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Waterway Management Consultants

35 HAMS ROAD AND 151-229 ANGLESEA ROAD, WAURN PONDS

SURFACE WATER MANAGEMENT STRATEGY

(Version 3)

For: SMEC Urban P/L

19 September 2013

Neil M Craigie

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1. INTRODUCTION

This report outlines the surface water management strategy (SWMS) for proposed residential development of the 23.7 ha area of land at Hams Road, Waurn Ponds. It supersedes the original version dated 9 August 2012.

The land comprises two parcels; A-east 9.5 ha (35 Hams Road), and B-west 14.2 ha (151-229 Anglesea Road), which are under different ownership but proposed to be developed with a common drainage strategy.

2. EXISTING CONDITIONS

The subject land is cleared agricultural land previously used for grazing and cropping and totals 23.7 ha.

Figure 1 is a nearmap extract showing the site and surrounds as at June 2013. Figure 2 is the current preliminary development plan.

Hams Road forms the northern boundary, Ghazepore Road and the Powercor Waurn Ponds Terminal Station form the east boundary, with Anglesea Road along the westerly boundary. The southerly frontage comprises the VicRoads Anglesea Road/Warrnambool-Geelong Railway intersection (southwest) and the Warrnambool-Geelong Railway embankment (southeast).

Within the site existing drainage features are constructed open drains and three onstream dams. External catchments enter via pipes under Anglesea Road and Hams Road.

On the north side of Hams Road 28 ha of developed land in the Grange Park Estate is drained into an existing retarding basin which discharges across Hams Road into the subject land. This basin was constructed as part of Stage 3 of Grange Park Estate and currently has a temporary 300 mm pipe outfall across Hams Road with a bubble-up pit outlet to the open drain in 35 Hams Road. As part of future drainage works within 35 Hams Road this 300 mm pipe will need to be replaced with a 600 mm diameter pipe extending across to the pit on the north side of Hams Road.

Several culverts ranging in size enter the site from the Anglesea Road catchment on the westerly frontage. These are now combined into two culvert crossings of the elevated bike trail. As can be seen from Figure 1 much of the land to the west of Anglesea Road and south of Hams Road (46 ha catchment) has been excavated as a quarry and is internally drained. Land north of Hams Road (39 ha catchment) is developed as a rural-residential area. A box

culvert on Hams Road alignment serves as a trail crossing and overland flowpath under the Anglesea Road embankment.

The Railway embankment and the raised Ghazepore Road northern approach form the dominant drainage control for the site with overflow level of 59.0 m AHD.

An existing pipe culvert of 1500 mm nominal diameter is located under the Railway embankment. This pipe culvert is currently buried under silt deposits and vegetation growth and is not visible or accessible. Based on the pipe sizing shown on VicRoads records, surveyed headwall level of 56.12 m (SMEC) and probed depth of 1.78 m to the overt of the culvert (advice received from A Stafford, APP), the invert is less than or equal to 52.84 m.

> *(Note: It will be necessary to cleanout the Railway culvert in order to confirm as-built dimensions and levels).*

The Railway culvert is connected by an open drain to an existing 900 mm diameter culvert 80 m downstream under Ghazepore Road, which drains to Armstrong Creek in the Armstrong Creek West Precinct (ACWP). The culvert under Ghazepore Road has a surveyed invert level of 53.75 m with overtopping crest level on the road being 55.81 m.

Hence this information shows that:

- in larger floods Ghazepore Road will overtop and create tailwater levels of about 56.0 m for the Railway culverts;

- the invert level at Ghazepore Road is about 0.9 m higher than the estimated invert of the existing pipe under the Railway;

- it will be necessary for the culvert under Ghazepore Road to be upgraded in capacity and at lower invert level as part of future works downstream of the Railway in the Armstrong Creek West Precinct;

- Final design and construction of the Ghazepore Road works (by others) will be dependent on cleanout and survey proving of the pipe under the Railway;

- Provided that development finished surface levels are safely above the Railway crest level, drainage invert levels are above the surveyed existing bed of the drain on the north side of the Railway), and peak flows expected under existing conditions are not increased, there is no requirement for the Ghazepore Road drainage upgrade to be completed prior to commencement of the 35 Hams Road development.

Studies by others have shown that no significant remnant environmental values (flora/fauna) nor cultural/heritage values apply across the subject land.

Figure 1 Nearmap.com extract (June 2013) showing existing site conditions and surrounds.

