Stormwater Water Management Strategy

Collison Estate

Collison Estate Group Incorporated

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KLM SPATIAL
LAND DEVELOPMENT INTELLIGENCE

Collison Estate

Contents

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1.0 Introduction

This report has been prepared to develop design concepts and further review feasibility for the proposed Stormwater Management Strategy of the Collison Estate as an extension of the previous report completed by Incitus. The inputs for the Incitus report are deemed to remain valid (the document is attached in Appendix A and is to be read in conjunction with the following KLMS Report).

A detailed strategy and concept design have been prepared based on the Incitus Report – Option 3 – Distributed Management. Detailed calculations, catchment analysis and 3d modelling has been undertaken for hydraulic, storage and treatment components to ensure their feasibility and spatial requirements.

The assessment has been conducted by experienced engineers from KLM Spatial, considering the Drainage Strategy, proposed development plan, and relevant feedback/advice from Council's planning and engineering departments, and Melbourne Water.

The report considers the following elements of the water cycle relevant to development of the site:

- Natural Catchments
- Stormwater Capture – Proposed Drainage Network
- Stormwater Quantity Management
- Stormwater Quality Management/WSUD Options

2.0 Site and Surrounds

The proposed Collison Estate is an 82ha conglomerate of 94 low density residential allotments. The site is bounded by Mayfield Road to the west, Linsell Boulevard to the north, residential development to the east and Berwick-Cranbourne Road to the south. The site is traversed from north to south by Collison Road and east to west by Heather Grove and Garden Street.

The site is located approximately 45km south-east of Melbourne in Cranbourne East. The site is planning to re-develop to a standard and medium density residential area.

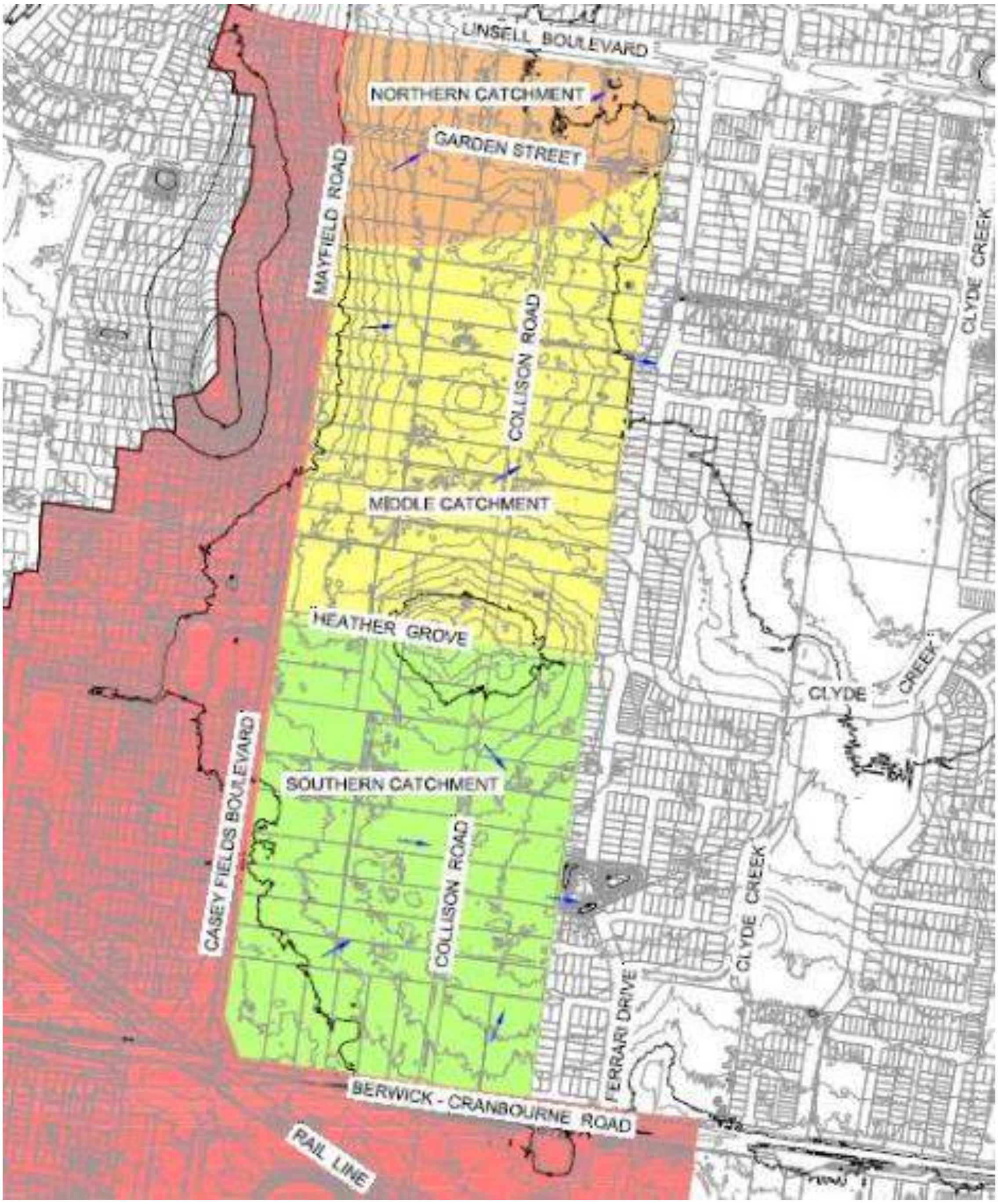
Figure 1: Aerial Image of Site and Surrounds

3.0 Precinct Catchments

The sites topography has been identified through LiDAR information, and generally falls from West to the East of the property. The site is generally flat, but there are several steep undulations, the largest being the rise at the Heather Grove and Collison Road intersection.

The site has 3 major catchments as shown in Figure 2 below. The northern, southern and central catchments. The catchment shown in red is an external catchment which bypasses the subject site.

Figure 2: Contour Plan



Each catchment will connect into existing infrastructure to the east. Minor flows to existing pipes, and major (gap) flows into existing road reserves. Some of these outfalls were designed with the proposed development in mind, while others were not. *Table 1* below provides a summary of the existing infrastructure.

Table 1: Existing Outfalls

CATCHMENT	OUTLET PIPE	ROAD	INVERT LEVEL	ALLOWABLE FLOW (cu.m/s)	CATCHMENT ALLOWANCE
Northern	750mm dia.	Linsell Boulevard	31.400	0.583	Developed
	525mm dia.	Garden Street	33.425	0.430	Developed
Middle	1350mm dia.	Rosina Street	32.455	1.909	Existing
Southern	900mm dia.	Buick Court	35.995	1.128	Existing

As KLM moved further into the detailed modelling of our distributed management approach these catchments have been further broken down into catchments A-J, please refer to *Appendix B* for catchment plan.

Table 2: Catchment Analysis

CATCHMENT		AREA (ha)	DEVELOPED FRACTION IMPERVIOUS	ALLOWABLE DISCHARGE 0.2 EY (cu.m/s)	ALLOWABLE DISCHARGE 1% AEP (cu.m/s)
Northern	A1	7.359	0.7	0.583	1.444
	A2	5.252	0.7	0.430	1.070
Middle	B	4.265	0.7	0.233	0.578
	C	15.483	0.7	0.846	2.097
	D	4.158	0.7	0.227	0.563
	E	10.022	0.7	0.548	1.357
Southern	F	5.060	0.7	0.154	0.371
	G	8.071	0.7	0.246	0.592
	H	9.557	0.7	0.291	0.701
	I	6.946	0.7	0.212	0.510
	J	5.623	0.7	0.171	0.412

4.0 Melbourne Water Drainage Scheme

The Collison Estate is located within the Melbourne Water drainage scheme "*2371 Collison Road DS*". However, with the exception of the northern catchment (catchments A1 & A2), there was no hydraulic or quality allowances made for the development of the Collison Estate.

Where sufficient hydraulic and treatment infrastructure has been provided for in the northern catchment (catchments A1 & A2), drainage scheme contributions will be payable to Melbourne Water. Current rates for the scheme as at 7/12/2020 are:

- Hydraulic Contributions = $112,146/ha
- Water Quality Treatment = $6,923/ha

Where hydraulic and treatment infrastructure was only provided to service the existing rural residential development under the scheme, contributions will not be payable, however, stormwater management measures will need to be undertaken on site to meet best practise objectives.

5.0 Stormwater Capture – Proposed Drainage Network

The site layout and staging have been developed to ensure that stormwater management is considered and optimised as the development progresses.

The proposal attempts to equitably distribute the land required for drainage purposes for retardation to mitigate the flows discharging from the site to existing flow magnitudes, and treatment of the stormwater runoff from the site where required. It utilises linear drainage reserves distributed throughout the site to equally encumber each land-owner, but with sufficient size to create green spines throughout the estate and enhance liveability within the re-development.

The key to this being a digression from the conventional development with pipe drainage for minor drainage, instead providing direct house connections to the kerb and channel, and sheet flowing the runoff from each allotment into the green spines. Flows from the drainage reserve will be captured at the end point and conveyed by pipe for minor storms and road reserve for major storms into the existing outfall drainage.

For the small number of sites that do not directly front a channel, stormwater will have to flow across a small distance to the nearest channel. Due to the small distance and proposed road layout this grading will be easily achievable.

Due to low flow volumes and flat channel grades the shear stress on the low flow channels will be minimal. As such, it will be appropriate to line the channel with Jute Matting and Vegetation as opposed to rock.

The proposal gives flexibility for individual land parcels to develop out of sequence by partially building storage channels and using existing drainage easements for temporary outlets via interim pipe or existing channel - as may apply on a case-by-case basis.

For details of the proposed drainage strategy including layout plans and typical sections, please refer to *Appendix C*.

6.0 Stormwater Quantity – Detention

6.1. Proposed Storage Infrastructure

The proposed strategy uses a combination of rainwater tanks and linear drainage reserves to detain flows.

Detention will apply to the gap between the pre-development 1% AEP flows and post development 1% AEP flows. This will be reliant an appropriately sized overflow weir which will outfall to the adjacent road in the 1% event. For channels A, D, E, H and I where they back onto existing properties, the top water level in the event of this overflow would not achieve sufficient freeboard to the existing dwellings. In this case, additional storage will be provided to retard 1% AEP post-development flows back to 0.2 EY pre-developed flows. In this case, all water will outfall through the pipe-network, lowering the top water level to provide sufficient freeboard to the adjacent lots.

Storage calculations have been undertaken using Boyd's Formula. The table below provides a summary of storage requirements for each catchment.

Table 3: Storage Results

CATCHMENT	AREA (ha)	STORAGE REQUIRED (cu.m)	DESIGN STORMS (cu.m)
A	12.611	1484	1% AEP Flows Restriction Back to 1% AEP Outfall
B	4.265	392	1% AEP Flows Restriction Back to 1% AEP Outfall
C	15.483	1419	1% AEP Flows Restriction Back to 1% AEP Outfall
D	4.158	567	1% AEP Flows Restriction Back to 0.2 EY Outfall
E	10.022	1397	1% AEP Flows Restriction Back to 0.2 EY Outfall
F	5.060	898	1% AEP Flows Restriction Back to 1% AEP Outfall
G	8.071	1389	1% AEP Flows Restriction Back to 1% AEP Outfall
H	9.557	1504	1% AEP Flows Restriction Back to 0.2 EY Outfall
I	6.946	1310	1% AEP Flows Restriction Back to 0.2 EY Outfall
J	5.623	727	1% AEP Flows Restriction Back to 1% AEP Outfall

A conservative assumption on density would see a total 1,600 residential lots within the 82ha Collison Estate giving 19.5lots/ha. Current discussions with council indicate the ultimate density may be up to 1700 lots, however any additional lots above 1,600 would only provide additional storage. It is assumed each lot will install a 2kl tank which will have 30% capacity available for storage, giving 0.6kl storage per lot. This will equate to 11.7cu.m/ha of storage by the rainwater tanks.

Table 4: Storage Distribution

CATCHMENT	STORAGE TANKS (cu.m)	STORAGE CHANNEL (cu.m)
A	147	1337
B	49	343
C	181	1238
D	48	519
E	117	1280
F	59	839
G	94	1295
H	111	1393
I	81	1229
J	65	662

Some catchments will not require the full depth of the channel to store flows. As freeboard is provided above the top of channel, this additional depth will minimise the freeboard required above the channel to finished lot levels.

For details of the concept design for these channels refer to *Appendix D*.

6.2. Channel Grading

Council have expressed concern around the grade of the channel.

We acknowledge that standards such as AustRoads will call for a minimum grade of 1in200, but this is for a road side table drain only capturing flow from a very small catchment off of the pavement.

As the proposed channels will take in a large-scale catchment on a neighborhood scale, we believe Melbourne Waters Waterway Standards would provide a more accurate portrayal of preferential grades.

In Melbourne Waters "Constructed Waterways Design Manual: Part D: Technical Design Elements" Section D1.6 sets the minimum grade at 1in800 and maximum grade at 1in200.

Our proposed grades are between 1in300 and 1in500 which are on the steeper side of Melbourne Waters standards.

Please refer below extract from the standard:

> Longitudinal grade is a fundamental design criterion for constructed waterways, as it is for many other types of civil engineering infrastructure (e.g. roads). It is essential that the designer is aware of the contextual differences between waterway grades and grades appropriate for other infrastructure. For example, a road with a longitudinal grade of 1 in 100 is generally considered to be of relatively mild or gentle slope, whereas a longitudinal grade of 1 in 100 in a waterway is considered "steep" and likely to erode.

Due to the topography of the site the channels cannot be feasible steepened and still obtain sufficient depth and storage to allow to channel to function properly. Furthermore, steepening of the channels will increase shear stress and risk of erosion.

Due to the depth of the existing outfall drains, a diversion drain will not be able to be installed beneath the channels as it will be too low for the connection point. The only option would be to install a separate drain along-side the channel, however, this does not fit with the overall scheme where it is intended for water to flow overland to the channels. Where channels have flows coming in from both sides, drains would need to be duplicated on both sides as levels will not permit pipes to cross the channels. This would increase the cost of the scheme significantly.

This would also be a major digression from the originally proposed distributed management scheme proposed by Incitus where direct house connections would be provided to the kerb and channel, and sheet flow runoff from each allotment into the green spines.

Furthermore, if self-cleansing of the channel is of concern, we believe diverting flows away from the channels would only decrease the self-cleansing abilities of the channel.

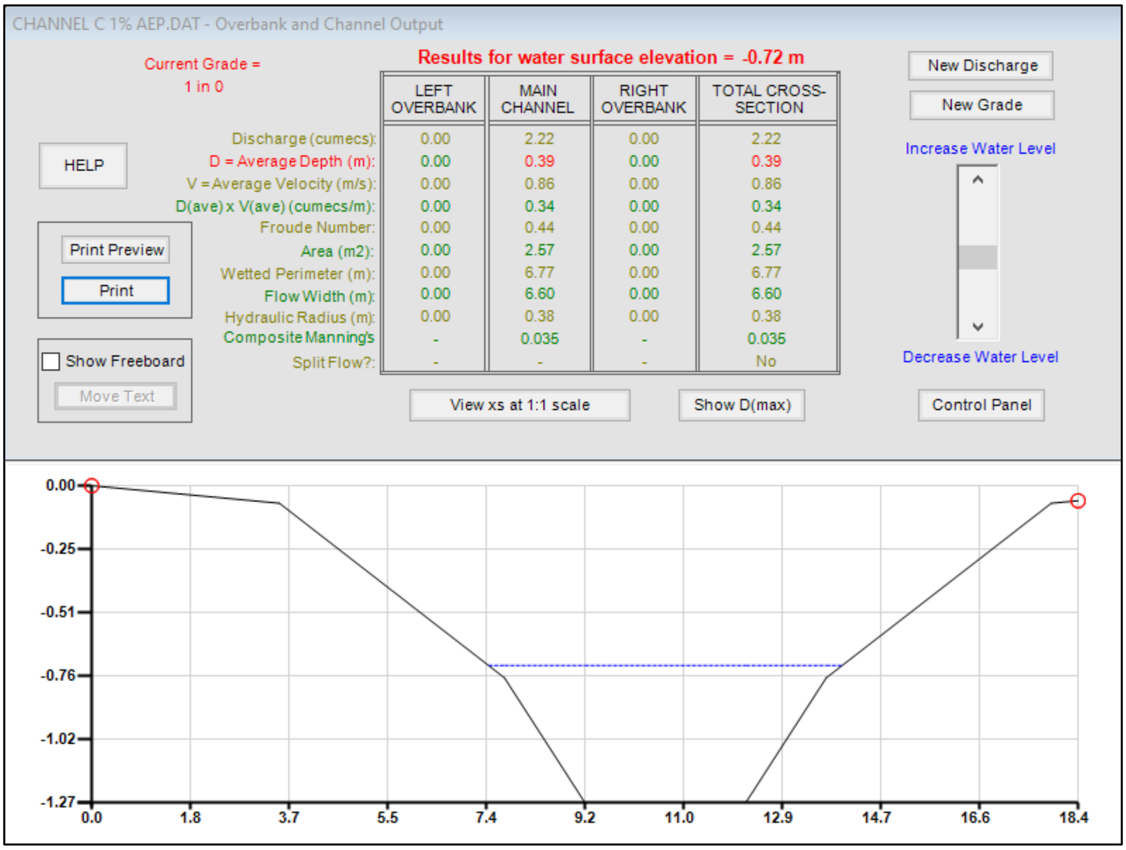
In summary, we feel that the construction of the proposed additional drainage pipe does not provide any benefit to the scheme, but will incur a large unnecessary cost for the developers.

6.3. Typical Channel Flow Depths

Flows through the channel will be minimal in respect to the size of the channel. The channels have been sized with significant depth to provide storage, whereas the flow in major events would only require a small portion of the channel's capacity.

To demonstrate, the highest channel flow within the estate has been modelled in PC convey and the top water level would sit just above the top of the pilot channel. This is the worst-case scenario at the downstream outlet of the channel with the largest catchment. Most channels will have far smaller catchments and flows upstream of the outfall will be significantly lower.

Figure 3: Channel Flow Depths



6.4. Effects of Scour on Channel

As the major flows through the channel will be quite small, the shear stress on the channel base will be minimal.

Based on Melbourne Water procedures, Du Boys equation was used to calculate the shear stress on the channel. For the worst-case scenario as modelled above, Shear Stress would equate to 12.42N/m2.

$$\tau = \gamma RS$$

Where τ = shear stress (N/m^2), γ = the specific weight of water (N/m^3), R = hydraulic radius (m), and S = friction gradient (equal to channel bed gradient for uniform flow, m/m)

Based on “Melbourne Water’s Constructed Waterways Design Manual – Table 18” which is included below. The shear stress on the channel would be well below the threshold for short native grass and no further armouring of the channel would be required.

The calculated worst-case section is close to the limit of 12N/m2 for stiff clay and alluvial silts which will be applicable for the duration of construction. As the calculation is based on the worst-case scenario, the majority of the channels with catchment areas significantly smaller than this would also be subject to significantly less shear stress and there would be no issues. However, it is recommended that each channel is reviewed thoroughly in detailed design, and, where shear stress is close the allowable threshold during construction, jute matting or similar is adopted to provide extra stability until vegetation can establish.

Table 5: Erosion Thresholds

Table 18 - Erosion thresholds for different waterway boundary materials (Fischenich 2001)

BOUNDARY CATEGORY	BOUNDARY TYPE	SHEAR STRESS EROSION THRESHOLD (N/M2)
Soils	Fine colloidal sand	1.5
	Alluvial silt and silty loam (non-colloidal)	3
	Firm loam and fine gravels	4
	Stiff clay and alluvial silts (colloidal)	12
Gravel/Cobble	25 mm, 51 mm, 152 mm, and 305 mm	16, 32, 96, and 192 respectively
Vegetation	Turf	45 to 177
	Long native grasses	80
	Short native and bunch grass	45

7.0 Water Quality – WSUD Options

Stormwater quality measures are required to be applied to this site in accordance with the Clause 44 of the State Environmental Protection Policy (SEPP).

To meet minimum SEPP requirements, developments should meet the Best Practice Environmental Management Guidelines for Urban Stormwater, available from CSIRO Publishing.

Best practice stipulates the following outcomes for both construction, and post-construction phases of the project:

Construction Phase

Pollutant type	Receiving water objective	Current best practice performance objective
Suspended solids	Comply with SEPP	Effective treatment of 90% of daily run-off events (e.g. <4 months ARI). Effective treatment equates to a 50 percentile suspended solids concentration of 50 mg/L. This can be achieved by installing a sediment ponds to remove 95% of sediment down to 125 µm for a 1 year ARI.
Litter	Comply with SEPP	Prevent litter from entering the stormwater system. This requirement extends until 95% of the lots are constructed or a period of two years has passed.
Other pollutants	Comply with SEPP	Limit the application, generation and migration of toxic substances to the maximum extent practicable.

Post-construction Phase

Pollutant type	Receiving water objective	Current best practice performance objective
Suspended solids (SS)	Comply with SEPP (not to exceed the 90th percentile of 80 mg/L) (1)	80% retention of the typical urban annual load
Total phosphorus (TP)	Comply with SEPP (base flow concentration not to exceed 0.08 mg/L) (2)	45% retention of the typical urban annual load
Total nitrogen (TN)	Comply with SEPP (base flow concentration not to exceed 0.9 mg/L) (2)	45% retention of the typical urban annual load
Litter	Comply with SEPP (No litter in waterways) (1)	70% reduction of typical urban annual load (3)
Flows	Maintain flows at pre-urbanisation levels	Maintain discharges for the 1.5 year ARI at pre-development levels

7.1. Treatment Train Analysis

Treatment sizing and effectiveness has been based on information within Incitus report included in *Appendix A*, which indicates 20sq.m of rain garden will be required per hectare of re-development.

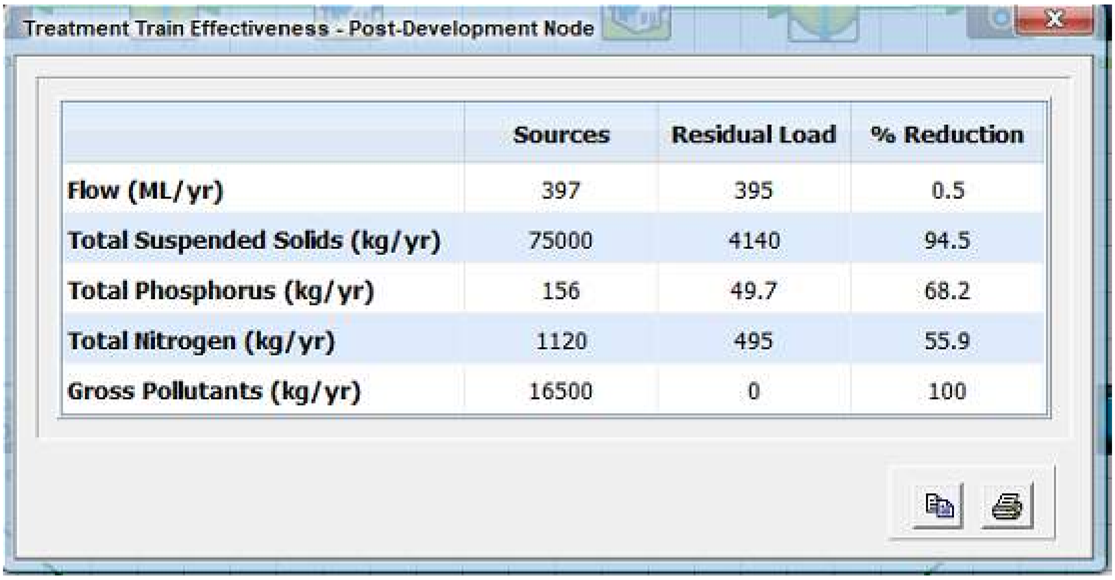
Raingardens have been placed at the outfall end of each channel as an end of line treatment for individual catchments. The raingarden will be located within the base of the channel. The below table includes a summary of raingarden sizing.

Table 6: Raingarden Sizing

CATCHMENT	AREA (ha)	RAINGARDEN REQUIRED (sq.m)	RAINGARDEN WIDTH (m)	RAINGARDEN LENGTH (m)
A	252	8.3	30.4	252
B	94	5.8	16.3	94
C	341	5.8	58.9	341
D	70	8.3	8.4	70
E	172	8.3	20.8	172
F	133	5.8	23.0	133
G	206	5.8	35.5	206
H	134	8.3	16.2	134
I	117	8.3	14.1	117
J	108	5.8	18.6	108

Post-design a revised MUSIC model was produced confirming treatment areas provide sufficient treatment to meet best practise objects. Summary of treatment train effectiveness has been included below.

