Creamery Road Precinct Structure Plan - Development Services Scheme

ADDENDUM TO FUNCTIONAL DESIGN REPORT: REVISED CONCEPT DESIGNS

June 2024

alluvium

Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This Addendum Report has been prepared by Alluvium Consulting Australia Pty Ltd for the City of Greater Geelong under the contract titled 'Cowies Creek Stormwater Management Strategy'.

Authors: Jenny Butcher, Caroline Carvalho, John Chen
Reviewed: Jenny Butcher
Approved: Jenny Butcher

Version: 04 – Addendum (June 2024) to Functional Design Report (Alluvium, Dec 2022)
Date issued: 26 June 2024
Issued to: Cynthia Quach, City of Greater Geelong
Description: This Addendum Report – Revised Concept Designs is in response to the revised (October 2023) Future Urban Structure, updated technical studies, and the new Conservation Management Plan for Cowies Creek, as well as additional feedback from Council in April 2024.

Title: Creamery Road Precinct Structure Plan - Development Services Scheme – Addendum to Functional Design Report: Revised Concept Designs (Final V04), June 2024.

Cover image: abstract river image, Shutterstock

Contents

Figures

Tables

Abbreviations

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
DCP	Development Contributions Plan
DSS	Drainage Services Scheme
GPT	Gross Pollutant Trap (primary treatment system)
IDA	Integrated Development Area

IFD	Intensity–Frequency–Duration
IWM	Integrated Water Management
PSP	Precinct Structure Plan
RB	Retarding Basin
RCP	Representative Concentration Pathways (for climate change sensitivity)
SB	Sediment Basin (primary treatment system)
SBRB	Integrated sediment basin (primary treatment system) with retarding basin
TGP	Total Gross Pollutants (e.g. litter, debris, coarse materials)
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WL	Wetland
WLRB	Integrated wetland treatment and retarding basin system

1 Introduction

Alluvium Consulting Australia (Alluvium) has been engaged by the City of Greater Geelong (the City) to revise the stormwater drainage solution for the Creamery Road Precinct Structure Plan (PSP).

This revision is to a concept level only. It is presented as this *Addendum Report*, which forms part of the previously delivered Functional Design Report (Alluvium, Dec 2022). This Addendum responds to the October 2023 Future Urban Structure (FUS), updates to various technical studies, the recent Cowies Creek Conservation Management Plan, and seeks to address matters raised in recent submissions to the Draft Development Contributions Plan (DCP) and decisions of the City, as well as further direction from Council provided in April 2024. It builds on the previous functional design level work undertaken on the proposed stormwater drainage infrastructure designs for the PSP.

The City conducted public consultation on the draft DCP Memo and associated technical studies including the stormwater functional designs, delivered by Alluvium in December 2022. The feedback received related predominantly to transport assets and stormwater management (drainage assets) in the precinct.

This Addendum Report responds to the consultation process and captures new technical studies and revised inputs, including the new Cowies Creek Conservation Area Conservation Management Plan (CMP). These have informed this concept-level redesign work which includes revised catchment boundaries, hydrologic and treatment modelling, revised concept layouts, high-level cost estimates and design solutions for the proposed (and some new) stormwater drainage assets to best service the PSP.

These revisions are to a concept design level only. Similarly, the previous cost estimate tables, which were completed to a more detailed functional level, have since been updated in this Addendum Report. However, updated line items, to complement the concept redesigns, have only been updated to a high-level / concept design level only, to ensure project efficiencies in time and cost and scope of works.

The City will pursue the functional design development of all proposed assets following the planning panels process (see note below). The PSP, DCP and FUS for the Creamery Road precinct will be updated in response to this work, in order to finalise the PSP and DCP for Council adoption and exhibition.

Note: It is anticipated that the Development Services Scheme (DSS) will evolve further, post-exhibition and in response to the planning panel Standing Advisory Committee (SAC) recommendations. The final DSS will include functional designs for all proposed assets.

Therefore, this Addendum does not include a revision to the previously completed hydraulic modelling as the concept level re-design changes were not anticipated to influence the precinct-scale flood modelling in any significant manner. Further, the stormwater design approach adopted for the assets has been "in cut" (i.e. no loss of floodplain storage), and the retarding basins (RBs) are designed to retard peak flows to pre-development peak flow rates. An update to the precinct scale flood modelling design scenario can be pursued at a post-exhibition / post-panels process stage.

1.1 Project context

The City is in the process of finalising the Creamery Road Precinct Structure Plan (CRPSP) and Creamery Road Development Contributions Plan (CRDCP) for the precinct.

Following completion of the Creamery Road PSP Functional Design Report (Alluvium, Dec 2022) and the City's subsequent consultation process for the Draft DCP, the following summarises the scope of works for this project, that is – Creamery Road Precinct DSS – *Addendum to Functional Design Report: Revised Concept Designs* (Alluvium, June 2024).

This report seeks to address key concerns and changes in relation to:

- the updated Future Urban Structure (FUS) dated October 2023
- new technical studies and the Conservation Management Plan
- stormwater drainage of the precinct and any further improvements to the overall DSS to further –
  - reduce overall land take and costs wherever possible
  - ensure relevant standards and best practice requirements are being met
  - respond specifically to actions of the Northern and Western Geelong Growth Area (NWGGA) Integrated Water Management Plan (IWMP) and the Northern and Western Geelong Growth Areas Framework Plan 2020.

1.2 Scope of work and principal changes

This Addendum Report responds to the above changes and requirements with regard to the PSP's stormwater related assets and provides concept-level documentation, with clear rationale and recommendations to support the Creamery Road PSP and Development Contributions Plan (DCP). It includes revised asset locations (previously proposed and new), revised drainage corridor widths, land take, concept designs and associated cost estimates (to a high-level) to best inform the ongoing PSP/DCP process.

The City will then further update the FUS in response to this conceptual redesign, allowing the PSP and DCP finalisation and Council's adoption and exhibition.

Below is a summary of the key changes, information inputs, and City / other requirements that have informed this Addendum Report and Concept Redesigns:

- Consider and respond to updated and new background information [refer to Section 2 for a summary of the new / updated background studies that have informed this concept redesign]
- Consider and respond to submissions received and opportunities to maximise developable land
- Consider and address the updated FUS to ensure developable areas are treated to address best practice [refer Table 1 below for a summary of FUS changes and implications on the PSP's stormwater designs]
- Consider and address specific requirements of the new Conservation Management Plan (CMP) relevant to drainage assets and stormwater management
- Consider relocating assets closer to waterway corridors, while remaining as offline systems
- Change batter slopes away from previously nominated 1:8 batters – the City has decided to proceed with 1:5 vegetated batters for all wetland-retarding basin embankments to be consistent with Melbourne Water's guidelines – *Constructed Wetlands Design Manual and Retarding Basin Design Guidelines*
- Consider land ownership when defining sub-catchments and locating assets within a single ownership parcel, where it is practical and cost-effective to do so.
- Update cost estimates accordingly – **Note:** The previous cost estimate tables were completed to a more detailed functional level and have been updated in this Addendum Report. However, updated

line items, to complement the concept redesigns, have only been updated to a high-level / concept design level only.

- Storm water quality treatment objectives
    - Stormwater treatment concepts are required to meet the Urban Stormwater Best Practice Environmental Management (BPEM) Guidelines (CSIRO, 1999) pollution reduction targets as set out in the VPPs, before being discharged into stormwater networks and receiving waters. These targets are defined as:
        - • 70% removal of the Total Gross Pollutant load
        - • 80% removal of Total Suspended Solids (TSS)
        - • 45% removal of Total Nitrogen (TN)
        - • 45% removal of Total Phosphorus (TP).
    - In previous versions of the concept redesign (March 2024), Alluvium has sought to achieve best practice treatment at the outfall of each individual catchment, as opposed to a precinct-wide approach.
    - Council have now directed Alluvium to adopt an offsetting approach, whereby the nutrient removal shortfalls from two small catchments (serviced only by Gross Pollutant Traps as opposed to previously proposed bioretention systems) are offset in treatment assets throughout the precinct, ultimately ensuring that the entire precinct meets best practice treatment targets.
    - Alluvium have not redesigned the remainder of the stormwater assets as a result of this new offsetting approach (i.e. the WLRBs and bioretention systems). Excess nitrogen and phosphorus treatment was already being achieved as a result of Total Suspended Solids being the limiting pollutant (discussed in section 5.2). This approach helps limit overall DCP costs and land take for stormwater assets.
    - Council has confirmed that they have received advice from the Strategic Environment team and is comfortable with the approach of having stormwater from two catchments outfalling into the Cowies Creek conservation areas with only treatment from GPTs.
    - **Future design of treatment assets needs to ensure that as a whole the precinct meets the best practice treatment targets**. This could be done through ensuring that the equivalent load reduction (kg/year) is maintained as the design progress through to detailed design. However, any changes to land use and fraction imperviousness will also need to be carefully considered as the subdivisional designs progress.

Further to the above scope of works and key changes, the City sought the following considerations for the concept redesign under the new FUS:

1. City: Requests a minimisation of dead spaces

   Alluvium: While minimisation of dead spaces or isolated pockets of land around assets improves on land take / potential release of developable land areas, in some cases, catchment or other constraints limit how much these areas can be reduced. It may impact other objectives and priorities of the study, for instance, ensuring assets are located within a single land ownership (property title) to allow efficient development staging.

The concept redesigns are based on application of the new FUS, a redefining of catchment and landuse boundaries, and adjusting asset batter slopes down to 1 in 5 (as per the MW guidelines). The asset extents have been able to be determined to actual top of bank, as a result of using previous earthworks modelling that was undertaken during previous functional design documentation (Dec 2022).

While all due care has been taken to reduce (avoid) dead spaces or isolated pockets of land, in some instances these remain (e.g. around WLRB5 and WW02). Various aspects have affected this including:

- the specific limitations of each sub-catchment
- designing the assets to work with the existing topography (in cut, not fill)
- ensuring assets remain outside the 1% AEP flood extents
- ensuring the assets do not overlap / impact other proposed land uses
- ensuring assets fall within a single property boundary for ease of development staging
- and noting these naturalised and functional assets are not designed to be square structures and contribute to landscape amenity.

2. City: Advises passive open space areas are subject to change

   Alluvium: While it is acknowledged that some changes to passive open space areas may occur in the future, this should have no considerable impact on asset locations or sizing, as long as the open space allocation remains within the same sub-catchment (i.e. not reallocated to a different sub-catchment).

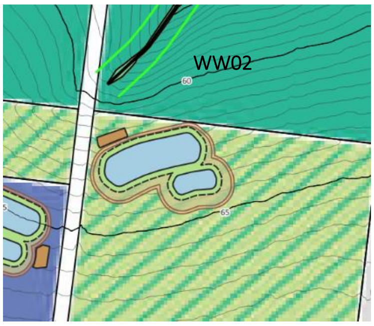
   If this open space allocation does shift into different sub-catchments in the future planning, this will change matters considerably, as it will impact overall fraction impervious (FI) values for the sub-catchment, which in turn informs asset sizing and will require changes to input parameters and remodelling.

This Report is an Addendum to the previously completed Functional Design Report (Alluvium, Dec 2022) and therefore forms part of the completed package of works to inform the stormwater related aspects of the PSP. It addresses the principal changes to the FUS (Dec 2022 version) previously applied to the Functional Design package; accounts for new technical reports that have since been undertaken (during 2023); and addresses the specific inputs and requirements from the City (including the CMP) – all of which have informed this revised stormwater DSS for the precinct.

1.3 Implications of the updated FUS

The table below summarises the key changes to the FUS and the implications on the previously developed stormwater drainage functional designs (Alluvium, Dec 2022) proposed for the Creamery Road growth precinct. These implications have informed our concept redesign response – this Addendum response and summarised below. Note: To ensure all proposed developable areas are treated to best practice, additional assets to manage this stormwater runoff have been added to the overall stormwater drainage solution for the PSP.

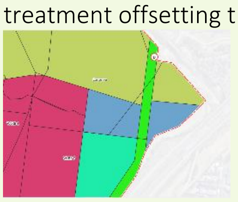
Table 1. Summary of FUS changes and implications on stormwater drainage redesign

FUS Changes	Implication on stormwater drainage design
Conservation boundaries – conservation area has been reduced to the GGF 100m buffer zone and new areas for residential development.	The conservation boundary has been reduced back to the GGF 100m buffer zone which has resulted in more developable land area for residential purposes under the new FUS. These areas require the appropriate treatment and storage solutions in order to meet best practice. This additional developable area has resulted in some changes to asset sizing for **WLRB3b** (associated with 30-35 Avonlea Rd/165 Bluestone Bridge Rd) and **WLRB8** (in north-west portion of the PSP / 200 Geelong-Ballan Rd). WLRB8 has increased slightly within the inlet zone (i.e. sediment basin) as a 'custom outflow storage relationship' was not undertaken in the MUSIC modelling as this is a concept level redesign (typically this modelling is undertaken at functional stages). However, the overall peak storage of the RB component and wetland treatment area have both reduced. Peak storage volume was reduced from 6600m3 to 5130m3, while the wetland treatment area was reduced from 4700m2 to 3900m2.
Transport network – road alignments	Changes to road alignments influence sub-catchment delineations (boundaries) where roads can act as "levees". While the Clever Creative Corridor (CCC) – a key road within the PSP has not shifted, the north-south road which runs through the PSP (east of the CCC) and adjacent to the existing private school, has changed in its alignment. The catchment modelling has taken this into consideration as part of the redesign. WLRB5 has been relocated as close as possible to WW02 and designed along the existing contours (working with existing site fall / topography) to avoid a large land take. However, a small area of dead space is still present as a result of ensuring the asset does not cross property ownership boundaries (remains within a single land parcel). If the asset was moved closer to reduce remaining dead space this would result in the asset crossing land ownership boundaries and an overlapping with the road reserve. WLRB5 with geo-referenced land ownership underlay.  **Note:** The new FUS does not show a road alongside the Cowies Creek conservation management zone. However, Alluvium has presumed a road will run along this alignment to enable stormwater to be conveyed (via the minor/major pipe arrangements) into the proposed PSP stormwater assets.

Drainage corridors – widths of corridors have been updated to respond to Dec 2022 DSS	There is now more developable land area allocated under the new FUS. These areas will require the appropriate treatment and storage solutions to be designed to meet best practice. These additional developable areas have resulted in minor changes to drainage land take as assets have been relocated / redesigned to accommodate FUS changes and/or additional assets are required to treat now developable areas. The table below provides a summary of these changes in land take from previous FUS (2022) to current FUS (2023). WLRB1 has increased in size due to being relocated into the medium landslide zone and is a result of managing the steep grades. Other assets have had minor decreases or no change to overall land take. Overall land take for drainage corridors has increased slightly as a result of accommodating new developable areas with stormwater assets to meet BPEM requirements.

Asset	Catchment Area (last version) (ha)	Catchment Area (Var 6.) (ha)	Previous Asset Land Take (ha)	Current Asset Land Take (ha)
WLRB1	24.0	24.3	1.9	2.3
WLRB2	33.5	33.5	2.5	2.2
WLRB3a	31.8	31.9	1.9	1.7
WLRB3b	24.7	26.7	2.5	2.1
WLRB4	32.2	32.5	1.7	1.6
WLRB5	32.5	34.6	1.8	1.8
WLRB6	31.5	31.5	1.5	1.5
WLRB7	35.3	33.8	2.0	1.6
WLRB8	26.5	18.9	2.2	1.4
SBRB9	New Asset	13.4	New Asset	0.9
Bio 1	3.39	3.66	0.02	0.04

	There was no change to the waterway designs required in this concept redesign phase and these waterway corridors remain the same as per previous (Alluvium, Dec 2022).
Medium density – alterations to extent of medium density areas (purple) – now changed from 30 dwellings/ha to 25 d/ha	The IDA areas were previously modelled with an FI value of 0.9 in line with the proposed 30d/ha developed density at the time. The new FUS has revised this density down to 25 d/ha in the north-west corner of the PSP – now designated 'conventional residential', which has an FI value of 0.75. This has resulted in a reduction in treatment and storage requirements in this catchment and a reduction in the sizing of the treatment/storage area for WLRB8. A slight increase in sediment basin sizing has also occurred.
Moderate Landslide Susceptibility – moderate areas now considered in NDA (net developable area)	The assets were previously (Dec 2022) located outside the moderate landslide susceptibility zones to avoid potential risks. Under the new FUS, areas of moderate landslide susceptibility are now proposed to be 'developable'. This has impacted asset sizing / locations for WLRB1 and WLRB3b where these assets have been shifted further down the escarpments in order to receive future flows from these now developable areas. Asset sizing and levels have changed in the redesigns to accommodate the assets' relocation lower down the escarpment.
High Landslide Susceptibility – now considered potentially developable, subject to further Geotech assessment and drainage	These areas were previously not considered developable. No assets are currently proposed in high landslide susceptibility areas. These areas weren't considered as net developable area but now is, following a recent decision made by the City. Given the time limit, Alluvium is not engaged to investigate these areas to determine a drainage solution and therefore, these matters need to be dealt with later at the subdivision application stage.

assessment to be undertaken by the development proponent at the subdivision application stage	
New Integrated Development Area (IDA) category – IDA 30 d/ha	No change – these areas were previously considered as having a FI of 0.9 (at 30 d/ha) and this would continue to be the case.
Asset relocation – WLRB5	WLRB5 was originally proposed to be located closer to the CCC to support the Barwon IWM network vision, then later consultations, was shifted to Myers Reserve to allow future IWM potential through stormwater harvesting and park irrigation opportunities. Based on the new FUS, WLRB5 has been relocated back towards the CCC, between the road alignments (CCC and North-South road). The catchment size and asset levels have changed slightly to allow for this relocation and to ensure the asset can fit appropriately within this space, minimising land take, dead spaces and avoiding crossing property boundaries / other land uses.
Heritage Homestead – now classified as conventional residential	The heritage listed parcel of land and area east of the homestead was proposed as future 'rural living zone' with a FI of 0.2 and was not previously treated. This area is now proposed as 'conventional residential' which means a FI 0.75 has been applied to the redesign concepts. To meet BPEM requirements for this small area, a Gross Pollutant Trap (GPT) has been proposed (see note). WLRB7 has been adjusted as per revised catchment boundaries. The size of the contributing catchment to WLRB7 has reduced slightly (from 35.32ha to 33.80 ha). This area, under the new FUS will be developed as 'conventional residential', therefore a FI value of 0.75 has been applied in the concept redesign. This has resulted in a slightly larger sediment basin, however the overall land take for the asset has reduced. **Note:** The Heritage Homestead land is located downstream of proposed WLRB7 and will require a separate treatment system for site runoff. Given the small land area, a GPT, as directed by Council, is proposed to treat both parcels (blue) - west and east of Bluestone Bridge Road rather than a WLRB. This will manage Total Suspended Solids only, with nitrogen and phosphorus removal occurring as treatment offsetting throughout the precinct within the other treatment assets.  It should also be noted that this parcel of land is considered to be of medium contamination risk.

In order to respond to the new FUS, the functional design work previously undertaken (Dec 2022) for the PSP has required re-modelling and conceptual re-design of proposed assets, with some additional assets added to treat smaller, now developable areas. This redesign (to a conceptual level only) has involved:

- Re-mapping sub- catchments based on new FUS, new information (reports), staging requirements etc.
- Identifying and designing new assets as required
- Re-doing the treatment (MUSIC) modelling to ensure assets are meeting best practice requirements
- Re-doing the RORB modelling (existing and developed scenarios) based on the new catchments

- Re-doing the sediment capture efficiency and velocity calculations, based on the new catchments and rational calculations
- Refining the asset footprints based on the new sizing requirements (treatment and storage), as well as the reduced batter slopes
- Undertaking concept-level costings on all proposed (and new) assets for the PSP
- New concept design layouts for proposed assets (and new assets)
- Updated recommendations on stormwater drainage and waterway corridor boundaries.

This updated version of the FUS (October 2023) is shown in Figure 1 below, with Figure 2 provided for comparative purposes (as per the table summary above). It should be noted that the Functional Design documentation (Alluvium, Dec 2022) for the Creamery Road precinct was based on the August 2022 version of the FUS. The stormwater asset locations shown in the City's Aug 2022 FUS (Figure 2 below) are actually showing an earlier design iteration (draft stage) and does not reflect the actual finalised Functional Design documentation (Alluvium, Dec 2022).

Figure 1. *Updated FUS (City of Greater Geelong, October 2023)*

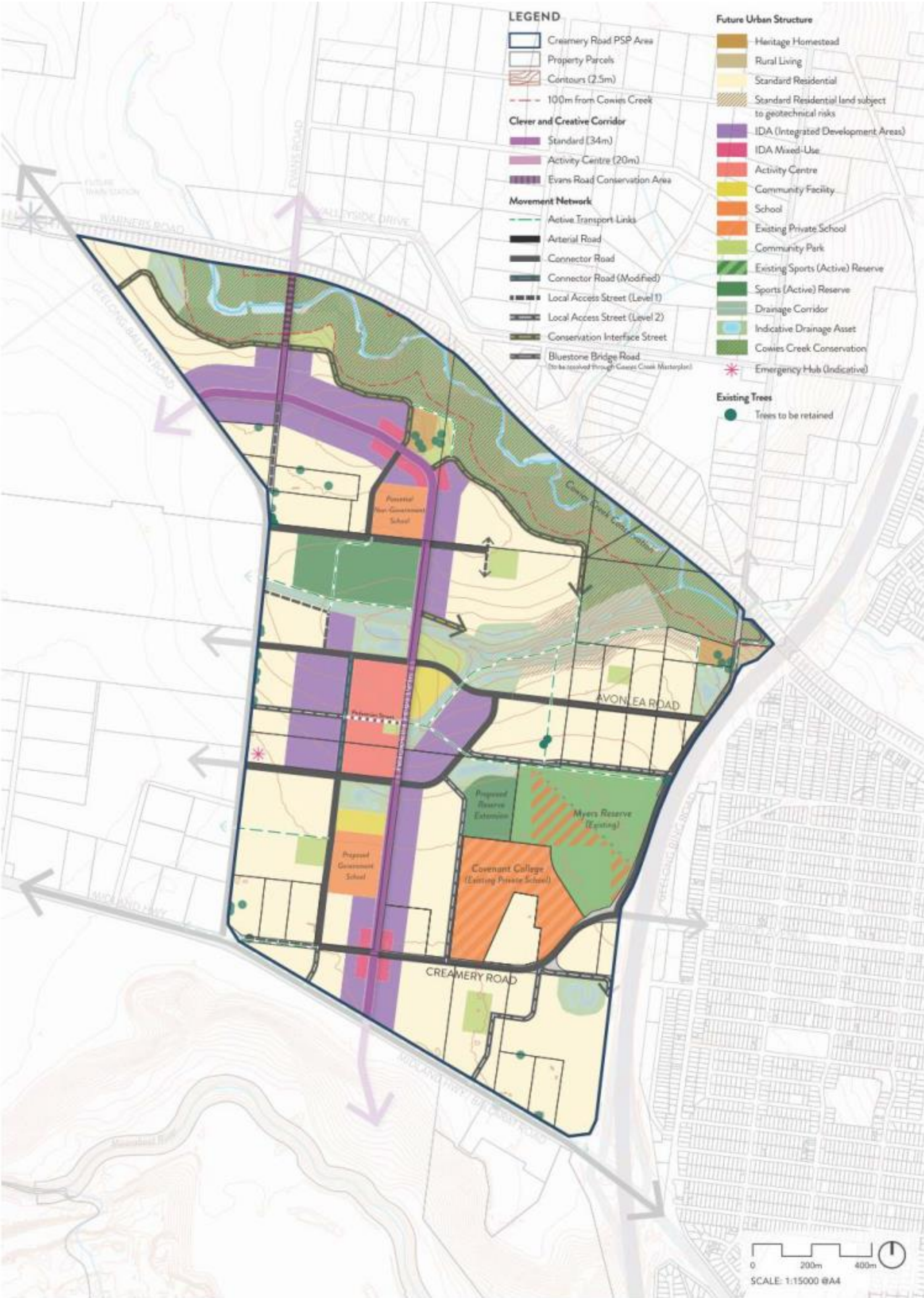


Figure 2. *Previous FUS used to inform drainage modelling and functional designs (City of Greater Geelong, FUS version August 2022)*

1.4 Caveats on concept-level redesign

The previous DSS stormwater design was undertaken to a functional design level (Alluvium, Dec 2022). This Addendum Report and re-design is only to a concept design level as per scope of works. There are differences in the level of detail in the modelling undertaken between the two design phases (functional previously vs concept only here), and the resulting outputs for each, including cost estimations. For instance, custom-stage-storage-discharge relationships are not undertaken in MUSIC for concept design level, therefore, care should be taken when comparing the two.

A summary of the key differences are:

- Treatment: MUSIC modelling to a functional design stage requires custom stage-storage-discharge inputs in the treatment nodes. This can improve treatment results / accuracy, which in turn can mean that treatment assets can be refined and reduced. (Note: TSS has been the limiting factor in this instance). Concept level treatment modelling does not include custom stage-storage-discharge inputs and therefore only provides conceptual level details / asset sizing until further refined at future functional stages.

- Flows: Flows used in the velocity calculations and sediment capture efficiency calculations were based on rational method calculations, as opposed to RORB flows as was previously done for functional design. Checks were undertaken for catchments where the properties had not changed greatly, and the flows were comparable.

- Storage: Manual estimations of stage-storage for the proposed retarding basins were used as inputs in the RORB modelling, as opposed to actual stage-storage volumes extracted from 12d (earthworks modelling) which is typically undertaken at functional design stages.

- Footprints: The final footprints for the concept assets were determined in 12d, which is not usually the case for concept-level designs. This was done due to the design already having been set up in 12d, and the fact that the site has considerable slope. Therefore, this approach more accurately identifies actual land take for proposed assets than would otherwise be available at concept stages, noting the 12d design has not been undertaken to the same level of detail as the functional design package in terms of internal wetland and sediment basin bathymetry. It is expected that this would be refined in subsequent design stages, not at a concept level.

- Cost Estimates: Functional design costings include an itemisation of all civil and planting elements. This was informed by previous detailed earthworks modelling. Concept level costing is a much more stripped back version of this, with a greater contingency applied due to the limited level of detail (more unknowns, the higher the contingency).

  However, due to itemised costings having already been set up as part of the previous Functional Design documentation (Alluvium, Dec 2022) the itemised costings were adopted from Dec 2022 and updated for specific line items associated with this concept level redesign. This provides a far greater level of detail than would typically be provided at this (conceptual) stage of design delivery.

  The itemised lines have not been quantified to the same degree as previously shown in the Functional Design documentation, as they are concept only. Nominal pipe sizes have been adopted, as pipe sizing was not part of this concept level scope of work. Allowances for certain items have also been made, where the design of that item was not part of this scope of work. With regard to locations for stormwater pipe mains, as this was not part of the scope, these have been shown indicatively, and aligned to be in low points/natural gully lines and to avoid ridgelines. These can be adjusted further with future modelling and design refinements, and with further clarity on proposed road alignments and subdivisional layout.

2 Existing conditions – new and updated reports

This section summarises the new/updated (key) documents provided to Alluvium (Oct 2023) by the City at the commencement of (this project) – the concept level redesign. Any implications on the previously proposed stormwater designs have been noted and summarised below, and further considered in the concept redesigns.

2.1 NWGGA Draft Environment Protection & Biodiversity Conservation Plan (CoGG, May 2023)

To support development in the proposed Growth Areas and protect Matters of National Environmental Significance (MNES), the City is undertaking a strategic assessment under Part 10 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

As part of the strategic assessment process the City has prepared the Northern and Western Geelong Growth Areas EPBC Plan (the Plan) which:

- Ensures development within the Growth Areas, as well as associated infrastructure development outside the Growth Areas, protects MNES and proceeds in accordance with the requirements of the EPBC Act
- Is supported by four key documents including a Strategic Assessment Report (SAR) and three (3) implementation documents (Figure 3) as follows:
    - NWGGA Biodiversity Conservation Strategy (BCS)
    - NWGGA Commitments and Measures
    - NWGGA Funding Program.

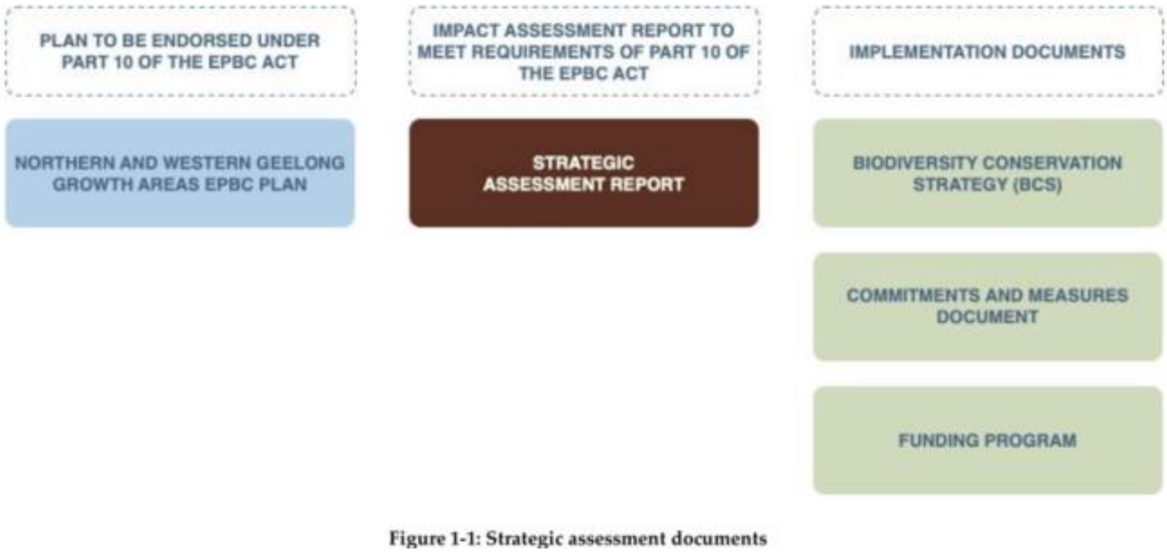


Figure 3. *Strategic Assessment Report (source: City of Greater Geelong, May 2023)*

2.2 Draft NWGGA Strategic Assessment Report (SAR, Biosis, May 2023)

Development of the Growth Areas has potential to impact various biodiversity values, protected under the Commonwealth EPBC Act and Victorian State Biodiversity Regulations. As per Part 10 of the EPBC Act, the City has developed the SAR which:

- provides landscape scale assessment and approval of development under the EPBC Act
- provides opportunity to deliver improved environmental and developmental outcomes for the areas
- states that direct impacts in the Cowies Creek Conservation Area will be limited as much as possible, and only permitted when facilitating positive environmental management outcomes
- accounts for any indirect impacts, such as changes to surface waters / groundwater flows or reductions in surface waters / groundwater quality, which could adversely affect biodiversity values beyond developable land areas. Disturbance from increased public access to natural areas is also of relevance to stormwater assets.

2.3 NWGGA Draft Biodiversity Conservation Strategy (BCS, CoGG, May 2023)

Development within the Growth Areas will likely lead to impacts to biodiversity values of national, state, and local significance. The Biodiversity Conservation Strategy (BCS) has been developed to address these impacts and guide the delivery of positive outcomes for the biodiversity values that are present within the Growth Areas. Recommendations relating to stormwater infrastructure are summarised (below):

- In the WGGA there are four biodiversity opportunity areas (refer Figure 4). These relate to drainage areas that are likely to be required for diverse types of stormwater infrastructure. These areas may also provide co-benefits to biodiversity and provide biodiversity links and habitat connectivity across the growth area.
- In addition to minimising impacts through the avoidance planning process, impacts on biodiversity values will be further minimised by managing development to mitigate indirect impacts on biodiversity values that are avoided, or that occur outside the Growth Areas. Some of the impacts in relation to stormwater assets relate to changes to water flows and water quality, disturbance from increased public access to natural areas, disturbance due to noise, dust, or light, and fauna mortality and/or barriers to movement.
- The BCS includes commitments (refer Commitments and Measures document) to minimise these impacts, including requirements to implement "*additional specific mitigation measures to address key biodiversity values associated with waterways, riparian areas and wetlands, and to protect the strategic conservation areas.*"

These additional specific mitigation measures were defined through the assessment of the indirect impacts of the development on MNES in the EPBC Strategic Assessment Report (SAR). While these address specific risks to MNES associated with waterways, riparian areas and wetlands, and other biodiversity values within the strategic conservation areas, these additional measures will also minimise impacts to state and local biodiversity values.

