Appendix F

Drainage Impact Assessment

ARUP

Application for Amendment of Plan under Section 12A of the Town Planning Ordinance (Cap. 131) for Proposed Residential Development and Associated Infrastructure at Various Lots in D.D. 32 and Adjoining Government Land, Wong Yi Au, Tai Po, New Territories

Drainage Impact Assessment Report

Reference:

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Job number 292635

Arup Hong Kong Limited

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1. Introduction

1.1 Project Background

1.1.1.1 This Drainage Impact Assessment ("DIA"), appended to the Supporting Planning Statement, is prepared in support of the Planning Application under Section 12A of the Town Planning Ordinance (Cap. 131) for Proposed Residential Development and Associated Infrastructure ("Proposed Amendment") at Various Lots in D.D. 32 and Adjoining Government Land, Wong Yi Au, Tai Po, New Territories ("the Application Site").

1.2 Proposed Development

1.2.1.1 The Proposed Development is located in an abandoned agricultural land within Wong Yi Au. There would be 4 blocks of residential buildings and an access road (subject to detailed design) adjoining Yung Yi Road.

1.3 Purpose of this Report

1.3.1.1 The scope of the Project comprises development private housing and a clubhouse in Wong Yi Au.

1.3.1.2 The DIA Report shall be prepared, which should:

(a) fully satisfy the requirements of this Scope in respect of the prediction and assessment of impacts, the identification of drainage impact mitigation measures and the associated residual impacts;

(b) provide assessment and evaluation of the drainage impact and cumulative effects arising from the Project sufficient to identify those issues of key concern during the construction and operation of the Project;

(c) define measurable drainage parameters and features likely to be affected by the Project;

(d) recommend optimum drainage scheme for the Project.

(e) provide the assessment findings, conclusions, recommendations and a mechanism for implementation; and

(f) include any revisions or supplements to the above as might be required by the DSD.

1.3.1.3 The DIA Report shall be prepared and submitted for DSD's approval on the methodologies, findings, proposals, recommendations and conclusions of the DIA, including the proposed drainage schemes, drainage mitigation measures as well as temporary drainage impact mitigation measures and monitoring and audit requirements during construction stage.

1.3.1.4 This Report is structured as follows:

Section 1 – introduces the project background, objectives and scope of the Project.

Section 2 – presents the methodology and design criteria.

Section 3 – presents the existing and proposed drainage system

Section 4 – presents the changes to drainage characteristics.

Section 5 – presents the potential drainage impacts and drainage mitigation measures.

Section 6 summarises the conclusions.

2. Methodology and Design Criteria

2.1 Hydraulic Models

2.1.1.1 InfoWorks ICM has been adopted for this Project and the latest version 2023.2 will be used. The hydraulic models built from the previous DMP Review Studies were collected and upgraded to InfoWorks ICM version 2023.2 for hydraulic analysis of this Project.

2.1.1.2 InfoWorks ICM is a modelling platform which incorporates both urban and river catchments, with full integration of one-dimensional (1D) and two-dimensional (2D) hydrodynamic simulation techniques. ICM enables the hydraulics and hydrology of natural and built environments to be incorporated into a single model. A 1D numerical model of river / conduits complimented by a 2D model of the overland flow provides improvements in hydraulic modelling accuracy and computation efficiency.

2.2 Modelling Approach and Parameters

Standards and Design Manuals

2.2.1.1 The DIA has been prepared in accordance with the following standards and design manuals:

- Stormwater Drainage Manual (SDM) Fifth Edition, January 2018;
- Stormwater Drainage Manual – Corrigendum No. 1/2022;
- Stormwater Drainage Manual – Corrigendum No. 1/2024;
- Stormwater Drainage Manual – Corrigendum No. 2/2024 (SDM 2024);
- DSD's Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects;

1D Drainage System

2.2.1.2 Rivers and channel studied via InfoWorks ICM have been modelled as 1D elements with bank connection between 1D channels and 2D overland flow area. In addition, the drainage pipe and box culvert have also been modelled in 1D with connection of 2D at manhole, where considered appropriate for good representation of flows and model stability.

2.2.1.3 In the 1D domain the flow was modelled with the Saint Venant equations applied over the full water depth. The direction of flow in the 1D domain was assumed to follow the channel/pipe x-axis and in the model it carried its momentum in this direction.

2.2.1.4 The bathymetry of the 1D channel was derived from topographical survey data when it is available or LiDAR data in locations where topographical survey was not undertaken.

2D Overland Flow

2.2.1.5 The overland flow areas are modelled in 2D. The use of 2D modelling has distinct advantages over a solely 1D model, particularly the ability to accurately identify flow paths / breakout points, and simulate detailed flood behaviour in urban environments. The 2D mesh cells were placed outside the 1D domain. The 1D Saint Venant equations were applied only up to bank level. The outside of this bank level, the flow description in the 2D mesh takes over.

2.2.1.6 The 2D component of the hydraulic model primarily relies upon LiDAR data for topography.

2.2.1.7 Since the overland flow cannot pass through buildings in reality, buildings were modelled as void polygons in the 2D model such that no overland flow could pass through them.

Runoff Estimation

2.2.1.8 Runoff was calculated via the SCS or fixed runoff coefficient (C) methods recommended in the SDM 2024. For the SCS method, each sub-catchment was assigned suitable runoff coefficient in form of Curve Number (CN) value, based solely on the fraction of pervious / impervious ground within the catchment. Area of impervious ground was calculated using the total areas of road, building roof and paved surface. Paved fraction of each sub-catchment was then determined by using the ratio of impervious area to total sub-catchment area. The proposed CN and fixed runoff coefficient to be used in this Study are shown in **Table 2.1**.

Table 2.1 - Curve Numbers and Fixed Runoff Coefficients

SCS Method	
Landuse Use	**Curve Number**
Agriculture and Upland	
Woodland	67
Scrubland	70
Grassland	78
Agriculture	78
Drainage	
River Channel	100
Reservoir	100
Wetland	100
Highway and Road	
Major Road and Junction	100
Special Use	
Government, Institution or Community	90 to 100
Fire Station	100
Hospital	100
Cemetery	65
Urban	
Commercial / Residential	95
Residential	95
Village	

SCS Method	
Landuse Use	**Curve Number**
Village	78 to 80
Storage and Industrial	
Industrial	90
Open Space	90
Rail	
Rail	100
Boulder and Rocky Area	
Boulder and Rocky Area	100
Fixed Coefficient Method	
Surface Type	**Fixed Runoff Coefficient**
Impervious Surface	0.90
Pervious Surface	0.30

2.2.1.9 The above CN and fixed runoff coefficients at concerned areas of proposed drainage improvement works will be subjected to refinement as part of the subsequent model verification process to provide a better representation of the recorded flood behaviour.

Hydraulic Roughness

2.2.1.10 Based on the guidelines provided by the SDM 2024, Colebrook-white roughness coefficients (ks) are selected for 1D urban drainage system. Similarly, the values of manning's "n" for natural watercourses and channels, which are commonly used for design, is also considered for simulation. The adopted values of ks and n in this Study are shown in the below **Table 2.2**. These values will be modified within suitable ranges as part of the verification process.

Table 2.2 - Preliminary Roughness in 1D Drainage Model

Urban Drainage System	
Roughness Type	ks (mm)
Existing Pipeline / Culvert	3.0
Proposed Pipeline / Culvert	0.6
Open Channel / River System	
Roughness Type	n
Engineered channels with concrete lining	0.016
Engineered channels with masonry sides	0.020
Engineered channels with grasscrete lining	0.025
Natural channels	0.040

Sedimentation Depth

2.2.1.11 According to Section 9.3 of SDM 2024, the following effect of flow capacity due to materials deposited on the bed will be considered in the hydraulic modelling and design of the proposed drainage works under this Project.

(a) 5% reduction in flow area if the gradient is greater than 1 in 25.

(b) 10% reduction in flow area in other cases.

2.3 Design Criteria

Flood Protection Standard

2.3.1.1 The SDM 2024 recommends minimum flood protection standards for various land uses, as shown in **Table 2.3** below.

Table 2.3 - Design Flood Protection Standards

Intensively used Agricultural Land	2-5 years
Village Drainage including Internal Drainage System under a Polder Scheme	10 years[1,3]
Main Rural Catchment Drainage Channels	50 years[2,3]
Urban Drainage Trunk Systems	200 years[4]
Urban Drainage Branch Systems	50 years[4]

Notes:

1. The impact of a 50 year event should be assessed in each village to check whether a higher standard than 10 years can be justified.
2. Embanked channels must be capable of passing a 200 year flood within banks.
3. For definitions of Village Drainage and Main Rural Catchment Drainage Channels, refer to Section 6.6.1 of SDM.
4. For definitions of Urban Drainage Branch and Urban Drainage Trunk Systems, refer to Section 6.6.2 of SDM.

2.3.1.2 Where catchments are tidally influenced, the SDM 2024 recommends that for a T-year flood, peak flood levels are taken as the higher of the flood levels resulting from the following two cases:

Case I : a T-year sea level in conjunction with a X-year rainfall; and

Case II : a X-year sea level in conjunction with a T-year rainfall.

In the above rule,

X = 10 when T = 50, 100 or 200; and

X = 2 when T = 2, 5 or 10.

Design Rainfall

2.3.1.3 The catchment falls within Hong Kong Observatory (HKO) Headquarters rainfall profile as per SDM 2024 Figure 3. The associated design rainstorm profiles to be applied to the hydrologic models were obtained from the storm rainfall parameters provided in SDM 2024 Table 3a. The modelled catchment areas are less than 25km2, hence no aerial reduction factor has been applied.

Design Sea Level

2.3.1.4 The near tide gauge from the Study Area is located at Tai Po Kau. The design sea levels at Tau Po Kau provided in Table 8 of SDM 2024 and summarised in **Table 2.4** have been used for this Study.

Table 2.4 - Design Sea Levels at Tai Po Kau

Return Period	Design Sea Levels (mPD) at Tai Po Kau
2	2.97
5	3.27
10	3.54
20	3.86
50	4.41
100	4.93
200	5.59

Climate Change Scenario

2.3.1.5 With reference to Section 6.8 of the SDM 2024 new drainage provision or developments with potential drainage impact should consider the climate change effects up to End-21st century.

2.3.1.6 Climate change impacts on both design sea levels and rainfall intensities have been incorporated as defined in SDM 2024 Table 28 and Table 29, storm surges and design allowances defined in SDM Table 30b and Table 31 have been included as per SDM 2024 section 6.8 requirements.

Freeboard

2.3.1.7 In general, a 300mm freeboard has been considered to account for the inaccuracies in computations.

2.4 Design and Modelling Scenarios

2.4.1.1 The design scenarios shown in Table 2.5 covering have been adopted to represent different land use conditions and assess the proposed development impacts. considered for simulation and design of the proposed drainage improvement works.

Table 2.5 - Simulation and Design Scenarios for Drainage Improvement Works

Design Scenario	Land Use and Drainage Network	Design Return Period (Year)	Rainfall Return Period (Year)	Sea Level Return Period (Year)
Baseline Scenario	Planned Land Use and Existing Drainage Network	200A at End 21st century (ECC)	200 at ECC	10 at ECC
		200B at ECC	10 at ECC	200 at ECC
Proposed Scenarios	Planned Land use and Planned Drainage Network	200A at ECC	200 at ECC	10 at ECC
		200B at ECC	10 at ECC	200 at ECC

3. Existing and Proposed Drainage System

3.1 Existing Drainage System

3.1.1.1 The existing land use occupied by the Application Site is mainly zoned as "Green Belt" ("GB") within a minor portion on "Village Type Development" ("V") under the Approved Tai Po Outline Zoning Plan no. S/TP/32 as shown in **Figure 3.1.**

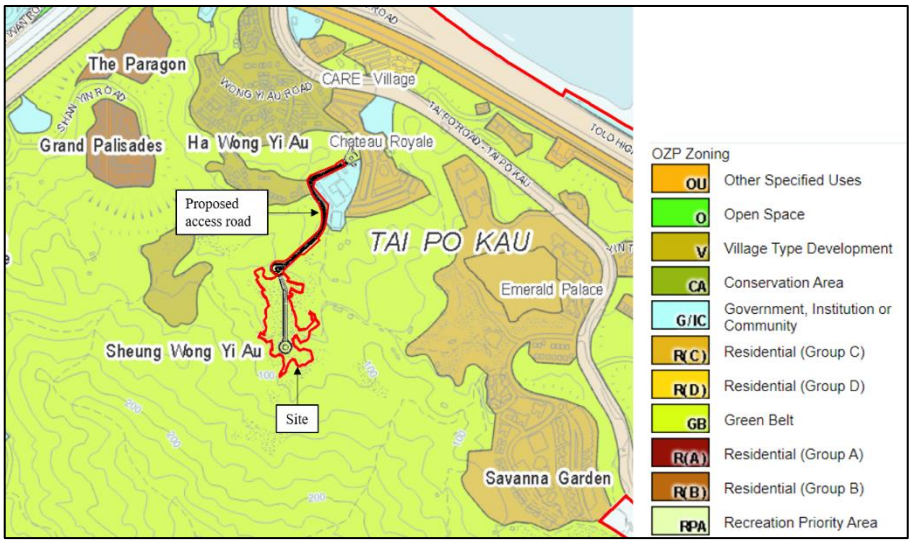


Figure 3.1 - Zoning of existing Sheung Wong Yi Au and the vicinity (source: TPB SPP3)

3.1.1.2 Based on DSD drainage records, the proposed Application Site in Wong Yi Au currently discharges to an existing natural watercourse. Such watercourse conveys flows to an existing 1-cell 2000x2250 box culvert north of the development area in the vicinity of Ling Liang Church M H Lau Secondary School. The box culvert runs along Yung Yi Road and becomes an open channel along the northern side of Care Village. The channel is conveyed beneath the existing railway tracks via twin 1200mm dia. pipes which discharge to a 2-cell 2500x2500 box culvert beneath Yuen Shin Road and Tolo Highway and consequently into Tolo Harbour.

3.1.1.3 Natural watercourses collecting hilly woodlands runoff cross the site and need to be diverted and intercepted.

3.2 Proposed Drainage System

3.2.1.1 A new 2,100mm diameter concrete pipe is proposed to serve the Application Site, plan layout is shown in **Appendix B**. The proposed pipe will collect runoff flows at the site entrance roundabout. The pipe will then follow the proposed access road alignment and discharge to the existing natural watercourse. The proposed pipe is classified as Trunk Drain as per SDM 2024 section 6.6.2.

3.2.1.2 The 2,100mm diameter pipe has been considered with a minimum gradient of 1 in 100; following SDM 2024 section 8.3 the proposed pipe capacity is around 16.4 m^3/s as detailed blow.

$$V = -\sqrt{32 * g * R * S_f} * \log\left(\frac{k_s}{14.8 * R} + \frac{1.25 * v}{R * \sqrt{32 * g * R * S_f}}\right)$$

$$Q = V * A * (1 - Silt) = 16.4\ m^3/s$$

Where:

- V is the flow velocity in m/s
- g is the gravity acceleration in m/s^2 (9.81 m/s^2)
- A is the flow area in m^2 (for 2.1m diameter = 3.46m^2)
- R is the hydraulic radius in m (for 2.1m diameter =0.525m)
- Sf is the pipe gradient in m/m (adopted 1 in 100 = 0.01m/m)
- ks is the friction factor in mm (adopted 0.6mm)
- v is the kinematic viscosity factor (1.14^-6 m^2/s)
- Silt is the siltation allowance (adopted 10%)

3.2.1.3 The proposed 2,100mm diameter concrete pipe will serve the proposed development only. It will be managed and maintained by the developer.

3.2.1.4 The existing 1,650mm diameter drain beneath Ha Wong Yi Au Road will be extended at the upstream end near the entrance of Yung Yi Villa, to suit the proposed road alignment.

3.3 Proposed Drainage Diversions and Extensions

3.3.1.1 The Site is crossed by existing natural watercourses as shown in **Figure 3.2**. These watercourses will be intercepted and diverted by the drainage system within the site and discharged to the proposed 2,100mm diameter drain.

