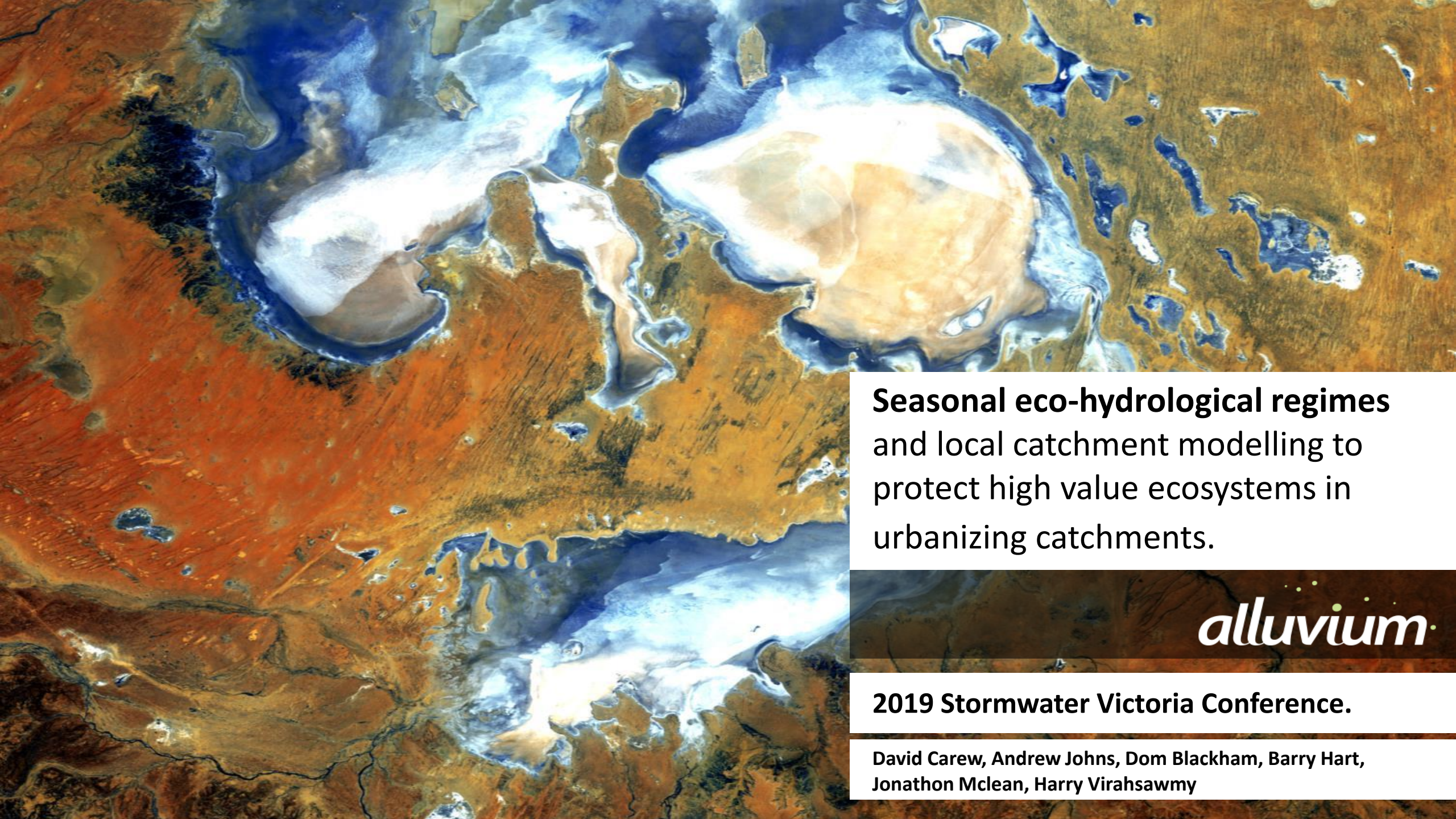

Seasonal eco-hydrological regimes and local catchment modelling to protect high value ecosystems in urbanizing catchments.

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2019 Stormwater Victoria Conference.

David Carew, Andrew Johns, Dom Blackham, Barry Hart, Jonathon Mclean, Harry Virahsawmy

Ecohydrology

When we need to consider it

What do we need to consider

Examples

Ecohydrology –
is an interdisciplinary scientific field studying the interactions between water and ecological systems. It is considered a sub discipline of hydrology, with an ecological focus.

Ecohydrology –
is an interdisciplinary scientific field studying the interactions between water and ecological systems. It is considered a sub discipline of hydrology, with an ecological focus.

Seasonal flow patterns

Drying periods

A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes

D. Frood and P. Papas

June 2016

Arthur Rylah Institute for Environmental Research

Technical Report Series No. 266

Many EAV species have phenotypic plasticity.

For species that grow in permanently inundated situations, plants grown in increased water depth divert resources from roots to shoots, increase shoot height, and reduce shoot number to maintain enough shoot material above water to obtain sufficient light, carbon dioxide, and oxygen.

These changes occur over several weeks. Then growth rate is suppressed, if depth is maintained at levels greater than that necessary for long term survival, death occurs 2-3 years later.

The role of water regime in emergent aquatic vegetation (EAV) decline
Department of Primary Industries
Tony Dugdale, Fiona Ede June 2013

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Flora and Fauna Guarantee Act 1988 Threatening Processes List December 2016

Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing is a threatening process.

Examples of species listed under the FFG and EPBC acts

- *Litoria raniformis* Growling Grass Frog
- *Galaxiella pusilla* Dwarf Galaxias

Many wetlands have been lost, and much of what remains has been affected by one or more degrading processes. The main process contributing to wetland loss and degradation in Victoria (which constitutes the bulk of the species' range) has been total or partial drainage, and 37% of the State's natural wetland area has been lost in this way.

Seasonal Herbaceous Wetlands of the Lowland Plains has been listed as a Threatened Ecological Community under the EPBC Act.

Urban habitat for Dwarf Galaxias

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Seasonal Herbaceous Wetlands

SHW are listed as critically endangered under the federal Environmental Protection and Biodiversity Conservation Act (EPBC Act)

Seasonal Herbaceous Wetlands of the Temperate Lowland Plains (SHW) are isolated freshwater wetlands that are seasonally or intermittently filled by rainfall. They are usually inundated in the cooler months (winter – spring), and generally dry out by late summer, so surface water is not permanently present.
Occur in seasonally inundated drainage-lines and depressions (sometimes poorly defined) which are filled by rainfall.

The vegetation varies through the seasons and they are often thought of as “disappearing wetlands”.
Often been used for agriculture.

Isotoma fluviatilis ssp australis

An example of SHW at One Tree Hill Swamp.