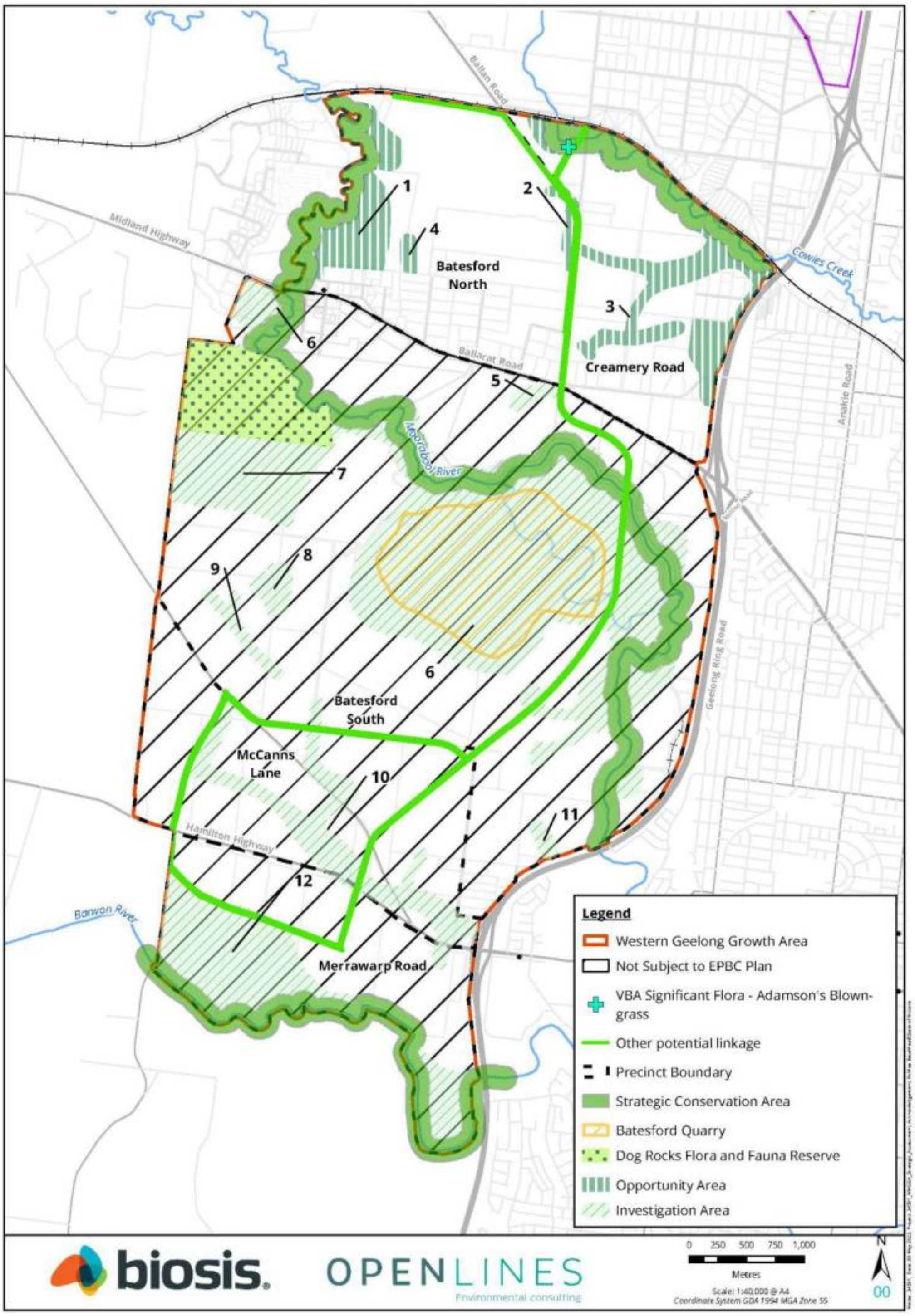


Figure 4-2: Biodiversity areas within the WGGA

- Area 3 may provide an important opportunity for habitat creation and enhancement for the Growling Grass Frog, connecting through to the Cowies Creek Conservation Area. For example, the species has been known to occupy suitably designed urban stormwater basins. The potential development of this tributary of Cowies Creek in a way that supports movement or provides refuge for the Growling Grass Frog could play a helpful role in supporting the long-term viability of the Cowies Creek metapopulation

Figure 4. *Biodiversity and opportunity areas identified in the Biodiversity Conservation Strategy (Biosis, 2023)*

2.4 NWGGA Draft Commitments and Measures (CoGG, May 2023)

The EPBC Plan and the Biodiversity Conservation Strategy (BCS) objectives and outcomes will be achieved through the delivery of a set of commitments and measures. The recommendations relating to stormwater infrastructure includes:

Outcomes:

- The long-term viability of the important population of the GGF along Cowies Creek is supported through the protection and enhancement of habitat within the WGGA

- MNES associated with waterways, riparian areas and wetlands are protected from any notable adverse impacts of development under the Plan.

Commitments:

- The Cowies Creek Conservation Area will be established in perpetuity to avoid loss and protect habitat needed to support the continued persistence of the GGF in the WGGA

- A Conservation Management Plan (CMP) will be prepared and implemented for the protection and ongoing management of GGF, and areas of potential habitat for Adamson's Blown-grass Butterfly within the Cowies Creek Conservation Area

- Ensure the design of stormwater infrastructure and ongoing stormwater management is sympathetic to, and does not notably alter, habitat for the GGF within downstream reaches of Cowies Creek (Measure 39)

- Unavoidable clearing due to the external infrastructure development of any areas confirmed to support MNES will be offset in accordance with the EPBC Act Environmental Offsets Policy and associated Offsets Assessment Guide (Commonwealth of Australia, 2012; DSEWPC, 2012) or equivalent.

2.5 NWGGA Framework Plan (CoGG, Aug 2022)

The City of Greater Geelong's Framework Plan for the Northern and Western Growth Areas is a high level strategy that informs the future of these growth areas and identifies IWM as a key driver of sustainable urban development and building climate resilience for the region, landscapes, communities, assets / infrastructure, and the natural environment. For example, the Plan states "*neighbourhoods will maximise the use of alternate water sources to meet fit-for-purpose needs and deliver multi-functional benefits* (Action W2.3.6).

Commitments: The Plan was informed by earlier work between Barwon Water, the City and key stakeholders that informed the future plans for PSP growth areas where integrated water management outcomes include:

- Improvement to ecological outcomes through rehabilitation, enhancements, buffer protection, preservation of conservation areas

- Stormwater solutions that allow for flood protection, treatment, infiltration, harvest and fit-for-purpose use

- Support for community and landscape amenity values where multifunctional assets with multi benefit outcomes are key to asset infrastructure designs for stormwater management

- Stormwater / IWM asset designs incorporate passive and active open space connections, blue-green corridors with diverse multifunctional uses for broader scale benefits.

These IWM principles applied at Functional Design documentation stage (Dec 2022) still apply and have continued through the concept redesign response to the new FUS. The concept level redesigns provide:

- Multi-functional, multi-benefit community and environmental protections and enhancements (wherever possible)
- Naturalised asset form / design options to sit within the landscape and provide broader amenity / community value beyond asset function (as opposed to pits and pipes approach)
- Opportunity and flexibility in the concepts to allow future design refinements for stormwater harvesting, passive infiltration and open space irrigation (to be modelled and refined further at functional design stage, not concepts)
- Support to IWM and liveability principles and values through:
    - location of assets – close to waterways, natural areas where appropriate
    - proximity to open spaces, proximity to the CCC and future alternate water supply networks
    - ability to allow extraction from WLRB assets to service landscape assets.

2.6 Creamery Road Native Vegetation Precinct Plan (NVPP, Biosis, May 2023)

A review of Native Vegetation Precinct Plan (NVPP), to be listed under the Schedule to Clause 52.16 of the Greater Geelong Planning Scheme, was undertaken. The NVPP includes requirements of the Department of Environment, Land, Water and Planning Guidelines (2017). Under Section 10, which relates to the removal, destruction or lopping of native vegetation, it is noted that:

- The removal, destruction or lopping of native vegetation in accordance with this NVPP, will not require a planning permit, provided conditions and requirements specified in the NVPP are met
- As per Clause 52.16 of the Greater Geelong Planning Scheme, a planning permit is required if any native vegetation is proposed to be removed, destroyed, or lopped outside of / or not in accordance with the NVPP
- Native vegetation identified in the NVPP 'to be retained' has been identified following a strategic approach to retaining native vegetation with greater biodiversity or other values (see Figure 5)
- For native vegetation to be retained (located within the Cowies Creek Conservation Area) this obligation remains in place until such time as the land is vested in the City of Greater Geelong for conservation purposes.

Figure 5. *Overview of native vegetation to be removed and/or retained (Biosis, 2023)*

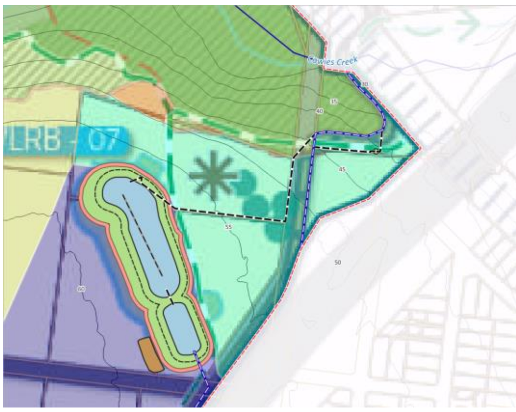
Implications for proposed stormwater infrastructure

Where areas of native vegetation are to be retained, these have been identified for protection. However, it should be noted that the proposed outfall alignments from WLRB8, SBRB9 and WLRB7/GPT 2 (shared outfall) will impact the native vegetation identified to be retained and protected, to achieve connection (discharge) to Cowies Creek. While limited in footprint, these outfalls will result in additional removal of native vegetation and likely require offset arrangements (subject to Council approvals). There may be an opportunity to limit these impacts with further refinements of the asset outfalls in future design stages.

Minimising the number of outfall arrangements from the PSP to Cowies Creek would avoid further environmental and native vegetation impacts to Cowies Creek from multiple discharge arrangements (infrastructure).

Therefore, the outfall arrangements for WLRB7 are now via Bluestone Bridge Road to allow capture of treated flows from a (new) proposed GPT further downstream. The GPT is designed to treat these smaller developing catchments (Total Suspended Solids only).

An indicative outfall alignment for WLRB7 to Bluestone Bridge Road, and Bioretention 3 outfall is shown.



2.7 WGGA Cowies Creek Conservation Area Growling Grass Frog (GGF) Conservation Management Plan (Biosis, October 2023)

Biosis were engaged to prepare a Growling Grass Frog (GGF) Conservation Management Plan (CMP) for the section of Cowies Creek located within the Creamery Rd precinct.

The objective of the conservation area is to '*support the persistence of GGF within the WGGA and to maintain the metapopulation dynamics with the broader Cowies Creek metapopulation downstream*'.
It is noted that:

- The GGF is a species of national conservation significance. It is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Victoria's *Flora and Fauna Guarantee Act 1988* (FFG Act).
- The boundary of the conservation area (as of October 2023) is proposed as a 100-metre buffer surrounding Cowies Creek, measured from the centreline of the creek to 100 metres.
- The conservation area discussed in the CMP is reflective of the conservation boundary provided by the City (17 October 2023). The conservation boundary has been amended to include native vegetation patches identified for retention in the Native Vegetation Precinct Plan (NVPP), and removal of areas near Coolangatta Homestead not required for GGF conservation.
- Maintaining a buffer of at least 100 metres is important to encompass the aquatic and vast majority of terrestrial habitat likely to be in use by GGFs.
- The unnamed tributary of Cowies Creek (at the eastern end of the WGGA) is unlikely to provide habitat for GGF. However, enhancement of ephemeral waterways outside of the conservation area may be ecologically beneficial and terrestrial habitat enhancements throughout this area should be considered.
- The draft CMP proposes a total of six (6) GGF off-stream wetlands to be created within the conservation area. The proposed locations of these assets are shown in Figure 6 below and are indicative only.
- The location and number of wetlands may be varied according to Council and DEECA input. The off-stream GGF wetlands are proposed to be located primarily in the mid to downstream reaches of the conservation area – where the topography is suitable, there is sufficient terrestrial space, and the wetlands can be safely constructed, accessed, and managed.

Implications for proposed stormwater infrastructure

One of the objectives of the CMP is to identify locations <u>suitable</u> for stormwater management assets and associated infrastructure to ensure that the right considerations (as per above) for GGF protection are being made. The design response has ensured that:

- Associated disturbances are minimised within the conservation areas by preferably locating stormwater assets outside these areas in the first instance (minimises risk / likelihood of impacts on GGF).
- While the GGF habitat design standards (developed for the Melbourne Strategic Assessment) allows for these assets within GGF conservation areas, stormwater wetlands proposed within the conservation areas <u>are at least</u> 30 metres away from the normal water level (NWL) of GGF breeding habitat (Cowies Creek and GGF wetlands, Figure 6).
- Given the proposed PSP assets are integrated systems – retardation and treatment – asset footprints have been located outside the 1% AEP extent wherever possible, allowing the asset to adequately perform its retardation function at all times.

- Stormwater retention basins have been located away from GGF critical habitat to reduce the likelihood of the species occurring (being found) within these assets, thereby allowing periodic sediment maintenance works to be carried out without risk or potential harm to GGF individuals / population.

- Wherever possible, maintenance access tracks have been located outside the conservation areas.

It should be noted that the design response has been based on the current / known information as to high value areas requiring avoidance / protection from infrastructure services. The outfall locations for proposed PSP stormwater management assets are based on this current knowledge. This may change over time (in future design stages) if new / emerging areas of high value / significance are identified.

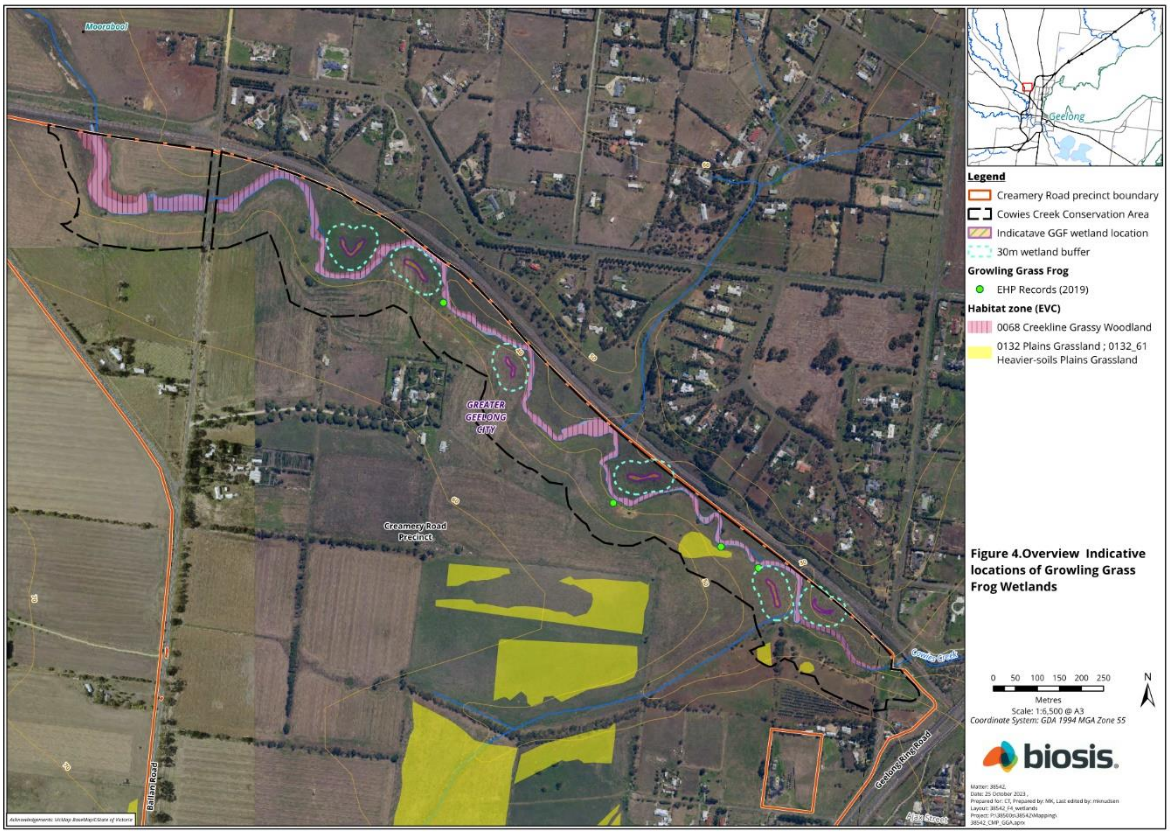


Figure 6. *GGF conservation boundary, existing GGF open pools and indicative GGF wetland locations shown (Biosis, 2023)*

2.8 Creamery Road PSP - Geotechnical Assessment Review (GHD, November 2022)

The Functional Design documentation (Alluvium, Dec 2022) was based on a previous geotechnical review (Aug 2022) by GHD. GHD was further engaged by the City to provide an updated review (Nov 2022) which has informed this concept-level redesign and includes the following:

- Updated advice on geotechnical conditions in relation to landslip susceptibility in the Creamery Rd Precinct. The assessment included a desktop review, site walkover, assessment of landslide hazards and susceptibility, and outlines implications and considerations with respect to the Creamery Road PSP.

- Review geotechnical information prepared by others to assist in the preparation of the Creamery Rd PSP. GHD's assessment included a review of the Douglas Partners susceptibility mapping with the aim of updating mapping and recommendations, where necessary. The GHD assessment generally agreed with the mapping by Douglas Partners.

- The desktop / related geotechnical review by GHD was limited to providing further clarifications and comments on the existing geotechnical conditions, as they relate to potential geotechnical hazards (with a particular focus on landslide hazards) and to outline any landslide related implications, considerations and recommendations that need to be addressed and accounted for at the precinct planning stage (as outlined in Table 3 of the GHD report, Nov 2022).

- The report concluded that further investigations were required to confirm implications for excavation works and the requirement for the areas to be assessed, based on site specific information to determine batter and related stability risks, as stability within the volcanic clays can be problematic.

Table 3 of the GHD Report (Figure 7) recommends the City consider and implement an appropriate planning or related trigger for the management of development activity within each susceptibility zone. Specific reporting requirements were clearly outlined in the report, as they relate to further assessments and works planned within the PSP.

Table 3 Summary of susceptibility zones

Landslide susceptibility zone	Susceptibility zone rationale	Implications for development
Low susceptibility (Green)	Underlying geology of Newer Volcanics basalt plains. Site assessment indicated no signs of slope instability within this zone. No historical evidence of landsliding within similar site conditions. Slope angles < 5°.	No significant geotechnical issues identified for development with regards to landslide hazards. Geotechnical risks within this zone do not need to be addressed within the PSP.
Moderate susceptibility (Orange)	No clear evidence of slope instability observed during site assessment but geomorphological features and geology to indicate the potential for landslide hazards. Areas potentially vulnerable to landslide retrogression if landslides occur on steeper slopes below. Slope angles of 5 - 10°	Any development within this zone should undertake a geotechnical assessment in accordance with AGS 2007 (Australian Geomechanics Guidelines for Landslide Risk Management). The assessment should be undertaken prior to development and should determine whether risk is acceptable, tolerable or unacceptable. In the absence of existing risk evaluation criteria, AGS 2007 recommendations for risk criteria should be adopted.
High susceptibility (Red)	Geomorphological features and underlying geology considered susceptible to landsliding. Site assessment identified features indicating evidence of historical slope instability. Historical evidence of slope instability within the same ground conditions in other locations outside site area. E.g. landslides known to occur on slopes > 10° within the Gellibrand Marl Formation. Slope angles > 10°.	Avoid development in this zone. Any permanent structures would have exposure to landside hazards. Should any development be required in this zone (should not include habitable development or structures occupied for extended periods) then a full geotechnical assessment (in accordance with AGS 2007) which includes detailed subsurface investigation and risk evaluation for both individual risk and societal risk must be undertaken. The assessment should achieve Low to Very Low risk levels (deemed acceptable risk) to allow development.

Figure 7. *Landslide susceptibility zones and implications on development (GHD, 2022)*

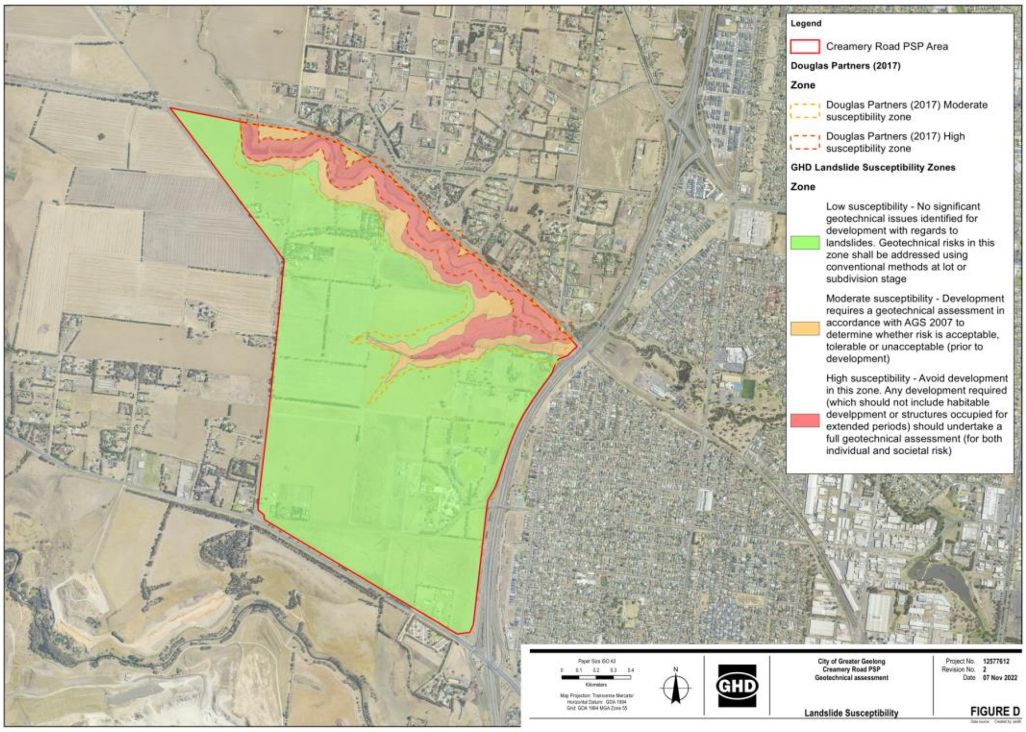


Figure 8. *Landslide susceptibility plan (GHD, 2022)*

Implications for proposed stormwater infrastructure

- The document (the Geotechnical assessment review report prepared by GHD) identifies that any development within the landslide susceptibility zone should undertake a geotechnical assessment, prior to development, to determine whether the risk is acceptable, tolerable, or unacceptable.
- Alluvium's approach during functional designs was to avoid these areas until further geotechnical assessments were carried out to best inform a way forward.
- Under the new FUS, the City advises that both the moderate and high landslide susceptibility areas now form part of the Net Developable Area (NDA) for the precinct. This Addendum and concept redesign has only considered the moderate susceptibility areas as in the redesign modelling and asset placements for the future developable areas.
- Following the concept redesigns (March 2024), Council informed Alluvium that the high landslide susceptibility areas (which are currently untreated) are now considered potentially developable, subject to geotechnical assessment followed by a drainage assessment to be undertaken by the development proponent at the subdivision application stage. Alluvium is not engaged to investigate these areas to determine a drainage solution and therefore, these matters need to be dealt with later at the subdivision application stage.

Note: Given GHD's recommendations for additional geotechnical analysis be done in these medium susceptibility areas, prior to development occurring, consideration needs to be given as to the potential that such assessments may deem development to be too high risk / not feasible in this location. In that case, the stormwater assets would need to be relocated back up the escarpment to service the contributing developing catchment, however, if that area is already set aside for development, then there may not be an allowance of space for this drainage asset. Consideration needs to be made for this potential outcome to ensure appropriate drainage reserve area is set aside early (a backup plan) for this potential outcome.

2.9 Land Capability Assessment – Creamery Road PSP, Planning Practice Note 30 Updates Addendum (Meinhardt, June 2023)

Meinhardt Infrastructure & Environment (Meinhardt) were engaged by the City in late 2020 (to June 2023) to complete a Land Capability Assessment for Creamery Rd PSP. An addendum was undertaken in August 2021 (finalised in June 2023) as a result of the update to the Planning Practice Note for Potentially Contaminated Land.

The objective of the addendum was to provide guidance on the outcomes of the identification of potentially contaminated land within the precinct to understand the capability of residential, commercial and industrial land uses and inform strategic decisions. A Potential for Contamination (PfC) assessment was undertaken (Figure 9) to assess contamination risk.

The ratings were based on the outcomes of the desktop assessment. No properties were identified as having a high PfC. Two properties were identified as having a medium PfC, and all others were identified as having a Low PfC. This is one more property (Property 13) than previously identified. Further assessment is required at subdivisional stages to verify site contamination through a preliminary risk screen assessment.

Implications on stormwater infrastructure

- WLRB7 was previously proposed to be located outside property 7, however the outfall was proposed to traverse through the property. This was re-considered during the concept re-designs in light of the medium PfC.

Note: Outfall from WLRB7 is now proposed to discharge via Bluestone Bridge Road towards Cowies Creek. The overall aim here is to minimise the number of discharge points to Cowies Creek through conveyance / integration into one point of discharge that services multiple assets (e.g. WLRB7, GPT 2, and proposed roads and associated drainage network). The new proposed outfall direction also minimises interactions with the potential contaminated land.

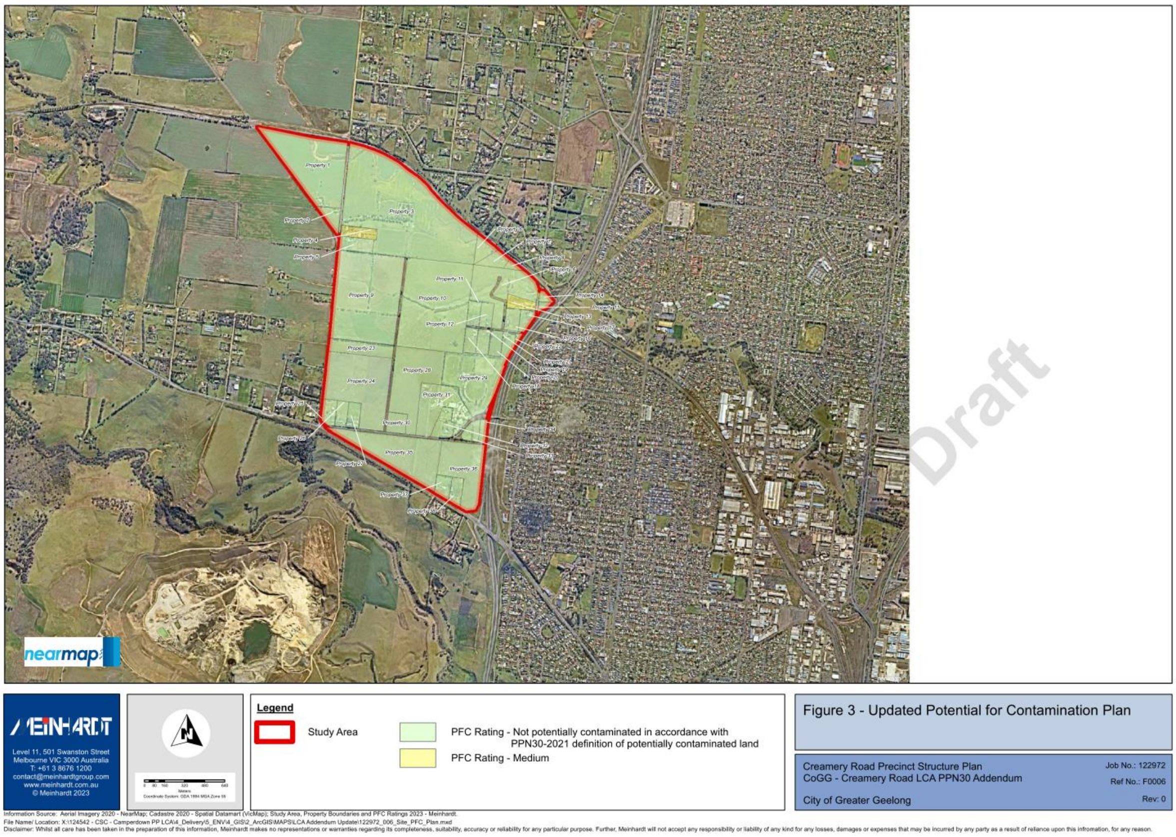


Figure 9. *Land capability assessment (Meinhardt, 2023)*

2.10 Creamery Rd Precinct Aboriginal Cultural Heritage Impact Assessment (Unearthed Heritage, July 2023)

Unearthed Heritage were engaged by the City to prepare an Aboriginal Cultural Heritage Impact Assessment of the Creamery Road PSP (finalised in July 2023). The primary purpose of this assessment was to document the known and potential Aboriginal cultural heritage values of the study area, to assist / inform the planning process and design development for the PSP.

The assessment comprised of a desktop assessment and a site survey. The assessment identified a number of artefact scatters within the precinct. The study found the following areas of cultural sensitivity:

- Registered cultural heritage places and lands within 50m of these
- Land within 200m of a waterway.

Predictive archaeological sensitivity mapping of the precinct was undertaken. The mapping shows areas of potential sensitivity, and the degree of likelihood that the areas are likely sensitive. Based on the mapping, the majority of the precinct is identified as being *highly likely* or *likely* for Aboriginal cultural sensitivity. However, outside of the heritage place extents and locations of artefact scatter, there have been no definite findings to determine that the rest of the precinct is culturally sensitive.

Any proposed stormwater assets will need to remain outside of the Aboriginal place extents as shown in yellow in Figure 10 below. These areas were established as part of a Cultural Heritage Management Plan (CHMP) undertaken for a 10 lot subdivision ([redacted]).

This mapping has been updated and we note the *likely* and *highly likely* areas have slightly reduced when compared to the previous version of this modelling.

2.11 Creamery Road PSP Cultural Values Assessment (Unearthed Heritage, October 2023)

The Aboriginal Cultural Values Assessment (CVA) report was prepared for the City to inform and support planning processes for the Creamery Road PSP. The purpose of the CVA is to identify areas of Wadawurrung living cultural heritage sensitivity, and cultural values across the study area, through consultation and collaboration with the Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) who are the Registered Aboriginal Party (RAP) for the area.

The ACHIA report is distinct from the CVA report in that it focuses on tangible heritage values and a review of the Victorian Aboriginal Heritage Register (VAHR). The ACHIA also includes a review of previously registered Aboriginal places with the study area, and details the results of a cultural heritage survey, and newly registered Aboriginal cultural heritage and mapping of archaeological sensitivity.

There are several recommendations provided in Table 5-2-1 of the CVA report. Those pertaining to water related infrastructure – i.e. Yulluk – are shown below.

Water - *Yulluk*		**Water systems of Country**
	5.	It is recommended that all cultural water flows be respected and maintained as much as possible in their authenticity of flow route, water purification and ponding, and servicing of ephemeral and perennial wetlands-related vegetation systems.
	6.	To define 'cultural flows', *Paleert Tjaara Dja* (2020: 34) explains that Yulluk (Waterways, rivers, estuaries and wetlands) "… are living sources from Bundjil … Our waters were made for our survival, the survival of all things living" and therefore, as defined in the *Echuca Declaration* (MLDRIN 2010): "***Article 1 - Cultural Flows*** are water entitlements that are legally and beneficially owned by the Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right."
	7.	It is recommended that a high priority be given to the conservation and biodiversity enrichment of cultural flows along the Cowies Creek watercourse, including suitable vegetation re-establishment and water purification/cleansing strategies and actions to aid this overall recommendation.
	8.	It is recommended that care be taken in the actioning of any hydraulic engineering measures be taken to ensure the quality of cultural flows during construction and operational phases of the new suburb within this Study Area be undertaken to protect and ensure the health of water systems and the habitats adjacent to such watercourses.
	9.	It is recommended that a master plan be prepared, and or co-designed with the WTOAC, to create an integrated Cowies Creek Linear Park through the new suburb within this Study Area, to aid pathway connectivity, native vegetation re-establishment, cultural flow purification and cleansing, and animal habitat re-establishment and enrichment.
	10.	It is recommended that such Cowies Creek Linear Park conserve at a minimal all lands and waters within 60m of the centre of the watercourse bed of Cowies Creek, and as a minimum all lands and waters within 30m of the centre of the unnamed watercourses that flow from approximately 38° 05' 29.41" S, 144° 18' 44.79" E and 38° 05' 17.24" S, 144° 18' 46.96" E to 38° 05' 13.07" S, 144° 19' 22.61" E into Cowies Creek.

Figure 11. *Extract from recommendations and invitations provided in the Cultural Values Assessment (Unearthed Heritage, 2023)*

Implications on stormwater infrastructure

Item 10 (above) recommends that *"all lands and waters… within 30m of the centre of the unnamed watercourses that flow….into Cowies Creek"* (i.e. tributaries) be conserved and protected. The tributaries are currently proposed to become constructed waterways (i.e. WW01 and WW02) for the PSP, with waterway corridors ranging from 30m – 45m (Figure 12):

- While there are isolated locations where the boundary is extended or shifted to retain trees and to ensure a cohesive drainage interface, the corridor widths do not meet the '30m either side' recommendation of Item 10 above.
- However, the design response for these constructed waterways and associated corridors have adopted the principles in Melbourne Water's *Waterway Corridor Guidelines* to ensure:
  - 'an appropriate waterway corridor or reserve is provided adjacent to development in order to accommodate objectives for flood protection, river health, biodiversity, safety and amenity
  - the waterway corridor is defined as the waterway channel and its associated riparian zone, which consists of two parts' – core riparian zone and vegetated buffer
  - riparian connectivity is provided by locating shared paths/other infrastructure outside the CRZ
  - stormwater treatments (e.g. wetlands and bioretention) footprints are predominantly located outside the CRZ so as not to unduly degrade its ecological function
  - assigning a waterway corridor width for the PSP waterways, allows preservation of the riparian zone and waterway health enhancements
  - opportunities for passive recreational routes are made along these corridors (while remaining outside the CRZ).

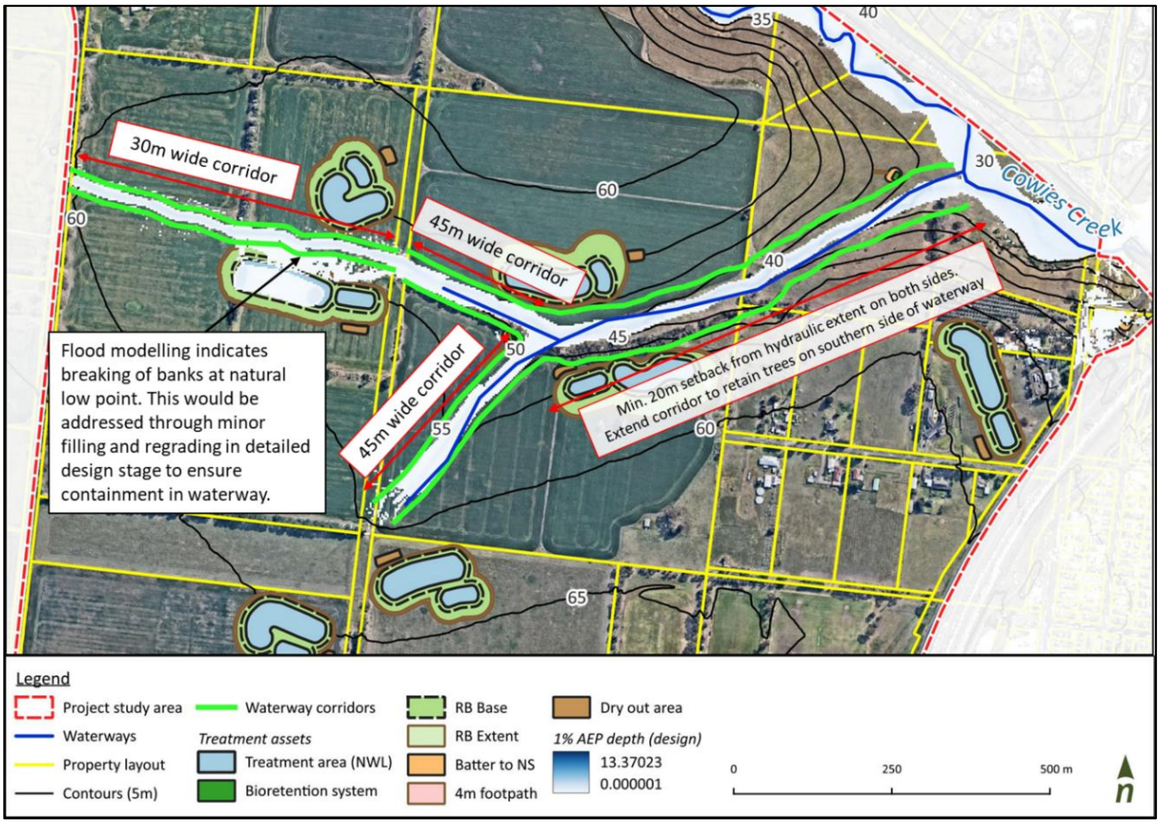


Figure 12. *Proposed waterway corridors (Alluvium, Dec 2022)*

3 Catchment Analysis

The catchment mapping was refined based on the new FUS. The sections below detail the new sub-catchments for the Creamery Road PSP.