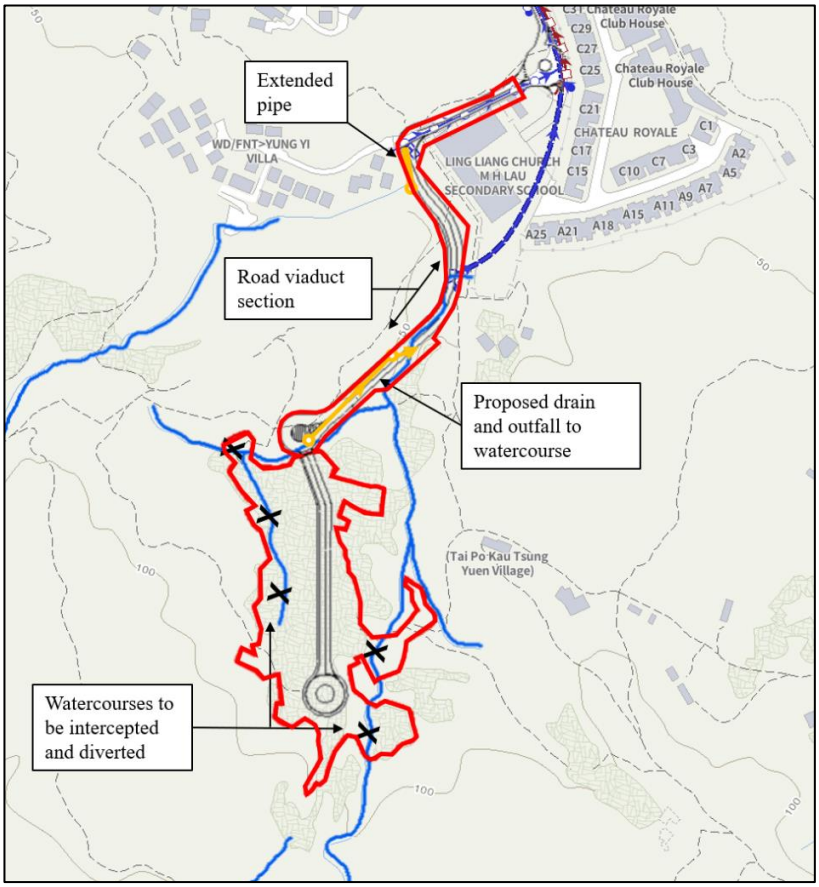


Figure 3.2 Diversion works for the existing streams

3.3.1.2 The existing drainage upstream of manhole SMH1007590 will be demolished and replaced by a 1650mm diameter drain to suit proposed road layout. This proposed drain will provide a new inlet facility to the existing catchments and is an extension of the existing 1650mm diameter pipe.

3.3.1.3 Before pipes demolition, inspection survey shall be carried out to verify the absence of existing un-mapped connections to the existing manholes. The demolished pipes shall be treated according to DSD Technical Circular No. 1/2022 "*Handling of Abandoned Pipes under DSD's Purview*".

3.4 Ecologically Important Streams/Rivers

3.4.1.1 The Streams and Rivers across and downstream of the Site are not classified as Ecologically Important Streams/Rivers (EIS) as per ETWB TCW No. 5/2005 and associated website[1]. There are no EIS in the vicinity that will be affected by proposed works.

[1] Ecologically Important Streams AFCD website, inspected on 16/04/2024

https://www.afcd.gov.hk/english/conservation/con_wet/streams_rivers_hk/Con_NSR/Ecologically_Important_Streams.html

4. Changes to Drainage Characteristics

4.1 Change in Land Use and Surface Runoff Characteristics

4.1.1.1 The land use of the proposed scheme will be changed from woodland, shrubland to paved area with partial landscape. The site has been conservatively assumed as fully paved. The additional paved area due to the development will increase the equivalent runoff coefficient of the site and consequently runoff flows.

4.1.1.2 The CN and runoff coefficient values comparison before and after the proposed development are shown in **Table 4.1** and **Table 4.2**.

Table 4.1 - Curve Numbers for the sub-catchment before and after the development

Catchment ID	Before Development Area (m^2)	After Development Area (m^2)	Before Development CN	After Development CN
Catchment_114	230,436	215,562	68.45	68.45
Catchment_124_M2	15,152	15,152	79.70	81.32

Table 4.2 - Runoff coefficients for urban catchments before and after the development

Catchment ID	Total Area (m^2)	Before Development Paved %	After Development Paved %
Site	14,874	-	100%
SMH1007589	627	77%	98%
SMH1007588	1,072	80%	95%
SMH1007587	857	65%	96%
SMH1007586	769	26%	92%
SCH1003833	2,720	88%	92%

4.2 Changes in Peak Runoff

4.2.1.1 The impact of the proposed development on catchment runoffs for End of 21st Century climate change conditions is shown in **Table** 4.3. The proposed development expected total runoff increase is of around 0.42m^3/s which accounts for 3% of the total runoff flow.

Table 4.3 – Catchment runoff before and after the development

Catchment ID	Runoff 200year End 21st century storm			
	Before development	After development	Increase	
	[m^3/s]	[m^3/s]	[m^3/s]	[%]
Catchment_114 & Site	13.59	13.92	0.33	2%
Catchment_124_M2	1.36	1.37	0.01	1%
SMH1007589	0.05	0.05	0.01	19%
SMH1007588	0.08	0.09	0.01	14%
SMH1007587	0.06	0.08	0.02	30%
SMH1007586	0.03	0.07	0.03	107%
SCH1003833	0.22	0.23	0.01	3%
Total	**15.39**	**15.81**	**0.42**	**3%**

4.3 Changes in Flood Storage

4.3.1.1 To compensate the increased paved area due to the proposed development, a stormwater retention tank is proposed. The stormwater retention tank will be located within the proposed development and attenuate the proposed development runoff flows before discharging to the proposed network.

4.3.1.2 The site runoff will be conveyed to the proposed stormwater retention tank; there a 525mm diameter outlet will throttle the incoming flow causing water level increase in the tank and consequently storage. The stormwater retention tank stored volume for end of 21st Century has been preliminarily estimated in around 1,500 m^3. The exact location and arrangement of the stormwater retention tank will be detailed in detail design stage.

5. Potential Drainage Impacts and Drainage Mitigation Measures

5.1 Proposed Network Performance

5.1.1.1 The performance of the proposed drain is summarised in **Table 5.1**. The proposed drain has sufficient capacity to discharge the design flow.

Table 5.1 – Proposed drain design flow and capacity

Design flow 200yr End 21st century storm		Proposed pipe		
From catchment	Flow [m^3/s]	Diameter [mm]	Capacity [m^3/s]	Usage [%]
Catchment_114	12.90	2100	16.4	79%

5.1.1.2 The proposed 1650mm diameter drain extension upstream of manhole SMH1007590 has sufficient capacity to convey the design flows as shown in **Appendix C**.

5.2 Existing Network Performance and Potential Impacts

5.2.1.1 The proposed stormwater retention tank attenuates the incoming runoff flows; the downstream network is not affected by the proposed development. Two key locations have been considered; one at the upstream end of the existing box culver in the vicinity of Ling Liang Church M H Lau Secondary School; the other location is at the downstream end of such box culvert, in the vicinity of Care village. The design flows after the development in these key locations is shown in Error! R eference source not found. The benefit of the proposed stormwater tanks diminish moving downstream in the network.

Table 5.2 – Existing drain, impacts on design flows for End of 21st Century

Location	Drainage Pipe upstream node ID	Before Development Peak Flow	After Development Peak Flow	Peak Flow Increase	
		[m^3/s]	[m^3/s]	[m^3/s]	[%]
BC near Secondary School	N3633326379	16.02	15.28	-0.73	-5%
BC near Care Village	SGJ1002441	25.13	24.20	-0.93	-4%
Drain downstream of SMH1007590	SMH1007590	7.20	7.29	0.09	1%

5.2.1.2 Changes in water level caused by the proposed development in the existing network are summarised in **Table 5.3**. The assessment identifies that the performance of the existing network is unchanged by the proposed development and impacts are minimal; the existing box culvert well performs within freeboard requirements. The existing channel near Care village has negative freeboard due to existing low-lying terrain, the proposed development has marginal benefits on the channel performance.

Table 5.3 – Existing drain, impacts on 200year End 21st Century storms water levels

Location	Node / Manhole ID	Ground Level	Existing Scenario			Proposed Scenario			
			Case A	Case B	Min Freeboard	Case A	Case B	Min Freeboard	Water Level Change
			Water Level	Water Level		Water Level	Water Level		
		[mPD]	[mPD]	[mPD]	[m]	[mPD]	[mPD]	[m]	[mm]
BC near Secondary School	N3633326379	35.994	32.508	32.120	3.486	32.485	32.094	3.509	-23mm
BC near Care Village	CARE_ VILLAGE_ CH250	8.300	7.211	7.269	1.031	7.201	7.268	1.032	-1mm
Channel near Care Village	CARE_ VILLAGE_ CH360	3.172	7.258	7.304	-4.132	7.246	7.302	-4.130	-2mm

5.3 Drainage Mitigation and Precautionary Measures

5.3.1.1 The proposed stormwater storage tank attenuates the runoffs from the proposed development and achieves lower flow rates in the downstream existing networks compared to existing conditions. There are no adverse effects from the proposed development on the downstream network. The developer shall comply with the requirements of the Stormwater Drainage Manual for the design, operation, and maintenance of the proposed stormwater storage tank.

5.3.1.2 To further reduce impacts, blue-green elements such as rain gardens, swales and other features that can be integrated in the landscape design and reduce design flows to the downstream network will be considered in detailed design.

5.3.1.3 Detail design shall confirm no adverse impact on the drainage system during operation. Appropriate precautionary measures shall be provided in detail design to prevent any disturbance, damage and pollution from the development to any parts of the existing drainage facilities in the vicinity of the lot.

5.4 Temporary Site Drainage and Monitoring During Construction Phase

5.4.1.1 It is proposed that the temporary works for the existing stream diversion are carried out in the dry season where possible in order to avoid heavy rainfall and excessive sediment wash down that may affect the hydraulic capacity of both the existing channel and any temporary diversion channels. All works shall be scheduled in phases and carried out sequentially during consecutive dry seasons to avoid undertaking work in the wet seasons. However due to the scale of the works it is estimated that construction may be required during the wet seasons and construction drainage impact assessment and temporary drainage works should be conducted to avoid any adverse hydraulic impacts during construction. Stockpiling material should be kept away from the streams and drainage system.

5.4.1.2 During construction stage, Temporary Drainage Management Plan (TDMP) should be submitted by the Contractor for DSD's comments before carrying out any diversion and upgrading work. Sufficient information to show clearly the nature of works proposed shall be clearly described in TDMP. TDMP shall also explain how the drainage works will be implemented with works programme, and assess the impact on the drainage system with proposed mitigation measures. Monitoring and mitigation procedure with contingency plans shall be provided. All works shou comply with "DSD Technical Circular No.1/2017 Temporary Flow Diversions and Temporary Works Affecting Capacity in Stormwater Drainage Systems".

5.4.1.3 Appropriate mitigation measures shall be proposed to ensure that the proposed works will not cause any unacceptable increase in the risk of flooding throughout the construction period, and fulfil all relevant requirements of DSD. The provision of site drainage should be adequate during construction. Any temporary dewatering required for underground works will be by pumping to a suitable storm drain. During wet weather, ponding of water in localized low spots within works sites may develop in respect of temporary works and temporary storage. This will need to be collected by the temporary site drains and gravity discharge / pumped to the nearest storm drain or culvert. This flow discharge is required to be desilted and closely monitored for the compliance with the EPD statutory requirements.

5.4.1.4 Surface run-off from the construction site should be directed into the existing public storm water drainage system via adequately designed sand / silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers will be provided on site to properly direct storm water to such silt removal facilities.

5.4.1.5 Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit will be removed regularly, and particularly after each rainstorm, to ensure that these facilities are functioning properly at all times.

5.4.1.6 During excavation in the wet season, temporarily exposed soil surfaces should be covered wherever practicable and temporary access roads should be protected by crushed stone or gravel as excavation proceeds. Intercepting channels will be provided, for example along the crest / edge of the excavation, to prevent storm runoff from washing across exposed soil surfaces. Arrangements will be in place to ensure that adequate surface protection measures can be safety carried out well before the arrival of a rainstorm; and Earthworks final surfaces will be well compacted and the subsequent permanent work or surface protection will be carried out as soon as practical after the final surface are formed to prevent erosion caused by rainstorms. Appropriate intercepting channels will be provided, where necessary. Rainwater pumped out from trenches or foundation excavations will be discharged into storm drains via silt removal facilities.

6. Conclusion

6.1.1.1 A drainage impact assessment study has been carried out for the proposed development. The existing land use occupied by the Application Site is mainly zoned as "GB" within a minor portion on "V" zone. The site currently is served by a watercourse which discharges to an existing 1-cell 2000x2250 box culvert north of the development area; flows are then conveyed to Tolo Harbour.

6.1.1.2 The land use of the proposed scheme will be changed from woodland, shrubland to paved area with partial landscape. The expected total runoff increase by the proposed development is of around 0.42m^3/s which accounts for 3% of the total runoff flow.

6.1.1.3 A new 2,100mm diameter pipe is proposed to serve the Application Site; the proposed drain has sufficient capacity to discharge the design flows.

6.1.1.4 A stormwater retention tanks is proposed within the Application Site. The stormwater retention tank will attenuate the runoff flows from the proposed development and achieve a lower discharge rate to the downstream network compared to existing conditions.

6.1.1.5 The proposed stormwater retention tank will operate through a throttled outlet. The preliminarily estimated stored runoff water volume is of 1,500 m^3. Exact arrangement and configuration will be further elaborated in detailed design stage.

6.1.1.6 At manhole SMH1007590, the existing 1650mm drain is proposed to be extended to re-provide stormwater inlet structure to suit proposed road layout. The proposed extension has sufficient capacity to convey the design flows.

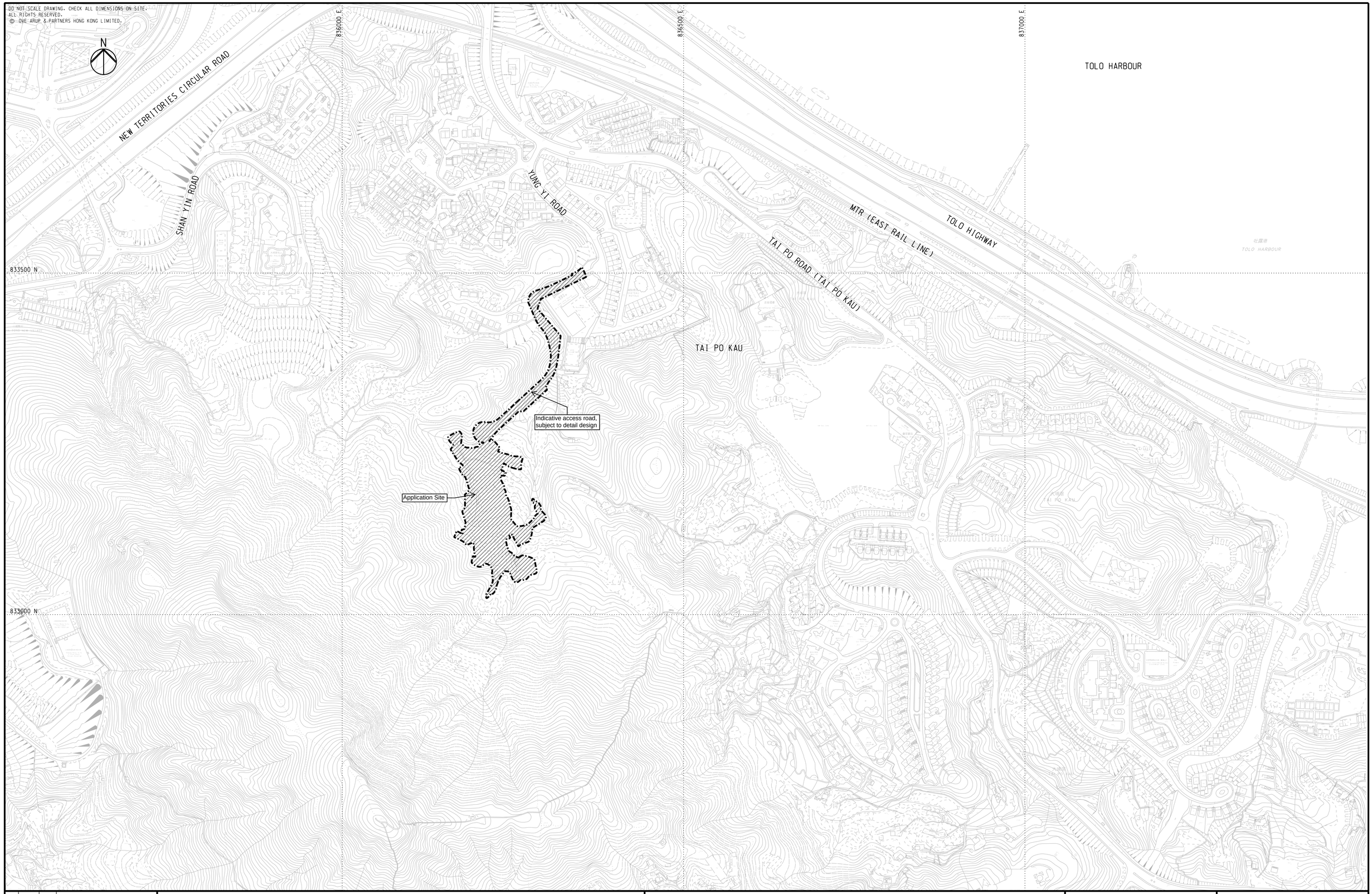
6.1.1.7 The proposed development has no negative impact on the downstream drainage network. This DIA confirms the feasibility of the Proposed Development in terms of its drainage impacts.

