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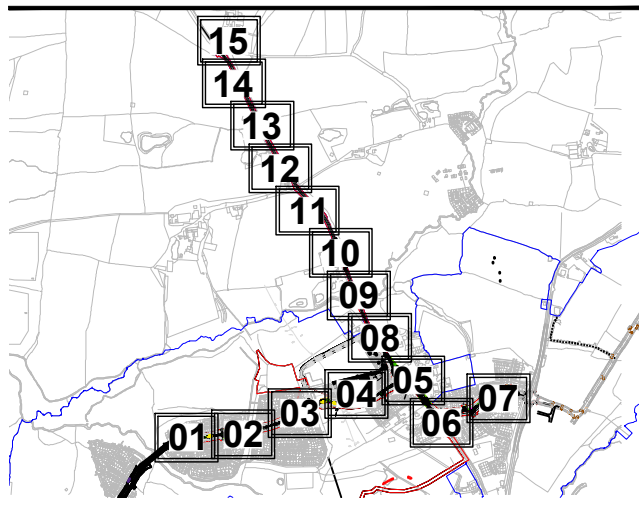
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	Land Ownership Boundary
	Road Centreline
	Road Kerblines
	Footpath
	Verge
	Stone Inset Edging
	Visibility Splays, unless otherwise stated
	2.4 x 4.2m VS
	Forward Visibility Splay, unless otherwise stated
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	Dropped Kerb
	New Trees
	Root Protection Zone
	Sign Post
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	Lighting Column
	Mini-Ensign bollard
	Block Paved Carriageway 200 x 100 x 50mm Grey Block Pavements
	Planted Verge Refer to Landscape Architects plans
	Grasscrete Maintenance Lay-by Turf or Seed & Topsoil Mix
	Carriageway Ramp
	Flexible Asphalt Carriageway 50mm HRA 30/14 F SURF 40/50. Red Coloured New/Top Heavy Duty 10mm or similar
	Flexible Footway and Cycleway AC6 Dense Surf 100/150, colour as shown

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P04	16/10/2024	ROAD DESIGN AMENDMENTS
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P02	19/12/2023	UPDATE FOLLOWING INTERNAL COORDINATION
P01	10/11/2023	FIRST ISSUE
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KEY PLAN



PROJECT NUMBER

60610807

SHEET TITLE

ADOPTABLE HIGHWAY
GENERAL ARRANGEMENT
SHEET 12

SHEET NUMBER

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PROJECT

Brookleigh -
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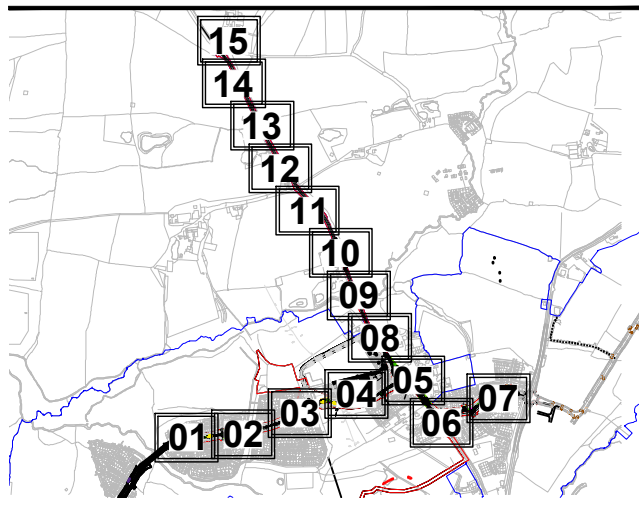
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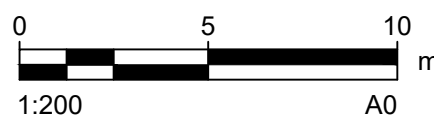
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SHEET 13

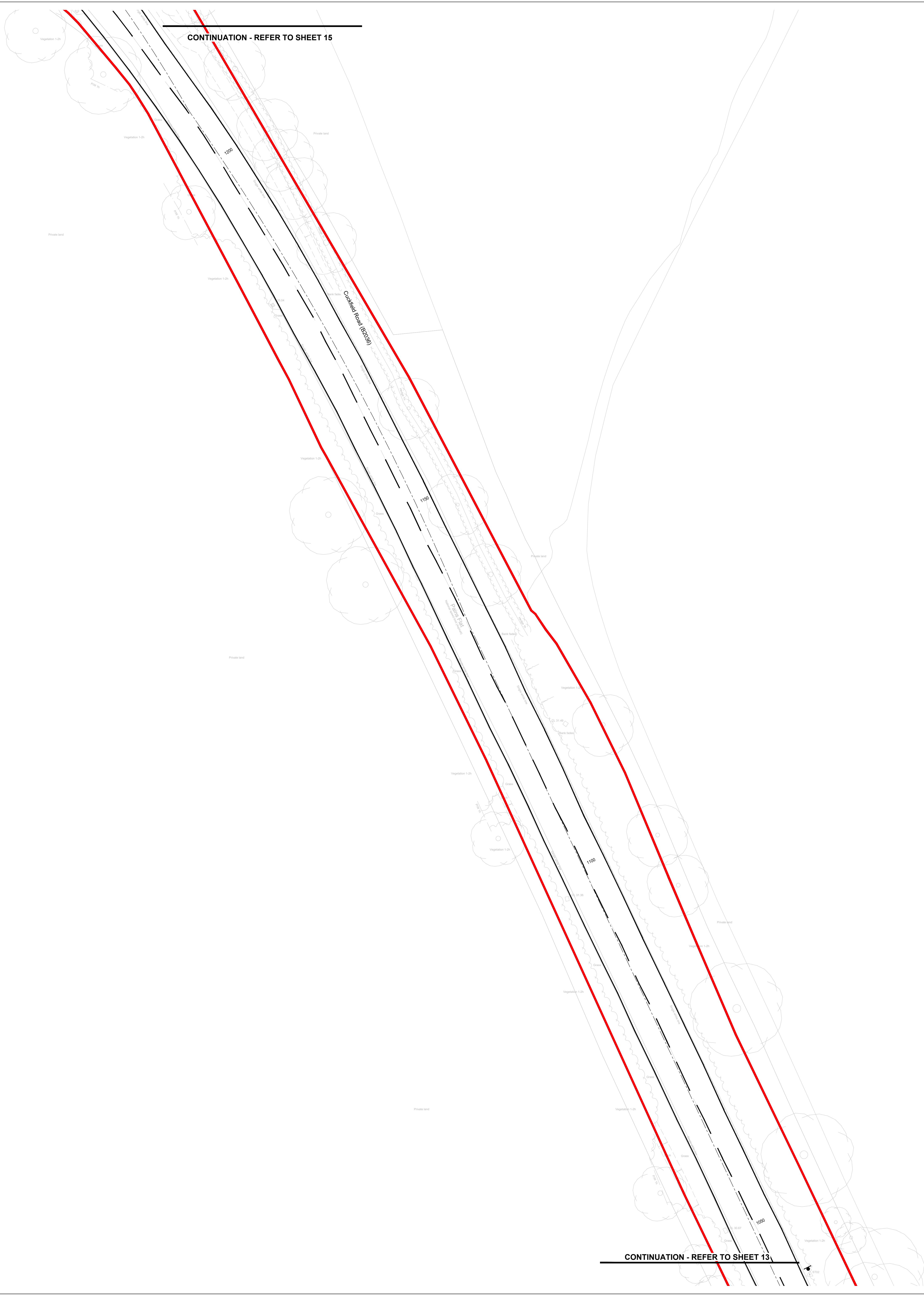
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CONTINUATION - REFER TO SHEET 12





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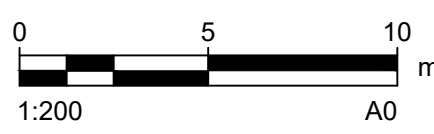
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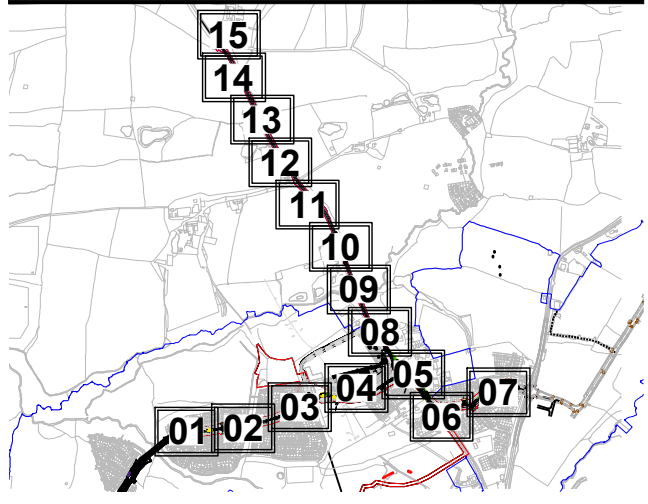
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PROJECT NUMBER

60610807

SHEET TITLE

ADOPTABLE HIGHWAY
GENERAL ARRANGEMENT
SHEET 14

SHEET NUMBER

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PROJECT

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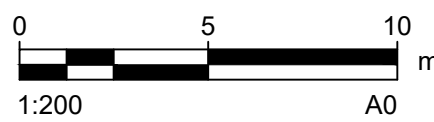
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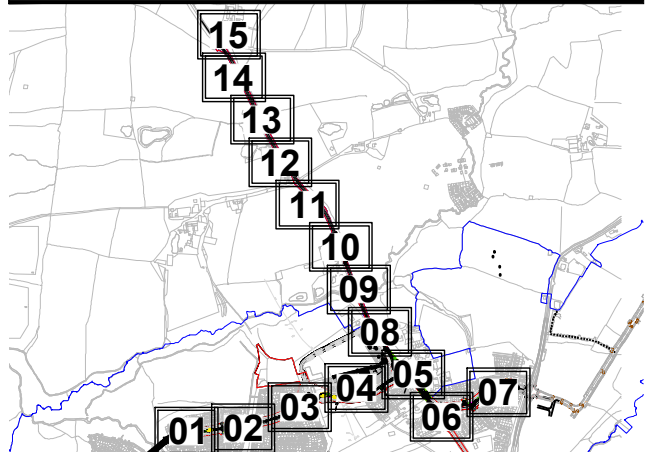
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PROJECT NUMBER

60610807

SHEET TITLE

ADOPTABLE HIGHWAY
GENERAL ARRANGEMENT
SHEET 15

SHEET NUMBER

60610807-ACM-CS-ZZ-DR-HW-00-0115

Appendix C – Hydraulic Modelling of the River Adur, Copyhold Stream and World's End Stream (Base Study)

**Hydraulic Modelling of the River
Adur, Copyhold Stream and
World's End Stream
(Base Study)**

**Burgess Hill Northern
Arc Urban Extension**

**Prepared for
Rydon Homes and
Gleeson Strategic Land**

by

**Stuart Michael
Associates Limited**

June 2017



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SMA Ref: 4909/H2

Issue Status: 02

DOCUMENT CONTROL			
Project	Burgess Hill Northern Arc Urban Extension, West Site		
Job No.	4909		
Document Title	Hydraulic Modelling of River Adur, Copyhold Stream and World End's Stream (Base Study)		
File Location	N:\Admin Project\4900 to 4999\4909 - Burgess Hill, Northern Arc\Reports\Hydraulic Model\H2 Hydraulic Model		
Prepared by	R. J. Mackley	Date	16/10/15
Reviewed by	T. S. Wood	Date	16/10/15
Approved by	R. M. E. Hewitt	Date	16/10/15
Document Issue	Description / Changes	Revised by	Date
01	For EA review	RM	16/10/15
02	Addendum reflecting EA and MSDC comments	GB	30/6/17



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EXECUTIVE SUMMARY

This report has been updated to reflect comments from the Environment Agency (EA) and Mid Sussex District Council (MSDC) following an outline planning application, reference DM/16/3947, for the first and second phases of the Burgess Hill Northern Arc (BHNA) urban extension.

The hydraulic model was initially submitted 16. October 2015 and approved 16. November 2015 by the EA, reference PAC/SLTSDN/0040 (**Appendix A**).

EA climate change allowances for Flood Risk Assessments were updated in February 2016. This advice updates previous climate change allowances to support the National Planning Policy Framework (NPPF).

The climate change allowances include predictions of anticipated change for peak river flows by river basin district.

The River Adur (RA) and its tributaries are situated within the South East River Basin District, which could see a potential change in peak river flows for the 2080's (2070 to 2115) of up to 105%. Therefore, a range of climate change allowances up to 105% increase in peak flows have been considered and applied to the existing model of the RA and Copyhold Stream (CHS).

The World's End Stream (WES) is a tributary of the River Adur which flows through Phase 1 and 2 of the BHNA. As requested by the EA and MSDC, the WES has been modelled, included a range of climate change allowances up to 105%.

An assessment of the culvert beneath Freek's Lane, including a range of blockage scenarios, has been included in the latest model as requested by MSDC.

This report confirms that, taking the above into consideration, there will be no increase in fluvial flood risk to the Site.



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8.0 RESULTS	14
9.0 CONCLUSIONS	15

FIGURES

Figure 1	SITE LOCATION PLAN
Figure 2	PLAN OF CROSS SECTION LOCATIONS
Figure 3	MODELLED CROSS-SECTIONS
Figure 4	FLOOD MAP BLOCKAGE SCENARIOS
Figure 5	FLOOD MAP

APPENDICES

Appendix A	EA RESPONSE LETTER – November 2015
Appendix B	EA RESPONSE LETTER – April 2015
Appendix C	HEC-RAS STANDARD RESULTS TABLE



ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
CC	Climate change allowances
CHS	Copyhold Stream
EA	Environment Agency
FEH	Flood Estimation Handbook
GGWWTW	Goddards Green Waste Water Treatment Works
ha	Hectares
HEC-RAS	Hydrologic Engineering Centre - River Analysis Software
m	Meters
mm	Millimetres
MSDC	Mid Sussex District Council
ReFH	Revitalised Flood Hydrograph
SMA	Stuart Michael Associates
RA	River Adur
WES	World's End Stream



1.0 INTRODUCTION

- 1.1 Stuart Michael Associates Limited (SMA), consulting engineers, has prepared this hydraulic modelling report, hereafter referred to as the 'report', on behalf of both Rydon Homes (RH) and Gleeson Strategic Land (GSL), hereafter referred to as the 'clients'.
- 1.2 This report is to be read in conjunction with the SMA report: Hydrological Assessment of the River Adur and Copyhold Stream, SMA Ref: 4909/H1.
- 1.3 SMA has been instructed by the clients to investigate the extent of flooding along the reaches of the River Adur (RA) and Copyhold Stream (CHS) which are situated adjacent to the proposed residential development, referred to as Burgess Hill Northern Arc (BHNA) and hereafter referred to as the 'Site'.
- 1.4 In 2011, Hyder Consulting Limited (HCL) produced a hydraulic model of the RA using the river analysis software ISIS. This model was used to predict the flood levels for the River Adur up to the 0.1% probability (1 in 1000 year) surface water flood event.
- 1.5 As agreed with the Environment Agency (EA), a revised hydraulic model for the east branch of the RA and the CHS is required. The EA's response letter dated 7 April 2015 confirming this is attached as **Appendix B**.
- 1.6 Following comments from the EA and Mid Sussex District Council (MSDC) regarding outline application reference DM/16/394, The World's End Stream (WES) has also been included in the model.
- 1.7 The new hydraulic model will be used to inform a Flood Risk Assessment (FRA) of the proposed BHNA development.