3.1 Sub-catchments

Based on the existing topography and revised urban layout, the precinct was divided into appropriate sub-catchments (Figure 13). The sub-catchment information was then used to inform treatment modelling inputs to determine the likely target pollutant loading, and the necessary treatment requirements to manage stormwater runoff from the precinct. The sub-catchment information was also used as inputs for the hydrologic modelling:

- Figure 13 shows the sub-catchment layout and respective direction of flows. Small, isolated sub-catchments for proposed development, that are located downstream of WLRB assets, are shown (red circles) with approximate areas noted (insets). See note below.
-
-
-
- Table 2 shows the areas and future Fraction Impervious (FI) based on the land use planning proposed for each sub-catchment. The total FI is based on the various land uses proposed in the FUS for each sub-catchment.
- Table 3 shows the total loads of the target pollutants for each sub-catchment.

Note: It can be seen in Figure 13 that some small, isolated areas proposed for development are not currently serviced by any of the proposed stormwater assets. These are referred to as Local isolated catchment (LIC) 1 (0.29ha) and LIC 2 (0.17ha) in the figure below. These areas are locally isolated as they sit low in the site's topography, and it is not feasible to bring flows from these areas back up to the proposed stormwater treatment assets. It is likely, these areas will require offsetting in larger assets or lot-scale treatments to ensure BPEM is being met for any developed flows prior to discharge downstream. These areas are otherwise currently untreated areas. The high landslide susceptibility areas, which sit between proposed treatment assets and waterway corridors/conservation zones, have also been mapped and are provided in Figure 13. These areas are currently untreated and would require a drainage strategy should the areas be deemed acceptable to develop following geotechnical assessments.

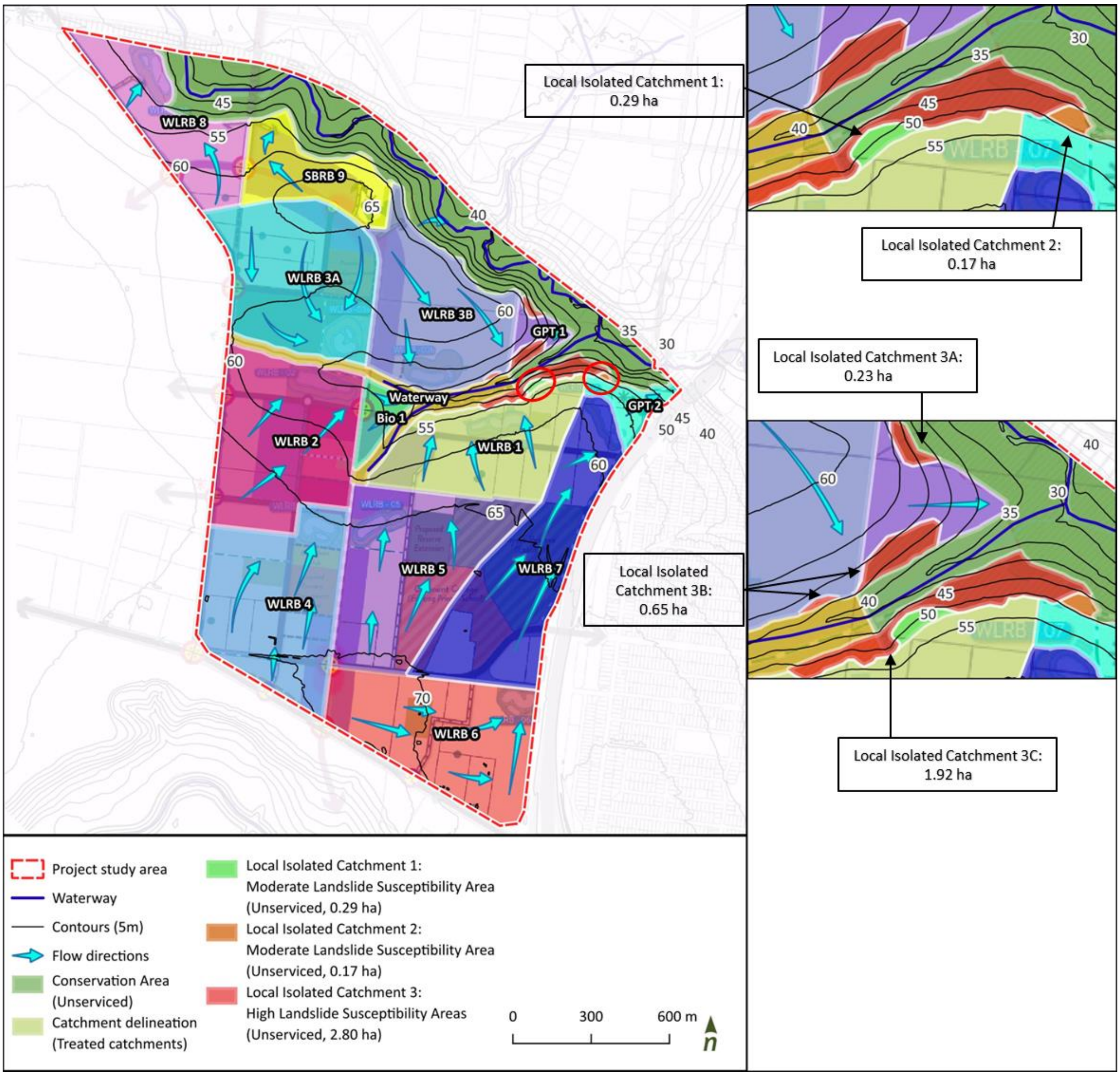


Figure 13. *Sub-catchment layout showing direction of flows with the proposed urban layout as underlay (watermark). Local isolated catchments (LIC) or untreated areas are shown in red (circles/insets).*

Table 2. Developed conditions effective imperviousness area by sub-catchment

Sub-Catchment	Area (ha)	Fraction Impervious (FI)
WLRB 1	24.3	0.75
WLRB 2	33.47	0.79
WLRB 3a	31.87	0.59
WLRB3b	26.73	0.74
WLRB 4	32.5	0.72
WLRB 5	34.63	0.61
WLRB 6	31.5	0.72
WLRB 7	33.8	0.55
WLRB 8	18.92	0.73
SBRB 9 and Bioretention system 2	13.41	0.77
Bioretention system 1	3.66	0.62
Gross Pollutant Trap 1	2.65	0.75
Gross Pollutant Trap 2	4.02	0.74
Total developed area*	**291.5**	

***** No conservation and waterway corridors included.

Table 3. Developed mean annual flow and pollutant loads in each sub-catchment

Sub catchment	Flow (ML/yr)	Total Suspended Solids (kg/yr)	Total Phosphorus (kg/yr)	Total Nitrogen (kg/yr)	Gross Pollutants (kg/yr)
WLRB1	81.3	16300.0	33.3	232.0	3580.0
WLRB2	117	23400.0	48.8	336	5100.0
WLRB3a	87.1	16700.0	34.6	249.0	3970.0
WLRB3b	88.4	17700.0	35.9	256.0	3900.0
WLRB4	105	21200.0	43.0	299.0	4660.0
WLRB5	97.3	19000.0	38.9	277.0	4420.0
WLRB6	102.0	20300.0	42.1	292.0	4520.0
WLRB7	87.3	16700.0	34.7	248.0	4000.0
WLRB8	61.9	12600.0	25.5	176.0	2740.0
SBRB9 and Bio 2	45.9	9390.0	18.8	132.0	2010.0
Bioretention system 1	10.4	2040.0	4.3	30.0	473.0
Gross Pollutant Trap 1	8.87	1790.0	3.6	25.3	391.0
Gross Pollutant Trap 2	13.3	2670.0	5.5	38.0	587.0
Total	**905.8**	**179,790.0**	**369.0**	**2590.3**	**40,351.0**

4 Hydrologic Analysis

Revised hydrologic modelling (RORB) was undertaken for the concept re-design, adopting the new sub-catchments as previously presented. Figure 14 provides the updated RORB layout.

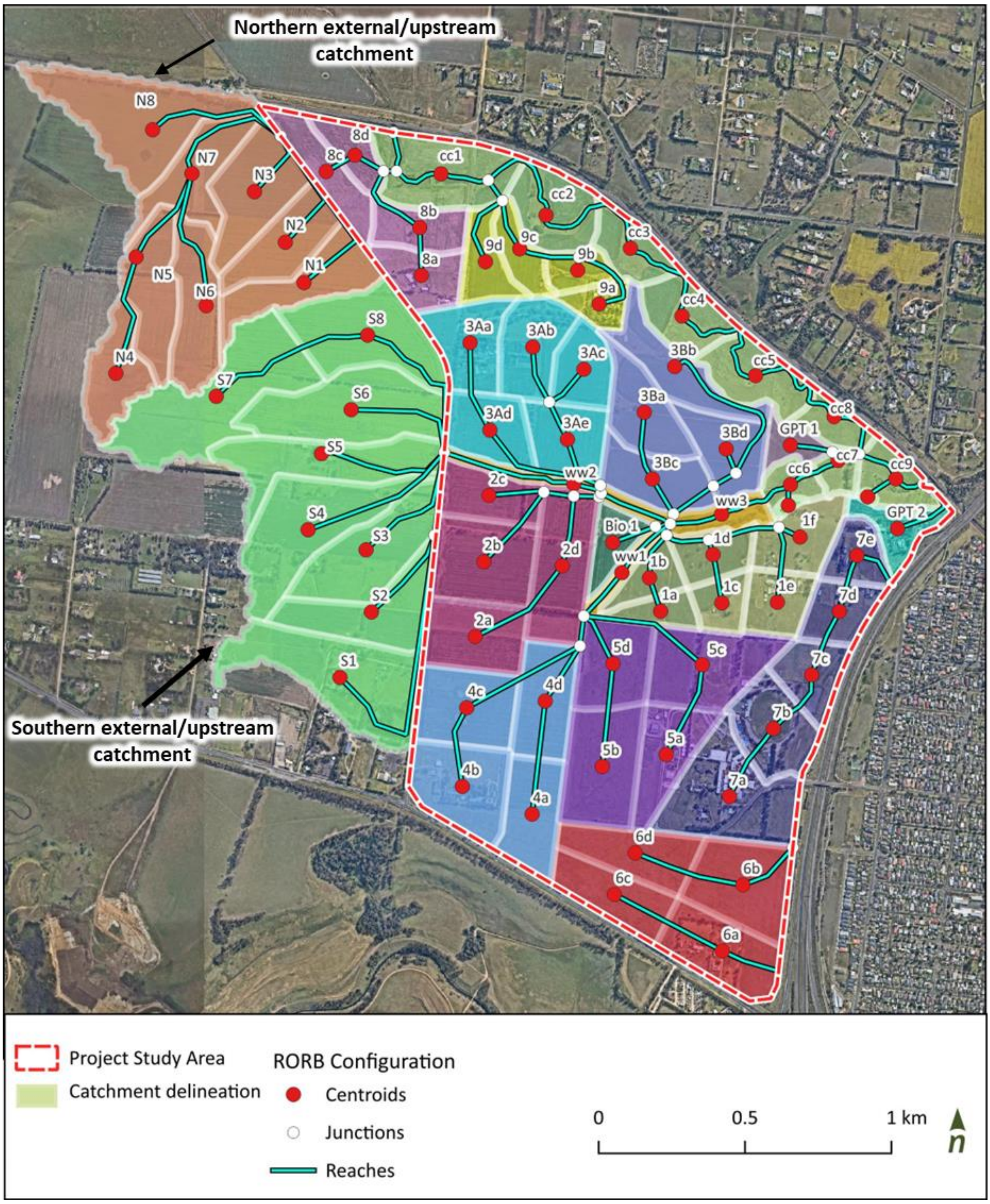


Figure 14. *Delineated sub-catchments for hydrologic modelling – RORB layout*

4.1 Results - RORB

The revised RORB model was computed for the pre and post developed conditions, under the 1% AEP flood event, with results as shown below. The peak flows are at the locations of the proposed stormwater assets.

Table 4. 1% AEP RORB modelling results

Asset	Catchment area	Current conditions		Developed conditions (No RBs)	
	Ha	Peak flow m^3/s	Storm duration	Peak flow m^3/s	Storm duration
WLRB 1	24.30	1.69	45 min, TP22	4.46	20 min, TP28
WLRB 2	33.47	2.20	45 min, TP26	6.47	20 min, TP28
WLRB 3a	31.87	1.96	1.5 hr, TP27	5.52	20 min, TP29
WLRB 3b	26.73	1.77	45 min, TP26	5.17	20 min, TP28
WLRB 4	32.50	1.88	1.5 hr, TP26	5.18	20 min, TP26
WLRB 5	34.63	2.04	1.5 hr, TP26	5.67	20 min, TP27
WLRB 6	31.50	1.65	1.5 hr, TP26	3.69	20 min, TP27
WLRB 7	33.80	1.62	1.5 hr, TP27	4.31	25 min, TP28
WLRB 8	18.92	1.65	45 min, TP26	4.03	20 min, TP23
SBRB 9 and Bio 2	13.41	0.85	1.5 hr, TP28	2.38	20 min, TP27
Bioretention system 1	3.66	0.39	45 min, TP26	0.87	20 min, TP27
Gross Pollutant Trap 1	2.65	0.28	45 min, TP26	0.66	10 min, TP23
Gross Pollutant Trap 2	4.02	0.35	45 min, TP26	0.85	20 min, TP28

4.2 Retarding basin design

Following the establishment of existing (pre) and post-development peak flows without mitigation, the retarding basins have then been modelled and sized to control the 1% AEP peak flow.

Wetlands are to be located (integrated) in the base of the RBs. Melbourne Water's wetland compliance criteria for the design, construction and establishment of constructed wetlands (Melbourne Water, 2020) has been referred to during the design development process.

The required wetland footprint was established through treatment modelling (detailed in Section 5). The retarding basin sizing was undertaken iteratively, with the treatment modelling, to ensure the wetland can fit within the RB, and that the required storage was provided, to meet the discharge criteria.

- RB *stage-storage-relationships* were established using a manual calculation, assuming an RB floor base of at least the wetland and sediment basin areas, plus allowance for the internal access track, and a 1 in 5 RB batter. These relationships were updated in the hydrologic modelling. This was an iterative process to identify potential wetland NWLs, RB base levels, RB extents, and testing these with various outfall arrangements in RORB, to achieve the allowable peak discharge.

  The wetland volume has not been included in the storage calculations. The required retardation storage provides storage for retardation above the NWL of the wetland design.

- The total required area for each asset has been approximately designed in the earthworks model assuming a 1(V):5(H) batter from the internal access track (500mm above wetland TED) to the peak flood level, with an allowance of a minimum 300mm of freeboard on top of the peak 1% AEP flood depth, to the existing surface low point.

- Retarding basins are designed fully "in cut" wherever practical. This is because any embankment structure that is required to hold water for a period of time, if not designed in cut, would be "in fill", thereby creating basin walls that are at risk of failure and potentially lead to loss of property and/or life. Any embankment structure (designed in fill) would require a comprehensive ANCOLD safety assessment. These assessments are required periodically, from Council to DEECA, to ensure ongoing safety / no risk of failure. This becomes an ongoing management option and costly audit exercise for council as the ultimate asset owner and responsible authority for its structural integrity. Regardless, all assets will require a consequence assessment to ensure appropriate design measures are put in place to manage the risk of failure. Any future designs which seek to optimise the footprint (i.e. minimise cut and battering) by incorporating small embankments would need to be approved by Council as the ultimate asset owner.

- Storage outlet sizes were adjusted until the peak 1% AEP outflows from the RB were equal or less than the current peaks. This was done through altering outlet properties in the hydrologic model (i.e. outlet pipe sizing or weir sizing) until the peak flows were less than, or close to, the existing peak flows.

- Peak storage volumes and flood heights within the basins were extracted from representative hydrograph runs.

Note: All retarding basins (RB) are designed as integrated assets with a proposed wetland treatment floor. This integrated design approach:

- achieves IWM principles for urban water management and broader liveability outcomes
- increases asset functionality (multi-functional within same asset)
- minimises overall land take by stormwater management assets
- provides an aesthetically visual asset, improved landscape amenity, improved urban biodiversity outcomes and broader community benefits (passive enjoyment).

Table 5 shows the required storage capacity of the retarding basins based on the RORB modelling conducted.

There is one RB asset without a WL floor. This asset is referred to as SBRB(9) and is an integrated sediment basin (SB for primary treatment) with a retarding basin (RB) function. Due to catchment size and site context a WLRB was not considered an appropriate design response in this location.

A sediment basin has been designed in this instance (rather than a GPT installation) to account for ongoing maintenance costs to council (e.g. plant equipment for cleanouts, budget resources, labour, frequency of attendance). The SB is designed for 5-yearly cleanouts. A GPT installation generally requires 3-mthly cleanouts (depending on the quality and quantity of catchment inflows) and frequency of storm events (post storm inspections and/or cleanouts) to remain effective.

A further three(3) sub-catchments are serviced by either a bioretention system (without flood storage) or GPT as these catchments are relatively small and do not warrant a WLRB configuration. GPTs have been proposed in two of the smallest catchments, as directed by Council. This is discussed further in section 5.

Note: The bioretention system does not provide any retardation function (treatment only). It is therefore recommended that on-site detention (tanks) be considered (mandated through council OSD policy / development conditions / or similar) for these small catchments, to provide some reduction (albeit small) in stormwater runoff to protect downstream conditions.

Table 5. Retarding basin requirements

Asset	Existing Peak flow (m^3/s)	Peak RB outflow (1% AEP) (m^3/s)	Peak RB storage (m^3)	Peak RB flood depth (m)	Freeboard above peak flood depth (mm)	Outlet structure (Spillway# width, m)
WLRB1	1.69	1.68 (1hr, TP27)	6720	0.83	min 300	3.0
WLRB2	2.20	2.15 (1hr, TP27)	9870	0.88	min 300	3.3
WLRB3a	1.96	1.94 (1hr, TP27)	8320	0.94	min 300	2.5
WLRB3b	1.77	1.75 (1hr, TP27)	7640	0.86	min 300	2.8
WLRB4	1.88	1.83 (1.5hr, TP27)	9240	0.90	min 300	2.6
WLRB5	2.04	1.98 (1.5hr, TP27)	9170	0.95	min 300	2.5
WLRB6	1.65	1.62 (1.5hr, TP27)	8300	0.84	min 300	2.8
WLRB7	1.62	1.56 (1.5hr, TP27)	9350	1.04	min 300	1.6
WLRB8	1.65	1.63 (45 min, TP26)	5130	0.76	min 300	3.6
SBRB 9	0.85	0.85 (1hr, TP27)	2300	1.40	min 300	0.3

 # Outlets were modelled as weirs set at the TED

A plan overview of the RB locations and asset footprints are provided in Figure 15. This map also shows the integrated wetlands within the RBs that are required to meet State pollutant reduction targets (discussed in Section 5 of this report).

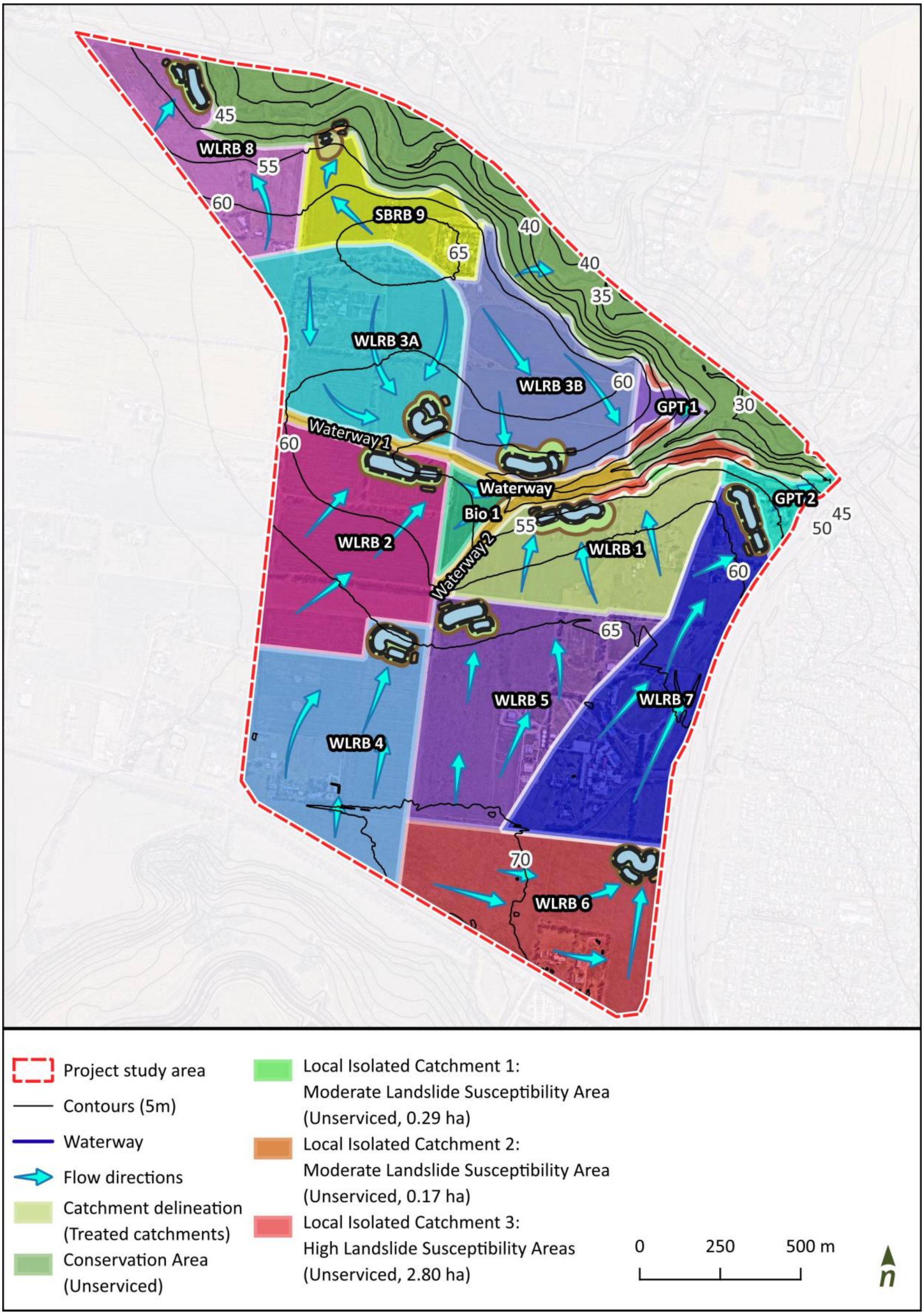


Figure 15. *Integrated Retarding Basin & Treatment Wetlands (WLRB) proposed for the PSP - Plan Overview*

Climate change sensitivity check

Climate change scenarios have been adopted within the hydrologic models built. The purpose of adopting climate change scenarios is not to design assets to these increased peaks, but to perform a sensitivity checks on how increased peak flows will move through the systems designed. For example, how an increased peak 1% AEP will sit within the provided freeboard in a proposed retarding basin.

The approach adopted for establishing climate change scenario sensitivity checks involved:

- the use of Bureau of Meteorology (BoM) Intensity–Frequency–Duration (IFD) curves derived for the site
- adjusted IFD curves to reflect increased intensity arising from climate change
- recommendations of Australian Rainfall and Runoff (ARR) guidelines 2019 relating to the adoption of a 5% increase in rainfall intensity per degree of global warming (Book 1, Chapter 6) for events up to the 1% AEP
- recommendations of ARR 2019 emissions scenarios or representative concentration pathways (RCPs) combined with land use change to test for climate change sensitivity. RCP 8.5 scenario was adopted. The catchment is located within the Southern Slopes cluster, which estimates a temperature increase (in RCP 8.5) of 3.6 degrees in the year 2090
- This approach results in a 19% increase in rainfall intensity, for the 1% AEP event, under the RCP 8.5 scenario
- The increase in rainfall intensity has not been applied to events greater than the 1% AEP.

In the 1% AEP developed scenario, the freeboard within the RBs have been designed to provide 300mm (minimum) freeboard above the peak flood depth, under developed conditions. The climate change sensitivity testing results indicate that in the 1% AEP climate change scenario, the freeboard above the peak flood depth, ranges from 110mm to 230mm, which indicates a reduction in freeboard above the peak flood depth. However, the freeboard reduction is within the designed freeboard under developed conditions for the 1% AEP – the results indicate there is no overtopping of the retarding basins. The RBs perform as required under the developed and climate change scenario modelling.

More detailed modelling would be required to understand the increase in the storage requirements that could provide a greater design response to cater for the climate change scenario further, should the City require this (e.g. to maintain a minimum 300mm freeboard). The results from the modelling are provided below.

Table 6. Retarding basin analysis (climate change scenario)

Asset	1% AEP developed scenario				Climate change scenario			
	1% AEP	1% AEP	1% AEP	1% AEP	1% AEP	1% AEP	1% AEP	1% AEP
	Peak RB outflow (m^3/s)	Peak RB storage (m^3)	Peak RB flood depth (m)	Freeboard above peak flood depth (mm)	Peak RB outflow (m^3/s)	Peak RB storage (m^3)	Peak RB flood depth (m)	Freeboard above peak flood depth (mm)
WLRB1	1.68	6720	0.83	min 300	2.11	7440	0.90	230
WLRB2	2.15	9870	0.88	min 300	2.68	10900	0.96	220
WLRB3a	1.94	8320	0.94	min 300	2.45	9320	1.04	200
WLRB3b	1.75	7640	0.86	min 300	2.19	8470	0.95	210
WLRB4	1.83	9240	0.90	min 300	2.29	10300	0.99	210
WLRB5	1.98	9170	0.95	min 300	2.49	10300	1.05	200
WLRB6	1.62	8300	0.84	min 300	2.02	9160	0.91	230
WLRB7	1.56	9350	1.04	min 300	1.97	10600	1.16	180
WLRB8	1.63	5130	0.76	min 300	2.02	5610	0.83	230
SBRB9	0.85	2300	1.40	min 300	1.02	2750	1.59	110

4.3 Other peak flow rates

Figure 14 (above) provides the updated RORB layout for the sub-catchments – internal to the PSP and external to the PSP. External catchments are described as *Upstream S* (southern external, upstream catchments #1 to #8) and *Upstream N* (northern external, upstream catchments #1 to #8). While PSP assets are not designed to retard or treat these external flows, the modelling must account for these flows that will pass through the PSP based on natural fall of the landscape.

Additional flow rates, as established in the developed conditions RORB model, are provided in Table 7 and Figure 16 below. Flow locations have been used to inform the constructed waterway designs, as shown in Figure 16.

- Point A - Flows from catchment Upstream S (external southern catchment) will be conveyed (pass) through a waterway (WW01) structure (vegetated swale). When development occurs upstream, flows will be required to be retarded back to pre-developed conditions. Existing conditions peak flows, at this location, were used as inputs to the start of the waterway structure. The waterway was sized for the combined external flows (Upstream S flows) plus the outflows from WLRB2 and WLRB3a.

- Point B – Flows from WLRB4 and WLRB5 will be conveyed from this point through a waterway (WW02) structure (vegetated swale). Flow results at model point B were used to size the waterway through this area.

- Point C – there are several sub-catchments where an RB has not been proposed due to the small nature of these catchments. Model point C is downstream of one of these sites and the start of the Existing Waterway (EW01) or existing tributary to Cowies Creek. The results are used to establish the overall change in peaks flows at this point, and commentary on whether any increase poses a risk to downstream environments. Future hydraulic modelling will need to be undertaken to confirm any flood condition changes.

- Point D – This is a point at the end of the hydrologic model to enable an assessment of the overall change in flows, given there are several catchments without any retardation proposed (i.e. only bioretention treatment systems).

  It should be noted that this point does not take into account all catchment flows passing through Cowies Creek from further upstream (i.e. outside this PSP assessment). Therefore, any changes would likely be further dwarfed when full catchment flows are considered.

The existing and developed condition peak flows at these locations are provided below. The cumulative flows in the existing waterway / tributary to Cowies Creek (at point C), and end of the model (point D) indicate that the peak flows increase marginally. It is likely that this increase has negligible impact on downstream flood conditions.

Note: This will need to be confirmed by future flood modelling. Additional retardation of catchments with bioretention systems or GPTs only, could have the unintended impact of further increasing peak flows if the critical durations of peak outflows coincide.

Table 7. Calculated peak flows at different locations

	Existing conditions flows (m^3/s)	Developed conditions flows (incl. RBs) (m^3/s)
Point A (WW-01)	7.19	7.26
Point B (WW-02)	3.81	3.80
Point C (EW-01)	12.20	12.60
Point D (End of Waterway / End of Model)	14.03	15.27

Table 8. Calculated flow rates for constructed* waterway design

Storm event	Flow rate (m^3/s) – Waterway 1	Flow rate (m^3/s) – Waterway 2
1% AEP	4.89m^3/s (flow from external catchment S, at start of waterway. 7.26m^3/s, flows downstream of WLRB2 and WLRB3a (Point A).	3.80 m^3/s, combined flows from WLRB4 and WLRB5 (Point B)

*Note: EW-01 is an existing waterway / tributary of Cowies Creek

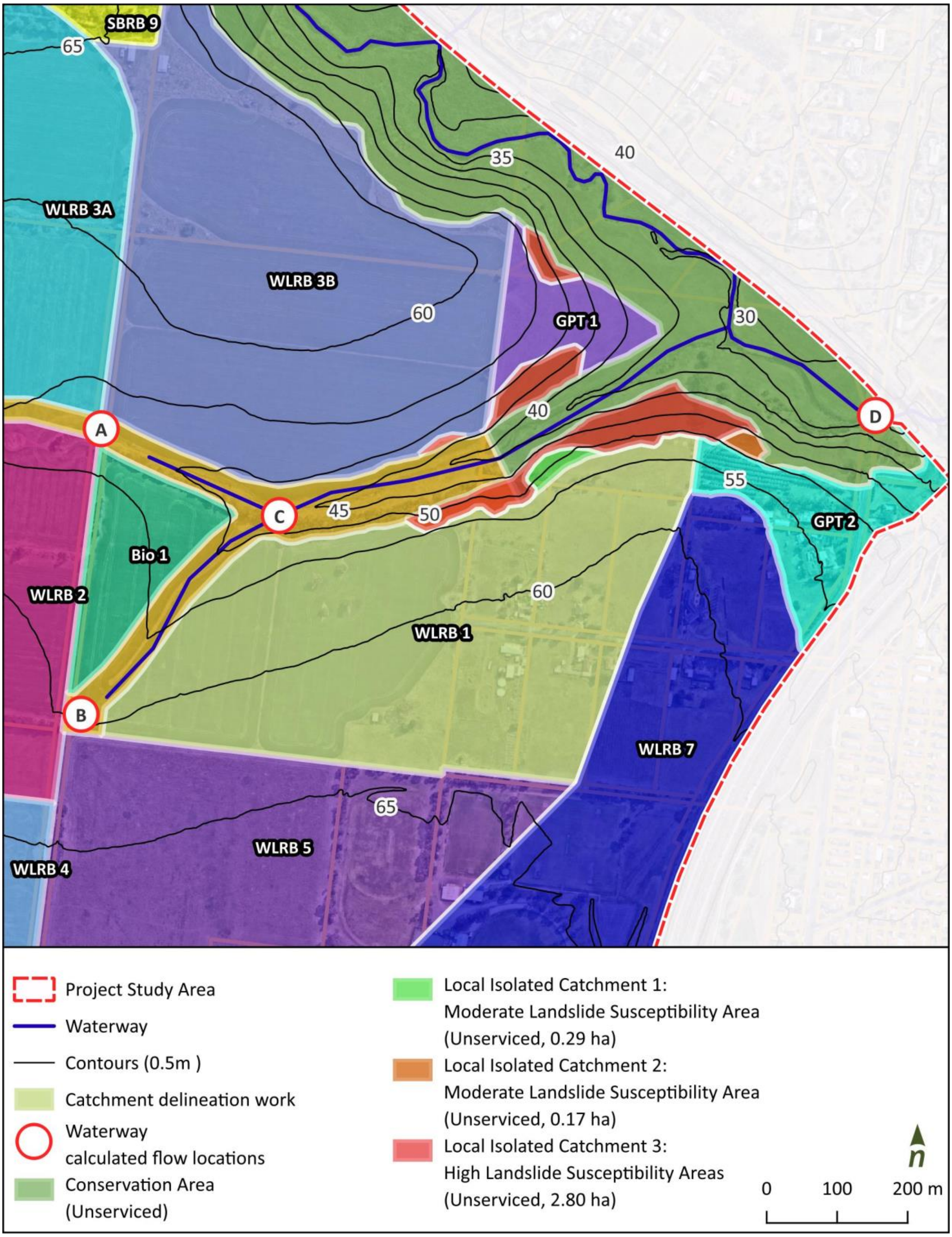


Figure 16. *Constructed waterway flow locations (A-WW01, B-WW02, C-confluence of WW01, WW02 and EWO1, D-end of EW01/model run)*

5 Wetland and Sediment Basin Design

This section details the analysis, modelling, and results for the treatment assets proposed for the Creamery Road PSP. This has been informed by the catchment analyses undertaken in Section 3 of this Addendum Report and detailed in Tables 2 to 6 (above). Proposed treatment assets across the PSP, and their relative catchment outfall conditions are summarised in Figure 22 and Table 9 below.

