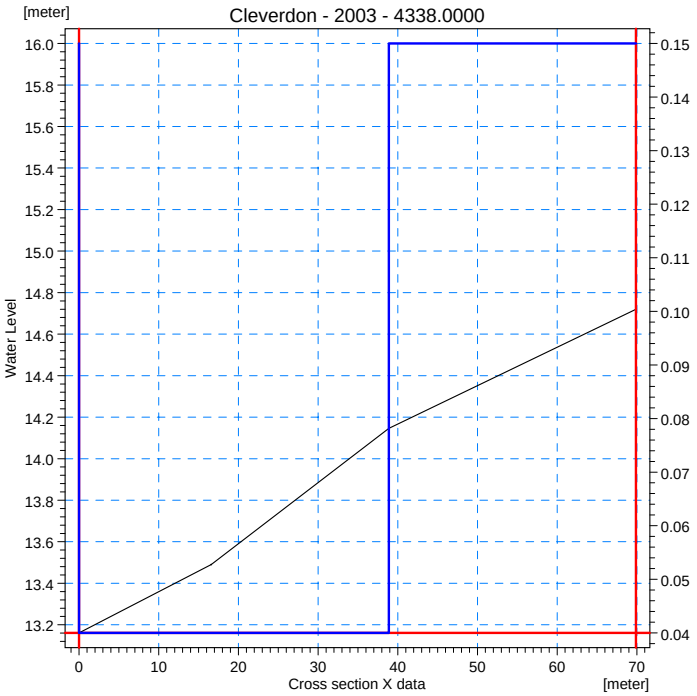
Water Level
Resist.
Cross section X data
[meter]


Cleverdon - 2003 - 4338.0000
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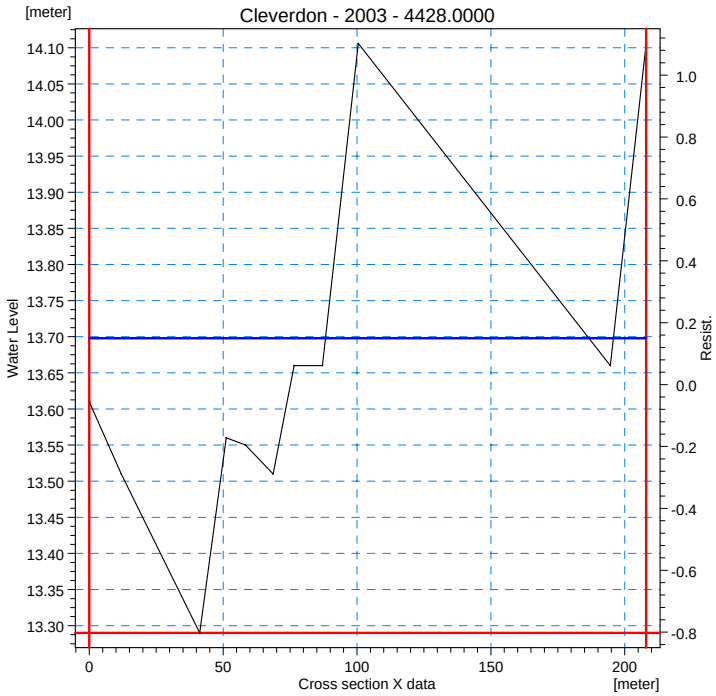
Cross section X data
[meter]


Cleverdon - 2003 - 4428.0000
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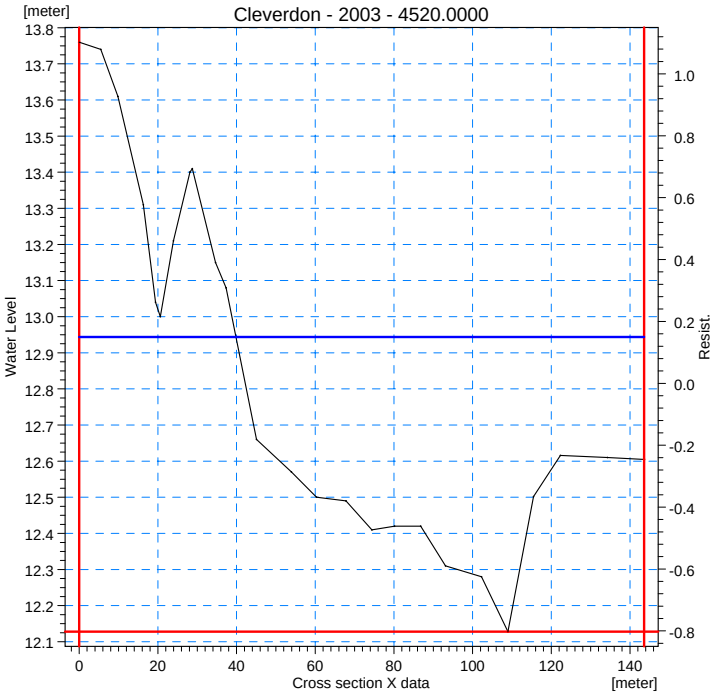
[meter]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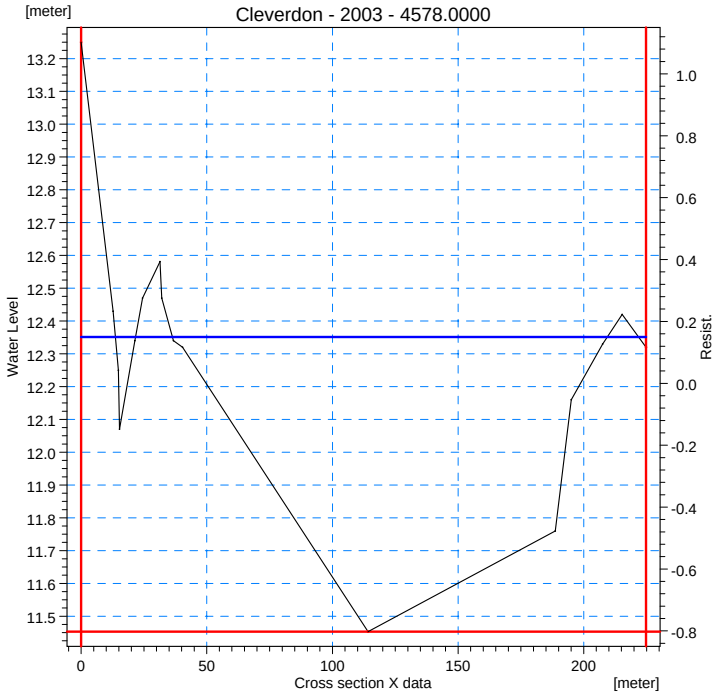
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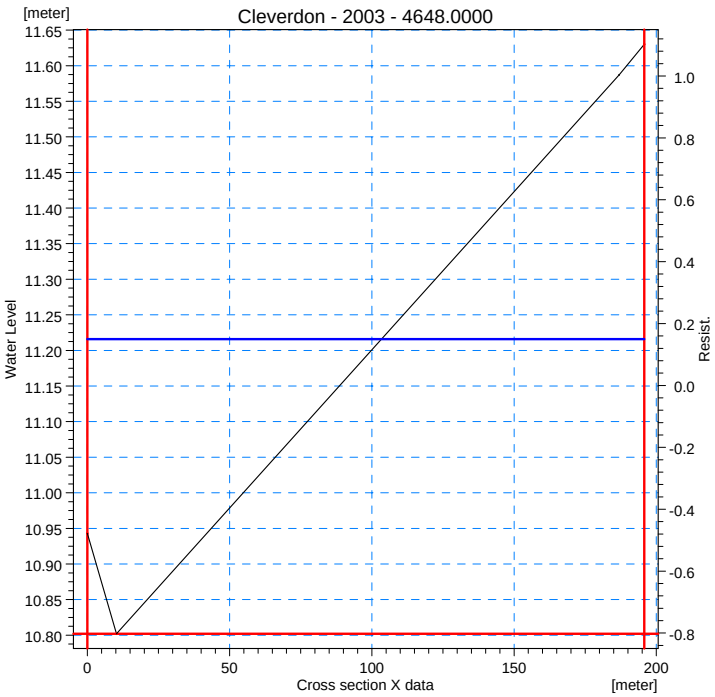
[meter]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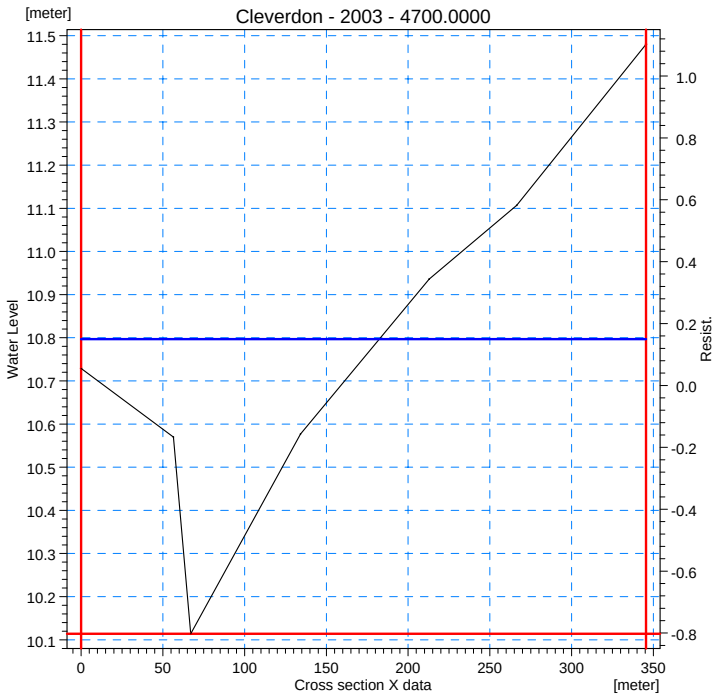
[meter]


Cleverdon - 2003 - 4700.0000
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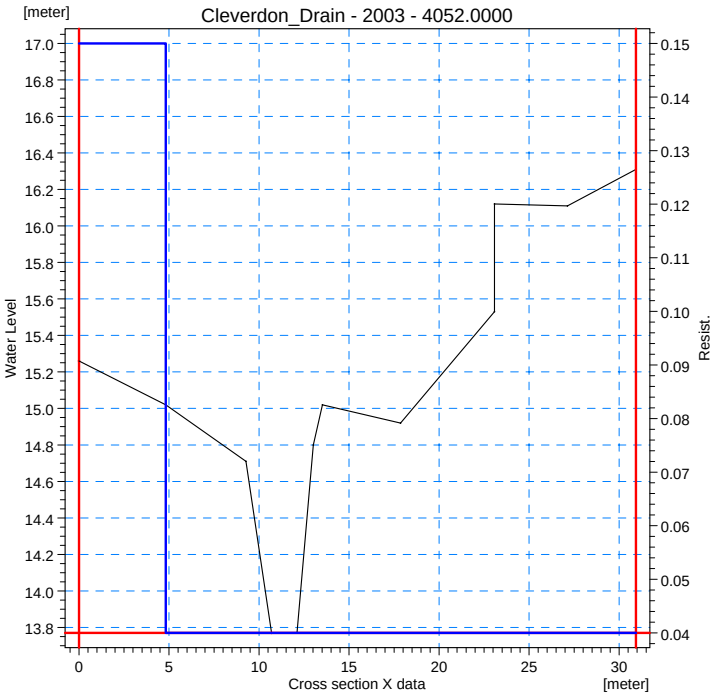
Cross section X data
[meter]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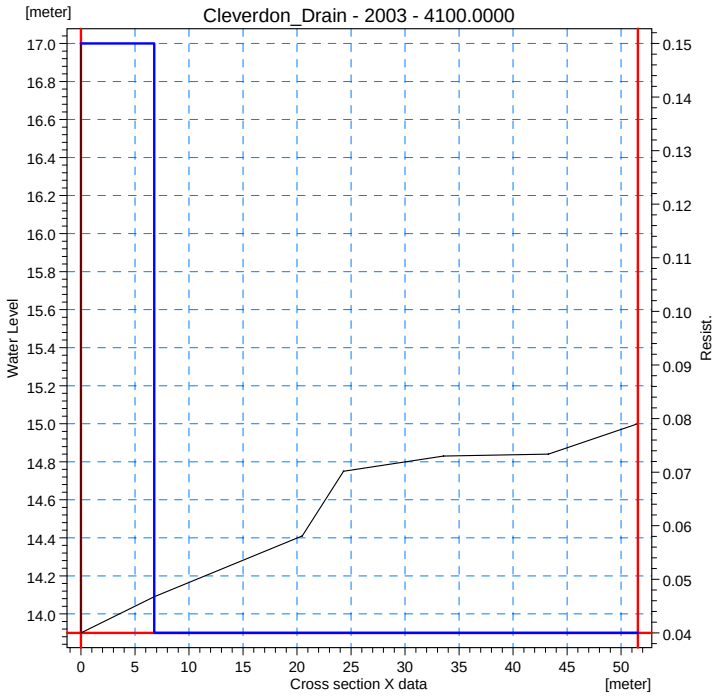
Resist.
Cross section X data
[meter]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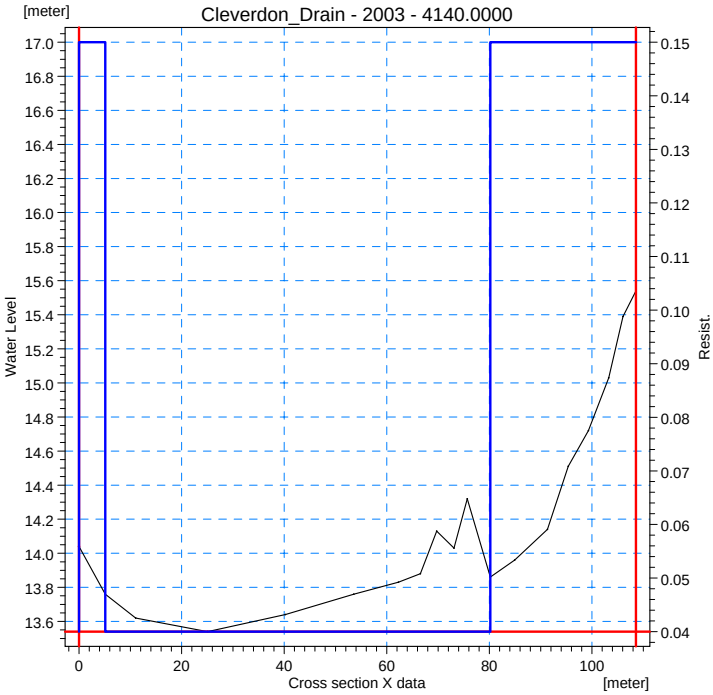
Resist.
Cross section X data
[meter]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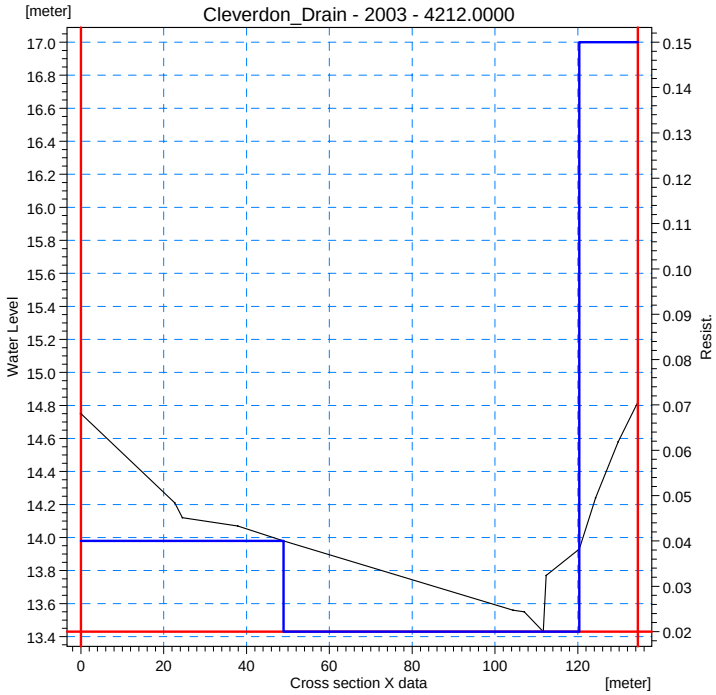
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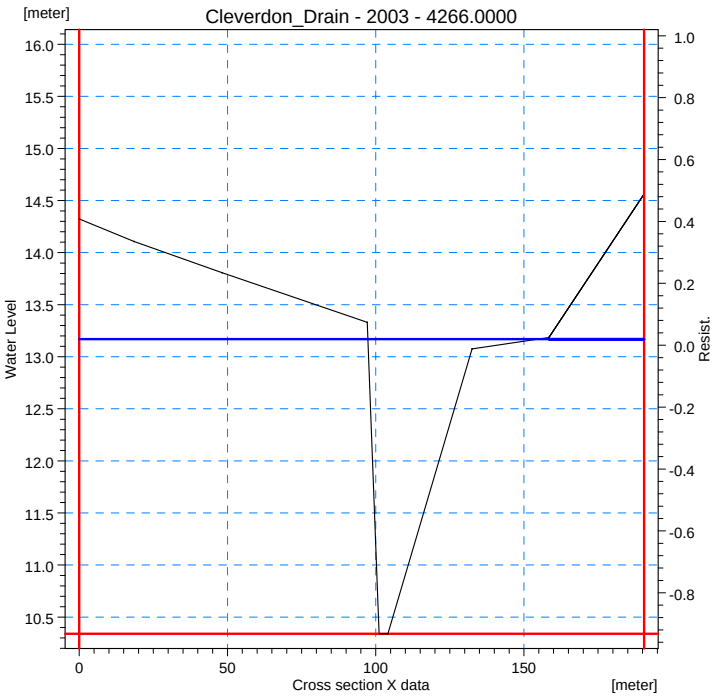
[meter]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Water Level
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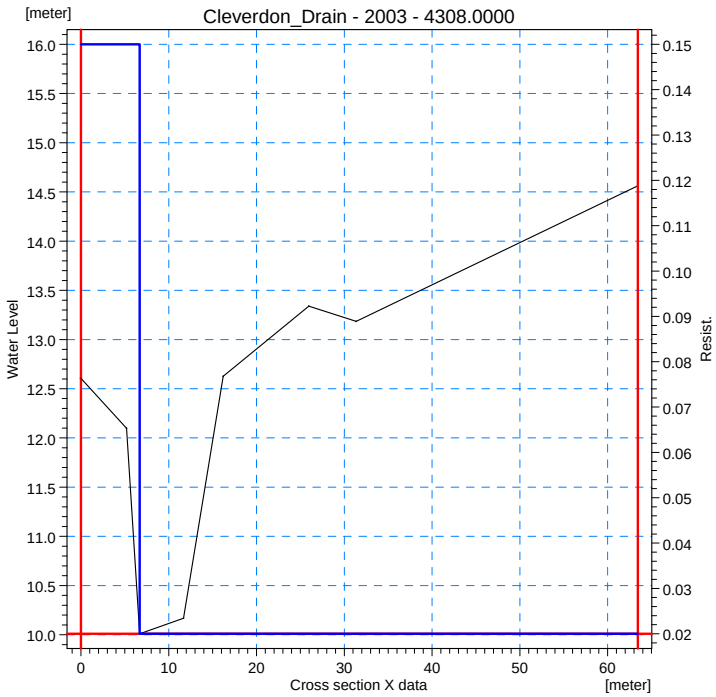
[meter]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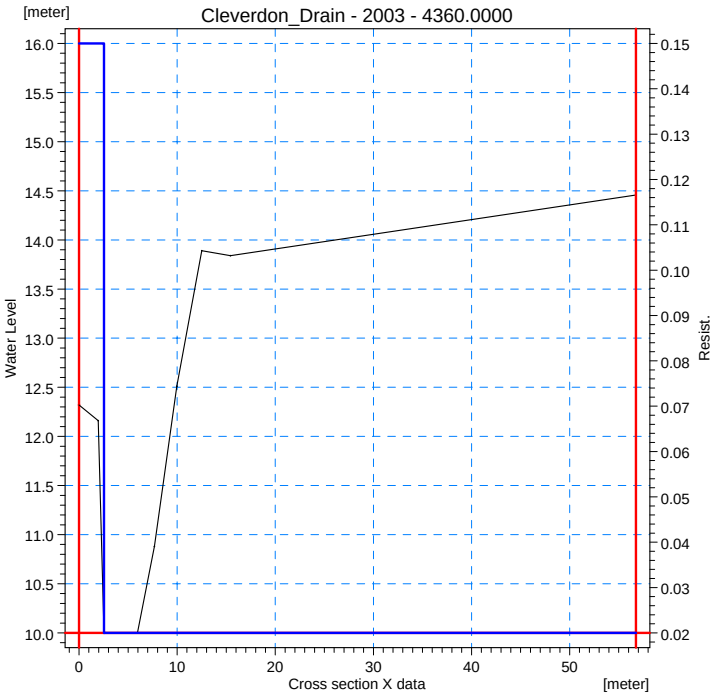
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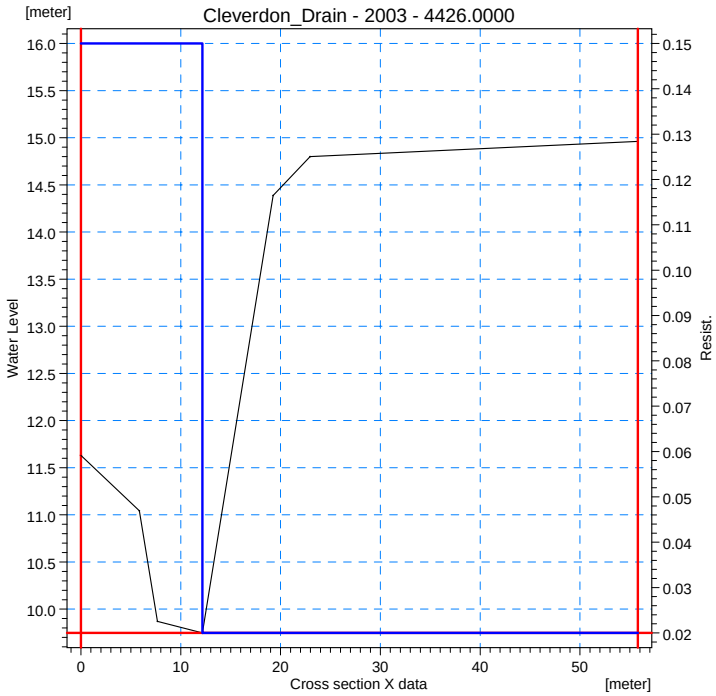
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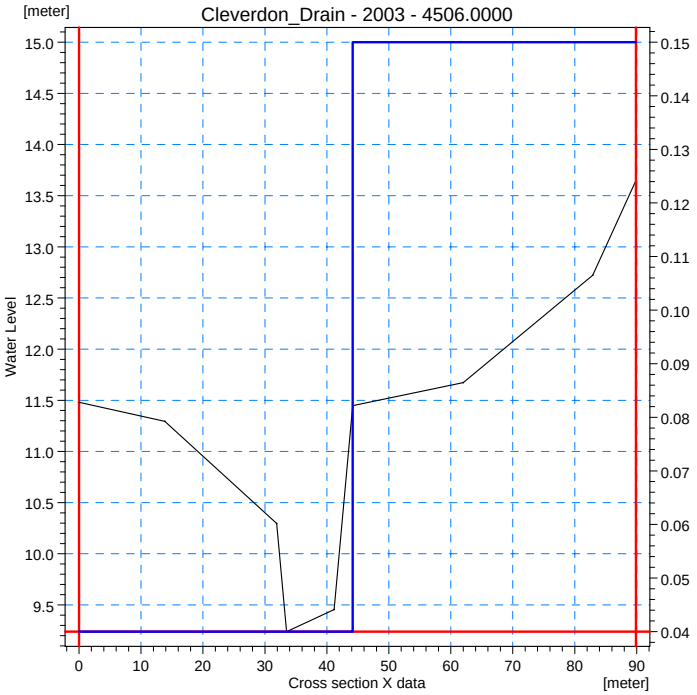
[meter]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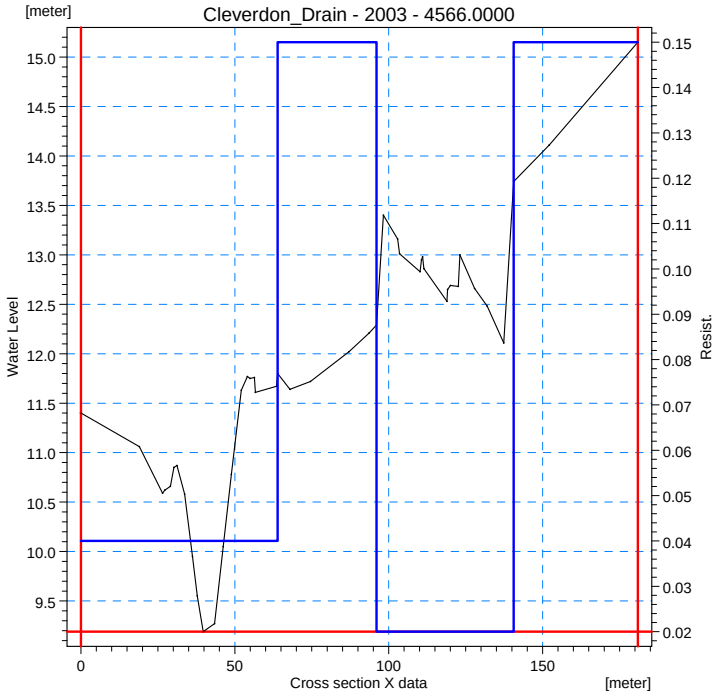
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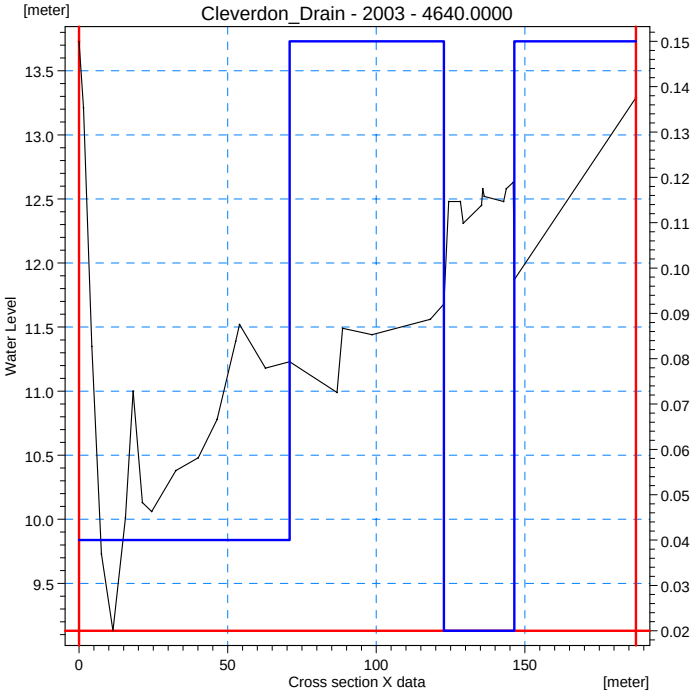
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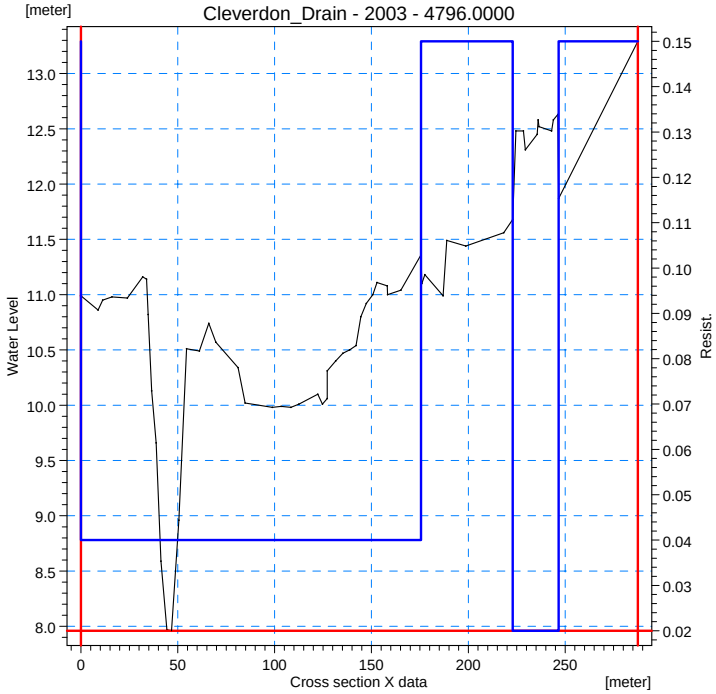
[meter]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Water Level
Resist.
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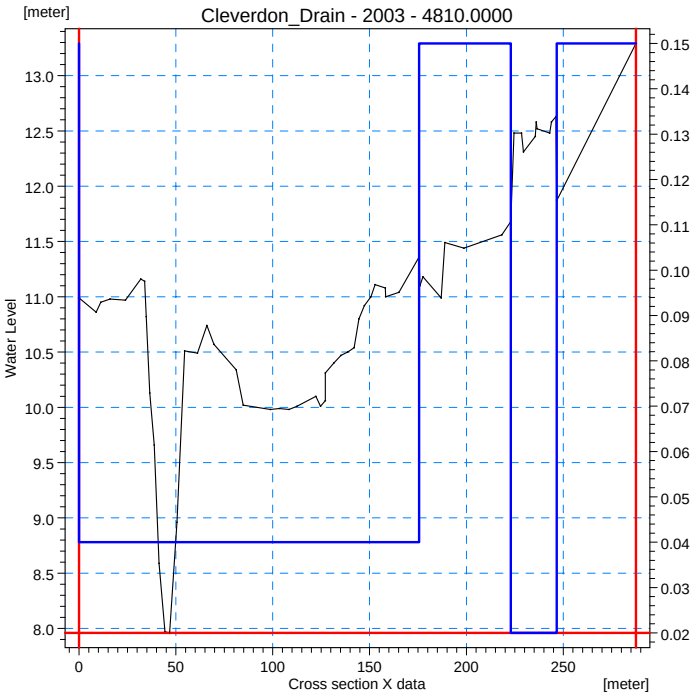
[meter]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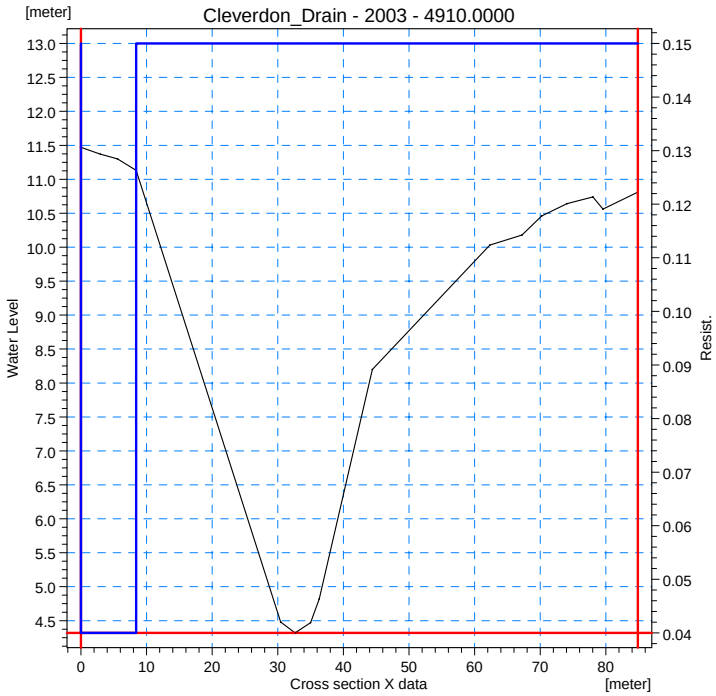
Resist.
Cross section X data
[meter]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Water Level
Resist.
Cross section X data
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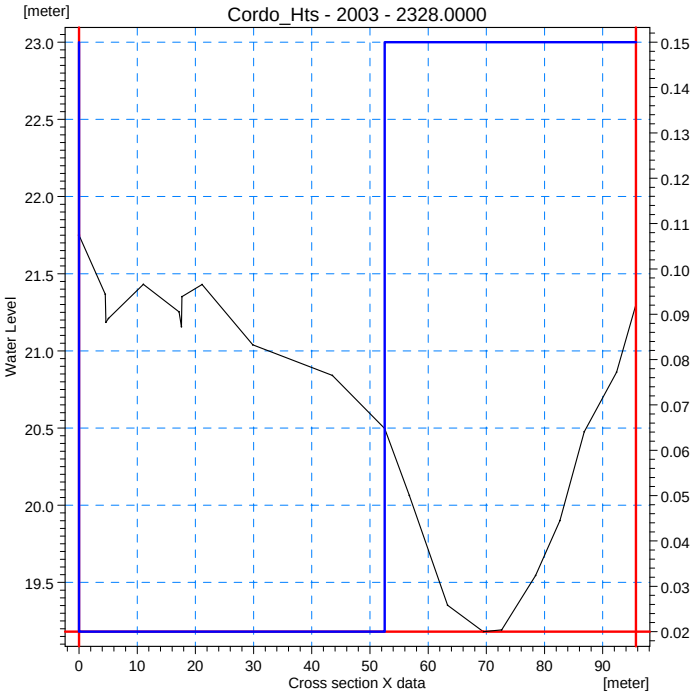
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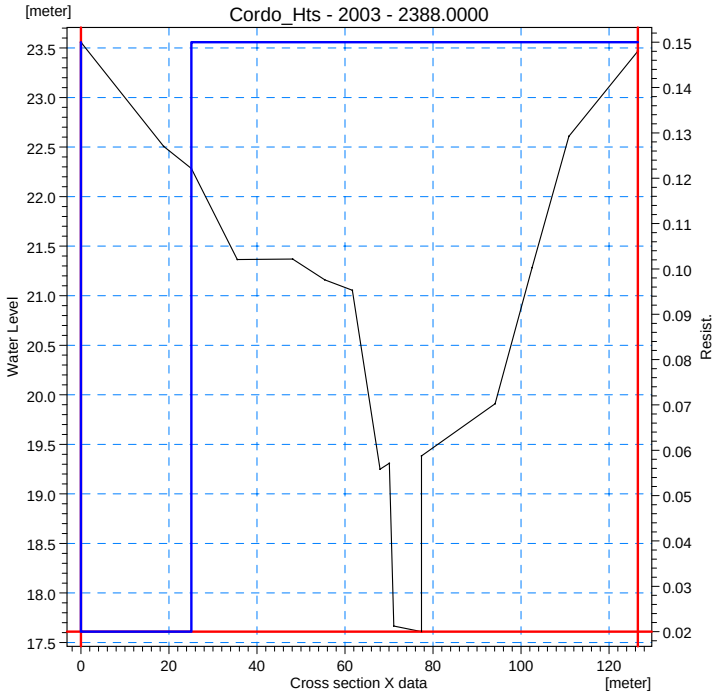
Water Level
Resist.
Cross section X data
[meter]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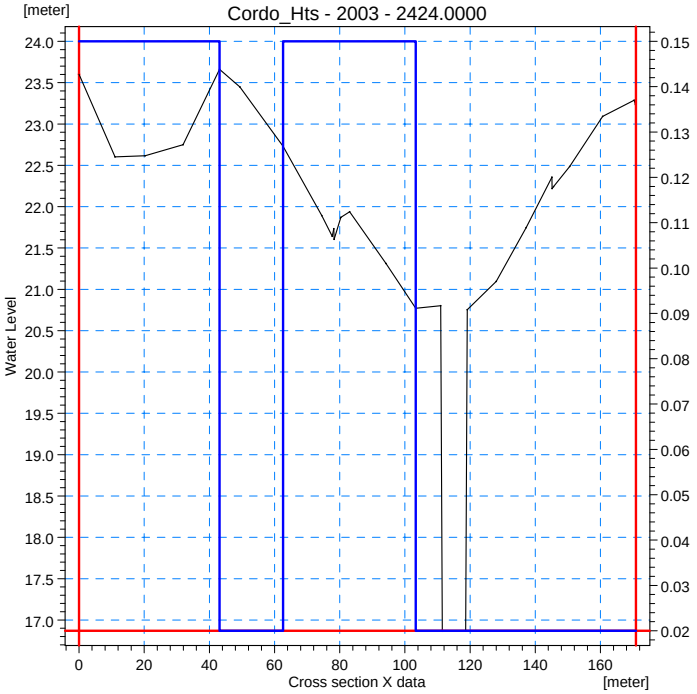
Water Level
Resist.
Cross section X data
[meter]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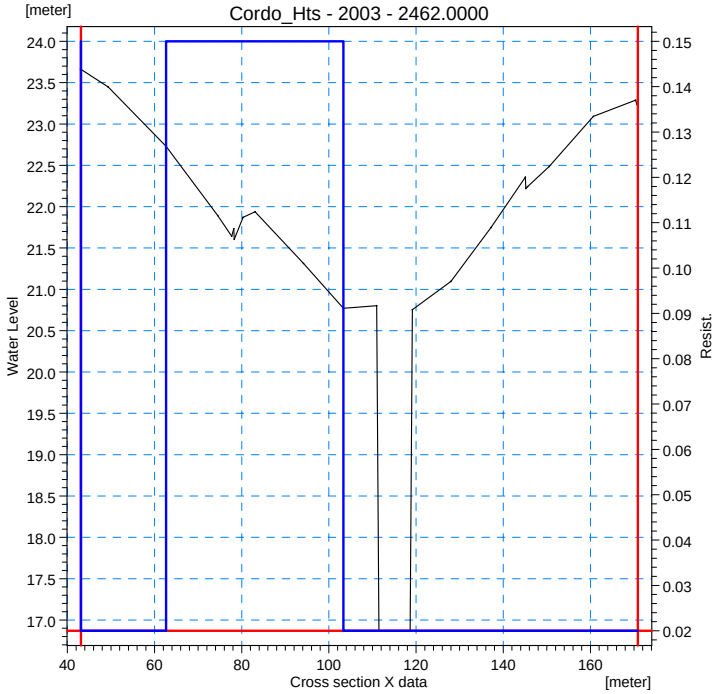
Resist.
Cross section X data
[meter]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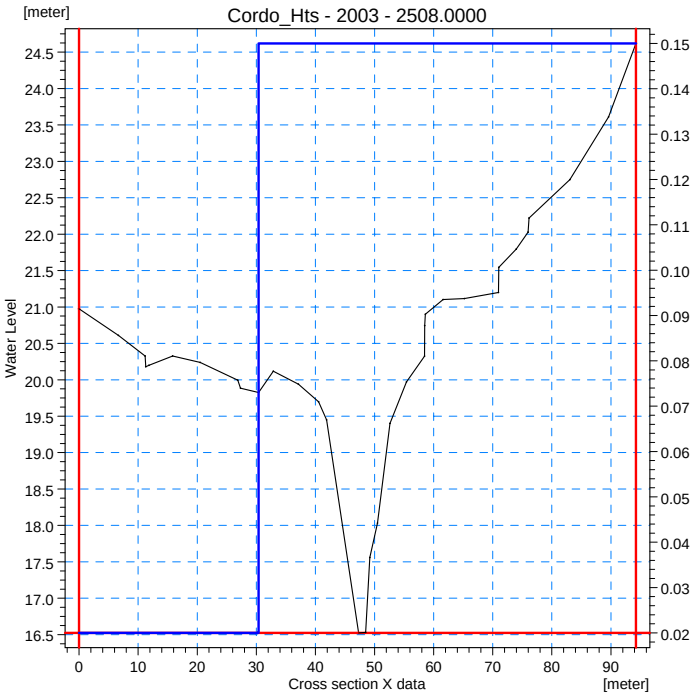
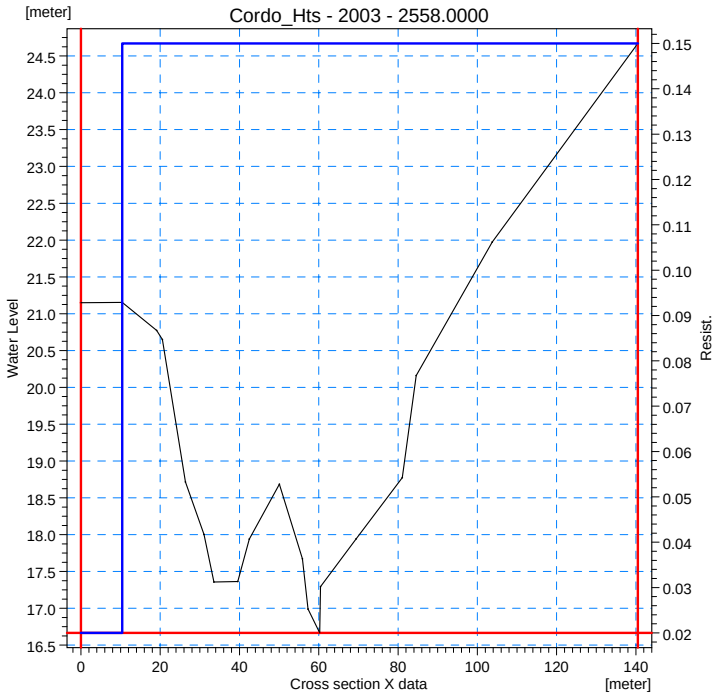
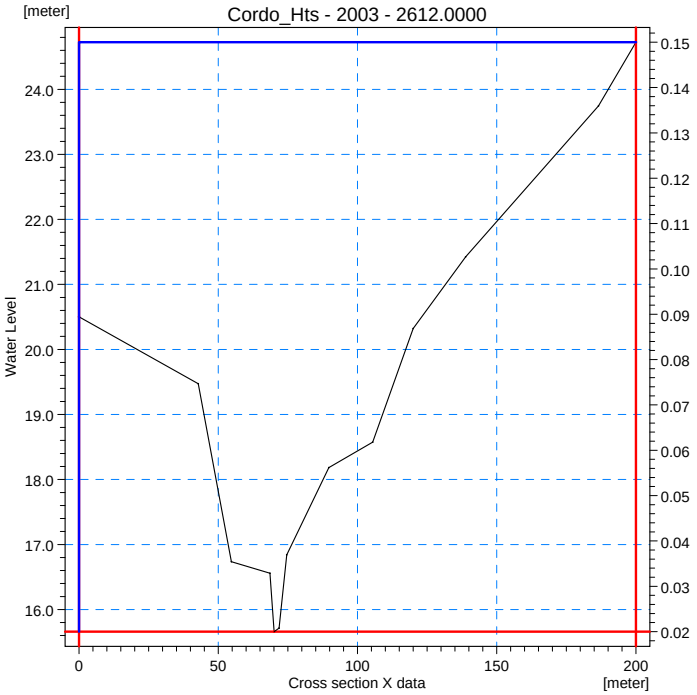
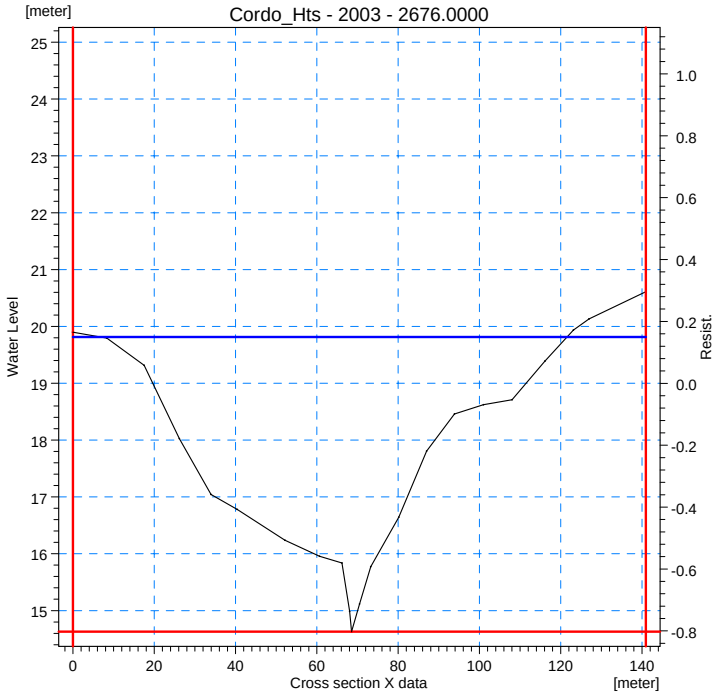
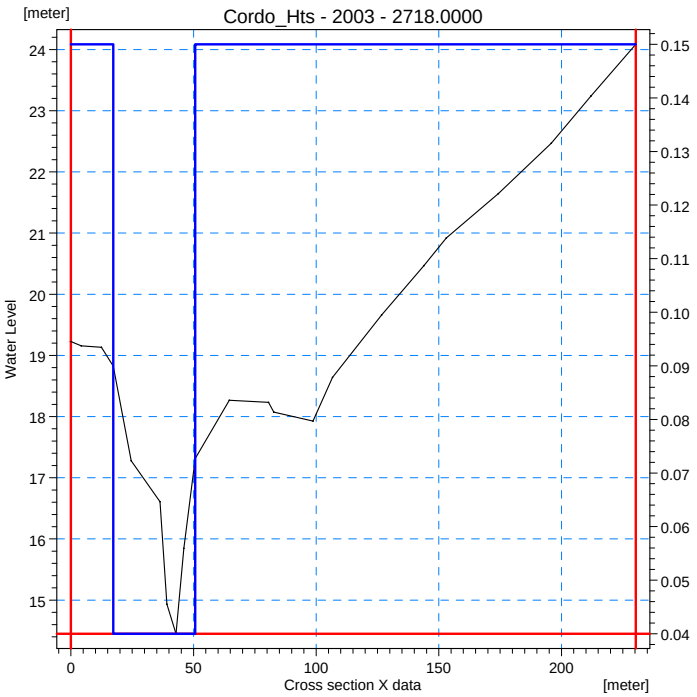
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2508.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2558.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2612.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2676.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2718.0000
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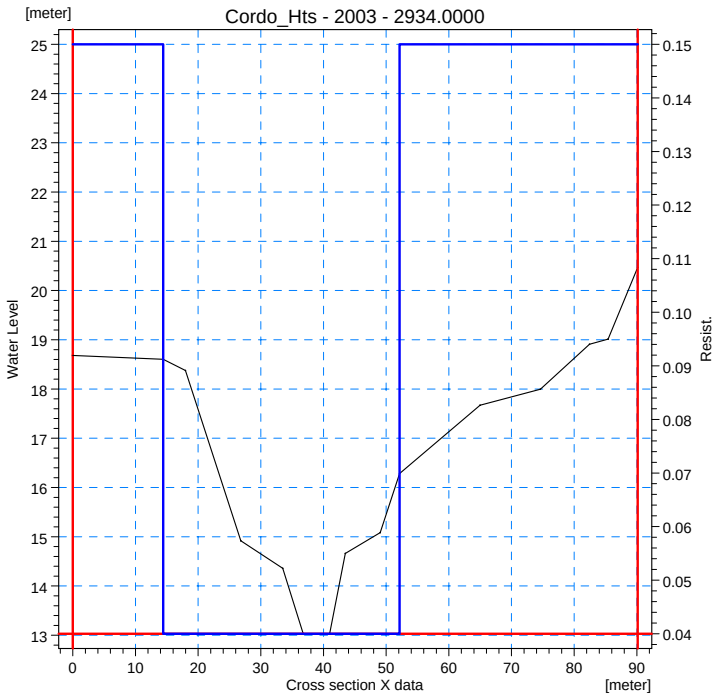
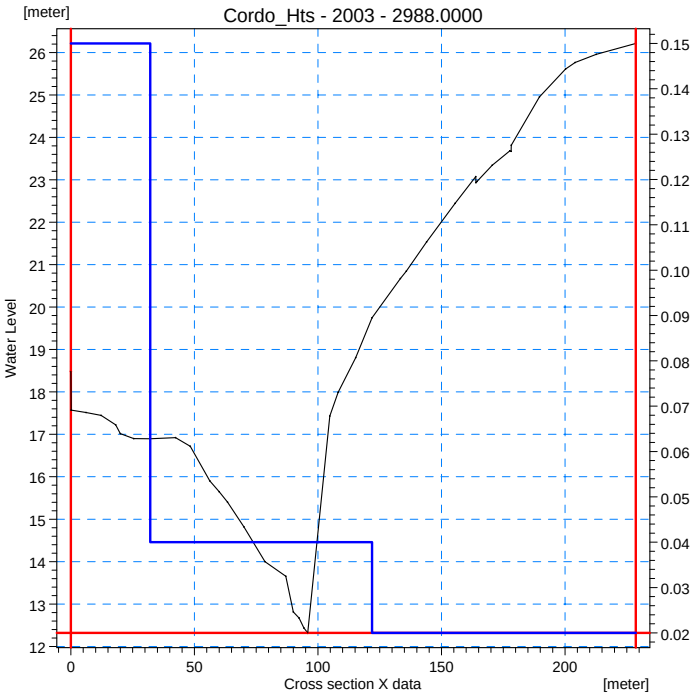
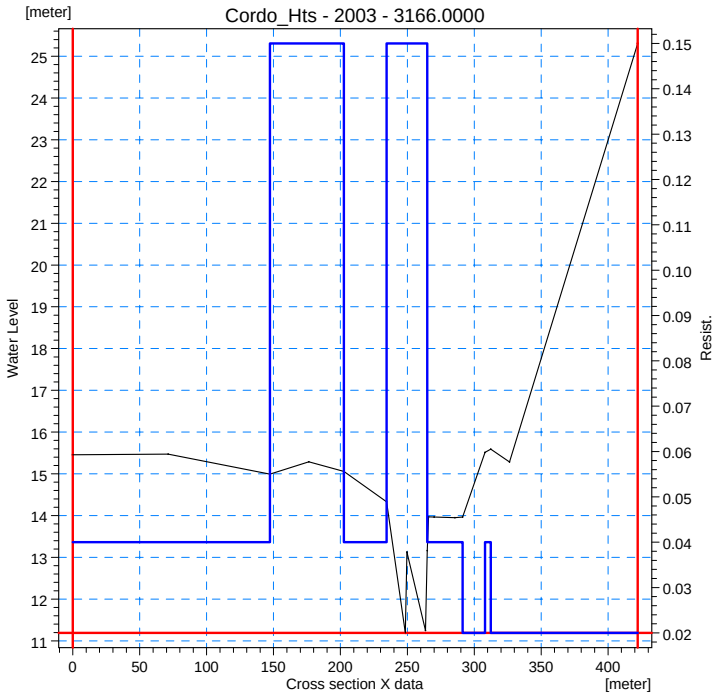
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2934.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 2988.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Hts - 2003 - 3166.0000
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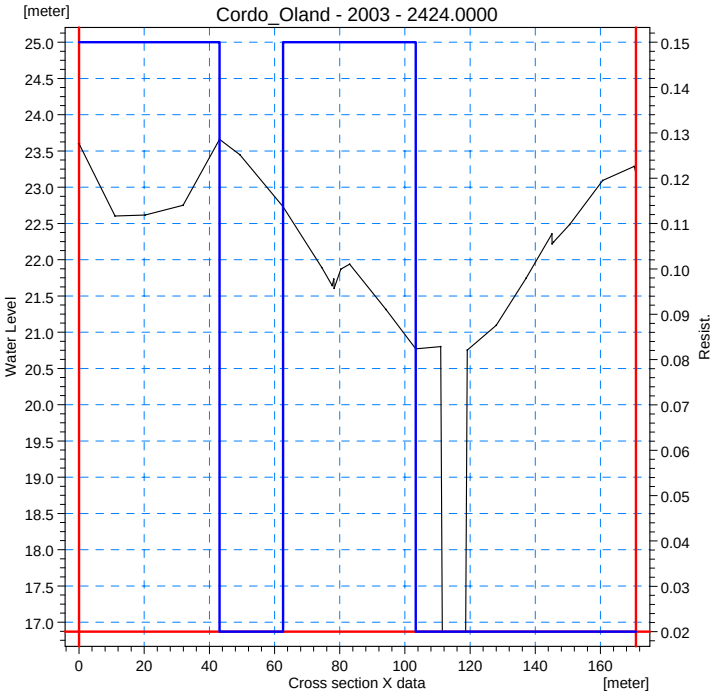
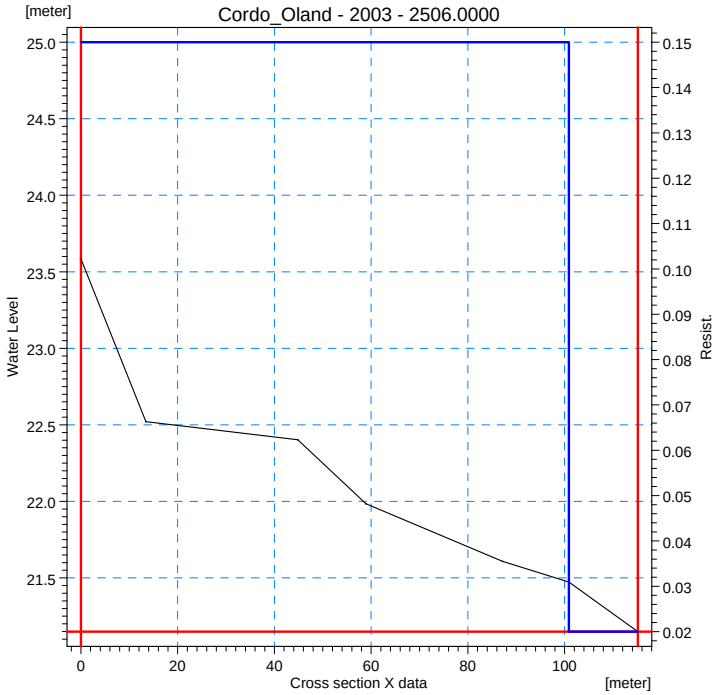
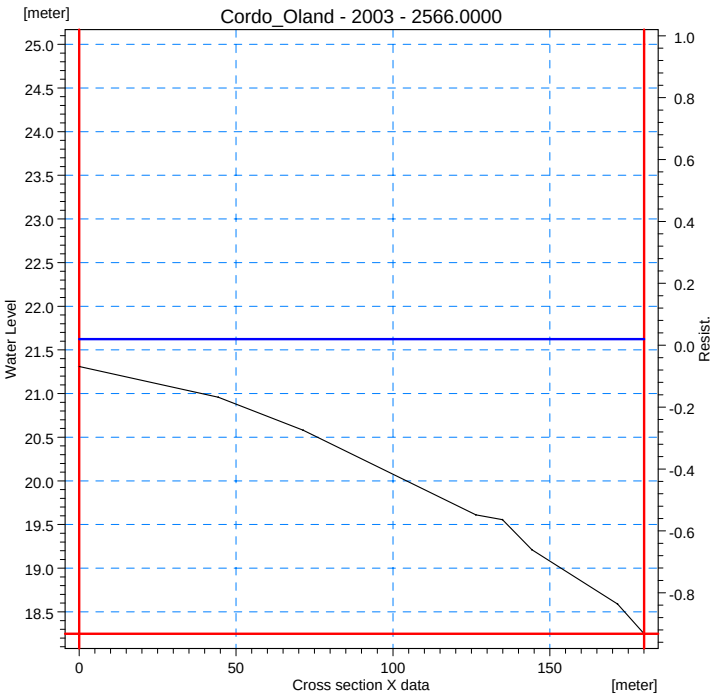
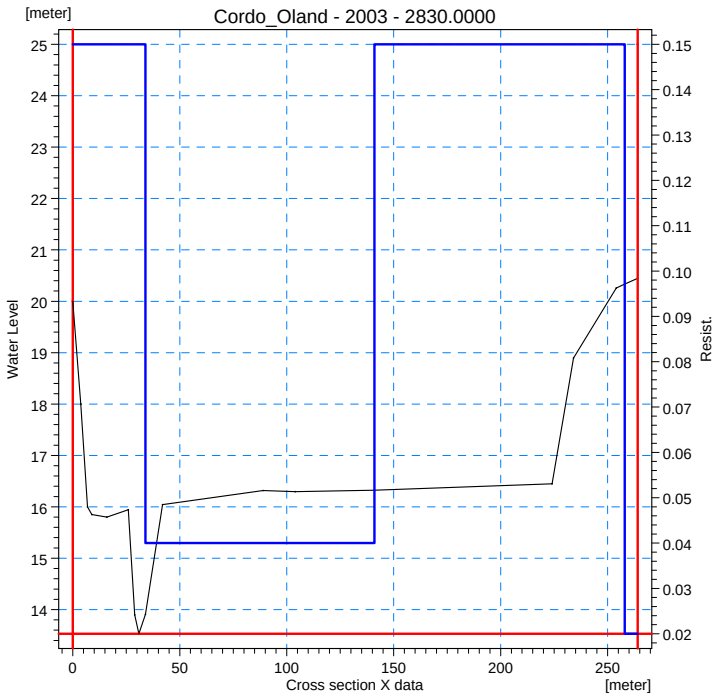
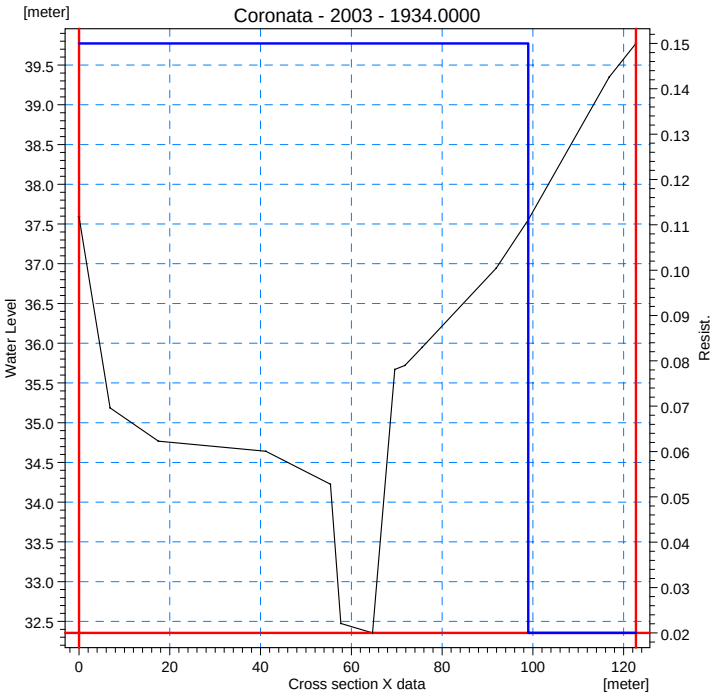
Water Level
Resist.
Cross section X data
[meter]

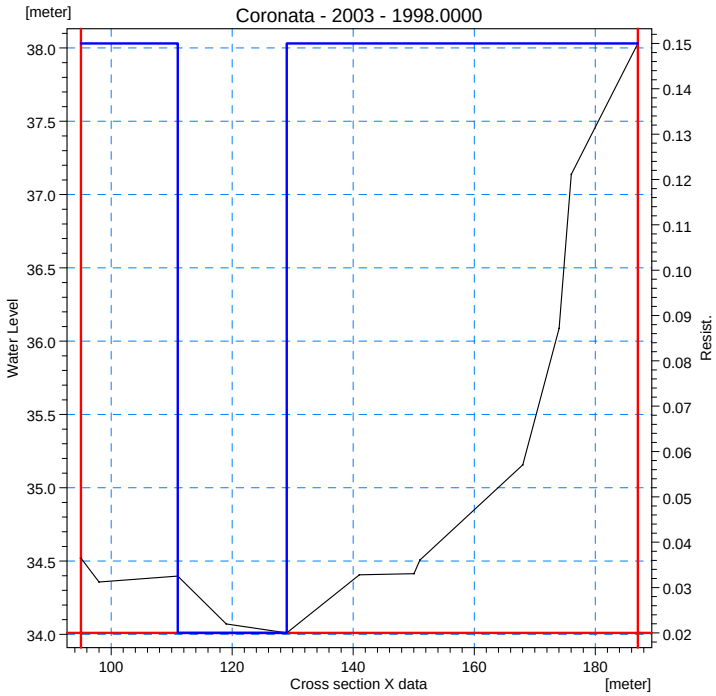

Cordo_Oland - 2003 - 2424.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

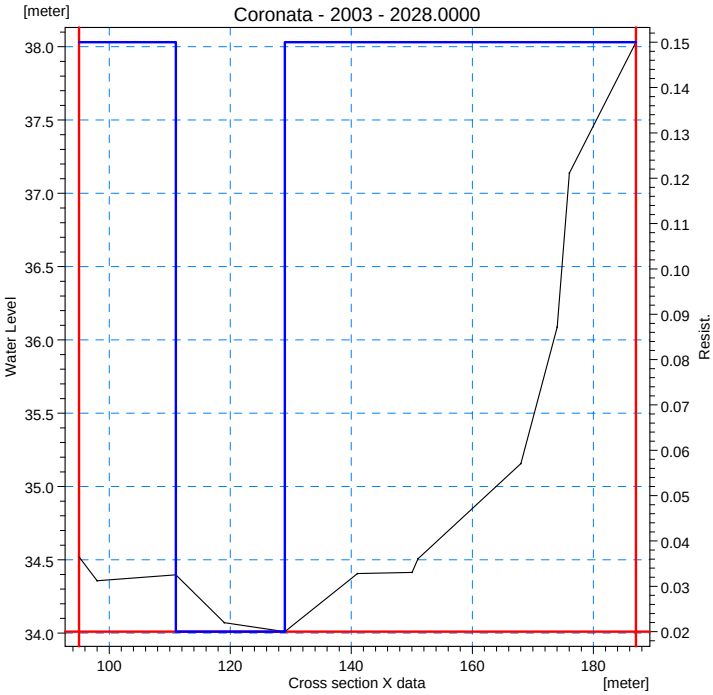

Cordo_Oland - 2003 - 2506.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

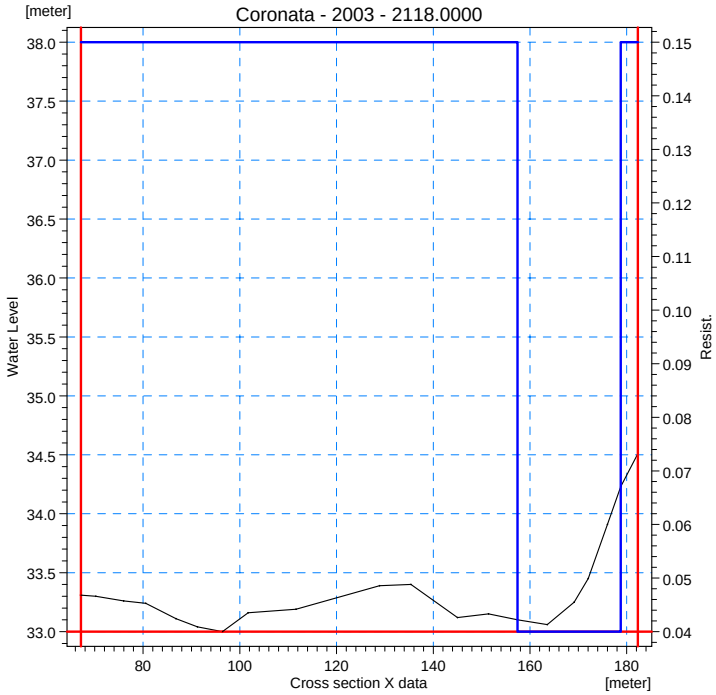

Cordo_Oland - 2003 - 2566.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cordo_Oland - 2003 - 2830.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 1934.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 1998.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2028.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2118.0000
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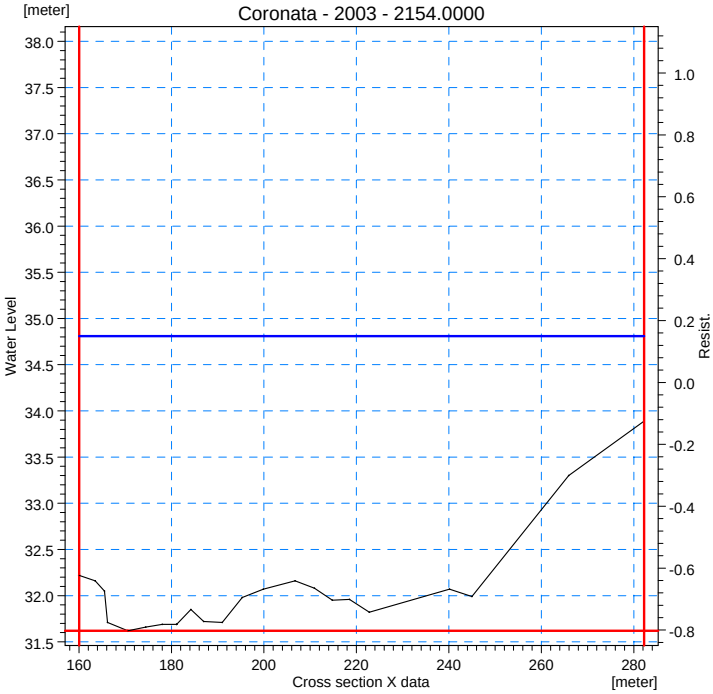
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2154.0000
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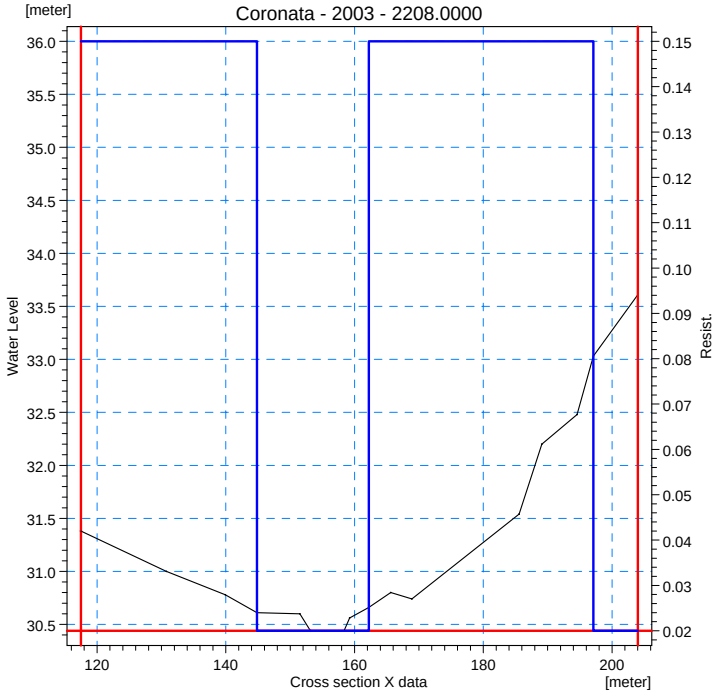
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2208.0000
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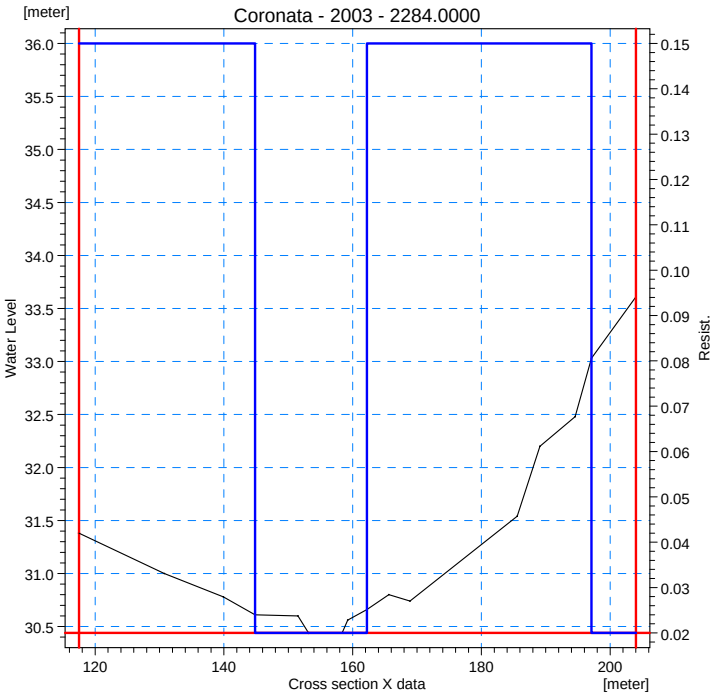
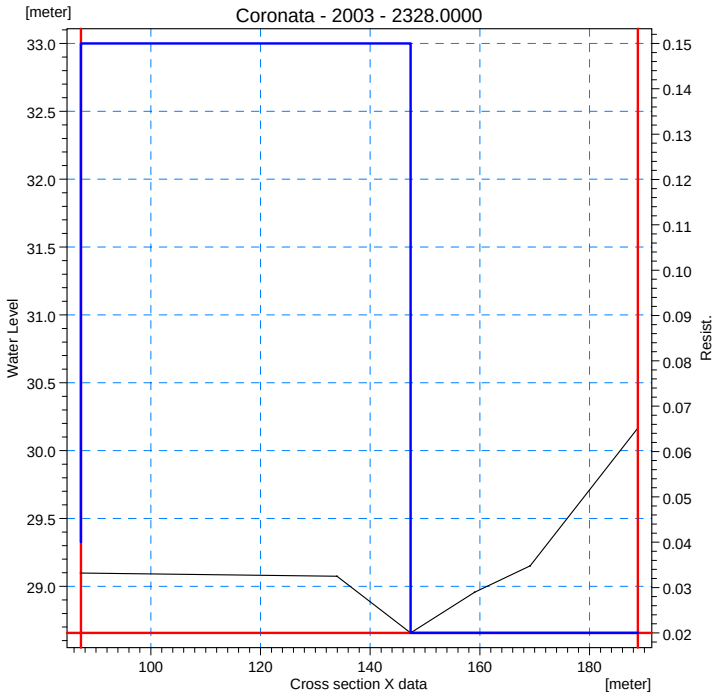
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2284.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Coronata - 2003 - 2328.0000
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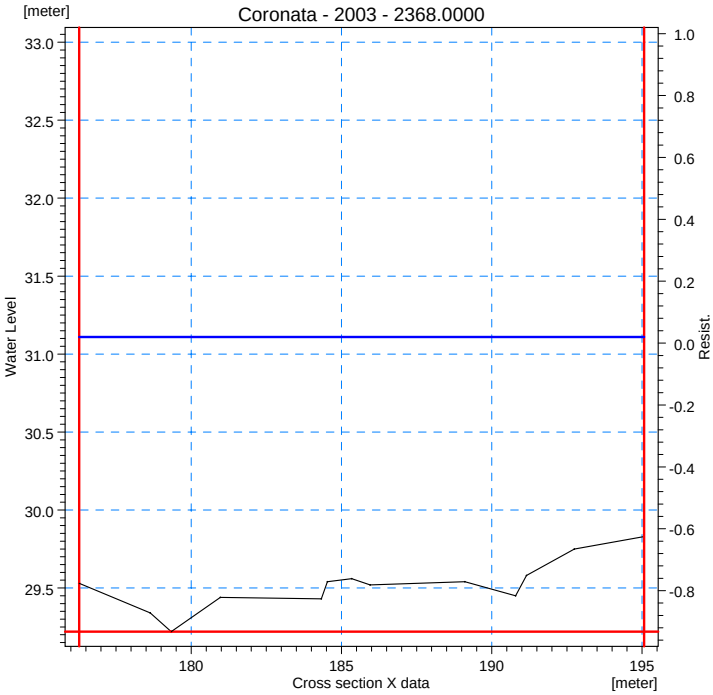
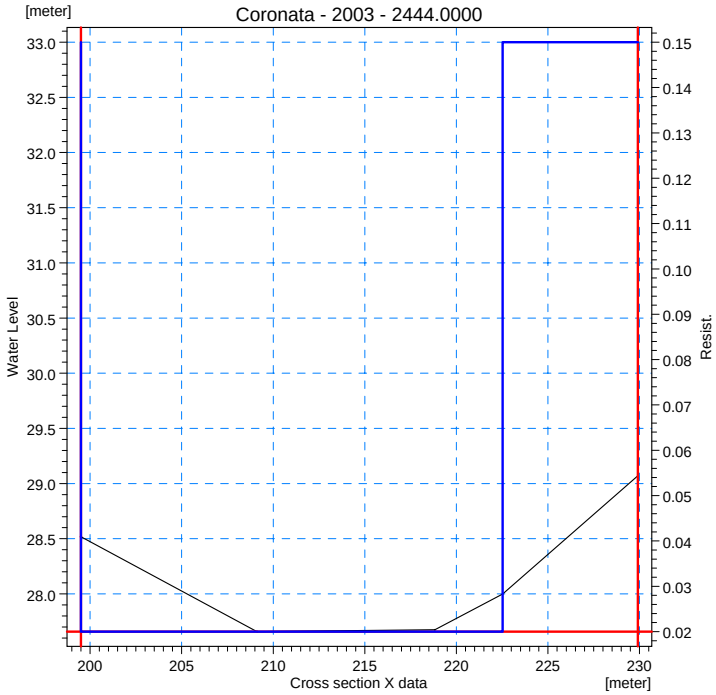
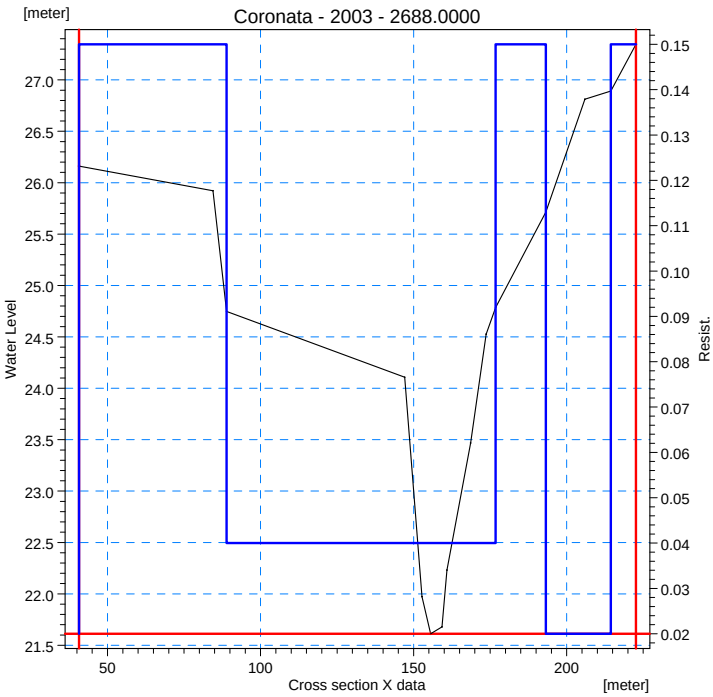
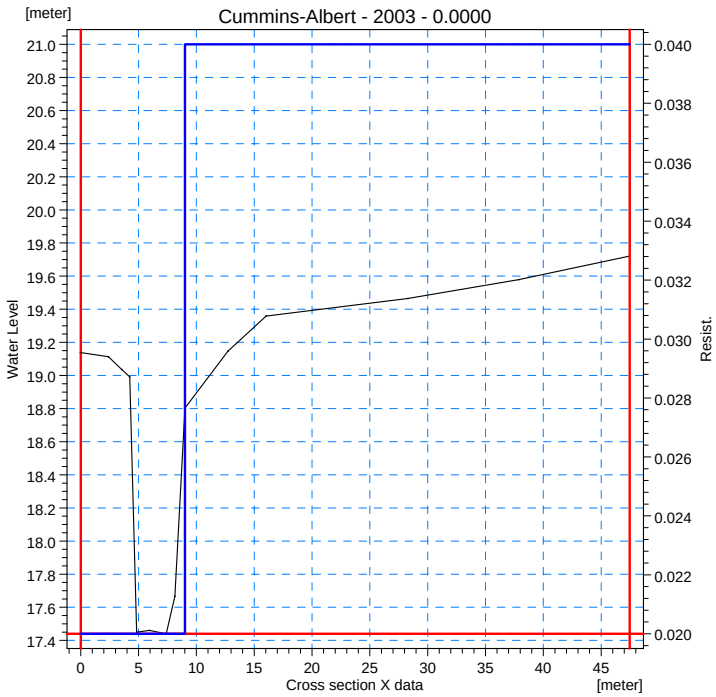
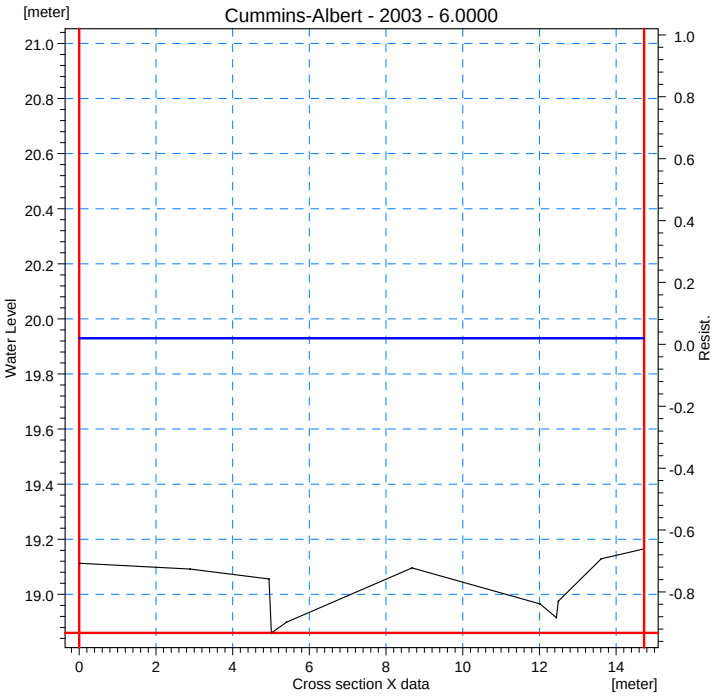
Water Level
Resist.
Cross section X data
[meter]

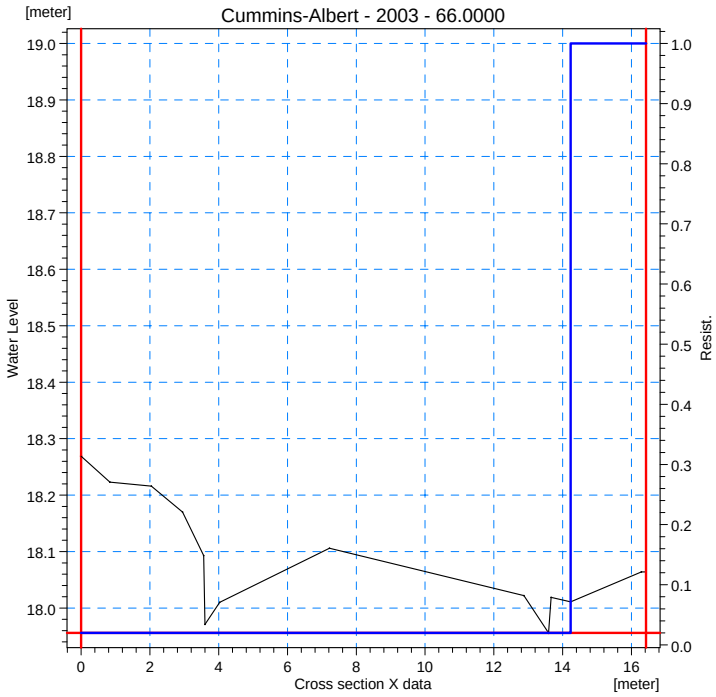

Coronata - 2003 - 2368.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

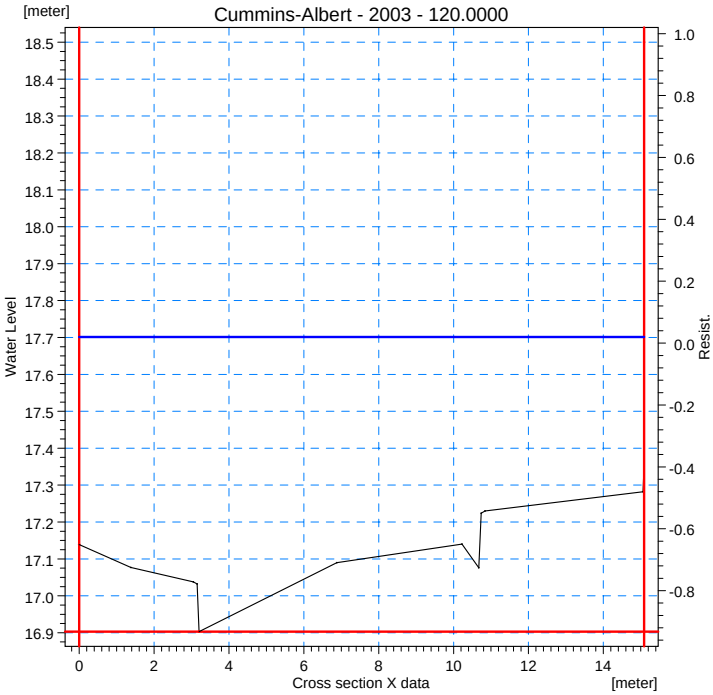

Coronata - 2003 - 2444.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

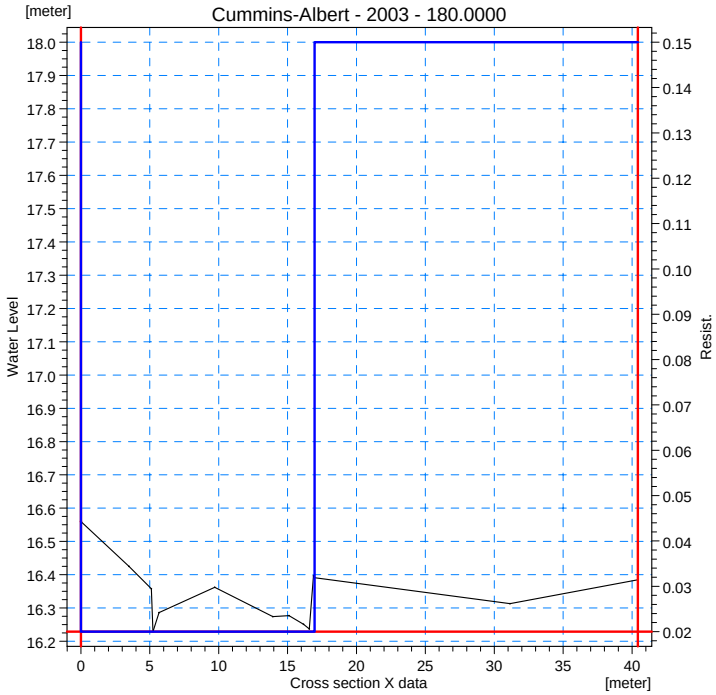

Coronata - 2003 - 2688.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

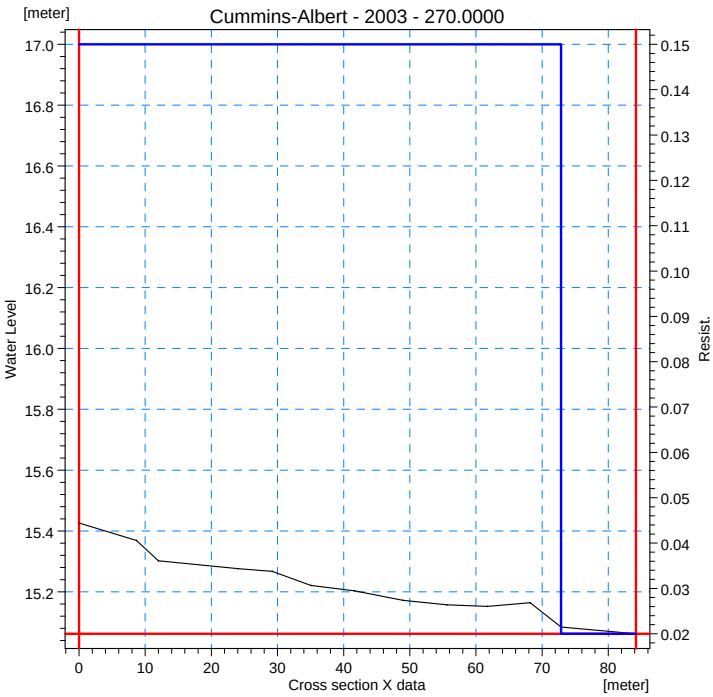

Cummins-Albert - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

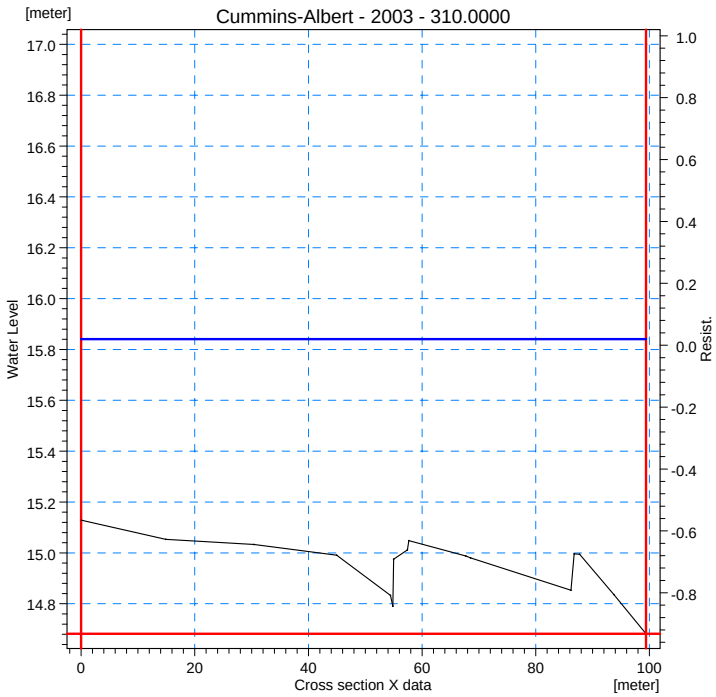

Cummins-Albert - 2003 - 6.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

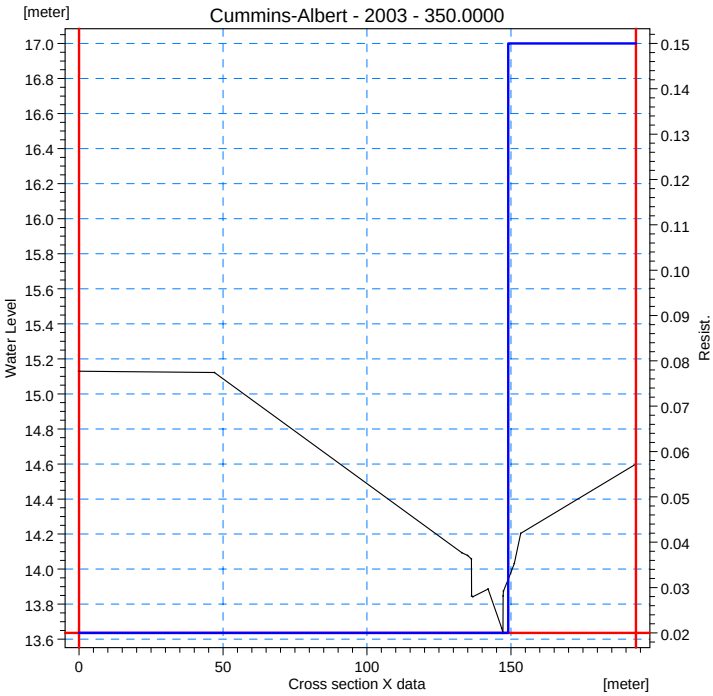

Cummins-Albert - 2003 - 66.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

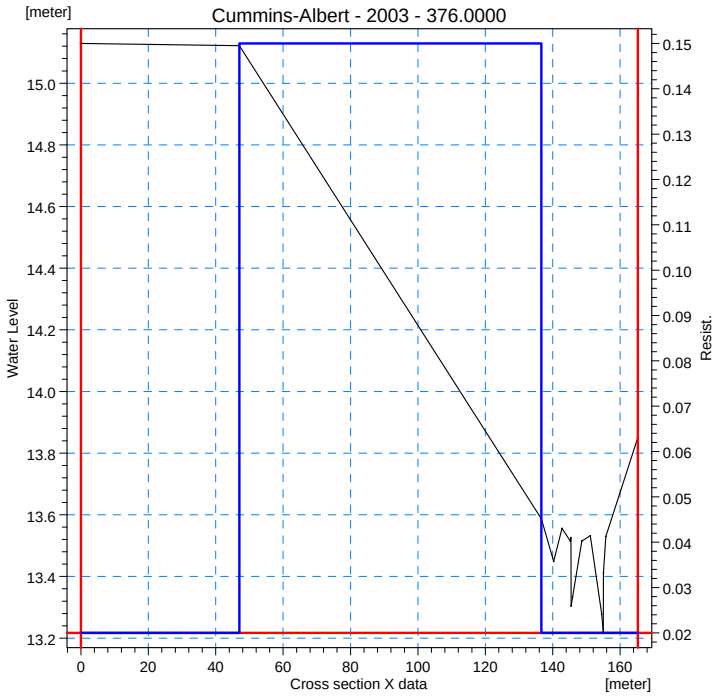

Cummins-Albert - 2003 - 120.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

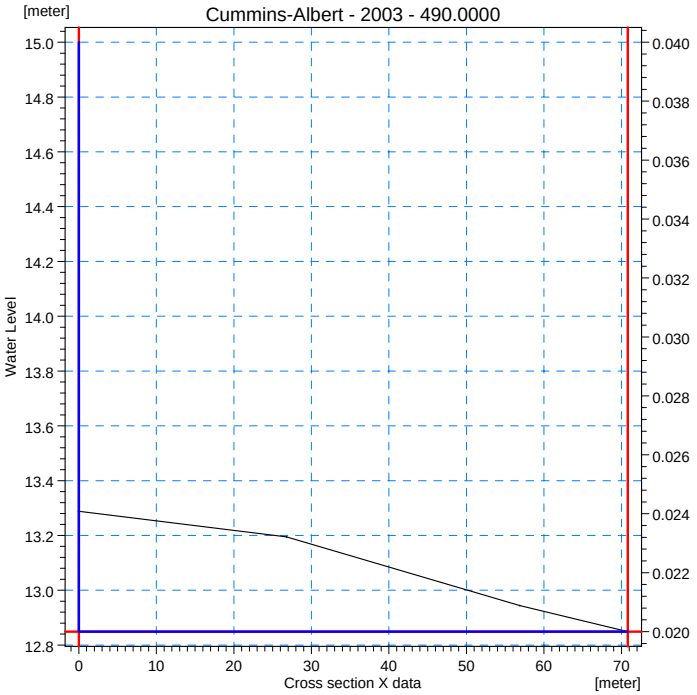

Cummins-Albert - 2003 - 180.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

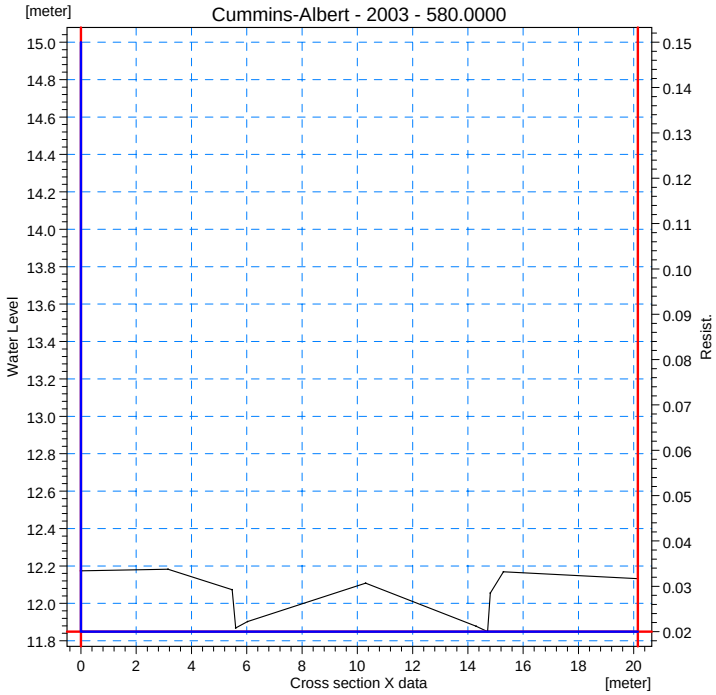

Cummins-Albert - 2003 - 270.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

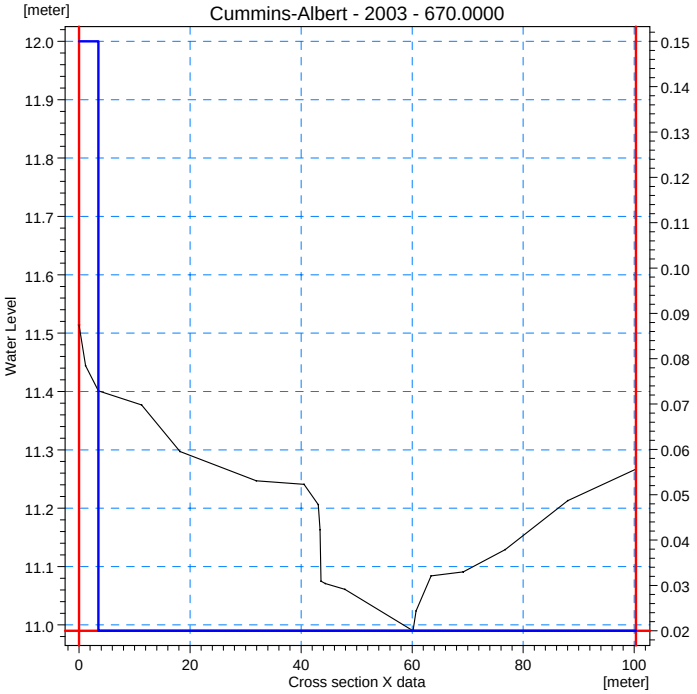

Cummins-Albert - 2003 - 310.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