Appendix A

Hydraulic Model (Digital Only)

Appendix B

Drawings



Mark	Date	By	Rev.
D	01/26	AL	FOURTH ISSUE
C	02/25	JP	THIRD ISSUE
B	04/24	JP	SECOND ISSUE
A	02/23	AH	FIRST ISSUE

LEGEND

PROPOSED DEVELOPMENT

Job Title

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A OF THE TOWN PLANNING ORDINANCE (CAP. 131) FOR PROPOSED RESIDENTIAL DEVELOPMENT AT VARIOUS LOTS IN D.D. 32 AND ADJOINING GOVERNMENT LAND, WONG YI AU, TAI PO, NEW TERRITORIES

Drawing Title

LOCATION PLAN

Drawing Status

SUBMISSION

ARUP

Scale 1:2500 @ A1

Drn. RY Date 02/23 Chd. JW Passed KK

Job No. 292635 Drawing No. C/001 Rev. D

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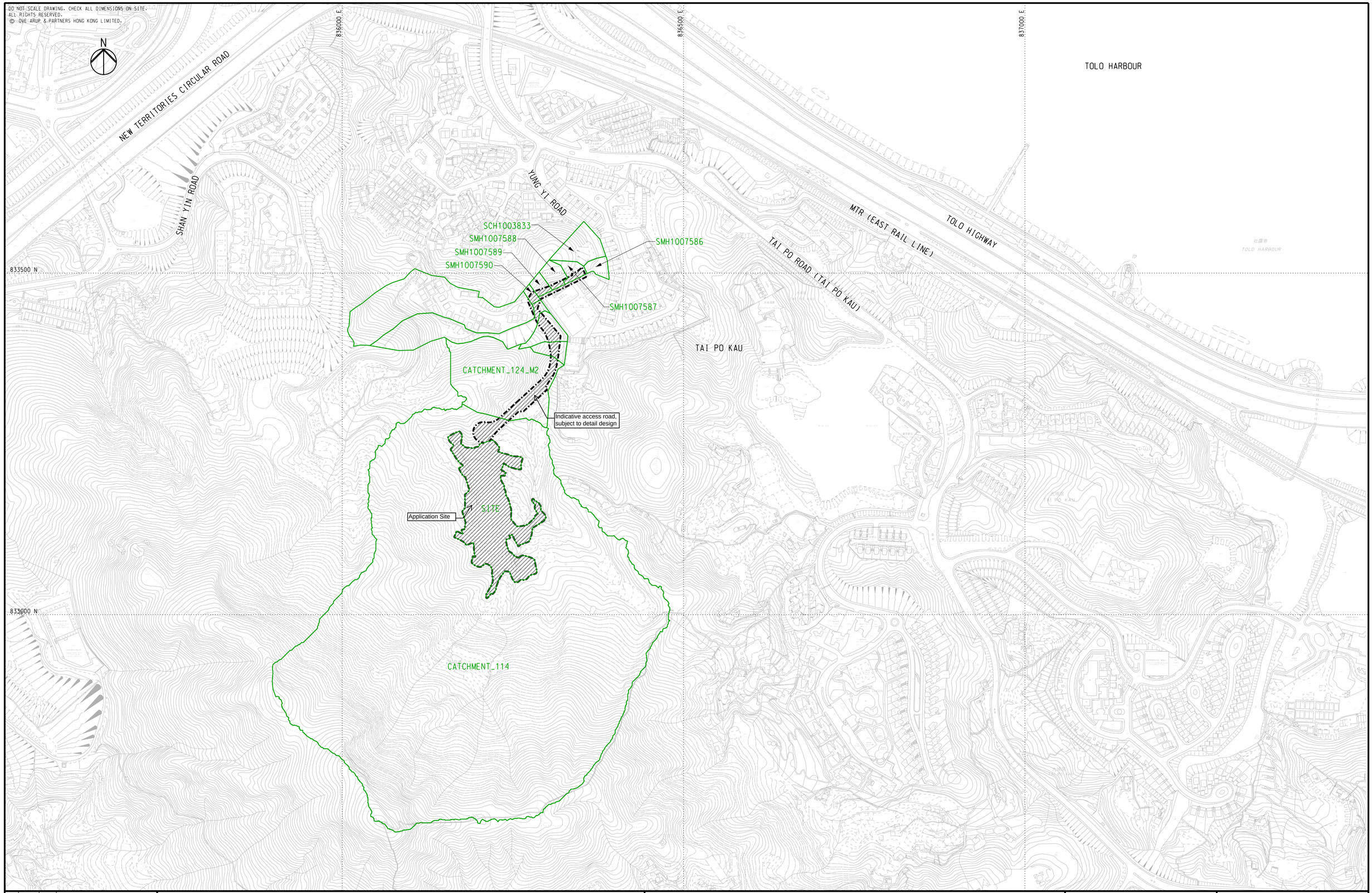


Mark	Date	By	Rev.
C	01/26	AL	THIRD ISSUE
B	03/25	JP	SECOND ISSUE
A	09/24	JP	FIRST ISSUE

LEGEND

PROPOSED DEVELOPMENT

Job Title

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A OF THE TOWN PLANNING ORDINANCE (CAP. 131) FOR PROPOSED RESIDENTIAL DEVELOPMENT AT VARIOUS LOTS IN D.D. 32 AND ADJOINING GOVERNMENT LAND, WONG YI AU, TAI PO, NEW TERRITORIES

Drawing Title

LOCATION PLAN AND PROPOSED CATCHMENTS

Drawing Status

SUBMISSION

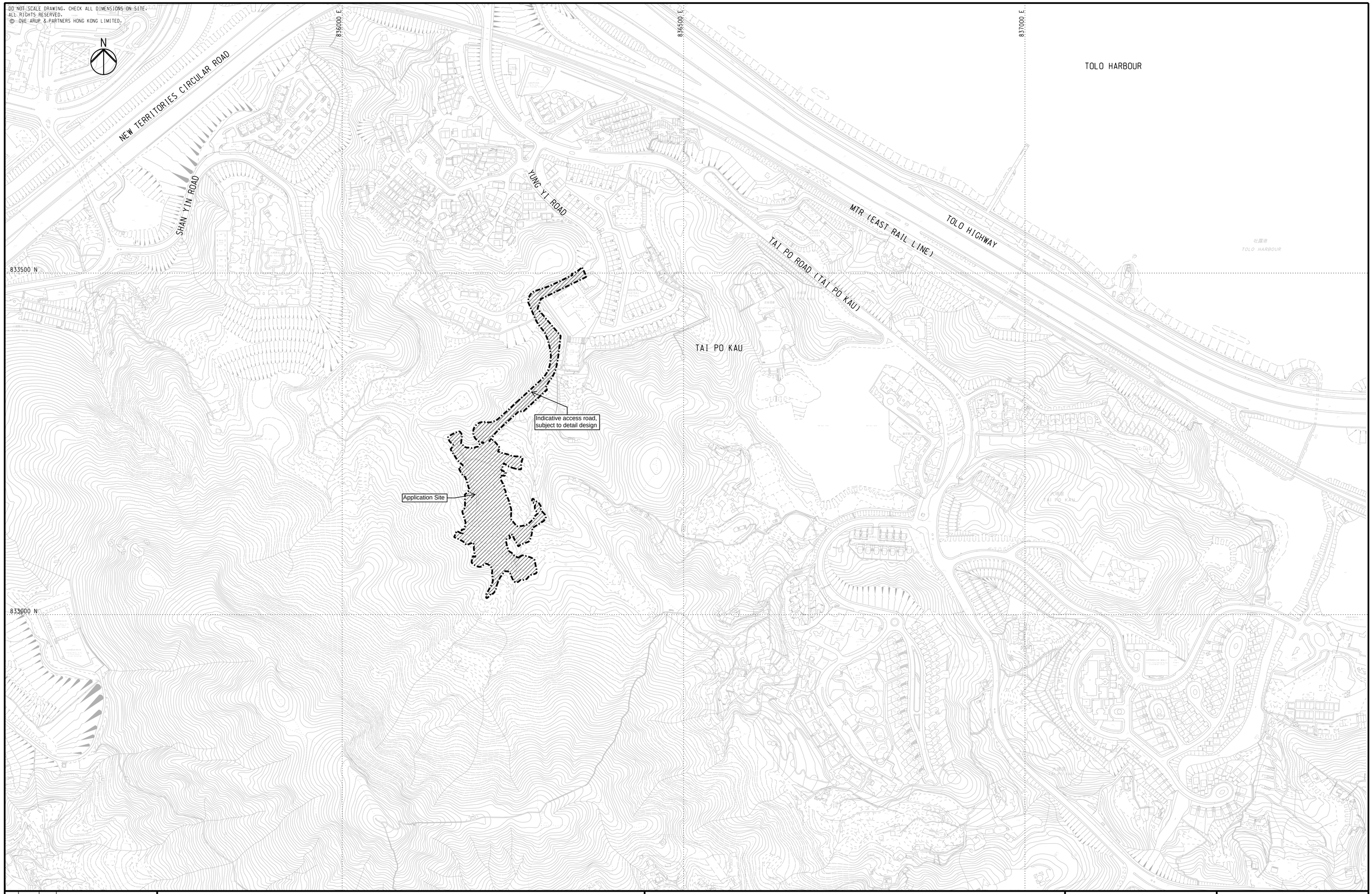
ARUP

Scale 1:2500 @ A1

Drn. RY Date 09/24 Chd. JW Passed KK

Job No. 292635 Drawing No. C/002 Rev. C

Printed by : $USER$
Filename : $FILE$
$DATE$



Mark	Date	By	Rev.
D	01/26	AL	FOURTH ISSUE
C	02/25	JP	THIRD ISSUE
B	04/24	JP	SECOND ISSUE
A	02/23	AH	FIRST ISSUE

LEGEND

PROPOSED DEVELOPMENT

Job Title

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A OF THE TOWN PLANNING ORDINANCE (CAP. 131) FOR PROPOSED RESIDENTIAL DEVELOPMENT AT VARIOUS LOTS IN D.D. 32 AND ADJOINING GOVERNMENT LAND, WONG YI AU, TAI PO, NEW TERRITORIES

Drawing Title

LOCATION PLAN

Drawing Status

SUBMISSION

ARUP

Scale 1:2500 @ A1

Drn. RY Date 02/23 Chd. JW Passed KK

Job No. 292635 Drawing No. C/001 Rev. D

Printed by : $USER$
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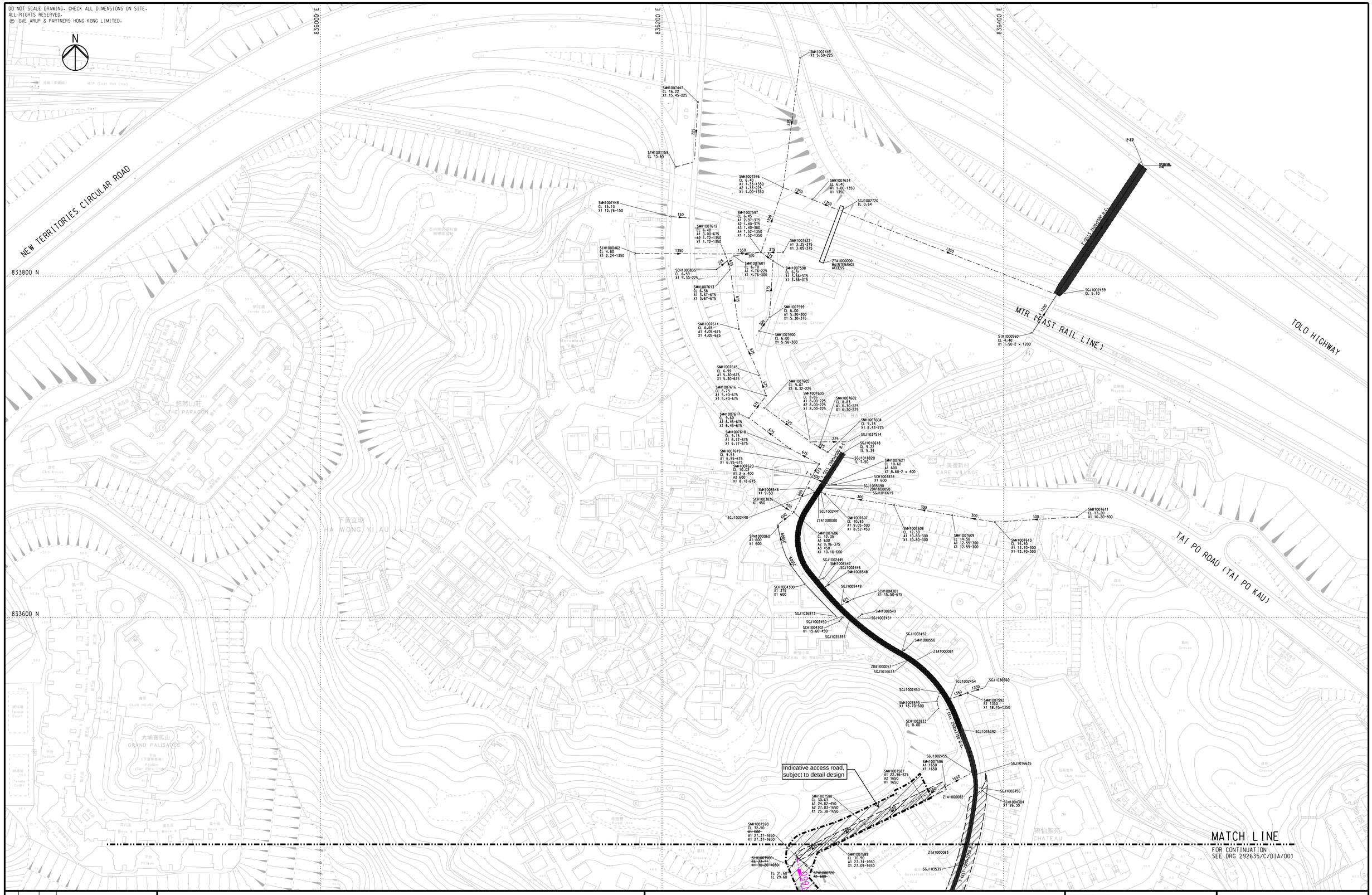