From: The impact of Melbourne's growth on 'Seasonal herbaceous wetlands (freshwater) of the temperate lowland plains'
Melbourne Strategic Assessment


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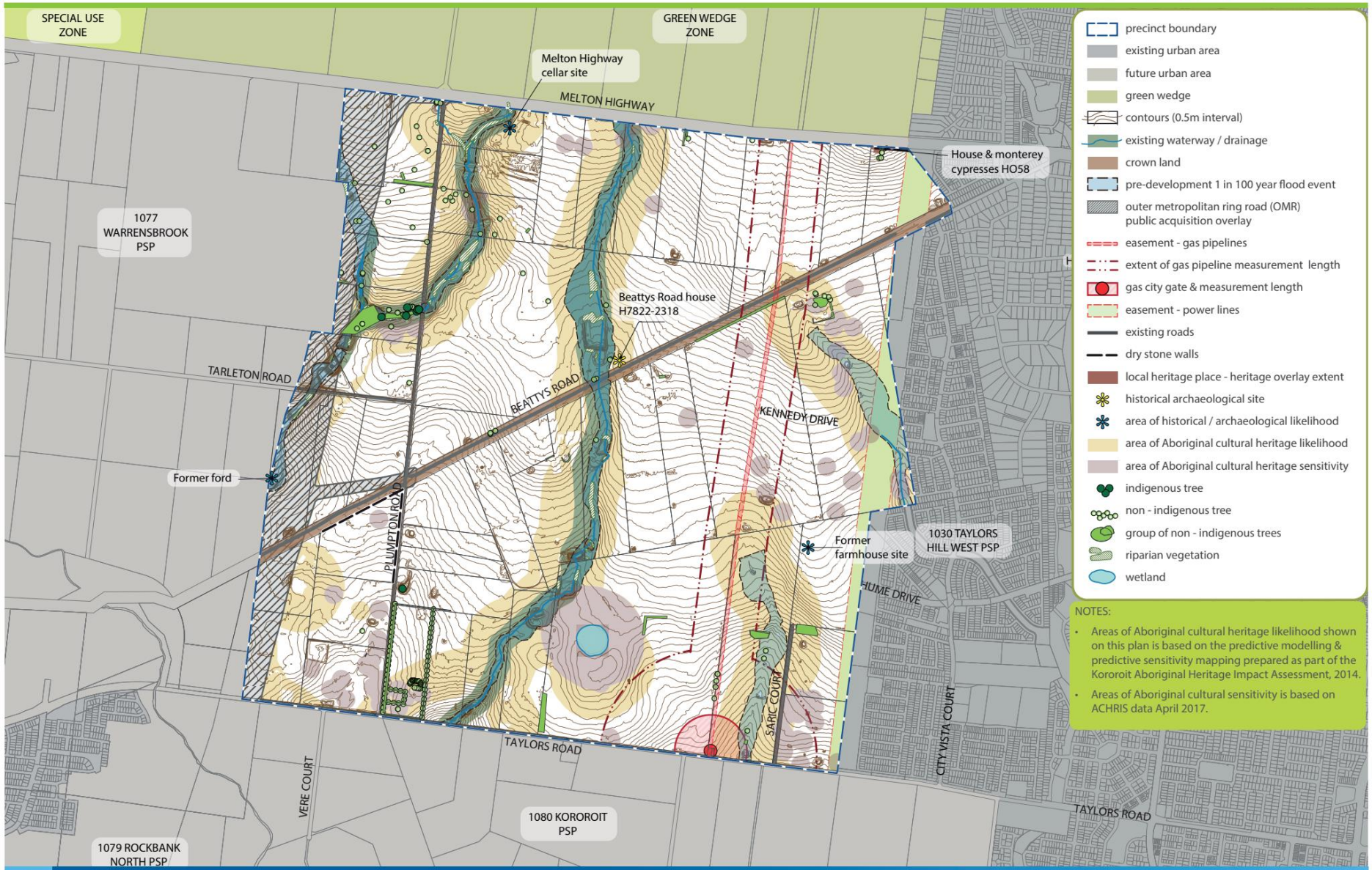
When do we consider ecohydrology

Plan 2 - Precinct Features

Plumpton Precinct Structure Plan

1:25,000 @ A4

0 200 400 600 800 1,000m



NOTES:

- Areas of Aboriginal cultural heritage likelihood shown on this plan is based on the predictive modelling & predictive sensitivity mapping prepared as part of the Kororoit Aboriginal Heritage Impact Assessment, 2014.
- Areas of Aboriginal cultural sensitivity is based on ACHRIS data April 2017.

Plan 3 - Future Urban Structure

Plumpton Precinct Structure Plan

1:25,000 @ A4

0 200 400 600 800 1,000m

N

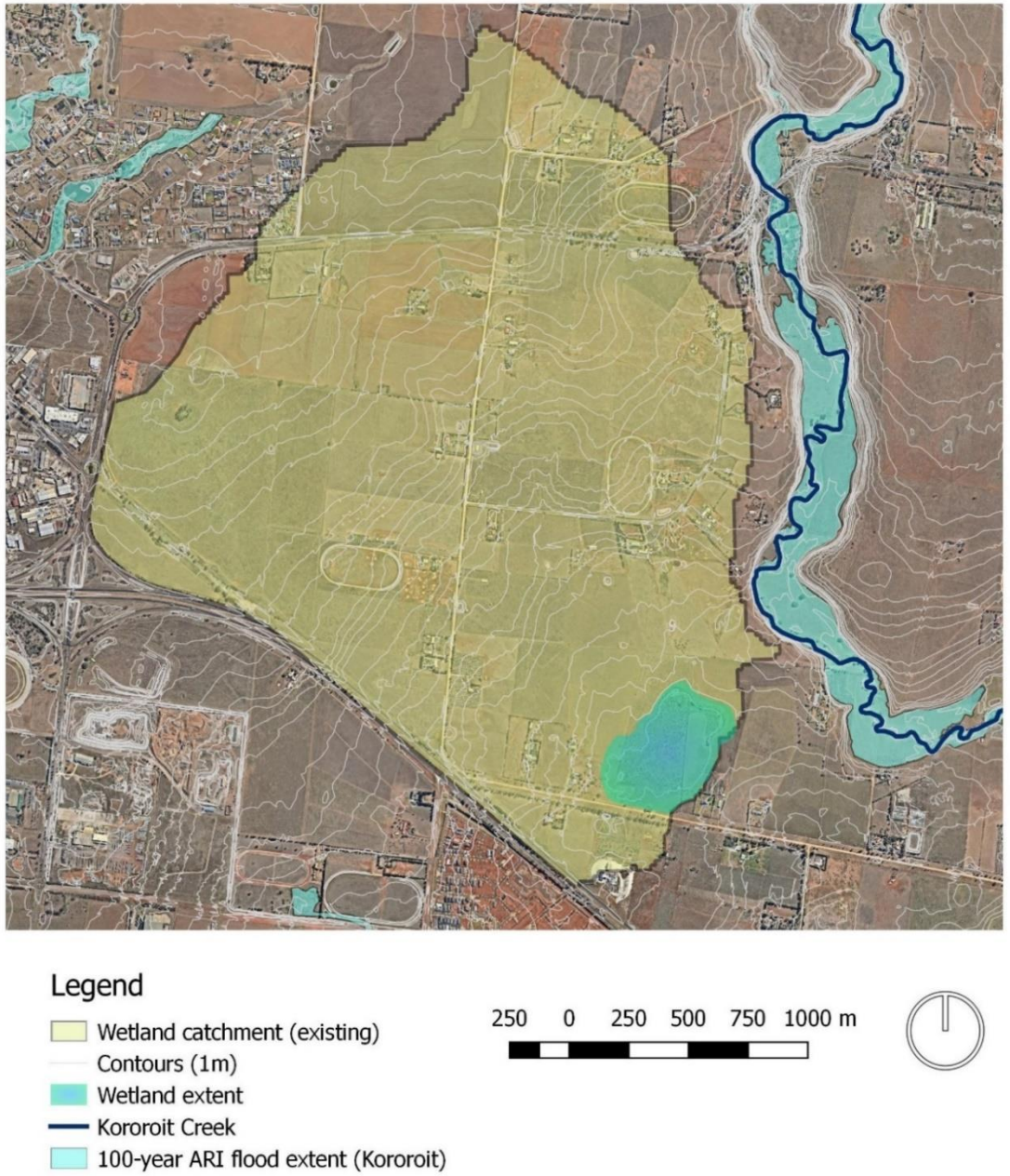
- precinct boundary
- walkable residential catchment
- residential
- business
- mixed use
- industrial
- town centre
- local convenience centre
- future government school
- potential non-government school
- community facilities
- indoor recreation (aquatic centre)
- uncredited open space (drainage)
- credited open space
- uncredited open space (beattys road reserve)
- easement with pylons - utilities
- proposed substation
- public acquisition overlay
- arterial road (6 lanes)
- arterial road (4 lanes)
- connector street
- connector street - town centre
- feature main street
- local access street
- future premium bus route
- existing urban area
- future urban area
- local heritage place
- pedestrian & cyclist bridge