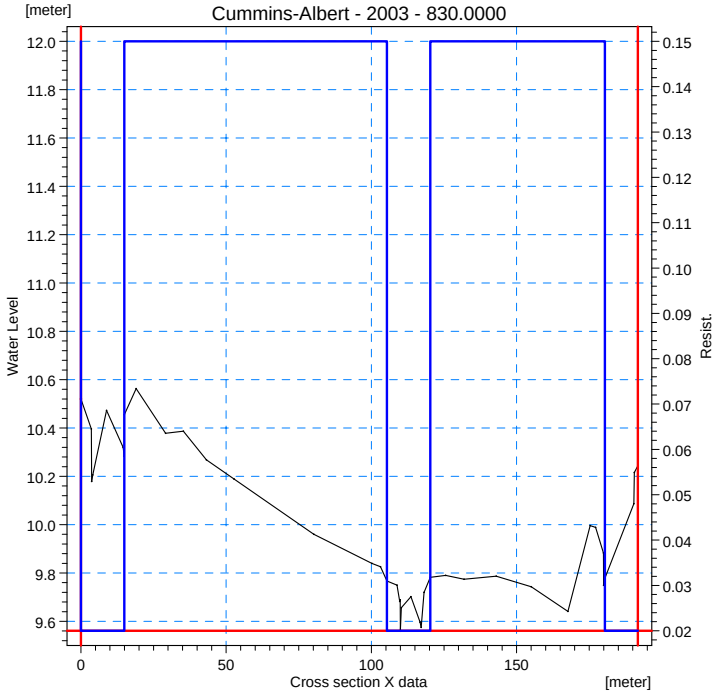

Cummins-Albert - 2003 - 350.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

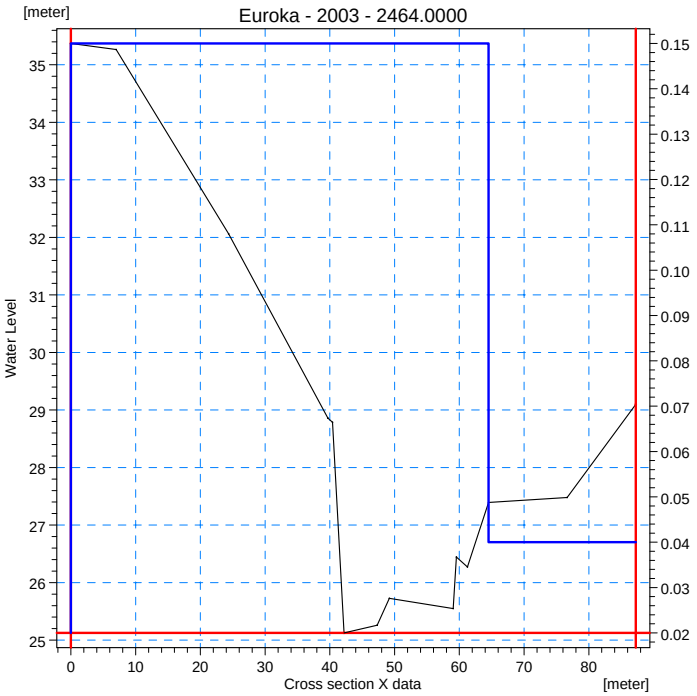

Cummins-Albert - 2003 - 376.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cummins-Albert - 2003 - 490.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cummins-Albert - 2003 - 580.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cummins-Albert - 2003 - 670.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Cummins-Albert - 2003 - 830.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Euroka - 2003 - 2464.0000
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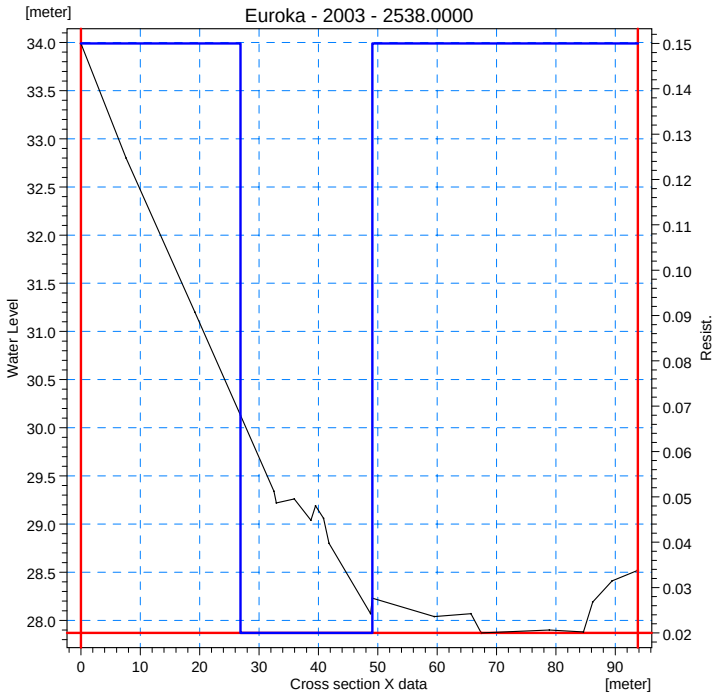
Water Level
Resist.
Cross section X data
[meter]


Euroka - 2003 - 2538.0000
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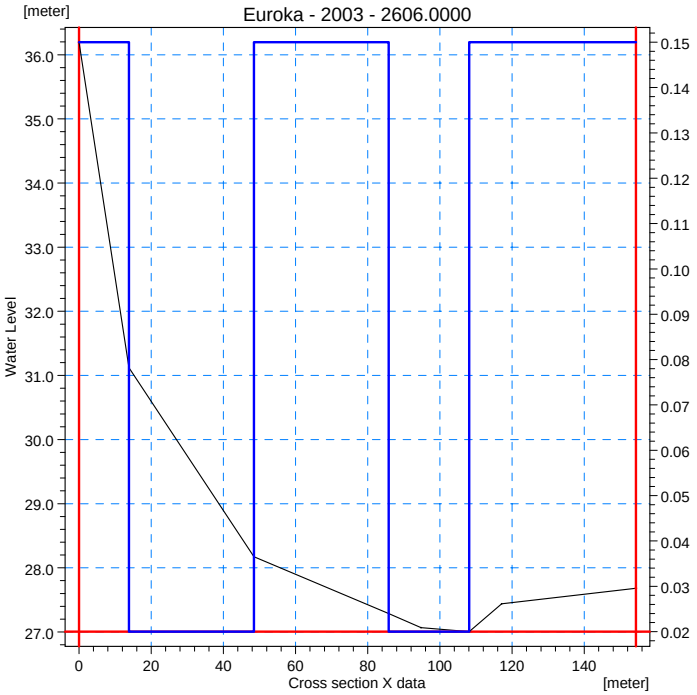
Water Level
Resist.
Cross section X data
[meter]


Euroka - 2003 - 2606.0000
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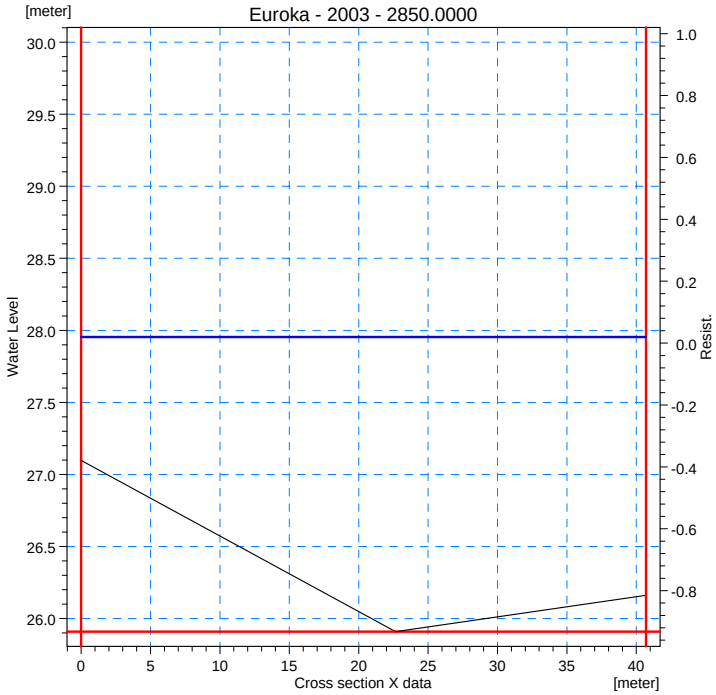
Water Level
Resist.
Cross section X data
[meter]


Euroka - 2003 - 2850.0000
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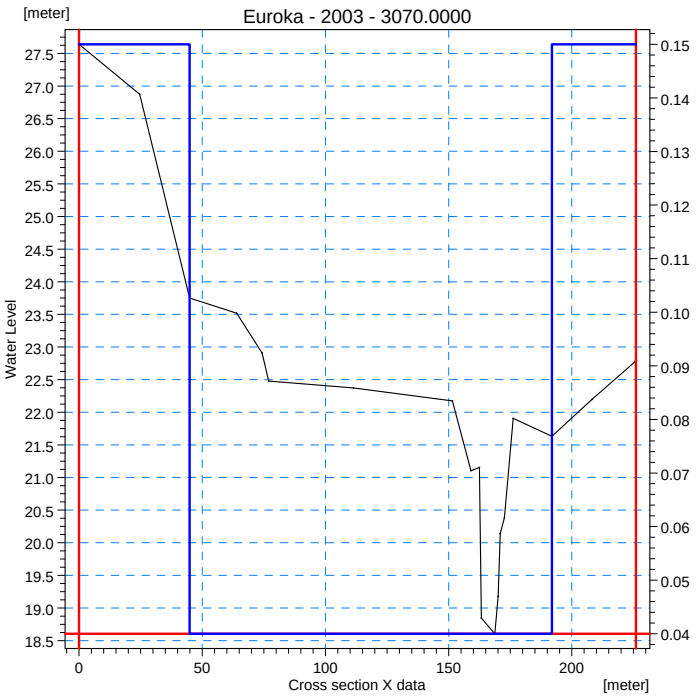
Water Level
Resist.
Cross section X data
[meter]


Euroka - 2003 - 3070.0000
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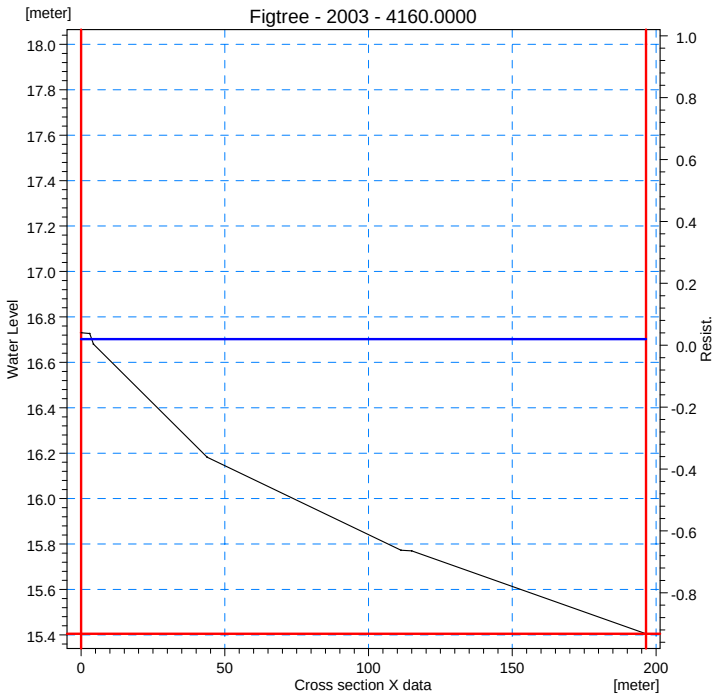
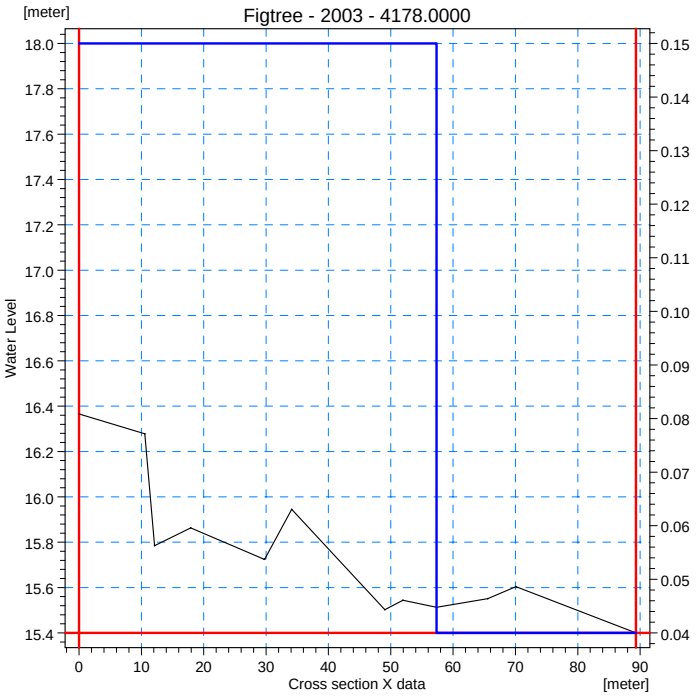
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4178.0000
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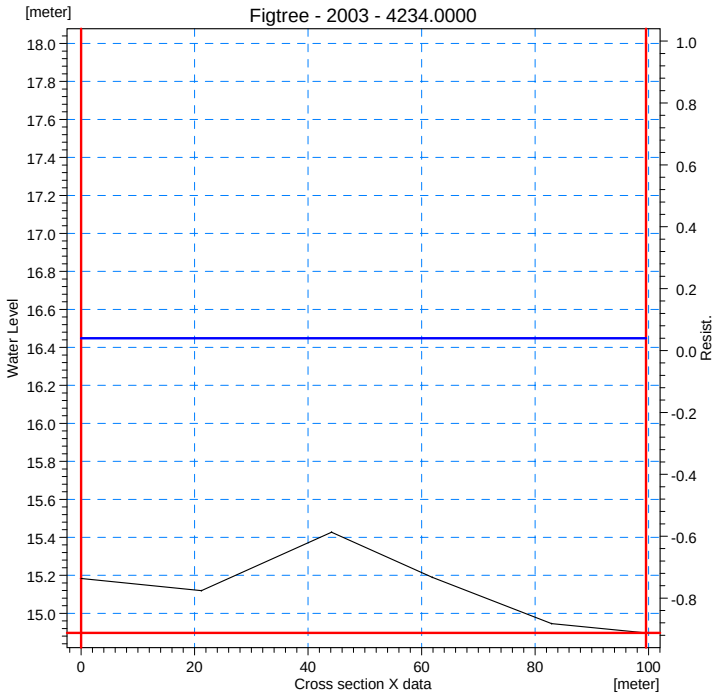
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4234.0000
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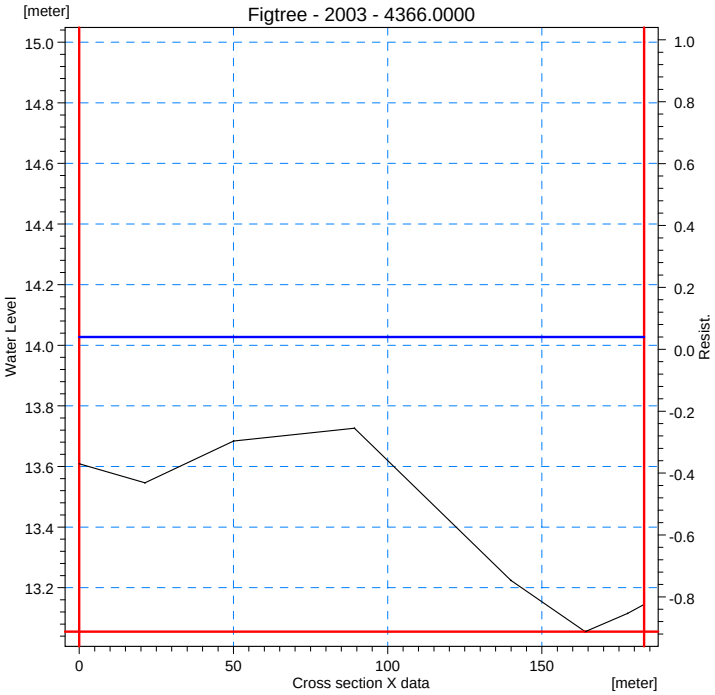
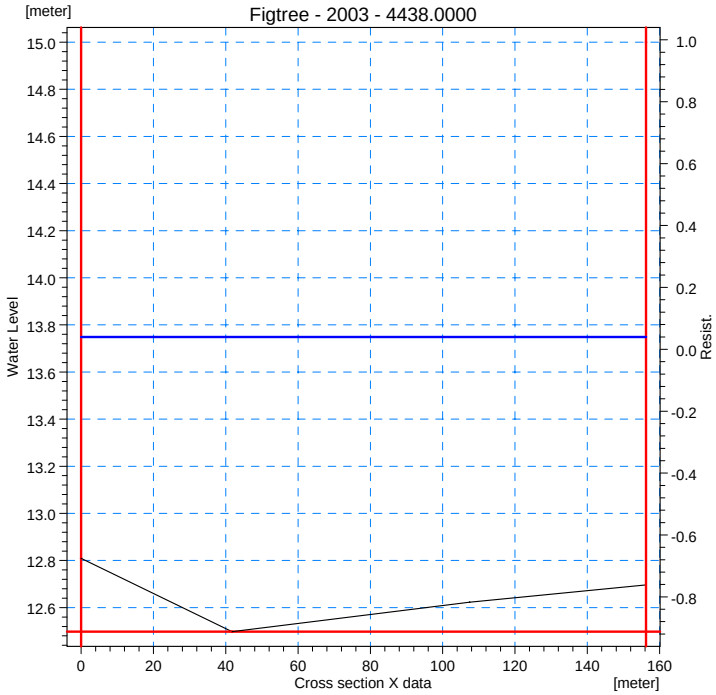
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4366.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4438.0000
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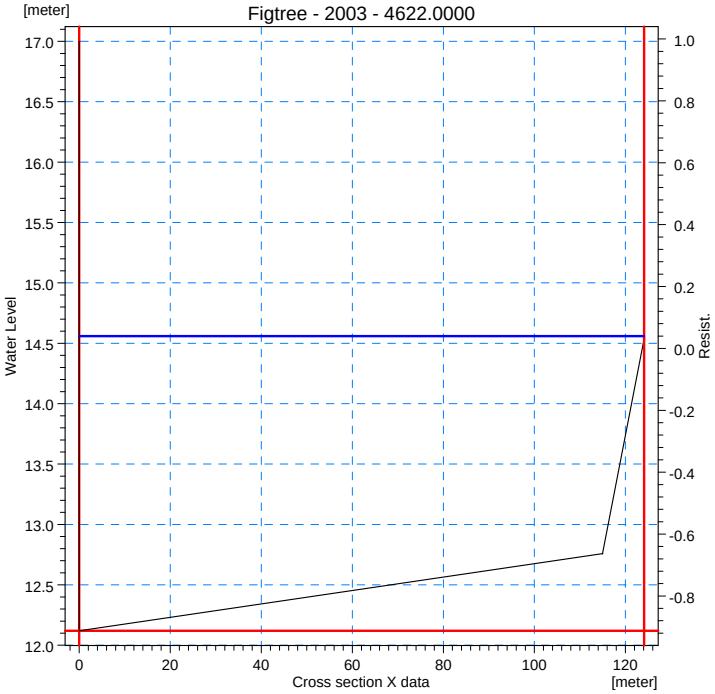
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4622.0000
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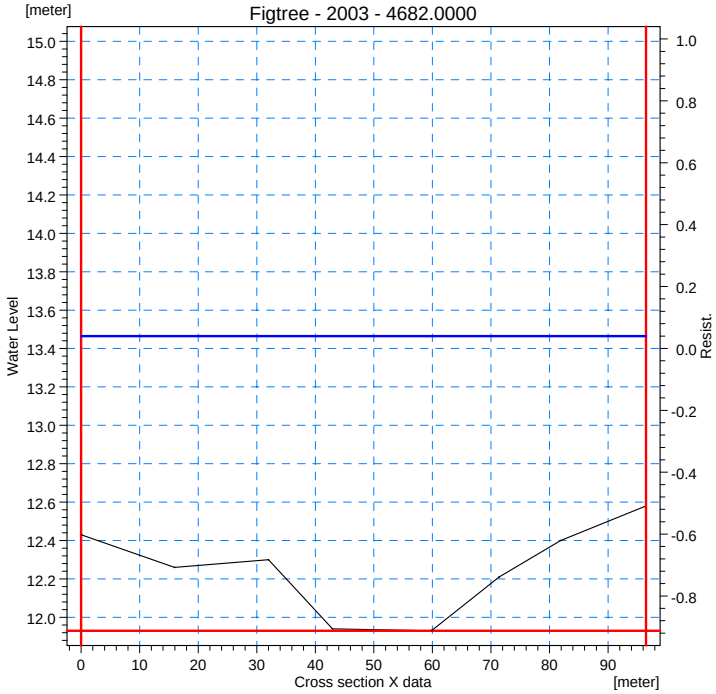
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4682.0000
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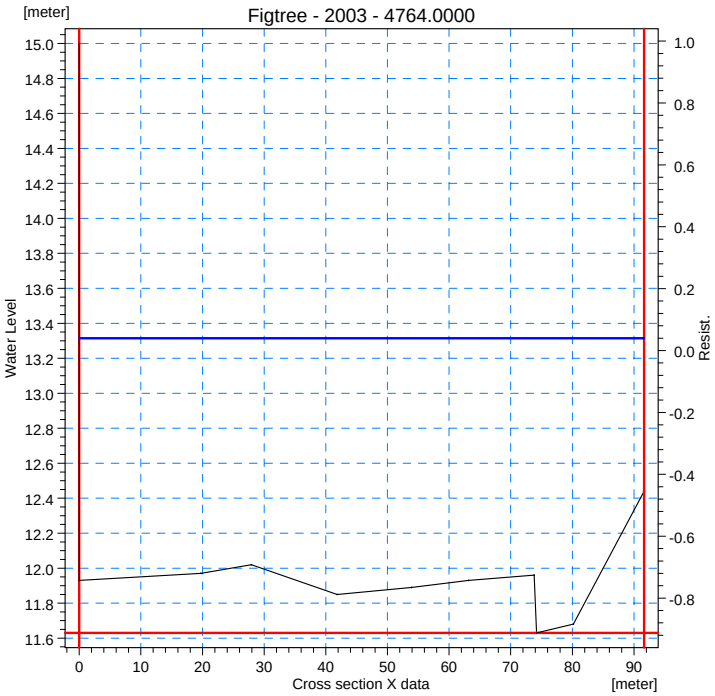
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4764.0000
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Cross section X data
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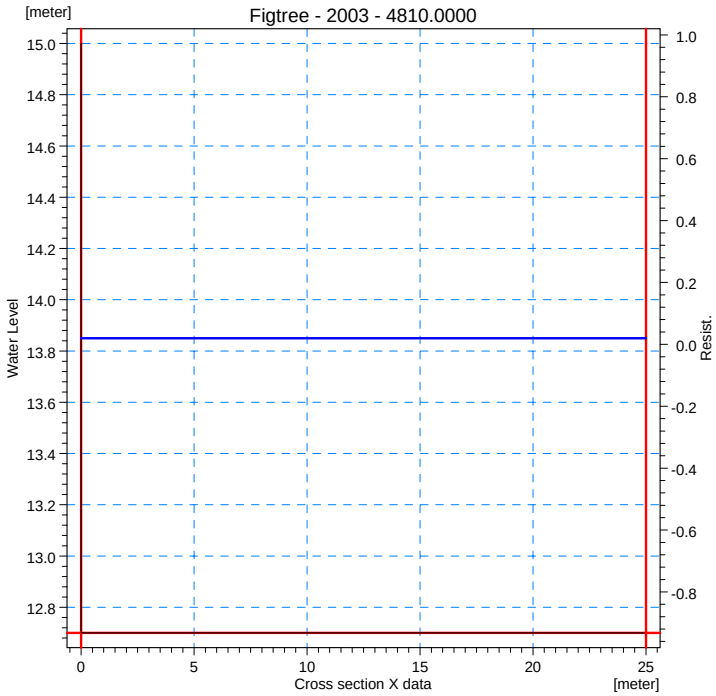
Figtree - 2003 - 4810.0000
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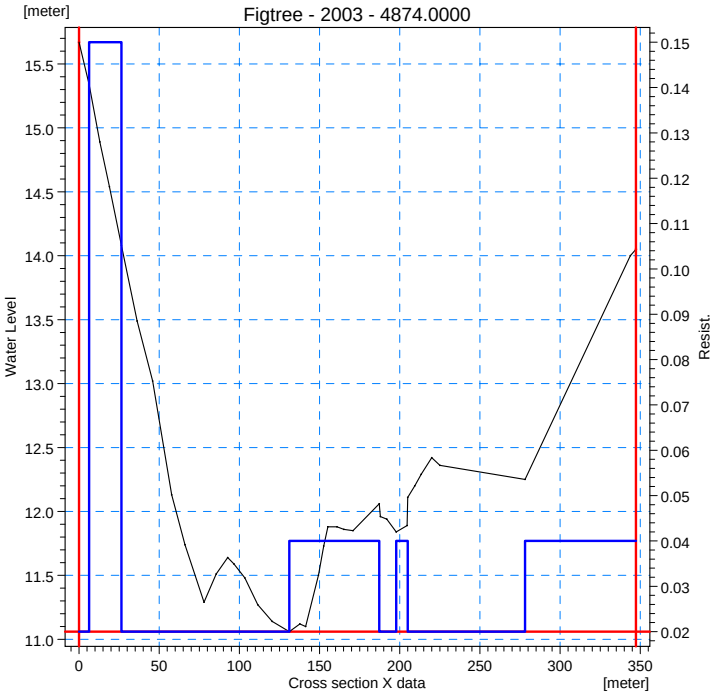
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4874.0000
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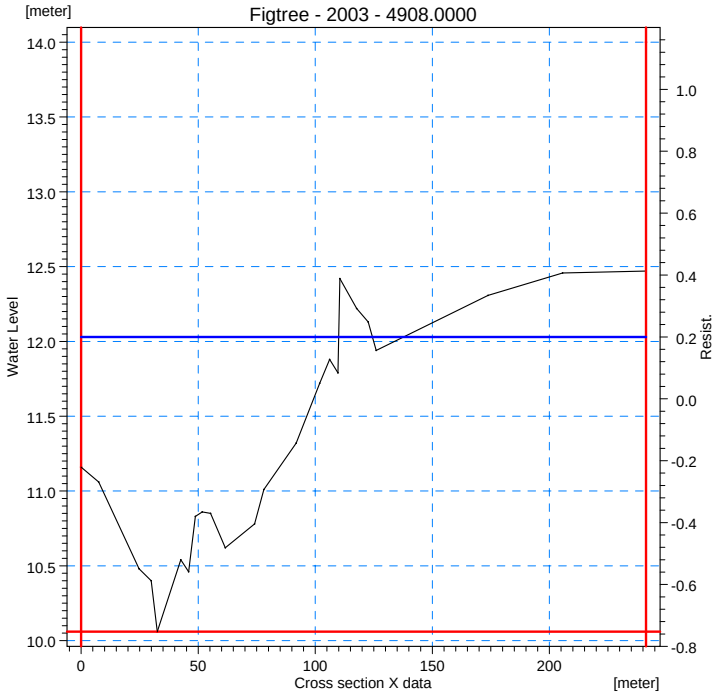
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4908.0000
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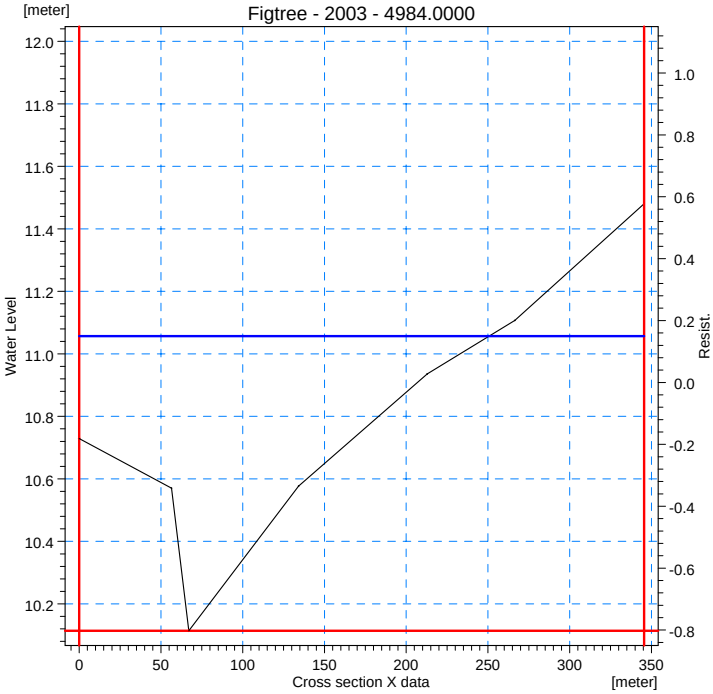
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 4984.0000
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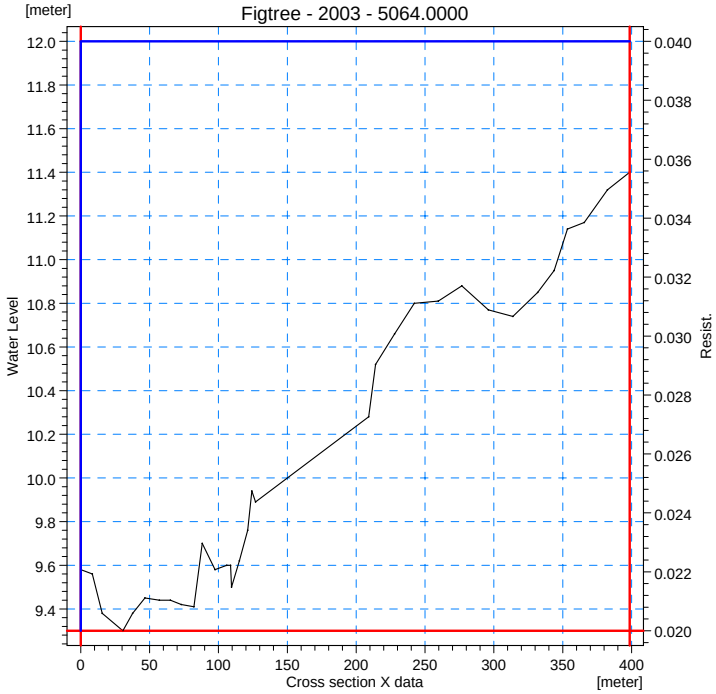
Water Level
Resist.
Cross section X data
[meter]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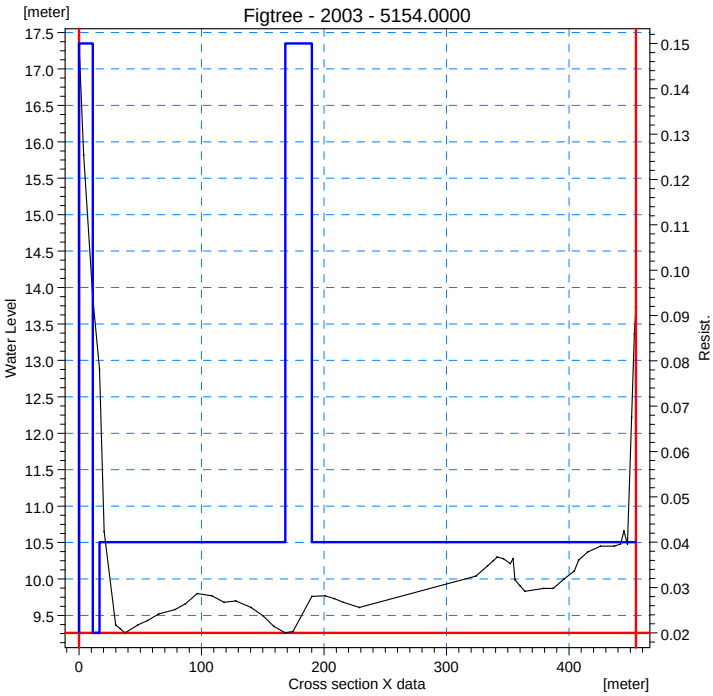
Cross section X data
[meter]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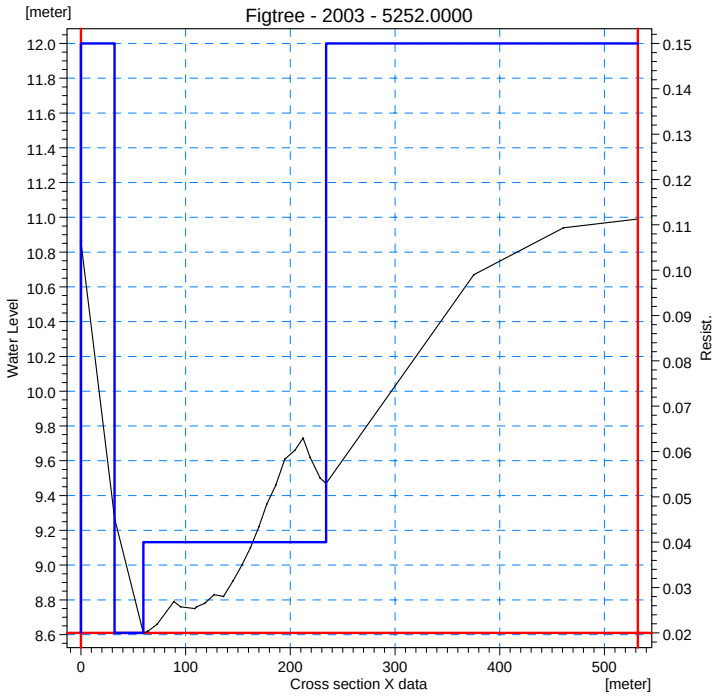
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 5252.0000
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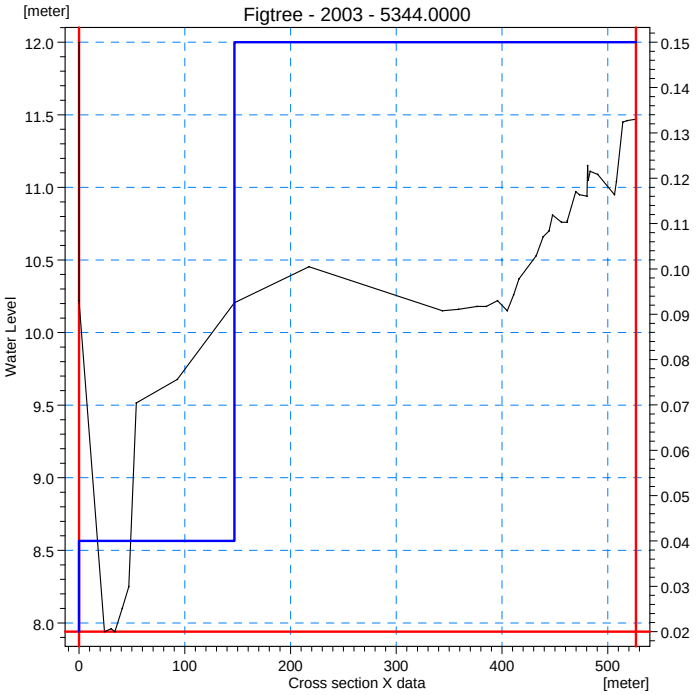
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 5344.0000
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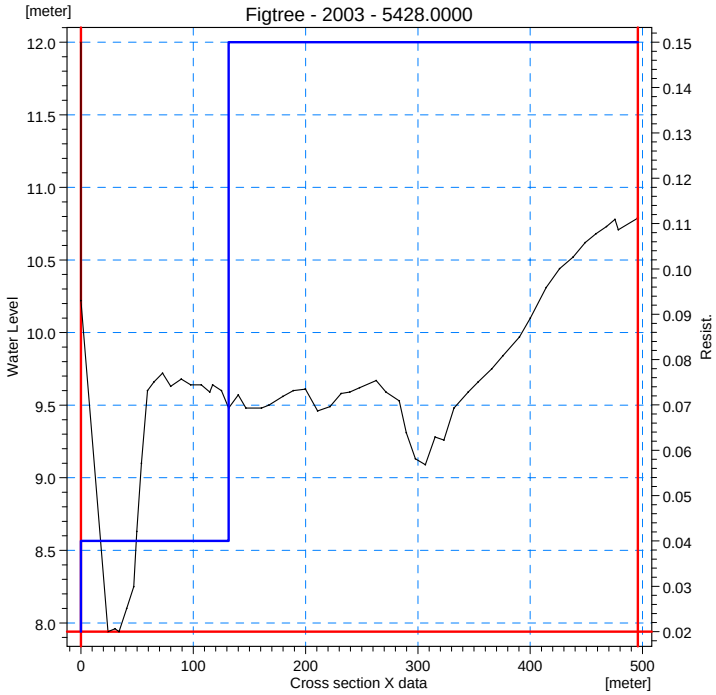
Water Level
Resist.
Cross section X data
[meter]


Figtree - 2003 - 5428.0000
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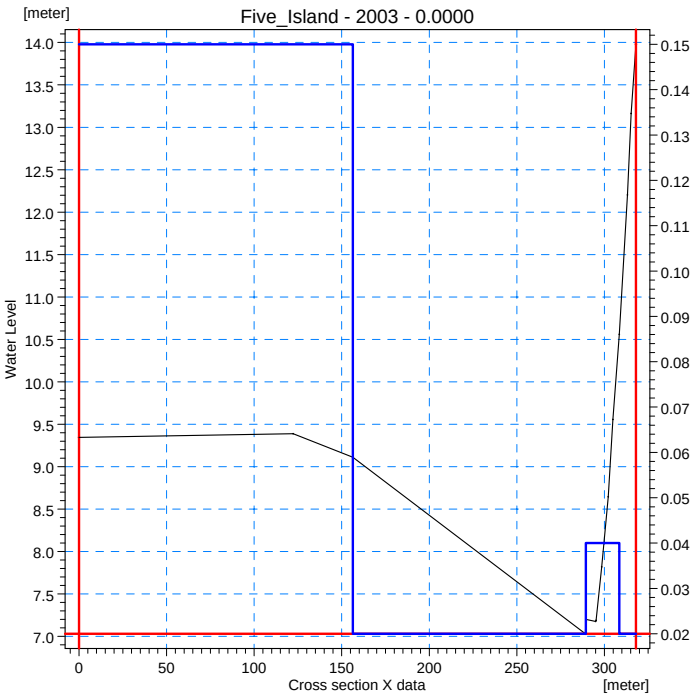
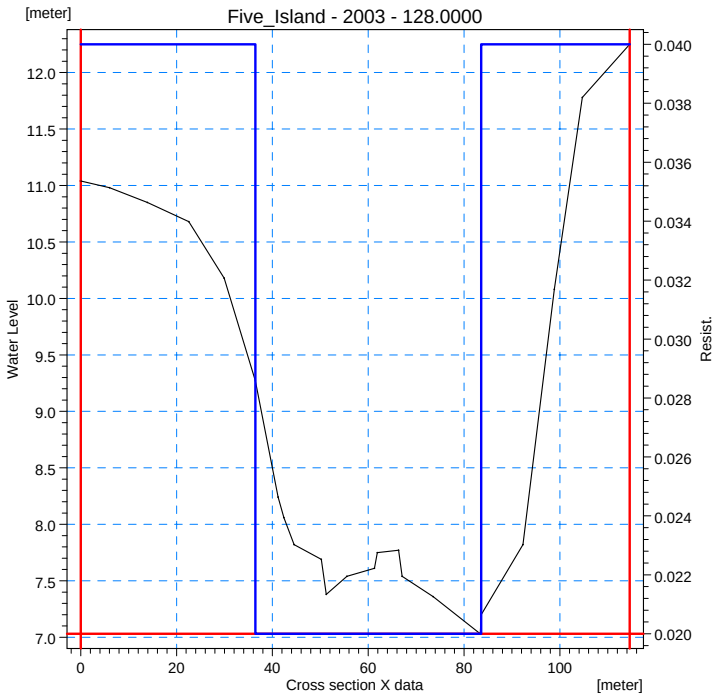
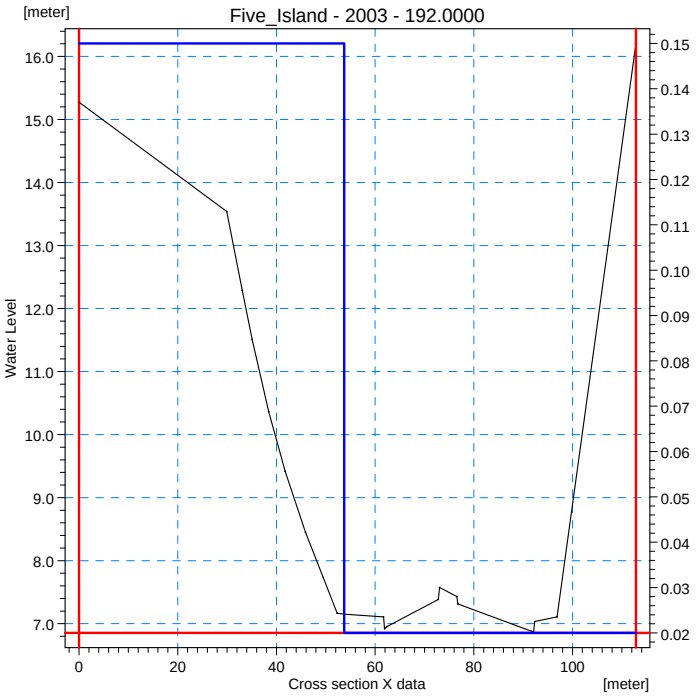
Water Level
Resist.
Cross section X data
[meter]


Five_Island - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Five_Island - 2003 - 128.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Five_Island - 2003 - 192.0000
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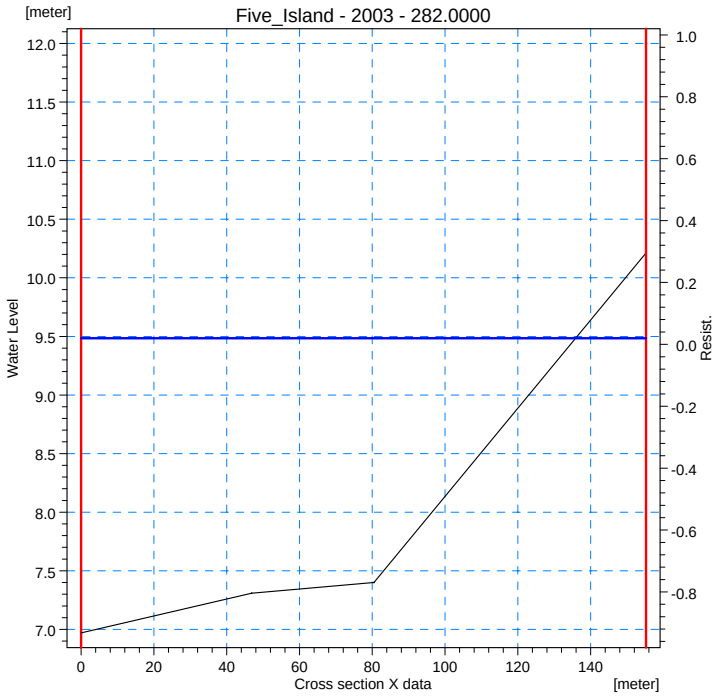
Water Level
Resist.
Cross section X data
[meter]


Five_Island - 2003 - 282.0000
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Water Level
Resist.
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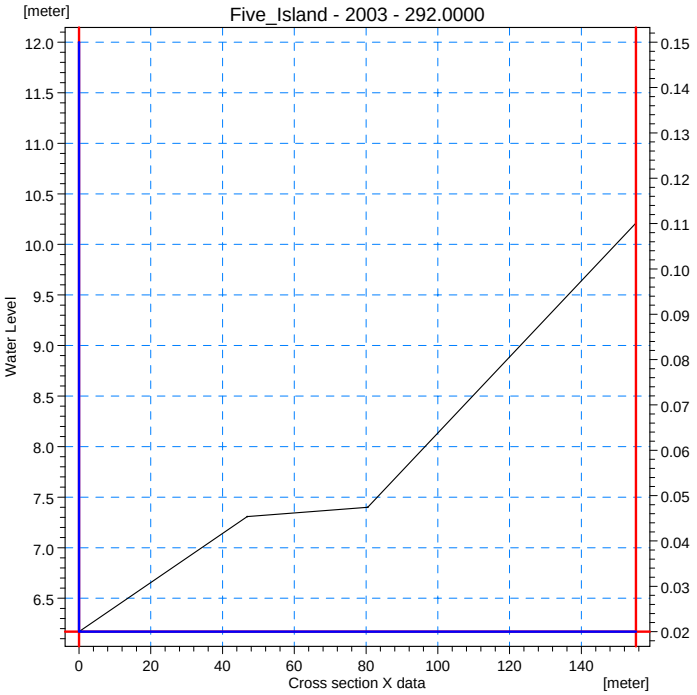
[meter]


Five_Island - 2003 - 292.0000
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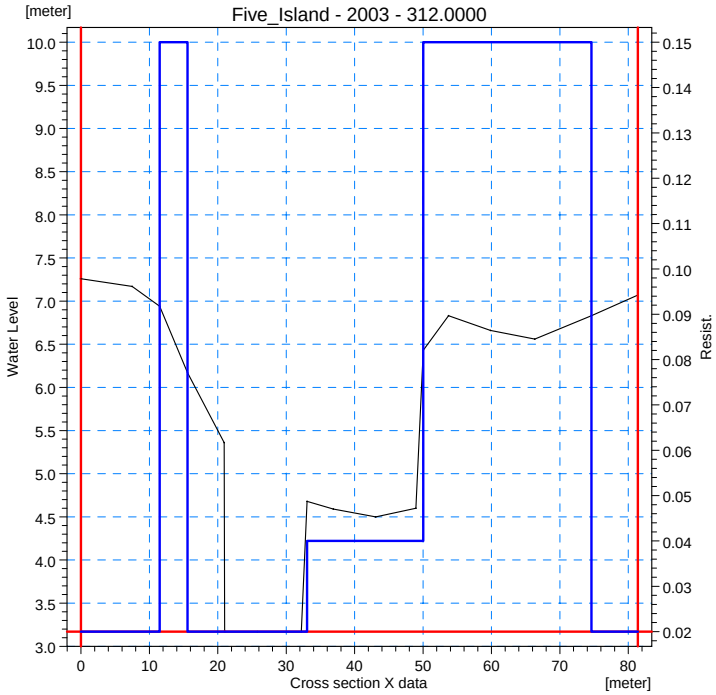
Water Level
Resist.
Cross section X data
[meter]


Five_Island - 2003 - 312.0000
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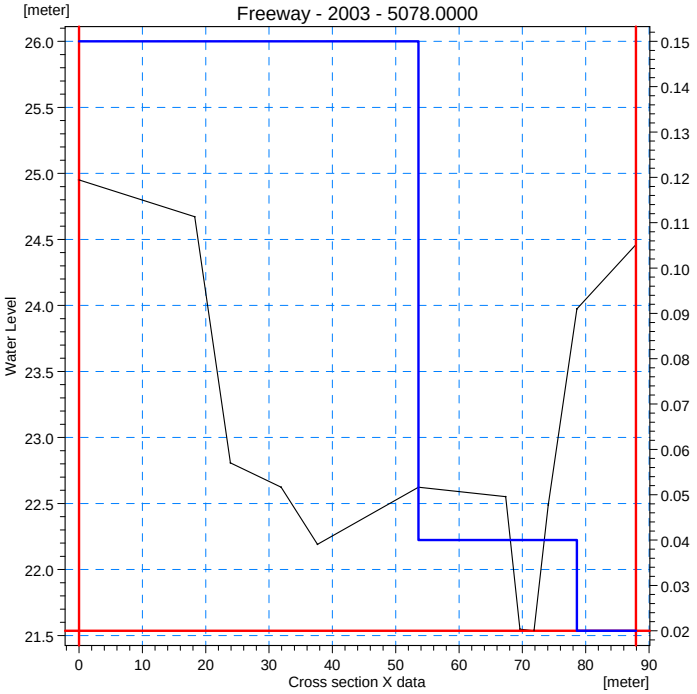
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 5078.0000
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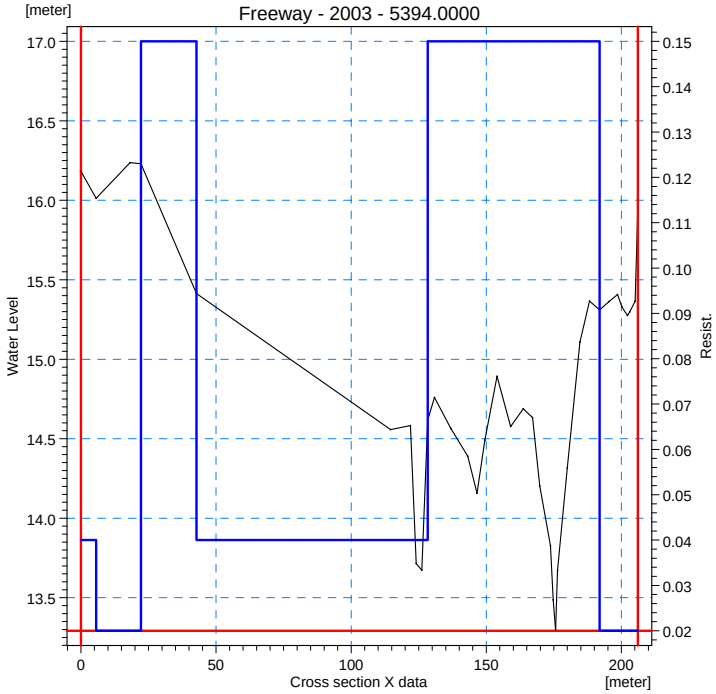
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 5394.0000
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Water Level
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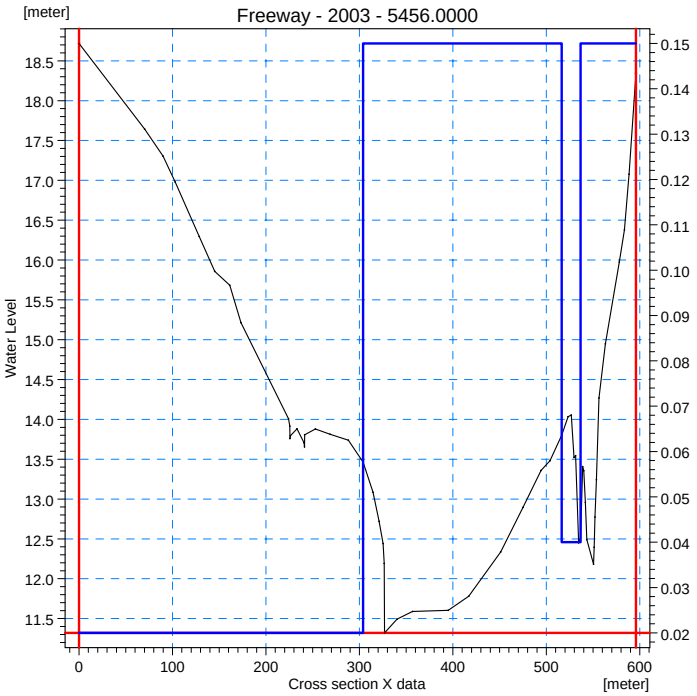
Cross section X data
[meter]


Freeway - 2003 - 5456.0000
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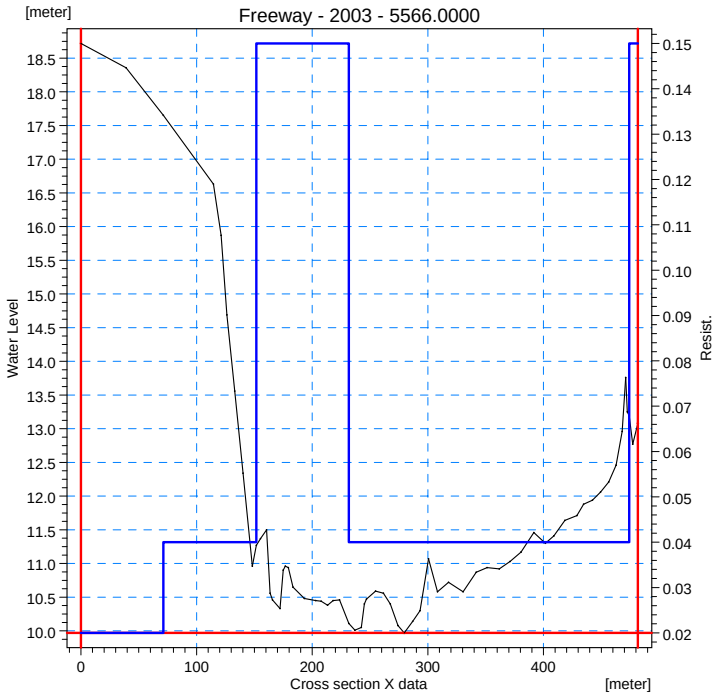
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 5566.0000
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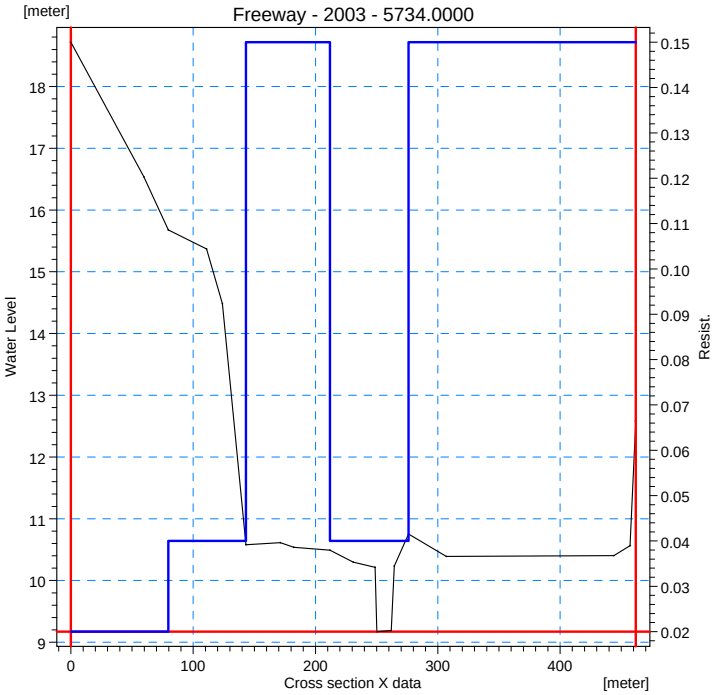
Water Level
Resist.
Cross section X data
[meter]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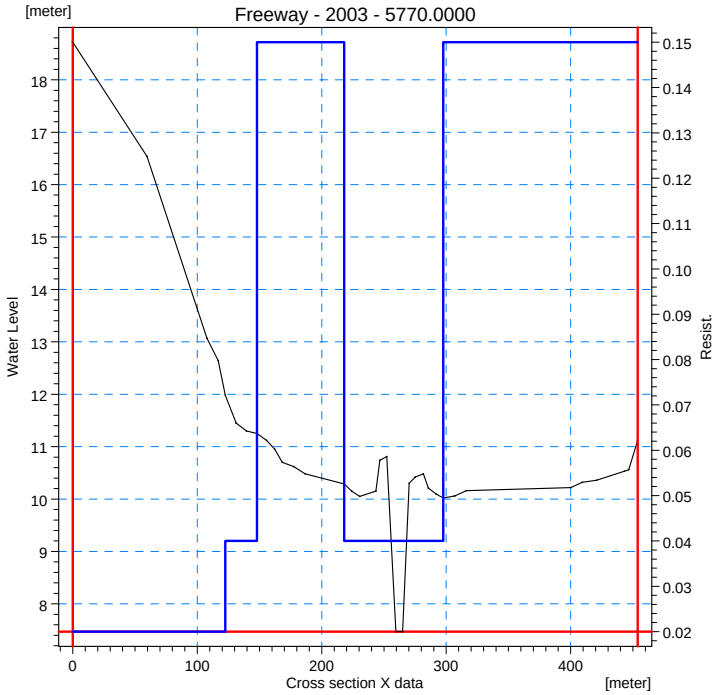
Water Level
Resist.
Cross section X data
[meter]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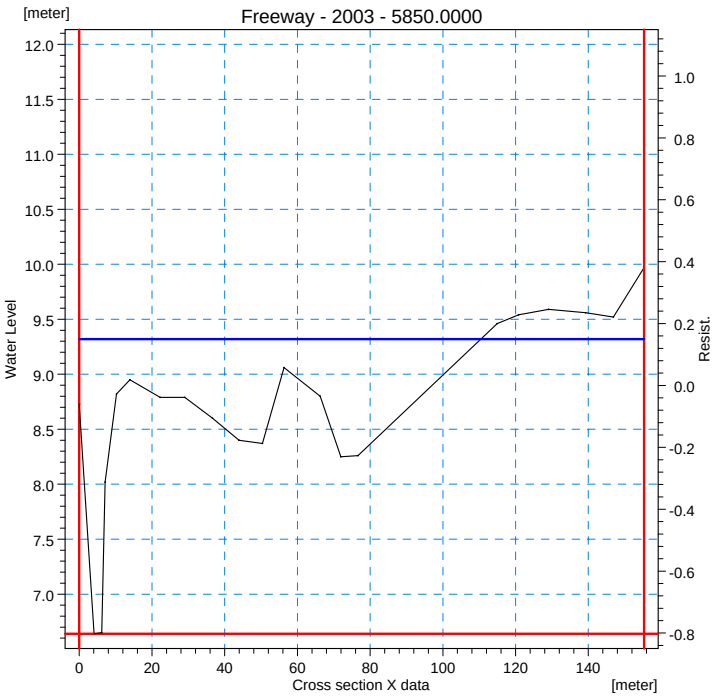
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 5850.0000
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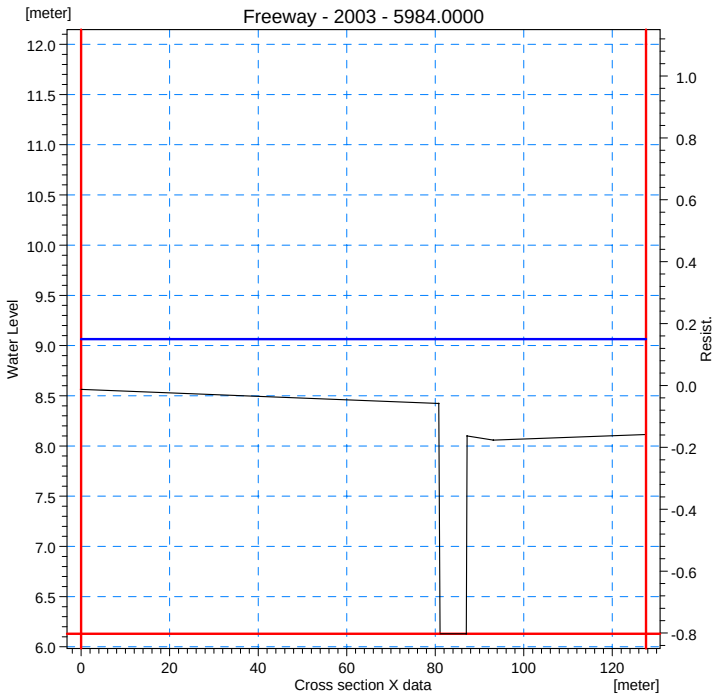
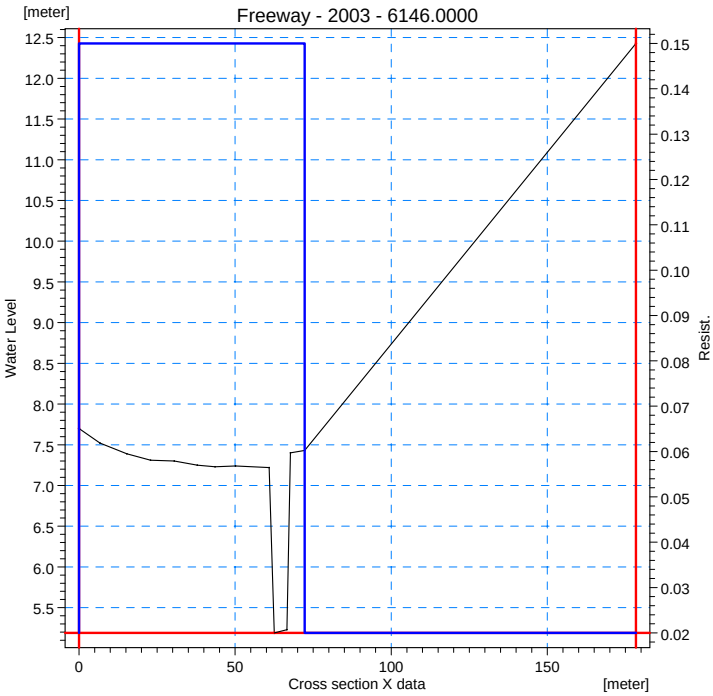
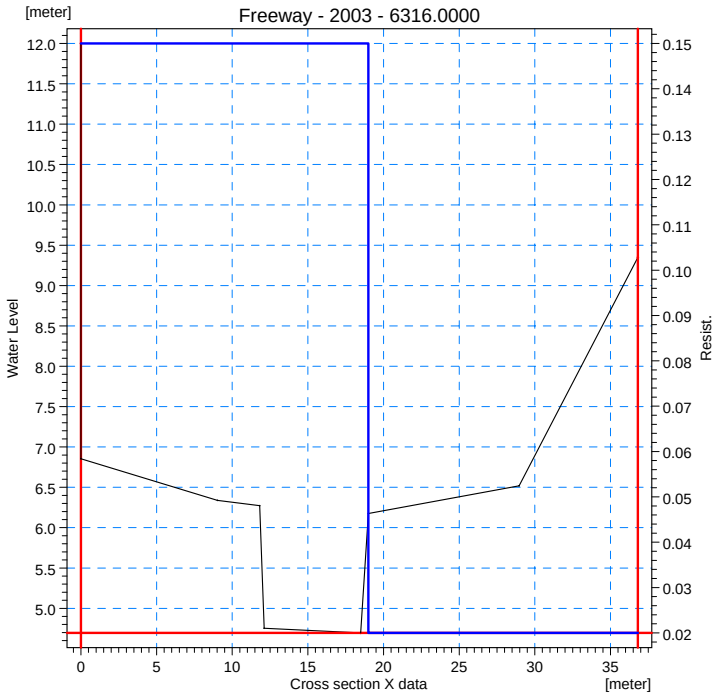
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 5984.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6146.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6316.0000
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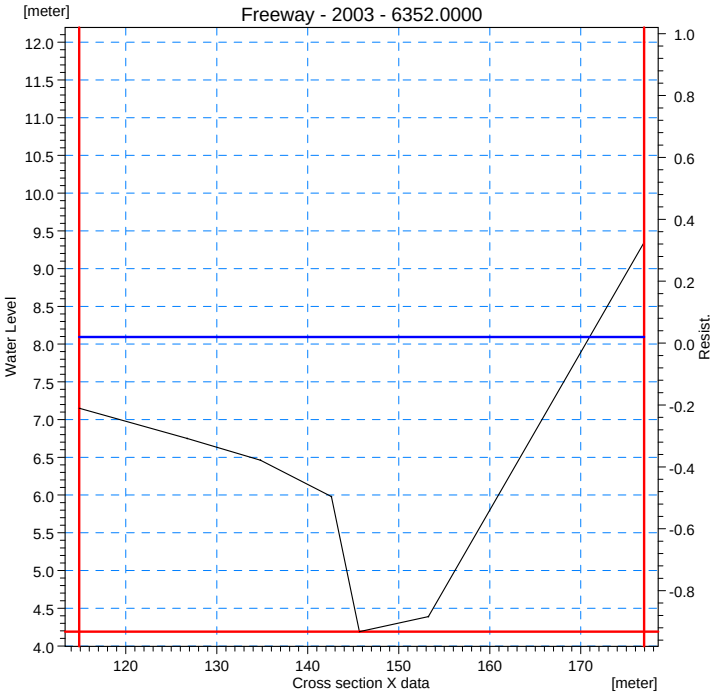
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6352.0000
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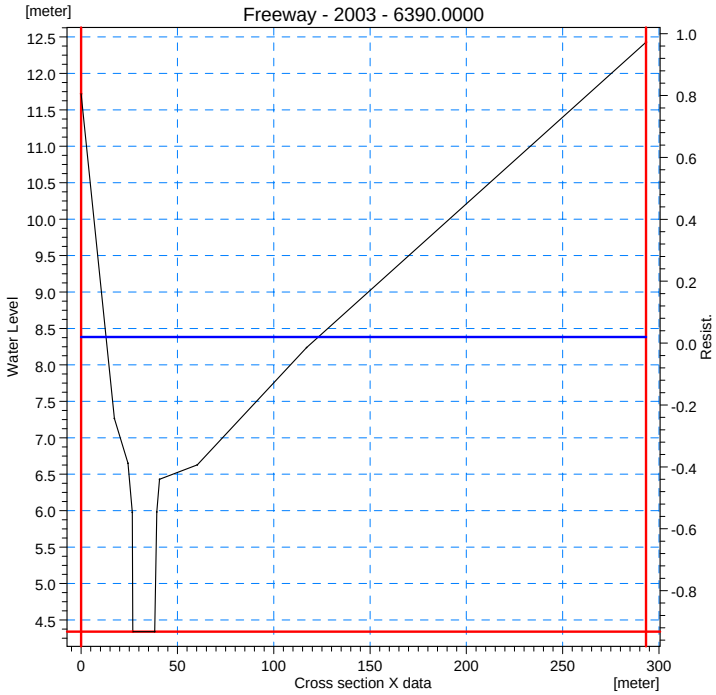
Water Level
Resist.
Cross section X data
[meter]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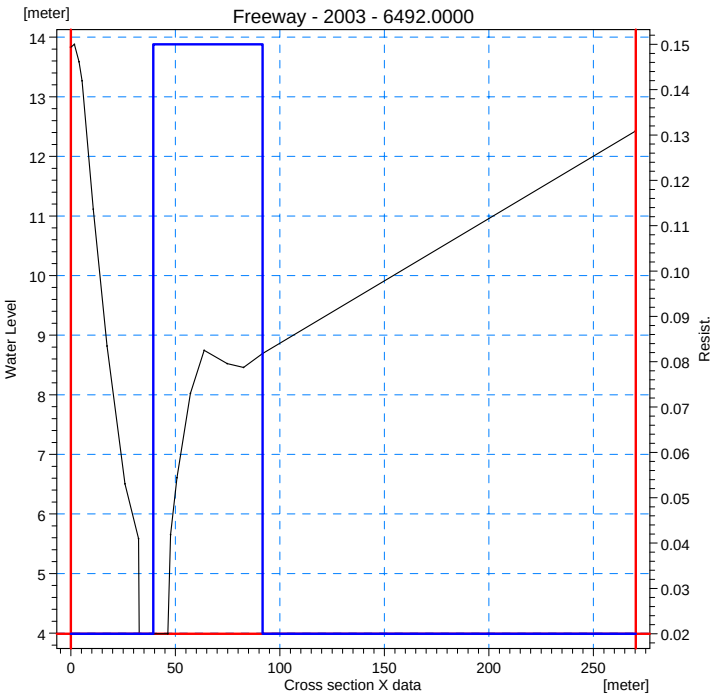
Water Level
Resist.
Cross section X data
[meter]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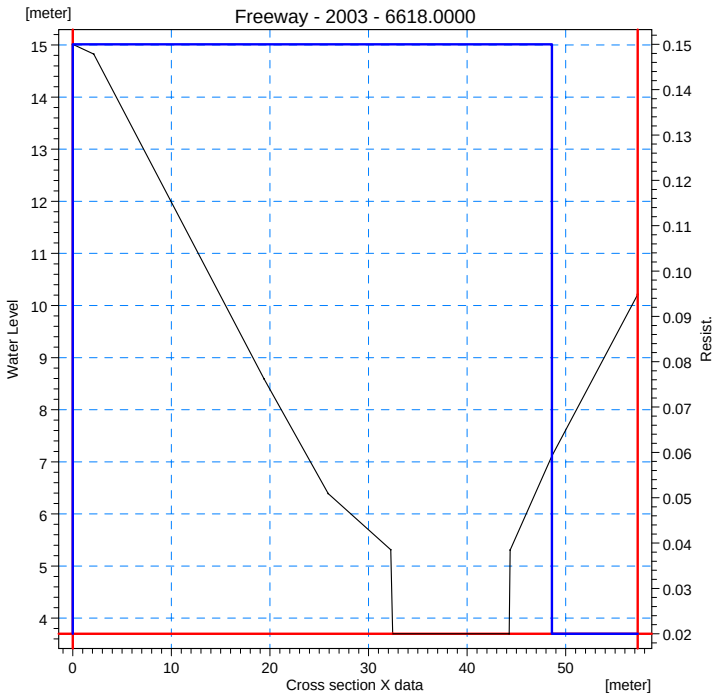
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6618.0000
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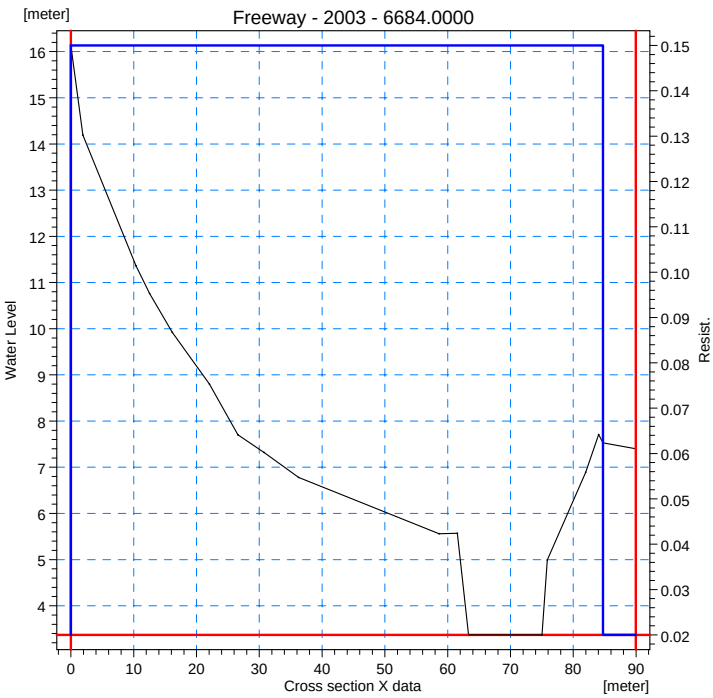
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6684.0000
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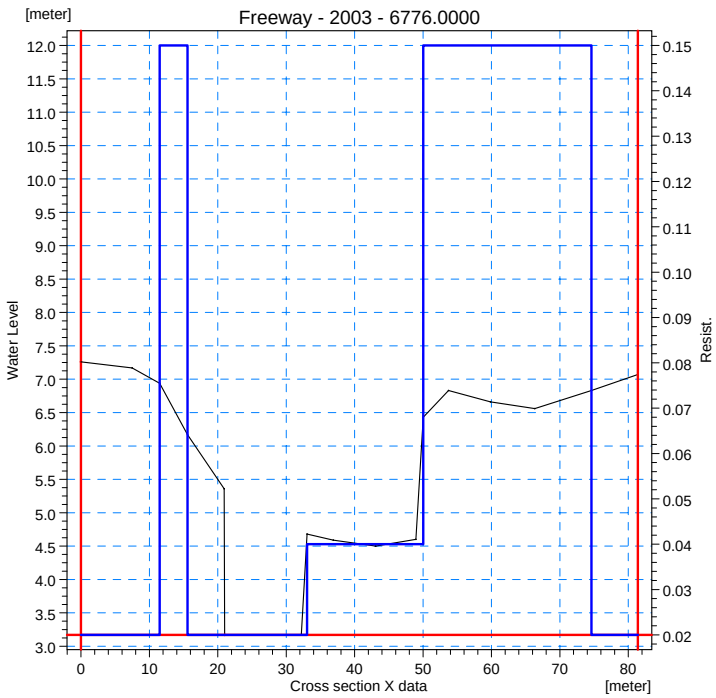
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6776.0000
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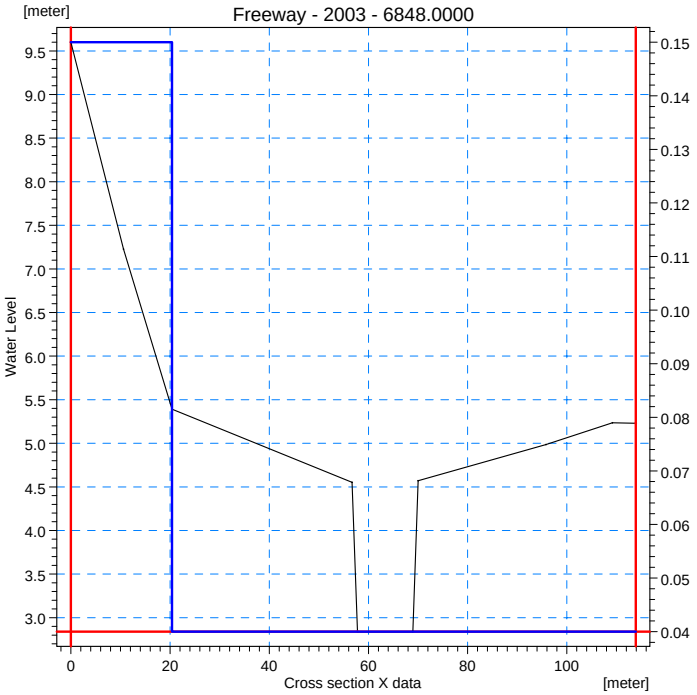
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6848.0000
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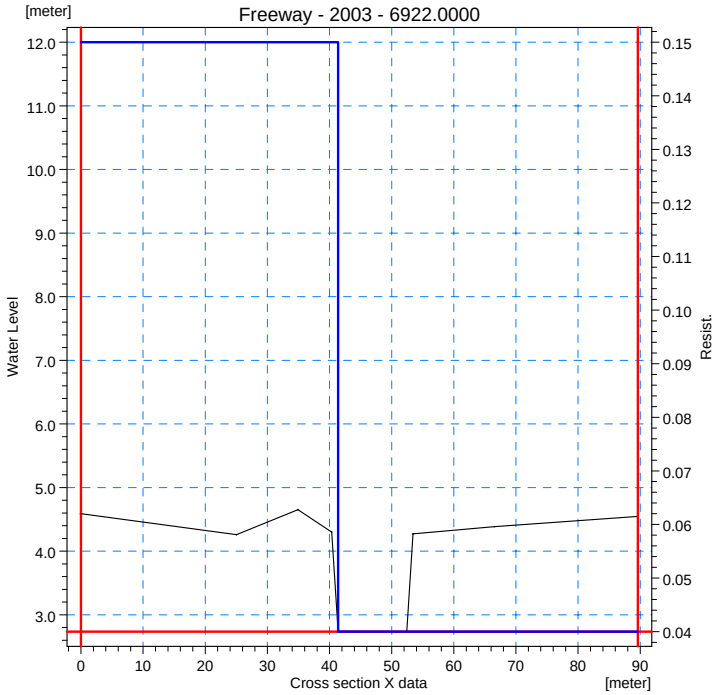
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 6922.0000
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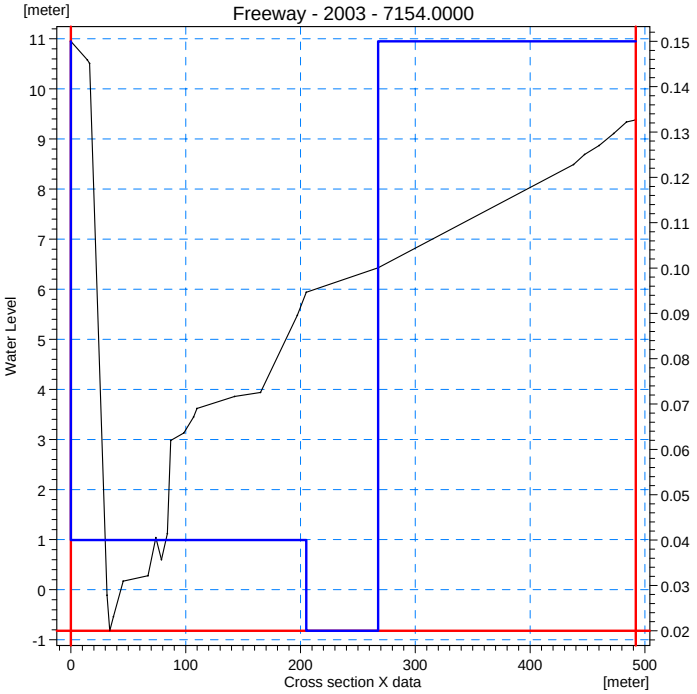
Water Level
Resist.
Cross section X data
[meter]


Freeway - 2003 - 7154.0000
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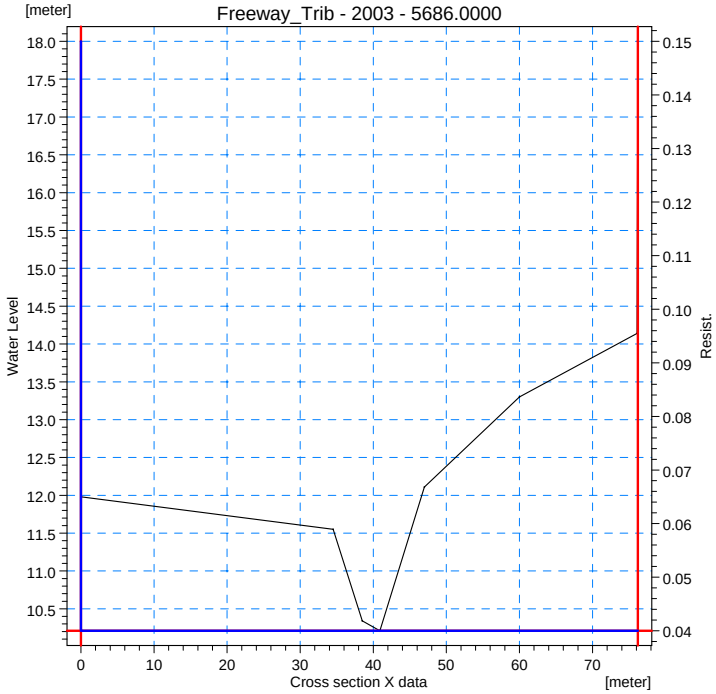
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 5686.0000
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Water Level
Resist.
Cross section X data
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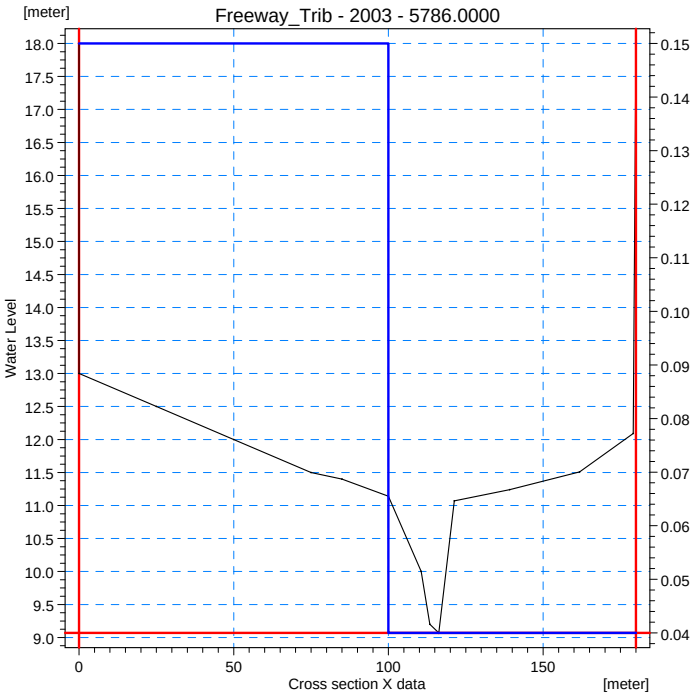
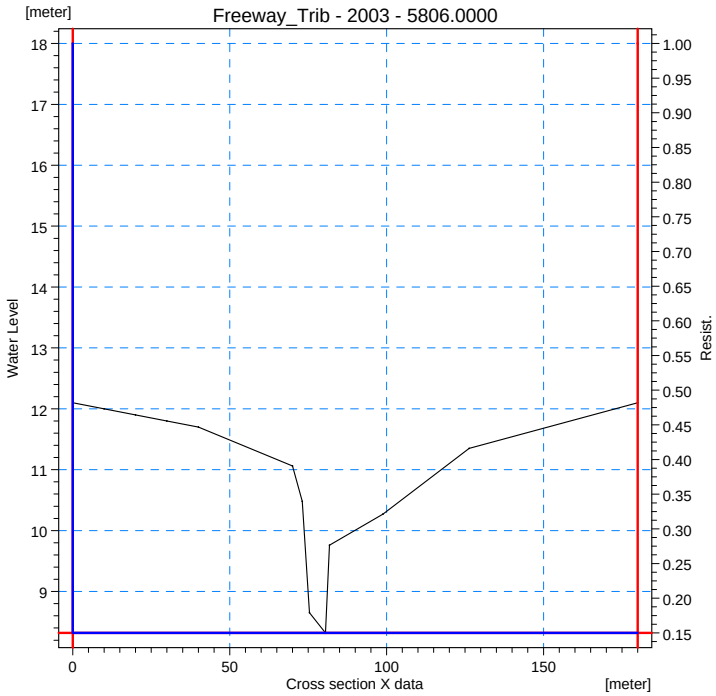
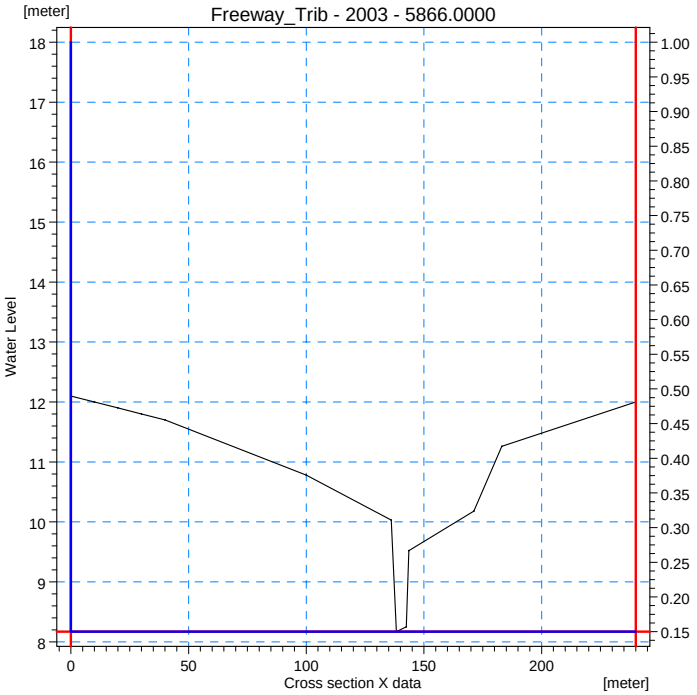
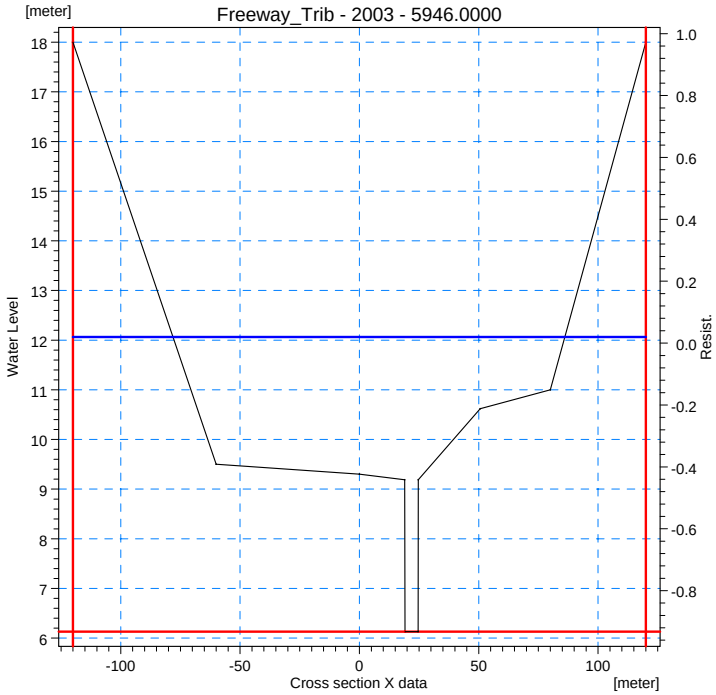
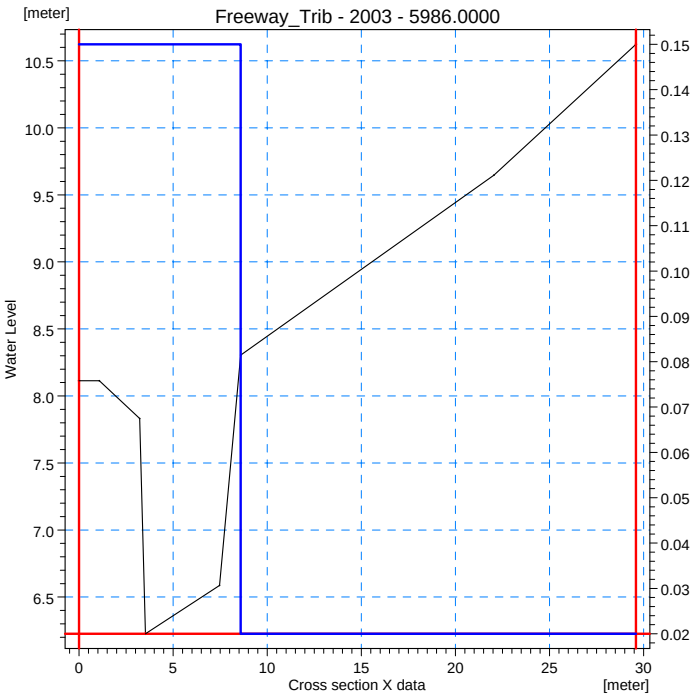

Freeway_Trib - 2003 - 5786.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 5806.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 5866.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 5946.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 5986.0000
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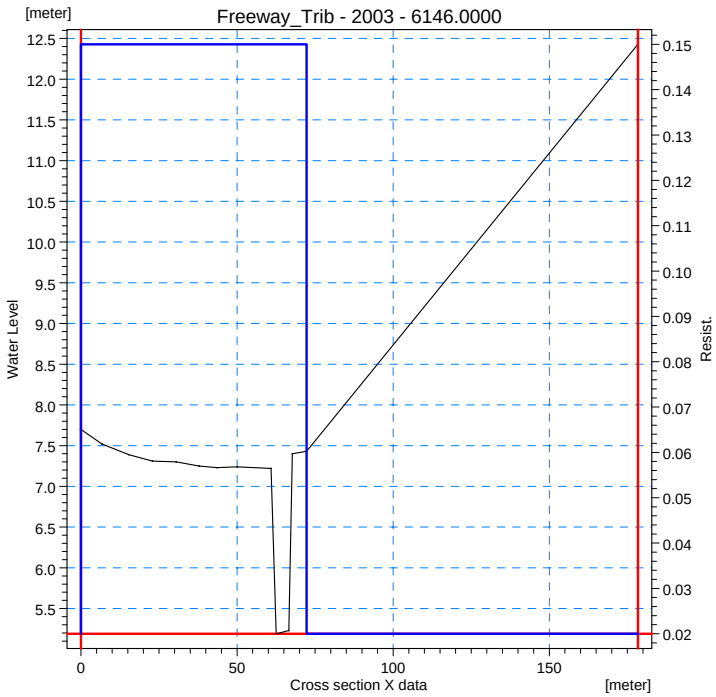
Water Level
Resist.
Cross section X data
[meter]


Freeway_Trib - 2003 - 6146.0000
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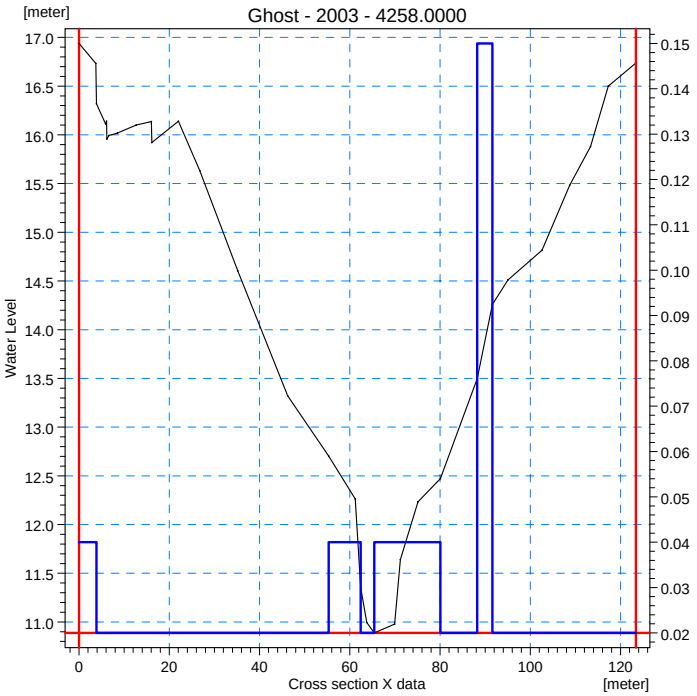
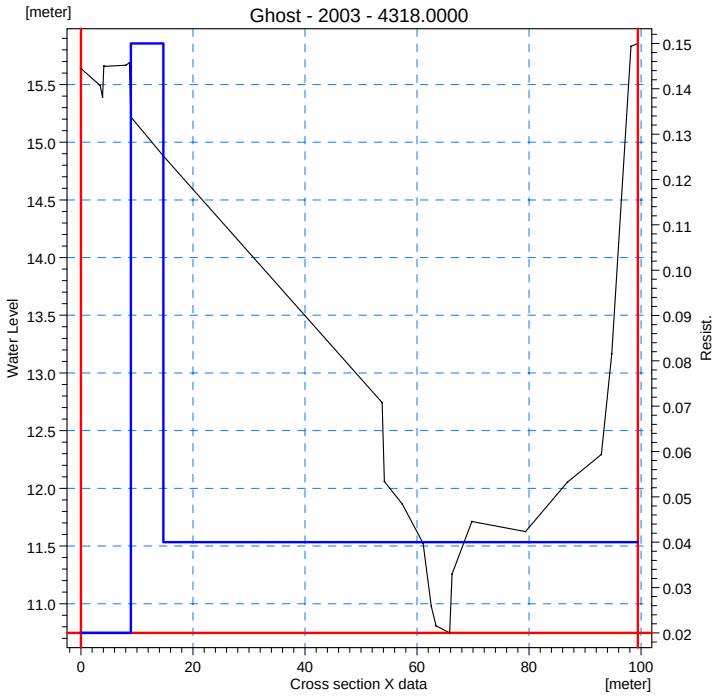
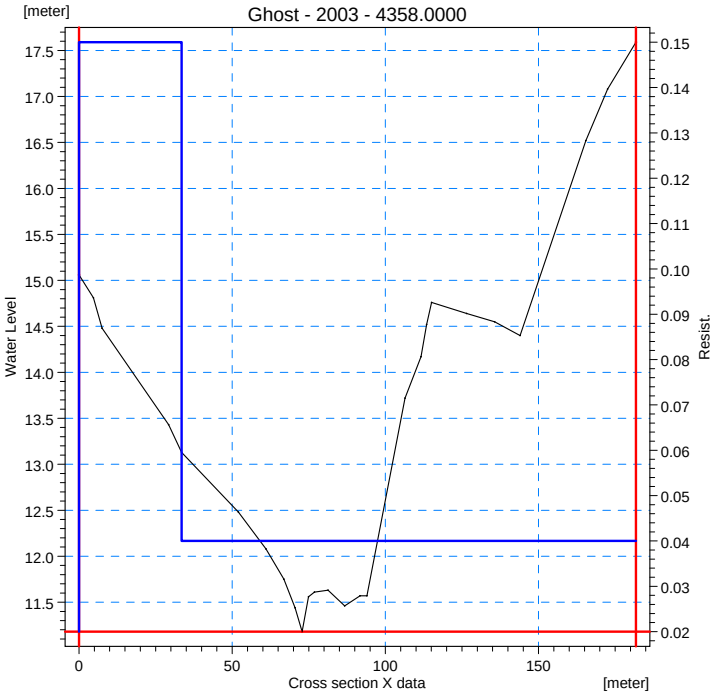
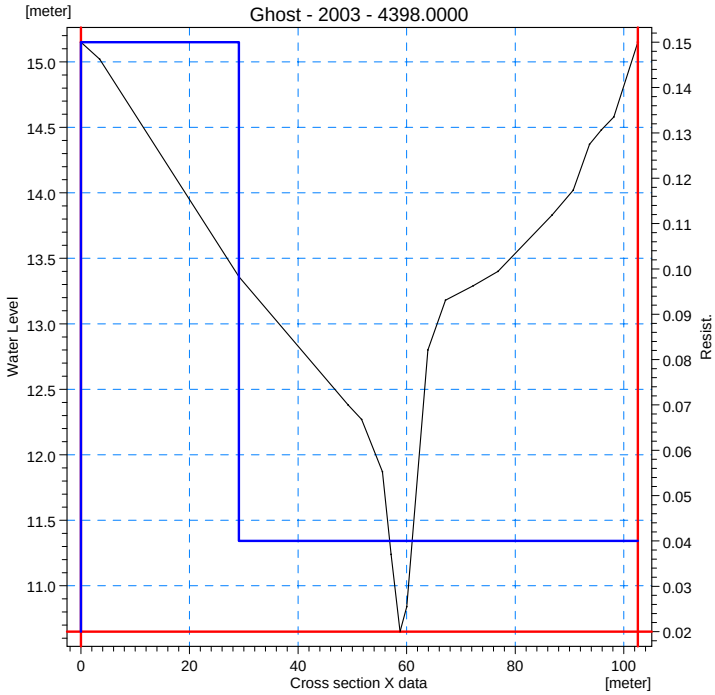
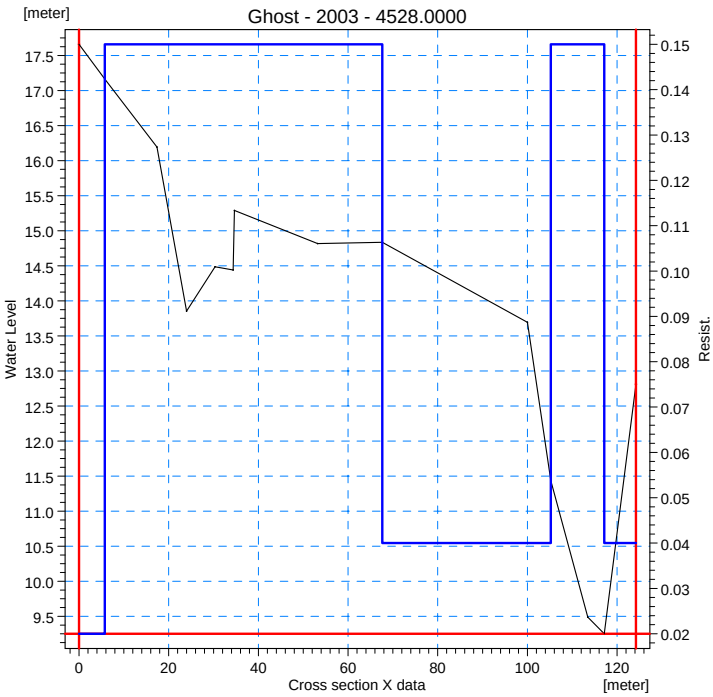
Water Level
Resist.
Cross section X data
[meter]