Mark	Date	By	Rev.
D	01/26	AL	FOURTH ISSUE
C	03/25	JP	THIRD ISSUE
B	04/24	JP	SECOND ISSUE
A	02/23	AH	FIRST ISSUE

LEGEND

PROPOSED DEVELOPMENT

EXISTING DRAINAGE AND MANHOLE

Job Title

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A OF THE TOWN PLANNING ORDINANCE (CAP. 131) FOR PROPOSED RESIDENTIAL DEVELOPMENT AT VARIOUS LOTS IN D.D. 32 AND ADJOINING GOVERNMENT LAND, WONG YI AU, TAI PO, NEW TERRITORIES

Drawing Title

EXISTING DRAINAGE NETWORK (SHEET 2 OF 2)

Drawing Status

SUBMISSION

ARUP

Scale	1:1000 @ A1		
Drn. RY	Date 02/23	Chd. JW	Passed KK
Job No. 292635	Drawing No. C/DIA/002		Rev. D

Printed by : $USER$
Filename : $FILE$
$DATE$

Appendix C

Hydraulic Model Outputs

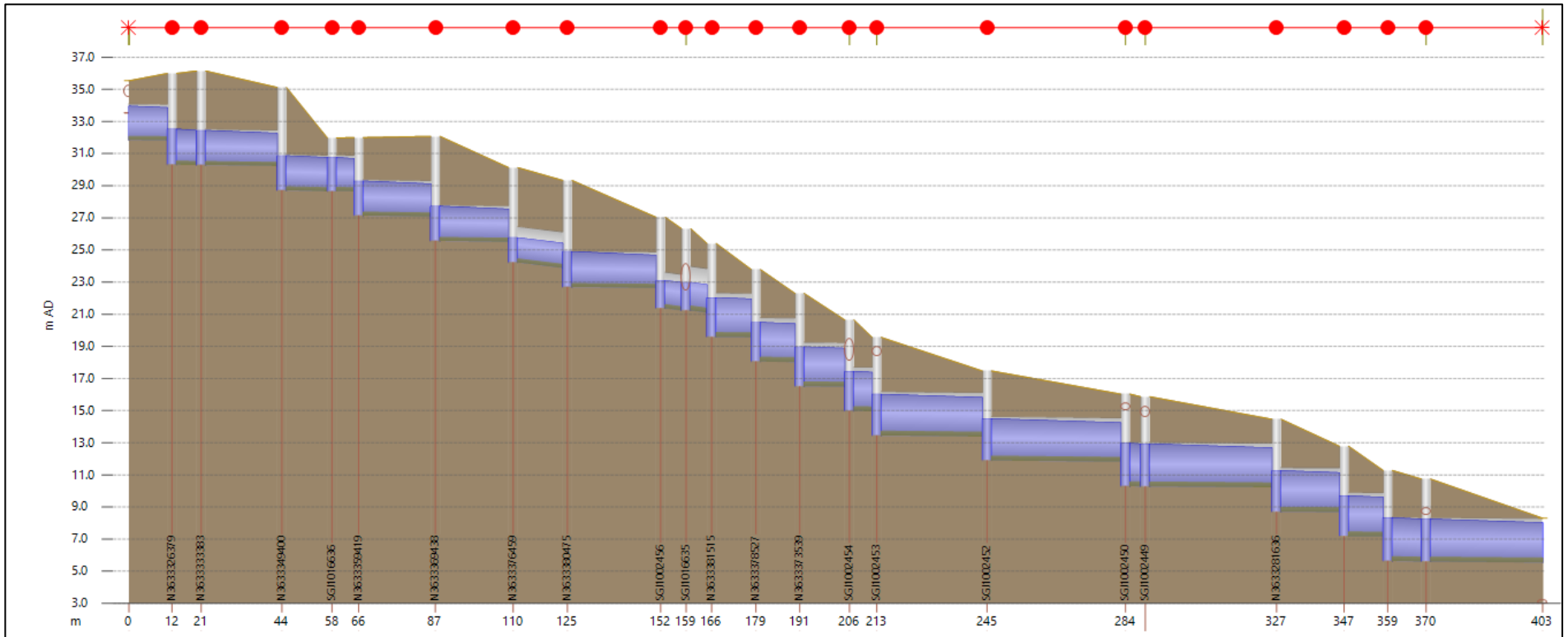
ARUP

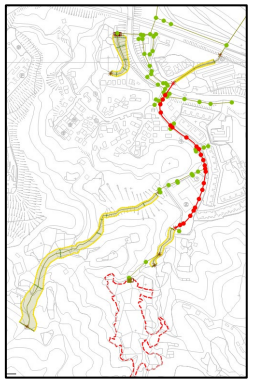
Hydraulic Model 200yrs Case A End Century Baseline Scenario

ARUP

Hydraulic Model 200yrs Case A End Century

Baseline Scenario





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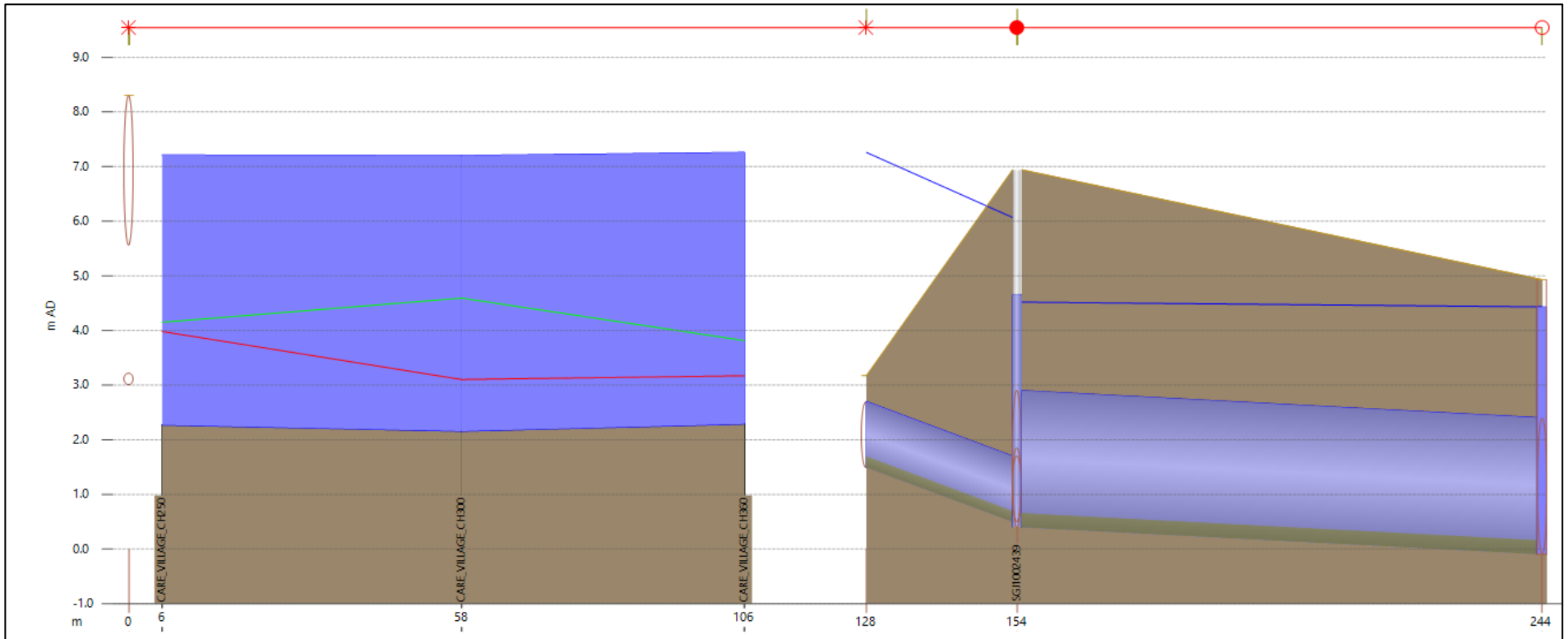
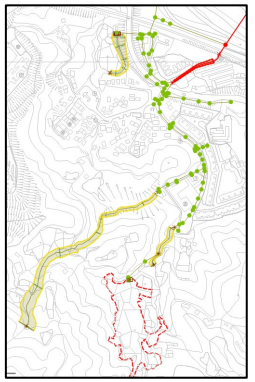
Shape ID	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	-	-	RECT	RECT	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	RECT
width (mm)	2000	-	2000	2000	-	2000	2000	2000	2000	-	-	2500	2500	2500	-	2500	2500	-	2500	2500	2500	2500	2500
height (mm)	2250	-	2250	2250	-	2250	2250	2250	2250	-	-	2750	2750	2750	-	2750	2750	-	2750	2750	2750	2750	2750
us inv (m AD)	31.854	-	30.285	28.709	-	27.134	25.560	24.220	22.686	-	-	19.586	18.049	16.513	-	13.443	11.894	-	10.283	8.706	7.171	5.632	5.600
ds inv (m AD)	31.828	-	30.226	28.652	-	27.077	25.507	23.878	22.635	-	-	19.564	18.024	16.492	-	13.380	11.809	-	10.224	8.683	7.150	5.600	5.550
r.pfc (m3/s)	7.947	-	8.730	10.899	-	8.812	8.422	25.655	7.552	-	-	12.548	13.471	11.571	-	13.472	13.960	-	11.943	10.401	12.345	-	11.663
DS flow (m3/s)	-	-	16.03345	-	-	16.44947	16.45788	-	16.59189	-	-	-	-	-	-	24.45795	24.48066	-	24.82803	24.82769	-	-	25.12825
Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SGJ1002452	-	-	N3633281636	-	-	-	-
ground (m AD)	-	-	36.143	35.119	-	32.001	32.075	30.130	29.333	27.037	-	-	-	-	-	19.558	17.468	16.027	15.865	14.462	12.782	-	10.740	8.300
level (m AD)	-	-	32.429	30.851	-	29.279	27.713	25.753	24.892	23.082	-	-	-	-	-	16.002	14.482	12.955	12.912	11.250	9.677	-	8.232	7.211
volume (m3)	-	2.2	2.1	2.1	2.1	2.1	2.2	1.5	2.2	1.7	-	2.4	2.4	2.4	2.5	2.6	2.6	2.7	2.6	2.5	2.5	2.7	2.6	0.0

Hydraulic Model 200yrs Case A End Century

Baseline Scenario





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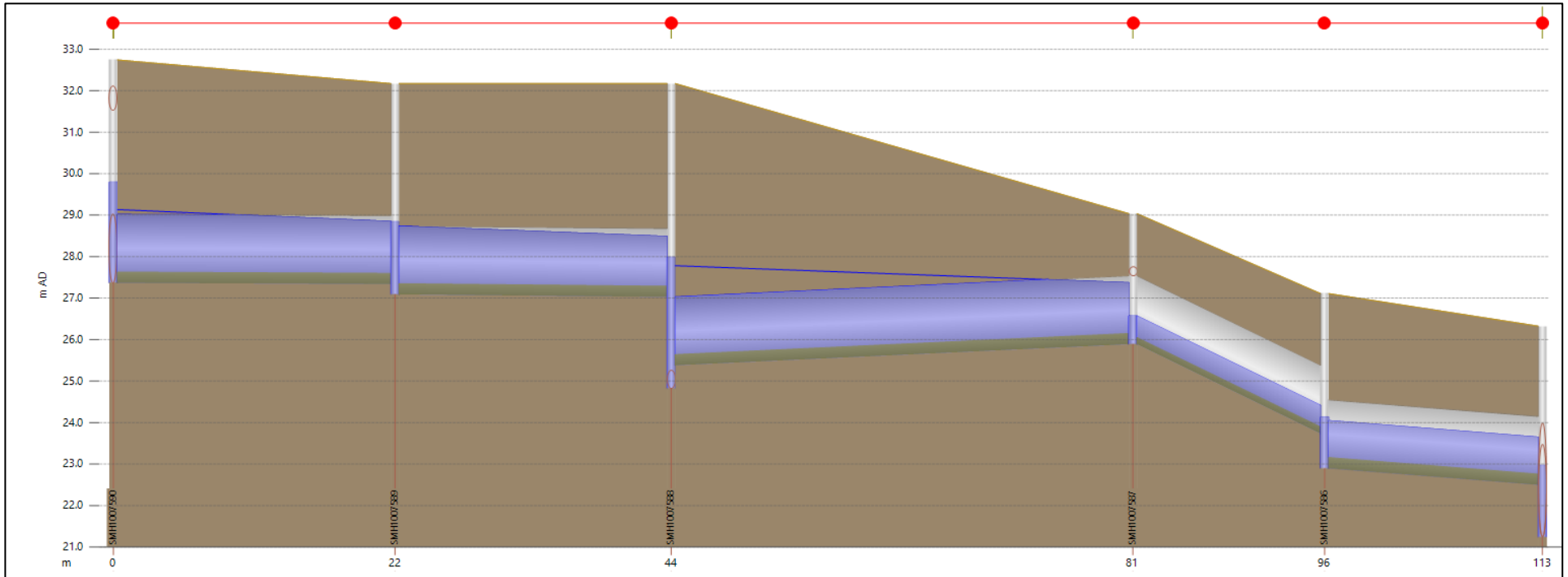
Shape ID		CIRC	RECT
width (mm)		1200	2500
height (mm)		1200	2500
us inv (m AD)	2.271	1.500	0.400
ds inv (m AD)	2.289	0.500	-0.100
r.pfc (m3/s)	6.087	5.835	19.713
DS flow (m3/s)	11.74859	6.11046	7.90653

Node	CARE_VILLAGE_CH250	CARE_VILLAGE_CH360	SGJ1002439	SGJ1017447
ground (m AD)	8.300	3.172	6.939	4.932
level (m AD)	7.211	7.258	4.655	4.430
volume (m3)	0.0	0.0	35.6	

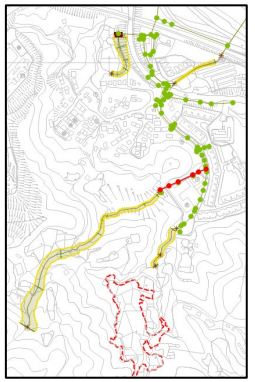
Hydraulic Model 200yrs Case A End Century

Baseline Scenario



Link	SMH1007590.1	SMH1007589.1	SMH1007588.1	SMH1007587.1	SMH1007586.1
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)	1650	1650	1650	1650	1650
height (mm)	1650	1650	1650	1650	1650
us inv (m AD)	27.370	27.090	25.380	25.890	22.900
ds inv (m AD)	27.340	27.030	25.890	23.734	22.500
pfc (m3/s)	2.522	3.603	-8.131	28.087	10.491
DS flow (m3/s)	7.20468	7.23386	7.61923	7.74310	7.76494

Node	SMH1007590	SMH1007589	SMH1007588	SMH1007587	SMH1007586	SGJ1016635
ground (m AD)	32.741	32.173	32.173	29.037	27.110	26.325
level (m AD)	29.798	28.842	27.985	26.571	24.135	22.969



