Horsham South Structure Plan

Preliminary Drainage Assessment

18th October 2022

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Note that for the purposes of this report, Stormy Water Solutions (**SWS**) consists of two business entities being:

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Contents

1 Introduction and Background

Stormy Water Solutions (**SWS**) has been engaged by Mesh Planning (**Mesh**) on behalf of Horsham Rural City Council (**Council**) to conduct a Preliminary Drainage Assessment (**PDA**) of the Horsham South Structure Plan (**HSSP**) area. Ultimately a Stormwater Management Strategy (**SWMS**) will be developed for the HSSP area. This work represents the first part of the SWMS development process.

The HSSP area is detailed in Figure 1.

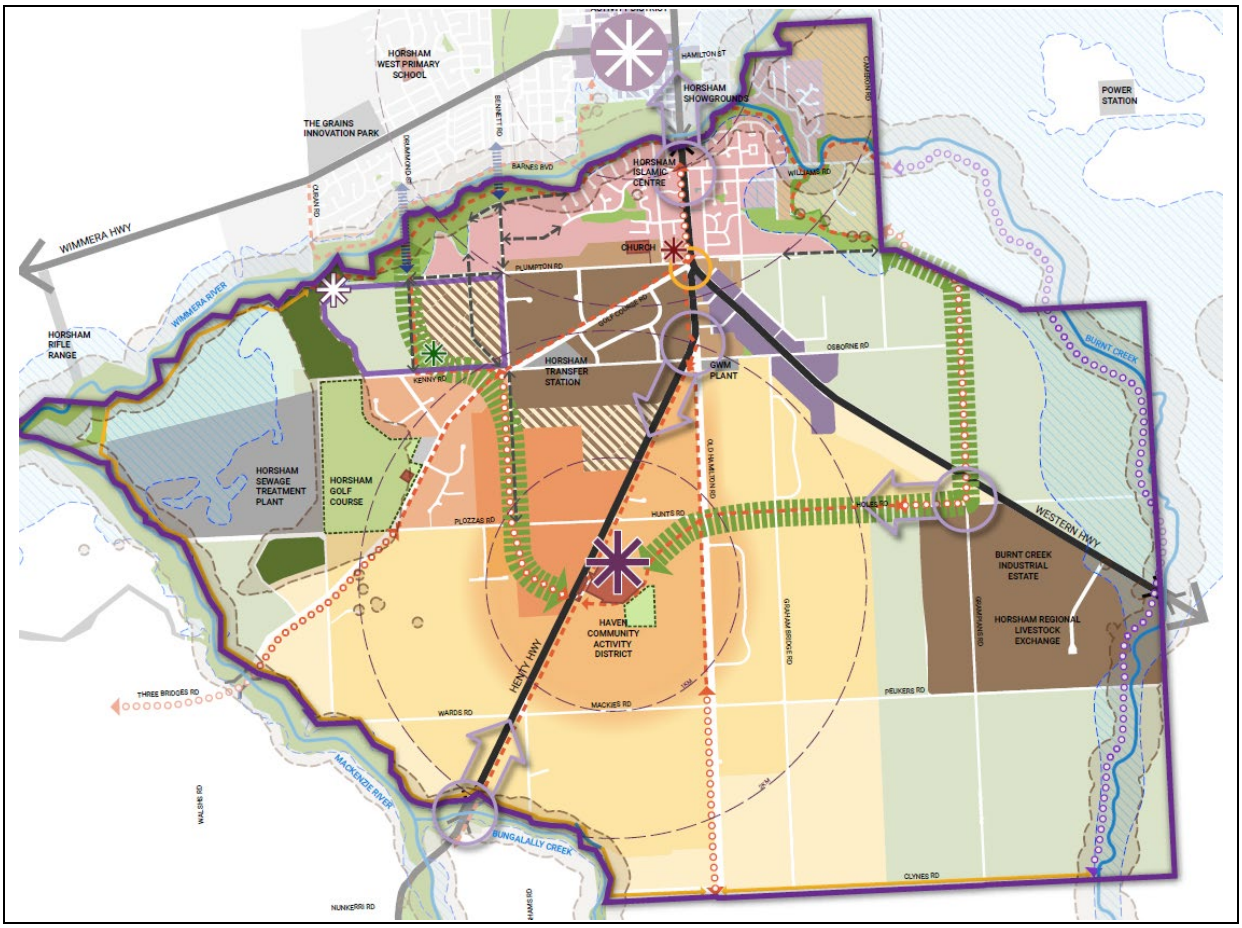


Figure 1 **Subject Land – Horsham South Structure Plan Area**
Source – Mesh Planning July 2022

The first step in developing a SWMS is to ask:

1. What drainage infrastructure currently exists and?
2. What are the issues with the current infrastructure (if any)?
3. What needs to be added to the drainage system to ensure no adverse flooding impact of local areas or regional rivers and creeks when the HSSP area is developed? and
4. What needs to be added to the drainage system to ensure no adverse environmental impacts (primarily water quality impacts of receiving rivers and creek) when the HSSP area is developed?

This report is a Preliminary Drainage Assessment (**PDA**) for the HSSP area.

It is the intent of this PDA Report is to:

- Provide detail into the four considerations above, and
- Provide Council with a direction forward in relation to how a SWMS can be developed in this large and complex drainage area.

This PDA provides a proposed direction for Council in regard to formulating a SWMS for the HSSP area. It is noted that there is significant work required before a robust SWMS can be adopted. However, the recommendations in this report should provide Council a reasonable way forward in regard to facilitating development on the HSSP area in a logical and planned manner.

2 Background Information

2.1 Subject Land

For the purposes of this PDA, the subject land considers the whole of the HSSP area as shown in Figure 1. However, primary considerations focus on the potential "change" areas shown in Figure 2.

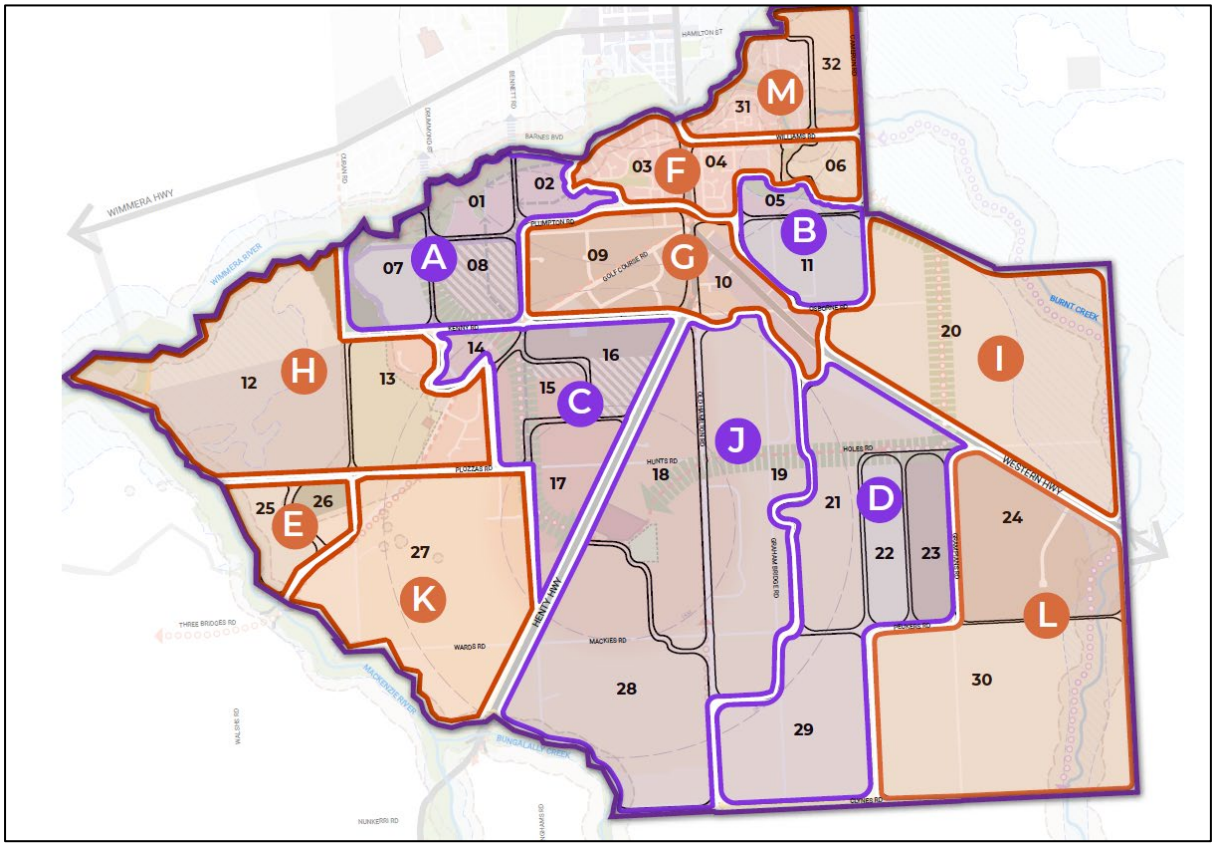


Figure 2 **Potential Change Areas Plan**
Source – Mesh Planning July 2022
Purple: Potential "change" areas
Orange: Potential "no change" areas

Drainage lines and catchment boundaries cross over the various areas defined in Figure 2.

