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Dear Will

RE: Gilead Stage 2 – Interim biodiversity planning for integration of naturalised stormwater management systems within conservation corridors

This letter outlines the proposed principles and objectives for delivering naturalised stormwater management systems as a component of restored conservation corridors (that is the corridor land that is currently grazing land). The principles and objectives provided the basis for the design and configuration of stormwater management basins (bioretention systems and/or ephemeral wetlands + on-site detention) to be a valid component of the restored corridors.

Project background

Gilead Stage 2 land is either bounded by, or contains several waterways; Nepean River, Menangle Creek, Woodhouse Creek, and Nepean Creek. Environmental conservation zones have been assigned to the waterways. The waterway conservation zones form an important extension of north-south ecological connectivity corridors and include proposed east-west conservation corridors connecting the Nepean and Georges Rivers corridors at their closest points. The assigned conservation includes a significant proportion of rural grazing land that is to be restored and are wider than the existing native riparian corridors, and riparian buffer requirements of the Water Management Act 2000 (20m to 40m each side of the waterway from top of bank depending on stream order). The conservation corridors are considered critical to protecting the Campbelltown Koala population by ensuring

adequate corridors for movement. Conservation corridor extents (corridor widths, lengths, buffer widths) and fencing requirements have been mapped at a regional scale by the NSW Department of Planning and Environment using advice provided by the NSW Chief Scientist and Engineer.

WSUD strategy

The WSUD Strategy for Gilead Stage 2 seeks to integrate blue-green infrastructure within the development to support urban cooling. This includes increased permeability and passive irrigation to enhance soil moisture and canopy cover; rainwater harvesting tanks and retention of water in the landscape with biofiltration raingardens, wetlands and enhanced natural ponds. This will contribute to reducing stormwater volume with excess flows controlled through gross pollutant traps and end of pipe stormwater management basins, incorporating both treatment and on-site detention function. Three place-based configurations are proposed:

1. Naturalised Basins (within conservation corridor accessible by fauna)
2. Semi-Naturalised Urban Fringe Basins (outside designated koala corridors – accessible by birds and insects but fenced from conservation corridors)
3. Boundary Basins (adjacent to designated Heritage Canal Corridor, constrained by heritage and WaterNSW drainage and performance requirements – fenced from conservation corridors. These systems are intended to drain across the WaterNSW canal and have no hydraulic impacts on the canal.)

The design and configuration of these basins need to satisfy an integrated range of objectives, including; stormwater treatment, habitat creation, and landscape and urban design requirements.

The focus of this letter is to present the proposed principles and objectives to guide the design and configuration of the Naturalised Basins.

Naturalised basins

Principles and objectives

- **Protection of native plants and animals:** Stormwater basins are located within land currently clear of any significant native vegetation due to previous agricultural uses and outside of riparian buffers.
- **Enhancement and linkage of environmental areas:** Stormwater basins include native trees, provide for animal movement, and are not located in the vicinity of corridor pinch points.
- **Supporting biodiversity**: Stormwater basins provide a range of habitat opportunities and a diversity of native plant species, to support native fauna that currently inhabit or could inhabit the conservation corridors. Stormwater treatment must be provided prior to the provision of habitat for aquatic organisms.

- **Resilient, sustainable and climate responsive:** Stormwater basins are designed and configured to be resilient to changes in climatic conditions and seek to enhance the resilience of the corridor flora and fauna by increasing soil moisture and providing opportunities for cool refuge.
- **Efficient, low impact maintenance:** Stormwater basins are designed to support long functional life spans, aligned to the tree species growing within, and provide access for regular low impact (non-mechanical) maintenance. Upstream GPTs, located outside the conservation corridors, to protect basins from coarse sediment and litter.
- **Research, monitoring and evaluation:** Stormwater basins are designed to support effective monitoring to evaluate their ecological success and allow for adaptive management.

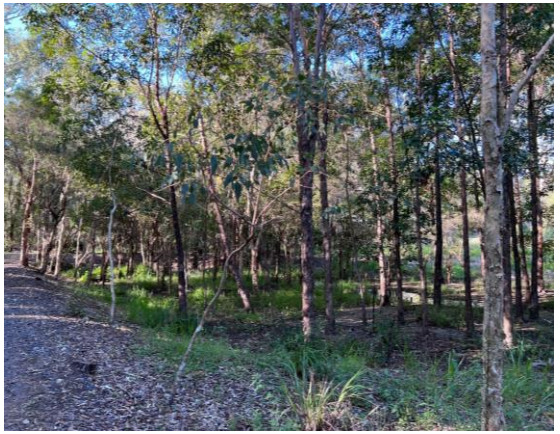
Draft design requirements

Table 1 outlines the key design requirements/development controls that would need to be considered during the planning and design of the stormwater basins located within conservation corridors to support the intent and outcomes of the corridors and stormwater controls.