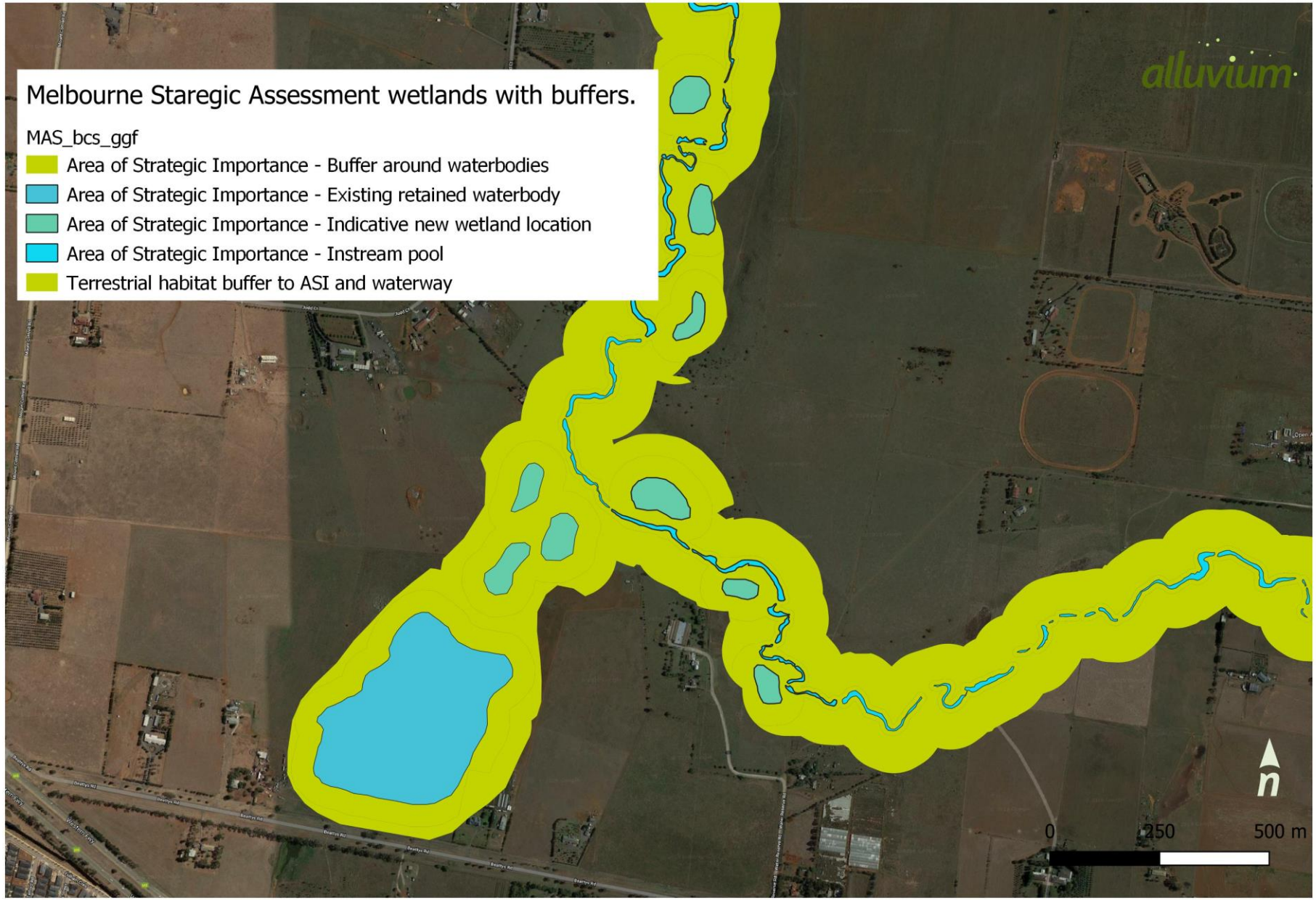
NOTE:

- For open space details see plan 6
- For local street hierarchy see plan 8
- Local road alignments illustrated on this plan and plan 8 are indicative only. Detailed planning at the subdivision stage is envisaged to identify actual road alignments and access arrangements (including Beattys road), which should generally accord with the indicative alignments shown in the PSP, subject to the responsible authority's approval.
- Areas of the PSP are subject to flooding in the pre-development 1 in 100 year flood extent. see plan 2 for flood extent.

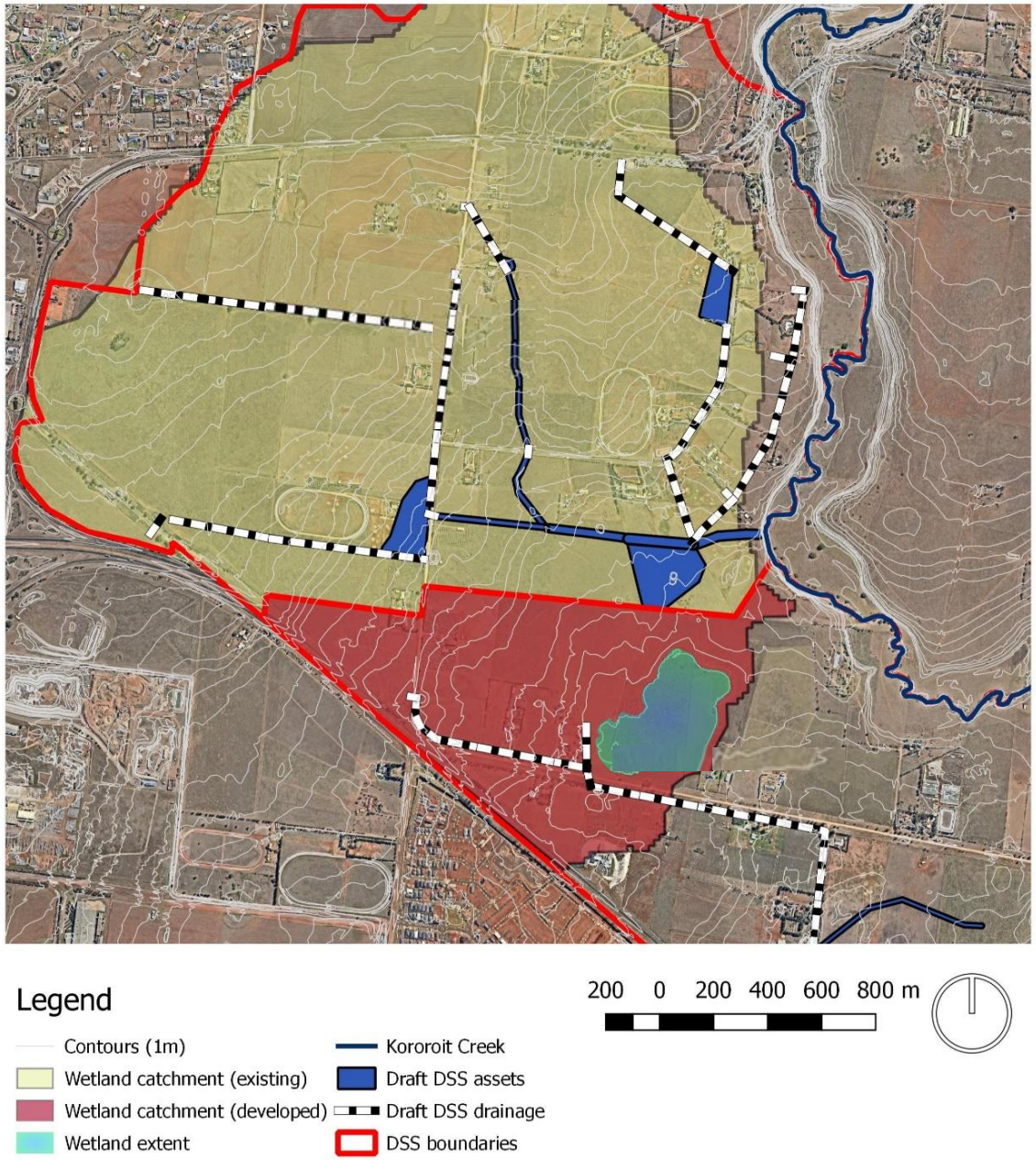
Wetland catchment is from local sources
– not from the waterway.