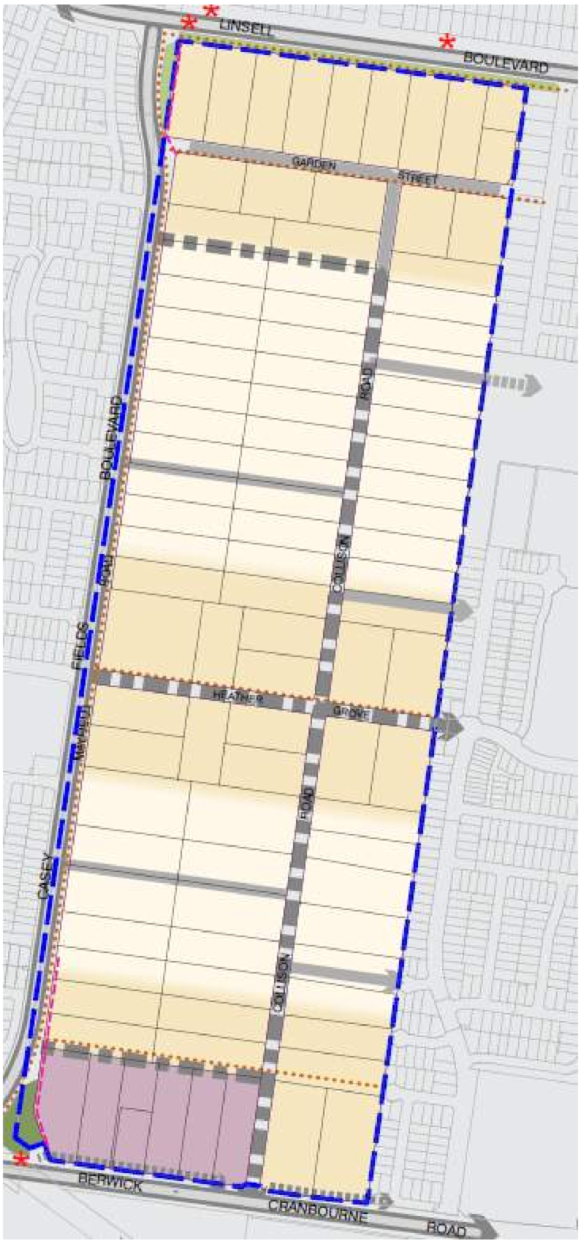
Figure 4: MUSIC Results


Treatment Train Effectiveness - Post-Development Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	397	395	0.5
Total Suspended Solids (kg/yr)	75000	4140	94.5
Total Phosphorus (kg/yr)	156	49.7	68.2
Total Nitrogen (kg/yr)	1120	495	55.9
Gross Pollutants (kg/yr)	16500	0	100

Appendix A

Drainage Strategy Prepared by Incitus, Dated 12/03/2020 (REV4)



Collison Estate Cranbourne East

Stormwater Strategy

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Contents

1 Introduction

Incitus has been engaged to undertake a Stormwater Strategy for the development of Collison Estate, Cranbourne East. Collison Estate is an 82 ha conglomerate of 94 low density residential allotments. The site is bounded by Mayfield Road to the west, Linsell Boulevard to the north, residential development to the east and Berwick – Cranbourne Road to the south. The site is traversed from north to south by Collison Road and east to west by Heather Grove and Garden Street.

The site is illustrated in **Figure 1.1** below.

Figure 1.1 Collison Estate, Cranbourne East

The site is located approximately 45 km south-east of Melbourne in Cranbourne East. The site is planning to re-develop to a standard and medium density residential area.

Urbanisation leads to an increase in stormwater runoff and a subsequent increase in pollutant wash-off. It also has detrimental effects on the receiving waterways. In determining the urban structure, it is critical that assets required for drainage purposes are determined early so that the impacts from the increase of stormwater runoff due to urbanisation can be mitigated and all new development can proceed without the risk of flooding, of flooding neighbouring properties and without impacting on the natural environment, receiving waterways and ultimately, Westernport Bay.

Undertaking a drainage assessment of the catchment that identifies the quantity of runoff, the conveyance of this runoff, the need to retard the runoff and the treatment and / or reuse of the runoff will assist in determining the assets and / or land-take required for the stormwater management of this catchment. It will also identify the location of all stormwater assets.

Liveability and resilience should be incorporated into all new developments. With respect to stormwater management, this involves utilising the stormwater as an asset for the community whilst ensuring fundamentals such as flood protection, safety with respect to flow management and water supply security are maintained. This can be achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Stormwater Strategy for the re-development of Collison Estate, Cranbourne East outlines a management plan for the stormwater that is generated from the urbanisation of the land. It identifies the assets required to manage the increased surface water runoff from urbanisation and sets a framework to achieve the intent of the stormwater assets. The surface water management for the site has been optimised and designed to achieve multiple benefits for the community and the environment.

2 Catchment Characteristics

Collison Estate straddles Collison Road in Cranbourne East and is approximately 82.4 ha in size. The land was subdivided as low-density residential development decades prior to the urban growth encompassing Cranbourne East. The average annual rainfall for the region is approximately 800 mm.

The site has three distinct catchments, the smaller northern catchment discharging to Linsell Boulevard, the middle catchment to Heather Grove discharging east towards Clyde Creek and the southern catchment between Heather Grove and Berwick – Cranbourne Road discharging east towards the upper reach of Clyde Creek.

The topography and Melbourne Water hydrologic model indicates the site has an external catchment of approximately 295 ha contributing from Casey Fields and Blue Hills Rise Estate to the south, however the runoff from this catchment is conveyed around Collison Estate towards the upper reach of Clyde Creek via Ferrari Drive. An additional 67 ha contributes from the west and is conveyed through the site via a Q100 pipeline along Heather Grove. This catchment is retarded on the west of Casey Fields Boulevard (Mayfield Road) prior to entering the site. An un-retarded catchment of approximately 14 ha from west of Casey Fields Boulevard (Mayfield Road) is conveyed through the site via Garden Street.

Figure 2.1 depicts the general site characteristics.

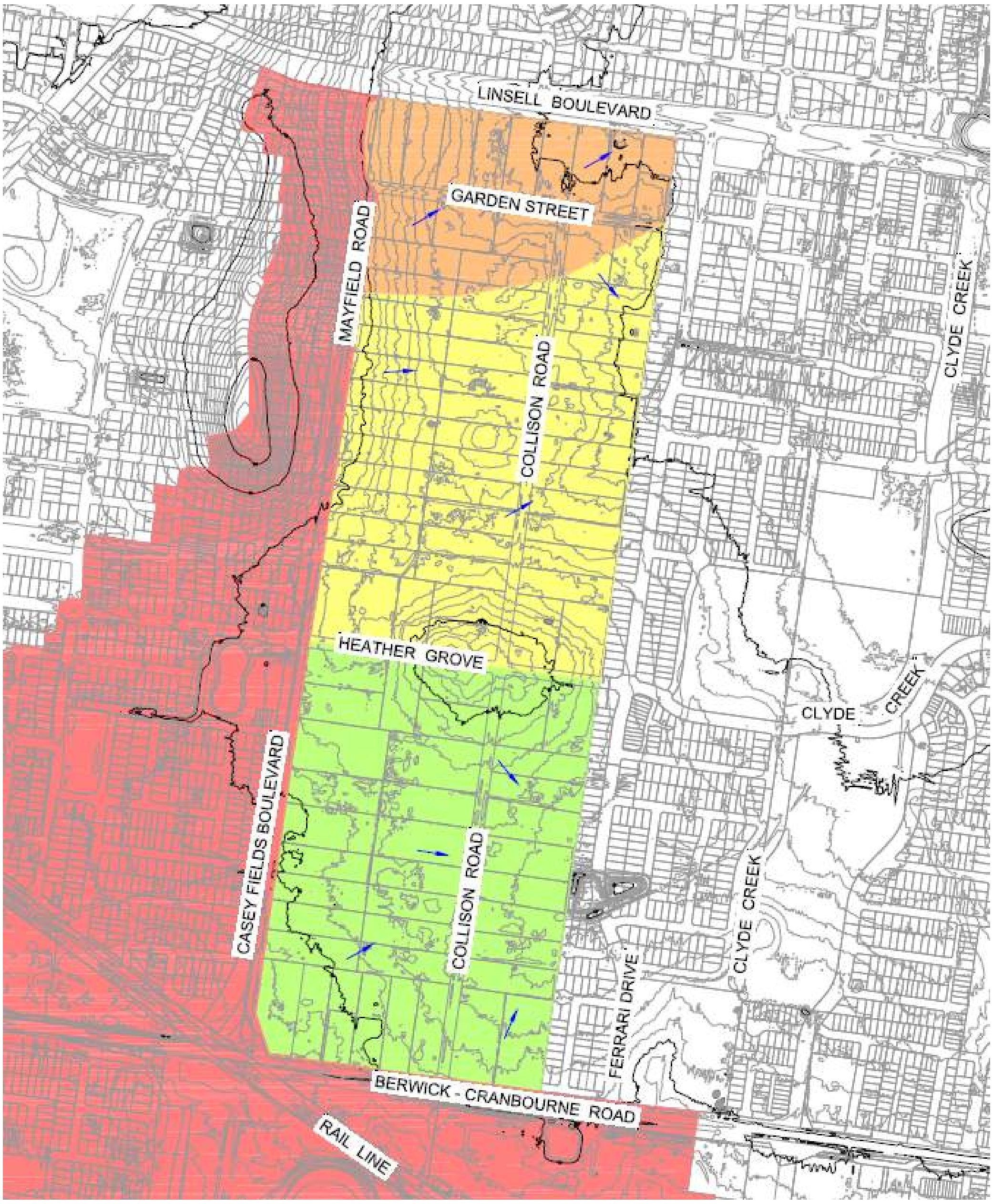

Figure 2.1 Catchment Characteristics of Collison Estate, Cranbourne East

3 Stormwater Management Requirements

Whilst the site is located within Melbourne Water's Collison Road Development Services Scheme (DSS), the re-development of the site was not planned at the inception of the DSS and therefore no allowance has been made by the DSS for the conveyance and management of the stormwater runoff generated from the re-development of the site.

The re-development of Collison Estate will require:

- The construction all stormwater assets required for the site
- Maintain existing peak flows discharging from the site for all storm events up to and including the 1% Annual Exceedance Probability (AEP) storm
- Maintain existing external flows through the catchment
- Achieve best practice water quality objectives for the stormwater runoff generated from the site
- Allowance for safe conveyance of gap flows through the site utilising road reserves, both existing and proposed

4 Proposed Development Layout

The proposed development layout for Collison Estate consists of a mix of uses, predominantly residential, with additional road reserves to connect the new development with the existing development surrounding Collison Estate. The proposed development layout is illustrated in **Figure 4.1**.

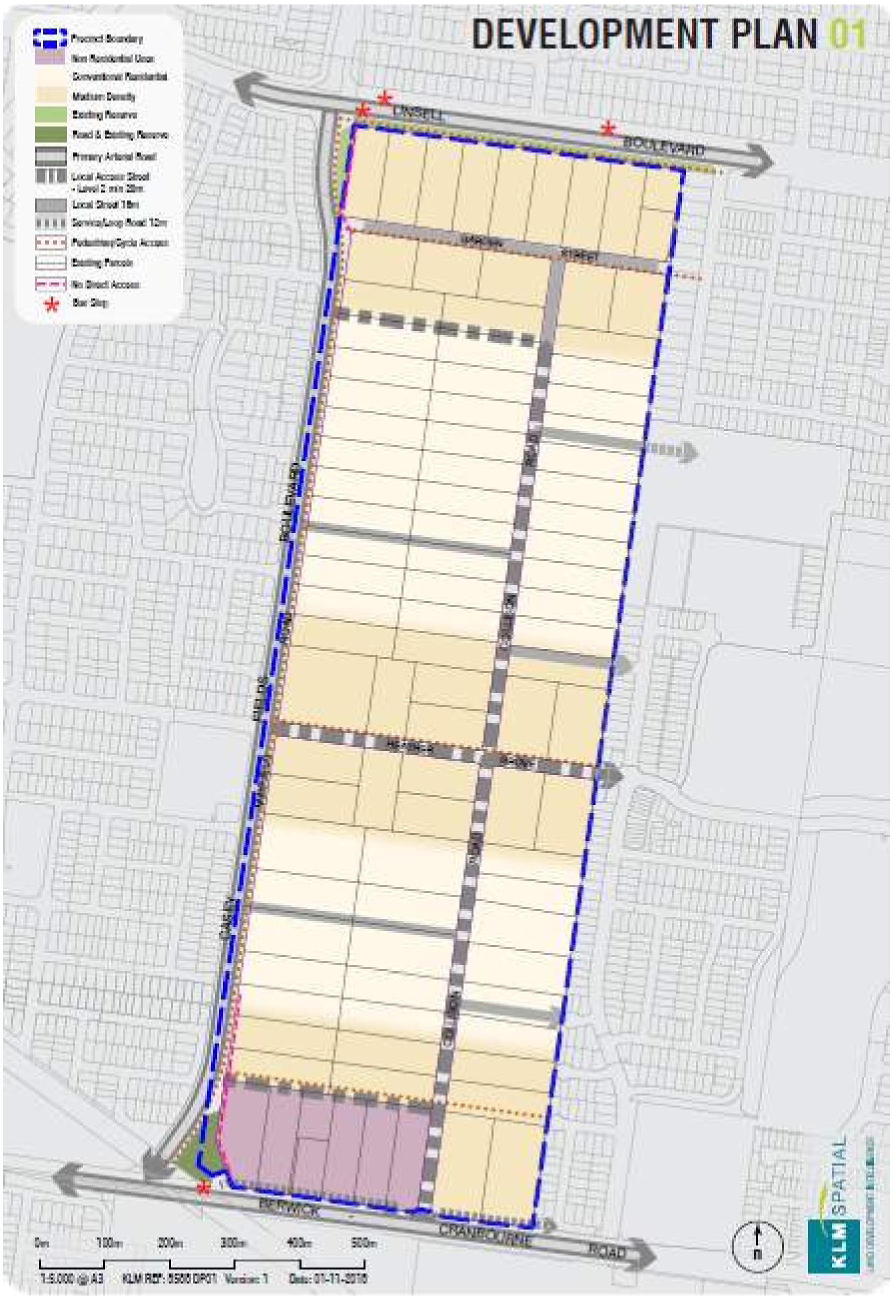

Figure 4.1 Proposed Development Layout

5 Stormwater Management

The development of Collison Estate has the following stormwater management options:

- Option 1 - Retardation and treatment utilising end-of-pipe, catchment scale methods with assets located prior to discharging from site
- Option 2 – At-source treatment and retardation based on mandated rain water tanks
- Option 3 – Distributed retardation and treatment of runoff with clusters of drainage assets distributed throughout the development

5.1 Stormwater Quantity

The drainage system for the re-development of Collison will be designed to prevent property flooding occurring in a 1% Annual Exceedance Probability (AEP) storm event and the stormwater runoff can be safely conveyed through the development. To achieve this, the development will adopt a minor / major drainage system philosophy.

5.1.1 Minor Drainage System

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 20% Annual Exceedance Probability (AEP) design storm for residential catchments.

The system will be designed in accordance with the Victorian Planning Authority's Engineering Design and Construction Manual.

5.1.2 Major Drainage System

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1% AEP storm event and to ensure the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserve.

There is an existing Land Subject to Inundation Overlay (LSIO) within the site. For areas covered by the LSIO, the re-development of Collison Estate will be designed so that the new allotment levels are set to a minimum of 450 mm above the 1% AEP flood level, and the finished floor levels for new dwellings are set a minimum of 600 mm above the 1% AEP flood level associated with any drainage reserve or any existing LSIO.

For all other areas within the re-development of Collison Estate, the finished floor levels for new dwellings are to be set a minimum of 300 mm above the relevant 1% AEP flood level which is likely to be related to the overland flow path, and new garage finished floor levels are to be set a minimum of 150 mm above the relevant 1% AEP flood level.

The redevelopment of Collison Estate includes overland flow path connections to the neighbouring developments to ensure no unnecessary encumbrances on properties.

5.1.3 Peak 1%AEP Design Flows

The re-development of Collison Estate will increase the average portion of impervious surface within the site from 30%[1] to 70%. This will increase the volume and magnitude of runoff generated from the site. **Table 5.1** outlines the proposed catchments and the peak 1% AEP design flows for the catchments from the re-development without the inclusion of any on-site retardation. The proposed catchments are illustrated in **Figure 5.1**.

Table 5.1 Catchments and Peak 1% AEP Design Flows

Catchment	Area (ha)	Existing Peak 1% AEP design flow (m^3/s)	Peak 1% AEP design flow (m^3/s)	Estimated Peak Overland Flow (m^3/s)
External Catchment through Garden Street	13.960	2.73	2.73	1.64
Northern Catchment	14.080	3.85*	5.05*	3.03*
Middle Catchment	33.096	4.14	7.50	4.50
Southern Catchment	35.454	4.61	8.36	5.01

* includes the conveyance through the catchment along Garden Street of the external catchment.

[1] Average fraction impervious value applied in the hydrologic model for the Collison Road DSS

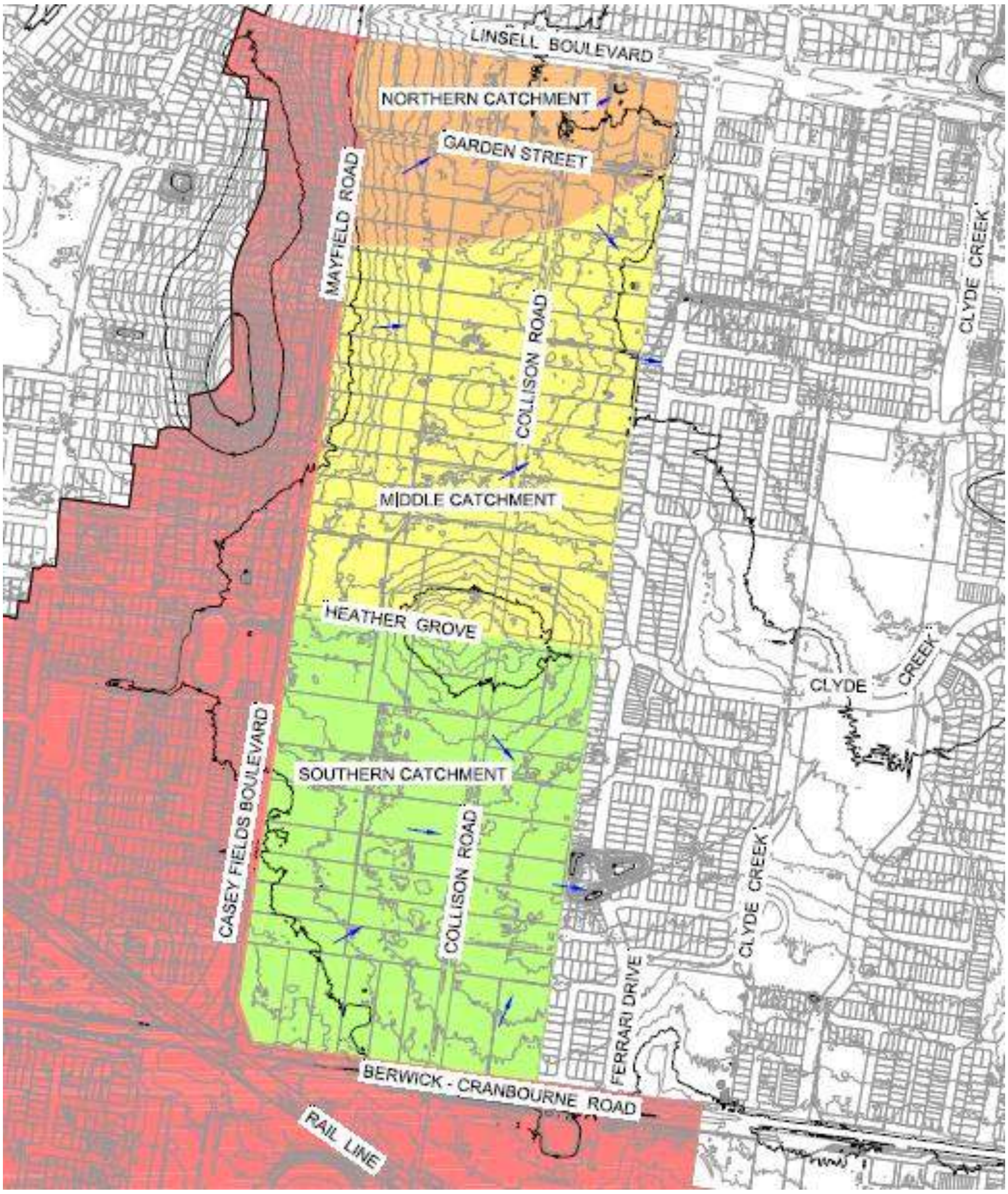

Figure 5.1 Collison Estate Catchments

Melbourne Water provided Incitus with the Collison Road DSS RORB model *Review_SWS_August_09.cat*. This model relates to the review of the Collison Road DSS undertaken by Stormy Water Solutions in August 2009. This model has since been superseded by the Clyde Creek DSS RORB model which incorporates the Collison Road DSS catchment. The Clyde Creek DSS RORB model allows for the assessment of the flows to the proposed South East Wetland Retarding Basin (SE WLRB) located prior to the outfall of Clyde Creek to Westernport Bay.

The Clyde Creek DSS RORB model *Modified Clyde Creek July 2018.catg* was used as a base for the hydrologic modelling. An assessment of the catchments between the rail line and Cascades on Clyde retarding basin (Clyde Creek RB) was undertaken to validate the model to the topography and current land use. The assessment indicated that the fraction impervious value for the catchments encompassing Collison Estate are too low based on the surrounding land use adopting a f_{imp} = 0.50 (SWS Collison Road DSS 2009 Technical Review). These areas have been modified to adopt a f_{imp} = 0.60 for the urbanised areas.

The model was then further modified to reflect the re-development of Collison Estate, increasing the f_{imp} = 0.30 for Collison Estate (SWS Collison Road DSS 2009 Technical Review) to f_{imp} = 0.70.

The results of peak 1% AEP design flows extracted from the three models at various locations along Clyde Creek are listed in **Table 5.2**.

Table 5.2 Peak 1% AEP Design Flows flor Clyde Creek

Location	Existing Model Peak 1% AEP design flow (m^3/s)	Modified Model Peak 1% AEP design flow (m^3/s)	Re-developed Model Peak 1% AEP design flow (m^3/s)
Cascades on Clyde RB In	19.31	25.11	25.64
Cascades on Clyde RB Out	10.71	11.47	13.15
Clyde Creek at Tuckers Rd (Edgebrook Estate)	17.31	18.46	18.66
Clyde Creek at GGF	21.71	22.91	23.09
Clyde Creek at Ballarto Road	22.22	23.46	23.64
SE WLRB In	35.26	35.35	35.49
SE WLRB Out	31.61	32.08	32.14

The results indicate that there is an increase in flow magnitude predominately due to the increase hydraulic efficiency in the modified model simulated by the increased fraction impervious value for the catchments. This is clearly demonstrated by the significant increase in peak flow entering the Cascades on Clyde retarding basin. However, the impact of this is mitigated as the flow is conveyed downstream due to the number of retarding basins it will pass through prior to discharging into Westernport Bay.

The increase peak 1% AEP design flow from the re-development of Collison Estate is less significant than the difference between the existing model and the modified model. The main concern is the peak flow discharging from the Cascades on Clyde retarding basin, with the re-developed model experiencing a 1.7 m^3/s increase in peak flow discharging. The increase in peak flow due to the re-development of Collison Estate is fairly negligible further downstream.

The Technical Review of the Collison Road DSS undertaken by Stormy Water Solutions in August 2009 indicates that the pre-development 1% AEP flow at the Cascades on Clyde retarding basin is 12 m^3/s and that the peak 1% AEP design flow discharging from this basin is 15.7 m^3/s. The technical review indicates that this provides a 50 year flood protection for the downstream properties and that this has been deemed acceptable by Melbourne Water.

Clyde Creek on the east side of Berwick – Cranbourne Road has experience significant amounts of development since the August 2009 Technical Review of the Collison Road DSS. This includes the creek adopting a constructed form from Berwick - Cranbourne Road to the Growling Grass Frog (GGF) conservation zone located half way between Pattersons Road and Ballarto Road; and passing through four online wetland / retarding basin systems along the way. **Figure 5.2** illustrates the Clyde Creek DSS from Berwick - Cranbourne Road to the GGF conservation zone.

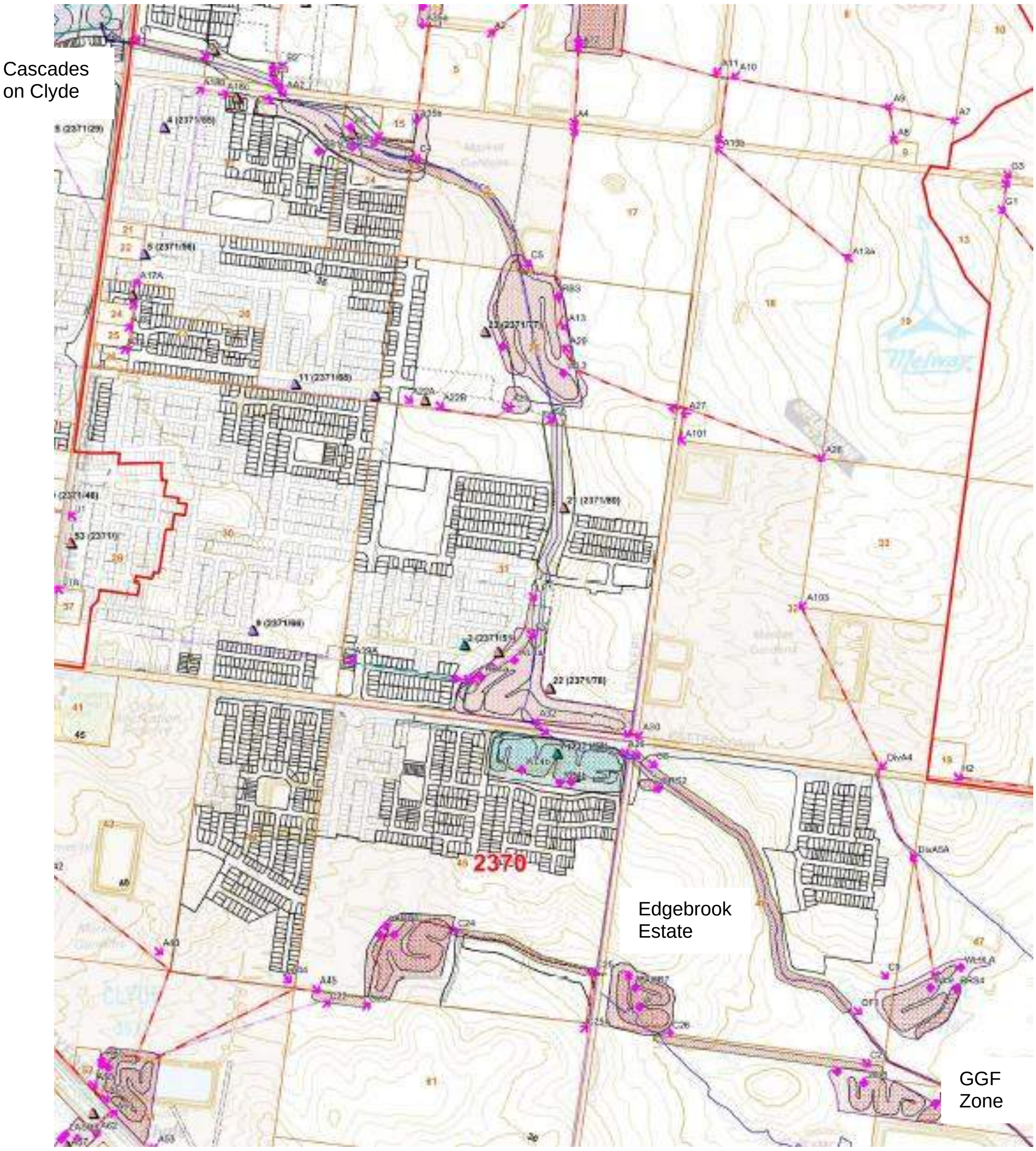

Figure 5.2 Clyde Creek DSS

Hydraulic analysis has been undertaken on the section of Clyde Creek between Berwick – Cranbourne Road and Hardys Road using as constructed survey; and on Clyde Creek through Edgebrook Estate using the constructed waterway design (from Tuckers Road / Pattersons Road to the GGF zone). The analysis has compared the peak 1% AEP flood levels for the existing model, the modified model and the model with the re-development of Collison Estate.