The Site

- 1.8 The Site is located 1.3 miles north of the town centre of Burgess Hill (approx. National Grid Reference: 530530E, 120840N). A location plan is presented as **Figure 1**.
- 1.9 The site currently comprises approximately 180ha of primarily Greenfield, agricultural land, and a golf course located towards the south of the site.



- 1.10 The proposed development consists of 3,500 homes, as well as new sports facilities, a business park and new schools.
- 1.11 A topographical survey of the site, including cross sections of the watercourses, was undertaken by a specialist surveyor - Survey Solutions in April 2015. The topographical Survey was updated March 2017 to include The World's End Stream.
- 1.12 The Survey indicates that levels are generally between 25m AOD and 28m AOD across the Site, with levels falling to between 14m AOD and 16m AOD along the River Adur. The levels of the golf course, in the south, lie between 15m AOD and 23m AOD.
- 1.13 Bed levels of the Copyhold Stream fall from between 20.89m AOD to 14.31m AOD.

Watercourses

- 1.14 There are a number of smaller tributaries of the RA across the Site, the inflows of which have been included into the hydraulic model as outlined in SMA's hydrological assessment of the Site.
- 1.15 The RA and CHS comprise sinuous open channels in well-defined valleys with steep banks. The watercourses converge upstream of the Goddards Green Waste Water Treatment Works (GGWWTW) at a confluence point located towards the west of the Site.
- 1.16 Downstream within the Site, the valley widens around the confluence of the two watercourses to form a floodplain.
- 1.17 The World's End Stream is a sinuous open channel in a well-defined valley with steep banks. It converges with the RA within close proximity to the Site.
- 1.18 There are three existing arch road bridges on Cuckfield Road within the Site, two of which cross the River Adur to the west and south of the Site, with one crossing the Copyhold Stream towards the north.
- 1.19 There is one existing crossing over the WES (Freeke's Lane) where the watercourse passes through a culvert.
- 1.20 All existing bridges and culverts have been included within the hydraulic model.



- 1.21 The cross-sectional areas and conveyance of the bridges are less than the conveyance of the channels which they span.



2.0 METHOD STATEMENT AND JUSTIFICATION

Selecting the type of model

- 2.1 As agreed with the EA in its letter dated 7 April 2015, a one-dimensional analysis approach for the hydraulic model was determined to be sufficiently appropriate for the purposes of this study. The RA, the WES and CHS all have a relatively flat floodplain, indicating that areas of storage are negligible. Two-dimensional analysis was therefore not required for the study.
- 2.2 A steady-state analysis was undertaken on the hydraulic model, which assumes that the water levels remains constant with exclusive respect to time. This is justified by the relatively flat and constant gradient of the river bed and flood plain across the Site.

Selecting the modelling software

- 2.3 The modelling software which was chosen for this updated study was HEC-RAS version 5.0 released February 2016. This software is in widespread use across the industry and is listed in the EA's document 'Requirements for completing Computer River modelling for Flood Risk Assessments' as a tool 'well known to the Environment Agency'.
- 2.4 The HEC-RAS version previously used for this report was HEC-RAS 4.1, which was released January 2010 and was outdated when this report was updated.
- 2.5 HEC-RAS 5.0 has improved stability, flood mapping and GIS functionalities and was therefore chosen to update this report.



3.0 DATA SOURCES

- 3.1 A topographical survey of the site was undertaken by Survey Solutions in April 2015. The survey included cross-sectional data of the RA and CHS, as well as smaller tributaries, both within and adjacent to the Site.
- 3.2 The topographical survey was extended in March 2017 to include The World's End Stream.
- 3.3 A digital terrain model (DTM) in the form of LiDAR data based on a 1m grid was used in the hydraulic model. The DTM boundary covered the extents of the RA, WES and CHS passing through and adjacent to the Site. The LiDAR data was exclusively used to determine the levels for the floodplain where no topographical survey data was available. All river channel bank and bed levels were taken from the topographical surveys.
- 3.4 Inflow data for the model was taken from SMA report 'Hydrological Assessment of the River Adur, Copyhold Stream and World's End Stream (SMA report ref 4909/H1 Issue Status 02)', which outlines the procedures for estimation and verification of these values.
- 3.5 The Manning's roughness coefficients for the watercourses were found by comparing site observations and satellite terrain maps sourced from Google with photographic images and 'n' values set out in the textbook 'Open Channel Hydraulics' (Ven T Chow).



4.0 HYDROLOGICAL MODEL

- 4.1 A Hydrological Assessment (Ref: 4909/H1 Issue Status 01) undertaken by SMA was submitted for review to the EA in February 2015.
- 4.2 In its response (letter dated 7 April 2015), the EA confirmed that the Hydrological Assessment was suitable to inform an updated hydraulic model of the River Adur (East Branch) and Copyhold Stream, by which the Site is situated.
- 4.3 The WES was added to the Hydrological Assessment, using the same methodologies as the RA and CHS.
- 4.4 Final design flows for a range of return periods for the RA, CHS and WES are presented in **Table 1**.

Return Period (yrs)	Fitting for Growth Curve (GL)	RA Q (m ³ /s)	CHS Q (m ³ /s)	WES Q (m ³ /s)
2	1.000	7.666	3.935	0.76
5	1.347	10.329	5.301	1.02
10	1.602	12.378	6.304	1.12
25	1.976	15.199	7.776	1.45
50	2.300	17.628	9.051	1.75
100	2.671	20.144	10.511	2.36
200	3.099	23.56	12.195	2.55
500	3.766	28.49	14.820	2.55
1000	4.271	32.046	16.806	3.94
100 + 105%CC	4.715	41.2952	21.54755	4.838

Table 1 Peak flood flows for the River Adur, Copyhold Stream and World's End Stream for a range of return periods.



5.0 HYDRAULIC MODEL

Overview

- 5.1 An updated hydraulic model is required to analyse the RA, CHS and WES to demonstrate the extent of flooding at the proposed development.
- 5.2 EA climate change allowances for Flood Risk Assessments were updated in February 2016. This advice updates previous climate change allowances to support the National Planning Policy Framework (NPPF). The new climate change allowances have been included in the hydraulic model.
- 5.3 The RA, WES and CHS have well-defined floodplains. As a result, there are no distinctive flood storage areas/temporary reservoirs in the flood plain extending across the Site.
- 5.4 Cross-sectional data used to develop the model was obtained from a topographical survey undertaken by Survey Solutions. Additional work was undertaken by Survey Solutions in March 2017 to survey the reaches of the WES that pass through the Site. A plan outlining the survey and cross-section locations is reproduced as **Figure 2**. Cross-sectional drawings of the modelled system are produced as **Figure 3**.
- 5.5 Where no topographical survey could be provided due to physical or land ownership constraints, LiDAR data was used to determine the levels of the extensions of the cross-sections to the flood plain boundary.

Modelling Approach

- 5.6 The hydraulic modelling software HEC-RAS version 5.0 was used to produce a one-dimensional steady-state backwater model of the RA, CHS tributary and WES as required for the purposes of this study.
- 5.7 The modelled river system was divided into reaches and schematised by nodes at which cross-sections were surveyed. The RA was modelled as three reaches, one upstream of the confluence point with the WES, one downstream of the confluence point until the confluence point with the CHS and one downstream of the confluence point with the CHS. The CHS and WES was each modelled as a single reach.
- 5.8 A summary of the reaches and cross sections is presented in **Table 2** below.



Reach	Cross Section	Reach Description
River Adur (Lower Reach)	RA.001-RA.035	Sections of the River Adur immediately downstream of the confluence point with CHS.
River Adur (Upper Reach)2	RA.040-RA.138	Sections of the River Adur immediately upstream of the confluence point with CHS.
River Adur (Upper Reach)	RA upper 140-RA upper174	Sections of the River Adur immediately upstream of the confluence point with WES.
Copyhold Stream	CHS.001-CHS.036	Sections of the Copyhold Stream upstream of the confluence point with RA.
World's End Stream	WES 001-WES 028	Sections of the World's End Stream upstream of the confluence point with RA.

Table 2 River reaches and cross-sections



6.0 PARAMETERS

Manning's roughness coefficient (n)

- 6.1 Manning's roughness coefficients (n) for the watercourses, their banks and floodplains were estimated following a visual inspection of the watercourses and by reference to the publication *Open Channel Hydraulics* (Ven T Chow, 1959).
- 6.2 A value of 0.030 was assumed for the main channel. The left and right overbanks which form the floodplain of the River Adur and Copyhold Stream vary in nature and description. The various floodplain descriptions and corresponding Manning's coefficients taken from Ven T Chow are shown in **Table 3** below.

Floodplain Description	Manning's roughness coefficient (n)
Short grass pasture, no brush	0.030
Scattered brush pasture	0.050
Light brush and trees	0.060

Table 3 Manning's coefficients for the river floodplains

Inflows

- 6.3 The inflows for the hydraulic model were previously determined during a hydrological assessment undertaken by SMA.

Boundary Conditions

- 6.4 Mixed flow regimes require both upstream and downstream boundary conditions for each of the reaches in the river model. In each case, critical depth was chosen as both the upstream and downstream boundary conditions.

Structural Coefficients

- 6.5 The structural coefficients used for the HEC-RAS model were determined by referring to the HEC-RAS Hydraulic Reference Manual.
- 6.6 Contraction, expansion and weir coefficients (k) for all the structures were taken from the standard values presented within the HEC-RAS computer model.
- 6.7 Contraction and expansion coefficients for the bridges were set at 0.3 and 0.5 respectively.



- 6.8 The opening of the most downstream existing arch bridge was modelled as a culvert due to the geometry of the hydraulic structure. Coefficients for the entrance and exit losses of the culvert were selected with reference to the HEC-RAS Applications Guide.
- 6.9 The values of the coefficients for the culvert entrance and exit losses were chosen and values of 0.2 and 1.0 respectively.



7.0 SENSITIVITY ANALYSIS

Manning's roughness coefficient (n)

- 7.1 Sensitivity analysis on the Manning's roughness coefficient (n) was undertaken in order to assess the extent to which alterations of the channel roughness affect the calculated surface water level of the river system for each flood event.
- 7.2 The results of globally altering the Manning's 'n' values at five cross-sections within the hydraulic model are shown in **Table 5** below.
- 7.3 The results show that globally altering the Manning's value has caused a maximum change in water surface elevation of less than 2% in all cases.

X-section	Manning's	100yr Water Level (m)	100yr ^{+105%} Water Level (m)
RA 004 River Adur (Lower Reach)	n ^{-20%}	16.24	17.19
	n ^{-10%}	16.24	17.19
	n	16.24	17.19
	n ^{+10%}	16.24	17.19
	n ^{+20%}	16.24	17.19
RA 035 River Adur (Confluence)	n ^{-20%}	16.65	17.36
	n ^{-10%}	16.70	17.40
	n	16.75	17.43
	n ^{+10%}	16.80	17.46
	n ^{+20%}	16.85	17.50
CHS 013 Copyhold Stream	n ^{-20%}	19.56	20.19
	n ^{-10%}	19.64	20.19
	n	19.73	20.19
	n ^{+10%}	19.81	20.19
	n ^{+20%}	19.84	20.19
RA 090 River Adur (Upper Reach)	n ^{-20%}	17.98	18.45
	n ^{-10%}	18.03	18.49
	n	18.09	18.53
	n ^{+10%}	18.13	18.57
	n ^{+20%}	18.19	18.62
RA 146 River Adur (Upper Reach)	n ^{-20%}	20.73	22.72
	n ^{-10%}	20.77	22.73
	n	20.97	22.73
	n ^{+10%}	21.11	22.74
	n ^{+20%}	21.23	22.75

Table 4 Results of the sensitivity test on altering the Manning's roughness coefficient (n)



Model Inflows

- 7.4 The results from the sensitivity analysis of the model inflows is presented in **Table 5** below.
- 7.5 The results show that globally altering the inflows has caused a maximum change in water surface elevation of less than 2.5% in all cases.

X-section	Total Inflow	100yr Water Level (m)	100yr ^{+105%} Water Level (m)
RA 004 River Adur (Lower Reach)	Q ^{-10%}	16.23	16.92
	Q	16.24	17.19
	Q ^{+10%}	16.25	17.47
RA 035 River Adur (Confluence)	Q ^{-10%}	16.68	17.27
	Q	16.75	17.43
	Q ^{+10%}	16.82	17.63
CHS 013 Copyhold Stream	Q ^{-10%}	19.65	20.31
	Q	19.73	20.19
	Q ^{+10%}	19.81	20.24
RA 090 River Adur (Upper Reach)	Q ^{-10%}	18.02	18.47
	Q	18.09	18.53
	Q ^{+10%}	18.14	18.59
RA 146 River Adur (Upper Reach)	Q ^{-10%}	20.73	22.16
	Q	20.97	22.73
	Q ^{+10%}	21.29	23.39

Table 5 Results of the Sensitivity Test on altering the inflows

- 7.6 Boundary conditions are necessary to establish the starting water surface at the upstream and downstream sections of the river system. In mixed flow regime (sub-critical and super-critical) calculations, boundary conditions must be applied at all end stations of the modelled river system.
- 7.7 The boundary conditions for the hydraulic model were varied by altering the input option from critical depth to normal depth. HEC-RAS offers alternative methods of boundary condition input including a known water elevation value and a gradient input option. However, as the River Adur is ungauged, no known surface water elevation data was available for input. Therefore the sensitivity test on the boundary conditions for the modelled river system only evaluates the difference between selecting the critical depth and normal depth option.



7.8 The results of the sensitivity test on the boundary conditions for the hydraulic model are shown in **Table 7** below.

The results show that the type of downstream boundary condition selected has no influence on the value of the water surface elevation in the hydraulic model.

X-section	DS Boundary Condition at RA 001	100yr Water Level (m)	100yr ^{+105%} Water Level (m)
RA 004 River Adur (Lower Reach)	Critical Depth	16.24	17.19
	Normal Depth	16.24	17.19
RA 035 River Adur (Confluence)	Critical Depth	16.75	17.43
	Normal Depth	16.75	17.43
CHS 013 Copyhold Stream	Critical Depth	19.73	20.19
	Normal Depth	19.73	20.19
RA 090 River Adur (Upper Reach)	Critical Depth	18.09	18.53
	Normal Depth	18.09	18.53
RA 146 River Adur (Upper Reach)	Critical Depth	20.97	22.73
	Normal Depth	20.97	22.73

Table 6 Results of the Sensitivity Test on altering the downstream boundary condition

Culvert entrance and exit loss coefficients

7.9 The results of the sensitivity testing on the entrance and exit loss coefficients of the culvert used in the hydraulic model are presented in **Table 7** and **Table 8** respectively below.