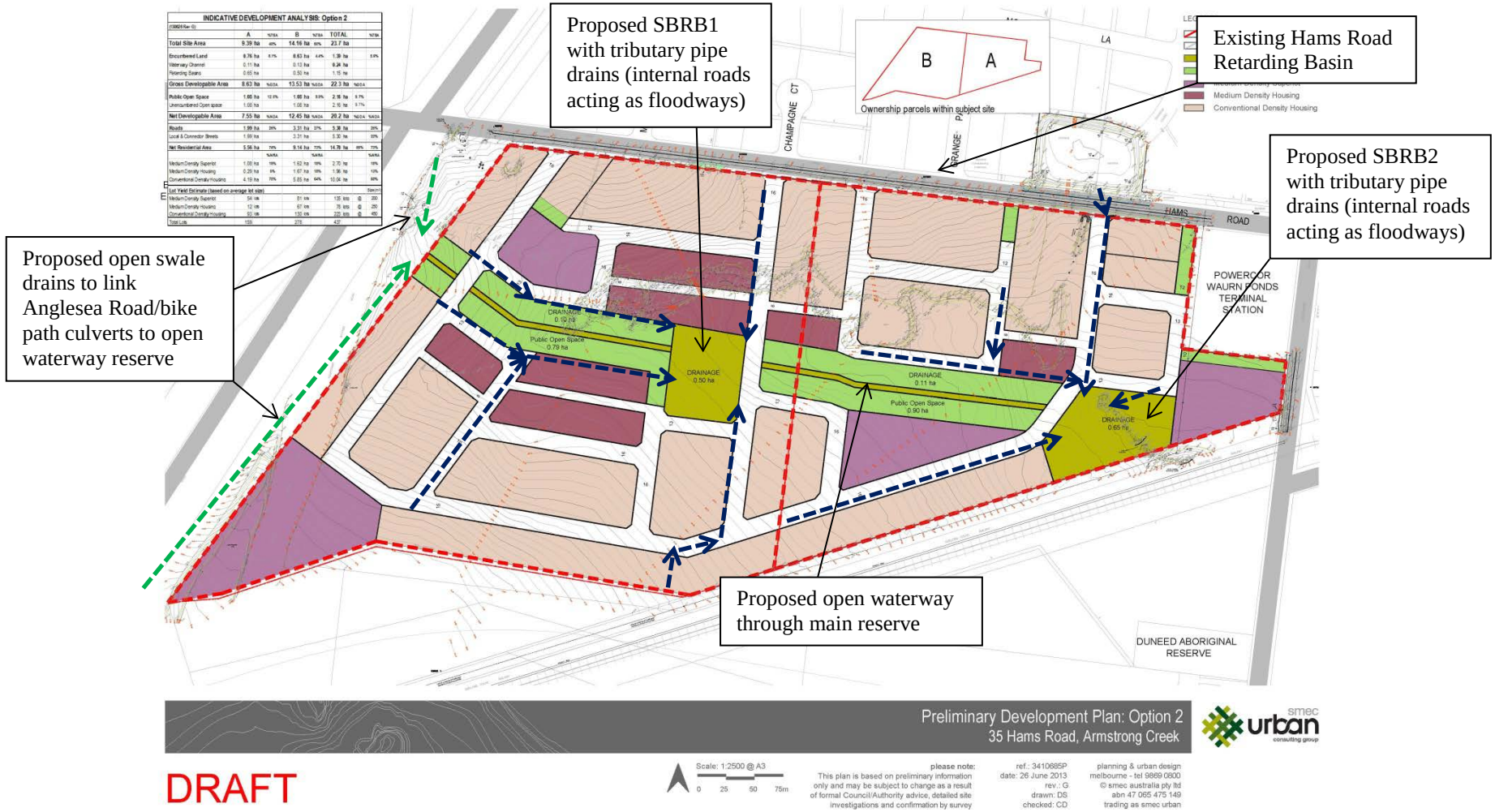

Figure 2 Preliminary Development Plan

3. FACTORS TO BE CONSIDERED FOR DEVELOPMENT

3.1 Philosophical Approach

From a holistic viewpoint the surface water management strategy for any property development must address contemporary Best Management Practices, through application of the principles of Water Sensitive Urban Design (WSUD).

As set out in Section 1.3 of Australian Runoff Quality –A Guide to Water Sensitive Urban Design (Engineers Australia 2006), the guiding principles of WSUD are centred on achieving integrated water cycle management solutions linked to an ecologically sustainable development focus aimed at:

1. Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters;

2. Using stormwater in the urban landscape to maximise the visual and recreational amenity of developments;

3. Preserving the natural hydrological regime of catchments;

4. Reducing potable water demand through water efficient appliances, rainwater and greywater reuse;

5. Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters;

In regard to stormwater (surface water) management, which is the subject of this report, ARQ 2006 lists best practice objectives as including:

1. providing flood protection and drainage;

2. protecting downstream aquatic ecosystems (including groundwater systems);

3. removing contaminants;

4. promoting stormwater elements as part of the urban form.

Urban Stormwater-Best Practice Environmental Guidelines were developed by the Victorian Stormwater Committee in 1999 and have since been incorporated into the State Planning Policy Framework. These Guidelines define the best practice performance objectives for Total Suspended Solids (TSS), Total Phosphorus (TP), Total Nitrogen (TN) and Gross

Pollutants (GP) to be 80%, 45%, 45% and 70% reduction of the typical urban annual loads respectively.

Clause 56 of the Victorian Planning Provisions (Sustainable Neighbourhoods) was brought into effect in 2006. The Integrated Water Provisions of Clause 56 requires all planning applications for subdivision lodged across Victoria to comply with the current Victorian best practice stormwater quality performance objectives through the use of WSUD and, unless approval is given to the contrary by the responsible authority and there are no detrimental impacts downstream, also ensure no increase in peak discharges of stormwater from the development.

With the site to be developed for residential purposes, the Clause 56 provisions apply to the subject development at 35 Hams Road and 151-229 Anglesea Road (and surrounding developments as well).

The adopted SWMS for Armstrong Creek West Precinct (ACWP) also assumes that rural drainage characteristics will be maintained from the subject land both in regard to water quality and quantity.

3.2 Performance Objectives

In no order of priority, the performance objectives for a surface water management strategy (SWMS) for the subject land are as follows:

- minimise offsite discharge of stormwater pollutants, both during development and in the long term;

- ensure any offsite discharge of pollutants generated from the proposed urban development fully complies with best practice management objectives for environmental protection;

- maximise the economic, environmental, aesthetic and recreational benefits of stormwater, while ensuring that such use does not result in any loss of user safety or creation of nuisance;

- mitigate existing flood threats downstream of the development area by ensuring future peak discharges are maintained as close to existing conditions as possible for all events up to and including the 100 year Average Recurrence Interval (ARI) storm;

- protect all new development areas from flooding threats;

- ensure finished surface levels for development and drainage invert designs are all safely above existing constraints posed by the silted culvert under the Railway and the invert level and capacity of the existing Ghazepore Road culvert;

- subject to the above objectives being satisfactorily addressed, locate and design new stormwater management assets to minimise capital investment and operation and maintenance costs in the long term.

3.3 The Proposed Drainage Layout

The drainage solution for the subject site is driven by existing inlet culverts and outlet drainage controls.

The new Anglesea Road formation effectively limits inflows from the western catchments to the capacity of existing culverts. The original proposal was for these culverts to be linked to an internal stormwater pipe drainage system across the subject land. A reserve connection was also provided between the road reserve and the internal road network in the subject land to allow for possible overland flows to enter the development and thence be passed through via internal road and reserve layouts.

Following meetings and site inspections with Council and the CCMA, it was resolved that:

- piping of drainage through the site was not acceptable to the CCMA;

- an open constructed waterway would have to be provided through the entirety of the site in a reserve;

- a confined channel sized to convey the peak 100 year ARI flows in a width of 5 m could be meandered through a reserve totaling 45 m in width;

- the land either side of the meandering 5 m wide channel would qualify as Public Open Space. A trail would be co-located in this reserve through the site;

- online water quality/quantity management assets could be incorporated into the waterway reserve but would be considered as encumbered land for the purposes of open space contributions.

The development layout shown on Figure 2 provides for a small open waterway through the entire site with two integrated sediment basin/retarding basins (SBRB's) sited to reflect property ownership and likely staged development. The upper SBRB1 is located to utilize the

north-south road crossing as the hydraulic control. The lower SBRB2 is located in the lowest land abutting the railway line.

On the north side of Hams Road the existing retarding basin temporary outfall across Hams Road has to be replaced with at least a 600 mm diameter pipe extending from the pit on the north side of Hams Road to the lower SBRB. Overflows from this retarding basin must also be catered for through 35 Hams Road. Given the small catchment size a roadway is proposed to provide this function.