2.2 Development Potential in the HSSP

This PDA assumes that the existing zonings within the HSSP will apply into the future. The only changes the HSSP applies are that:

- Undeveloped areas can now be developed under the current zonings, and
- Existing developments may be able to increase in density, with consideration to current zonings.

In essence, the development of a SWMS for the HSSP will be to ensure that there is an overall planned approach to the development of undeveloped areas in the HSSP area.

2.3 Background Reports, Information and Designs

The formulation of this PDA has utilised information from the following sources relating to designs, studies and/or current works in the catchments/sites surrounding the Subject Land. Information obtained from each source below is described in more detail in subsequent parts of this report where required.

- Stormwater Drainage, Water and Sewer Infrastructure Assessment Report, TGM Group, May 2019 (**2019 TGM Report**);
- Horsham South Issues and Opportunities Background Report, Mesh Planning, October 2019;
- Horsham South Key Strategic Directions Discussion Paper for Community Consultation Mesh Planning, November 2019;
- Horsham South Emerging Options Discussion Paper for Stakeholder and Community Engagement, Mesh Planning, March 2020;
- Emerging Options Community Engagement Outcomes Brochure, Mesh Planning, December 2020;
- Calibration Report – Horsham and Wartook Valley Flood Investigation, Water Technology;
- Desktop Biodiversity Assessment for the Horsham South Structure Plan, Victoria, Ecology and Heritage Partners, August 2022 (**2022 E&HP Report**);
- Various Horsham South Structure Plan Drawings produced by Mesh Planning in July 2022 (**2022 HSSP Drawings**);
- A HSSP "Change Area Plan" produced by Mesh Planning in July 2022;
- Digital rain on grid Water Technology Flood Mapping results within the HSSP area (no date) (**WT Flood Mapping**);
- Wimmera Soil Type Map – Extracted from Wimmera Catchment Management Authority (**WCMA**) web site on 14 October 2022;
- Workshops with Council and various site visits performed by SWS staff on the 25th and 26th of August 2022; and
- A meeting with SWS, Council and the Wimmera Catchment Management Authority (**WCMA**) on 16 September 2022.

2.4 Manuals and Guidelines

Where applicable, the designs developed as part of this SWMS will be consistent with the following Manuals or Guidelines:

1. Australian Rainfall and Runoff 2019, Geoscience Australia, (**ARR 2019**);
2. Environmental Protection Agency Victoria (2021), '*Urban Stormwater Management Guidance*', publication 1739.1, June 2021 (the **Updated Guidance**); and
3. Infrastructure Design Manual (**IDM**), Local Government Infrastructure Design association, V5.4, September 2022
4. CSIRO (1999). "Urban Stormwater Best Practice Environmental Management Guidelines." CSIRO PUBLISHING, Melbourne (**BPEMG**);
5. Melbourne Water (2005). "*WSUD Engineering Procedures: Stormwater Melbourne"*, CSIRO Publishing (the **WSUD Engineering Procedures**);
6. Melbourne Water (2017), "*Floodway safety criteria"* (the **Floodway Safety Criteria**);

7. Melbourne Water (2022). "*MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Guideline",* May 2022, Melbourne Water (the **MUSIC Tool Guidelines**).

3 Issues and Requirements

3.1 Regional Flooding

Major river systems are located (essentially) on the HSSP boundaries being the Wimmera River, Burnt Creek, Mackenzie River and Bungalally Creek.

2019 TGM report presented a plan showing the estimated 1% Annual Exceedance Probability (**AEP**) flooding due to the major river and creek systems in the area. This is reproduced (with SWS additional annotations) as Figure 3 below.

Documented 1% AEP flood mapping shows that riverine flooding generally affects the HSSP area as:

- Minor flooding from the Wimmera River in the north-west corner of the study area,
- Flooding from the Wimmera River affecting the Grampians Wimmera-Mallee Water sewerage treatment plant,
- Flood influence generally limited to the waterway boundaries of the MacKenzie River and Bungalally Creek with 1% AEP flooding confined to the outer limit of the south-west corner of the HSSP area, and
- Large flood plain impacts in the Farming Zone (**FZ**) land (north of the Western Highway) from Burnt Creek and its local anabranch. It is noted that the Land Subject to Inundation overlay (**LSIO**) extends further south than shown (towards the Western highway) in this area.

In general, riverine and creek flooding will be a consideration, but is not expected to have a large influence on the siting of densification areas in the HSSP area.

The WCMA has confirmed that 1% AEP flood flows from the HSSP area entering the Wimmera River, Burnt Creek, Mackenzie River and/or Bungalally Creek must be retarded to predevelopment flow rates.

Depending on the considerations detailed in Section 4, SWS recommends the following in regard to mitigating flood flows to regional rivers and creeks:

- Large scale retarding basins at catchment outlets and/or at strategic locations in the catchment implemented via a drainage scheme (See Section 4), or
- Development scale (on site) flood retention to mitigate impacts on existing developments/landholdings downstream.

SWS does not recommend the use of roof tanks for flood retention as:

- These are complex to assess in regard to actual performance (in regard to flood retention benefits), and
- This retardation function often gets “confused” with the (more common) stormwater reuse function of tanks in both the design, assessment and permit application process. This can compromise the whole strategy (if relying of tanks for stormwater retention purposes).

In addition SWS does not recommend tanks under road reserves or driveways for flood retardation. These types of retardation assets are expensive to construct and difficult for council to inspect and maintain.