X-section	Culvert entry coefficient	100yr Water Level (m)	100yr ^{+105%} Water Level (m)
RA 004 River Adur (Lower Reach)	$k_{en}^{-10\%}$	16.24	17.19
	k_{en}	16.24	17.19
	$k_{en}^{+10\%}$	16.24	17.19
RA 035 River Adur (Confluence)	$k_{en}^{-10\%}$	16.75	17.43
	k_{en}	16.75	17.43
	$k_{en}^{+10\%}$	16.75	17.43

Table 7 Results of the Sensitivity Test on altering the culvert entrance loss coefficients



X-section	Culvert exit coefficient	100yr Water Level (m)	100yr ^{+20%} Water Level (m)
RA 004 River Adur (Lower Reach)	$k_{ex}^{-10\%}$	16.24	17.19
	k_{ex}	16.24	17.19
	$k_{ex}^{+10\%}$	16.24	17.19
RA 035 River Adur (Confluence)	$k_{ex}^{-10\%}$	16.75	17.43
	k_{ex}	16.75	17.43
	$k_{ex}^{+10\%}$	16.75	17.43

Table 8 Results of the Sensitivity Test on altering the culvert exit loss coefficients

Blockage Scenarios

- 7.10 The EA requested an assessment of the additional flood risk associated with the blockage of the culvert on WES under Freek's Lane.
- 7.11 In line with Defra/EA guidance Aflux at bridges and culverts W5A-061/TR1, it was decided that 3 different blockage scenarios of the Freek's Lane Culvert, between 0% and 100%, would be modelled. In this instance 20%, 50% and 80% blockage scenarios were modelled.
- 7.12 A flood map showing the resulting water levels for the 20%, 50% and 80% blockage scenario is produced in **Figure 4**.
- 7.13 **Table 9** shows the water level in the immediate downstream cross section WES 017 and the immediate upstream cross section WES 018 for the 1 in 100 year rainfall event with and without additional 105% climate change allowance.



Blockage Scenario	World's End Stream 017	World's End Stream 018
100yr 20% Blockage Water Level (m)	21.98	23.31
100yr 50% Blockage Water Level (m)	21.98	23.33
100yr 80% Blockage Water Level (m)	21.98	23.35
100yr +105%CC 20% Blockage Water Level (m)	22.73	23.38
100yr +105%CC 50% Blockage Water Level (m)	22.73	23.39
100yr +105%CC 80% Blockage Water Level (m)	22.73	23.4

Table 9 Results of the Sensitivity Test on altering the blockage percentage in the culvert underneath Freeks Lane



8.0 RESULTS

- 8.1 A steady flow analysis using a mixed flow regime was undertaken. Mixed flow was chosen as this allows both sub-critical and super-critical flow to be calculated at each location.
- 8.2 Water level information for each cross-section was extracted from the HEC-RAS model and was transposed onto the topographical survey information to predict the extent of flood inundation. **Figure 3** refers.
- 8.3 HEC-RAS provides standard tables of results of the hydraulic analysis undertaken on the model, which shows outputs for peak flow, velocity, water surface elevation, critical depth and Froude's number.
- 8.4 The standard table of results of the hydraulic analysis are presented as **Appendix B**.
- 8.5 The results were used in conjunction with the topographical survey to generate a flood map showing the water elevation for each storm event up to and including the 1 in 100 years + 105% allowance for climate change storm. This flood map is presented as **Figure 5**.
- 8.6 Results for the 100year storm and the 100 year + 105%CC; 20%, 50% and 80% blockage scenarios of the Freek's Lane culvert are presented as **Figure 4**.



9.0 CONCLUSIONS

- 9.1 This report presents an estimation of the flood events up to the 1 in 1000 year probability and the 100year plus 105% CC event for the River Adur, Copyhold Stream and World's End Stream and a blockage analysis on the culvert at the WES based on the HEC-RAS model produced.
- 9.2 Sensitivity tests were undertaken on each of the model parameters used to build the model, and it was concluded that the results were found to only alter by a maximum of less than 2% in each case. This implies that the hydraulic model presents a reasonable estimation of the 1% AEP plus 105% climate change flood event on both the RA and CHS.



Figure 1

Site Location Plan



Legend

— The Site

Site Location

Map Centre

Post Code: Rh15 8RF

Easting: 530400

Northing: 120859

South West Corner

Post Code: BN6 9LQ

Easting: 528190

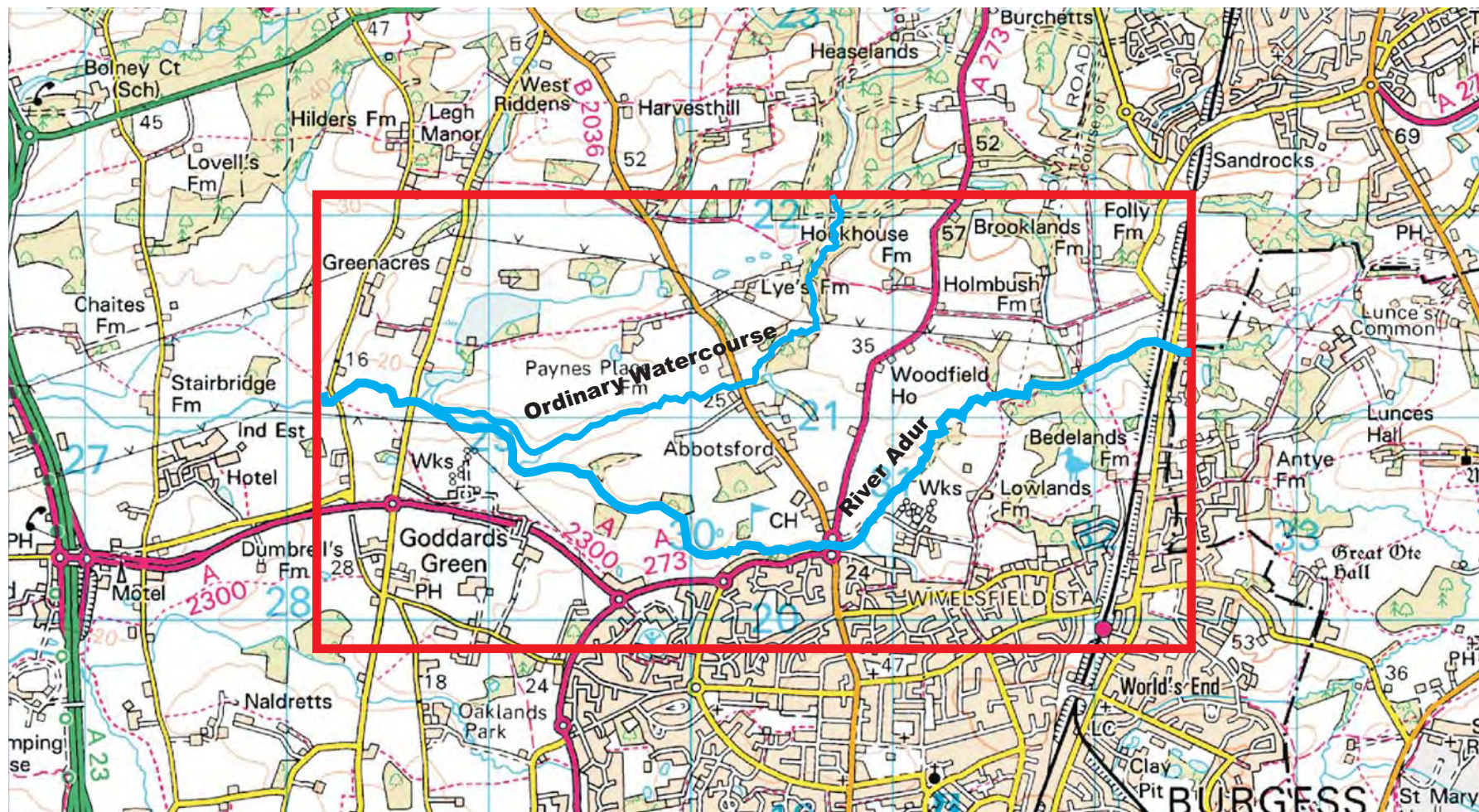
Northing: 119940

North East Corner

Post Code: Rh16 4TW

Easting: 532405

Northing: 122027



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JOB TITLE

Burgess Hill

DRAWING TITLE

Site Location Plan

FIGURE NO.

Figure 1

SCALE:

nts

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Figure 2

Plan of Cross Section Locations



1. ALL LEVELS ARE EXPRESSED IN METRES ABOVE ORDNANCE DATUM NEWLYN.

ORDNANCE DATUM NEWLYN.

2. WATERCOURSE PROFILES, CROSS SECTIONS, INTERMEDIATE NODES AND FLOOD LEVELS ARE SHOWN

3. GROUND LEVELS WITHIN DEVELOPMENT SITE AND

TOPOGRAFICAL SURVEY REF:
740968 04 000 0770 000000000000

PROPERTY

SURVEY

10010700

BASED ON LIDAR DATA.

DESIGN FROM 100% ESTIMATED USING THE STATISTICAL METHOD AS APPROVED BY THE

DETAILED FLOWS, REFER TO SMA REPORT 4909/HI -
'HYDROLOGICAL ASSESSMENT OF THE RIVER ADUR AND

COPYHOLD STREAM.

HYDRAULIC MODELLING.

10

100

REF	DESCRIPTION	UNIT	CURR	DEBIT
REVISIONS				

Screening Issue	Assessed for Terrible
Screening Issue	Assessed for Terrible

Submitted for S278	As BUI	
DRAWING STATUS		

STUART MICHAEL

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Prudman Homes

Johnson
Johnson

[illegible]

URBAN EXTENSION

RIVER ADUR, COPYHOLD STREAM AND

WOLDS END STREAM REACHES AND
SECTIONS PLAN

[illegible]

4909 4005 NTS 2 AN

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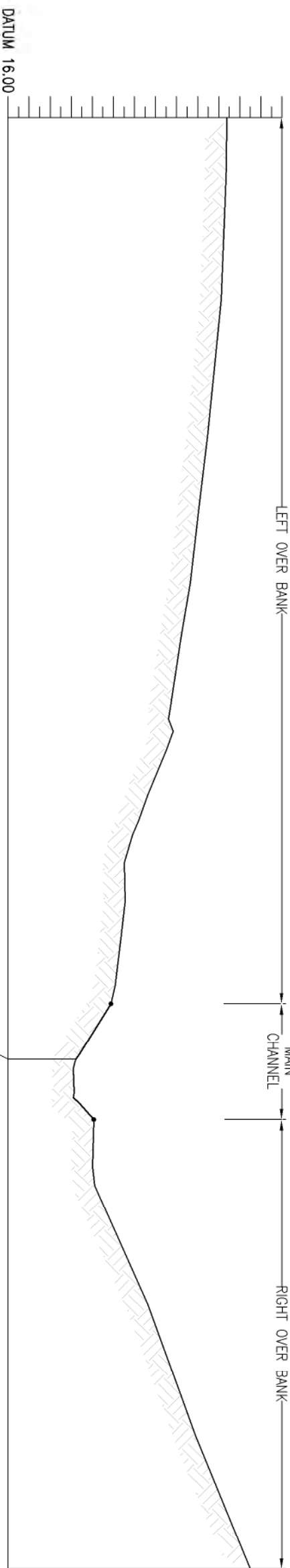


Figure 3

Modelled Cross Sections

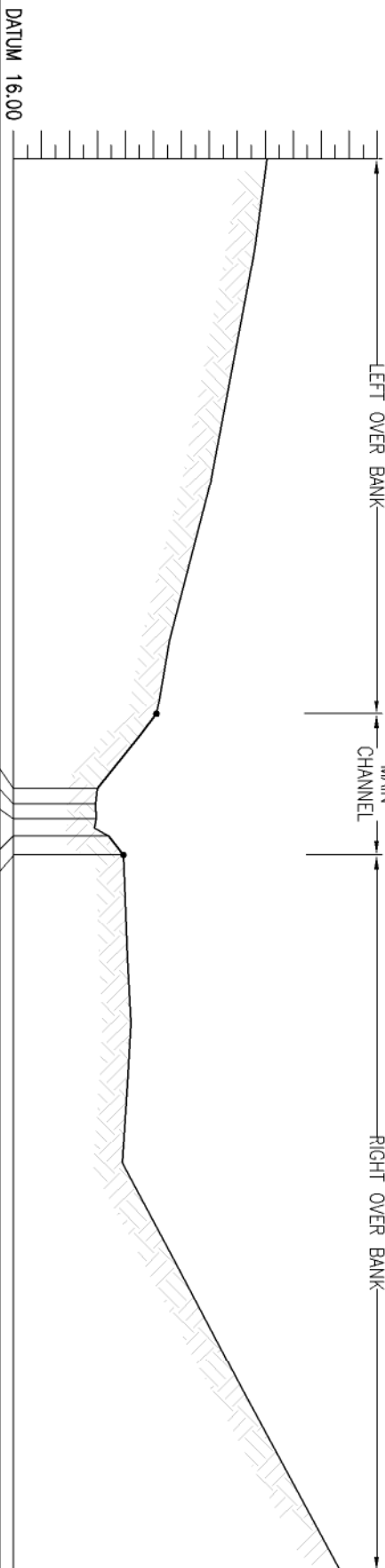
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DISTANCE (m)	0.00	2.94	8.64	15.13	22.09	28.56	28.56	33.32	35.32	37.13	40.95	44.66	45.13	46.48	47.52	49.76	50.65	56.30	62.55	68.87
LEVEL (m)	26.39	26.36	26.13	25.48	24.66	23.62	23.85	22.22	21.52	21.56	21.13	19.24	19.11	20.08	20.02	20.13	22.65	24.90	27.51	
MANNING'S (n)																				
BANK STN. (m)																				