The open waterway gradings and key levels are shown on Figure 3 with typical cross-sections shown on Figure 4. The waterway cross-section and grades fully contain the 100 year ARI peak flow of 3 m^3/s as determined in Section 4.

It should be noted that future detail design will show the open waterway meandering across the reserve. Finished cross-sectional grades are also able to be varied during detail design by excavation and/or filling of verges, to accord with Council requirements for complying public open space.

The concept layout for SBRB1 shown on Figure 5 uses a Normal Top water Level (NTWL) of 60.00 m and overtopping crest level of the north-south road of 62.00 m which approximates natural surface. All pipelines are directed into this basin and not to the open waterway.

The concept layout for SBRB2 shown on Figure 6 uses a Normal Top water Level (NTWL) of 55.50 m which is about 1.75 m above the Ghazepore Road culvert invert, 2.66 m above the assumed invert of the culvert under the Railway and above existing impeded drainage outlet as well (there was no observable ponding of water against the Railway embankment at levels below 55.50 m). All pipelines are directed into this basin and not to the open waterway.

With the only outfall under the Railway being a pipe culvert that has already proven to be subject to siltation in the absence of effective maintenance, it is necessary to adopt a conservative approach to development levels within 35 Hams Road.

A minimum development floor level of 59.15 m is recommended within 35 Hams Road to maintain a safety margin above the Railway/Ghazepore Road intersection level of 59.0 m, even though the 100 year ARI flood level for both existing and fully developed conditions is in theory at least, well below the embankment crest as discussed in Section 4.

Batter slopes, water surface setbacks, access, and sediment drying zones have all been arranged to accord with contemporary requirements of City of Greater Geelong (CoGG).

A variety of water edge treatments could be used as part of detail landscape design. Figure 5 shows a standard edge concept design which complies with all public safety requirements.

Appendix B shows an alternative stepped rock/planted edge detail that can be used to integrate trail/maintenance access close to waters edge and avoid mowing needs. Hardwalling inserts, jetties and boardwalks can all be integrated with the design to suit landscape design needs. These are matters for future detail design and negotiation with CoGG.

The physical characteristics of the existing Hams Road Retarding Basin in the Grange Park Estate, and the water surface areas and airspace flood storage volumes proposed for the SBRB's within 35 Hams Road are summarized in Tables 1-3.

Geotechnical investigations will be required during detail design to confirm lining requirements for the waterbodies and suitability of site soils. It will be important to ensure the wetland base is as watertight as possible to mitigate seepage losses.

It will also be essential for any dispersive subsoils to be fully covered with non-dispersive topsoil to mitigate ongoing high turbidity problems. Dispersive soils can normally be retained in base area of the pondages, subject to at least 200 mm of suitable non-dispersive topsoil being spread over the entire area below NTWL.

Hence it is important to test both subsoils and site topsoil to properly assess the threat that may be posed by dispersive soils and the appropriate remedial treatments.

3.4 Stage-Area-Storage Relations

TABLE 1 Stage-area-storage relation for existing Hams Road Retarding Basin (Grange Park Estate)

Stage (m)	Area (m^2)	Storage (m^3)	Comments
60.00	0	0	Invert of 450 mm dia outlet pipe
61.00	240	10	Base level of grassed area
61.25	2,250	311	
61.50	3,635	1,047	
61.75	3,955	1,996	
62.00	4,545	3,059	Spillway overflow to Hams Road
62.30	4,500	4,460	Embankment Crest

TABLE 2 Stage-area-storage relation for proposed SBRB1 (151-229 Anglesea Road)

Stage (m)	Area (m^2)	Storage (m^3)	Comments
60.00	1,000	0	NTWL for sediment basin
60.50	1,100	525	Top of Extended Detention (TEDD)
60.25	3,000	1,038	
61.75	4,400	4,738	
62.00	5,700	6,000	Road overtopping level

TABLE 3 Stage-area-storage relation for proposed SBRB2 (35 Hams Road)			
Stage (m)	**Area (m^2)**	**Storage (m^3)**	**Comments**
55.50	1,000	0	NTWL for sediment basin
56.00	1,100	525	Top of Extended Detention (TEDD)
56.25	3,000	1,038	
57.25	4,400	4,738	Embankment crest
58.00	5,630	8,500	Excludes storage in railway reserve

4. FLOOD MODELLING

The Armstrong Creek catchment RORB hydrologic model (originally developed by Mr T Jones at the CCMA) was modified to suit examination of the smaller catchments in and around Hams Road and, after confirmation of existing peak runoff regimes, was run in trial and error fashion to design the hydraulic controls for the flood retarding system.

It was found that a simple combination of weir controls would suffice for each SBRB:

- 100 mm wide weir @ NTWL 60.00 m, 1.0 m wide weir @ 60.50 m for SBRB1, and
- 300 mm wide weir @ NTWL 55.50 m, 1.1 m wide weir @ 56.00 m for SBRB2.

These weirs can be set within twin cell pits offline to the water surface areas with a submerged offtake pipe connection. The north-south roadway creates the flood storage control for SBRB1, whilst an embankment crest set at 57.25 m separates SBRB2 from the railway reserve. The railway reserve does not form part, nor is it counted in, the SBRB2 flood storage volume.

The key results from Table 4 and other runs are that:

- the existing Hams Road RB in Grange Park Estate is just overtopped in the 100 year ARI event. Spillway flows will be up to 0.9 m^3/s in the 100 year ARI event. This is well within the safe limit of a roadway and hence confirms this solution as being appropriate through 35 Hams Road to the WLRB.

- The existing Hams Road basin just contains the 50 year ARI flood with maximum pipe discharge of 0.56 m^3/s, which becomes the required minimum capacity in the downstream pipe drainage system in 35 Hams Road.

- All events up to and including the 100 year ARI flood are fully contained within the proposed SBRB2 storage system, outside the railway reserve boundary.

- Peak flows along the open waterway are maintained at or below 3 m^3/s in the 100 year ARI event.

- Peak flows at the Railway culvert are close to or matching those for existing conditions for all events up to and including the 100 year ARI event.