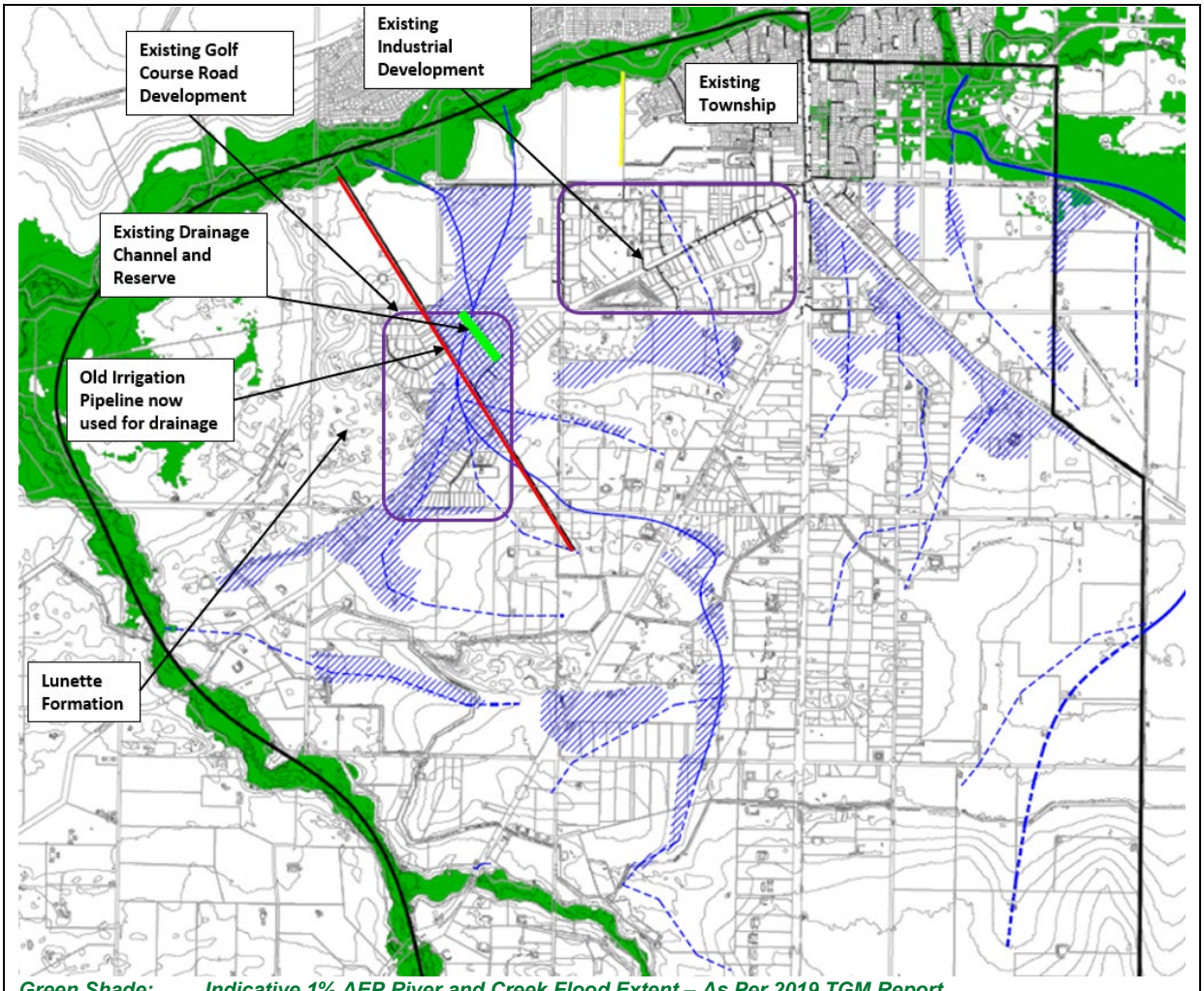
3.2 Local Drainage and Flooding

The WT Flood Mapping detailed the results of a "rain on grid" model for the HSSP area. This can be described as areas subject to relatively shallow (but often prolonged) nuisance flooding of areas exhibiting:

- Poor surface slopes, and
- Informal drainage systems such as small road swales etc.

The areas most affected by this type of flooding are as "roughly" indicated as the "blue hatched" areas of Figure 3 below.

Figure 4 details a typical table drain in the HSSP area.



Green Shade: *Indicative 1% AEP River and Creek Flood Extent – As Per 2019 TGM Report*
Blue Shade: *Indicative 1% AEP ponding of water within HSSP area (based WT Flood Mapping, however modified by SWS to indicatively show areas of most concern)*
Blue lines: *Indicative 1% AEP overland flow paths*

Figure 3 **Indictive Plan of 1% AEP Flood Impacts in (and adjacent to) the HSSP Area.**
Source of Base Plan: 2019 TGM Report.

Figure 4 **Typical Swale/Road Drain**
(Location: Golf Course Road Development)

There are areas where low flows are diverted along open road drains to existing developed areas (especially to the developed areas in the northern portion of the HSSP), while higher flows will continue to follow natural valleys. This does cause flooding of existing developed areas as defined by the rain of grid **WT Flood Mapping.**

For instance, south of the township there is limited formal stormwater drainage infrastructure. Largely drainage is via local swales or open earth table drains within road reserves. Often these drains are directed towards the existing township, because this is where the road alignment leads to. However, once the table drains are full (probably in events of much less magnitude than a 20% AEP storm event (which is the usual required “minor system” capacity)), it is expected that overland flow occurs in line with the general site contours (as roughly depicted by the “blue dashed” lines in Figure 3). This in turn, is the cause of flooding in the “blue hatched” areas shown.

The existing township is serviced by pipelines which (in some cases) discharge to existing pondages/retarding basins. It is expected that the Horsham Township piped drainage system cannot accept any increase in 20% or 1% AEP flood flows.

Of particular concern is the flooding of the Existing Golf Course Road Development (Figures 3, 4 and 5). Flooding in this area is due to:

- Overland flow impact as described above from a significant catchment to the south east,
- Blockage of this flow path in to the west by the lunette formation in the golf course, and
- The primary 20% AEP drainage outfall from this area being the old irrigation pipeline which is relatively small, shallow, and (at the time of the 2022 site visit), full of water.

There is also a shallow drainage channel and reserve which runs through the northern section of the Golf Course Road Development (See Figures 3 and 5). Channels of this type are usually designed to

convey the “major” flood flows (up to the 1% AEP flood flow). The efficiency of the channel may be limited as:

- It may not be located in the ideal location to “pick up” major overland flows in the area,
- It does not extend all the way from Kenny Road to the eastern boundary of the existing Golf Course Development (there is one undeveloped block which would need to be acquired by Council to achieve this connection), and
- It is relatively shallow (outfalling to a shallow culvert system at Kenny Road, which limits its ability to address nuisance flooding issues in the area (i.e. by providing a relatively deep local outfall).

Figure 5 Drainage Reserve and Channel in the Existing Golf Course Road Development

Addressing (and certainly not adding to) the existing local flood effects within the HSSP area will be a major objective on any SWMS going forward. Mitigation measures to be considered could include:

- Ensuring 1% AEP and 20% AEP retarding basins upstream of any existing development/township areas,
- Constructing drainage systems generally in line with the natural slope of the land,
- Where applicable, constructing “deep” drainage systems to facilitate development of adjacent land without the requirement to fill the land (to provide cover over pipes etc),
- Where deep drainage systems cannot be constructed, specifying shallow grassed swale systems as the primary drainage conveyance mechanism (which is consistent with the rural feel of the lower density areas proposed), and
- Siting retarding basins and wetlands (or the like) where:
    - They treat/catch the most catchment,
    - There are no (or little) ecological or aboriginal heritage constraints,
    - They can protect and improve flooding in existing development areas, and
    - Where an appropriate “outfall” can be achieved.

As such, this PDA aims to direct the ultimate SWMS to align new infrastructure in line with where the drainage line valleys occur, rather than to continue the practice of trying to drain the area along existing (or upgraded) road drains. In this way retarding basins and wetlands (etc) can be appropriately placed

to capture the most amount of flow and existing drainage infrastructure will not be impacted by increased flows.

It is noted that this PDA aims to match drainage sub catchments with “development” catchments as defined in Figure 2 (although this cannot always be achieved).

3.3 Existing WSUD Application

In addition, new development must be treated to the Best Practice Environmental Management Guidelines (**BPEMG**) objectives for environmental management of stormwater being:

- Total Suspended Solids (TSS) 80% retention of the typical urban annual load,
- Total Phosphorus (TP) 45% retention of the typical urban annual load,
- Total Nitrogen (TN) 45% retention of the typical urban annual load,
- Litter 70% retention of typical urban annual load, and
- Flows Maintain discharges for the 1.5-year ARI at pre-development Levels

Existing WSUD application in the HSSP area is limited to placement of pondages/retarding basins within the existing township and in new developments south of the township (such as in the Golf Course Road development (Figure 3). Figure 6 details a typical form of the constructed pondages in the area.

Figure 6 **Typical Existing Pondage**
Location – Existing Golf Course Road Development

Pondages (in a WSUD sense) should be treated as receiving bodies, not treatment elements. This is because, without pre-treatment of sediment and nutrients, the pondages can exhibit ongoing water quality issues over time.

Therefore, although the pondages are providing some stormwater treatment (mainly retaining sediment and total suspended solids (**TSS**)), they will not be treating their contributing catchments to best practice, and may be prone to ongoing issues themselves.

It is suggested that future application of WSUD in the base of retarding basins be gross pollutant traps (**GPT's**, primary treatment) to sediment ponds (secondary treatment) to wetlands (tertiary treatment) as per a best practice treatment train approach.

It is noted that the existing table drains cannot (generally) be considered functioning WSUD elements. To function as a WSUD element a swale is required to be (at least) fully grassed. As table drains or drains exhibiting erosion (Figure 4), many of the table drains are "part of the problem". That is, they contribute sediment and TSS to the runoff, rather than treat these pollutants. Future application of swale drains need to ensure they are fully grassed and maintainable well into the future.

3.4 Former GWMWater Irrigation System

It is noted that the Department of Environment Land Water and Planning (**DELWP**) map base currently defines a large amount of (decommissioned) irrigation channels as "waterways". These systems:

- Never had a "waterway function" in the drainage sense, and
- Have almost all been decommissioned, filled in and reconstructed to adjacent natural surface levels.

There are two exceptions to this being:

- Reconfiguring of the irrigation channel south of the Haven Township as an elevated walking /access path, and
- Retention of the shallow irrigation pipeline though the Golf Course Road development (as described in Section 3.2 above).