The hydraulic analysis has indicated that the peak 1% AEP flood level in the creek has increased from the existing model flows to the re-development model flows by approximately 150 mm between Berwick – Cranbourne Road and Hardys Road, and by up to 100 mm in Edgebrook Estate. The analysis has also shown that the allotments abutting the creek will still achieve a 600 mm freeboard to the re-development model flows peak flood levels; and the main increase in flood level is between the modified model and the existing model.

Figure 5.3 and **Figure 5.4** illustrate a typical section of Clyde Creek with the different 1% AEP flood levels for the section of waterway between Berwick – Cranbourne Road and Hardys Road; and the section within Edgebrook Estate.

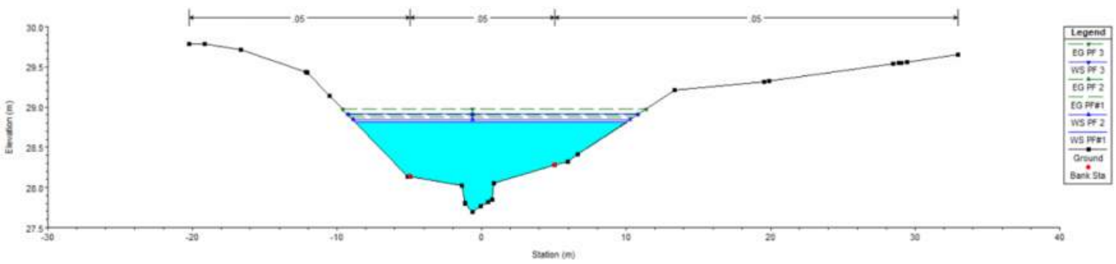

Figure 5.3 Clyde Creek Constructed Waterway between Berwick – Cranbourne Road and Hardys Road

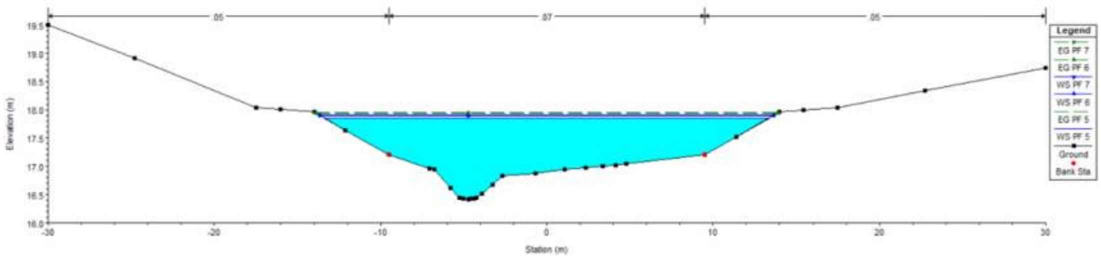

Figure 5.4 Clyde Creek Constructed Waterway within Edgebrook Estate

Despite the increase in imperviousness within Collision Estate having a negligible effect on the downstream system, the authorities require retardation within Collison Estate to mitigate the runoff to pre-development flow magnitudes. This is further discussed in the next sections.

5.2 Overland Flow Safety

It is imperative that the development conveys the overland flows safely along road reserves. This requires ensuring the overland flow along major flow paths complies with floodway safety requirements. The recommended safety limits for residential developments are as follows (from the *Guidelines for Development in Flood Affected Areas* and adapted from Australian Rainfall and Runoff):

At the entrance to lots and access ways:

- V.dmax <= 0.3 m^2/s
- Vmax <= 2.0 m/s
- dmax <= 0.30 m

For small cars and children:

- V.dmax <= 0.3 m^2/s
- Vmax <= 3.0 m/s
- dmax <= 0.30 m

The re-development of Collison Estate must also ensure that any flows discharging from the site can be safely conveyed through existing developments.

5.3 Stormwater Quality Treatment

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in the following targets:

Table 5.2 Best Practice Pollutant Reduction Targets

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80% reduction from typical urban load
Total Phosphorous (TP)	45% reduction from typical urban load
Total Nitrogen (TN)	45% reduction from typical urban load
Gross Pollutants (GP)	70% reduction from typical urban load

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

MUSIC (Model for Urban Stormwater Improvement Conceptualisation) has been used to simulate the stormwater runoff and associated pollutant wash-off, together with the pollutant reduction performance of the nominated treatment system. MUSIC is an industry accepted software modelling tool for demonstrating compliance with stormwater quality targets.

Collison Estate is located in the Collison Road DSS. This scheme discharges into the Clyde Creek DSS. Both of these schemes provide catchment scale assets for treatment of runoff from the contributing catchments.

The Clyde Creek DSS MUSIC model had the whole catchment of Collison Road DSS with an average fraction impervious value of 50%. Analysis of the hydrologic model indicates that the average fraction impervious value for the Collison Road DSS based on current land use is 46% and post re-development of Collison Estate is 50%. Therefore, the treatment assets within the Clyde Creek DSS have been designed based on the additional runoff equivalent to the re-development of Collison Estate.

The Clyde Creek DSS MUSIC model indicates that the Cascades on Clyde Wetland achieves 94% of the best practice pollutant reduction targets with the re-development of Collison Estate. The wetland achieves 97% of the targets without the re-development.

The Cascades on Clyde wetland is performing well with an anticipated 42.3% total nitrogen reduction even with the re-development of Collison Estate. The small shortfall is accounted for in the SE WLRB.

Despite the Collision Estate having a negligible effect on the downstream treatment assets and the provision for this catchment to be re-developed in the construction of treatment assets downstream of Cascades on Clyde; the authorities require treatment within Collison Estate to achieve best practice pollutant reduction targets. This is further discussed in the next sections.

6 Option 1 – Catchment Scale Management

This option requires the redevelopment of Collison Estate to undertake on-site retardation to mitigate the flows discharging from the site to existing flow magnitudes, and treatment of the stormwater runoff generated from the site to best practice pollutant reduction targets, with the assets to be located prior to the outfalls from the development.

6.1.1 On-site Catchment Scale Retardation within Collison Estate

Catchment scale stormwater management for the re-development of Collison Estate includes the provision of on-site retardation to mitigate the flows to pre-development magnitudes for all events up to and including the 1% AEP design storm.

Table 6.1 outlines the estimated volume of retardation required for Collision Estate to mitigate the flows discharging from the site to pre-development magnitudes all events up to and including the 1% AEP design storm.

Table 6.1 Retarding Volumes to Mitigate Peak 1% AEP Design Flows to Pre-Development Magnitudes

Catchment	Northern Catchment	Middle Catchment	Southern Catchment
Post Development Peak 1% AEP design flow (m^3/s)	5.05	7.50	8.36
Pre-Development Peak 1% AEP design flow (m^3/s)	3.85	4.14	4.61
Storage Volume (m^3)	1,720	3,825	3,980
Drainage Reserve (ha)	0.25	0.5	0.5
Drainage Reserve (ha) Combined retardation / treatment	0.30	1.2	1.2

Figure 6.1 illustrates potential storage locations for the retardation within the proposed development. The size of the drainage reserves has accounted for all relevant safe batters to the base of the reserve. The size of the drainage reserve with the combined treatment and retardation should be capable of containing the treatment, dry-out areas, access tracks and safe batters.

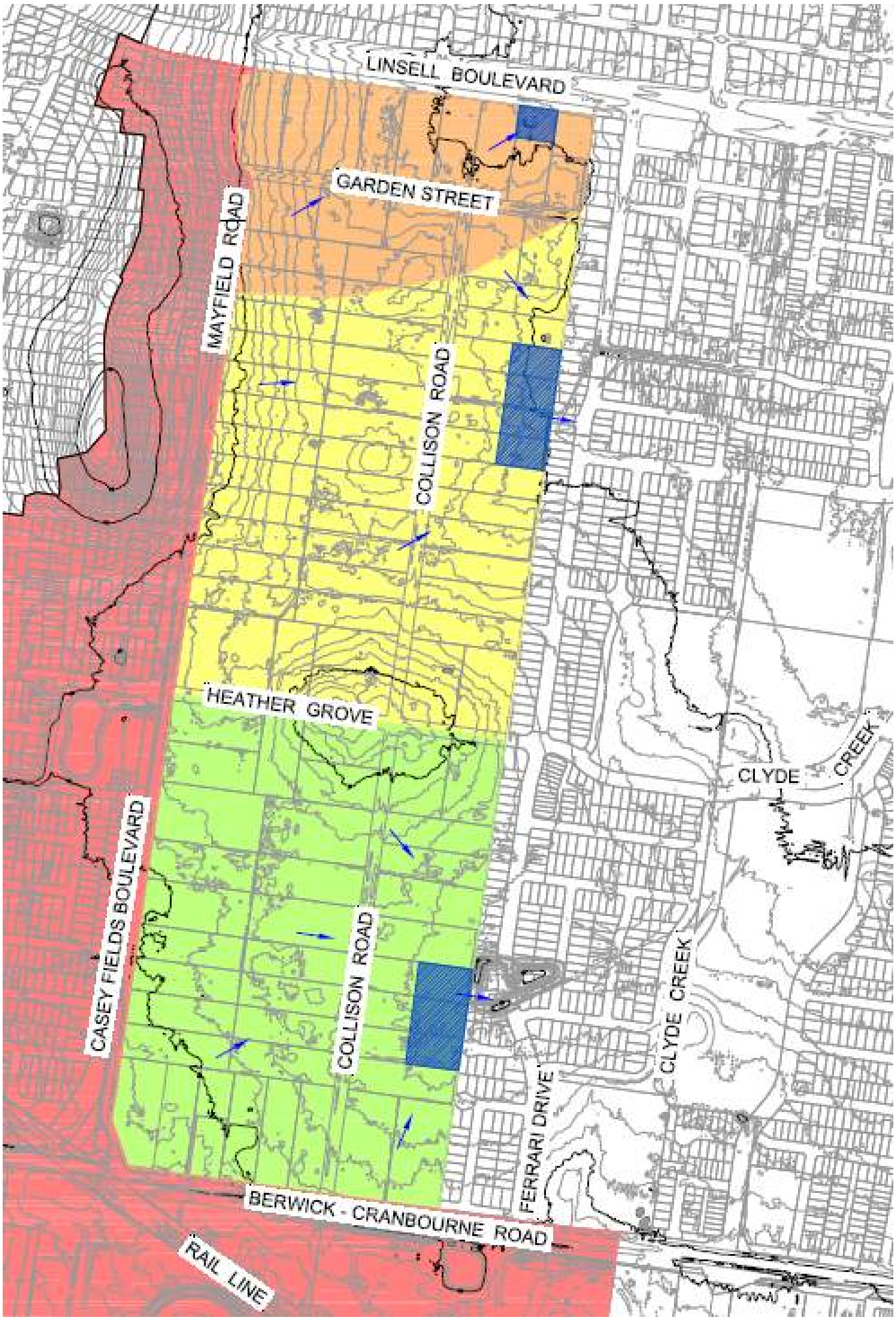

Figure 6.1 Proposed Flood Storage Locations

6.1.2 On-Site Catchment Scale Treatment within Collison Estate

The development may provide catchment scale treatment combined with the catchment scale retardation.

Should the site provide on-site treatment, a holistic approach will be adopted where some catchments over-treat to compensate for short-falls elsewhere. **Table 6.2** outlines the proposed treatment assets and footprints required to achieve best practice pollutant reduction targets for the re-development of Collison Estate.

Table 6.2 Proposed Treatment for the Development

Parameter	Northern Catchment	Middle Catchment	Southern Catchment
Treatment Type	Sediment Pond	Constructed Wetland	Constructed Wetland
Treatment Footprint (m^2)	700	6,500	6,700
Drainage Reserve (ha)	0.30	1.2	1.2

The size of the drainage reserve should be capable of containing the treatment, dry-out areas, access tracks and safe batters.

The performance results that are required of the proposed treatment for the development are listed in **Table 6.3**.

Table 6.3 Treatment Performance required for the Development

Pollutant	Source (kg/yr)	Load Reduction (kg/yr)	Overall % Reduction
Total Suspended Solids (TSS)	75,800	14,000	82%
Total Phosphorous (TP)	160	50.5	68T
Total Nitrogen (TN)	1,140	625	45%
Gross Pollutants (GP)	16,700	0	100%

7 Option 2 – At Source Management

This option requires the redevelopment of Collison Estate to undertake at-source retardation to mitigate the flows discharging from the site to existing flow magnitudes, and at-source treatment of the stormwater runoff generated from the site.

As the development layout is unknown, the following assumptions, based on existing development surrounding the site, have been applied to the calculations:

- The total development area is 82.63 ha, with an average fraction impervious value of 70% once re-developed
- 4 ha of the site will be open space, with an average fraction impervious of 10%
- 23 ha of the site will be road reserves, with an average fraction impervious value of 70%
- The balance of the site will be residential with an average fraction impervious value of 75%
- Roof area within the residential will account for an average 70% of the total allotment imperviousness, equating to a total area of 38.941
- Rain water tanks will be mandated in the re-development with Estate design guidelines
- 50% of the roof area on all new allotments will be connected to a rain water tank
- the minimum rain water tank size to be 2 kL (to achieve 6-star housing rating) and connected for toilet flushing and laundry use
- Based on an average density of 20 allotments per hectare, the site assumes 1653 new dwellings with rain water tanks
- The site assumes that, whilst mandating the inclusion of rain water tanks, there will be an overall failure of 30% of tanks within the site

7.1.1 At-Source Retardation within Collison Estate

At-source stormwater management for the re-development of Collison Estate includes the provision of retardation at, or close to, the source of stormwater runoff to mitigate the flows to pre-development magnitudes for all events up to and including the 1% AEP design storm.

For the at-source management option, the site is assuming that rain water tanks will be mandated for the construction of new dwellings. In addition to the minimum 2 kL requirement for treatment and to achieve the 6-star rating, the tanks will be increased in size to accommodate mitigation of runoff.

An additional 2 kL of storage is required per 100 m^2 of roof area connected to the tank to reduce the runoff from the connected roof area to an equivalent discharge of a land-use with 10% average imperviousness for all events up to and including a 1% AEP storm. Accounting for a 30% failure rate in tanks, the retardation from the tanks reduces the average impervious value of the re-development to 55%. This is still higher than the allowable discharge which equates to an average fraction impervious value of 30%, hence the development will need to provide additional at-source retardation. It is estimated that an additional 60 m^3 of storage per hectare of development will be required to mitigate the flows for all events up to and including the 1% AEP storm.

7.1.2 At-Source Treatment within Collison Estate

At-source stormwater management for the re-development of Collison Estate includes the provision of stormwater quality treatment at, or close to, the source of stormwater runoff.

For the at-source management option, the site is assuming that rain water tanks will be mandated for the construction of new dwellings, with the minimum size to be 2 kL to achieve the 6-star rating. The dwellings will have a minimum of 50% of the roof area connected to the tanks. The tanks will be plumbed for toilet flushing and laundry use.

The additional assumptions have been applied for the at-source stormwater quality modelling:

- demand adopted for toilet flushing is 20 L / person / day (Melbourne Water acceptable demand)
- demand adopted for laundry use is 21 L / person / day (Melbourne Water acceptable demand)
- Assumed 4 persons per dwelling on average based on the typical dwelling size
- All road reserves within the site will adopt passive irrigation of street trees, ensuring no directly connected imperviousness from road reserve catchments.

Modelling of the at-source treatment including rain water tanks with a 30% failure rate and passive irrigation in all road reserves has resulted in the treatment performance specified in **Table 7.1**.

Table 7.1 At-Source Treatment Performance for Rain Water Tanks and Road Reserve Passive Irrigation

Pollutant	Source (kg/yr)	Load Reduction (kg/yr)	Overall % Reduction
Total Suspended Solids (TSS)	56,100	40,700	27.4%
Total Phosphorous (TP)	116	88.2	24.1%
Total Nitrogen (TN)	829	661	20.2%
Gross Pollutants (GP)	11,800	8,300	29.5%

The performance has indicated that the rain water tanks and the passive irrigation measures do not achieve the best practice pollutant reduction targets for stormwater. Therefore, the site will need to incorporate additional treatment measures, which may be co-located with the additional retardation. Analysis indicates that the site will need to provide an additional 10 m^2 of rain garden treatment per hectare of allotments to meet best practice pollutant reduction targets.

8 Option 3 – Distributed Management

This option attempts to equitably distribute the land required for drainage purposes for retardation to mitigate the flows discharging from the site to existing flow magnitudes, and treatment of the stormwater runoff generated from the site. It utilises linear drainage reserves distributed throughout the site to equally encumber each land-owner, but with sufficient size to create green spines throughout the estate and enhance liveability within the re-development.

Key to this option is a digression from the conventional development with pipe drainage for the minor drainage, instead providing direct house connections to the kerb and channel, and sheet flowing the runoff from each allotment into the green spines. This option to retain stormwater runoff at the surface will assist in the reduction of the heat island effect through the cooling properties of the runoff, and minim a water sensitive city. The maximum flow anticipated to be conveyed along an access street within the development is 0.5 m^3/s. this magnitude of overland flow is safe and contained within the road reserve.

The proposed incorporation of the linear reserves / green spines into Collison Estate is illustrated in **Figure 8.1**.

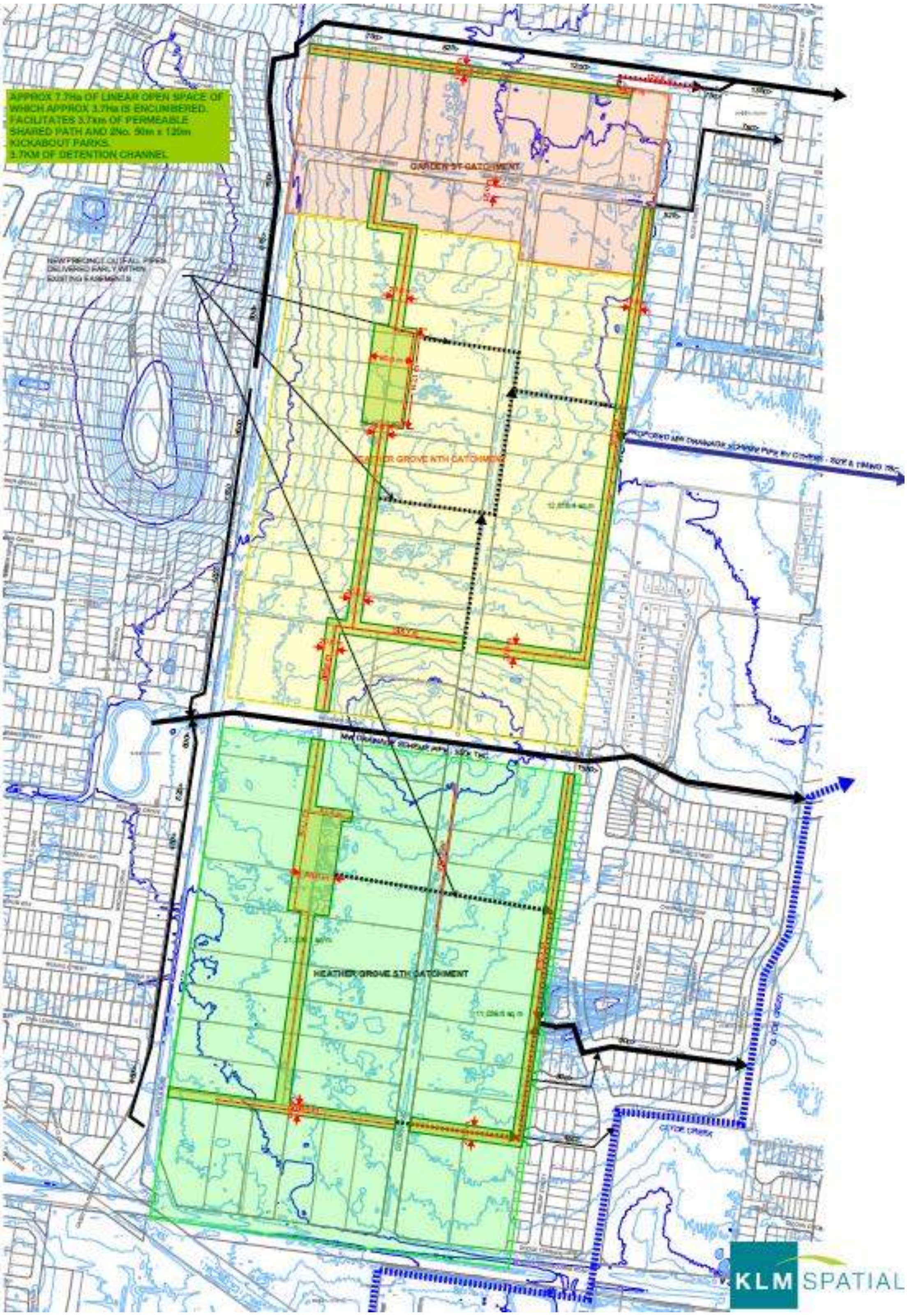

Figure 8.1 Proposed Linear Reserves / Green Spines Through Collison Estate

8.1.1 Distributed Retardation within Collison Estate

Distributed stormwater management for the re-development of Collison Estate includes the provision of retardation within the linear reserves / green spines to mitigate the flows to pre-development magnitudes for all events up to and including the 1% AEP design storm.

It is anticipated that all blocks within the existing estate will be able to discharge to a green spine. It is estimated that 101 m^3 of storage will be required per hectare of re-development for retardation within the green spine. Based on the typical section sketched in **Figure 8.2**, this equates to a length of approximately 18 m to 19.2 m of encumbered green spine per hectare.

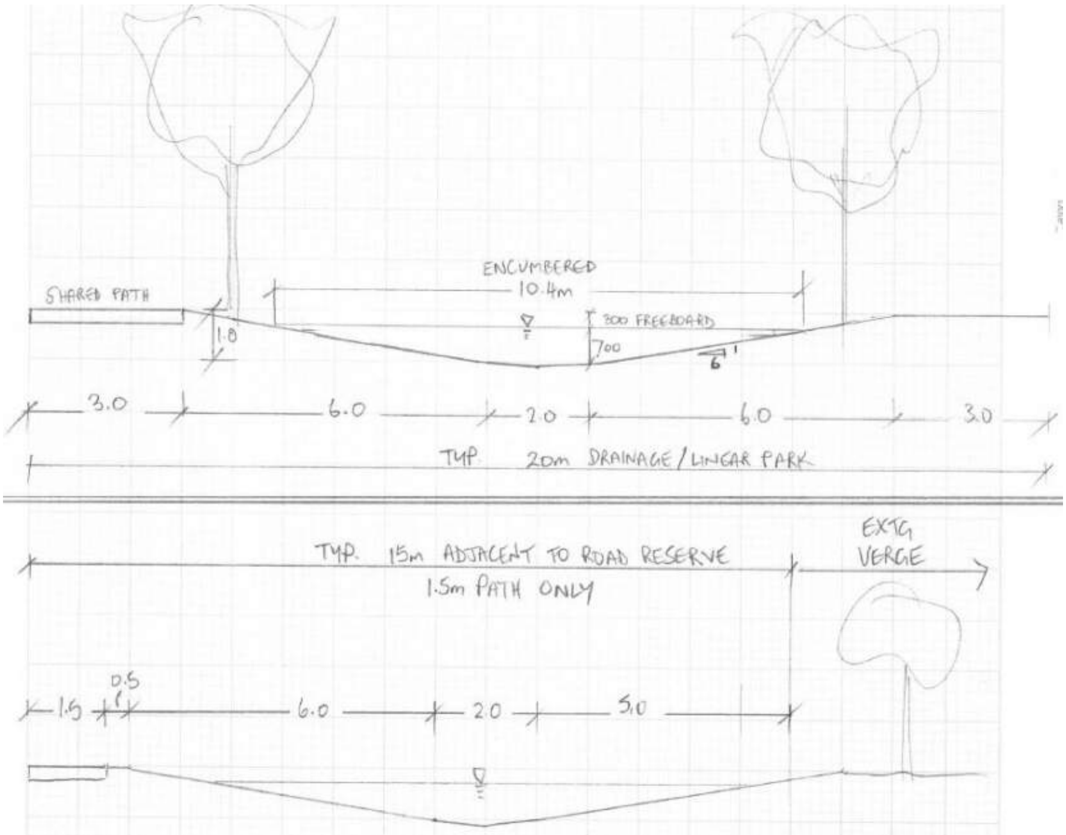

Figure 8.2 Proposed Cross Sections for Linear Reserves / Green Spines (by KLM Spatial)

8.1.2 Distributed Treatment within Collison Estate

Distributed stormwater management for the re-development of Collison Estate includes the provision of treatment within the linear reserves / green spines for runoff generated from the urbanisation of the site.

Modelling indicates that the site will need to provide 20 m^2 of rain garden per hectare of re-development to achieve best practice pollutant reduction targets. These rain gardens can be included within the linear reserves to create multi-functional drainage assets and provide an aesthetic break to the reserve.