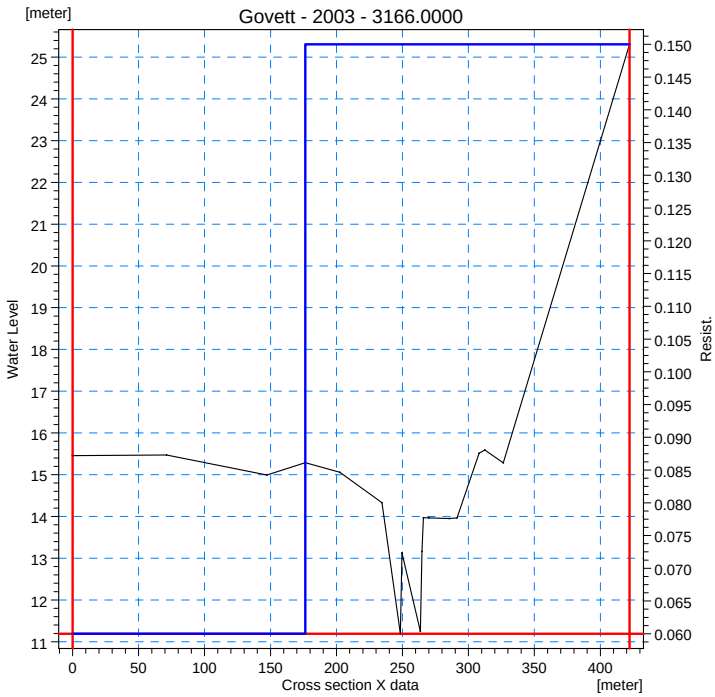

Ghost - 2003 - 4258.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

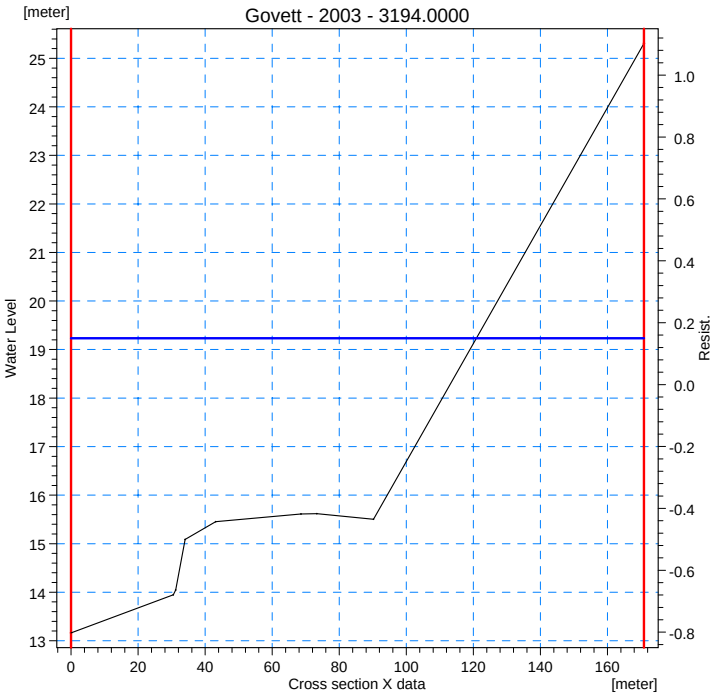

Ghost - 2003 - 4318.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

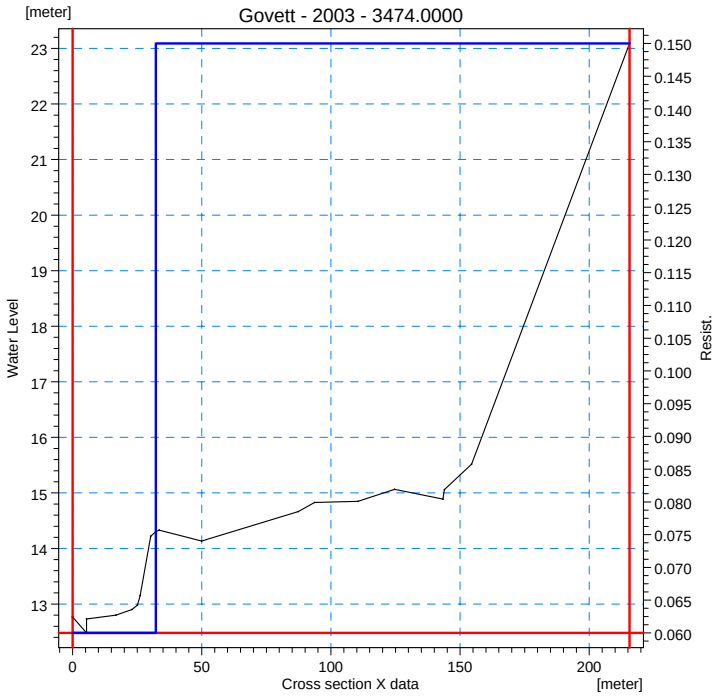

Ghost - 2003 - 4358.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

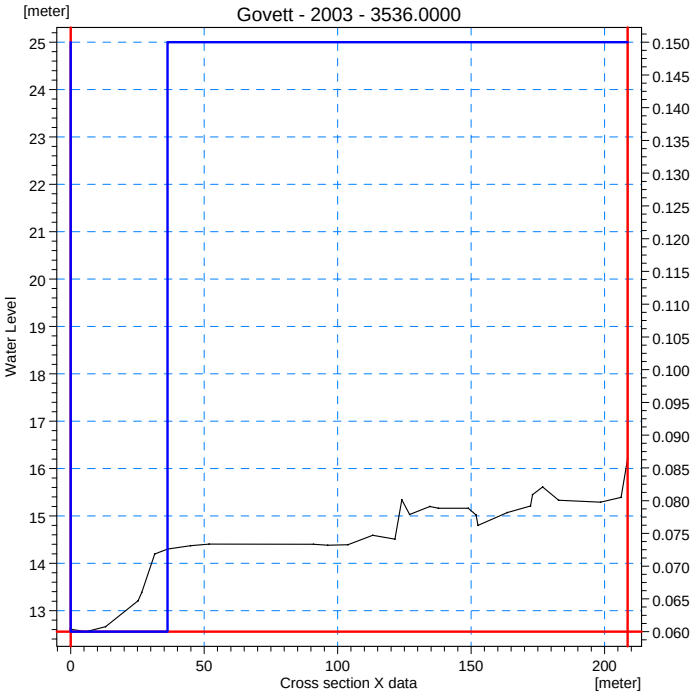

Ghost - 2003 - 4398.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

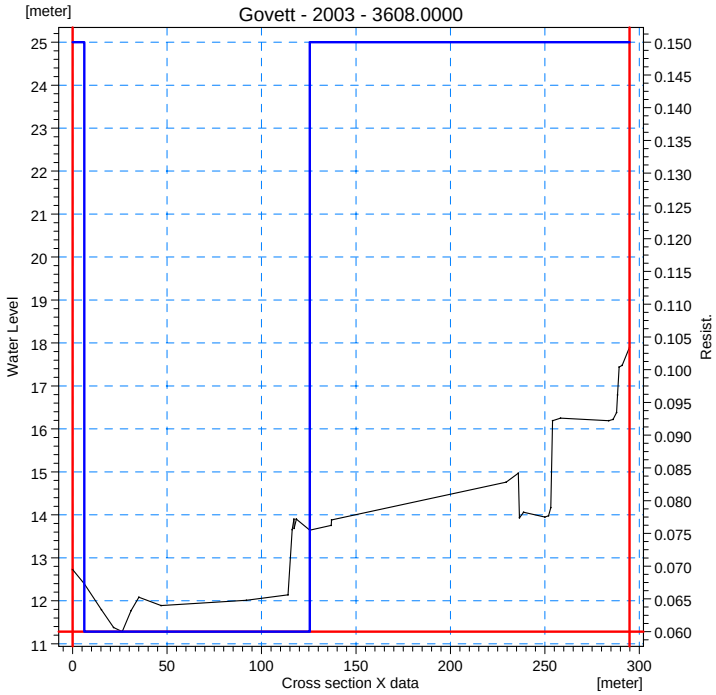

Ghost - 2003 - 4528.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

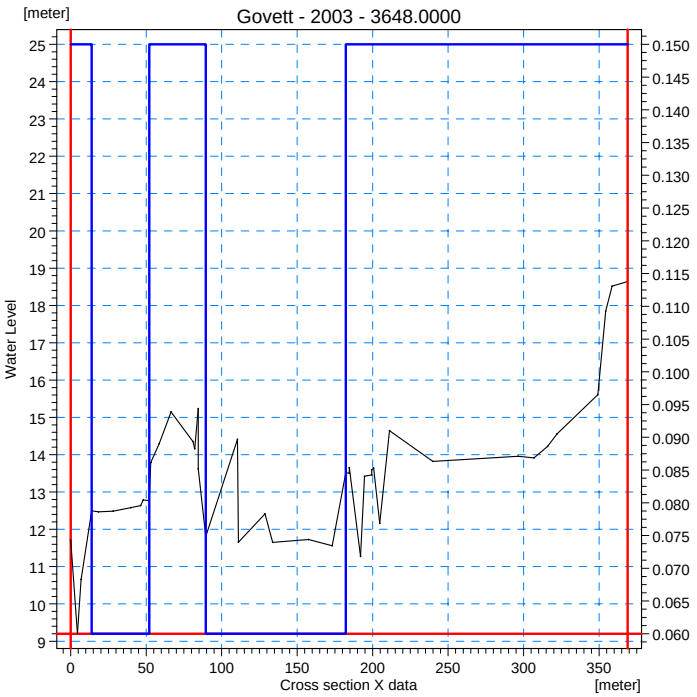

Govett - 2003 - 3166.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

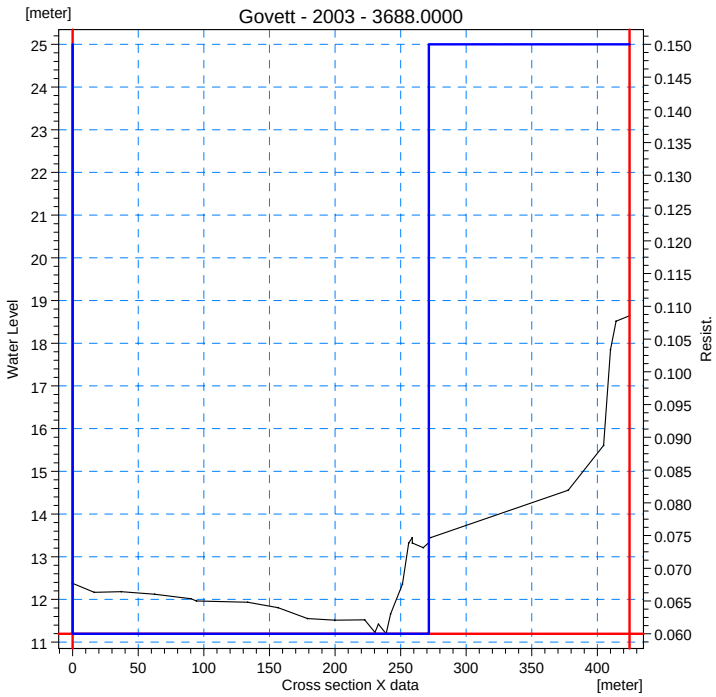

Govett - 2003 - 3194.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

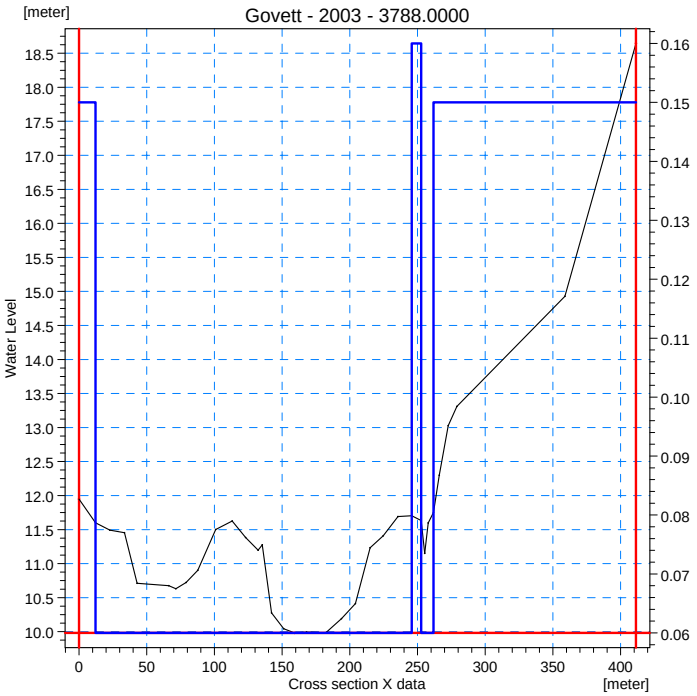

Govett - 2003 - 3474.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

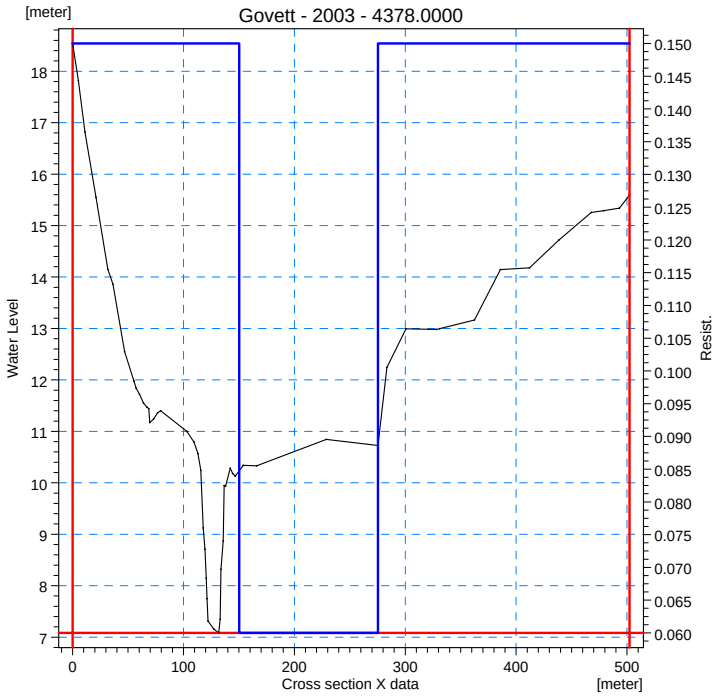

Govett - 2003 - 3536.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

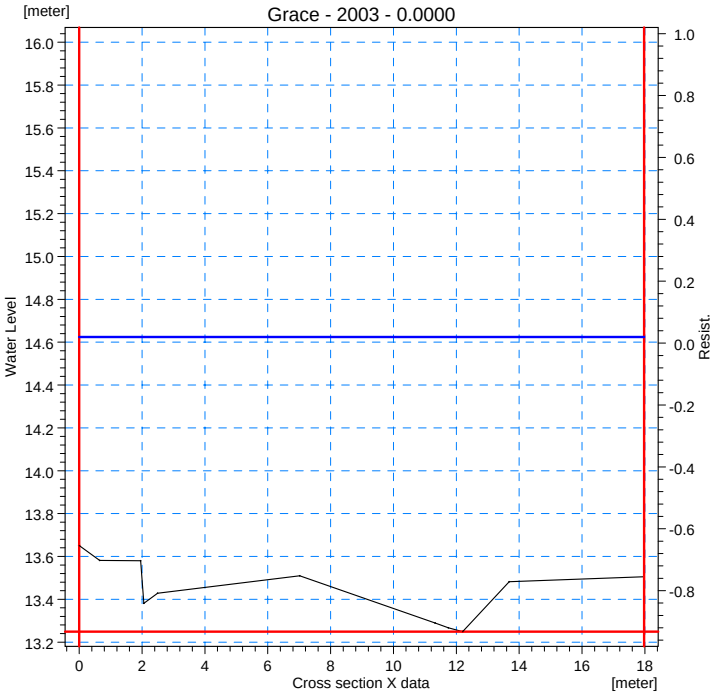

Govett - 2003 - 3608.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

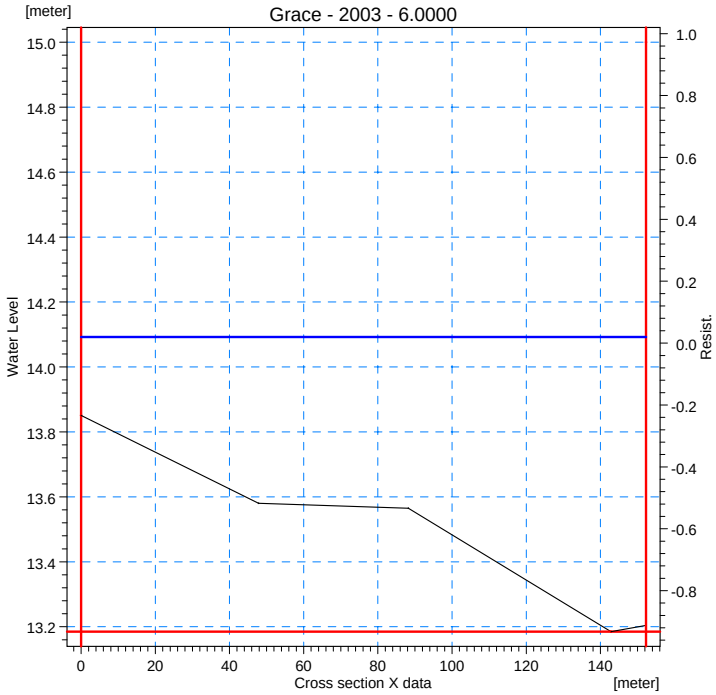

Govett - 2003 - 3648.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

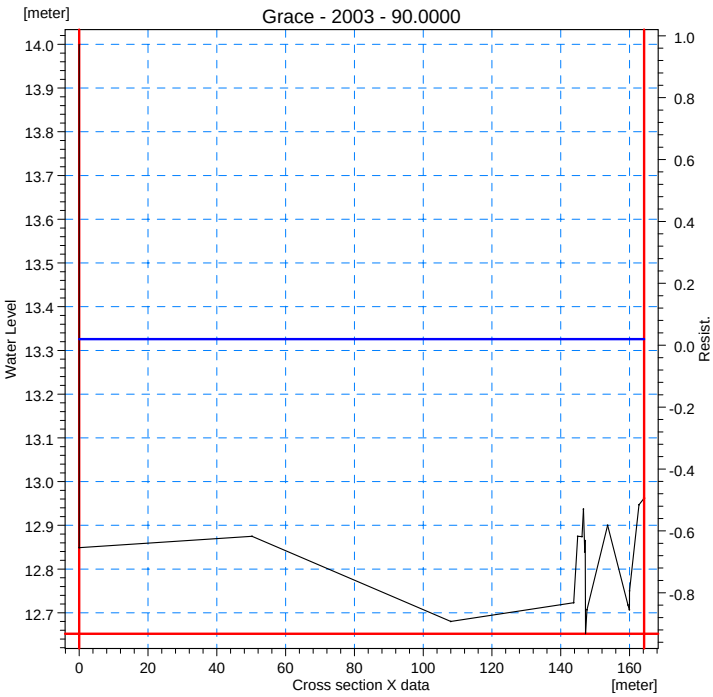

Govett - 2003 - 3688.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

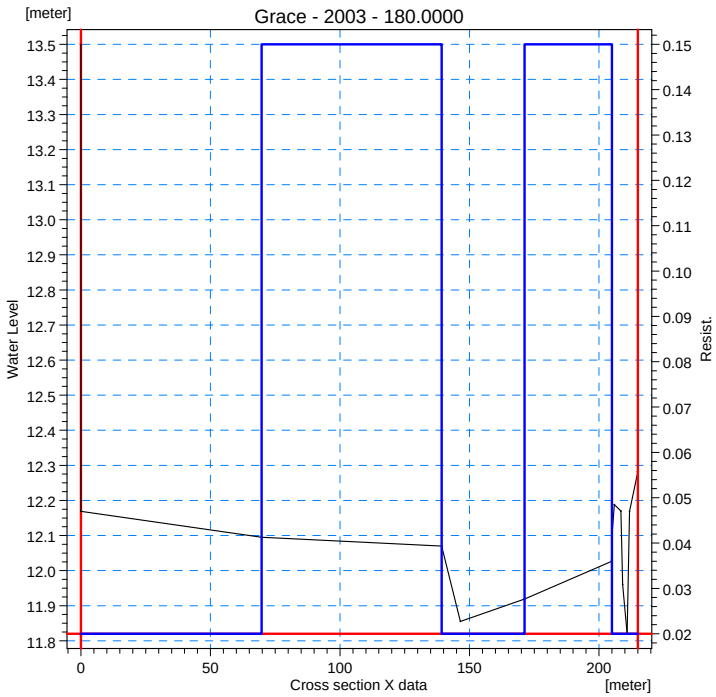

Govett - 2003 - 3788.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

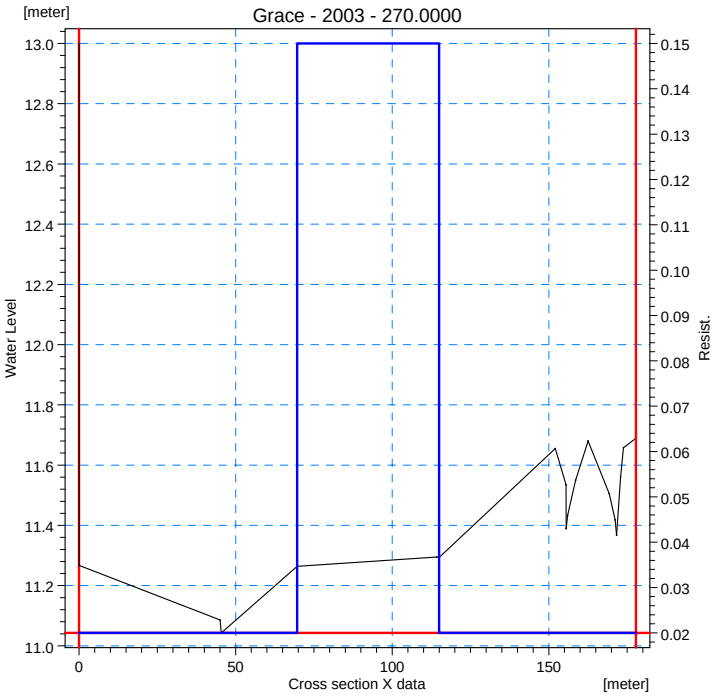

Govett - 2003 - 4378.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

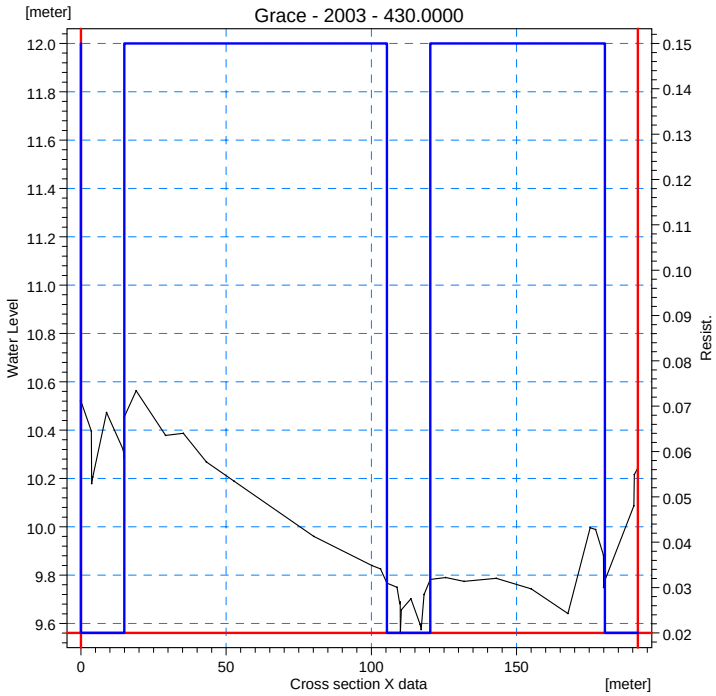

Grace - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

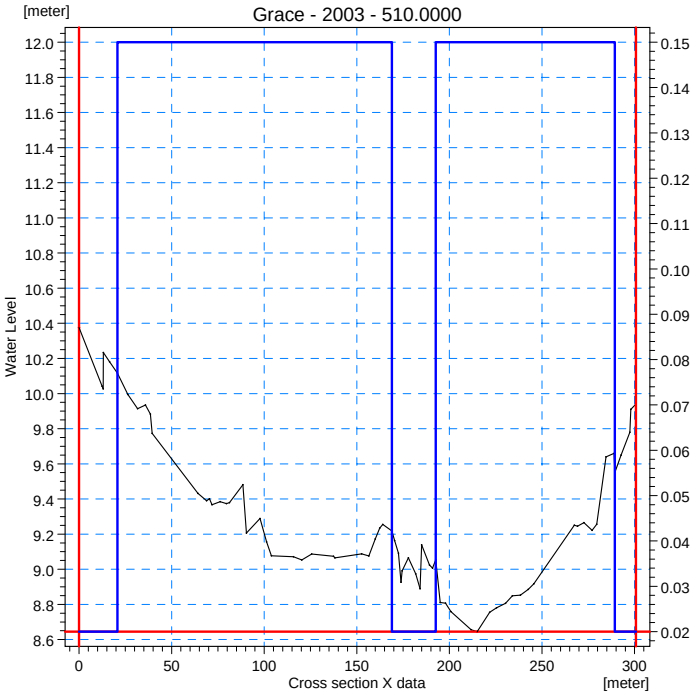

Grace - 2003 - 6.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

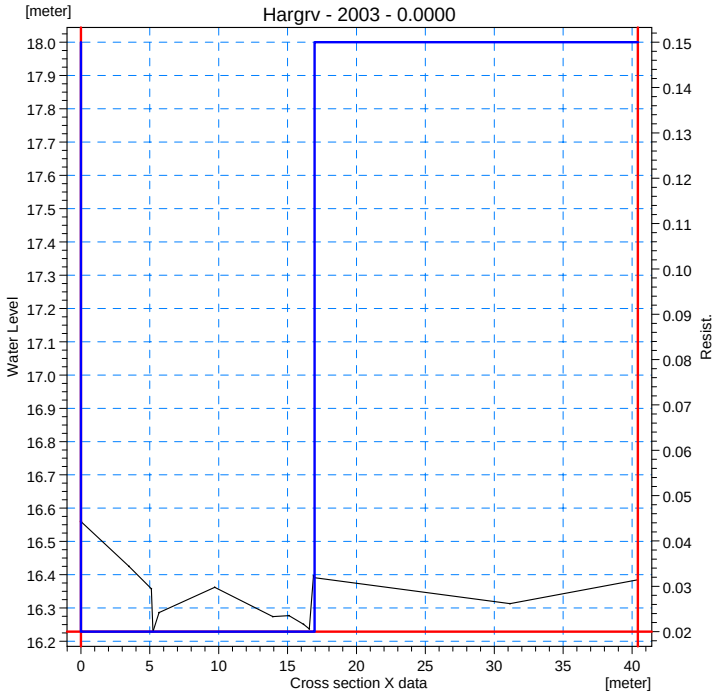

Grace - 2003 - 90.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

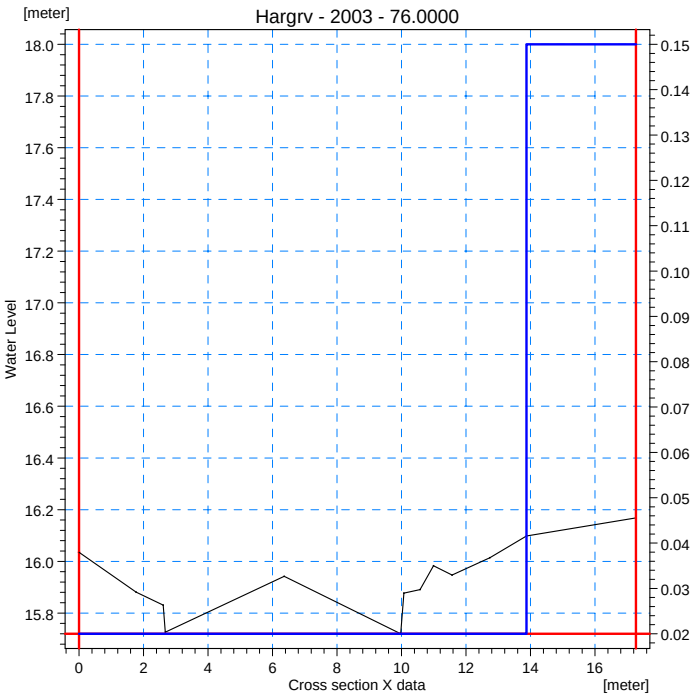

Grace - 2003 - 180.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

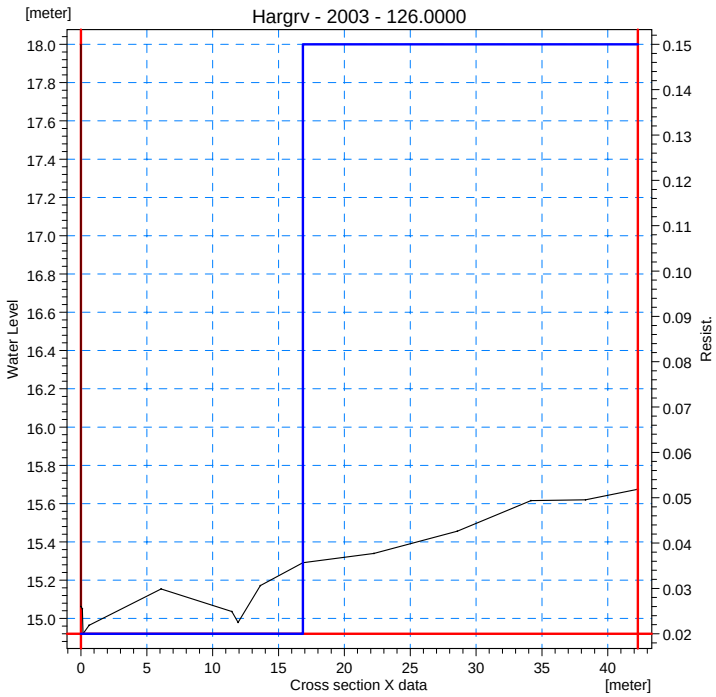

Grace - 2003 - 270.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

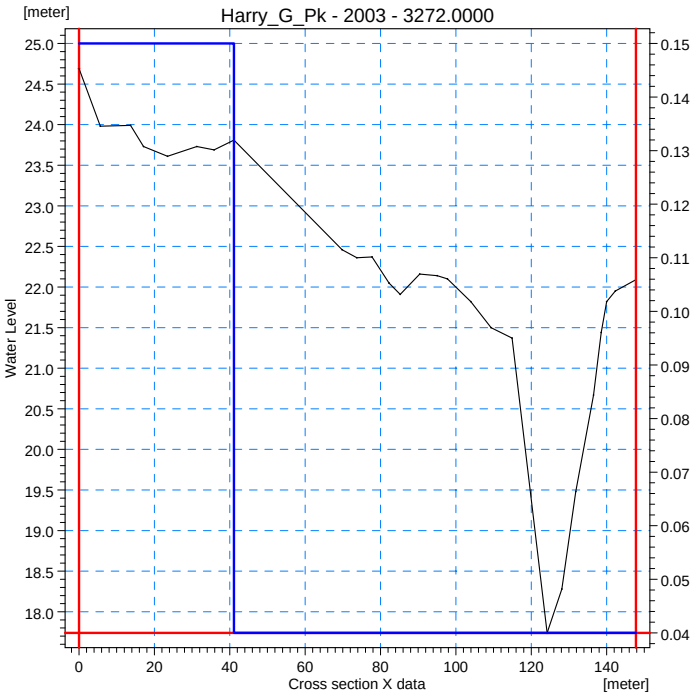

Grace - 2003 - 430.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

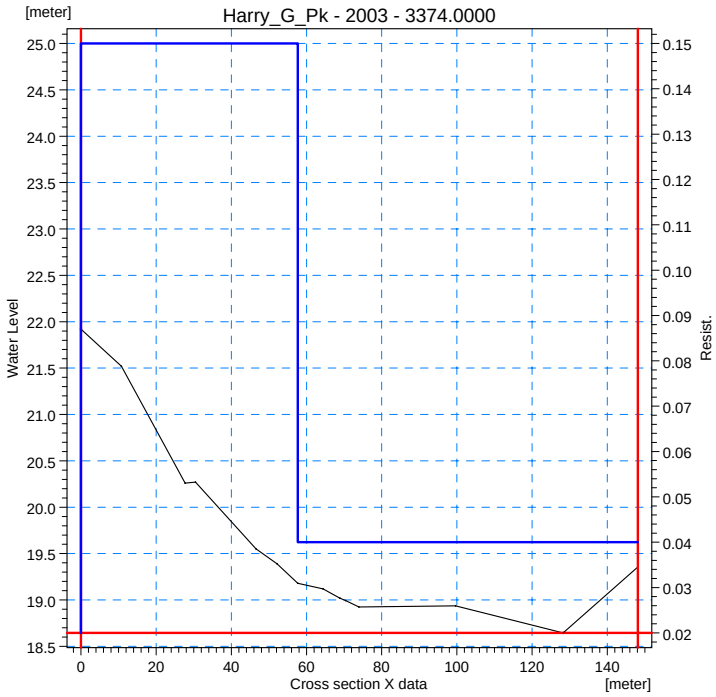

Grace - 2003 - 510.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

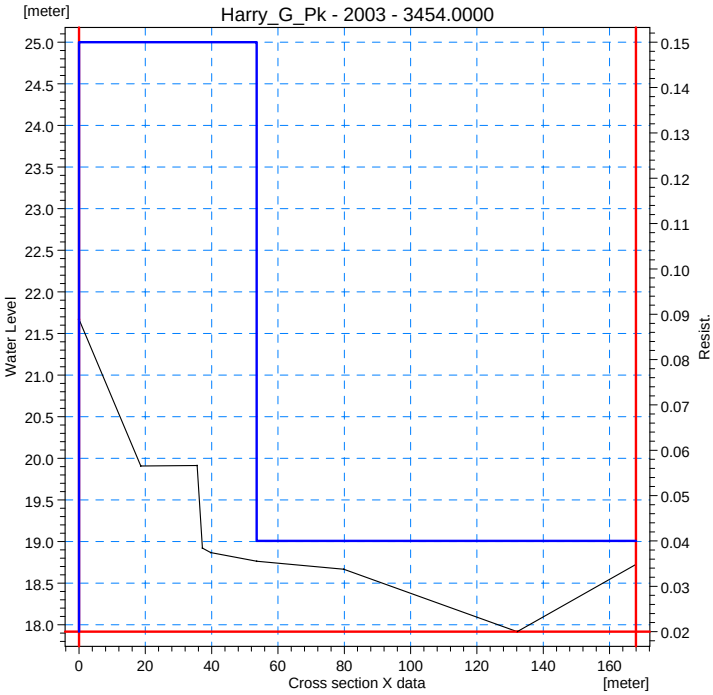

Hargrv - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

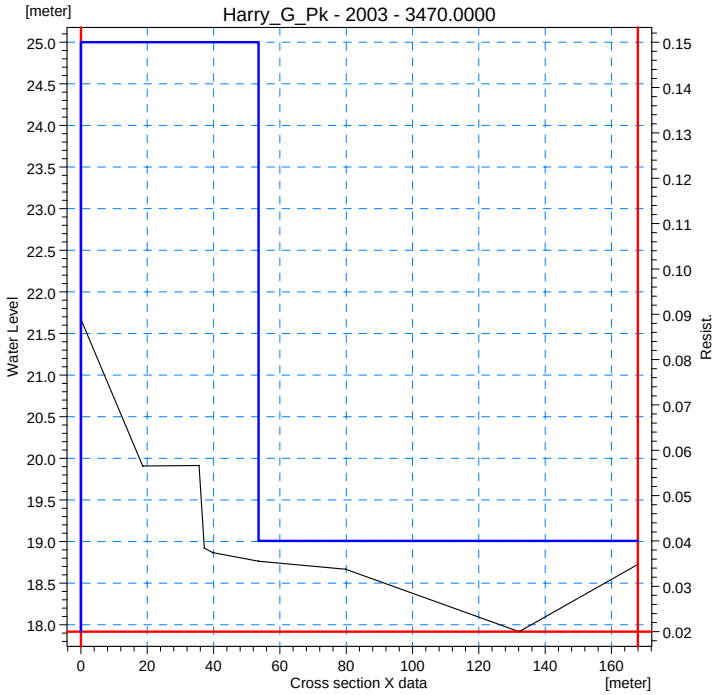

Hargrv - 2003 - 76.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

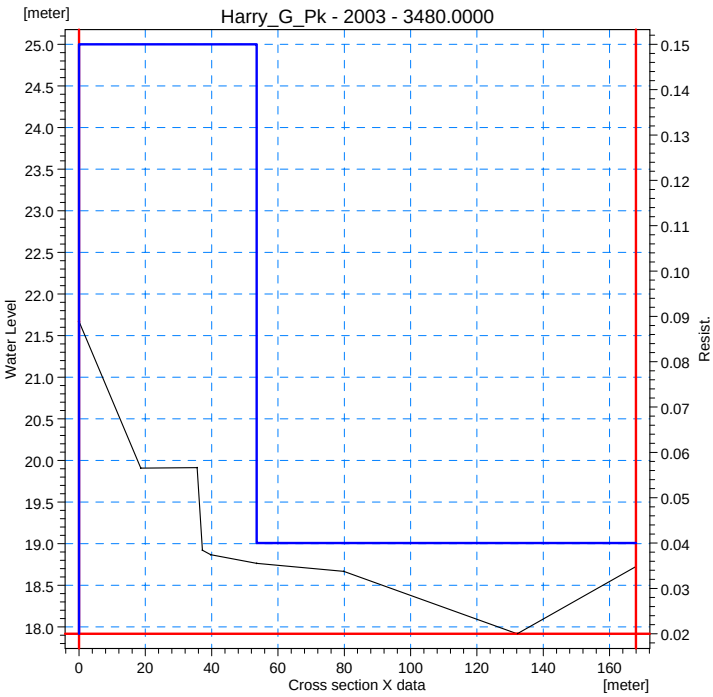

Hargrv - 2003 - 126.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

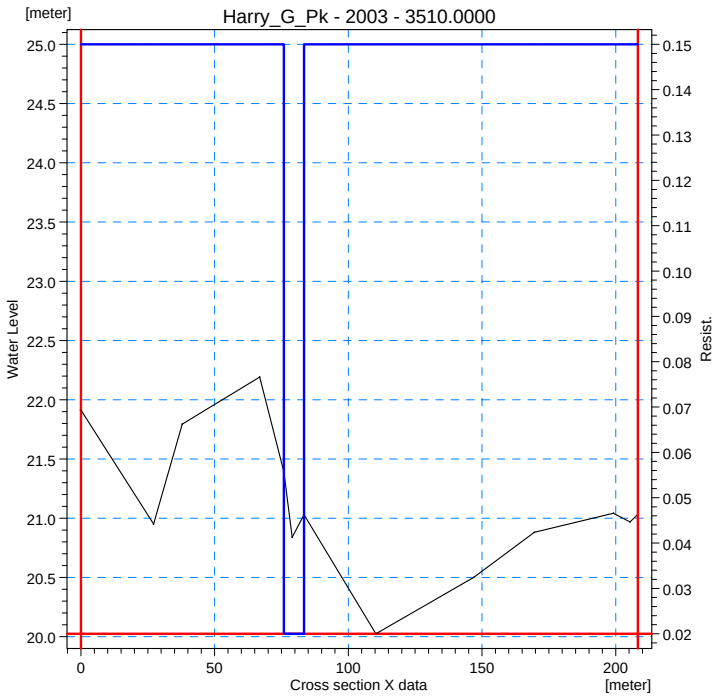

Harry_G_Pk - 2003 - 3272.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

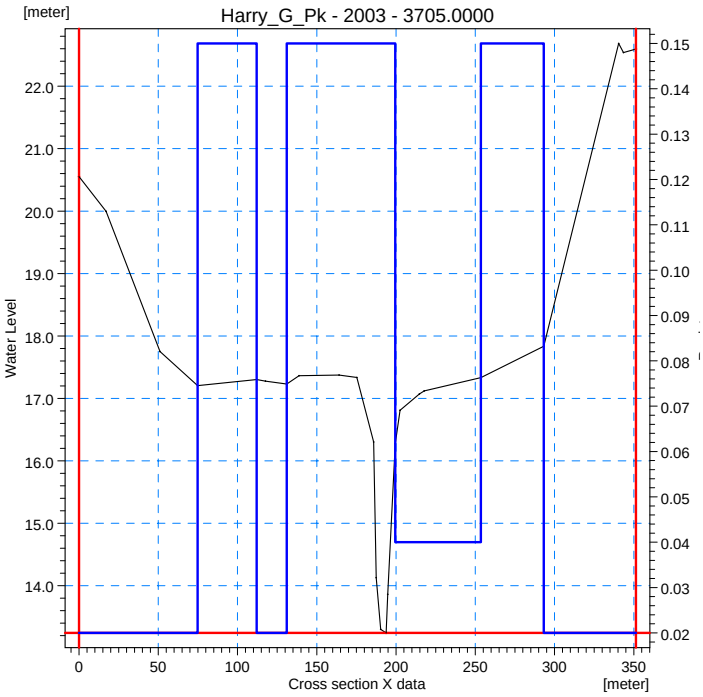

Harry_G_Pk - 2003 - 3374.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

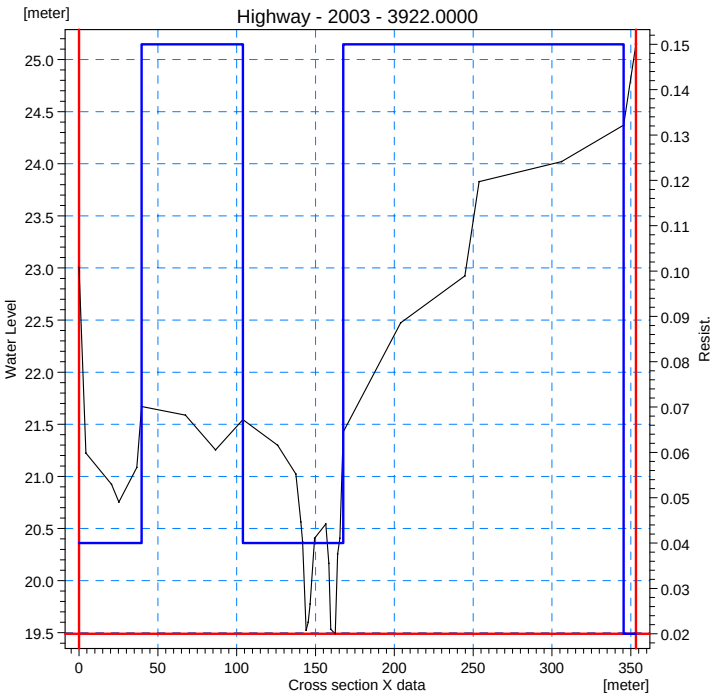

Harry_G_Pk - 2003 - 3454.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

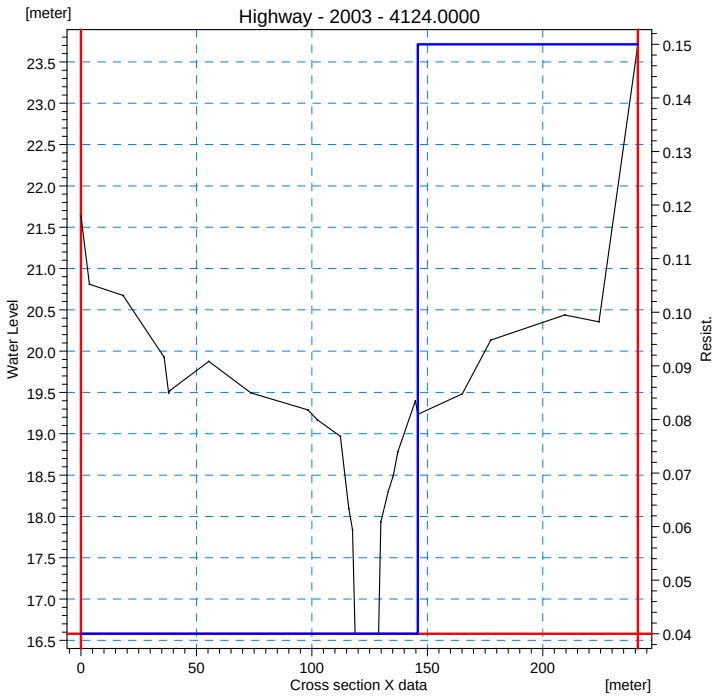

Harry_G_Pk - 2003 - 3470.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

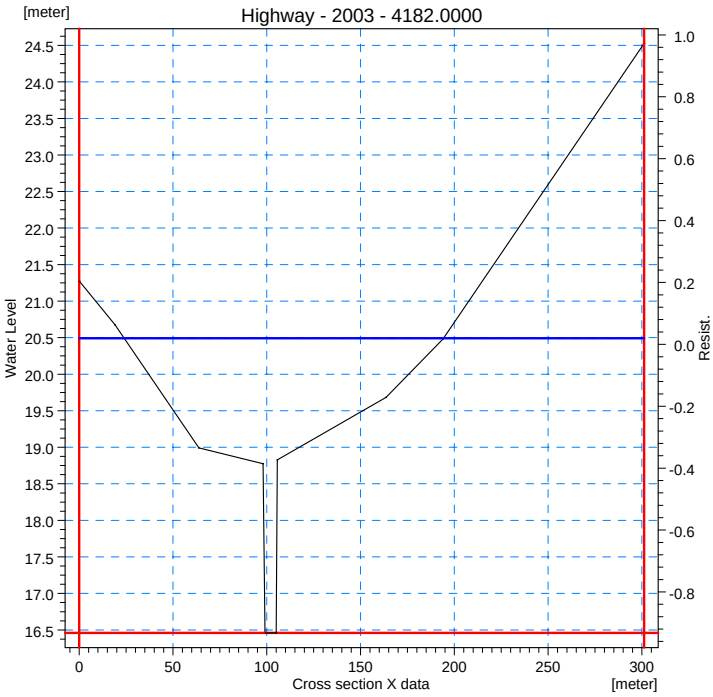

Harry_G_Pk - 2003 - 3480.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

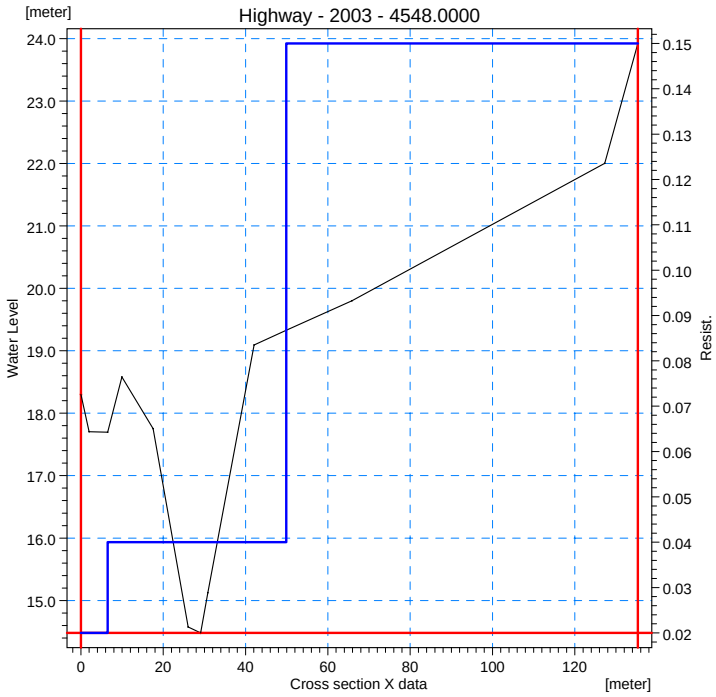

Harry_G_Pk - 2003 - 3510.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

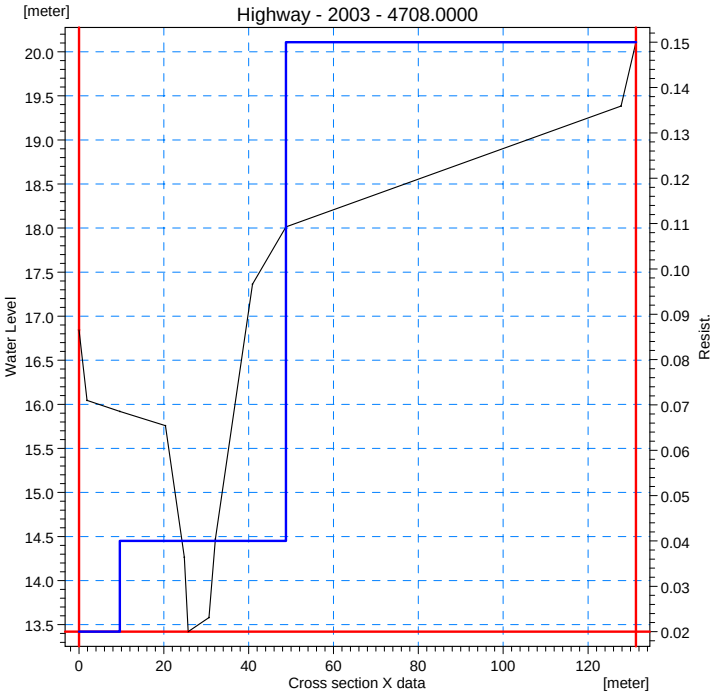

Harry_G_Pk - 2003 - 3705.0000
[meter]
Water Level
Cross section X data
[meter]

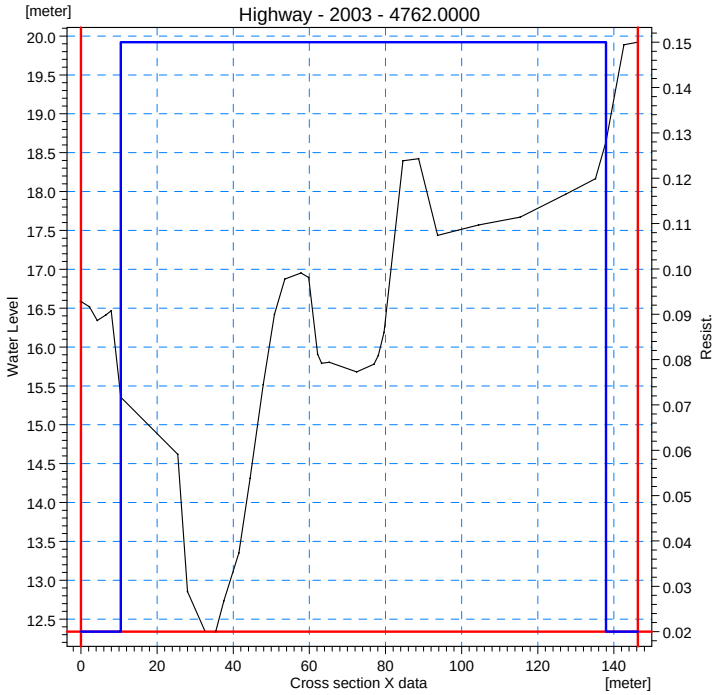

Highway - 2003 - 3922.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

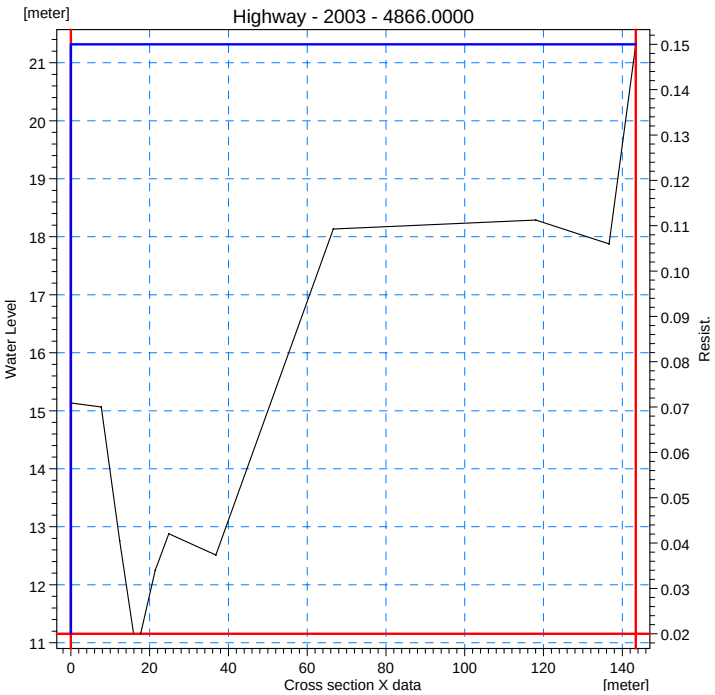

Highway - 2003 - 4124.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

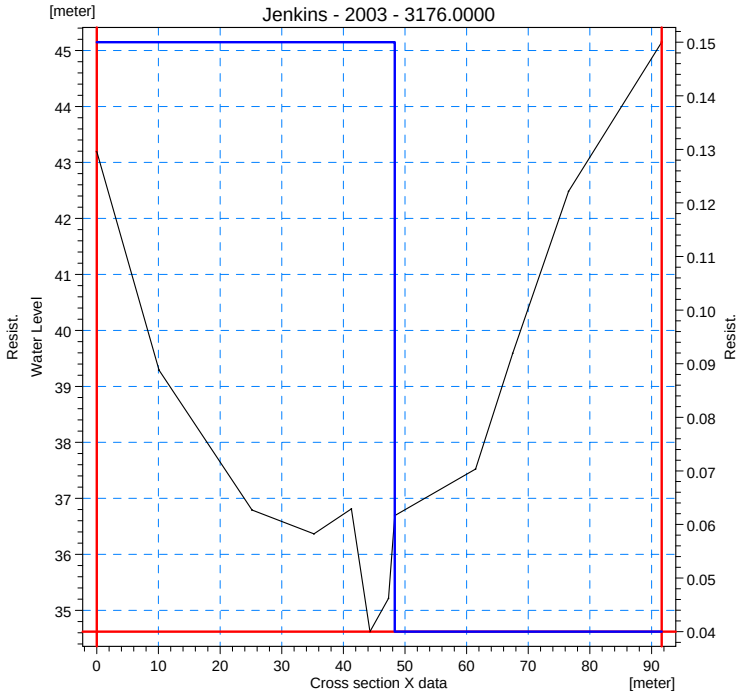

Highway - 2003 - 4182.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

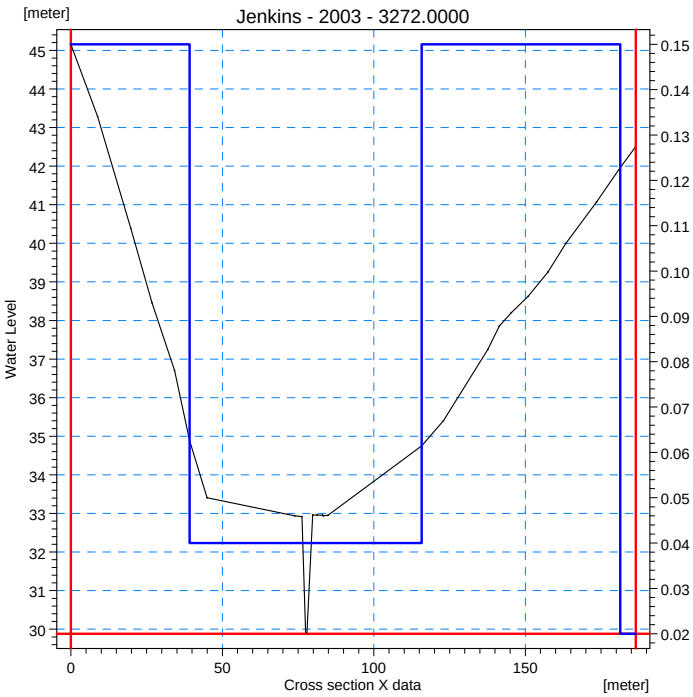

Highway - 2003 - 4548.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

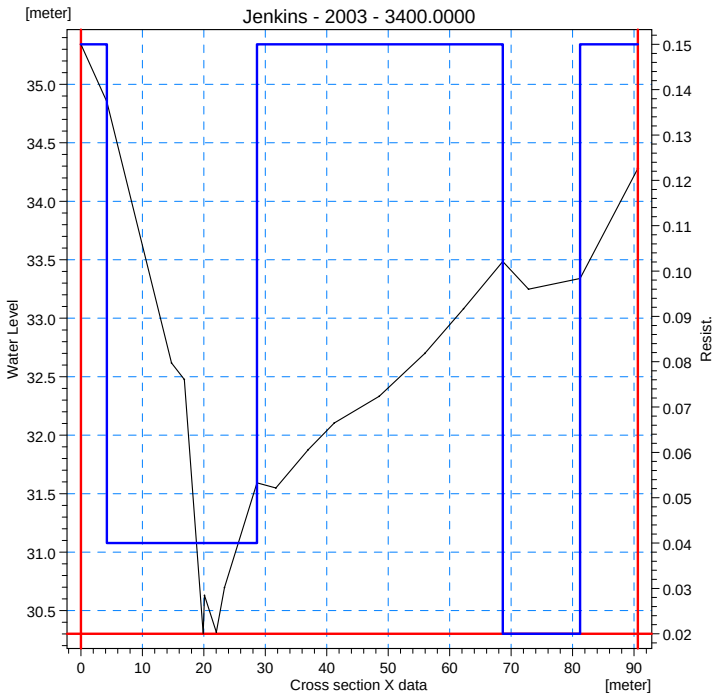

Highway - 2003 - 4708.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

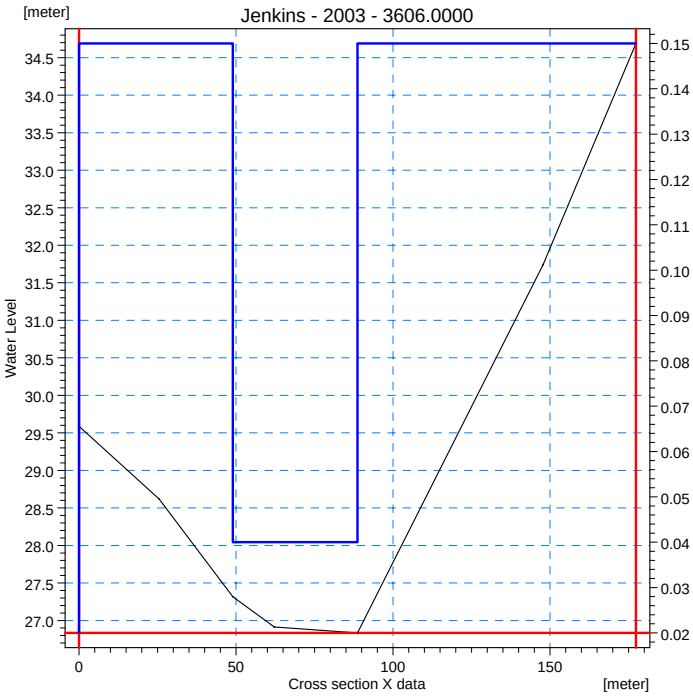

Highway - 2003 - 4762.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

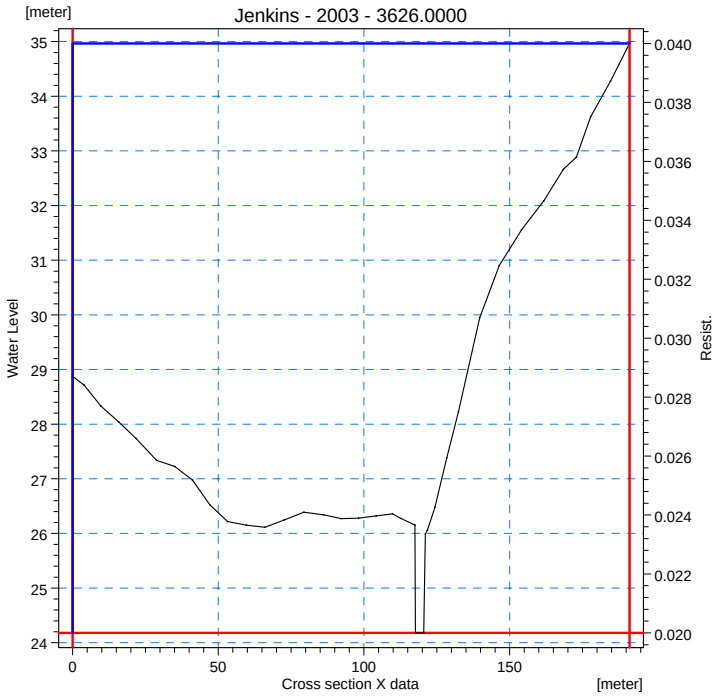

Highway - 2003 - 4866.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

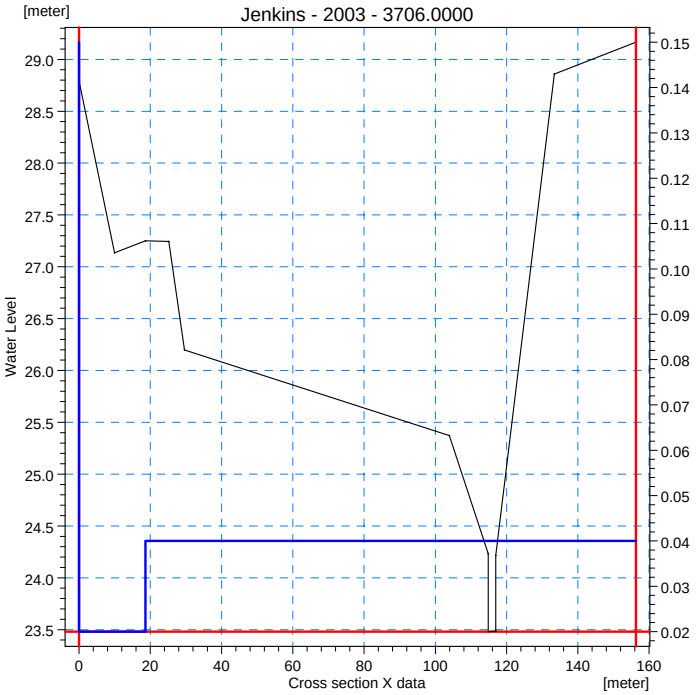

Jenkins - 2003 - 3176.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

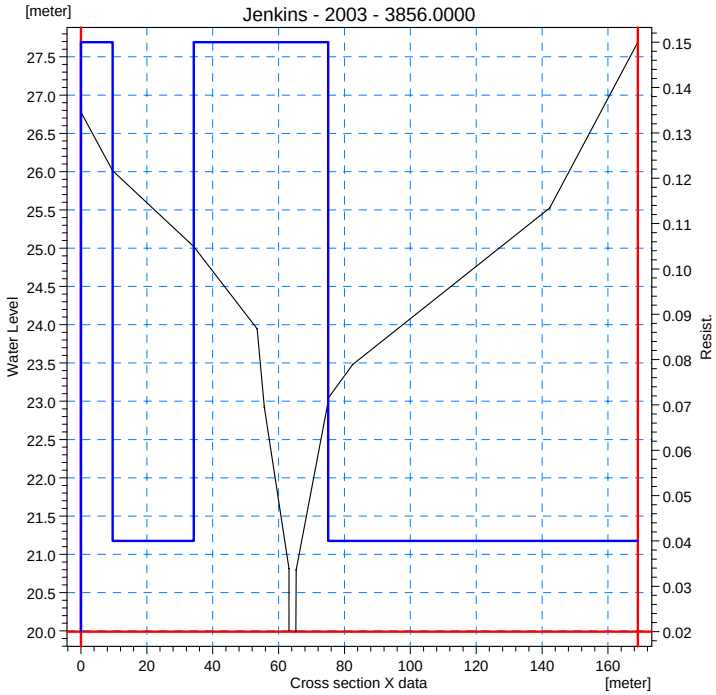

Jenkins - 2003 - 3272.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

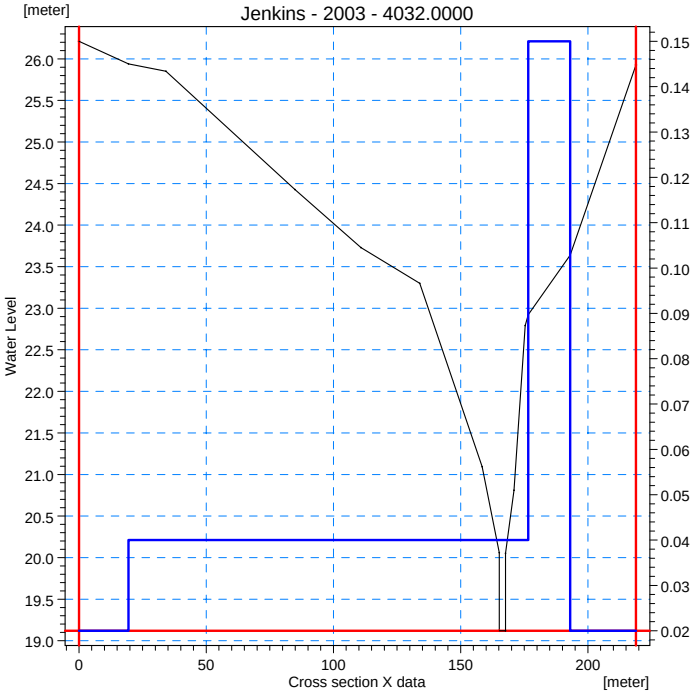

Jenkins - 2003 - 3400.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

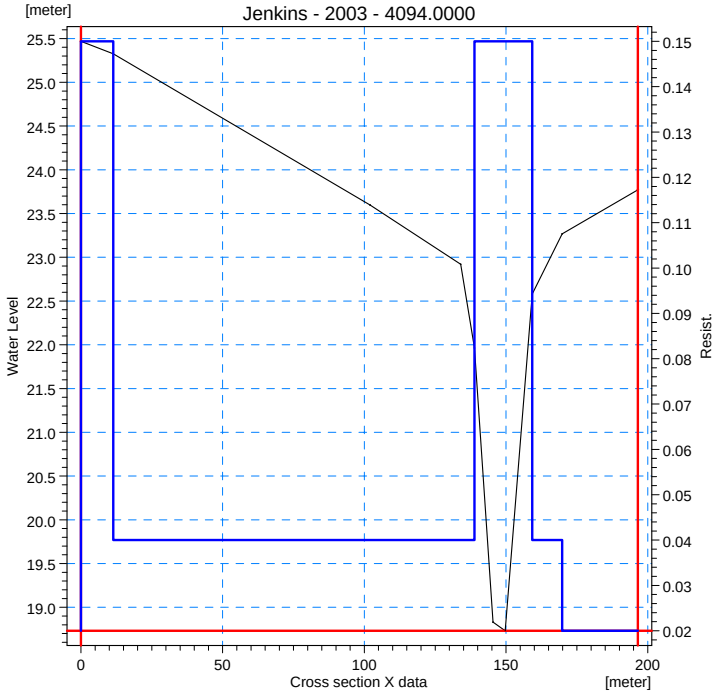

Jenkins - 2003 - 3606.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

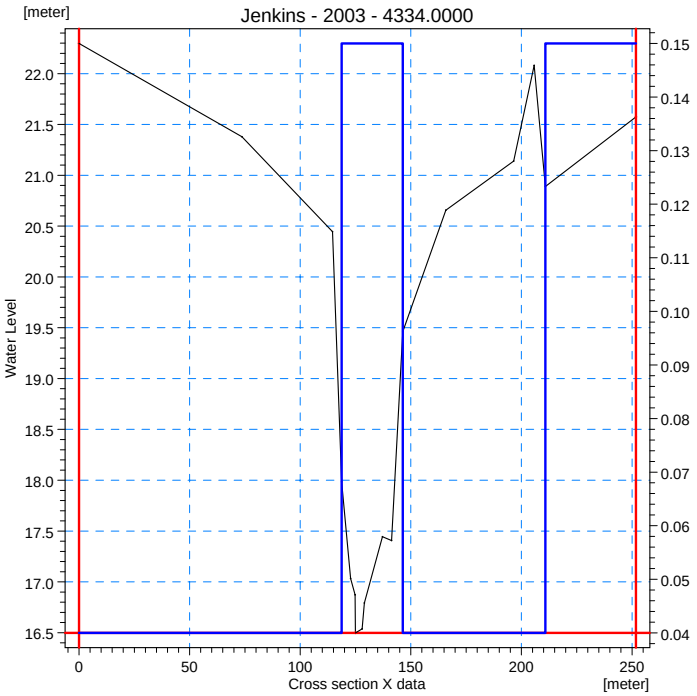

Jenkins - 2003 - 3626.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

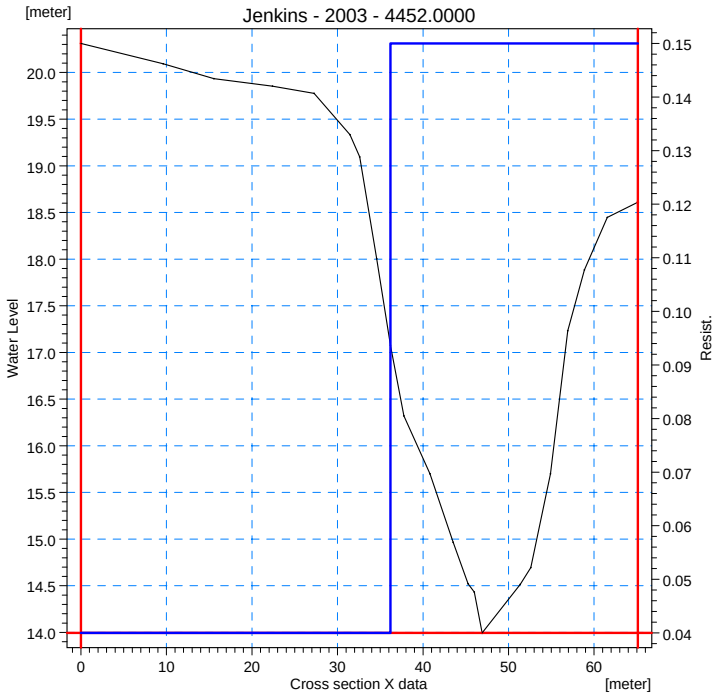

Jenkins - 2003 - 3706.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

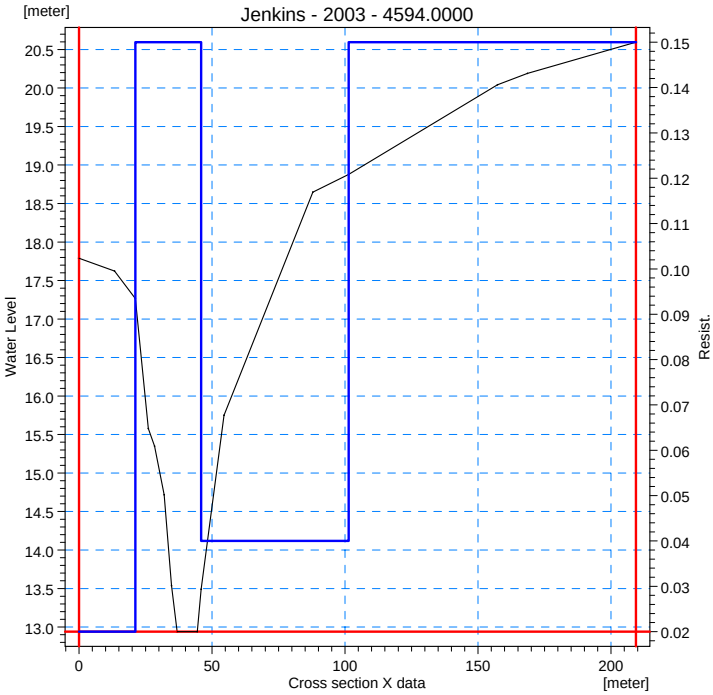

Jenkins - 2003 - 3856.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

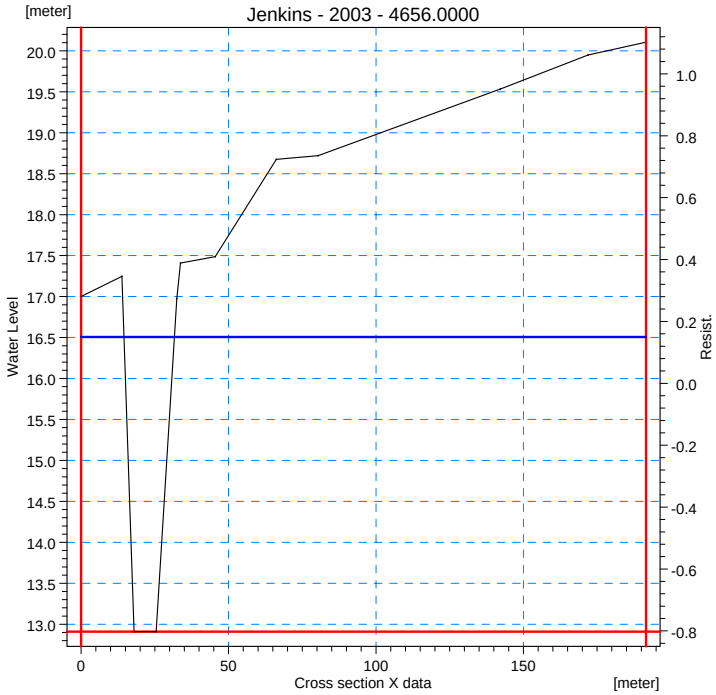

Jenkins - 2003 - 4032.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

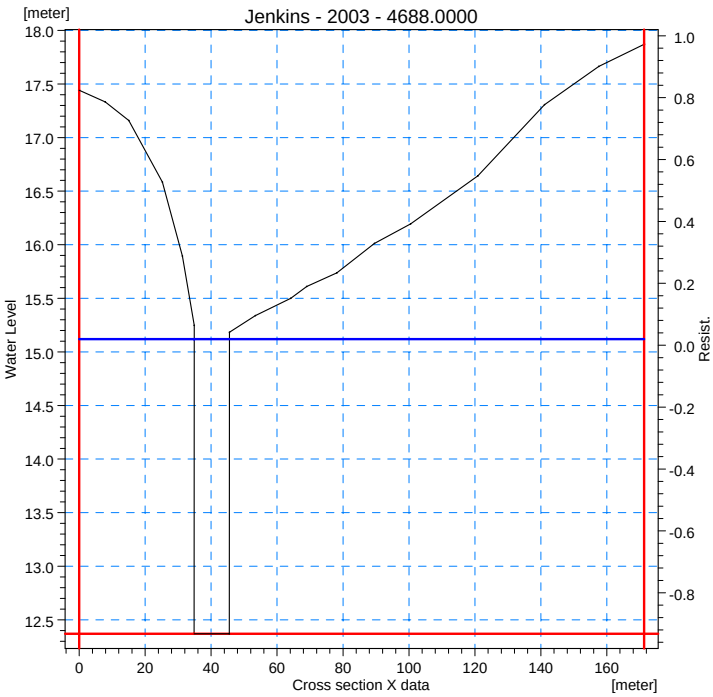

Jenkins - 2003 - 4094.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

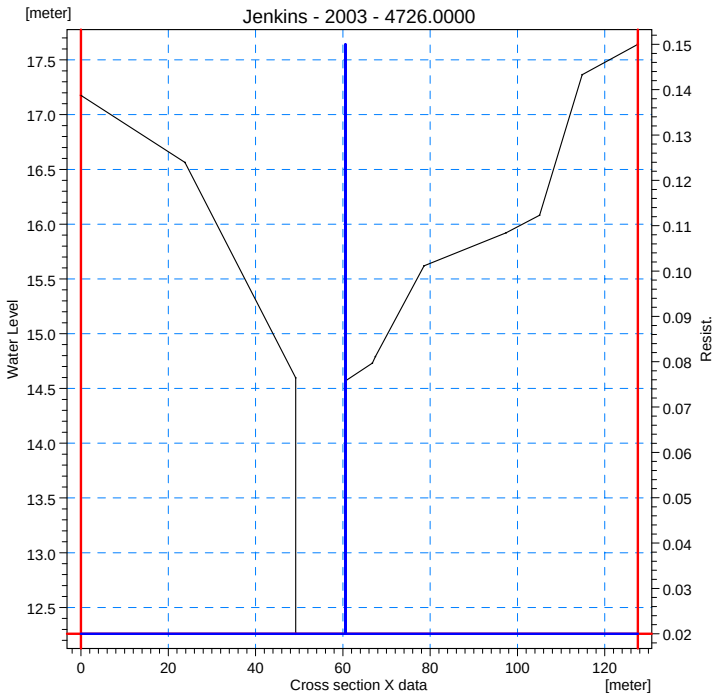

Jenkins - 2003 - 4334.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

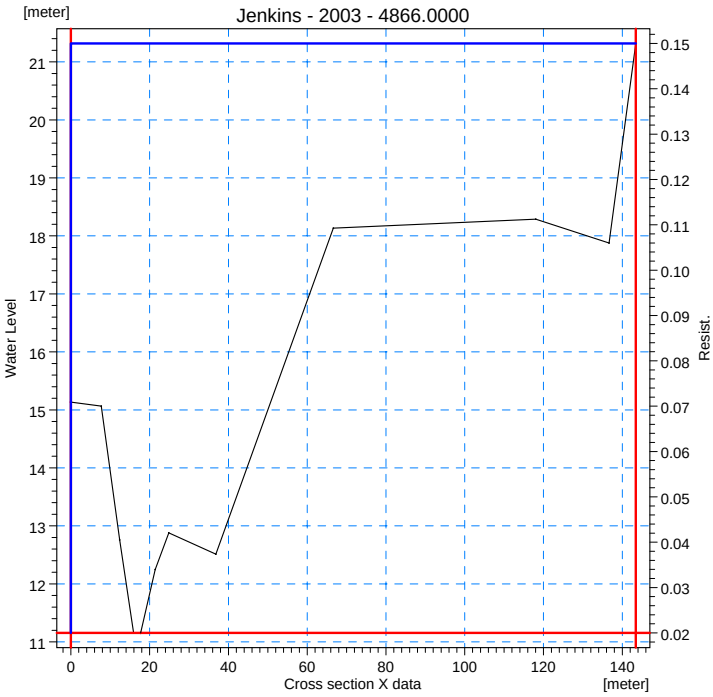

Jenkins - 2003 - 4452.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Jenkins - 2003 - 4594.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Jenkins - 2003 - 4656.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Jenkins - 2003 - 4688.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Jenkins - 2003 - 4726.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Jenkins - 2003 - 4866.0000
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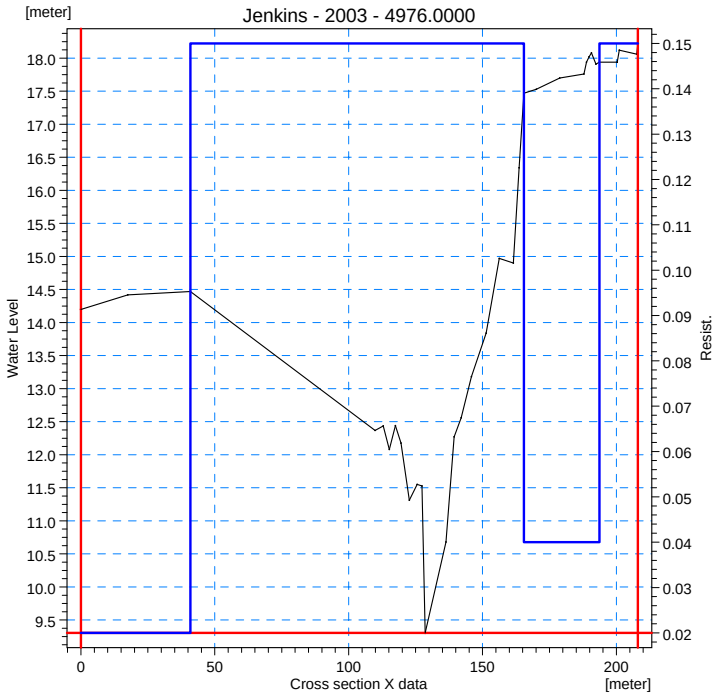
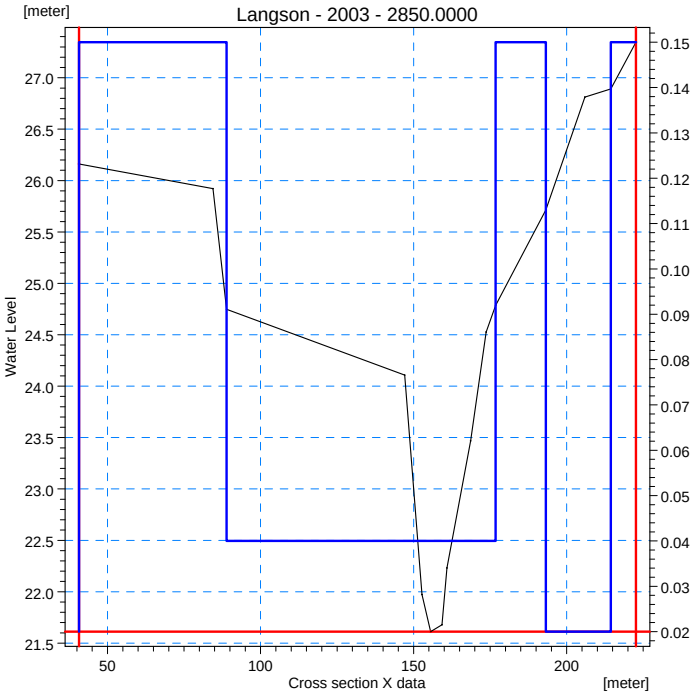
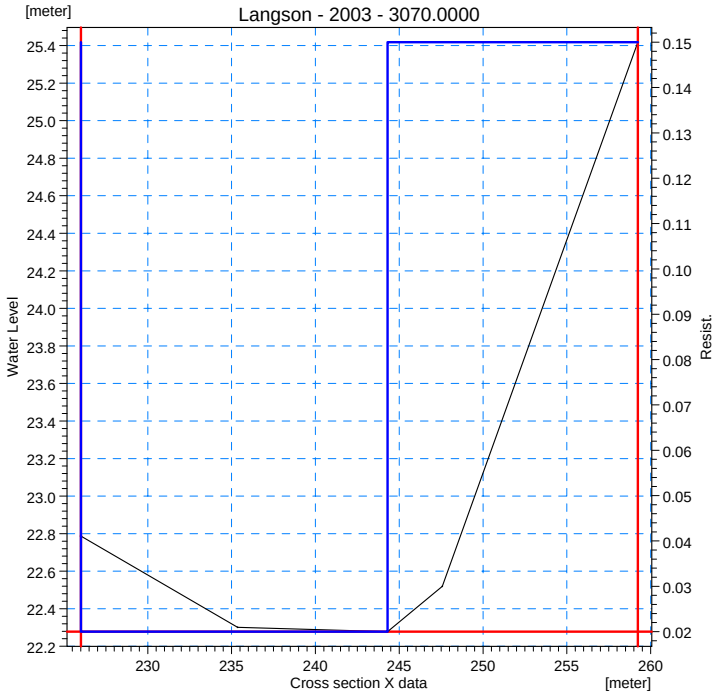
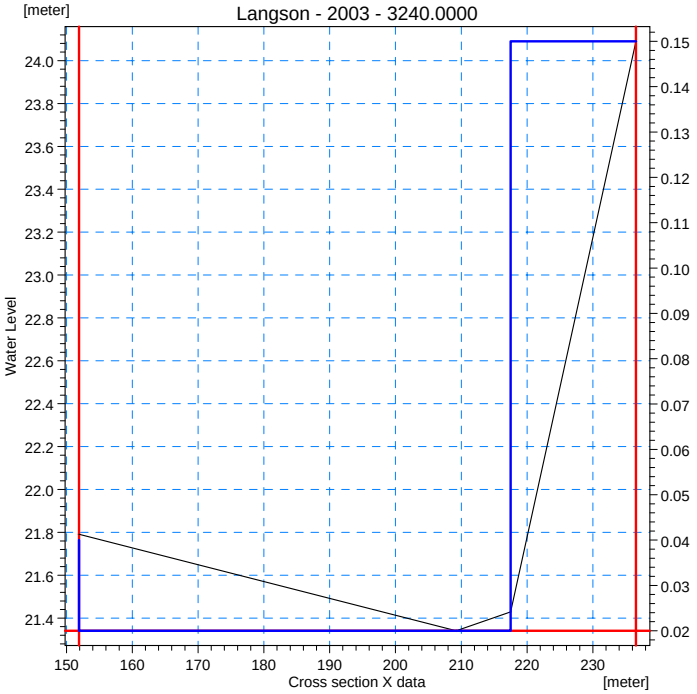
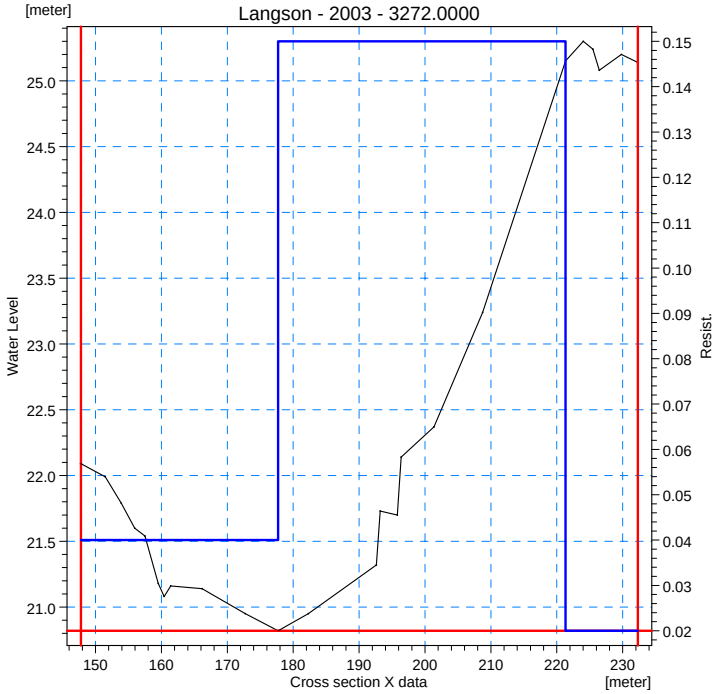
Water Level
Resist.
Cross section X data
[meter]

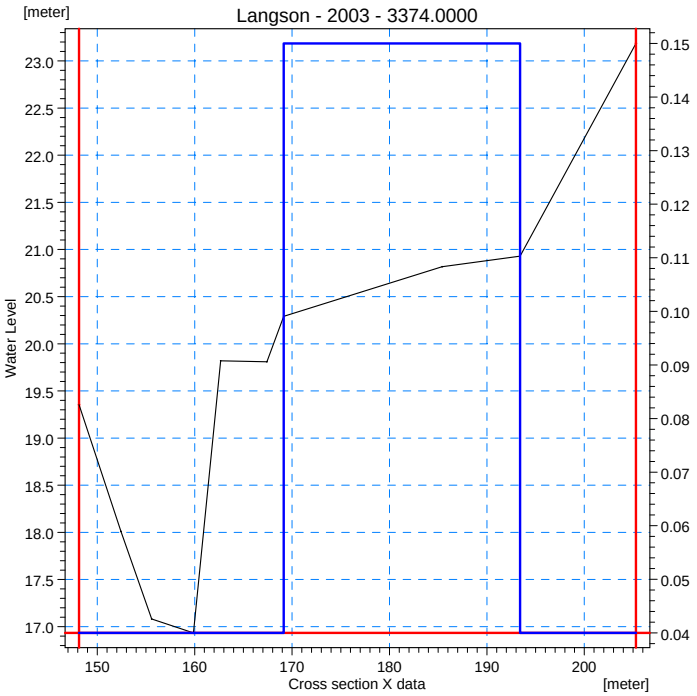

Jenkins - 2003 - 4976.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

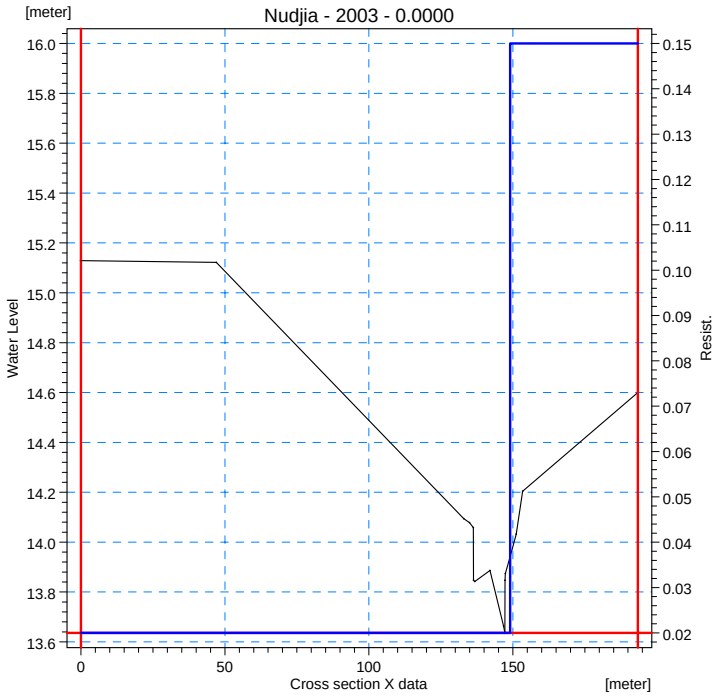

Langson - 2003 - 2850.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

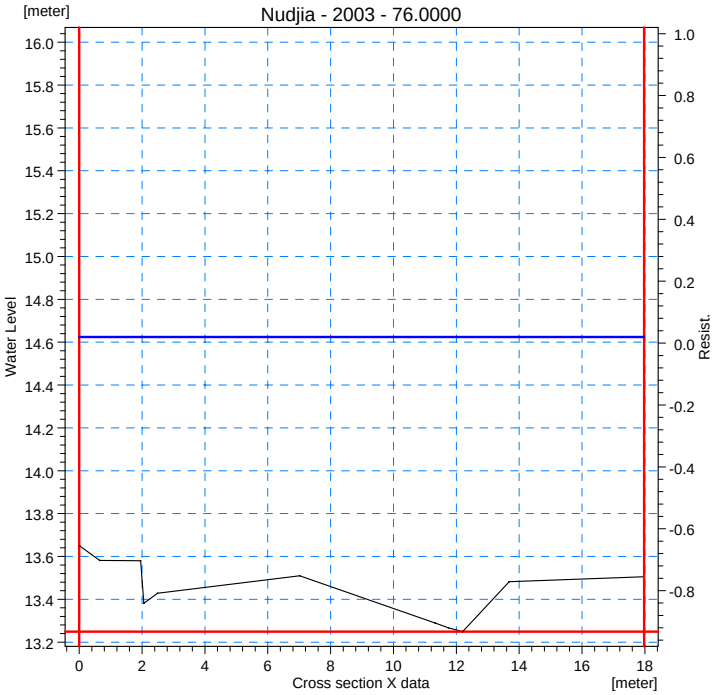

Langson - 2003 - 3070.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Langson - 2003 - 3240.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Langson - 2003 - 3272.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Langson - 2003 - 3374.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Nudjia - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Nudjia - 2003 - 76.0000
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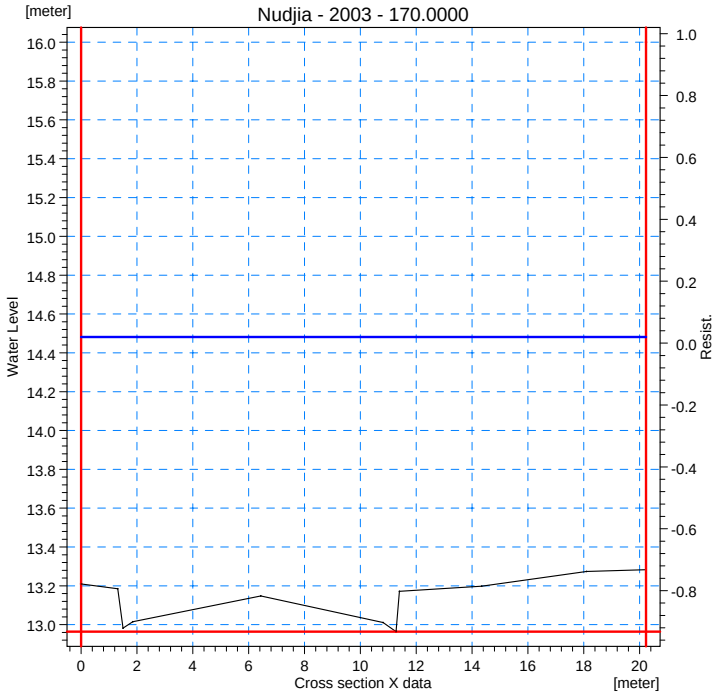
Water Level
Resist.
Cross section X data
[meter]