Both of these "assets" should be considered in any SWMS going forward in regard to any constraints and/or opportunities they may place on future drainage system augmentation.

4 PDA Proposed Direction in Regard to SWMS Development

It is the intent of this PDA Report to give council some direction forward in relation to how a SWMS can be developed in the large and complex drainage area. It is noted that this PDA is only the first step in regard to development of the SWMS for the HSSP area.

4.1 Catchment and Flow Path Delineation

The HSSP area encompasses an area of some 4,537 ha. The area varies in regard to:

- Existing drainage provisions and issues (as described in Section 3 above),
- Proposed densification of land use, and in
- What drainage "solutions" can actually work given individual catchment conditions and individual site attributes and constraints.

In essence, every catchment, drainage line and (by inference) overall drainage solution for each catchment (and in some cases sub catchment) will be different. In addition, each strategy, while contributing to the SWMS of the HSSP as a whole, must be developed on a catchment by catchment basis. This is in line with the principles of a "total catchment management" approach.

The first step in regard to understanding the scale of the project is to understand the catchment delineation in the area. As such, SWS has formulated "approximate" catchment boundaries and overland flow conveyance paths as per Figure A.1 (Appendix A).

These catchments have then been considered on an individual basis in regard to meeting the requirements as discussed in Section 3 above.

It is noted that catchment (and sub catchment) flood retardation and stormwater pollutant requirements are generally envisaged to be met in one of two ways. These are discussed below.

4.2 Individual Drainage Schemes

Drainage Schemes is a term used by Melbourne Water (and other Victorian Councils) to define a SWMS at a catchment scale. Essentially, large scale wetland/retarding basins and conveyance mechanisms are proposed (pipes, overland flow paths and waterways (if required)) to convey, treat and retard stormwater on a catchment (or sub catchment scale). Then as each development occurs the landowner either:

- Constructs drainage works in kind,
- Pays a drainage levy towards the drainage works, or
- Contributes as a combination of both of the above.

In regard to Figure A.1, SWS recommends that at least 7 drainage schemes be considered for the HSSP being:

1. Catchments A1 – A3,
2. Catchment B1 – B3,
3. Catchment C1,

4. Catchment E1,
5. Catchment F1,
6. Catchment G1, and
7. Catchment H3.

These catchments:

- Have appropriate sites located at strategic locations in the catchment which are applicable to accommodating a large scale asset via being:
    - in Council owned land,
    - at a location which will significantly aid development of adjacent land, and/or being
    - located directly at a HSSP area outfall point etc);
- Can encompass a catchment scale solution which will not only aid in development of the whole catchment, but also (potentially) aid in alleviating existing drainage issues; and
- Will generally incorporate relatively dense development in the future (e.g.: “Large Life style Residential 1ha – 2 ha”(or less), commercial and/or industrial development). In developments of this type of site scale applications are limited and complex to apply on a site by site basis and payment of the Drainage Scheme Levy is a simple solution for the developer and Council.

4.3 Development Via Permit Conditions

Densification of lots to areas of greater than 2ha may occur in an ad hoc basis in the HSSP area. This is largely because there are areas which exhibit a significant amount of landholdings in the order of the densification proposed under the current HSSP proposals. As such, uniform and staged development of areas defined as “rural living residential (2ha – 10 ha, or larger)” cannot be assumed. In these areas it may be more prudent to allow development via permits conditions requiring:

A. Definition of an agreed legal point of discharge,
B. Drainage of the development site by grassed swale systems to the legal point of discharge,
C. Identification of building envelopes, access locations and any site fill requirements as per the suggestions in Section 5.6 of this report,
D. Surface 1% AEP flood retardation (to predevelopment flow rates) in shallow “landscaped” basins or shallow ponding in roads, noting that surface retardation is advocated as, in most cases, the receiving waterway or drain directly downstream of the development will be very shallow, and
E. On site Water Sensitive Urban Design (**WSUD**) initiatives such as tanks (for use of stormwater for toilet flushing and laundry) in combination with the shallow swale conveyance system advocated above.

The catchments identified as largely being suitable for this approach are:

- Catchment B1 because it discharges to the existing Golf Course Road Development area (where flooding cannot be exacerbated) although at a catchment scale it would also need to

be considered as part of the overall B1 – B3 drainage scheme to ensure best practice water quality objectives are met,

- Catchment D1 – D4 because they are on the fringes of the HSSP and discharge directly to Bungalally Creek or MacKenzie Creek,
- Catchment F2 because its land use is not proposed to change,
- Catchments G2 and G3 because their land use is not proposed to change,
- Catchments H1, H2 and H4 because their land use is not proposed to change,
- Catchment I1 because there are only a couple of potential developers. These developers could develop strategies in line with small drainage schemes themselves.

4.4 Overall HSSP SWMS Assessment

In summary Flood Retardation provisions are proposed to be met via a site draining to a defined retarding basin (in a drainage scheme) or via site scale retardation (as required by permit conditions).

Stormwater Quality requirements are proposed to be met in the same two ways, however it is recognised that best practice stormwater pollutant treatment may not be met via the simple initiatives proposed in Section 4.3 for “development under permit conditions”.

SWS proposes Permit Condition E above because the WSUD assets proposed are simple and easy to construct and maintain (for the ultimate landowner). Essentially the landowner just needs to make sure their tanks of working and they have to mow their swale, with Council just mowing swales in road reserves.

If best practice is exceeded in other “Drainage Scheme” catchments, then Council could apply a water quality shortfall levy to areas not meeting best practice. In essence, areas not meeting best practice pay toward tertiary treatment of stormwater in the larger sediment ponds and wetland located in other more suitable catchments.

As such, development of the SWMS for the HSSP area required both catchment scale drainage scheme development and precinct scale modelling to set an appropriate:

- Drainage Levy for flood mitigation in Drainage Scheme areas,
- Water Quality levy for WSUD infrastructure in Drainage Scheme areas, and
- A “Gap” Water Quality levy in Areas developing under permit conditions requiring site retardation, but incorporating WSUD which will not meet best practice.

To make it easy for Council administration, a uniform rate should be set for each of the above three rate definitions, rather than a catchment by catchment rate. Again, this can only be achieved via consideration of precinct scale modelling, once individual drainage schemes are adopted.

4.5 Proposed Sub Catchment SWMS Development

Given the above, SWS recommends that the drainage schemes and overall HSSP area SWMP be developed in line with the suggestions detailed for each sub catchment as detailed in Tables 1 to 9 below.

It is noted that all the wetland/retarding basins, structural conveyance systems, swales and channels suggested in Tables 1 to 9 have not been sized at this stage. Sizing of these assets, especially determination of drainage reserve sizes (given all considerations such as function requirements (flood retardation and water treatment) access for maintenance, safety, cut batters, sediment pond dewatering areas) will be required as part of the next steps in the development of an overall SWMS for the HSSP area.

It is noted that SWS considers that it is imperative that a Drainage Scheme be developed for the whole of Catchment A (being catchments A1, A2 and A3). This is because this catchment:

- Encompasses the areas identified under the 2022 HSSP plans as the area where the most densification of dwellings will occur;
- Is within a potential change area;
- Is the only “large” catchment which has a defined outfall directly to a waterway (Wimmera River),
- Offers the opportunity to augment and deepen the existing drainage system via the construction of
    - W_RB A2
    - W_RB A3
    - A large (1% AEP?) box culvert conveyance system between W_RB A3 and W_RB A2 (located within the existing Golf Course Road Development, although one lot on the eastern edge of the development will be required to be acquired by Council),
    - A pipeline system between W_RB A2 and W_RB A3, which
- Then allows all “new” adjacent development to now discharge to a deep outfall, allowing piped drainage throughout the most highly developed areas in the HSSP area.

Figure 7 has been formulated to show that (at a high level), the above “strategy” can result in a new “trunk” drainage system in Catchment A between 2 and 4 metres deep. This is expected not only to enable development to occur in the catchment, but also largely alleviate existing drainage issues in the area.