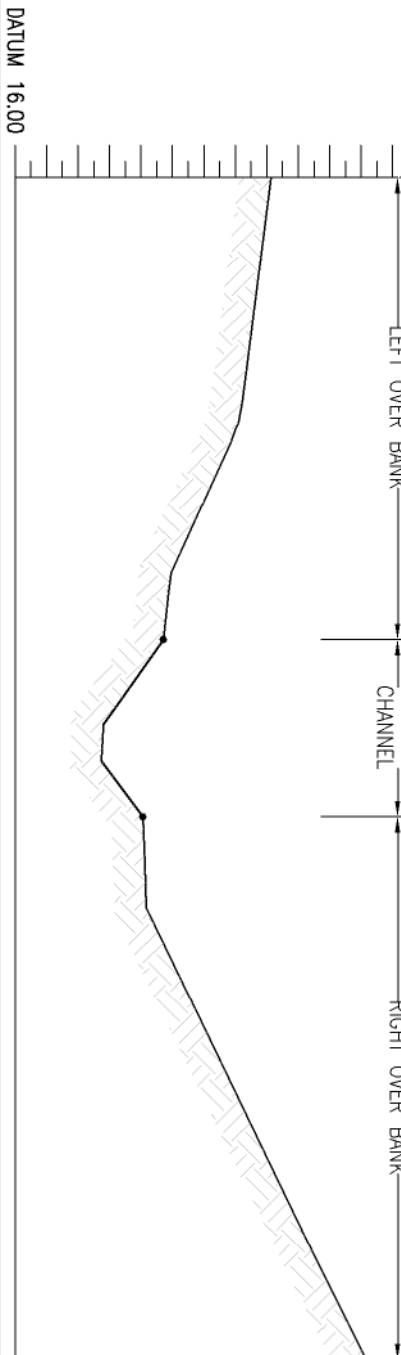
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DISTANCE (m)	0.00	3.01	11.45	17.18	19.84	22.49	23.05	23.05	28.53	30.86	35.87	44.03	50.44
LEVEL (m)	25.07	24.67	23.08	21.60	21.13	18.99	18.94	18.97	20.08	20.20	19.89	24.24	27.70
MANNING'S (n)													
BANK STN. (m)													



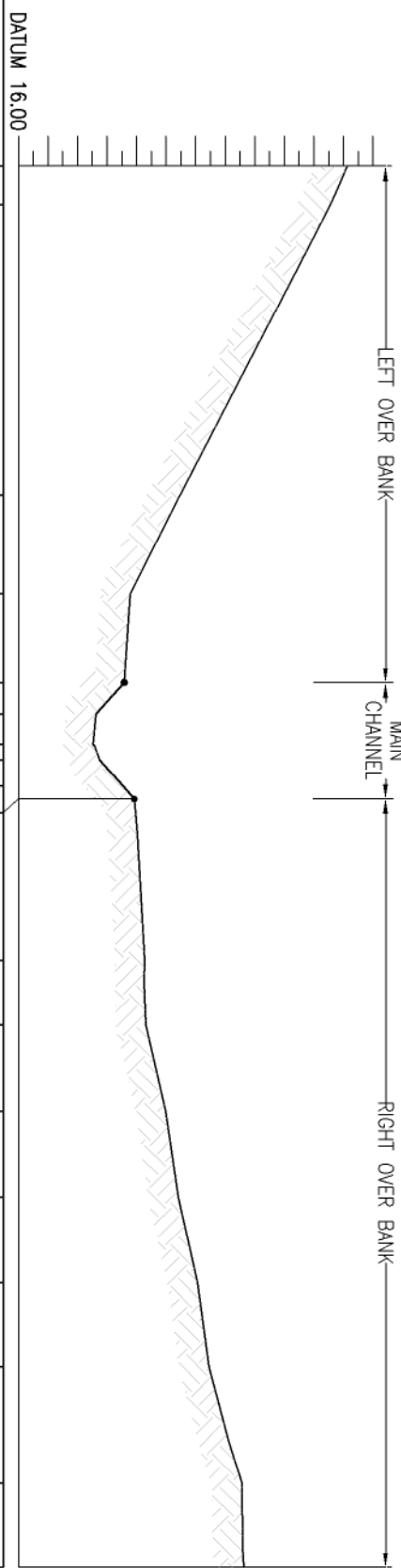
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DISTANCE (m)	0.00	7.16	7.83	12.61	14.71	16.76	17.42	20.35	23.23	34.68	37.60
LEVEL (m)	24.14	23.23	23.10	20.96	20.73	19.29	18.81	20.08	20.18	25.72	27.18
MANNING'S (n)											
BANK STN. (m)											



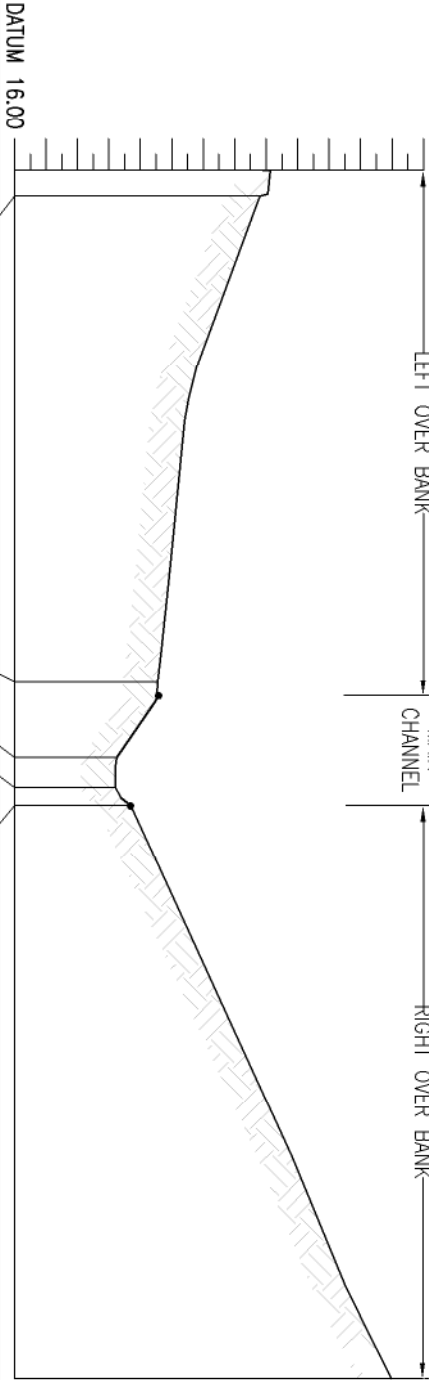
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DISTANCE (m)	0.00	1.30	11.14	14.49	17.48	18.53	18.53	26.86	29.06	31.96	34.85	37.77	40.60	44.54	47.40
LEVEL (m)	27.15	26.57	21.48	19.80	19.58	18.63	18.54	20.29	20.33	21.00	21.42	22.08	22.46	23.58	23.65
MANNING'S (n)															
BANK STN. (m)															



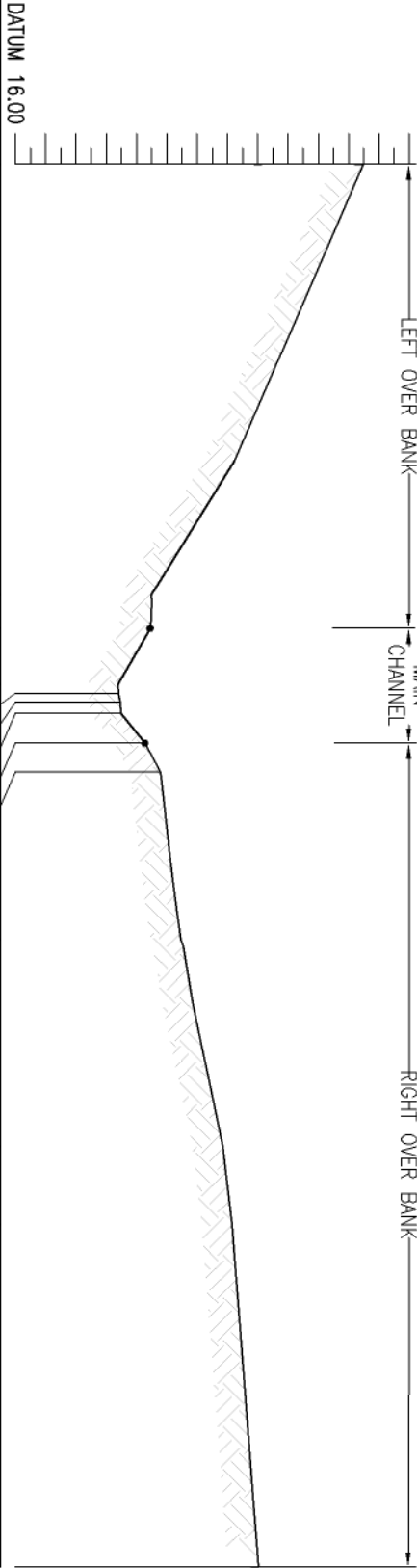
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DISTANCE (m)	0.00	0.81	6.30	7.96	15.21	15.21	15.21	18.66	31.36	35.38	38.42
LEVEL (m)	24.14	24.07	21.79	21.41	20.68	20.55	20.59	19.26	24.83	26.50	27.99
MANNING'S (n)											
BANK STN. (m)											



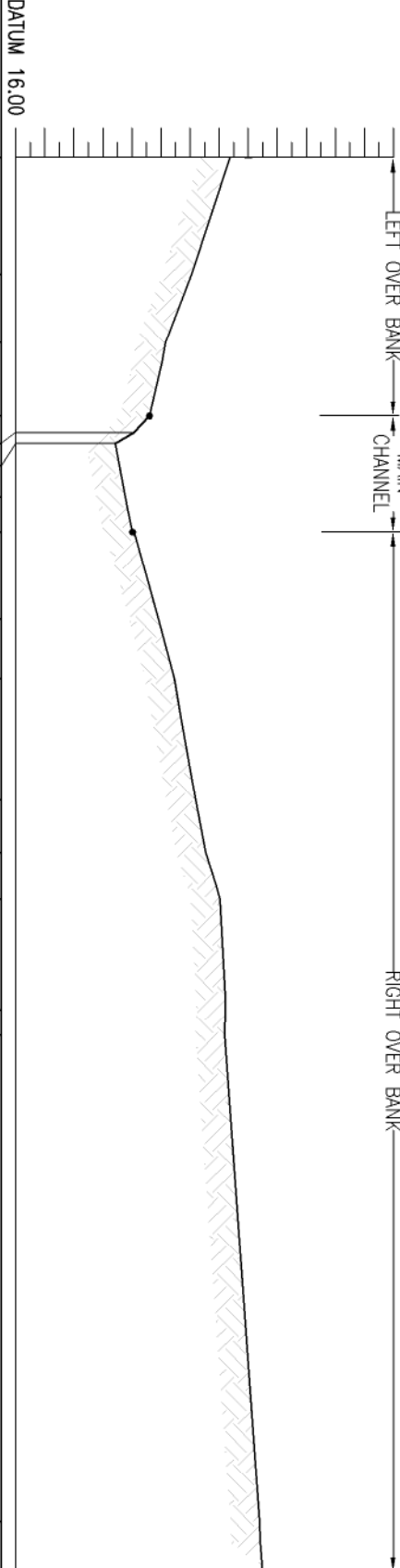
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DISTANCE (m)	0.00	9.76	14.19	15.31	17.15	17.45	17.75	19.10	20.05	25.58	32.40	34.96	46.28
LEVEL (m)	27.49	23.25	20.50	20.46	19.40	19.41	19.48	20.30	20.80	21.48	22.86	23.17	24.04
MANNING'S (n)													
BANK STN. (m)													



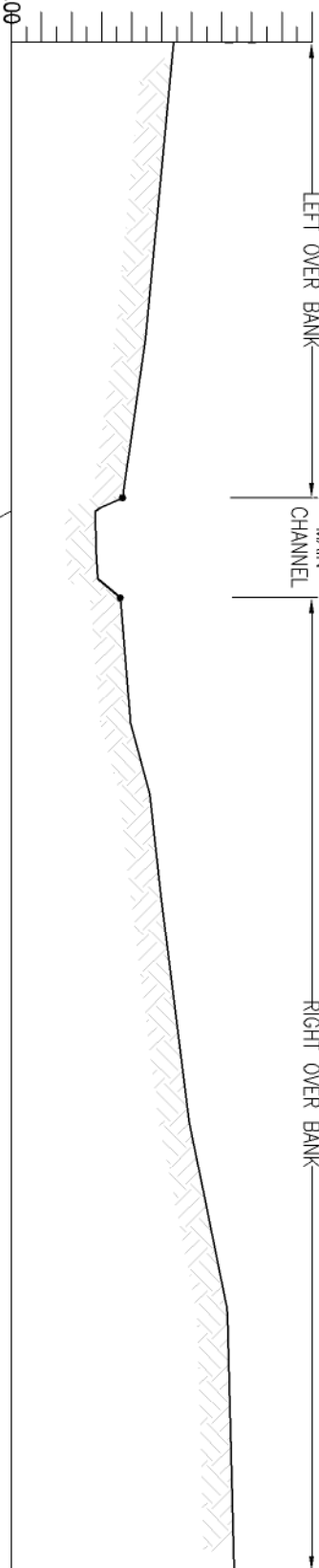
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DISTANCE (m)	0.00	4.01	6.34	8.88	9.46	9.53	11.65	12.86	15.87	17.93	22.13	23.94	25.53	29.33	30.20	46.93	48.66
LEVEL (m)	23.40	22.06	21.17	20.62	20.07	19.44	19.79	20.04	20.92	21.48	22.21	22.55	23.04	23.23	23.12	24.40	24.50
MANNING'S (n)																	
BANK STN. (m)																	



SECTION WES.008
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 17.34m)

DISTANCE (m)	0.00	8.10	9.84	15.16	15.61	17.85	18.49	22.66	25.04	35.88	42.01	50.88
LEVEL (m)	22.41	21.67	21.46	20.72	19.60	19.88	20.64	20.97	21.61	22.91	24.15	24.43
MANNING'S (n)												
BANK STN. (m)												



PRELIMINARY

NOTES:

- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
- CROSS-SECTIONAL DATA IS BASED ON A HYDROGRAPHICAL SURVEY UNDERTAKEN BY: **SURVEY SOLUTIONS**
- ALL SECTIONS EXTEND TO THE FLOOD PLAN DEFINED BY THE 1 IN 100 YEAR STORM +20% CLIMATE CHANGE.
- IN CASES WHERE THE CROSS-SECTIONAL DATA LAY OUTSIDE THE SCOPE OF THE HYDROGRAPHICAL SURVEY, LIDAR DATA WAS USED TO EXTEND THE OVERBANKS TO THE FLOOD PLAN.