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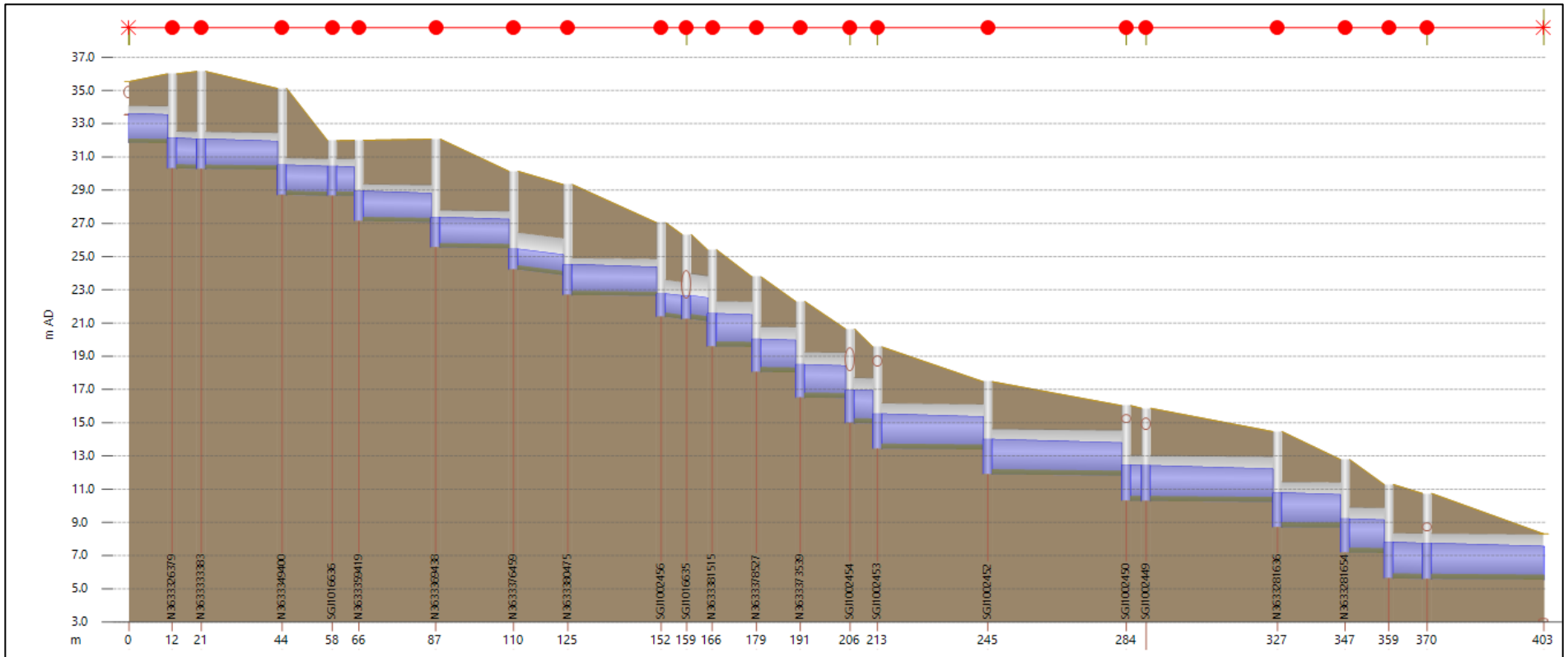
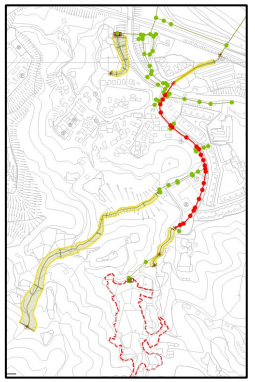
Hydraulic Model 200yrs Case B End Century Baseline Scenario

ARUP

Hydraulic Model 200yrs Case B End Century

Baseline Scenario



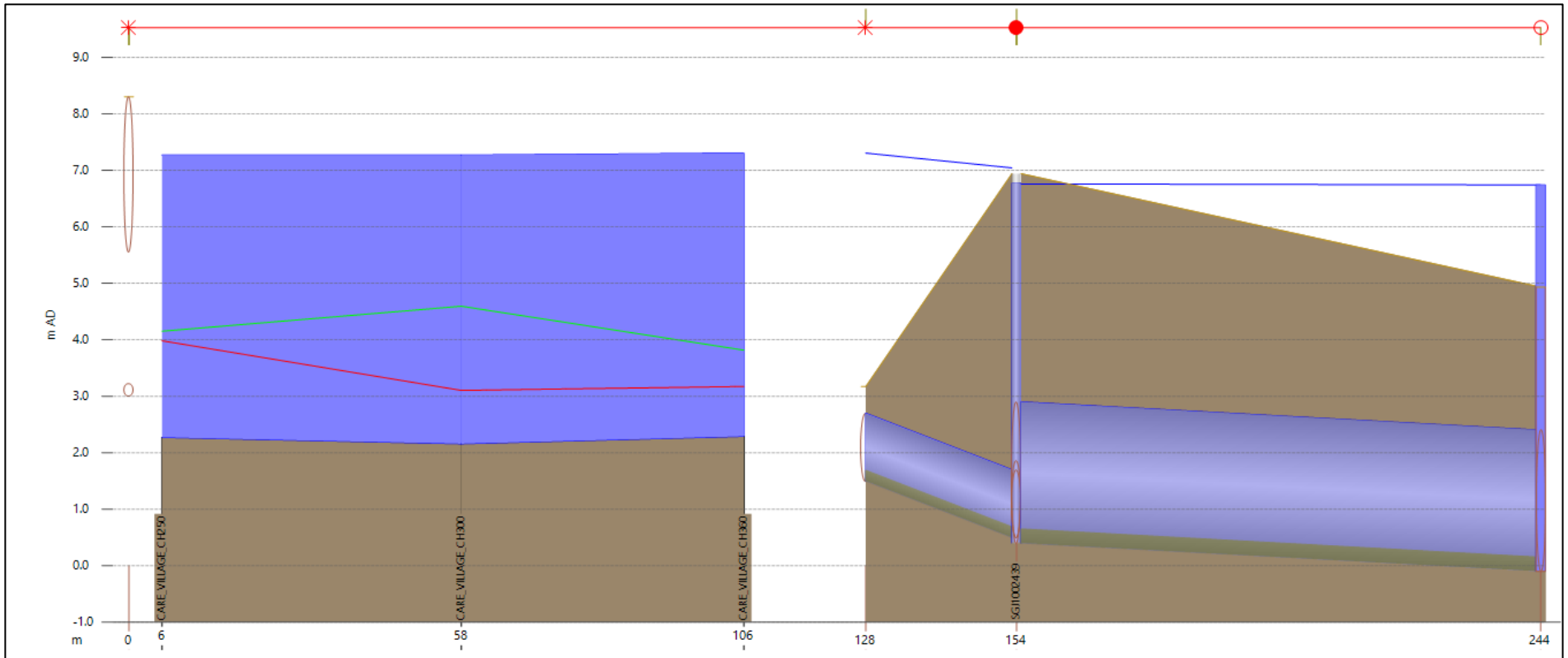


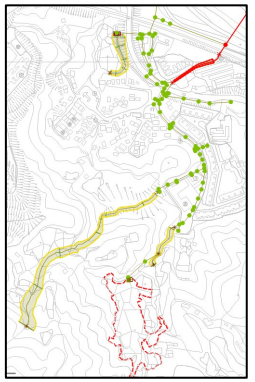
Link	-	-	-	-	-	-	-	-	N3633380475.1	-	-	-	-	-	-	SGJ1002453.1	SGJ1002452.1	-	SGJ1002449.1	-	-	-	SGJ1002441.1
Shape ID	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	-	-	RECT	RECT	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	RECT
width (mm)	2000	-	2000	2000	-	2000	2000	2000	2000	-	-	2500	2500	2500	-	2500	2500	-	2500	2500	2500	2500	2500
height (mm)	2250	-	2250	2250	-	2250	2250	2250	2250	-	-	2750	2750	2750	-	2750	2750	-	2750	2750	2750	2750	2750
us inv (m AD)	31.854	-	30.285	28.709	-	27.134	25.560	24.220	22.686	-	-	19.586	18.049	16.513	-	13.443	11.894	-	10.283	8.706	7.171	5.632	5.600
ds inv (m AD)	31.828	-	30.226	28.652	-	27.077	25.507	23.878	22.635	-	-	19.564	18.024	16.492	-	13.380	11.809	-	10.224	8.683	7.150	5.600	5.550
r.pfc (m3/s)	7.947	-	8.730	10.899	-	8.812	8.422	25.655	7.552	-	-	12.548	13.471	11.571	-	13.472	13.960	-	11.943	10.401	12.345	-	11.663
DS flow (m3/s)	-	-	11.11218	-	-	11.30216	11.30201	-	11.30166	-	-	-	-	-	-	16.97795	16.99485	-	17.24654	17.24583	-	-	17.51775

Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SGJ1002452	-	-	N3633281636	-	-	-	-
ground (m AD)	-	-	36.143	35.119	-	32.001	32.075	30.130	29.333	27.037	-	-	-	-	-	19.558	17.468	16.027	15.865	14.462	12.782	-	10.740	8.300
level (m AD)	-	-	32.070	30.505	-	28.932	27.363	25.442	24.514	22.747	-	-	-	-	-	15.518	13.990	12.439	12.409	10.771	9.203	-	7.732	7.269

Hydraulic Model 200yrs Case B End Century

Baseline Scenario





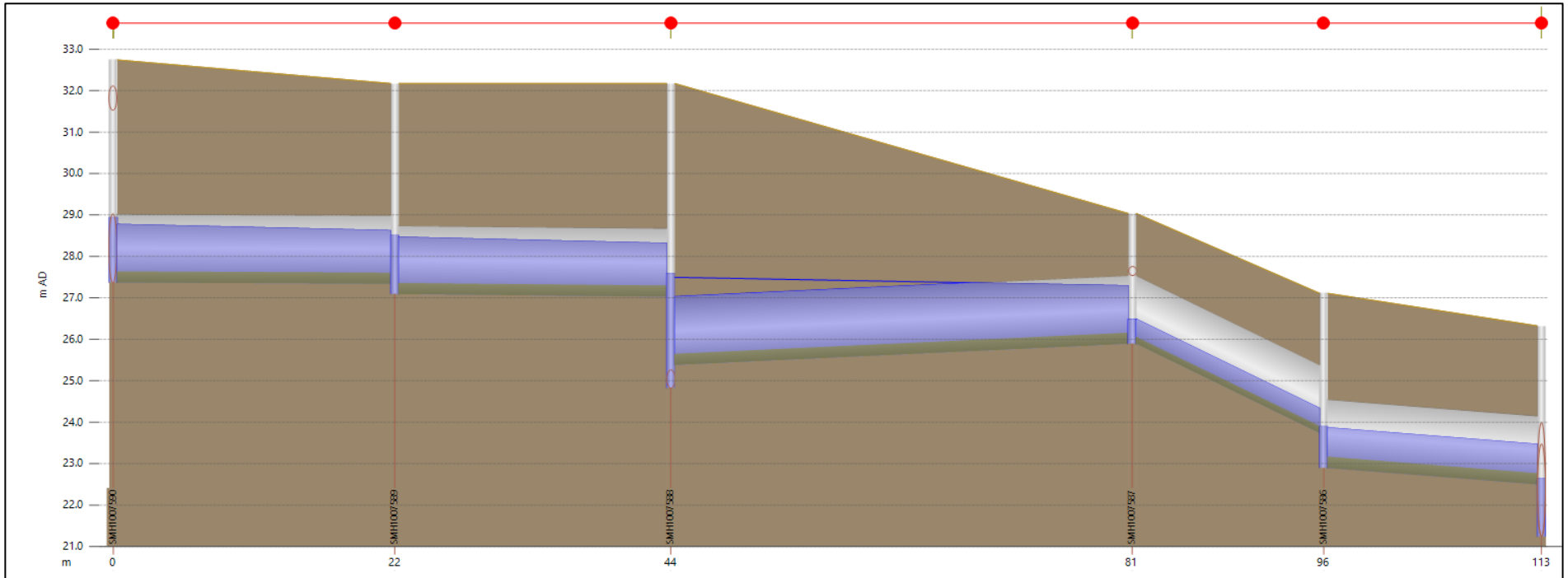
Link	CARE_VILLAGE_CH250.1	CARE_VILLAGE_CH360.1	SGJ1002439.1
Shape ID		CIRC	RECT
width (mm)		1200	2500
height (mm)		1200	2500
us inv (m AD)	2.271	1.500	0.400
ds inv (m AD)	2.289	0.500	-0.100
r.pfc (m3/s)	6.087	5.835	19.713
DS flow (m3/s)	-12.68670	-6.34322	-7.27988

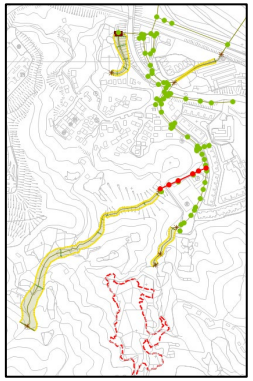
Node	CARE_VILLAGE_CH250	CARE_VILLAGE_CH360	SGJ1002439	SGJ1017447
ground (m AD)	8.300	3.172	6.939	4.932
level (m AD)	7.269	7.304	6.773	6.740

ARUP

Hydraulic Model 200yrs Case B End Century

Baseline Scenario





Link	SMH1007590.1	SMH1007589.1	SMH1007588.1	SMH1007587.1	SMH1007586.1
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)	1650	1650	1650	1650	1650
height (mm)	1650	1650	1650	1650	1650
us inv (m AD)	27.370	27.090	25.380	25.890	22.900
ds inv (m AD)	27.340	27.030	25.890	23.734	22.500
pfc (m3/s)	2.522	3.603	-8.131	28.087	10.491
DS flow (m3/s)	5.24408	5.26586	5.55009	5.64084	5.65718

Node	SMH1007590	SMH1007589	SMH1007588	SMH1007587	SMH1007586	SGJ1016635
ground (m AD)	32.741	32.173	32.173	29.037	27.110	26.325
level (m AD)	28.942	28.508	27.593	26.491	23.902	22.642

ARUP

Hydraulic Model 200yrs Case A End Century Proposed Scenario

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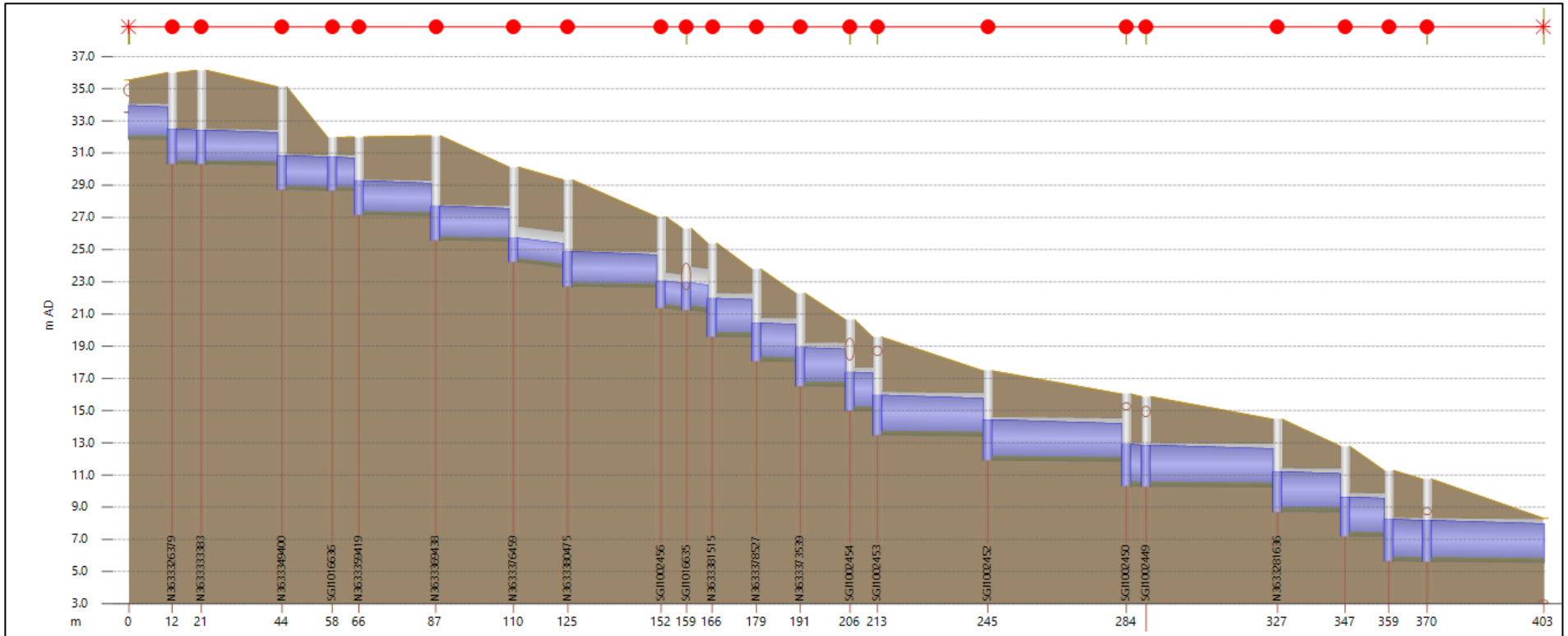
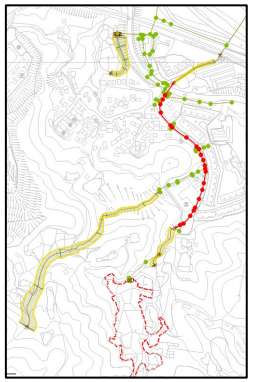
Hydraulic Model 200yrs Case A End Century