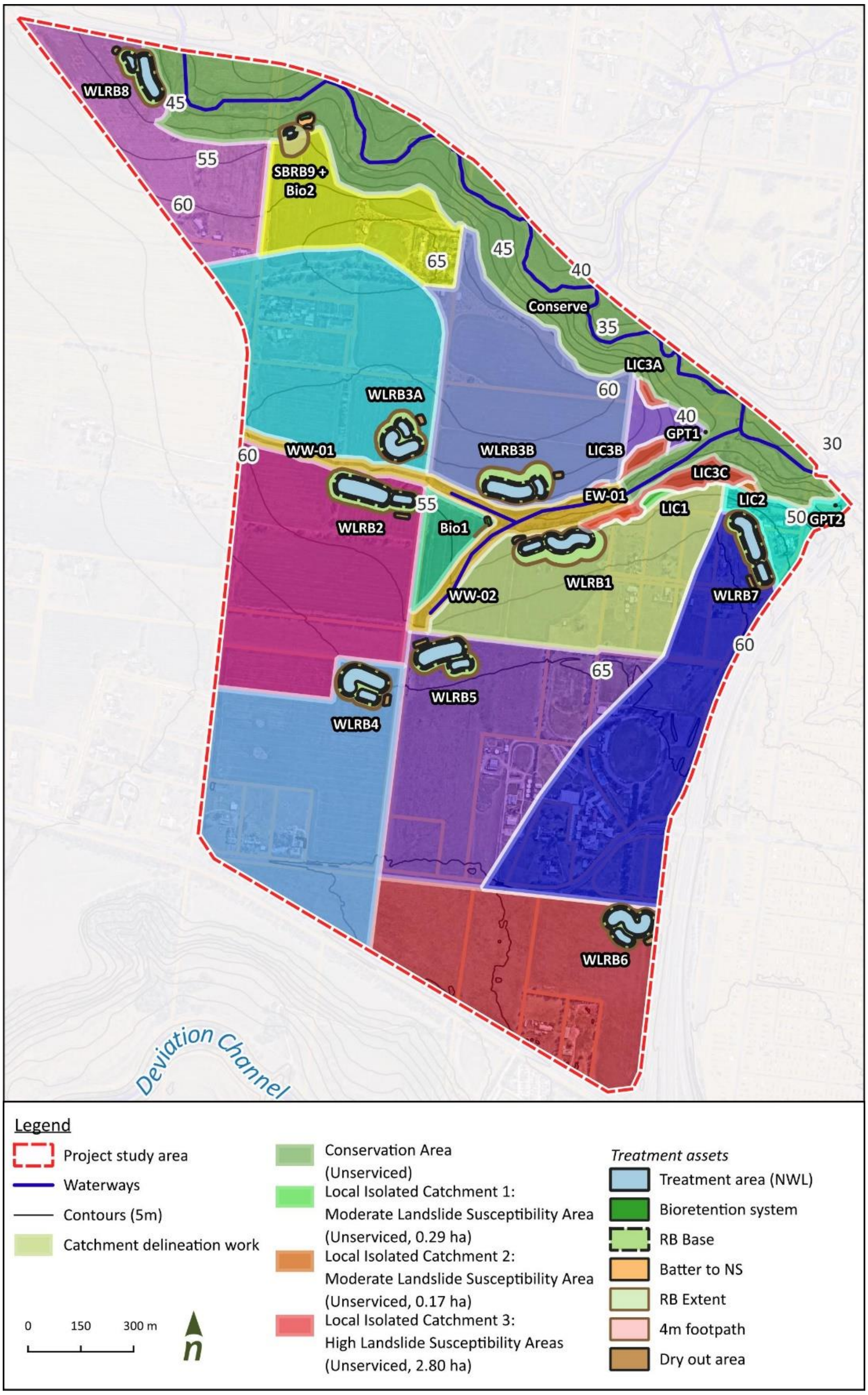


Figure 17. *Proposed stormwater drainage assets for Creamery Road PSP - Plan Overview*

Table 9. Sub-catchments with proposed treatment assets and outfalling conditions for Creamery Road DSS

Sub-catchments	Type	Area (ha)	Proposed asset	Outfalling conditions
Upstream N	External	70.0	-	External Upstream Catchment N is graded and outfalls northeast into Cowies Creek
Upstream S	External	102.8	-	External Upstream Catchment S outfalls east into WW-01
1	Internal	24.3	WLRB 1	Catchment 1 outfalls north into the existing Cowies Creek tributary (EW-01)
2	Internal	33.5	WLRB 2	Catchment 2 outfalls northeast to Constructed Waterway 1 (WW-01)
3A	Internal	31.9	WLRB 3A	Catchment 3A outfalls southeast to Constructed Waterway 1 (WW-01)
3B	Internal	26.7	WLRB 3B	Catchment 3B outfalls south to Constructed Waterway 1 (WW-01)
4	Internal	32.5	WLRB 4	Catchment 4 outfalls northeast to Constructed Waterway 2 (WW-02)
5	Internal	34.6	WLRB 5	Catchment 5 outfalls north to Constructed Waterway 2 (WW-02)
6	Internal	31.5	WLRB 6	Catchment 6 outfalls east to vegetated swale alongside Princes Freeway and eventually outfalls into Cowies Creek to the north.
7	Internal	33.8	WLRB 7	Catchment 7 outfalls northeast through Catchment B3 and via Bluestone Bridge Road, ultimately outfalling into Cowies Creek in the northeast
8	Internal	18.9	WLRB 8	Catchment 8 outfalls east directly into Cowies Creek
9	Internal	13.4	SBRB 9 + Bio 2	Catchment 9 outfalls north directly into Cowies Creek
B1	Internal	3.7	Bio 1	Catchment B1 outfalls east directly into Constructed Waterway 1 (WW-01)
GPT 1	Internal	2.7	GPT 1	Catchment GPT 1 outfalls southeast directly into the existing Cowies Creek tributary (EW-01)
GPT 2	Internal	4.0	GPT 2	Catchment GPT 2 north outfalls north via Bluestone Bridge Road into Cowies Creek (combined outfall with WLRB7)
LIC1	Internal	0.3	Untreated	Local Isolated Catchment 1 outfalls north directly into Cowies Creek
LIC2	Internal	0.2	Untreated	Local Isolated Catchment 2 outfalls north directly into Cowies Creek
LIC3A	Internal	0.2	Untreated	High landslide susceptibility area. Local Isolated Catchment 3A outfalls northeast as sheetflow (due to the topography) into Cowies Creek. This area is proposed as a park in the FUS.
LIC3B	Internal	0.7	Untreated	High landslide susceptibility area. Local Isolated Catchment 3B outfalls south as sheetflow (due to steep topography) in EW-01.
LIC3C	Internal	1.9	Untreated	High landslide susceptibility area. Local Isolated Catchment 3C outfalls north as sheetflow (due to steep topography) EW-01.

High landslide susceptibility areas weren't considered as net developable area but now potentially are subject to a geotechnical assessment, following a recent decision made by the City. Alluvium is not engaged to investigate these areas to determine a drainage solution and therefore, these matters need to be dealt with later at the subdivision application stage.

5.1 Design arrangements – overview

There are eight (8) WLRBs proposed for the Creamery Road PSP to accommodate proposed development across the sub-catchments. In Section 1 of this Addendum Report, Table 1 summarised the stormwater drainage implications and redesign response required for the PSP, in light of the new FUS.

In the wetland design scenarios below, the sediment basin (wetland inlet zones) sizing has increased slightly as a result of concept-only modelling, where 'custom outflow storage relationship' modelling is not undertaken at concept design stages (typically this is undertaken at functional design stage where sizing is further refined).

In the case of WLRB1, this has increased in size due to being relocated into the medium landslide zone and is a result of excavating in the steep escarpment grades, and chasing the natural grade. Other assets have had minor decreases or no change to overall land take.

Overall land take for drainage corridors across the PSP have increased slightly overall as a result of accommodating changes to the FUS and proposed development areas, and provision of new stormwater assets to service new areas now developable, while still achieving BPEM requirements.

There was no change to the waterway designs required in this concept redesign phase and these waterway corridors remain the same as per previous (Alluvium, Dec 2022).

The design arrangements for the sediment basins and wetlands have been based on the following design principles as per best practice standards and requirements:

- Assets are to be fed by the minor drainage network (20% AEP) from the contributing catchments
- SBs have been designed to capture 95% of coarse particles (≥ 125µm diameter) entering the system
- Wetlands have been sized based on achieving best practice treatment targets for TSS, TN, TP, TGP
- Designs allow for maintenance requirements
- Designs aim to avoid fill wherever possible.

The smaller catchments within the PSP are proposed to be managed through bioretention systems rather than wetland treatment systems. These are discussed further in Section 6. A design arrangement for the assets was completed based on the above design principles and arranged to fit within the existing topography and site constraints / catchment limitations.

The sediment basin and wetland arrangements (refer to design drawings) have been designed to optimise treatment and meet Melbourne Water's *Constructed Wetland Design Manual Deemed to Comply* criteria as best as possible. The asset designs and changes under the new FUS are further discussed below:

- Wetland 1: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to the existing (waterway) tributary of Cowies Creek (EW01). The wetland is integrated within the floor of the retarding basin (RB1). The retardation capacity of the RB sits above the NWL of the treatment wetland.

  Key design considerations included the steep topography and medium susceptibility landslide risk in this area, which will need to be further investigated by future geotechnical assessments. The steep topography has resulted in a much larger batter extents (on the upstream/southern side) which has resulted in an increase in overall land take for this asset than previously.

  Wetland 2: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to a new constructed waterway (WW01). WW01 also receives flows from the external upstream catchment N (as shown in Figure 17 above) and treated flows from WLRB3a. Compared to the functional designs previously undertaken (Alluvium, Dec 2022) the size of the sediment basin has changed (from 1000 m3 to 1500 m3). Note: the asset modelling is only to a concept (high level) stage and can result in an increase in asset sizing, which can be further refined at functional design stages with further modelling (e.g. custom stage storage relationship modelling in MUSIC).

The wetland is integrated within the floor of the retarding basin (RB2). The retardation capacity of the RB sits above the NWL of the treatment wetland. Key design considerations included ensuring an allowance for the waterway corridor for WW01 (new vegetated swale structure).

- Wetland 3a: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to a new constructed waterway (WW01 / vegetated swale structure). Sediment basin sizing has increased as a result of concept only modelling.

  The wetland is integrated within the floor of the retarding basin (RB3a). The retardation capacity of the RB sits above the NWL of the treatment wetland.

- Wetland 3b: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to a new constructed waterway (WW01 / vegetated swale structure) near the confluence with WW02.

  The wetland is integrated within the floor of the retarding basin (RB3b). The retardation capacity of the RB sits above the NWL of the treatment wetland. Key design considerations included the steep topography and the medium susceptibility landslide risk in this area, which will need to be confirmed by future geotechnical assessments. The steep topography has resulted in a much larger batter extents (on the upstream/northern side) which has resulted in an increase in overall land take for this asset than previously.

- Wetland 4: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to a new constructed waterway (WW02/vegetated swale structure), which also receives treated outflows from WLRB5.

  The wetland is integrated within the floor of the retarding basin (RB4). The retardation capacity of the RB sits above the NWL of the treatment wetland. The topography in this asset location is relatively flat.

- Wetland 5: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to a new constructed waterway (WW02/vegetated swale structure), which also receives treated outflows from WLRB4.

  The wetland is integrated within the floor of the retarding basin (RB5). The retardation capacity of the RB sits above the NWL of the treatment wetland. The asset was designed to fit between the proposed roads (CCC and north-south connector road) as per the new FUS changed transport network (road) alignments.

WLRB5 has been relocated as close as possible to WW02 and designed along the existing contours (working with existing site fall / topography) to avoid a large land take. However, a small area of dead space is still present between WLRB5 and WW02 as a result of ensuring the asset does not cross property ownership boundaries (remains within a single land parcel). If the asset was moved closer to reduce remaining dead space this would result in the asset crossing land ownership boundaries and potential overlapping of the road reserve.

- Wetland 6: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall into an existing vegetated swale alongside Princes Fwy/Geelong Ring Road, eventually discharging into Cowies Creek.

  The wetland is integrated within the floor of the retarding basin (RB6). The retardation capacity of the RB sits above the NWL of the treatment wetland. The topography at this location is very flat. Key design considerations for this asset included ensuring free-draining subdivisional outfall into the RB, and design of the outfall, given the long distance to convey flows to its discharge point at the creek. The WLRB6 outfall is proposed to be to the adjacent existing swale alongside Princes Fwy/Geelong Ring Road.

- Wetland 7: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to Cowies Creek.

  The wetland is integrated within the floor of the retarding basin (RB7). The retardation capacity of the RB sits above the NWL of the treatment wetland. The topography is relatively steep in this area, which heavily influenced battering extents and overall land take for the asset. Key design considerations included the medium susceptibility landslide risk in this area, the adjacent GGF corridor, and the heritage homestead.

- Wetland 8: this wetland receives inflows from the surrounding catchment's minor drainage network. The system consists of a sediment basin (primary treatment) which is part of the wetland system and connects to the macrophyte zone (tertiary treatment) before treated flows outfall to Cowies Creek.

  The wetland is integrated within the floor of the retarding basin (RB8). The retardation capacity of the RB sits above the NWL of the treatment wetland.

  This asset is located within the GGF corridor, and as such the wetland design responds to the GGF wetland design guidelines / consideration of the CMP's requirements to protect these areas. The asset is designed to ensure 30m from NWL of GGF habitats and located outside the 1% AEP flood extents (as provided by WMS – Part A Flood Study for Cowies Creek Catchment). These requirements must be followed in future functional and detailed design stages. An allowance for rockwork (for rock piles) has also been included in the revised (high-level) costings.

- Sediment basin and bioretention system 2: In the previous functional design package for WLRB8, the catchment extended east across the CCC. However, to enable development staging ease in the future, and to respond submissions (feedback), this catchment has since been divided into two. The catchment east of the CCC is now proposed to be managed by an SBRB(9). That is, a sediment basin (for primary treatment) located within the retarding basin (RB9) for retardation of developed flows, with a bioretention system for water quality treatment, that sits outside the RB. This is to ensure the catchment meets BPEM prior to downstream discharge to Cowies Creek. A wetland treatment system has not been proposed for this location due to the smaller nature of this catchment.

Key design considerations relating to the sediment basin was to manage this catchment which is greater than 10ha. The 4EY flows are transferred from the sediment basin to the bioretention system, which sits downstream (lower) in the landscape, with the ultimate outfall to Cowies Creek.

In terms applying a sediment basin versus a GPT (as stated in Section 4.2) a sediment basin has been selected to account for ongoing maintenance costs to council (e.g. plant equipment for cleanouts, budget resources, labour, frequency of attendance). The sediment basin is designed for a maintenance regime of 5-yearly cleanouts.

A GPT installation generally requires 3-mthly cleanouts (depending on the quality and quantity of catchment inflows) and frequency of storm events (post storm inspections and/or cleanouts) to remain effective. Therefore, from a cost perspective (capital and maintenance) a sediment basin to pre-treat flows for Total Suspended Solid (TSS) is considered more feasible and suitable for the subject area and protects the downstream bioretention system from TSS loading (which can reduce the asset's ongoing function and hydraulic conductivity). GPTs have only been considered for much smaller catchments, where directed by Council.

Further, the asset has been located within the conservation management zone due to the challenging topography at this location, and the presence of numerous ridgelines within the catchment. The assets have been located beyond 30m of the NWL of GGF habitat areas, and outside the 1% AEP flood extent as required. It is anticipated that the overall footprint could be further refined and optimised in subsequent functional design stages, as these designs are concept only.

- Construction Environmental Management Plan (CEMP): A detailed CEMP will need to be prepared, approved (by Council) and implemented (by developer) prior to commencement of any construction works for the proposed stormwater drainage assets. This is as per best practice and regulatory requirements and applies to the whole PSP area, not just areas of conservation value.

While it is acknowledged that distributed blue-green infrastructure solutions throughout the precinct at subdivisional / streetscape level (e.g. passively irrigated street trees or roadside treatment swales) may reduce the required treatment footprints of the proposed wetlands, it should be noted that they will not contribute to flow retardation and storage requirements that the RBs are designed to achieve for post developed flows.

Therefore, given treatment wetlands are integrated into the floor of the RBs, without compromising flood storage requirements, any reduction to wetland area when streetscape treatments are applied, will not reduce the required asset footprints, as these are based on post developed retardation requirements.

5.2 Stormwater treatment modelling

The updated MUSIC model layout is shown in Figure 18. The following summarises the modelling approach to treatment assets:

- The treatment assets (wetlands, sediment basins and bioretention systems) have been sized to treat pollutant loads generated from the future developable areas, to BPEM standards, for each sub-catchment. There is no treatment of external catchment inflows (only conveyance through the PSP has been considered).
- The wetlands were not modelled with *custom stage storage discharge* relationships as this is not undertaken at the concept design stage (undertaken at functional stage).
- The wetland sizing was done in conjunction with velocity checks and sediment capture efficiency calculations. For full details on wetland dimensions refer to Section 5.5.
- High flow bypasses in the treatment nodes were set at 100.

- The bioretention systems were set up to only take 4 Exceedances per Year (4EY) flows, as established in the rational calculations.
- Extended Detention Depth for the wetlands was set at 0.35m and 0.2m for bioretention systems.
- Wetland outlets in the wetland node were sized to obtain a 72-hour notional detention time to allow sufficient treatment performance to meet targets.
- Sediment basin sizing details are provided in Section 5.3.
- GPTs were included in the modelling, detailed further below.
- Sediment basins were assumed to have an <u>average</u> depth of 0.8m, which informed the wetland inlet volume.

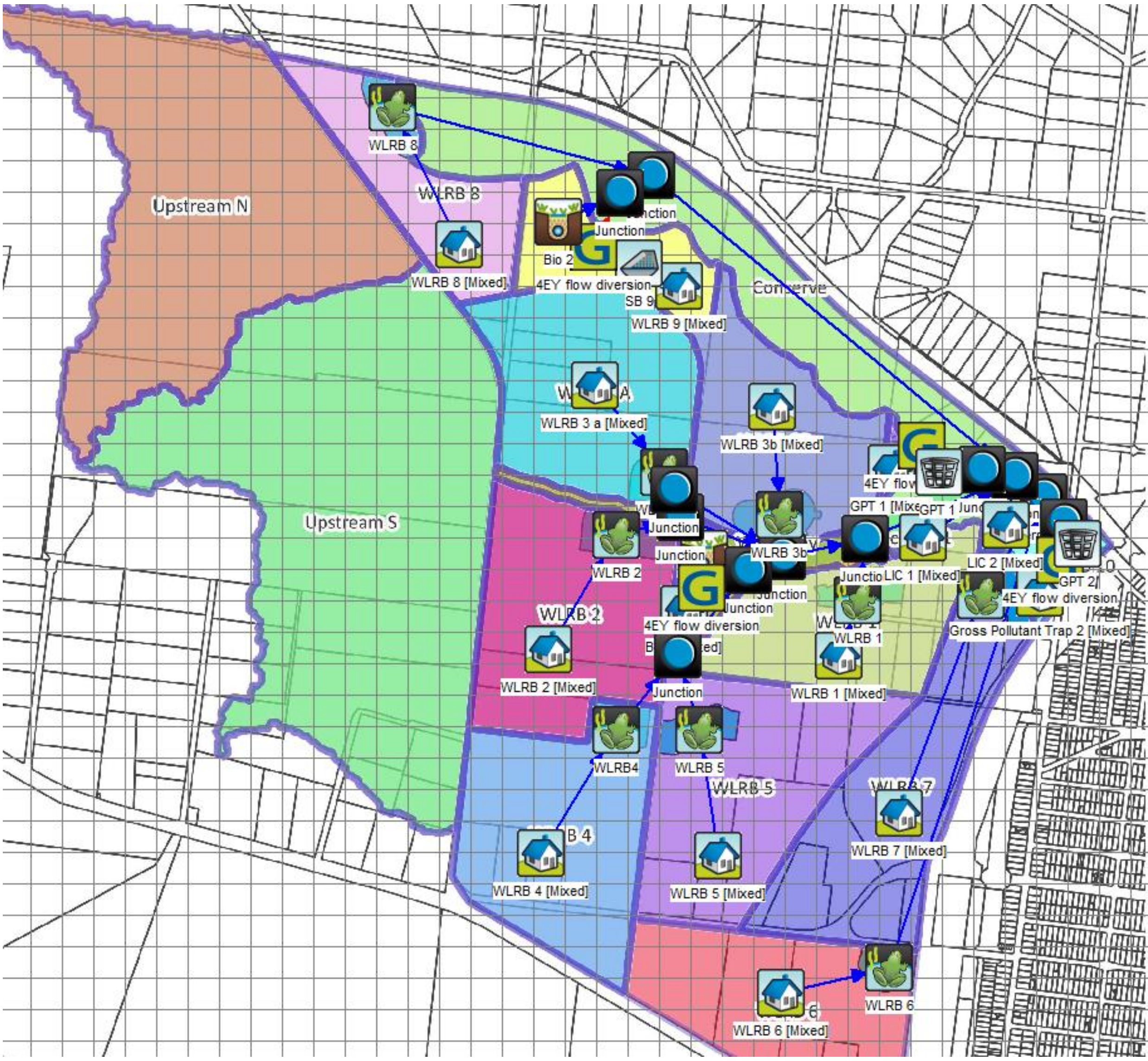


Figure 18. *MUSIC modelling – treatment model layout*

GPT modelling

As directed by the Council, Gross Pollutant Traps (GPTs) were proposed instead of the bioretention systems originally proposed as Bioretention 2 and Bioretention 3 in previous version of the concept redesign, with the aim to reduce the overall land take, DCP cost, and ongoing maintenance costs. Shortfalls in nutrient removal from these individual catchments are offset via other assets throughout the precinct, ensuring that best practice treatment targets are achieved for the entire precinct.

Council has indicated that a Vortex Hydrodynamic GPT is the preferred GPT. The GPT units are proposed to treat Gross Pollutants and Total Suspended Solids, as well as grease and oil prior to outfalling into Cowies Creek.

Gross pollutant traps are generally designed to capture litter and larger sediment materials. Proprietary products do generally claim to achieve a level of Total Suspended Solids (TSS) and Total Phosphorus (TP) removal in addition to gross pollutants. A summary of the adopted treatment efficiencies, as per an example Vortceptor Hydrodynamic GPT (Atlan) capture performance efficiencies, are provided in Table 10 below. As a conservative approach, no phosphorus removal has been assumed for the GPT.

Table 10. Adopted performance efficiencies for Vortceptor GPT

Pollutant	Adopted efficiency (%) in MUSIC	Vortceptor performance efficiency (%)*
Total Suspended Solids (TSS)	70%	70%
Total Phosphorus (TP)	0%	30%
Total Nitrogen (TN)	0%	0%
Gross Pollutants	99%	99%

*Source: Atlan Vortceptor hydrodynamic GPT

The GPTs receive the 4EY flows from the catchment. Pipe flows higher than this are bypassed around the GPT. This is reflected in the MUSIC modelling. The 4EY for GPT 1 is 0.059m^3/s and the 4EY for GPT 2 is 0.083m^3/s.

Asset Performance

The MUSIC modelling determined the sizing required for the wetland assets located at each of the catchment low points. The wetlands have been designed to inform the retarding basin stage-storage relationship presented in the hydrologic modelling section of this Report (Section 4). The details of the treatment systems are shown in Table 11 below.

Table 11. Asset parameters for proposed stormwater treatment assets

Asset	Catchment area	Normal Water Level (NWL) area (m^2)	Inlet pond volume (m^3)*	Average depth wetland (m)	Extended detention (m)	Extended detention time (hr)
WLRB1	24.3	4300	1040	0.4	0.35	72
WLRB2	33.47	6700	1200	0.4	0.35	72
WLRB3a	31.87	4900	960	0.4	0.35	72
WLRB3b	26.73	5000	960	0.4	0.35	72
WLRB4	32.5	5900	1120	0.4	0.35	72
WLRB5	34.63	5500	1160	0.4	0.35	72
WLRB6	31.5	5700	1120	0.4	0.35	72
WLRB7	33.8	4700	1120	0.4	0.35	72
WLRB8	18.92	3900	640	0.4	0.35	72
SBRB 9 + Bio 2	13.41	290 (bio)	232 (SB)	-	0.2 (bio)	-
Bio 1	3.66	130	-	-	0.2 (bio)	-

*See section 5.3 for sediment basin NWL areas and calculations.

The results of the MUSIC modelling analysis above, demonstrates that BPEM Guidelines / State pollutant reduction targets are being met for the entire precinct. The TSS reduction (79.7%) is very close to the 80% target, and could easily be refined in subsequent design stages to ensure that 80% is met. The MUSIC model results for each individual wetland, and the bioretention systems, are provided in the following tables. It should be noted that the limiting pollutant in this instance was Total Suspended Solids (TSS).

In each case, the pollutant reduction target for TN, TP and TGPs are slightly exceeded. This is not an overtreatment performance of these systems, given these “exceedances” are a result of trying to achieve all targets – with TSS reduction of 80% still required. Ordinarily, TN target of 45% reduction is the difficult one to achieve and typically results in higher performances for TSS and TP. This exceedance of TN and TP within the individual assets allows for the offsetting of the lack of TN and TP removal in the catchments with only the GPTs installed.

In the case of gross pollutants (litter, debris, coarse materials) the State reduction target of 70% is commonly exceeded when trying to achieve the other target pollutants (TSS, TP, TN – more critical to achieve in terms of downstream ecology and waterway / catchment health).

Table 12. Overall MUSIC modelling results for the precinct

	Source load	Residual load	% Reduction	kg/yr removed
Flow (ML/year)	907.0	842.0	7.2	
Total Suspended Solids (kg/yr)	180000.0	36400.0	79.7	143600.0
Total Phosphorus (kg/yr)	371.0	125.0	66.2	246.0
Total Nitrogen (kg/yr)	2600.0	1390.0	46.4	1210.0
Gross Pollutants (kg/yr)	40400.0	147.0	99.6	40253.0

Table 13. Wetland 1 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	16300.0	3240.0	80.2	13060.0
Total Phosphorus (kg/yr)	33.3	10.6	68.1	22.7
Total Nitrogen (kg/yr)	232.0	123.0	46.9	109.0
Gross Pollutants (kg/yr)	3580.0	0.0	100	3580.0

Table 14. Wetland 2 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	23400.0	4640.0	80.2	18760.0
Total Phosphorus (kg/yr)	48.8	15.3	68.6	33.5
Total Nitrogen (kg/yr)	336.0	175.0	47.9	161.0
Gross Pollutants (kg/yr)	5100.0	0.0	100	5100.0

Table 15. Wetland 3a treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	16700.0	3320.0	80	13380.0
Total Phosphorus (kg/yr)	34.6	10.9	68.6	23.7
Total Nitrogen (kg/yr)	249.0	130.0	48	119.0
Gross Pollutants (kg/yr)	3970.0	0.0	100	3970.0

Table 16. Wetland 3b treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	17700.0	3630.0	79.6	14070.0
Total Phosphorus (kg/yr)	35.9	11.3	68.4	24.6
Total Nitrogen (kg/yr)	256.0	134.0	47.7	122.0
Gross Pollutants (kg/yr)	3900.0	0.0	100	3900.0

Table 17. Wetland 4 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	21200.0	4210.0	80.1	16990.0
Total Phosphorus (kg/yr)	43.0	13.6	68.5	29.4
Total Nitrogen (kg/yr)	299.0	157.0	47.5	142.0
Gross Pollutants (kg/yr)	4660.0	0.0	100	4660.0

Table 18. Wetland 5 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	19000.0	3830.0	79.9	15170.0
Total Phosphorus (kg/yr)	38.9	11.9	69.4	27.0
Total Nitrogen (kg/yr)	277.0	143.0	48.4	134.0
Gross Pollutants (kg/yr)	4420.0	0.0	100	4420.0

Table 19. Wetland 6 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	20300.0	4080.0	79.9	16220.0
Total Phosphorus (kg/yr)	42.1	13.4	68.2	28.7
Total Nitrogen (kg/yr)	292.0	153.0	47.7	139.0
Gross Pollutants (kg/yr)	4520.0	0.0	100	4520.0

Table 20. Wetland 7 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	16700.0	3260.0	80.5	13440.0
Total Phosphorus (kg/yr)	34.7	10.9	68.5	23.8
Total Nitrogen (kg/yr)	248.0	129.0	47.8	119.0
Gross Pollutants (kg/yr)	4000.0	0.0	100	4000.0

Table 21. Wetland 8 treatment results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	12600.0	2500.0	80.2	10100.0
Total Phosphorus (kg/yr)	25.5	7.6	70.2	17.9
Total Nitrogen (kg/yr)	176.0	88.9	49.6	87.1
Gross Pollutants (kg/yr)	2740.0	0.0	100	2740.0

Table 22. Sediment basin + bioretention system 2 results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	9200.0	1610.0	82.5	7590.0
Total Phosphorus (kg/yr)	18.9	7.8	58.7	11.1
Total Nitrogen (kg/yr)	131.0	72.4	44.9	58.6
Gross Pollutants (kg/yr)	2010.0	0.0	100	2010.0

Table 23. Bioretention system 1 results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	2040.0	403.0	80.2	1637.0
Total Phosphorus (kg/yr)	4.3	1.9	56.2	2.4
Total Nitrogen (kg/yr)	30.0	15.9	46.9	14.1
Gross Pollutants (kg/yr)	473.0	24.2	94.9	448.8

Table 24. Gross Pollutant Trap 1 results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	1790.0	616.0	65.7	1174.0
Total Phosphorus (kg/yr)	3.6	3.6	0	0.0
Total Nitrogen (kg/yr)	25.3	25.3	0	0.0
Gross Pollutants (kg/yr)	391.0	20.8	94.7	370.2

Table 25. Gross Pollutant Trap 2 results

Target pollutant	Source load	Residual load	% Reduction	kg/yr removed
Total Suspended Solids (kg/yr)	2670.0	907.0	66.0	1763.0
Total Phosphorus (kg/yr)	5.5	5.5	0	0.0
Total Nitrogen (kg/yr)	38.0	38.0	0	0.0
Gross Pollutants (kg/yr)	587.0	34.1	94.2	552.9

Inundation frequency analysis

Inundation frequency analysis was not undertaken at this concept redesign stage. This should be undertaken in the functional design stage to ensure sustainable plant health for ongoing wetland function / treatment performance.

5.3 Sediment basin sizing

The velocity calculations (Table 26) and sediment capture efficiency calculations (Table 27) were performed iteratively to ensure all criteria were met and the sediment basins were sized appropriately. The flows used in these calculations are from rational method calculations.

The results from the treatment modelling indicated that TSS was the limiting pollutant to target. The sediment efficiency calculations show that the results are largely around 99% capture efficiency, which is slightly higher than the 95% target. This should be further refined in later design stages (i.e. functional), noting that it will not have significant impacts on overall land take or costings, as the land take is largely driven by the storage requirements.

Table 26. Velocity calculations – sediment basins

	Parameter	WLRB 1	WLRB 2	WLRB 3a	WLRB3b	WLRB 4	WLRB 5	WLRB 6	WLRB 7	WLRB 8	SBRB 9
Flow conditions	4EY flow (m^3/s)	0.49	0.62	0.46	0.48	0.57	0.53	0.39	0.41	0.36	0.29
	20% AEP flow (m^3/s)	2.46	3.10	2.28	2.38	2.87	2.63	1.93	2.06	1.78	1.43
	Flow depth (m)-between NWL and TED	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Sediment pond	Basin area (m^2)	1300	1500	1200	1200	1400	1450	1400	1400	800	290
	Width at NWL (m)	21	23	20	20	22	22	21	21	16	15
	Width at EDD (m)	24.5	26.5	23.5	23.5	25.5	25.5	24.5	24.5	19.5	18.5
	Average width (m)	22.8	24.8	21.8	21.8	23.8	23.8	22.8	22.8	17.8	16.8
	Flow Area (m^2)	8.0	8.7	7.6	7.6	8.3	8.3	8.0	8.0	6.2	5.9
	Flow Velocity (m/s) (20% AEP)	0.31	0.36	0.30	0.31	0.35	0.32	0.24	0.26	0.29	0.24
	Check	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK	< 0.5 OK
	Length to width ratio*	2.95	2.84	3.00	3.00	2.89	3.00	3.17	3.17	3.13	1.29

*The reduced length to width ratios are reflected in the hydraulic efficiency of the sediment basins

Table 27. Sediment basin sizing

	Parameter	WLRB 1	WLRB 2	WLRB 3a	WLRB3b	WLRB 4	WLRB 5	WLRB 6	WLRB 7	WLRB 8	SBRB 9
Conditions	Contributing Catchment (ha)	24.30	33.47	31.87	26.73	32.50	34.63	31.50	33.80	18.92	13.41
	Area of Basin (m^2)	1300	1500	1200	1200	1400	1450	1400	1400	800	290
Capture Efficiency	Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm]	11	11	11	11	11	11	11	11	11	11
	Hydraulic Efficiency (λ)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.11
	Permanent Pool Depth, dp (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Extended detention depth, de	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	Number of CTSR's, n	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.1
	Depth below permanent pool that is sufficient to retain sediment, d* (m)	1	1	1	1	1	1	1	1	1	1
	Design Discharge (m^3/s) [4EY]	0.49	0.62	0.46	0.48	0.57	0.53	0.39	0.41	0.36	0.29
	Capture Efficiency	99%	99%	99%	99%	99%	99%	99%	99%	99%	95.1%
	Check (>95%)	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Sediment Storage	Sediment Loading rate, Lo ($m^3/ha/yr$)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	Desired clean-out frequency, Fr	5	5	5	5	5	5	5	5	5	5
	Storage volume required, St	192	265	252	212	257	274	250	268	150	102
	Available sediment storage volume	650	750	600	600	700	725	700	700	400	145
	Check (Available storage > required storage)	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Sediment dewatering	Depth for dewatering area (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
	Area required for dewatering (m^2)	385	530	505	423	514	549	501	537	299	204

5.4 Wetlands sizing

Velocities

The updated calculations for the flow velocities through the wetlands, as well as the length to width ratios, are shown below.