Rev	A	100% ± 20% WATER LEVEL PLOTTED	Rev	150% ± 10.10.15
Description			Rev	150% ± 10.10.15
REVISIONS				
Preliminary Issue	✓	Submitted for S104		
Planning Issue		Issued for Tender		
Submitted for S108		Submitted for Construction		
Submitted for S278		As Built		
DRAWING STATUS				

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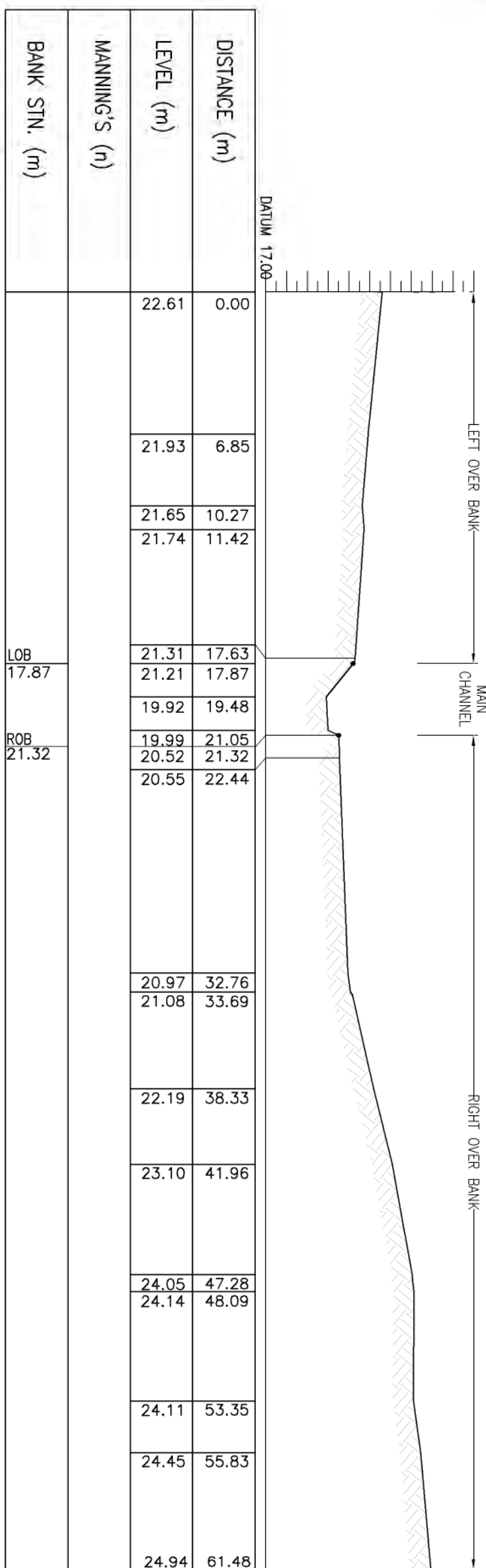


BURGESS HILL NORTHERN ARC
URBAN EXTENSION

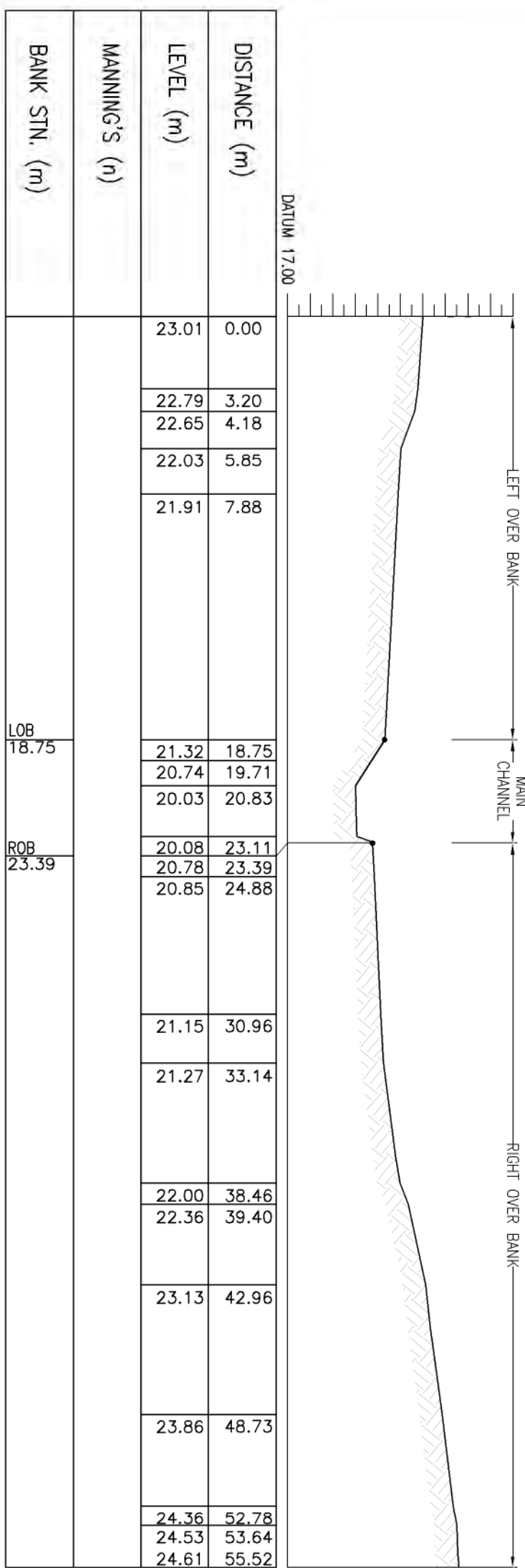
RIVER ADUR, COPYHOLD STREAM AND
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CROSS-SECTIONS (SHEET 1 OF 4)

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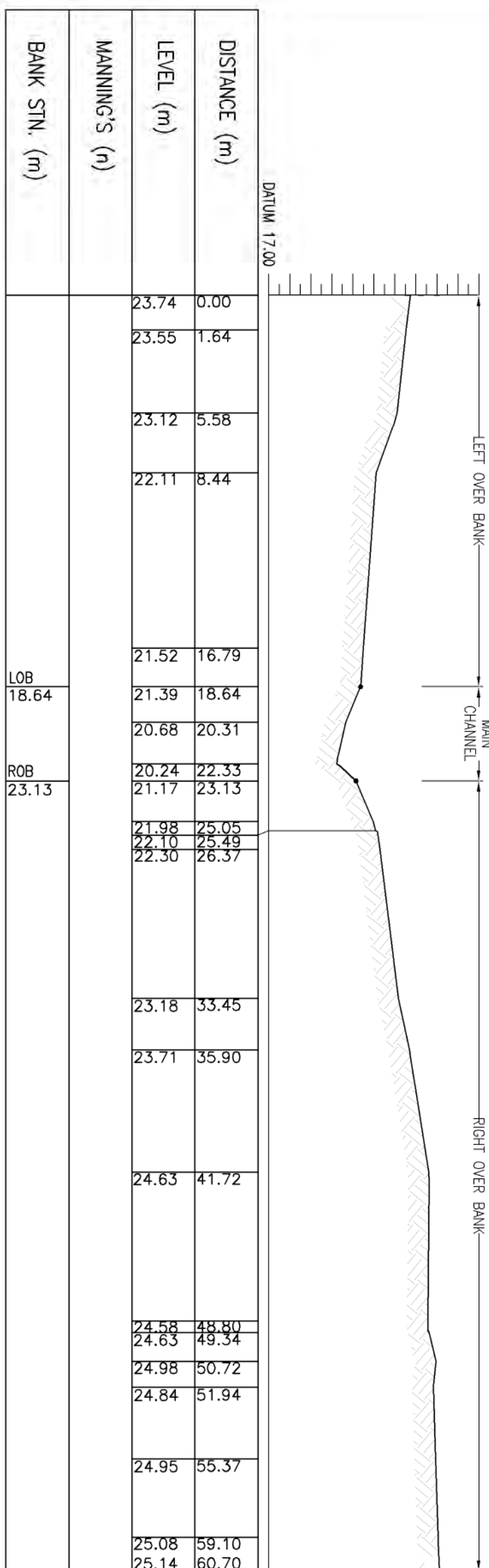
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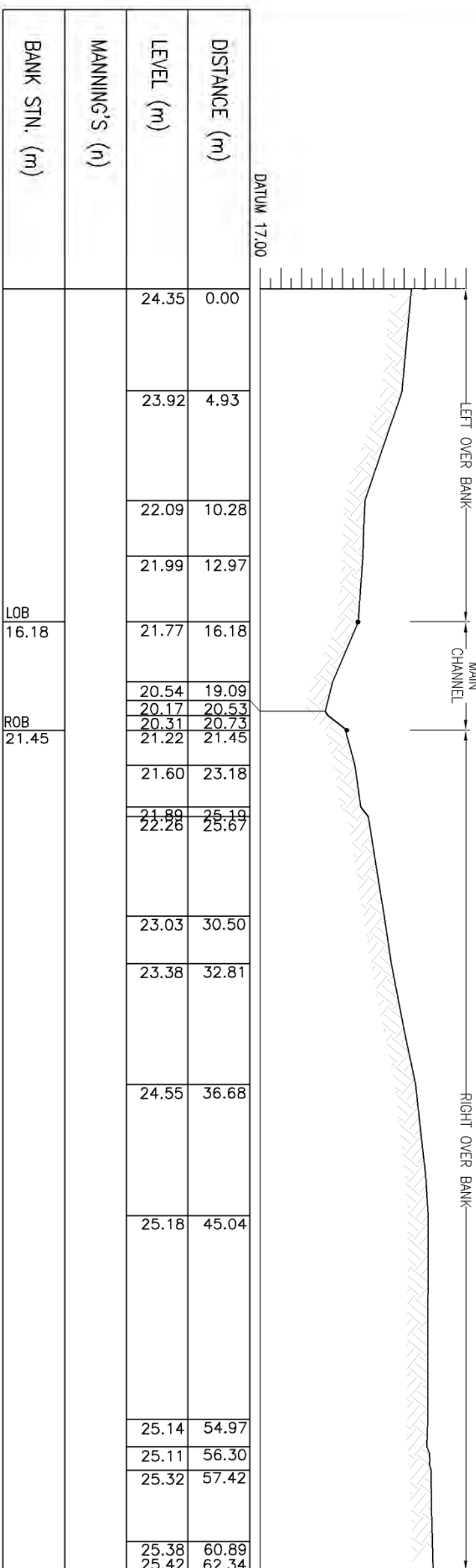
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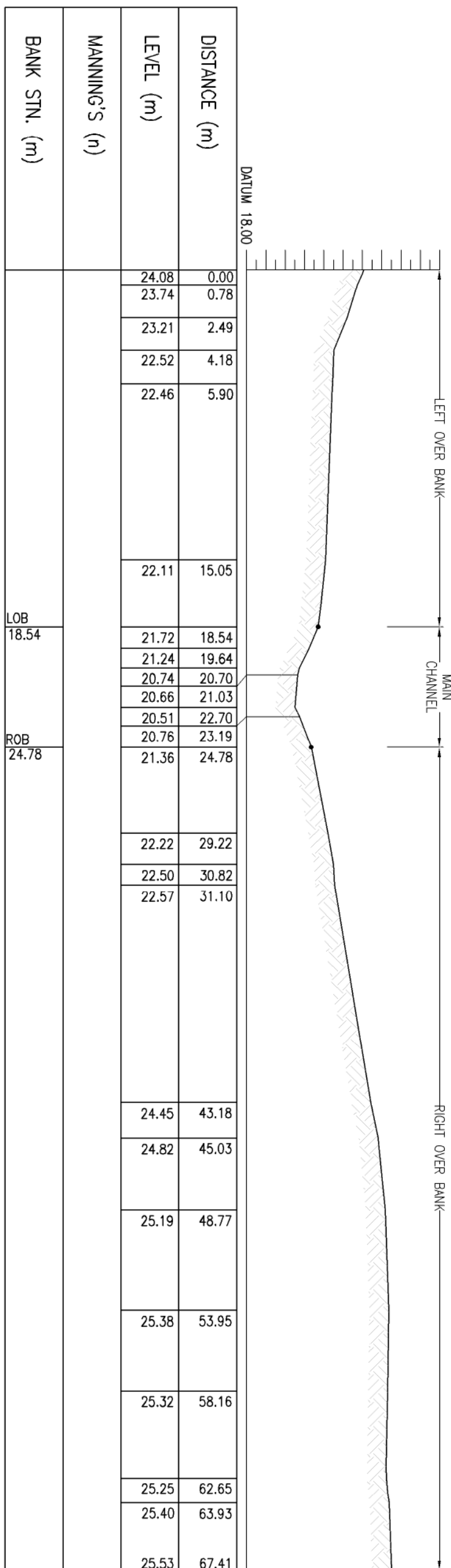
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(DISTANCE TO DOWNSTREAM CROSS-SECTION = 23.15m)



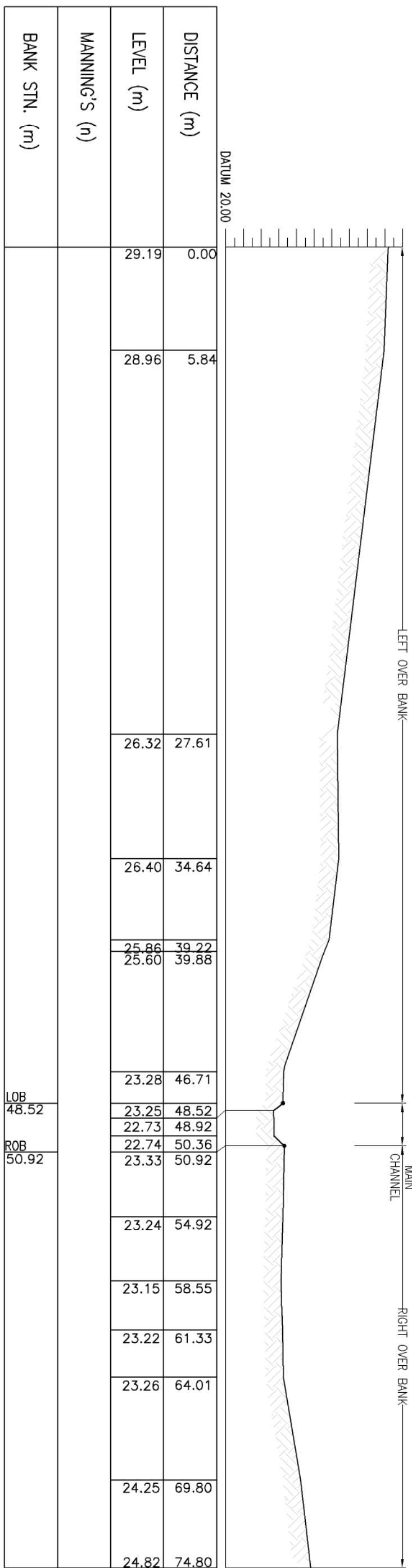
SECTION WES.011
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 21.52m)