TABLE 4		**RORB model results for catchment to Railway Line**			
Asset	**ARI**	**Peak Inflow (+duration) (m3/s)**	**Peak Level (m)**	**Peak Outflow (+duration) (m3/s)**	**Peak Storage (m^3)**
Hams Rd RB (Ex)	1	0.8 (25m)	61.15	0.42 (9 hr)	186
	10	1.7 (1.5 hr)	61.61	0.50 (9 hr)	1,460
	100	4.1 (2 hr)	62.03	1.4 (9 hr)	3,230
West inlet (Existing Conditions)	1			0.4 (9 hr)	
	10			1.1 (9 hr)	
	100			2.5 (9 hr)	
Railway outlet (Existing Conditions)	1			0.6 (9 hr)	
	10			1.5 (9 hr)	
	100			3.3 (9 hr)	
SBRB1 (151-229 Anglesea Road fully developed)	1	0.8 (15 m)	60.83	0.5 (30 hr)	1,320
	10	1.7 (2 hr)	61.24	1.3 (9 hr)	2,870
	100	3.0 (2 hr)	61.71	2.6 (9 hr)	4,580
SBRB2 (151-229 Anglesea Road and 35 Hams Road fully developed)	1	0.7 (25m)	56.28	0.6 (9 hr)	1,130
	10	1.8 (9 hr)	56.67	1.7 (9 hr)	2,590
	100	3.5 (2 hr)	57.12	3.3 (9 hr)	4,250

5. WATER QUALITY MODELLING

The MUSIC model Version 3 has been used to simulate the wetland treatment system. The 6 minute continuous data sequence for Geelong North for the 10 year period 1980-89 was used as is normally required by CoGG. A node representing assumed best practice treatment was included for the VicRoads land external to 35 Hams Road. Results are listed in Table 5.

TABLE 5 WQ treatment performance – SBRB's in 151-229 Anglesea Road and 35 Hams Road (Geelong North, 1980-89 6 minute rainfall)

Parameter	External Source Loads	151-229 Anglesea Rd and 35 Hams Rd Source Loads	Total Source Loads	SBRB1 Load removal	SBRB2 Load removal	Loads Removed in 151-229 Anglesea Rd and 35 Hams Rd	%removal of 151-229 Anglesea Rd and 35 Hams Rd Source Loads	Overall %removal
Flow (ML)	183	70	253	0.5	1	1.5	2	1
Suspended Solids (kg/yr)	32,500	13,200	45,700	11,300	12,500	23,800	180	66
Total Phosphorus (kg/yr)	70	27	97	19	19	38	141	47
Total Nitrogen (kg/yr)	509	198	707	58	59	117	59	24
Gross Pollutants (kg/yr)	6,370	2,910	9,280	3,920	4,140	8,060	277	100

Thus the proposed twin SBRB system in 151-229 Anglesea Road and 35 Hams Road comfortably exceeds best practice water quality treatment standards for treatment of stormwater generated from the development, and achieves significant reduction in overall pollutant loads generated from the total catchment.

6. CONSTRUCTION STAGE MANAGEMENT

The construction phases of the open waterway and twin SBRB system, subdivisional development and subsequent building works must also be properly managed to ensure environmental values are protected along the way. To do this, Site Environmental Management Plans (EMP's) will need to be prepared to address construction-related impacts. These plans would be submitted for approval prior to commencement of works on each stage or group of stages as the case may be.

Key items to be factored into the EMP's are as follows:

- All site works are to be carried out in accord with contemporary best site management practice.

- Implement erosion prevention and control measures generally in accordance with the provision of "Construction Techniques for Sediment Pollution Control" (EPA Publication No. 275, 1991), with "Environmental Guidelines for Major Construction Sites" (EPA Publication No. 480, December 1995), and with "Doing it right on subdivisions. Temporary environmental protection measures for subdivision construction sites" (EPA Publication No. 960).

- Areas of disturbance should be kept to a minimum on each stage and stage works areas clearly fenced to prevent machine access or materials storage elsewhere.

- Construct and establish sedimentation pondages (in segments as appropriate to scale of stage development), as part of initial construction. Establishment of appropriate aquatic vegetation communities can follow after completion of the final basin shaping and topsoiling.

- Divert runoff from undisturbed areas away from active works areas.

- Locate soil stockpiles at least 20 metres from any drainage line or pit.

- Remove soil and clay from tyres before trucks leave site.

- Remove foreign soil and plant matter from trucks before entering site.

- All significant vegetation to be retained should be fenced out prior to commencement of any site works within appropriate setbacks.

- Timing and frequency of maintenance activities including removal of sediment from sediment ponds and swales should be clearly designated.

7. SUMMARY AND CONCLUSIONS

This report outlines the Surface Water Management Strategy (SWMS) and concept functional design for the proposed open waterway and twin SBRB system to manage stormwater discharge arising from proposed residential development in 151-229 Anglesea Road and 35 Hams Road, Waurn Ponds. The works will discharge to the existing culvert under the Warrnambool-Geelong Railway and thence under Ghazepore Road into the Armstrong Creek West Precinct.

Section 3 describes the proposed strategy with concept sketches of the proposed open waterway and SBRB's provided in Figures 3-6. Section 4 presents RORB flood modeling results. Section 5 presents final MUSIC modeling for water quality treatment outcomes. Sections 6 discusses construction management requirements.

The RORB hydrologic modeling results in Table 4 show that with the functional design in place, peak outflow limits and flood level targets are effectively achieved, with full development of the subject lands. The key results are that:

- the existing Hams Road RB in Grange Park Estate is just overtopped in the 100 year ARI event. Spillway flows will be up to 0.9 m^3/s in the 100 year ARI event. This is well within the safe limit of a roadway and hence confirms this solution as being appropriate through 35 Hams Road to the WLRB.

  (The basin just contains the 50 year ARI flood with maximum pipe discharge of 0.56 m^3/s which thus becomes the required capacity in the downstream pipe drainage system in 35 Hams Road.).

- All events up to and including the 100 year ARI flood are fully contained within the proposed SBRB1 and SBRB2 storage system, outside the railway reserve boundary.

- Peak flows along the open waterway are maintained at or below 3 m^3/s in the 100 year ARI event.

- Peak flows at the Railway culvert are close to or matching those for existing conditions for all events up to and including the 100 year ARI event.

The MUSIC modeling results in Section 5 show that the proposed twin SBRB system comfortably exceeds best practice water quality treatment standards for treatment of stormwater generated from the development, and achieves significant reduction in overall pollutant loads generated from the total catchment.

Other conclusions are that:

- To provide free drainage outfall to the existing Railway culvert it will be necessary for the culvert under Ghazepore Road to be upgraded in capacity and at lower invert level as part of future works downstream of the Railway in the Armstrong Creek West Precinct;

- Final design and construction of the Ghazepore Road works (by others) will be dependent on cleanout and survey proving of the presently obscured pipe under the Railway;

- Provided that development finished surface levels are safely above the Railway crest level, drainage invert levels are above the surveyed existing bed of the drain on the north side of the Railway), and peak flows expected under existing conditions are not increased, there is no requirement for the Ghazepore Road drainage upgrade to be completed prior to commencement of the 35 Hams Road development.