Proposed Scenario



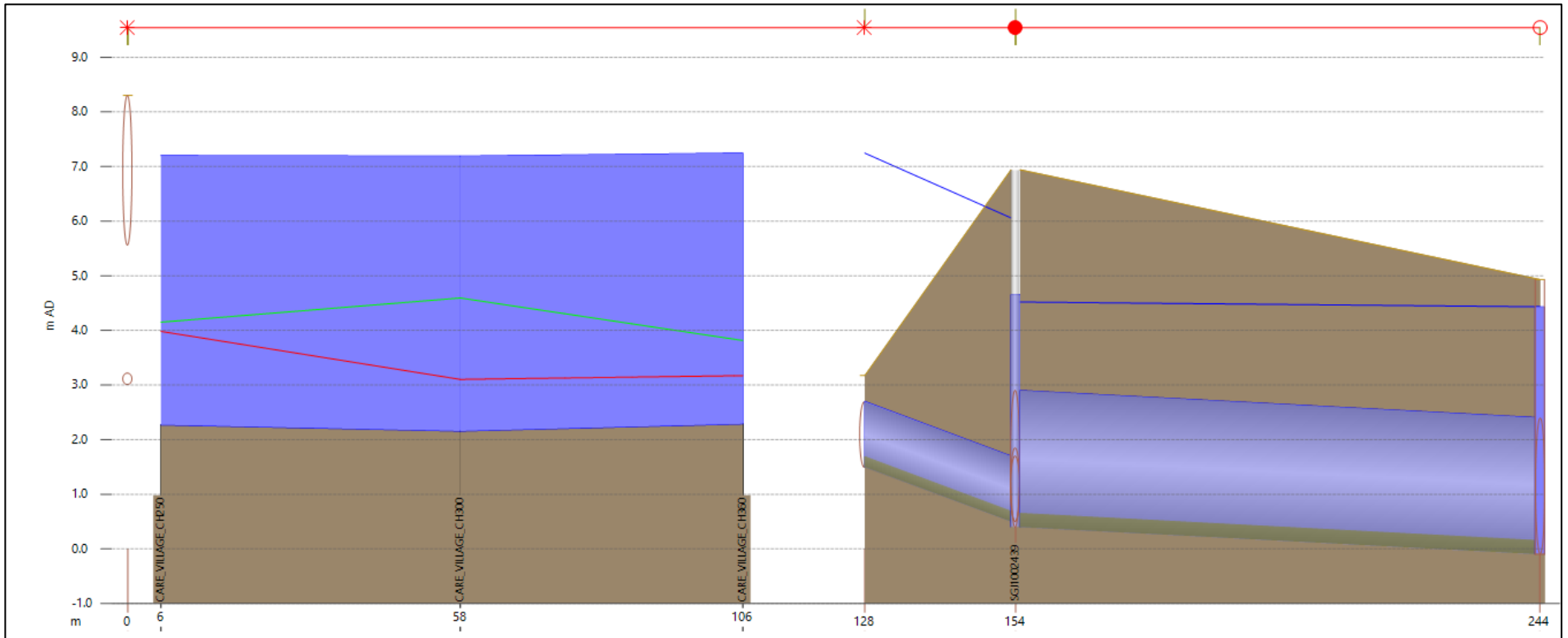


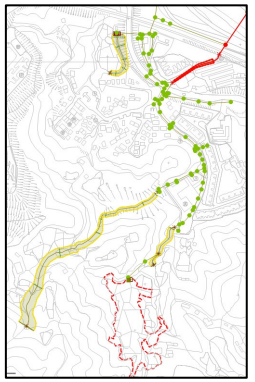
Link	-	-	-	-	-	-	-	-	N3633380475.1	-	-	-	-	-	-	SGJ1002453.1	SGJ1002452.1	-	SGJ1002449.1	-	-	-	SGJ1002441.1
Shape ID	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	-	-	RECT	RECT	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	RECT
width (mm)	2000	-	2000	2000	-	2000	2000	2000	2000	-	-	2500	2500	2500	-	2500	2500	-	2500	2500	2500	2500	2500
height (mm)	2250	-	2250	2250	-	2250	2250	2250	2250	-	-	2750	2750	2750	-	2750	2750	-	2750	2750	2750	2750	2750
us inv (m AD)	31.854	-	30.285	28.709	-	27.134	25.560	24.220	22.686	-	-	19.586	18.049	16.513	-	13.443	11.894	-	10.283	8.706	7.171	5.632	5.600
ds inv (m AD)	31.828	-	30.226	28.652	-	27.077	25.507	23.878	22.635	-	-	19.564	18.024	16.492	-	13.380	11.809	-	10.224	8.683	7.150	5.600	5.550
r.pfc (m3/s)	7.947	-	8.730	10.899	-	8.812	8.422	25.655	7.552	-	-	12.548	13.471	11.571	-	13.472	13.960	-	11.943	10.401	12.345	-	11.663
DS flow (m3/s)	-	-	15.29948	-	-	15.69516	15.70217	-	15.83010	-	-	-	-	-	-	23.52601	23.54936	-	23.90043	23.89991	-	-	24.20053

Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SGJ1002452	-	-	N3633281636	-	-	-	-
ground (m AD)	-	-	36.143	35.119	-	32.001	32.075	30.130	29.333	27.037	-	-	-	-	-	19.558	17.468	16.027	15.865	14.462	12.782	-	10.740	8.300
level (m AD)	-	-	32.415	30.837	-	29.263	27.697	25.709	24.870	23.037	-	-	-	-	-	15.945	14.422	12.880	12.845	11.194	9.621	-	8.165	7.201
volume (m3)	-	2.2	2.1	2.1	2.1	2.1	2.1	1.5	2.2	1.7	-	2.4	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.5	2.5	2.6	2.6	0.0

Hydraulic Model 200yrs Case A End Century

Proposed Scenario





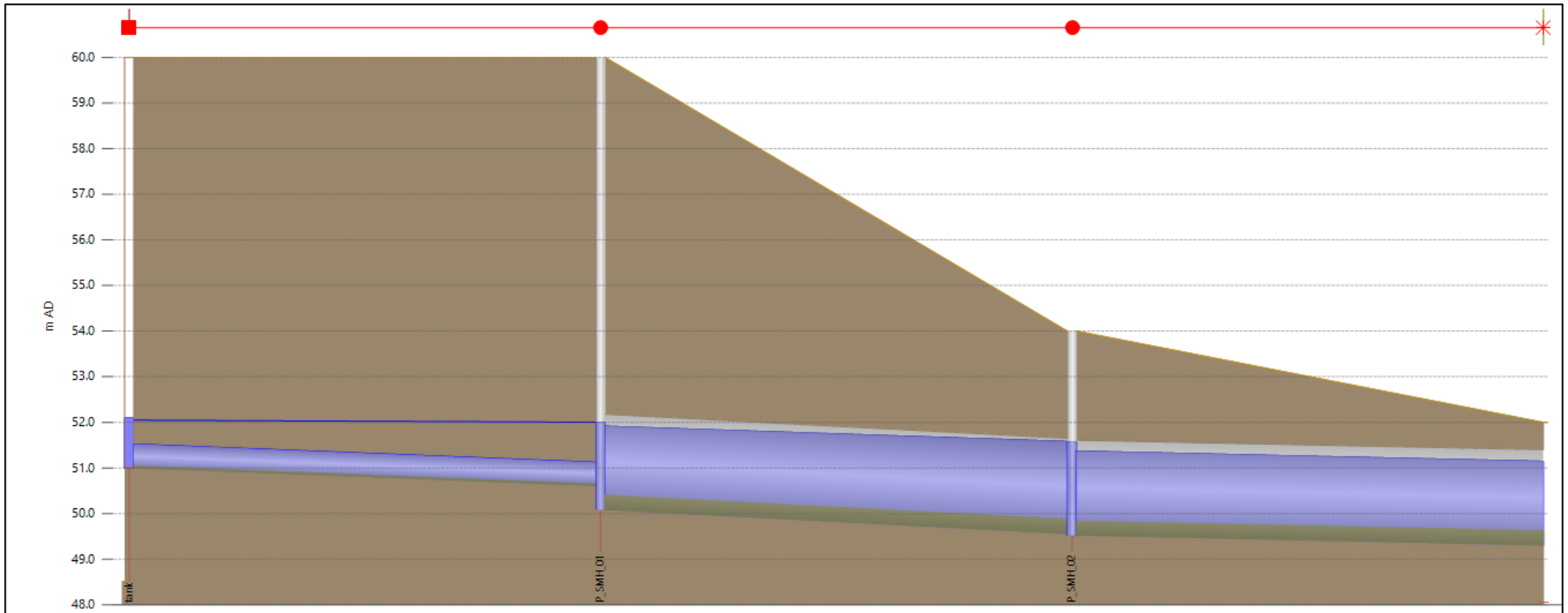
Link	CARE_VILLAGE_CH250.1	CARE_VILLAGE_CH360.1	SGJ1002439.1
Shape ID		CIRC	RECT
width (mm)		1200	2500
height (mm)		1200	2500
us inv (m AD)	2.271	1.500	0.400
ds inv (m AD)	2.289	0.500	-0.100
r.pfc (m3/s)	6.087	5.835	19.713
DS flow (m3/s)	11.72385	6.09652	7.88905

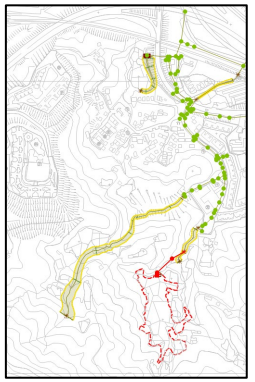
Node	CARE_VILLAGE_CH250	CARE_VILLAGE_CH360	SGJ1002439	SGJ1017447
ground (m AD)	8.300	3.172	6.939	4.932
level (m AD)	7.201	7.246	4.654	4.430
volume (m3)	0.0	0.0	35.5	

ARUP

Hydraulic Model 200yrs Case A End Century

Proposed Scenario



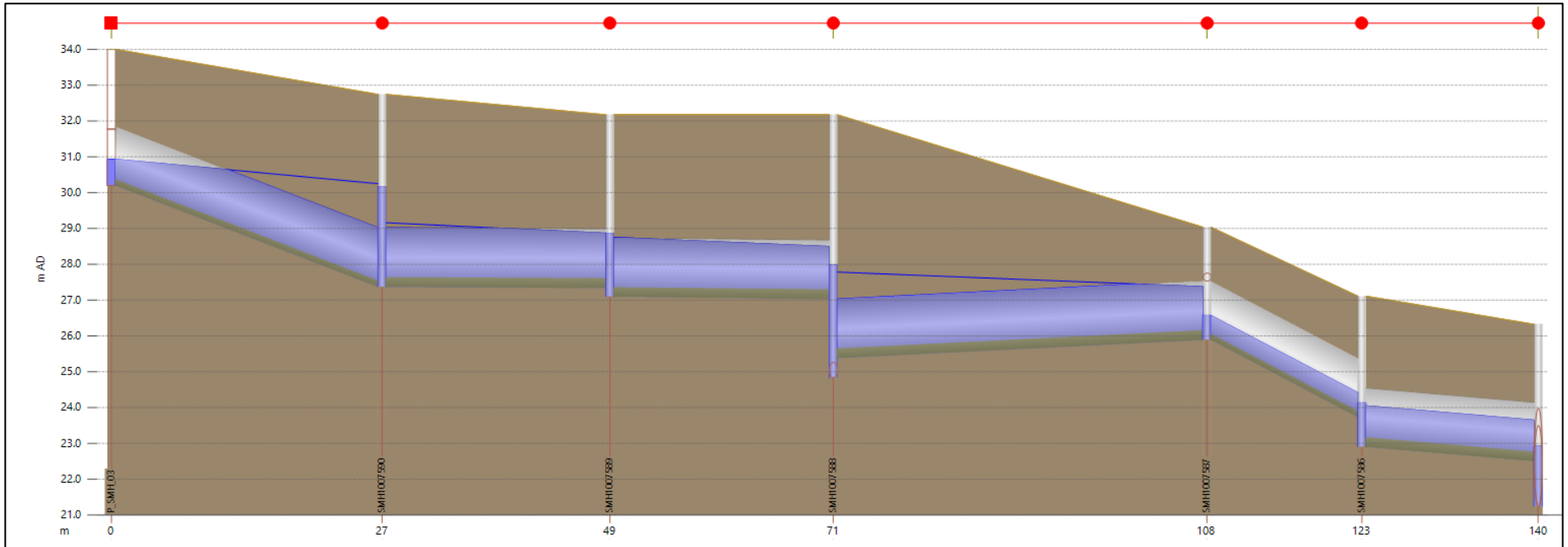


Link	tank.2	P_SMH_01.1	P_SMH_02.1
Shape ID	CIRC	CIRC	CIRC
width (mm)	525	2100	2100
height (mm)	525	2100	2100
us inv (m AD)	51.000	50.078	49.511
ds inv (m AD)	50.600	49.550	49.300
r.pfc (m3/s)	1.108	15.661	12.168
DS flow (m3/s)	0.83441	12.89867	12.89850

Node	tank	P_SMH_01	P_SMH_02	Node
ground (m AD)	60.000	60.000	54.000	52.000
level (m AD)	52.096	52.002	51.565	48.623
volume (m3)	1095.6	12.4	13.2	0.0

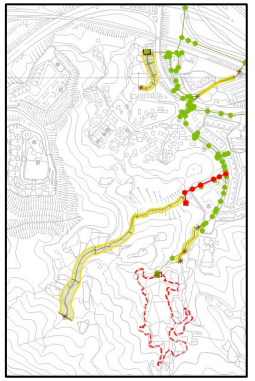
Hydraulic Model 200yrs Case A End Century

Proposed Scenario



Link	P_SMH_03.1	SMH1007590.1	SMH1007589.1	SMH1007588.1	SMH1007587.1	SMH1007586.1
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)	1650	1650	1650	1650	1650	1650
height (mm)	1650	1650	1650	1650	1650	1650
us inv (m AD)	30.200	27.370	27.090	25.380	25.890	22.900
ds inv (m AD)	27.370	27.340	27.030	25.890	23.734	22.500
grad (m/m)	0.10653	0.00134	0.00274	-0.01391	0.14155	0.02314
pfc (m3/s)	29.505	2.522	3.603	-8.131	28.087	10.491
DS flow (m3/s)	7.27364	7.29070	7.32468	7.61495	7.74710	7.78528

Node	P_SMH_03	SMH1007590	SMH1007589	SMH1007588	SMH1007587	SMH1007586	SGJ1016635
ground (m AD)	34.000	32.741	32.173	32.173	29.037	27.110	26.325
level (m AD)	30.936	30.163	28.860	27.985	26.571	24.138	22.927
volume (m3)	1.8	12.8	8.1	14.5	3.1	5.7	1.7



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Hydraulic Model 200yrs Case B End Century Proposed Scenario