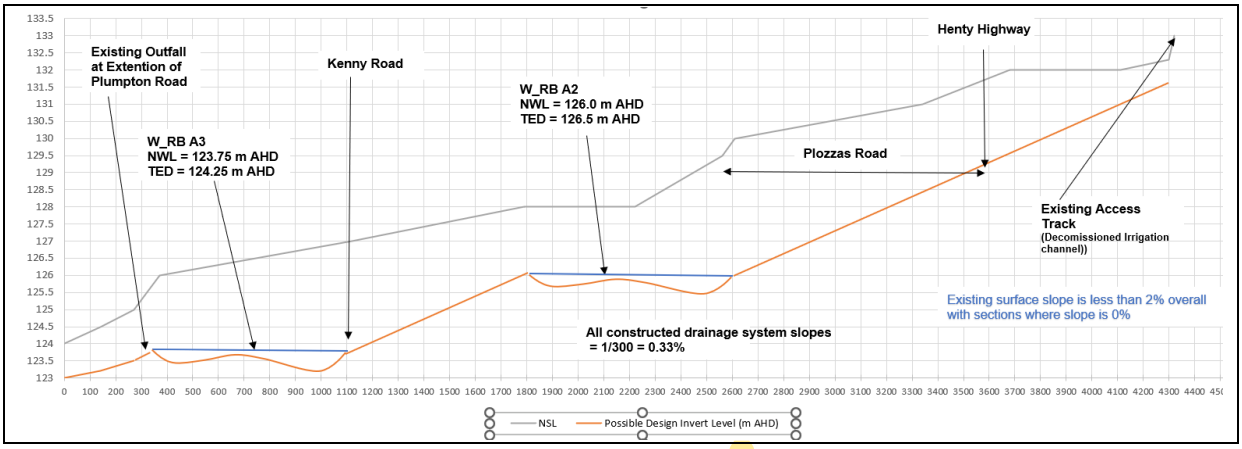


Figure 7 **Possible Longitudinal Section of a “Truck” drainage system in Catchment A along the alignment detailed in Figure A.1 (Appendix A).**

Table 1 Suggested SWMS Development for Catchments A1 to A3

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
A1 *High Priority Area for Drainage*	1 – 2 ha large lifestyle residential north of Mackies Road 2 – 10ha rural living south of Mackies Road	Assume densification to 1 ha lots north of Mackies Road Assume densification to 2 ha lots south of Mackies Road	Develop a drainage strategy for Catchment A1 which will be further incorporated assessed in conjunction with the proposals for Catchments A2 and A3 as an overall Catchment A Drainage Scheme. Conveyance System • Grassed swale drains running generally along existing drainage paths and existing central gully. Flood Retardation – W_RB A1: • Formalise retardation function of existing depression to ensure no increase in 1% AEP flood flow downstream of A1. A new outlet pipe under the access track may be required. WSUD – W_RB A1: • Utilise existing woodland as W_RB A1. W_RB A1 will be an ephemeral treatment wetland via planting in and around existing trees with sedges and rushes and formalising outlet under trail. • Utilise grassed swale treatment function • Incorporate tanks for toilet flushing and laundry on all new dwellings NOTE: No excavation of change to significant ecology in depression now defined as Retarding Basin/Wetland A1
A2 *High Priority Area for Drainage*	1 – 2 ha large lifestyle residential and Haven Activity district east of Henty Hwy Highest concentration density west of Henty Hwy	Assume densification to 1 ha lots and define high fraction imperviousness in actively centre east of Henty Highway. Assume densification to 0.2 ha lots west of Henty Highway	Develop a drainage strategy for Catchment A2 which will be further incorporated/assessed in conjunction with proposals for Catchments A1 and A3 as an overall Catchment A Drainage Scheme. Conveyance System • New piped drainage (1/300 slope) from the new Haven Activity Centre (and picking up the (new) outlet from W_RB A1) under Henty Hwy and running along Plozzas Road to discharge into W_RB A2. Flood Retardation – Retarding Basin A2: • Retarding basin flood storage provision above the TED level of W_RB A2 WSUD • New “on line” sediment pond and wetland in the base of W_RB A2 • Incorporate tanks for toilet flushing and laundry on all new dwellings
A3 *High Priority Area for Drainage*	Largely industrial, with some existing residential	Define high fraction imperviousness in areas which may ultimately be industrial Retain appropriate fraction imperviousness for existing residential areas. Assume densification to 0.2 ha lots west of Henty Highway	Develop a drainage strategy for Catchment A3 which will be further incorporated assessed in conjunction with proposals for Catchments A1 and A2 as an overall Catchment A Drainage Scheme. Conveyance System • New piped drainage (1/300 slope) between W_RB A2 and W_RB A3. • Disconnect upper catchment from old irrigation pipe Flood Retardation – Retarding Basin A2: • Retarding basin flood storage provision above the TED level of W_RB A3 WSUD • New “on line” sediment pond and wetland in the base of W_RB A3 • Incorporate tanks for toilet flushing and laundry on all new dwellings

Table 2 Suggested SWMS Development for Catchments B1 to B3

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
B1 *High Priority Area for Drainage*	Largely 2 – 10 rural living over most of catchment	Assume densification to 2 ha lots	Assume individual lots can subdivide to 2ha (subject to permit conditions) in line with the principles below. However, this area is to be incorporated into an overall drainage scheme for Catchment B, as wetland in W_RB B1 will be proving water quality benefits. Conveyance System • New developments to ensure existing conveyance mechanisms and flow paths retained from external catchments are enlarged/augmented (as formal grassed swales) if possible. Flood Retardation: • Flood retardation on site by site basis. Permits to allow surface 1% AEP flood retardation (to predevelopment flow rates) in shallow "landscaped" basins, shallow ponding of roads etc. WSUD - best practice required on a site by site basis. • New grassed swales (or linear ephemeral, vegetated wetland systems) can contribute to WSUD initiatives on a site by site basis • Incorporate tanks for toilet flushing and laundry on all new dwellings NOTE: No significant excavation or change to existing drainage system expected.
B2	Existing residential development and Golf course	No change assumed.	Connecting the old irrigation pipeline (which is the primary drainage outfall from Catchment B1) to W_RB B1 should aid in allowing this pipeline not to be full of water in between flood events (as currently occurs). This should help existing drainage issues in the area. Notwithstanding the above, the cause of the ponded water in the existing pipeline should be investigated by Council. Existing drainage system (and possible modifications) to be incorporated into an overall Drainage Scheme for Catchment B
B3 *High Priority Area for Drainage*	Defined as "Long term Growth Area" in the current July 2022 HSSP	Assume densification to 0.1 ha lots	Develop a drainage strategy for Catchment B3 which will be further incorporated assessed in conjunction with proposals for Catchments B1 and B2 as an overall Catchment B Drainage Scheme. Conveyance System • Consider enlarging and deepening old irrigation pipe and connect into proposed W_RB B1 for total catchment flood retardation and treatment (Catchment B1, B2 and B3) Flood Retardation – Retarding Basin B1: • Retarding basin flood storage provision above the TED level of W_RB B1 WSUD • New "on line" sediment pond and wetland in the base of W_RB B1 • Incorporate tanks for toilet flushing and laundry on all new dwellings

Table 3 Suggested SWMS Development for Catchment C1

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
C1 *Mostly High Priority Area for Drainage*	Suburban Residential < 0.1 ha)	Assume densification to 600 m^2 lots	Develop a standalone drainage scheme to be developed for Catchment C1 Conveyance System • New piped drainage (1/300 slope) and associated overland flow paths along road reserves to discharge to W_RB C1 Flood Retardation – Retarding Basin C1: • Retarding basin flood storage provision above the TED level of W_RB C1 WSUD • New "on line" sediment pond and wetland in the base of W_RB C1 • Incorporate tanks for toilet flushing and laundry on all new dwellings

Table 4 Suggested SWMS Development for Catchments D1 to D4

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
D1 D2 D3 D4 *High Priority Area for Drainage*	About 70% of catchment(s) 2 – 10 ha rural living over most of catchment About 30% of catchment(s) > 10 ha rural Properties	Assume densification to 2-5 ha lots	Assume individual lots can subdivide to 2 to 5 ha subject to permit conditions in line with the principles below. Conveyance System • New developments to ensure existing conveyance mechanisms and flow paths retained from external catchments are enlarged/augmented (as formal grassed swales) if possible. Flood Retardation: • Flood retardation on site by site basis. Permits to allow surface 1% AEP flood retardation (to predevelopment flow rates) in shallow "landscaped" basins, shallow ponding of roads etc. WSUD - best practice required on a site by site basis. • New grassed swales (or linear ephemeral, vegetated wetland systems) can contribute to WSUD initiatives on a site by site basis • Incorporate tanks for toilet flushing and laundry on all new dwellings NOTE: No significant excavation or change to existing drainage system expected.