- The proposed strategy satisfies all of these conditions.

<u>Geotechnical investigations</u> will be required during detail design to confirm lining requirements for the wetland and suitability of site soils. It will be important to ensure the wetland base is as watertight as possible to mitigate seepage losses.

It will also be essential for any dispersive subsoils to be fully covered with non-dispersive topsoil to mitigate ongoing high turbidity problems. Dispersive soils can normally be retained in base area of the pondages, subject to at least 200 mm of suitable non-dispersive topsoil being spread over the entire area below NTWL.

Hence it is important to test both subsoils and site topsoil to properly assess the threat that may be posed by dispersive soils and the appropriate remedial treatments.

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8. ABBREVIATIONS AND DEFINITIONS

AHD	Australian Height Datum. Common base for all survey levels in Australia. Refers to height in metres above mean sea level.
ARI	Average Recurrence Interval. The average length of time in years between two floods of a given size or larger
Ephemeral	Waterways which flow for only short periods of time after significant rainfall events. Also refers to wetlands which are either rarely inundated or only inundated for a very short period of time.
Evapotranspiration	The loss of water to the atmosphere by means of evaporation from free water surfaces (eg. dams or lakes or wetlands) or by transpiration by plants
Groundwater	All water stored or flowing below the ground surface level
Ha	Hectare (10,000 square metres)
Km	Kilometre (1000 metres)
M^3/s	Unit of discharge = cubic metre/second
ML	Megalitre (1000 cubic metres)
NTWL	The Normal Top Water Level (m AHD) or water surface level of a waterbody when just full to low flow overflow level.
Pond	A small artificial body of open water (eg. dam or small lake)
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
Sedimentation basin (sediment pond)	A pond that is used to remove sediments from inflowing water mainly by settlement processes. Edge zones may have similar appearance to wetland margins.
Surface water	All water stored or flowing above the ground surface level
Swale	A drainage line with essentially trapezoidal cross-sectional form. Can have rocky or soil bed form, be fully vegetated with indigenous species, or grassed. The base can be fitted with a filter zone to further assist in pollutant removal (termed a bio-retention swale). Foundations can be ripped to encourage seepage losses in suitable soils.
Waterlogging	Term used to describe saturated surface soil conditions where some free surface water may also be present
Wetland	A transitional area between land and water systems which is either permanently or periodically inundated with shallow water and either permanently or periodically supports the growth of aquatic macrophytes (eg. swamp, marsh, fen, bog)

9. REFERENCES

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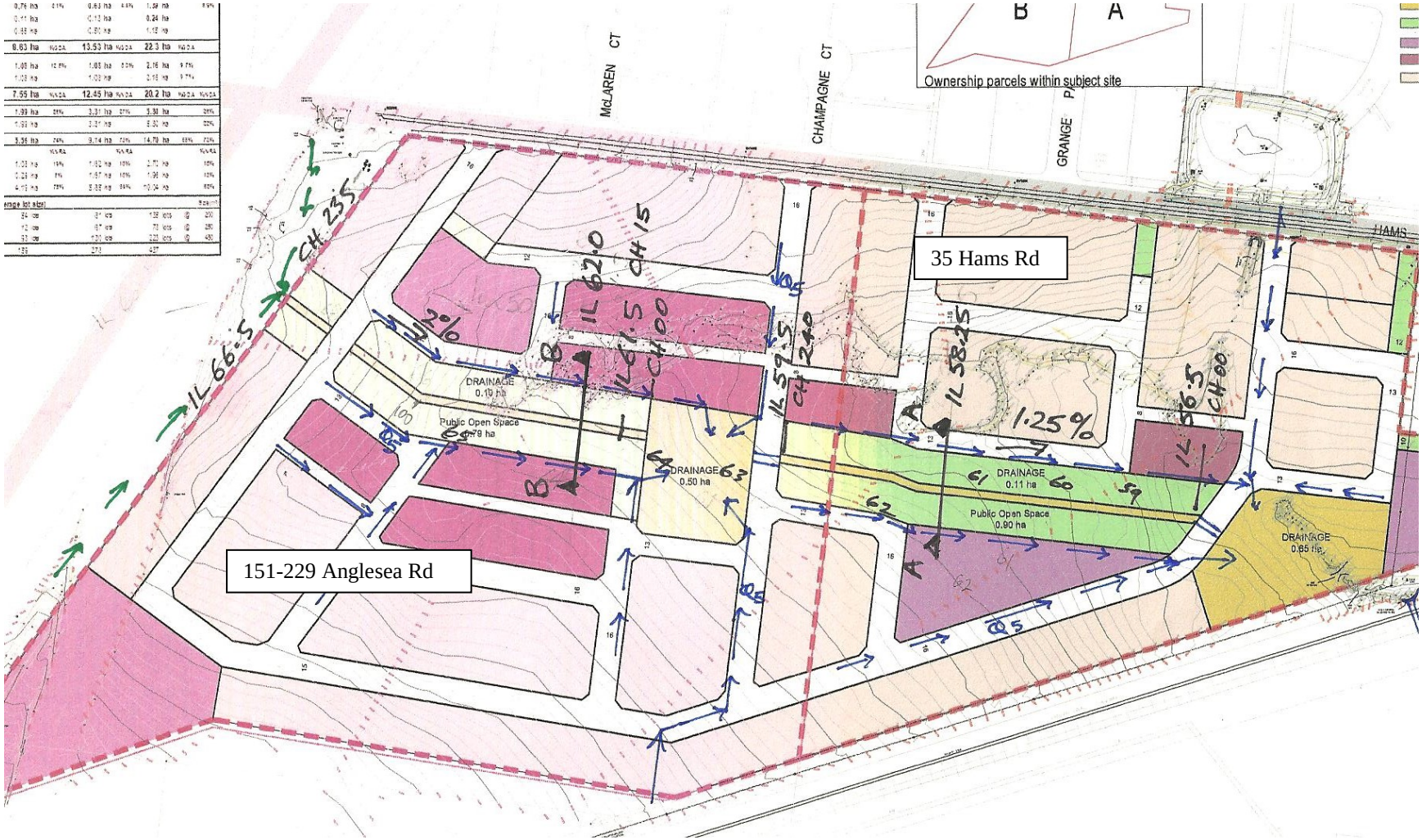
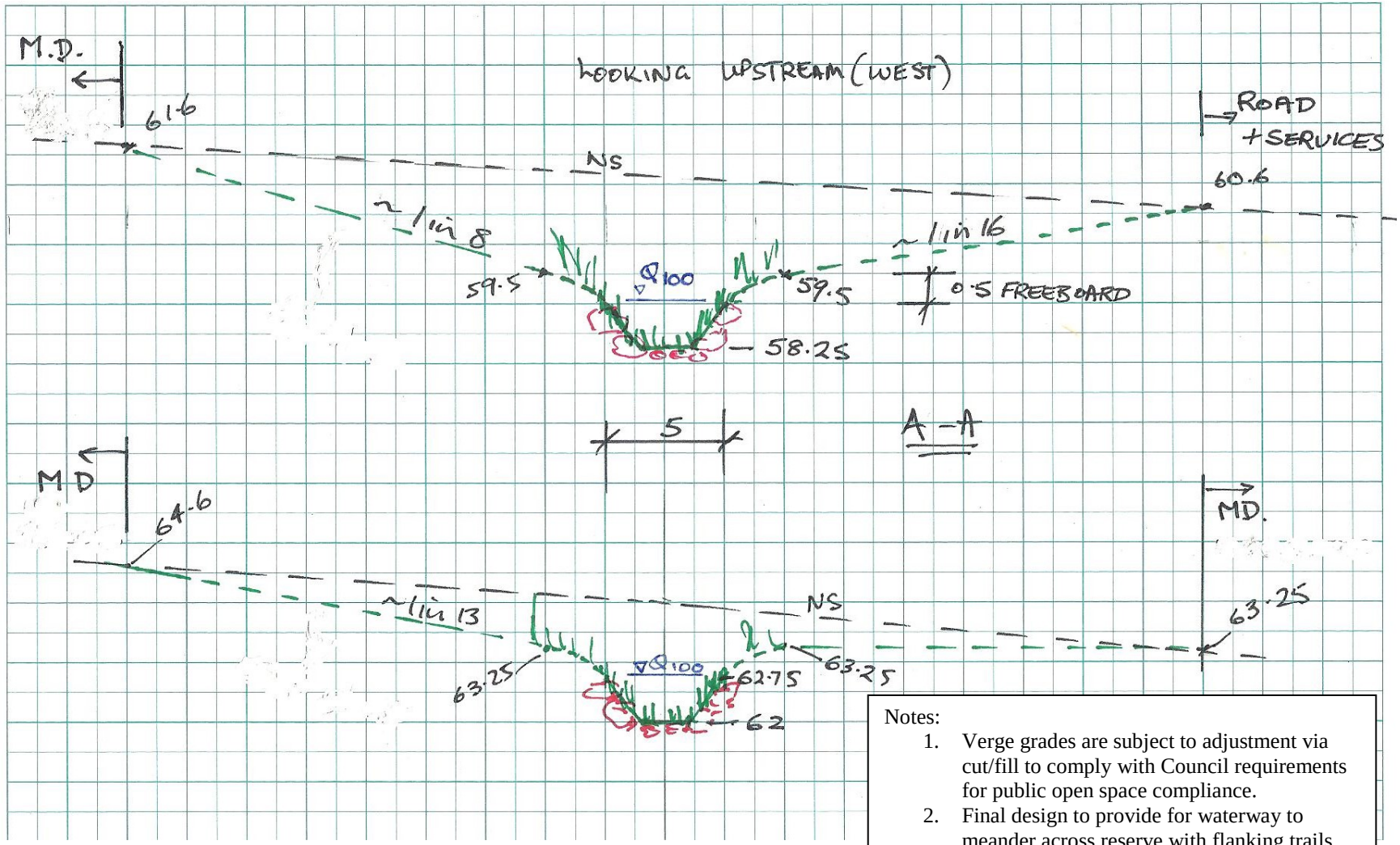