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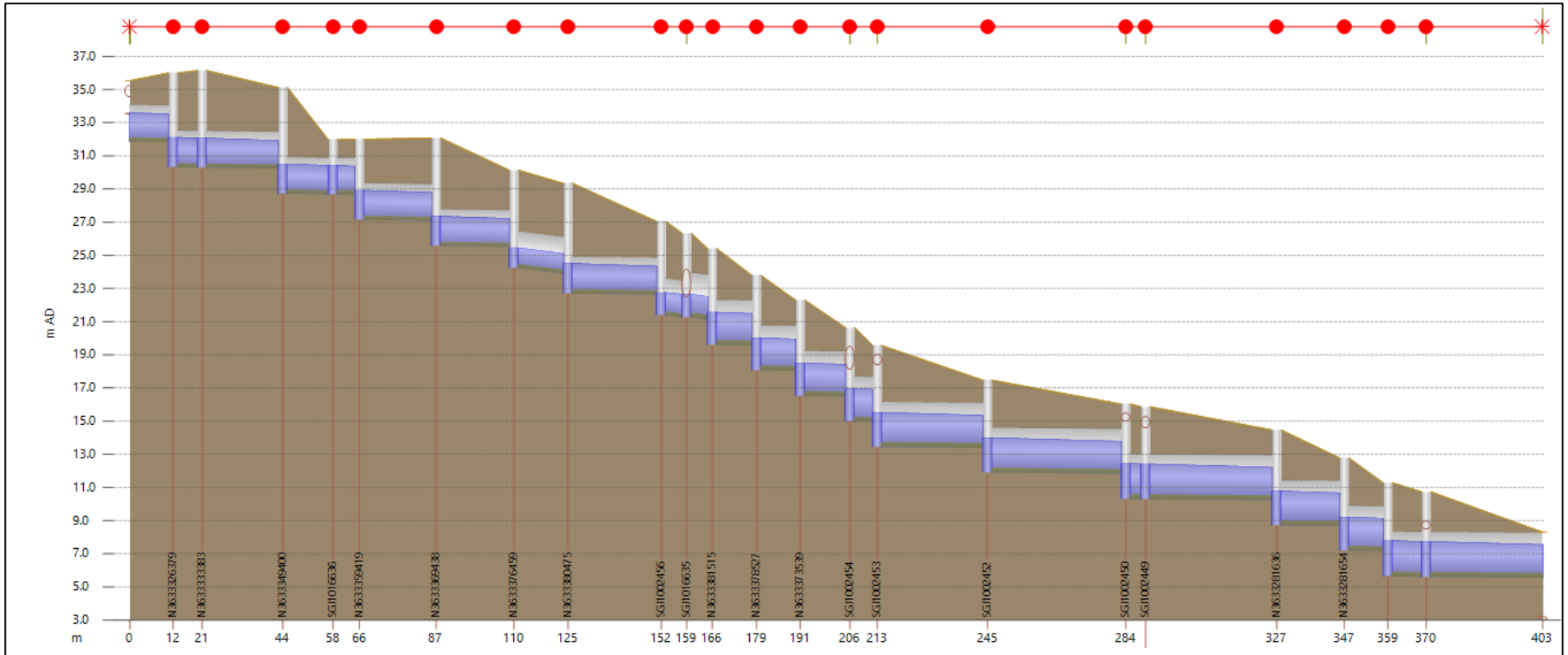
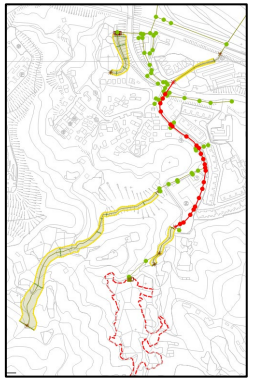
Hydraulic Model 200yrs Case B End Century

Proposed Scenario



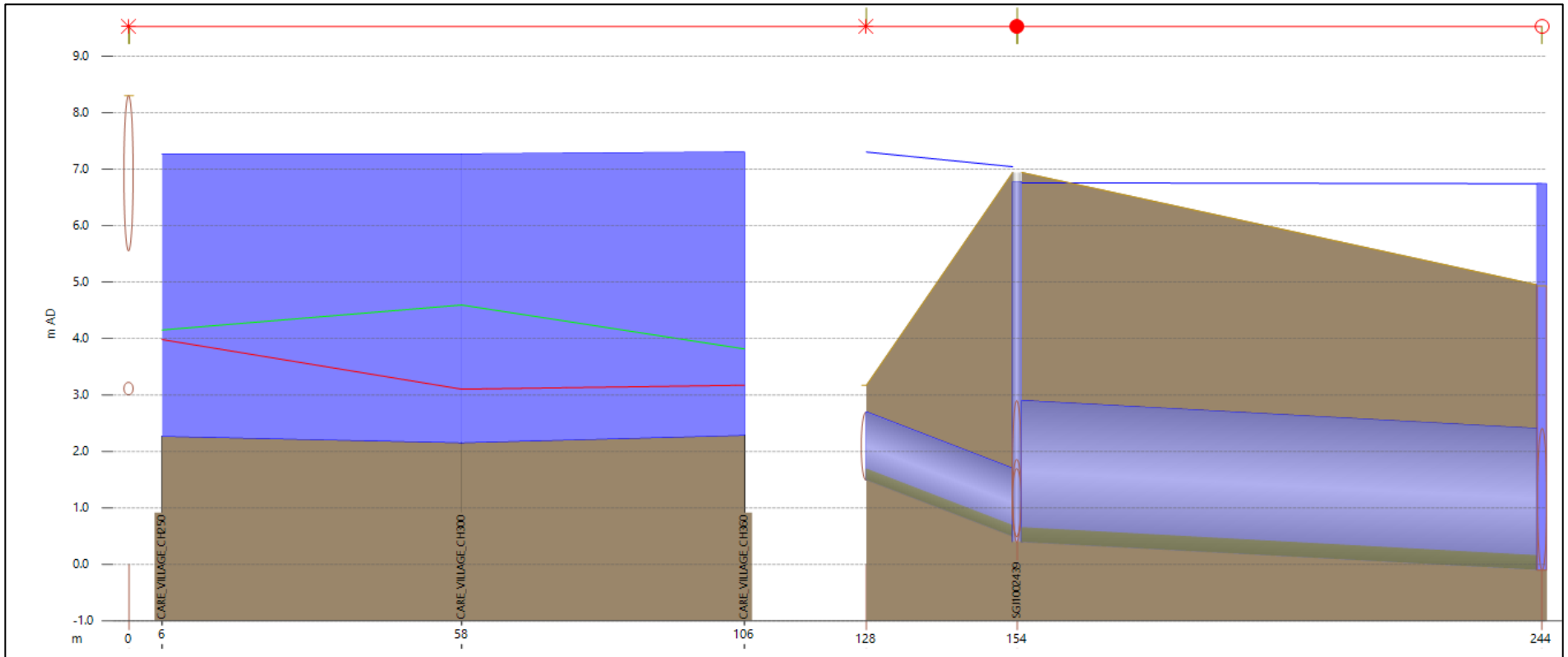


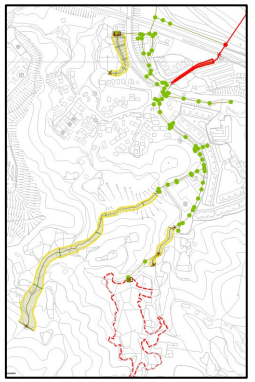
Link	-	-	-	-	-	-	-	-	N3633380475.1	-	-	-	-	-	-	SGJ1002453.1	SGJ1002452.1	-	SGJ1002449.1	-	-	-	SGJ1002441.1
Shape ID	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	-	-	RECT	RECT	RECT	-	RECT	RECT	-	RECT	RECT	RECT	RECT	RECT
width (mm)	2000	-	2000	2000	-	2000	2000	2000	2000	-	-	2500	2500	2500	-	2500	2500	-	2500	2500	2500	2500	2500
height (mm)	2250	-	2250	2250	-	2250	2250	2250	2250	-	-	2750	2750	2750	-	2750	2750	-	2750	2750	2750	2750	2750
us inv (m AD)	31.854	-	30.285	28.709	-	27.134	25.560	24.220	22.686	-	-	19.586	18.049	16.513	-	13.443	11.894	-	10.283	8.706	7.171	5.632	5.600
ds inv (m AD)	31.828	-	30.226	28.652	-	27.077	25.507	23.878	22.635	-	-	19.564	18.024	16.492	-	13.380	11.809	-	10.224	8.683	7.150	5.600	5.550
r.pfc (m3/s)	7.947	-	8.730	10.899	-	8.812	8.422	25.655	7.552	-	-	12.548	13.471	11.571	-	13.472	13.960	-	11.943	10.401	12.345	-	11.663
DS flow (m3/s)	-	-	10.84351	-	-	11.03246	11.03220	-	11.03180	-	-	-	-	-	-	16.80081	16.81794	-	17.07447	17.07423	-	-	17.34877

Node	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SGJ1002452	-	-	N3633281636	-	-	-	-
ground (m AD)	-	-	36.143	35.119	-	32.001	32.075	30.130	29.333	27.037	-	-	-	-	-	19.558	17.468	16.027	15.865	14.462	12.782	-	10.740	8.300
level (m AD)	-	-	32.045	30.480	-	28.907	27.338	25.426	24.490	22.735	-	-	-	-	-	15.506	13.978	12.427	12.397	10.759	9.191	-	7.720	7.268

Hydraulic Model 200yrs Case B End Century

Proposed Scenario



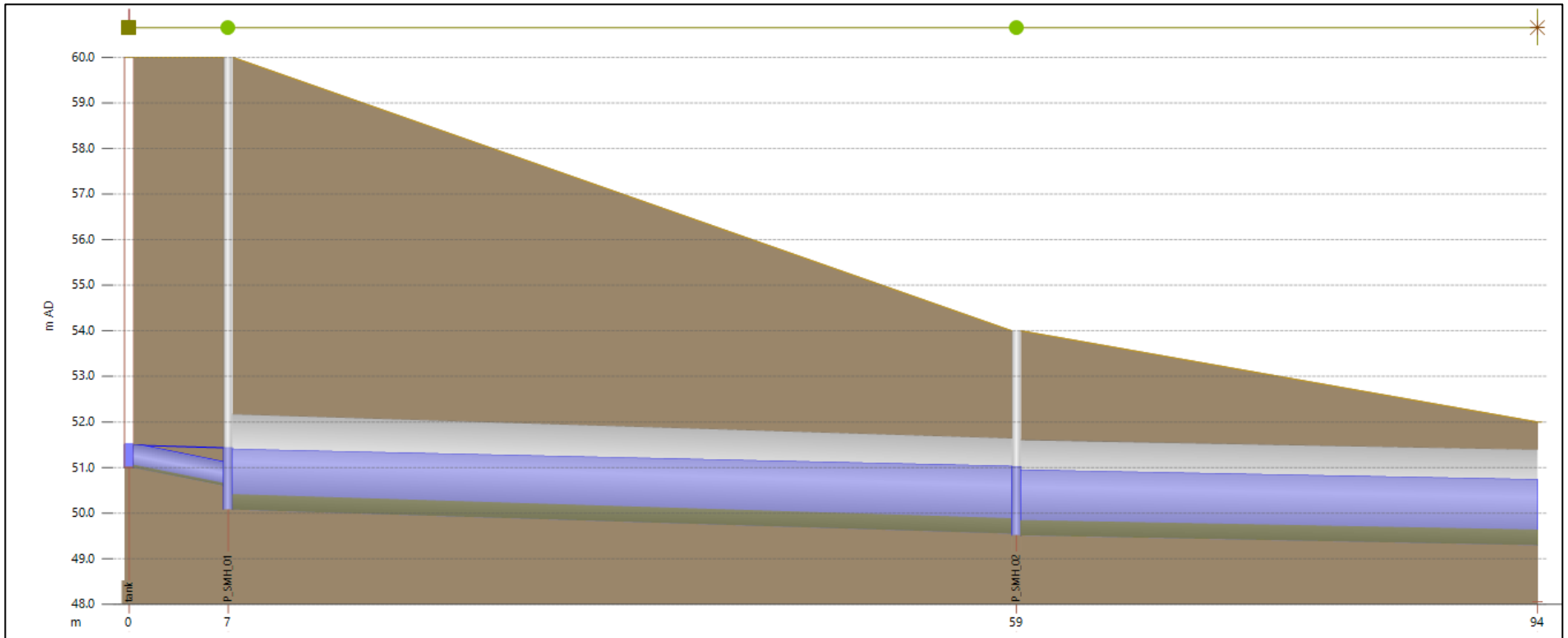


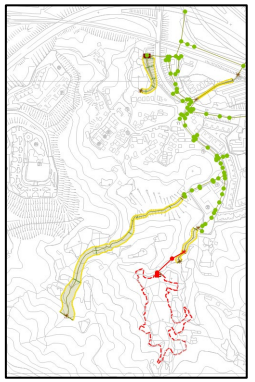
Link	CARE_VILLAGE_CH250.1	CARE_VILLAGE_CH360.1	SGJ1002439.1
Shape ID		CIRC	RECT
width (mm)		1200	2500
height (mm)		1200	2500
us inv (m AD)	2.271	1.500	0.400
ds inv (m AD)	2.289	0.500	-0.100
r.pfc (m3/s)	6.087	5.835	19.713
DS flow (m3/s)	-12.68670	-6.34322	-7.27988

Node	CARE_VILLAGE_CH250	CARE_VILLAGE_CH360	SGJ1002439	SGJ1017447
ground (m AD)	8.300	3.172	6.939	4.932
level (m AD)	7.268	7.302	6.773	6.740

Hydraulic Model 200yrs Case B End Century

Proposed Scenario



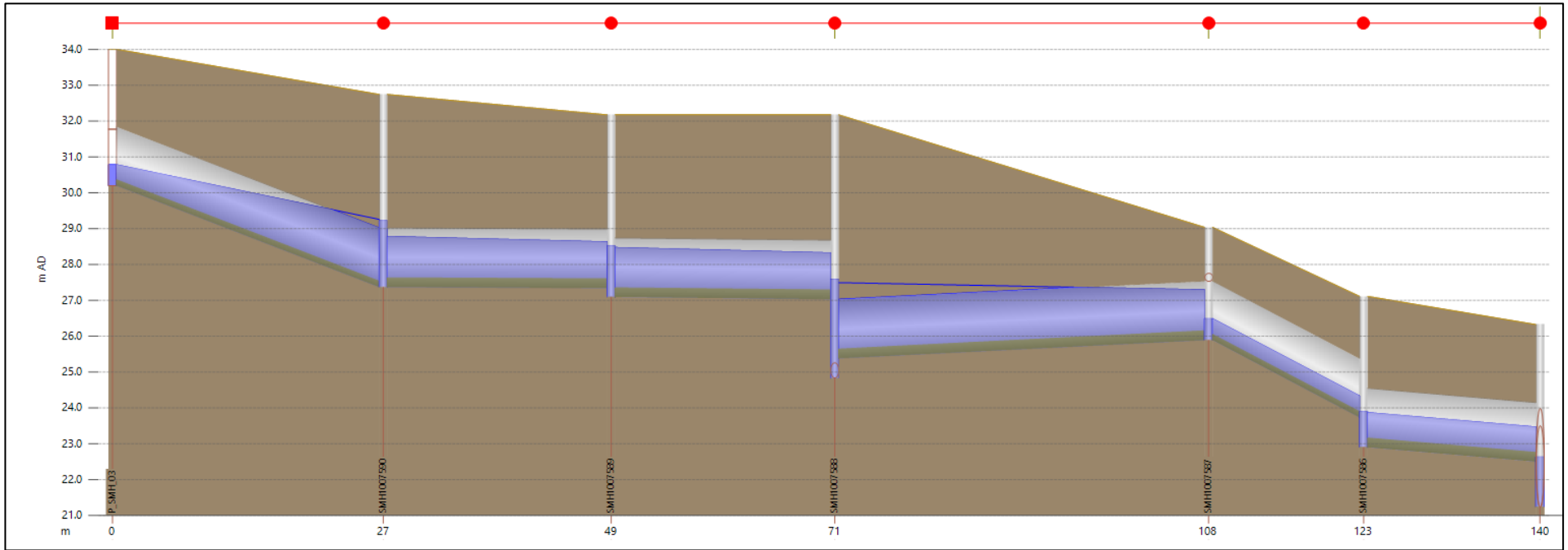


Link	tank.2	P_SMH_01.1	P_SMH_02.1
Shape ID	CIRC	CIRC	CIRC
width (mm)	525	2100	2100
height (mm)	525	2100	2100
us inv (m AD)	51.000	50.078	49.511
ds inv (m AD)	50.600	49.550	49.300
r.pfc (m3/s)	1.108	15.661	12.168
DS flow (m3/s)	0.61690	9.01230	9.01180