Table 5 Suggested SWMS Development for Catchment E1

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
E1 *Partly inside High Priority Area for Drainage*	About 40% of catchment 2 – 10 ha rural living over most of catchment About 40% of catchment > 10 ha rural Properties About 20% of the catchment - agricultural	Assume densification to 2 ha lots Assume 10 ha lots Assume no change to agricultural use	Develop a standalone drainage scheme for Catchment E1 which is a combination of piped and swale drainage to new wetland/retarding basin W_RB E1 located in the buffer to the industrial area to the east. Conveyance System • Combination of swales and a new piped drainage (1/300 slope) Peukers Road and Grampians Road to relatively deep outfall at the new W_RB E1 Flood Retardation – Retarding Basin A2: • Retarding basin flood storage provision above the TED level of W_RB E1 WSUD • New "on line" sediment pond and wetland in the base of W_RB E1 • Incorporate tanks for toilet flushing and laundry on all new dwellings Note that overtreatment of E1 may occur (given limited development proposed, but this could offset other catchments in the HSSP which do not meet current best practice requirements.

Table 6 Suggested SWMS Development for Catchments F1 and F2

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
F1 *Inside High Priority Area for Drainage*	Mainly 2 – 10 ha rural living over most of catchment HSSP states to "protect area fronting Western Highway for "long term commercial"	Assume densification to 2 ha lots Assume appropriate commercial fraction imperviousness.	Develop a stand-alone drainage scheme for Catchment F1 which is a piped drainage to new wetland/retarding basin W_RB F1 located just south of the Western highway. Conveyance System • New piped drainage (1/300 slope) constructed as development south of the Western Highway proceeds Flood Retardation – Retarding Basin F1: • Retarding basin flood storage provision above the TED level of W_RB F1 WSUD • New "on line" sediment pond and wetland in the base of W_RB F1 • Incorporate tanks for toilet flushing and laundry on all new dwellings
F2 *Outside High Priority Area for Drainage*	To remain Agricultural	No Change	W_WB F1 requires a new outfall drain to be constructed though the HSSP area land to the south of the Western Highway (to Burnt Creek) to ensure provision of a functioning outfall.

Table 7 Suggested SWMS Development for Catchments G1 – G3

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
G1 *Inside High Priority Area for Drainage*	Mainly light industrial	Define high fraction imperviousness assuming ultimate industrial development	Develop a standalone drainage scheme for Catchment G1 which is a piped drainage to new wetland/retarding basin W_RB G1 located just south of Kenny Road. Conveyance System • New piped drainage (1/300 slope) constructed as development south of Kenny Road proceeds Flood Retardation – W_RB G1: • Retarding basin flood storage provision above the TED level of W_RB G1 WSUD • New “on line” sediment pond and wetland in the base of W_RB G1 Note outfall from W_RB G1 can be achieved by connecting into existing pipe system at Turnbull Drive
G2 *Inside High Priority Area for Drainage*	To remain Industrial	No Change assumed	Infill development to be managed via appropriate permit conditions.
G3 *Outside High Priority Area for Drainage*	To remain existing Residential Development	No Change assumed	No works required. Little, or no, additional development potential

Table 8 Suggested SWMS Development for Catchments H1 to H4

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
H1 *Inside High Priority Area for Drainage*	Mainly 2 – 10 ha rural living over most of catchment Some agricultural land east of Western Highway	Assume densification to 2 ha lots, although this has largely occurred already in this catchment. It is noted individual site drainage strategies are currently proposed in this catchment.	Assume individual lots can subdivide to 2ha subject to permit conditions in line with the principles below. Conveyance System • New developments to ensure existing conveyance mechanisms and flow paths retained from external catchments and enlarged/augmented if possible. • It is imperative that individual developments have an agreed legal point of discharge with Council. Flood Retardation: • Flood retardation on site by site basins. Permits to allow surface 1% AEP flood retardation (to predevelopment flow rates) in shallow "landscaped" basins, shallow ponding of roads and/or underground tanks (if outfall invert levels allow) etc. WSUD - best practice required on a site by site basis. • New grassed swales (or linear ephemeral, vegetated wetland systems) can contribute to WSUD initiatives on a site by site basis • Incorporate tanks for toilet flushing and laundry on all new dwellings
H2 *Inside High Priority Area for Drainage*	To remain Agricultural	No Change	Assumed no HSS changes

Table 8 (Continued) Suggested SWMS Development for Catchments H1 to H4

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
H3 *Inside High Priority Area for Drainage*	Suburban Residential (< 0.1 ha)	Assume densification to 600 m^2 lots This catchment, although small, may be one of the hardest to coordinate a strategic response to drainage, given the small existing landholdings in the area.	Assume individual lots can subdivide to 600 m^2 subject to permit conditions in line with the principles below **OR** formation of a drainage scheme for H3 could be considered by Council Conveyance System • New developments to ensure existing conveyance mechanisms and flow paths retained from external catchments and enlarged/augmented if possible. • It is imperative that individual developments have an agreed legal point of discharge with Council. • Alternatively, Council (or a developer consortium) could formalise a drainage system as a drainage scheme where small pipes discharge to a new wetland/regarding basin W_RB H3 located in the proposed open space south of the Burnt Creek Anabranch Flood Retardation: • Flood retardation on site by site basin. Permits to allow surface 1% AEP flood retardation (to predevelopment flow rates) in shallow "landscaped" basins, shallow ponding of roads and/or underground tanks (if outfall invert levels allow) etc. • Alternatively, Council (or a developer consortium) could provide a retarding basin in the new open space are located south of the Burnt Creek Anabranch . WSUD - best practice required on a site by site basis. • New grassed swales (or linear ephemeral, vegetated wetland systems) can contribute to WSUD initiatives on a site by site basis • Incorporate tanks for toilet flushing and laundry on all new dwellings. • Council could formalise a drainage system where small pipes discharge new wetland/regarding basin W_RB H3 located in the proposed open space south of the Burnt Creek Anabranch
H4 *Outside High Priority Area for Drainage*	To remain Residential	No Change	Assumed no HSSP changes

Table 9 Suggested SWMS Development for Catchments A1 to A3

Catchment	Potential Development	Catchment change to be allowed for in development of SWMS	Potential drainage strategy required to be investigated
I1	HSSP states "Large Lifestyle Residential (1ha – 2ha)	Assume densification to 1ha lots It is noted that Council is currently considering development proposals in this catchment.	Assume individual lots can subdivide to 1 ha subject to permit conditions in line with the principles below. There are (possibly) two distinct catchments draining north and south to separate outfall points. Therefore collaboration between landholdings in the same catchments would be beneficial to all in regard to producing a coordinated drainage response. Conveyance System • New developments to ensure existing conveyance mechanisms and flow paths retained from external catchments and enlarged/augmented (as formal grassed swales or pipes) if possible. Flood Retardation: • Flood retardation on site by site (or preferably catchment by catchment) via retarding basin provisions. Permits to allow surface 1% AEP flood retardation (to predevelopment flow rates) in (preferably) flood storage provided above wetlands and sediment ponds (servicing a whole catchment). WSUD - best practice required on a site by site basis. • The preferred solution would be pipes/swales out falling into sediment ponds and wetland systems located upstream of defined catchment outfall points. The sediment pond and wetlands would be located in the base of the retarding basin(s) described above. • Incorporate tanks for toilet flushing and laundry on all new dwellings Alternatively, Council could consider investigating a small drainage scheme in this area to aid in supporting a coordinated drainage response from affected landowners. Otherwise, individual permit conditions on individual development may be required.

5 Other Considerations

Other important considerations in regard to the application of an overall SWMS for the HSSP area are described below.

5.1 Asset Ownership and Maintenance

All large drainage assets (as suggested in Appendix A) are assumed to ultimately by Council assets in this PDA. In line with this, SWS has only proposed assets which require minimal maintenance (such and grassed channels, wetlands etc), rather than high maintenance assets such as bioretention systems.

Site and lot scale WSUD and conveyance assets required under permit conditions (such as roof tanks for stormwater harvesting on site and site scale swales and flood storage provisions) will ultimately be maintained by the individual landowner. Maintenance may be required to be ensured via appropriate site 173 agreements going forward.

5.2 Ecology

The 2022 E&HP Report details a desktop assessment of the existing ecological areas of significance in the HSSP area. It is assumed that all mitigation measures suggested in the 2022 E&HP report will be undertaken going forward.