13 Ha wetland with a
605 Ha catchment




Melbourne Staregic Assessment wetlands with buffers.
MAS_bcs_ggf
Area of Strategic Importance - Buffer around waterbodies
Area of Strategic Importance - Existing retained waterbody
Area of Strategic Importance - Indicative new wetland location
Area of Strategic Importance - Instream pool
Terrestrial habitat buffer to ASI and waterway
alluvium
n
0
250
500 m

Standard Drainage Scheme design would see the catchment segmented with significant changes to the surface flows and impacts on the wetland.



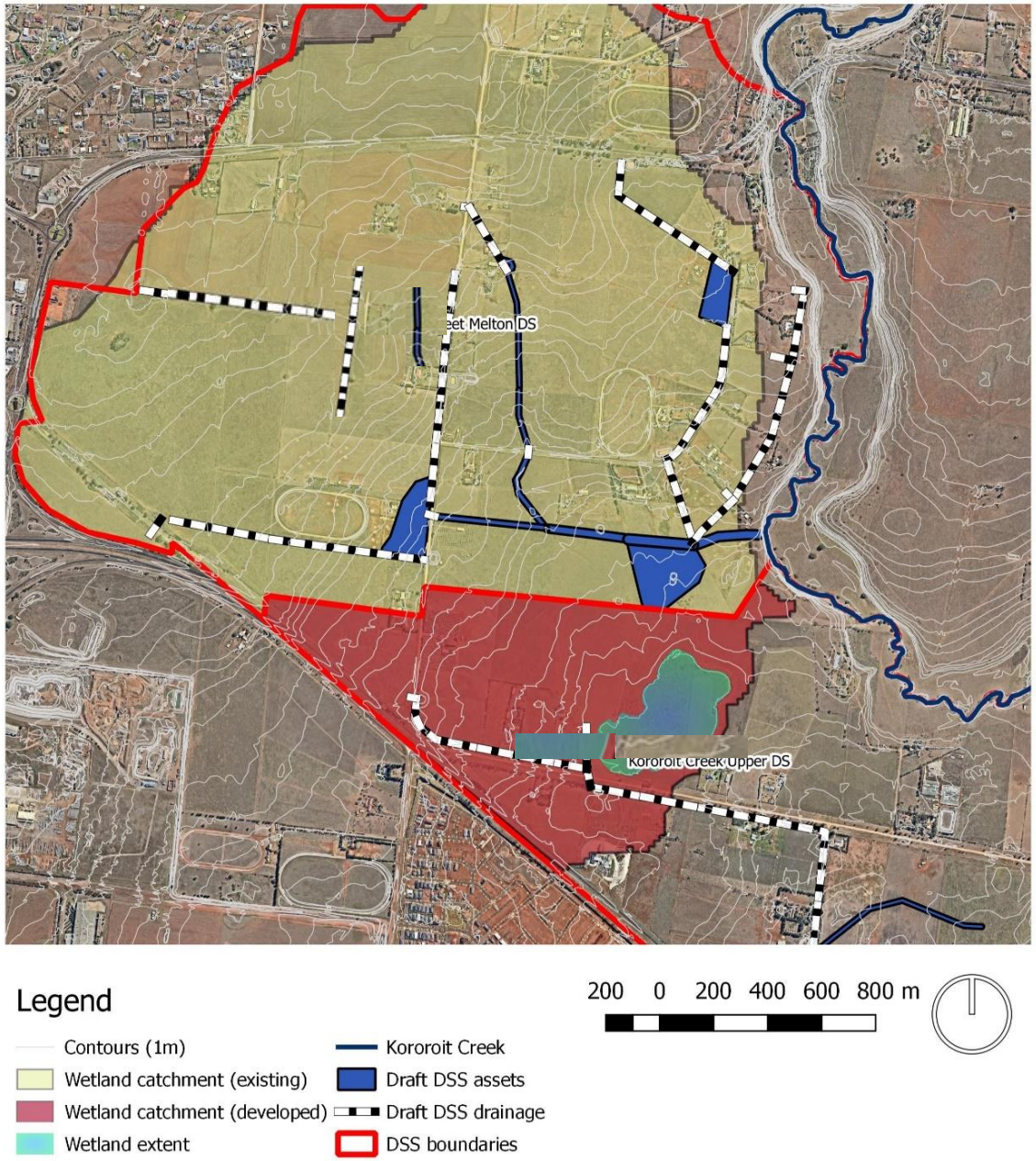
Scenario	Catchment area (ha)	Fraction impervious
Existing	605	0
Developed	112	0.75*

*Assumed as an overall catchment average, given the inclusion of industrial zoning

Two scenarios considered for developed conditions:

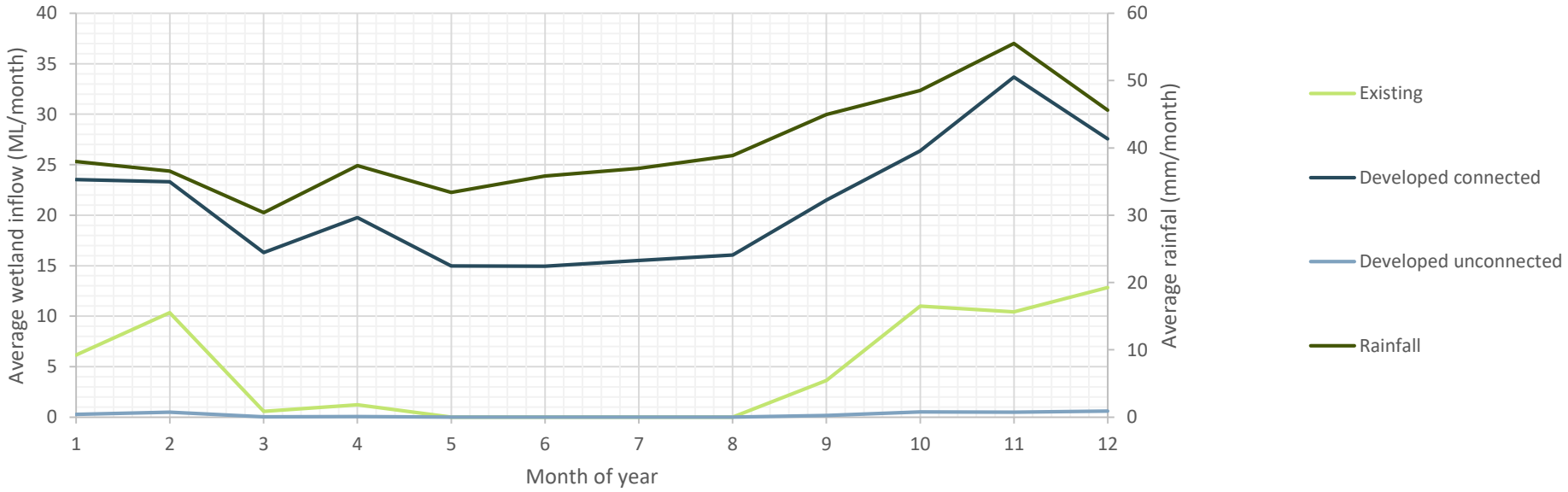
- Direct connection of impervious surfaces to the wetland. In this **connected scenario** local high and low flow drainage systems directly connect to the wetland

- Impervious surfaces bypassing the wetland in this **unconnected scenario** local drainage (hence all impervious area) bypasses the wetland.



Modelling scenario total inundation spells in the 38-year simulation period

Scenario	Catchment area in model scenario (Ha)	Number of inundation occurrences	Average duration of inundation (days)	Average time between inundation events (days)
Existing conditions	605	18	80	739
Developed - connected	112	868	55*	15
Developed - unconnected	112	12	6	1109

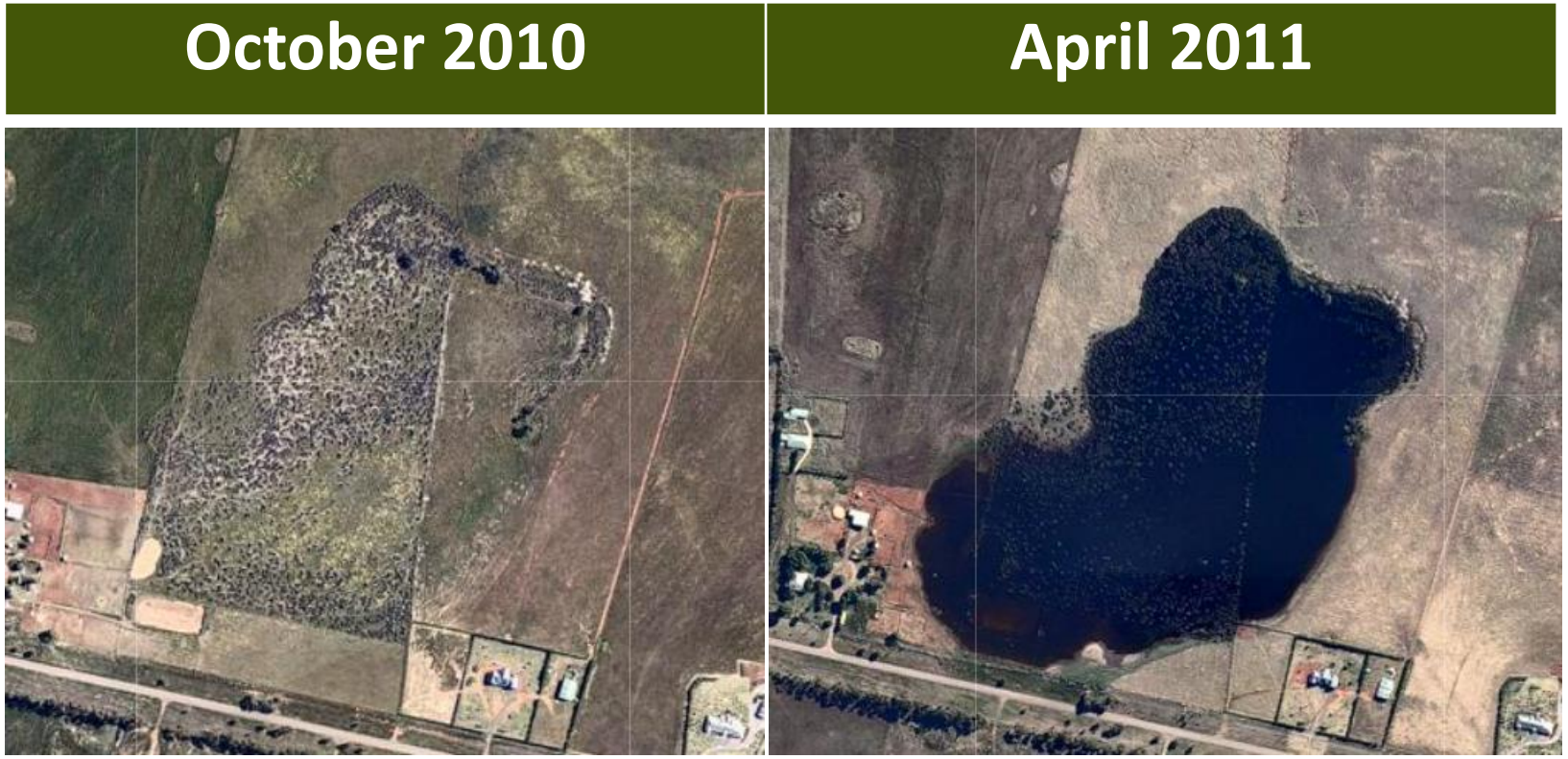


Seasonal Herbaceous Wetland hydrology

Vegetation community	Management objectives	Failure modes	Consequence of failure	Likelihood of failure	Recommended water regime			Depth (mm)	Mitigation Actions
					Frequency	Duration	Timing		
Seasonal Herbaceous Wetland	**Persistence of SHW**				**Annual** (Max 3 year interval between inundations)	**4-6 months**	**June - January**	**<600mm**	**Desired hydrology regime**
					Unmitigated water regime				
	Seasonal inundation	Inundation does not occur seasonally. (Insufficient Catchment area – reduced by development)	Major Change in vegetation assemblage and loss of SHW.	Almost certain	> 5 years	< 2months	July - Sept	100mm	• Consider alternative water supplies. • Prevent development via overlays and planning controls • Ensure seasonal inflow using diversion structure
	Seasonal inundation	Inundation period is longer than 9 months per annum – (Connected & developed catchment prevents wetland from drying out seasonally)	Major Change in vegetation assemblage and loss of SHW.	Almost certain	Annual	9 to 12 months	Jan - Dec	>1000mm	• Prevent development via overlays and planning • Reduce inflows to wetland via flow diversion.
	Species aligned to the vegetation community are present with herbaceous species >40% cover	Reduced frequency of inundation enables growth of exotic grasses	Major Change in vegetation assemblage and loss of SHW	Almost certain					• Monitor vegetation cover and undertake strategic vegetation management
	Species aligned to the vegetation community are present with herbaceous species >40% cover	Increase in length of inundation promotes growth of Tall Marsh species especially *Phragmites australis*	Major Change in vegetation assemblage and loss of SHW	Almost certain					• Monitor vegetation cover and undertake strategic vegetation management