Node	tank	P_SMH_01	P_SMH_02	Node
ground (m AD)	-	60.000	54.000	52.000
level (m AD)	-	51.430	51.019	48.530
volume (m3)	511.2	8.7	9.7	0.0

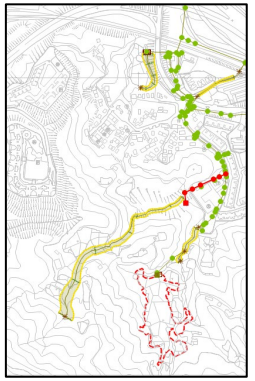
Hydraulic Model 200yrs Case B End Century

Proposed Scenario



Link	P_SMH_03.1	SMH1007590.1	SMH1007589.1	SMH1007588.1	SMH1007587.1	SMH1007586.1
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)	1650	1650	1650	1650	1650	1650
height (mm)	1650	1650	1650	1650	1650	1650
us inv (m AD)	30.200	27.370	27.090	25.380	25.890	22.900
ds inv (m AD)	27.370	27.340	27.030	25.890	23.734	22.500
grad (m/m)	0.10653	0.00134	0.00274	-0.01391	0.14155	0.02314
pfc (m3/s)	29.505	2.522	3.603	-8.131	28.087	10.491
DS flow (m3/s)	5.28487	5.29686	5.32121	5.53047	5.62322	5.65082

Node	P_SMH_03	SMH1007590	SMH1007589	SMH1007588	SMH1007587	SMH1007586	SGJ1016635
ground (m AD)	34.000	32.741	32.173	32.173	29.037	27.110	26.325
level (m AD)	30.785	29.227	28.516	27.588	26.490	23.901	22.634
volume (m3)	1.5	8.5	6.5	12.6	2.7	4.6	1.4



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Supplementary Information on Connection to Existing watercourse

Proposed Connection to Watercourse

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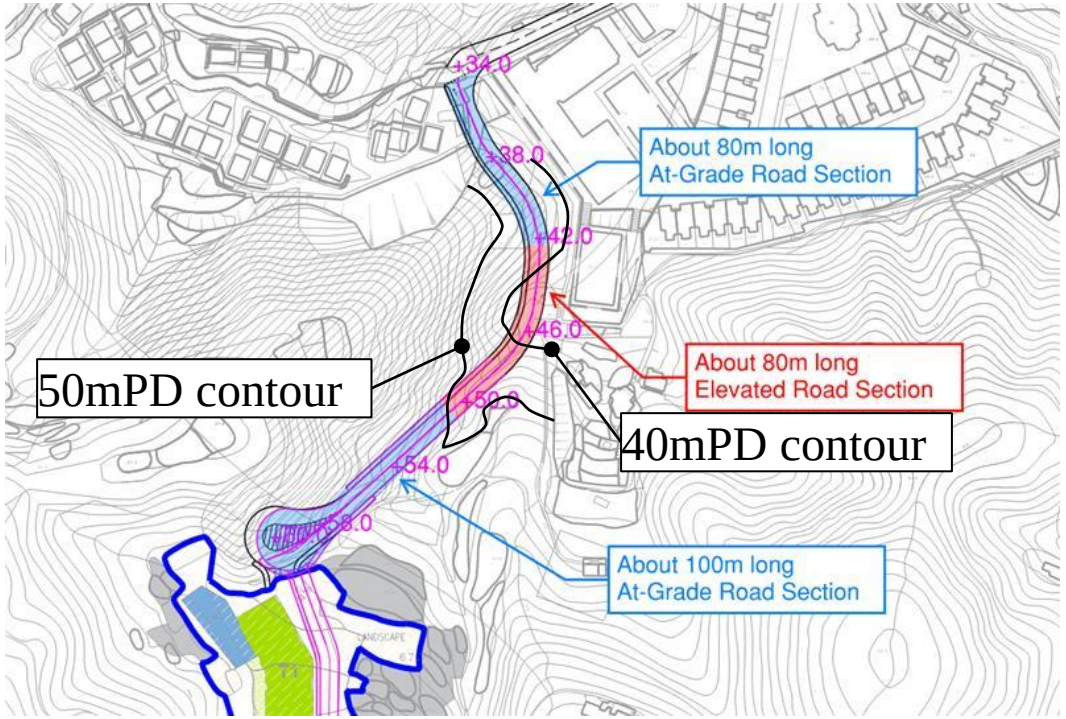
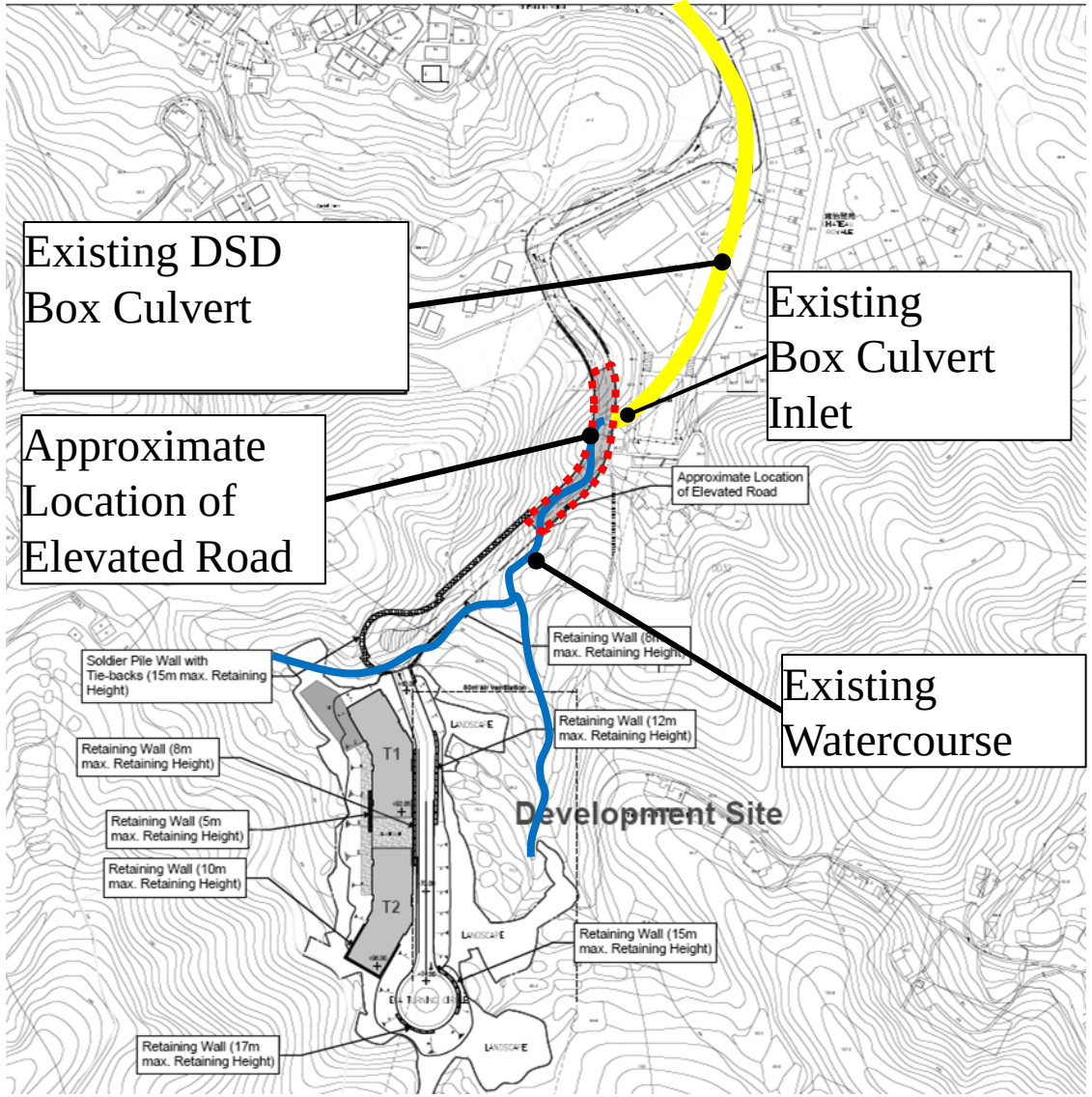
- The proposed access road will have an elevated (viaduct) section above the existing watercourse
- The viaduct section will span above the existing watercourse, the road level will be around 6m higher than the watercourse.





Proposed Connection to Watercourse

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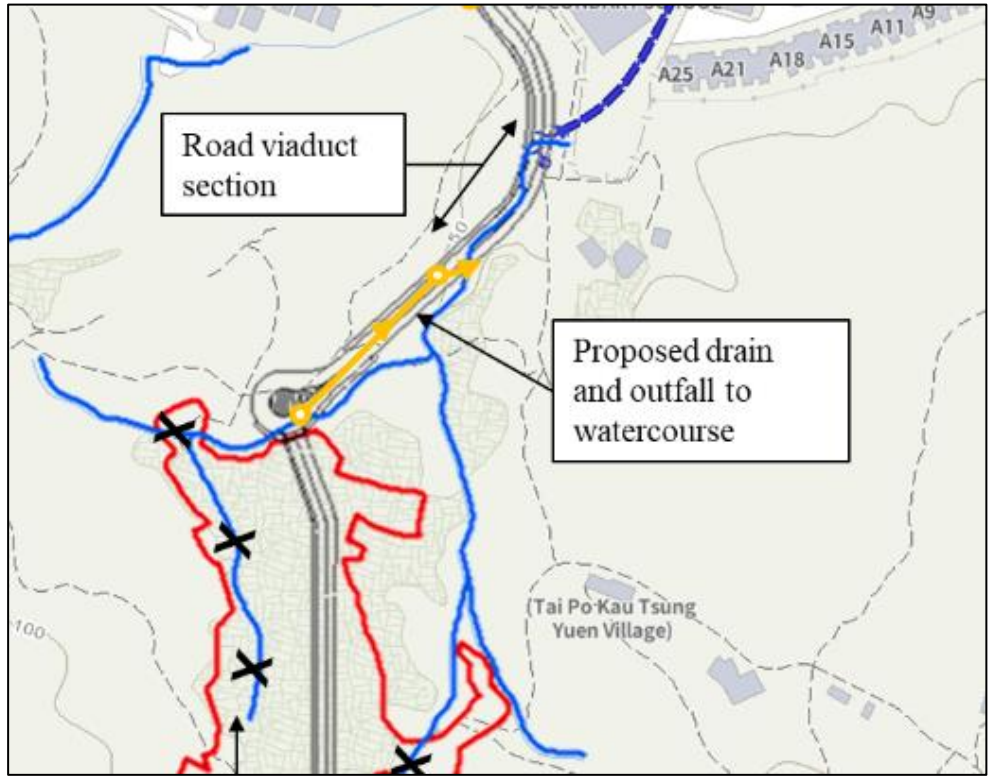
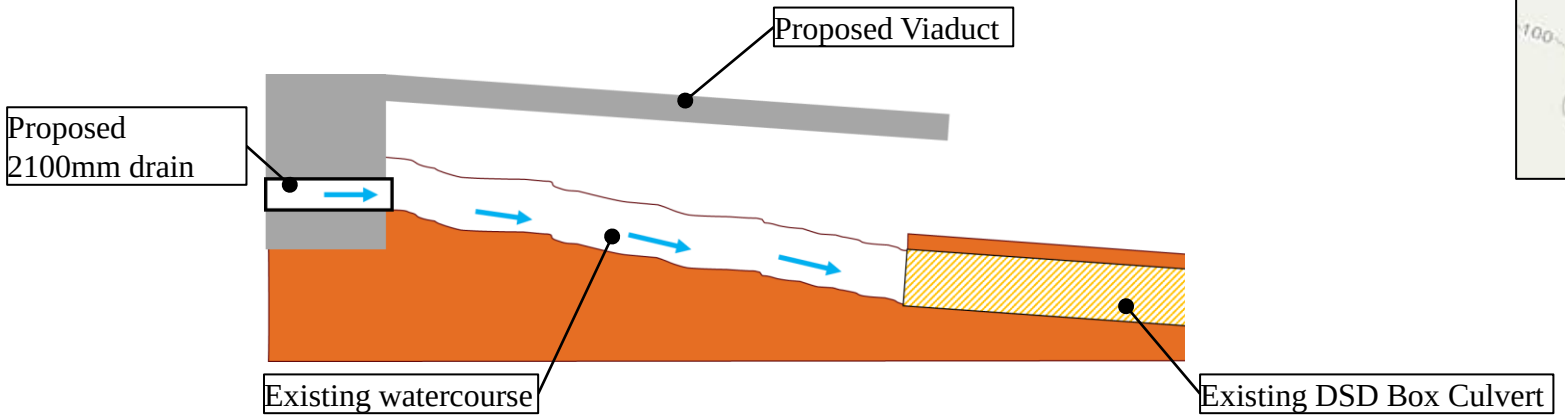
The proposed 2,100mm drain will bel placed beneath the proposed road. At the proposed viaduct location, the drain will discharge to the existing watercourse which, around 80m downstream will discharge to the existing box culvert.





Schematic Arrangement of the proposed connection to the existing watercourse

Proposed Connection to Watercourse

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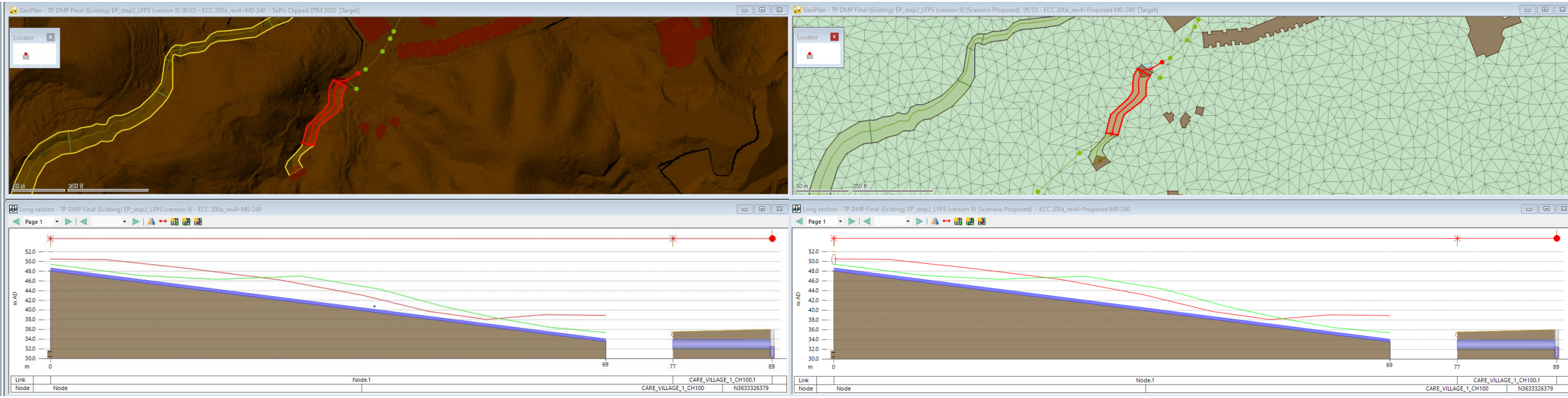
The existing watercourse has been included in the hydraulic modelling assessment.

The watercourse has sufficient capacity to convey the stormwater flows before and after the proposed development for the assessed 200year End of Century storm.



Baseline Conditions

Proposed Conditions