9 Outfall Arrangement and Staging

Collison Estate has three outfalls which are existing or soon to be existing. The outfalls have been designed for the conveyance of the flows from the current land-use of Collison Estate. The re-development of Collison Estate may will use these outfalls and provide retardation to mitigate the runoff to the capacity of these outfalls for pipe drainage; and the capacity of the road reserves for overland flow.

It is imperative that the re-development of Collision Estate commences at the drainage outfalls so that interim drainage measures are not required. Any significant drainage infrastructure required, such as retardation, should be constructed prior to the re-development of the catchment associated with the drainage assets.

Parcels of land located upstream of an outlet from the existing Estate must construct all required pipe infrastructure to the outlet with easements and overland flow paths prior to commencement of any other works.

Existing drainage easements are located throughout the Estate and provide developers the opportunity to construct the permanent outfall should they precede the downstream development within the Estate.

Development of each individual site within the Estate must ensure the re-development has a permanent outfall, provides adequate retardation and stormwater quality treatment.

10 Conclusion

Collison Estate is currently a low-density development consisting of 94 allotments that drains into Clyde Creek. The Estate is proposing a re-development to a combination of standard and medium density allotments.

Analysis of the Clyde Creek catchment has indicated that the catchment has the capacity to convey the peak flows from the re-development of Collison Estate without the provision of any on-site retardation, however the existing pipe infrastructure between the Estate and Clyde Creek is insufficient to convey the 20% AEP flows generated from the re-development of the Estate.

The Collison Road DSS catchment and Clyde Creek DSS catchments, together with the proposed South East Wetland Retarding Basin asset (SE WLRB) provide treatment to the re-development of Collison Estate.

The authorities have indicated that it is preferable for Collison Estate to provide on-site retardation and stormwater quality treatment. Collison Estate can provide this through catchment scale options, at-source options or distributed options.

Catchment scale options result in the creation of three drainage reserves located immediately upstream of each outfall from the site.

At-source management includes the mandating of rain water tanks for treatment and retardation, as well as passive irrigation of all road reserves and additional treatment and retardation.

Tanks need to be a minimum of 2 kL per dwelling for treatment, and 2 kL of additional storage per 200 m^2 of roof area[2]. An additional 60 m^3 of storage per hectare of re-development and 10 m^2 of rain garden per hectare of redevelopment is required to achieve the management targets for the at-source option.

Distributed management will direct runoff overland to linear reserves which incorporate storage and treatment. The linear reserves will act as green spines throughout the Estate, linking the community. They will need to provide 101 m^3 of storage and 20 m^2 of rain garden per hectare of re-development to achieve the management targets.

Ideally, the re-development of Collison Estate should commence from the drainage outlets and progress upstream. Any out-of-sequence development should ensure that the pipe infrastructure and suitable overland flow paths exist, with drainage easements over the assets, prior to the commencement of any re-development works.

Irrespective of the stormwater management option adopted for Collison Estate, the Victorian Planning Provisions Cl53.18 and Cl56.07-4 require the management of flows and the pollutant wash-off from the site to best practice stormwater management. Council may utilise these planning provisions to ensure any re-development within Collison Estate retards runoff to pre-development magnitudes, provides safe conveyance of stormwater runoff, and treats stormwater runoff to best practice pollutant reduction targets.

[2] Based on 50% of roof area connected to the tank, and 2 kL of storage per 100 m^2 of roof connected

11 References

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Appendix A – RORB Parameters

RORB File	Modified Clyde Creek July18.catg
kc	15.41
m	0.8
IL	10 mm
RoC	0.6 (100 year ARI)
Rainfall Location	CLYDE NORTH
Temporal Pattern	Filtered
Aerial Pattern	Uniform
Aerial Reduction Factor	Siriwardena and Weinmann
Loss Factor	Constant Losses

IFD Parameters

Location	CLYDE NORTH
${}^{2}I_{1}$	17.64
${}^{2}I_{12}$	3.80
${}^{2}I_{72}$	1.10
${}^{50}I_{1}$	33.93
${}^{50}I_{12}$	7.34
${}^{50}I_{72}$	2.12
Skew	0.38
F2 Value	4.27
F50 Value	14.97
Zone	1

Appendix B – Intensity Frequency Duration Data

Cranbourne Intensity Frequency Duration Table

Latitude: -38.1092 [Nearest grid cell: 38.1125 (S)]
Longitude: 145.3131 [Nearest grid cell: 145.3125 (E)]

Duration	Average Exceedance Probability						
	63.20%	50%#	20%*	10%	5%	2%	1%
1 min	89.8	102	143	173	203	245	279
2 min	78.2	88.1	120	143	166	191	211
3 min	69.9	78.9	108	129	150	174	194
4 min	63.5	71.9	99.2	119	138	163	182
5 min	58.3	66.2	92	110	129	153	173
10 min	42.8	48.9	68.9	83.3	98.1	119	137
15 min	34.7	39.6	56	67.9	80.1	97.8	112
20 min	29.6	33.8	47.7	57.7	68.1	83	95.2
25 min	26	29.7	41.8	50.5	59.5	72.3	82.7
30 min	23.4	26.6	37.3	45.1	53	64.2	73.2
45 min	18.3	20.8	28.8	34.6	40.5	48.5	54.9
1 hour	15.3	17.3	23.8	28.4	33.1	39.4	44.4
1.5 hour	11.9	13.4	18.1	21.4	24.8	29.2	32.7
2 hour	9.91	11.1	14.9	17.5	20.2	23.6	26.3
3 hour	7.64	8.51	11.3	13.2	15.1	17.6	19.6
4.5 hour	5.87	6.52	8.57	9.98	11.4	13.3	14.8
6 hour	4.85	5.38	7.06	8.2	9.33	10.9	12.2
9 hour	3.69	4.1	5.37	6.24	7.11	8.39	9.4
12 hour	3.03	3.36	4.42	5.15	5.89	6.99	7.86
18 hour	2.27	2.52	3.35	3.93	4.52	5.42	6.13
24 hour	1.84	2.05	2.74	3.24	3.75	4.51	5.13
30 hour	1.55	1.74	2.34	2.78	3.24	3.91	4.45
36 hour	1.35	1.51	2.05	2.45	2.86	3.46	3.94

Duration	Average Exceedance Probability						
	63.20%	50%#	20%*	10%	5%	2%	1%
48 hour	1.08	1.21	1.66	1.99	2.34	2.83	3.23
72 hour	0.79	0.884	1.21	1.46	1.73	2.08	2.37
96 hour	0.633	0.707	0.961	1.16	1.37	1.64	1.86
120 hour	0.536	0.595	0.8	0.956	1.12	1.34	1.52
144 hour	0.469	0.519	0.688	0.813	0.948	1.13	1.27
168 hour	0.422	0.464	0.604	0.705	0.814	0.971	1.09

Appendix C – Storage Calculations Catchment Scale Management

Northern Catchment

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	21.400	8143.9	3845	24	10	4886.3	3921.9	964.4
95.2	21.400	5659.1	3845	24	20	6790.9	5075.4	1715.5
73.2	21.400	4351.3	3845	24	30	7832.4	6228.9	1603.5
59.8	21.400	3554.8	3845	24	40	8531.5	7382.4	1149.1
50.8	21.400	3019.8	3845	24	50	9059.3	8535.9	523.4
44.4	21.400	2639.3	3845	24	60	9501.6	9689.4	-187.8
39.5	21.400	2348.1	3845	24	70	9861.8	10842.9	-981.1
35.7	21.400	2122.2	3845	24	80	10186.4	11996.4	-1810.0
32.7	21.400	1943.8	3845	24	90	10496.7	13149.9	-2653.2
30.2	21.400	1795.2	3845	24	100	10771.3	14303.4	-3532.1
26.3	21.400	1563.4	3845	24	120	11256.4	16610.4	-5354.0
22.4	21.400	1331.6	3845	24	150	11984.0	20070.9	-8086.9
19.6	21.400	1165.1	3845	24	180	12583.2	23531.4	-10948.2
16.0	21.400	951.1	3845	24	240	13696.0	30452.4	-16756.4
13.7	21.400	814.4	3845	24	300	14659.0	37373.4	-22714.4
12.2	21.400	725.2	3845	24	360	15664.8	44294.4	-28629.6

Middle Catchment

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	26.742	10176.7	4141	18	10	6106.0	3478.4	2627.6
95.2	26.742	7071.7	4141	18	20	8486.0	4720.7	3765.3
73.2	26.742	5437.5	4141	18	30	9787.4	5963.0	3824.4
59.8	26.742	4442.1	4141	18	40	10661.0	7205.3	3455.6
50.8	26.742	3773.5	4141	18	50	11320.6	8447.6	2873.0
44.4	26.742	3298.1	4141	18	60	11873.3	9689.9	2183.3
39.5	26.742	2934.1	4141	18	70	12323.4	10932.2	1391.2
35.7	26.742	2651.9	4141	18	80	12729.0	12174.5	554.4
32.7	26.742	2429.0	4141	18	90	13116.7	13416.8	-300.1
30.2	26.742	2243.3	4141	18	100	13459.9	14659.1	-1199.2
26.3	26.742	1953.6	4141	18	120	14066.1	17143.7	-3077.7
22.4	26.742	1663.9	4141	18	150	14975.3	20870.6	-5895.4
19.6	26.742	1455.9	4141	18	180	15724.0	24597.5	-8873.5
16.0	26.742	1188.5	4141	18	240	17114.6	32051.3	-14936.7
13.7	26.742	1017.7	4141	18	300	18318.0	39505.1	-21187.2
12.2	26.742	906.2	4141	18	360	19574.8	46958.9	-27384.1

Southern Catchment

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	28.647	10901.7	4612	17	10	6541.0	3735.7	2805.3
95.2	28.647	7575.5	4612	17	20	9090.6	5119.3	3971.3
73.2	28.647	5824.9	4612	17	30	10484.7	6502.9	3981.8
59.8	28.647	4758.6	4612	17	40	11420.5	7886.5	3534.0
50.8	28.647	4042.4	4612	17	50	12127.2	9270.1	2857.0
44.4	28.647	3533.1	4612	17	60	12719.2	10653.7	2065.5
39.5	28.647	3143.2	4612	17	70	13201.4	12037.3	1164.1
35.7	28.647	2840.8	4612	17	80	13635.9	13420.9	215.0
32.7	28.647	2602.1	4612	17	90	14051.3	14804.5	-753.2
30.2	28.647	2403.2	4612	17	100	14418.9	16188.1	-1769.2
26.3	28.647	2092.8	4612	17	120	15068.2	18955.3	-3887.1
22.4	28.647	1782.5	4612	17	150	16042.2	23106.1	-7063.9
19.6	28.647	1559.7	4612	17	180	16844.3	27256.9	-10412.6
16.0	28.647	1273.2	4612	17	240	18334.0	35558.5	-17224.5
13.7	28.647	1090.2	4612	17	300	19623.1	43860.1	-24237.0
12.2	28.647	970.8	4612	17	360	20969.5	52161.7	-31192.2

Appendix D – Storage Calculations At-Source Management

Rain Water Tank Storage Per 200 m^2 of Connected Roof

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	0.020	7.6	2.7	5	10	4.6	1.2	3.4
95.2	0.020	5.3	2.7	5	20	6.3	2.0	4.3
73.2	0.020	4.1	2.7	5	30	7.3	2.8	4.5
59.8	0.020	3.3	2.7	5	40	8.0	3.6	4.3
50.8	0.020	2.8	2.7	5	50	8.5	4.5	4.0
44.4	0.020	2.5	2.7	5	60	8.9	5.3	3.6
39.5	0.020	2.2	2.7	5	70	9.2	6.1	3.1
35.7	0.020	2.0	2.7	5	80	9.5	6.9	2.6
32.7	0.020	1.8	2.7	5	90	9.8	7.7	2.1
30.2	0.020	1.7	2.7	5	100	10.1	8.5	1.6
26.3	0.020	1.5	2.7	5	120	10.5	10.1	0.4
22.4	0.020	1.2	2.7	5	150	11.2	12.6	-1.4
19.6	0.020	1.1	2.7	5	180	11.8	15.0	-3.2
16.0	0.020	0.9	2.7	5	240	12.8	19.8	-7.0
13.7	0.020	0.8	2.7	5	300	13.7	24.7	-11.0
12.2	0.020	0.7	2.7	5	360	14.6	29.6	-14.9

Additional Storage Required per Hectare of Re-development

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	0.672	255.7	170	10	10	153.4	102.0	51.4
95.2	0.672	177.7	170	10	20	213.2	153.0	60.2
73.2	0.672	136.6	170	10	30	246.0	204.0	42.0
59.8	0.672	111.6	170	10	40	267.9	255.0	12.9
50.8	0.672	94.8	170	10	50	284.5	306.0	-21.5
44.4	0.672	82.9	170	10	60	298.4	357.0	-58.6
39.5	0.672	73.7	170	10	70	309.7	408.0	-98.3
35.7	0.672	66.6	170	10	80	319.9	459.0	-139.1
32.7	0.672	61.0	170	10	90	329.6	510.0	-180.4
30.2	0.672	56.4	170	10	100	338.2	561.0	-222.8
26.3	0.672	49.1	170	10	120	353.5	663.0	-309.5
22.4	0.672	41.8	170	10	150	376.3	816.0	-439.7
19.6	0.672	36.6	170	10	180	395.1	969.0	-573.9
16.0	0.672	29.9	170	10	240	430.1	1275.0	-844.9
13.7	0.672	25.6	170	10	300	460.3	1581.0	-1120.7
12.2	0.672	22.8	170	10	360	491.9	1887.0	-1395.1

Appendix E – Storage Calculations Distributed Management

Per Hectare of Re-development

I (mm/hr)	Ae (ha)	Qa (l/s)	Qp1 (l/s)	Ts (mins)	Td (mins)	Vin (m^3)	Vout (m^3)	Vstored (m^3)
137.0	0.808	307.5	185	8	10	184.5	99.9	84.6
95.2	0.808	213.7	185	8	20	256.4	155.4	101.0
73.2	0.808	164.3	185	8	30	295.7	210.9	84.8
59.8	0.808	134.2	185	8	40	322.1	266.4	55.7
50.8	0.808	114.0	185	8	50	342.1	321.9	20.2
44.4	0.808	99.7	185	8	60	358.8	377.4	-18.6
39.5	0.808	88.7	185	8	70	372.4	432.9	-60.5
35.7	0.808	80.1	185	8	80	384.6	488.4	-103.8
32.7	0.808	73.4	185	8	90	396.3	543.9	-147.6
30.2	0.808	67.8	185	8	100	406.7	599.4	-192.7
26.3	0.808	59.0	185	8	120	425.0	710.4	-285.4
22.4	0.808	50.3	185	8	150	452.5	876.9	-424.4
19.6	0.808	44.0	185	8	180	475.1	1043.4	-568.3
16.0	0.808	35.9	185	8	240	517.1	1376.4	-859.3
13.7	0.808	30.7	185	8	300	553.5	1709.4	-1155.9
12.2	0.808	27.4	185	8	360	591.5	2042.4	-1450.9

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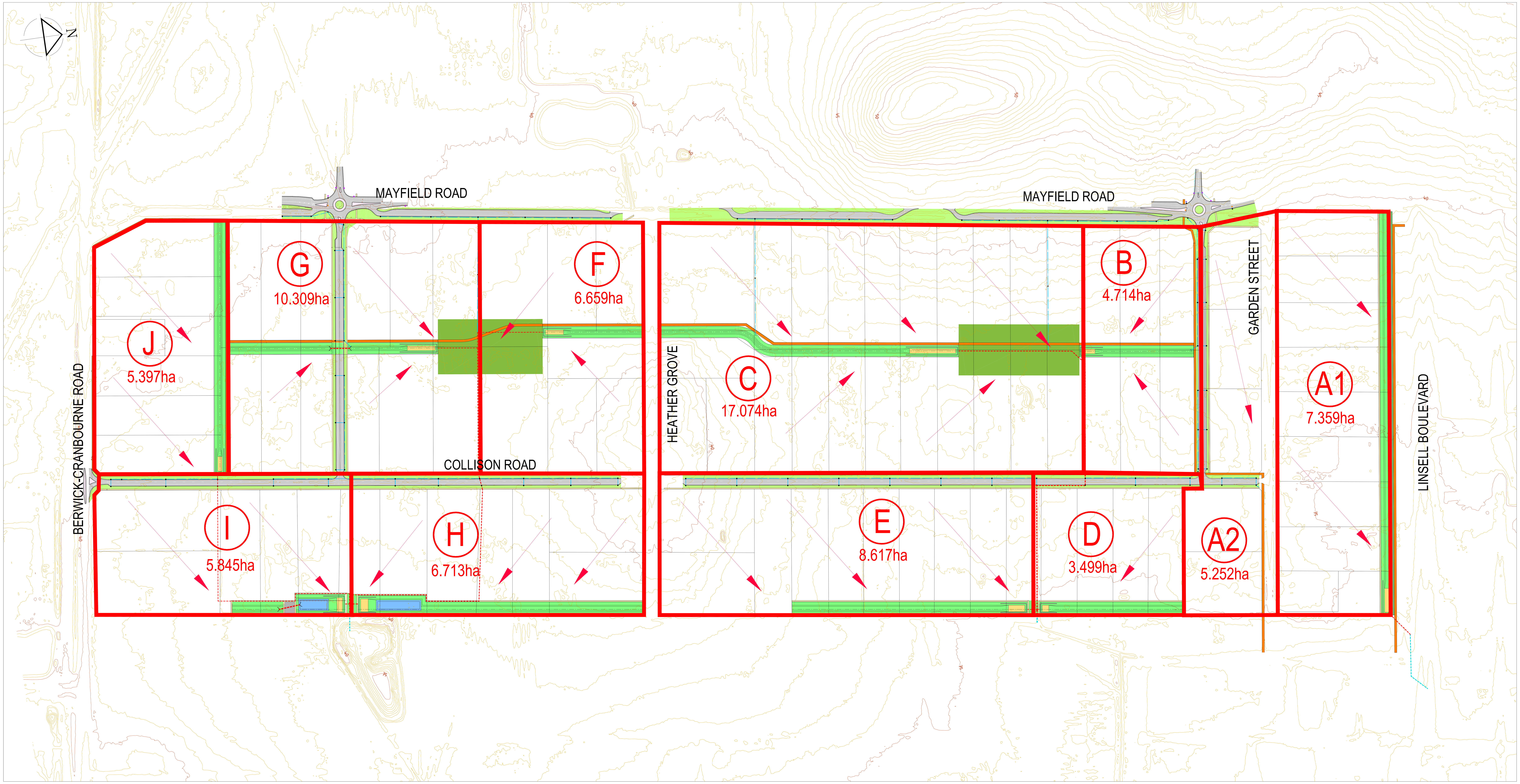
Appendix B

Catchment Plan

Verify all dimensions prior to construction - Do not scale



CATCHMENT PLAN

HORIZ 0 25 50 100 150 200

SCALE 1:2500H AT A1 SIZE
1:5000H AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
C	COUNCIL COMMENTS	S.Y	S.Y	R.F	04/12/2020
B	COUNCIL COMMENTS	S.Y	S.Y	R.F	01/09/2020
A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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CATCHMENT PLAN

Job: E8588.00
Drawing: C_01
Revision: D

Sheet: 01 of 14
Scale: AS SHOWN @ A1
Municipality: CITY OF CASEY
Melway Ref. 134F6

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Appendix C

Layout Plan and Typical Sections

Verify all dimensions prior to construction - Do not scale

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LAYOUT PLAN

HORIZ 0 25 50 100 150 200

SCALE 1:2500H AT A1 SIZE
1:5000H AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
C	COUNCIL COMMENTS	S.Y	S.Y	R.F	04/12/2020
B	COUNCIL COMMENTS	S.Y	S.Y	R.F	01/09/2020
A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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LAYOUT PLAN

Job: E8588.00
Drawing: C_02
Revision: D

Sheet: 02 of 14
Scale: AS SHOWN @ A1
Municipality: CITY OF CASEY
Melway Ref. 134F6

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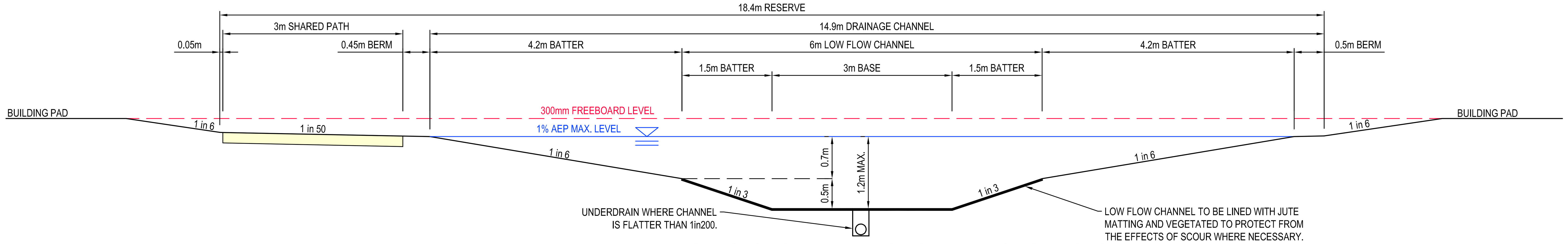
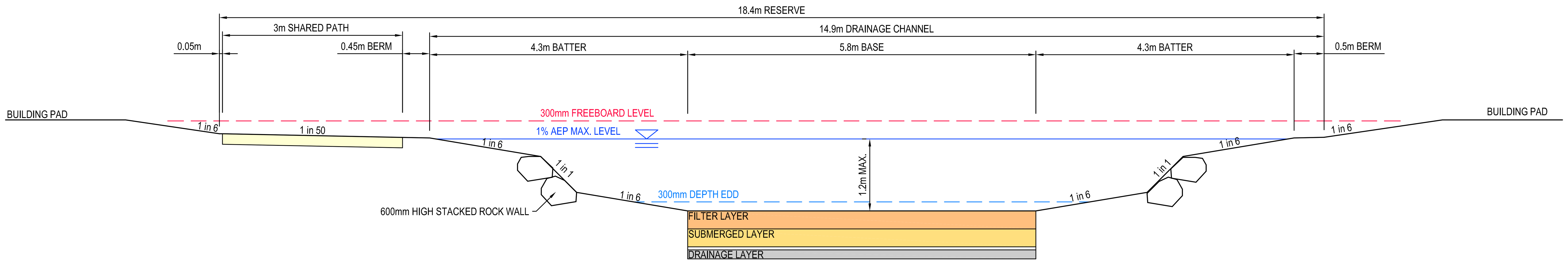
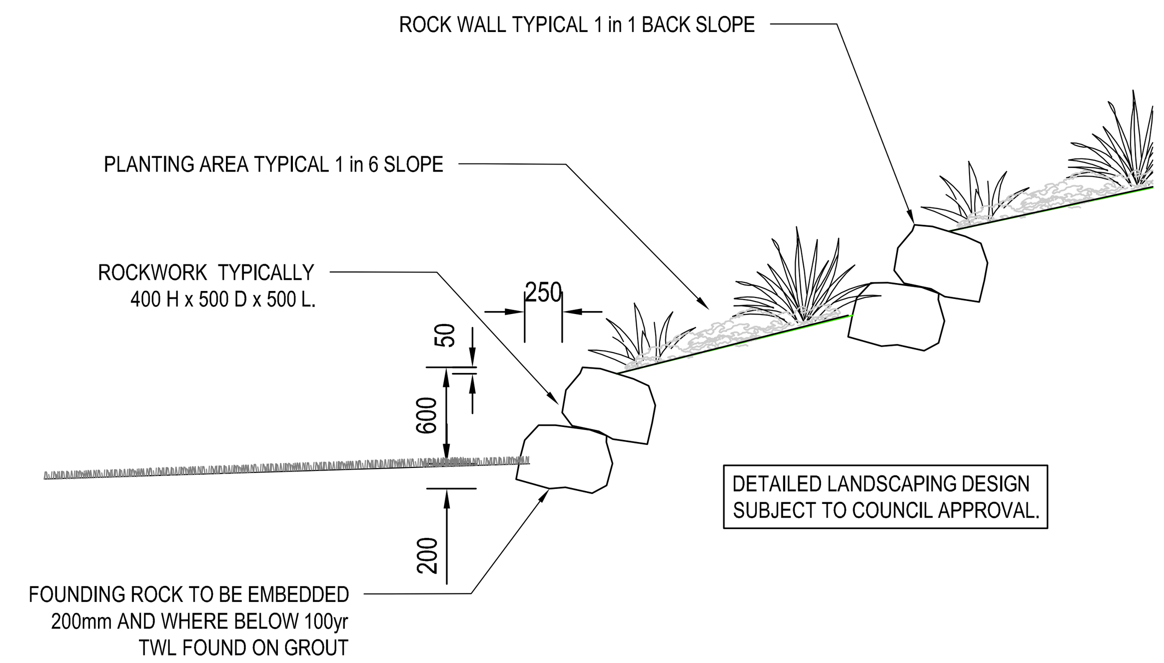


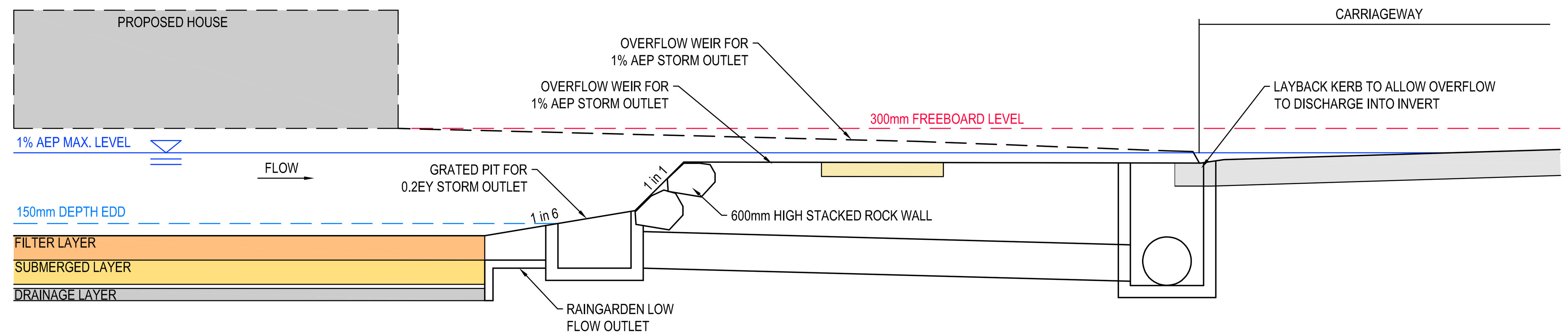
TYPICAL SECTION - DRAINAGE CHANNEL (B, C, F, G, J)