Mitigation options

- Do not allow the catchment to develop
- Create hydrologic buffer zone
- Water supply augmentation
- Install operable flow diversion and
  WSUD devices in the drainage system

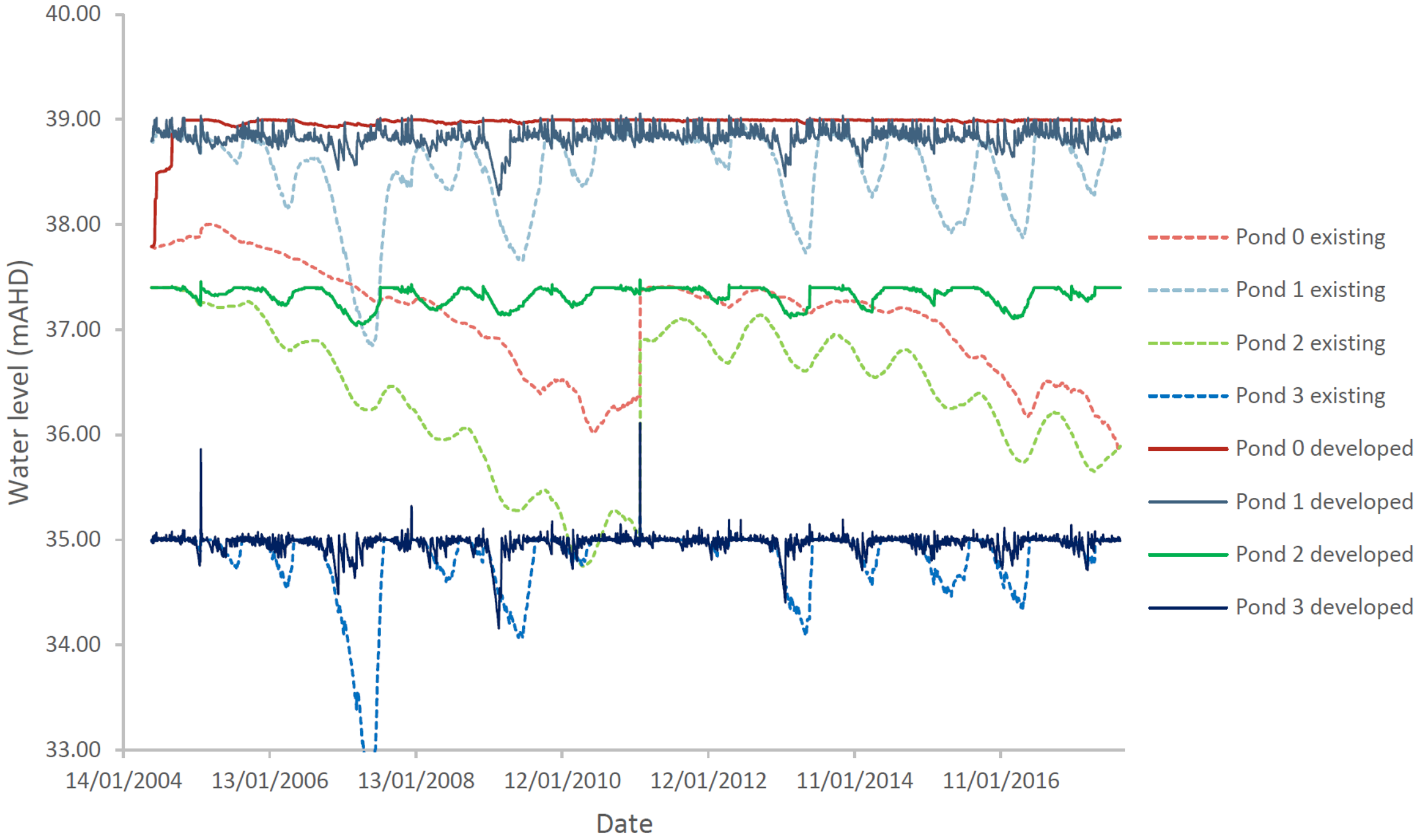


Project principles for Ecological protection and enhancement

The impact on the existing ecological values needs to be minimised whilst the opportunity for enhancement should be considered to lessen the overall impact from the PSP development.

In summary the key criteria are:

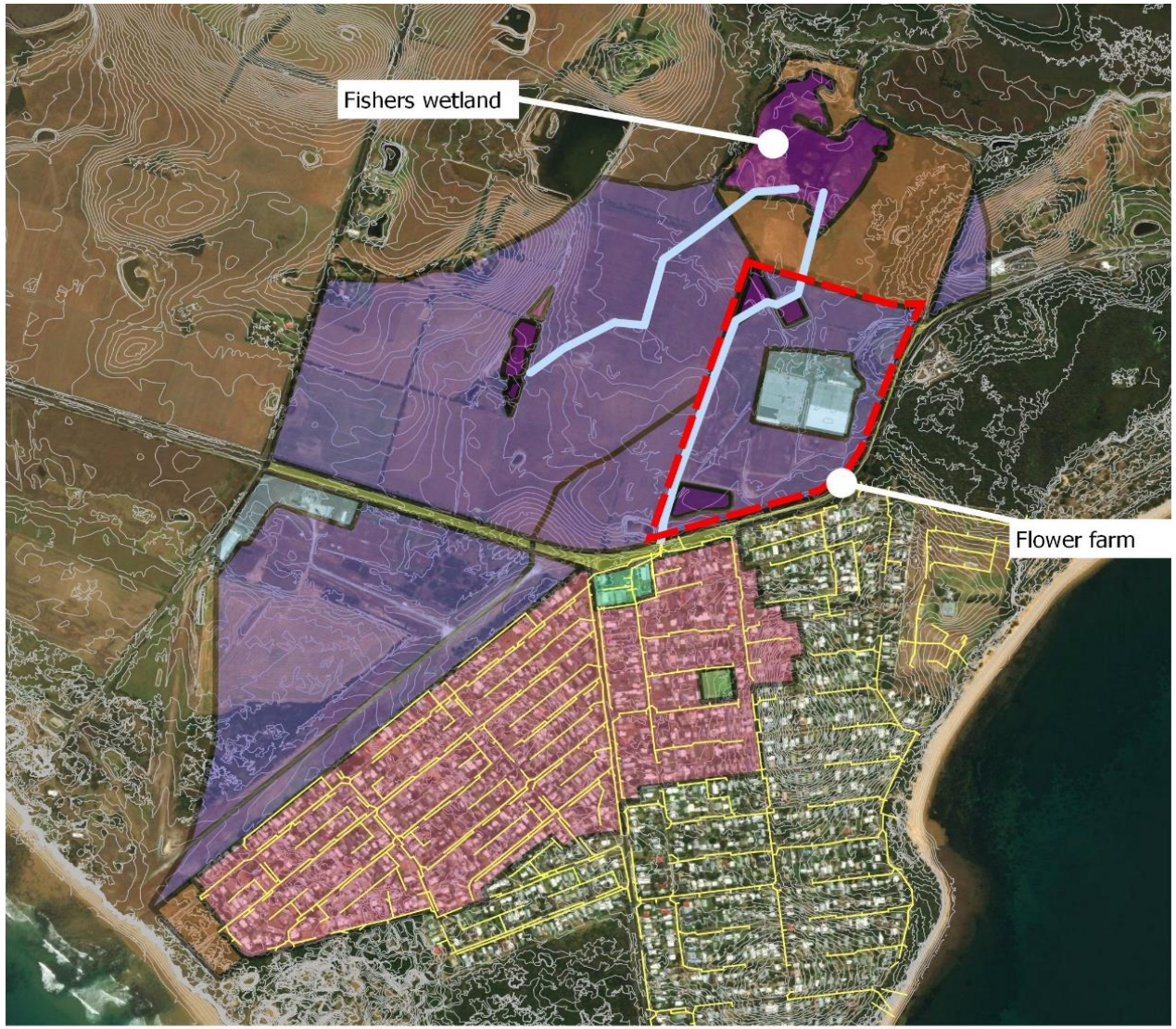
- Maintain hydrological regime in habitats supporting Latham Snipe and the Growling Grass Frog.
- Retain the current hydrological regime in areas of permanent open water for foraging and breeding habitat for state listed waterbirds.
- Retain the breeding waterbird islands.
- Retain and enhance Dwarf Galaxias habitat
- Develop at least some wetlands to include key Growling Grass Frog wetland habitat
- Maintain and enhance shallow areas within existing wetlands and create new shallow, well-vegetated wetlands.
- Minimise disturbance to existing swamp scrub by minimising works between the toe of the existing embankment of waterway