Nudjia - 2003 - 170.0000
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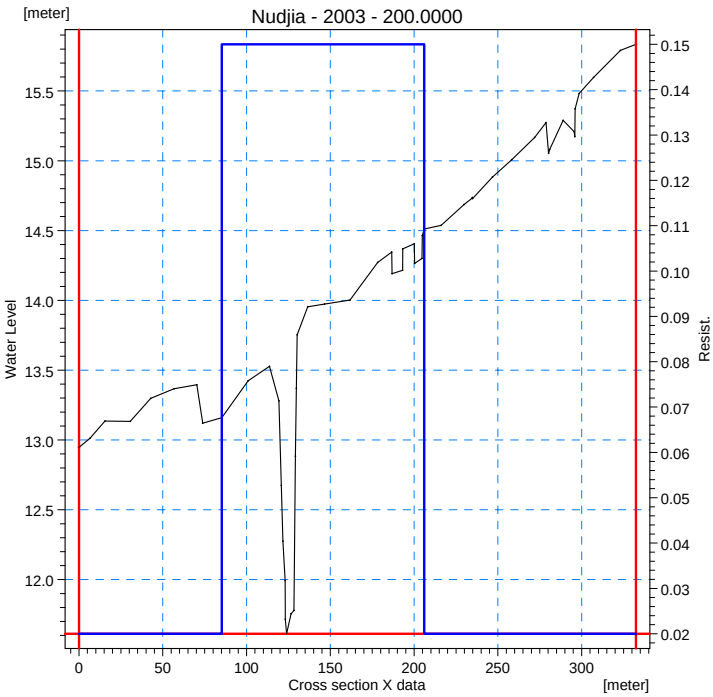
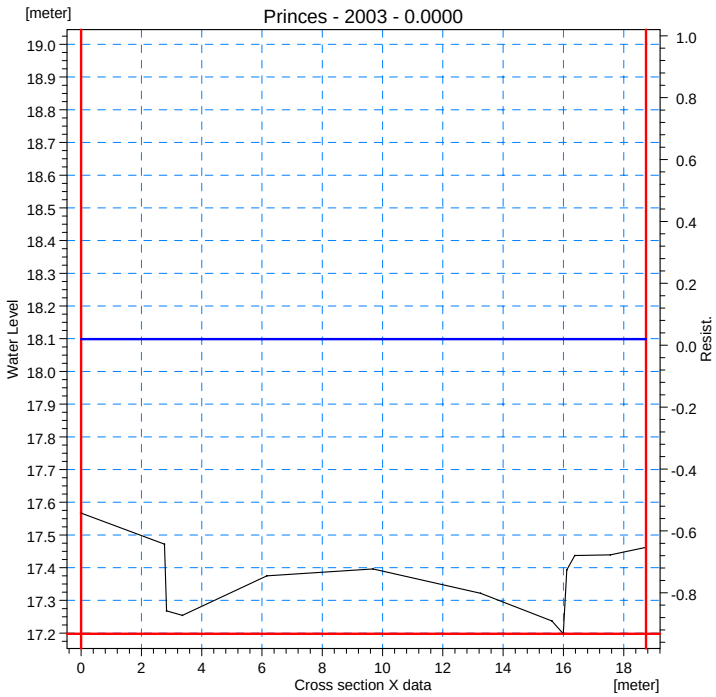
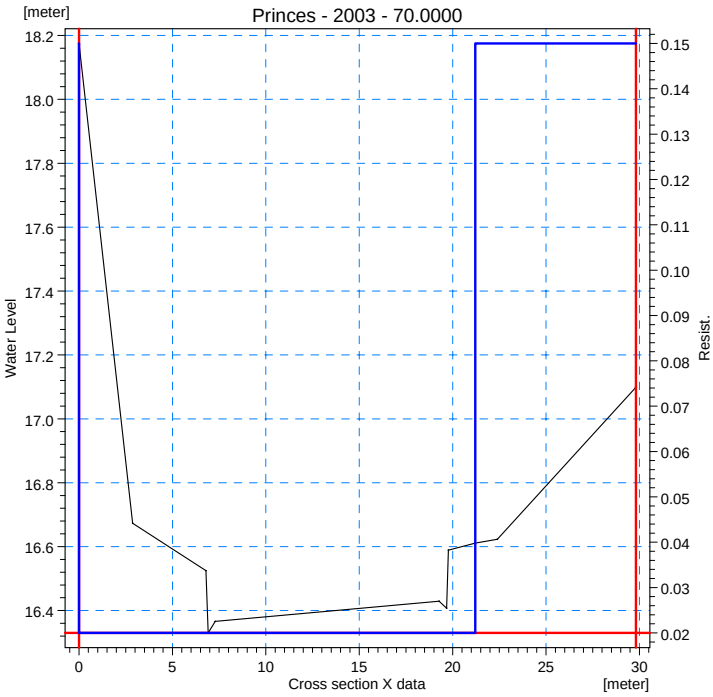
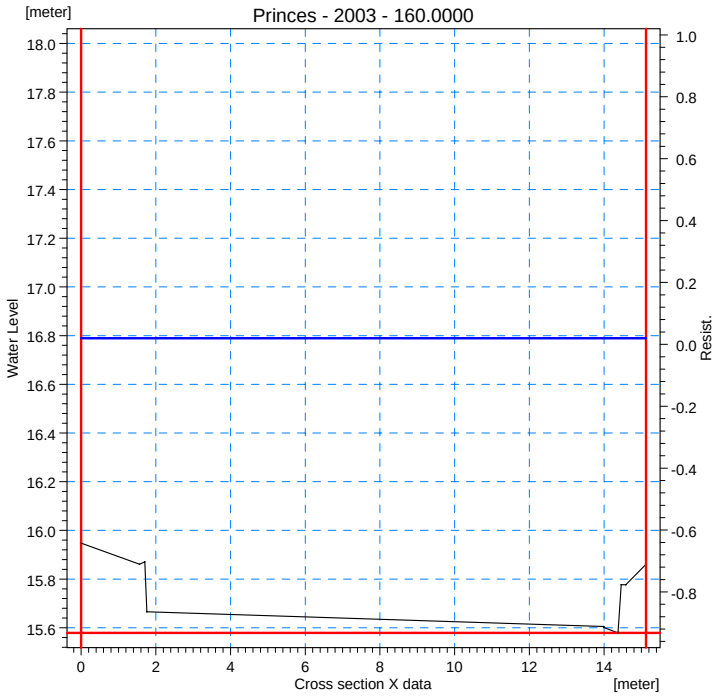
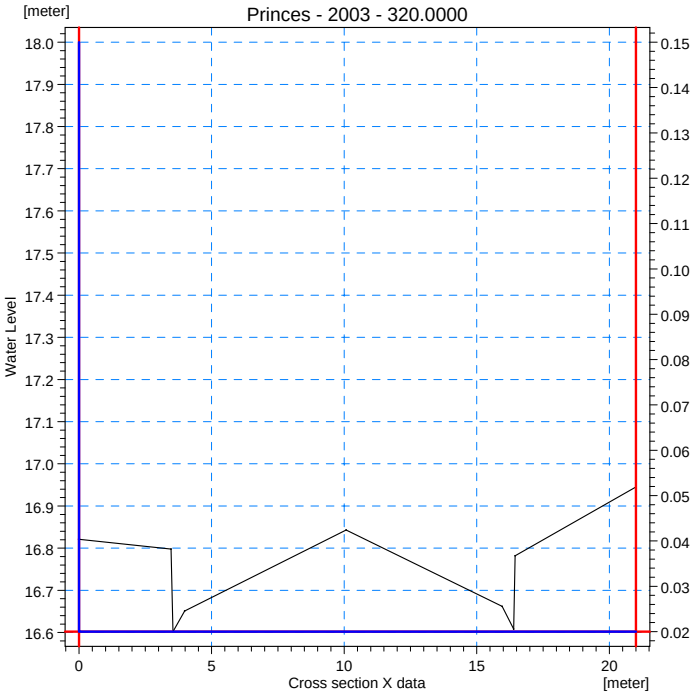
Water Level
Resist.
Cross section X data
[meter]

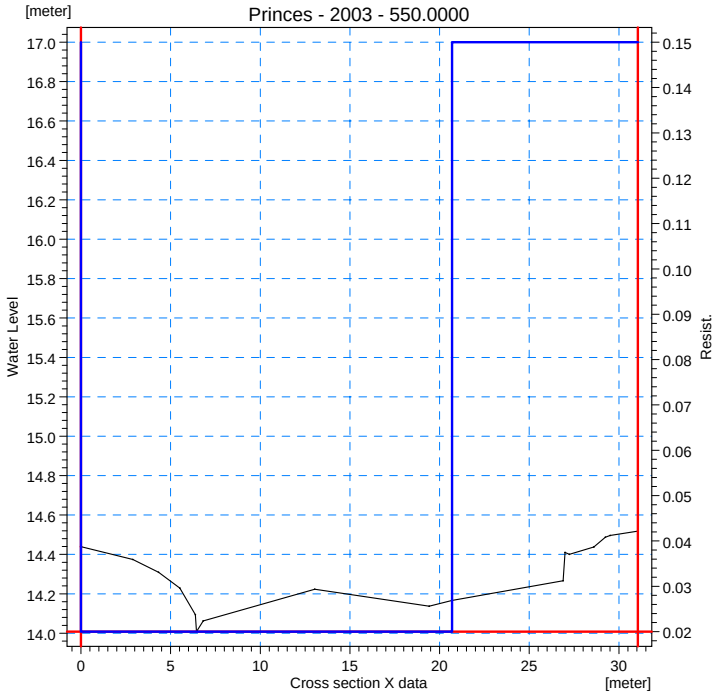

Nudjia - 2003 - 200.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

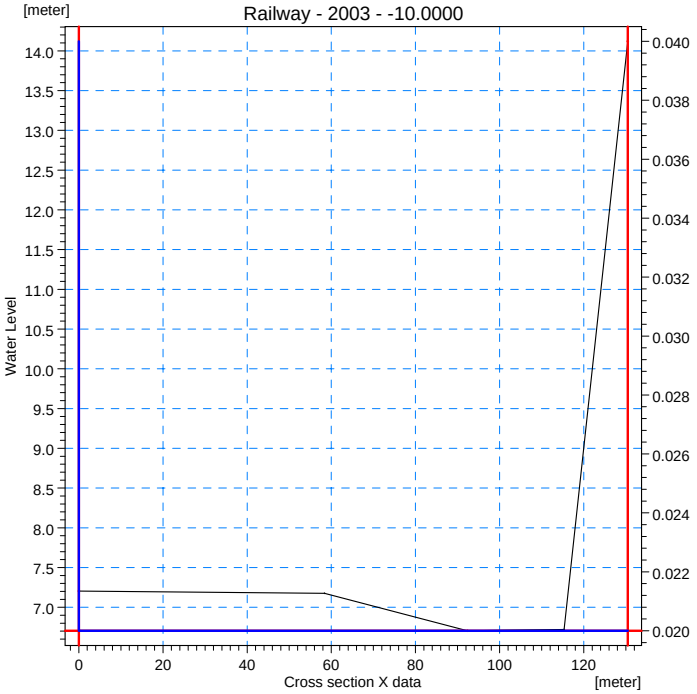

Princes - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

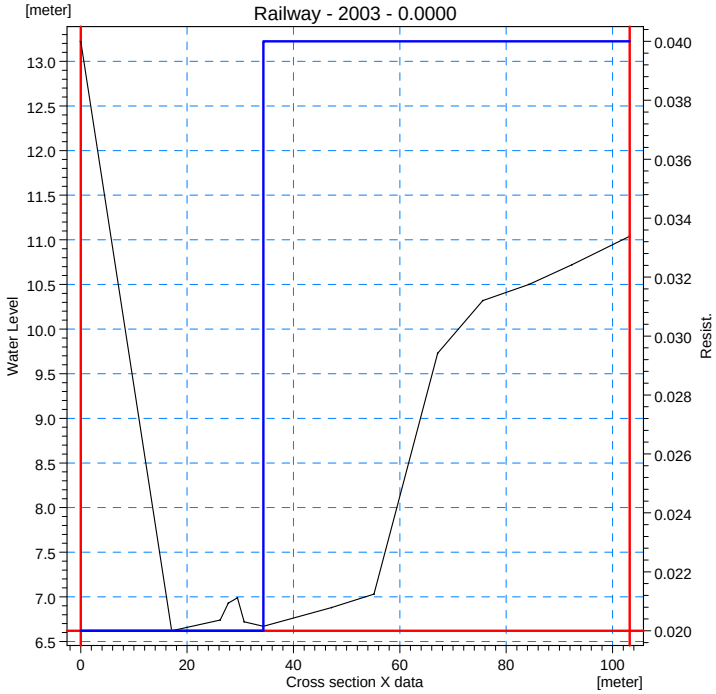

Princes - 2003 - 70.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

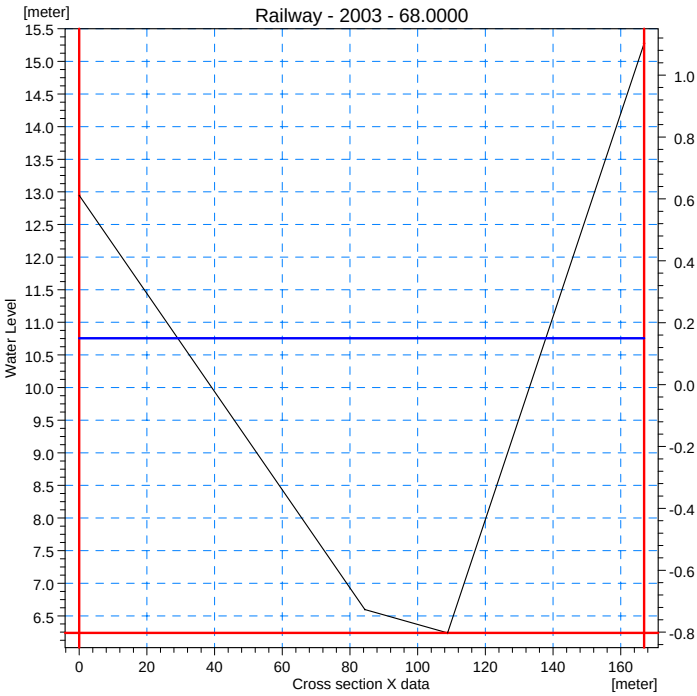

Princes - 2003 - 160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

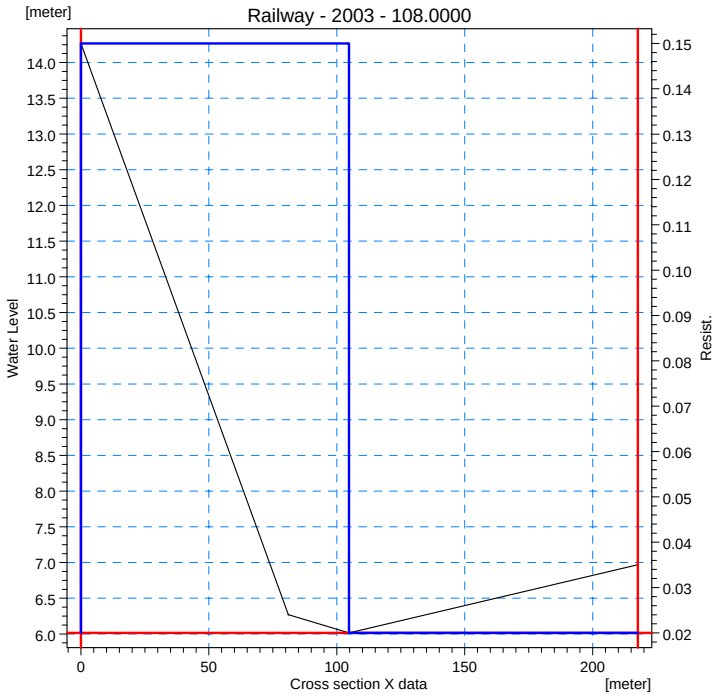

Princes - 2003 - 320.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

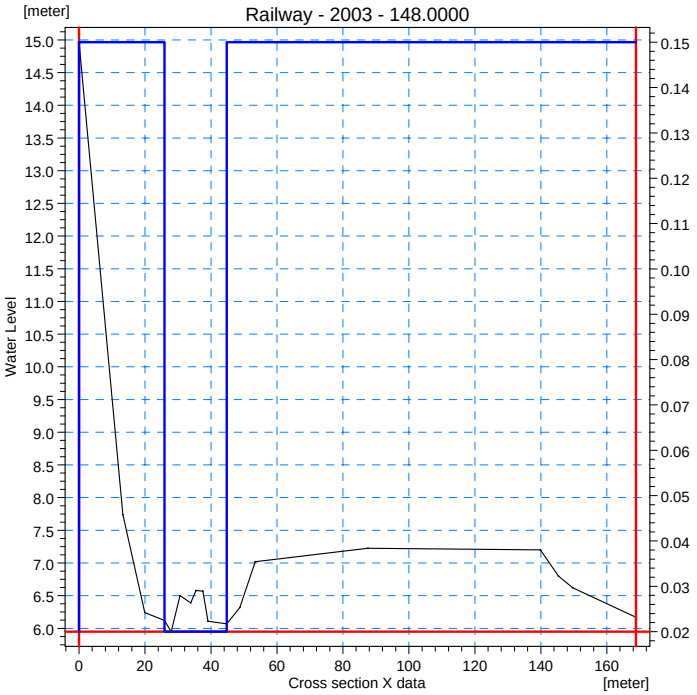

Princes - 2003 - 550.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

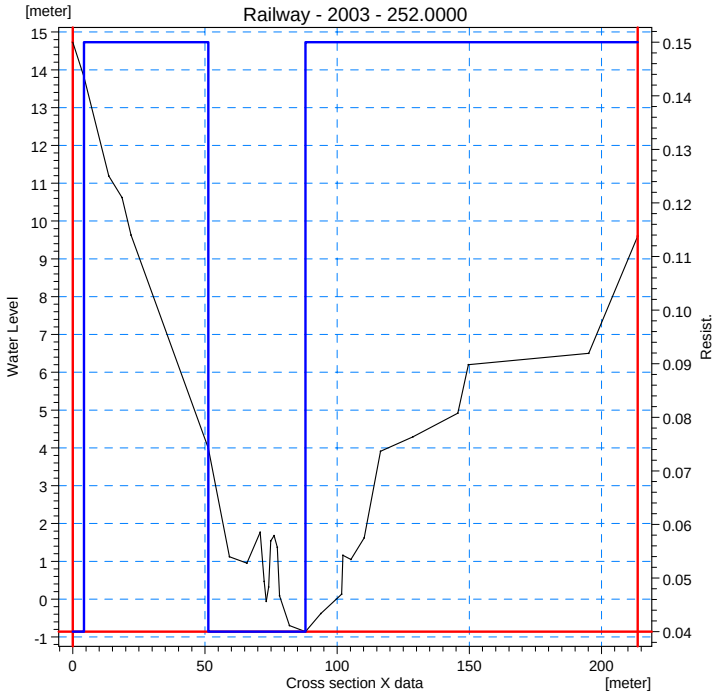

Railway - 2003 - -10.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

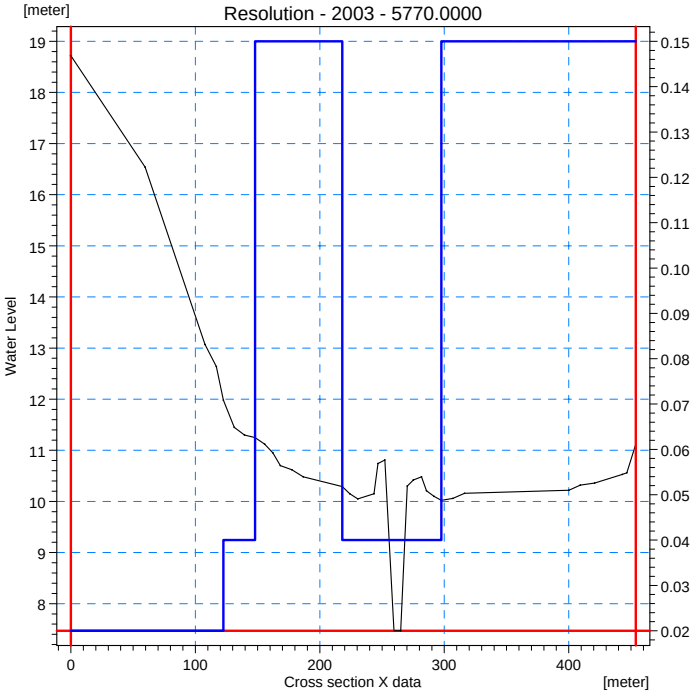

Railway - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

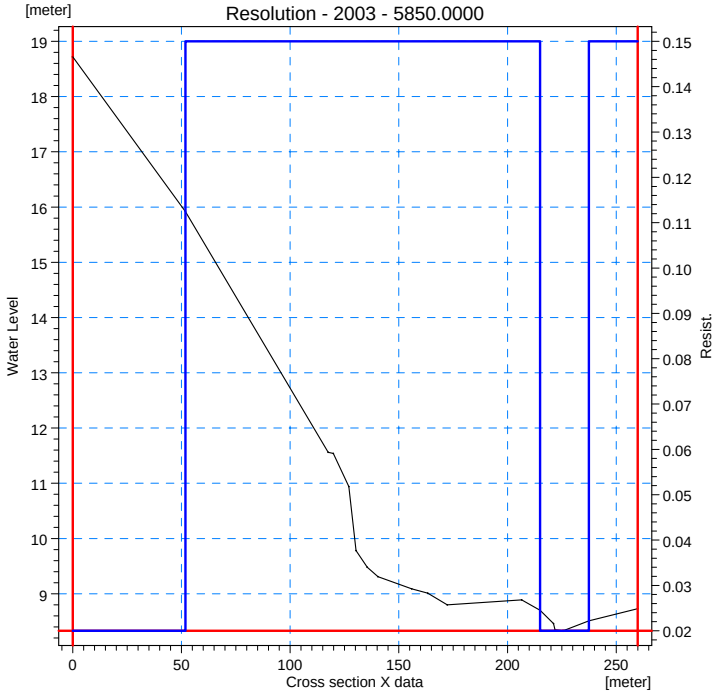

Railway - 2003 - 68.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Railway - 2003 - 108.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Railway - 2003 - 148.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Railway - 2003 - 252.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 5770.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 5850.0000
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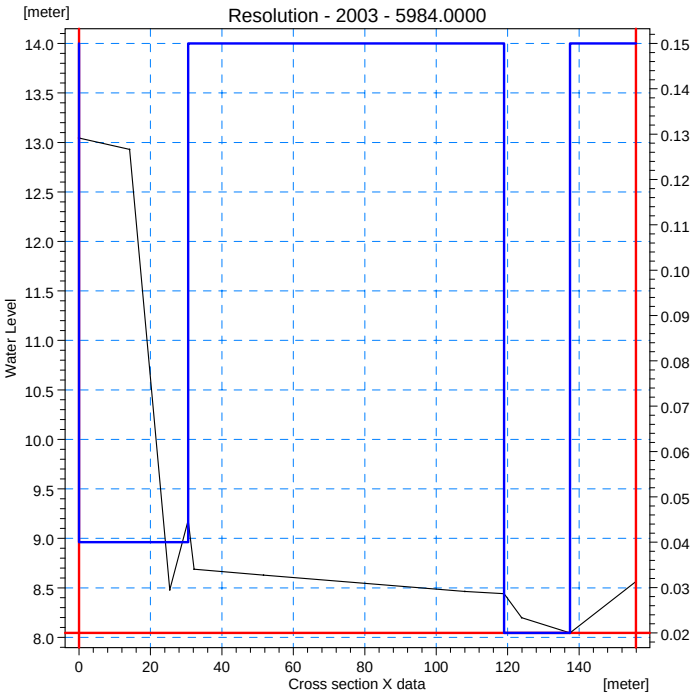
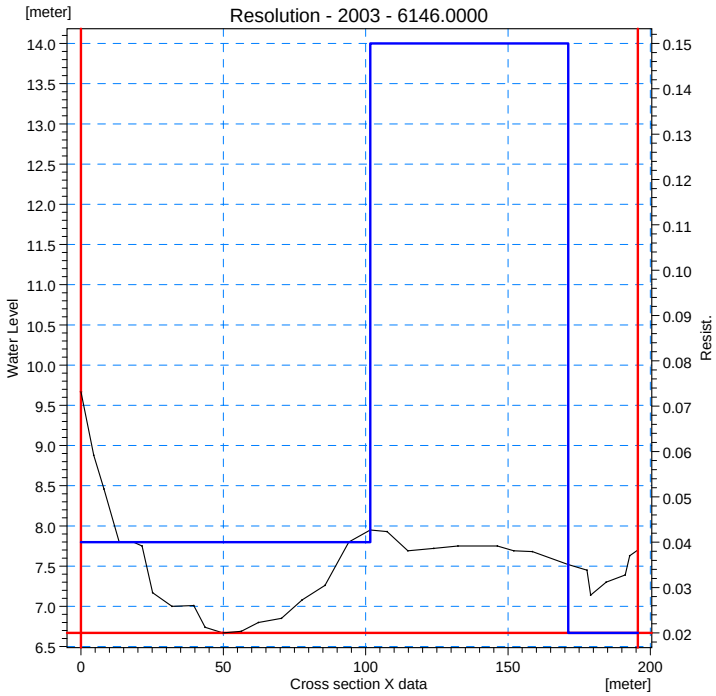
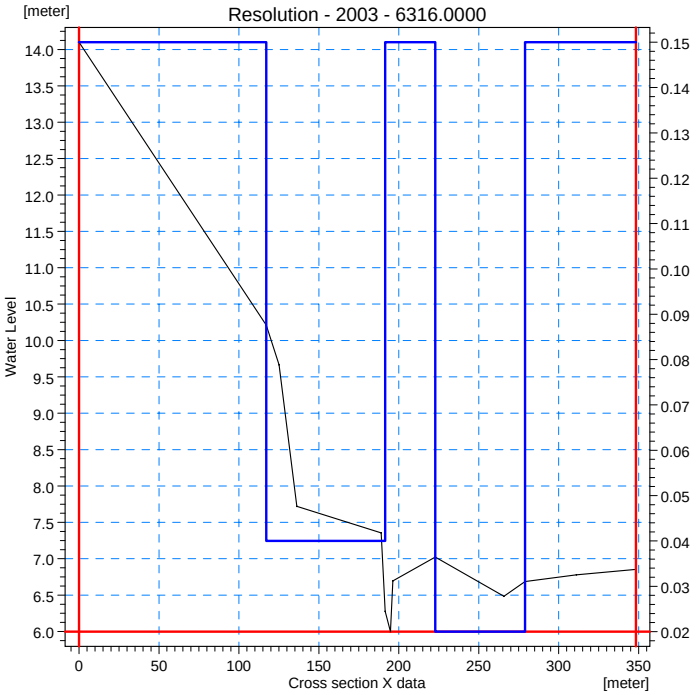
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 5984.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6146.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6316.0000
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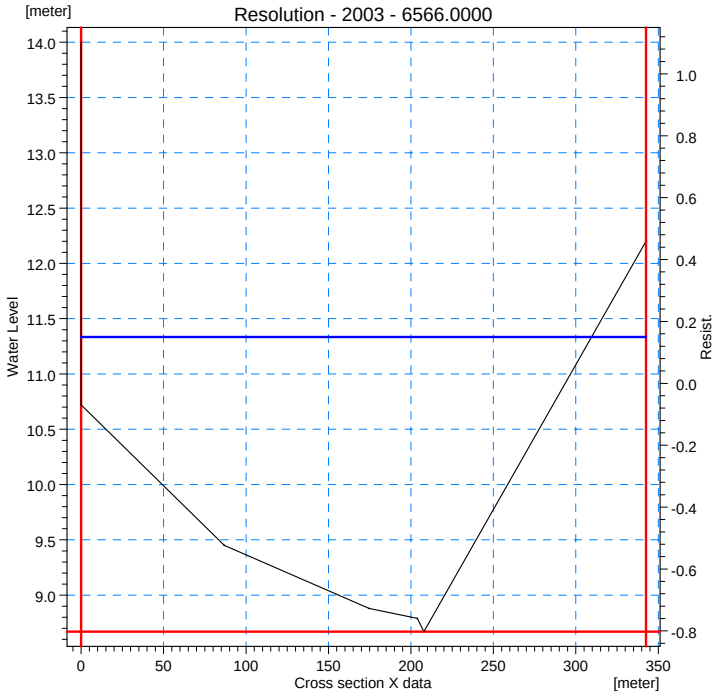
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6566.0000
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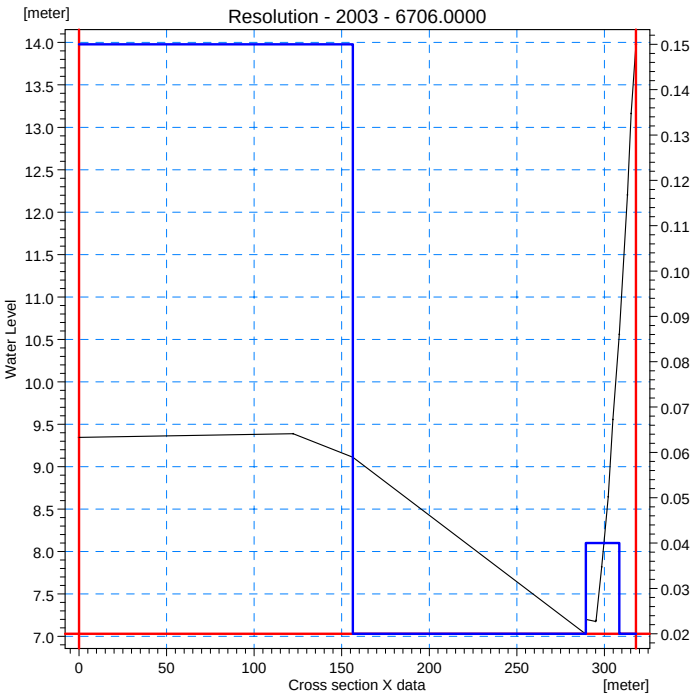
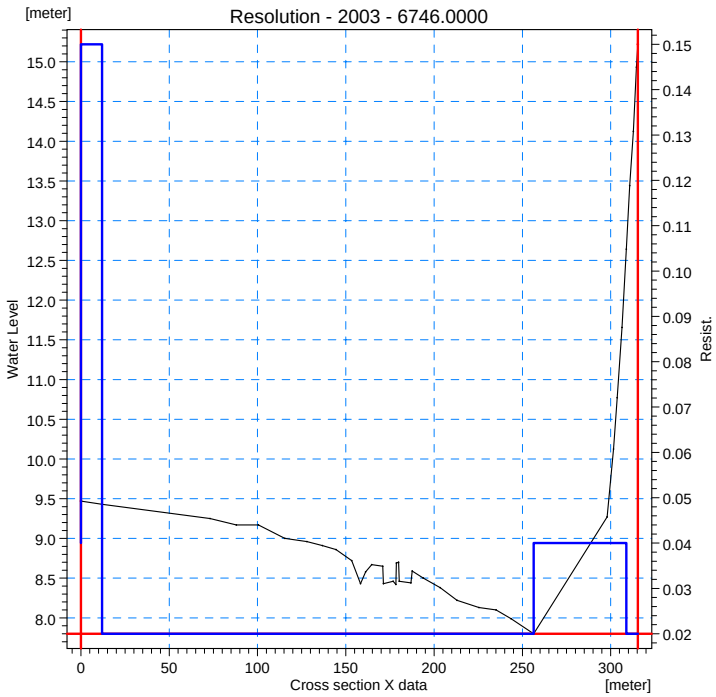
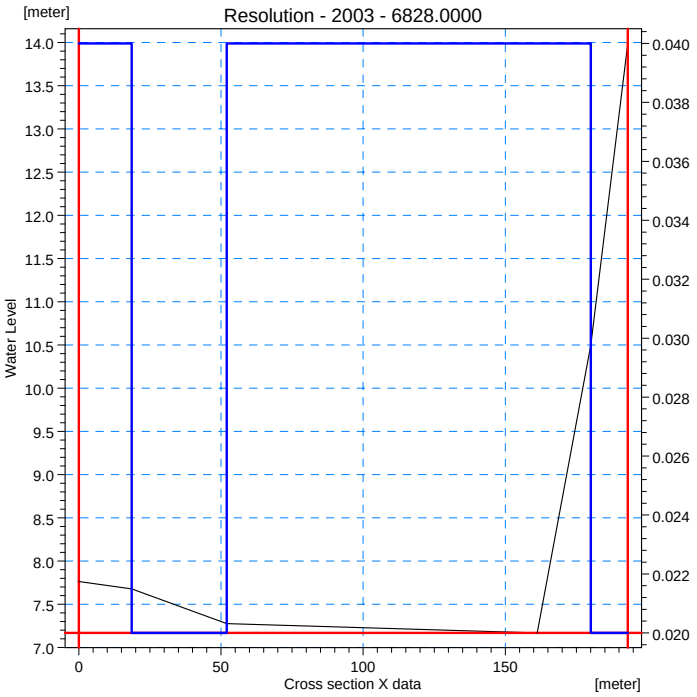
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6706.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6746.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Resolution - 2003 - 6828.0000
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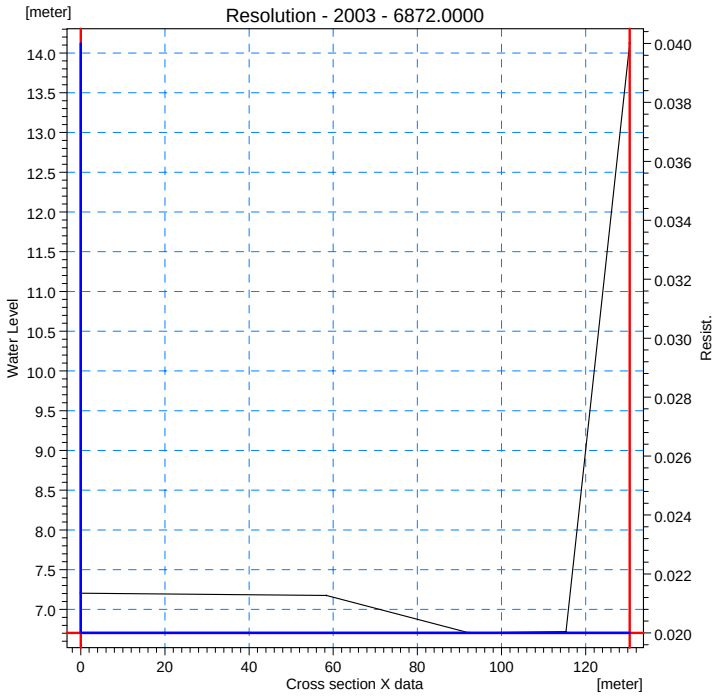
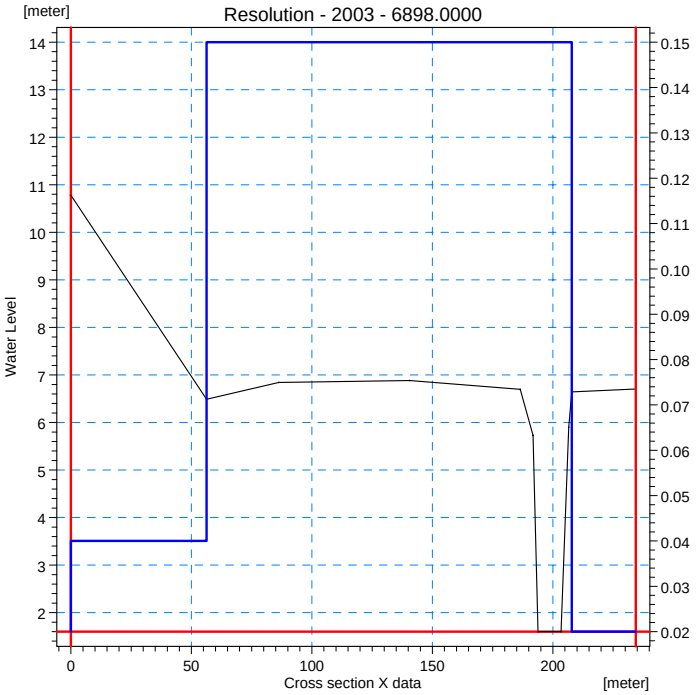
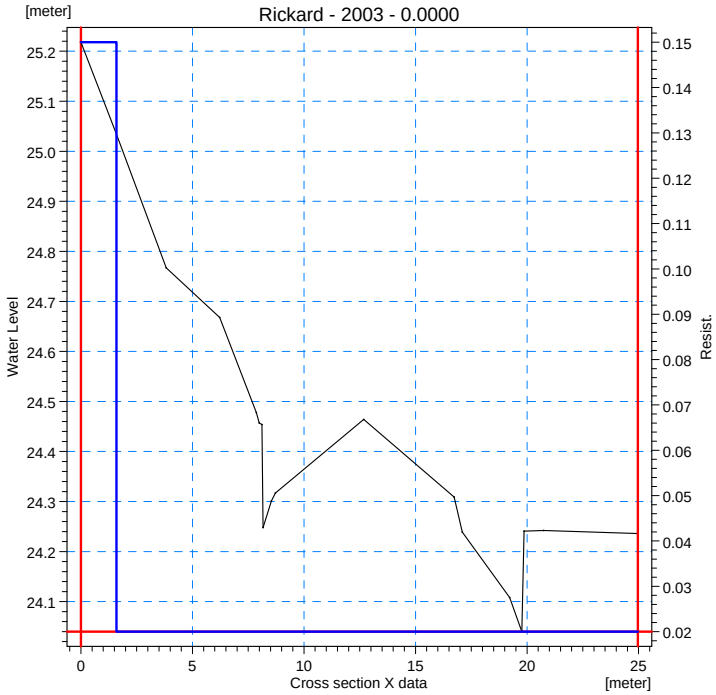
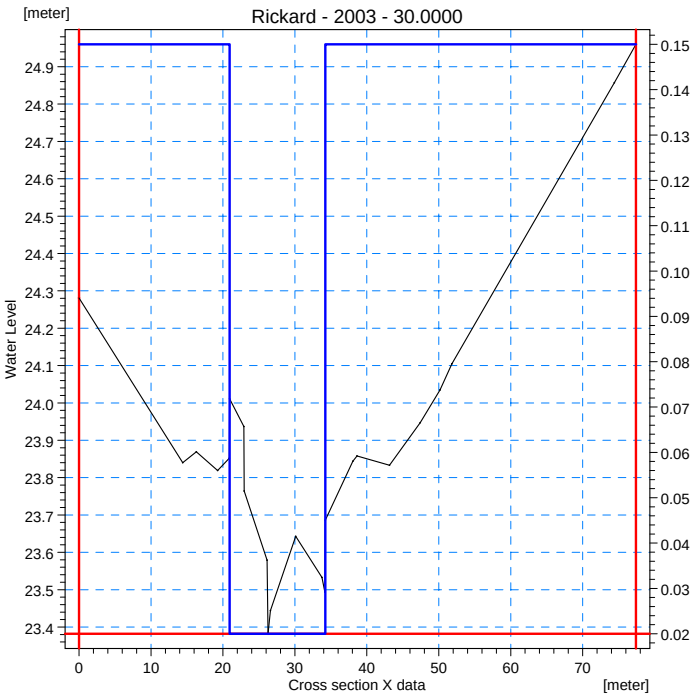
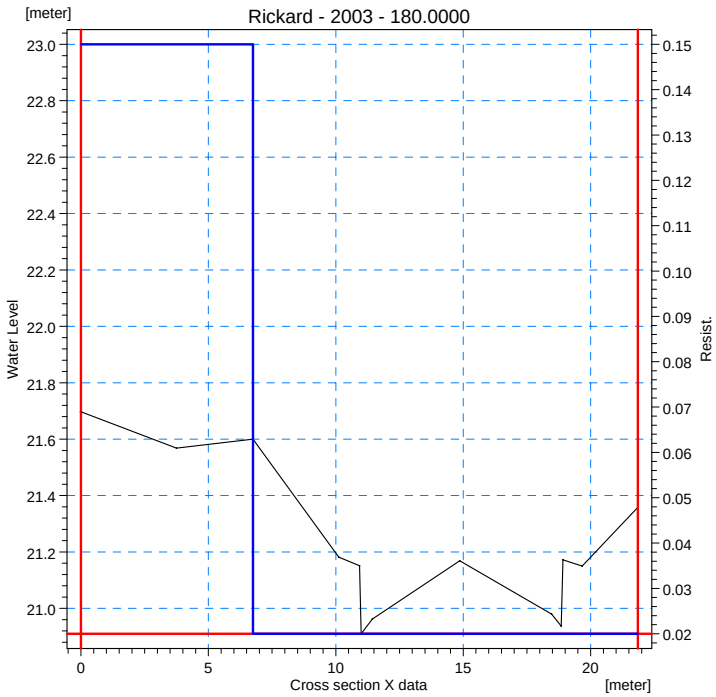
Water Level
Resist.
Cross section X data
[meter]

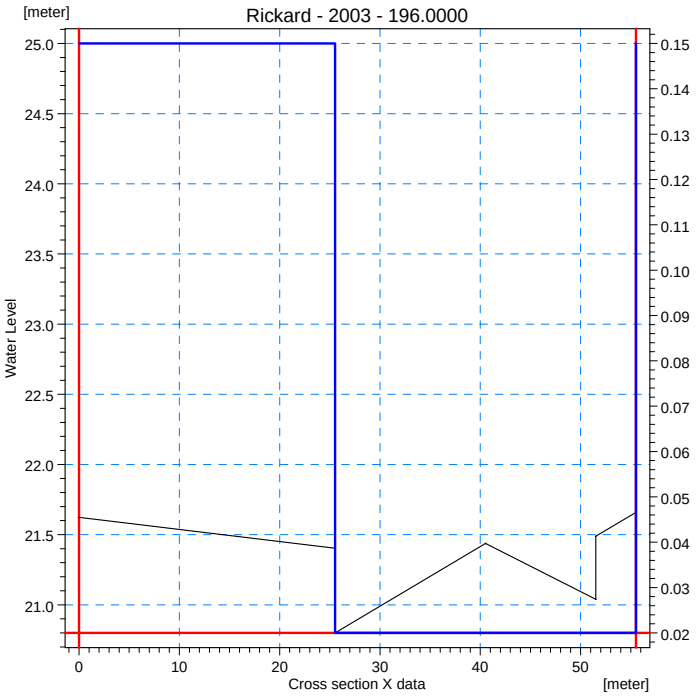

Resolution - 2003 - 6872.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

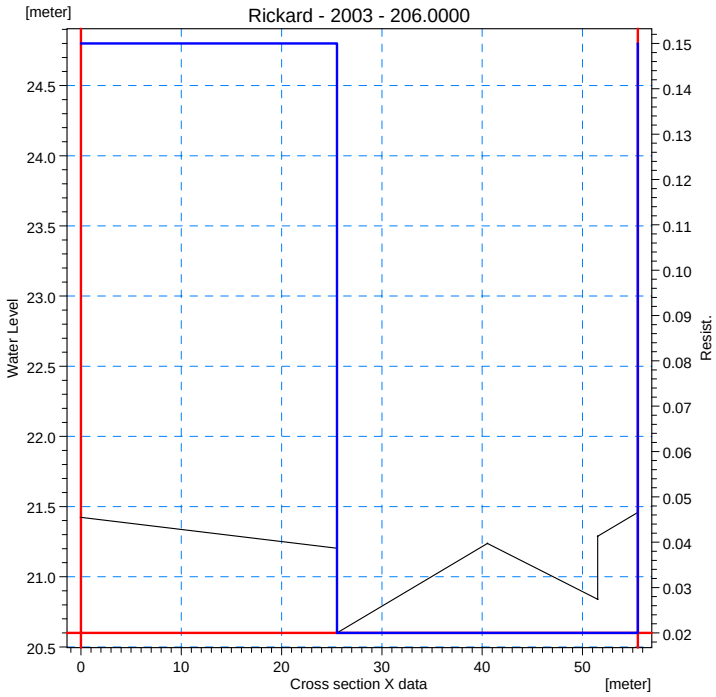

Resolution - 2003 - 6898.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

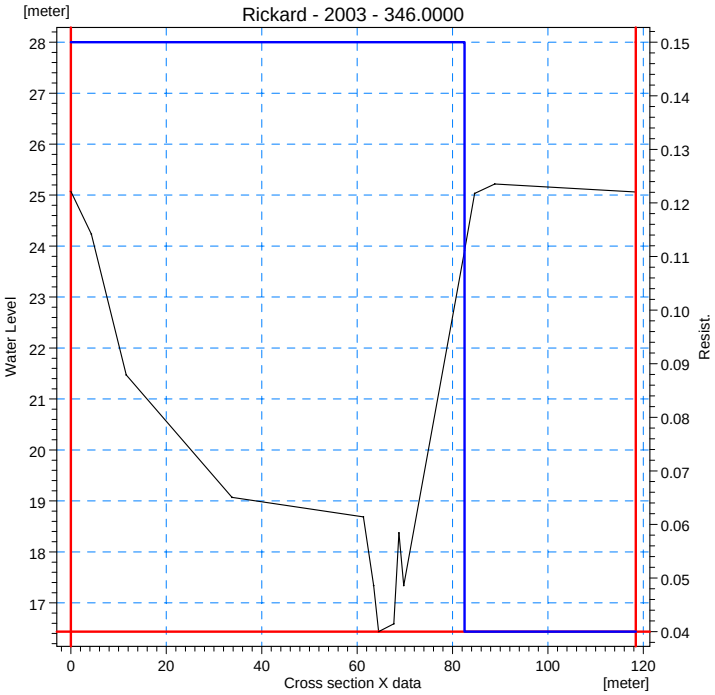

Rickard - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

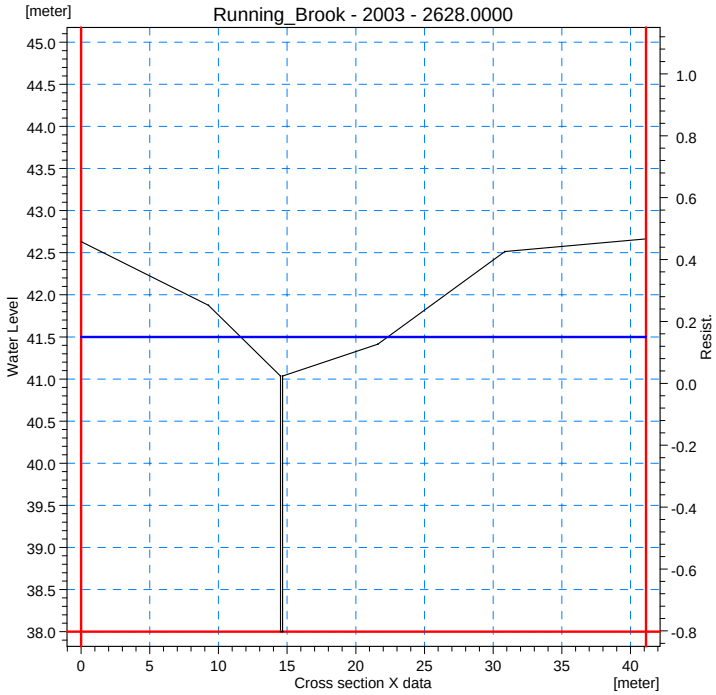

Rickard - 2003 - 30.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

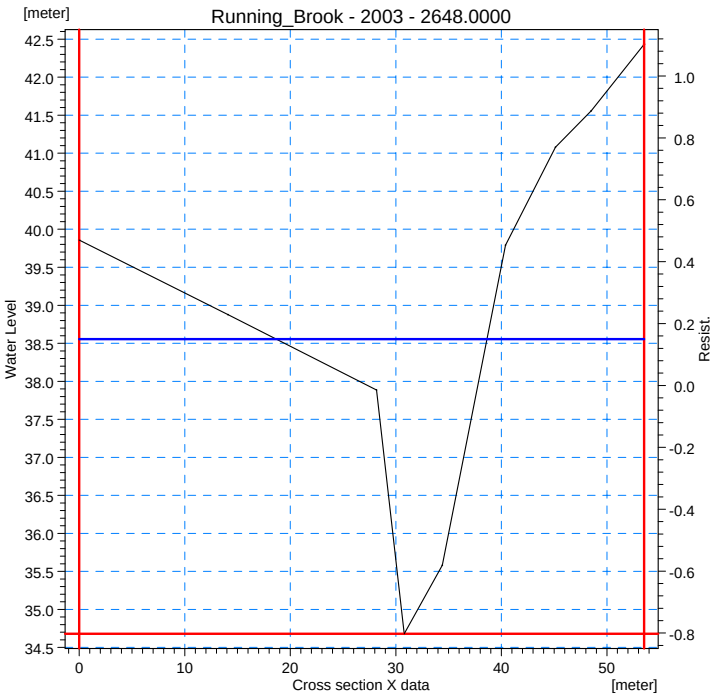

Rickard - 2003 - 180.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

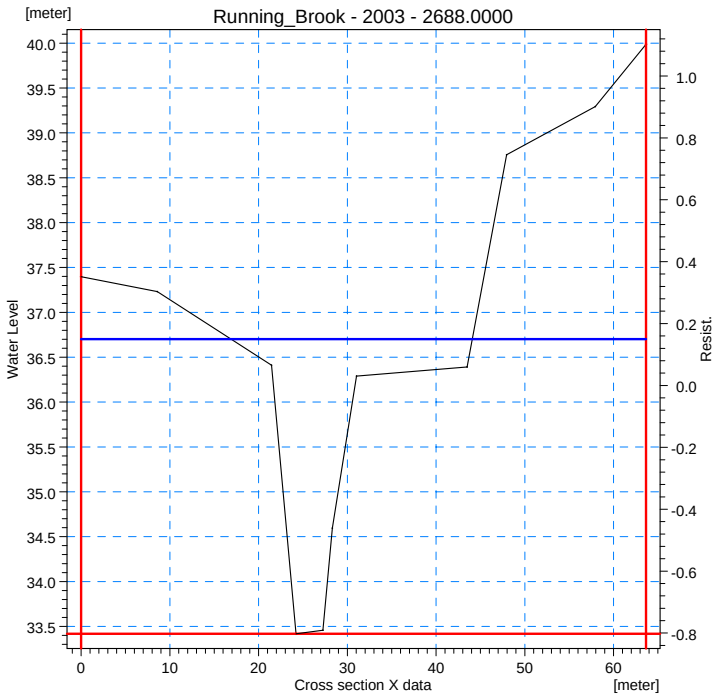

Rickard - 2003 - 196.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

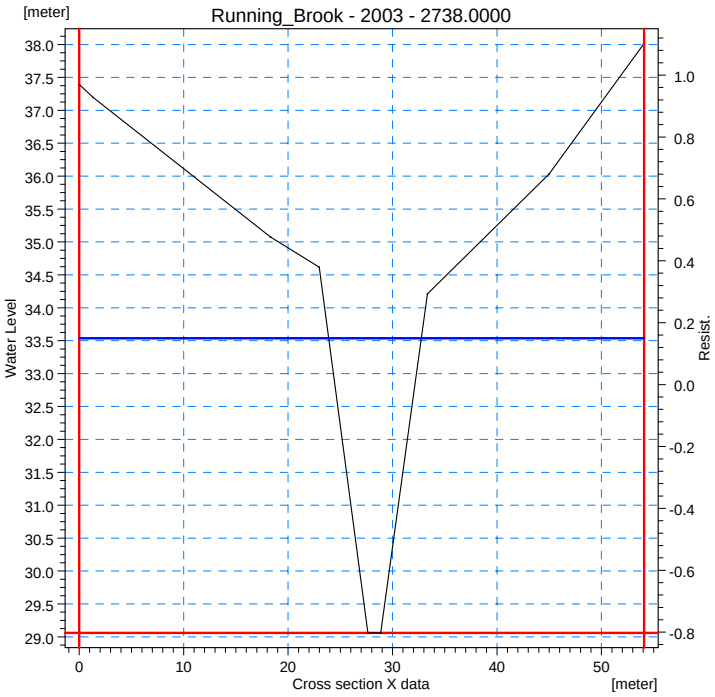

Rickard - 2003 - 206.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

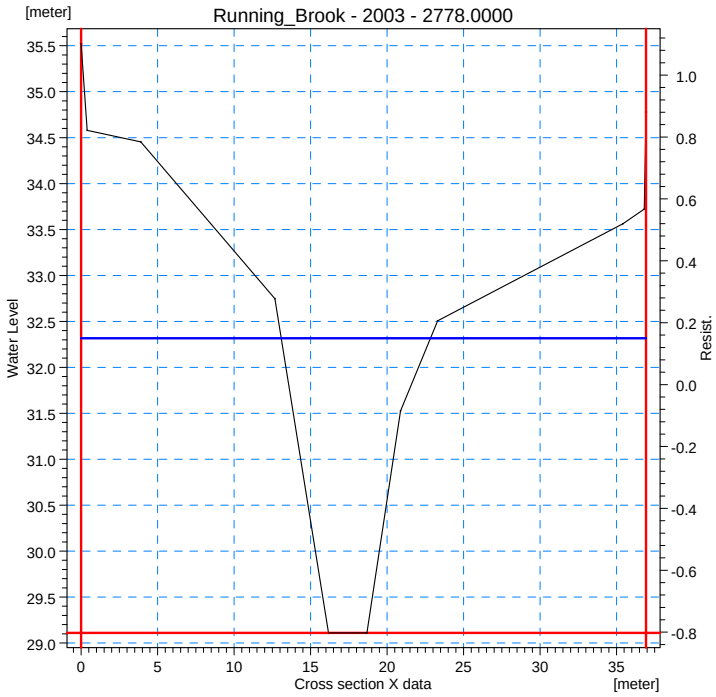

Rickard - 2003 - 346.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

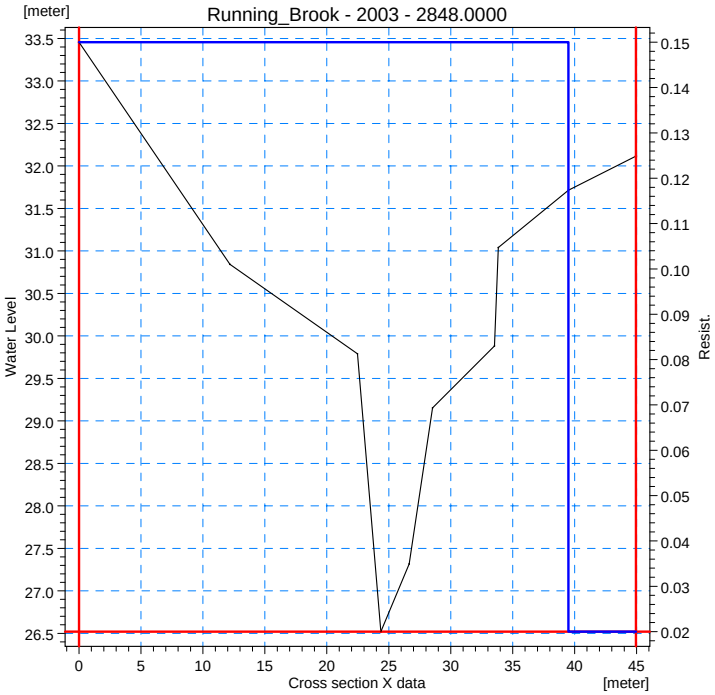

Running_Brook - 2003 - 2628.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

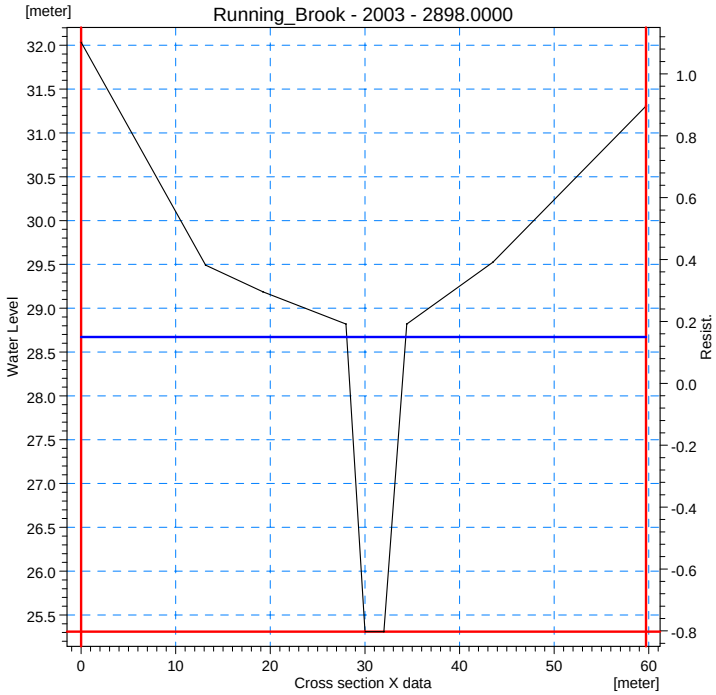

Running_Brook - 2003 - 2648.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

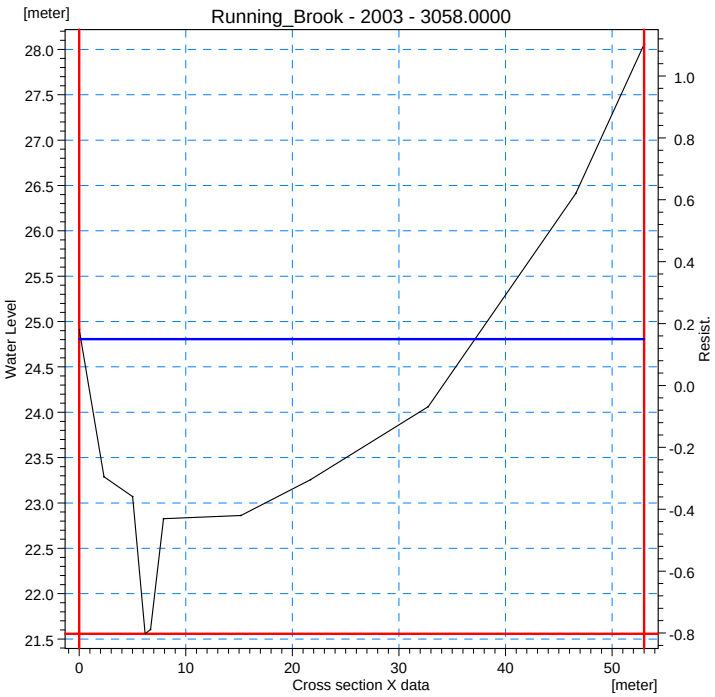

Running_Brook - 2003 - 2688.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

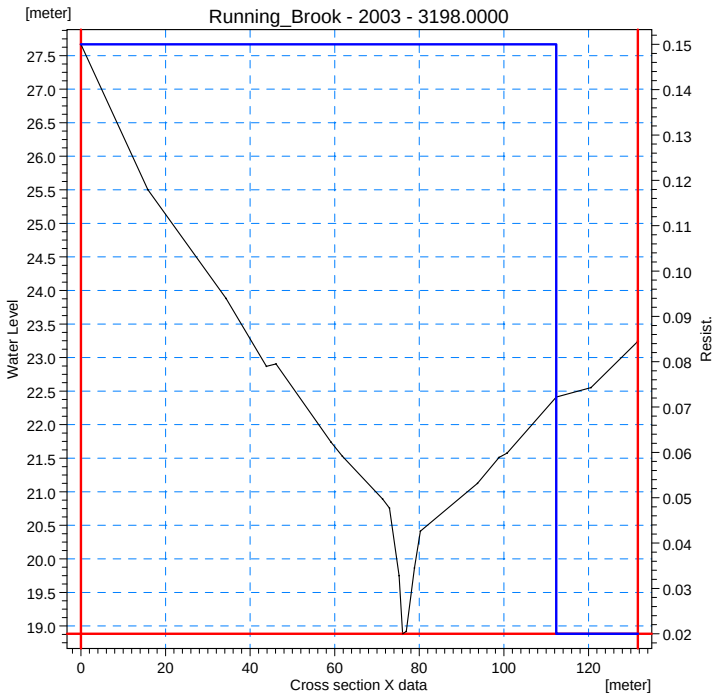

Running_Brook - 2003 - 2738.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

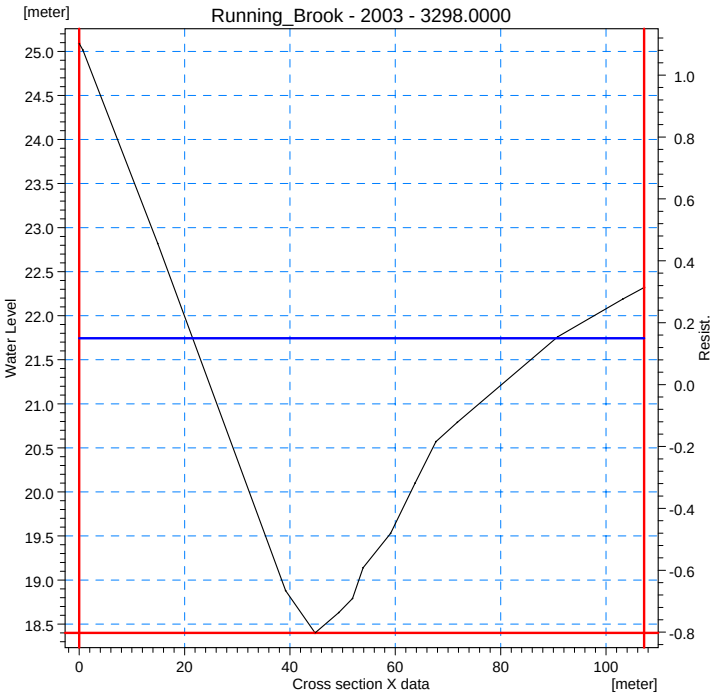

Running_Brook - 2003 - 2778.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

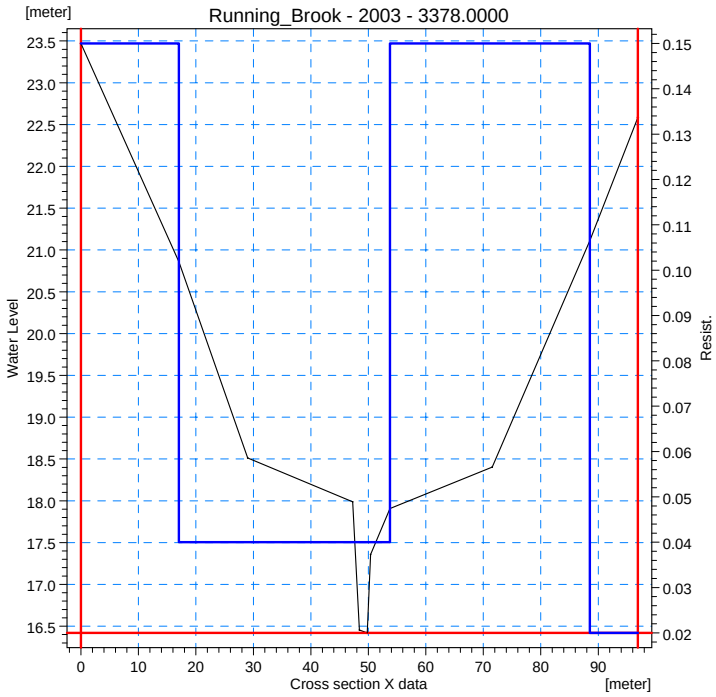

Running_Brook - 2003 - 2848.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

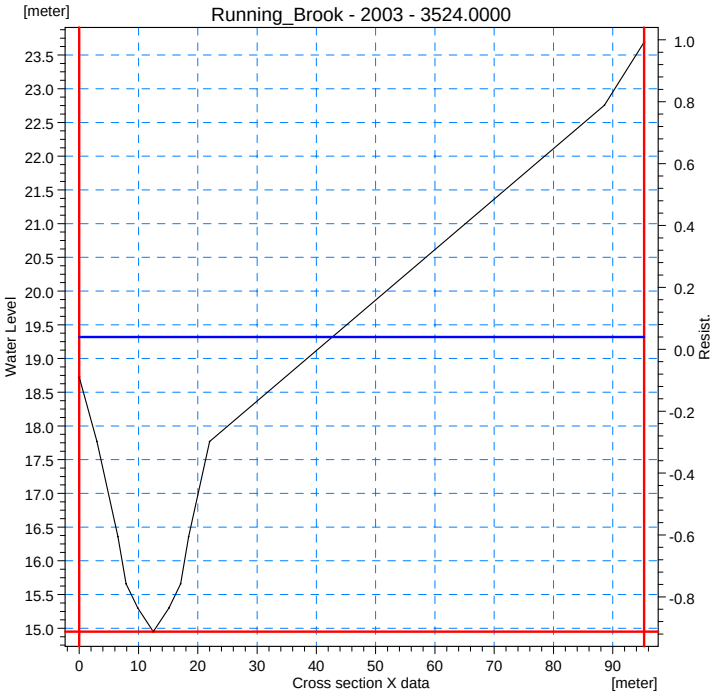

Running_Brook - 2003 - 2898.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

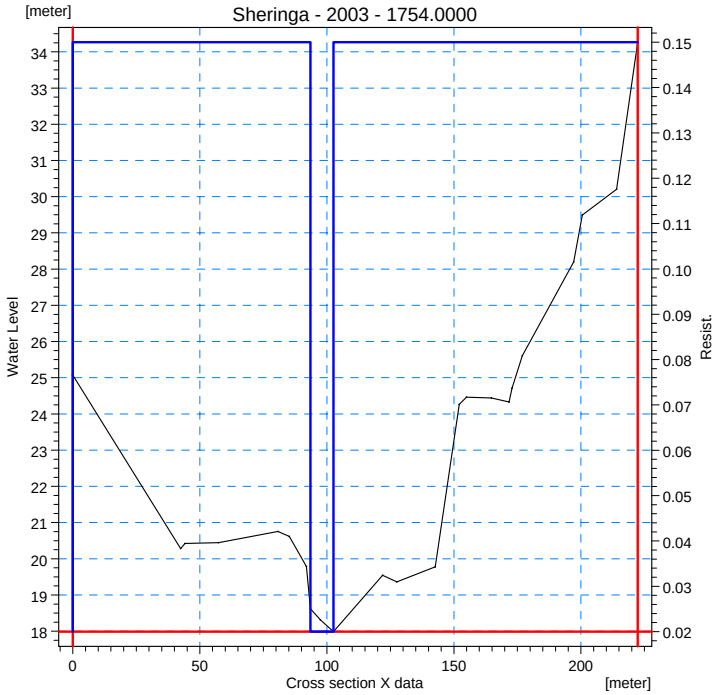

Running_Brook - 2003 - 3058.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

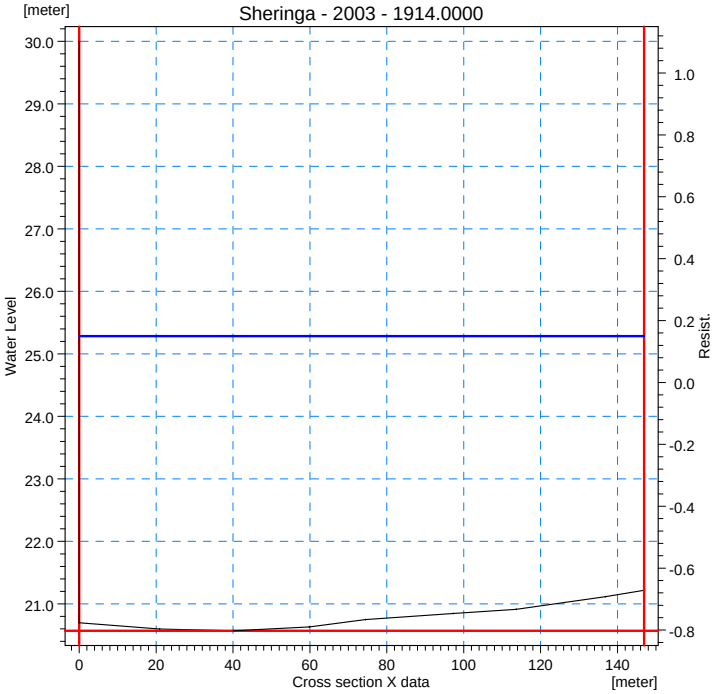

Running_Brook - 2003 - 3198.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

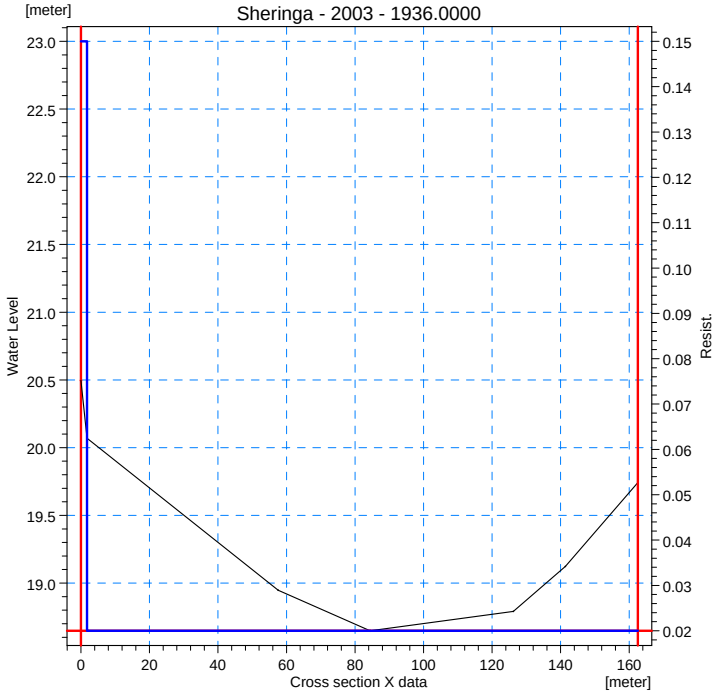

Running_Brook - 2003 - 3298.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

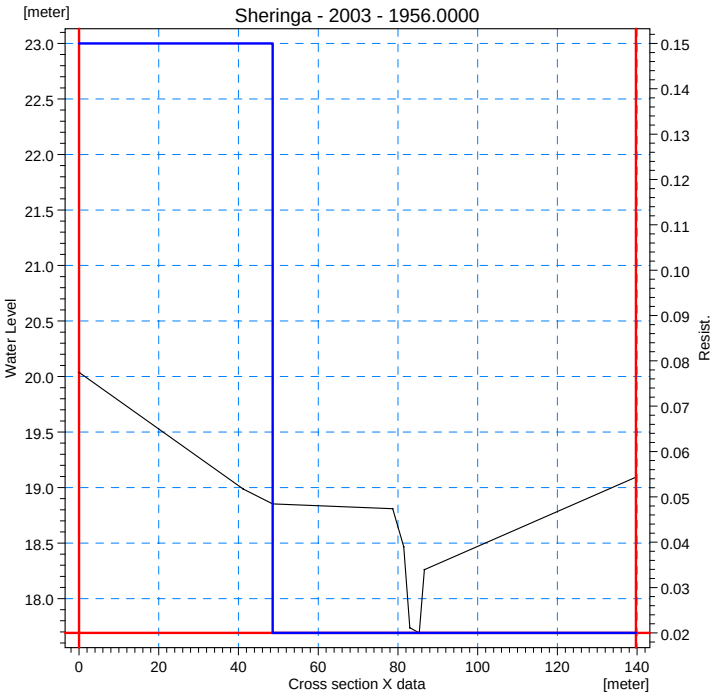

Running_Brook - 2003 - 3378.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

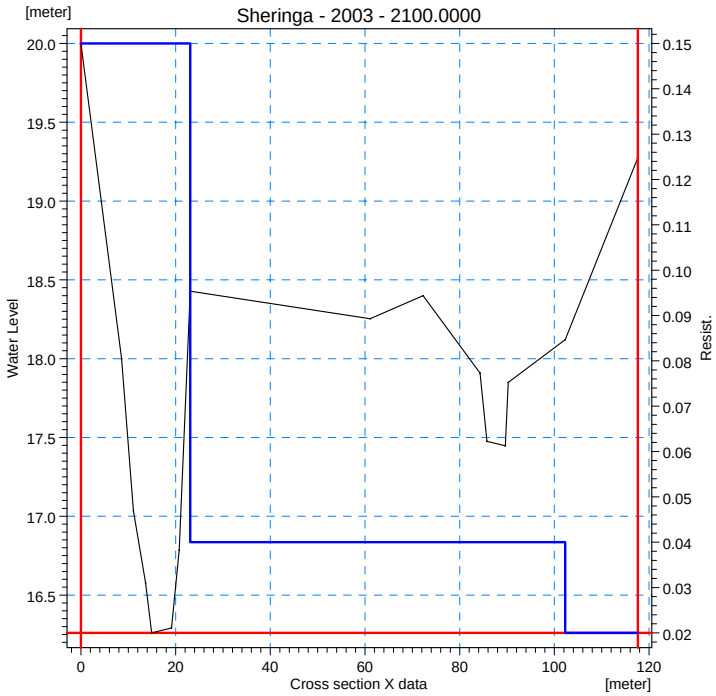

Running_Brook - 2003 - 3524.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

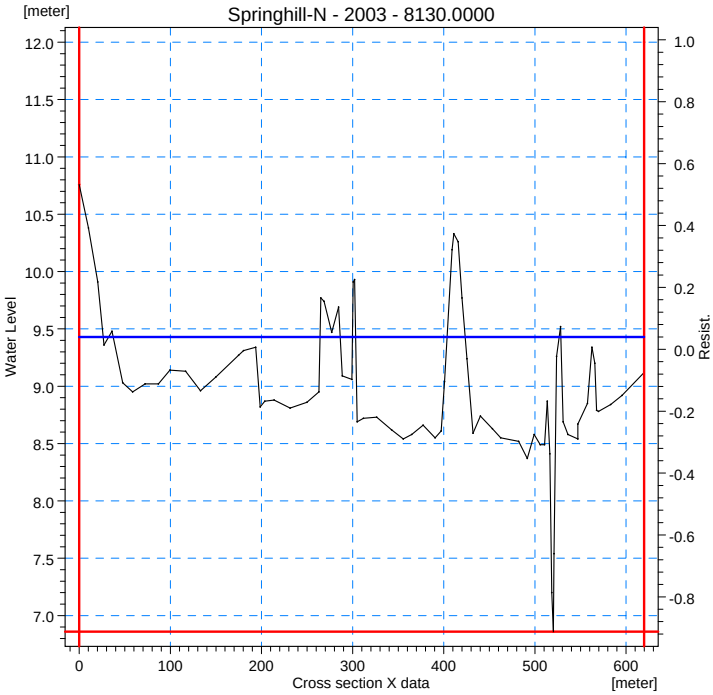

Sheringa - 2003 - 1754.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

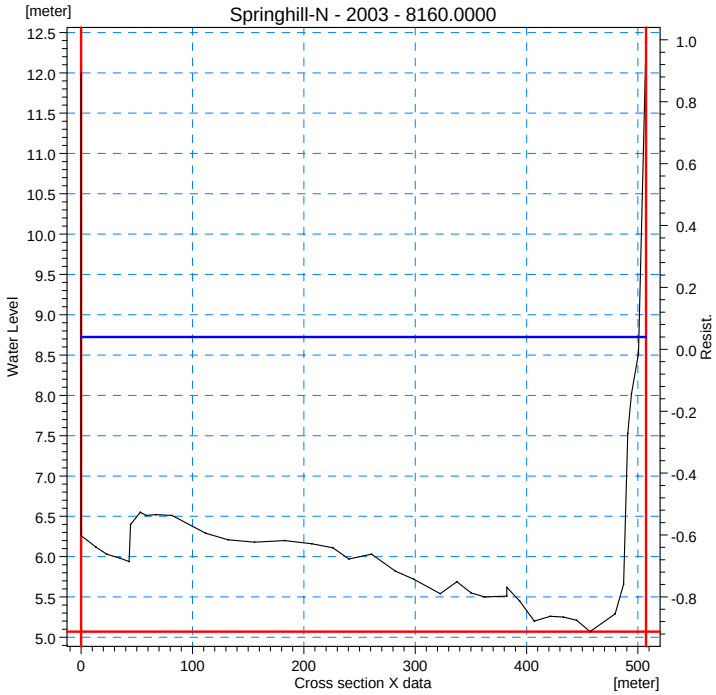

Sheringa - 2003 - 1914.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

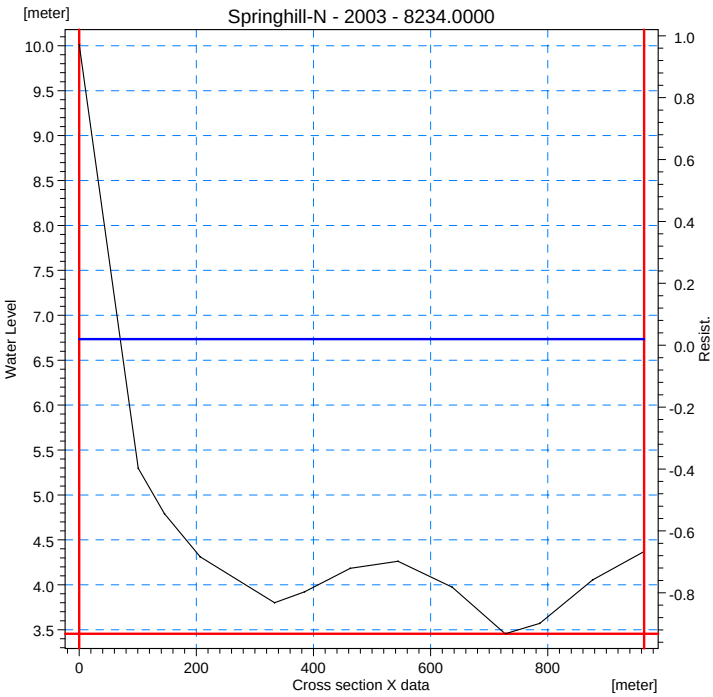

Sheringa - 2003 - 1936.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

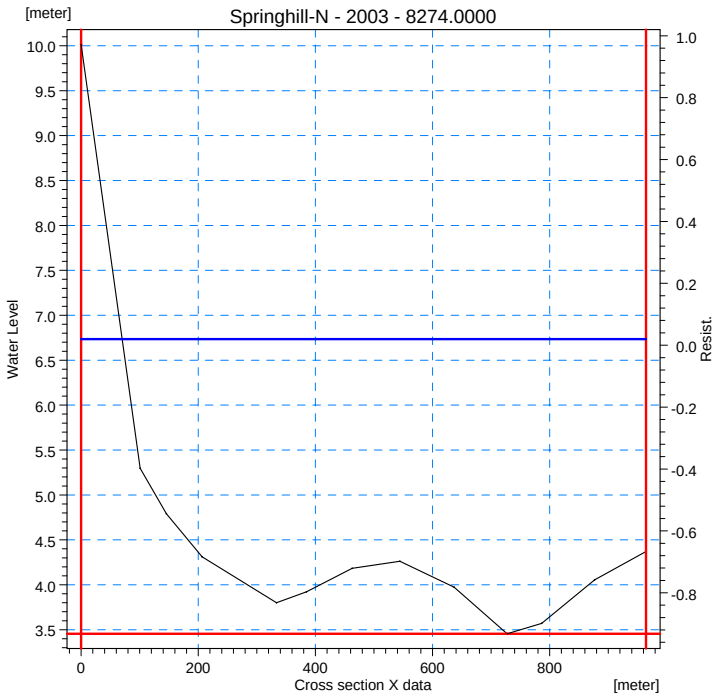

Sheringa - 2003 - 1956.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

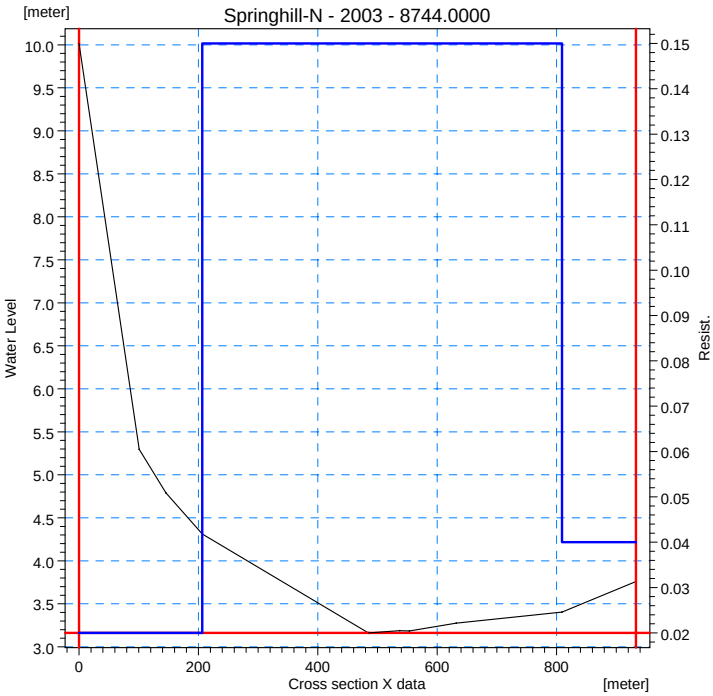

Sheringa - 2003 - 2100.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

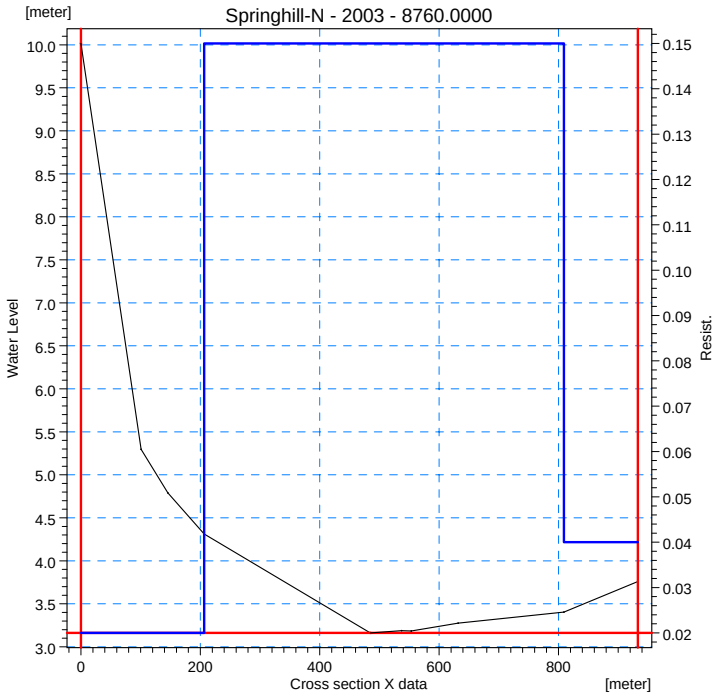

Springhill-N - 2003 - 8130.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

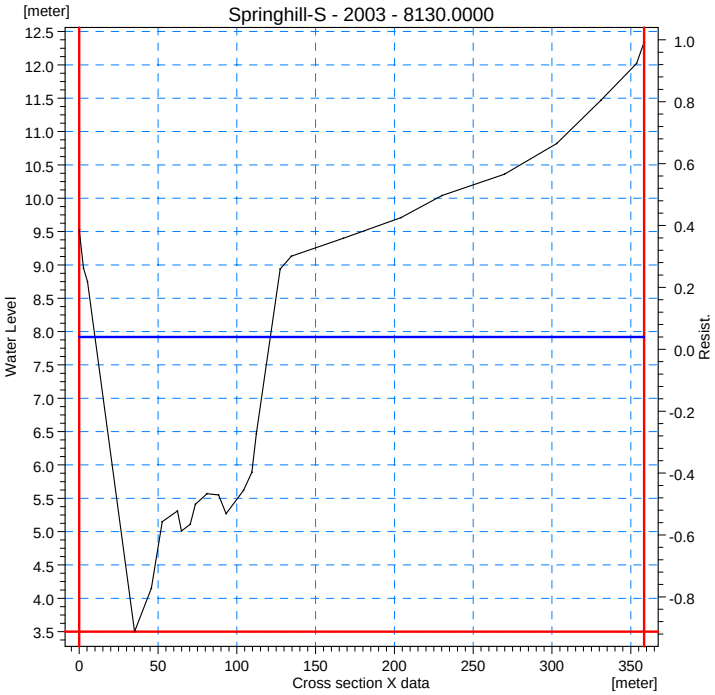

Springhill-N - 2003 - 8160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

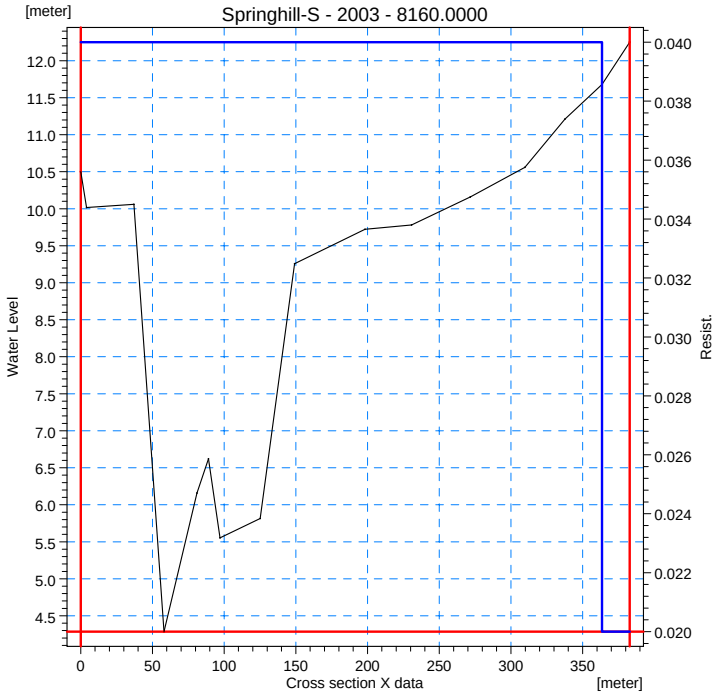

Springhill-N - 2003 - 8234.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

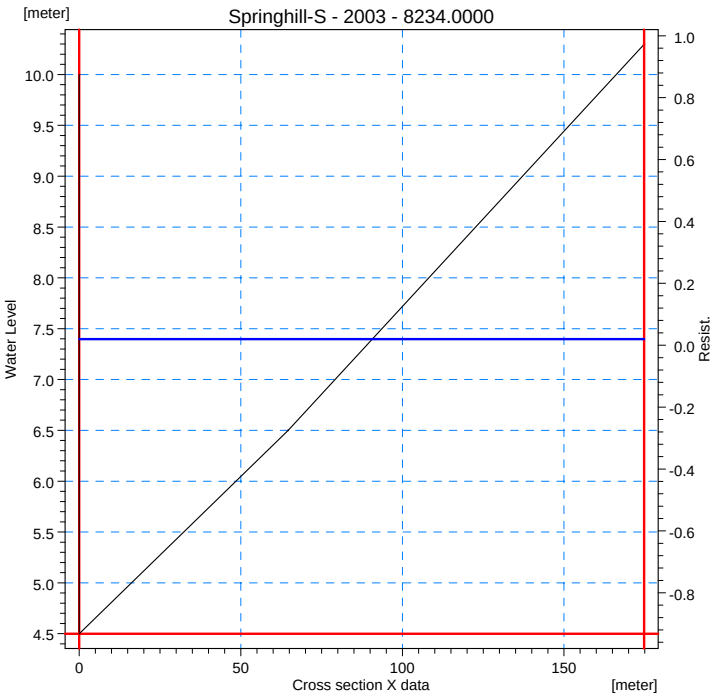

Springhill-N - 2003 - 8274.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

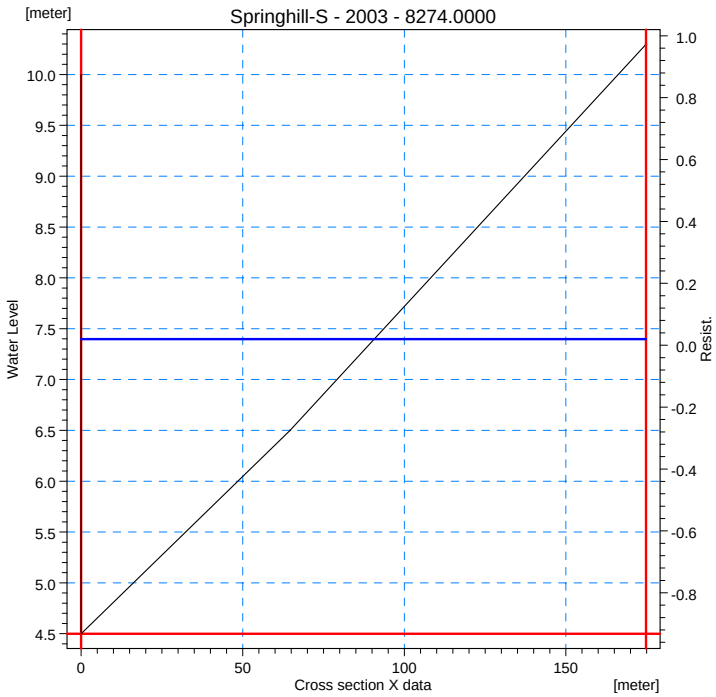

Springhill-N - 2003 - 8744.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

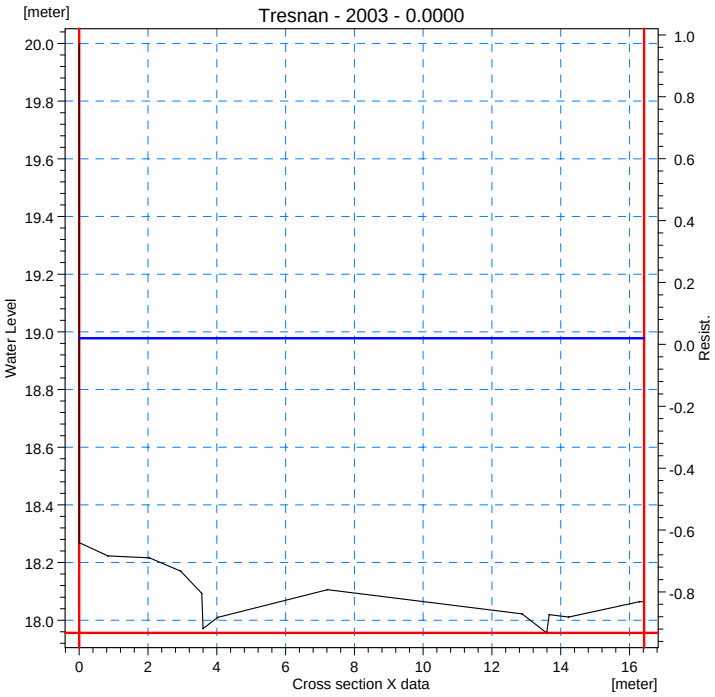

Springhill-N - 2003 - 8760.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

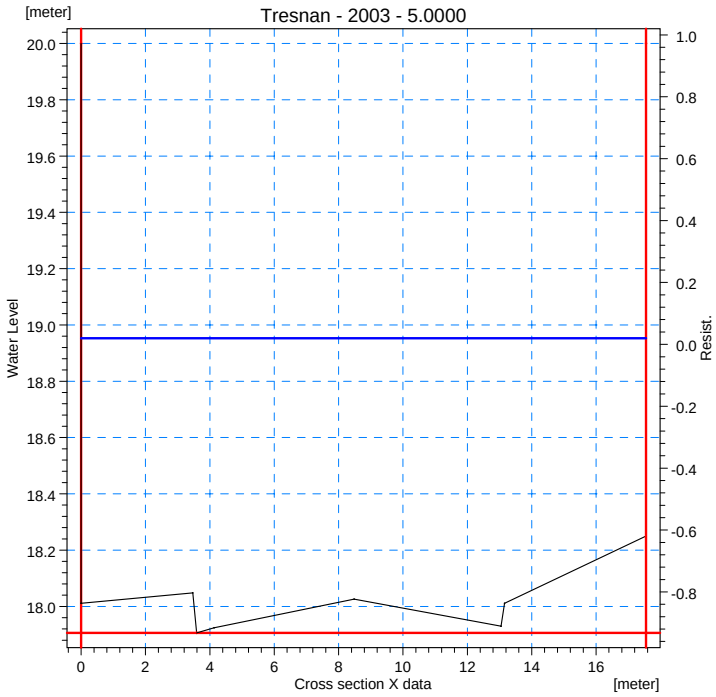

Springhill-S - 2003 - 8130.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

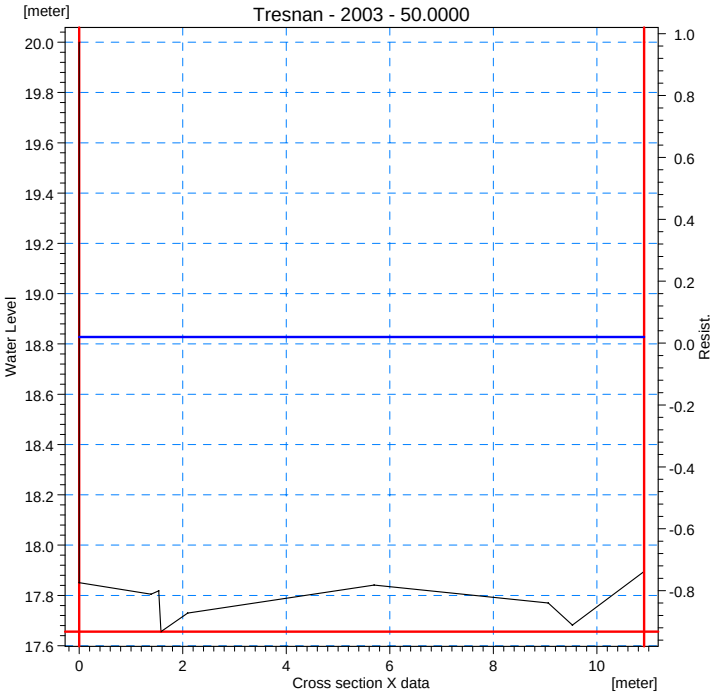

Springhill-S - 2003 - 8160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

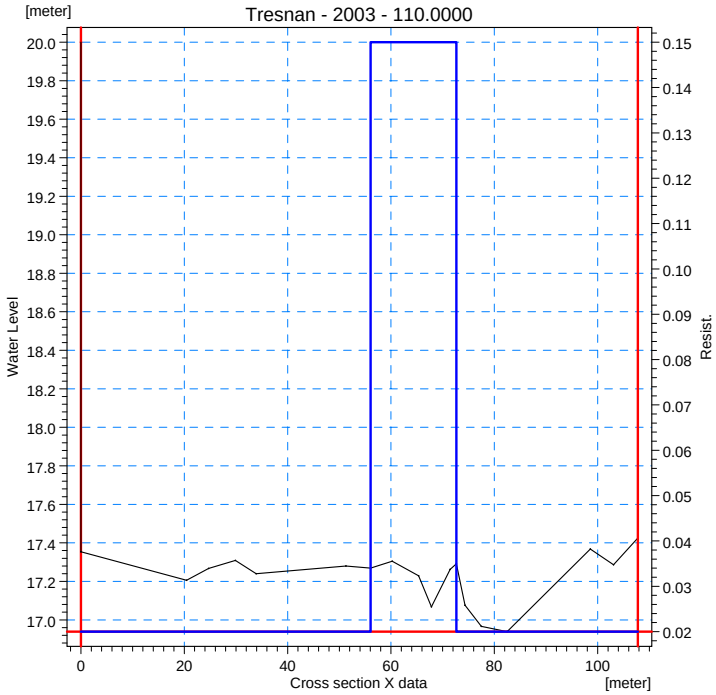

Springhill-S - 2003 - 8234.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

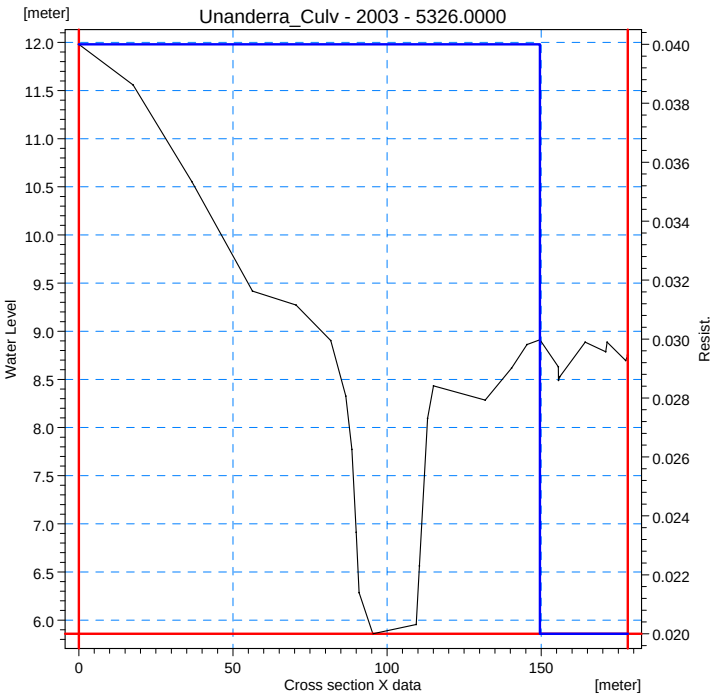

Springhill-S - 2003 - 8274.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

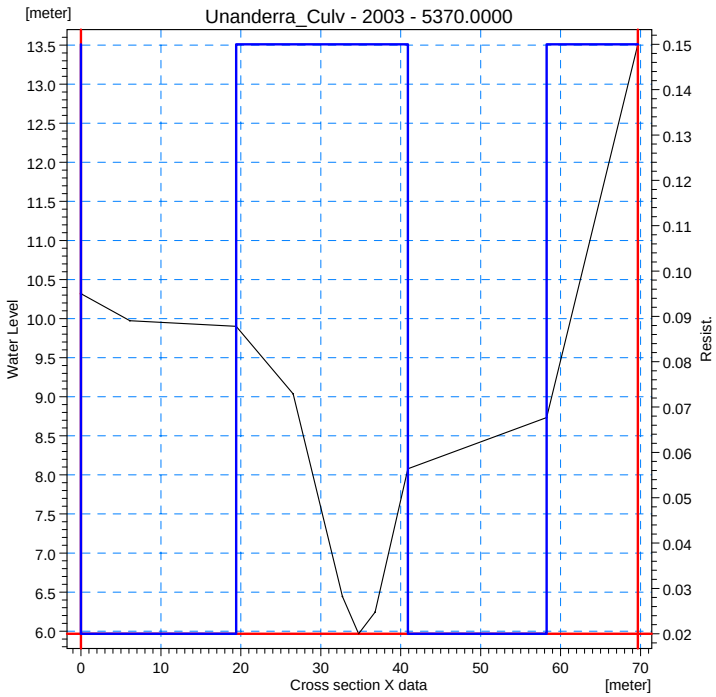

Tresnan - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

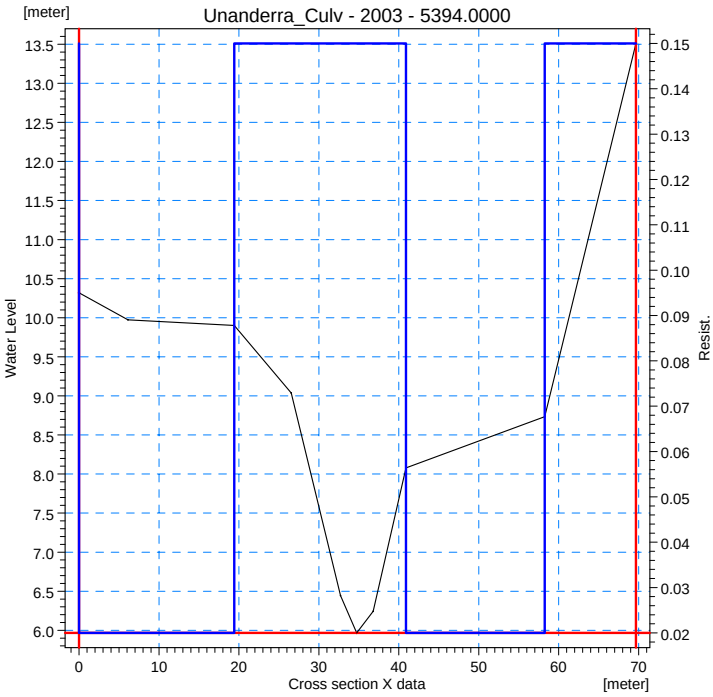

Tresnan - 2003 - 5.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

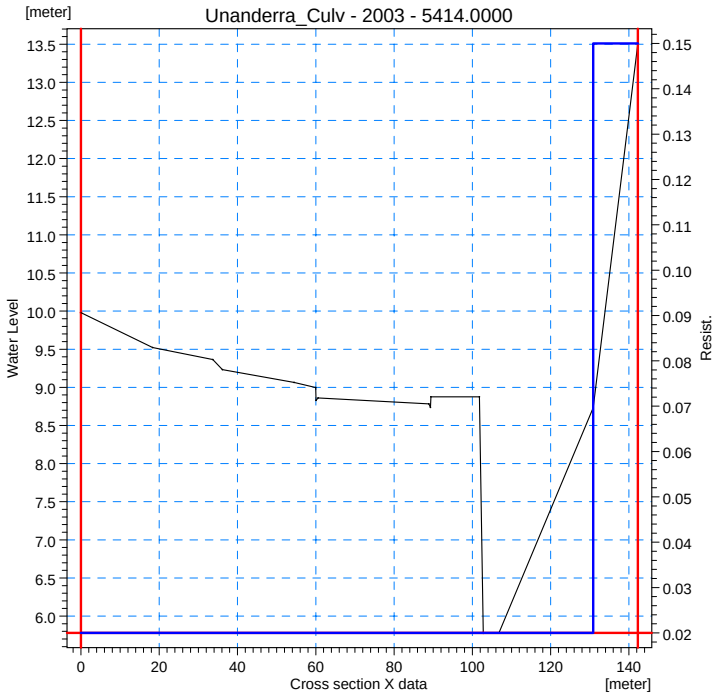

Tresnan - 2003 - 50.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

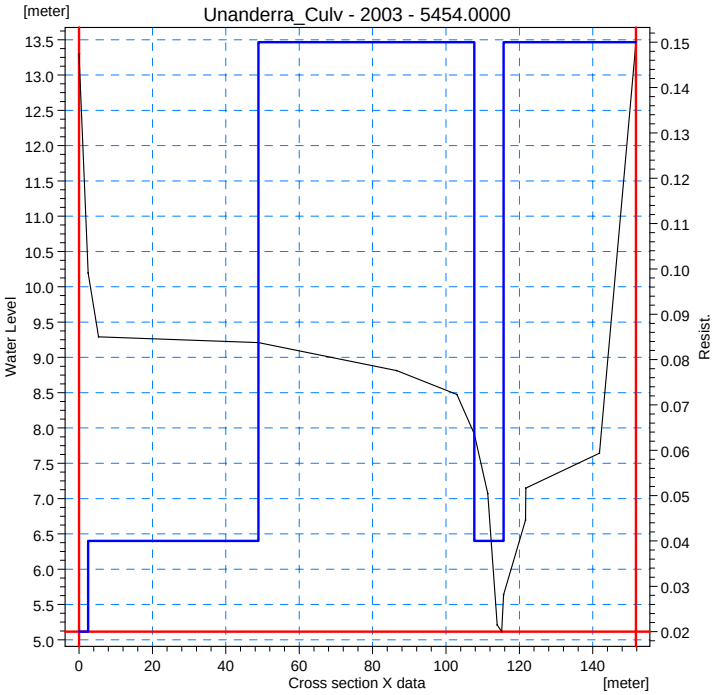

Tresnan - 2003 - 110.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

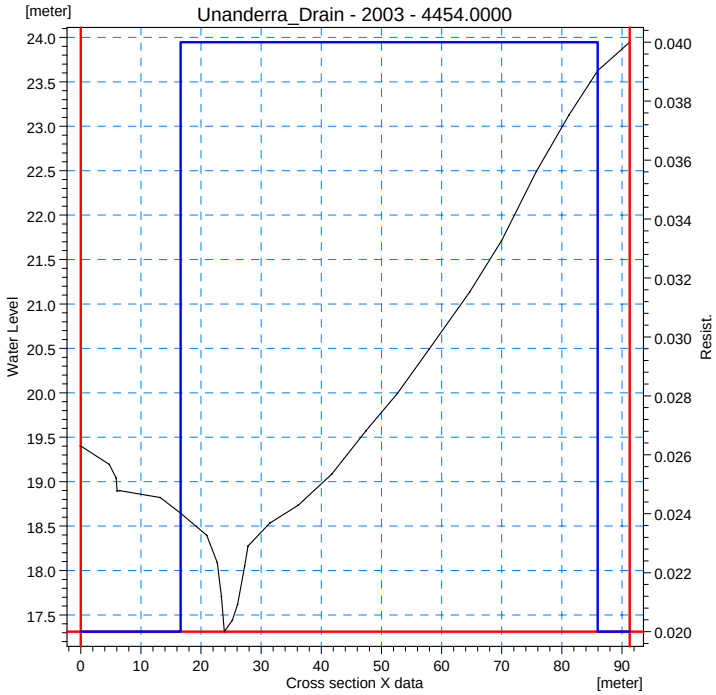

Unanderra_Culv - 2003 - 5326.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