Table 1

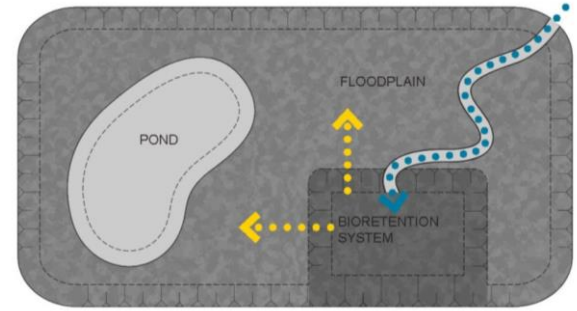
Draft Naturalised Basin Design Requirements

Principle	Objective	Stormwater Basin Design Requirements
Protection of native plants and animals	*Stormwater basins are located within land currently clear of any significant native vegetation due to previous agricultural uses and outside of riparian buffers.*	• No stormwater basins to be placed in areas currently vegetated/uncleared or have been identified as having other environmental or cultural heritage values to be retained. Note: Traditional owner and native title should also be considered in the determination of these protection areas. • Stormwater basins to be located outside of all riparian buffers. • Control the discharge of stormwater from the basins to waterways and through protection areas (conservation and riparian corridors) such that it minimises impacts to existing values.
Enhancement and linkage of environmental areas	*Stormwater basins include native trees, provide for animal movement, and are not located in the vicinity of corridor pinch points.*	• Stormwater basins must not create a barrier to the movement and dispersal of native flora and fauna species including Koalas. • Basins must support safe and effective terrestrial fauna movement (e.g. barriers or fences, limited permanent water, suitable planting structure). This should be informed by the movement requirements of the Koalas and other target fauna species. • Stormwater basins to incorporate native trees and groundcovers within the base and on the batters • Excavate basins, and avoid embankments, to enable tree planting on batters where practical. • Batter design to be gently sloping (1 in 4 or flatter on average) to support successful tree and vegetation growth and movement of fauna. • Where possible, locate stormwater basins within the widest sections of the corridor. • Do not locate basins in the vicinity of pinch points such as fauna road crossings (culverts, underpasses or bridges) • Co-locate within cleared and degraded zones to restore these areas for increased resilience and multifunction. • Configure basins primarily within corridor buffers (i.e. linear/parallel to corridor boundary fence). • Locate stormwater treatment component of the basin on the outer section of basins (development side) and flood retardation component on the inner section. Examples of stormwater basins with native trees and ground cover vegetation provided in Figure 1.

Principle	Objective	Stormwater Basin Design Requirements
		    Figure 1. Native trees within stormwater basins (Photo credits: E2Designlab)

Principle	Objective	Stormwater Basin Design Requirements
Supporting biodiversity	*Stormwater basins provide a range of habitat opportunities and a diversity of native plant species, to support native fauna that currently inhabit or could inhabit the conservation corridors. Stormwater treatment must be provided prior to the provision of habitat for aquatic organisms.*	• Select species from local Plant Community Types (PCT) that will thrive in the hydrologic regimes of the proposed stormwater treatment and flood retardation basins. • Select species which promote biodiversity and plant native flora species that support local wildlife within the conservation corridors. • Incorporate habitat enhancements such as ephemeral or permanent watering holes/pools (receiving treated stormwater only), rock piles, fallen wood and hollow logs for wildlife to access. • Note: having watering holes which are regularly recharged with treated stormwater provides an intermittent source of water supply for biota in the outer extents of the conservation corridors that may be several hundred meters from the waterway corridor. These ponds/watering holes wouldn't naturally form from direct rainfall alone. The collection and retention of treated stormwater creates an opportunity for increased diversity and a cool refuge. Figure 2 provides examples of stormwater basins with a diversity of plant community and habitat types. The examples in Figure 3 illustrate the incorporation of watering holes/ponds.  Figure 2. Diversity of plant community types within stormwater basins (Photo credits: E2Designlab)