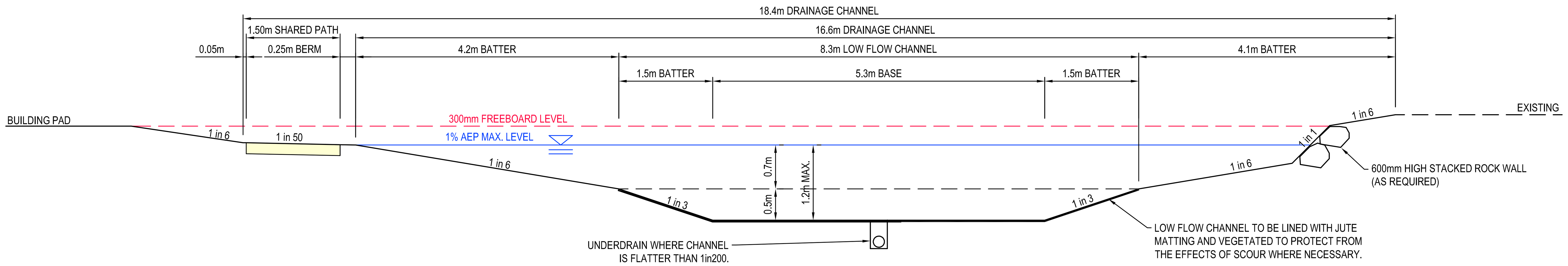
TYPICAL SECTION - DRAINAGE CHANNEL WITH RAINGARDEN (B, C, F, G, J)



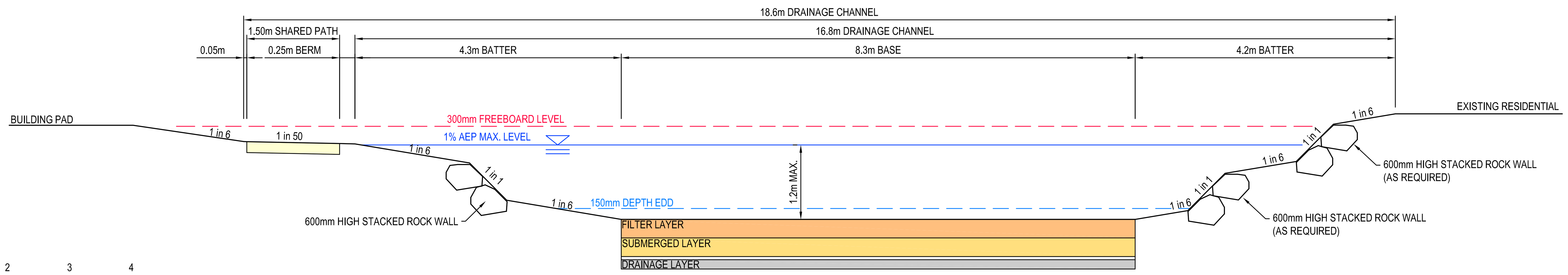
TYPICAL SECTION - STACKED ROCK WALL



TYPICAL SECTION - DRAINAGE CHANNEL OUTFALL - (B, C, F, G, J)



TYPICAL SECTION - DRAINAGE CHANNEL (A, D, E, H, I)



SCALE 1:50H AT A1 SIZE
1:100H AT A3 SIZE

TYPICAL SECTION - DRAINAGE CHANNEL (A, D, E)

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
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TYPICAL CROSS SECTIONS

SHEET 1 OF 2

Job: E8588.00
Drawing: C_03
Revision: D

Sheet : 03 of 14
Scale : AS SHOWN @ A1
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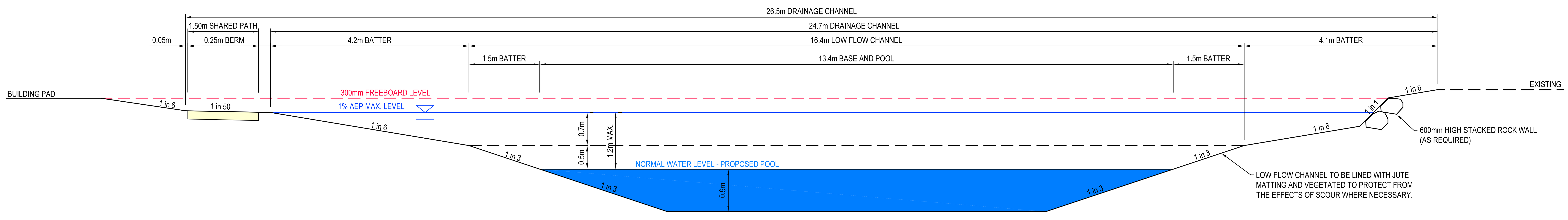
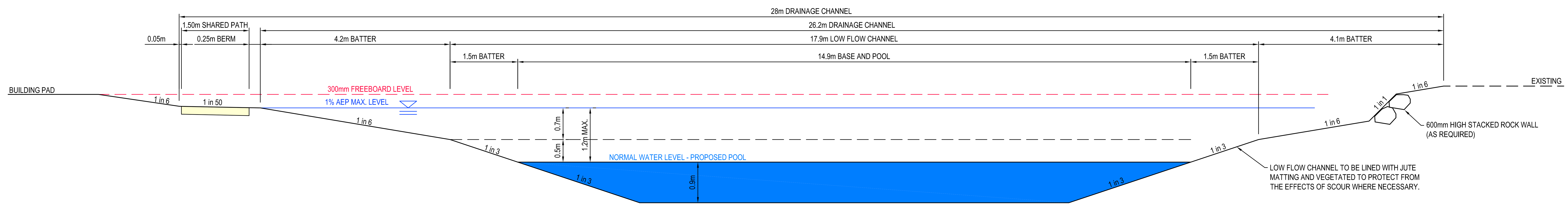


TYPICAL SECTION - DRAINAGE CHANNEL WIDENING (H)



TYPICAL SECTION - DRAINAGE CHANNEL WIDENING (I)

SCALE 1:50H AT A1 SIZE
1:100H AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
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B	COUNCIL COMMENTS	S.Y	S.Y	R.F	01/09/2020
A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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TYPICAL CROSS SECTIONS

SHEET 2 OF 2

Job	Drawing	Revision
E8588.00	C_04	D

Sheet : 04 of 14
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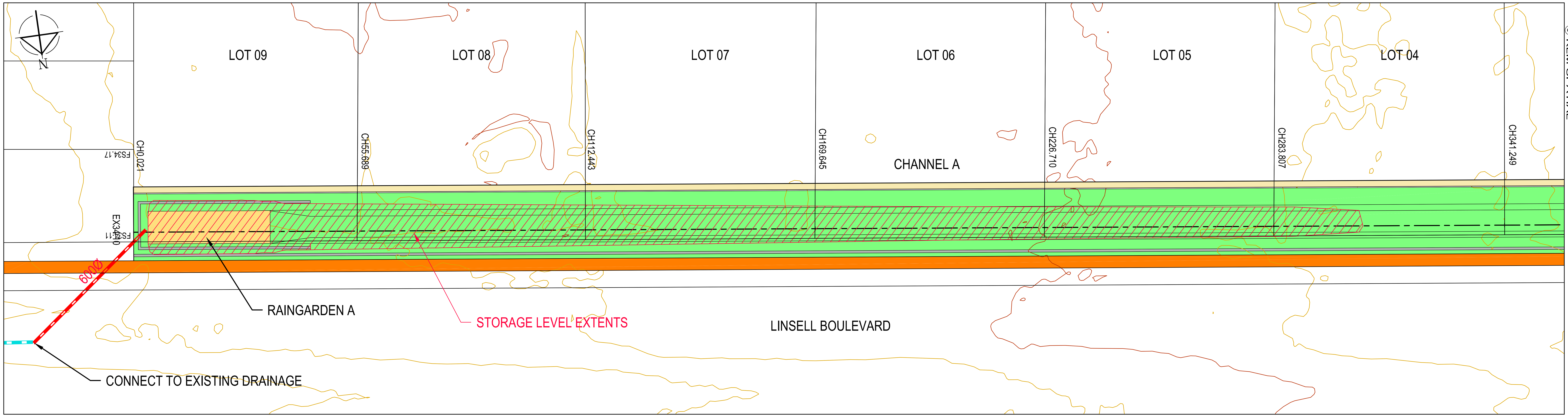
Appendix D

Concept Design

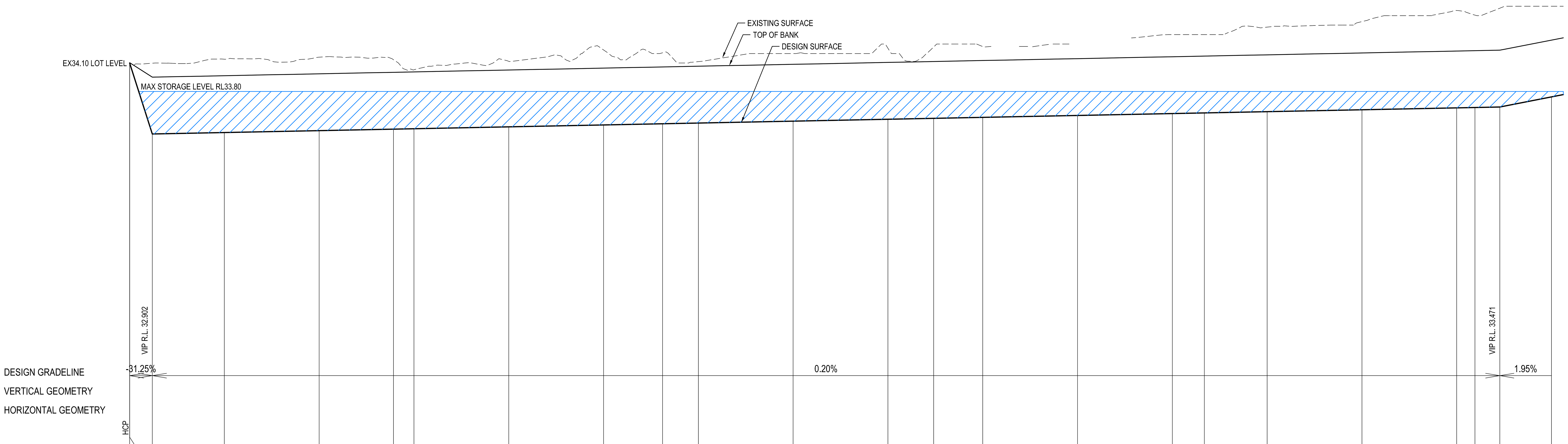
Verify all dimensions prior to construction - Do not scale



DETAIL PLAN - CHANNEL A

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DATUM 26.0

DESIGN LINE LEVEL	34.4	34.39	32.9	32.93	32.97	33	33.01	33.05	33.09	33.12	33.13	33.17	33.21	33.23	33.25	33.29	33.33	33.35	33.37	33.41	33.45	33.46	33.47	33.68
TOP OF BANK LEVEL			34.1	34.13	34.17	34.2	34.21	34.25	34.29	34.32	34.33	34.37	34.41	34.43	34.45	34.49	34.53	34.55	34.57	34.61	34.65	34.66	34.67	34.88
EXISTING SURFACE LEVEL			34.4	34.48	34.52	34.47	34.26	34.44	34.68	34.62	34.43	34.6	34.71	34.74	34.75		35	35	35.16	35.27	35.51	35.41	35.56	35.6
CHAINAGE AT CENTRELINE	0	0.03	4.79	20	40	55.68	60	80	100	112.45	120	140	160	169.64	180	200	220	226.75	240	260	280	283.84	289.09	300

LONGITUDINAL SECTION - CHANNEL A

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
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DETAIL PLAN

SHEET 01 OF 10

Job: E8588.00
Drawing: C_05
Revision: D

Sheet : 05 of 14

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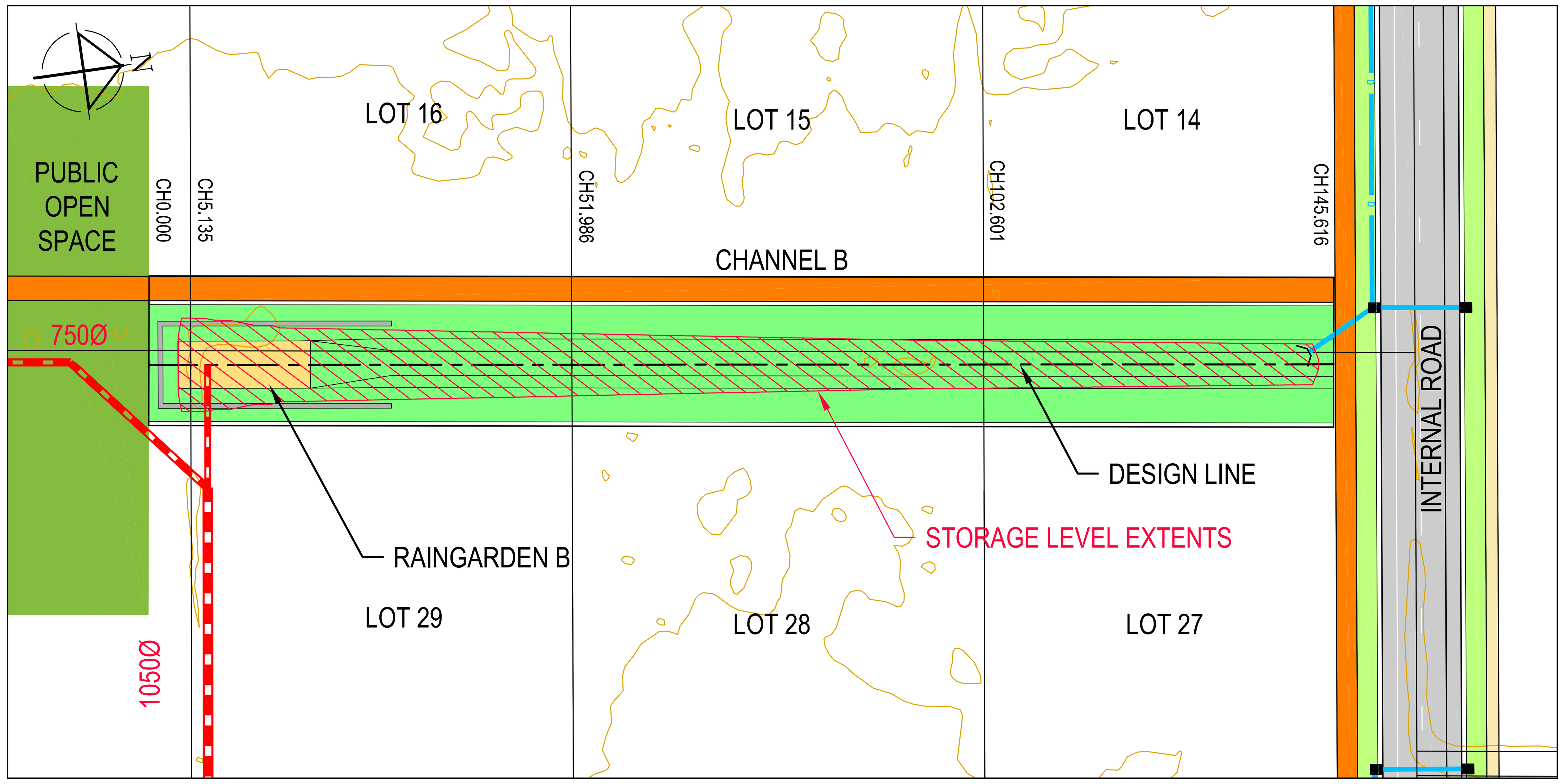
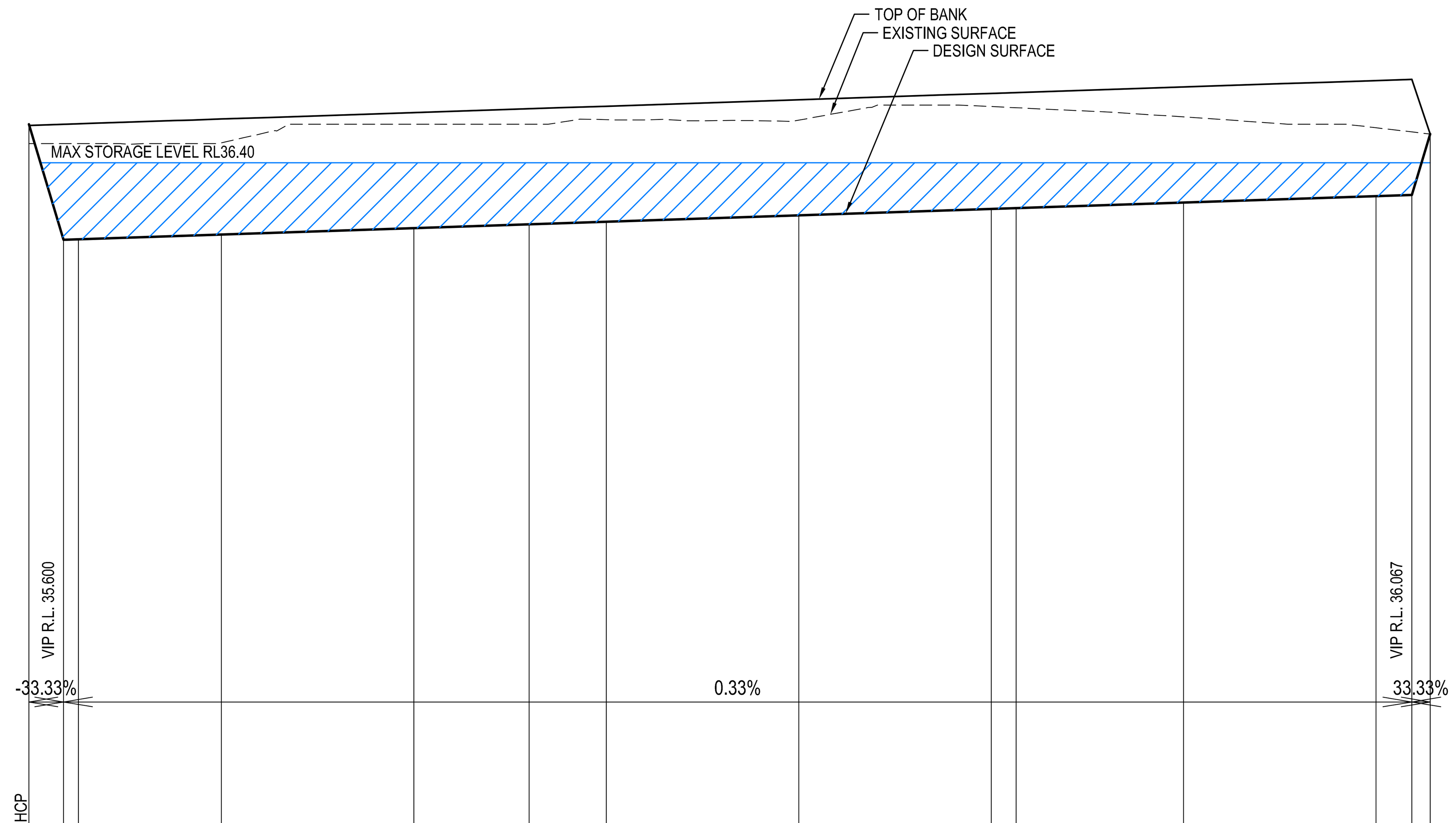


DETAIL PLAN - CHANNEL B

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DATUM 29.0

DESIGN LINE LEVEL	36.8	35.6	35.61	35.65	35.72	35.76	35.79	35.85	35.92	35.93	35.99	36.05	36.07	36.7
TOP OF BANK LEVEL		36.8	36.8	36.85	36.92	36.96	36.99	37.05	37.12	37.13	37.19	37.25		
EXISTING SURFACE LEVEL	36.6	36.6	36.6	36.61	36.8	36.8	36.85	36.84	36.98	36.97	36.88	36.76	36.72	36.7
CHAINAGE AT CENTRELINE	0	3.6	5.13	20	40	51.99	60	80	100	102.6	120	140	143.72	145.62

LONGITUDINAL SECTION - CHANNEL B

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
C	COUNCIL COMMENTS	S.Y	S.Y	R.F	04/12/2020
B	COUNCIL COMMENTS	S.Y	S.Y	R.F	01/09/2020
A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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DETAIL PLAN

SHEET 02 OF 10

Job: E8588.00
Drawing: C_06
Revision: D

Sheet : 06 of 14

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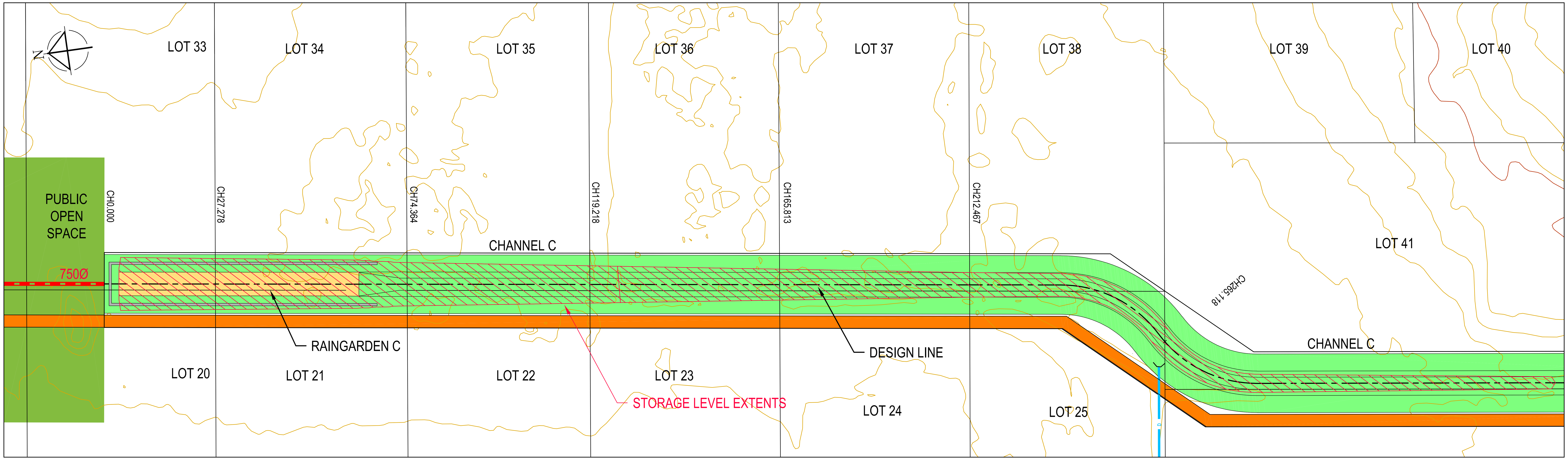
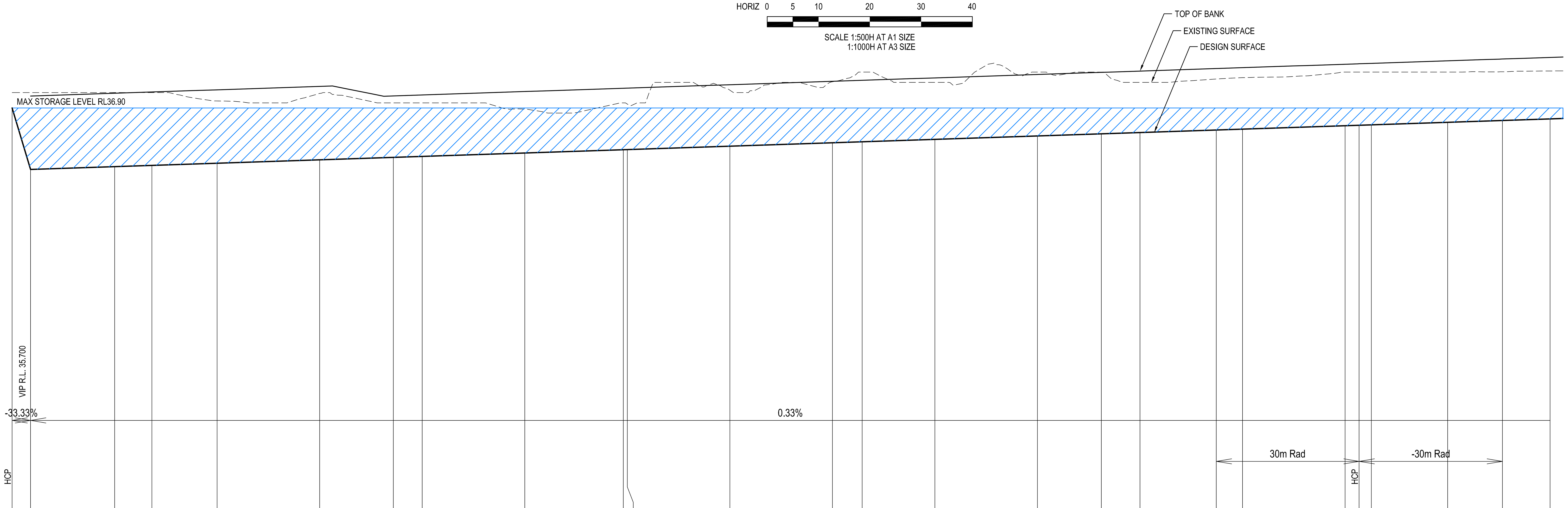


DETAIL PLAN - CHANNEL C

HORIZ 0 5 10 20 30 40
SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DESIGN GRADELINE
VERTICAL GEOMETRY
HORIZONTAL GEOMETRY