Figure 3 **Proposed Open Waterway Grades and Levels and main pipes. Refer to Figure 4 for typical cross-sections A-A, B-B**



Notes:

1. Verge grades are subject to adjustment via cut/fill to comply with Council requirements for public open space compliance.
2. Final design to provide for waterway to meander across reserve with flanking trails.

Figure 4 Cross-sections A-A and B-B as per Figure 3.

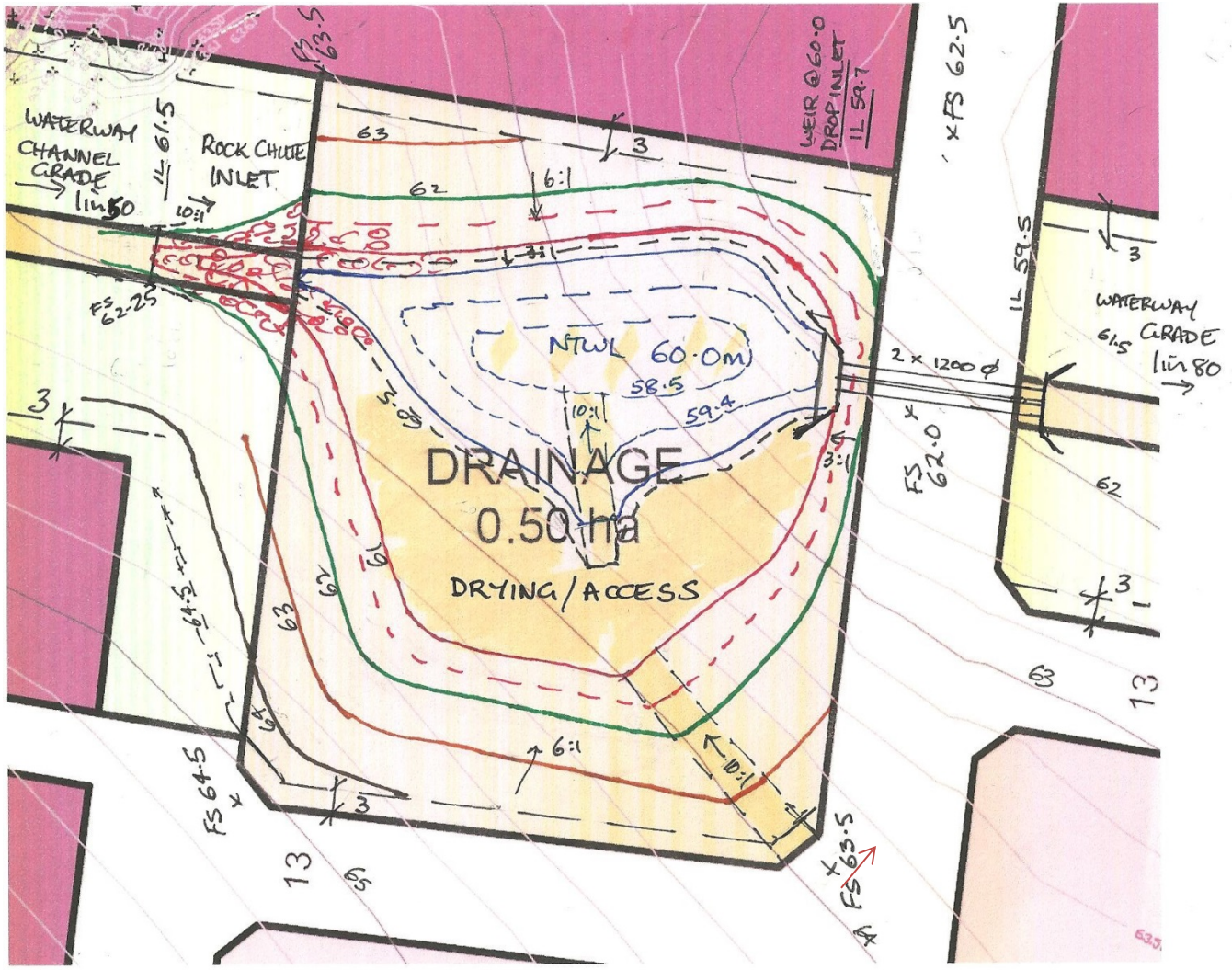
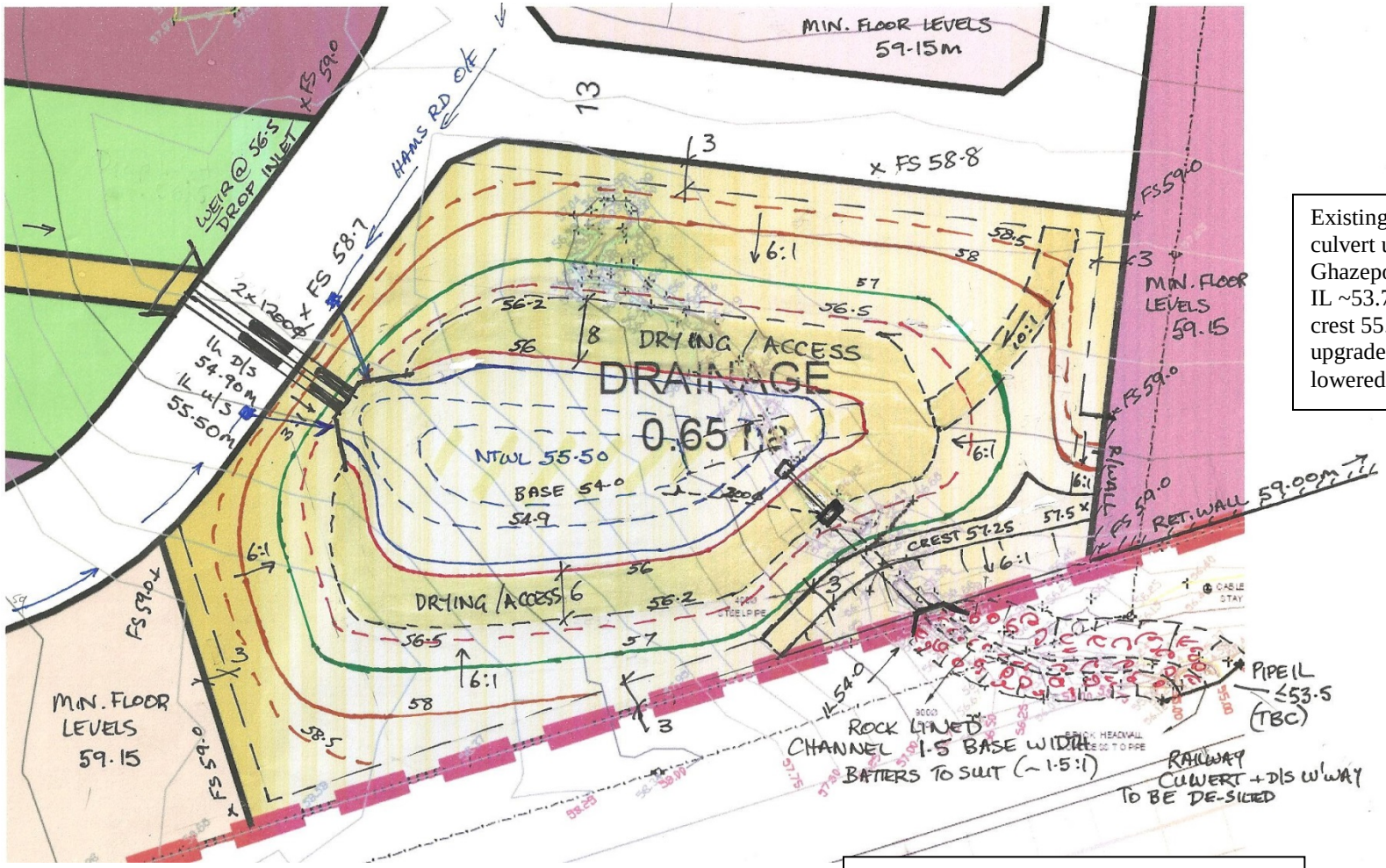


Figure 5 **Concept Layout for SBRB1 in 151-229 Anglesea Road**



Existing 900 mm culvert under Ghazepore Rd, IL ~53.75 m, road crest 55.81 .(To be upgraded and lowered by others)