40.00
39.00
38.00
37.00
36.00
35.00
34.00
33.00
Water level (mAHD)
14/01/2004
13/01/2006
13/01/2008
12/01/2010
12/01/2012
11/01/2014
11/01/2016
Date
Pond 0 existing
Pond 1 existing
Pond 2 existing
Pond 3 existing
Pond 0 developed
Pond 1 developed
Pond 2 developed
Pond 3 developed

Pond	Changes to hydrologic regime	Typical water level annual variability (+-)
0	Completely full, almost no variability in levels throughout the year. All seasonality and ephemerality are eliminated. In comparison under existing conditions the pond only fills irregularly (eg once every five years or so) and slowly empties where it can be dry for many years.	0-0.1m
1	High frequency variation, no gradual seasonal trends	0.2-0.4m
2	Some seasonal variation, no major drying/inundation cycles.	0.2-0.3m
3	High frequency variation, reduced seasonal trends. Northern marsh zone is almost permanently inundated, removing the previous "dual-zone" regime in the northern and southern sections. Southern section remains at high water levels. Presence of high water levels leads to increased incidence of flooding (i.e. pond loses its natural storage effect).	0.3-0.5m

Mitigation options here were to match the existing hydrology by limiting the water supply.

Stormwater diversions and reuse where possible are being proposed to deliver the historic hydrology.



Wetland Catchment

250 0 250 500 750 1000 m

egend

Pipe network
Channels
Contours (0.5m)
Water bodies
Farming zone
Residential
Mixed use
Conservation
Public parks
Road
Other (flower farm and airport)

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Current seasonal vegetation variation