The ecological attributes in the area have been identified as per the current HSSP proposals (Figure 1). The PDA presented in this report largely avoids large drainage assets in areas of significance (although this is required to be confirmed into the SWMS preparation phase).

Notwithstanding the above , further ecological assessment will be required as the projects develop into adoption of Drainage Schemes (if deemed appropriate by Council), and formulation of the concept design of the proposed drainage scheme assets.

WSUD, sediment ponds, wetlands and vegetated channels should support the 2022 E&HP Report design principle recommendations of providing naturalistic assets to supplement the existing ecological attributes of the area and providing addition wildlife habitat corridors etc.

5.3 Soils and Landforms

The soils within the HSSP area (as per Figure 7 below) appear to be predominantly

- Cracking and self-mulching clays on the edges of the HSSP area and
- Seasonally wet soils covering much of the centre of the HSSP area.

In general clayey soils are ideal for placement/construction of sediment ponds and wetland systems as they help “hold the water”. The deepening of the drainage outfall system (in Drainage Scheme areas) will help alleviate nuisance flooding associated with the seasonally wet soils. Notwithstanding the above, detailed soil tests will be required at the location of proposed drainage scheme assets, if they are ultimately progressed to the functional design stage of adoption.

The most significant landform in the area is the lunette formation in the western portion of the HSSP. This forms a natural barrier to stormwater flowing west (from the HSSP area) and is an area of very high cultural heritage. This has been accounted for in the preliminary recommendations of this PDA.

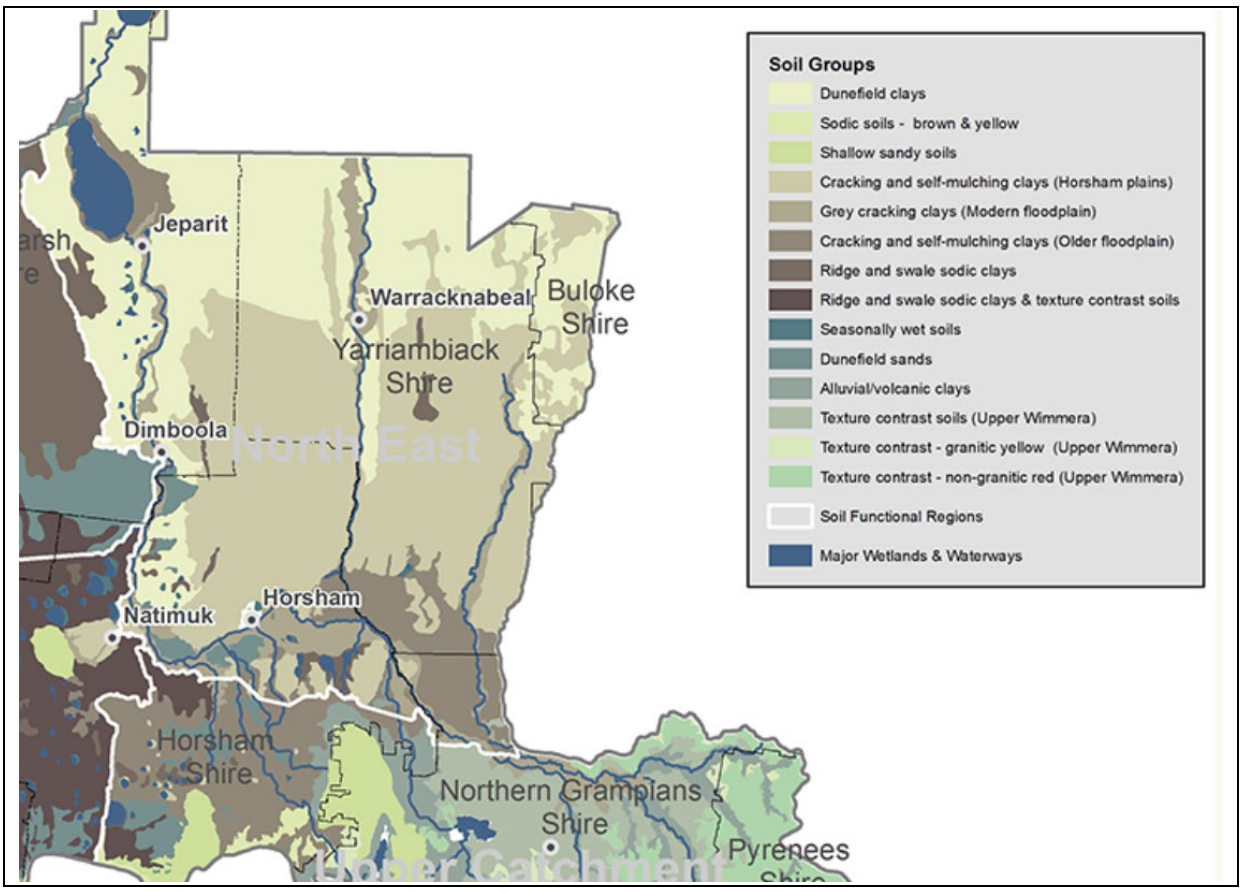


Figure 7 Wimmera Soil Types (Source : WCMA web site)

5.4 Aboriginal Cultural Heritage

The formulation of the HSSP has considered “Aboriginal Sensitive Areas” as defined on the Vic Data web site and as identified by local knowledge etc.

These areas have been accounted for (at a high level) in the formation of the PDA proposals in this report.

Notwithstanding the above, more detailed aboriginal cultural heritage assessments will be required as the projects develop into adoption of Drainage Schemes (if deemed appropriate by Council), and formulation of the concept design of the proposed drainage scheme assets. It goes without saying that collaboration with the appropriate first nation people(s) is essential going forward.

5.5 Other Considerations

As with development of drainage schemes and drainage strategies in other areas of Victoria the following may also be required to be considered going forward.

1. Future catchment scale proposals should be based on (at least) 200 mm lidar information (this PDA is largely based on 1 m lidar information)

2. Drainage scheme development must consider all other local services affecting each sub catchment including water, gas, communication and electrical services.

3. The development of individual drainage schemes and the overall HSSP SWMS may require detailed “rain on grid” flood modelling of the proposals (which will firstly be designed using simpler models such as RORB and Hec Ras) to assess the benefits of the proposals in regard to alleviating existing flooding issues.

4. An ANCOLD assessment may be required on any retarding basin asset ultimately required to incorporate a raised embankment. Retarding basins proposed to be totally cut construction will not generally require this assessment.

5. Individual drainage schemes may identify areas required to be filled to accommodate development. This fill may be for flood protection (i.e. freeboard considerations etc) or to provide cover over pipelines to ensure the pipes can fall to an identified outfall system. Areas identified as requiring fill should be shown (at least at a high level) at the drainage scheme development stage of each catchment.

6. Where permit conditions will apply to development, SWS suggests that given the flat nature of the area, that all new dwellings require the developer to show building envelopes and proposed access roads/driveways. It would be prudent to require building envelopes to be raised 300 mm above natural surface level and access roads to be raised 150 mm above natural surface level (at least) to ensure new assets are not prone to nuisance flooding. Consideration of siting of the above MUST consider the effect this filling may have in regard to increasing the flood effect on adjacent properties.

6 Progression to Implementation of a SWMS for the HSSP Area

The development of a SWMS for the HSSP will be to ensure that there is an overall planned approach to the development of undeveloped areas in the HSSP area. This PDA is the first step in developing an applicable SWMS.

This PDA identifies:

- Problem areas and constraints,
- The existing drainage system(s) and associated issues, and
- Council opportunities in regard to implementation of an appropriate HSSP SWMS.

SWS suggest the next step is to formulate a high level HSSP SWMP by:

- Developing all retarding basins, sediment ponds, wetlands, channel and pipes suggested in the PDA to an appropriate concept design level (noting that this includes definition of an appropriate drainage reserve for each asset given appropriate definition of key asset levels (e.g. NWL, TED), cut lines, access tracks and maintenance provisions such as sediment pond dewatering areas);
- Assessing the overall flood retention benefits of the concept designs (and proposed possible permit conditions in areas not to be serviced by drainage schemes) of the entire HSSP SWMS area using an appropriate hydrologic model (such as RORB);
- Assessing the overall stormwater pollutant benefits of the concept designs (and proposed possible permit conditions in areas not to be serviced by drainage schemes) of the entire HSSP SWMS area using an appropriate model such as MUSIC;
- Undertaking preliminary costing of the major drainage works proposed, and
- Proposing possible drainage levies for flood retardation and stormwater treatment in both proposed drainage scheme areas and areas which may develop under permit conditions, noting that proposed assets may be able to offset shortfalls in other catchments via levy payment schemes.