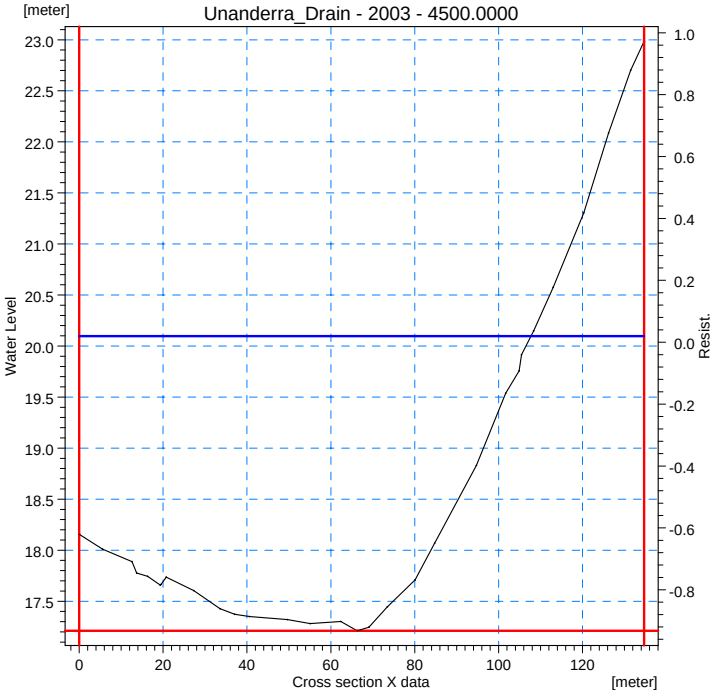

Unanderra_Culv - 2003 - 5370.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

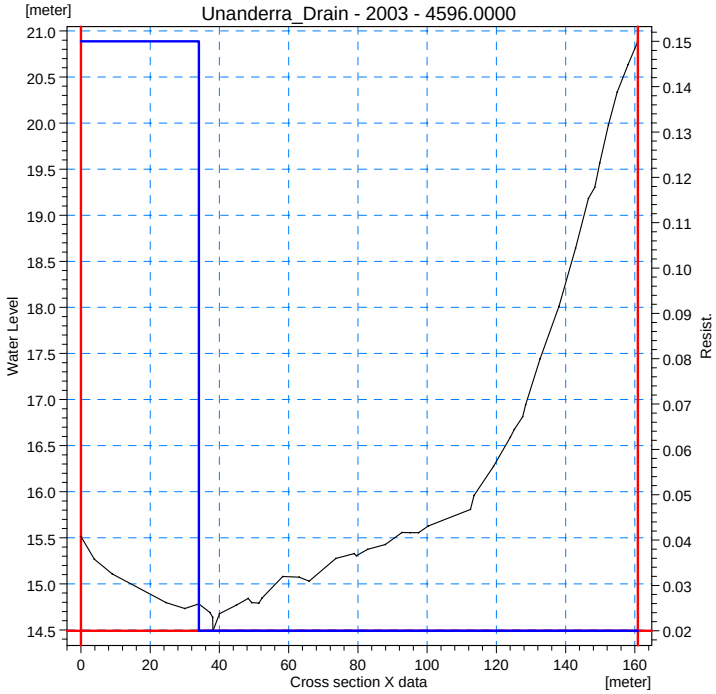

Unanderra_Culv - 2003 - 5394.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

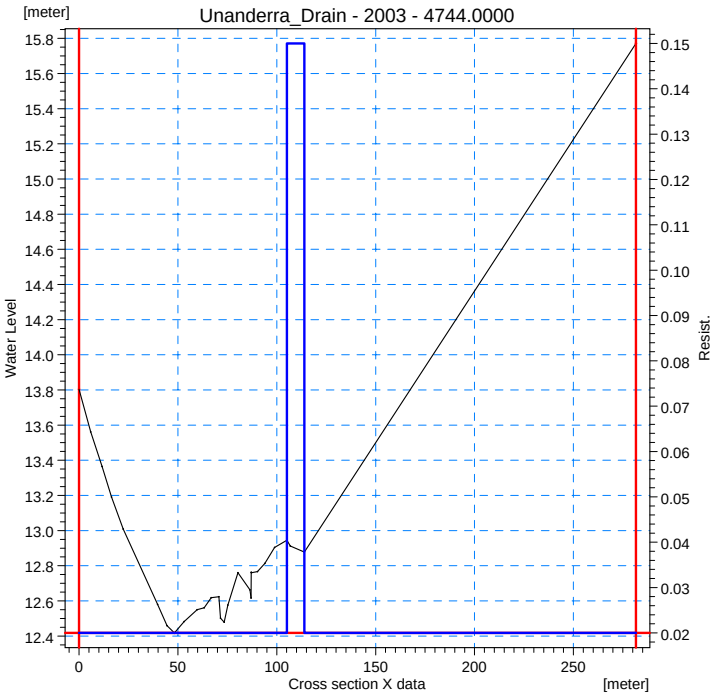

Unanderra_Culv - 2003 - 5414.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

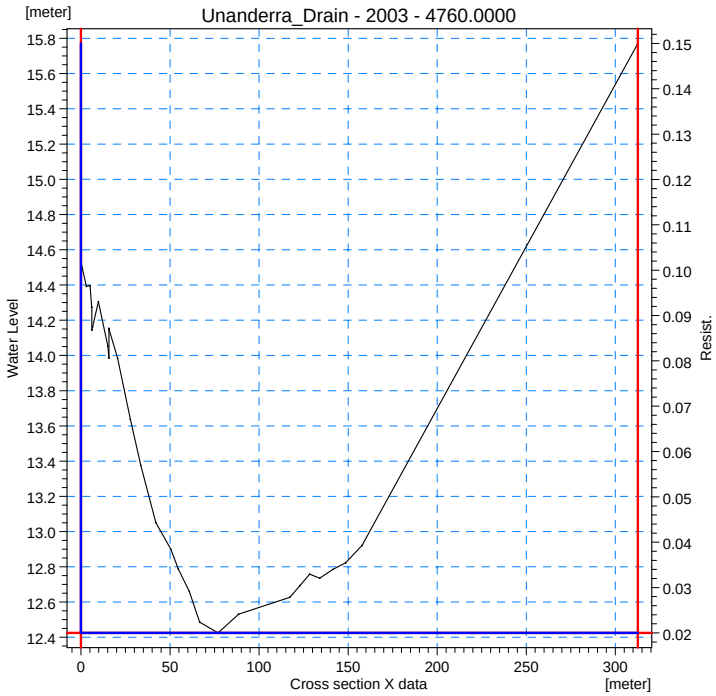

Unanderra_Culv - 2003 - 5454.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

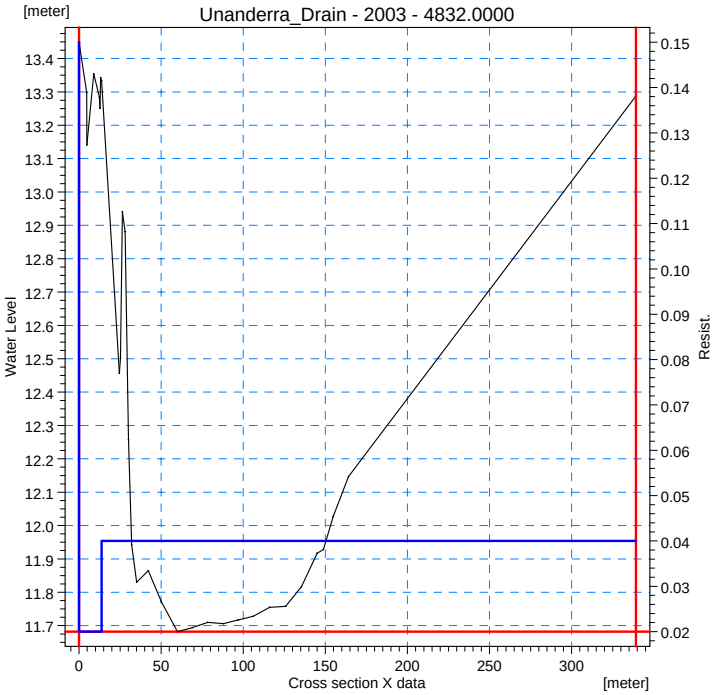

Unanderra_Drain - 2003 - 4454.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

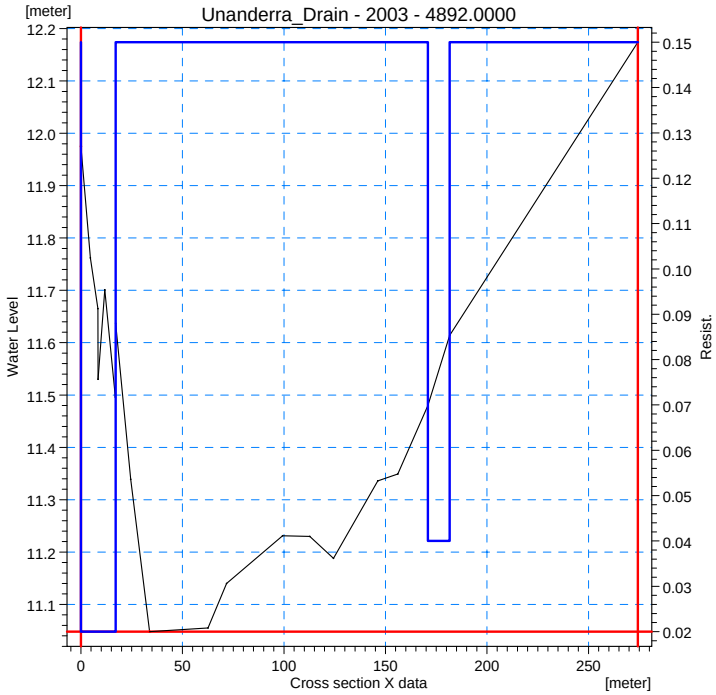

Unanderra_Drain - 2003 - 4500.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

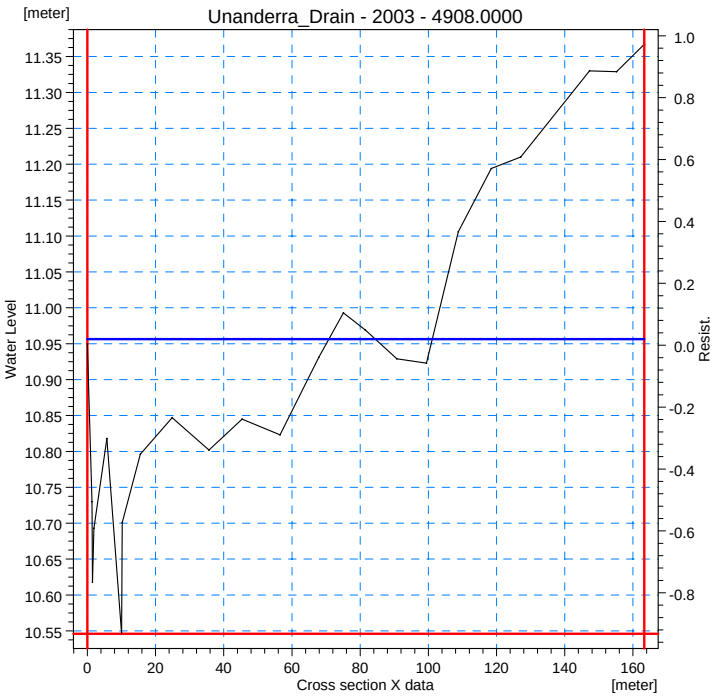

Unanderra_Drain - 2003 - 4596.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

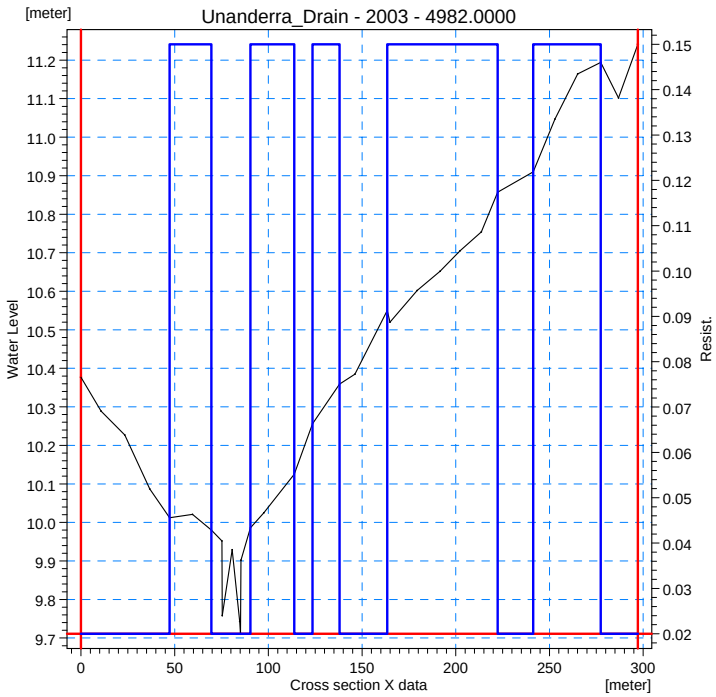

Unanderra_Drain - 2003 - 4744.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

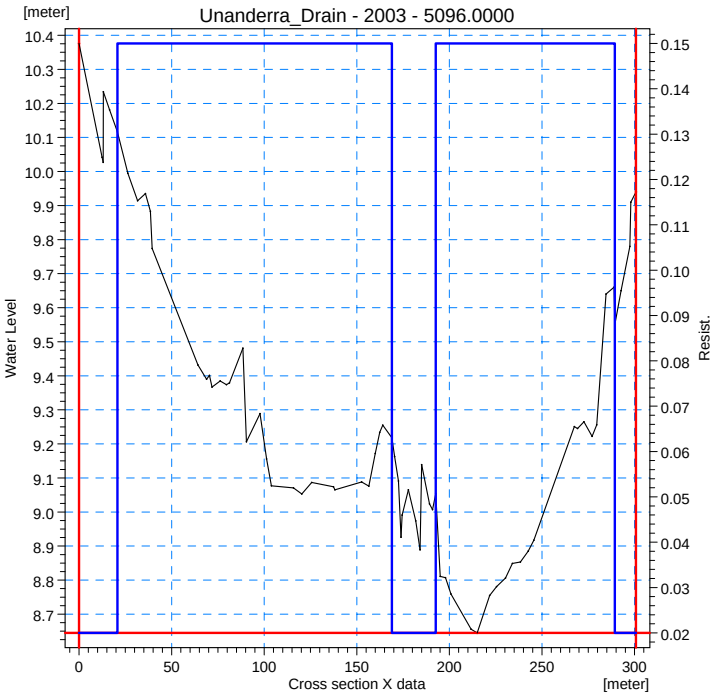

Unanderra_Drain - 2003 - 4760.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

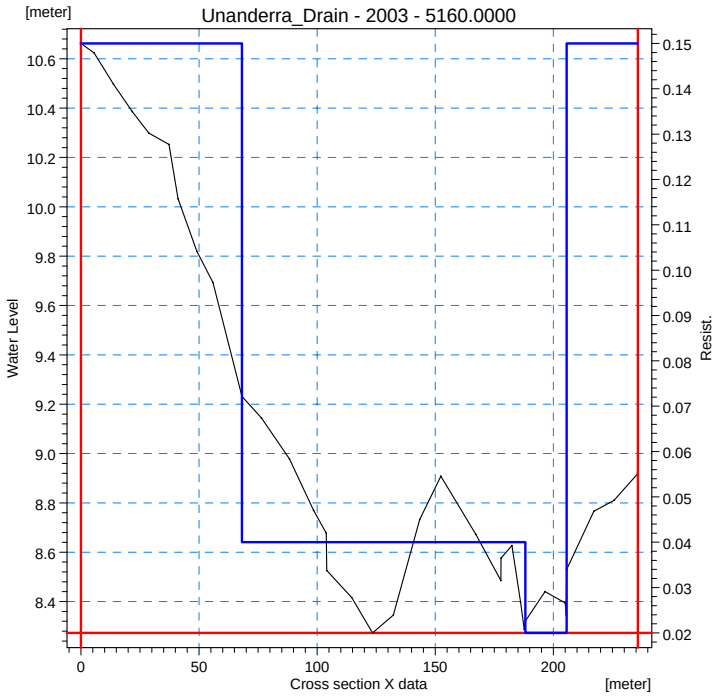

Unanderra_Drain - 2003 - 4832.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

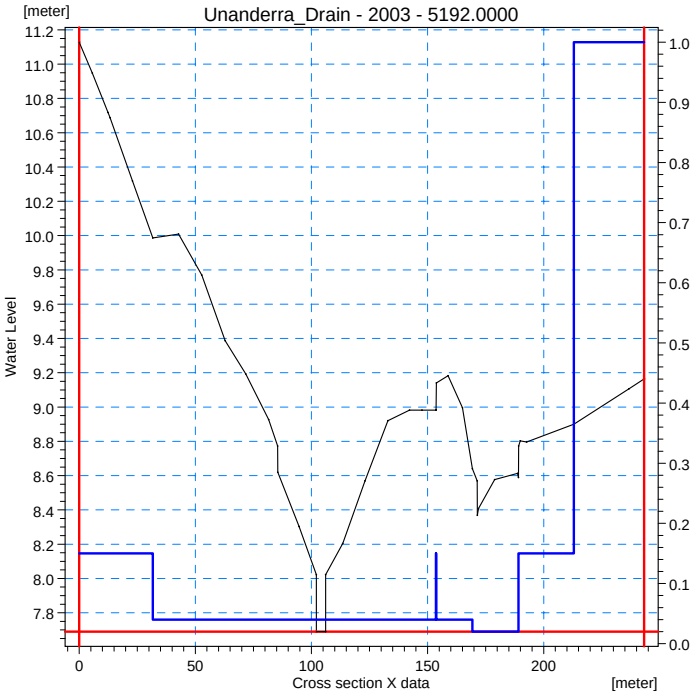

Unanderra_Drain - 2003 - 4892.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

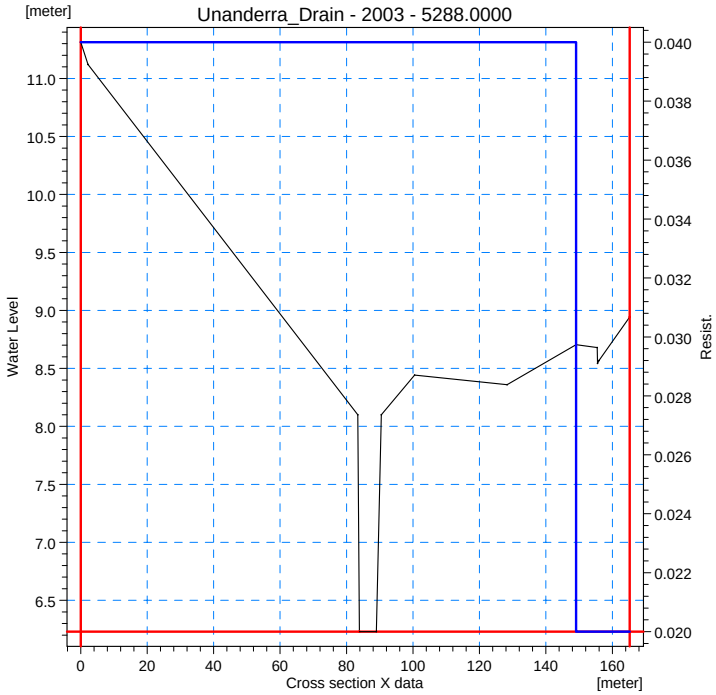

Unanderra_Drain - 2003 - 4908.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

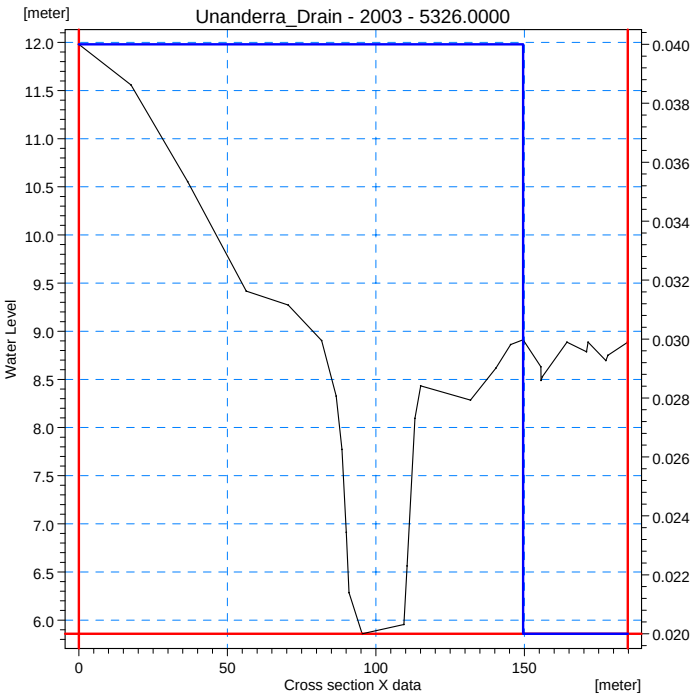

Unanderra_Drain - 2003 - 4982.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

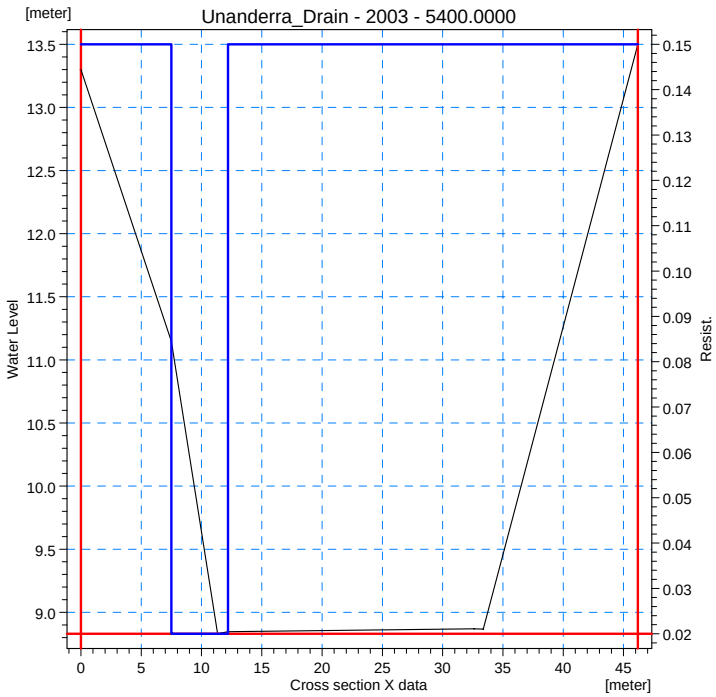

Unanderra_Drain - 2003 - 5096.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

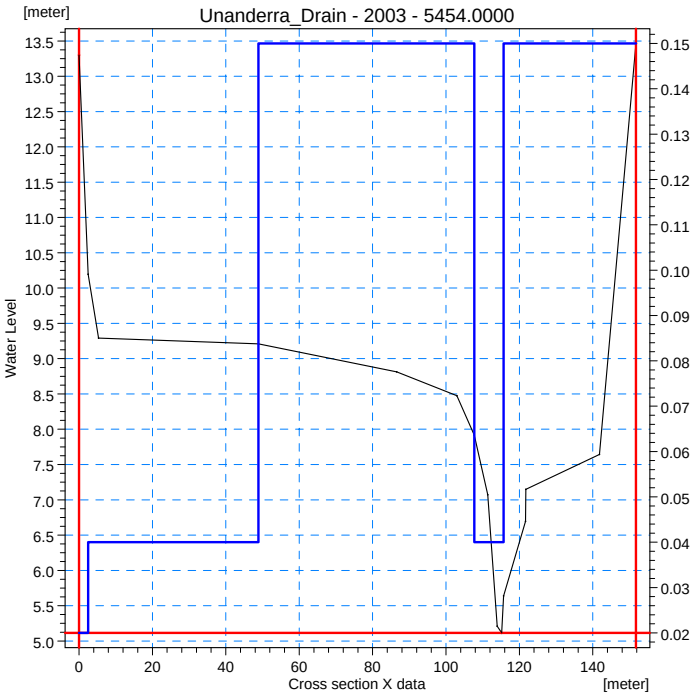

Unanderra_Drain - 2003 - 5160.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

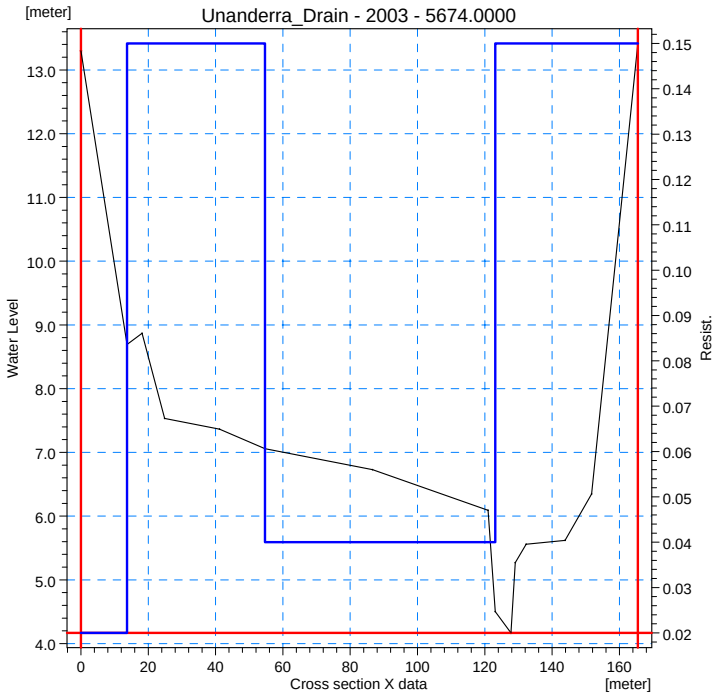

Unanderra_Drain - 2003 - 5192.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

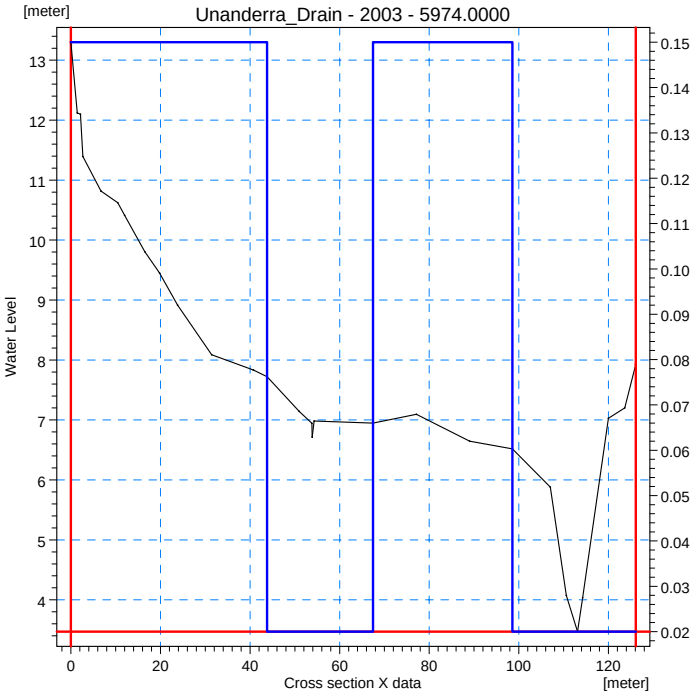

Unanderra_Drain - 2003 - 5288.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

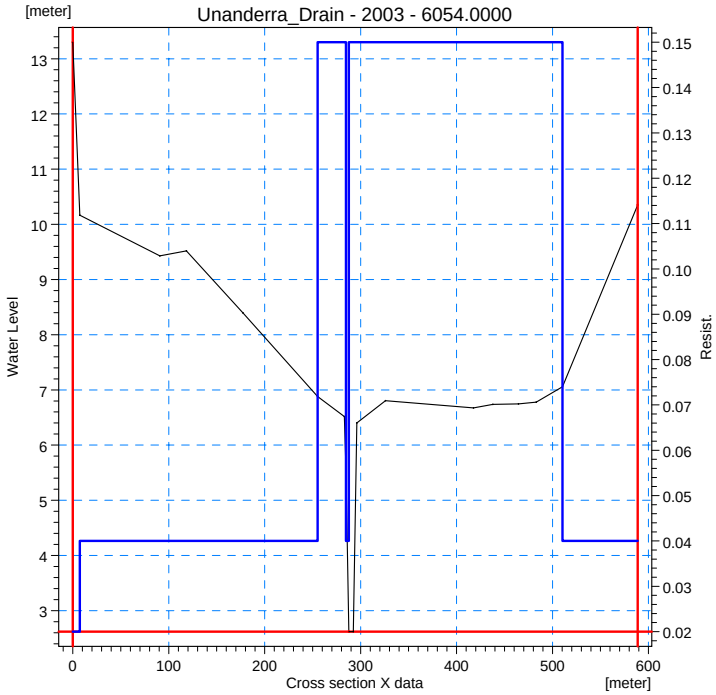

Unanderra_Drain - 2003 - 5326.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

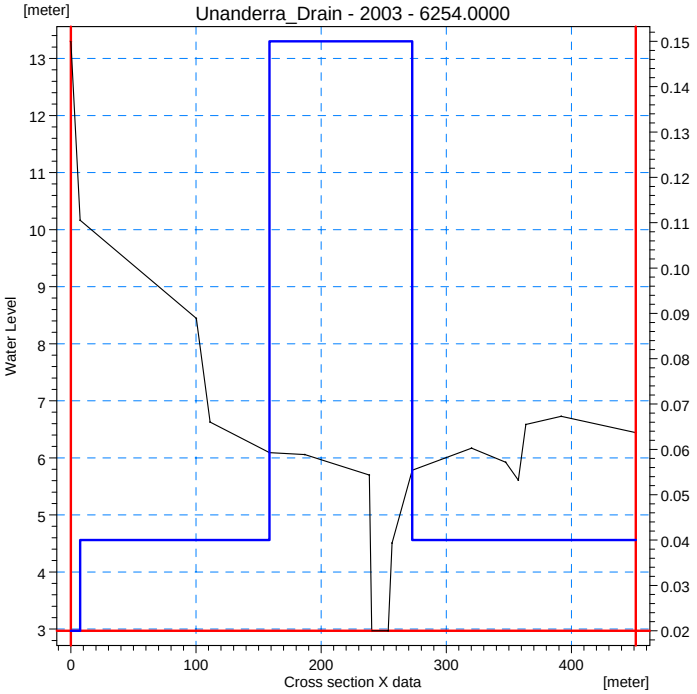

Unanderra_Drain - 2003 - 5400.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

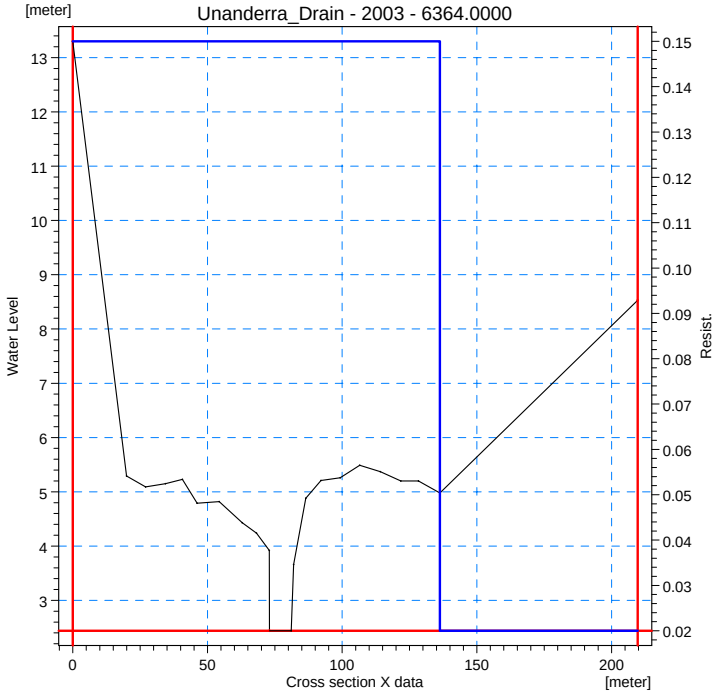

Unanderra_Drain - 2003 - 5454.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

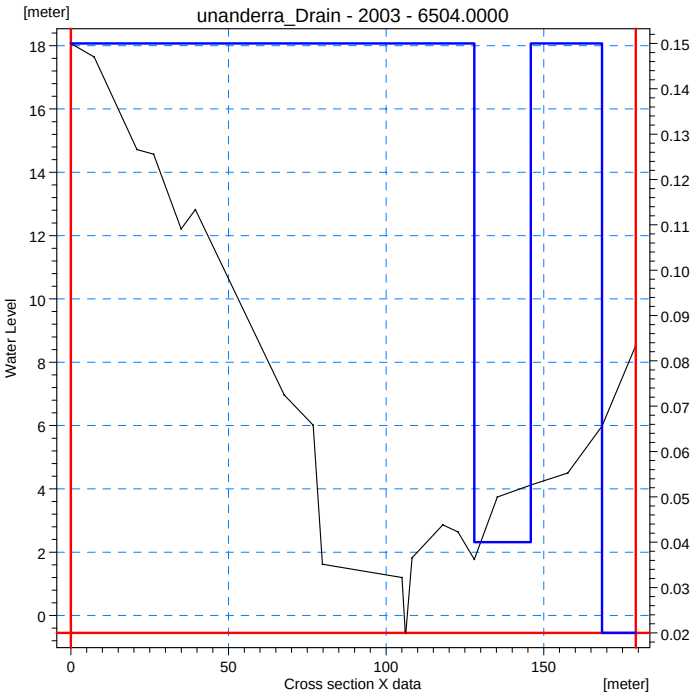

Unanderra_Drain - 2003 - 5674.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

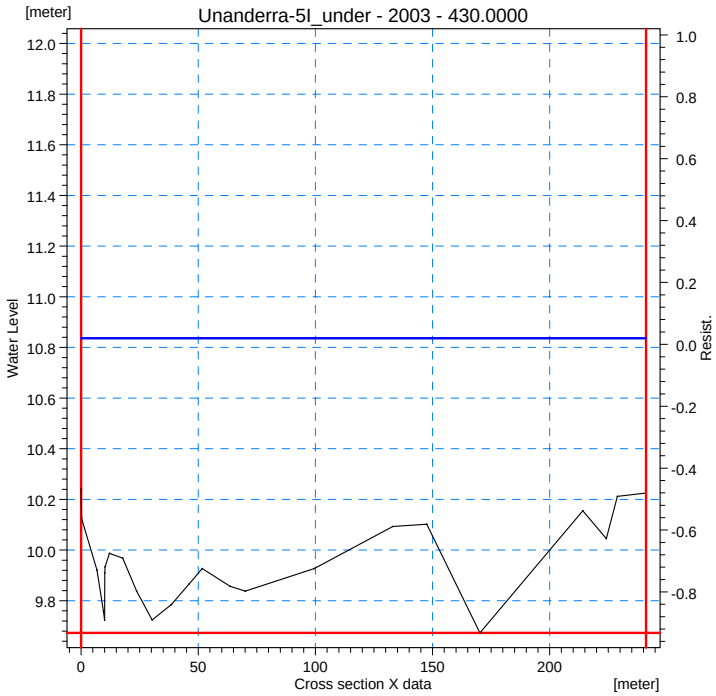

Unanderra_Drain - 2003 - 5974.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

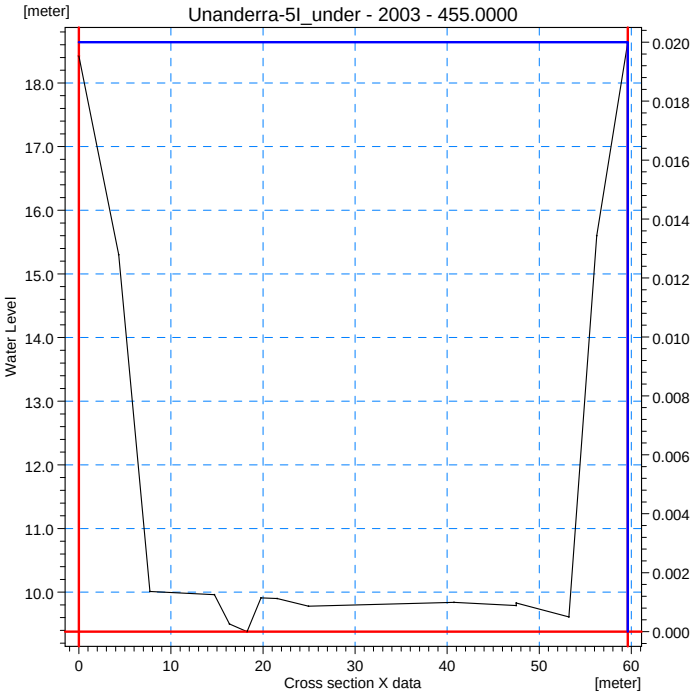

Unanderra_Drain - 2003 - 6054.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

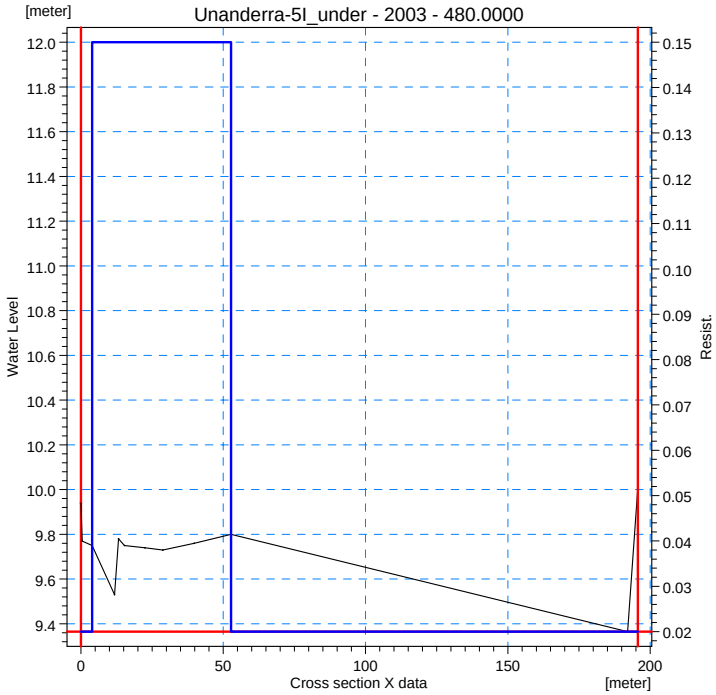

Unanderra_Drain - 2003 - 6254.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

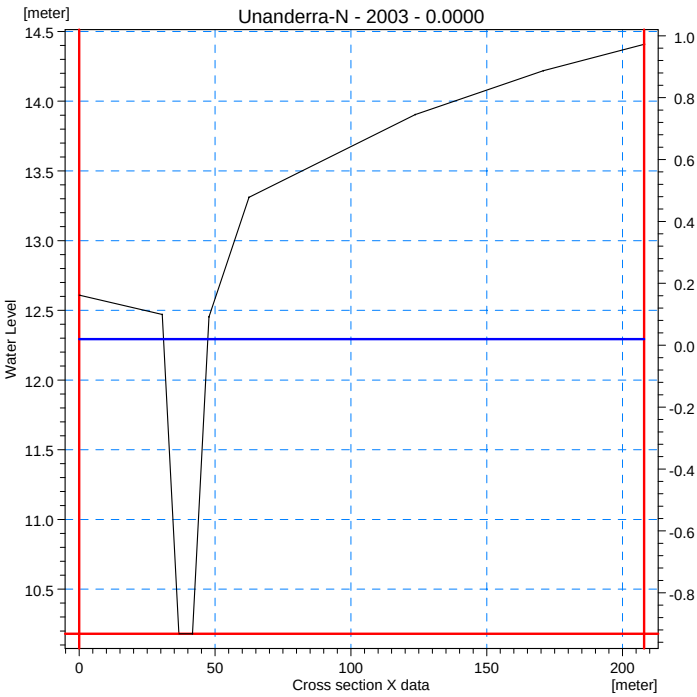

Unanderra_Drain - 2003 - 6364.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

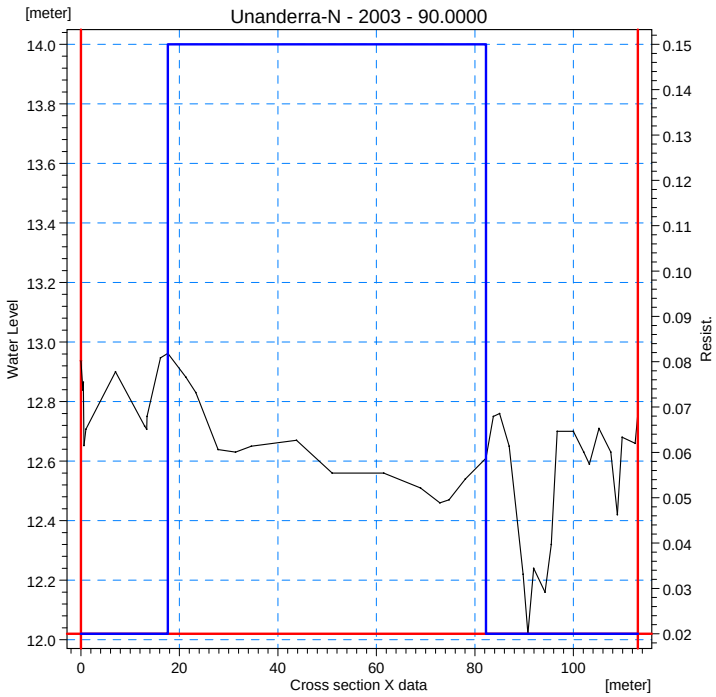

unanderra_Drain - 2003 - 6504.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

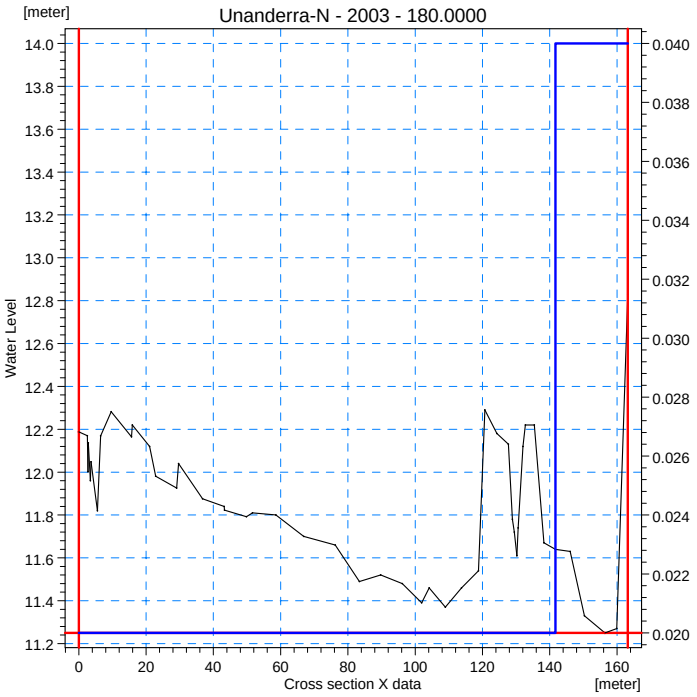

Unanderra-5I_under - 2003 - 430.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

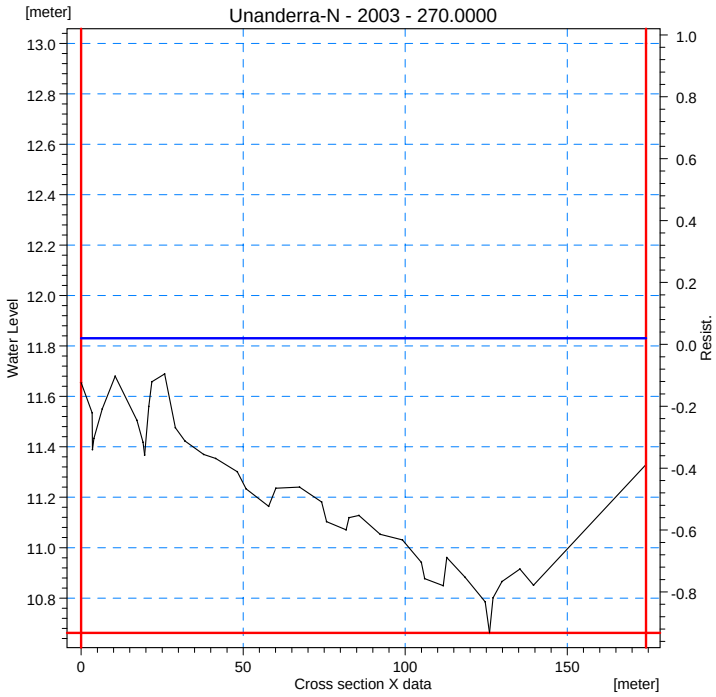

Unanderra-5I_under - 2003 - 455.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

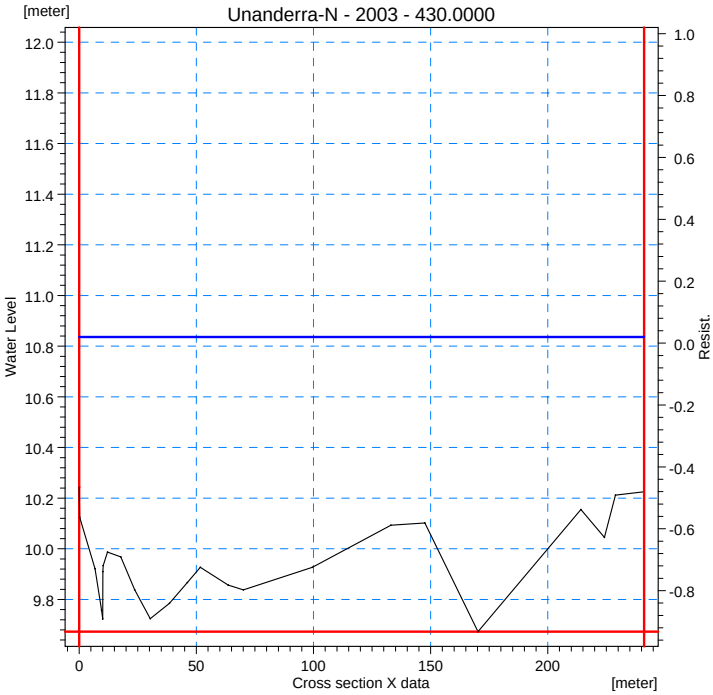

Unanderra-5I_under - 2003 - 480.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

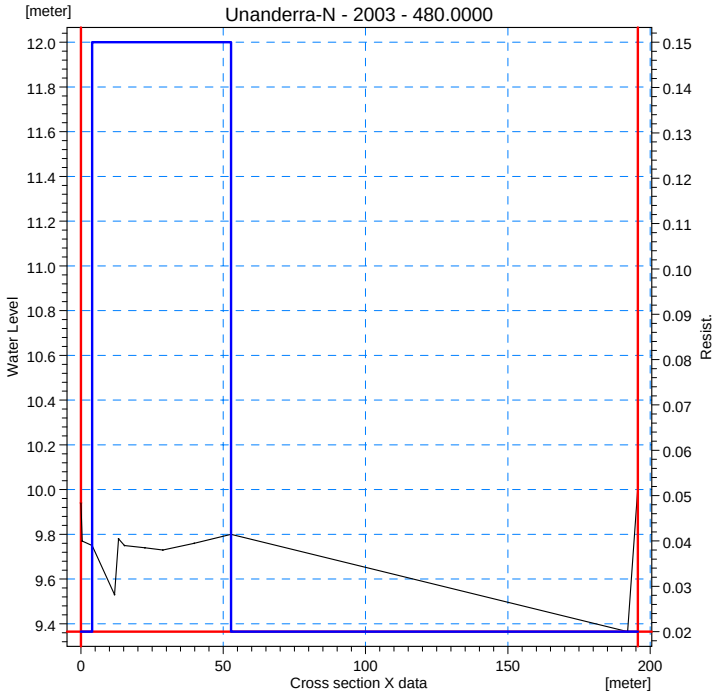

Unanderra-N - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

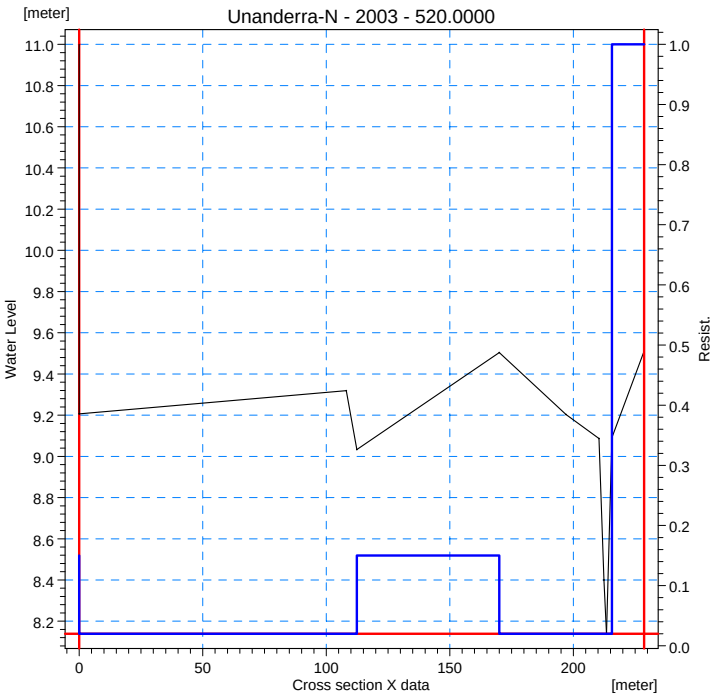

Unanderra-N - 2003 - 90.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Unanderra-N - 2003 - 180.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Unanderra-N - 2003 - 270.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Unanderra-N - 2003 - 430.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Unanderra-N - 2003 - 480.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Unanderra-N - 2003 - 520.0000
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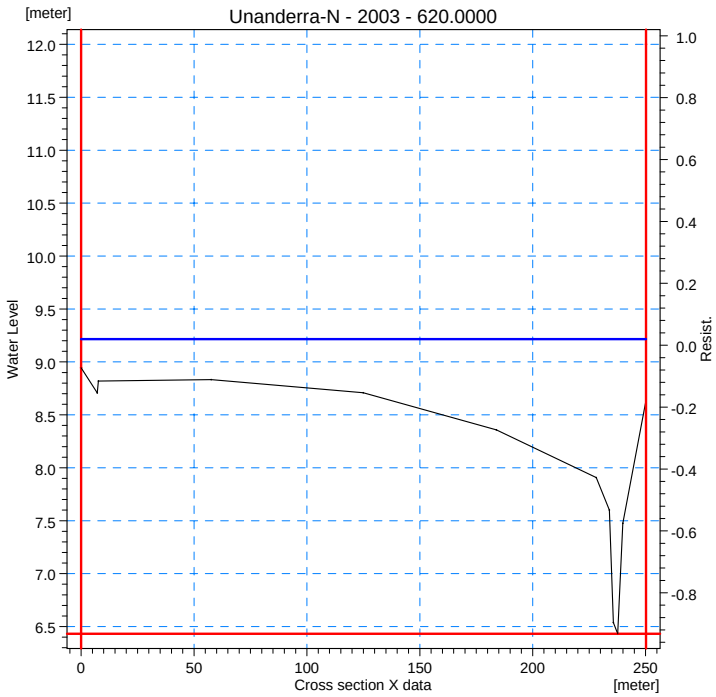
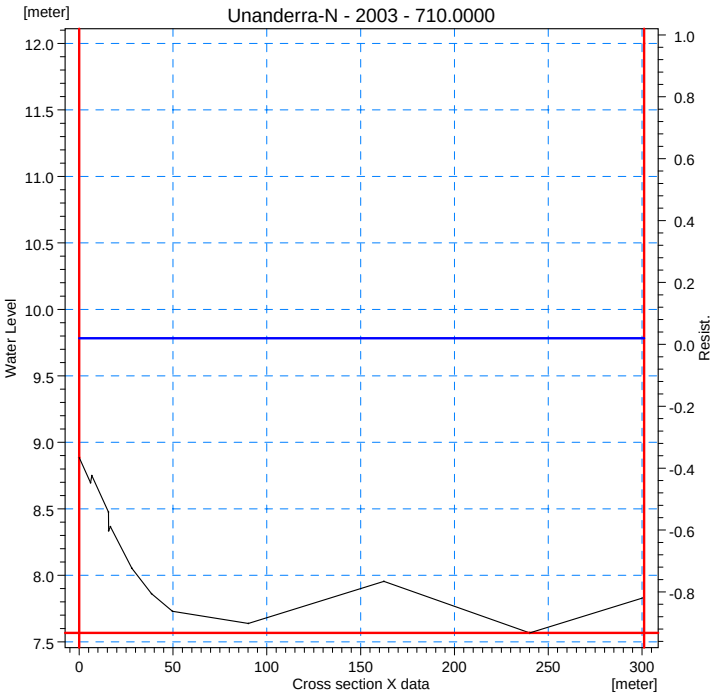
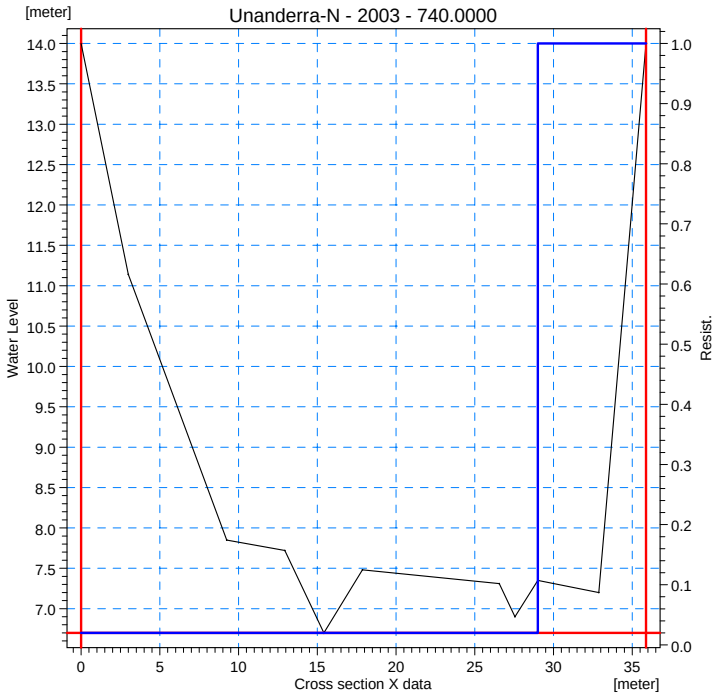
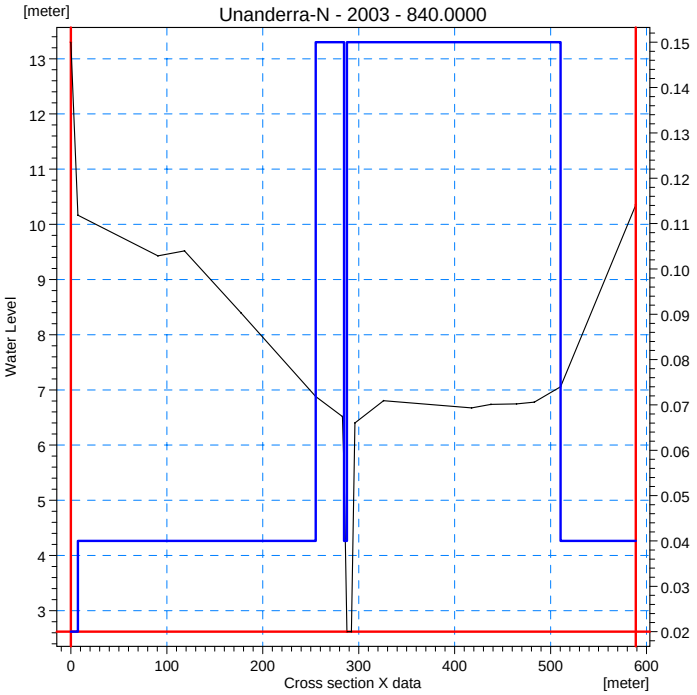
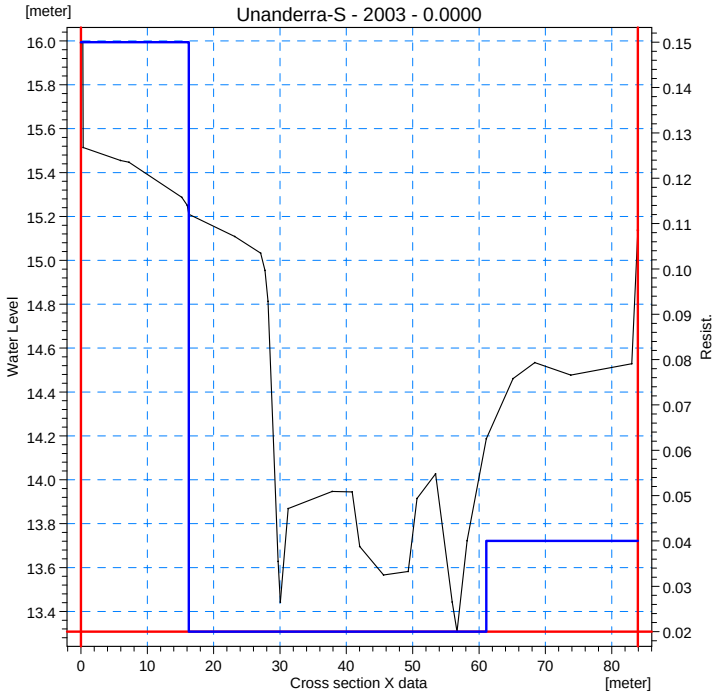
Water Level
Resist.
Cross section X data
[meter]

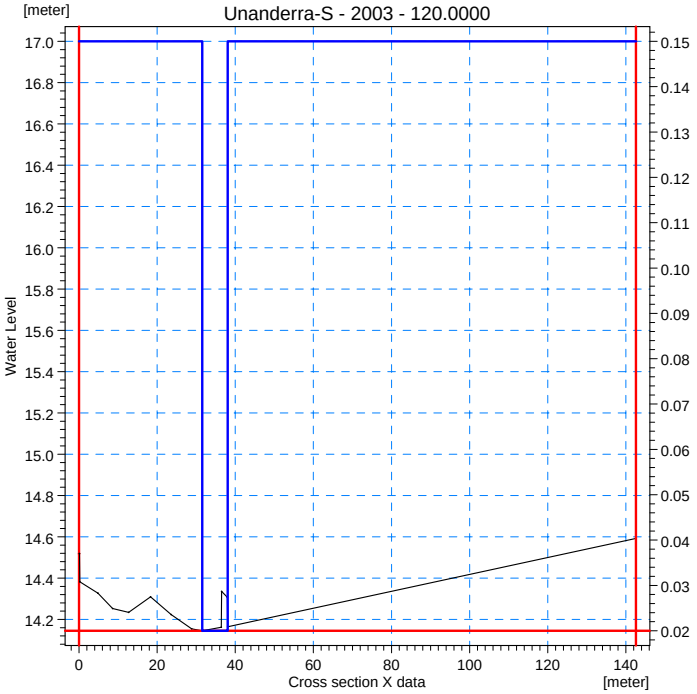

Unanderra-N - 2003 - 620.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

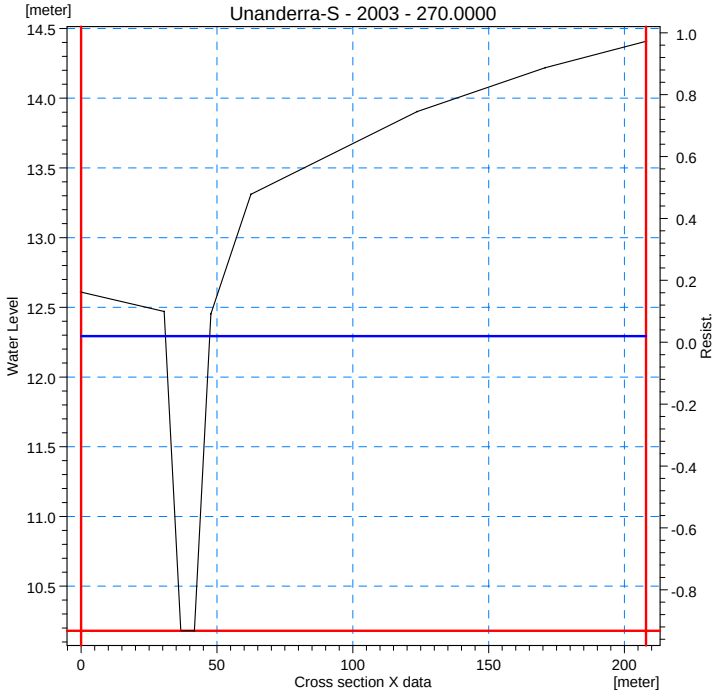

Unanderra-N - 2003 - 710.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

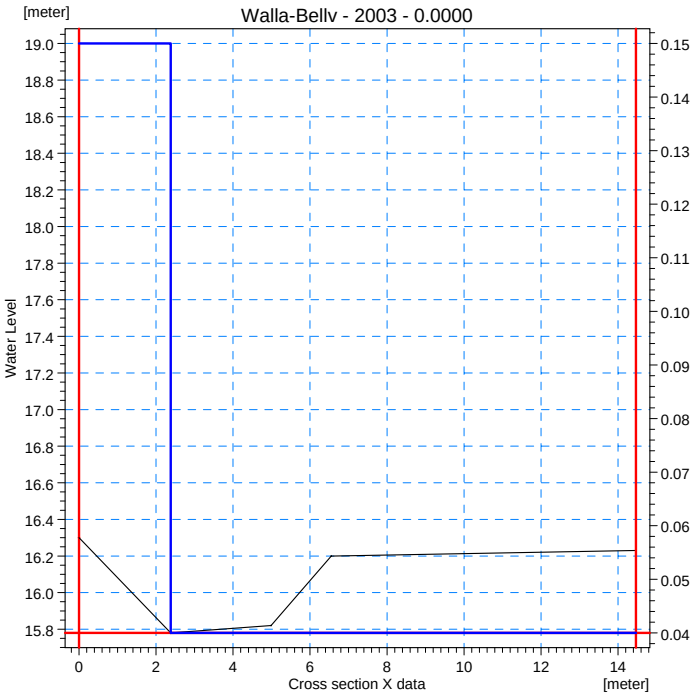

Unanderra-N - 2003 - 740.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

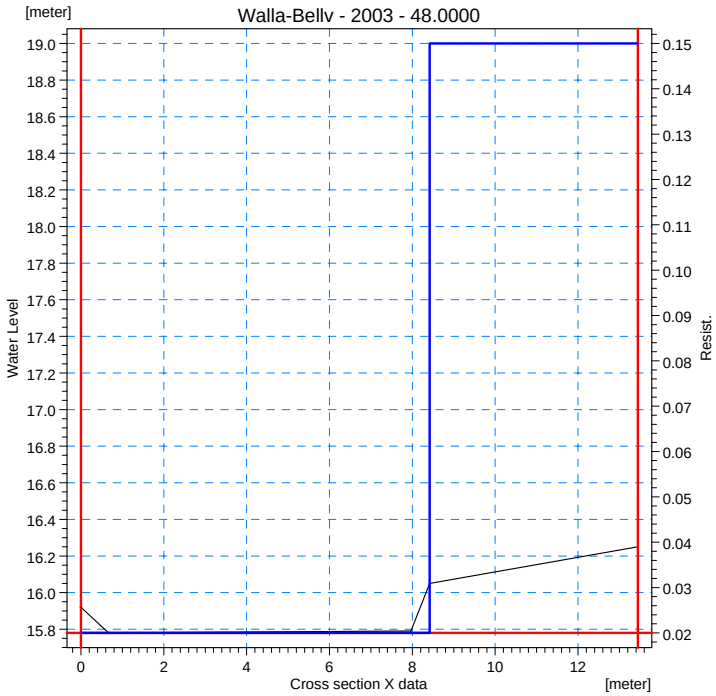

Unanderra-N - 2003 - 840.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

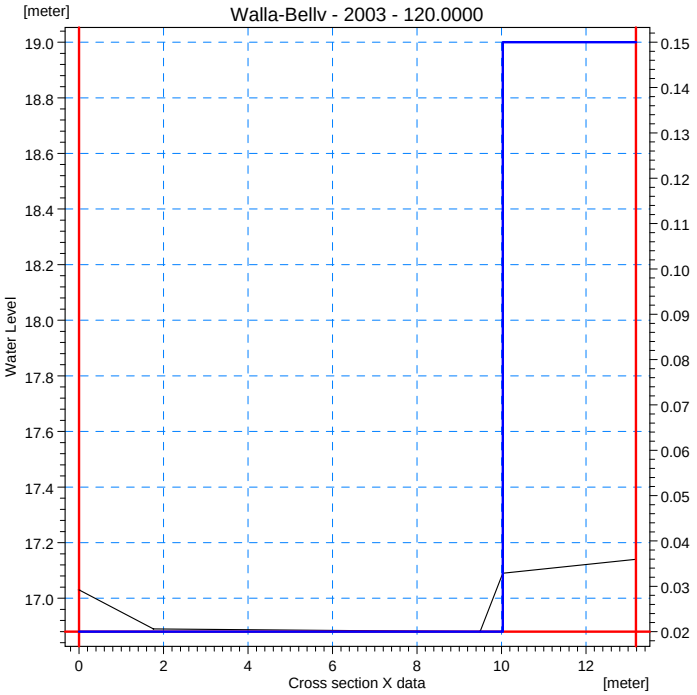

Unanderra-S - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

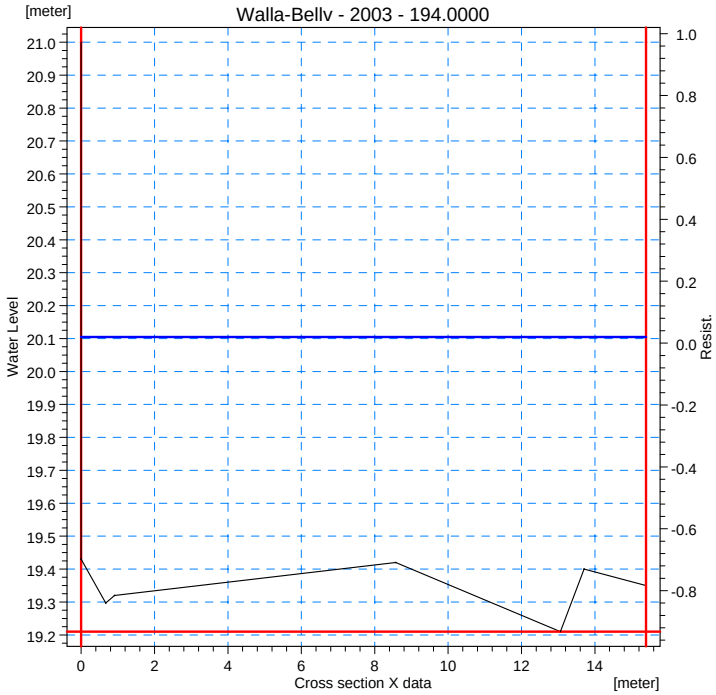

Unanderra-S - 2003 - 120.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

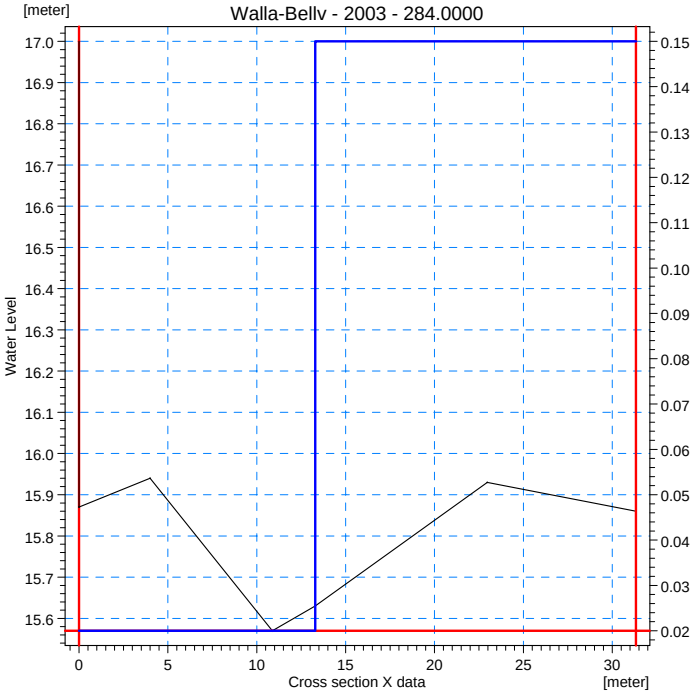

Unanderra-S - 2003 - 270.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

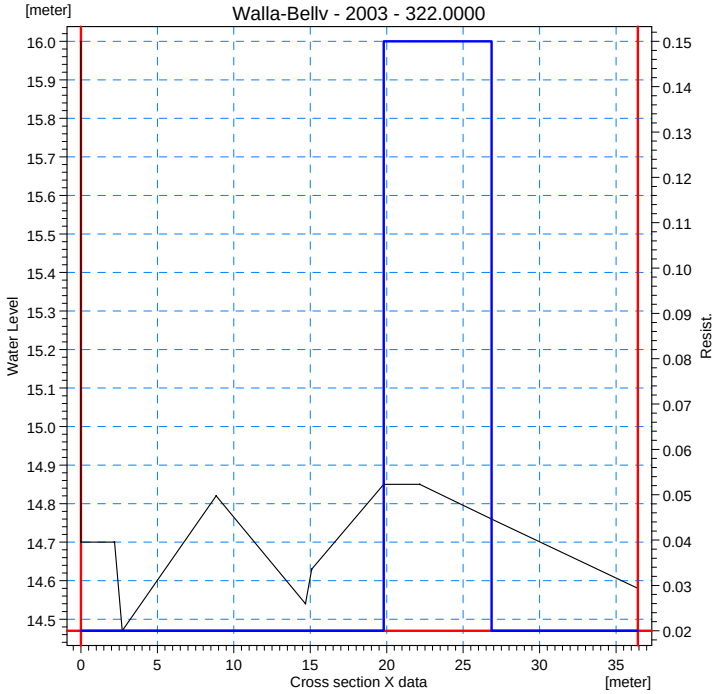

Walla-Bellv - 2003 - 0.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

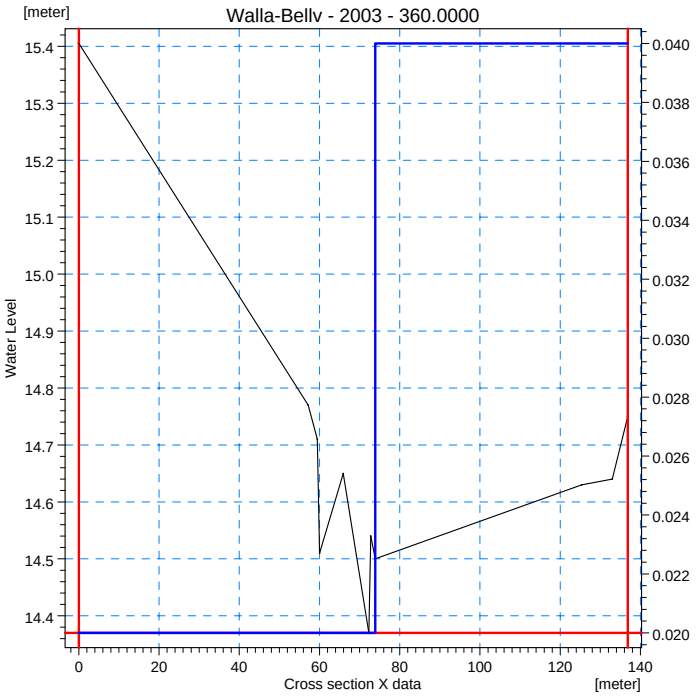

Walla-Bellv - 2003 - 48.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

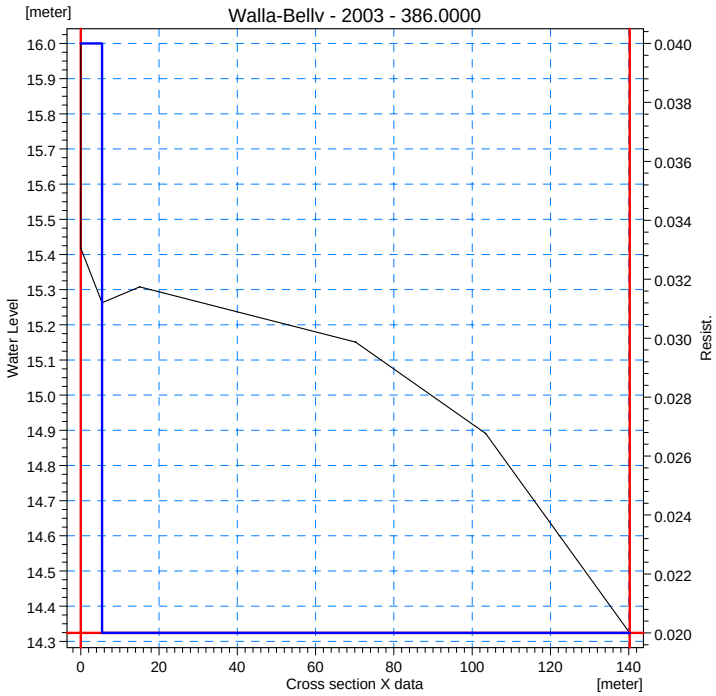

Walla-Bellv - 2003 - 120.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

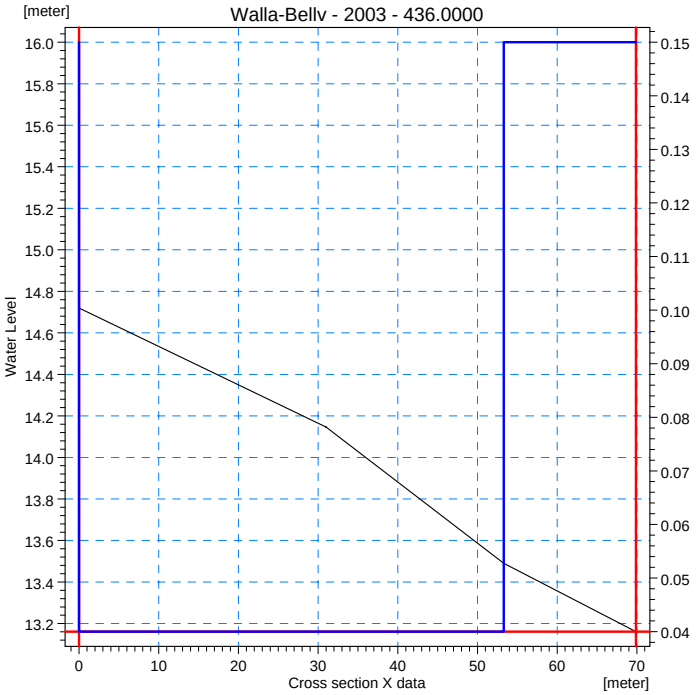

Walla-Bellv - 2003 - 194.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

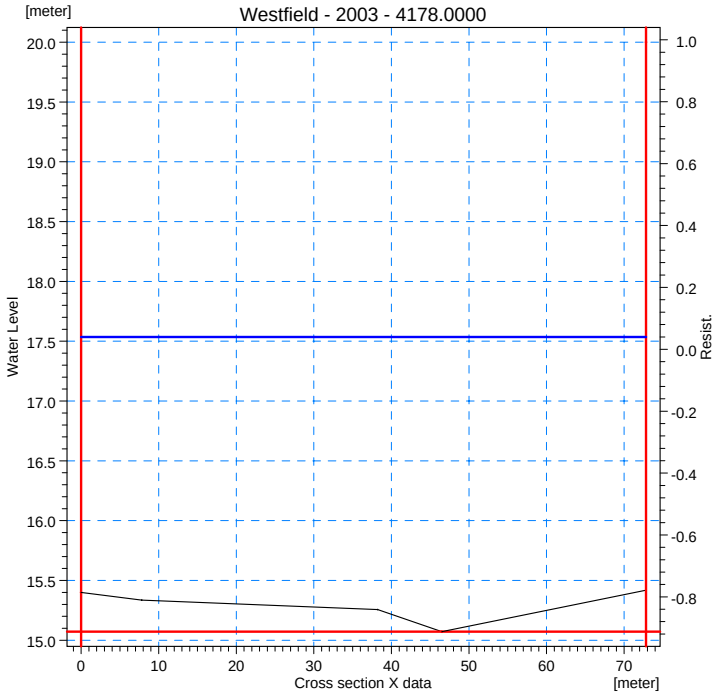

Walla-Bellv - 2003 - 284.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

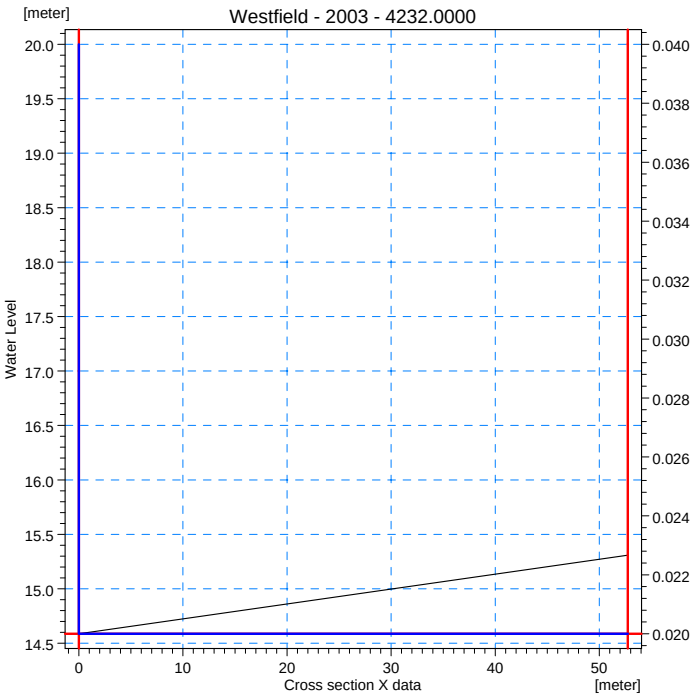

Walla-Bellv - 2003 - 322.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

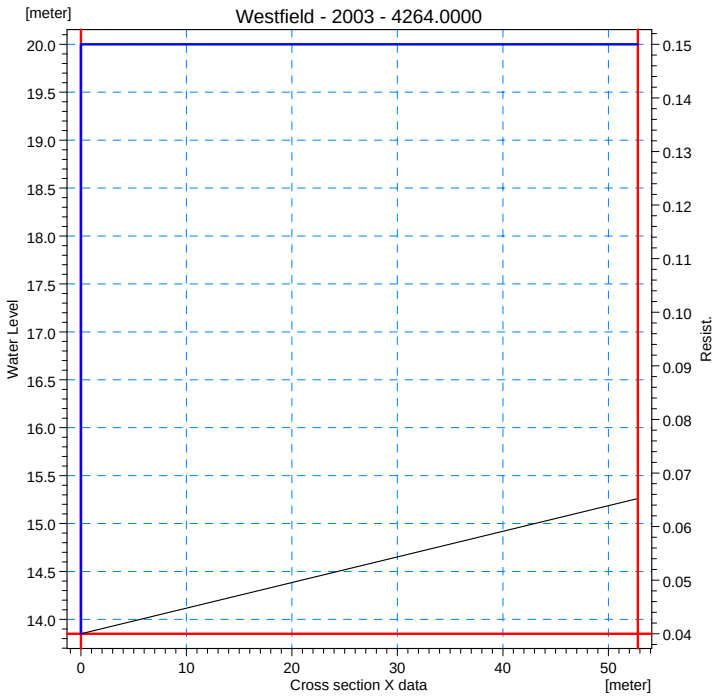

Walla-Bellv - 2003 - 360.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

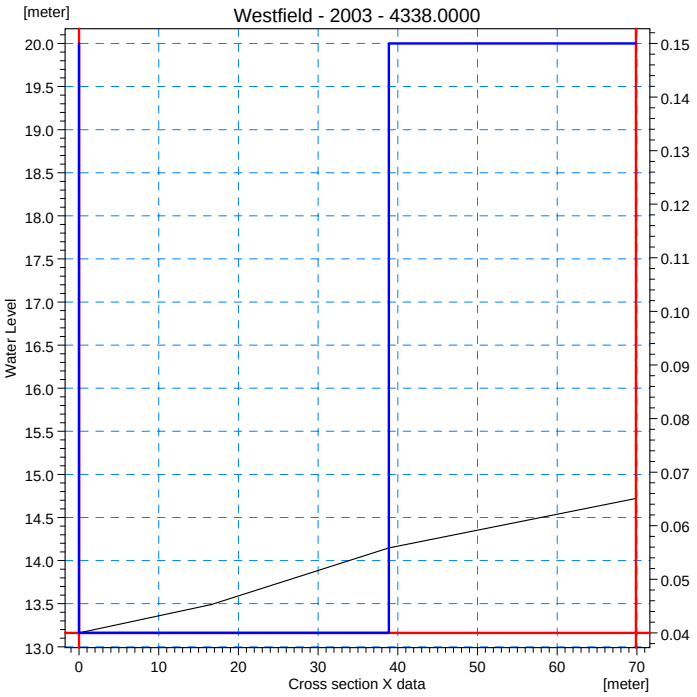

Walla-Bellv - 2003 - 386.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Walla-Bellv - 2003 - 436.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4178.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4232.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4264.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4338.0000
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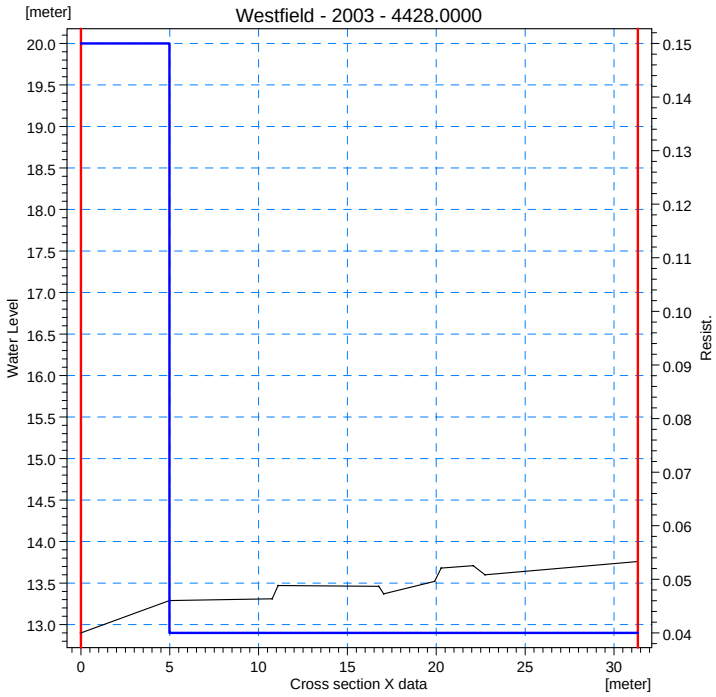
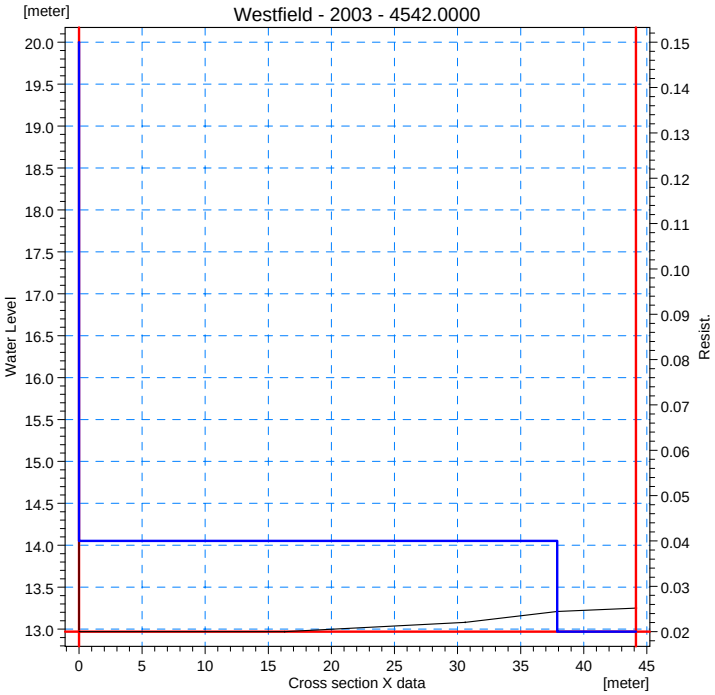
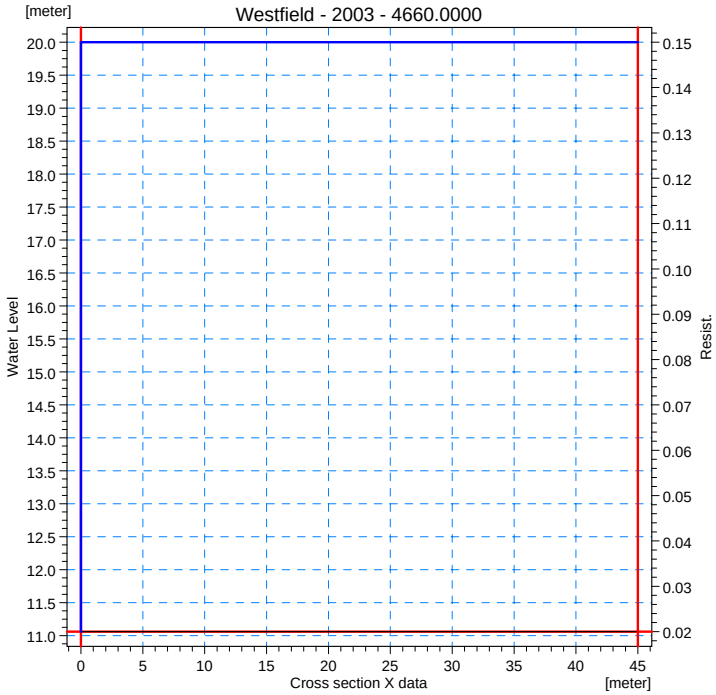
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4428.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