DATUM 29.0

DESIGN LINE LEVEL	36.9	35.7	35.75	35.78	35.82	35.89	35.94	35.95	36.02	36.09	36.09	36.15	36.22	36.24	36.29	36.35	36.4	36.42	36.47	36.49	36.55	36.56	36.57	36.62	36.66	36.69
TOP OF BANK LEVEL		37.13	37.19	37.21	37.25	37.32	37.14	37.15	37.22	37.29	37.29	37.35	37.42	37.44	37.49	37.55	37.6	37.62	37.67	37.69	37.75	37.76	37.77	37.82	37.86	37.89
EXISTING SURFACE LEVEL	37.2	37.2	37.2	37.2	37.04	37.18	37	37	36.88	37	36.98	37.25	37.41	37.6	37.4	37.6	37.6	37.4	37.47	37.49	37.6	37.6	37.6	37.6	37.61	37.62
CHAINAGE AT CENTRELINE	0	3.6	20	27.28	40	60	74.36	80	100	119.22	120	140	160	165.81	180	200	212.47	220	234.88	240	260	262.75	265.12	280	290.7	300

LONGITUDINAL SECTION - CHANNEL C

HORIZ 0 10 20 40 60 80
VERT 0 1 2 4 6 8
SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
C	COUNCIL COMMENTS	S.Y	S.Y	R.F	04/12/2020
B	COUNCIL COMMENTS	S.Y	S.Y	R.F	01/09/2020
A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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CLIENT:
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PROJECT:
COLLISON ESTATE
DRAINAGE STRATEGY

DETAIL PLAN
SHEET 03 OF 10

Job: E8588.00 Drawing: C_07 Revision: D
Sheet: 07 of 14
Scale: AS SHOWN @ A1 Municipality: CITY OF CASEY Melway Ref. 134F6

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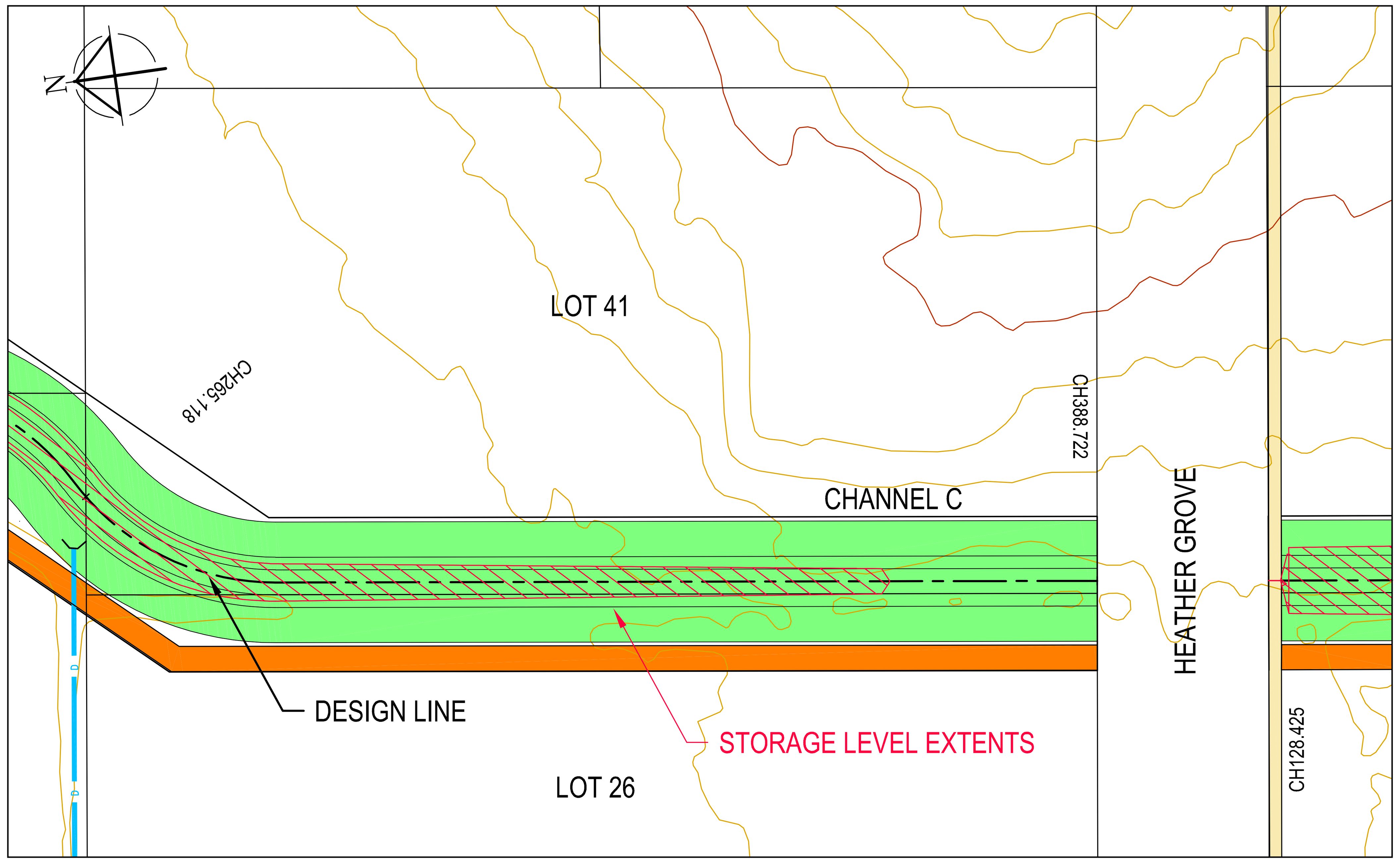
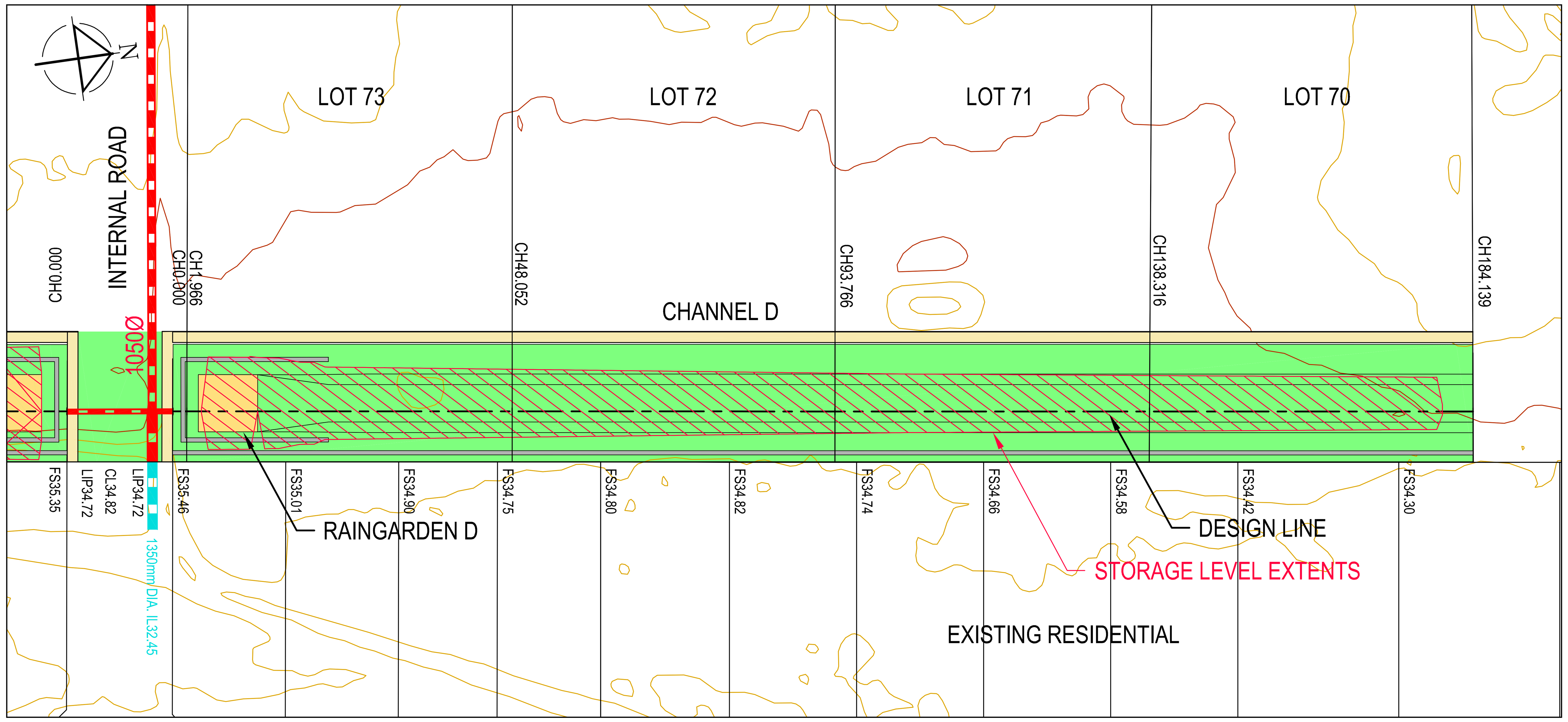


DETAIL PLAN - CHANNEL C

HORIZ 0 5 10 20 30 40

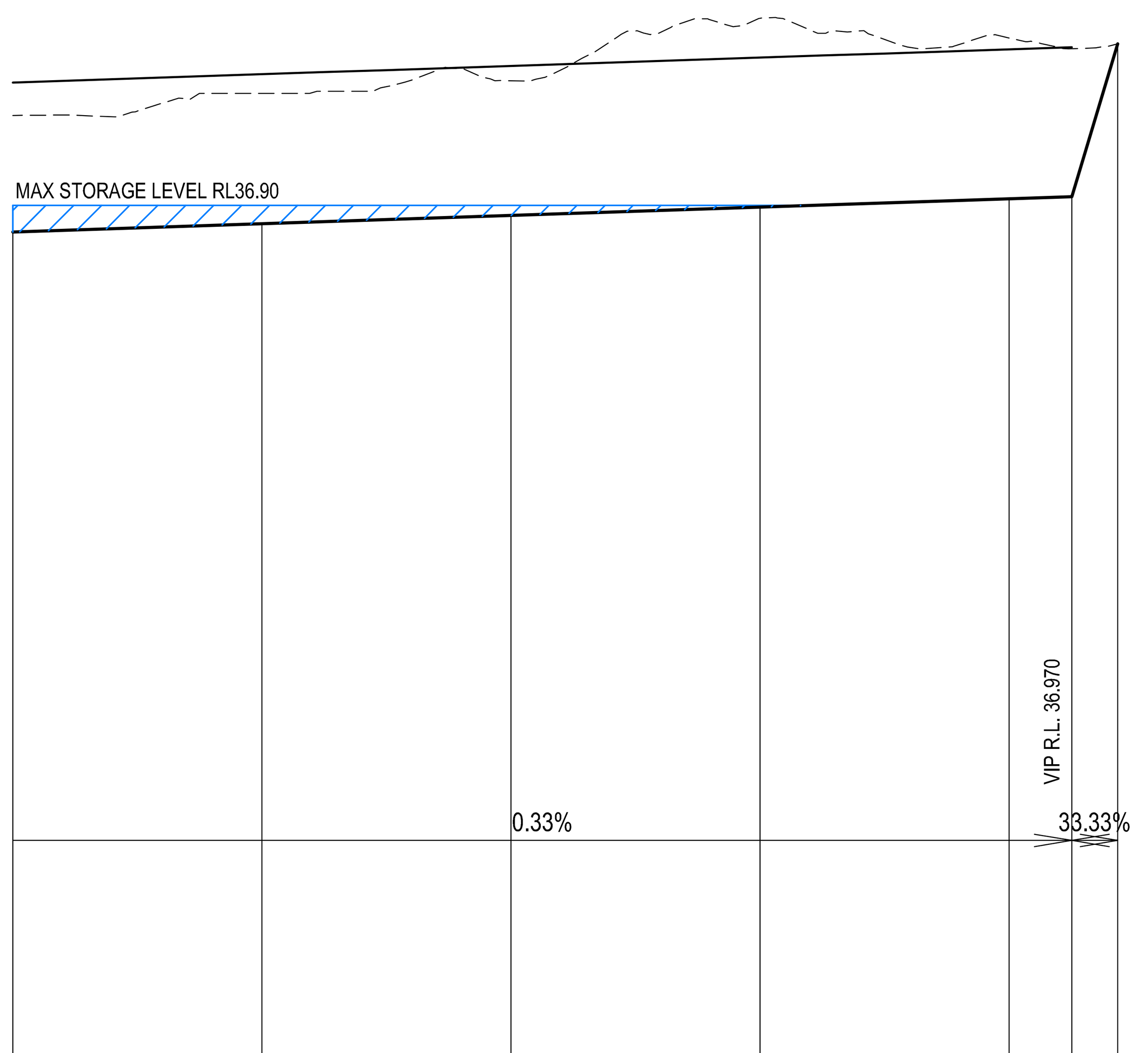
SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE

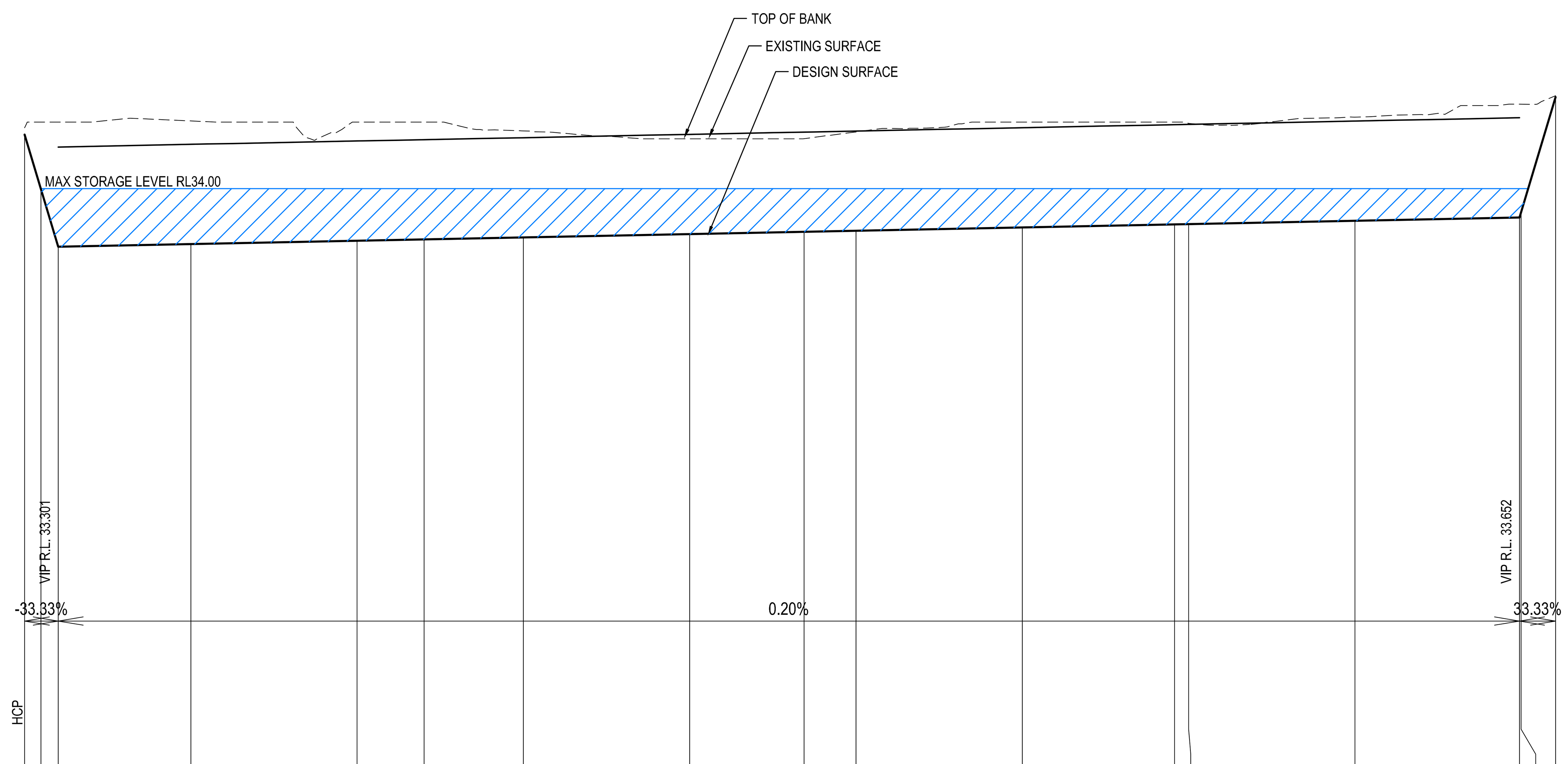


DETAIL PLAN - CHANNEL D

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE





DESIGN GRADELINE

VERTICAL GEOMETRY

HORIZONTAL GEOMETRY

DATUM 30.0

DESIGN LINE LEVEL	36.69	36.75	36.82	36.89	36.95	36.97	38.2
TOP OF BANK LEVEL	37.89	37.95	38.02	38.09	38.15		
EXISTING SURFACE LEVEL	37.62	37.8	37.9	38.4	38.24	38.16	38.2
CHAINAGE AT CENTRELINE	300	320	340	360	380	385.04	388.72

LONGITUDINAL SECTION - CHANNEL C

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

34.65	33.99	33.3	33.33	33.37	33.39	33.41	33.45	33.48	33.49	33.53	33.57	33.57	33.61	33.65	33.72	35.1
			34.53	34.57	34.59	34.61	34.65	34.68	34.69	34.73	34.77	34.77	34.81			
34.73	34.8	34.8	34.81	34.8	34.8	34.69	34.6	34.6	34.68	34.8	34.8	34.79	34.86	35.02	35.02	35.12
0	1.97	4.05	20	40	48.05	60	80	93.77	100	120	138.31	140	160	179.8	180	184.14

LONGITUDINAL SECTION - CHANNEL D

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
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DETAIL PLAN

SHEET 04 OF 10

Job: E8588.00 | Drawing: **C_08** | Revision: **D**

Sheet : 08 of 14

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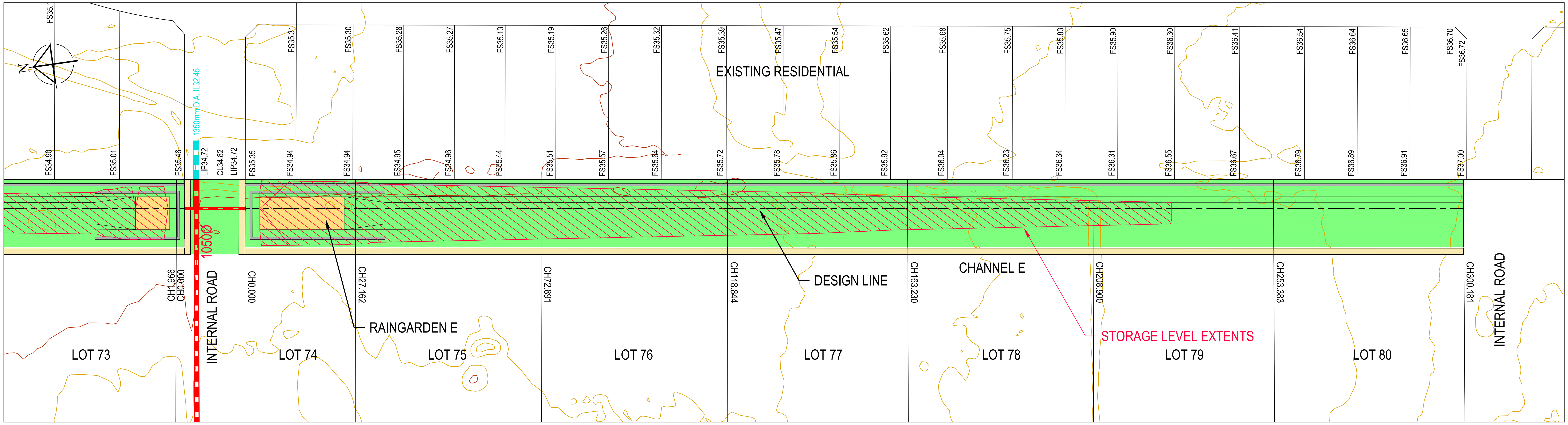
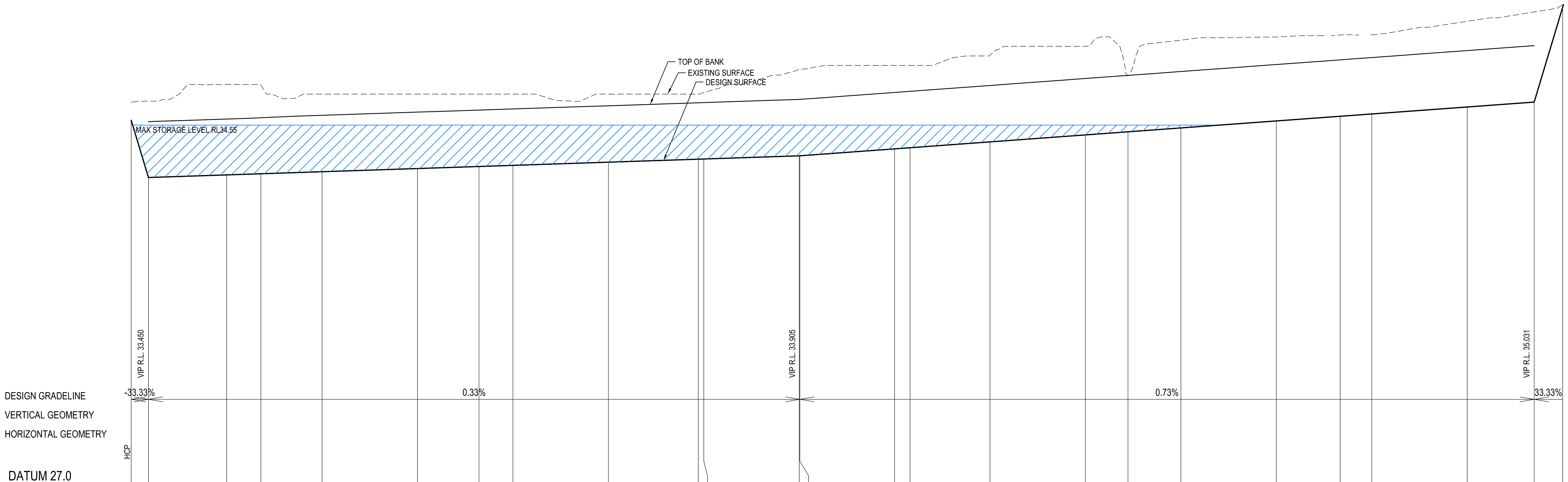


DETAIL PLAN - CHANNEL E

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DATUM 27.0

DESIGN LINE LEVEL	34.65	33.45	33.5	33.53	33.57	33.64	33.68	33.7	33.77	33.83	33.84	33.9	33.9	34.05	34.07	34.2	34.34	34.41	34.49	34.64	34.73	34.78	34.93	35.03	37.02
TOP OF BANK LEVEL		34.62	34.68	34.7	34.75	34.82	34.86	34.89	34.95	35.02	35.02	35.09	35.09	35.23	35.26	35.38	35.53	35.59	35.67	35.82	35.92	35.97	36.11		
EXISTING SURFACE LEVEL	35.03	35.05	35.4	35.39	35.2	35.2	35.2	35.2	35.2	35.2	35.23	35.71	35.72	35.8	35.8	36.01	36.2	35.6	36.33	36.4	36.44	36.44	36.73	36.92	37.07
CHAINAGE AT CENTRELINE	0	3.6	20	27.16	40	60	72.89	80	100	118.84	120	140	140.15	160	163.23	180	200	208.9	220	240	253.38	260	280	294.04	300

LONGITUDINAL SECTION - CHANNEL E

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

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PROJECT:
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DETAIL PLAN