Principle	Objective	Stormwater Basin Design Requirements



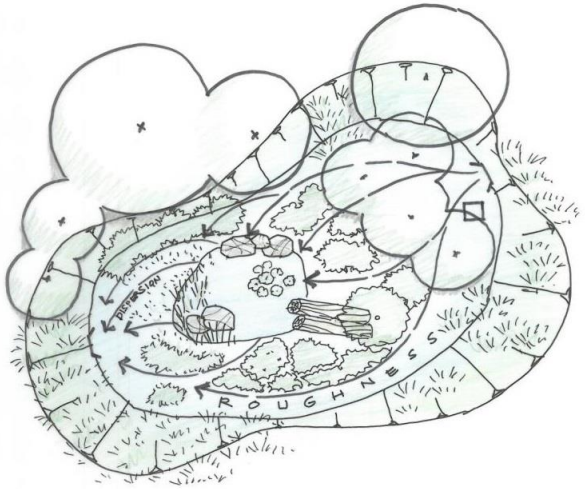
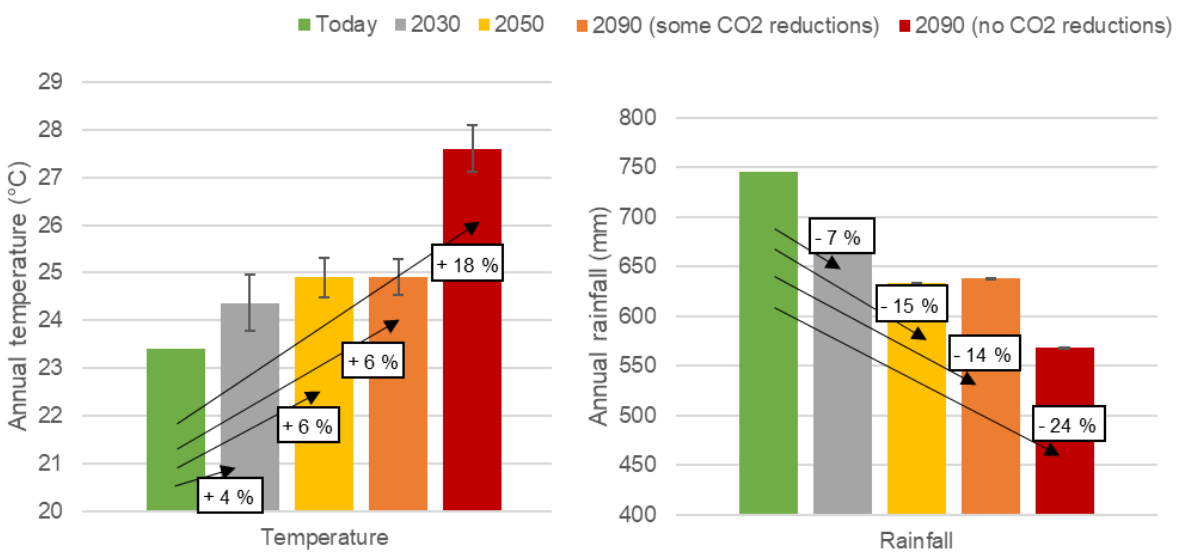


Figure 3. Examples of incorporating ephemeral and permanent pools within stormwater basins (Photo credits: E2Designlab: Image credits: Peter Breen (E2Designlab) & Courtney Henderson (AECOM))

Principle	Objective	Stormwater Basin Design Requirements

Resilient, sustainable and climate responsive	*Stormwater basins are designed and configured to be resilient to changes in climatic conditions and seek to enhance the resilience of the corridor flora and fauna by increasing soil moisture and providing opportunities for cool refuge.*	• Where space permits, on cleared degraded land and within flood extents (including overland flow paths), prioritise ephemeral wetlands for stormwater treatment over bioretention. Whilst wetlands have a larger footprint, they are more resilient to fine sediment loading, are simple in configuration (typically no filter media or underdrainage) and can support the native vegetation structure and diversity of species associated with riparian communities.
		• Inclusion of organic materials into bioretention filter media to provide a source of carbon to improve water holding capacity, soil fertility and support beneficial microbes.
		• Bioretention basins to include subsurface water storage zones/saturated zones to provide soil moisture to the plants during dry weather.
		• Detention basins to be unlined/permeable to encourage exfiltration into soils for deep soil moisture and groundwater recharge.
		• Consider climate change and the potential impacts on existing vegetation communities and fauna species. Note, in general, Gilead can expect to experience:
		  ○ Increase in average temperatures in all seasons
		  ○ More hot days and warm spells
		  ○ Decreases in winter rainfall
		  ○ Increase intensity of extreme rainfall
		  ○ Harsher fire-weather climate
		https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-analogues/analogues-explorer/
		
		The predicated changes in temperature and rainfall under 4 climate scenarios is presented in the Figure 4 below.