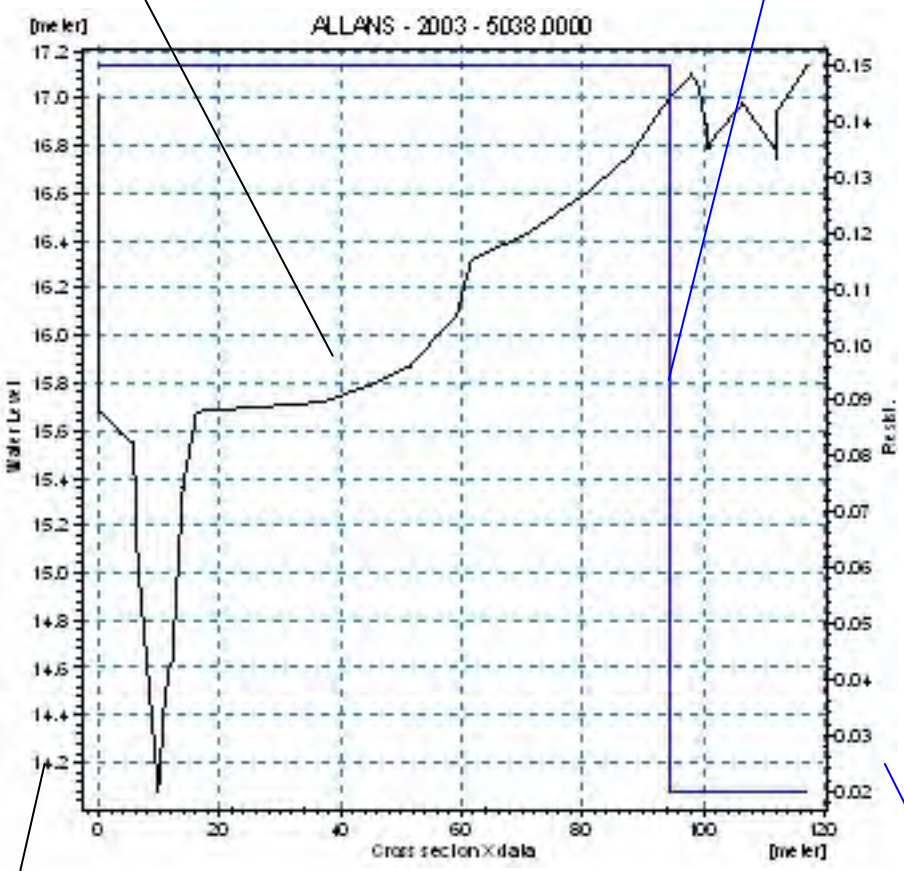

Westfield - 2003 - 4542.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]


Westfield - 2003 - 4660.0000
[meter]
Water Level
Resist.
Cross section X data
[meter]

LEGEND

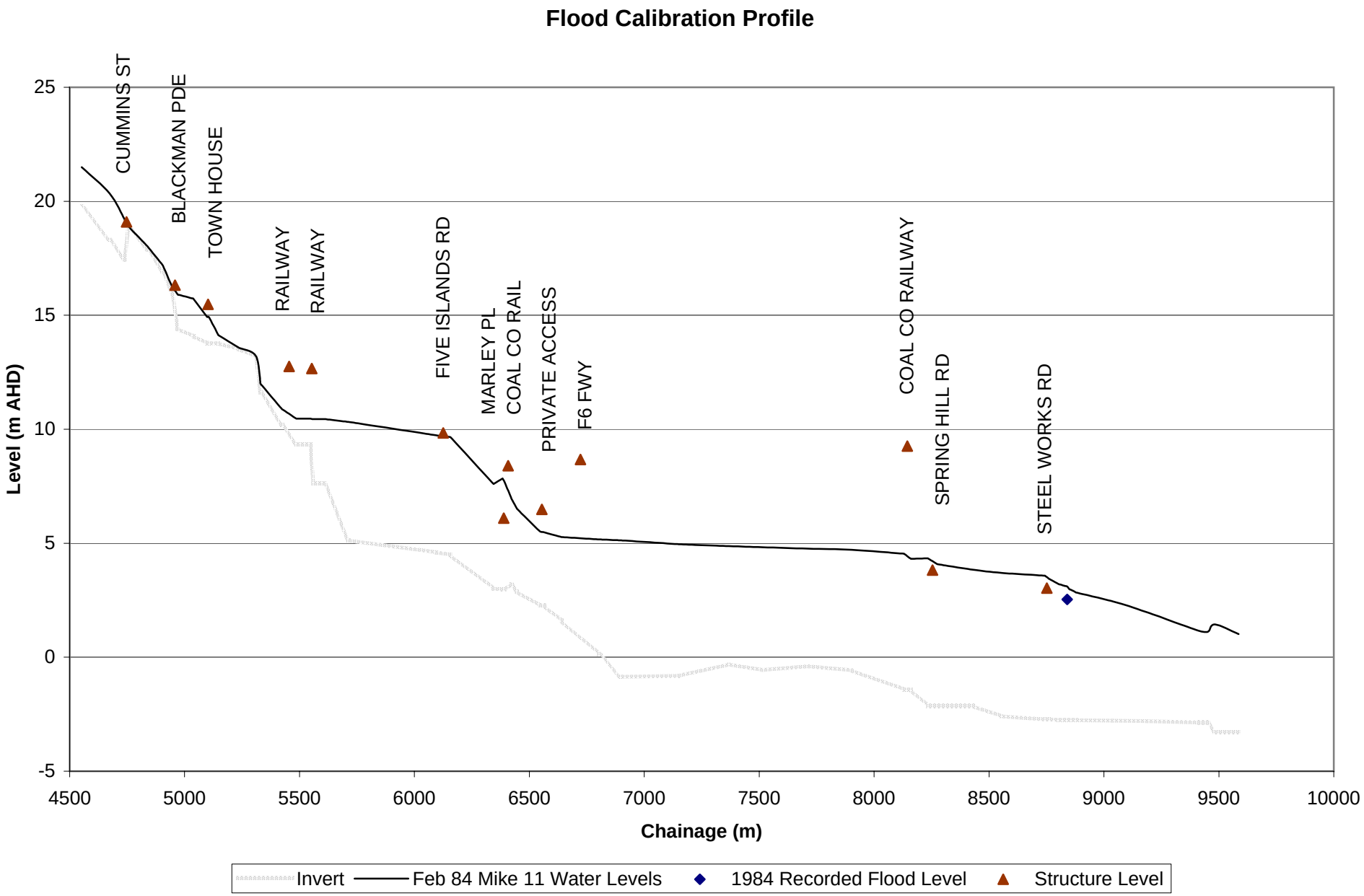
Cross Section Levels

Manning's n Values



Cross Section Scale

Manning's n Scale



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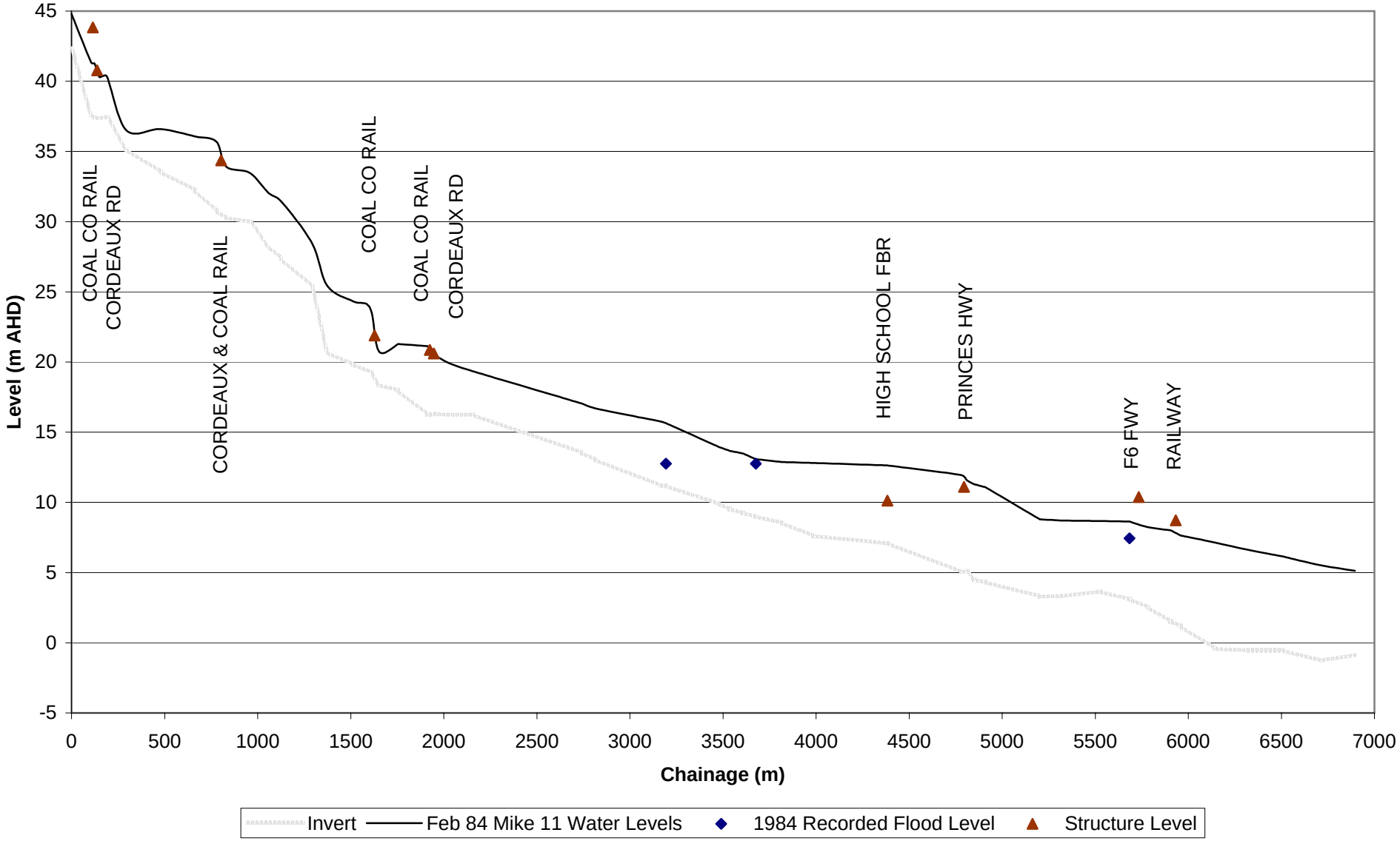
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E39
1984 Flood Calibration Levels - Allans Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls

Flood Calibration Profile



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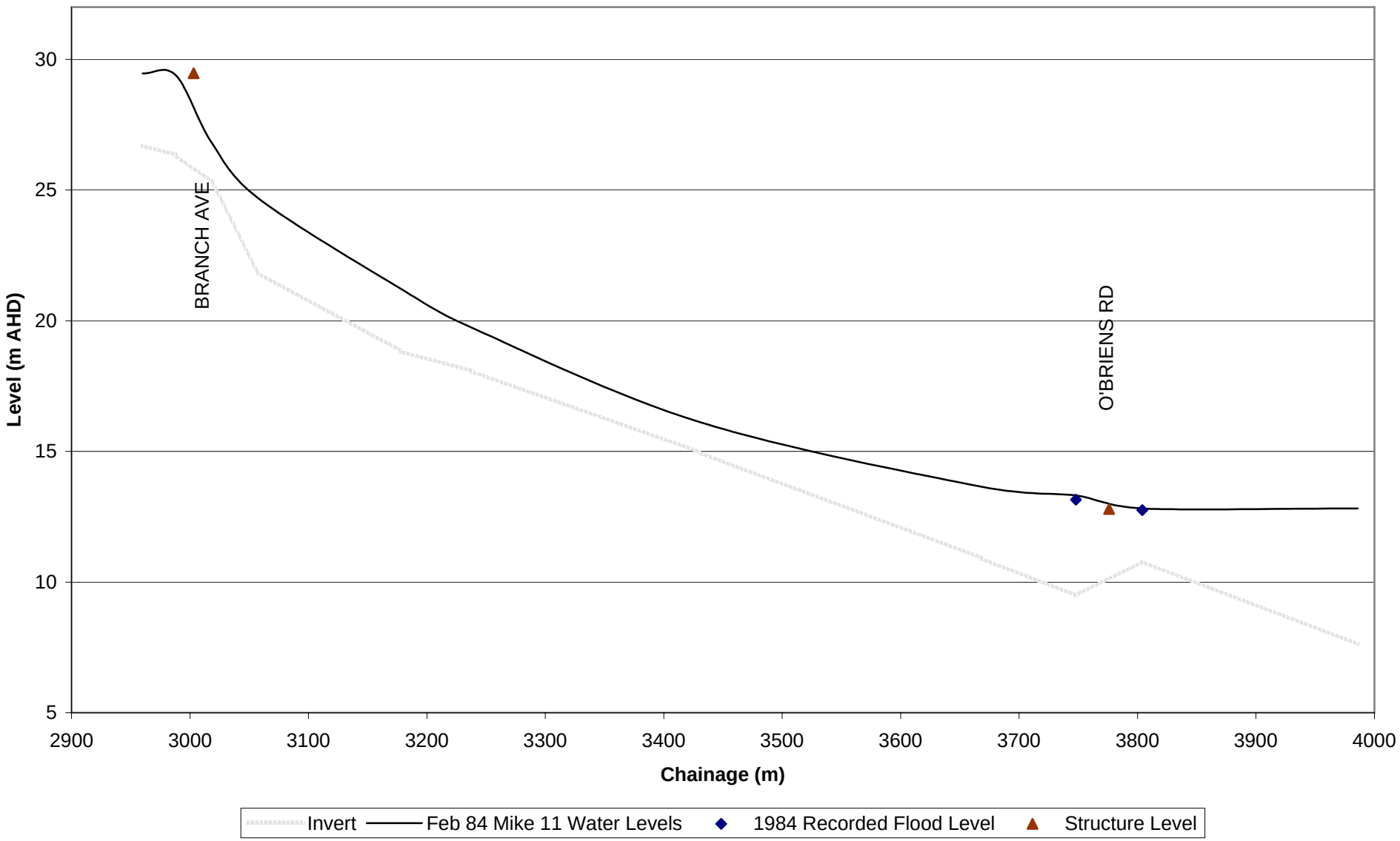
1 September 2006

Allans Creek Flood Study

FIGURE E40
1984 Flood Calibration Levels - American Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls

Flood Calibration Profile



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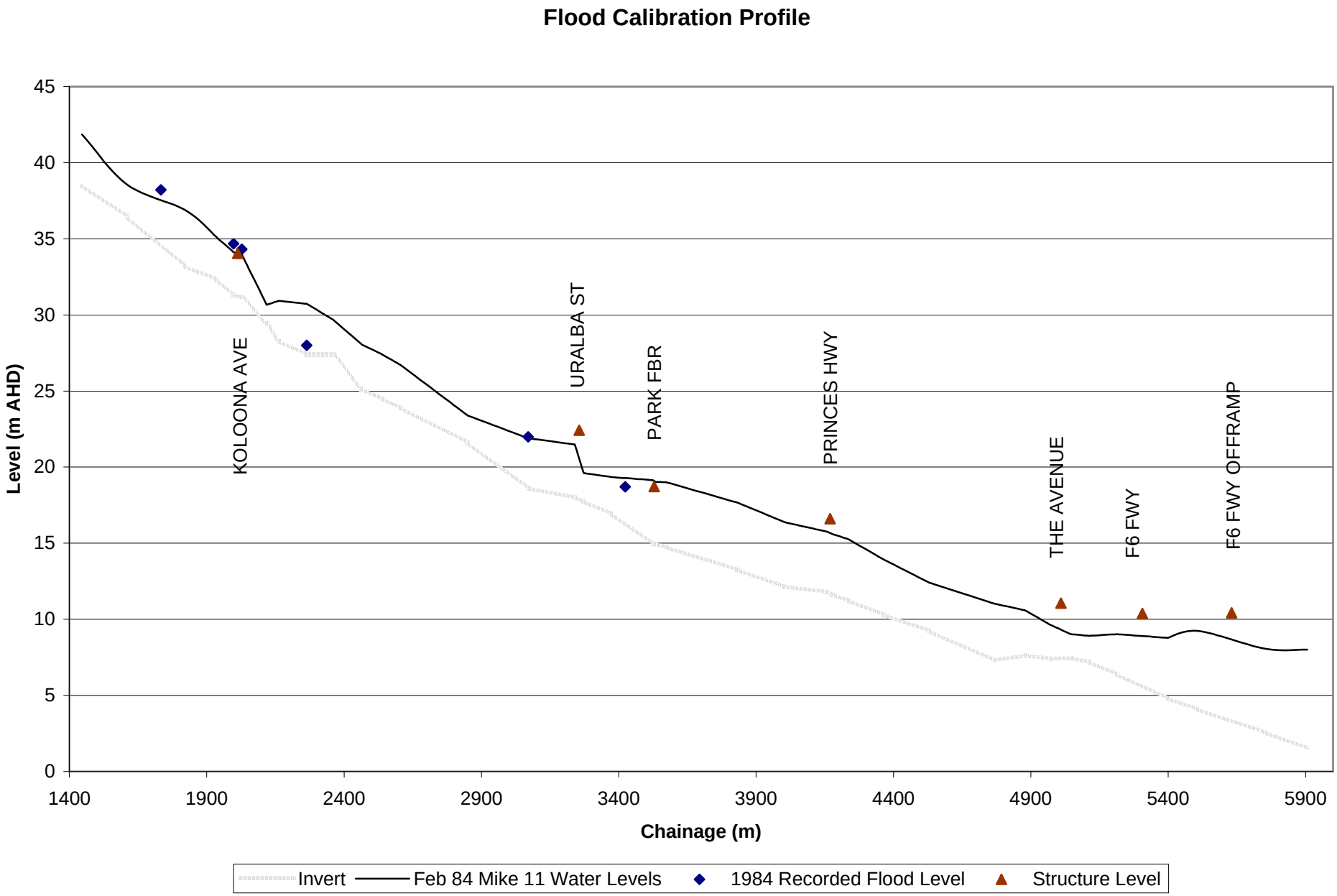
1 September 2006

Allans Creek Flood Study

FIGURE E41
1984 Flood Calibration Levels - Branch Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls



LAWSON AND TRELOAR
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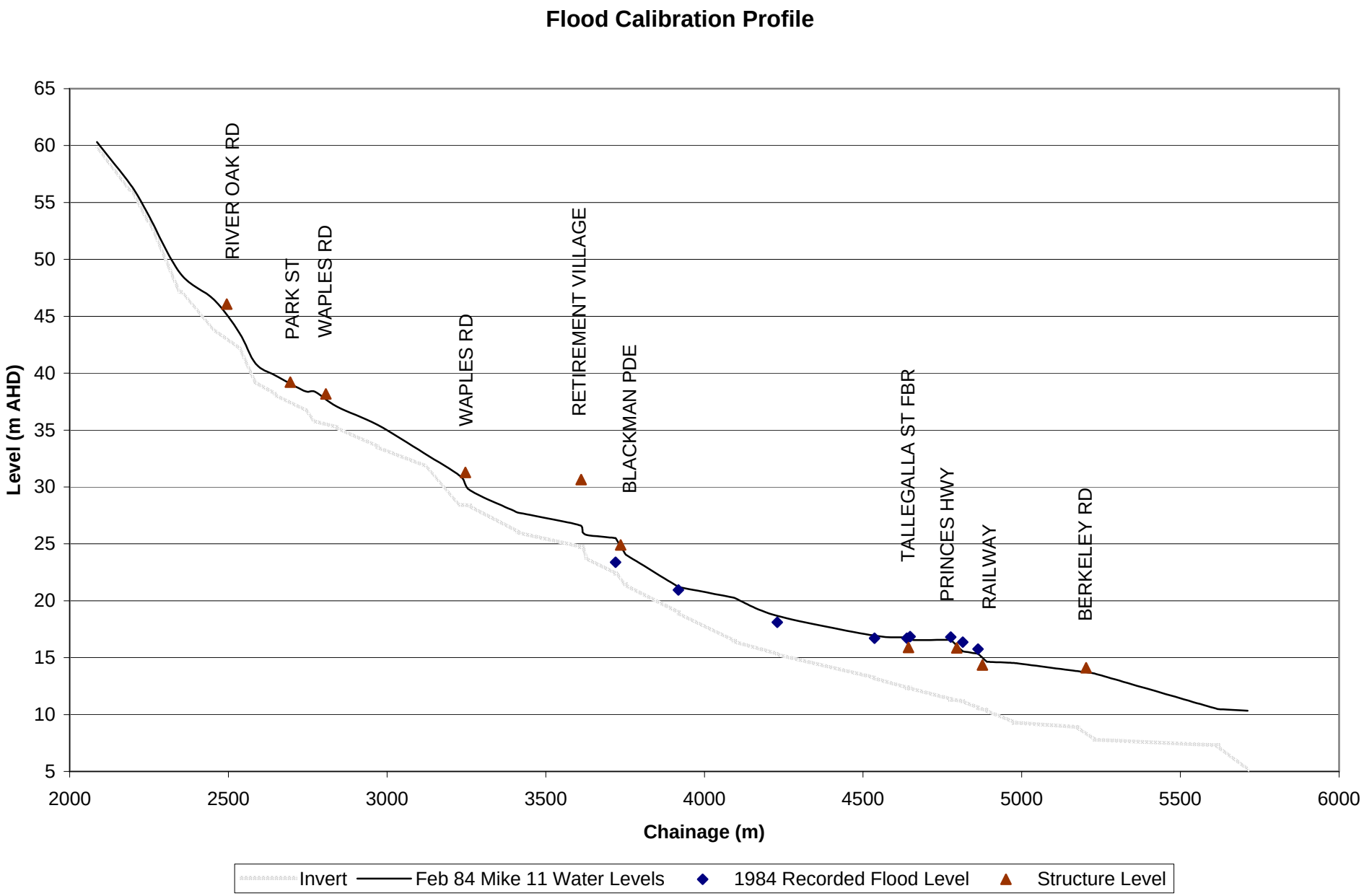
1 September 2006

Allans Creek Flood Study

FIGURE E42
1984 Flood Calibration Levels - Byarong Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls



LAWSON AND TRELOAR
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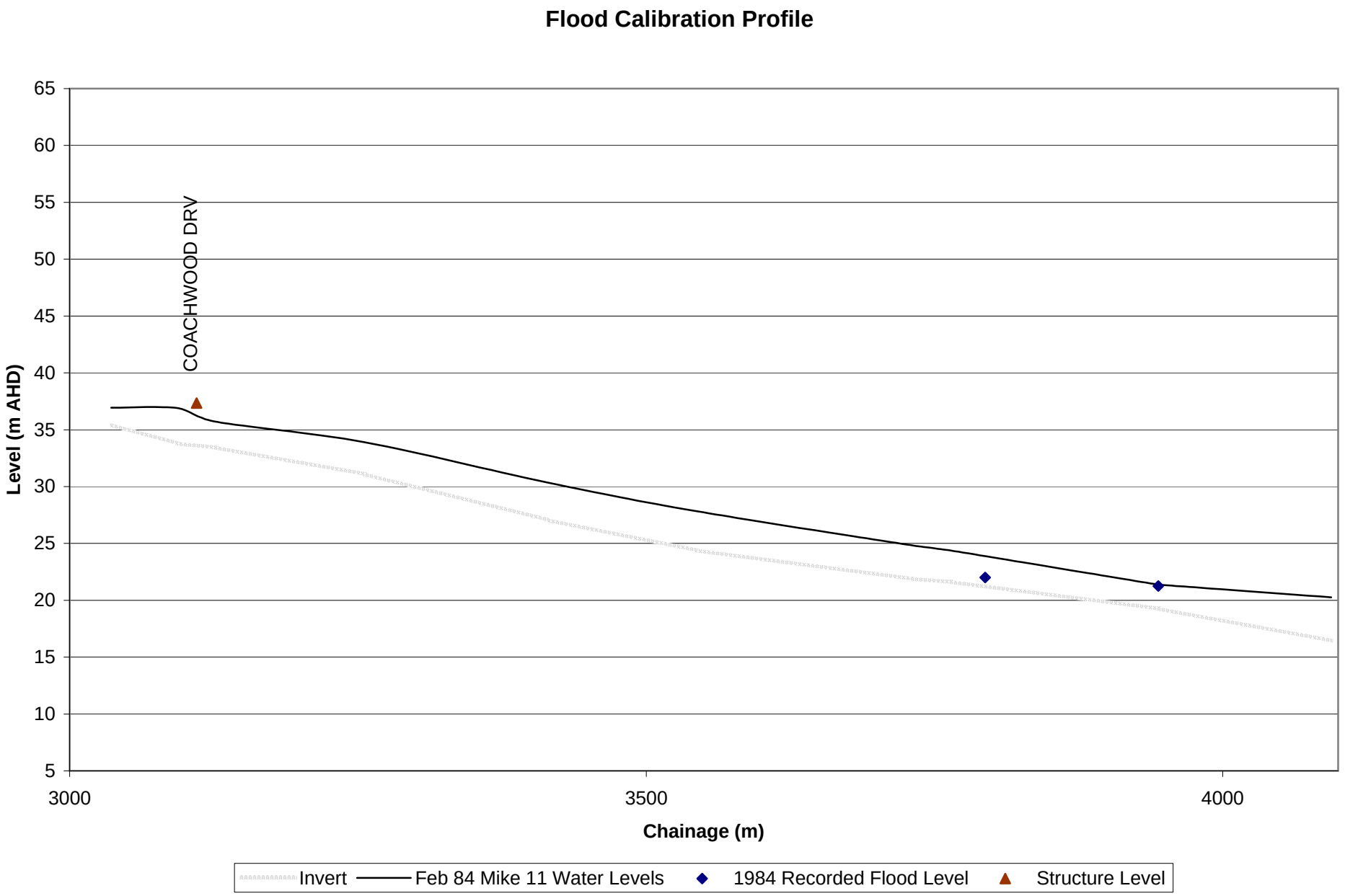
1 September 2006

Allans Creek Flood Study

FIGURE E43
1984 Flood Calibration Levels - Charcoal Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls



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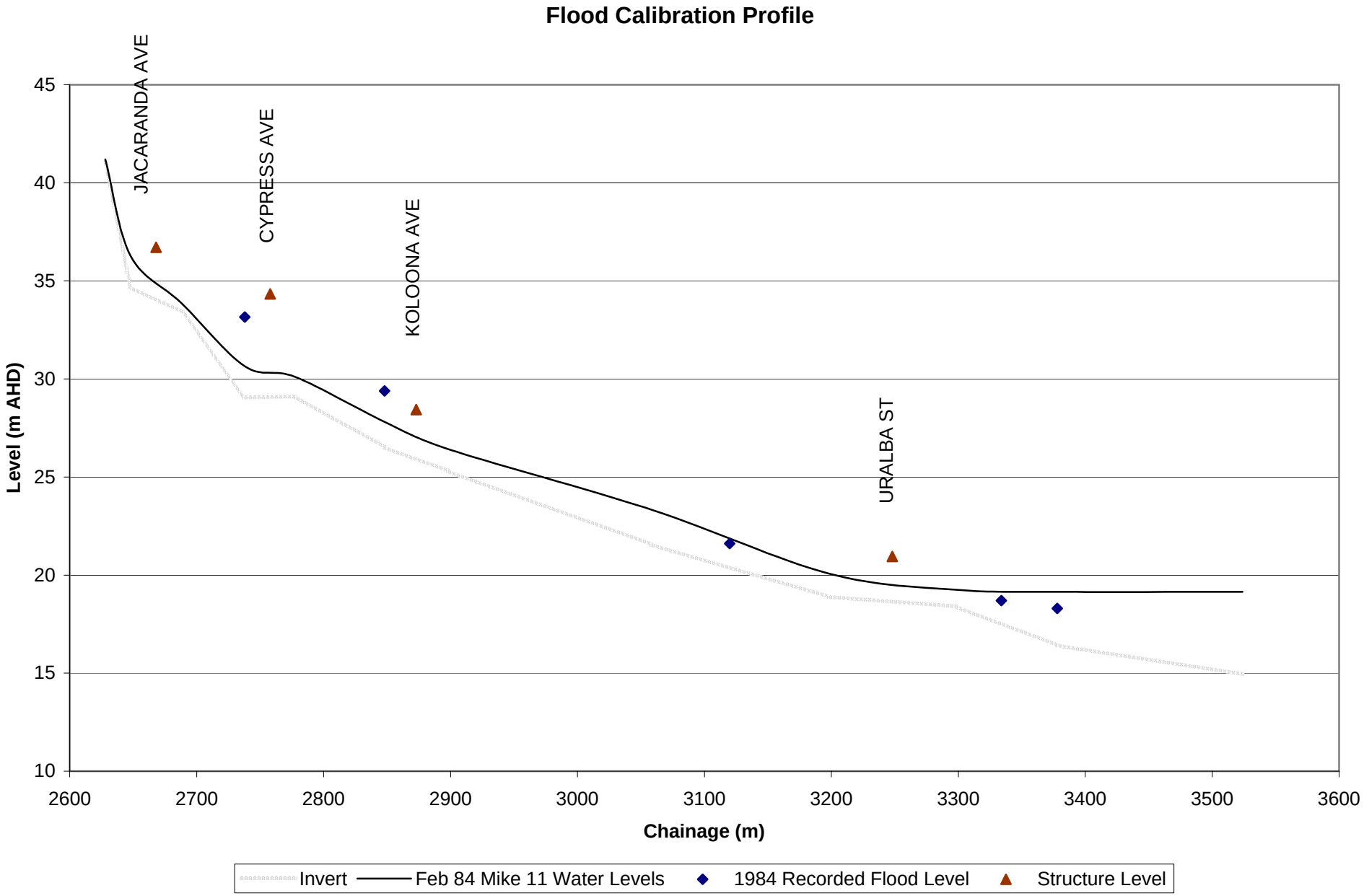
1 September 2006

Allans Creek Flood Study

FIGURE E44
1984 Flood Calibration Levels - Charcoal Major Tributary Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls



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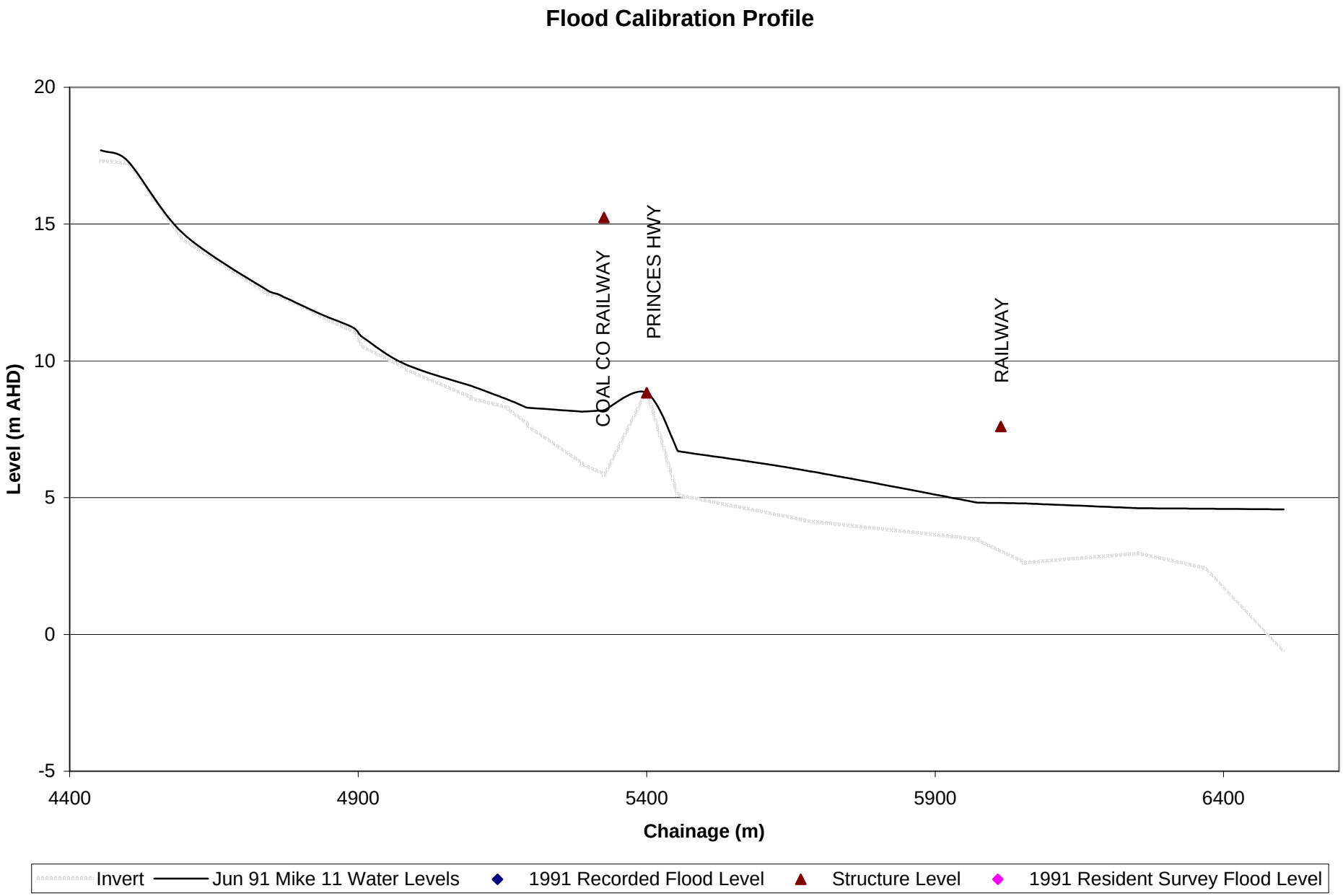
1 September 2006

Allans Creek Flood Study

FIGURE E45
1984 Flood Calibration Levels - Running Brook Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 84 Calib Flood Profiles.xls



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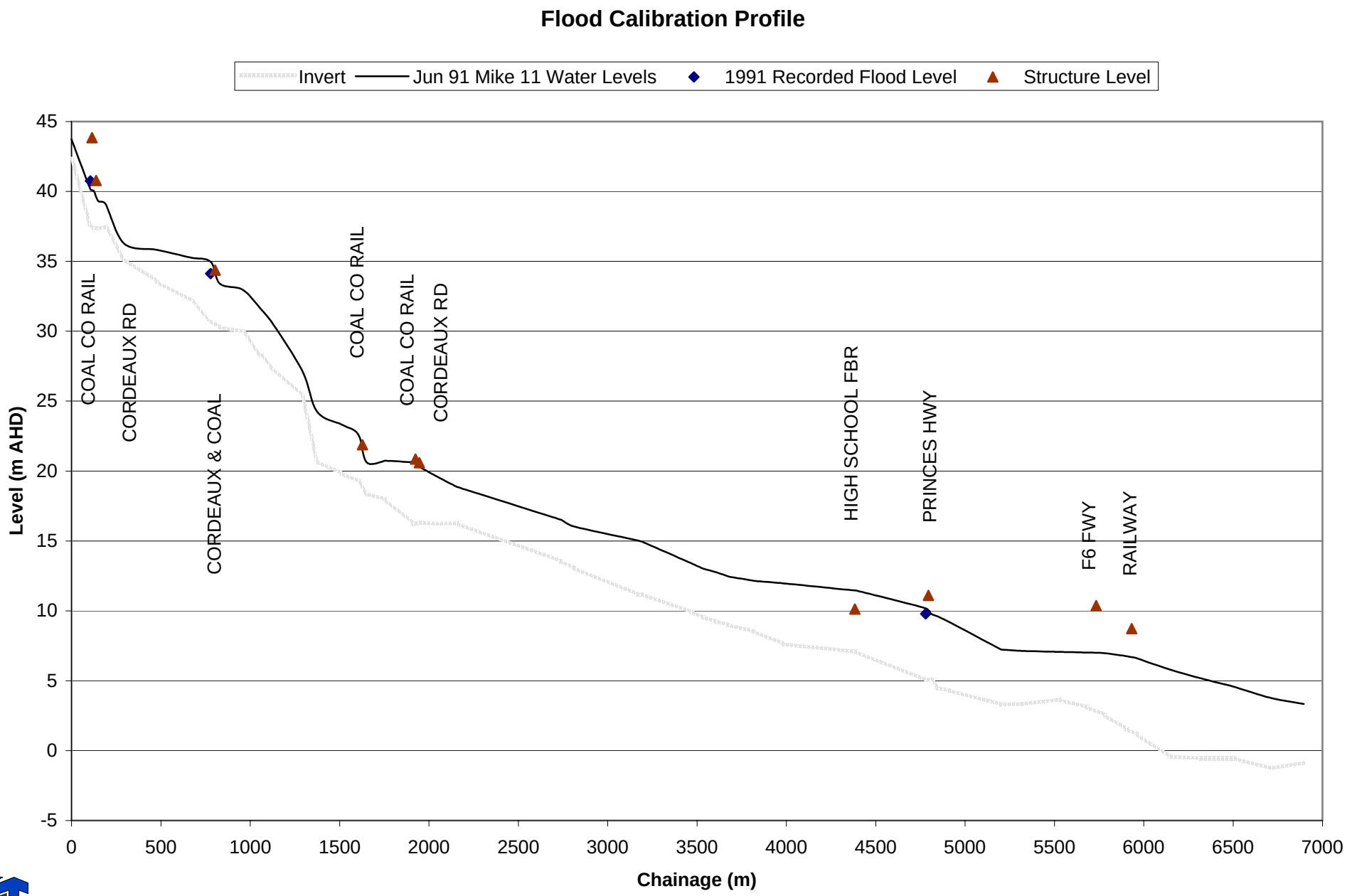
1 September 2006

Allans Creek Flood Study

FIGURE E33
1998 Flood Calibration Levels - Unanderra Drain Branch
Jobs/J1946/AppendicesV6/Appendix E - 91 Calib Flood Profiles.xls



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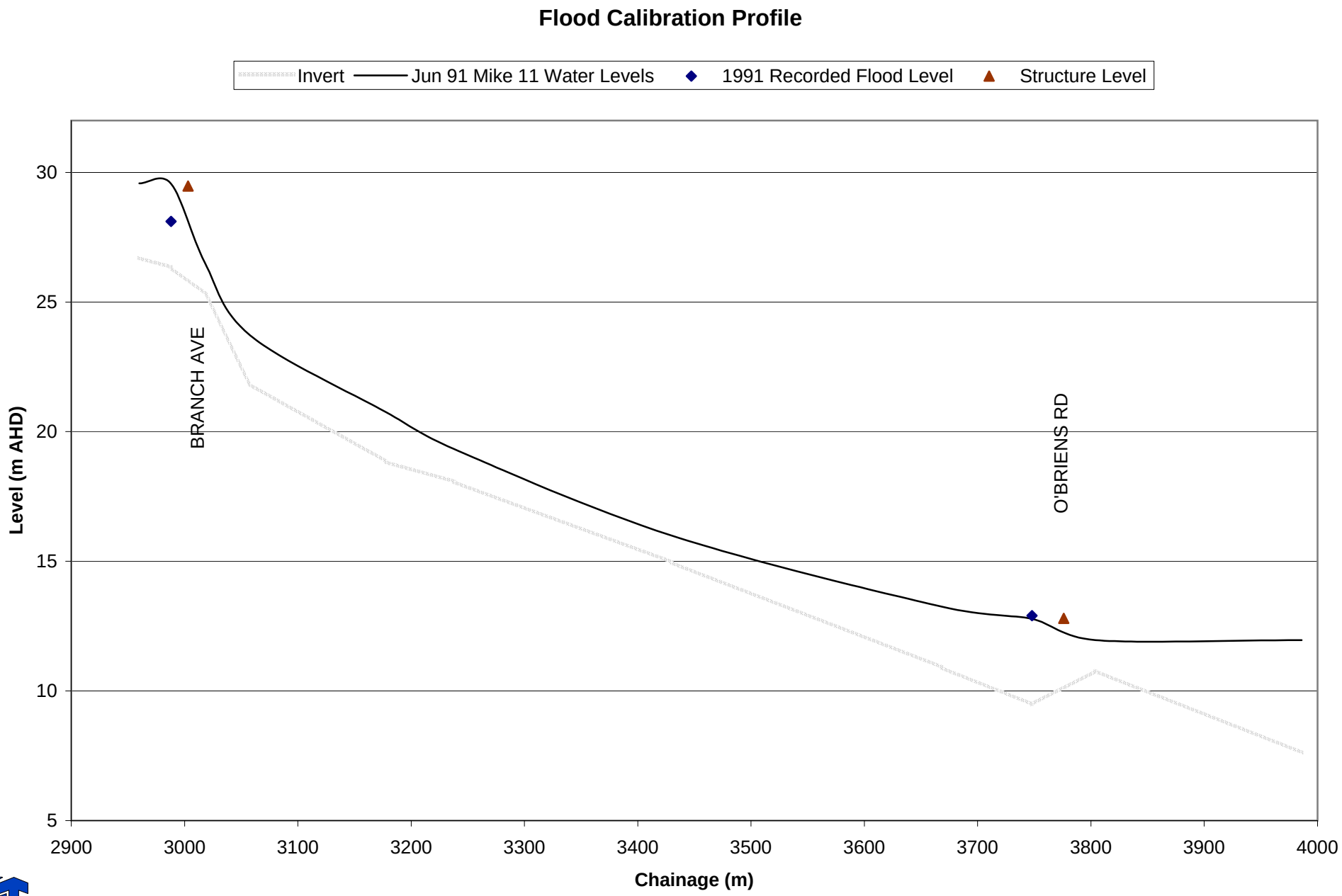
1 September 2006

Allans Creek Flood Study

FIGURE E34
1991 Flood Calibration Levels - American Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 91 Calib Flood Profiles.xls



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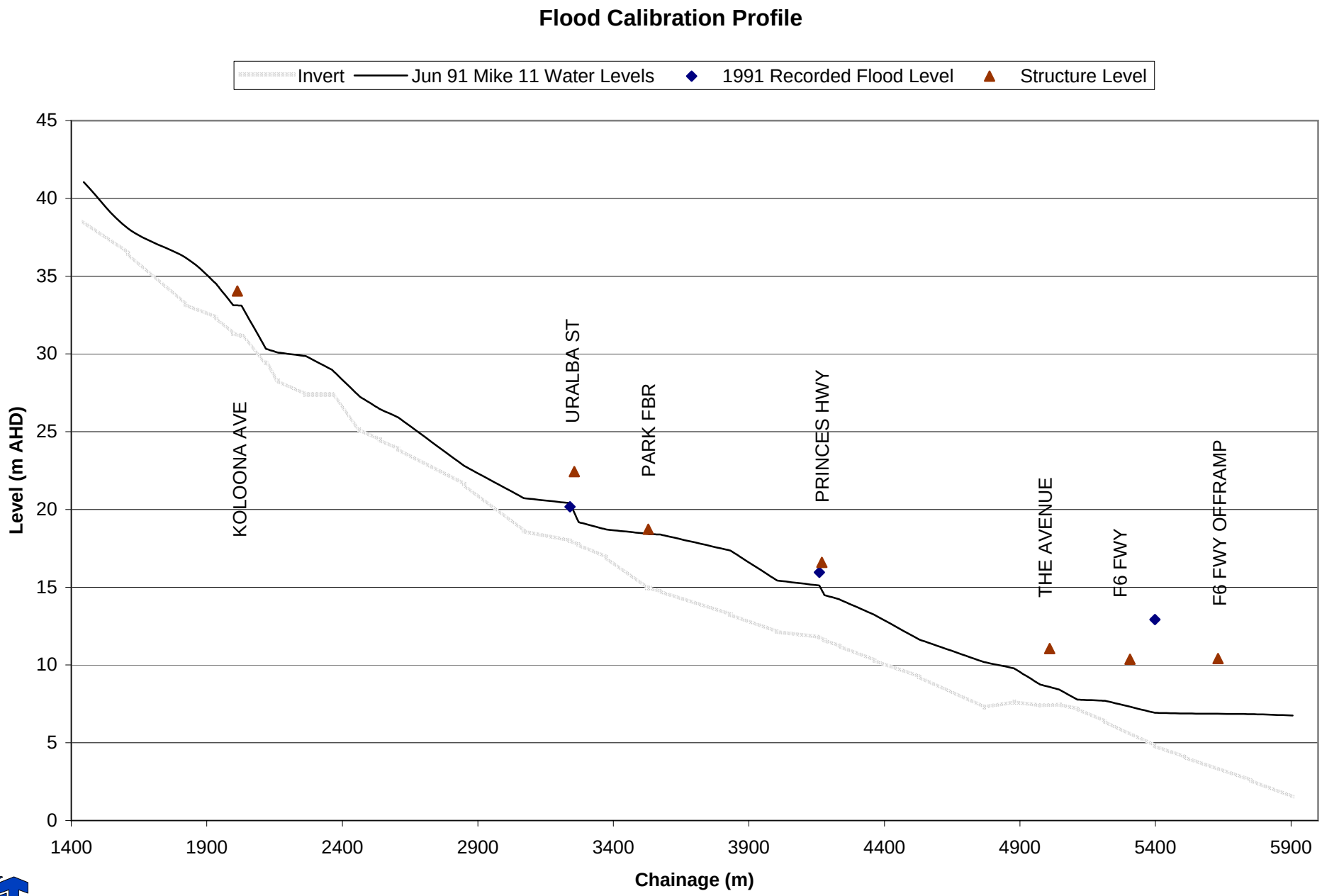
1 September 2006

Allans Creek Flood Study

FIGURE E35
1991 Flood Calibration Levels - Branch Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 91 Calib Flood Profiles.xls



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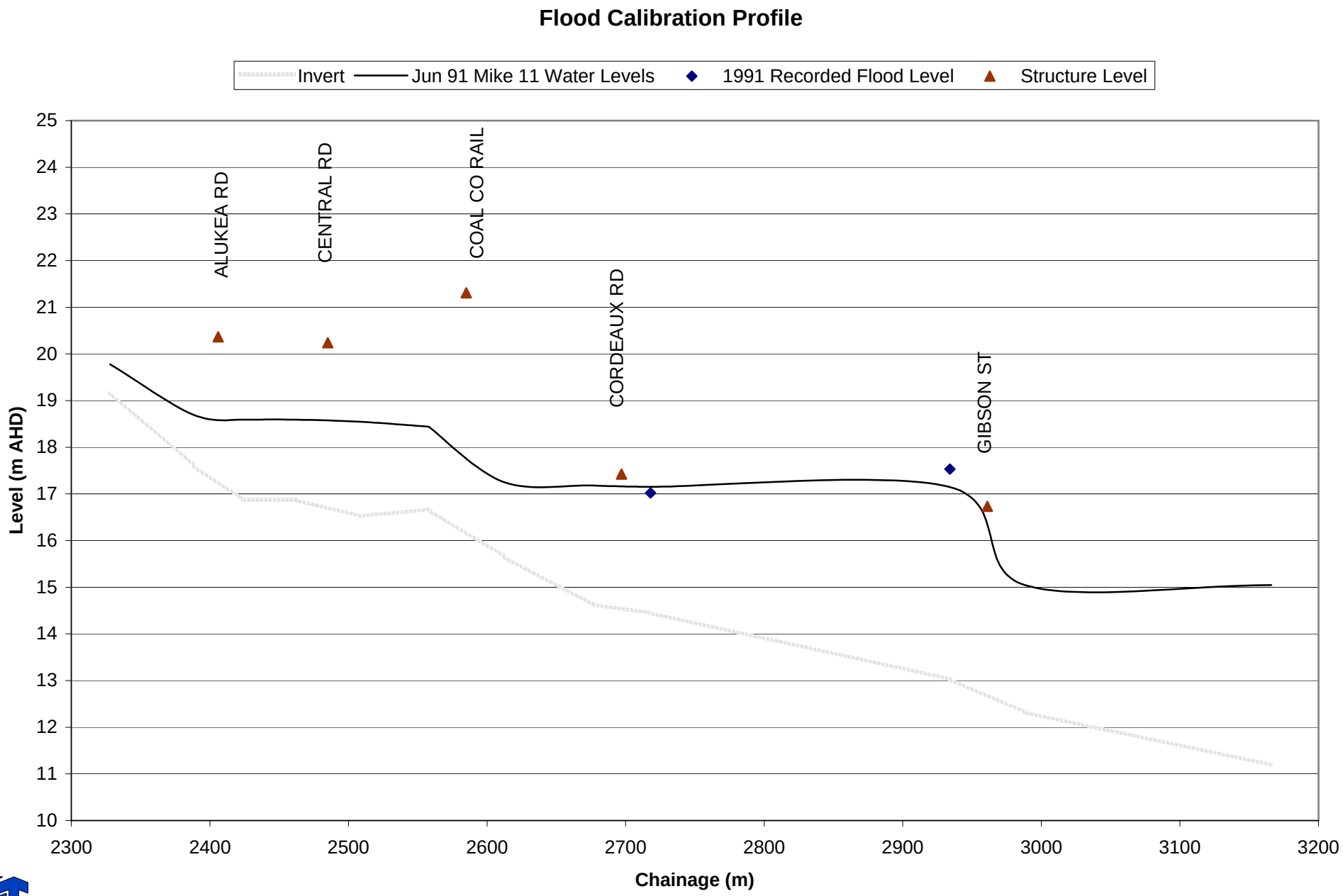
1 September 2006

Allans Creek Flood Study

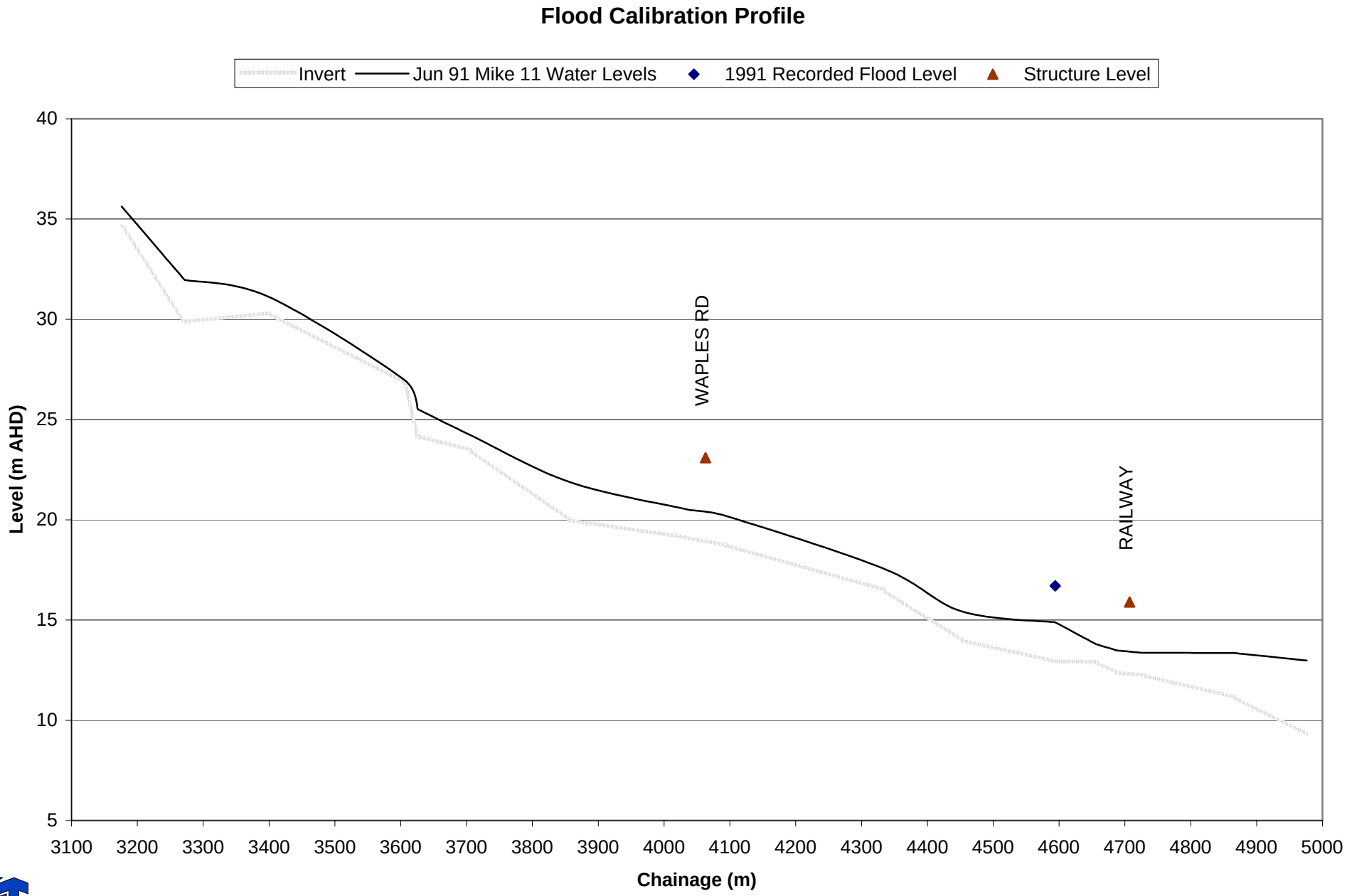
FIGURE E36
1991 Flood Calibration Levels - Byarong Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 91 Calib Flood Profiles.xls



LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E37
1991 Flood Calibration Levels - Cordo Hts Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 91 Calib Flood Profiles.xls



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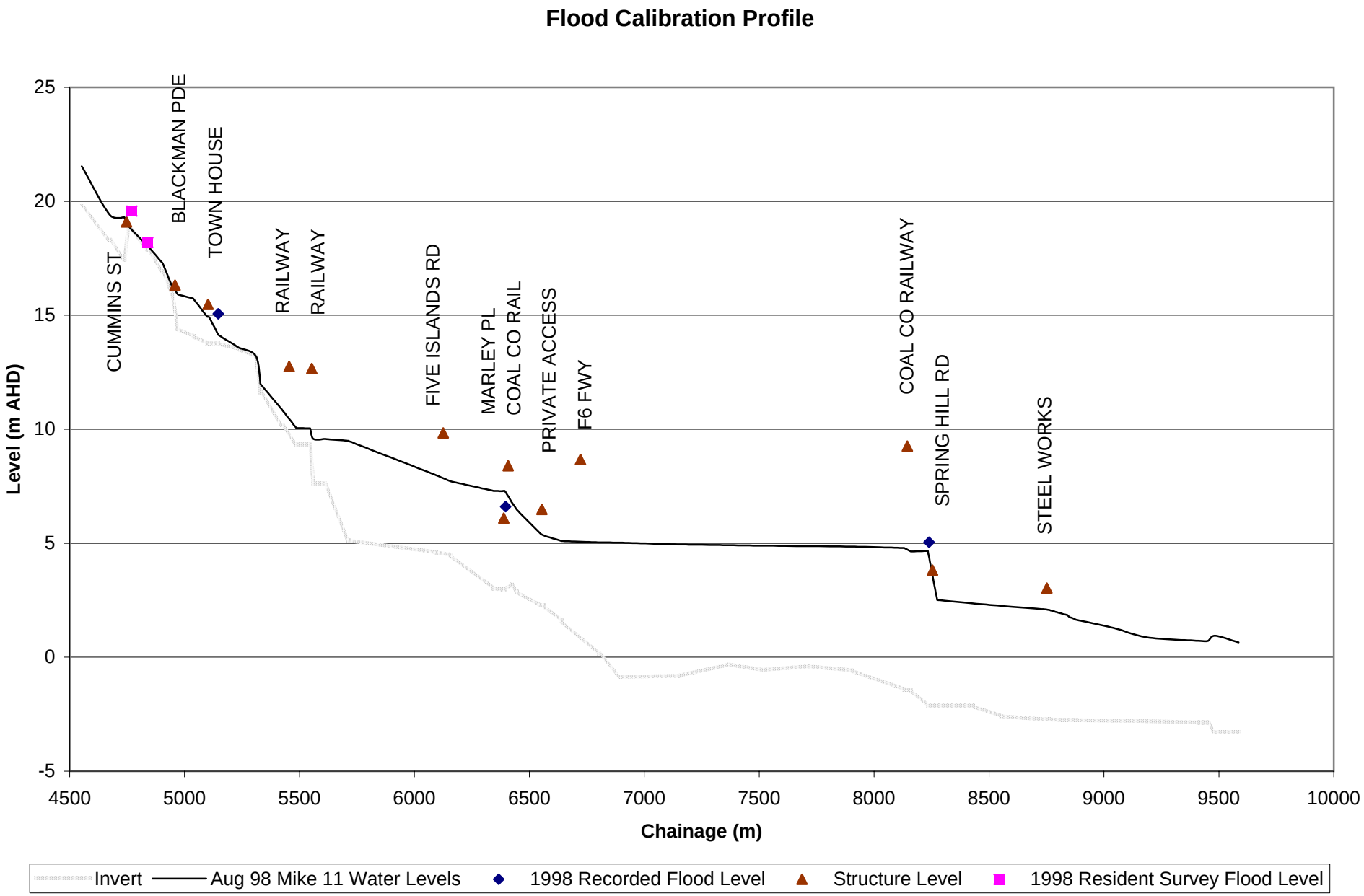
1 September 2006

Allans Creek Flood Study

FIGURE E38
1991 Flood Calibration Levels - Jenkins Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 91 Calib Flood Profiles.xls



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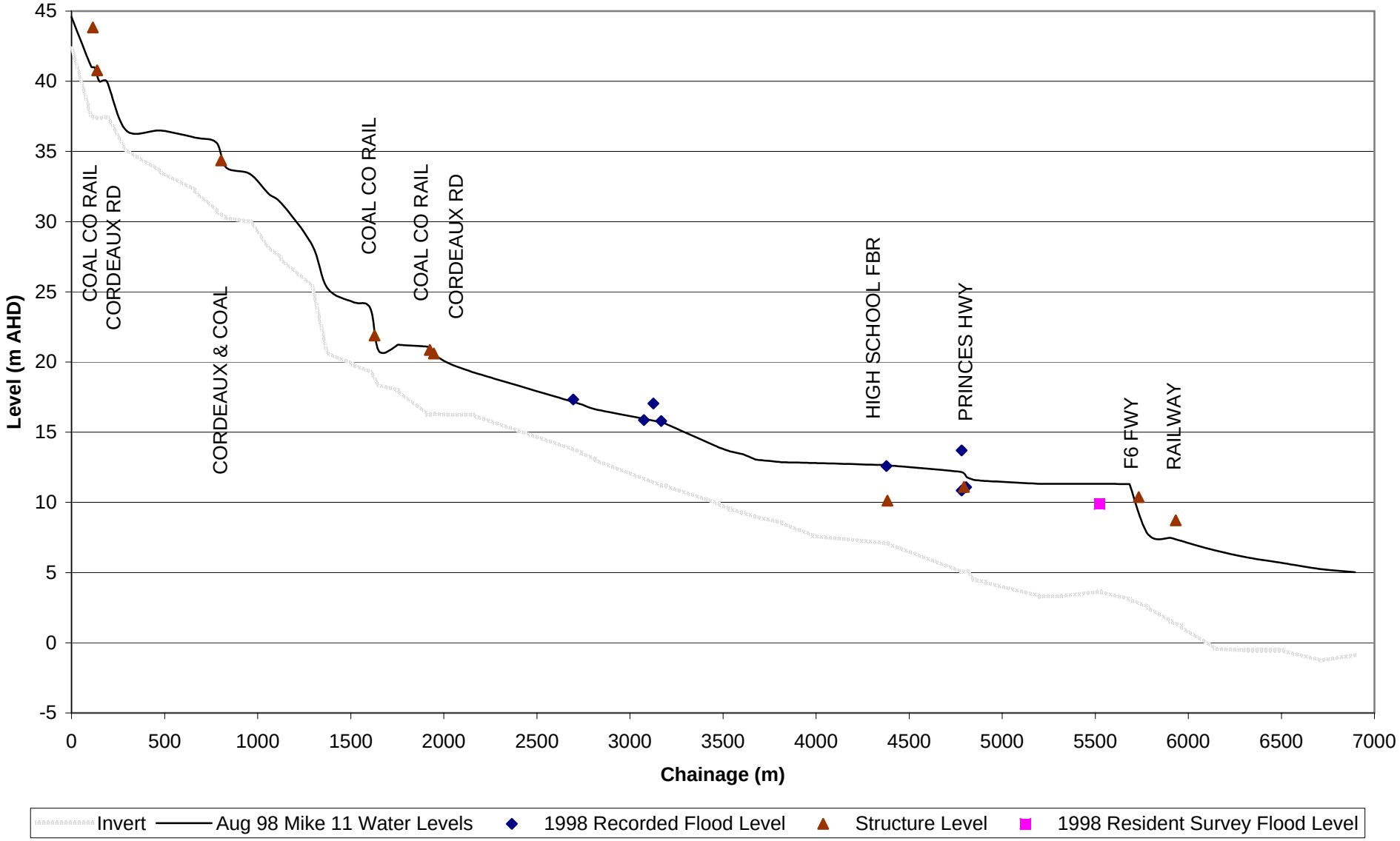
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E17
1998 Flood Calibration Levels - Allans Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls

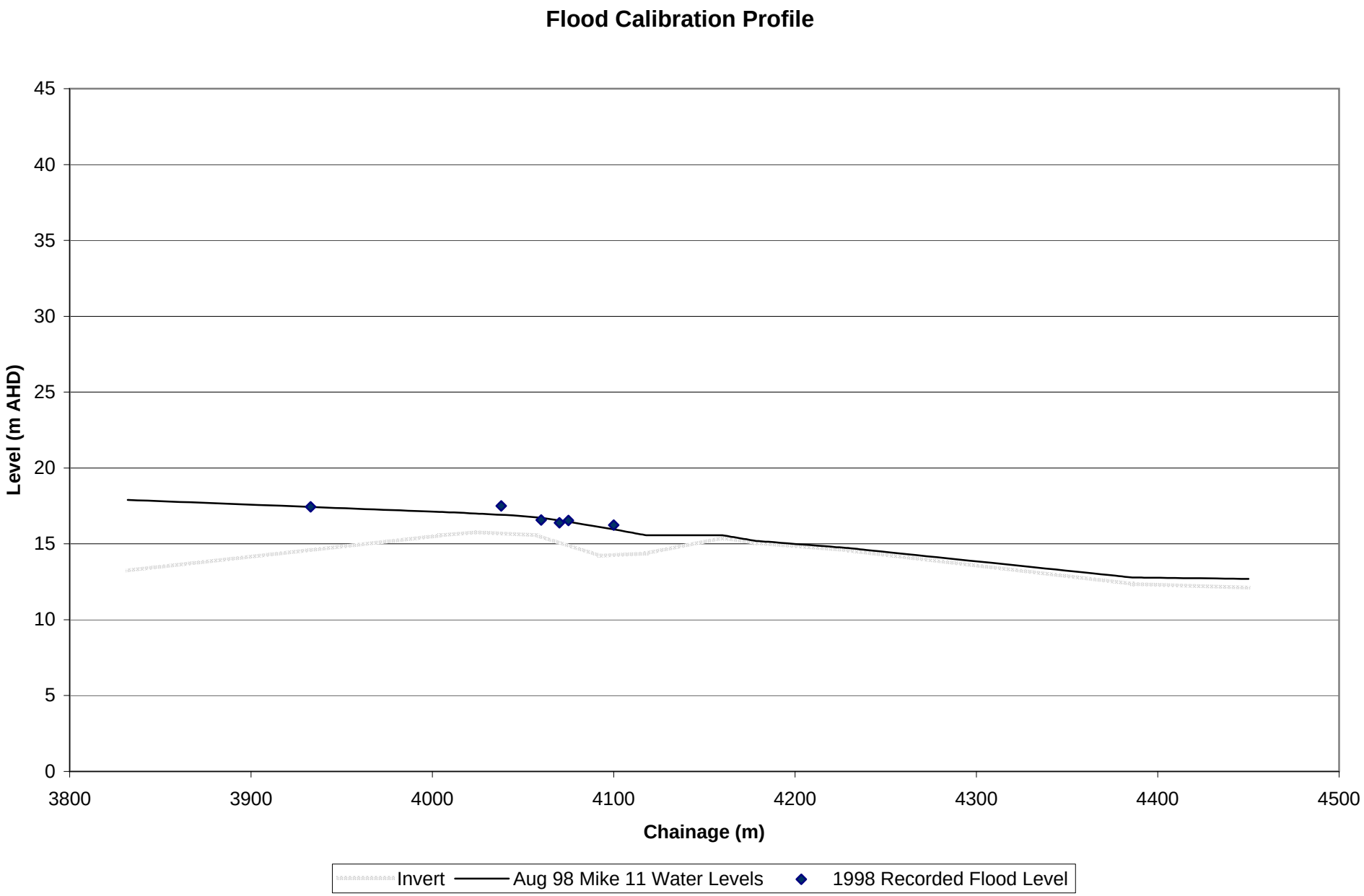
Flood Calibration Profile



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E18
1998 Flood Calibration Levels - American Creek
Jobs/J1946/Flood Study figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
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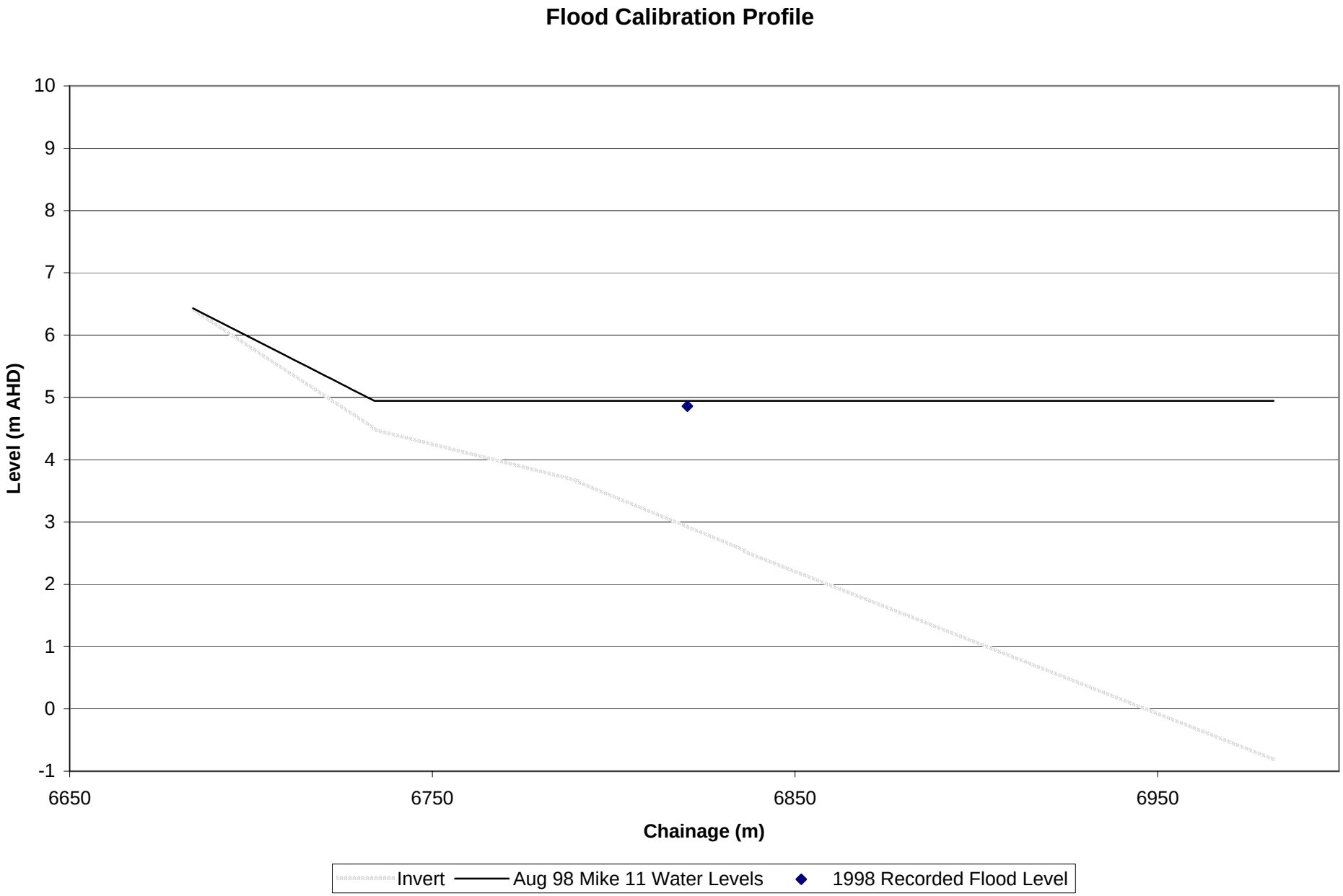
1 September 2006

Allans Creek Flood Study

FIGURE E19
1998 Flood Calibration Levels - Arrow Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
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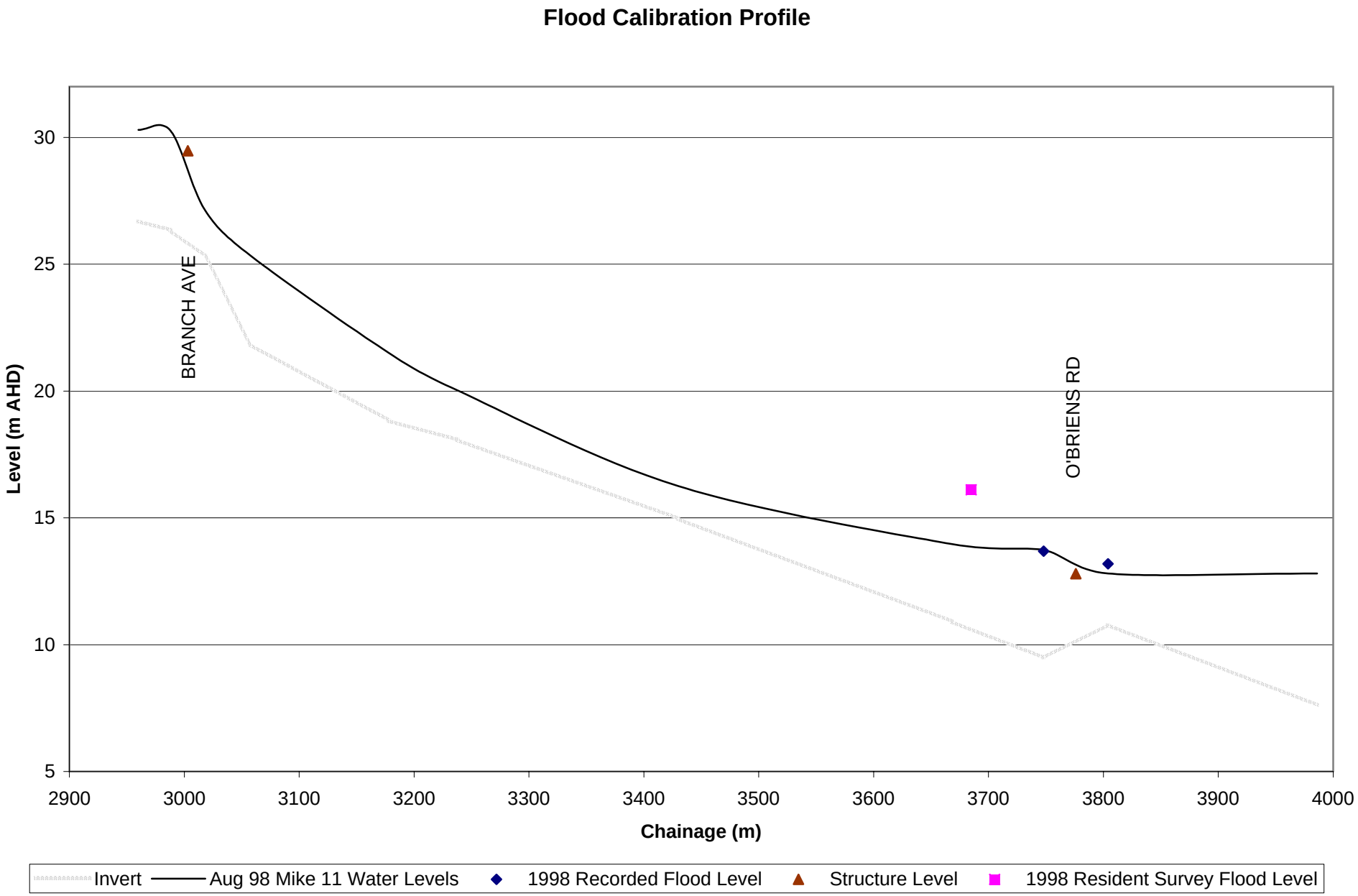
1 September 2006

Allans Creek Flood Study

FIGURE E20
1998 Flood Calibration Levels - Berkeley Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



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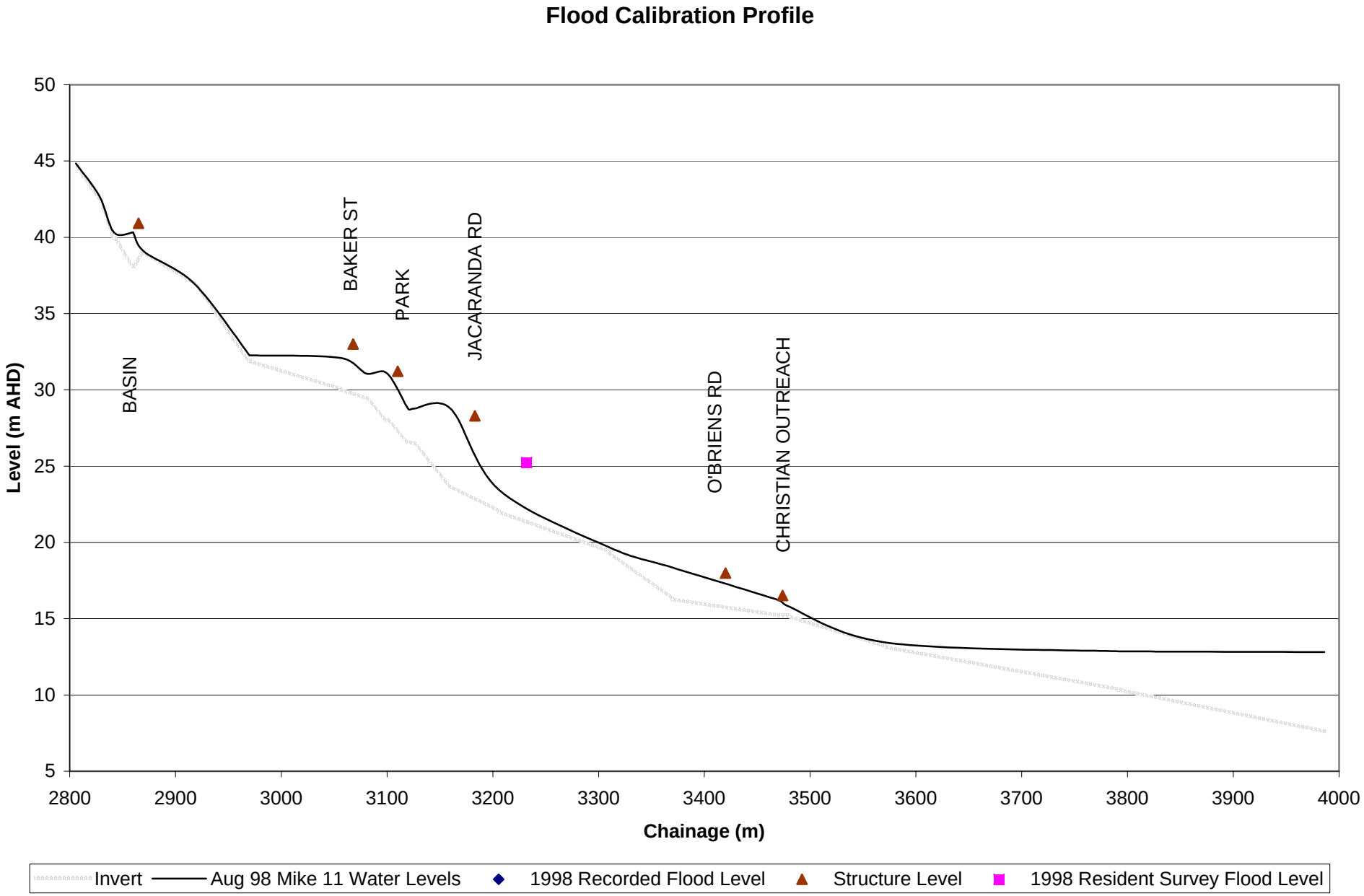
1 September 2006

Allans Creek Flood Study

FIGURE E21
1998 Flood Calibration Levels - Branch Creek
Jobs/J1946/Flood Study figures V6/Appendix E - 98 Calib Flood Profiles.xls

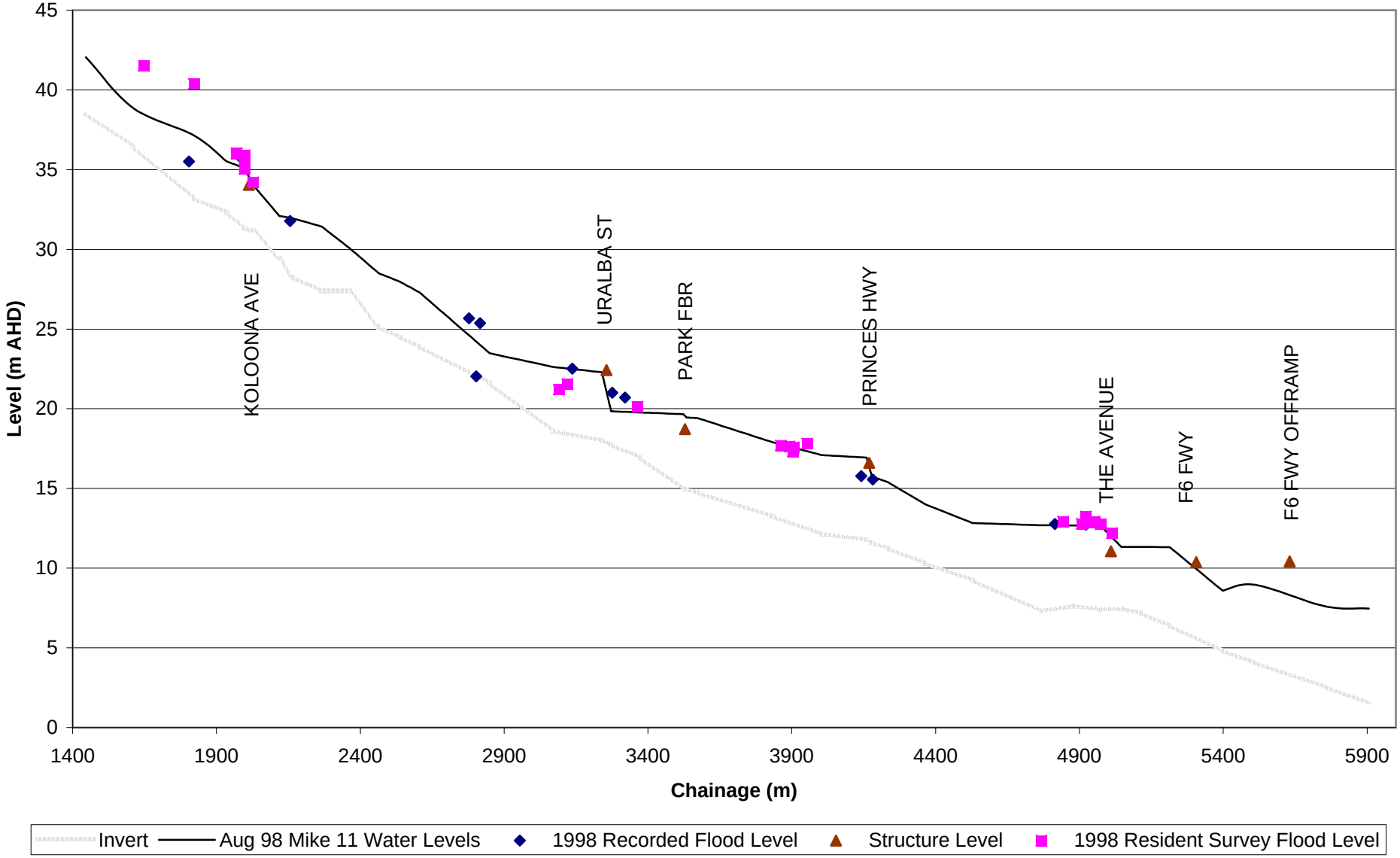


LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E22
1998 Flood Calibration Levels - Branch-Trib Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls

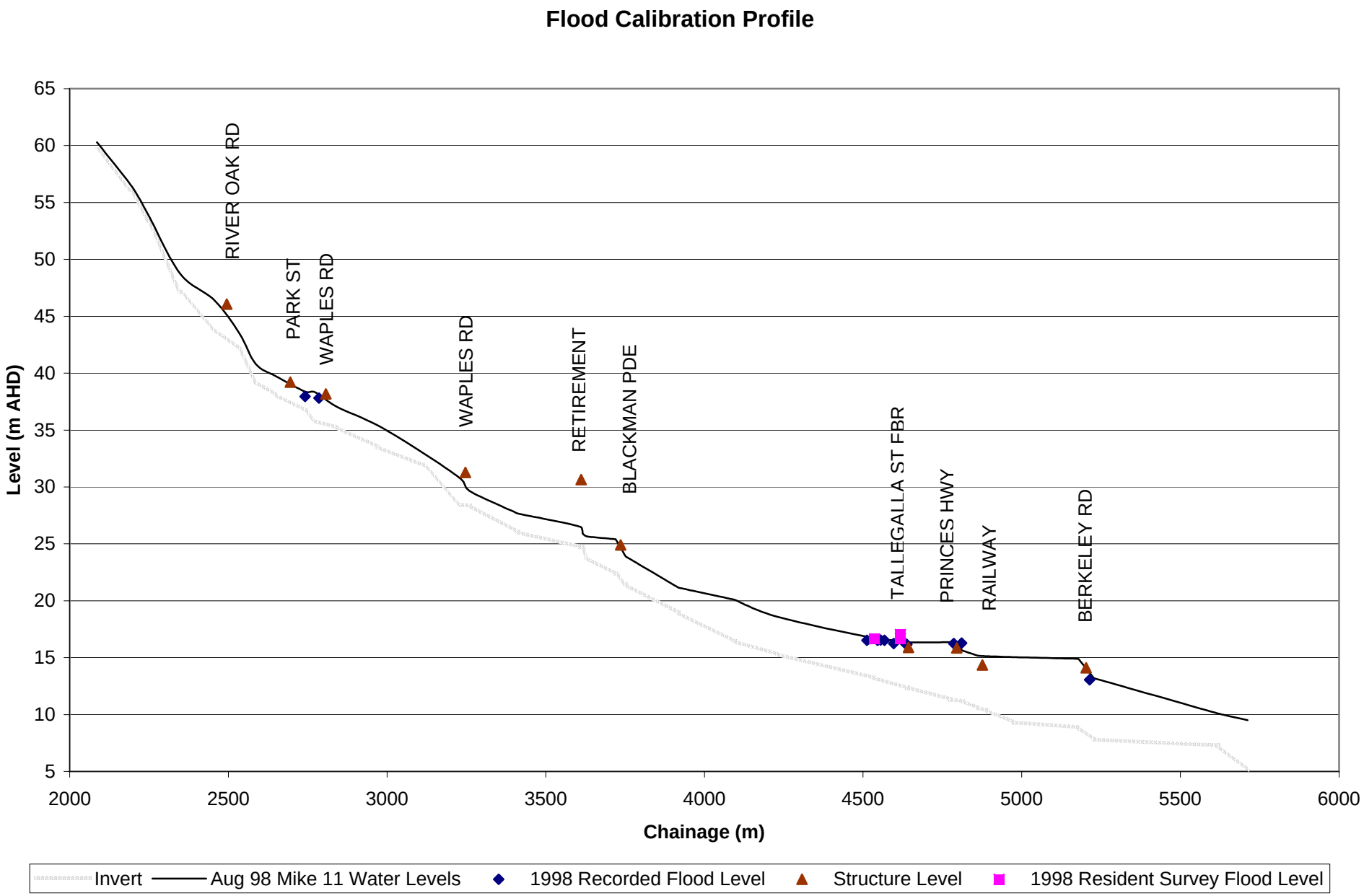
Flood Calibration Profile



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E23
1998 Flood Calibration Levels - Byarong Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



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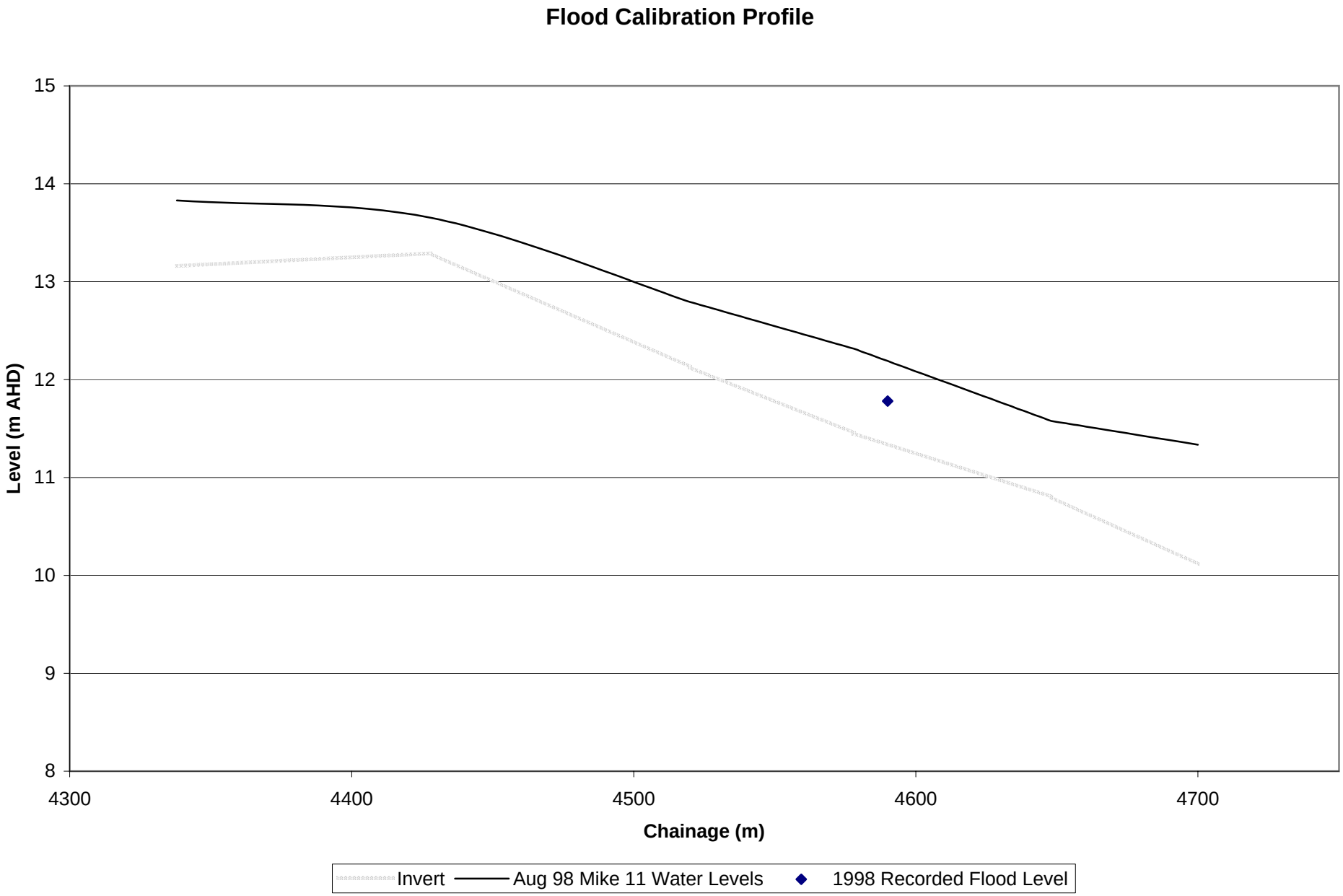
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E24
1998 Flood Calibration Levels - Charcoal Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