Existing Railway culvert 1500 mm dia, IL~52.84 m-To be confirmed after cleanout

Figure 6 Concept layout for SBRB2 in 35 Hams Road

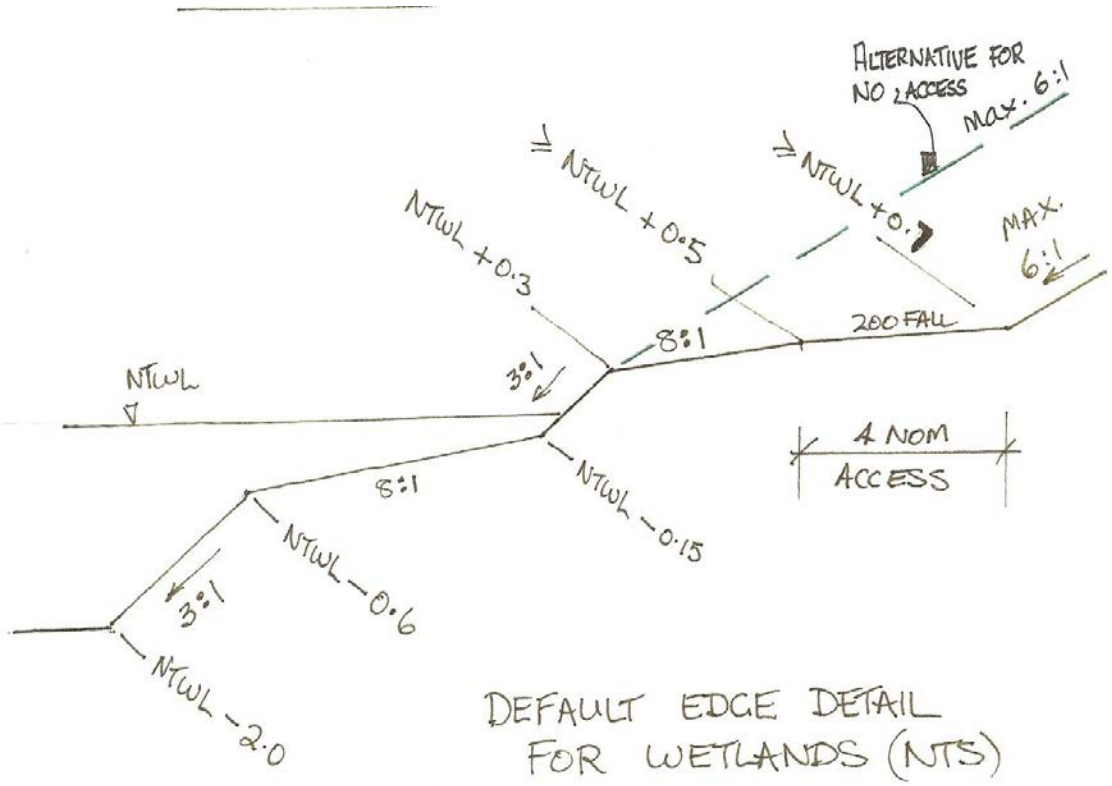


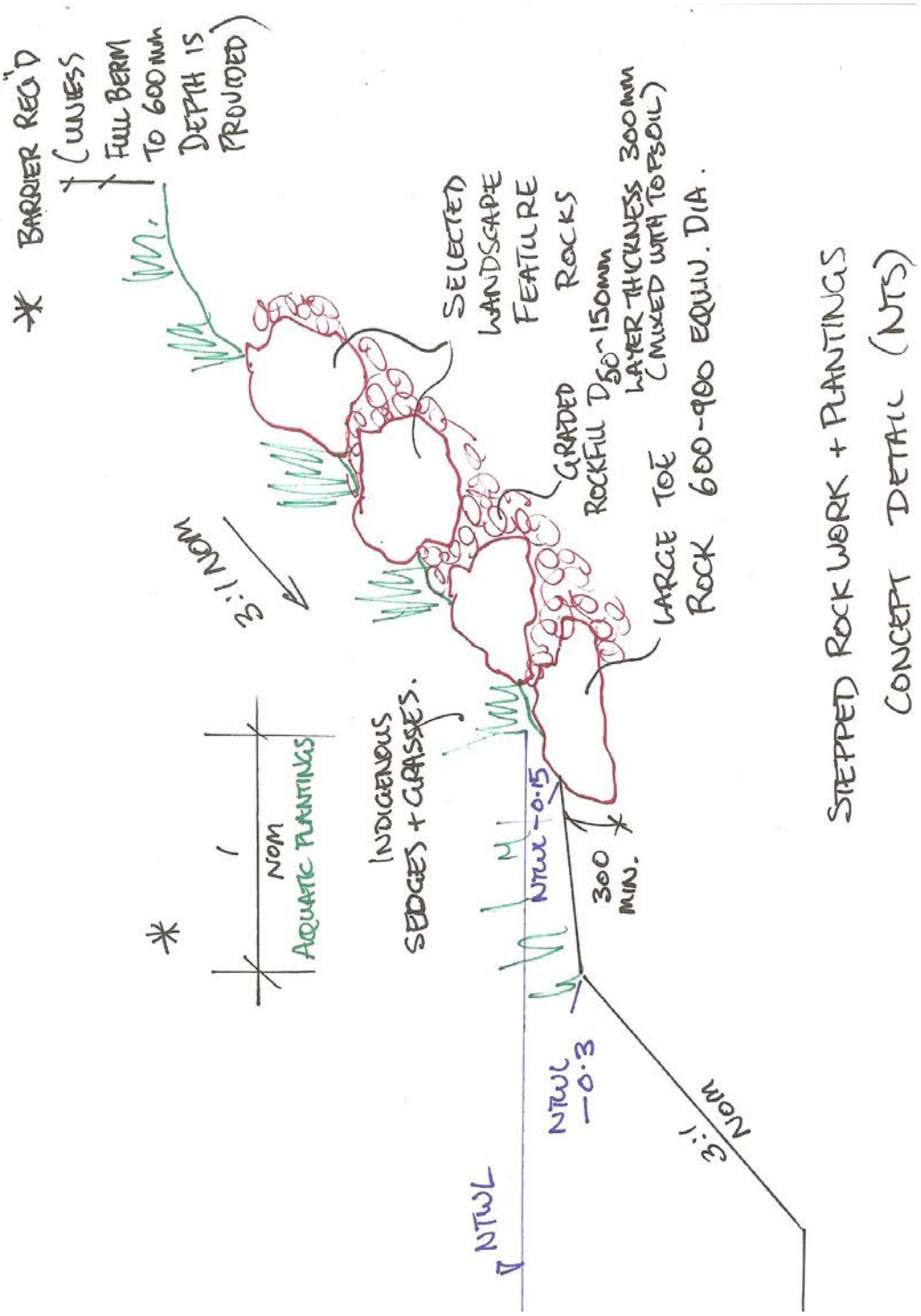
Figure 7

Standard Concept Drawing

DEFAULT EDGE DETAIL FOR WETLANDS AND SEDIMENTATION BASINS
(Vegetation treatment only for upper slopes)

APPENDIX A STEPPED AND PLANTED ROCK EDGE TO WETLANDS

Examples of constructed wetland edges at 3:1 average slope to flanking pedestrian/bike trail (Delfin Lend Lease at Malcolm Creek, Craigieburn)


BARRIER REQ'D
(UNLESS FULL BERM TO 600mm DEPTH IS PROVIDED)
SELECTED LANDSCAPE FEATURE ROCKS
GRADED ROCKFILL D50~150mm LAYER THICKNESS 300mm (MIXED WITH TOPSOIL)
LARGE TOE ROCK 600-900 EQUIV. DIA.
3:1 NOM
1
NOM
AQUATIC PLANTINGS
INDIGENOUS SEDGES + GRASSES.
NTWL -0.15
300 MIN.
NTWL -0.3
NTWL
3:1 NOM
STEPPED ROCK WORK + PLANTINGS
CONCEPT DETAIL (NTS)