Principle	Objective	Stormwater Basin Design Requirements
		 Figure 4. Temperature and rainfall predictions for Camden NSW (closest reference point to Gilead) based on four climate change scenarios (https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-analogues/analogues-explorer/) • Note: the provision of stormwater basins within corridors may be beneficial by providing zones of increased soil moisture and cooling to increase the resilience of vegetation to climate change. Allow access by fauna, by locating within Koala fences may also provide opportunities for cool refuge and watering holes for fauna to increase resilience to extreme heat and drought.
Efficient, low impact maintenance	*Stormwater basins are designed to support long functional life spans, aligned to the tree species growing within, and provide access for regular low impact (non-mechanical) maintenance. Upstream GPTs,*	• Include high density native ground cover planting to minimise weeds, particularly during the early establishment phase of the trees. Consider the species of ground cover to ensure fauna movement is provided in the medium and long term (e.g. mix of sun loving and shade tolerant plants). Note: the ground cover layer will thin out as the canopy develops over time and the canopy will help to shade out weeds. • Include groundcover species with matting or rhizomatous root systems to help bind the soil surface and avoid weed growth. • Separate frequent flows to the bioretention system and infrequent flows to the flood retarding basin.

Principle	Objective	Stormwater Basin Design Requirements
	located outside the conservation corridors, to protect basins from coarse sediment and litter.	• Tailor vegetation design for the stormwater treatment and flood retardation components based on the different hydrologic and soil conditions. • Provide outlet structure protection to avoid blockage, scour and erosion. • Provide flow spreaders to the outlets, to avoid scour and erosion, and tailor design to the local conditions. • Co-locate maintenance access tracks with trails and fire breaks where possible. • Design maintenance access tracks to be permeable (e.g. Figure 5 below) • Do not located trees within 3m of exclusion fences (to avoid damage to fence in event of fall) • Develop an Asset Management Plan, in accordance with ISO 55001:2014, for all stormwater basins and their components, to ensure effective and efficient asset management is in place including financial planning, maintenance and procedures, review and adaptive management.  Figure 5. Maintenance access and pedestrian trial located at Wakerley Bioretention Basin in Brisbane, QLD. Remnant vegetation is to the left of the track and bioretention vegetation to the right of the track. System is 15 years old. (Photo credit: E2Designlab)

Principle	Objective	Stormwater Basin Design Requirements
Research, monitoring and evaluation	*Stormwater basins designed to support effective monitoring to evaluate their ecological success and allow for adaptive management.*	• Design the basins to enable cost effective research and monitoring. • Research and monitoring opportunities will be refined with the development team and researchers, but could include: quantitative vegetation monitoring of quadrats, visual remote sensing (fauna), soundscape analyses (fauna), soil carbon and fungal analyses (soil health and microbiological diversity) • Evaluate the ecological success of the stormwater basins and implement adaptive management based on findings. • Stage the construction of stormwater basins and adapt the designs, as required, in response to the research findings for continued refinement to maximise beneficial outcomes. • Share learning for transparency, education and capacity building.

Limitations and gaps

This interim letter has been developed based on first principles ecology and engineering, including a desktop review of available information. As such, the draft assumptions made in this report will need to be checked during a site inspection and worked through with the design team. We also note, the integrity of the conservation corridors will also be influenced by the land uses and activities which occur adjacent to the corridor buffers, including urban infrastructure (e.g. urban density and roads), vegetation/tree removal and changes in water quality and hydrology. Whilst this has not been a focus of this stage of the project, further consideration and guidance on planning and design approaches to enhanced protection of environmental values within and/or connected to the conservation corridors is proposed as part of the design process. Additional interventions within the development (i.e. outside of the conservation corridors) may reduce the size and extent of end of pipe stormwater control measures and should be considered in the design process.

Conclusions

We believe both stormwater treatment systems (e.g. ephemeral wetlands and bioretention systems) and flood retardation basins can be designed in a way that these naturalised assets allow for Koala movement as the primary conservation function but also form viable habitat for a range of other biota.

We also believe that given the width of the identified (Koala) conservation corridors, there is room for naturalised basins within the Koala conservation corridor, but outside the designated riparian corridors/buffers. This is an opportunity to develop genuine multifunction conservation – urban assets.

We look forward to discussing this proposed approach further.

Yours faithfully

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