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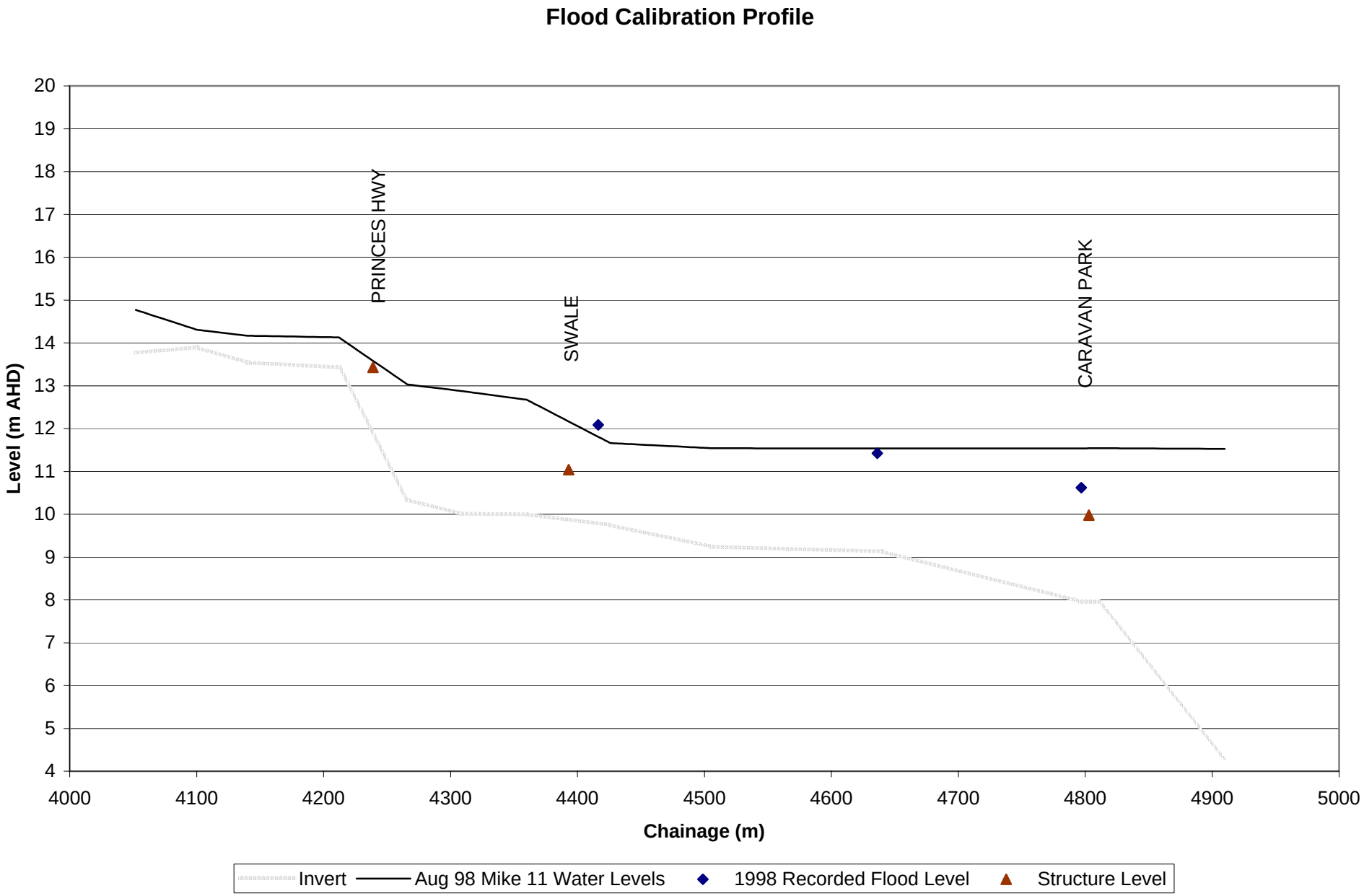
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E25
1998 Flood Calibration Levels - Cleverdon Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



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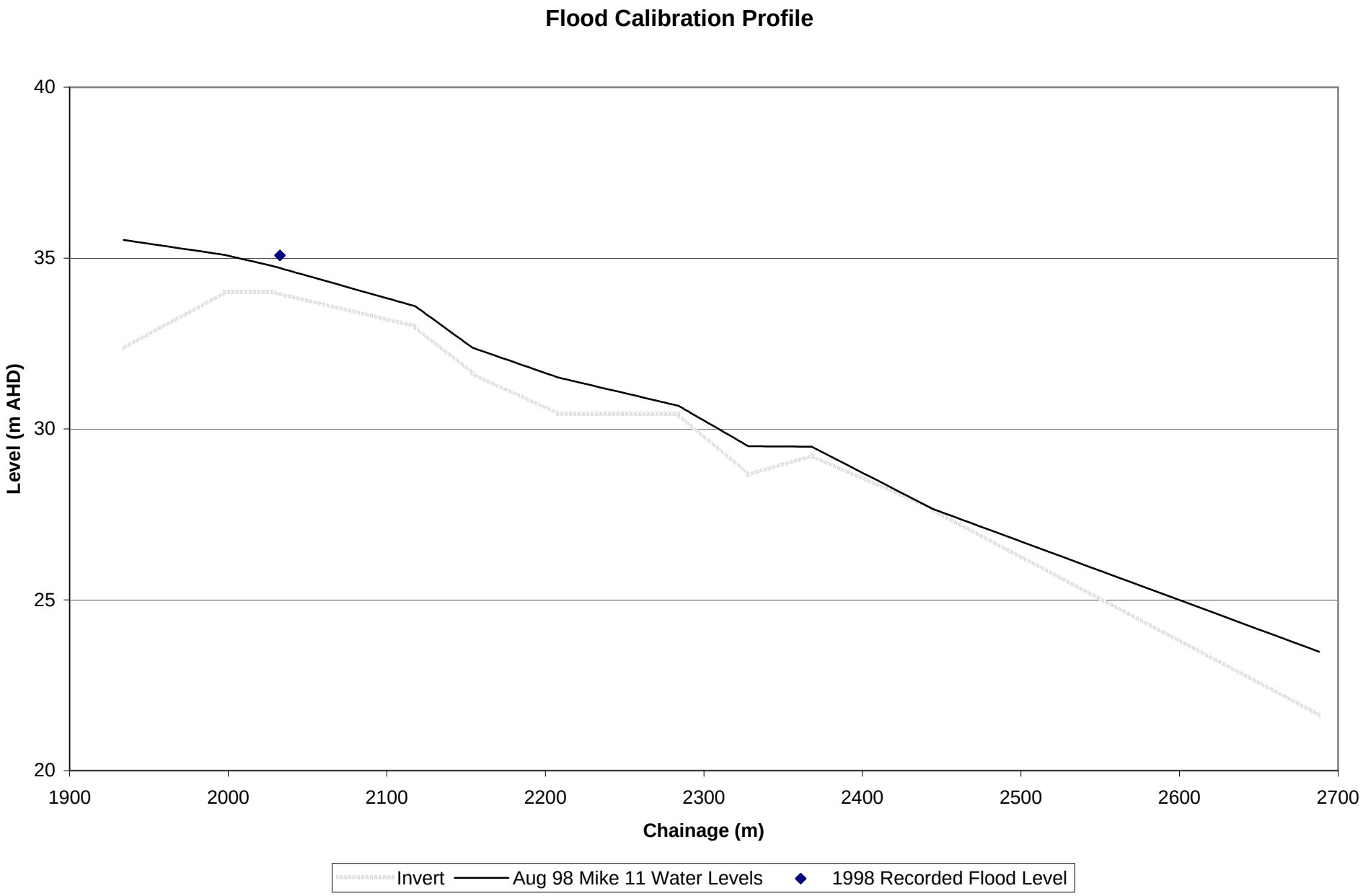
1 September 2006

Allans Creek Flood Study

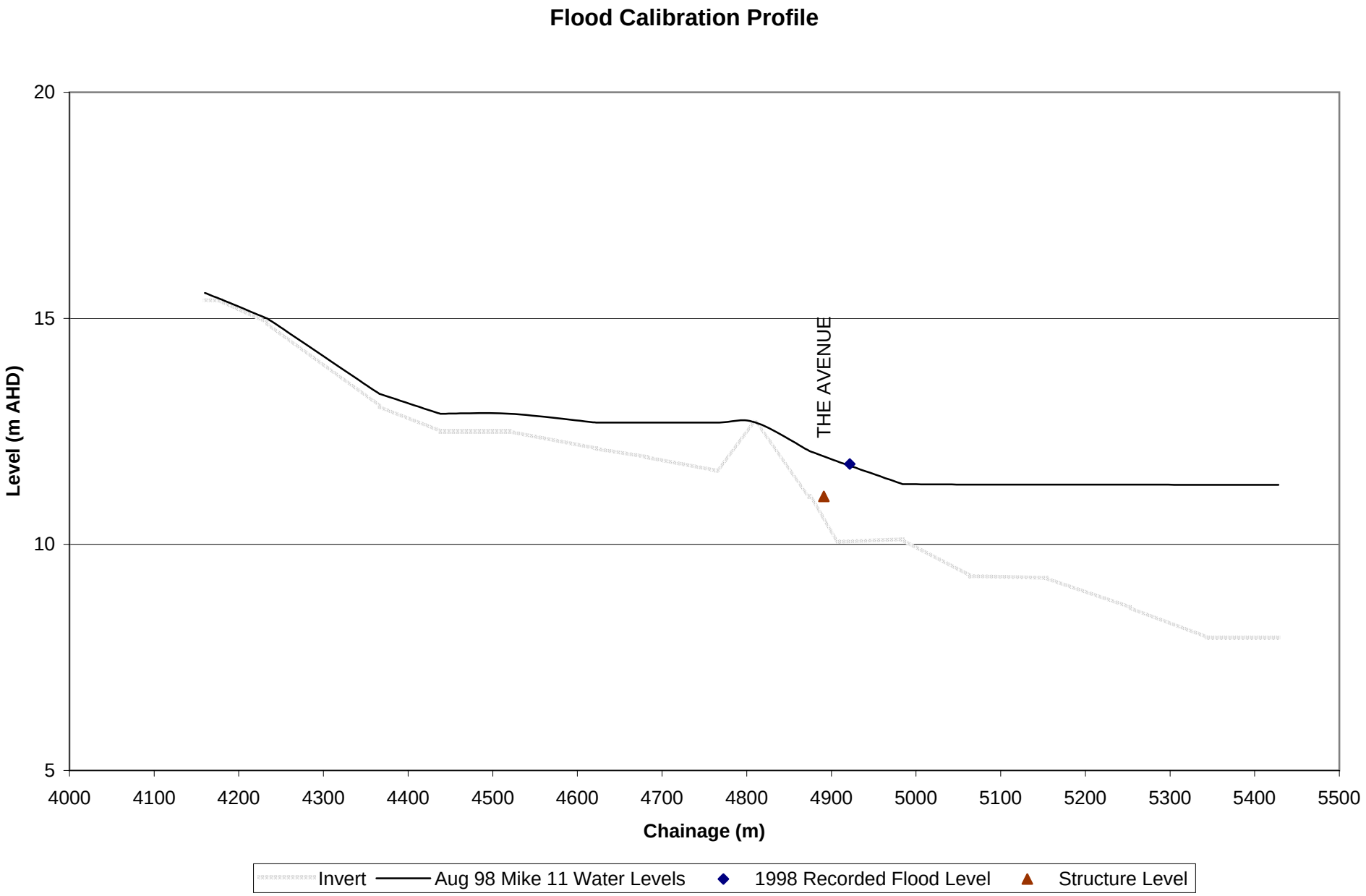
FIGURE E26
1998 Flood Calibration Levels - Cleverdon Drain Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

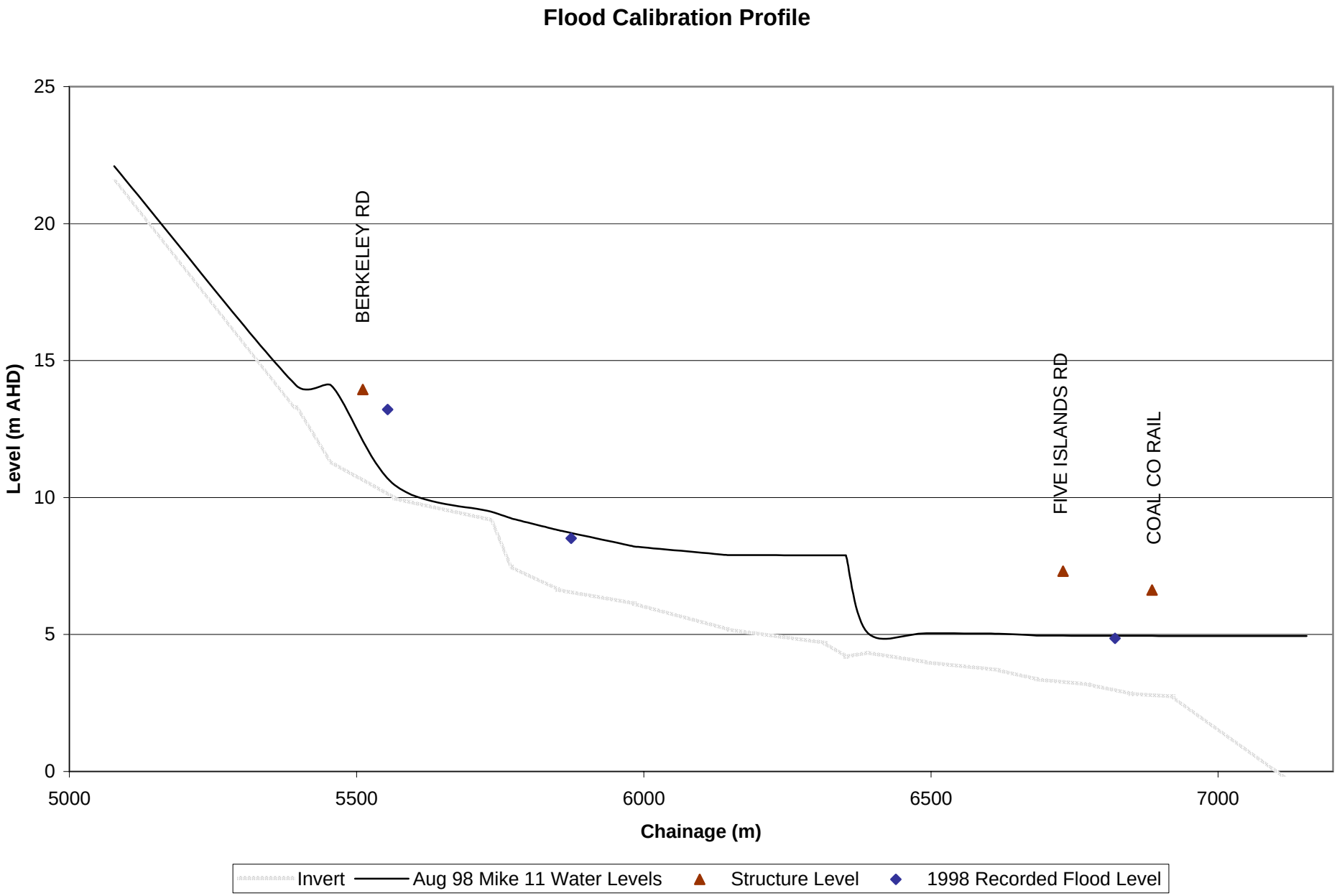
FIGURE E27
1998 Flood Calibration Levels - Coronata Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

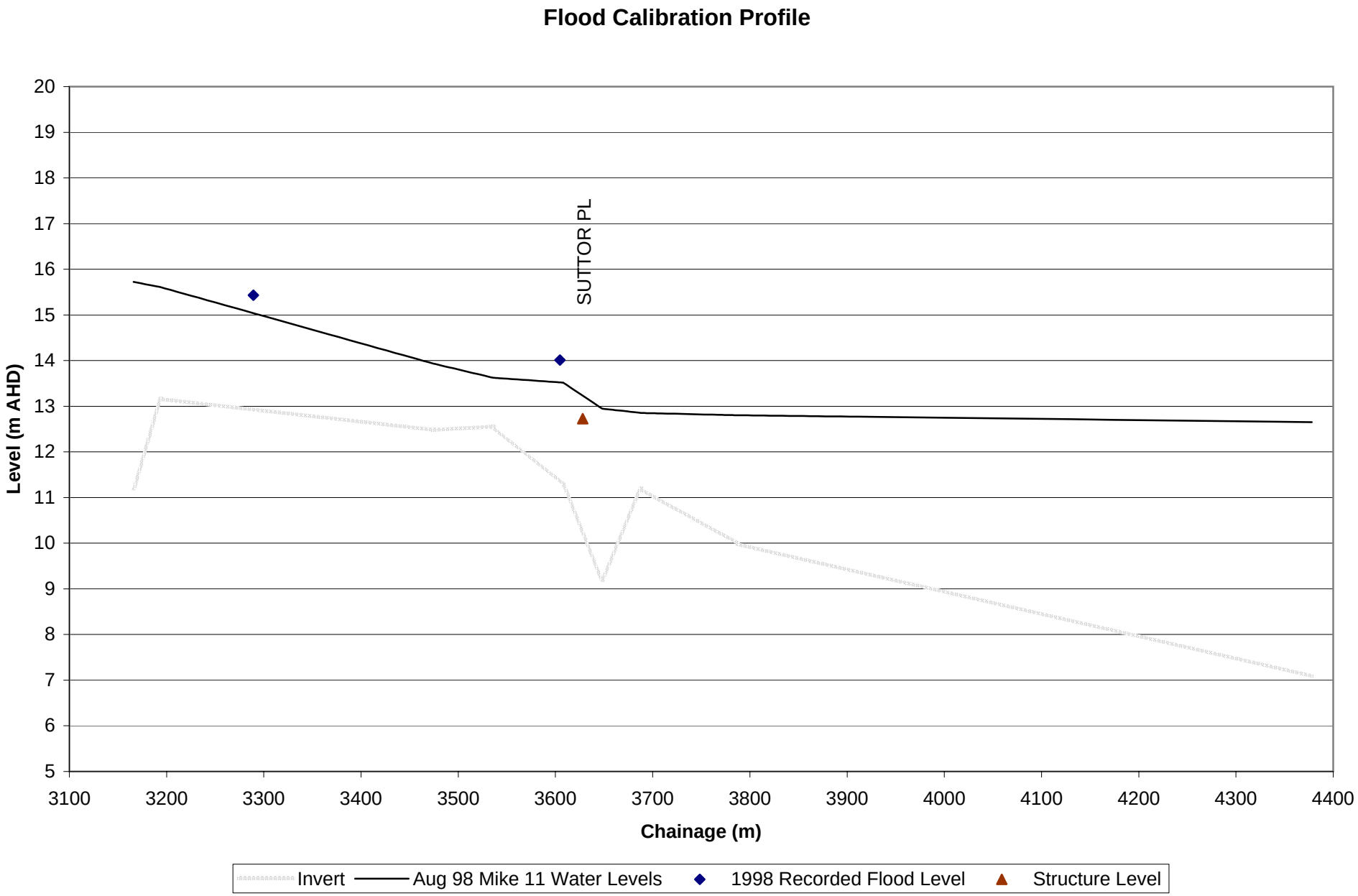
FIGURE E28
1998 Flood Calibration Levels - Figtree Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

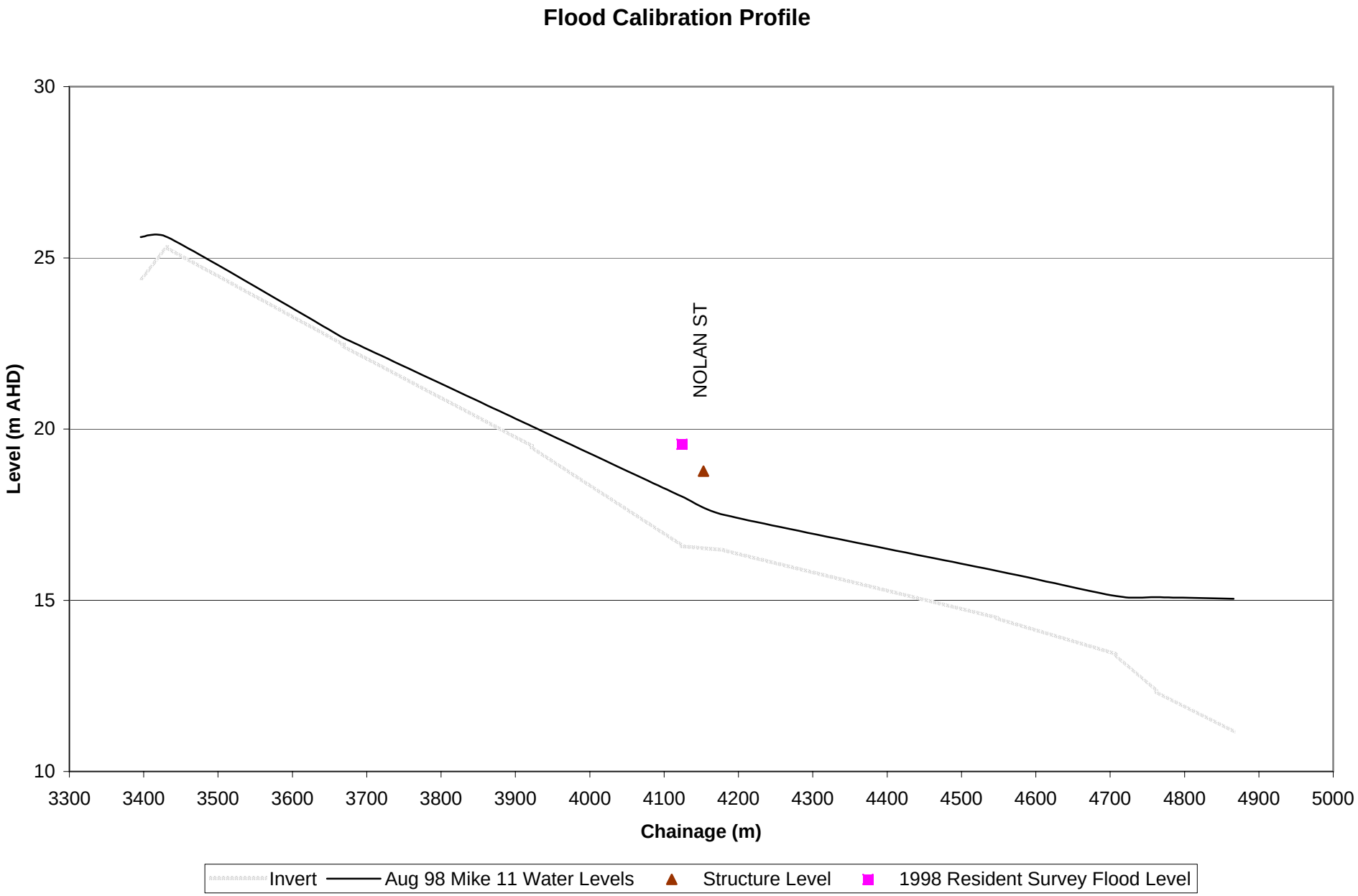
FIGURE E29
1998 Flood Calibration Levels - Freeway Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

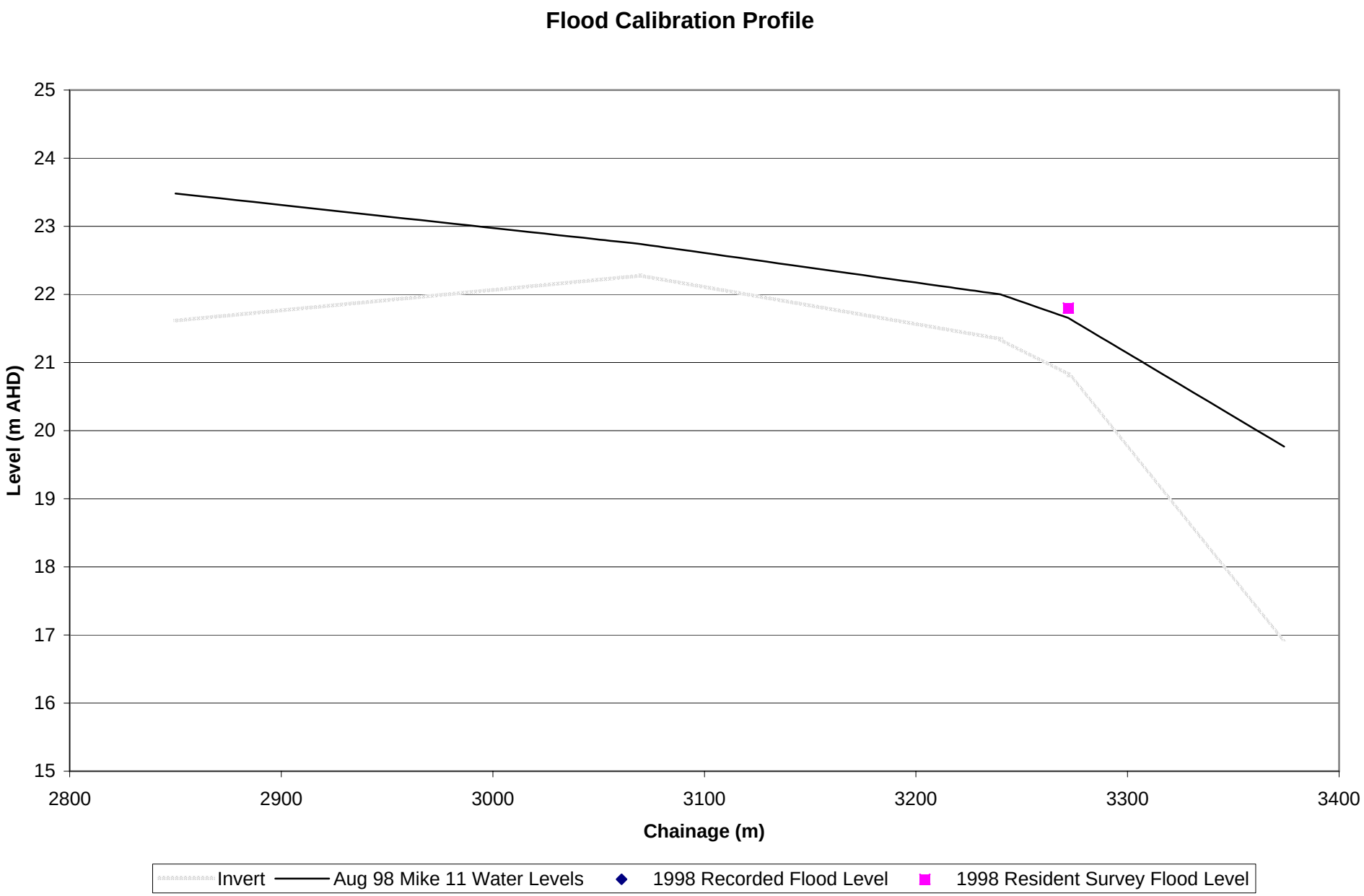
FIGURE E30
1998 Flood Calibration Levels - Govett Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

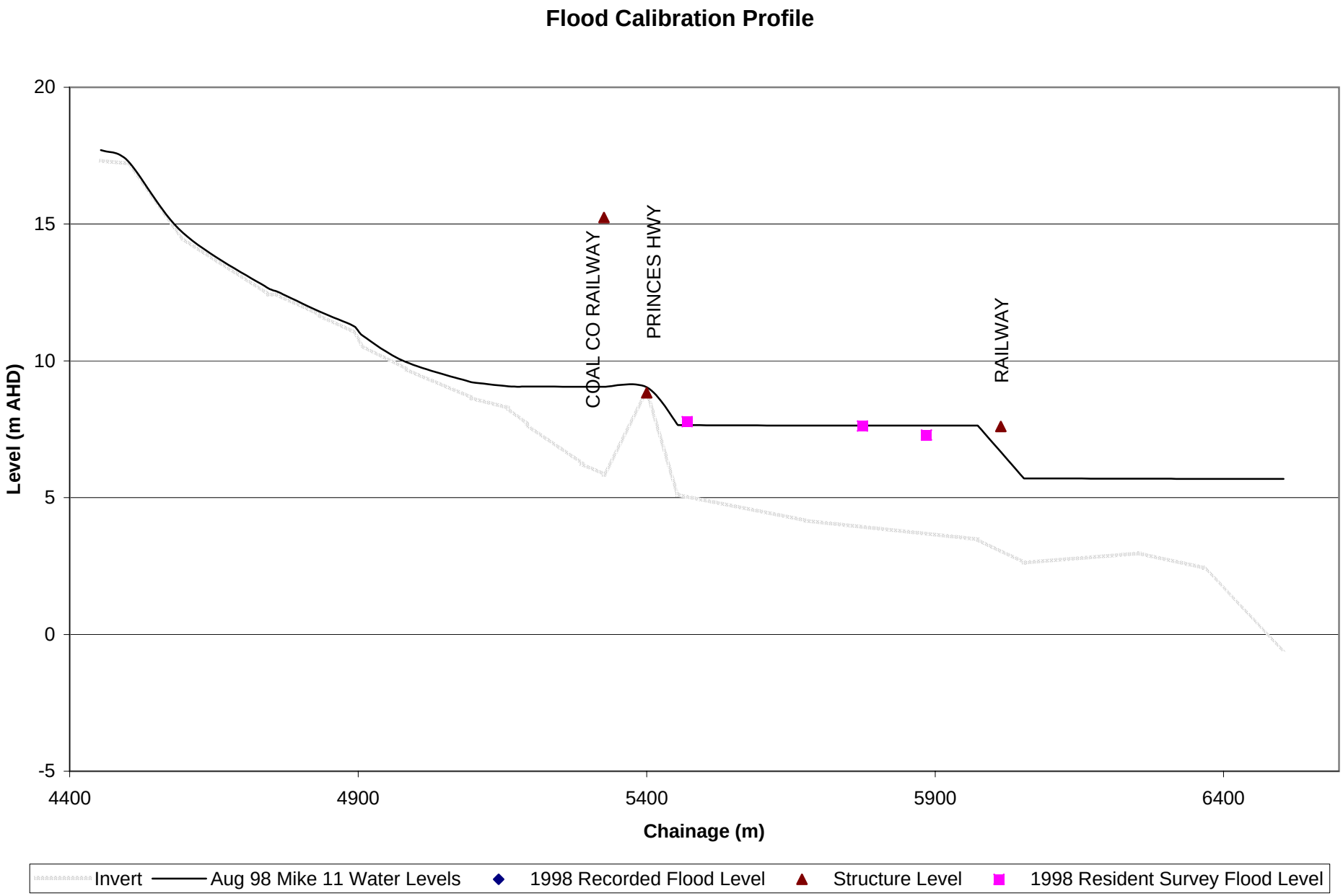
FIGURE E31
1998 Flood Calibration Levels - Highway Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

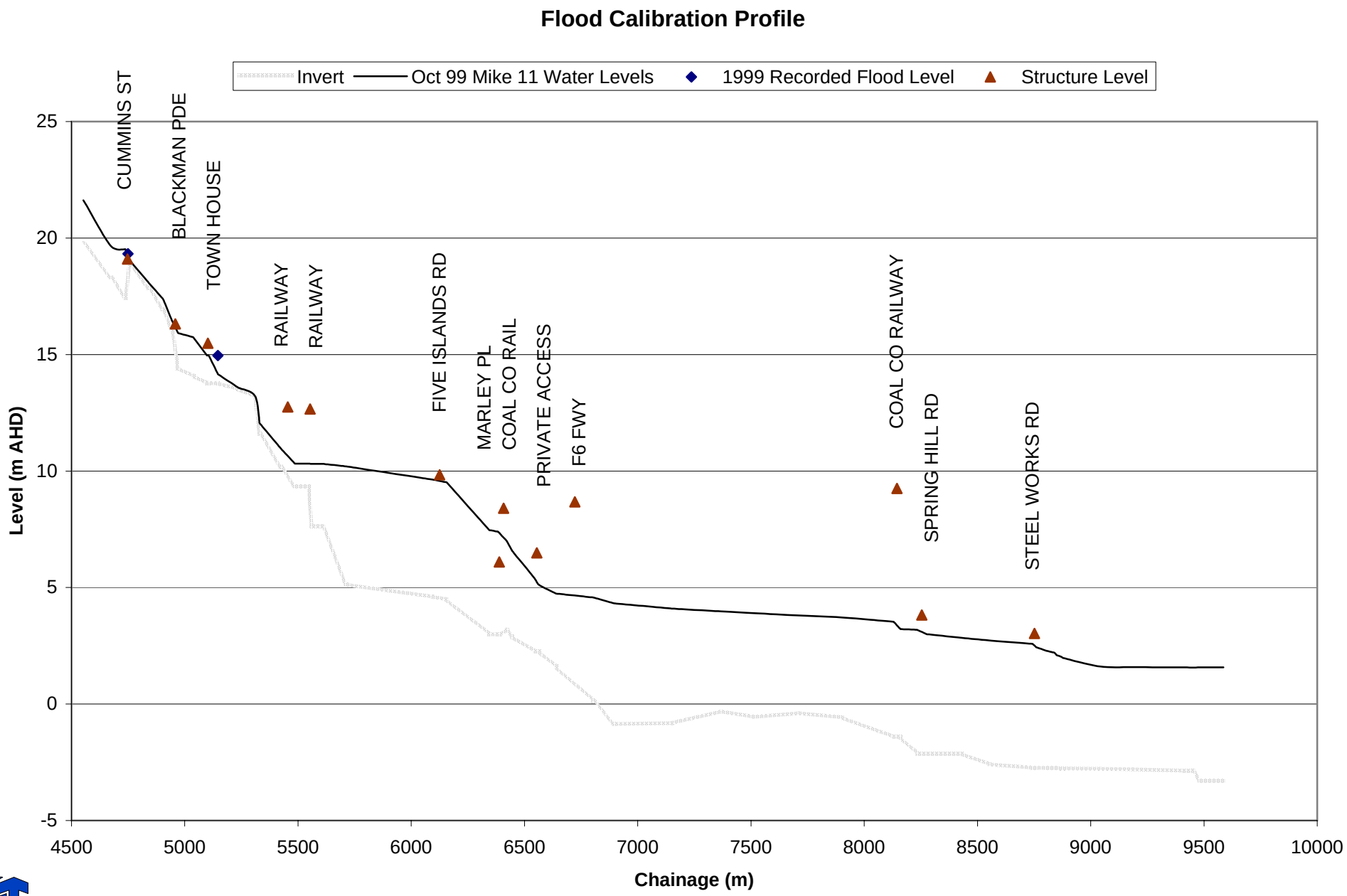
FIGURE E32
1998 Flood Calibration Levels - Langson Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON AND TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

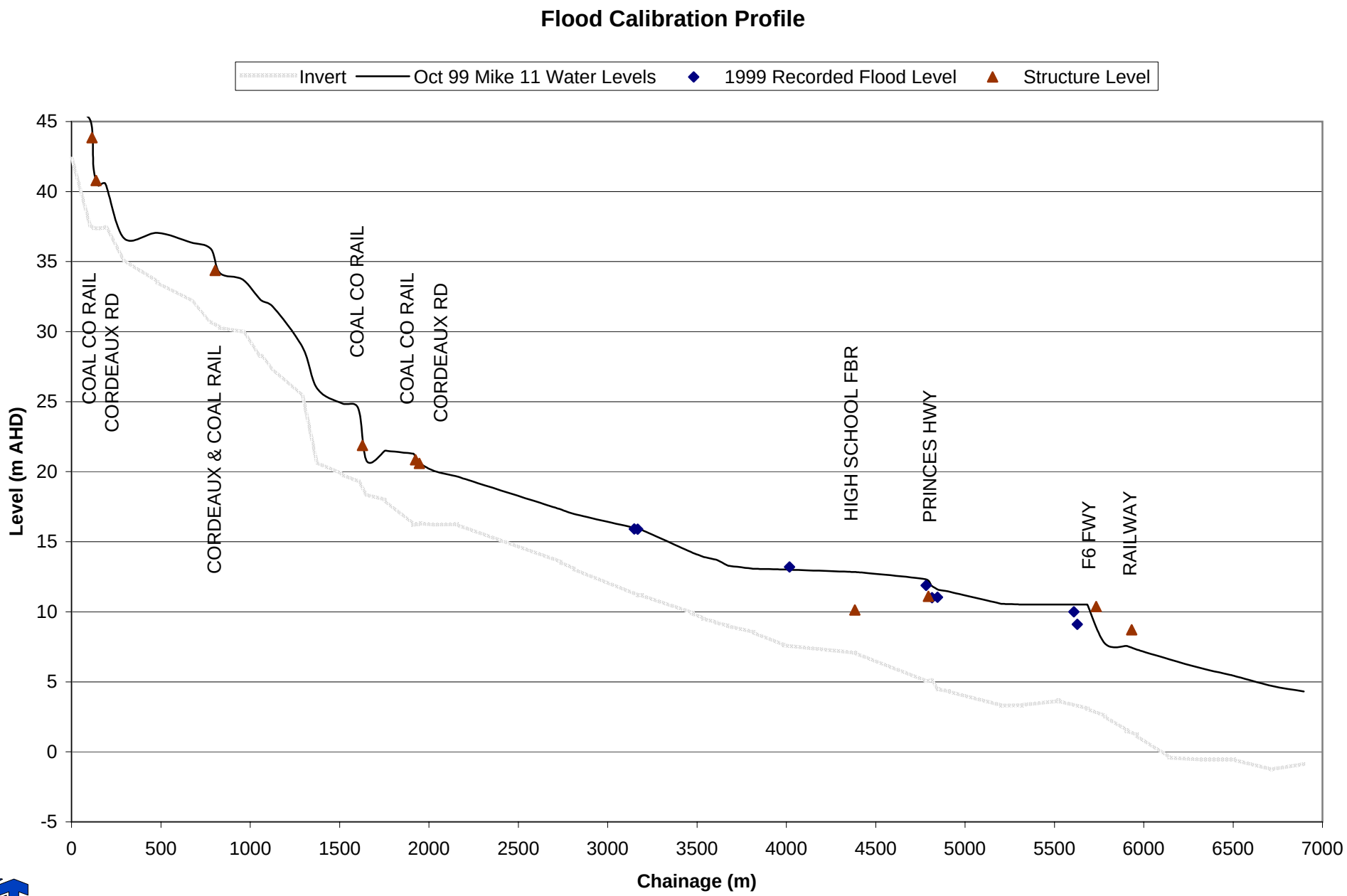
FIGURE E33
1998 Flood Calibration Levels - Unanderra Drain Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 98 Calib Flood Profiles.xls



LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E1
1999 Flood Calibration Levels - Allans Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls



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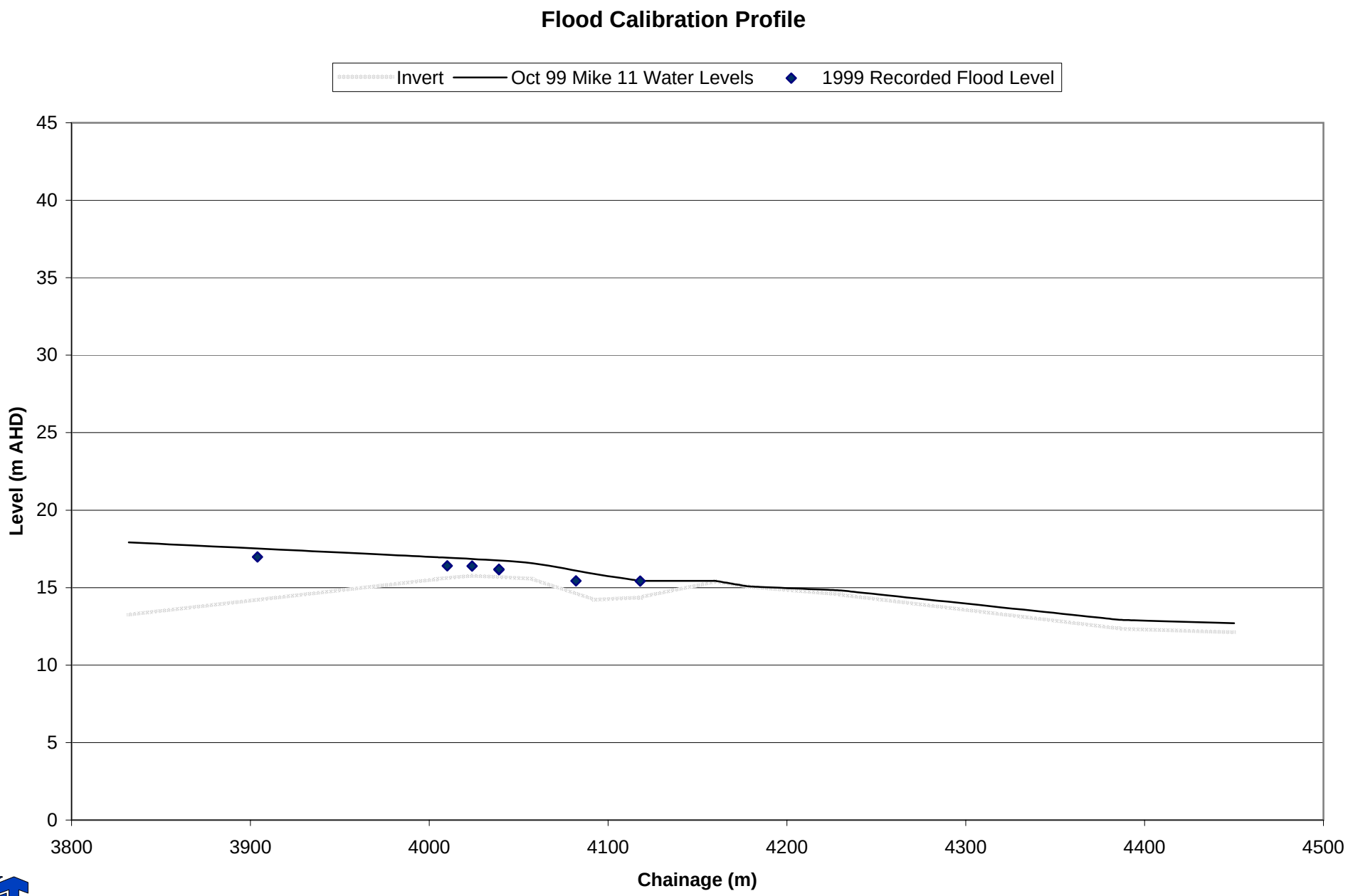
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E2
1999 Flood Calibration Levels - American Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls



LAWSON & TRELOAR
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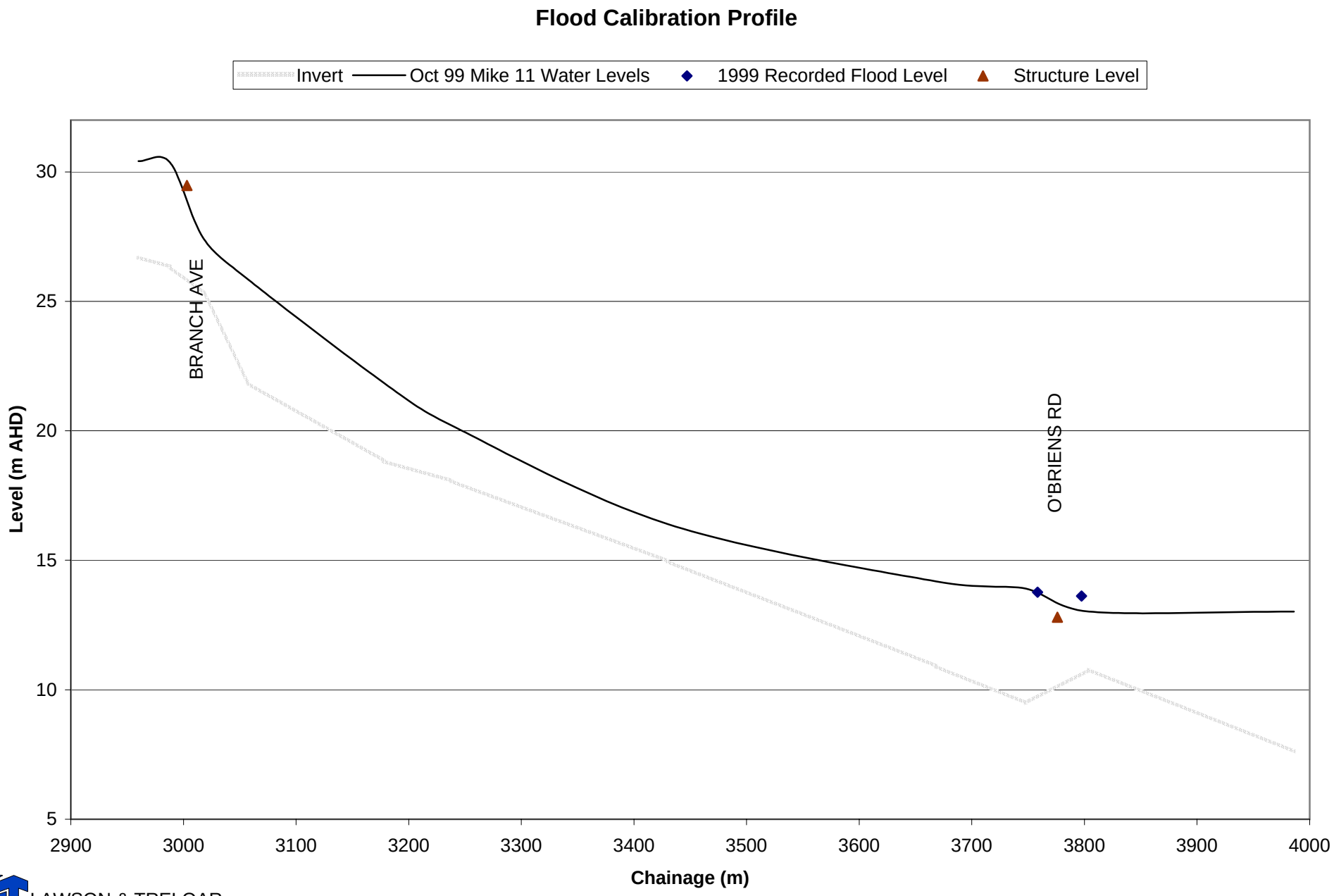
1 September 2006

Allans Creek Flood Study

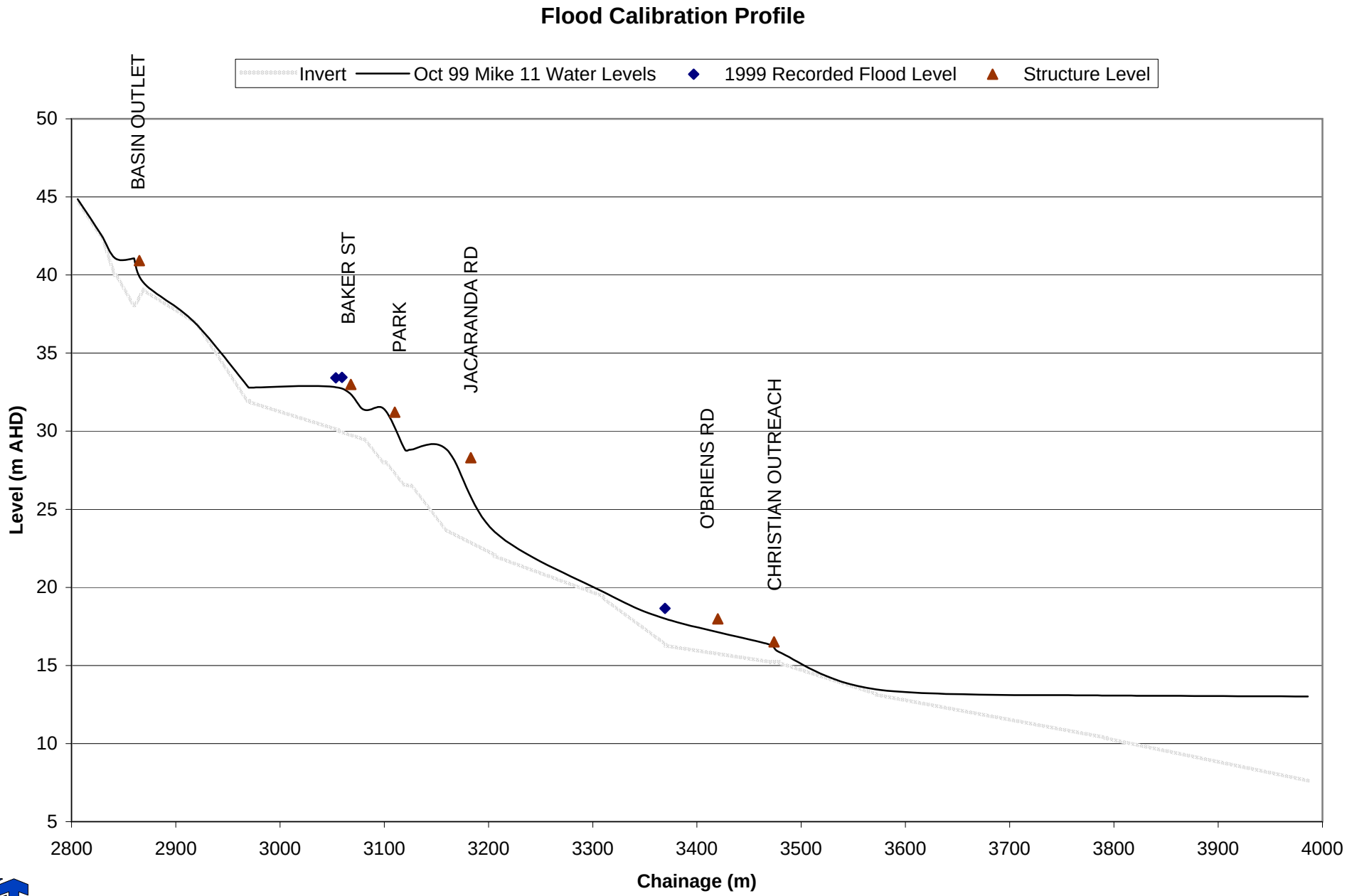
FIGURE E3
1999 Flood Calibration Levels - Arrow Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls



LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E4
1999 Flood Calibration Levels - Branch Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls



LAWSON & TRELOAR
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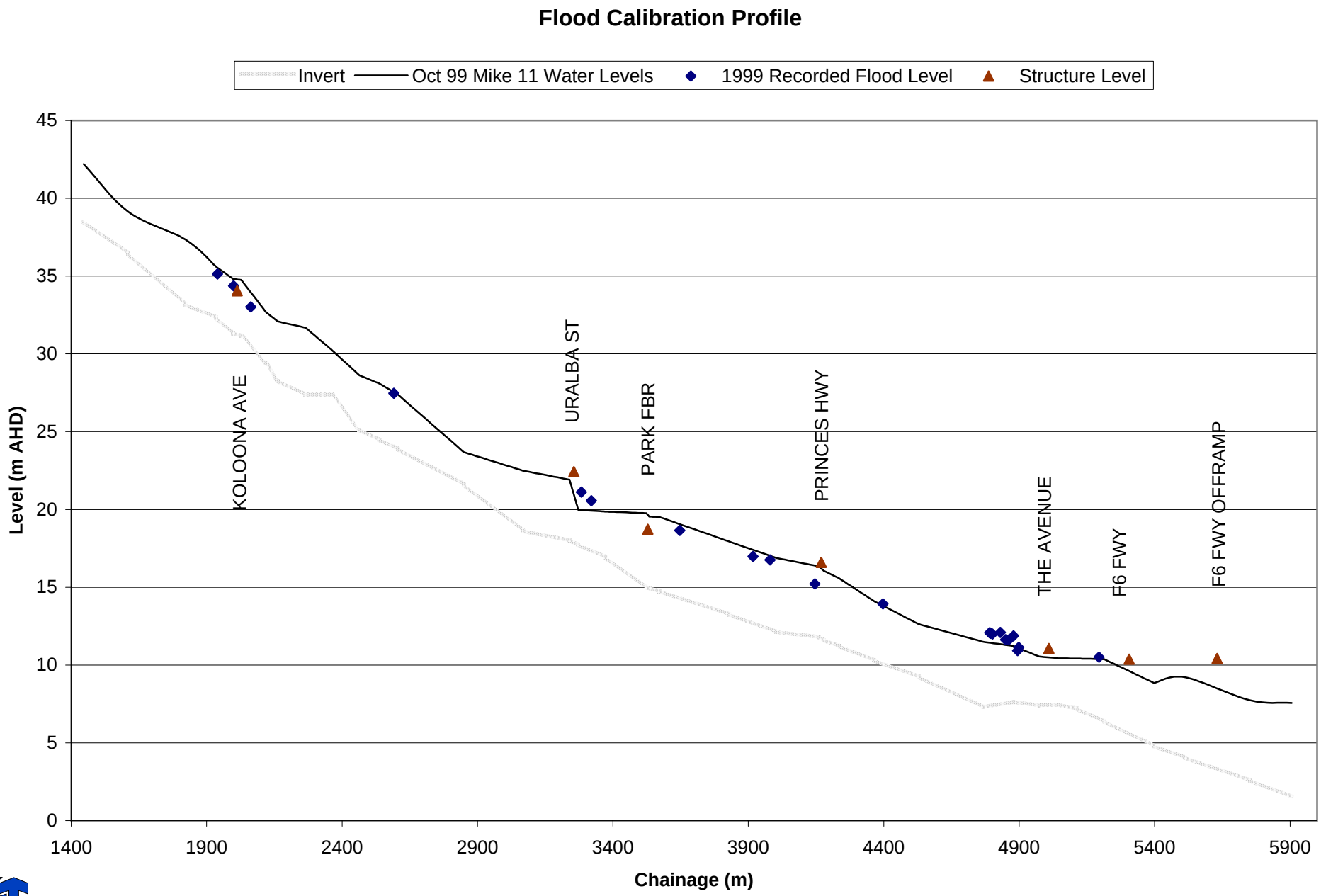
1 September 2006

Allans Creek Flood Study

FIGURE E5
1999 Flood Calibration Levels - Branch-Trib Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls



LAWSON & TRELOAR
J1946/R1986/V6
1 September 2006

Allans Creek Flood Study

FIGURE E6
1999 Flood Calibration Levels - Byarong Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

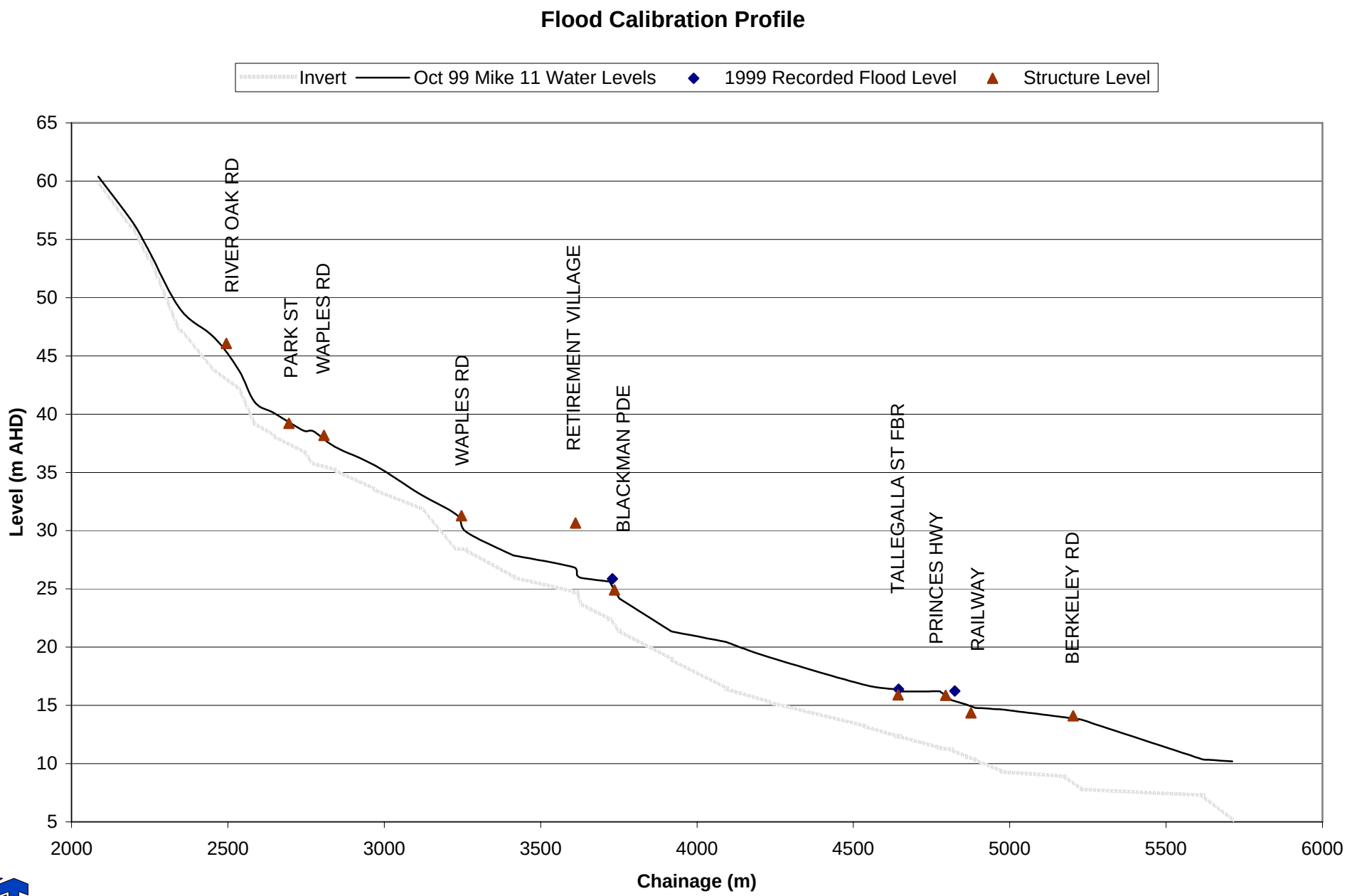


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FIGURE E7
1999 Flood Calibration Levels - Charcoal Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

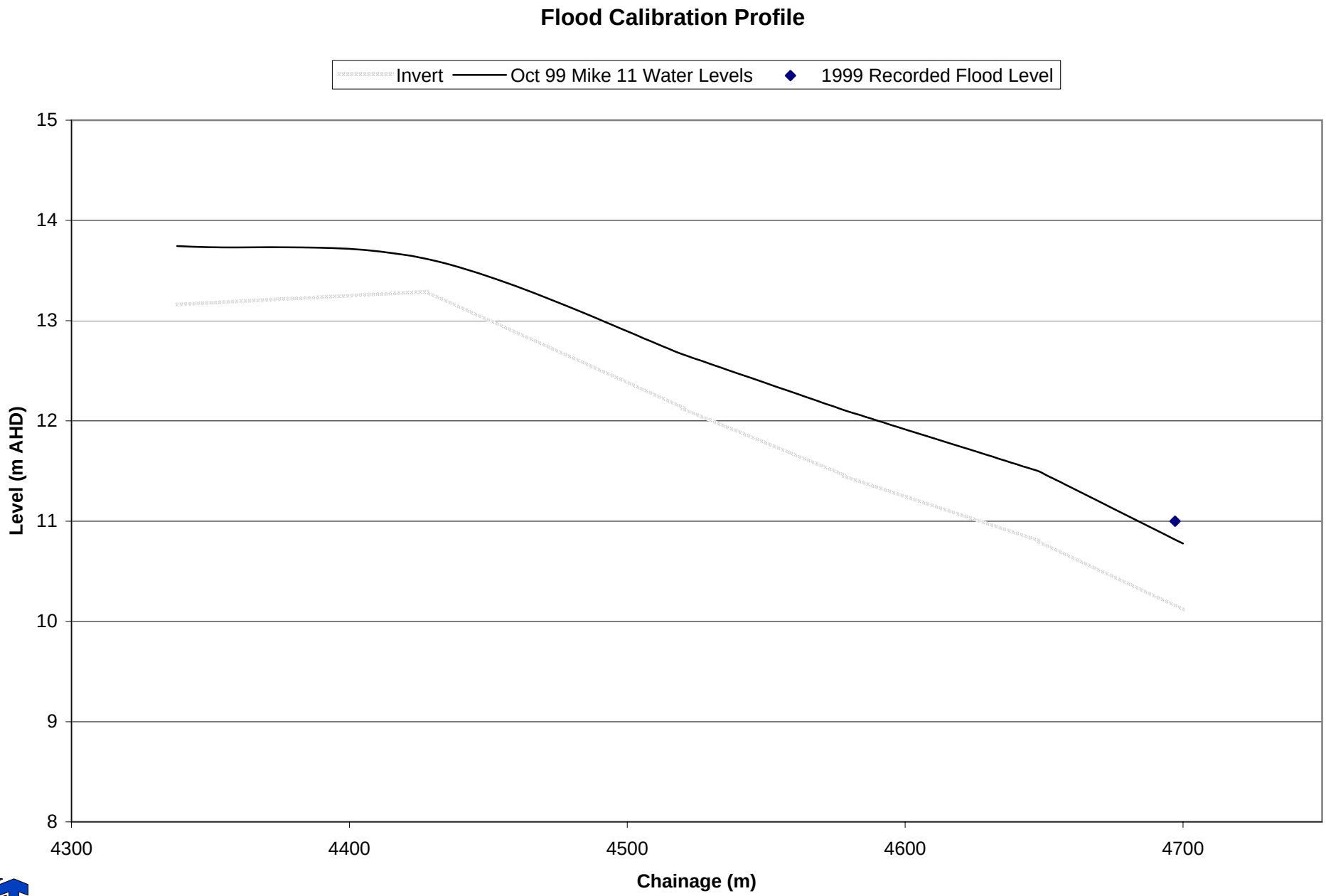

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FIGURE E8
1999 Flood Calibration Levels - Cleverdon Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

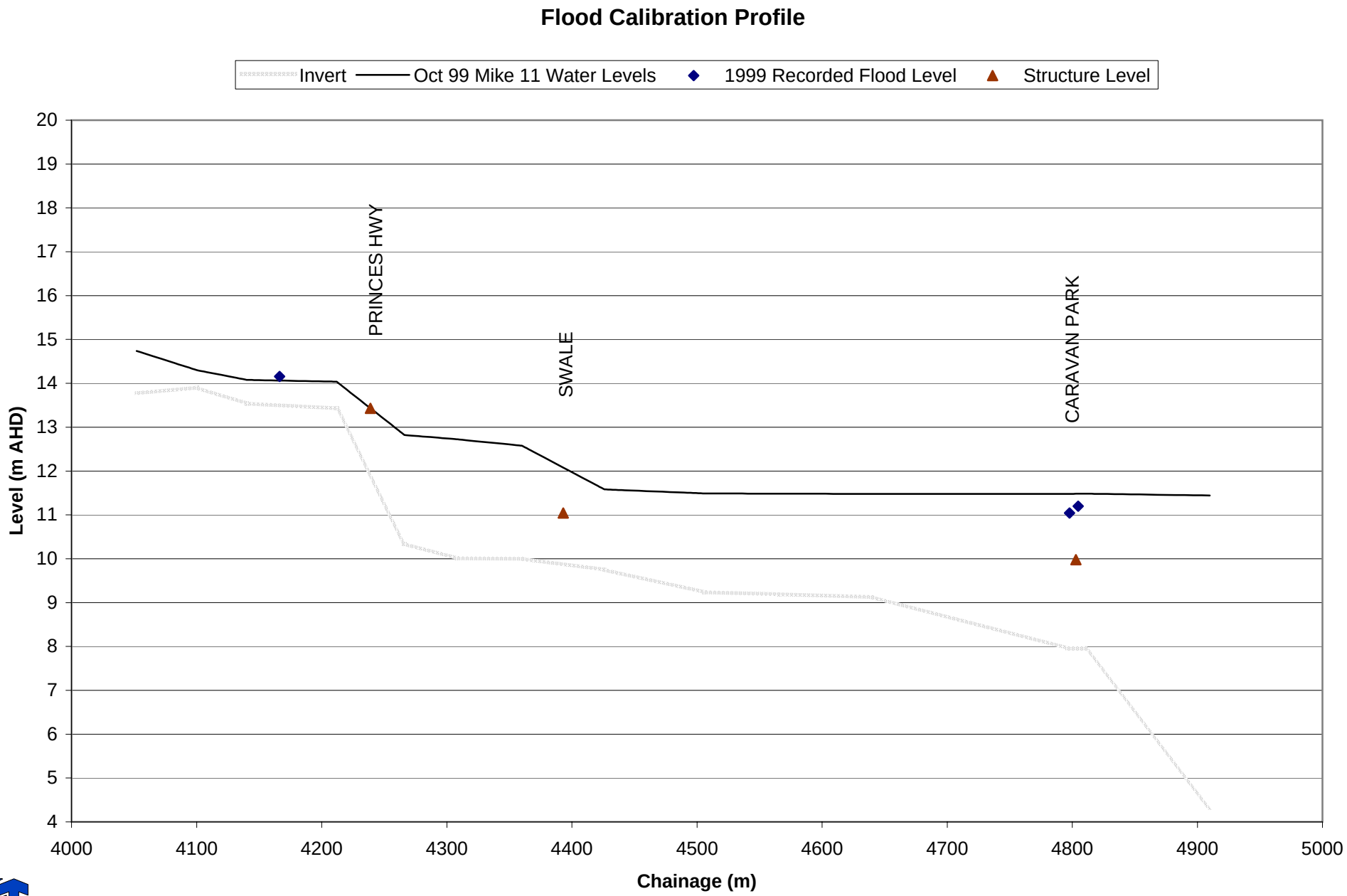

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FIGURE E9
1999 Flood Calibration Levels - Cleverdon Drain Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

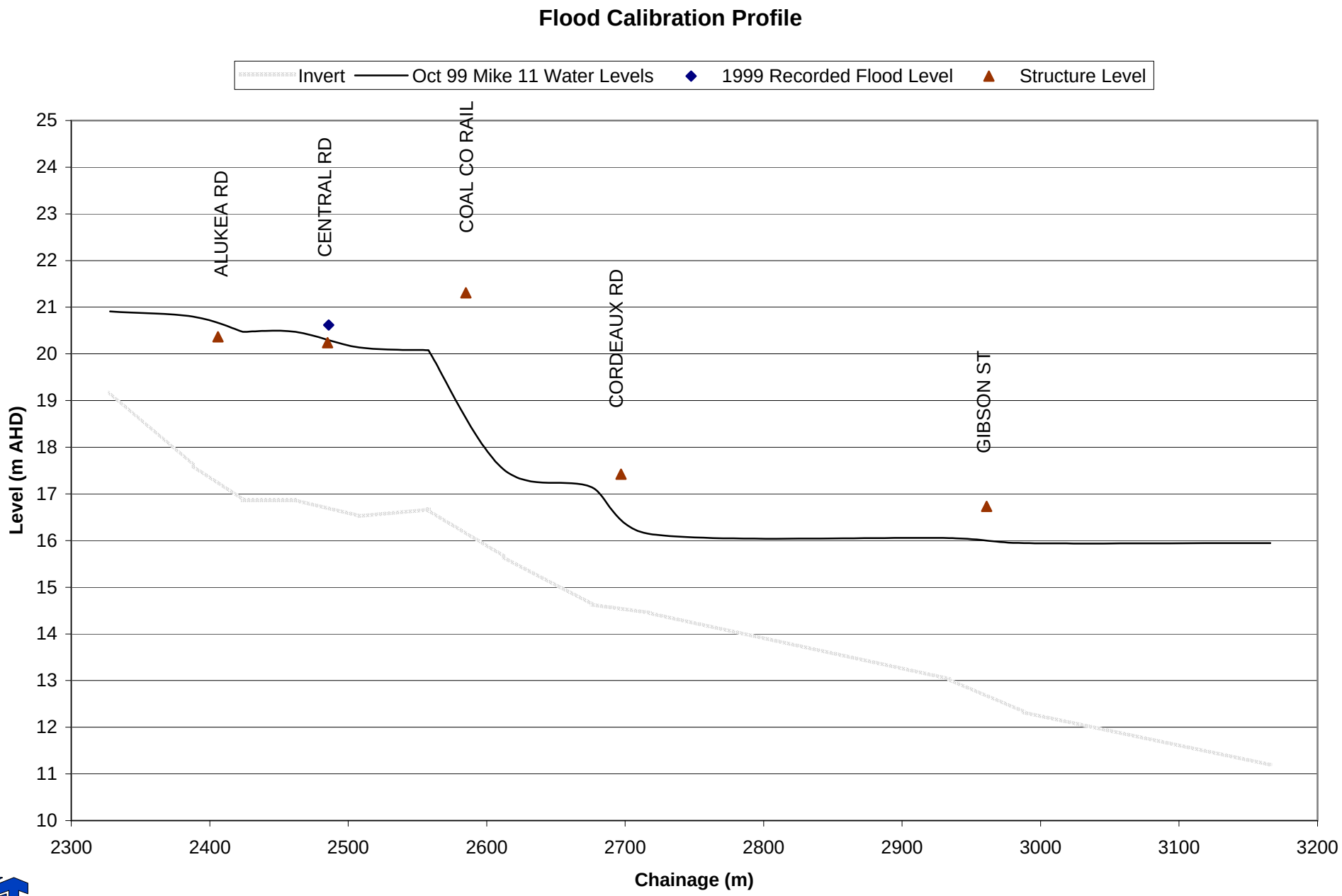

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FIGURE E10
1999 Flood Calibration Levels - Cordo Hts Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

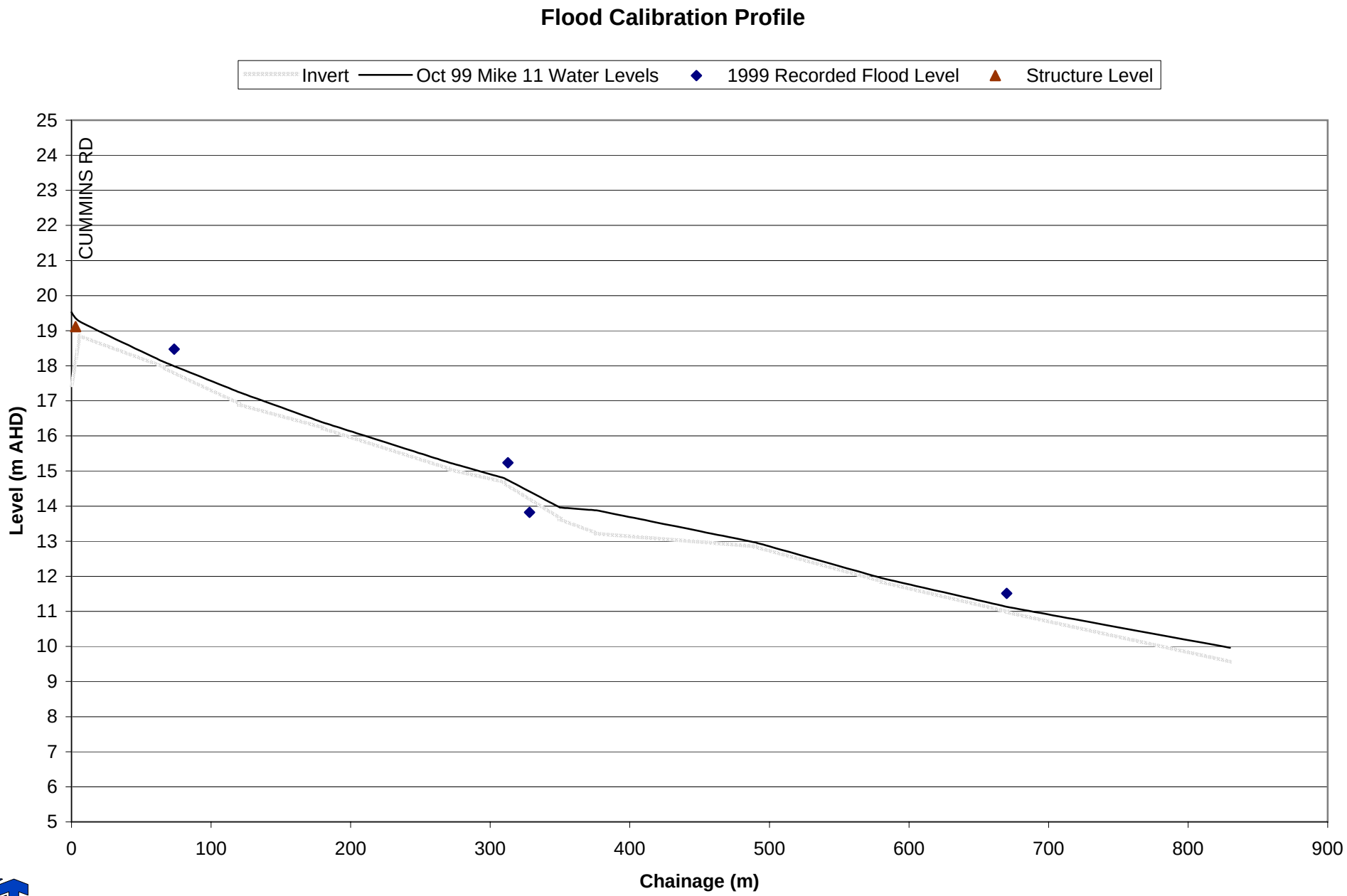

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FIGURE E11
1999 Flood Calibration Levels - Cummins-Albert Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

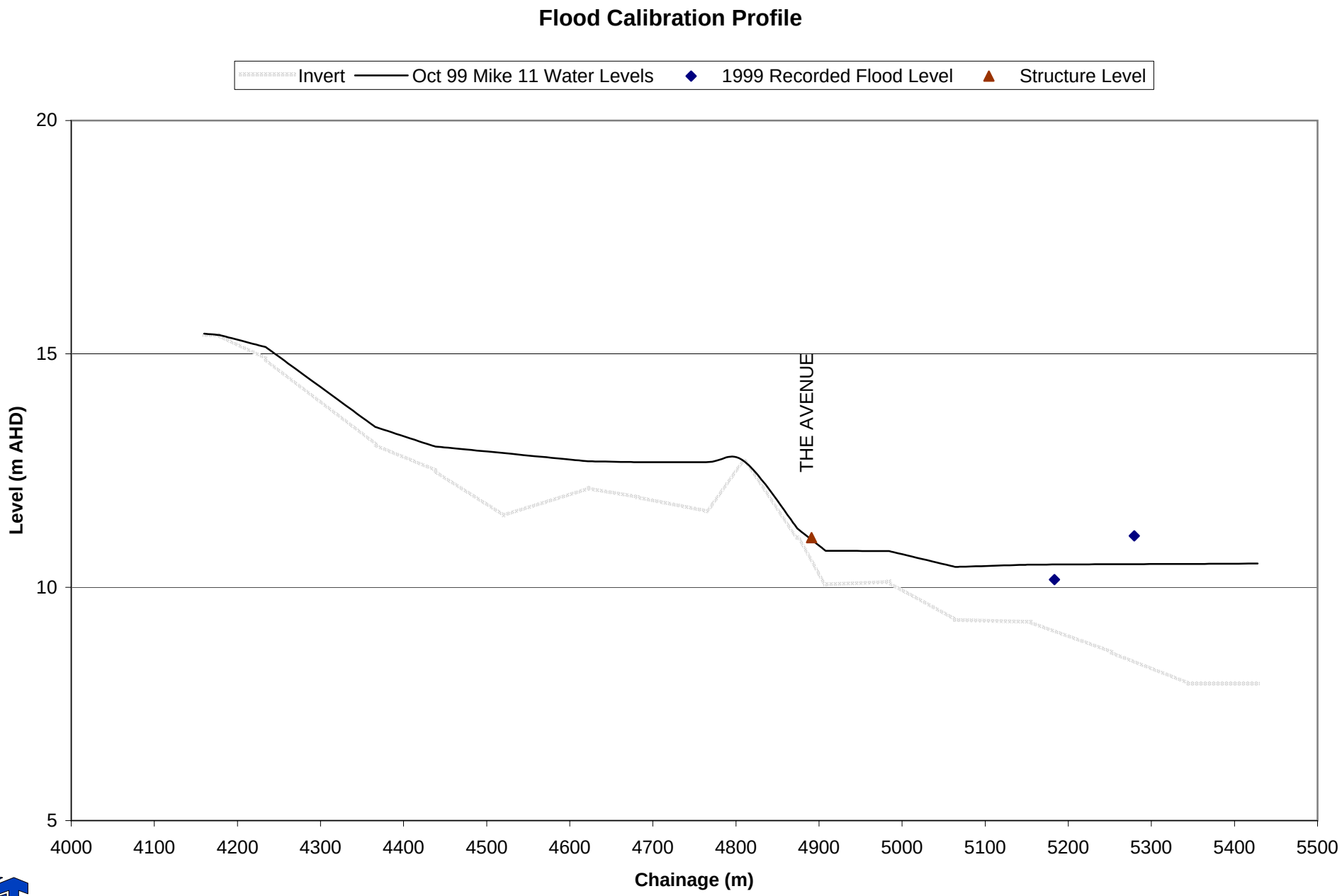

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FIGURE E12
1999 Flood Calibration Levels - Figtree Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

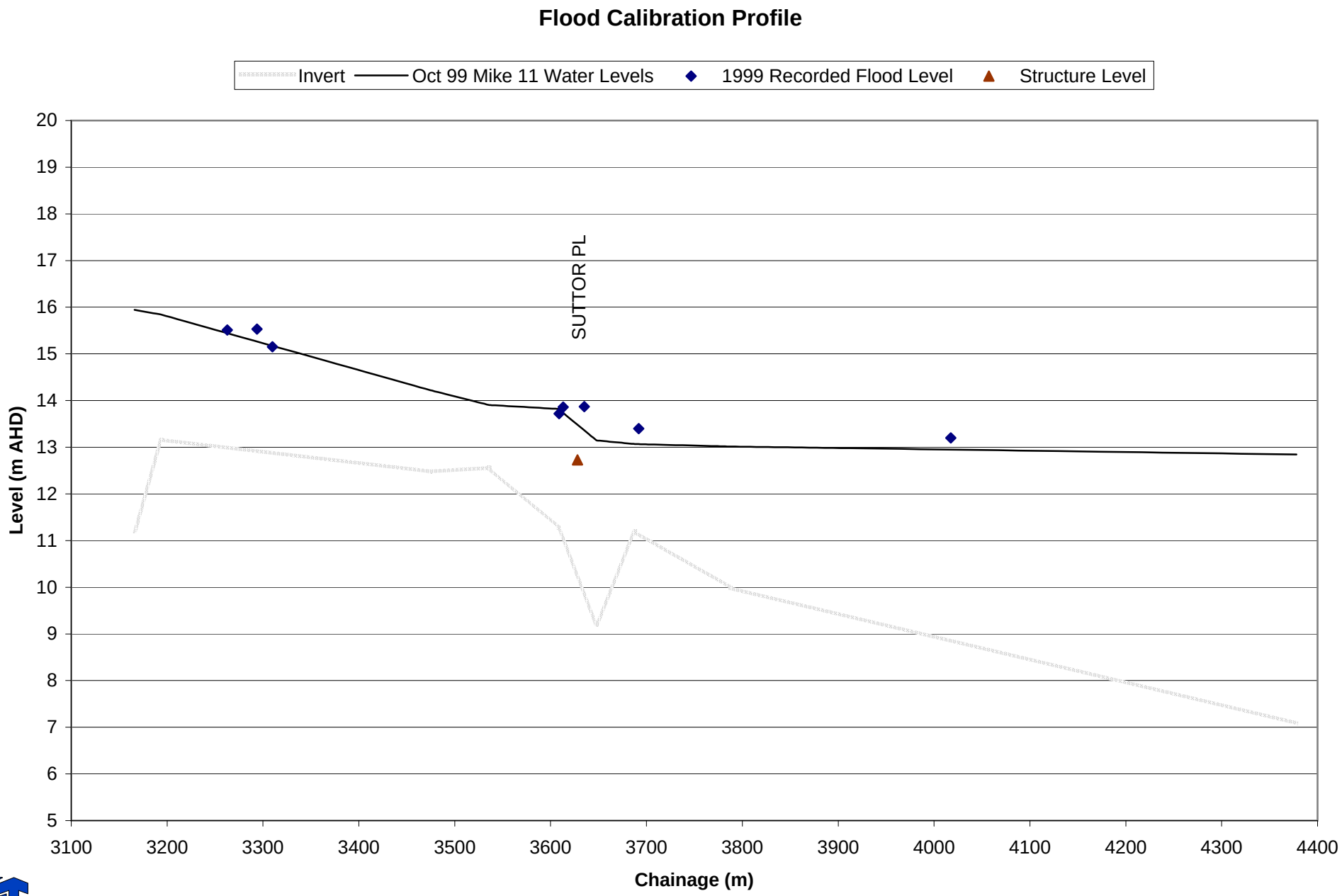

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FIGURE E13
1999 Flood Calibration Levels - Govett Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

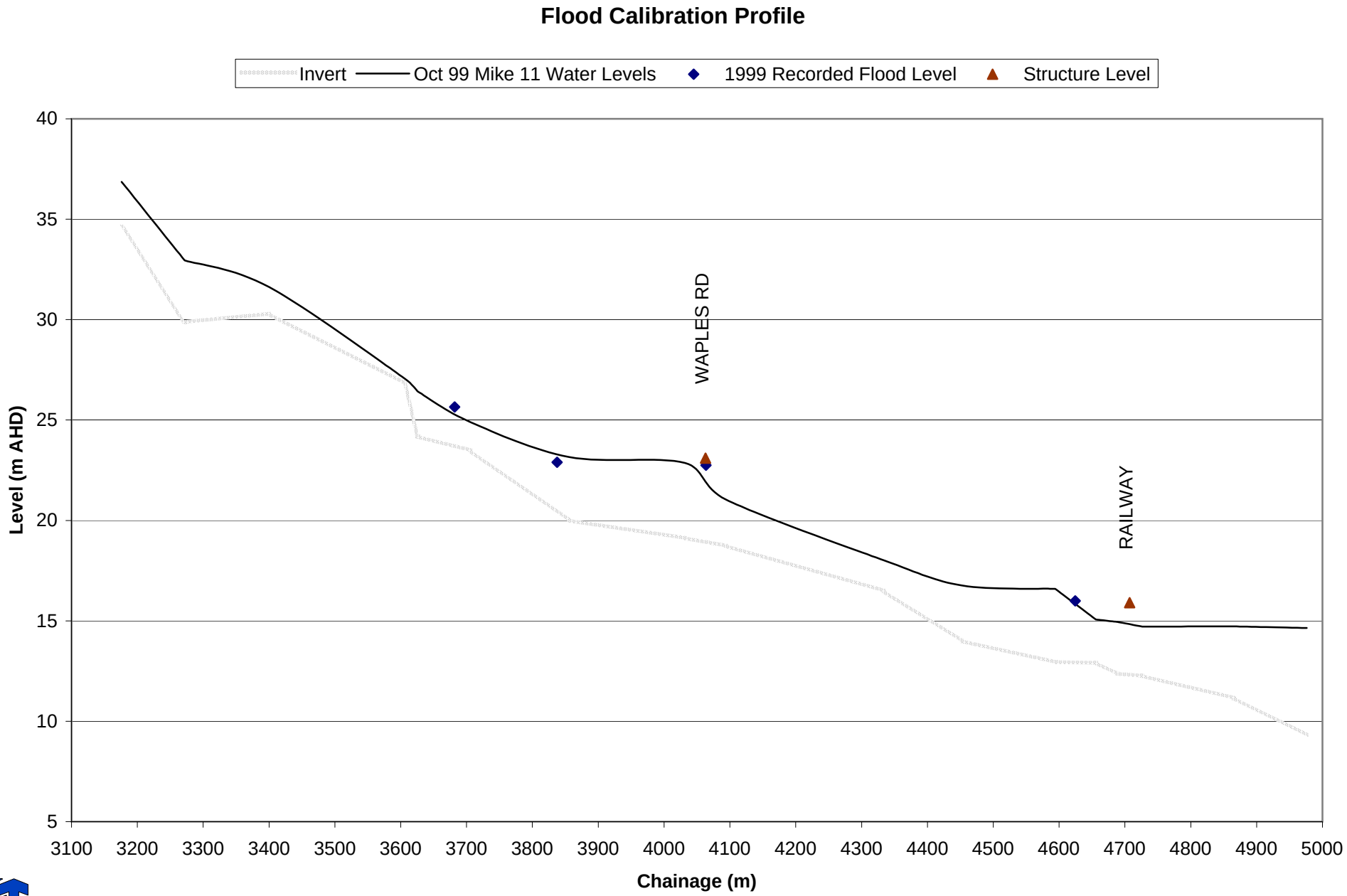

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FIGURE E14
1999 Flood Calibration Levels - Jenkins Creek
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

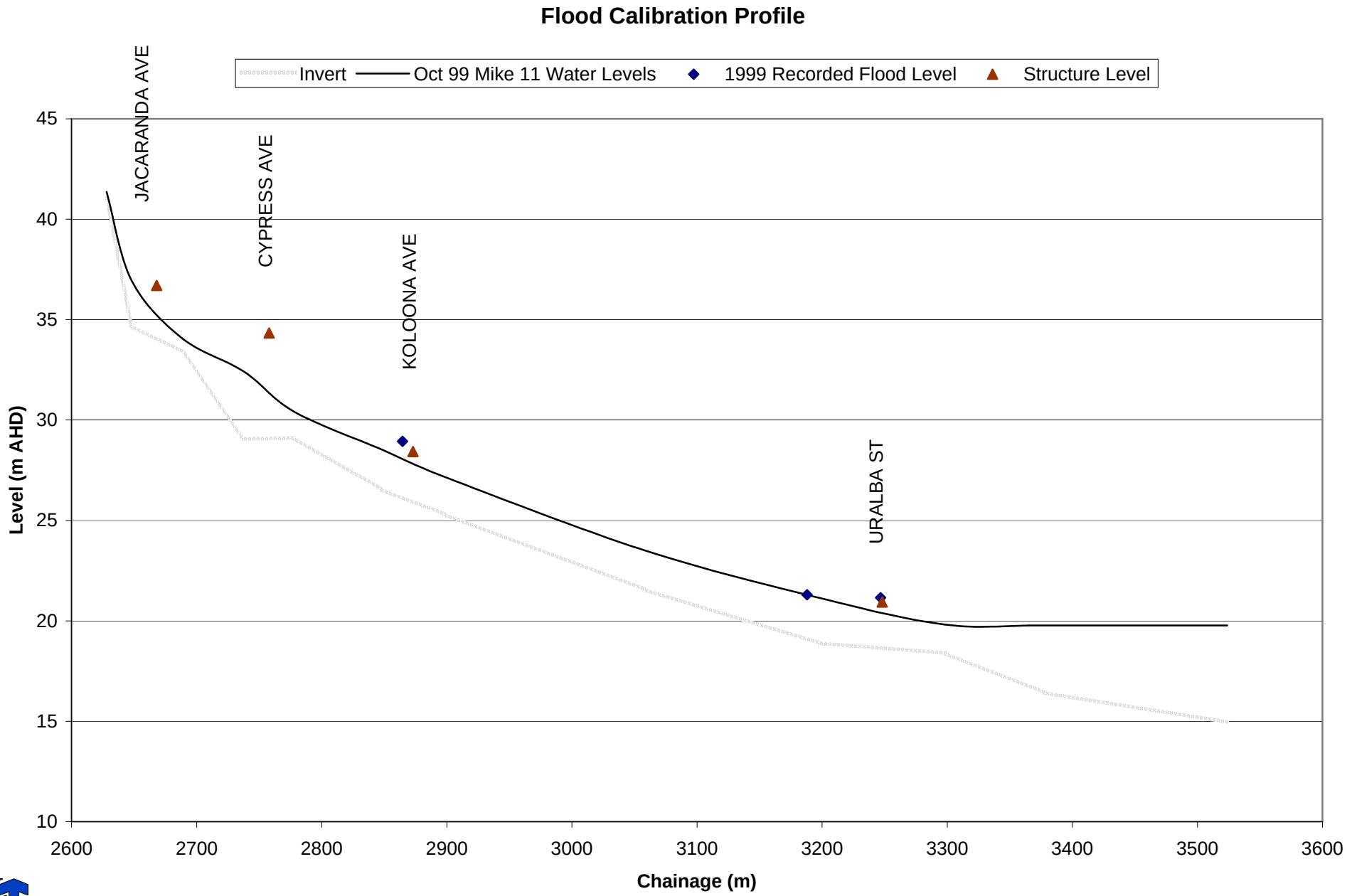

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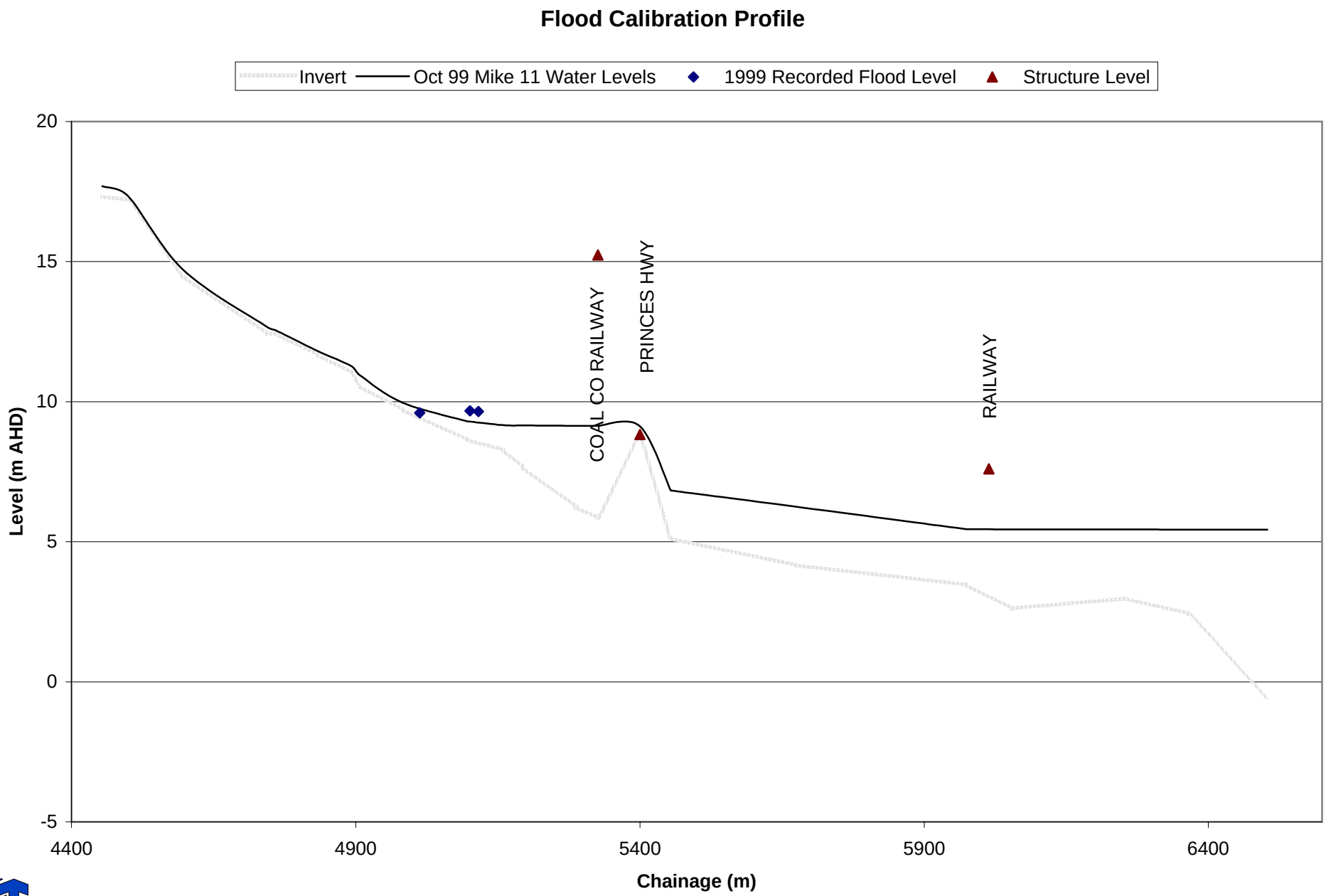
FIGURE E15
1999 Flood Calibration Levels - Running Brook Creek
Jobs/J1946/Flood Study Results V6/Appendix E - 99 Calib Flood Profiles.xls



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1 September 2006

Allans Creek Flood Study

FIGURE E16
1999 Flood Calibration Levels - Unanderra Drain Branch
Jobs/J1946/Flood Study Figures V6/Appendix E - 99 Calib Flood Profiles.xls