Table 28. Velocity calculations - wetlands

	Parameter	WL1	WL2	WL3a	WL3b	WL4	WL5	WL6	WL7	WL8
Flow conditions	4EY (3 month flow) (m^3/s)	0.49	0.62	0.46	0.48	0.57	0.53	0.39	0.41	0.36
	Flow depth (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Wetland	Width at NWL (m)	32	40	35	35	38	36	37	34	29
	Width at EDD (m)	35.5	43.5	38.5	38.5	41.5	39.5	40.5	37.5	32.5
	Average width (m)	34	42	37	37	40	38	39	36	31
	Flow Area (m^2)	12	15	13	13	14	13	14	13	11
	Flow Velocity (m/s)	0.042	0.042	0.036	0.037	0.041	0.04	0.03	0.03	0.03
	Check	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK	< 0.05 OK
	Length: width ratios	4.20	4.19	4.00	4.08	4.09	4.24	4.16	4.07	4.64

Dimensions and quantities - wetlands

Tables 28 and 29 below, detail the key asset parameters for the proposed treatment wetlands.

Table 29. Wetland dimensions and parameters (WL1, WL2, WL3a, WL3b, WL4)

Parameter	WLRB1	WLRB2	WLRB3a	WLRB3b	WLRB4
Sediment basin					
NWL	51.30 m AHD	52.61 m AHD	53.73 m AHD	48.94 m AHD	63.52 m AHD
NWL area	1300 m^2	1500 m^2	1200 m^2	1200 m^2	1400 m^2
NWL width (average)	21 m	23 m	20 m	20 m	22 m
EDD	0.35m	0.35m	0.35m	0.35m	0.35m
TED	51.65 m AHD	52.96 m AHD	54.08 m AHD	49.29 m AHD	63.87 m AHD
Pool depth	1.5m	1.5m	1.5m	1.5m	1.5m
Batters (NWL to TED)	1:5	1:5	1:5	1:5	1:5
Transfer pit crest (NWL)	51.30 m AHD	52.61 m AHD	53.73 m AHD	48.94 m AHD	63.52 m AHD
Wetland	WL1	WL2	WL3a	WL3b	WL4
NWL	51.20 m AHD	52.51 m AHD	53.63 m AHD	48.84 m AHD	63.42 m AHD
NWL area	4300 m^2	6700 m^2	4900 m^2	5000 m^2	5900 m^2
NWL width (average)	32 m	40 m	35 m	35 m	38 m
EDD	0.35m	0.35m	0.35m	0.35m	0.35m
TED	51.55 m AHD	52.86 m AHD	53.98 m AHD	49.19 m AHD	63.77 m AHD
Pool depth	1.5m	1.5m	1.5m	1.5m	1.5m
Batters (NWL to TED)	1:5	1:5	1:5	1:5	1:5

Table 30. Wetland dimensions and parameters (WL5, WL6, WL7, WL8, SB9)

Parameter	WLRB5	WLRB6	WLRB7	WLRB8	SBRB9
Sediment basin					
NWL	60.89 m AHD	67.24 m AHD	55.76 m AHD	44.54 m AHD	47.8m AHD
NWL area	1450 m2	1400 m2	1400 m2	800 m2	290m2
NWL width (average)	22 m	21 m	21 m	16 m	15 m
EDD	0.35m	0.35m	0.35m	0.35m	0.35m
TED	61.24 m AHD	67.59 m AHD	56.11 m AHD	44.89 m AHD	48.15 AHD
Pool depth	1.5m	1.5m	1.5m	1.5m	1.5m
Batters (NWL to TED)	1:5	1:5	1:5	1:5	1:5
Transfer pit crest (NWL)	60.89 m AHD	67.24 m AHD	55.76 m AHD	44.54 m AHD	47.8m AHD
Wetland	WL5	WL6	WL7	WL8	
NWL	60.79 m AHD	67.14 m AHD	55.66 m AHD	44.44 m AHD	-
NWL area	5500 m2	5700 m2	4700 m2	3900 m2	-
NWL width (average)	36 m	37 m	34 m	29 m	-
EDD	0.35m	0.35m	0.35m	0.35m	-
TED	61.14 m AHD	67.49 m AHD	56.01 m AHD	44.79 m AHD	-
Pool depth	1.5m	1.5m	1.5m	1.5m	-
Batters (NWL to TED)	1:5	1:5	1:5	1:5	-

5.5 Wetland design checklist

The list below provides the design compliance criteria from the Melbourne Water *Constructed Wetlands Design Manual: Design, Construction and Establishment of Wetlands (2020).* For criteria related to modelling and key design requirements calculated by Alluvium, the relevant section of this report is referenced in the table below.

Table 31. Compliance criteria addressed

Category	Design condition	Brief description	Design phase	Met	Notes
General	GN1	Modelling in MUSIC	Concept Functional Detailed	✓	Performed
	GN2	MUSIC meteorological data	Concept Functional Detailed	✓	Geelong North (station # 087133) from 1971-1980
	GN3	MUSIC consistent with plans	Concept Functional Detailed	✓	Provided
	GN4	Peak design flows in accordance with AR&R	Concept Functional Detailed	✓	Peak flows are calculated using RORB and adopting ARR2019. Rational calculations used for pipe flows for SB calcs and velocity calcs.
Maintenance provisions	MN1	Sediment pond drained with macrophyte zone at NWL	Functional Detailed	✓	SB NWL sitting 100mm above the wetland NWL
	MN2	Sediment pond accessibility	Functional Detailed	✓	An access track around the sediment basin has been included as well as an access ramp
	MN3	Sediment pond base	Detailed	✓	
	MN4	Hardstand area for edge cleaned sediment basins	Detailed		
	MN5	Maintenance access ramps for sediment ponds that cannot be edge cleaned.	Functional Detailed	✓	Provided
	MN6	Maintenance access tracks to sediment pond access ramp	Concept Functional Detailed	✓	Provided
	MN7	Turning circle	Detailed Functional		
	MN8	Clearly marked intersections with pedestrian paths	Detailed		
	MN9	Sediment dewatering areas	Concept Functional Detailed	✓	Sediment dewatering areas will need to be located outside of the RB.
	MN10	Maintenance vehicle access for macrophyte zone	Concept Functional Detailed	✓	4m maintenance access provided around the perimeter of the RB. Access also provided

					around the wetland for at least 50% of wetland perimeter.
Sediment Pond	SP1	Located offline to waterway, online to pipe	Concept Functional Detailed	✓	All SBs located within RBs.
	SP2	Located at each stormwater entrance point	Concept Functional Detailed	✓	SBs located where stormwater enters the wetland systems. No SB where the incoming stormwater is <5% of the total wetland catchment.
	SP3	Sediment pond size	Functional Detailed	✓	
	SP4	EDD <= 350 mm	Concept Functional Detailed	✓	EDD of 350mm
Macrophyte zone	MZ1	80% area must be less than 350 mm deep	Functional Detailed		
	MZ2	EDD <= 350 mm	Concept Functional Detailed	✓	EDD of 350mm has been adopted in all wetlands
	MZ3	Macrophyte zone located offline	Concept Functional Detailed	✓	Macrophyte zones located offline to waterways.
	MZ4	Length > = four times average width	Concept Functional Detailed	x	Length to width ratio is above 4:1 for most wetlands. Some less than 4:1 (minimum 3:1) due to managing velocities (i.e. requiring wider wetlands)
	MZ5	Outlet located at opposite end to inlet	Concept Functional Detailed	✓	Provided.
	MZ6	Submerged, shallow and deep marsh zones in a banded manner.	Functional Detailed		
	MZ7	Inlet and outlet pool depth <=1.5m	Functional Detailed		
	MZ8	Intermediate Pools depth <=1.2m	Functional Detailed		
	MZ9	Flow velocities limits	Functional Detailed	✓	4EY flow velocities are below the 0.05m/s thresholds.
	MZ10	Residence time 90th percentile of 3 days or 72 hours	Functional Detailed		
	MZ11	Minimum longitudinal grade	Functional Detailed		
	MZ12	Water level marker	Detailed		
	MZ13	No islands within wetland	Concept Functional Detailed	✓	No islands

Bypass	BY1	Sediment basin bypass/overflow sizing	Concept Functional Detailed	x	No bypasses provided.
Inlets and outlets	IO1	Pits, grilles and structures	Detailed	✓	
	IO2	Outlet structures – easily identifiable and maintainable	Detailed	✓	
	IO3	Controlled outlet	Detailed	✓	
	IO4	Sediment pond to wetland connection	Functional Detailed	✓	
	IO5	Controlled outlet submerged	Detailed	✓	
	IO6	Control macrophyte zone water level	Functional Detailed	✓	
	IO7	Maintenance drawdown pipes	Functional Detailed	✓	
Vegetation	VG1	80% emergent macrophytes	Functional Detailed	✓	
	VG2	Open water < 20%	Concept Functional Detailed	✓	Share of open water from the macrophyte zone is less than 20%.
	VG3	Densely planted ephemeral batters	Functional Detailed	✓	
	VG4	Ephemeral batters planting cells	Detailed	✓	
	VG5	Densely planted shallow marsh	Functional Detailed	✓	
	VG6	Densely planted deep marsh	Functional Detailed	✓	
	VG7	Densely planted submerged marsh	Functional Detailed	✓	
	VG8	Seedlings	Detailed	✓	
	VG9	Seedlings	Detailed	✓	
	VG10	Effective water depth	Functional Detailed	✓	
	VG11	Stormwater harvesting	Concept Functional Detailed	✓	Ability to harvest off the wetland control pits in downstream chamber.
	VG12	Wetland outfall	Functional Detailed	✓	
	VG13	Grassed areas	Functional Detailed	✓	
	VG14	Mulch and jute mat	Functional Detailed	✓	
Liner and topsoil	LN1	Exfiltration rate	Concept Functional Detailed	✓	Clay liners in sediment basins, wetlands.

	LN2	Impermeable liners	Detailed	✓	
	LN3	Topsoil depth	Functional Detailed	✓	
	LN4	Topsoil type	Detailed	✓	
Landscape design structures	LDS1	Landscape design structures in accordance with MW guidelines requirements	Detailed	✓	
	LDS2	Boardwalks or viewing platforms not permitted over sediment ponds, pipes and pits, weirs, rock chutes	Concept Functional Detailed	✓	No boardwalks or viewing platforms.
	LDS3	Vehicle exclusion bollards	Concept Functional Detailed	✓	Provided
Edge treatment	ET1	Deep open water edge not obscured	Functional Detailed	✓	
	ET2	Batters	Functional Detailed	✓	
	ET3	Minimum offset of 15 m wetland NWL to any allotment	Detailed	✓	

5.6 Gross Pollutant Trap design principles

- Council's preferred GPTs are vortex hydrodynamic GPTs that have the capability of separating and capturing gross pollutants, sediments, silt and total suspended solids, along with some nutrients and oil and grease.
- The GPTs will need to be designed to intercept the 4EY flows. Pipe flows higher than this are bypassed around the GPT.
- Allowance for access to the GPTs for maintenance will be required.
- Regular inspections of the GPTs will be required – at least quarterly – to ensure accumulated material is removed and the GPT continues to function as intended.

The GPTs have been indicatively located in the concept design section (8), at the bottom of the catchments. The ultimate location and sizing will be influenced by the subdivisional layout and drainage design.

6 Bioretention System Designs

Bioretention systems were adopted for the small catchments, where a wetland/retarding basin is not appropriate given the relatively small catchment areas and often challenging site topography (steep grades) which can further increase land take.

6.1 Asset sizing

MUSIC has been used to size the bioretention assets. MUSIC modelling assumptions and outputs are outlined in the table below. Bioretention designs are in accordance with Council's *Design Note 3 – Bioretention* where assets servicing a catchment area that is greater than 10ha, a sediment basin upstream of the bioretention system is required to drop out coarse sediments. This applies to bioretention system 2 only. Sediment forebays will be required for the other bioretention system to protect the asset from TSS loading, which can compromise asset hydraulic function and treatment performance and result in asset failure and/or higher asset renewal efforts.

Table 32. MUSIC modelling design assumptions

Parameters	Bio 1	Bio 2
Filter media area	130 m^2	290 m^2
Extended Detention	0.2 m	0.2 m
Lined / unlined*	Lined	Lined
Saturated Hydraulic Conductivity	100 mm/hr	100 mm/hr
Filter Depth	500mm	500mm
TN Content	800 mg/kg	800 mg/kg
Orthophosphate content	55 mg/kg	55 mg/kg
Exfiltration rate	0 mm/hr given inclusion of liner	0 mm/hr given inclusion of liner
Underdrain present	Yes	Yes
Submerged zone	Yes	Yes
Design flow	0.063m^3/s (4EY of contributing catchment)	0.285 m^3/s (4EY of contributing catchment)

*The bioretention systems are lined with an impermeable liner to create a saturated zone, which assists in stormwater treatment, and provides an additional source of water for the biofilter plants to access. The liner also ensures groundwater does not interfere with drainage of the bioretention system.

6.2 Dimensions and quantities

A summary of typical bioretention details is provided.

Table 33. Bioretention system design summary

Item	Brief description	Notes/value
Bioretention profile	Sediment pre-treatment provided to protect filter media	Grouted rock scour protection. Catchments >10ha require a sediment basin.
	Filter media hydraulic conductivity (100-300 mm/hr)	100 mm/hr
	Filter media depth (≥ 400mm)	500 mm
	Transition layer depth (≥ 100mm)	300 mm
	Drainage layer depth (≥ 50mm drainage material above underdrainage slotted pipe)	200 mm
	Extended detention depth (EDD)/ ponding depth (≤ 500mm)	200 mm EDD
	Freeboard to top of batter	200 mm minimum
	Total depth below top of filter media	1000 mm
	Liner (around base and sides of bioretention system)	Impermeable liner is proposed
Layout	Filter area	As per table above
	Batter slope	1 (V) : 4 (H)
Inlt and diversion design	Diversion type	Weir structure in proposed new pit to divert water to bioretention system
	Inlet type	Pipe
	Diversion pipe	300 mm Reinforced Concrete (RC) Class 2
Outlet and connection design	Overflow structure type	Overflow pit
	Overflow pit dimension (internal)	TBC in later design stages
	Overflow weir length	N/A
	Outlet type	Pipe
Maintenance and erosion protection	Provision of maintenance vehicle access	Vehicle access through local roads (TBC). 4m wide access path from closest road in FUS should be allowed for.
	Scour protection provided at inflow location	Grouted rock scour protection
	Trees and shrubs to be included	No
	Planting density (number of plants/m^2)	6-8 plants/m^2
	Mulch type and depth	No mulch on filter media

7 Waterway Designs

7.1 Waterway design flows

Melbourne Water's *Constructed Waterway Design Manual* was applied to guide the waterway designs for the PSP, noting that the proposed constructed waterway assets are more akin to vegetated swales than strictly an open, flowing waterway channel. However, many of the design criteria are still relevant to ensure a stable, diverse and naturalised system is achieved.

As provided in the report (above sections), the following peak flow rates were used to inform the waterway designs, as established in the developed conditions RORB model. These are extremely similar to the peak flows used to design the waterways in the Functional Design documentation (Alluvium, Dec 2022). Therefore the waterway design developed previously to a functional design level, has been adopted in this instance – concept redesigns. All additional details on the waterway designs can be found in the functional design documentation (to which this Addendum Report is part of).

Table 34. Calculated flow rates for constructed waterway design (from RORB)

Storm event	Flow rate (m^3/s) – Waterway 1	Flow rate (m^3/s) – Waterway 2
1% AEP	4.89m^3/s (flow from external catchment S, at start of waterway. 7.26m^3/s, flows downstream of WLRB2 and WLRB3a (Point A).	3.80 m^3/s, combined flows from WLRB4 and WLRB5. (Point B)

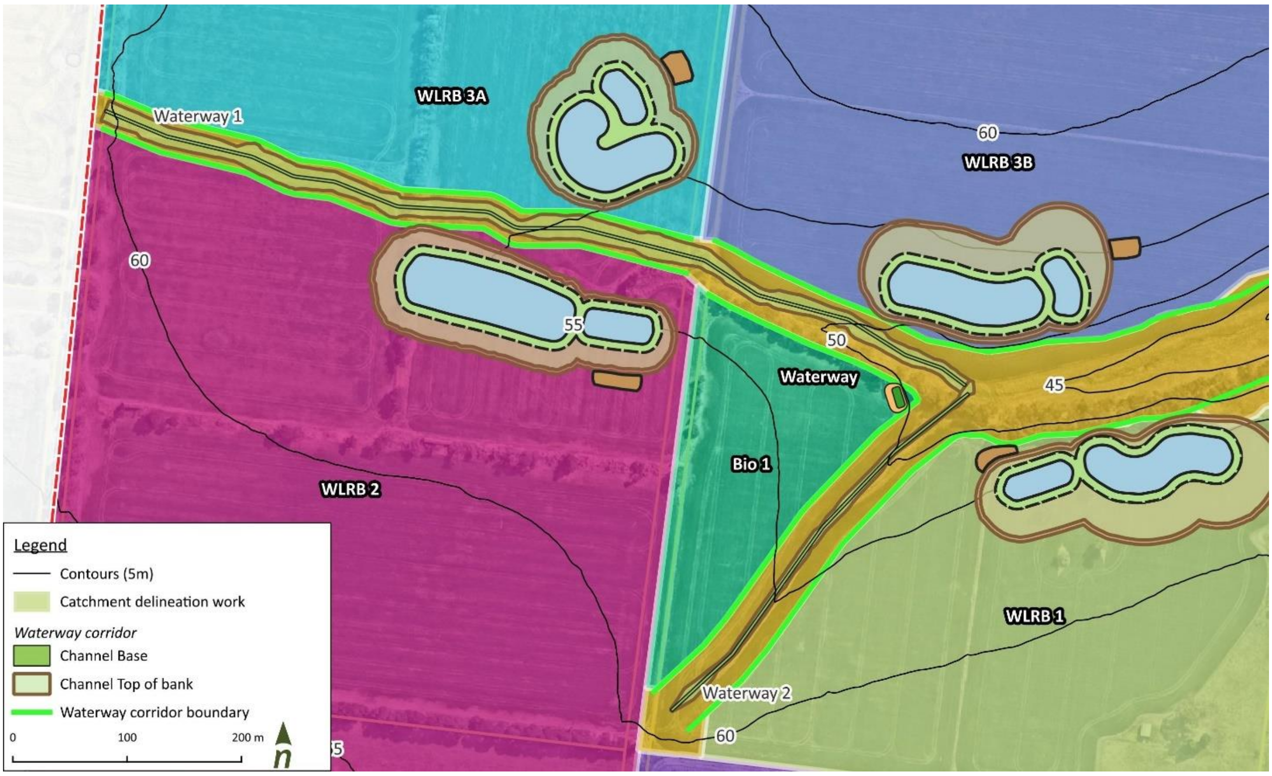


Figure 19. *Waterway designs layouts – WW01 & WW02 confluence with each other at existing waterway (EW01) – existing tributary of Cowies Creek*

7.2 Waterway corridors

The design response for the proposed constructed waterways (WW01 and WW02) and associated corridors have adopted the principles in Melbourne Water's *Waterway Corridor Design Guidelines* to ensure:

- 'an appropriate waterway corridor or reserve is provided adjacent to development in order to accommodate objectives for flood protection, river health, biodiversity, safety and amenity'
- the waterway corridor is appropriately defined as the waterway channel with associated riparian zone (i.e. the CRZ and VB)
- riparian connectivity is provided by locating shared paths/other infrastructure outside the CRZ
- stormwater treatments (e.g. wetlands and bioretention) footprints are predominantly located outside the CRZ so as not to unduly degrade its ecological function
- a waterway corridor width is assigned for PSP waterways to preserve the riparian zone / provide waterway health enhancements
- opportunities for passive recreational routes are made along these corridors (while remaining outside the CRZ).

Constructed waterways with hydraulic widths of <15m are recommended to have a reduced waterway corridor of 30m, to encourage uptake of waterway designs, as opposed to pipe and road arrangements, given the latter does not provide for biodiversity, amenity or urban cooling and liveability outcomes. This was discussed with Council early in the design process, and was agreed to be the approach adopted, in line with IWM principles.

Given the waterway peak flows for the proposed waterways are almost the same as previously established in the functional design work (Alluvium, Dec 2022) the previous waterway corridors are deemed appropriate for this concept level redesign. This should be confirmed further at functional design stages with hydraulic modelling (outside the scope of this work).

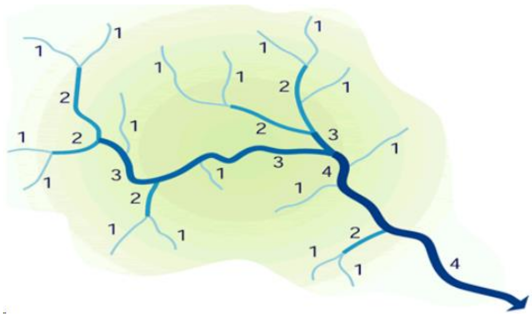
A summary of the corridor widths is presented in the table below. All additional details and mapping can be found in the functional design documentation (refer Alluvium, Dec 2022).

Table 35. Constructed waterways - Summary of corridor widths

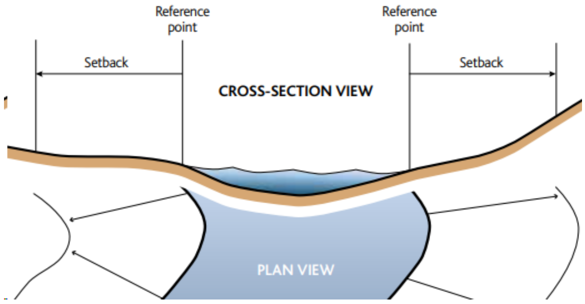
Waterway	Hydraulic width	Corridor width (m) (as per hydraulic width)
Waterway 1 (WW-01)	Varies, up to ~15m (U/S CCC) Varies, up to ~33m (D/S CCC)	30 (upstream of CCC) 45 (downstream of CCC)
Waterway 2 (WW-02)	Varies, up to ~35m	45

Natural waterways (EW-01) – corridor widths

The existing tributary (EW-01) is not proposed to be reconstructed, rather enhanced. It is existing and intended to remain and be protected through the upstream design response for the PSP assets. As per Melbourne Water's waterway corridor guidelines, in the case of natural waterways, the waterway corridor width is set by the Strahler stream order (image left). The Strahler stream order of this system (EW-01) is 2, which would require a 20m setback (image right) from the reference point (typically the top of bank).



Strahler stream order



Reference point – setbacks

Figure 20. *Natural waterway corridor widths (Waterway corridor guidelines, Melbourne Water)*

However, this tributary is in a valley form, meaning there are less defined 'top of banks' from which to determine a clear reference point to then inform the setbacks. While the guidelines do not provide clear guidance in this matter, in this instance, an alternate reference point has been applied – that is, the hydraulic width (HW) of the waterway. The hydraulic width is defined by the channel width required to safely contain the 1% AEP flows.

The extent of the 1% AEP hydraulic width, as established in WMS's hydraulic modelling, has been adopted as the reference point for the EW01 corridor setback. Some minor adjustments should be considered along the waterway length to ensure any protected vegetation (understorey or tree retention), riparian connectivity and continuity of the drainage interface, is well managed. Constructability considerations also influence matters where the topography is steep and drops into the valley form. In some cases, a development setback from topography break lines could be adopted.

For a site like this, the overall development setback is likely to be more influenced by setbacks to retain landscape character, amenity and/or environmental values. These will likely be driven by Council's planning, landscape design and urban planning experts, as well as guided by the CMA and strategic plans that inform development expectations for the northern and western Geelong region. Council may wish to create development setbacks to:

- retain key sight lines and enhanced landscape amenity
- maintain an interface with natural systems and safe community interactions
- retain the current look and feel of the valley form.

For detailed representation of the constructed waterways (WW01 and WW02) with the existing waterway (EW-01) refer back to Figure 12 above.

8 Concept Designs

The following figures present the concept designs for all proposed stormwater assets within the precinct.

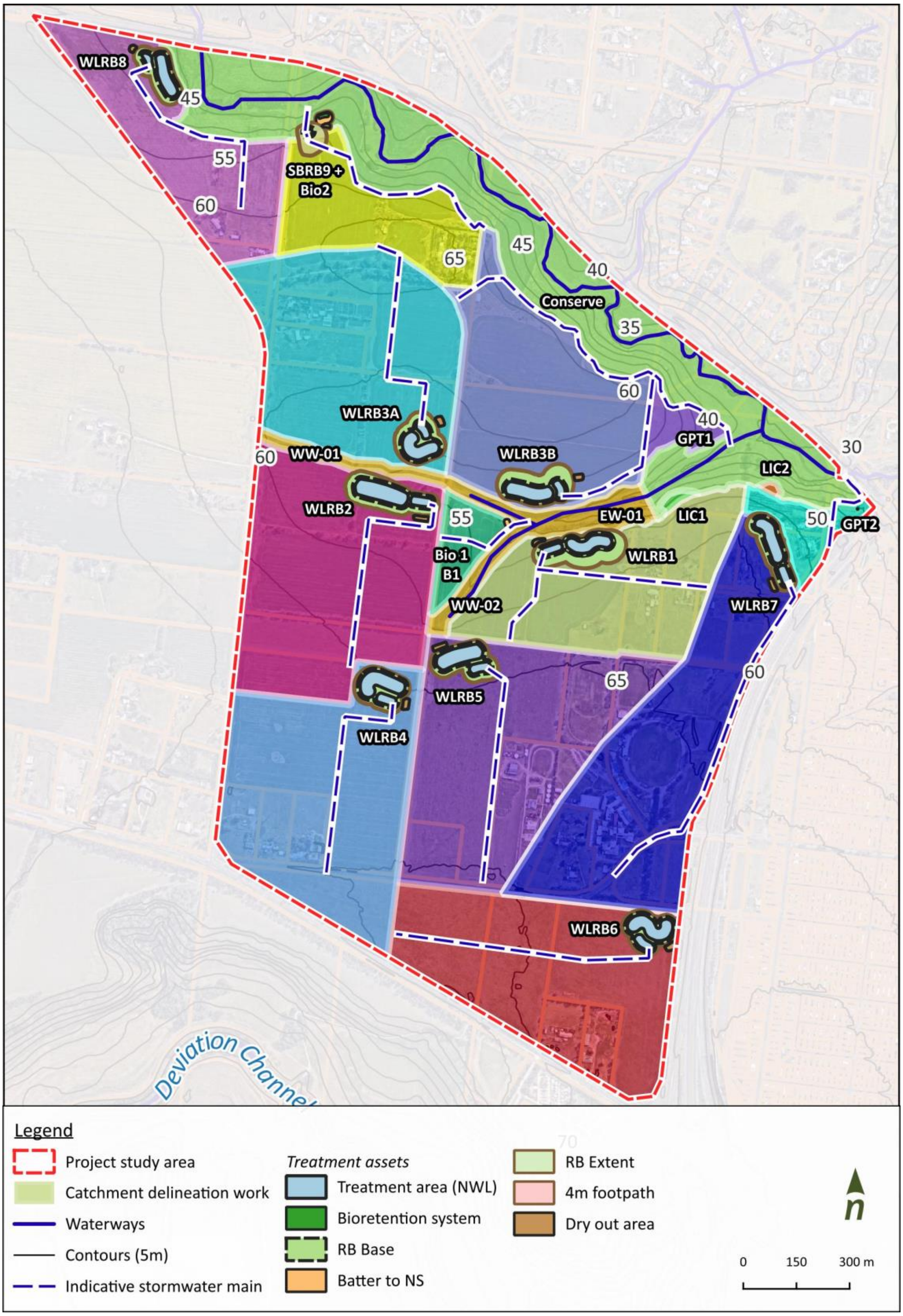


Figure 21. *Concept design overview showing indicative only (out of scope) stormwater mains*