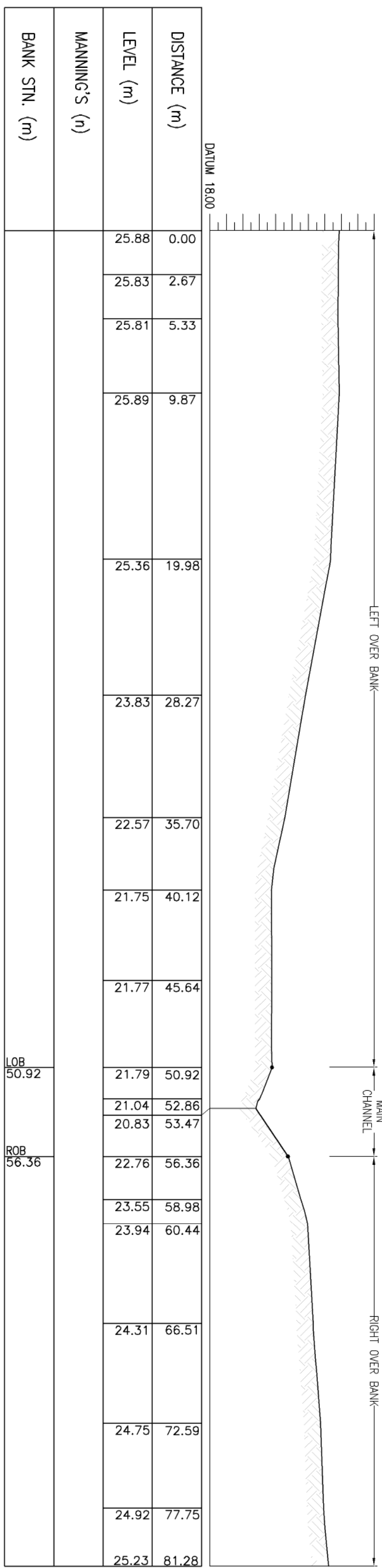
SECTION WES.012
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 21.65m)



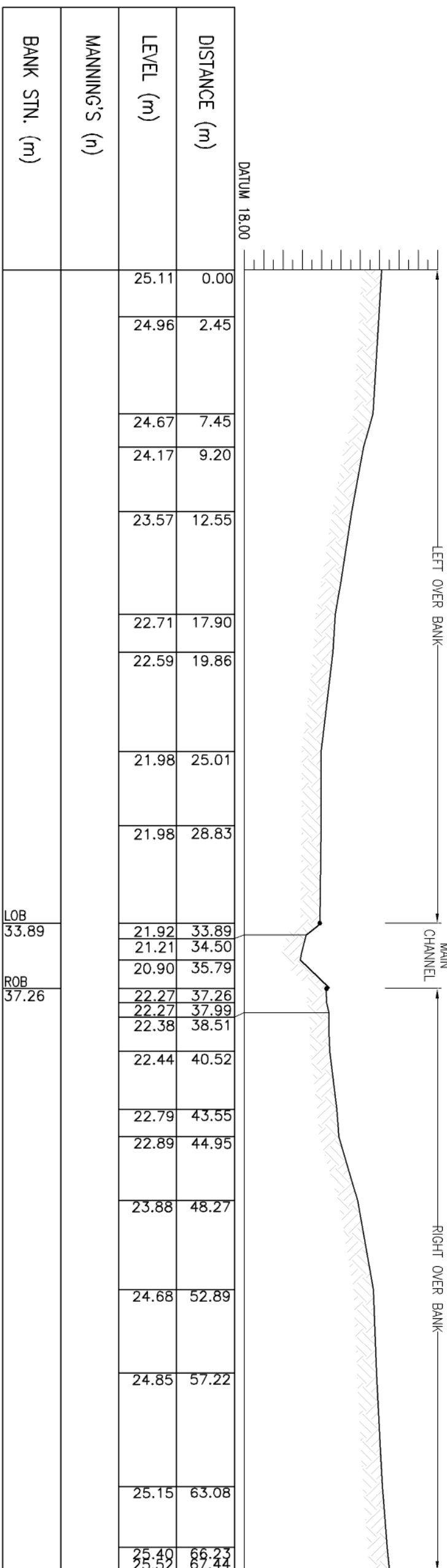
SECTION WES.013
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 20.48m)



SECTION WES.014
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 29.16)



SECTION WES.015
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 29.16)



SECTION WES.016
(DISTANCE TO DOWNSTREAM CROSS-SECTION = 29.16)

PRELIMINARY

NOTES:

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
3. CROSS-SECTIONAL DATA IS BASED ON A HYDROGRAPHICAL SURVEY UNDERGOWN BY:

SURVEY SOLUTIONS
4. ALL SECTIONS EXTEND TO THE FLOOD PLAN DEFINED BY THE 1 IN 100 YEAR STORM +20% CLIMATE CHANGE.
5. IN CASES WHERE THE CROSS-SECTIONAL DATA LAY OUTSIDE THE SCOPE OF THE HYDROGRAPHICAL SURVEY, LOGUE DATA WAS USED TO EXTEND THE OVERTAKES TO THE FLOOD PLAN.



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F: 01635 861 715 **w: www.stuartmichael.co.uk**