SHEET 05 OF 10

Job: E8588.00 | Drawing: C_09 | Revision: D

Sheet : 09 of 14

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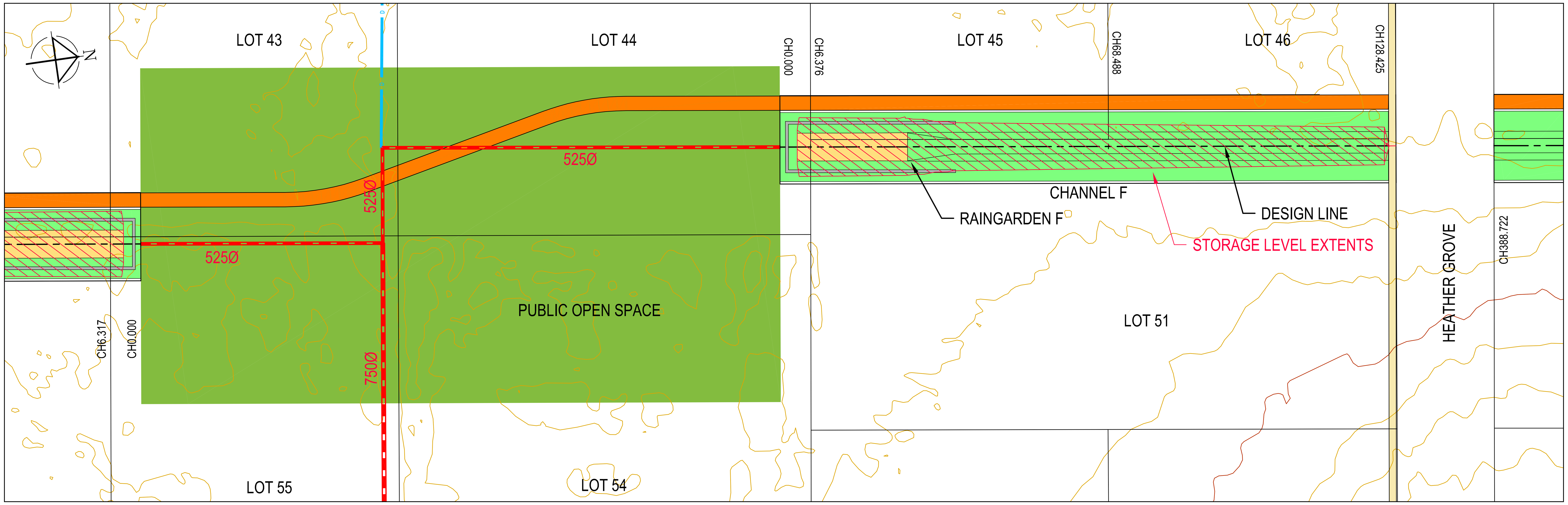
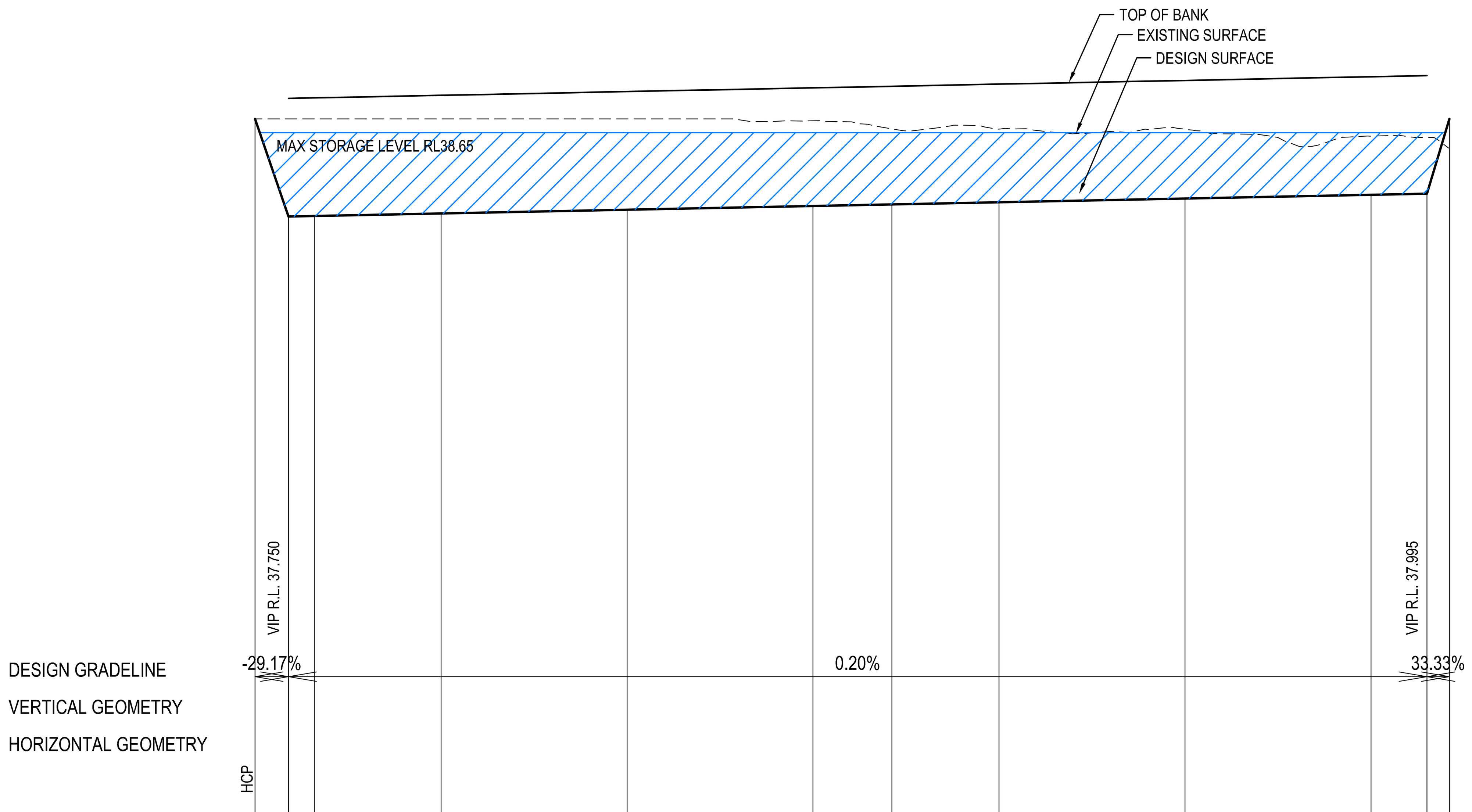


DETAIL PLAN - CHANNEL F

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DATUM 31.0

DESIGN LINE LEVEL	38.8	37.75	37.76	37.78	37.82	37.86	37.88	37.9	37.94	37.98	37.99	38.8
TOP OF BANK LEVEL		39.02	39.03	39.05	39.09	39.13	39.15	39.17	39.21	39.25		
EXISTING SURFACE LEVEL	38.8	38.8	38.8	38.8	38.8	38.78	38.69	38.69	38.69	38.61	38.6	38.48
CHAINAGE AT CENTRELINE	0	3.6	6.38	20	40	60	68.49	80	100	120	126.01	128.43

LONGITUDINAL SECTION - CHANNEL F

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
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PROJECT:
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DRAINAGE STRATEGY

DETAIL PLAN

SHEET 06 OF 10

Job: E8588.00 Drawing: C_10 Revision: D

Sheet: 10 of 14

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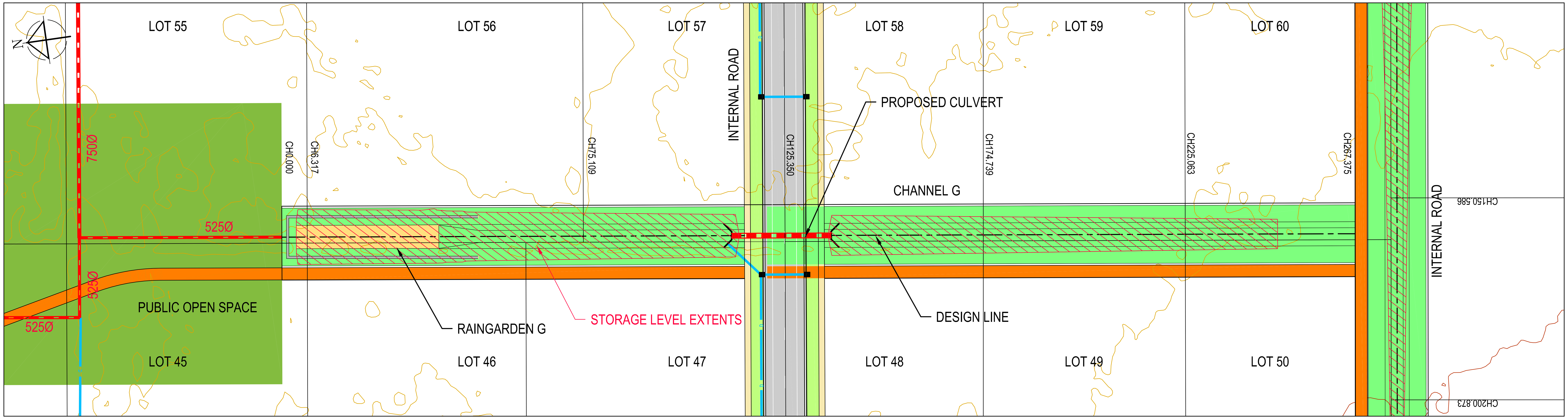
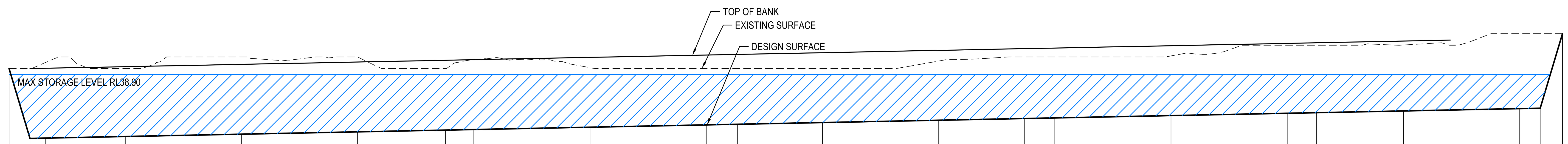


DETAIL PLAN - CHANNEL G

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DESIGN GRADELINE

VERTICAL GEOMETRY

HORIZONTAL GEOMETRY

HCP

DATUM 31.0

DESIGN LINE LEVEL	39	37.8	37.81	37.83	37.87	37.91	37.94	37.95	37.99	38.03	38.04	38.07	38.11	38.14	38.15	38.19	38.23	38.24	38.27	38.31	38.32	39.6
TOP OF BANK LEVEL		39	39.01	39.03	39.07	39.11	39.14	39.15	39.19			39.27	39.31	39.34	39.35	39.39	39.43	39.44	39.47			
EXISTING SURFACE LEVEL	39	39	39.11	39	39.2	39.2	39	39.16	39.02	39	39	39	39.13	39.2	39.2	39.22	39.4	39.4	39.4	39.6	39.6	39.6
CHAINAGE AT CENTRELINE	0	3.6	6.32	20	40	60	75.11	80	100	120	125.35	140	160	174.74	180	200	220	225.06	240	260	263.53	267.38

LONGITUDINAL SECTION - CHANNEL G

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
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DETAIL PLAN

SHEET 07 OF 10

Job: E8588.00
Drawing: C_11
Revision: D

Sheet: 11 of 14

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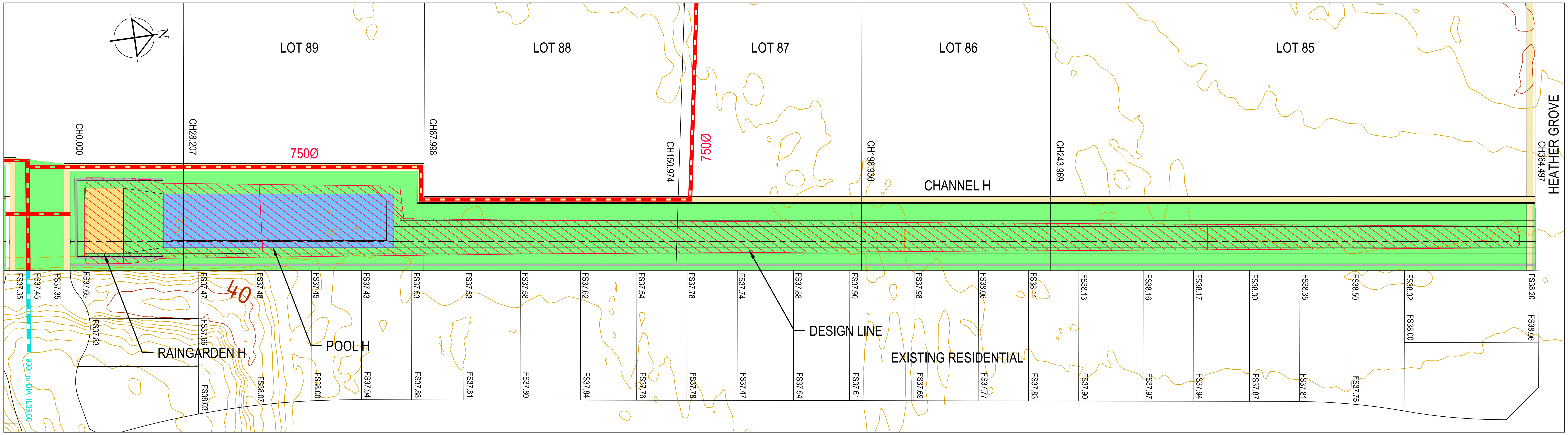
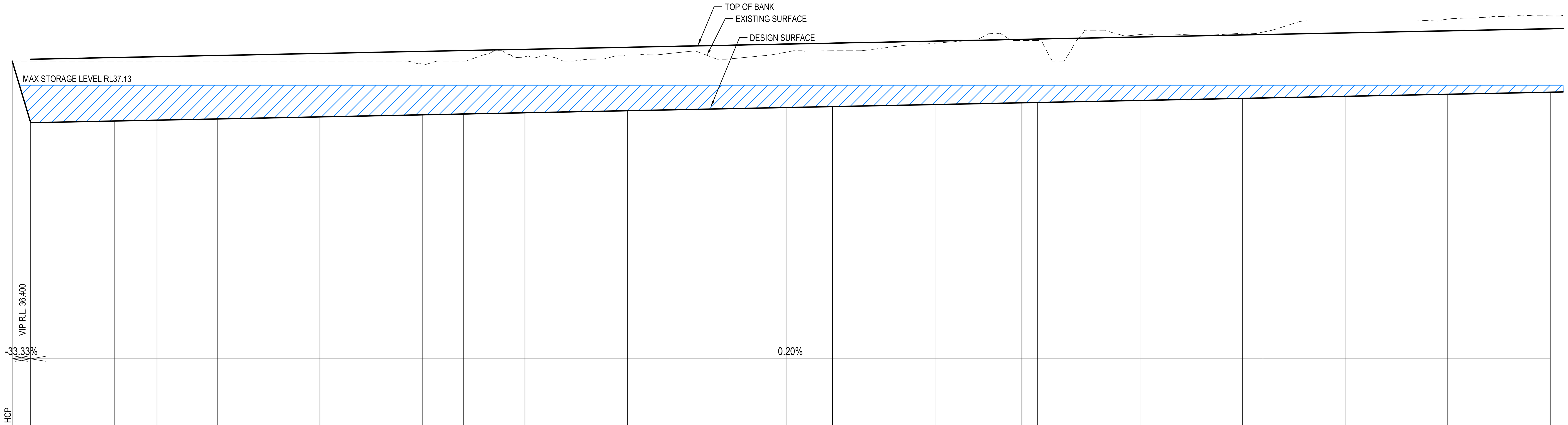


DETAIL PLAN - CHANNEL H

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DESIGN GRADELINE
VERTICAL GEOMETRY
HORIZONTAL GEOMETRY

DATUM 30.0

DESIGN LINE LEVEL	37.6	36.4	36.43	36.45	36.47	36.51	36.55	36.57	36.59	36.63	36.67	36.69	36.71	36.75	36.79	36.79	36.83	36.87	36.88	36.91	36.95	36.99
TOP OF BANK LEVEL		37.64	37.67	37.69	37.71	37.75	37.79	37.8	37.83	37.87	37.91	37.93	37.95	37.99	38.02	38.03	38.07	38.11	38.12	38.15	38.19	38.23
EXISTING SURFACE LEVEL	37.6	37.6	37.6	37.6	37.6	37.6	37.55	37.6	37.68	37.72	37.64	37.77	37.8	37.95	38	38	38.12	38.14	38.16	38.4	38.42	38.48
CHAINAGE AT CENTRELINE	0	3.6	20	28.21	40	60	80	88	100	120	140	150.96	160	180	196.93	200	220	240	243.97	260	280	300

LONGITUDINAL SECTION - CHANNEL H

HORIZ 0 10 20 40 60 80
VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
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DETAIL PLAN
SHEET 08 OF 10

Job: E8588.00 | Drawing: C_12 | Revision: D

Sheet: 12 of 14 | Scale: AS SHOWN @ A1 | Municipality: CITY OF CASEY | Melway Ref. 134F6

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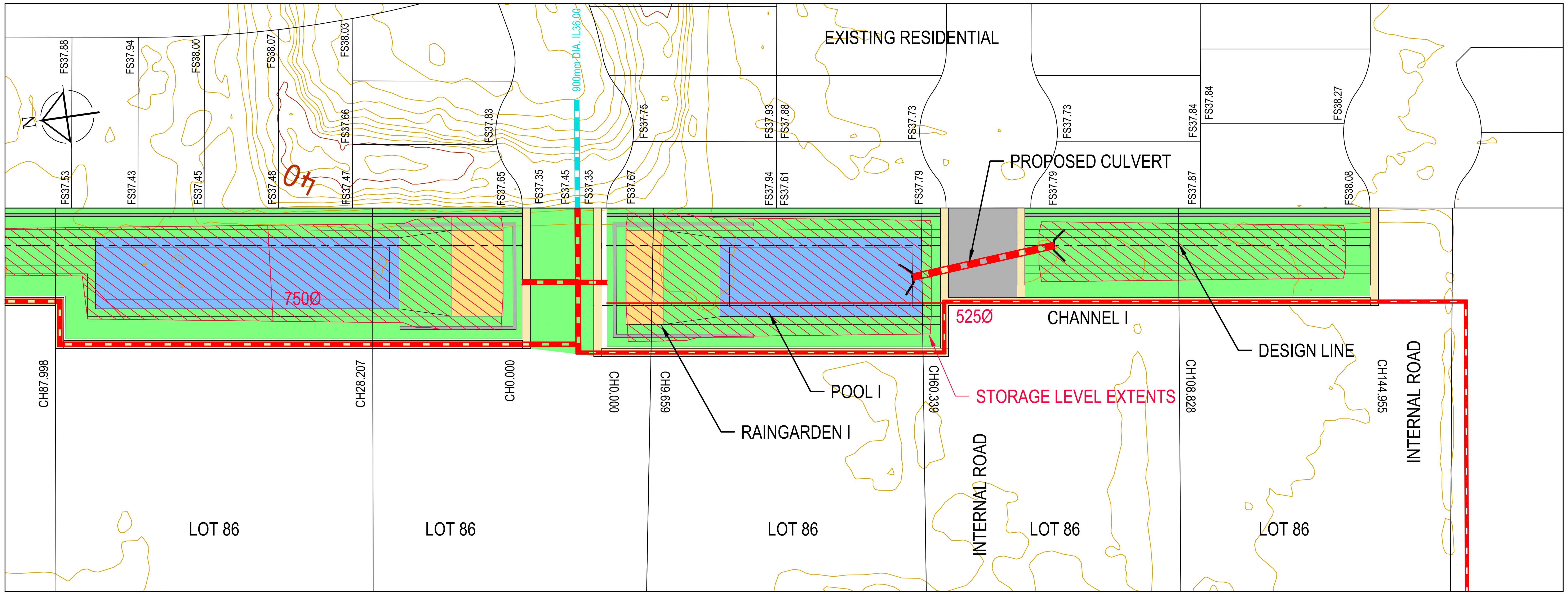
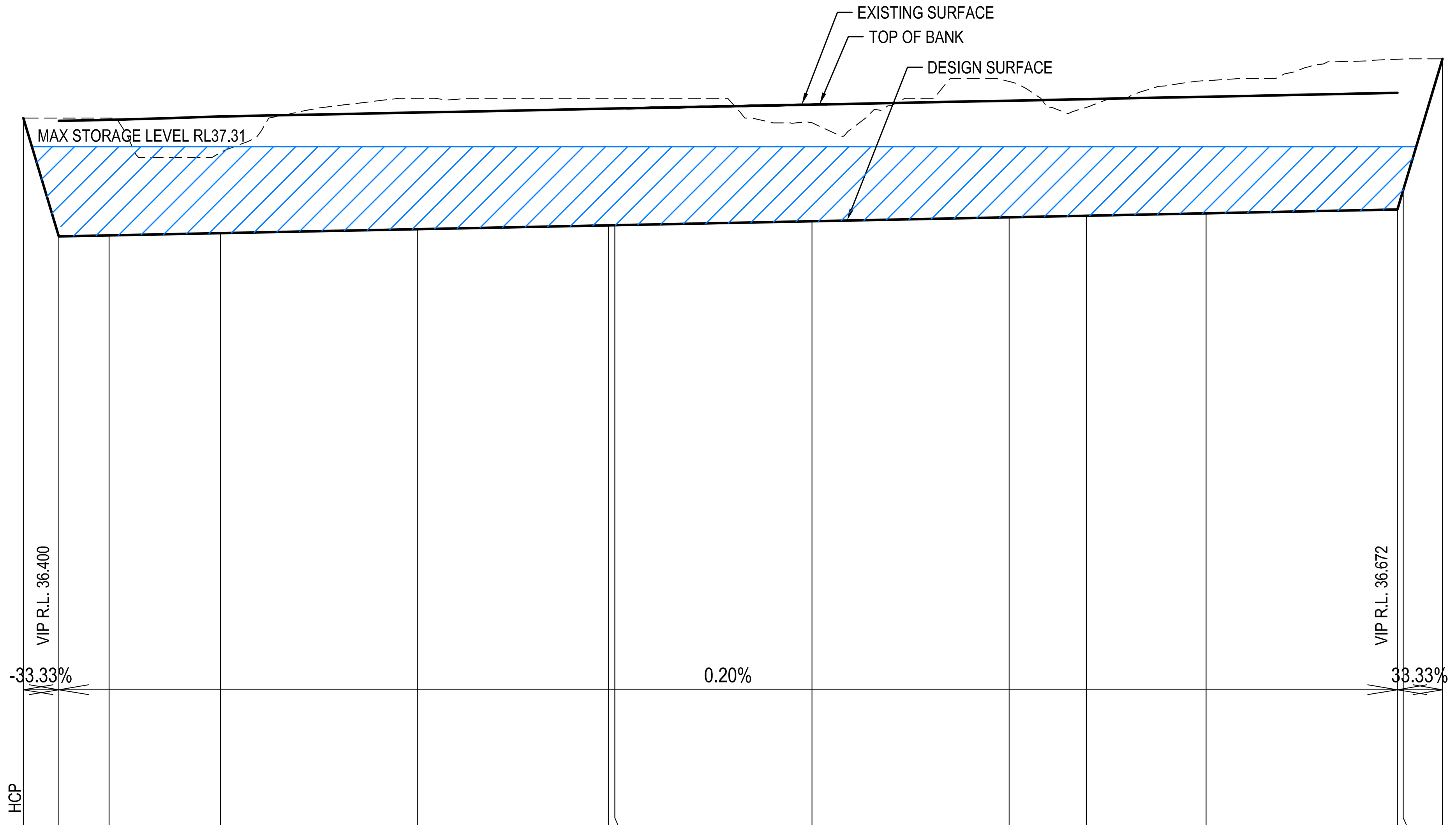


DETAIL PLAN - CHANNEL I

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DESIGN GRADELINE
VERTICAL GEOMETRY
HORIZONTAL GEOMETRY

DATUM 30.0

DESIGN LINE LEVEL	37.6	36.4	36.41	36.43	36.47	36.51	36.51	36.55	36.59	36.61	36.63	36.67	36.87	38.2
TOP OF BANK LEVEL		37.57	37.58	37.62	37.66	37.69	37.7		37.78	37.79	37.82			
EXISTING SURFACE LEVEL	37.6	37.6	37.6	37.25	37.8	37.8	37.8	37.55	37.97	37.71	37.98	38.2	38.2	38.2
CHAINAGE AT CENTRELINE	0	3.6	8.69	20	40	59.36	60	80	100	107.85	120	139.4	140	143.98

LONGITUDINAL SECTION - CHANNEL I

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
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DETAIL PLAN

SHEET 09 OF 10

Job: E8588.00
Drawing: C_13
Revision: D

Sheet : 13 of 14

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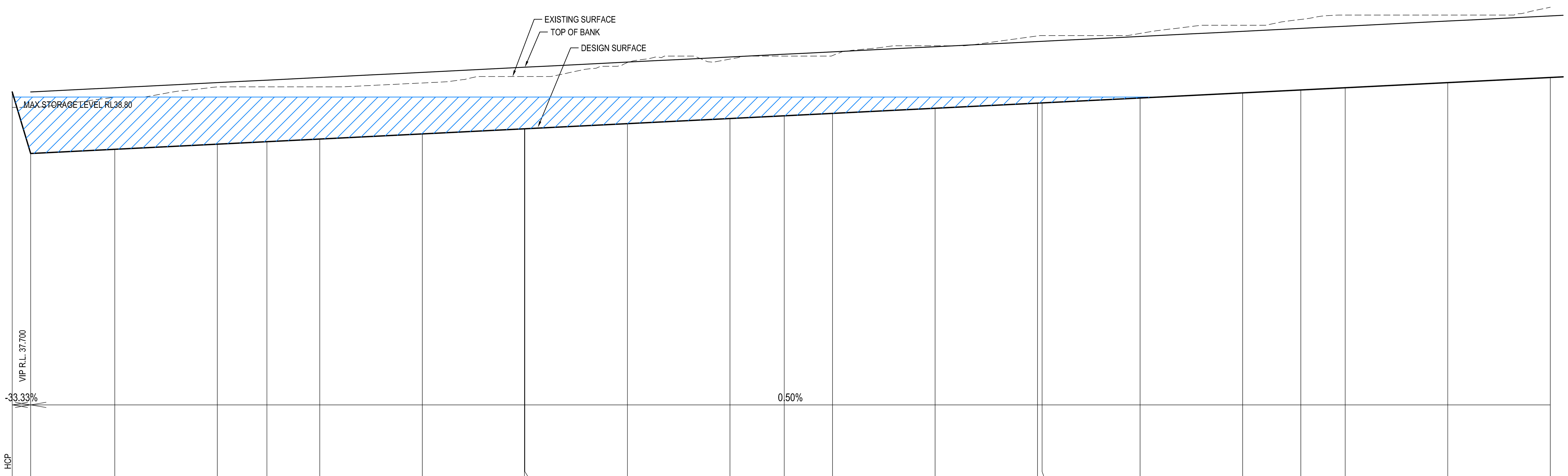
DETAIL PLAN - CHANNEL J

HORIZ 0 5 10 20 30 40

SCALE 1:500H AT A1 SIZE
1:1000H AT A3 SIZE



DESIGN GRADELINE
VERTICAL GEOMETRY
HORIZONTAL GEOMETRY

DATUM 31.0

DESIGN LINE LEVEL	38.9	37.7	37.78	37.88	37.93	37.98	38.08	38.18	38.18	38.28	38.38	38.43	38.48	38.58	38.68	38.69	38.78	38.88	38.94	38.98	39.08	39.18
TOP OF BANK LEVEL		38.9	38.98	39.08	39.13	39.18	39.28	39.38	39.38	39.48	39.58	39.64	39.68	39.78	39.88	39.89	39.98	40.08	40.14	40.18	40.28	40.38
EXISTING SURFACE LEVEL	38.6	38.6	38.8	39	39	39	39.08	39.2	39.2	39.47	39.54	39.6	39.61	39.8	39.99	40	40.04	40.2	40.31	40.4	40.4	40.55
CHAINAGE AT CENTRELINE	0	3.6	20	40	49.68	60	80	99.91	100	120	140	150.6	160	180	200	200.88	220	240	251.33	260	280	300