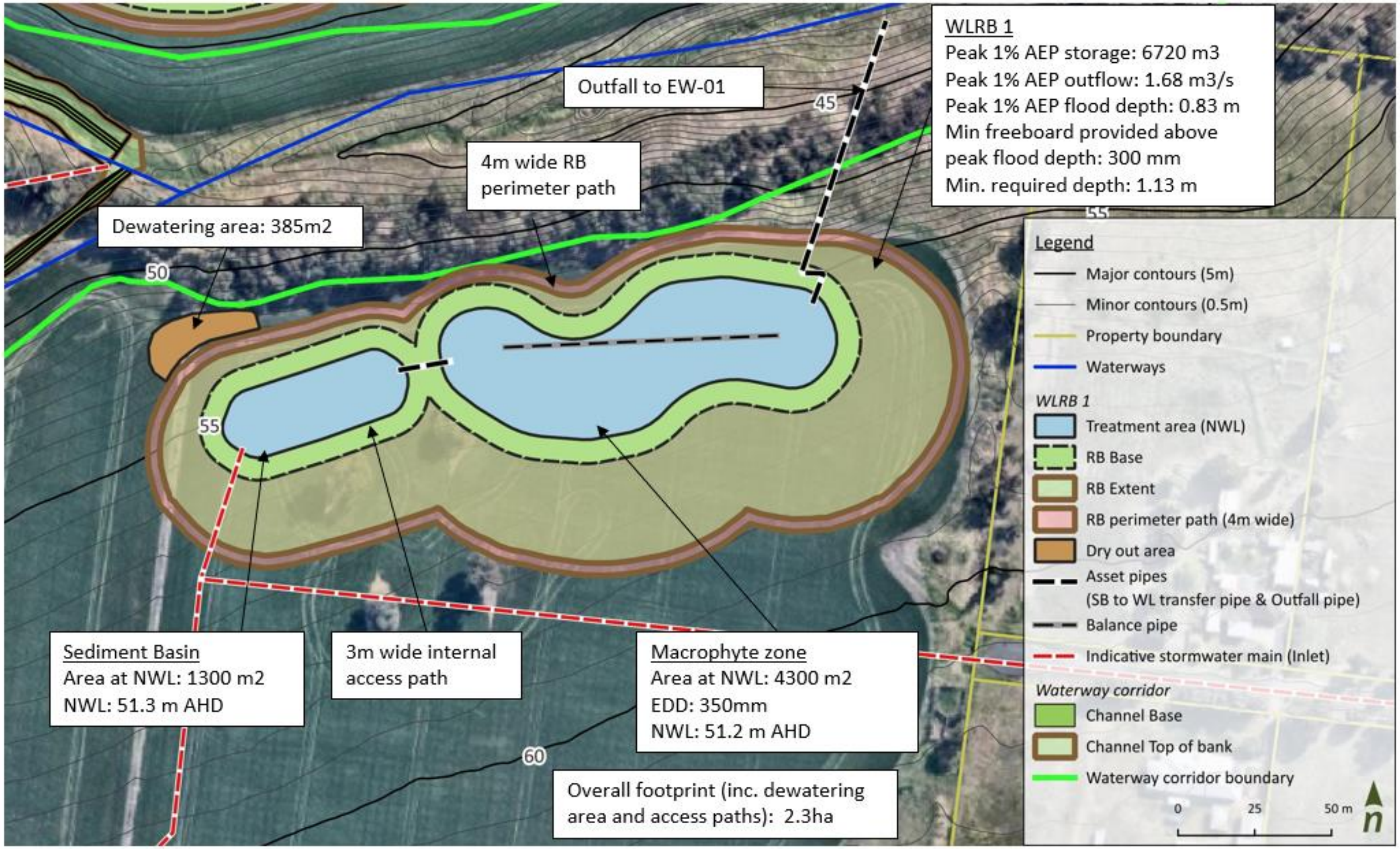


Figure 22. *WLRB1 concept design*

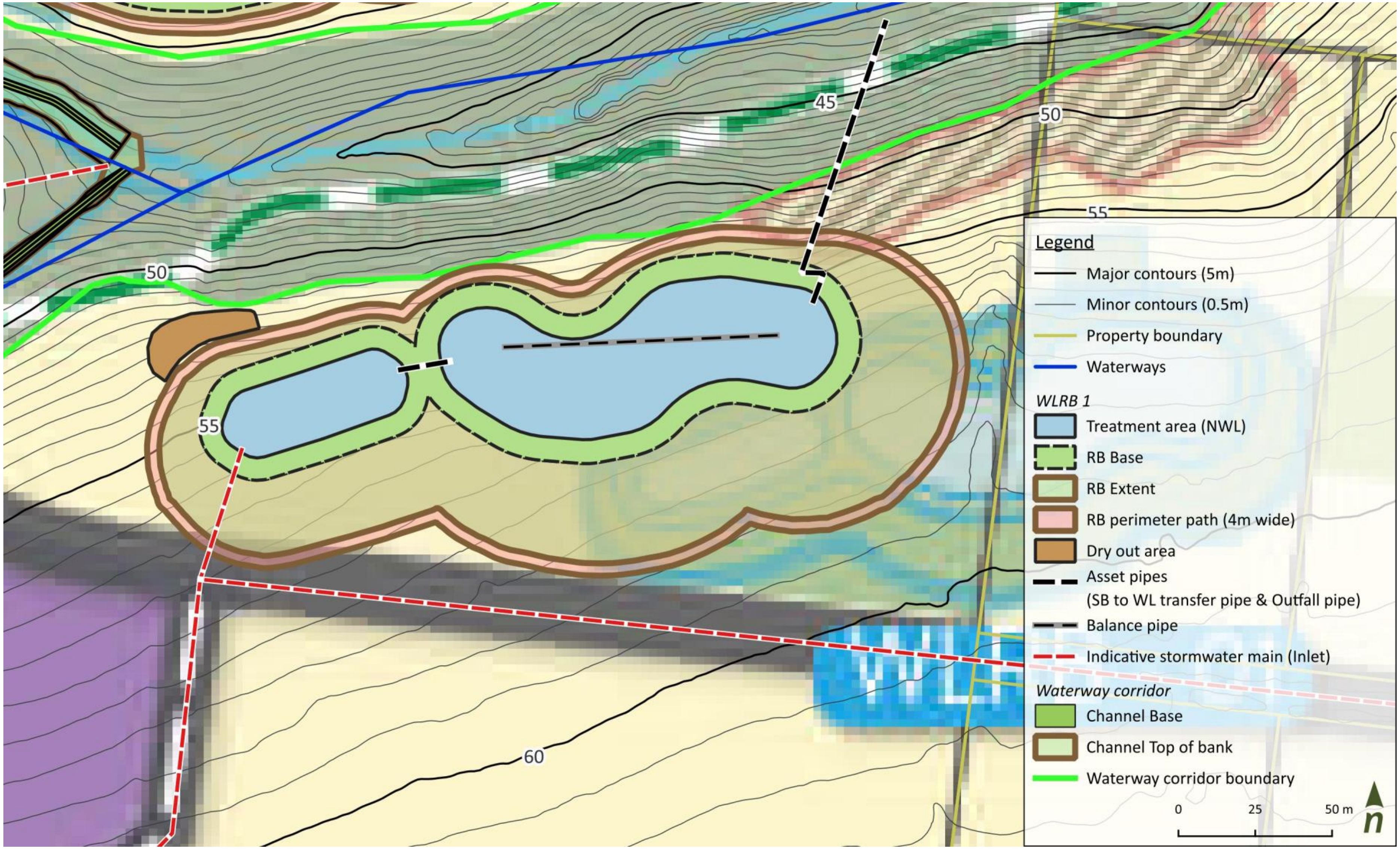


Figure 23. *WLRB1 concept design (FUS underneath)*

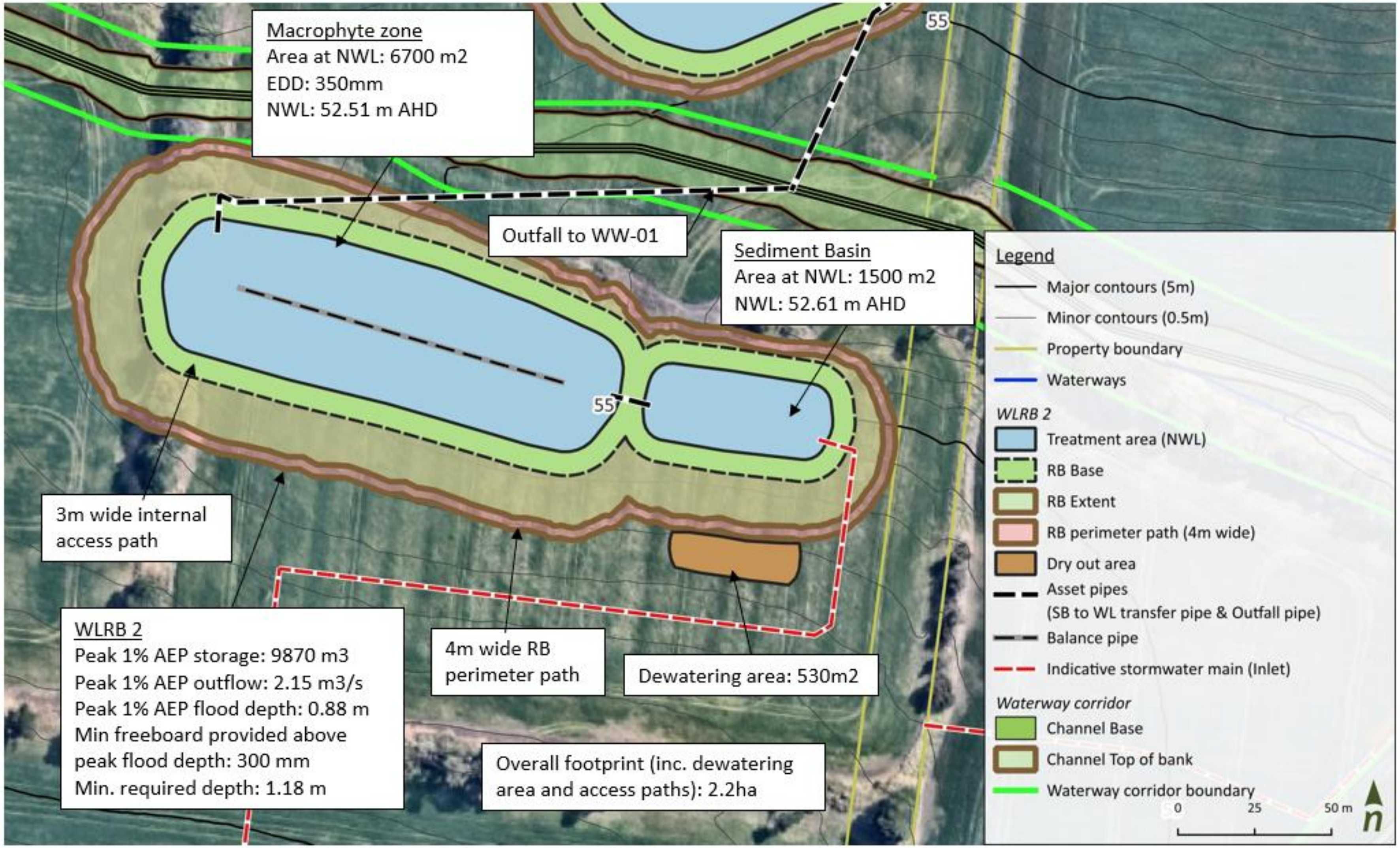


Figure 24. *WLRB2 concept design*

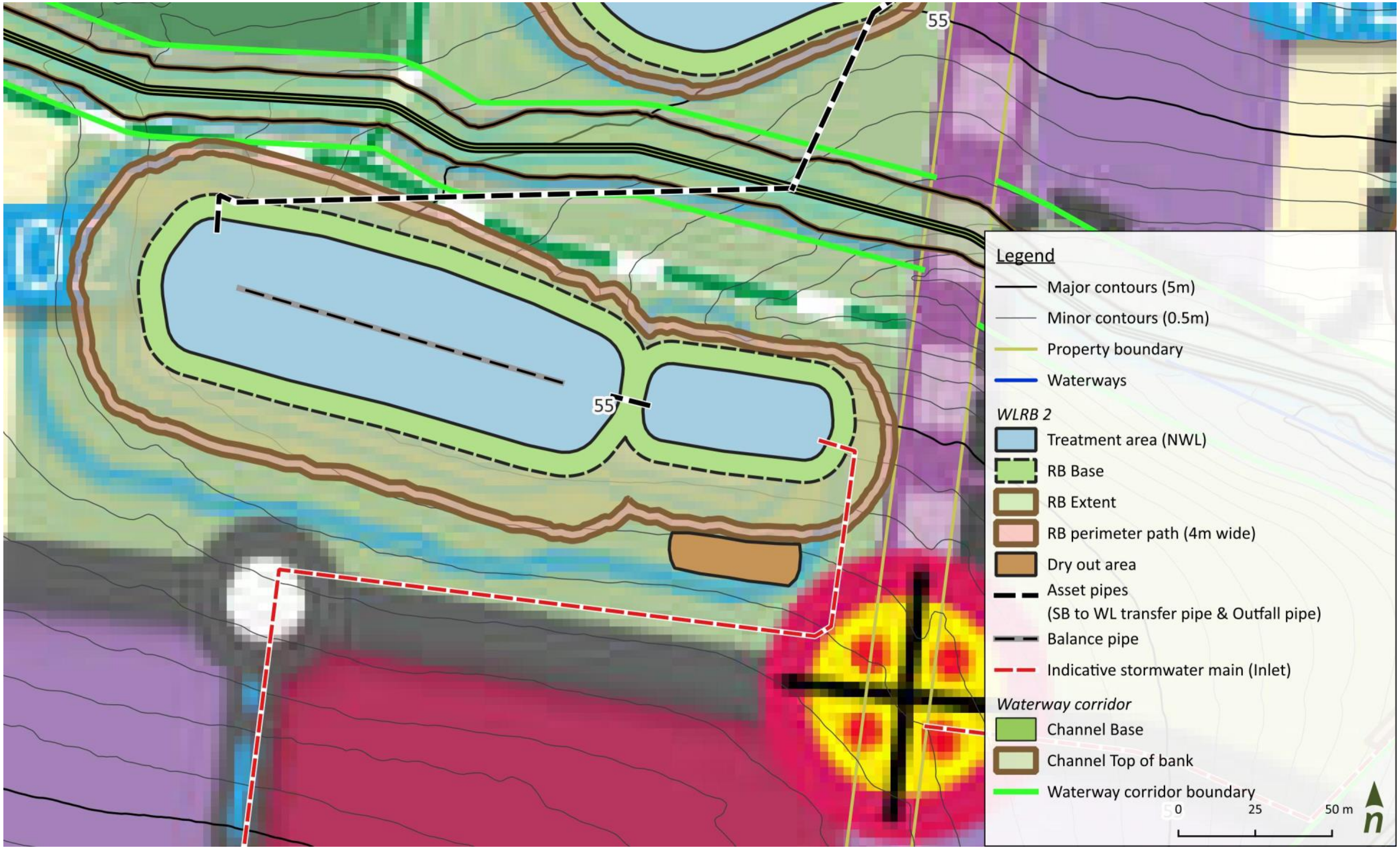


Figure 25. *WLRB2 concept design (FUS underneath)*

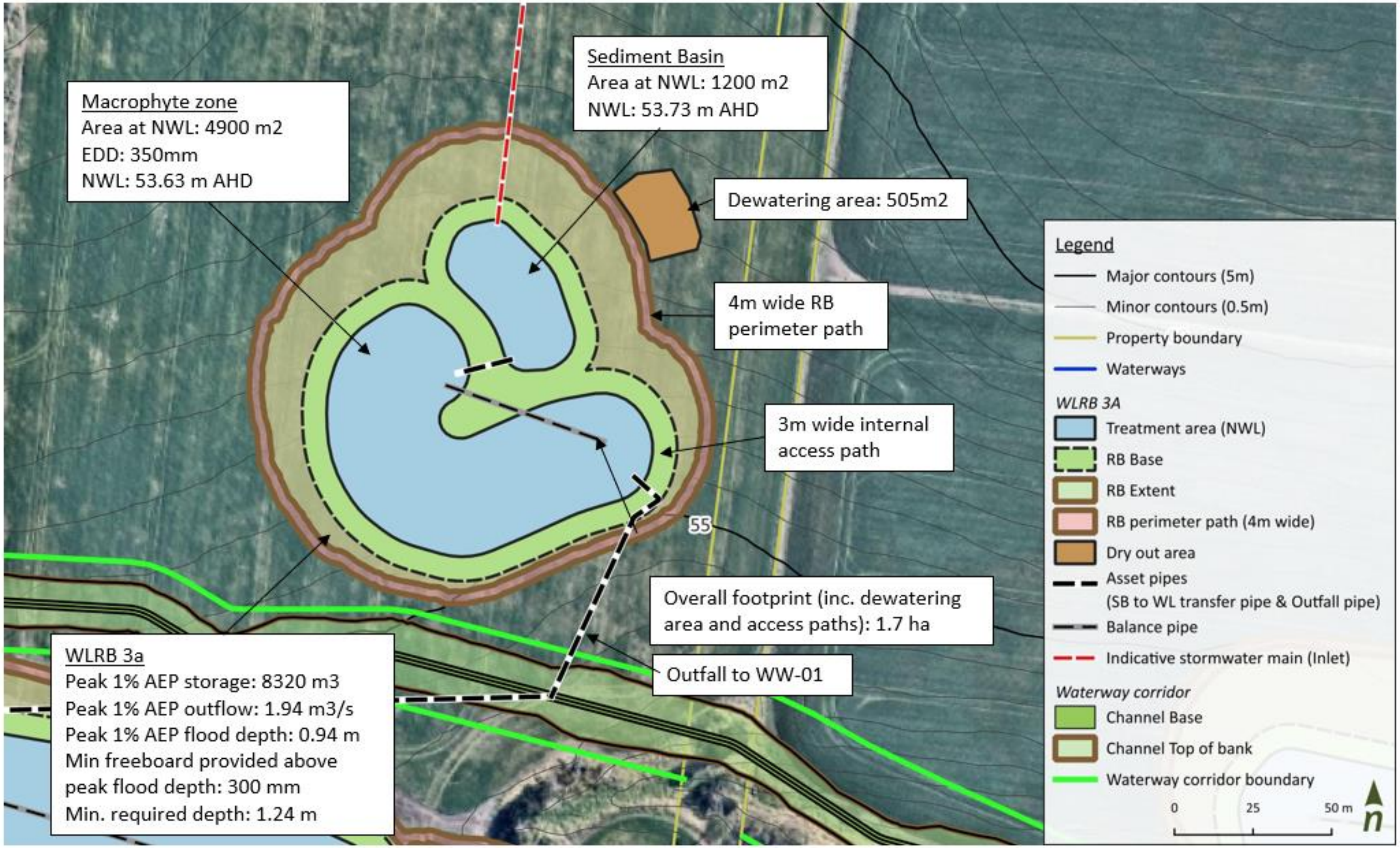


Figure 26. *WLRB3a concept design*

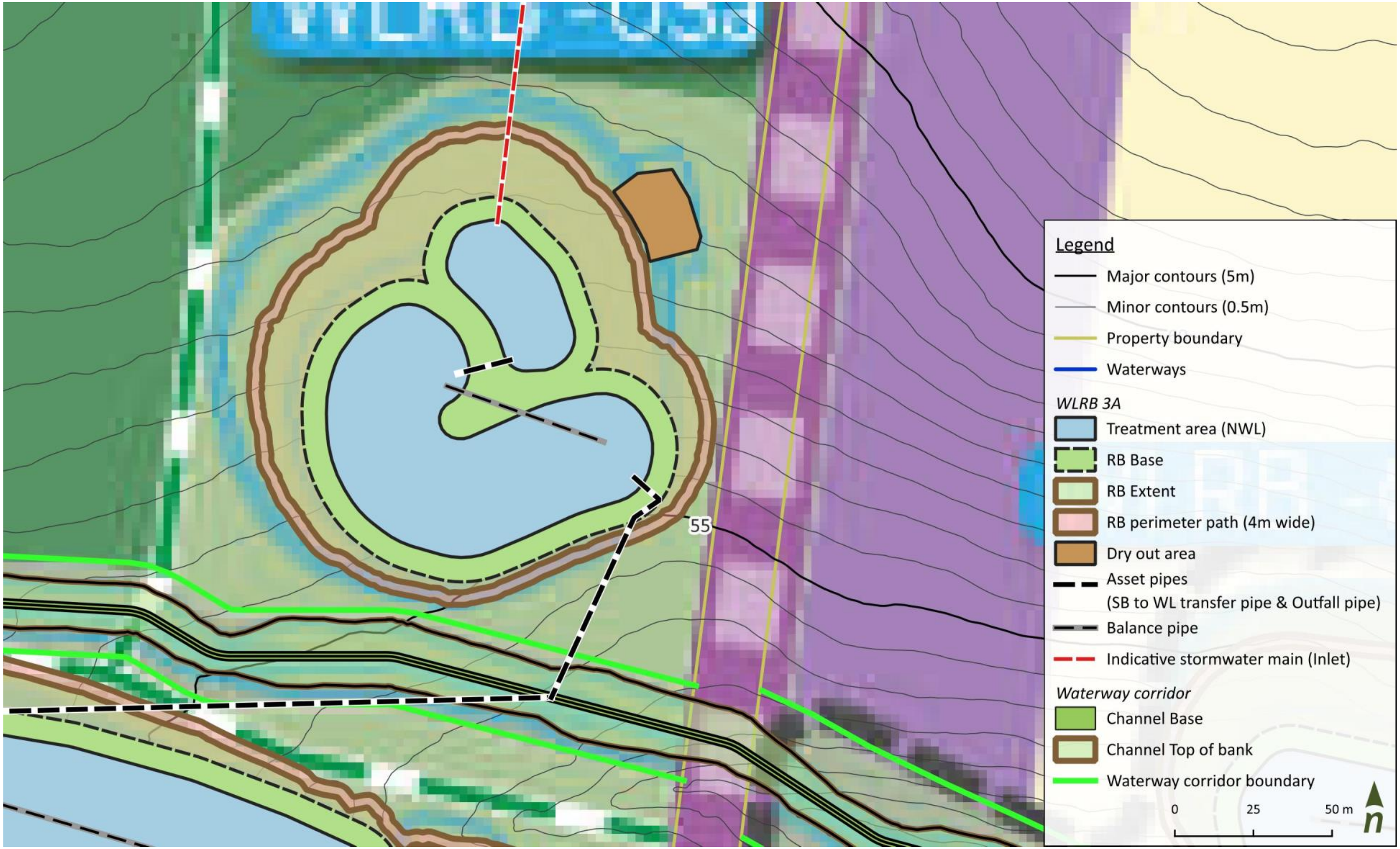


Figure 27. *WLRB3a concept design (FUS underneath)*

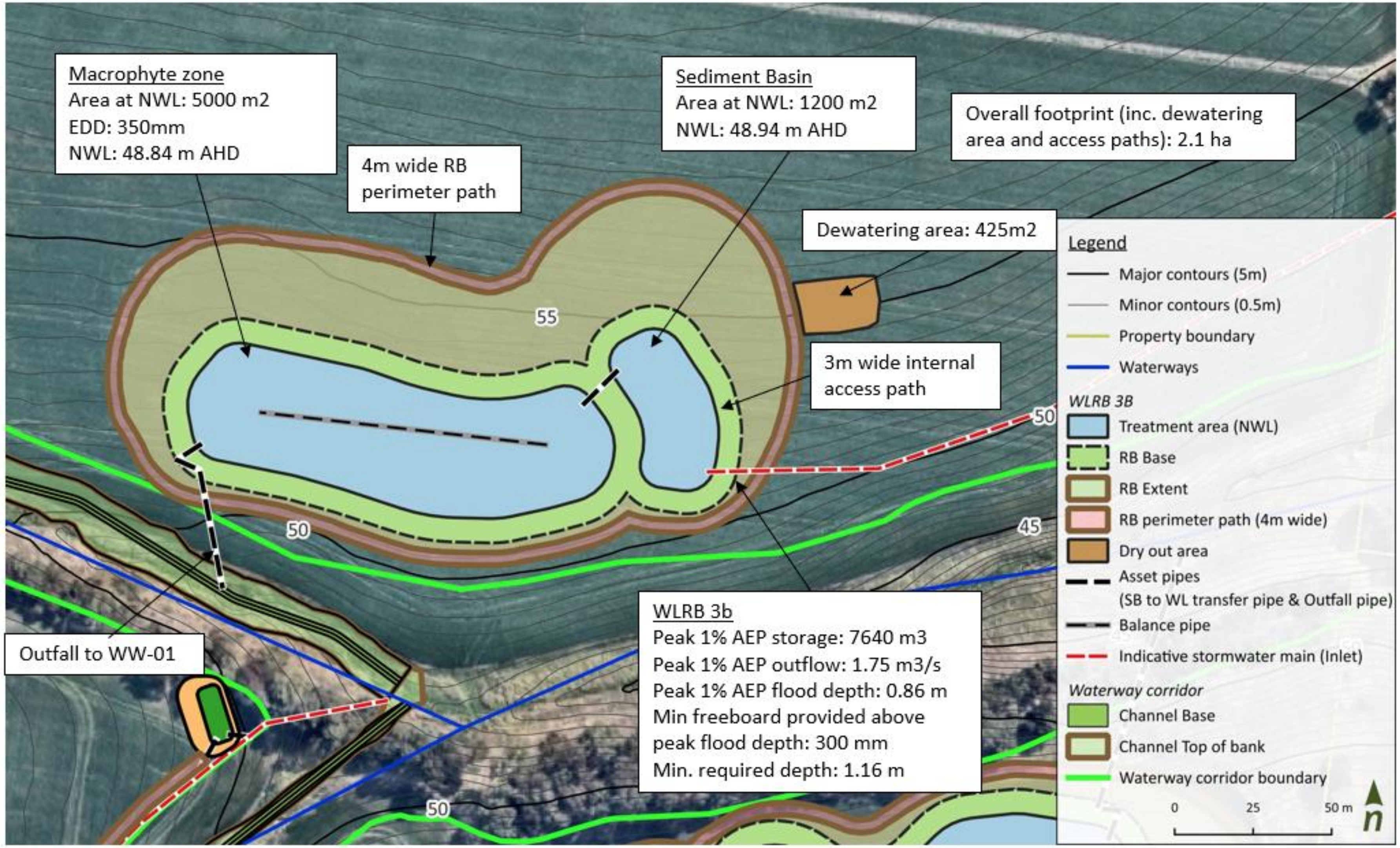


Figure 28. *WLRB3b concept design*

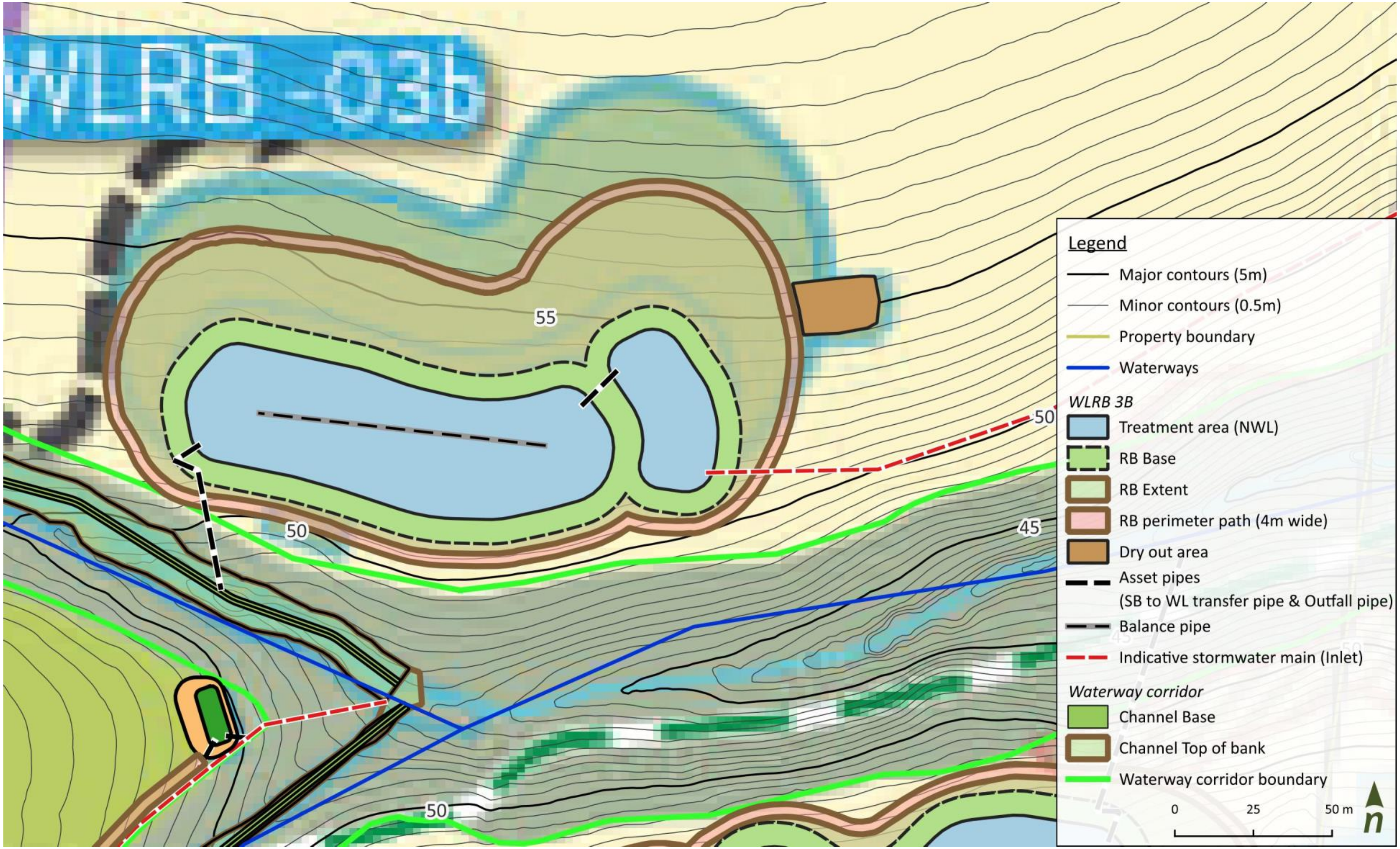


Figure 29. *WLRB3b concept design (FUS underneath)*

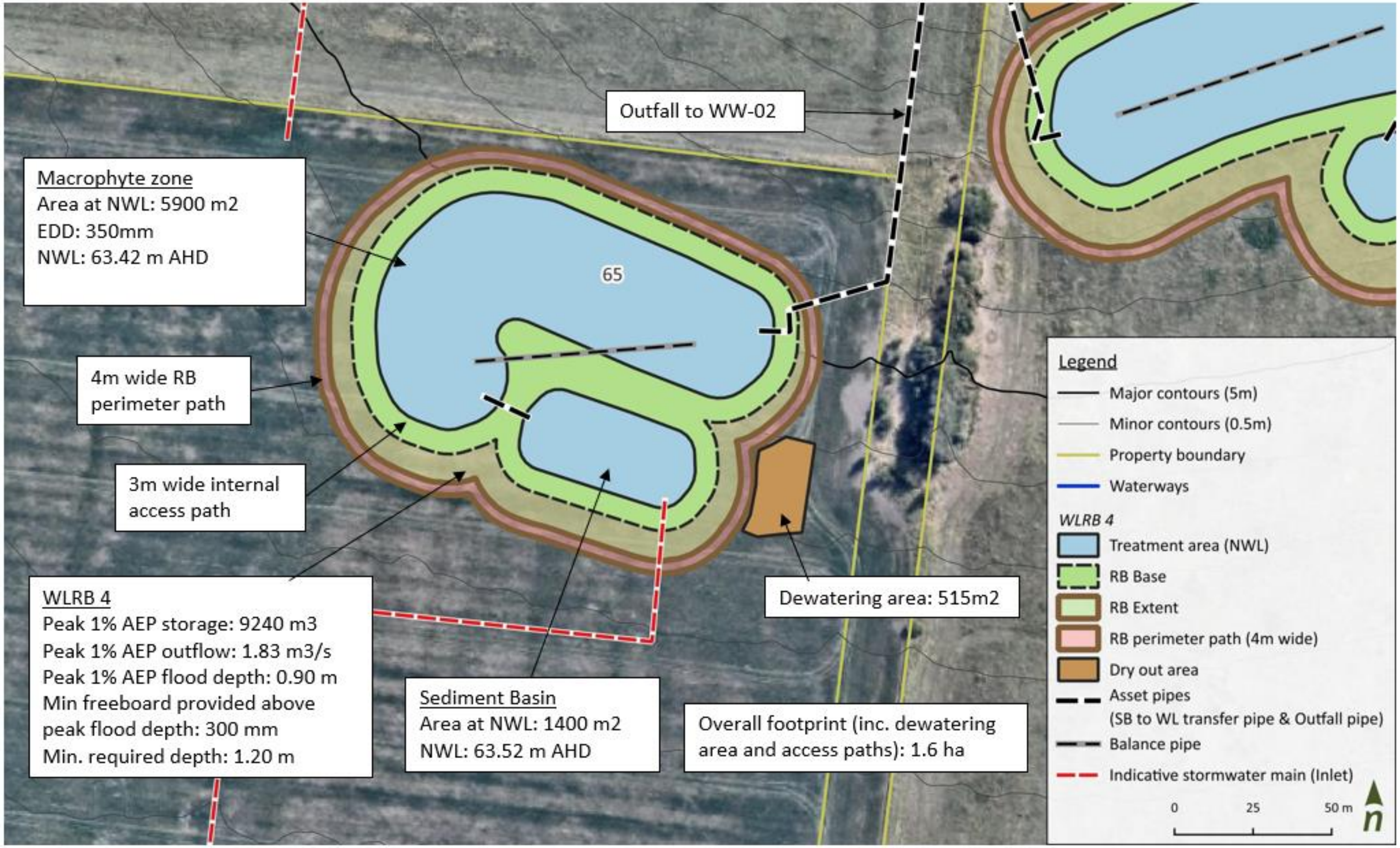


Figure 30. *WLRB4 concept design*

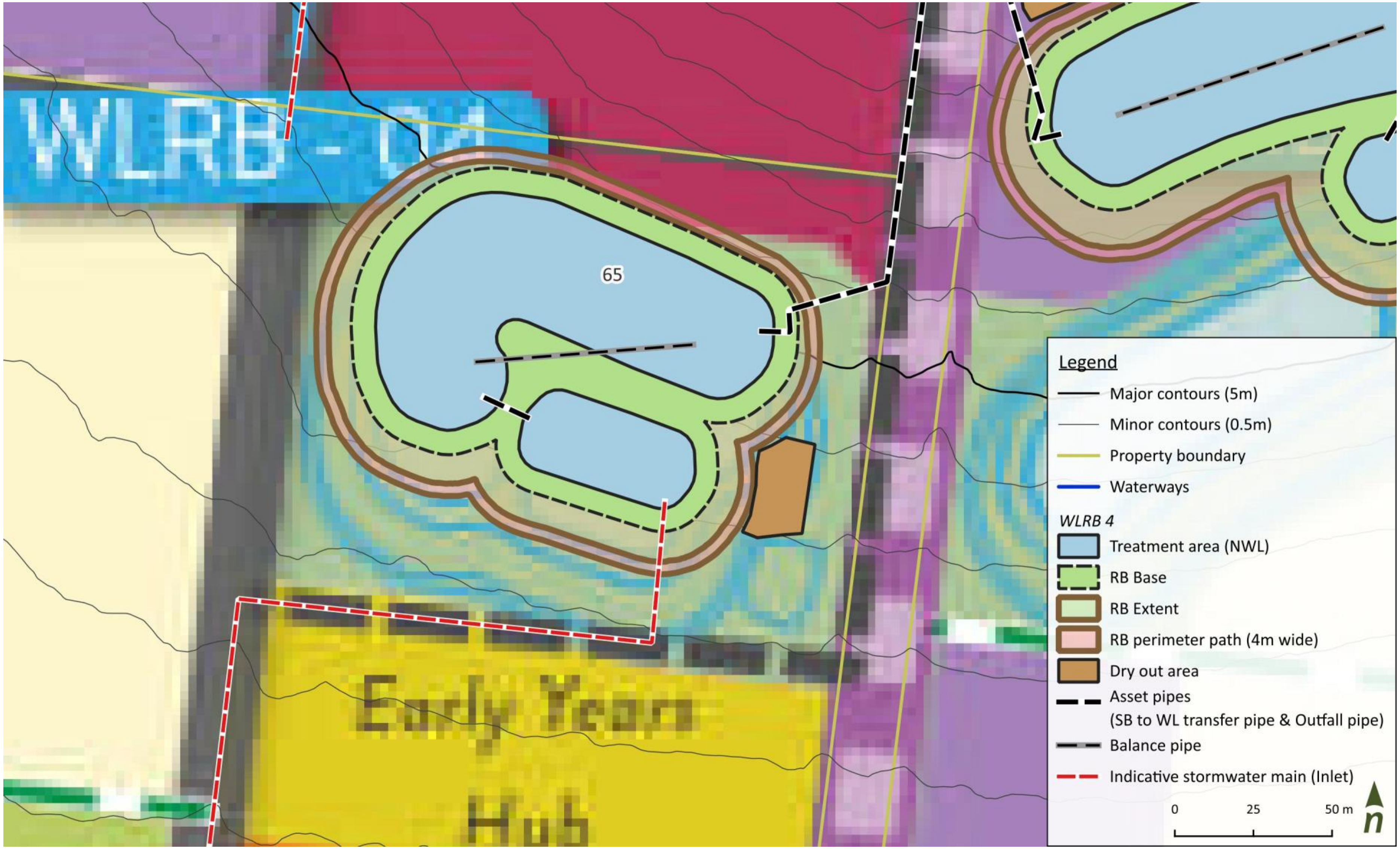


Figure 31. *WLRB4 concept design (FUS underneath)*

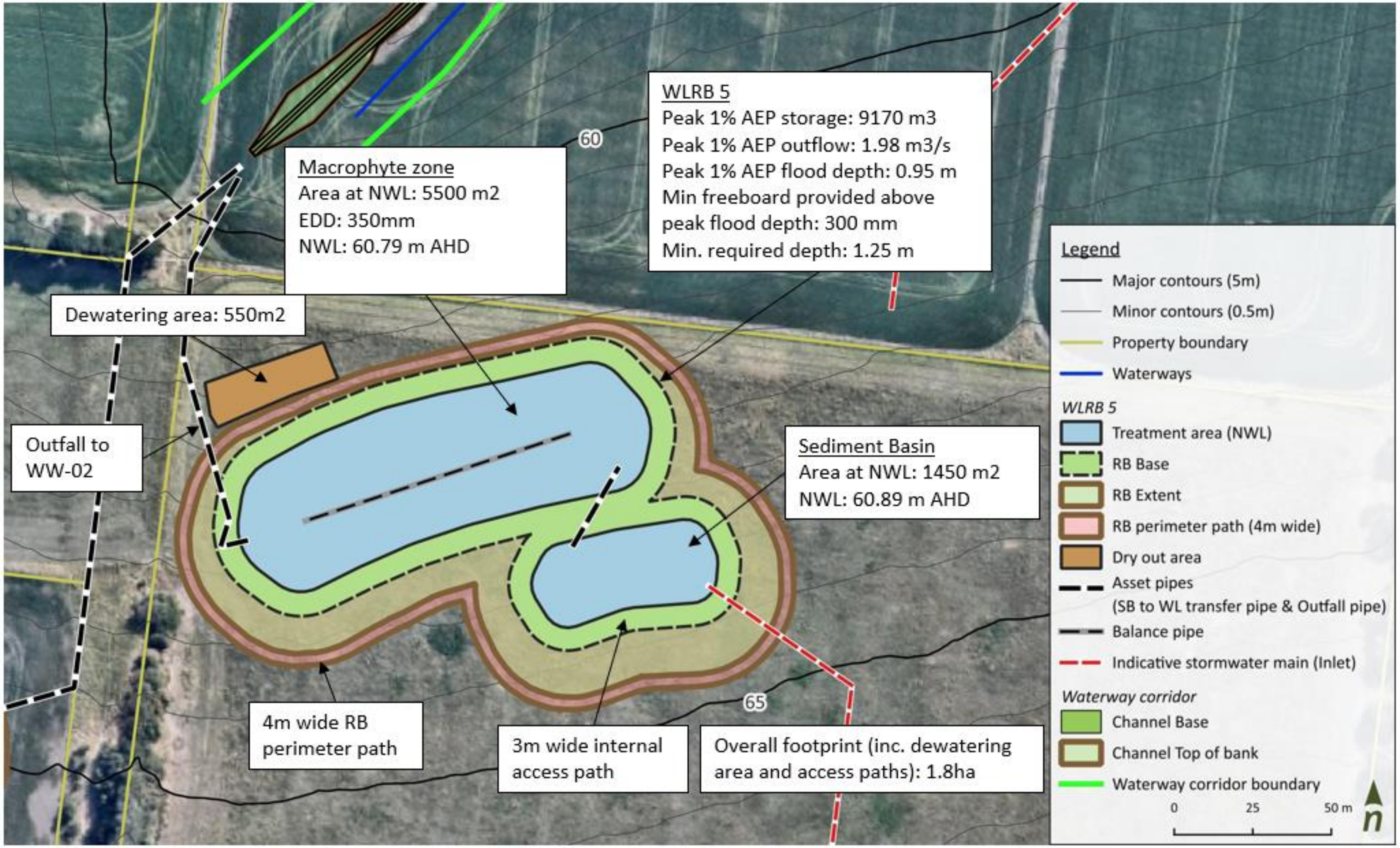


Figure 32. *WLRB5 concept design*

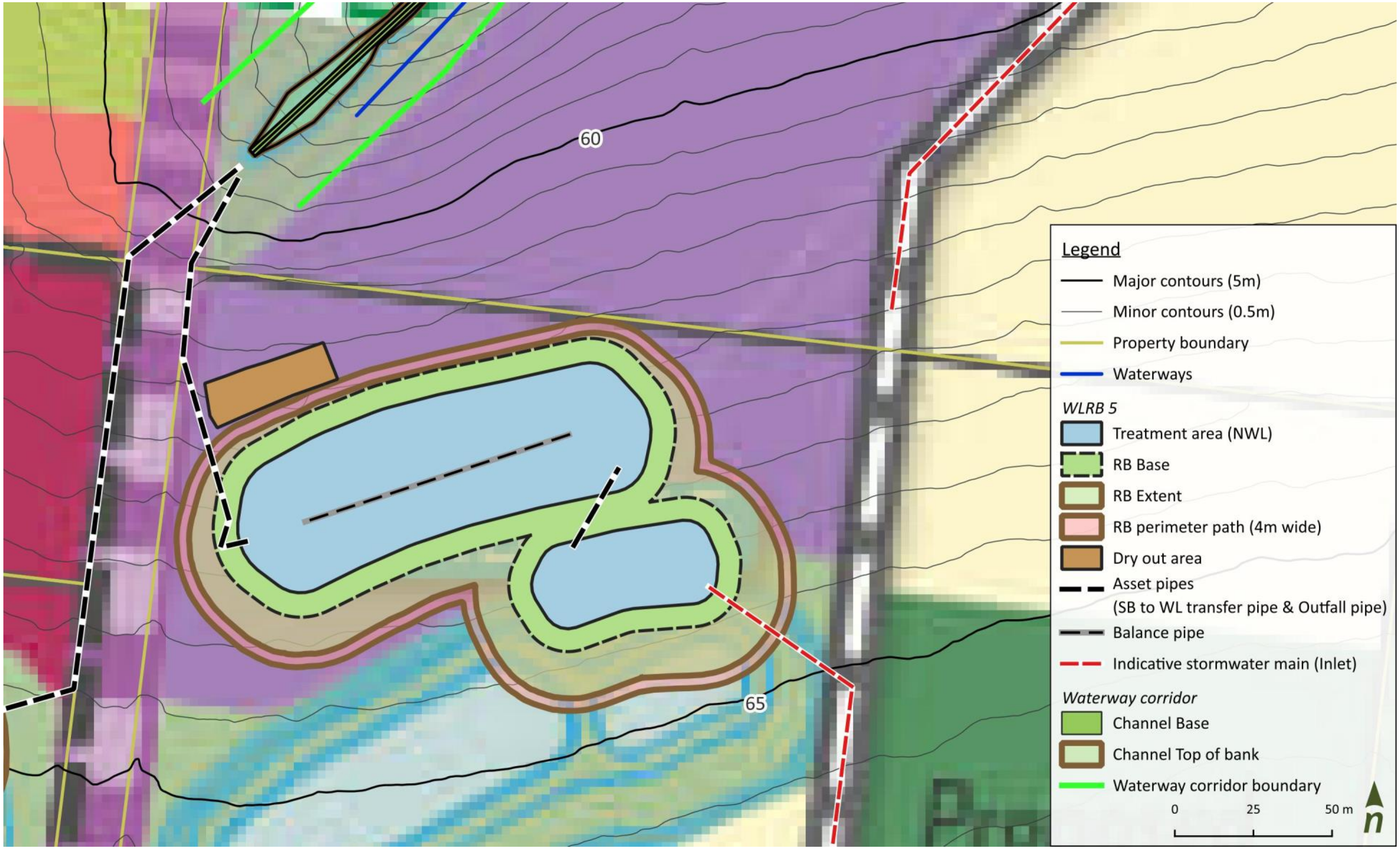


Figure 33. *WLRB5 concept design (FUS underneath)*

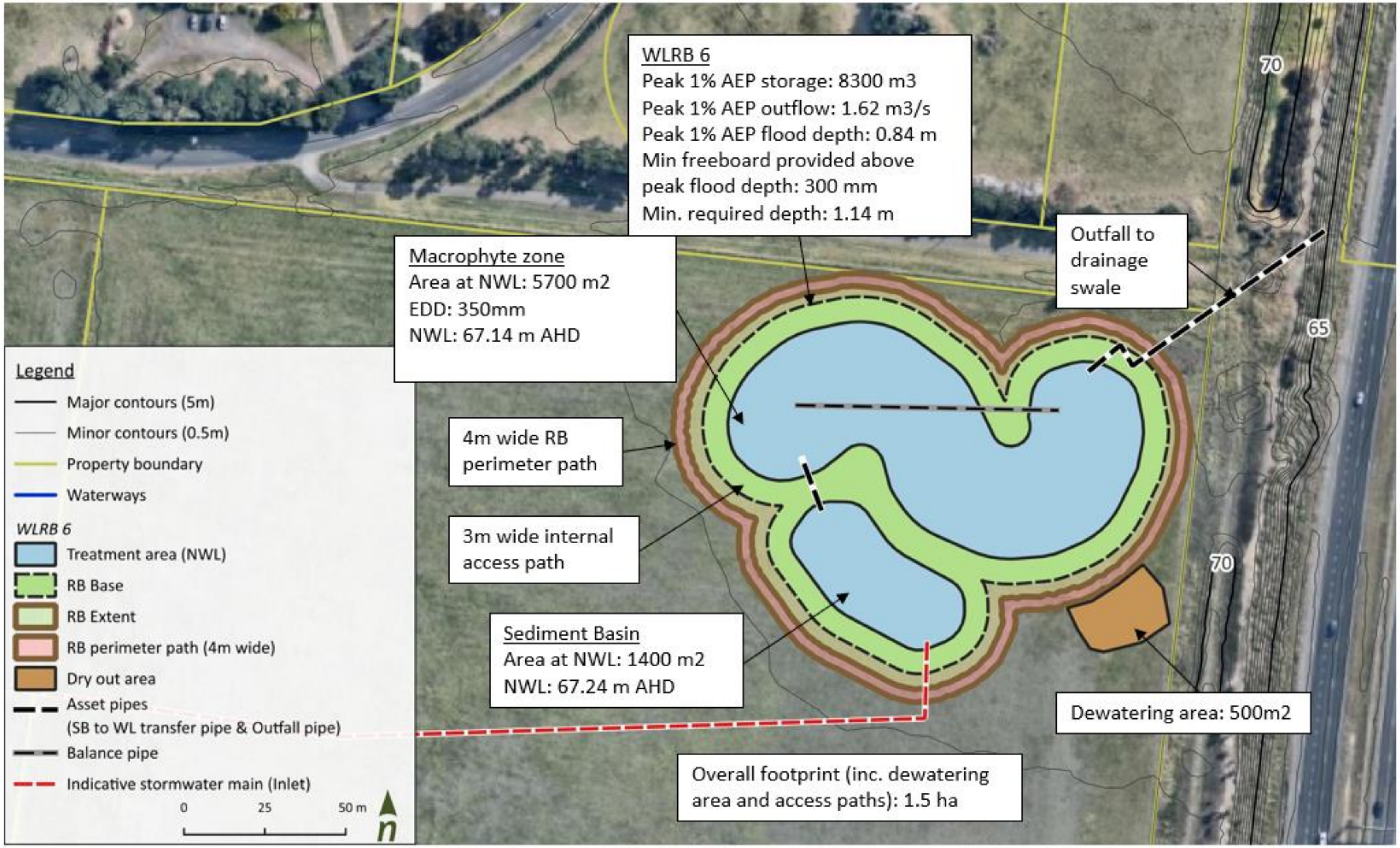


Figure 34. *WLRB6 concept design*

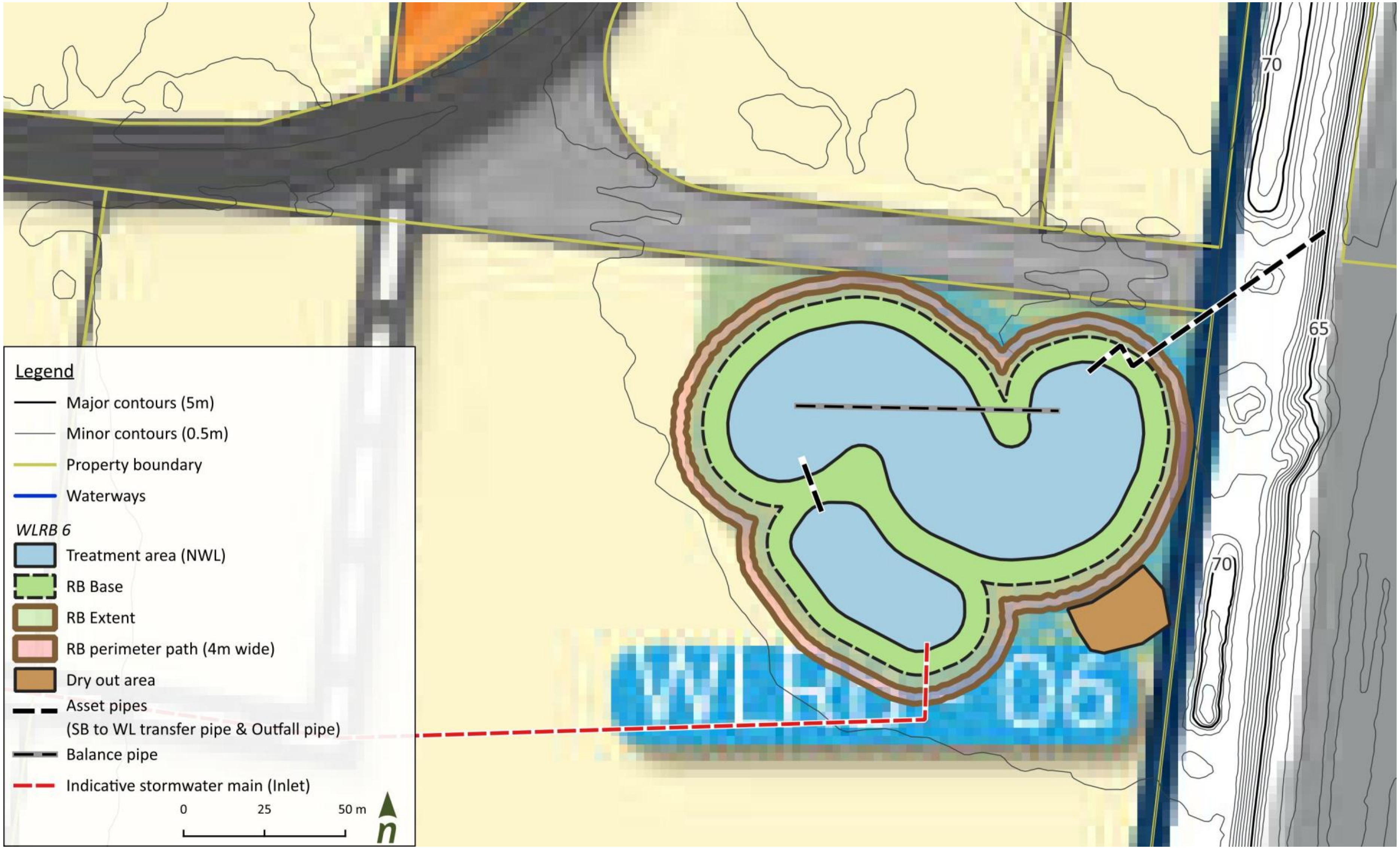


Figure 35. *WLRB6 concept design (FUS underneath)*

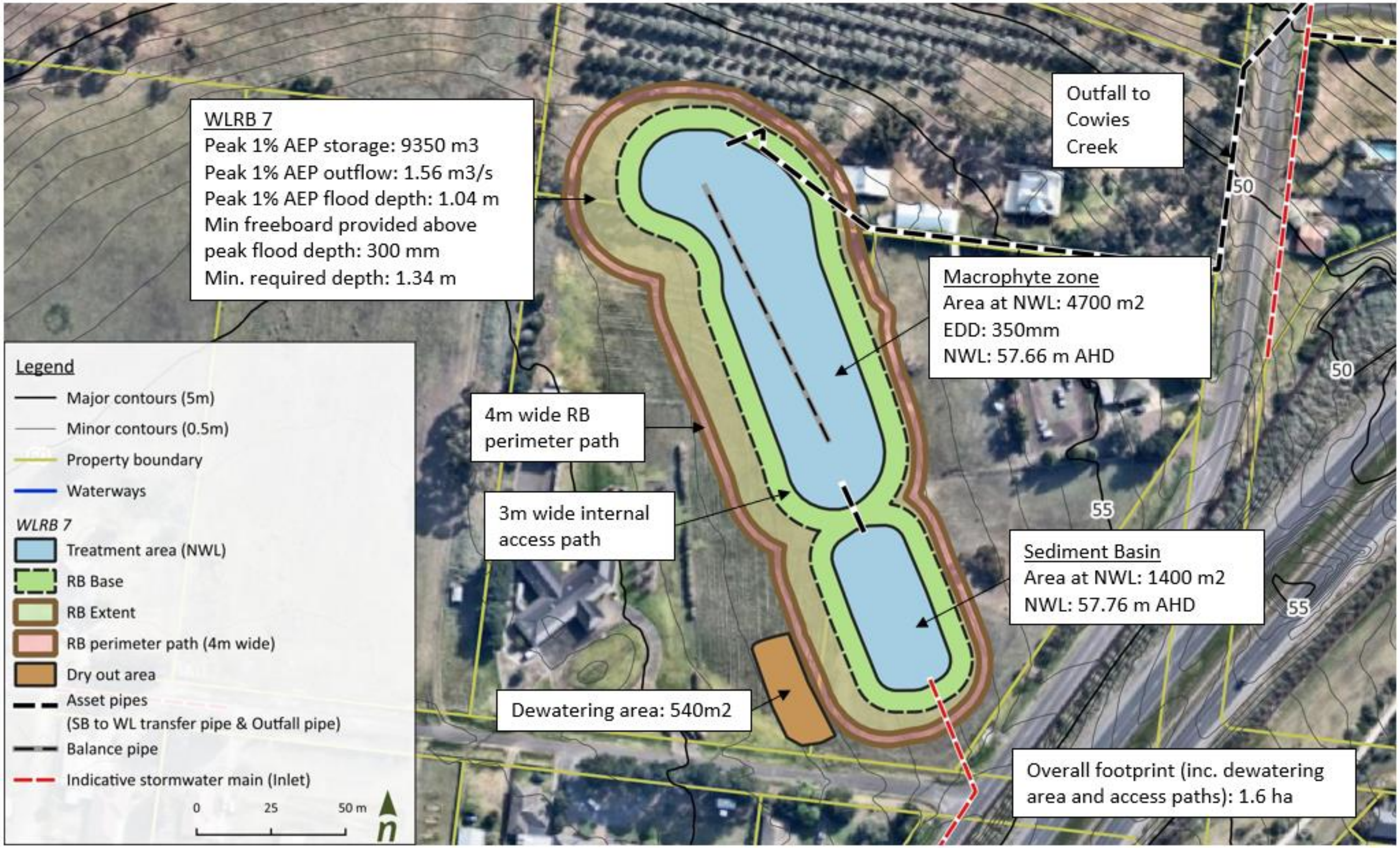


Figure 36. *WLRB7 concept design*

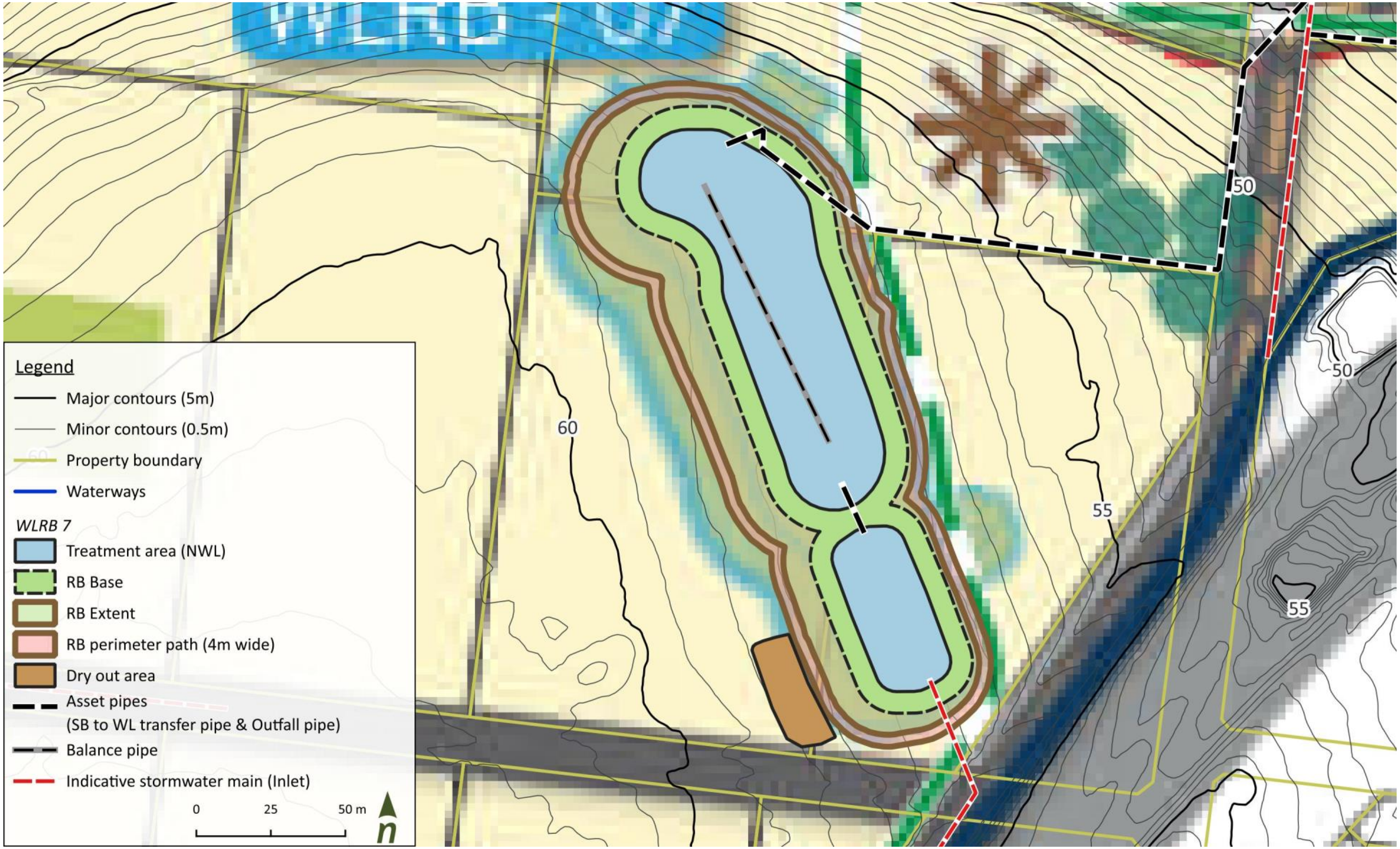


Figure 37. *WLRB7 concept design (FUS underneath)*

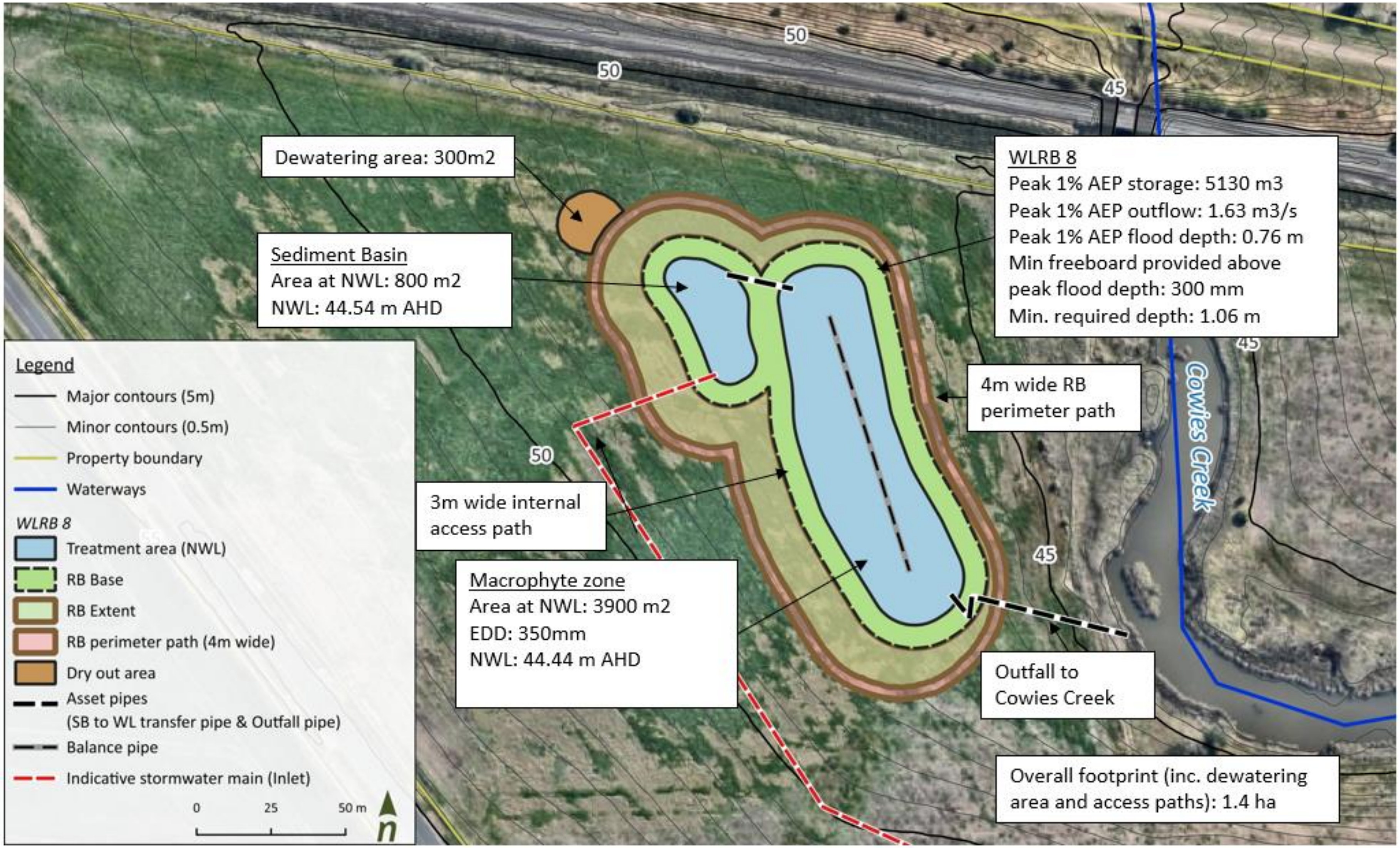


Figure 38. *WLRB8 concept design*

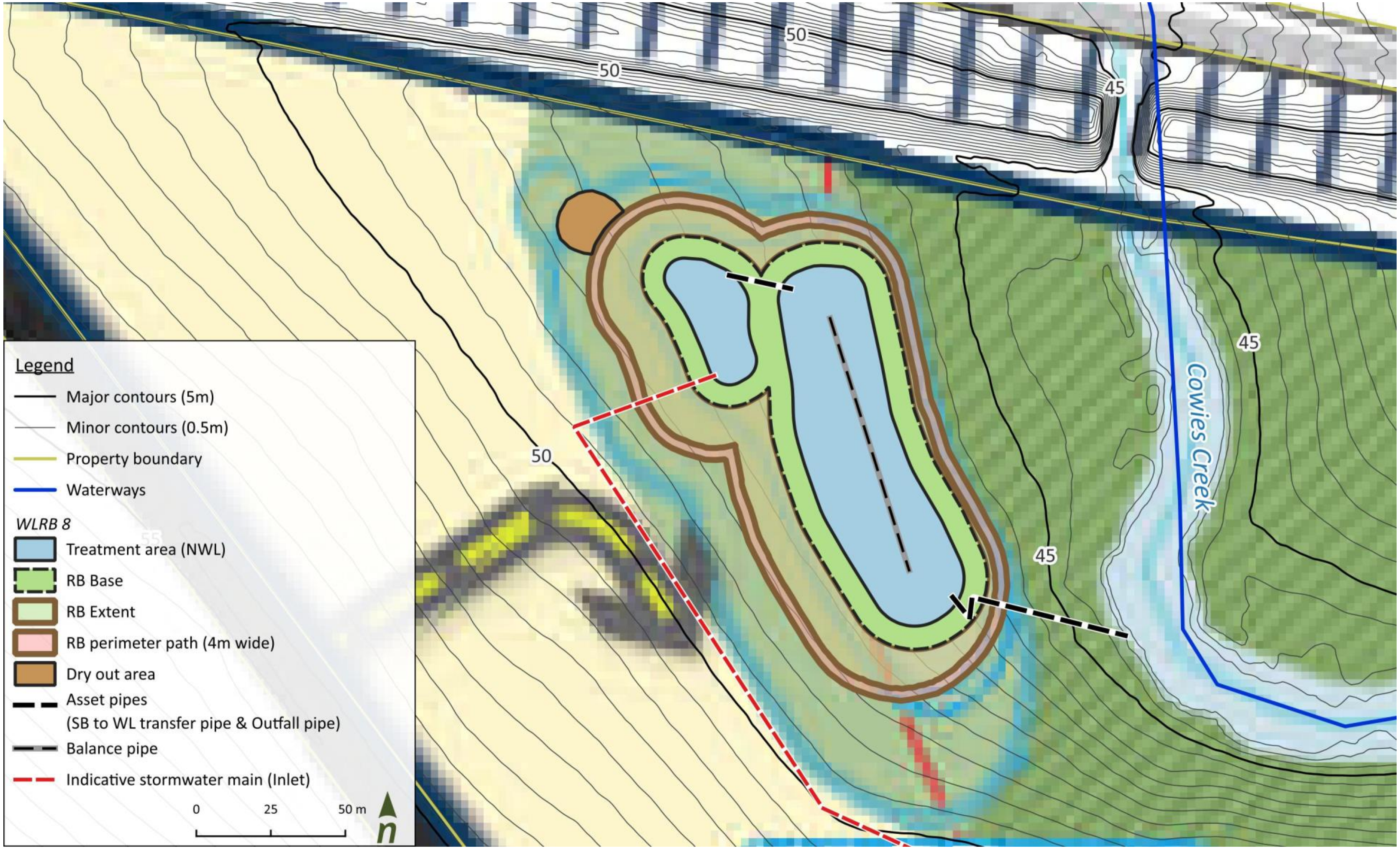


Figure 39. *WLRB8 concept design (FUS underneath)*

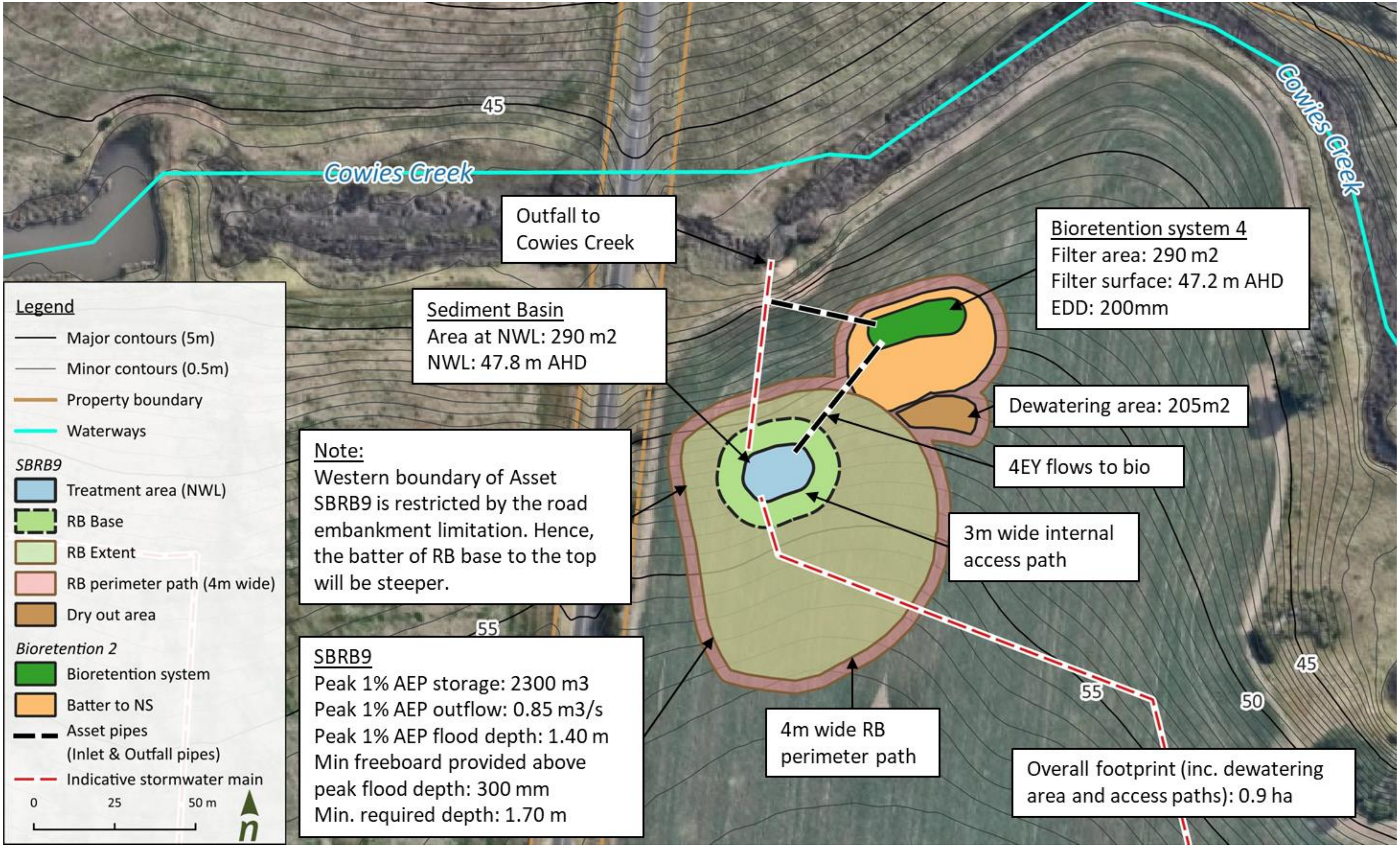


Figure 40. *SBRB9 + bioretention system 4 concept design*

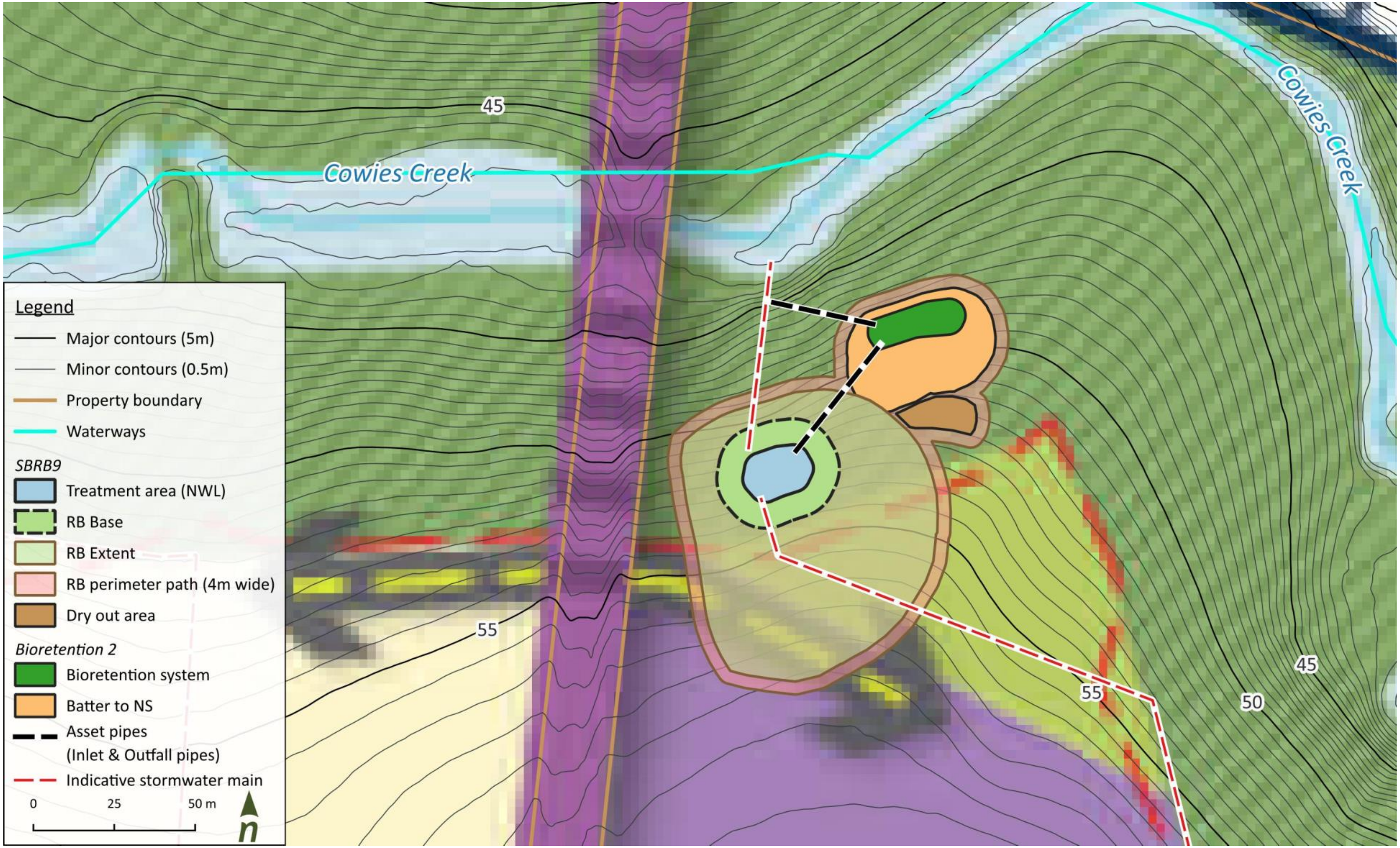


Figure 41. *SBRB9 + bioretention system 4 concept design (FUS underneath)*

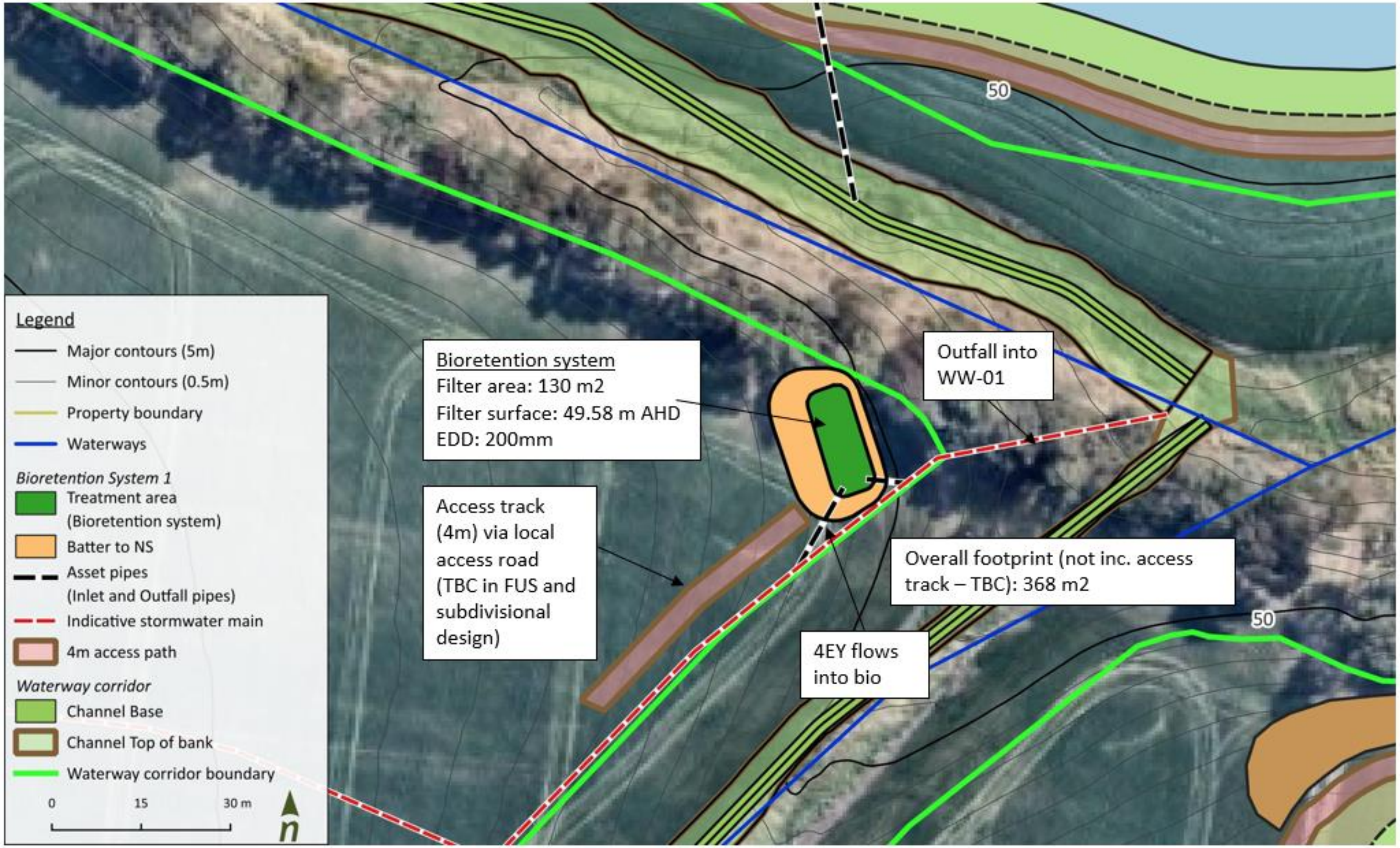


Figure 42. *Bioretention system 1 concept design*

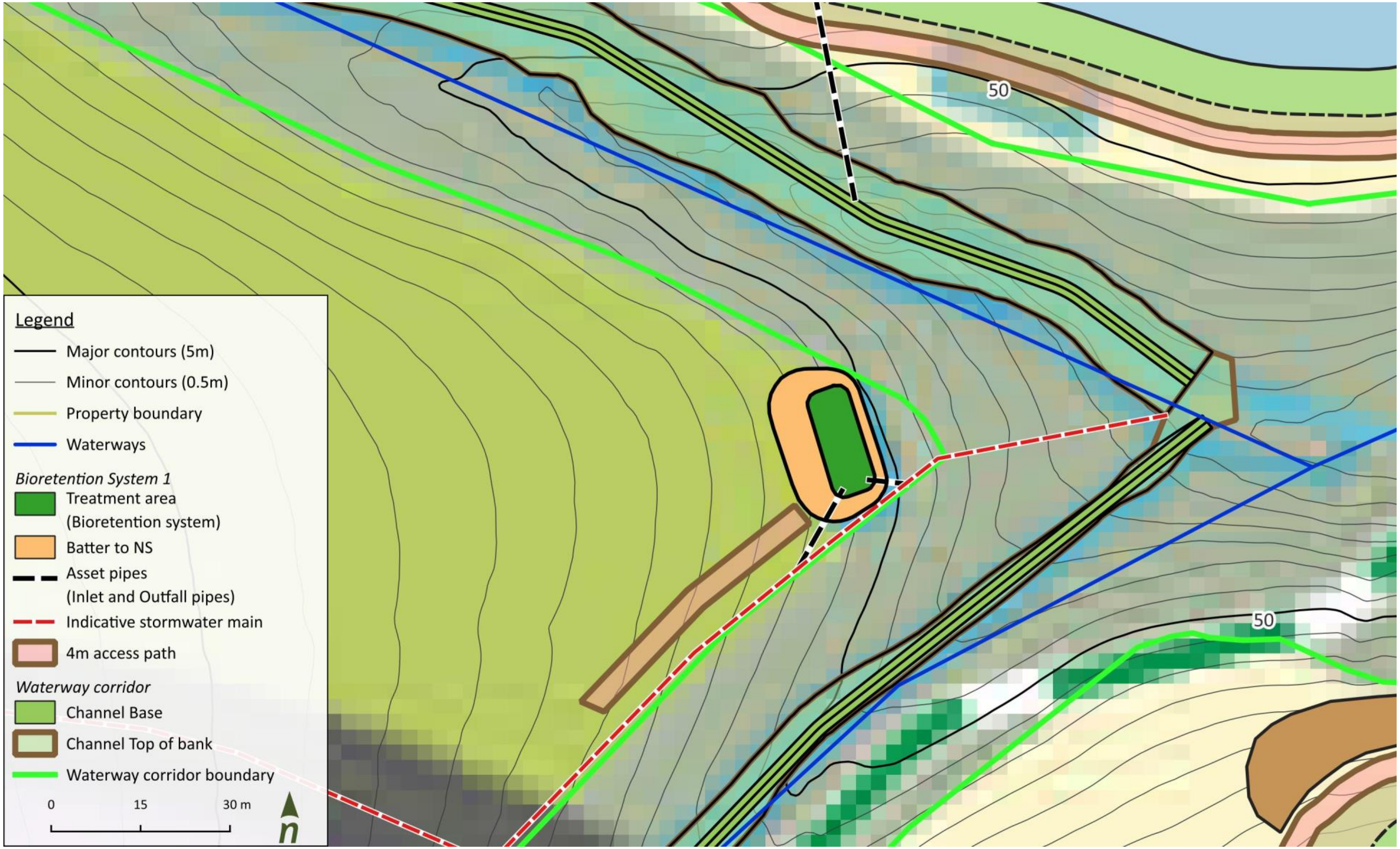


Figure 43. *Bioretention system 1 concept design (FUS underneath)*

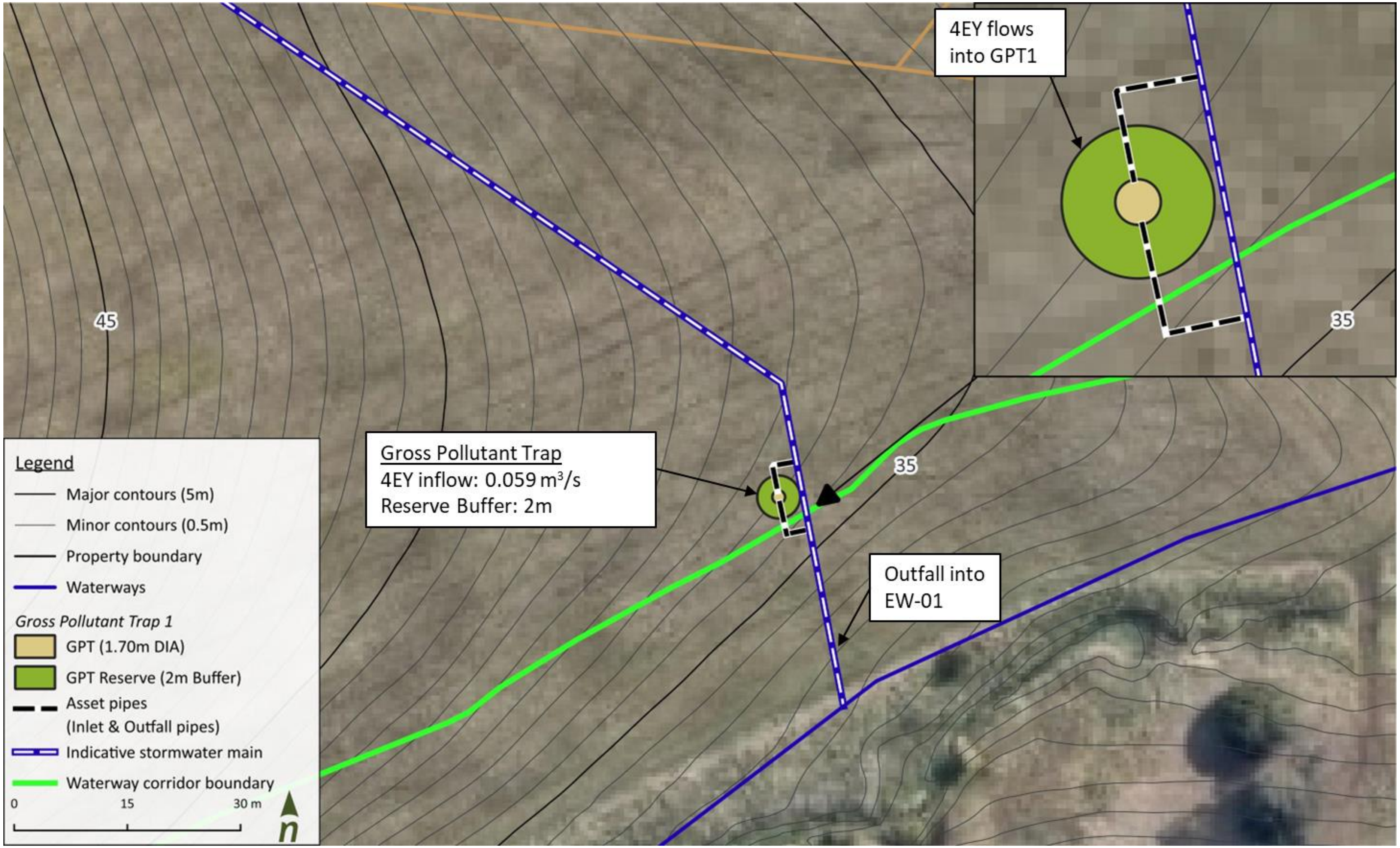


Figure 44. *Gross Pollutant Trap 1 concept design*

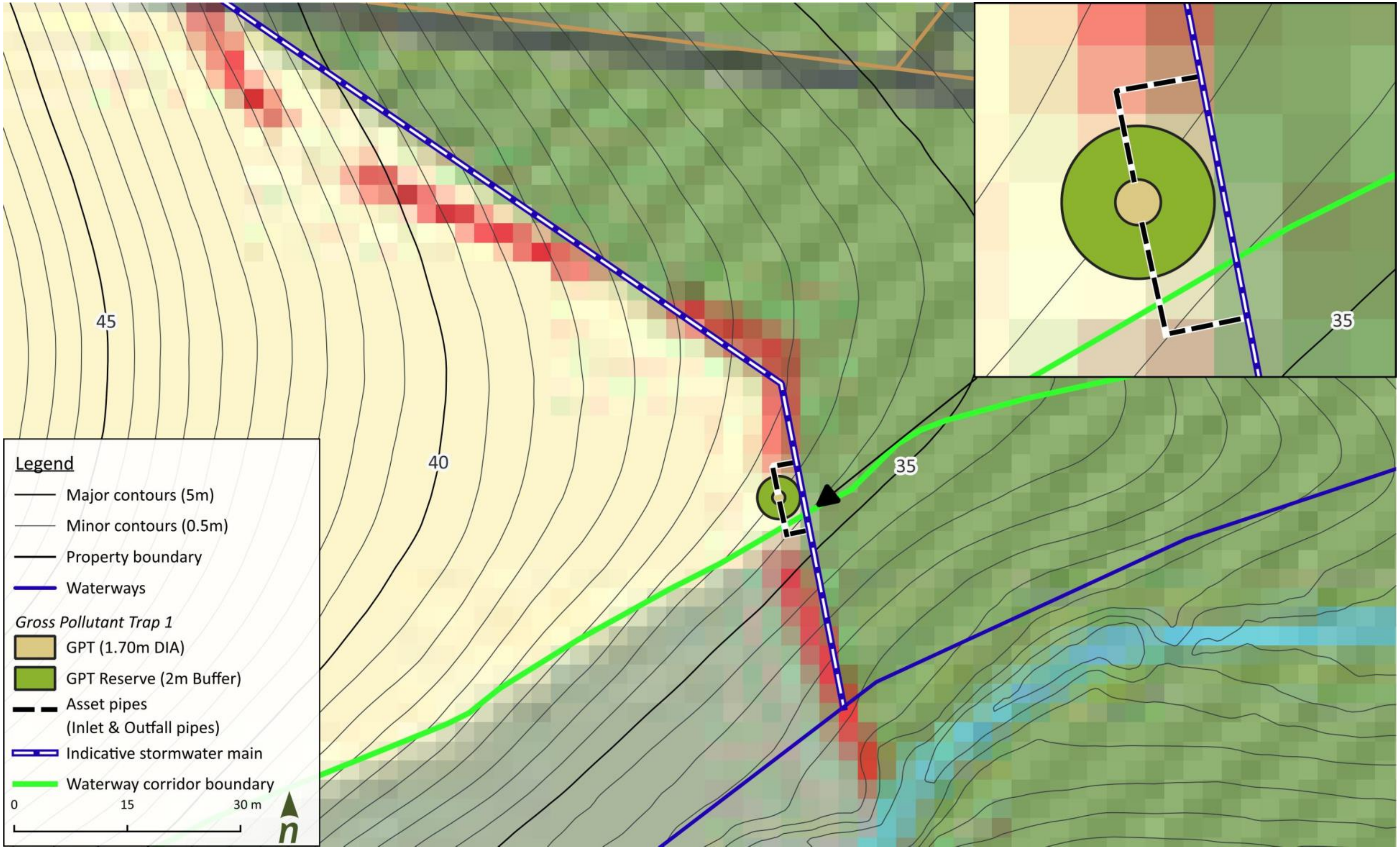


Figure 45. *Gross Pollutant Trap 1 concept design (FUS underneath)*

Figure 46. *Gross Pollutant Trap 2 concept design*

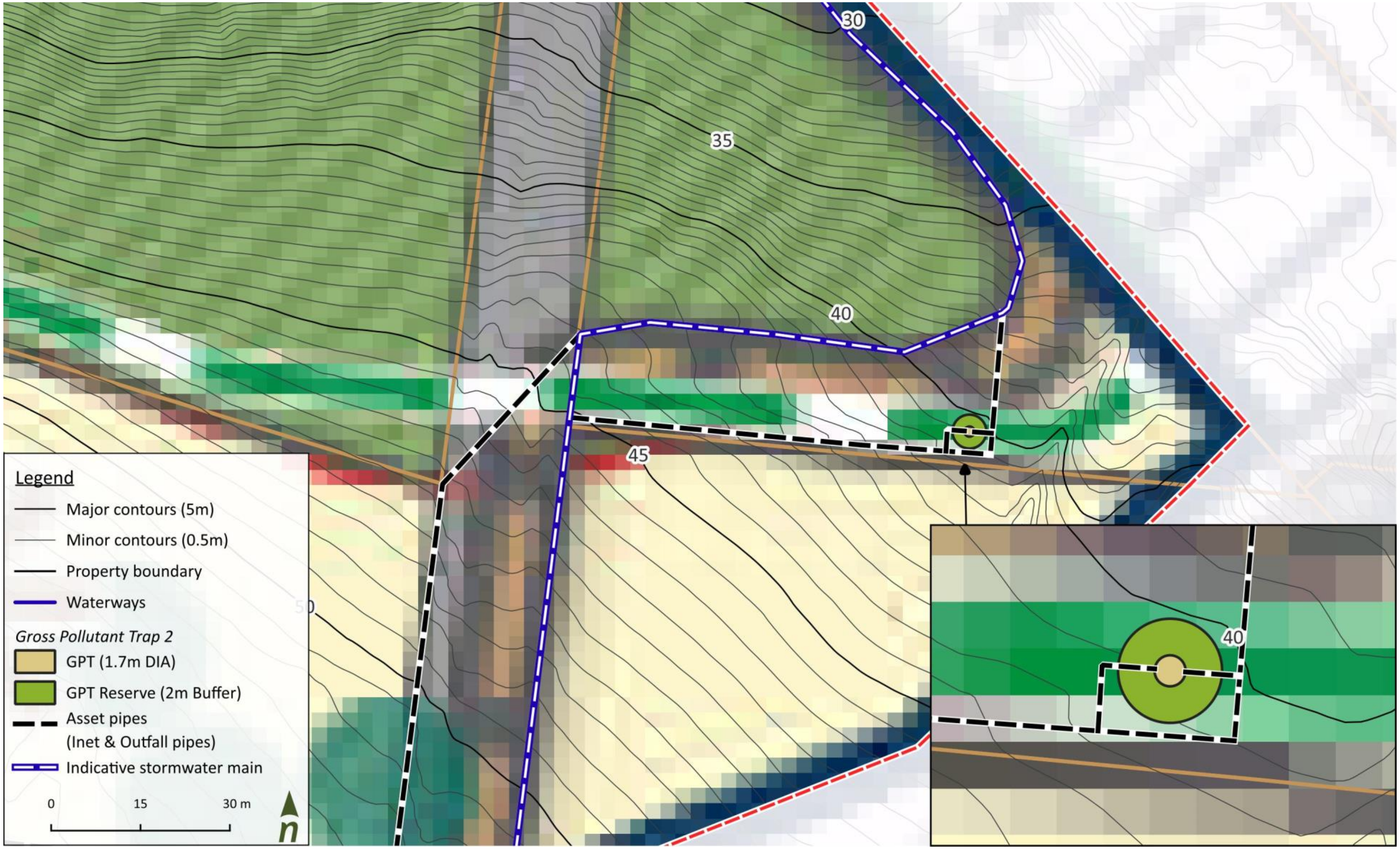


Figure 47. *Growth Pollutant Trap 2 concept design (FUS underneath)*

9 Costing

Cost estimate summaries for each asset are provided in Table 36 below. The values provided are high-level estimates only – concept level. The rates are based on the current Australian Construction Handbook, as well as our experience with similar projects (PSPs/DCPs). More detailed cost breakdowns for the proposed assets are provided in the attached Concept Design Cost Estimate spreadsheet. This includes all quantities, assumed rates and cost assumptions.

It should be noted that the cost estimate tables for each asset are more itemised and detailed than would normally be expected at a concept design stage. This is because itemised costings had already been set up for the functional designs (previously) and these have been applied to the concept redesigns. These figures would be further refined at functional design stages when further modelling and asset refinement is undertaken to provide more detailed cost estimations.

Details regarding pit and pipe sizing are not included as these are outside the scope of this work however, nominal pipe sizes and/or rates have been adopted for these line items as appropriate. A contingency of 30% has been adopted as per Council direction. This allows for uncertainty around some of the nominal items, and uncertainty around geotechnical conditions (e.g. rock excavation). It is expected this will drop as further modelling and functional design detail is undertaken in future stages.

Table 36. Cost estimate summary for the proposed works

Item	Description	WLRB1	WLRB2	WLRB3a	WLRB3b	WLRB4	WLRB5	WLRB6	WLRB7	WLRB8	SBRB9 + bio 2	Bioretention 1	GPT 1	GPT 2	Waterway 1	Waterway 2	EW-01	ALL ASSETS
1	SITEWORKS AND EARTHWORKS	$2,341,955.5	$1,723,399.3	$1,316,085.5	$1,879,496.7	$ 985,792.4	$1,172,169.0	$ 802,822.4	$ 979,482.9	$ 902,282.9	$ 93,354.5	$ 20,451.6	$ 2,671.0	$ 2,671.0	$ 442,108.1	$ 49,334.1	$ 18,208.0	$12,732,284.6
2	DRAINAGE	$ 542,653.5	$ 526,817.0	$ 445,750.0	$ 710,847.0	$ 509,327.0	$ 477,130.0	$ 506,985.0	$ 818,123.0	$ 440,098.0	$ 402,460.0	$ 115,117.0	$ 149,296.0	$ 131,459.0	$ -	$ -	$ -	$ 5,776,062.5
3	ROCK WORKS	$ 67,783.0	$ 69,063.0	$ 69,543.0	$ 70,823.0	$ 68,263.0	$ 68,583.0	$ 67,943.0	$ 68,103.0	$ 68,583.0	$ 126,234.8	$ 32,724.1	$ -	$ -	$ 252,148.3	$154,015.4	$ 48,180.0	$ 1,231,989.7
4	CLAY LINER	$ 130,007.2	$ 184,506.8	$ 139,986.0	$ 141,985.8	$ 165,943.0	$ 157,762.0	$ 162,428.2	$ 140,652.6	$ 109,787.0	$ 8,302.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,341,360.8
5	TOPSOIL	$ 60,337.2	$ 56,931.6	$ 42,682.2	$ 54,093.6	$ 40,091.7	$ 43,705.2	$ 36,692.7	$ 39,081.9	$ 36,012.9	$ 21,153.0	$ 785.4	$ -	$ -	$ 43,774.5	$ 5,577.0	$ -	$ 480,918.9
6	AQUATIC PLANTING	$ 325,720.4	$ 304,233.4	$ 234,649.2	$ 292,525.9	$ 220,070.7	$ 238,648.7	$ 203,458.9	$ 216,857.5	$ 202,209.9	$ 128,718.2	$ 8,977.4	$ -	$ -	$ 132,650.0	$ 16,900.0	$ 40,000.0	$ 2,565,620.2