BURGESS HILL NORTHERN ARC
URBAN EXTENSION

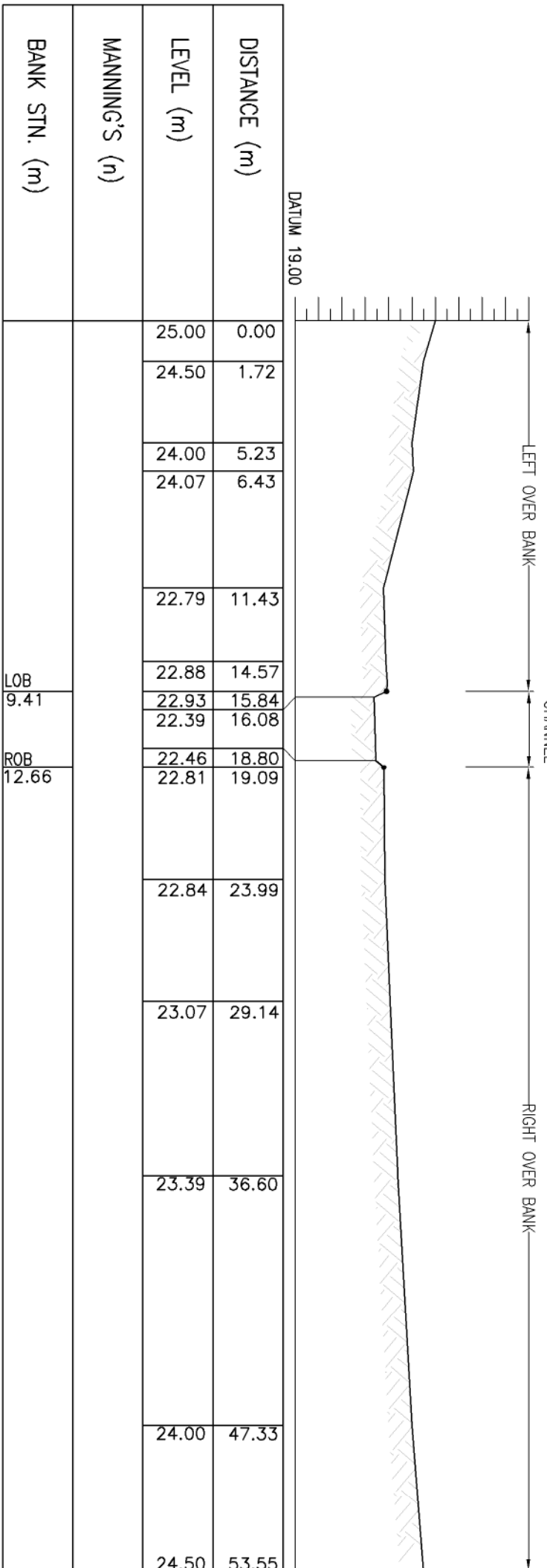
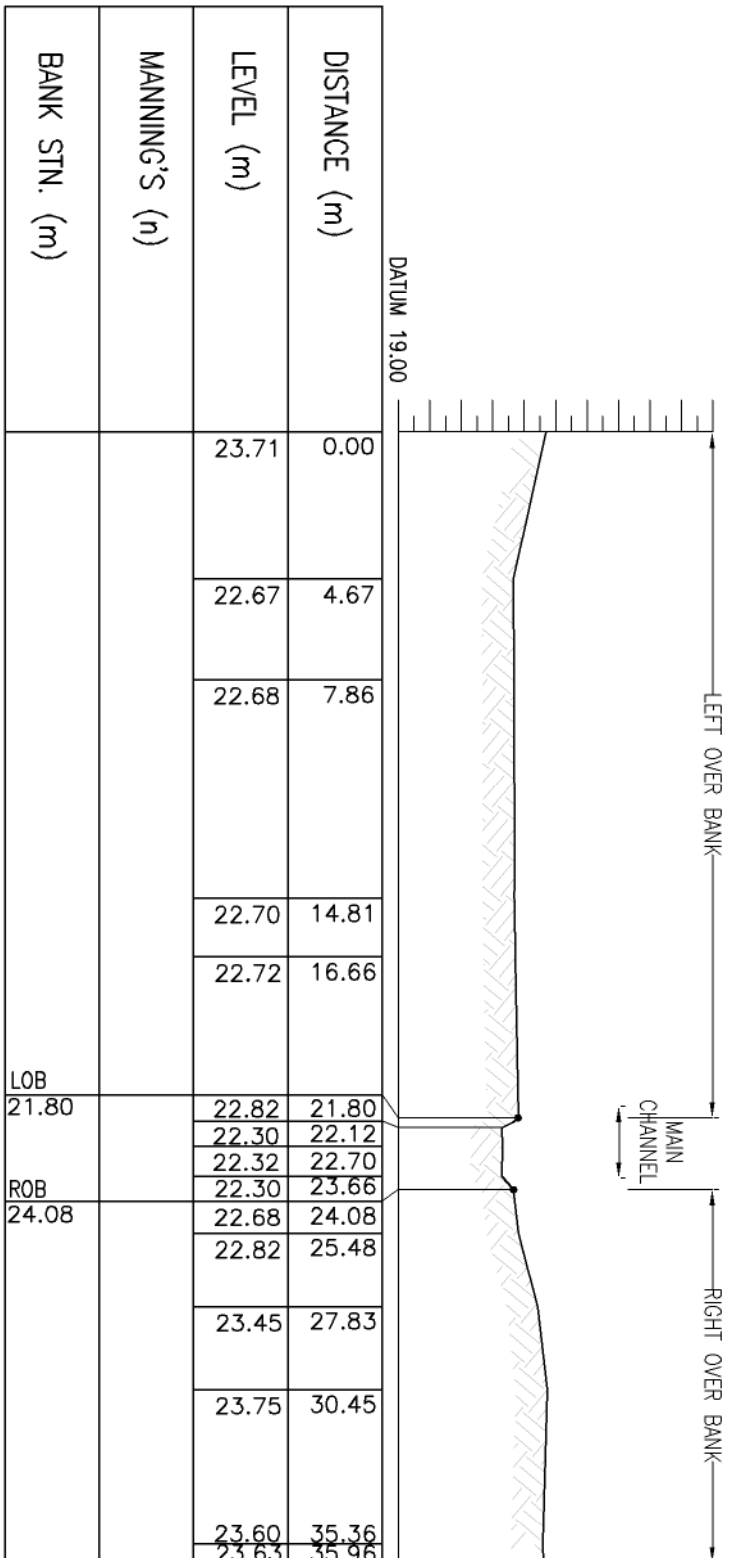
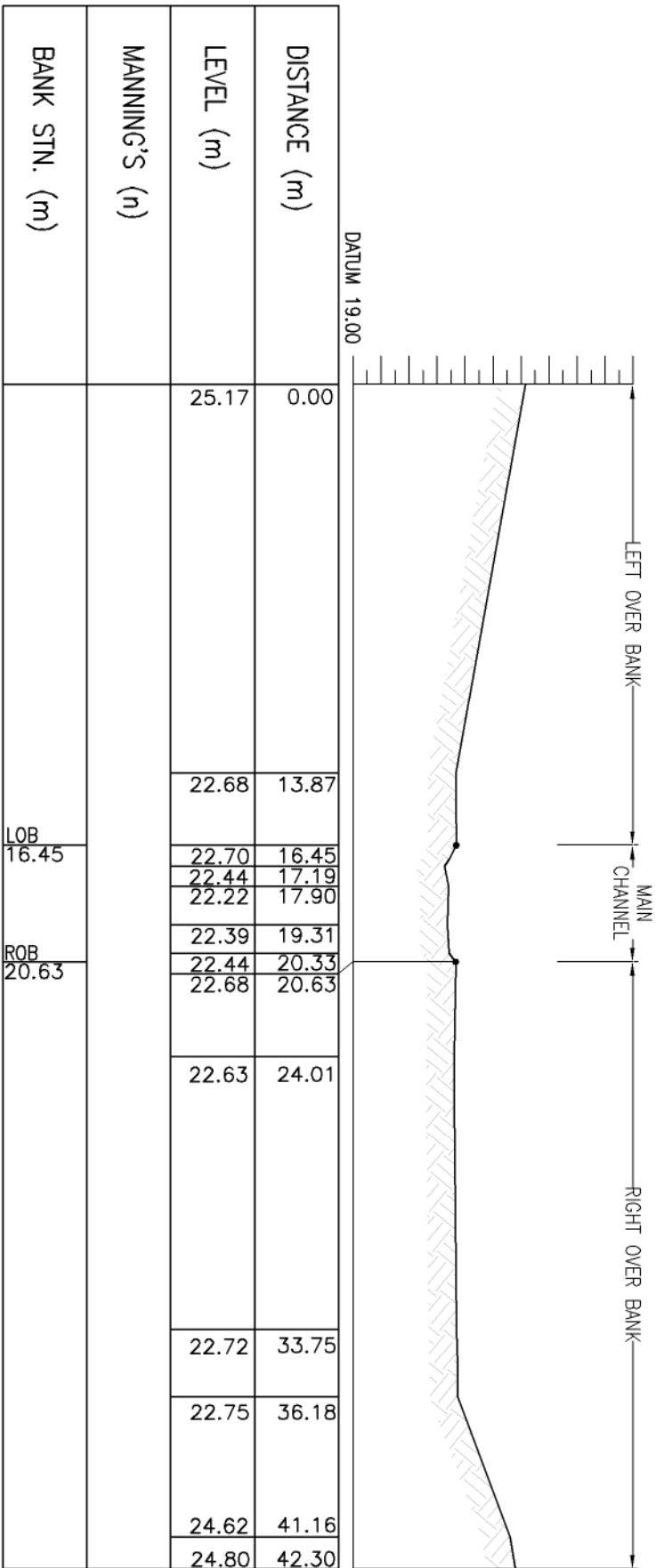
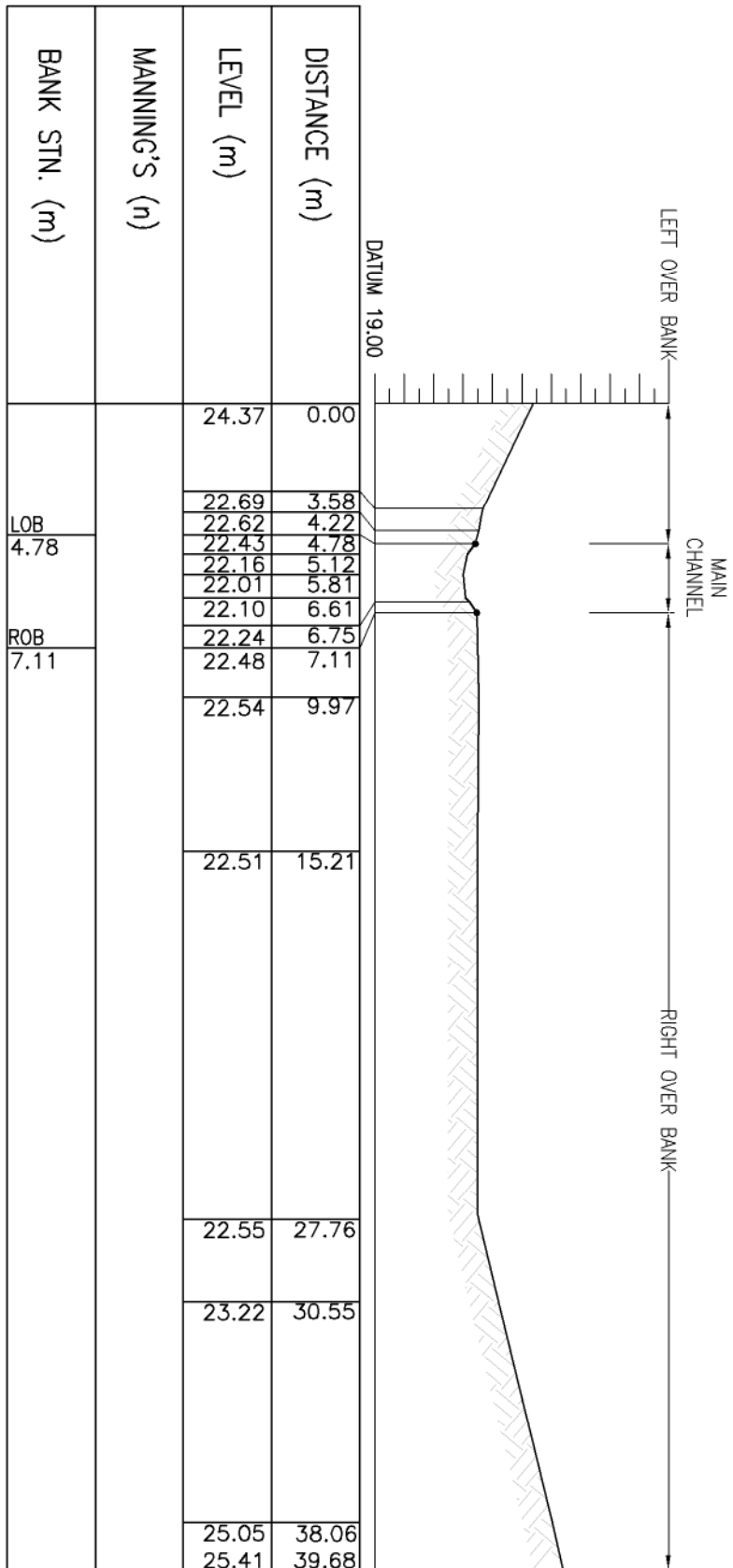
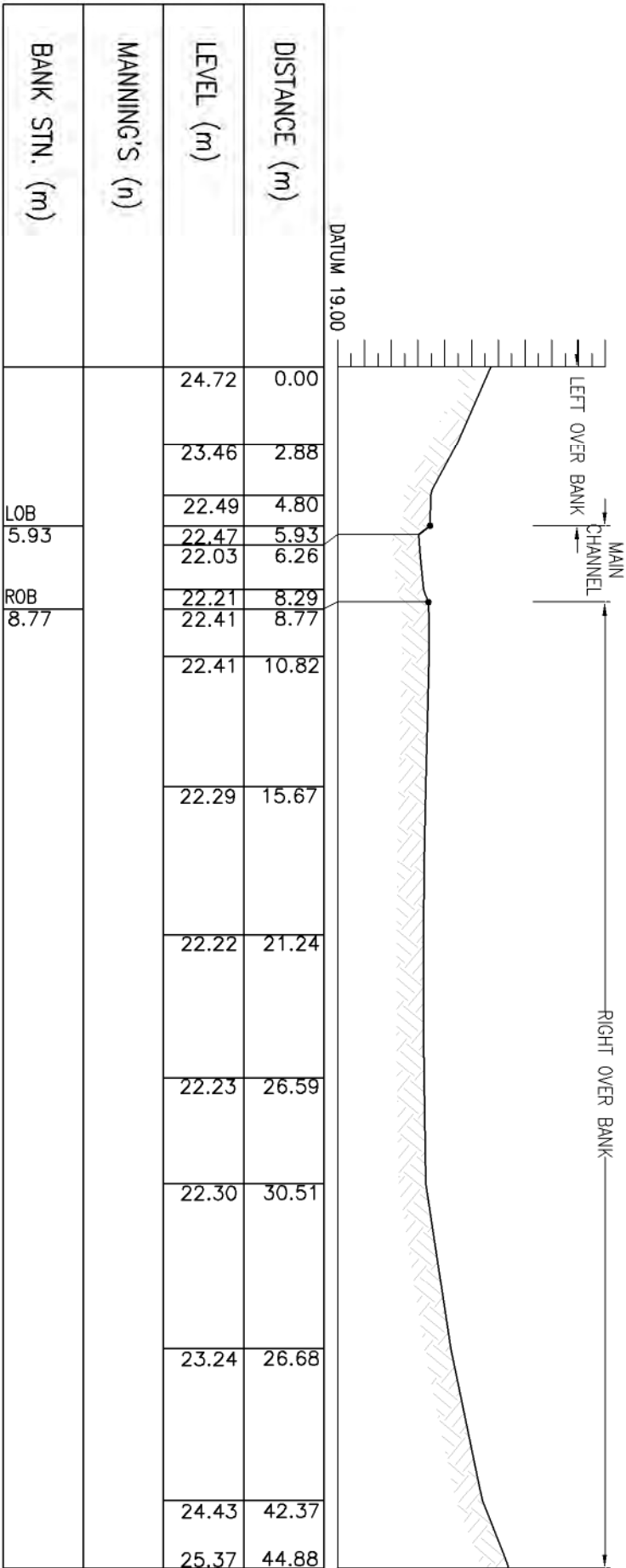
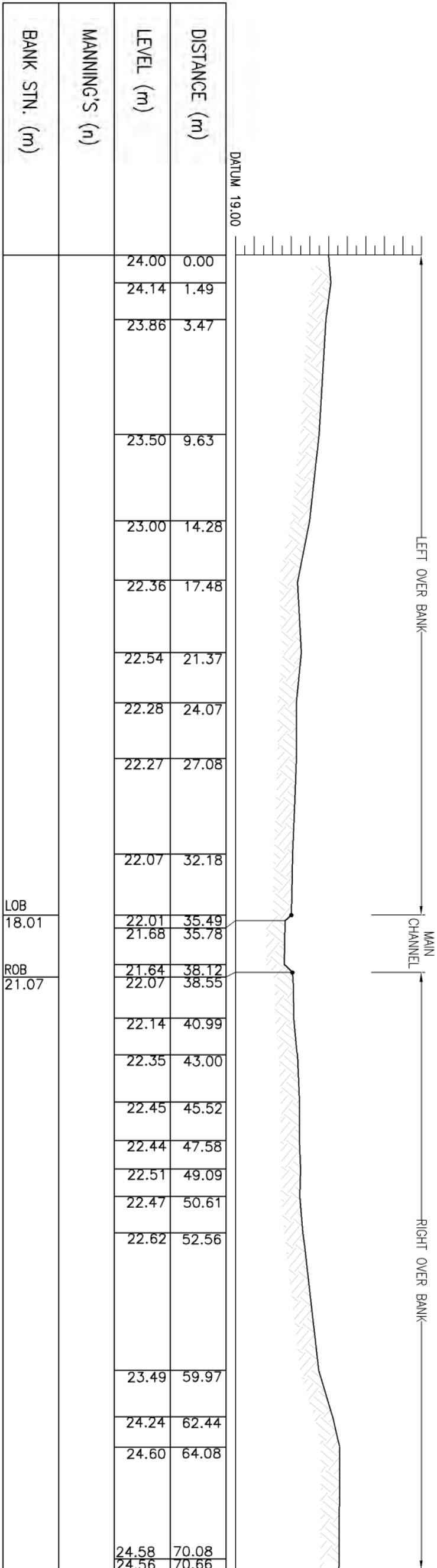
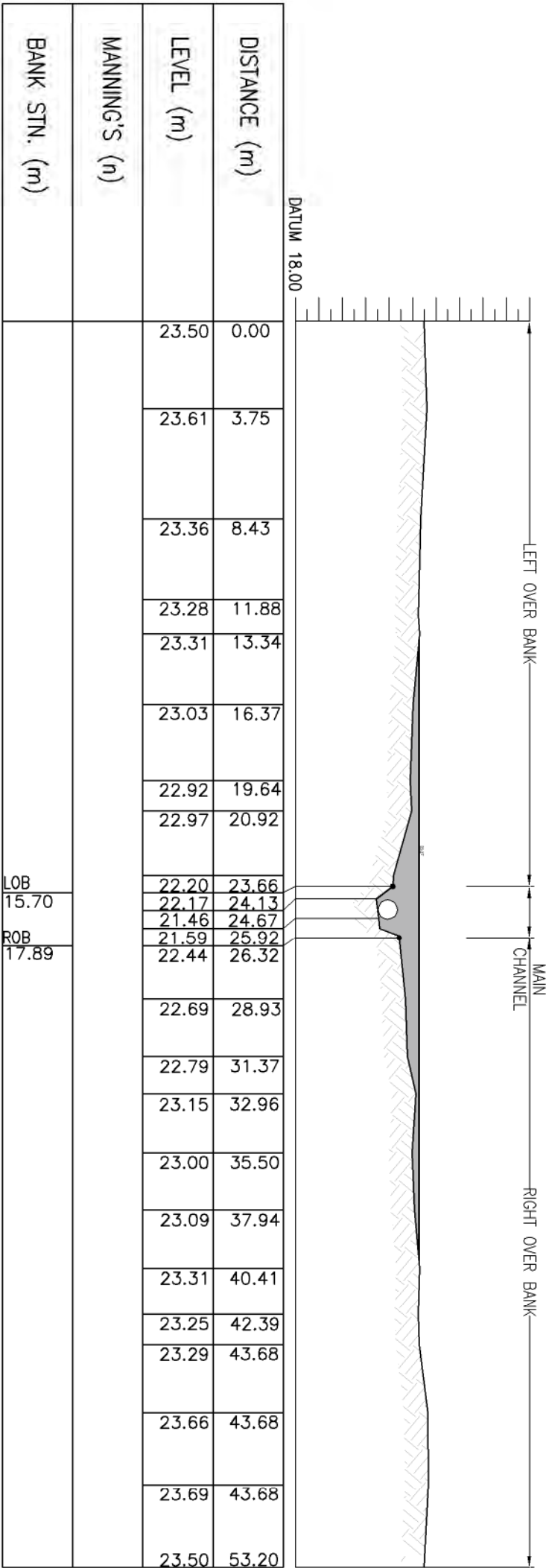
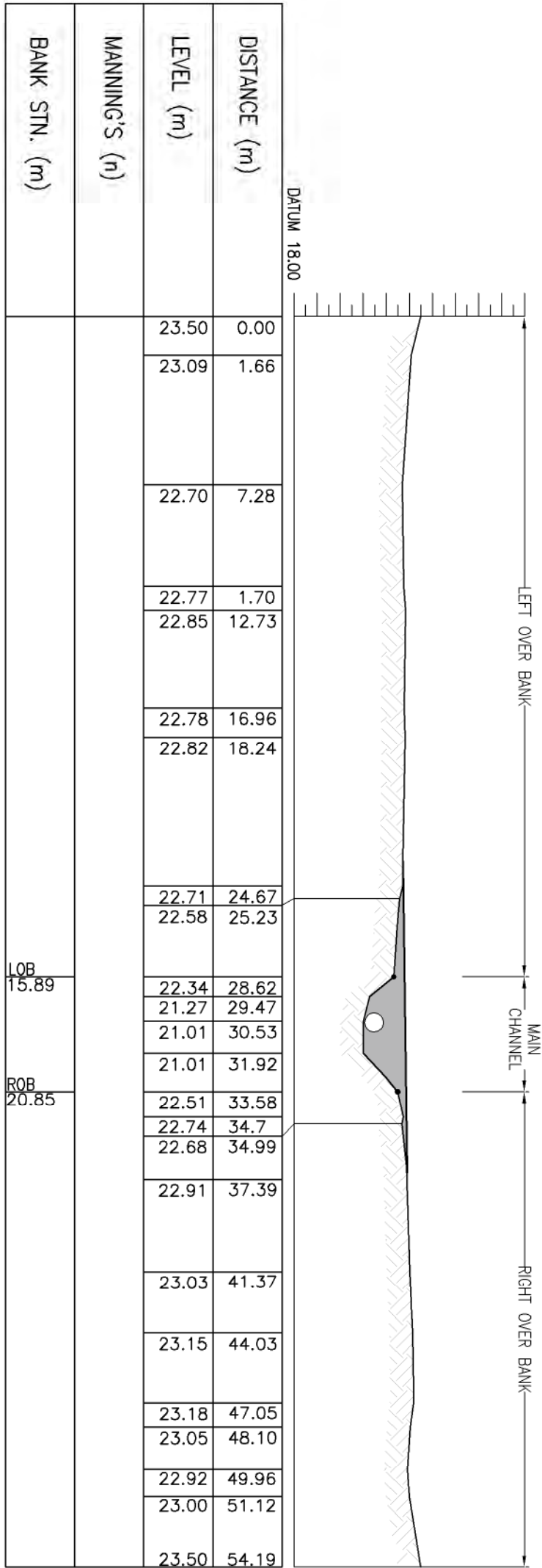
RIVER ADUR, COPYHOLD STREAM AND
WORLDS END STREAM
CROSS-SECTIONS (SHEET 2 OF 4)

REVISIONS					
Rev	Description	Revised By	Date	Drawn By	Date
A	100% + 20%CC WATER LEVEL PLOTTED	RJM/RSM	18.10.15		
Preliminary Issue	✓	Submitted for S104			
Planning Issues		Issued for tender			
Submitted for S108		Issued for Construction			
Submitted for S278		Is Built			

DRAINING STATUS

DATE	09/MAY	CHECKED
22.05.17	JPM	RMEH
DRAWING NO.	REV	SCALE
4909.486		1:250 @ A1

4909,486 1:250 @ A1



NOTES:

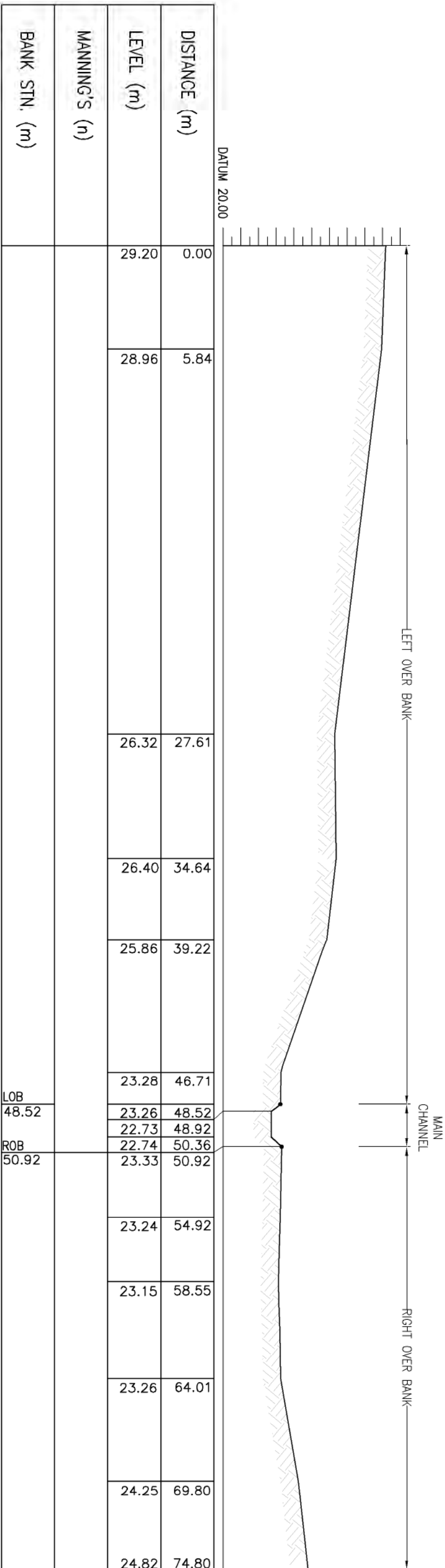
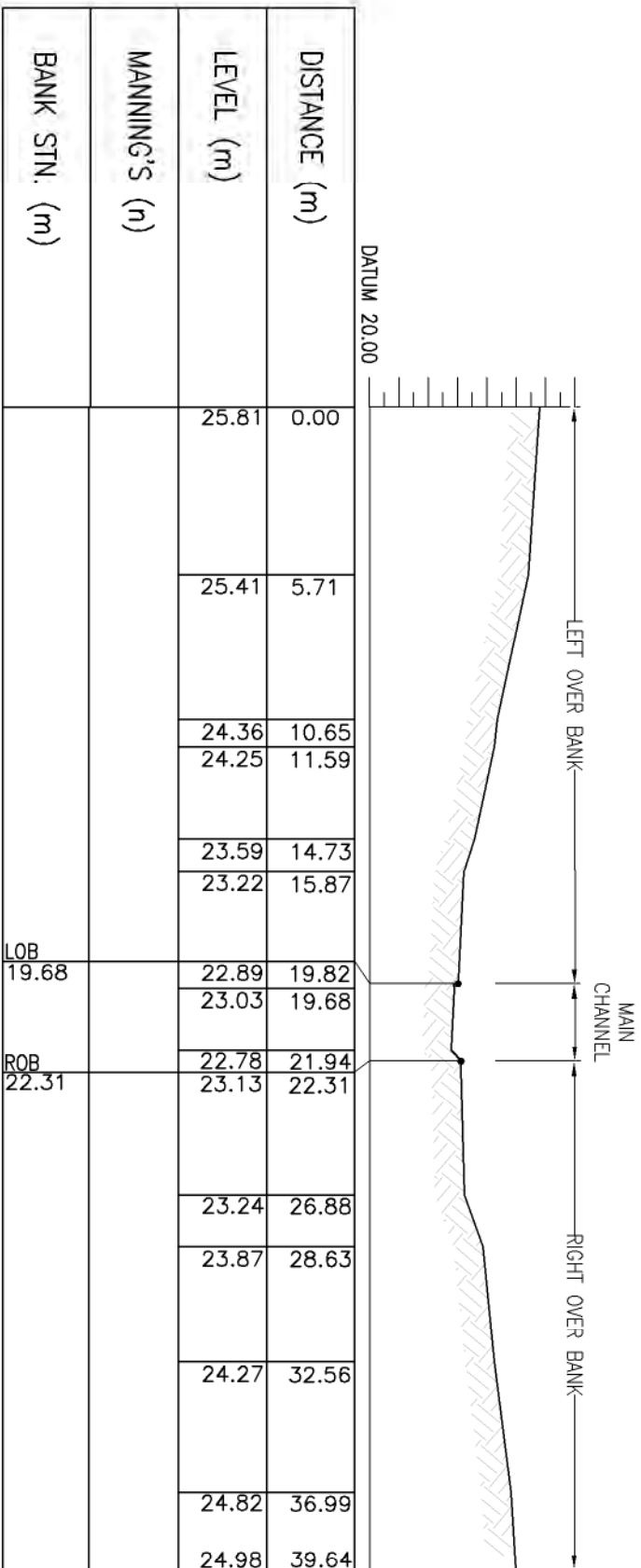
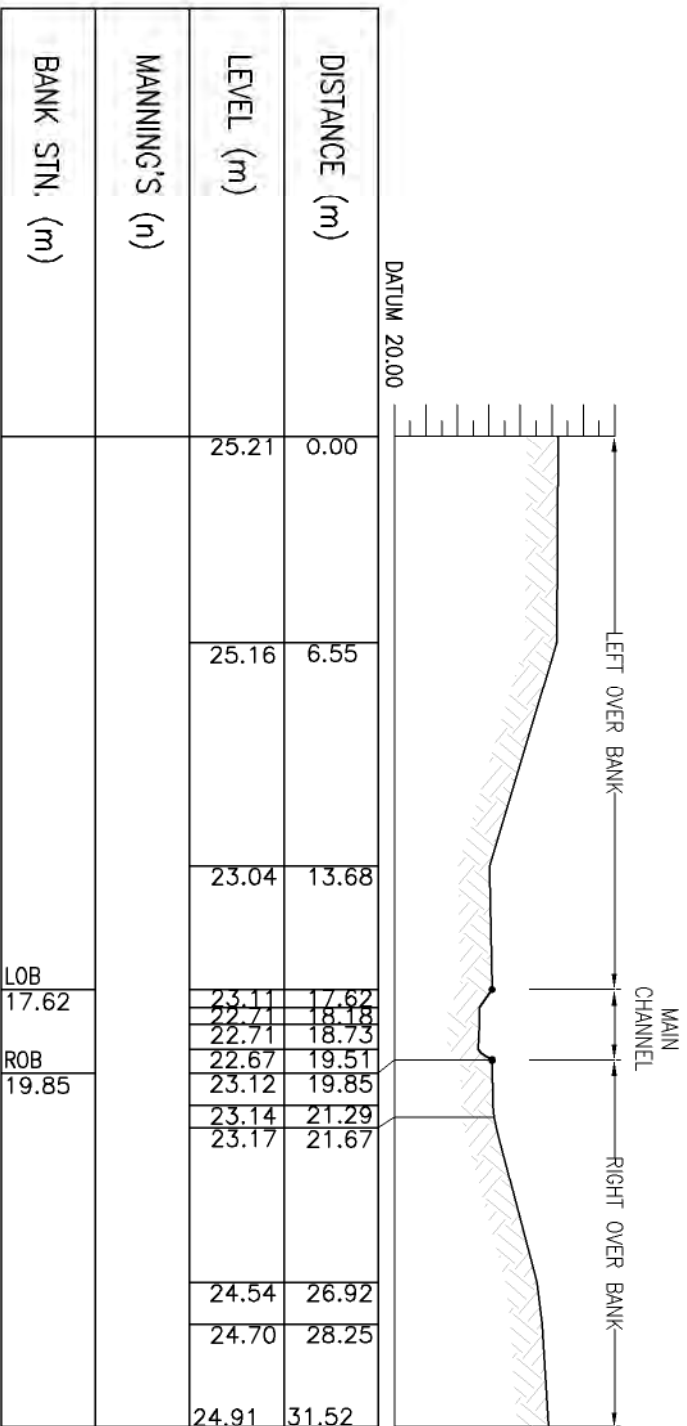
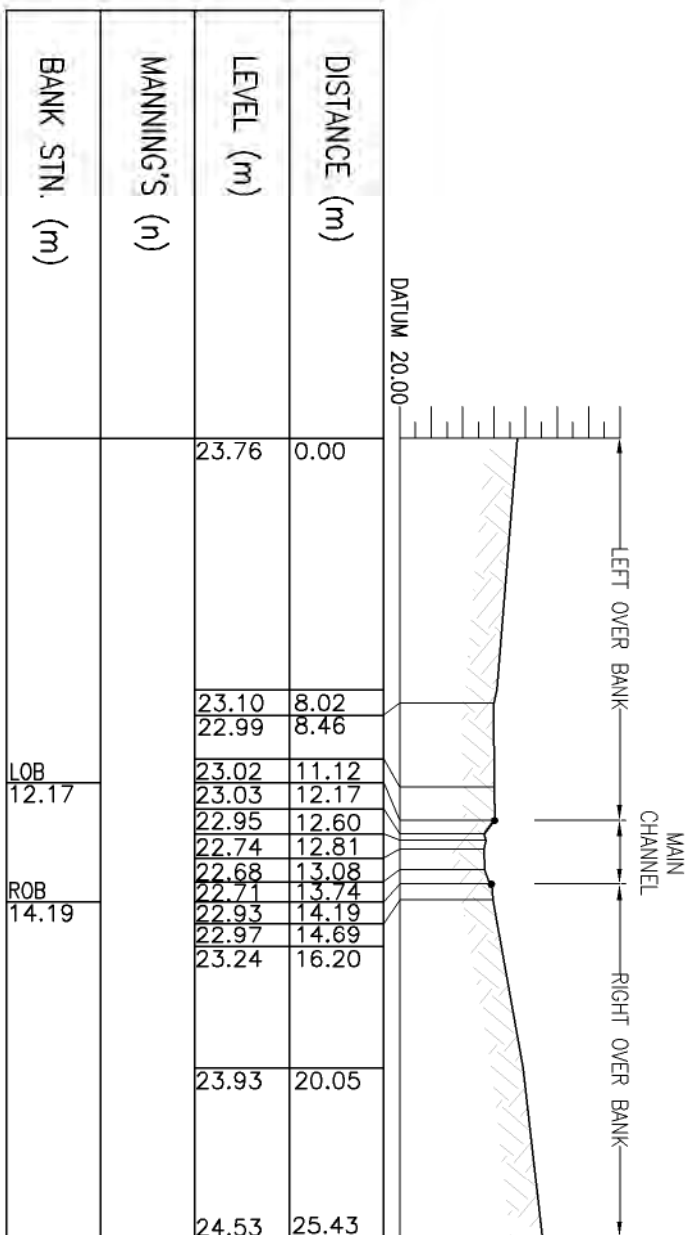
- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
- CROSS-SECTIONAL DATA IS BASED ON A HYDROGRAPHICAL SURVEY UNDERTAKEN BY: **SURVEY SOLUTIONS**
- ALL SECTIONS EXTEND TO THE FLOOD PLAN DEFINED BY THE 1 IN 100 YEAR STORM +200% CLIMATE CHANGE.
- IN CASES WHERE THE CROSS-SECTIONAL DATA LAY OUTSIDE THE SCOPE OF THE HYDROGRAPHICAL SURVEY, LIDAR DATA WAS USED TO EXTEND THE OVERBANKS TO THE FLOOD PLAN.

Rev	Description	Rev	Date
A	100% + 200% WATER LEVEL PLOTTED	Rev	Rev

Revisions	Revisions
Preliminary Issue	✓
Issued for Tender	
Submitted for Construction	
Submitted for S278	

STUART MICHAEL ASSOCIATES
CONSULTING ENGINEERS

Stuart Michael Associates Ltd
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NOTES:

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- ALL SECTIONS EXTEND TO THE FLOOD PLAN DEFINED BY THE 1 IN 100 YEAR STORM +20% CLIMATE CHANGE.
- IN CASES WHERE THE CROSS-SECTIONAL DATA LAY OUTSIDE THE SCOPE OF THE HYDROGRAPHICAL SURVEY, LIDAR DATA WAS USED TO EXTEND THE OVERBANKS TO THE FLOOD PLAN.

Rev	Description	Rev	Chk	Date
A	100% + 20% CLIMATE CHANGE WATER LEVEL PLOTTED	Rev	Chk	Date
REVISIONS				
Preliminary Issue				
Issued for Tender				
Submitted for Construction				
Submitted for S278				
DRAWING STATUS				

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BURGESS HILL NORTHERN ARC
URBAN EXTENSION

RIVER ADUR, COPYHOLD STREAM AND
WORLDS END STREAM
CROSS-SECTIONS (SHEET 4 OF 4)

DATE: 22.05.17
DRAWN: JPM
CHECKED: RMEH
SCALE: 1:250
SHEET: 4 OF 4

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PRELIMINARY



Figure 4

Flood Map Blockage Scenarios

Legend:

Flood Extent	Return Period	Value
100yr ARI	21.98	23.35
100yr ARI + 10% COC	22.73	23.36
100yr ARI + 10% COC BOP Blockade	22.73	23.39
100yr ARI + 10% COC BOP Blockade	22.73	23.40

Notes:

- ALL LEVELS ARE EXPRESSED IN METRES ABOVE ORIGINATE DATUM NEWLY.
- INTERMEDIATE PROFILES, CROSS SECTIONS, INTERMEDIATE NODES AND FLOOD LEVELS ARE SHOWN ON SHEETS 404-40 AT 1:500 SCALE.
- GROUND LEVELS WITHIN DEVELOPMENT SITE AND TOPOGRAPHICAL SURVEY REF. SHOWN ON 122594W-01.2286C133-CONTIGUOUS BY.
- GROUND LEVELS BEYOND THE SITE BOUNDARY ARE BASED ON LIDAR DATA.
- DESIGN PEAK FLOW ESTIMATED USING FEH STATISTICAL METHOD AS APPROVED BY THE ENVIRONMENTAL AGENCY FOR THE DESIGN OF THE DETAILED FLOOD, REFER TO SWA REPORT 4809/H - HYDROLOGICAL ASSESSMENT OF THE RIVER KOUR AND COTTAGE ROAD.
- FLOOD LEVELS HAVE BEEN DENIED BY HEC-RAS HYDRAULIC MODELING.

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Elevation
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12259se-01_22RevC(30+CO



**SURVEY
SOLUTIONS**

6. FLOOD LEVELS HAVE BEEN DERIVED BY HEC-RAS HYDRAULIC MODELLING.

Day	Date/Person	Day	Date
REVISIONS			
Preliminary Issue	✓	Submitted for S104	
Permitting Issue		Issued for Reader	
Scheduled for S38		Issued for Coordination	
Scheduled for S27B		As Bldg	
DRAWING STATUS			

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WORLD'S END STREAM FLOOD MAP
(CULVERT BLOCKAGE) (SHEET B)

PRELIMINARY



Figure 5

Flood Map Up To The 100year +105%CC Event