After this “overriding” work has been completed, more detailed design work may be required on an individual Drainage Scheme scale. Particular focus should be placed on the catchments located in potential “change” areas being catchments A1 to A3, C1, E1, G1 and H3 (with consideration of H1 and H2).

Given the above, it is noted that there is significant work required before an ultimate SWMS can be adopted by Council. However it is suggested that:

- Council adopt the high level direction(s) proposed in this PDA, and
- Obtain agreement from the WCMA to the overriding direction with regarding the development of the SWMS for the HSSP that this PDA advocates.

7 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which are referred to in this report.

Abbreviation Descriptions	Definition
AHD - Australian Height Datum	Common base for all survey levels in Australia. 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. A 100 Year ARI event has a 1 in 100 chances of occurring in any one year.
AEP – Annual Exceedance Probability	The chance of a storm (flow) of that magnitude (or larger) occurring in a given year. $AEP = 1 - e^{(\frac{-1}{ARI})}$. i.e. 20% AEP = 5 Year ARI (Approx), and 1% AEP = 100 Year ARI.
ANCOLD	Australian National Committee on Large Dams
BPEMG	Best Practice Environmental Management Guidelines. Available from: https://www.epa.vic.gov.au/business-and-industry/guidelines/water-guidance/urban-stormwater-bpemg
Bioretention system	WSUD elements which are used to collect TSS, TP and TN. Incorporates a horizontal vegetated base over which ponded water (to TED) infiltrates a sand filter for treatment.
DSS or DS	Development Services Scheme (DSS) or Drainage Scheme (DS) is a master plan developed my MWC for drainage within a catchment area.
EY – Exceedances per year	The amount of times a storm (flow) of that magnitude is expected to be exceeded per year. i.e. 4 EY = 3 Month ARI
GPT – Gross Pollutant Trap	Structural drainage mechanism usually placed on a pipeline (or drainage conveyance system) to specifically collect gross pollutants and large sediment.
Hectare (ha)	10,000 square metres
HECRAS	A hydraulic software package that enables the calculations of flood levels and velocities along a waterway given a specified flow.
m^3/s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC	Melbourne Water Corporation
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
NWL - Normal Water Level	Water level of a wetland or pond defined by the lowest invert level of the outlet structure
RORB	Hydrologic computer program used to calculate the design flood flow (in m^3/s) along a stormwater conveyance system (e.g. waterway)
Sediment basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by Settlement processes.
TED – Top of Extended Detention	Level to which water ponds in a wetland (above NWL) which encompasses water stored for treatment (as opposed to water stored for flood retardation (which occurs above this TED level if the wetland is located in a retarding basin)).
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to ○ Convey stormwater safely ○ Retain stormwater pollutants ○ Enhance local ecology ○ Enhance the local landscape and social amenity of built areas
Wetland	WSUD elements which are used to collect TSS, TP and TN. Usually incorporated at normal water level (NWL) below which the system is designed as shallow marsh, marsh, deep marsh and open water areas.

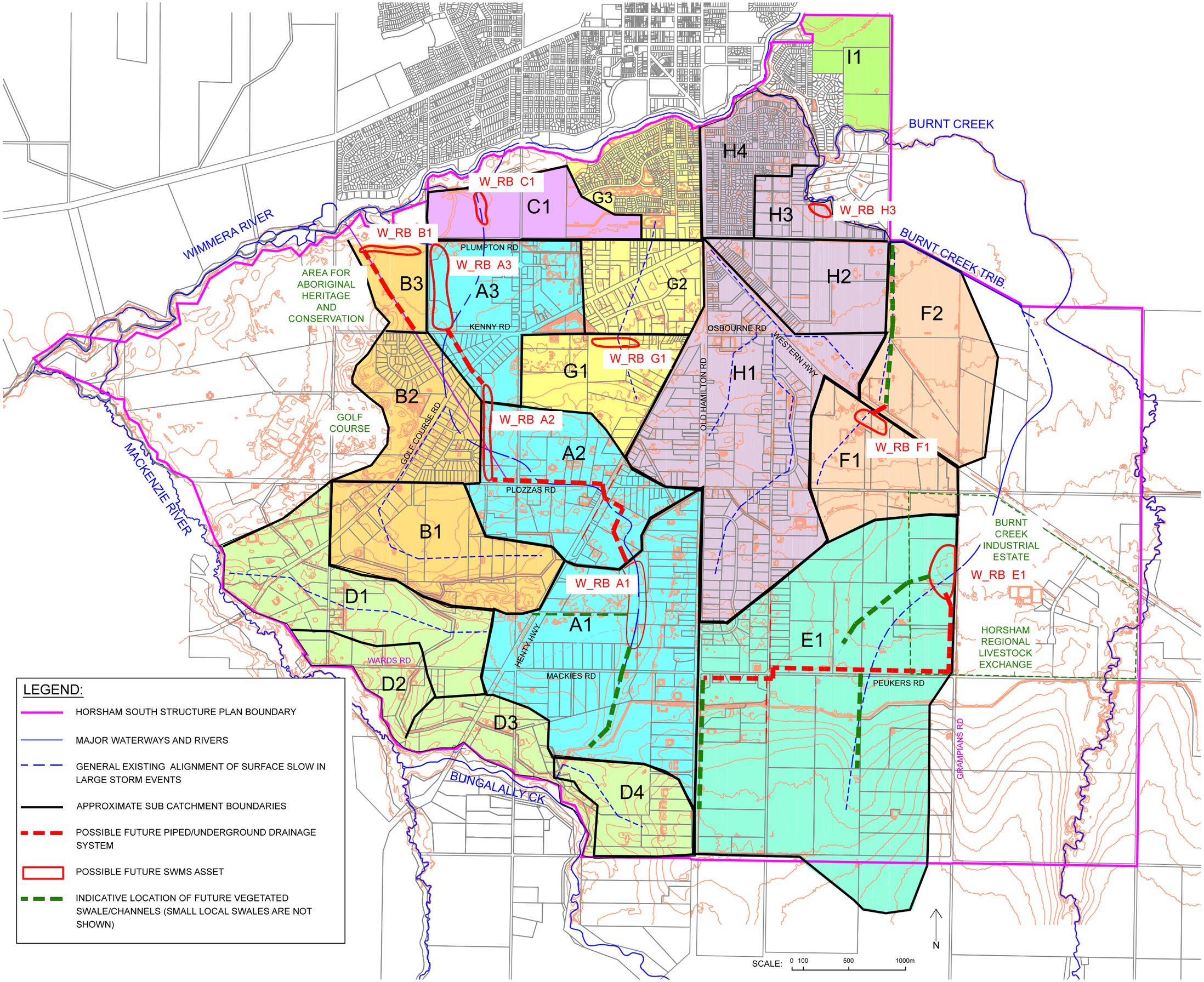
Appendix A Proposed Direction in Regard to SWMS Development

Table A.1 Approximate Sub Catchment Breakdown

Catchment	Sub Catchment	Area (ha)[1]
A	A1	305
	A2	180
	A3	150
	Total	**635**
B	B1	160
	B2	115
	B3	40
	Total	**315**
C	C1	85
	Total	**85**
D	D1	175
	D2	55
	D3	65
	D4	80
	Total	**375**
E	E1	600
	Total	**600**
F	F1	115
	F2	155
	Total	**270**
G	G1	100
	G2	85
	G3	90
	Total	**275**
H	H1	345
	H2	100
	H3	45
	H4	85
	Total	**575**
I	I1	60
	Total	**60**

Note 1 : Catchment approximate only and based on site observations and 1 metre lidar information. Not to be relied on for detailed catchment analysis going forward.

Figure A.1 Sub Catchment Breakdown and High Level Drainage Opportunities Plan



LEGEND:

- HORSHAM SOUTH STRUCTURE PLAN BOUNDARY
- MAJOR WATERWAYS AND RIVERS
- GENERAL EXISTING ALIGNMENT OF SURFACE SLOW IN LARGE STORM EVENTS
- APPROXIMATE SUB CATCHMENT BOUNDARIES
- POSSIBLE FUTURE PIPED/UNDERGROUND DRAINAGE SYSTEM
- POSSIBLE FUTURE SWMS ASSET
- INDICATIVE LOCATION OF FUTURE VEGETATED SWALE/CHANNELS (SMALL LOCAL SWALES ARE NOT SHOWN)