7	PUMPING	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	LANDSCAPE	$ 227,680.9	$ 215,061.1	$ 150,642.2	$ 193,744.1	$ 152,532.8	$ 180,529.8	$ 161,013.2	$ 197,819.3	$ 161,197.5	$ 80,786.1	$ 11,884.8	$ -	$ -	$ -	$ -	$ -	$ 1,732,891.8
9	MISCELLANEOUS	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 70,900.0	$ 60,900.0	$ 22,500.0	$ 6,000.0	$ 6,000.0	$ 64,800.0	$ 64,800.0	$ 54,000.0	$ 917,100.0
10	OTHER	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	$ -
	SUB-TOTAL WORKS	**$3,767,037.7**	**$3,150,912.2**	**$2,470,238.1**	**$3,414,416.1**	**$2,212,920.6**	**$2,409,427.7**	**$2,012,243.4**	**$2,531,020.2**	**$1,991,071.2**	**$ 921,908.8**	**$ 212,440.3**	**$ 157,967.0**	**$ 140,130.0**	**$ 935,480.9**	**$290,626.5**	**$160,388.0**	**$26,778,228.5**
11	DELIVERY (inc. 30% contingency)	$2,118,958.7	$1,772,388.1	$1,389,508.9	$1,920,609.1	$1,244,767.8	$1,355,303.1	$1,131,886.9	$1,423,698.8	$1,119,977.5	$ 921,908.8	$ 119,497.7	$ 88,856.4	$ 78,823.1	$ 526,208.0	$163,477.4	$ 90,218.3	$15,466,088.6
12	**TOTAL ESTIMATED COST**	**$ 5,885,996**	**$ 4,923,300**	**$ 3,859,747**	**$ 5,335,025**	**$ 3,457,688**	**$ 3,764,731**	**$ 3,144,130**	**$ 3,954,719**	**$ 3,111,049**	**$ 1,440,482**	**$ 331,938**	**$ 246,823**	**$ 218,953**	**$ 1,461,689**	**$ 454,104**	**$ 250,606**	**$41,840,982.0**

10 Development staging

The same development staging principles apply as stated in the functional design report (December 2022).

10.1 Staging recommendations

The revised development staging as recommended for the Creamery Road PSP stormwater assets delivery, is summarised below.

Table 37. Staging recommendations

Order	Asset	Comments
1	EW-01	This is an existing tributary of Cowies Creek and receives runoff from PSP assets. Investigate the potential head cut / erosion point and install rock stabilisation works as necessary. Ensure this is completed prior to commencing WW-01 and WW-02 works.
2	WW-01	To be delivered prior to WLRB2, WLRB3a and WLRB3b, as well as bioretention system 1. The RBs and bio 1 need to outfall to this waterway.
3	WW-02	To be delivered prior to WLRB4 and WLRB5. The RBs need to outfall to this waterway
4	WLRB1	Outfalls into EW-01. Does not rely on other works being undertaken first, subject to item 1 considerations above
5	WLRB2	Requires construction of WW-01 for outfall connection
6	WLRB3a	Requires construction of WW-01 for outfall connection
7	WLRB3b	Requires construction of WW-01 for outfall connection
8	WLRB4	Requires WW-02 to have been constructed to enable outfall. Given its location upstream of WLRB2, it is critical that should this catchment develop first, a suitable temporary basin must be constructed, prior to the establishment of WLRB4. If not, there is a risk of increased flows and downstream impacts on landholders located within WLRB2 catchment, downstream.
9	WLRB5	Requires construction of WW-02 for outfall connection. Given its location upstream of WLRB1, it is critical that should this catchment develop first, a suitable temporary basin must be constructed, prior to the establishment of WLRB5. If not, there is a risk of increased flows and downstream impacts on landholders located within WLRB1 catchment, downstream.
10	WLRB6	Does not rely on other works being undertaken first. Given the location at the top of the catchment, it is critical that should this catchment develop first, a suitable temporary basin must be constructed, prior to the establishment of WLRB6. If not, there is a risk of increased flows and downstream impacts on landholders (notably, Covenant College).
11	WLRB7	Outfalls to Cowies Creek via Bluestone Bridge Road – single point of discharge. Does not rely on other works being undertaken first. Works in the catchment will

		need to ensure the existing downstream properties (and heritage homestead) are protected prior to the ultimate basin being established. This asset shares an outfall pipe into Cowies Creek with GPT 2.
12	WLRB8	Outfalls to Cowies Creek. Does not rely on other works being undertaken first.
13	SBRB9 + bio 2	Outfalls to Cowies Creek. Does not rely on other works being undertaken first.
14	Bioretention 1	Outfalls to WW-01. Requires construction of WW-01 for outfall connection.
15	Gross Pollutant Trap 1	Outfalls to EW-01. Does not rely on other works being undertaken first.
16	Gross Pollutant Trap 2	Outfalls to Cowies Creek via pipe along Bluestone Bridge Road. Does not rely on other works being undertaken first. This asset shares an outfall pipe into Cowies Creek with WLRB7.

11 Conclusion

Alluvium Consulting has been engaged by the City of Greater Geelong to prepare revised concept level stormwater drainage designs (Development Services Scheme) for the Creamery Road Precinct Structure Plan, following on from submissions received on the Draft DCP, changes to the Future Urban Structure, new technical reports and Conservation Management Plan for Cowies Creek.

This Addendum Report captures the changes made to the previously proposed stormwater assets (Functional Design documentation, Alluvium Dec 2022), under the new FUS, to a high-level / concept design stage.

The concept redesign process has included:

- Review of new and updated background studies and data
- Incorporating feedback from stakeholders and submitters
- Revised treatment modelling to ensure best practice treatment targets were met