LONGITUDINAL SECTION - CHANNEL J

HORIZ 0 10 20 40 60 80

VERT 0 1 2 4 6 8

SCALE 1:1000H 1:100V AT A1 SIZE
1:2000H 1:200V AT A3 SIZE

Rev	Reason	Drawn.	Des.	Chk.	Date
D	COUNCIL COMMENTS	S.Y	S.Y	R.F	02/03/2021
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A	PRELIMINARY ISSUE	S.Y.	S.Y.	R.F.	17/05/2020

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PROJECT:
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DRAINAGE STRATEGY

DETAIL PLAN

SHEET 10 OF 10

Job: E8588.00
Drawing: C_14
Revision: D

Sheet : 14 of 14
Scale : AS SHOWN @ A1
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Melway Ref. 134F6

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Appendix E

Neighbouring Estate Plans

LEGEND

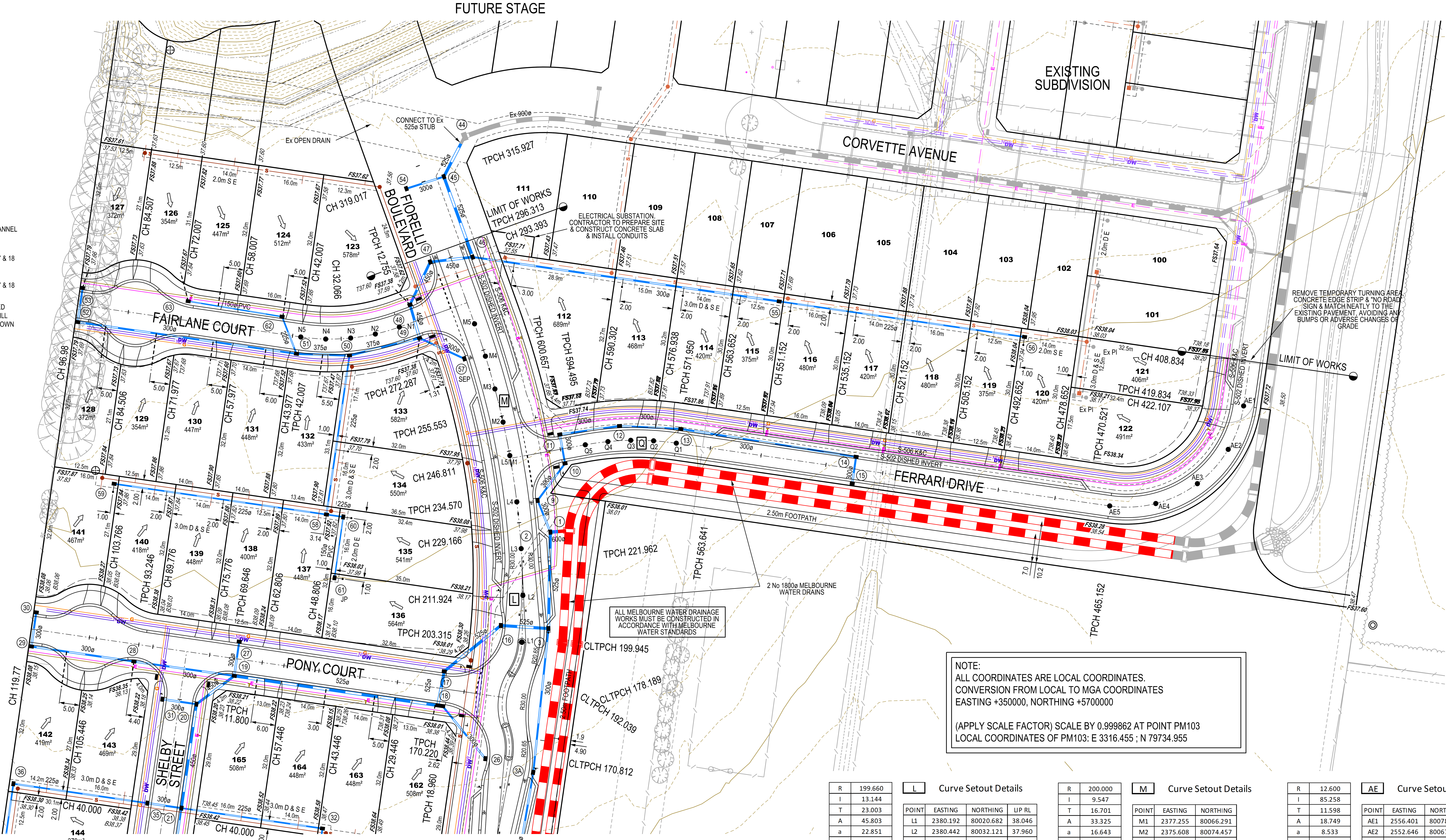
KERB TYPES

S-502-D1 = DISHED INVERT
S-506-BK&C = BARRIER KERB & CHANNEL

200-400mm FILL
REFER TO NOTES 17 & 18

> 400mm FILL
REFER TO NOTES 17 & 18

ALL OTHER AREAS WHERE FINISHED SURFACE LEVELS ARE SHOWING FILL ARE TO BE GRADED TO LEVELS SHOWN



NOTE:
ALL COORDINATES ARE LOCAL COORDINATES.
CONVERSION FROM LOCAL TO MGA COORDINATES
EASTING +350000, NORTHING +5700000

(APPLY SCALE FACTOR) SCALE BY 0.999862 AT POINT PM103
LOCAL COORDINATES OF PM103: E 3316.455 ; N 79734.955

SERVICE OFFSET TABLE

Location	Water	ND-Water	Gas	NBN	Elec	Sewer	BOK
FIORELLI BOULEVARD	3.10 W 4.30 W	2.60 W 3.70 W	2.10 W 3.10 W	2.10 E 4.90 W	2.60 E 5.50 W	1.00 W	7.13 W VARIES 6.0 E
FERRARI DRIVE	2.80 N&W	2.30 N&W	1.85 N&W	3.40 N&W	4.00LV N&W 4.60HV N&W	-	4.4 N 1.0 S
FAIRLANE COURT	3.10 S	2.60 S	2.10 S	2.10 N	2.60 N	1.00 S	4.2 N 1.5 S
PONY COURT	3.10 N	2.60 N	2.10 N	2.10 S	2.60 S	-	4.2 N 4.2 S
SHELBY STREET	3.10 W	2.60 W	2.10 W	2.10 E	2.60 E	-	4.2 W 4.2 E
DODGE TERRACE	3.10 N	2.60 N	2.10 N	0.40 S	0.90 S	-	4.35 N 2.5 S

NOTE: OFFSETS ARE FROM ROAD RESERVE BOUNDARY

L Curve Setout Details

R	199.660
I	13.144
T	23.003
A	45.803
a	22.851
b	1.312
c	11.445
d	0.328

POINT	EASTING	NORTHING	LIP RL
L1	2380.192	80020.682	38.046
L2	2380.442	80032.121	37.960
L3	2380.037	80043.555	37.873
L4	2378.978	80054.948	37.787
L5	2377.268	80066.261	37.700

M Curve Setout Details

R	200.000
I	9.547
T	16.701
A	33.325
a	16.643
b	0.694
c	8.329
d	0.174

POINT	EASTING	NORTHING
M1	2377.255	80066.291
M2	2375.608	80074.457
M3	2373.622	80082.547
M4	2371.301	80090.547
M5	2368.648	80098.444

AE Curve Setout Details

R	12.600
I	85.258
T	11.598
A	18.749
a	8.533
b	3.329
c	4.580
d	0.862

POINT	EASTING	NORTHING
AE1	2556.401	80078.407
AE2	2552.646	80067.795
AE3	2545.115	80059.428
AE4	2534.956	80054.579
AE5	2523.715	80053.988

N Curve Setout Details

R	50.000
I	27.997
T	12.465
A	24.432
a	12.095
b	1.485
c	6.093
d	0.373

POINT	EASTING	NORTHING
N1	2350.293	80097.664
N2	2344.434	80095.955
N3	2338.408	80094.972
N4	2332.309	80094.732
N5	2326.226	80095.236

Q Curve Setout Details

R	69.850
I	18.493
T	11.371
A	22.545
a	11.224
b	0.908
c	5.630
d	0.227

POINT	EASTING	NORTHING
Q1	2417.906	80069.306
Q2	2412.357	80069.882
Q3	2406.780	80070.009
Q4	2401.211	80069.685
Q5	2395.687	80068.914

Rev	Description	Date	By	App
E	BATTER LEVELS ADDED TO BLOCKS	06.08.12	JM	LH
D	CROSSOVERS & WATER CONNECTIONS AMENDED	10.07.12	JM	LH
C	TGSIS ALTERED, CONNECTIONS ALTERED	04.03.11	JM	LH
B	GAS & ELECTRICITY OFFSET ALTERED - FERRARI	18.02.11	JM	LH
A	ISSUED FOR CONSTRUCTION	23.11.10	JM	LH

Rev	Description	Date	By	App
H	AS CONSTRUCTED	09.12.16	LH	LH
G	DRIVEWAYS TO LOTS 126, 129 & 140 AMENDED	13.02.15	LH	LH
F	AMENDED INTERSECTION PONY CT/FIORELLI BVD	14.08.14	RH	LH

0 5 10 20 30 40 50

Designed R.HABEL
Date 25.07.14
Drawn C.KIRKCALDY
Approved L.HADDON
Date APPDT
PS Number PS

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Project Details: BROOKFORD ESTATE, STAGE 1C
NEW AGE REAL ESTATE PTY LTD
CITY OF CASEY

Drawing Title: LAYOUT PLAN
1 OF 2

Scale 1:500 @ A1

Project Ref	Stage No	Drawing No	Rev
5211	1C	R 101	H

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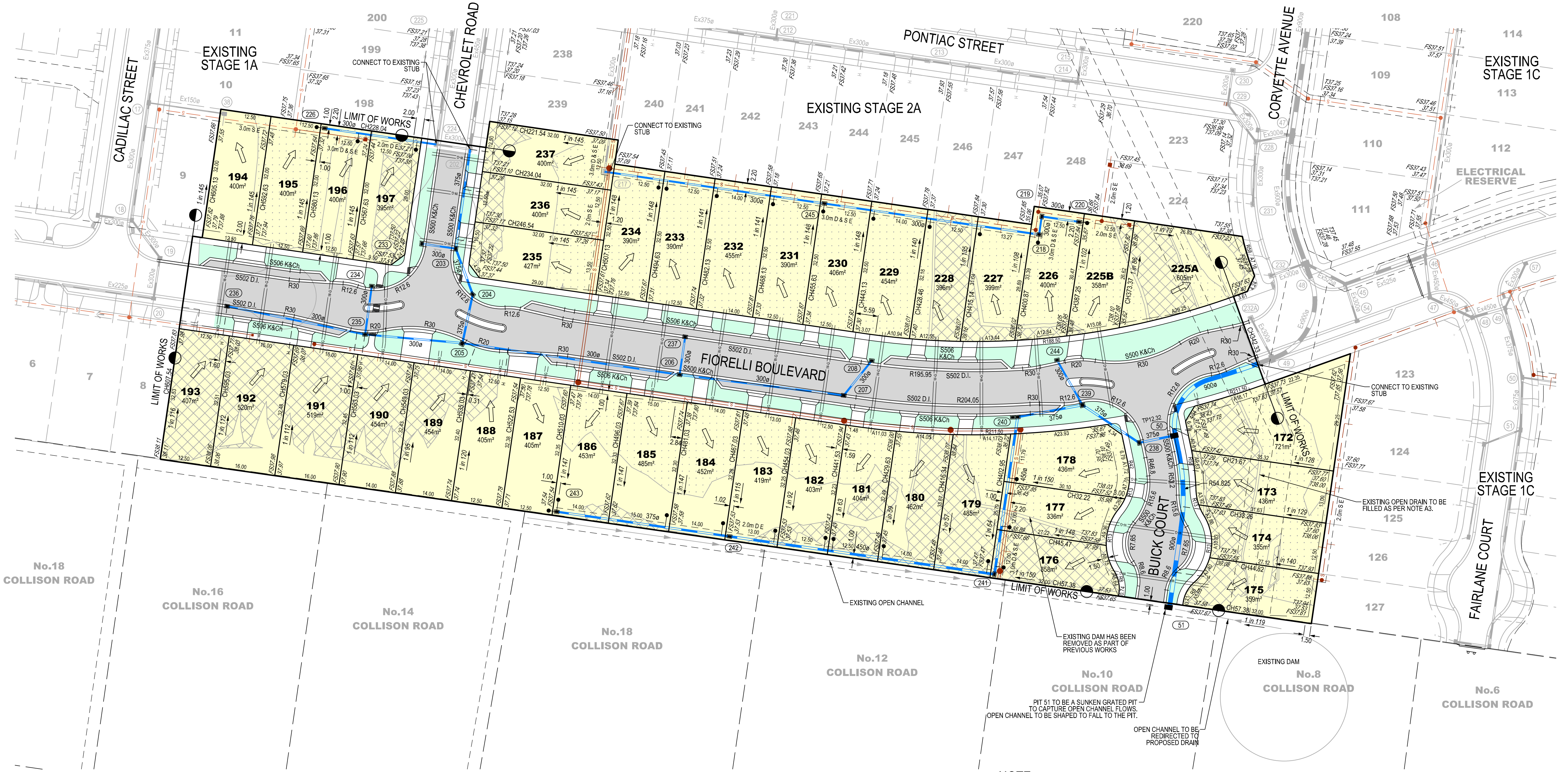

NOTE

PERMISSION TO ACCES LOTS TO BE OBTAINED PRIOR TO COMMENCING WORKS WITHIN NEIGHBOURING PROPERTY

LEGEND

- PROPOSED DRAINAGE (PROPERTY INLETS, PIT)
- MELBOURNE WATER DRAINAGE
- EXISTING DRAINAGE
- HOUSE CONNECTION (H)
- PROPOSED SEWERAGE (MH, IS, MS)
- EXISTING SEWERAGE
- WATER/NDW WATER/GAS/ELEC/NBN MAINS
- EXISTING WATER/NDW WATER/GAS/ELEC/NBN MAINS
- LIGHT POLES
- EXTENT OF CUT & FILL
- BATTER SLOPE
- PERMANENT SURVEY MARK (PSM)
- STREET SIGN
- TACTILE GROUND SURFACE INDICATORS
- TREES TO BE REMOVED
- LOT RUNOFF DIRECTION
- EXISTING SURFACE LEVEL (8.00)
- FINISHED SURFACE LEVEL (FS7.98)
- TOP OF BATTER LEVEL (T7.75)
- FILL AREA > 200mm
- CUT AREA
- FEATURE PAVING

SERVICE OFFSET TABLE

Location	Water	ND-Water	Gas	NBN	Elec	Sewer	BOK
FIORELLI BOULEVARD	3.80 W	2.90 W	2.10 W	2.10 E	2.60 E	1.00 W	4.55 W 4.55 E
CHEVROLET ROAD	3.10 N	2.60 N	2.10 N	1.80 S	2.45 S	-	4.2 N 4.2 S
BUICK COURT	3.10 N	2.60 N	2.10 N	1.00 S	1.85 S	-	4.2 N 4.2 S

NOTE: OFFSETS ARE FROM ROAD RESERVE BOUNDARY

Rev	Description	Date	By	App
E	AMENDED PARKING BAY OUTSIDE LOT 172	06.04.16	RH	RH
D	DRAINAGE LINE 240 - 243 UPDATED	11.02.16	LH	LH
C	BUICK COURT REGRADED	20.01.16	LH	LH
B	FRONT OF LOT BATTERS ADDED	02.07.15	RH	LH
A	AMENDED AS PER COUNCIL COMMENTS	10.06.15	RH	LH

Rev	Description	Date	By	App
G	AS CONSTRUCTED	08.09.16	RH	LH
F	LOT 179, 181, 182 & 184 DRIVEWAYS SHIFTED	14.04.16	LH	LH

0 5 10 20 30 40 50

Designed: R.HABEL
Date
Drawn: L.SUTHERLAND
Approved: L.HADDON
Date: APPDT
PS Number: PS738243H

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Project Details: BROOKFORD ESTATE, STAGE 2B
NEW AGE REAL ESTATE PTY LTD
CITY OF CASEY

Drawing Title: LAYOUT PLAN

Scale: 1:500 @ A1

Project Ref	Stage No	Drawing No	Rev
5211	2B	R 101	G

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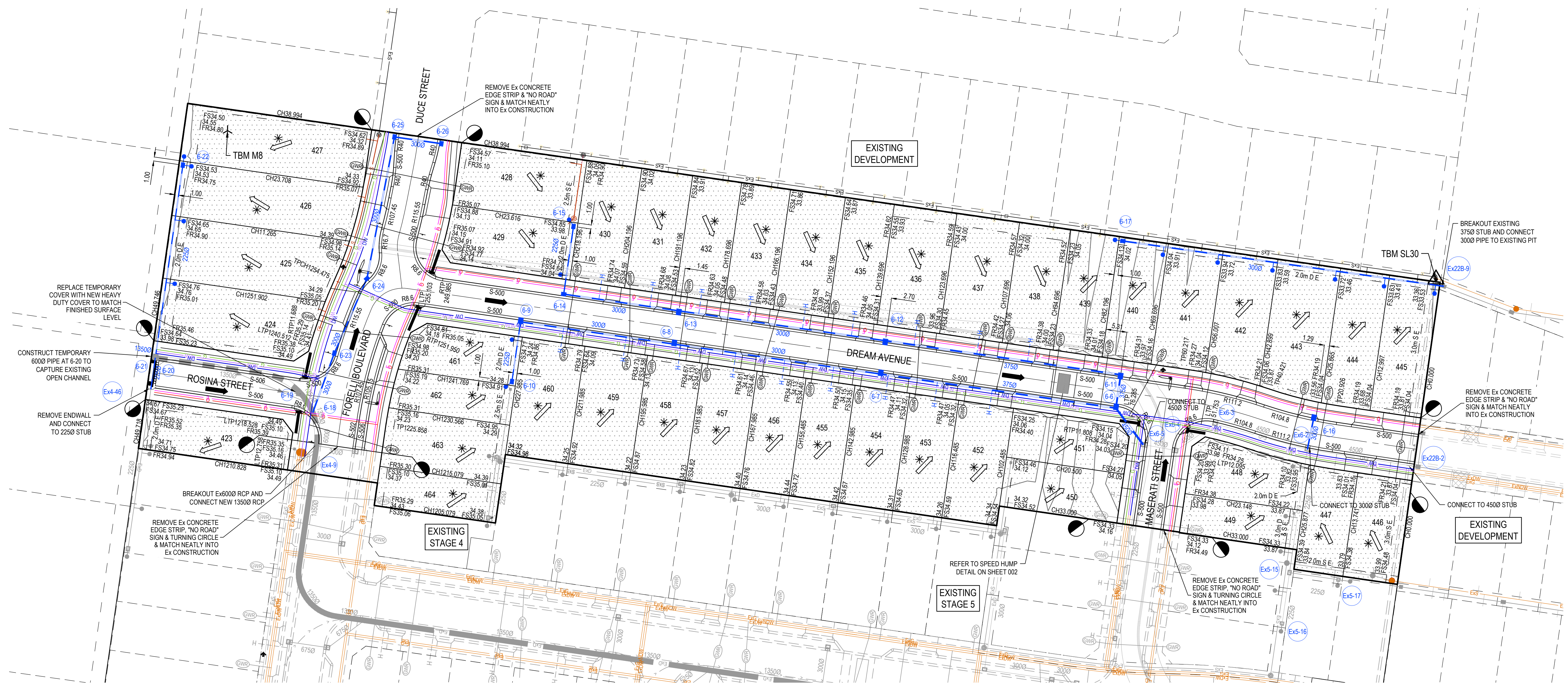

SERVICE OFFSET TABLE

Location	Gas		ND - Water		Water		Electricity		Telecommunication		Sewer	
	Side	Offset (m)	Side	Offset (m)	Side	Offset (m)	Side	Offset (m)	Side	Offset (m)	Side	Offset (m)
FIORELLI BOULEVARD	W	2.10	W	2.90	W	3.80	E	2.60	E	2.10	W	1.00
MASERATI STREET	W	2.10	W	2.60	W	3.10	E	2.60	E	2.10	-	-
DREAM AVENUE	S	1.90	S	2.40	S	2.90	N	2.30	N	1.80	-	-
ROSINA STREET	N	2.10	N	2.60	N	3.10	S	2.60	S	2.10	-	-
DUCE STREET	W	3.30	W	3.80	W	4.30	E	2.50	E	2.00	W	1.90

NOTE: STREET TREES ARE TO BE PLANTED IN THE CENTRE OF ALL NATURE STRIPS

TBM SCHEDULE

TBM	EASTING	NORTHING	LEVEL	DESCRIPTION
M8	2425.68	81102.79	34.260	STEEL PICKET
SL30	2731.24	81065.20	33.520	RIVET IN S/PIT
PM786	2716.27	80941.42	34.060	BRASS PLAQUE

WARNING
BEWARE OF UNDERGROUND SERVICES
The locations of underground services are approximate only and their exact position should be proven on site.
No guarantee is given that all existing services are shown.
Locate all underground services before commencement of works
DIAL 1100 BEFORE YOU DIG
www.1100.com.au

ROAD LAYOUT TABLE

Road Name	Reserve Width (m)	Road Width (m)			Kerb Type		Verge Width (m)	
		Lip to Lip	Inv to Inv	Back to Back	Nth/West	Sth/East	Nth/West	Sth/East
FIORELLI BOULEVARD	23.00	8.10 / 12.70	9.00 / 13.60	9.30 / 13.90	S-502 / S-506	S-502 / S-506	6.85 / 4.55	6.85 / 4.55
MASERATI STREET	16.00	6.40	7.30	7.60	S-500	S-500	4.20	4.20
DREAM AVENUE	16.00	6.40	7.30	7.60	S-500	S-500	4.20	4.20
ROSINA STREET	15.00	6.40	7.30	7.60	S-500	S-500	4.20	3.20

ISSUED FOR CONSTRUCTION

LEGEND - LAYOUT PLAN

- STORMWATER DRAIN, PIT & PROPERTY INLET
- MELBOURNE WATER DRAIN & PIT
- SWALE DRAIN
- S — SEWER & MAINTENANCE STRUCTURES
- H — HOUSE DRAIN
- GW — SERVICE CONDUITS
- E — ELECTRICITY (UNDERGROUND)
- O/H E — ELECTRICITY (OVERHEAD)
- O — OPTIC FIBRE
- T — TELECOMMUNICATIONS
- G — GAS
- DW — WATER
- NDW — RECYCLED WATER
- Ex D — EXISTING STORMWATER DRAIN
- ExE — EXISTING ELECTRICITY (UNDERGROUND)
- ExO/H E — EXISTING ELECTRICITY (OVERHEAD)
- ExG — EXISTING GAS
- ExO — EXISTING OPTIC FIBRE
- ExT — EXISTING TELECOMMUNICATIONS
- ExDW — EXISTING WATER
- ExNDW — EXISTING RECYCLED WATER
- Ex S — EXISTING SEWER
- H — EXISTING HOUSE DRAIN
- EXISTING SWALE DRAIN
- TACTILE PAVERS (INDICATIVE ONLY)
- 141.34 EXISTING SURFACE LEVEL
- FS140.35 FINISHED BUILDING LINE LEVEL
- FR157.40 FINISHED RIDGE LINE LEVEL
- TW159.30 TOP OF RETAINING WALL
- BW159.30 BOTTOM OF RETAINING WALL
- RIDGE LINE
- RETAINING WALL
- ZERO LOT LINES
- PAVEMENT TREATMENT
- STRUCTURAL FILL > 200mm DEEP
- EX. STRUCTURAL FILL > 200mm DEEP
- DIRECTION OF FALL
- OVERLAND FLOW
- ALLOTMENT TO BE GRADED EVENLY IN DIRECTION OF FALL TO LEVELS INDICATED
- CONCRETE EDGE STRIP WITH SUBSOIL DRAIN, "NO ROAD" SIGN & BARRIER
- LIMIT OF WORKS
- EXISTING TREE TO BE REMOVED
- PERMANENT SURVEY MARK
- TEMPORARY BENCH MARK
- PROPOSED DRIVEWAY

Rev	Description	Date		
B	DRIVEWAYS AMENDED FOR LOTS 444 TO 447	08.03.19	LS	LH
A	ISSUED FOR CONSTRUCTION	21.02.19	LS	LH

0 5 10 20 30 40 50

Designed R.HABEL
Date 05.07.16
Drawn L.SUTHERLAND
Approved L.HADDON
Date 21.02.19
PS Number PS820079L

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Project Details BROOKFORD ESTATE - STAGE 6
LOAN MINDER PTY LTD
CITY OF CASEY

Drawing Title LAYOUT PLAN

Scale 1:500 @ A1

N

Project Ref	Stage No	Drawing No	Rev
5211	06	010	B

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Rev	Amendments	App'd	Date
F	EXTRA DRIVEWAY ADDED TO LOT 410 & RESERVE NO.3 WIDTH REVISED TO 8.0M	T.P.	18/12/07
E	DRIVEWAY POSITION ON LOTS 518 AND 519 RELOCATED & SUBSTATION ADDED	T.P.	05/12/07
D	SEWER ALIGNMENT REVISED	T.P.	12/11/07
C	REVISED AS PER COUNCILS LETTER DATED 27 JULY 2007	T.P.	21/08/07
B	TENDER ISSUE	T.P.	19/07/07
A	ISSUED TO COUNCIL	T.P.	03/07/07

WARNING
BEWARE OF UNDERGROUND SERVICES
THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

REFER 131761R03 FOR CONTINUATION

Designed
Checked
Authorised

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file location G:\13\131761\ACAD
plotted by Thinh Huynh plot date 10/1/2008 8:51 AM

Standard Drawing RDA1 - Version 20070420

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Vertical 0 0 0 0 0 0

Map Reference Melway 134 H3
Sheet Number 2
Drg Status CONSTRUCTION

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Sustainability and Environment Agribusiness Project Management Strategic Consulting

CASCADES ON CLYDE
STAGES 4 & 5
DETAIL PLAN
MFS DIVERSIFIED GROUP
CITY OF CASEY

Rev F
Drg No 131761R02

coomes consulting