APPENDIX E - CALIBRATION CULVERT BLOCKAGE DETAILS

Creek	Chainage (m)	Street	No	Type	Height/Dia (m)	Width (m)	U/S Inv (mAHD)	D/S Inv (mAHD)	Length (m)	1984 (%)	1991 (%)	1998 (%)	1999 (%)
ALLANS	4854	Cummins	3	Circ	1.05		17.63	14.87	230			100	
ALLANS	5226	Central Road	6	Circ	0.75		13.77	12.21	160			100	
ALLANS	5318	Princes Hwy	3	Rect	0.91	1.52	12.21	11.97	25				
ALLANS	5102	Town houses	1	Irreg			13.79	13.79	6				
ALLANS	5455	Railway	2	Circ	1.38		10.19	9.34	87				
ALLANS	5553	Railway	2	Circ	1.38		9.34	9.34	15				
ALLANS	6125	Five Islands Rd	2	Irreg			4.6	4.2	34.1				
ALLANS	6379	Marley Pl	1	Irreg			2.98	2.97	4.8				
ALLANS	6403	Coal Co Railway Line	1	Irreg			3.2	3	4.8			30	
ALLANS	6554	Private Access	1	Irreg			2.3	2.1	10.7				
ALLANS	6722	Freeway	3	Rect	3.35	3.35	1.6	1.32	125				
ALLANS	8145	Railway	1	Irreg			-1.37	-1.37	15			30	
ALLANS	8254	Spring Hill Rd	1	Irreg			-1.37	-1.37	30.2			80	
ALLANS	8752	Steel Works Rd	1	Irreg			-2.73	-2.73	10				
ALLANS	8816	Steel Works Rail	1	Irreg			-2.39	-2.39	15				
ALLANS	8853	Steel Works Rd	1	Irreg			-1.98	-1.98	15				
ALLANS	8872	Steel Works Rd	1	Irreg			-2.14	-2.14	15				
ALLANS	9431	Steel Works Rd	1	Irreg			-2.86	-2.86	20				
AMERICAN	115	Coal Co. Railway	1	Irreg			37.6	37.4	4.1		30		100
AMERICAN	137	Cordeaux Rd	1	Irreg			38.1	37.9	16.1				
AMERICAN	804	Cordeaux Rd & Railway	1	Irreg			25.9	25.7	14.4				
AMERICAN	1628	Coal Co. Railway under Cordeaux Rd	1	Irreg			19.3	18.8	8.5			20	
AMERICAN	1925	Coal Co. Railway	1	Irreg			17.6	17.1	8				
AMERICAN	1946	Cordeaux Rd	1	Irreg			17.1	16.9	3.3				
AMERICAN	4383	Highschool fbr	1	Irreg			7.09	7.09	3			100	
AMERICAN	4795	Princes Hwy	1	Irreg			5.35	5.1	32.7			50	50
AMERICAN	5734	Freeway	8	Rect	3.51	3.65	3.1	2.55	75			70	70
AMERICAN	5932	Railway	1	Irreg			1.52	1.22	40				
BRANCH	3003	Branch Ave	2	Circ	1.53		26.48	26.37	22.3		30	100	100
BRANCH	3776	O'Briens Rd	2	Rect	1.1	2.1	11.01	10.78	23.5		30	100	100
BRANCH_BASIN	2865	Basin outlet	1	Circ	1.2		38.1	36.81	10				
BRANCH_BASIN	2920	Foy Ave	2	Circ	0.92		36.81	32.65	80			31	100
BRANCH_TRIB	3068	Baker Ave	1	Circ	1.2		30.06	29.46	32.3				
BRANCH_TRIB	3117	Park Mound	1	Circ	1.2		28.23	25	18				
BRANCH_TRIB	3172	Jacaranda Ave	1	Circ	1.2		23.7	22.05	54.4			90	100
BRANCH_TRIB	3383	O'Briens Rd	2	Circ	1.2		16.28	15.23	44.1			100	

APPENDIX E - CALIBRATION CULVERT BLOCKAGE DETAILS

Creek	Chainage (m)	Street	No	Type	Height/Dia (m)	Width (m)	U/S Inv (mAHD)	D/S Inv (mAHD)	Length (m)	1984 (%)	1991 (%)	1998 (%)	1999 (%)
BRANCH_TRIB	3474	Christian Outreach	2	Rect	1.15	1.5	15.27	15.23	8				
BYARONG	2013	Koloona Ave	1	Rect	2.1	3.9	31.3	31.17	14.5	30		100	
BYARONG	2013	Koloona Ave	1	Rect	2.1	4.1	31.3	31.17	14.5	30		100	
BYARONG	2013	Koloona Ave	2	Rect	2.1	3.6	31.3	31.17	14.5	30		100	
BYARONG	3256	Uralba St	1	Irreg			18.4	18.1	15	20		40	
BYARONG	3529	Foot Bridge	1	Irreg			14.95	14.95	5				
BYARONG	4169	Princes Hwy	1	Irreg			11.8	11.6	16.4		60	70	
BYARONG	5010	The Avenue	2	Rect	2.9	3.65	7.47	7.45	35			100	10
BYARONG	5010	The Avenue	2	Rect	2.75	3.65	7.47	7.45	35			100	10
BYARONG	5306	Freeway	4	Rect	2.5	3.05	6.38	4.8	120			80	20
BYARONG	5631	Freeway Offramp	3	Rect	2.75	3.35	4.67	3.12	42			20	
CHARCOAL	2495	River Oak Rd	1	Rect	1.15	2.4	43.9	43.69	23				
CHARCOAL	2695	Park Mound	2	Circ	1.35		38.14	37.98	22				
CHARCOAL	2807	Waples Rd	2	Circ	1.38		35.8	35.53	37.6				
CHARCOAL	3247	Waples Rd	2	Circ	2.05		28.44	28.38	17				
CHARCOAL	3612	Retirement village	1	Irreg			24.75	24.75	4				
CHARCOAL	3736	Blackman Pde	3	Circ	1.2		22.45	22.06	22.2				
CHARCOAL	4643	Tallegalla St	1	Irreg			12.36	12.35	2	100		60	30
CHARCOAL	4795	Princes Hwy	3	Rect	2.5	2.4	11.34	11.3	27	100		60	30
CHARCOAL	4876	Railway	10	Rect	2.43	2.6	10.59	10.38	24.5	100			
CHARCOAL	5203	Berkeley Rd	1	Irreg			7.9	7.8	5			80	
CHARCOAL_MAJ_TRIB	3110	Coachwood Drv	1	Rect	2.45	3.7	33.78	34.1	24.4				
CHARCOAL_MAJ_TRIB	3748	Blackman Pde	2	Rect	1.5	3.7	22.19	22.05	15.2	40	40	100	40
CLEVERDON_DRAIN	4393	swale bhd houses	2	Circ	0.9		10.01	9.8	60				
CLEVERDON_DRAIN	4753	Caravan Park Rd	1	Irreg			7.97	7.97	5				
CORDO_HTS	2406	Alukia	1	Rect	2.1	3.1	17.61	16.87	15				
CORDO_HTS	2485	Central Road	1	Rect	2.1	3.1	16.87	16.77	17				
CORDO_HTS	2585	Coal Co Railway Line	1	Circ	1.35		17.1	16.91	14				
CORDO_HTS	2585	Coal Co Railway Line	1	Circ	1.82		17.1	16.91	14				
CORDO_HTS	2697	Cordeaux Rd	1	Rect	2.5	3.05	14.63	14.45	18.5				
CORDO-HTS	2961	Gibsons Rd	1	Rect	3.66	3.66	13.03	12.9	24		100	80	
FREEWAY	5511	Berkeley Rd High	2	Circ	0.9		11.97	11.49	26			100	
FREEWAY	5511	Berkeley Rd High	2	Circ	1.28		11.97	11.49	53.5			100	
FREEWAY	5810	Berkeley Rd Low	2	Circ	1		7.48	6.82	20				
FREEWAY	5810	Berkeley Rd Low	2	Circ	0.88		7.56	6.88	20				
FREEWAY	6371	Freeway Off ramp	4	Rect	1.52	2.75	4.41	4.34	26			90	

APPENDIX E - CALIBRATION CULVERT BLOCKAGE DETAILS

Creek	Chainage (m)	Street	No	Type	Height/Dia (m)	Width (m)	U/S Inv (mAHD)	D/S Inv (mAHD)	Length (m)	1984 (%)	1991 (%)	1998 (%)	1999 (%)
FREEWAY	6555	Freeway	4	Rect	1.5	2.75	3.99	3.7	106				
FREEWAY	6730	Five Islands Rd	4	Rect	1.52	2.75	3.37	3.17	66			7	
FREEWAY	6885	Coal Co Railway Line	4	Rect	1.52	2.75	2.84	2.74	14.5				
FREEWAY_TRIB	5796	Glastonbury Ave	3	Circ	1.05		10.17	10	22				
FREEWAY_TRIB	5906	Freeway	3	Circ	1.68		8.41	7.51	70				
HIGHWAY	4153	Nolan St	2	Rect	1.2	3	16.58	16.46	19.5			100	
JENKINS	4063	Waples Rd	1	Rect	1.8	2.4	19.12	18.89	22			50	20
JENKINS	4625	Princes Hwy	3	Rect	2.4	2.5	12.94	12.91	20.2	50	50	70	70
JENKINS	4707	Railway	2	Rect	1.85	2.4	12.37	12.26	30				
JENKINS_CULVERT	3347	adj to Kotara Cres	1	Circ	1.52		31.96	29.24	150				
JENKINS_CULVERT	3524	adj to Kotara Cres	1	Circ	1.75		29.24	24.18	230				
RUNNING-BROOK	2668	Jacaranda Ave	1	Circ	0.92		34.68	33.69	27				
RUNNING-BROOK	2758	Cypress Ave	1	Circ	1.2		29.06	29.11	30				
RUNNING-BROOK	2873	Koloona Ave	1	Circ	1.53		26.52	25.31	55.6				
RUNNING-BROOK	3248	Uralba St	3	Circ	1.05		19.04	18.81	41.4				
SWIMPOOL_DRAIN	5192.5	Inlet to pipes	3	Rect	0.3	1.5	7.69	7.5	3				
UNANDERRA_CULV	5348	Coal Co Railway Line	2	Circ	1.52		6.11	6.01	35				75
UNANDERRA_CULV	5434	Princes Hwy	1	Circ	1.22		5.87	5.64	30			30	75
UNANDERRA_CULV	5434	Princes Hwy	1	Circ	1.82		5.78	5.42	30			50	75
UNANDERRA_DRAIN	6014	Railway	2	Circ	2.22		3.47	2.62	17			50	91
UNANDERRA_DRAIN	6309	Freeway	3	Rect	1.82	2.7	2.97	2.44	64			80	

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
ALLANS 4552.00	ALLANS	4552	22.06	21.87	21.83	21.78	21.72	21.68	DESIGN BLOCKAGE 1-2hr
ALLANS 4674.00	ALLANS	4674	20.28	20.02	19.98	19.92	19.85	19.79	DESIGN BLOCKAGE 2-2hr
ALLANS 4738.00	ALLANS	4738	20.14	19.90	19.86	19.80	19.63	19.56	DESIGN BLOCKAGE 2-2hr
ALLANS 4756.00	ALLANS	4756	19.44	19.31	19.31	19.26	19.12	19.09	DESIGN BLOCKAGE 2-0.5hr
ALLANS 4840.00	ALLANS	4840	18.34	18.23	18.18	18.18	18.11	18.10	DESIGN BLOCKAGE 2-2hr
ALLANS 4904.00	ALLANS	4904	17.69	17.55	17.53	17.49	17.40	17.39	DESIGN BLOCKAGE 2-2hr
ALLANS 4946.00	ALLANS	4946	16.79	16.63	16.60	16.56	16.45	16.41	DESIGN BLOCKAGE 2-2hr
ALLANS 4970.00	ALLANS	4970	16.13	15.97	15.96	15.95	15.94	15.93	DESIGN BLOCKAGE 1-2hr
ALLANS 5038.00	ALLANS	5038	15.85	15.76	15.76	15.75	15.75	15.74	DESIGN BLOCKAGE 1-2hr
ALLANS 5098.00	ALLANS	5098	15.66	15.63	15.63	15.58	14.98	14.97	DESIGN BLOCKAGE 2-2hr
ALLANS 5106.00	ALLANS	5106	15.13	15.03	15.01	14.99	14.97	14.96	DESIGN BLOCKAGE 1-1hr
ALLANS 5146.00	ALLANS	5146	14.32	14.23	14.22	14.21	14.17	14.16	DESIGN BLOCKAGE 3-1hr
ALLANS 5238.00	ALLANS	5238	13.96	13.60	13.59	13.59	13.57	13.57	DESIGN BLOCKAGE 3-1hr
ALLANS 5330.00	ALLANS	5330	13.60	12.73	12.53	12.41	12.08	12.06	DESIGN BLOCKAGE 4-2hr
ALLANS 5424.00	ALLANS	5424	13.56	12.62	12.37	12.36	10.98	10.94	DESIGN BLOCKAGE 4-2hr
ALLANS 5486.00	ALLANS	5486	13.22	12.31	12.17	12.09	10.16	10.12	DESIGN BLOCKAGE 2-2hr
ALLANS 5546.00	ALLANS	5546	13.22	12.31	12.17	12.09	10.15	10.10	DESIGN BLOCKAGE 2-2hr
ALLANS 5560.00	ALLANS	5560	11.43	10.90	10.73	10.47	9.95	9.61	DESIGN BLOCKAGE 6-2hr
ALLANS 5610.00	ALLANS	5610	11.42	10.90	10.73	10.47	9.94	9.61	DESIGN BLOCKAGE 6-2hr
ALLANS 5712.00	ALLANS	5712	11.27	10.77	10.61	10.35	9.86	9.53	DESIGN BLOCKAGE 6-2hr
ALLANS 6094.00	ALLANS	6094	10.43	10.06	9.98	9.78	9.44	7.93	DESIGN BLOCKAGE 6-2hr
ALLANS 6156.00	ALLANS	6156	9.87	9.85	9.77	9.70	9.50	7.00	DESIGN BLOCKAGE 4-6hr
ALLANS 6344.00	ALLANS	6344	9.86	8.16	8.04	7.85	7.48	6.89	DESIGN BLOCKAGE 7-6hr
ALLANS 6384.00	ALLANS	6384	9.90	8.25	8.18	8.01	7.84	6.90	DESIGN BLOCKAGE 4-6hr
ALLANS 6422.00	ALLANS	6422	9.87	8.14	8.01	7.83	6.99	6.80	DESIGN BLOCKAGE 7-6hr
ALLANS 6446.00	ALLANS	6446	9.86	8.14	8.01	7.83	6.55	6.45	DESIGN BLOCKAGE 7-6hr
ALLANS 6544.00	ALLANS	6544	9.86	8.13	8.00	7.82	5.46	5.10	DESIGN BLOCKAGE 7-6hr
ALLANS 6564.00	ALLANS	6564	9.85	8.13	8.00	7.82	5.27	4.79	DESIGN BLOCKAGE 7-6hr
ALLANS 6640.00	ALLANS	6640	9.84	8.12	8.00	7.82	4.87	4.36	DESIGN BLOCKAGE 7-6hr
ALLANS 6804.00	ALLANS	6804	9.81	5.78	5.47	4.98	4.68	4.23	DESIGN BLOCKAGE 1-6hr
ALLANS 6896.00	ALLANS	6896	9.81	5.77	5.44	4.92	4.52	4.08	DESIGN BLOCKAGE 1-6hr
ALLANS 7154.00	ALLANS	7154	9.72	5.66	5.28	4.72	4.34	3.87	DESIGN BLOCKAGE 2-6hr
ALLANS 7368.00	ALLANS	7368	9.72	5.62	5.21	4.63	4.22	3.75	DESIGN BLOCKAGE 2-6hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
ALLANS 7514.00	ALLANS	7514	9.71	5.59	5.15	4.57	4.17	3.67	DESIGN BLOCKAGE 2-6hr
ALLANS 7712.00	ALLANS	7712	9.69	5.55	5.09	4.49	4.11	3.57	DESIGN BLOCKAGE 2-6hr
ALLANS 7902.00	ALLANS	7902	9.68	5.52	5.04	4.44	4.02	3.49	DESIGN BLOCKAGE 2-6hr
ALLANS 8130.00	ALLANS	8130	9.64	5.41	4.86	4.26	3.82	3.30	DESIGN BLOCKAGE 2-6hr
ALLANS 8160.00	ALLANS	8160	9.25	4.74	4.55	4.00	3.52	2.94	DESIGN BLOCKAGE 1-6hr
ALLANS 8234.00	ALLANS	8234	9.32	4.80	4.60	3.99	3.51	2.90	DESIGN BLOCKAGE 1-6hr
ALLANS 8274.00	ALLANS	8274	9.33	4.55	4.32	3.75	3.28	2.74	DESIGN BLOCKAGE 1-6hr
ALLANS 8428.00	ALLANS	8428	9.31	4.29	4.05	3.54	3.10	2.60	DESIGN BLOCKAGE 1-6hr
ALLANS 8554.00	ALLANS	8554	9.30	4.20	3.90	3.40	2.96	2.47	DESIGN BLOCKAGE 2-6hr
ALLANS 8744.00	ALLANS	8744	9.30	4.19	3.84	3.26	2.80	2.32	DESIGN BLOCKAGE 2-6hr
ALLANS 8760.00	ALLANS	8760	9.30	4.17	3.75	3.15	2.73	2.29	DESIGN BLOCKAGE 2-6hr
ALLANS 8804.00	ALLANS	8804	9.20	4.04	3.61	2.94	2.56	2.16	DESIGN BLOCKAGE 2-6hr
ALLANS 8828.00	ALLANS	8828	8.14	3.82	3.40	2.88	2.50	2.10	DESIGN BLOCKAGE 2-6hr
ALLANS 8840.00	ALLANS	8840	8.22	3.82	3.39	2.86	2.48	2.07	DESIGN BLOCKAGE 2-6hr
ALLANS 8866.00	ALLANS	8866	6.95	3.52	3.15	2.67	2.31	1.93	DESIGN BLOCKAGE 1-6hr
ALLANS 8878.00	ALLANS	8878	5.78	3.42	3.06	2.60	2.24	1.87	DESIGN BLOCKAGE 1-6hr
ALLANS 9040.00	ALLANS	9040	5.33	2.99	2.65	2.22	1.87	1.54	DESIGN BLOCKAGE 1-6hr
ALLANS 9186.00	ALLANS	9186	5.04	2.49	2.17	1.78	1.44	1.16	DESIGN BLOCKAGE 1-6hr
ALLANS 9410.00	ALLANS	9410	4.67	2.14	1.77	1.11	0.82	0.81	DESIGN BLOCKAGE 2-6hr
ALLANS 9452.00	ALLANS	9452	2.01	0.87	0.82	0.82	0.81	0.80	DESIGN BLOCKAGE 1-6hr
ALLANS 9482.00	ALLANS	9482	1.63	0.75	0.73	0.73	0.73	0.73	DESIGN BLOCKAGE 3-3hr
ALLANS 9586.00	ALLANS	9586	0.73	0.73	0.73	0.73	0.73	0.73	DESIGN BLOCKAGE 1-6hr
AMERICAN 0.00	AMERICAN	0	46.85	45.65	45.40	45.06	44.82	44.63	DESIGN BLOCKAGE 1-2hr
AMERICAN 106.00	AMERICAN	106	45.20	43.53	42.95	42.35	41.38	41.12	DESIGN BLOCKAGE 2-2hr
AMERICAN 124.00	AMERICAN	124	43.86	42.72	42.44	42.03	41.30	41.06	DESIGN BLOCKAGE 2-2hr
AMERICAN 150.00	AMERICAN	150	42.01	40.72	40.58	40.39	40.28	40.05	DESIGN BLOCKAGE 1-2hr
AMERICAN 190.00	AMERICAN	190	42.26	41.00	40.80	40.50	40.32	40.07	DESIGN BLOCKAGE 1-2hr
AMERICAN 294.00	AMERICAN	294	37.10	36.72	36.68	36.68	36.59	36.49	DESIGN BLOCKAGE 1-2hr
AMERICAN 480.00	AMERICAN	480	38.37	37.39	37.24	37.02	36.78	36.51	DESIGN BLOCKAGE 1-2hr
AMERICAN 664.00	AMERICAN	664	37.76	36.76	36.60	36.36	36.16	36.00	DESIGN BLOCKAGE 2-2hr
AMERICAN 778.00	AMERICAN	778	36.99	36.23	36.11	35.94	35.76	35.64	DESIGN BLOCKAGE 2-2hr
AMERICAN 830.00	AMERICAN	830	35.54	34.51	34.36	34.15	33.99	33.87	DESIGN BLOCKAGE 1-2hr
AMERICAN 958.00	AMERICAN	958	35.00	34.03	33.89	33.69	33.54	33.42	DESIGN BLOCKAGE 1-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
AMERICAN 1058.00	AMERICAN	1058	33.35	32.53	32.41	32.23	32.09	31.99	DESIGN BLOCKAGE 1-2hr
AMERICAN 1126.00	AMERICAN	1126	33.46	32.23	32.04	31.75	31.53	31.35	DESIGN BLOCKAGE 1-2hr
AMERICAN 1292.00	AMERICAN	1292	31.09	29.45	29.23	28.87	28.59	28.38	DESIGN BLOCKAGE 1-2hr
AMERICAN 1374.00	AMERICAN	1374	29.18	26.89	26.56	26.08	25.57	25.29	DESIGN BLOCKAGE 2-2hr
AMERICAN 1514.00	AMERICAN	1514	28.75	26.35	25.99	25.47	24.52	24.23	DESIGN BLOCKAGE 2-2hr
AMERICAN 1604.00	AMERICAN	1604	28.68	26.23	25.87	25.34	24.09	23.74	DESIGN BLOCKAGE 2-2hr
AMERICAN 1652.00	AMERICAN	1652	21.69	21.60	21.30	21.20	20.77	20.75	DESIGN BLOCKAGE 2-3hr
AMERICAN 1754.00	AMERICAN	1754	23.05	22.17	22.03	21.83	21.37	21.25	DESIGN BLOCKAGE 4-2hr
AMERICAN 1914.00	AMERICAN	1914	22.76	22.02	21.90	21.73	21.20	21.11	DESIGN BLOCKAGE 4-2hr
AMERICAN 1936.00	AMERICAN	1936	22.69	21.98	21.87	21.70	20.78	20.72	DESIGN BLOCKAGE 4-2hr
AMERICAN 1956.00	AMERICAN	1956	21.34	20.78	20.70	20.55	20.49	20.45	DESIGN BLOCKAGE 1-2hr
AMERICAN 2032.00	AMERICAN	2032	21.11	20.27	20.19	20.04	19.96	19.90	DESIGN BLOCKAGE 1-2hr
AMERICAN 2156.00	AMERICAN	2156	21.02	20.01	19.91	19.68	19.53	19.39	DESIGN BLOCKAGE 1-2hr
AMERICAN 2742.00	AMERICAN	2742	18.63	17.68	17.51	17.28	17.08	16.92	DESIGN BLOCKAGE 1-2hr
AMERICAN 2812.00	AMERICAN	2812	18.08	17.32	17.17	16.97	16.77	16.60	DESIGN BLOCKAGE 1-2hr
AMERICAN 3166.00	AMERICAN	3166	17.10	16.17	16.05	15.89	15.73	15.58	DESIGN BLOCKAGE 4-2hr
AMERICAN 3194.00	AMERICAN	3194	16.99	16.06	15.94	15.77	15.61	15.44	DESIGN BLOCKAGE 4-2hr
AMERICAN 3474.00	AMERICAN	3474	15.69	14.51	14.36	14.13	13.92	13.78	DESIGN BLOCKAGE 3-2hr
AMERICAN 3536.00	AMERICAN	3536	15.43	14.20	14.04	13.81	13.60	13.45	DESIGN BLOCKAGE 3-2hr
AMERICAN 3608.00	AMERICAN	3608	15.25	14.02	13.86	13.60	13.38	13.23	DESIGN BLOCKAGE 3-3hr
AMERICAN 3676.00	AMERICAN	3676	14.99	13.62	13.45	13.19	12.92	12.80	DESIGN BLOCKAGE 3-6hr
AMERICAN 3818.00	AMERICAN	3818	14.89	13.46	13.28	13.02	12.66	12.46	DESIGN BLOCKAGE 3-6hr
AMERICAN 3986.00	AMERICAN	3986	14.85	13.41	13.24	12.97	12.56	12.31	DESIGN BLOCKAGE 3-6hr
AMERICAN 4388.00	AMERICAN	4388	14.65	13.22	13.06	12.81	12.38	12.12	DESIGN BLOCKAGE 3-6hr
AMERICAN 4780.00	AMERICAN	4780	14.27	12.79	12.61	12.38	11.67	11.36	DESIGN BLOCKAGE 2-6hr
AMERICAN 4810.00	AMERICAN	4810	14.26	12.76	12.58	12.30	11.23	10.82	DESIGN BLOCKAGE 2-6hr
AMERICAN 4850.00	AMERICAN	4850	14.09	12.64	12.47	12.21	11.00	10.61	DESIGN BLOCKAGE 2-6hr
AMERICAN 4910.00	AMERICAN	4910	13.90	12.58	12.47	12.18	10.79	10.29	DESIGN BLOCKAGE 2-6hr
AMERICAN 5202.00	AMERICAN	5202	13.81	12.55	12.48	12.15	8.39	8.08	DESIGN BLOCKAGE 2-6hr
AMERICAN 5320.00	AMERICAN	5320	13.81	12.55	12.49	12.15	8.30	8.00	DESIGN BLOCKAGE 2-6hr
AMERICAN 5524.00	AMERICAN	5524	13.81	12.55	12.48	12.15	8.27	7.96	DESIGN BLOCKAGE 2-6hr
AMERICAN 5684.00	AMERICAN	5684	13.81	12.55	12.50	12.15	8.23	7.92	DESIGN BLOCKAGE 2-6hr
AMERICAN 5784.00	AMERICAN	5784	10.79	9.06	8.90	8.44	7.96	7.74	DESIGN BLOCKAGE 6-6hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
AMERICAN 5906.00	AMERICAN	5906	10.79	8.90	8.77	8.28	7.67	7.41	DESIGN BLOCKAGE 6-6hr
AMERICAN 5958.00	AMERICAN	5958	10.78	8.22	7.98	7.65	7.39	7.21	DESIGN BLOCKAGE 6-6hr
AMERICAN 6144.00	AMERICAN	6144	10.62	7.85	7.56	7.12	6.71	6.43	DESIGN BLOCKAGE 6-6hr
AMERICAN 6318.00	AMERICAN	6318	10.34	7.38	7.05	6.56	6.12	5.79	DESIGN BLOCKAGE 6-6hr
AMERICAN 6504.00	AMERICAN	6504	9.96	6.87	6.55	6.05	5.61	5.24	DESIGN BLOCKAGE 6-6hr
AMERICAN 6714.00	AMERICAN	6714	9.86	6.19	5.87	5.35	4.91	4.51	DESIGN BLOCKAGE 1-6hr
ARROW 4004.00	ARROW	4004	18.09	17.39	17.26	17.11	16.85	16.76	DESIGN BLOCKAGE 3-2hr
ARROW 4024.00	ARROW	4024	18.01	17.29	17.16	17.00	16.73	16.64	DESIGN BLOCKAGE 3-2hr
ARROW 4058.00	ARROW	4058	17.90	17.07	16.93	16.74	16.44	16.34	DESIGN BLOCKAGE 3-2hr
ARROW 4092.00	ARROW	4092	17.57	16.57	16.38	16.13	15.68	15.55	DESIGN BLOCKAGE 3-2hr
ARROW 4118.00	ARROW	4118	16.12	15.76	15.68	15.57	15.33	15.26	DESIGN BLOCKAGE 2-2hr
ARROW 4160.00	ARROW	4160	15.98	15.73	15.65	15.56	15.40	15.40	DESIGN BLOCKAGE 2-2hr
ARROW 4178.00	ARROW	4178	15.51	15.34	15.30	15.19	15.07	15.07	DESIGN BLOCKAGE 2-2hr
ARROW 4230.00	ARROW	4230	15.10	14.92	14.89	14.81	14.72	14.63	DESIGN BLOCKAGE 1-2hr
ARROW 4386.00	ARROW	4386	14.30	13.22	13.08	12.92	12.79	12.71	DESIGN BLOCKAGE 4-2hr
BELLV-LANE 24.00	BELLV-LANE	24	15.24	15.04	14.99	14.95	14.85	14.80	DESIGN BLOCKAGE 2-2hr
BELLV-LANE 46.00	BELLV-LANE	46	14.47	14.36	14.34	14.31	14.25	14.22	DESIGN BLOCKAGE 2-2hr
BERKELEY 6684.00	BERKELEY	6684	9.72	6.66	6.65	6.63	6.43	6.43	DESIGN BLOCKAGE 4-6hr
BERKELEY 6734.00	BERKELEY	6734	9.72	5.66	5.28	4.94	4.49	4.49	DESIGN BLOCKAGE 2-6hr
BERKELEY 6790.00	BERKELEY	6790	9.72	5.66	5.28	4.72	4.42	3.87	DESIGN BLOCKAGE 2-6hr
BERKELEY 6836.00	BERKELEY	6836	9.72	5.66	5.28	4.72	4.36	3.87	DESIGN BLOCKAGE 2-6hr
BLACKMAN 50.00	BLACKMAN	50	16.51	16.40	16.38	16.34	16.21	16.17	DESIGN BLOCKAGE 2-1hr
BLACKMAN 106.00	BLACKMAN	106	15.46	15.34	15.33	15.31	15.28	15.25	DESIGN BLOCKAGE 2-2hr
BLACKMAN 176.00	BLACKMAN	176	15.26	15.10	15.06	14.99	14.85	14.79	DESIGN BLOCKAGE 2-2hr
BLACKMAN-S 0.00	BLACKMAN-S	0	26.31	25.93	25.87	25.75	25.51	25.39	DESIGN BLOCKAGE 2-2hr
BLACKMAN-S 70.00	BLACKMAN-S	70	24.64	24.52	24.51	24.49	24.37	24.32	DESIGN BLOCKAGE 2-2hr
BLACKMAN-S 120.00	BLACKMAN-S	120	25.69	25.24	25.17	25.05	24.65	24.52	DESIGN BLOCKAGE 2-2hr
BRANCH 2960.00	BRANCH	2960	31.33	30.66	30.57	30.44	30.02	29.85	DESIGN BLOCKAGE 2-2hr
BRANCH 2988.00	BRANCH	2988	31.15	30.58	30.50	30.39	29.95	29.78	DESIGN BLOCKAGE 2-2hr
BRANCH 3018.00	BRANCH	3018	29.43	28.00	27.80	27.50	27.28	27.08	DESIGN BLOCKAGE 4-2hr
BRANCH 3058.00	BRANCH	3058	27.94	26.57	26.38	25.96	25.56	25.15	DESIGN BLOCKAGE 2-1hr
BRANCH 3178.00	BRANCH	3178	23.20	22.45	22.34	22.00	21.77	21.57	DESIGN BLOCKAGE 1-2hr
BRANCH 3238.00	BRANCH	3238	21.18	20.52	20.41	20.25	20.03	19.88	DESIGN BLOCKAGE 2-1hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
BRANCH 3430.00	BRANCH	3430	17.60	16.78	16.67	16.56	16.46	16.36	DESIGN BLOCKAGE 1-2hr
BRANCH 3668.00	BRANCH	3668	15.37	14.51	14.38	14.21	13.89	13.77	DESIGN BLOCKAGE 2-2hr
BRANCH 3748.00	BRANCH	3748	14.86	14.12	14.03	13.92	13.45	13.36	DESIGN BLOCKAGE 2-2hr
BRANCH 3804.00	BRANCH	3804	14.85	13.41	13.24	12.97	12.56	12.31	DESIGN BLOCKAGE 3-6hr
BRANCH_TRIB 2806.00	BRANCH_TRIB	2806	45.07	44.95	44.94	44.91	44.90	44.88	DESIGN BLOCKAGE 1-1hr
BRANCH_TRIB 2828.00	BRANCH_TRIB	2828	42.77	42.72	42.72	42.72	42.72	42.72	DESIGN BLOCKAGE 1-6hr
BRANCH_TRIB 2842.00	BRANCH_TRIB	2842	41.46	41.26	41.22	41.17	40.42	40.21	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 2860.00	BRANCH_TRIB	2860	41.47	41.26	41.22	41.17	40.43	40.16	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 2870.00	BRANCH_TRIB	2870	39.77	39.58	39.55	39.52	39.07	39.07	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 2918.00	BRANCH_TRIB	2918	37.09	36.99	36.99	36.96	36.95	36.95	DESIGN BLOCKAGE 2-0.5hr
BRANCH_TRIB 2970.00	BRANCH_TRIB	2970	33.87	33.62	33.57	33.51	32.70	32.43	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3056.00	BRANCH_TRIB	3056	33.83	33.61	33.57	33.50	32.69	32.39	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3080.00	BRANCH_TRIB	3080	33.18	32.68	32.39	32.17	31.19	31.00	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3100.00	BRANCH_TRIB	3100	32.18	31.89	31.86	31.84	31.21	31.02	DESIGN BLOCKAGE 2-6hr
BRANCH_TRIB 3120.00	BRANCH_TRIB	3120	29.90	29.04	29.02	28.92	27.12	27.10	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3125.00	BRANCH_TRIB	3125	29.75	29.04	29.04	28.93	27.06	27.03	DESIGN BLOCKAGE 2-3hr
BRANCH_TRIB 3160.00	BRANCH_TRIB	3160	29.30	29.06	29.01	28.90	26.35	26.17	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3206.00	BRANCH_TRIB	3206	24.80	24.17	23.98	23.79	23.52	23.49	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3310.00	BRANCH_TRIB	3310	19.97	19.86	19.82	19.78	19.71	19.69	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3370.00	BRANCH_TRIB	3370	19.01	18.63	18.58	18.52	17.92	17.81	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3470.00	BRANCH_TRIB	3470	18.81	17.15	17.05	16.96	16.29	16.23	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3478.00	BRANCH_TRIB	3478	16.85	16.01	15.95	15.89	15.80	15.72	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3572.00	BRANCH_TRIB	3572	14.88	13.70	13.66	13.61	13.59	13.57	DESIGN BLOCKAGE 2-2hr
BRANCH_TRIB 3792.00	BRANCH_TRIB	3792	14.88	13.45	13.28	13.01	12.65	12.44	DESIGN BLOCKAGE 3-6hr
BRANDY&WATER 2202.00	BRANDY&WATER	2202	24.15	23.17	22.99	22.62	22.20	21.94	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER 2268.00	BRANDY&WATER	2268	23.00	22.20	22.05	21.70	21.46	21.26	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER 2348.00	BRANDY&WATER	2348	21.37	20.65	20.51	20.32	20.15	20.01	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER 2474.00	BRANDY&WATER	2474	20.72	19.97	19.82	19.62	19.46	19.32	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER 2722.00	BRANDY&WATER	2722	17.86	17.51	17.46	17.39	17.31	17.26	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER_TRIB 2494.00	BRANDY&WATER_TRIB	2494	20.41	20.02	19.96	19.87	19.80	19.72	DESIGN BLOCKAGE 1-6hr
BRANDY&WATER_TRIB 2558.00	BRANDY&WATER_TRIB	2558	18.62	18.44	18.41	18.36	18.33	18.30	DESIGN BLOCKAGE 1-2hr
BRANDY&WATER_TRIB 2754.00	BRANDY&WATER_TRIB	2754	17.52	16.77	16.65	16.47	16.34	16.23	DESIGN BLOCKAGE 1-2hr
BYARONG 1446.00	BYARONG	1446	42.82	42.48	42.38	42.24	42.13	42.05	DESIGN BLOCKAGE 1-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
BYARONG 1610.00	BYARONG	1610	40.47	39.72	39.53	39.25	39.01	38.82	DESIGN BLOCKAGE 1-2hr
BYARONG 1822.00	BYARONG	1822	38.61	37.84	37.66	37.44	37.25	37.10	DESIGN BLOCKAGE 1-2hr
BYARONG 1934.00	BYARONG	1934	36.73	36.09	35.97	35.77	35.53	35.35	DESIGN BLOCKAGE 2-2hr
BYARONG 1998.00	BYARONG	1998	36.02	35.51	35.42	35.27	34.74	34.51	DESIGN BLOCKAGE 2-2hr
BYARONG 2028.00	BYARONG	2028	35.60	35.14	35.00	34.83	34.67	34.46	DESIGN BLOCKAGE 1-2hr
BYARONG 2118.00	BYARONG	2118	33.77	33.06	32.94	32.73	32.57	31.77	DESIGN BLOCKAGE 2-1hr
BYARONG 2162.00	BYARONG	2162	33.48	32.67	32.60	32.29	31.99	31.61	DESIGN BLOCKAGE 1-1hr
BYARONG 2266.00	BYARONG	2266	33.11	32.21	32.01	31.81	31.62	31.26	DESIGN BLOCKAGE 1-2hr
BYARONG 2362.00	BYARONG	2362	31.65	30.74	30.57	30.34	30.15	29.94	DESIGN BLOCKAGE 1-2hr
BYARONG 2464.00	BYARONG	2464	29.77	29.08	28.94	28.71	28.51	28.31	DESIGN BLOCKAGE 1-2hr
BYARONG 2538.00	BYARONG	2538	29.37	28.72	28.54	28.23	27.93	27.71	DESIGN BLOCKAGE 2-2hr
BYARONG 2606.00	BYARONG	2606	28.63	28.01	27.84	27.51	27.15	26.93	DESIGN BLOCKAGE 2-2hr
BYARONG 2850.00	BYARONG	2850	24.65	23.92	23.86	23.75	23.67	23.57	DESIGN BLOCKAGE 1-1hr
BYARONG 3070.00	BYARONG	3070	23.44	22.98	22.89	22.69	22.29	21.98	DESIGN BLOCKAGE 2-2hr
BYARONG 3240.00	BYARONG	3240	23.13	22.53	22.43	22.25	21.75	21.38	DESIGN BLOCKAGE 2-2hr
BYARONG 3272.00	BYARONG	3272	20.71	20.36	20.22	19.99	19.85	19.72	DESIGN BLOCKAGE 2-2hr
BYARONG 3374.00	BYARONG	3374	21.19	20.41	20.22	19.94	19.66	19.49	DESIGN BLOCKAGE 2-2hr
BYARONG 3524.00	BYARONG	3524	21.16	20.37	20.16	19.87	19.53	19.31	DESIGN BLOCKAGE 2-2hr
BYARONG 3534.00	BYARONG	3534	20.63	19.94	19.77	19.54	19.34	19.16	DESIGN BLOCKAGE 1-2hr
BYARONG 3572.00	BYARONG	3572	20.63	19.92	19.75	19.52	19.32	19.14	DESIGN BLOCKAGE 1-2hr
BYARONG 3832.00	BYARONG	3832	18.72	18.14	18.05	17.93	17.82	17.72	DESIGN BLOCKAGE 3-2hr
BYARONG 4004.00	BYARONG	4004	18.07	17.36	17.24	17.09	16.65	16.48	DESIGN BLOCKAGE 3-2hr
BYARONG 4160.00	BYARONG	4160	17.61	17.11	17.03	16.90	16.06	15.85	DESIGN BLOCKAGE 3-2hr
BYARONG 4178.00	BYARONG	4178	16.99	16.41	16.25	16.05	15.86	15.69	DESIGN BLOCKAGE 1-2hr
BYARONG 4234.00	BYARONG	4234	16.16	15.79	15.71	15.59	15.49	15.35	DESIGN BLOCKAGE 4-2hr
BYARONG 4364.00	BYARONG	4364	14.62	14.22	14.17	14.10	14.04	13.96	DESIGN BLOCKAGE 4-2hr
BYARONG 4528.00	BYARONG	4528	14.33	13.20	13.10	12.95	12.57	12.47	DESIGN BLOCKAGE 4-3hr
BYARONG 4766.00	BYARONG	4766	14.42	13.12	13.00	12.82	11.30	11.04	DESIGN BLOCKAGE 4-3hr
BYARONG 4878.00	BYARONG	4878	14.21	13.11	13.00	12.82	10.93	10.59	DESIGN BLOCKAGE 4-3hr
BYARONG 4974.00	BYARONG	4974	14.17	13.09	12.97	12.80	9.93	9.62	DESIGN BLOCKAGE 4-3hr
BYARONG 5046.00	BYARONG	5046	14.16	12.57	12.41	12.33	9.09	8.78	DESIGN BLOCKAGE 2-6hr
BYARONG 5112.00	BYARONG	5112	14.11	12.65	12.42	12.17	8.99	8.59	DESIGN BLOCKAGE 2-6hr
BYARONG 5214.00	BYARONG	5214	13.92	12.70	12.41	12.16	8.99	8.62	DESIGN BLOCKAGE 2-6hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
BYARONG 5398.00	BYARONG	5398	13.04	12.08	11.94	11.74	8.43	7.60	DESIGN BLOCKAGE 2-6hr
BYARONG 5510.00	BYARONG	5510	13.06	12.08	11.95	11.75	9.02	7.60	DESIGN BLOCKAGE 2-6hr
BYARONG 5752.00	BYARONG	5752	10.80	8.96	8.77	8.42	7.75	7.45	DESIGN BLOCKAGE 2-6hr
CHARCOAL 2086.00	CHARCOAL	2086	60.76	60.60	60.55	60.47	60.40	60.34	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2192.00	CHARCOAL	2192	56.99	56.77	56.72	56.66	56.60	56.56	DESIGN BLOCKAGE 1-2hr
CHARCOAL 2248.00	CHARCOAL	2248	54.48	54.21	54.15	54.07	53.99	53.92	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2348.00	CHARCOAL	2348	50.02	49.52	49.38	49.19	49.01	48.87	DESIGN BLOCKAGE 1-2hr
CHARCOAL 2456.00	CHARCOAL	2456	47.42	47.09	47.01	46.91	46.60	46.50	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2534.00	CHARCOAL	2534	44.90	44.54	44.44	44.08	43.84	43.63	DESIGN BLOCKAGE 1-2hr
CHARCOAL 2586.00	CHARCOAL	2586	41.79	41.46	41.31	41.17	41.05	40.90	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2648.00	CHARCOAL	2648	41.00	40.64	40.58	40.49	40.08	39.88	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2742.00	CHARCOAL	2742	39.35	39.04	38.97	38.87	38.59	38.45	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2772.00	CHARCOAL	2772	39.28	38.99	38.92	38.83	38.54	38.40	DESIGN BLOCKAGE 2-2hr
CHARCOAL 2842.00	CHARCOAL	2842	38.00	37.61	37.51	37.35	37.20	37.11	DESIGN BLOCKAGE 1-2hr
CHARCOAL 2970.00	CHARCOAL	2970	36.55	36.07	35.94	35.78	35.58	35.48	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3116.00	CHARCOAL	3116	33.99	33.49	33.37	33.23	33.11	32.99	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3232.00	CHARCOAL	3232	32.50	32.22	32.16	32.08	31.31	30.92	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3262.00	CHARCOAL	3262	31.30	30.52	30.38	30.19	29.86	29.70	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3412.00	CHARCOAL	3412	29.90	28.62	28.40	28.13	27.86	27.72	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3608.00	CHARCOAL	3608	29.55	28.14	27.86	27.50	26.81	26.60	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3630.00	CHARCOAL	3630	27.13	26.51	26.39	26.22	25.91	25.73	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3720.00	CHARCOAL	3720	26.60	26.19	26.11	25.98	25.62	25.48	DESIGN BLOCKAGE 2-2hr
CHARCOAL 3752.00	CHARCOAL	3752	25.20	24.56	24.46	24.32	24.23	24.07	DESIGN BLOCKAGE 8-2hr
CHARCOAL 3918.00	CHARCOAL	3918	22.75	21.87	21.73	21.48	21.30	21.09	DESIGN BLOCKAGE 3-2hr
CHARCOAL 4094.00	CHARCOAL	4094	22.42	21.18	20.95	20.64	20.35	20.10	DESIGN BLOCKAGE 1-2hr
CHARCOAL 4230.00	CHARCOAL	4230	20.59	19.78	19.65	19.39	19.18	19.03	DESIGN BLOCKAGE 1-2hr
CHARCOAL 4536.00	CHARCOAL	4536	17.98	17.24	17.12	16.98	16.56	16.41	DESIGN BLOCKAGE 2-2hr
CHARCOAL 4638.00	CHARCOAL	4638	17.58	16.93	16.84	16.73	15.66	15.22	DESIGN BLOCKAGE 2-2hr
CHARCOAL 4648.00	CHARCOAL	4648	17.37	16.86	16.79	16.70	14.89	14.31	DESIGN BLOCKAGE 3-2hr
CHARCOAL 4776.00	CHARCOAL	4776	17.46	16.88	16.80	16.71	15.04	14.48	DESIGN BLOCKAGE 3-2hr
CHARCOAL 4814.00	CHARCOAL	4814	17.30	16.32	16.12	15.79	14.51	14.18	DESIGN BLOCKAGE 2-6hr
CHARCOAL 4862.00	CHARCOAL	4862	17.40	16.12	15.97	15.83	14.55	14.22	DESIGN BLOCKAGE 2-2hr
CHARCOAL 4890.00	CHARCOAL	4890	17.02	15.59	15.35	15.04	14.51	14.19	DESIGN BLOCKAGE 1-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
CHARCOAL 4976.00	CHARCOAL	4976	16.48	15.38	15.15	14.87	14.50	14.18	DESIGN BLOCKAGE 5-2hr
CHARCOAL 5178.00	CHARCOAL	5178	15.75	14.99	14.76	14.41	13.80	13.37	DESIGN BLOCKAGE 5-2hr
CHARCOAL 5228.00	CHARCOAL	5228	15.52	14.67	14.40	13.96	13.64	13.24	DESIGN BLOCKAGE 4-2hr
CHARCOAL 5618.00	CHARCOAL	5618	11.43	10.92	10.75	10.49	10.22	10.10	DESIGN BLOCKAGE 6-2hr
CHARCOAL_MAJ_TRIB 3036.00	CHARCOAL_MAJ_TRIB	3036	39.16	38.65	38.54	38.40	37.43	37.01	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MAJ_TRIB 3094.00	CHARCOAL_MAJ_TRIB	3094	39.16	38.65	38.54	38.41	37.41	36.98	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MAJ_TRIB 3126.00	CHARCOAL_MAJ_TRIB	3126	37.53	36.85	36.64	36.31	36.03	35.76	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MAJ_TRIB 3256.00	CHARCOAL_MAJ_TRIB	3256	35.16	34.51	34.38	34.21	34.06	33.85	DESIGN BLOCKAGE 1-2hr
CHARCOAL_MAJ_TRIB 3414.00	CHARCOAL_MAJ_TRIB	3414	31.41	30.90	30.84	30.75	30.50	30.42	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MAJ_TRIB 3544.00	CHARCOAL_MAJ_TRIB	3544	29.44	28.65	28.48	28.26	28.03	27.90	DESIGN BLOCKAGE 1-2hr
CHARCOAL_MAJ_TRIB 3732.00	CHARCOAL_MAJ_TRIB	3732	26.00	25.47	25.38	25.24	24.81	24.61	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MAJ_TRIB 3764.00	CHARCOAL_MAJ_TRIB	3764	25.29	24.88	24.80	24.65	24.57	24.44	DESIGN BLOCKAGE 8-2hr
CHARCOAL_MAJ_TRIB 3944.00	CHARCOAL_MAJ_TRIB	3944	22.75	21.96	21.85	21.72	21.53	21.34	DESIGN BLOCKAGE 2-2hr
CHARCOAL_MIN_TRIB 3052.00	CHARCOAL_MIN_TRIB	3052	39.79	39.67	39.65	39.61	39.58	39.56	DESIGN BLOCKAGE 1-2hr
CHARCOAL_MIN_TRIB 3232.00	CHARCOAL_MIN_TRIB	3232	32.56	32.53	32.52	32.52	32.47	32.47	DESIGN BLOCKAGE 2-0.5hr
CLEVERDON 4428.00	CLEVERDON	4428	14.23	13.74	13.70	13.65	13.61	13.61	DESIGN BLOCKAGE 2-2hr
CLEVERDON 4520.00	CLEVERDON	4520	14.04	13.02	12.91	12.79	12.48	12.40	DESIGN BLOCKAGE 2-2hr
CLEVERDON 4578.00	CLEVERDON	4578	14.12	12.71	12.58	12.32	11.97	11.87	DESIGN BLOCKAGE 2-6hr
CLEVERDON 4648.00	CLEVERDON	4648	13.84	12.80	12.46	12.17	11.38	11.26	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4052.00	CLEVERDON_DRAIN	4052	15.38	15.23	15.19	15.14	15.10	15.07	DESIGN BLOCKAGE 1-2hr
CLEVERDON_DRAIN 4100.00	CLEVERDON_DRAIN	4100	14.57	14.50	14.48	14.46	14.43	14.41	DESIGN BLOCKAGE 2-2hr
CLEVERDON_DRAIN 4140.00	CLEVERDON_DRAIN	4140	14.45	14.26	14.22	14.18	14.04	13.99	DESIGN BLOCKAGE 2-2hr
CLEVERDON_DRAIN 4212.00	CLEVERDON_DRAIN	4212	14.42	14.23	14.19	14.14	13.99	13.93	DESIGN BLOCKAGE 2-2hr
CLEVERDON_DRAIN 4266.00	CLEVERDON_DRAIN	4266	14.06	13.30	13.17	13.02	12.71	12.58	DESIGN BLOCKAGE 3-2hr
CLEVERDON_DRAIN 4308.00	CLEVERDON_DRAIN	4308	14.04	13.07	12.97	12.88	12.64	12.53	DESIGN BLOCKAGE 2-2hr
CLEVERDON_DRAIN 4360.00	CLEVERDON_DRAIN	4360	14.12	12.79	12.74	12.69	12.52	12.44	DESIGN BLOCKAGE 2-2hr
CLEVERDON_DRAIN 4426.00	CLEVERDON_DRAIN	4426	13.75	12.79	12.46	12.17	11.49	11.43	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4506.00	CLEVERDON_DRAIN	4506	14.08	12.65	12.41	12.17	11.04	11.01	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4566.00	CLEVERDON_DRAIN	4566	13.95	12.58	12.41	12.17	10.96	10.88	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4640.00	CLEVERDON_DRAIN	4640	13.92	12.58	12.42	12.17	10.91	10.50	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4796.00	CLEVERDON_DRAIN	4796	13.91	12.58	12.43	12.17	10.90	10.34	DESIGN BLOCKAGE 2-6hr
CLEVERDON_DRAIN 4810.00	CLEVERDON_DRAIN	4810	13.92	12.59	12.43	12.18	10.89	10.33	DESIGN BLOCKAGE 2-6hr
CORDO_HTS 2328.00	CORDO_HTS	2328	22.20	21.72	21.66	21.61	20.58	20.36	DESIGN BLOCKAGE 2-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
CORDO_HTS 2388.00	CORDO_HTS	2388	22.16	21.70	21.64	21.60	20.32	19.77	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2424.00	CORDO_HTS	2424	21.90	21.64	21.61	21.58	20.04	19.61	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2462.00	CORDO_HTS	2462	21.89	21.64	21.61	21.58	20.04	19.60	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2508.00	CORDO_HTS	2508	21.86	21.63	21.60	21.57	19.79	19.44	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2558.00	CORDO_HTS	2558	21.86	21.63	21.60	21.57	19.73	19.37	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2612.00	CORDO_HTS	2612	18.69	18.13	18.07	17.99	17.43	17.35	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2676.00	CORDO_HTS	2676	18.38	18.06	18.02	17.96	16.93	16.66	DESIGN BLOCKAGE 2-2hr
CORDO_HTS 2718.00	CORDO_HTS	2718	18.32	17.69	17.65	17.56	15.88	15.70	DESIGN BLOCKAGE 4-2hr
CORDO_HTS 2934.00	CORDO_HTS	2934	18.27	17.67	17.63	17.54	15.79	15.62	DESIGN BLOCKAGE 4-2hr
CORDO_HTS 2988.00	CORDO_HTS	2988	17.10	16.17	16.05	15.89	15.73	15.58	DESIGN BLOCKAGE 1-2hr
CORDO_OLAND 2506.00	CORDO_OLAND	2506	21.85	21.62	21.59	21.56	21.15	21.15	DESIGN BLOCKAGE 2-2hr
CORDO_OLAND 2566.00	CORDO_OLAND	2566	19.05	18.83	18.74	18.61	18.25	18.25	DESIGN BLOCKAGE 2-2hr
CORONATA 1998.00	CORONATA	1998	36.01	35.51	35.41	35.26	34.88	34.80	DESIGN BLOCKAGE 2-2hr
CORONATA 2028.00	CORONATA	2028	35.61	35.15	35.02	34.88	34.67	34.58	DESIGN BLOCKAGE 2-2hr
CORONATA 2118.00	CORONATA	2118	34.12	33.80	33.75	33.67	33.53	33.46	DESIGN BLOCKAGE 2-2hr
CORONATA 2154.00	CORONATA	2154	33.41	32.73	32.58	32.45	32.31	32.25	DESIGN BLOCKAGE 2-2hr
CORONATA 2208.00	CORONATA	2208	33.10	32.21	32.02	31.76	31.52	31.37	DESIGN BLOCKAGE 1-2hr
CORONATA 2284.00	CORONATA	2284	31.00	30.80	30.77	30.72	30.68	30.64	DESIGN BLOCKAGE 1-2hr
CORONATA 2328.00	CORONATA	2328	30.36	29.82	29.74	29.60	29.50	29.43	DESIGN BLOCKAGE 1-2hr
CORONATA 2368.00	CORONATA	2368	29.98	29.70	29.65	29.57	29.49	29.42	DESIGN BLOCKAGE 2-2hr
CORONATA 2444.00	CORONATA	2444	27.96	27.68	27.67	27.66	27.66	27.66	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 6.00	CUMMINS-ALBERT	6	19.77	19.56	19.54	19.44	19.33	19.27	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 66.00	CUMMINS-ALBERT	66	18.36	18.25	18.22	18.22	18.14	18.13	DESIGN BLOCKAGE 2-1hr
CUMMINS-ALBERT 120.00	CUMMINS-ALBERT	120	17.46	17.42	17.41	17.41	17.31	17.28	DESIGN BLOCKAGE 1-0.5hr
CUMMINS-ALBERT 180.00	CUMMINS-ALBERT	180	16.78	16.63	16.59	16.55	16.44	16.39	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 270.00	CUMMINS-ALBERT	270	15.47	15.35	15.34	15.32	15.29	15.25	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 310.00	CUMMINS-ALBERT	310	15.25	15.09	15.05	14.99	14.85	14.80	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 350.00	CUMMINS-ALBERT	350	14.30	14.11	14.08	14.06	13.97	13.96	DESIGN BLOCKAGE 2-1hr
CUMMINS-ALBERT 376.00	CUMMINS-ALBERT	376	14.30	14.13	14.08	14.03	13.92	13.89	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 490.00	CUMMINS-ALBERT	490	13.15	13.08	13.07	13.04	12.99	12.97	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 580.00	CUMMINS-ALBERT	580	12.31	12.21	12.20	12.17	11.99	11.96	DESIGN BLOCKAGE 2-2hr
CUMMINS-ALBERT 670.00	CUMMINS-ALBERT	670	11.38	11.28	11.25	11.21	11.15	11.13	DESIGN BLOCKAGE 2-0.5hr
CUMMINS-ALBERT 830.00	CUMMINS-ALBERT	830	10.26	10.12	10.08	10.05	10.00	9.97	DESIGN BLOCKAGE 5-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
EUROKA 2538.00	EUROKA	2538	29.37	28.80	28.73	28.60	28.47	28.30	DESIGN BLOCKAGE 1-2hr
EUROKA 2606.00	EUROKA	2606	28.63	28.01	27.84	27.70	27.54	27.34	DESIGN BLOCKAGE 2-2hr
EUROKA 2850.00	EUROKA	2850	26.31	26.19	26.17	26.12	26.07	25.92	DESIGN BLOCKAGE 2-2hr
FIGTREE 4178.00	FIGTREE	4178	15.88	15.55	15.53	15.43	15.40	15.40	DESIGN BLOCKAGE 2-2hr
FIGTREE 4234.00	FIGTREE	4234	15.44	15.24	15.20	15.14	15.03	14.96	DESIGN BLOCKAGE 1-2hr
FIGTREE 4366.00	FIGTREE	4366	14.26	13.50	13.46	13.43	13.42	13.37	DESIGN BLOCKAGE 4-2hr
FIGTREE 4438.00	FIGTREE	4438	14.24	13.20	13.11	13.02	12.93	12.85	DESIGN BLOCKAGE 4-3hr
FIGTREE 4622.00	FIGTREE	4622	14.22	13.13	13.01	12.83	12.57	12.47	DESIGN BLOCKAGE 4-3hr
FIGTREE 4682.00	FIGTREE	4682	14.20	13.11	13.00	12.82	12.56	12.47	DESIGN BLOCKAGE 4-3hr
FIGTREE 4764.00	FIGTREE	4764	14.19	13.11	13.00	12.82	12.56	12.47	DESIGN BLOCKAGE 4-3hr
FIGTREE 4810.00	FIGTREE	4810	14.90	12.83	12.80	12.72	12.70	12.70	DESIGN BLOCKAGE 2-6hr
FIGTREE 4874.00	FIGTREE	4874	13.90	12.77	12.43	12.42	11.23	11.23	DESIGN BLOCKAGE 2-6hr
FIGTREE 4908.00	FIGTREE	4908	13.84	12.76	12.43	12.40	10.71	10.58	DESIGN BLOCKAGE 2-6hr
FIGTREE 4984.00	FIGTREE	4984	13.83	12.67	12.41	12.16	10.70	10.56	DESIGN BLOCKAGE 2-6hr
FIGTREE 5064.00	FIGTREE	5064	13.83	12.57	12.40	12.16	9.70	9.64	DESIGN BLOCKAGE 2-6hr
FIGTREE 5154.00	FIGTREE	5154	13.87	12.56	12.40	12.17	9.56	9.52	DESIGN BLOCKAGE 2-6hr
FIGTREE 5252.00	FIGTREE	5252	13.86	12.56	12.40	12.16	8.86	8.82	DESIGN BLOCKAGE 2-6hr
FIGTREE 5344.00	FIGTREE	5344	13.84	12.55	12.46	12.16	8.53	8.43	DESIGN BLOCKAGE 2-6hr
FIGTREE 5428.00	FIGTREE	5428	13.81	12.55	12.48	12.15	8.40	8.32	DESIGN BLOCKAGE 2-6hr
FIVE_ISLAND 128.00	FIVE_ISLAND	128	9.82	8.10	8.02	7.86	7.37	7.03	DESIGN BLOCKAGE 6-2hr
FIVE_ISLAND 192.00	FIVE_ISLAND	192	9.82	8.09	8.01	7.83	7.24	6.85	DESIGN BLOCKAGE 6-2hr
FIVE_ISLAND 282.00	FIVE_ISLAND	282	9.71	7.37	7.23	7.14	7.00	6.97	DESIGN BLOCKAGE 7-6hr
FIVE_ISLAND 292.00	FIVE_ISLAND	292	9.71	7.34	7.18	6.94	6.32	6.17	DESIGN BLOCKAGE 7-6hr
FREEWAY 5078.00	FREEWAY	5078	22.95	22.63	22.59	22.51	22.41	22.35	DESIGN BLOCKAGE 2-2hr
FREEWAY 5394.00	FREEWAY	5394	14.70	14.20	14.16	14.09	13.76	13.71	DESIGN BLOCKAGE 2-6hr
FREEWAY 5456.00	FREEWAY	5456	14.55	14.16	14.12	14.07	13.04	12.93	DESIGN BLOCKAGE 2-6hr
FREEWAY 5566.00	FREEWAY	5566	10.99	10.58	10.54	10.49	10.45	10.41	DESIGN BLOCKAGE 1-2hr
FREEWAY 5734.00	FREEWAY	5734	9.93	9.64	9.61	9.57	9.47	9.42	DESIGN BLOCKAGE 5-2hr
FREEWAY 5770.00	FREEWAY	5770	9.92	9.48	9.45	9.41	9.22	9.16	DESIGN BLOCKAGE 5-2hr
FREEWAY 5850.00	FREEWAY	5850	9.91	9.12	9.04	8.89	8.80	8.77	DESIGN BLOCKAGE 6-6hr
FREEWAY 5984.00	FREEWAY	5984	9.91	9.12	9.03	8.88	8.33	8.24	DESIGN BLOCKAGE 6-6hr
FREEWAY 6146.00	FREEWAY	6146	9.91	9.12	9.03	8.88	7.74	7.71	DESIGN BLOCKAGE 6-6hr
FREEWAY 6316.00	FREEWAY	6316	9.91	9.12	9.03	8.88	6.26	6.01	DESIGN BLOCKAGE 6-6hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
FREEWAY 6352.00	FREEWAY	6352	9.91	9.12	9.03	8.88	5.68	5.41	DESIGN BLOCKAGE 6-6hr
FREEWAY 6390.00	FREEWAY	6390	9.89	9.10	9.01	8.86	5.62	5.35	DESIGN BLOCKAGE 7-6hr
FREEWAY 6492.00	FREEWAY	6492	9.89	9.10	9.01	8.86	5.60	5.32	DESIGN BLOCKAGE 7-6hr
FREEWAY 6618.00	FREEWAY	6618	9.72	7.71	7.67	7.62	5.51	5.25	DESIGN BLOCKAGE 4-6hr
FREEWAY 6684.00	FREEWAY	6684	9.72	7.68	7.65	7.61	4.35	4.08	DESIGN BLOCKAGE 4-6hr
FREEWAY 6776.00	FREEWAY	6776	9.71	5.74	5.71	5.65	4.33	3.92	DESIGN BLOCKAGE 3-6hr
FREEWAY 6848.00	FREEWAY	6848	9.73	5.74	5.71	5.65	4.30	3.88	DESIGN BLOCKAGE 3-6hr
FREEWAY 6922.00	FREEWAY	6922	9.72	5.66	5.28	4.73	4.29	3.87	DESIGN BLOCKAGE 2-6hr
FREEWAY_TRIB 5686.00	FREEWAY_TRIB	5686	12.10	11.65	11.59	11.52	11.34	11.31	DESIGN BLOCKAGE 2-2hr
FREEWAY_TRIB 5786.00	FREEWAY_TRIB	5786	12.04	11.61	11.56	11.50	11.30	11.27	DESIGN BLOCKAGE 2-2hr
FREEWAY_TRIB 5806.00	FREEWAY_TRIB	5806	12.03	11.60	11.54	11.46	10.72	10.57	DESIGN BLOCKAGE 2-2hr
FREEWAY_TRIB 5866.00	FREEWAY_TRIB	5866	11.83	11.52	11.47	11.41	10.38	10.16	DESIGN BLOCKAGE 2-2hr
FREEWAY_TRIB 5946.00	FREEWAY_TRIB	5946	9.92	9.12	9.03	8.88	8.45	8.37	DESIGN BLOCKAGE 6-6hr
FREEWAY_TRIB 5986.00	FREEWAY_TRIB	5986	9.91	9.12	9.03	8.88	8.35	8.28	DESIGN BLOCKAGE 6-6hr
GHOST 4258.00	GHOST	4258	14.57	13.38	13.25	13.07	12.94	12.82	DESIGN BLOCKAGE 4-2hr
GHOST 4318.00	GHOST	4318	14.56	13.38	13.25	13.07	12.92	12.80	DESIGN BLOCKAGE 4-2hr
GHOST 4358.00	GHOST	4358	14.56	13.37	13.23	13.05	12.91	12.79	DESIGN BLOCKAGE 4-2hr
GHOST 4398.00	GHOST	4398	14.52	13.23	13.12	12.96	12.73	12.61	DESIGN BLOCKAGE 4-2hr
GOVETT 3194.00	GOVETT	3194	17.00	16.07	15.95	15.78	15.61	15.44	DESIGN BLOCKAGE 4-2hr
GOVETT 3474.00	GOVETT	3474	15.69	14.51	14.36	14.13	13.93	13.78	DESIGN BLOCKAGE 3-2hr
GOVETT 3536.00	GOVETT	3536	15.41	14.17	14.03	13.80	13.59	13.45	DESIGN BLOCKAGE 3-2hr
GOVETT 3608.00	GOVETT	3608	15.25	14.11	13.95	13.70	13.48	13.33	DESIGN BLOCKAGE 3-3hr
GOVETT 3648.00	GOVETT	3648	14.91	13.50	13.33	13.08	12.79	12.70	DESIGN BLOCKAGE 3-6hr
GOVETT 3688.00	GOVETT	3688	14.89	13.45	13.28	13.01	12.64	12.43	DESIGN BLOCKAGE 3-6hr
GOVETT 3788.00	GOVETT	3788	14.86	13.41	13.24	12.97	12.56	12.30	DESIGN BLOCKAGE 3-6hr
GRACE 6.00	GRACE	6	13.82	13.46	13.44	13.43	13.42	13.40	DESIGN BLOCKAGE 3-2hr
GRACE 90.00	GRACE	90	13.06	12.95	12.93	12.92	12.90	12.89	DESIGN BLOCKAGE 3-2hr
GRACE 180.00	GRACE	180	12.33	12.24	12.22	12.19	12.17	12.14	DESIGN BLOCKAGE 2-2hr
GRACE 270.00	GRACE	270	11.47	11.38	11.36	11.35	11.33	11.31	DESIGN BLOCKAGE 2-0.5hr
HARGRV 76.00	HARGRV	76	16.06	16.00	15.98	15.95	15.87	15.78	DESIGN BLOCKAGE 2-2hr
HARRY_G_PK 3374.00	HARRY_G_PK	3374	21.19	20.42	20.22	19.93	19.67	19.50	DESIGN BLOCKAGE 2-2hr
HARRY_G_PK 3454.00	HARRY_G_PK	3454	21.18	20.40	20.20	19.92	19.64	19.47	DESIGN BLOCKAGE 2-2hr
HARRY_G_PK 3470.00	HARRY_G_PK	3470	21.17	20.40	20.20	19.92	19.64	19.47	DESIGN BLOCKAGE 2-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
HARRY_G_PK 3480.00	HARRY_G_PK	3480	21.17	20.40	20.20	19.91	19.64	19.47	DESIGN BLOCKAGE 2-2hr
HARRY_G_PK 3510.00	HARRY_G_PK	3510	21.12	20.39	20.20	20.03	20.03	20.03	DESIGN BLOCKAGE 2-2hr
HIGHWAY 3922.00	HIGHWAY	3922	20.95	20.60	20.53	20.41	20.28	20.19	DESIGN BLOCKAGE 4-2hr
HIGHWAY 4124.00	HIGHWAY	4124	19.82	19.48	19.43	19.37	18.56	18.29	DESIGN BLOCKAGE 2-2hr
HIGHWAY 4182.00	HIGHWAY	4182	19.11	18.15	18.02	17.86	17.70	17.58	DESIGN BLOCKAGE 8-2hr
HIGHWAY 4548.00	HIGHWAY	4548	17.49	16.80	16.62	16.44	16.28	16.20	DESIGN BLOCKAGE 3-2hr
HIGHWAY 4708.00	HIGHWAY	4708	16.84	15.59	15.40	15.14	14.92	14.76	DESIGN BLOCKAGE 5-2hr
HIGHWAY 4762.00	HIGHWAY	4762	16.82	15.55	15.35	15.02	14.71	14.52	DESIGN BLOCKAGE 5-2hr
JENKINS 3176.00	JENKINS	3176	37.27	37.09	37.03	36.96	36.90	36.85	DESIGN BLOCKAGE 1-2hr
JENKINS 3272.00	JENKINS	3272	33.67	33.47	33.36	33.20	33.03	32.95	DESIGN BLOCKAGE 2-2hr
JENKINS 3400.00	JENKINS	3400	32.57	32.06	31.95	31.84	31.69	31.61	DESIGN BLOCKAGE 2-2hr
JENKINS 3606.00	JENKINS	3606	27.22	27.14	27.13	27.11	27.10	27.07	DESIGN BLOCKAGE 2-2hr
JENKINS 3626.00	JENKINS	3626	26.80	26.61	26.56	26.52	26.44	26.31	DESIGN BLOCKAGE 2-2hr
JENKINS 3706.00	JENKINS	3706	25.65	25.31	25.25	25.13	25.03	24.93	DESIGN BLOCKAGE 1-2hr
JENKINS 3856.00	JENKINS	3856	24.56	24.19	24.11	24.00	23.11	22.84	DESIGN BLOCKAGE 2-2hr
JENKINS 4032.00	JENKINS	4032	24.34	24.06	24.01	23.91	22.60	22.11	DESIGN BLOCKAGE 2-2hr
JENKINS 4094.00	JENKINS	4094	22.63	21.88	21.73	21.47	21.13	21.02	DESIGN BLOCKAGE 2-2hr
JENKINS 4334.00	JENKINS	4334	19.64	18.87	18.76	18.55	18.13	18.05	DESIGN BLOCKAGE 3-2hr
JENKINS 4452.00	JENKINS	4452	18.75	18.35	18.28	18.16	16.24	16.17	DESIGN BLOCKAGE 2-2hr
JENKINS 4594.00	JENKINS	4594	18.53	18.28	18.22	18.13	15.00	14.71	DESIGN BLOCKAGE 2-2hr
JENKINS 4656.00	JENKINS	4656	17.14	16.89	16.83	16.71	14.94	14.63	DESIGN BLOCKAGE 4-2hr
JENKINS 4688.00	JENKINS	4688	17.10	16.87	16.81	16.70	14.80	14.41	DESIGN BLOCKAGE 4-2hr
JENKINS 4726.00	JENKINS	4726	16.54	15.43	15.22	14.92	14.57	14.28	DESIGN BLOCKAGE 5-2hr
JENKINS 4866.00	JENKINS	4866	16.56	15.43	15.22	14.92	14.58	14.28	DESIGN BLOCKAGE 5-2hr
LANGSON 3070.00	LANGSON	3070	23.17	22.89	22.84	22.82	22.81	22.80	DESIGN BLOCKAGE 2-2hr
LANGSON 3240.00	LANGSON	3240	23.12	22.44	22.26	22.00	21.79	21.77	DESIGN BLOCKAGE 2-2hr
LANGSON 3272.00	LANGSON	3272	22.64	22.15	21.96	21.65	21.38	21.36	DESIGN BLOCKAGE 2-2hr
NUDJIA 76.00	NUDJIA	76	13.81	13.47	13.46	13.46	13.45	13.44	DESIGN BLOCKAGE 3-1hr
NUDJIA 170.00	NUDJIA	170	13.56	12.97	12.97	12.97	12.97	12.97	DESIGN BLOCKAGE 3-0.5hr
PRINCES 0.00	PRINCES	0	17.86	17.81	17.79	17.73	17.20	17.20	DESIGN BLOCKAGE 2-1hr
PRINCES 70.00	PRINCES	70	17.60	17.04	16.96	16.84	16.33	16.33	DESIGN BLOCKAGE 3-2hr
PRINCES 160.00	PRINCES	160	17.41	16.88	16.79	16.69	15.58	15.58	DESIGN BLOCKAGE 3-2hr
PRINCES 320.00	PRINCES	320	16.98	16.86	16.79	16.69	16.60	16.60	DESIGN BLOCKAGE 3-2hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
PRINCES 550.00	PRINCES	550	15.51	14.55	14.53	14.30	14.01	14.01	DESIGN BLOCKAGE 3-2hr
RAILWAY 0.00	RAILWAY	0	9.84	8.03	7.91	7.74	6.62	6.62	DESIGN BLOCKAGE 7-6hr
RAILWAY 68.00	RAILWAY	68	9.84	7.84	7.73	7.57	6.24	6.24	DESIGN BLOCKAGE 7-6hr
RAILWAY 108.00	RAILWAY	108	9.81	7.36	7.25	7.06	6.07	6.02	DESIGN BLOCKAGE 7-6hr
RAILWAY 148.00	RAILWAY	148	9.81	7.29	7.17	6.94	6.07	5.95	DESIGN BLOCKAGE 7-6hr
RESOLUTION 5850.00	RESOLUTION	5850	9.91	9.12	9.03	8.88	8.69	8.60	DESIGN BLOCKAGE 6-6hr
RESOLUTION 5984.00	RESOLUTION	5984	9.91	9.12	9.03	8.88	8.22	8.22	DESIGN BLOCKAGE 6-6hr
RESOLUTION 6146.00	RESOLUTION	6146	9.91	9.12	9.03	8.88	7.12	6.96	DESIGN BLOCKAGE 6-6hr
RESOLUTION 6316.00	RESOLUTION	6316	9.91	9.12	9.03	8.88	6.91	6.86	DESIGN BLOCKAGE 6-6hr
RESOLUTION 6566.00	RESOLUTION	6566	9.90	9.12	9.03	8.88	8.67	8.67	DESIGN BLOCKAGE 6-6hr
RESOLUTION 6706.00	RESOLUTION	6706	9.83	8.25	8.19	8.03	7.44	7.03	DESIGN BLOCKAGE 6-6hr
RESOLUTION 6746.00	RESOLUTION	6746	9.83	8.26	8.18	8.02	7.81	7.80	DESIGN BLOCKAGE 4-6hr
RESOLUTION 6828.00	RESOLUTION	6828	9.84	8.12	7.99	7.81	7.18	7.17	DESIGN BLOCKAGE 7-6hr
RESOLUTION 6872.00	RESOLUTION	6872	9.84	8.12	7.99	7.81	6.72	6.71	DESIGN BLOCKAGE 7-6hr
RICKARD 30.00	RICKARD	30	24.94	24.52	24.47	24.34	24.03	23.87	DESIGN BLOCKAGE 2-2hr
RICKARD 180.00	RICKARD	180	22.46	22.36	22.18	22.11	21.80	21.71	DESIGN BLOCKAGE 4-2hr
RICKARD 196.00	RICKARD	196	22.76	22.43	22.34	22.15	21.99	21.76	DESIGN BLOCKAGE 4-3hr
RUNNING_BROOK 2628.00	RUNNING_BROOK	2628	41.75	41.59	41.56	41.51	41.48	41.45	DESIGN BLOCKAGE 1-2hr
RUNNING_BROOK 2648.00	RUNNING_BROOK	2648	38.04	37.73	37.65	37.54	37.28	37.16	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 2688.00	RUNNING_BROOK	2688	35.79	35.42	35.34	35.24	34.48	34.29	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 2738.00	RUNNING_BROOK	2738	35.36	35.14	35.11	35.05	34.02	33.35	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 2778.00	RUNNING_BROOK	2778	32.26	31.46	31.23	31.01	30.66	30.57	DESIGN BLOCKAGE 2-1hr
RUNNING_BROOK 2848.00	RUNNING_BROOK	2848	30.51	29.97	29.84	29.72	28.80	28.69	DESIGN BLOCKAGE 2-1hr
RUNNING_BROOK 2898.00	RUNNING_BROOK	2898	29.49	28.41	28.32	28.14	27.32	27.24	DESIGN BLOCKAGE 2-0.5hr
RUNNING_BROOK 3058.00	RUNNING_BROOK	3058	24.39	23.92	23.82	23.75	23.69	23.62	DESIGN BLOCKAGE 1-2hr
RUNNING_BROOK 3198.00	RUNNING_BROOK	3198	22.04	21.77	21.72	21.65	21.32	21.26	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 3298.00	RUNNING_BROOK	3298	21.17	20.38	20.18	19.88	19.60	19.51	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 3378.00	RUNNING_BROOK	3378	21.16	20.37	20.17	19.87	19.53	19.31	DESIGN BLOCKAGE 2-2hr
RUNNING_BROOK 3524.00	RUNNING_BROOK	3524	21.16	20.37	20.16	19.87	19.53	19.31	DESIGN BLOCKAGE 2-2hr
SHERINGA 1914.00	SHERINGA	1914	22.71	21.98	21.87	21.70	21.19	21.10	DESIGN BLOCKAGE 4-2hr
SHERINGA 1936.00	SHERINGA	1936	20.09	20.05	20.00	19.74	19.58	19.44	DESIGN BLOCKAGE 1-2hr
SHERINGA 1956.00	SHERINGA	1956	21.15	20.13	19.99	19.77	19.58	19.44	DESIGN BLOCKAGE 1-2hr
SPRINGHILL-N 8130.00	SPRINGHILL-N	8130	9.31	6.86	6.86	6.86	6.86	6.86	DESIGN BLOCKAGE 1-0.5hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
SPRINGHILL-N 8160.00	SPRINGHILL-N	8160	9.31	5.07	5.07	5.07	5.07	5.07	DESIGN BLOCKAGE 1-0.5hr
SPRINGHILL-N 8234.00	SPRINGHILL-N	8234	9.31	4.20	3.74	3.46	3.46	3.46	DESIGN BLOCKAGE 2-6hr
SPRINGHILL-N 8274.00	SPRINGHILL-N	8274	9.31	4.20	3.72	3.46	3.46	3.46	DESIGN BLOCKAGE 2-6hr
SPRINGHILL-N 8744.00	SPRINGHILL-N	8744	9.31	4.20	3.67	3.16	3.16	3.16	DESIGN BLOCKAGE 2-6hr
SPRINGHILL-N 8760.00	SPRINGHILL-N	8760	9.31	4.20	3.67	3.16	3.16	3.16	DESIGN BLOCKAGE 2-6hr
SPRINGHILL-S 8130.00	SPRINGHILL-S	8130	9.72	4.80	4.59	3.50	3.50	3.50	DESIGN BLOCKAGE 1-6hr
SPRINGHILL-S 8160.00	SPRINGHILL-S	8160	9.33	4.80	4.59	4.29	4.29	4.29	DESIGN BLOCKAGE 1-6hr
SPRINGHILL-S 8234.00	SPRINGHILL-S	8234	7.69	4.80	4.59	4.50	4.50	4.50	DESIGN BLOCKAGE 1-6hr
SPRINGHILL-S 8274.00	SPRINGHILL-S	8274	9.39	4.56	4.50	4.50	4.50	4.50	DESIGN BLOCKAGE 1-6hr
TRESNAN 5.00	TRESNAN	5	19.29	18.69	18.64	18.53	18.34	18.20	DESIGN BLOCKAGE 2-2hr
TRESNAN 50.00	TRESNAN	50	18.00	17.94	17.93	17.92	17.87	17.85	DESIGN BLOCKAGE 2-0.5hr
UNANDERRA_CULV 5370.00	UNANDERRA_CULV	5370	9.87	9.26	9.23	9.19	8.22	8.19	DESIGN BLOCKAGE 3-2hr
UNANDERRA_CULV 5394.00	UNANDERRA_CULV	5394	9.87	9.26	9.23	9.19	8.05	8.01	DESIGN BLOCKAGE 3-2hr
UNANDERRA_CULV 5414.00	UNANDERRA_CULV	5414	9.87	9.26	9.23	9.19	8.01	7.96	DESIGN BLOCKAGE 3-2hr
UNANDERRA_DRAIN 4454.00	UNANDERRA_DRAIN	4454	17.75	17.73	17.73	17.73	17.73	17.73	DESIGN BLOCKAGE 1-0.5hr
UNANDERRA_DRAIN 4500.00	UNANDERRA_DRAIN	4500	17.37	17.36	17.35	17.34	17.34	17.34	DESIGN BLOCKAGE 1-1hr
UNANDERRA_DRAIN 4596.00	UNANDERRA_DRAIN	4596	14.83	14.77	14.75	14.73	14.72	14.71	DESIGN BLOCKAGE 1-2hr
UNANDERRA_DRAIN 4744.00	UNANDERRA_DRAIN	4744	12.87	12.75	12.73	12.71	12.70	12.69	DESIGN BLOCKAGE 1-2hr
UNANDERRA_DRAIN 4760.00	UNANDERRA_DRAIN	4760	12.63	12.57	12.56	12.56	12.55	12.55	DESIGN BLOCKAGE 1-2hr
UNANDERRA_DRAIN 4832.00	UNANDERRA_DRAIN	4832	11.98	11.89	11.88	11.86	11.85	11.84	DESIGN BLOCKAGE 1-2hr
UNANDERRA_DRAIN 4892.00	UNANDERRA_DRAIN	4892	11.49	11.37	11.36	11.34	11.32	11.30	DESIGN BLOCKAGE 1-2hr
UNANDERRA_DRAIN 4908.00	UNANDERRA_DRAIN	4908	11.06	10.98	10.97	10.95	10.94	10.93	DESIGN BLOCKAGE 3-2hr
UNANDERRA_DRAIN 4982.00	UNANDERRA_DRAIN	4982	10.29	10.15	10.13	10.11	10.09	10.07	DESIGN BLOCKAGE 1-0.5hr
UNANDERRA_DRAIN 5096.00	UNANDERRA_DRAIN	5096	9.88	9.48	9.44	9.37	9.29	9.25	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5160.00	UNANDERRA_DRAIN	5160	9.88	9.32	9.28	9.23	9.08	9.02	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5192.00	UNANDERRA_DRAIN	5192	9.88	9.30	9.27	9.22	9.06	9.01	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5288.00	UNANDERRA_DRAIN	5288	9.87	9.26	9.24	9.20	9.04	8.99	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5326.00	UNANDERRA_DRAIN	5326	9.88	9.26	9.23	9.20	9.04	8.99	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5400.00	UNANDERRA_DRAIN	5400	9.87	9.24	9.21	9.18	9.03	8.98	DESIGN BLOCKAGE 2-2hr
UNANDERRA_DRAIN 5454.00	UNANDERRA_DRAIN	5454	9.87	8.16	8.03	7.85	7.19	7.10	DESIGN BLOCKAGE 7-6hr
UNANDERRA_DRAIN 5674.00	UNANDERRA_DRAIN	5674	9.87	8.15	8.02	7.84	6.39	6.32	DESIGN BLOCKAGE 7-6hr
UNANDERRA_DRAIN 5974.00	UNANDERRA_DRAIN	5974	9.87	8.15	8.02	7.84	5.78	5.37	DESIGN BLOCKAGE 7-6hr
UNANDERRA_DRAIN 6054.00	UNANDERRA_DRAIN	6054	9.87	8.14	8.02	7.83	5.74	5.35	DESIGN BLOCKAGE 7-6hr

APPENDIX F - SUMMARY OF HYDRAULIC MODEL RESULTS

MIKE 11	CREEK NAME	CHAINAGE	PMF	100 year ARI	50 year ARI	20 year ARI	10 year ARI	5 year ARI	
			Peak Water Level (mAHD)						Duration and Blockage
UNANDERRA_DRAIN 6254.00	UNANDERRA_DRAIN	6254	9.87	8.14	8.02	7.83	5.66	5.27	DESIGN BLOCKAGE 7-6hr
UNANDERRA_DRAIN 6364.00	UNANDERRA_DRAIN	6364	9.96	6.87	6.55	6.05	5.61	5.25	DESIGN BLOCKAGE 6-6hr
UNANDERRA-5I_UNDER 455.00	UNANDERRA-5I_UNDER	455	10.04	9.59	9.56	9.56	9.53	9.50	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 90.00	UNANDERRA-N	90	13.20	12.51	12.34	12.33	12.02	12.02	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 180.00	UNANDERRA-N	180	12.38	11.60	11.44	11.43	11.25	11.25	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 270.00	UNANDERRA-N	270	11.49	11.06	10.97	10.96	10.84	10.83	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 430.00	UNANDERRA-N	430	10.33	9.88	9.83	9.82	9.80	9.78	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 480.00	UNANDERRA-N	480	10.06	9.61	9.54	9.52	9.46	9.41	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 520.00	UNANDERRA-N	520	9.88	8.64	8.57	8.48	8.42	8.41	DESIGN BLOCKAGE 4-2hr
UNANDERRA-N 620.00	UNANDERRA-N	620	9.87	8.15	8.02	7.91	7.85	7.79	DESIGN BLOCKAGE 7-6hr
UNANDERRA-N 710.00	UNANDERRA-N	710	9.83	8.15	8.02	7.91	7.83	7.77	DESIGN BLOCKAGE 7-6hr
UNANDERRA-N 740.00	UNANDERRA-N	740	9.83	8.14	8.02	7.83	7.30	7.26	DESIGN BLOCKAGE 7-6hr
UNANDERRA-S 0.00	UNANDERRA-S	0	15.52	14.28	13.41	13.31	13.31	13.31	DESIGN BLOCKAGE 4-2hr
UNANDERRA-S 120.00	UNANDERRA-S	120	15.50	14.39	14.15	14.15	14.15	14.15	DESIGN BLOCKAGE 4-2hr
WALLA-BELLV 322.00	WALLA-BELLV	322	15.50	15.27	15.22	15.16	15.03	14.97	DESIGN BLOCKAGE 2-2hr
WALLA-BELLV 360.00	WALLA-BELLV	360	15.73	15.42	15.35	15.26	15.06	14.93	DESIGN BLOCKAGE 2-2hr
WALLA-BELLV 386.00	WALLA-BELLV	386	14.83	14.70	14.67	14.63	14.55	14.55	DESIGN BLOCKAGE 2-2hr
WESTFIELD 4232.00	WESTFIELD	4232	15.08	14.73	14.69	14.61	14.59	14.59	DESIGN BLOCKAGE 2-2hr
WESTFIELD 4264.00	WESTFIELD	4264	14.96	14.34	14.23	14.07	13.85	13.85	DESIGN BLOCKAGE 2-2hr
WESTFIELD 4338.00	WESTFIELD	4338	14.31	13.95	13.90	13.82	13.68	13.68	DESIGN BLOCKAGE 2-2hr
WESTFIELD 4428.00	WESTFIELD	4428	14.24	13.80	13.78	13.75	13.60	13.60	DESIGN BLOCKAGE 2-2hr
WESTFIELD 4542.00	WESTFIELD	4542	14.05	13.07	13.06	13.04	13.01	13.01	DESIGN BLOCKAGE 2-2hr

APPENDIX G - SUMMARY OF FLOW RESULTS AT BRIDGES

BRANCH	LOCATION	PMF (m^3/s)		100 year (m^3/s)		50 year (m^3/s)		20 year (m^3/s)		10 year (m^3/s)	5 year (m^3/s)
		Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Open
ALLANS	TOP OF REACH	58	58	34	34	29	29	23	23	19	16
ALLANS	PRINCES HIGHWAY	10	4	2	2	2	1	2	1	2	2
ALLANS	FIVE ISLANDS ROAD	180	164	213	118	199	107	153	92	156	70
ALLANS	F6 (INCLUDING OVERFLOW THROUGH FIVE ISLANDS ROAD AND COAL RAIL	471	440	144	93	120	69	100	45	78	67
ALLANS	SPRINGHILL ROAD	1279	1132	545	431	476	362	385	273	334	261
ALLANS	BHP BRIDGES	1112	880	542	405	474	352	396	269	333	270
ALLANS	OUTLET	1111	888	547	407	478	354	395	270	336	273
AMERICAN CREEK	CORDEAUX ROAD TOP OF REACH	263	263	133	127	110	109	86	86	71	59
AMERICAN CREEK	CORDEAUX ROAD NEAR WILLIAM JAMES DRIVE	464	466	225	224	193	192	152	152	123	102
AMERICAN CREEK	COAL CO RAIL UNDER CORDEAUX ROAD NEAR BOORIA BOLUEVARD	601	599	286	285	248	246	196	194	158	129
AMERICAN CREEK	COAL CO RAIL AND CORDEAUX ROAD NEAR BOORIA BVD	603	603	336	284	263	246	197	194	158	130
AMERICAN CREEK	TOP OF GOVETT CRESCENT	960	961	413	410	357	353	281	279	222	182
AMERICAN CREEK	FIGTREE HIGHSCHOOL FOOTBRIDGE	965	918	368	369	311	310	238	240	190	155
AMERICAN CREEK	PRINCES HIGHWAY	956	913	367	365	310	309	236	239	188	155
AMERICAN CREEK	F6 (INCLUDES BYARONG CREEK)	1355	1226	512	426	454	394	374	261	294	241
AMERICAN CREEK	SOUTH COAST RAILWAY	1179	1203	472	424	402	339	320	254	259	209
BRANCH CREEK	BRANCH AVENUE	96	96	43	43	37	38	30	30	24	20
BRANCH CREEK	O'BRIENS ROAD	121	121	52	52	45	45	35	35	29	24
BRANCH CREEK TRIBUTARY	FOY AVENUE	11	17	4	9	2	8	1	7	1	1
BRANCH CREEK TRIBUTARY	BAKER CRESCENT	20	19	7	10	6	9	4	7	4	4
BRANCH CREEK TRIBUTARY	JACARANDE AVENUE	25	23	7	12	6	10	5	7	5	4
BRANCH CREEK TRIBUTARY	O'BRIENS ROAD	32	33	9	14	8	12	7	9	6	5
BRANDY AND WATER CREEK	TOP OF REACH	398	398	208	208	179	179	143	143	116	94
BRANDY AND WATER CREEK TRIB	TOP OF REACH	20	20	8	8	6	6	5	5	4	3
BYARONG CREEK	TOP OF REACH	342	342	196	196	169	169	133	133	106	87
BYARONG CREEK	KOLOONA AVENUE	387	379	214	210	184	178	144	144	117	93
BYARONG CREEK	URALBA AVENUE	409	411	218	218	179	185	142	140	120	96
BYARONG CREEK	LINDSAY PARK PUBLIC SCHOOL FOOTBRIDGE	433	436	215	215	179	180	142	138	116	97
BYARONG CREEK	PRINCES HIGHWAY	440	448	206	210	173	177	138	134	111	91
BYARONG CREEK	THE AVENUE	716	363	158	289	136	204	110	152	88	72
BYARONG CREEK	F6 (INCLUDES AMERICAN CREEK FLOW)	1355	1226	512	426	454	394	374	261	294	241
CHARCOAL	UPSTREAM OF SANDALWOOD ROAD	46	46	27	27	24	24	18	18	15	12
CHARCOAL	RIVER OAK ROAD	61	61	36	36	30	30	24	24	19	15
CHARCOAL	WAPLES ROAD AT SUSAN PLACE	74	74	43	43	37	37	27	29	22	17

APPENDIX G - SUMMARY OF FLOW RESULTS AT BRIDGES

BRANCH	LOCATION	PMF (m^3/s)		100 year (m^3/s)		50 year (m^3/s)		20 year (m^3/s)		10 year (m^3/s)	5 year (m^3/s)
		Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Open
CHARCOAL	WAPLES ROAD	86	86	48	48	41	42	30	33	23	19
CHARCOAL	BLACKMAN PARADE	103	95	52	49	45	43	35	34	28	22
CHARCOAL	TALLEGALLA ST FOOTBRIDGE	251	245	116	111	96	105	81	79	59	48
CHARCOAL	PRINCES HIGHWAY	360	307	124	112	92	96	71	74	58	47
CHARCOAL	SOUTH COAST RAILWAY	684	761	357	489	88	383	70	307	57	46
CHARCOAL	BERKELEY ROAD	357	333	155	152	131	127	106	99	86	71
CHARCOAL MAJOR TRIB	COACHWOOD DRIVE	123	123	63	64	54	54	42	42	34	27
CHARCOAL MAJOR TRIB	BLACKMAN PARADE	140	139	72	70	62	61	47	47	38	30
COROADO HEIGHTS	ALUKEA ROAD	69	69	27	30	22	25	18	19	15	12
COROADO HEIGHTS	CENTRAL ROAD	54	51	26	23	22	19	18	15	15	12
COROADO HEIGHTS	COAL COMPANY RAILWAY	56	49	22	17	20	14	17	11	15	12
COROADO HEIGHTS	CORDEAUX ROAD	59	52	23	18	21	15	18	11	15	12
COROADO HEIGHTS	GIBBSON ROAD	64	55	24	19	22	16	19	11	16	13
FREEWAY BRANCH	TOP OF REACH	27	27	13	13	11	11	9	9	8	7
FREEWAY BRANCH	BERKELEY ROAD (SOUTH)	30	32	9	9	8	7	6	5	5	5
FREEWAY BRANCH	BERKELEY ROAD (NORTH)	52	55	17	15	15	13	12	9	10	9
FREEWAY BRANCH	F6 NORTHBOUND OFF RAMP	49	1	33	1	30	1	23	1	16	12
FREEWAY BRANCH	F6 FREEWAY	51	1	33	1	30	1	23	1	16	12
FREEWAY BRANCH	FIVE ISLANDS ROAD	53	2	34	1	31	1	23	1	17	12
HIGHWAY BRANCH	TOP OF REACH	1	1	1	1	1	1	1	1	1	1
HIGHWAY BRANCH	NOLAN STREET	97	95	43	42	36	36	29	29	23	20
HIGHWAY BRANCH TRIB	DOYLE AVENUE	45	45	21	21	18	18	14	14	12	10
JENKINS CREEK	TOP OF REACH	52	52	33	33	28	28	23	23	19	16
JENKINS CREEK	WAPLES ROAD	70	70	34	37	29	32	22	25	19	17
JENKINS CREEK	PRINCES HIGHWAY	79	69	35	38	30	33	24	25	21	19
JENKINS CREEK	SOUTH COAST RAILWAY	70	9	33	6	29	5	23	4	21	19
RUNNING BROOK	JACARANDA AVENUE	17	17	11	11	10	10	8	8	7	6
RUNNING BROOK	CYPRESS AVENUE	22	22	12	13	10	12	8	9	6	6
RUNNING BROOK	KOLOONA AVENUE	28	28	15	15	12	13	9	11	8	7
RUNNING BROOK	URALBA STREET	44	44	20	23	17	20	14	16	12	10
SWIMMING POOL	GRACE STREET	71	72	37	38	31	32	25	25	19	16
SWIMMING POOL	RICKARDS STREET	21	21	9	9	8	8	7	7	6	5
SWIMMING POOL	COAL COMPANY RAIL	52	47	26	20	23	18	19	15	19	15
SWIMMING POOL	SOUTH COAST RAILWAY	29	0	20	0	19	0	17	0	15	13
SWIMMING POOL	F6 FREEWAY	45	1	27	1	24	1	18	1	14	12