- High-level (concept) hydrologic modelling to ensure post-development flows are retarded back to pre-development flows
- Velocity and sediment capture efficiency calculations
- High-level earthworks modelling to determine more accurate asset footprints
- Concept design plans and associated cost estimates.

Eight (8) WLRBs, one (1) SBRB, two (2) constructed waterways (vegetated swale structures), and four (4) bioretention systems were developed as follows:

- WLRB1, outfalling into the Cowies Creek tributary (EW-01).
- WLRB2, outfalling into WW-01
- WLRB3a, outfalling into WW-01
- WLRB3b, outfalling into WW-01
- WLRB4, outfalling into the constructed WW-02
- WLRB5, outfalling into the constructed WW-02
- WLRB6, outfalling into vegetated swale alongside Princes Fwy, and eventually into Cowies Creek
- WLRB7, outfalling into Cowies Creek via Bluestone Bridge Road (combined with GPT 2 flows)
- WLRB8, outfalling into Cowies Creek
- SBRB9 + bioretention system 2, outfalling into Cowies Creek
- Bioretention system 1, outfalling into WW-01
- GPT 1, outfalling into EW-01
- GPT 2, outfall to Cowies Creek via Bluestone Bridge Road (combined with WLRB7 flows)
- Waterway 1 (WW-01)
- Waterway 2 (WW-02).

Ultimately these concept redesigns will need to be developed to a functional design level to obtain more refined asset designs which will inform refined land take and cost estimations. A summary of the proposed stormwater assets is provided below.

Table 38. DSS stormwater drainage assets - Summary table

Asset	Catchment area (ha)	Pre-development peak 1% AEP flow (m3/s)	RB peak 1% AEP outflow (m3/s)	Total asset footprint area (inc. perimeter track, sediment dewatering) (ha)	Pump house footprint allowance (m2)	Total cost (inc. delivery and 30% contingency)
WLRB1	24.3	1.69	1.68	2.3	9	$5,885,996
WLRB2	33.47	2.20	2.15	2.2	*	$4,923,300
WLRB3a	31.87	1.96	1.94	1.7	*	$3,859,747
WLRB3b	26.73	1.77	1.75	2.1	*	$5,335,025
WLRB4	32.5	1.88	1.83	1.6	*	$3,457,688
WLRB5	34.63	2.04	1.98	1.8	*	$3,764,731
WLRB6	31.5	1.65	1.62	1.5	9	$3,144,130
WLRB7	33.8	1.62	1.56	1.6	9	$3,954,719
WLRB8	18.92	1.65	1.63	1.4	9	$3,111,049
SBRB9 + Bio 2	13.41	0.85	0.85	0.9	*	$1,440,482
Bio 1	3.66			0.04	N/A	$331,938
GPT 1	2.65				N/A	$246,823
GPT 2	4.02				N/A	$218,953

Asset	Type	Peak 1% AEP flow	Waterway corridor	Total cost (inc. delivery and 30% contingency)
Waterway 1 (WW-01)	Constructed vegetated swale. Series of rock chutes and flat grades.	7.15 m^3/s	30m upstream of the CCC 45 downstream of the CCC	$1,461,689
Waterway 2 (WW-02)	Constructed vegetated swale with rock-lined treatments due to steeper grades.	3.83 m^3/s	45m	$454,104
EW-01	Maintain as existing (natural) waterway - protect and enhance.		20m setback from hydraulic width extent (1% AEP extent) used as reference point in lieu of clear top of bank (as per MW Guidelines)	$250,606

***Note:** Pump station footprints have not been provided for WLRB 2, 3a, 3b, 4 and 5 as these are located near the CCC and these wetland outflows (treated) could be gravity fed to the primary CCC distribution main proposed by Barwon Water. Only assets which sit below the CCC have pump station footprints as these treated outflows will need to be pumped back up to the distribution main. [Refer to Functional Design Report documentation, Section 4.2 Clever Creative Corridor – Long term water strategy where this is discussed further].

12 References

Atlan. Vortceptor Hydrodynamic GPT Product Brochure.

Biosis (May 2023). *Creamery Rd Native Vegetation Precinct Plan.*

Biosis (October 2023*). WGGA Cowies Creek Conservation Area Growling Grass Frog Conservation Management Plan.*

Biosis (May 2023). *Draft NWGGA Strategic Assessment Report.*

City of Greater Geelong (May 2023). *Northern and Western Geelong Growth Areas Draft EPBC Plan.*

City of Greater Geelong (May 2023). *Northern and Western Geelong Growth Areas Draft Commitments and Measures.*

City of Greater Geelong (May 2023). *Northern and Western Geelong Growth Areas Draft Biodiversity Conservation Strategy.*

City of Greater Geelong (2020*). Stormwater Services Strategy 2020-2030*.

City of Greater Geelong (Aug 2020). *Northern and Western Geelong Growth Areas Framework (IWM) Plan.*

Department of Environment, Land, Water and Planning (2017). *Growling Grass Frog Habitat Design Standards, Melbourne Strategic Assessment.*

Department of Environment, Land, Water and Planning (2017). *Growling Grass Frog Masterplan for Melbourne's Growth Corridors, Melbourne Strategic Assessment.*

Department of Environment, Land, Water and Planning (2016). *Water for Victoria Water Plan*.

Department of Environment, Land, Water and Planning (2018). *IWM Forum – Barwon Strategic Directions Statement.*

GHD (November 2022). *Creamery Road PSP - Geotechnical Assessment Review*.

Meinhardt (June 2023). *Land Capability Assessment – Creamery Road PSP, Planning Practice Note 30 Updates Addendum.*

Melbourne Water (2013). *Waterway corridors: guidelines for greenfield development areas within the Port Phillip and Westernport Region*.

Melbourne Water (2020). *Design, Construction and Establishment of Constructed Wetlands: Design Manual*.

Unearthed Heritage (July 2023). *Creamery Rd Precinct Aboriginal Cultural Heritage Impact Assessment.*

Unearthed Heritage (October 2023). *Creamery Road PSP Cultural Values Assessment.*