Summer

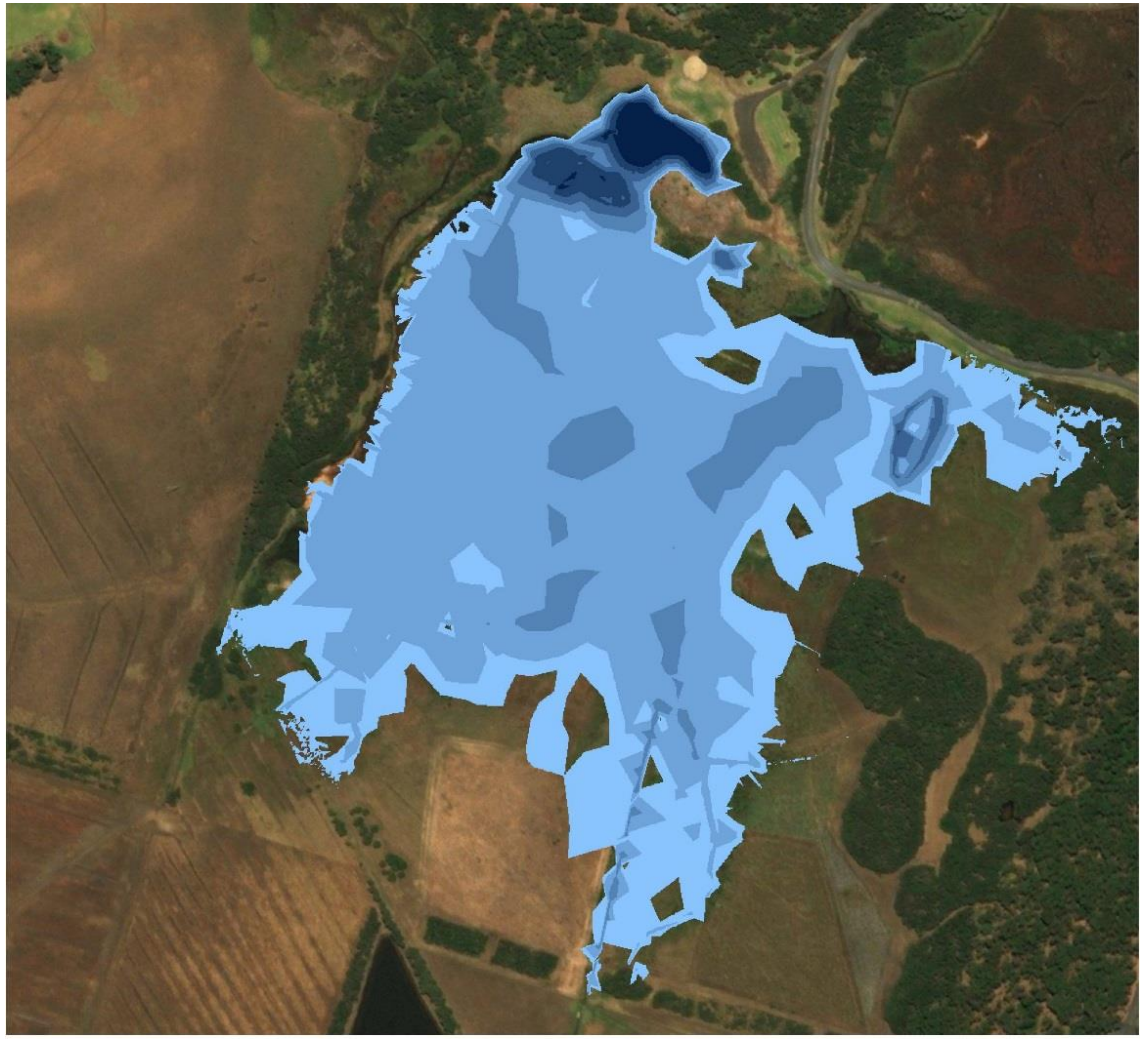
Winter

Legend

Habitat zones

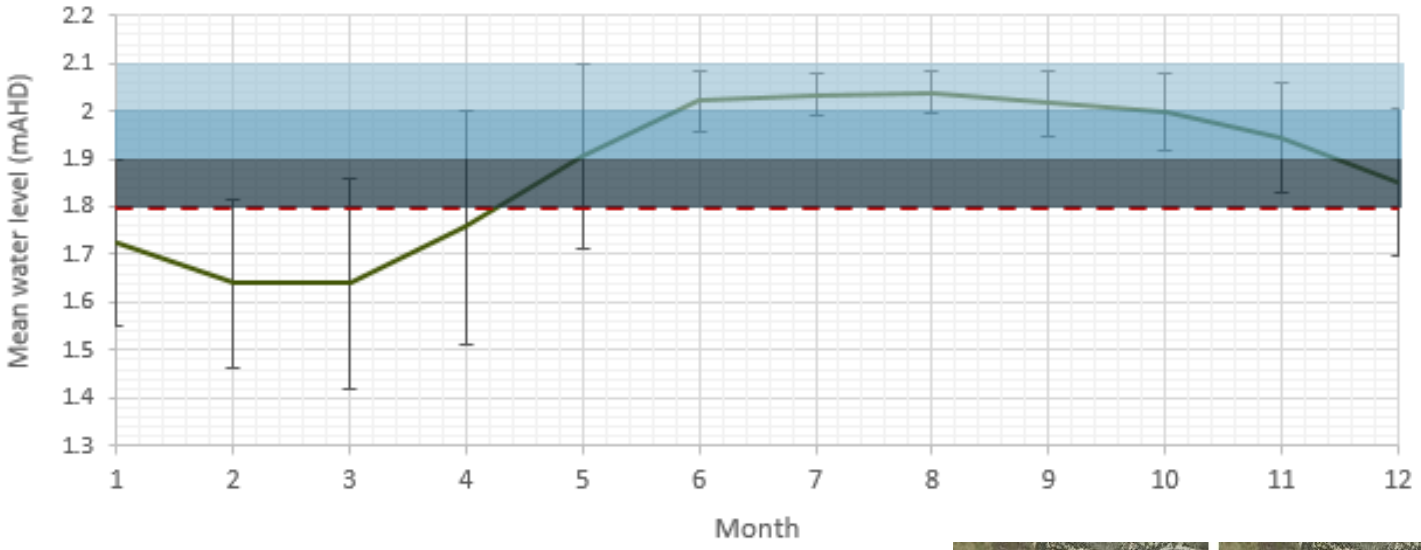
- Permanent Water
- Seasonal Open Water / Sub-saline Mudflat
- Emergent Marsh
- Grassland / Sedgeland
- Swamp Scrub
- Woodland
- Saltmarsh and Estuarine Scrub
- Seasonal Open Water

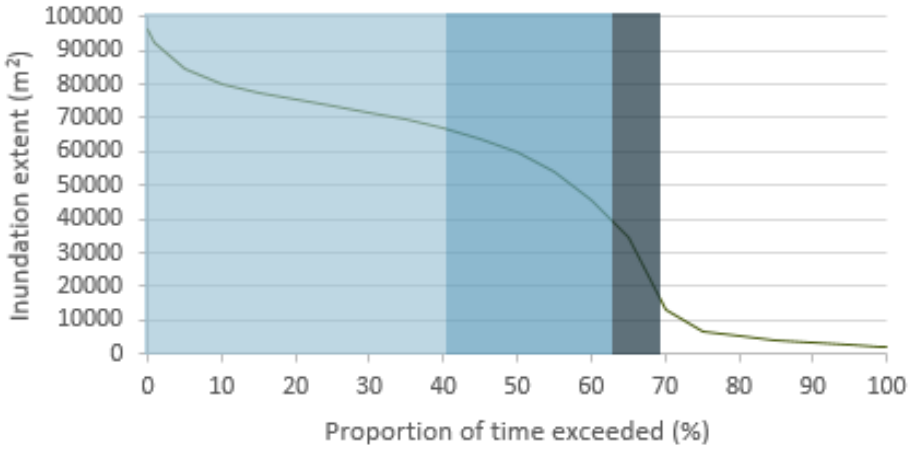
Bathymetric survey

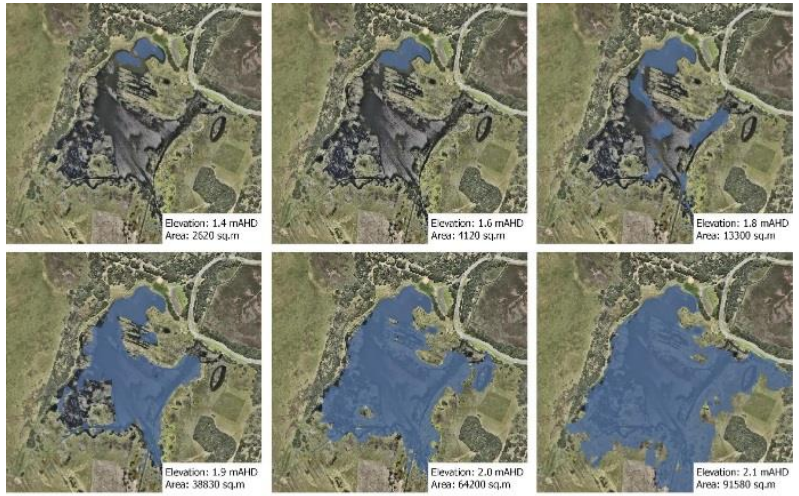


Habitat zones	Component EVCs	Management objectives	Failure modes	Actions	Recommended water regime			Elevation (m AHD)	Depth (mm)	Likelihood of regime being delivered	
					Frequency	Duration	Timing			2020	2050
Seasonal Open Water	Brackish Aquatic herbland (EVC 537) Brackish herbland (EVC 538)	Ensure open water is present periodically through each year.	Inflow to wetland is insufficient to zone	Monitor vegetation for non herbaceous plants and manage if necessary.	Inundate every 1-2 years	5-8 months	April - December	1.80-2.00	> 100-200 mm	High	High
		Ensure extent of open water varies seasonally	Inflow to wetland does not vary seasonally and water does not draw down	Monitor depth and lower water level if target period is exceeded.							
Permanent Open Water	Brackish Aquatic herbland (EVC 537)	Ensure birdhide pool is permanently full to AHD AHD 1.3m.	Very low rainfall and evaporation dries pond down.	Monitor level - supply water if level drops below 1.3 Consider alternative water supplies.	Annual	Permanent	January - December	0.5 - 1.8	> 800mm	High	High
Sub-saline mudflats	Brackish Aquatic herbland (EVC 537) Brackish herbland (EVC 538)	Ensure extent of open water varies seasonally with drawdown to exposed mudflats on a seasonally basis	Inflow to wetland does not vary seasonally and water does not draw down	Monitor depth and lower water level if target period is exceeded.	Expose every 1-2 years	4-7 months	November - May	1.80-2.00	< 400 mm	High	High
		Ensure only aquatic herbaceous vegetation grows in area.	Emergent aquatic vegetation establishes in mudflat areas.	Monitor establishing vegetation and control emergents.							
		Maintain view lines across the site.	Tall plants establish in area.	Monitor establishing plants (e.g. *Myporum insulare* and *Phragmites austalis*) - control if necessary							
Marsh with emergent vegetation	Estuarine Wetland (EVC 10) Brackish herbland (EVC 538)	Maintain areas of sedge land around the subsaline mudflats	Inundation is too deep for sedges to persist.	Monitor depth and lower water level if target period is exceeded.	Inundate every 1-2 years	2-3 months	April - December	1.9-2.10	0 - 200mm	High	High
		Manage for weeds <5% cover	Weeds establish and dominate vegetaiotn	Control weeds especially Water Couch and Tall Wheat Grass.							
		Maintain view lines across the site	Tall plants establish in area.	Monitor establishing plants (eg Myporum insulare and Phragmites austalis) - control if necessary							
Grassland/sedgelands	Estuarine Flats Grassland (EVC 914) Estuarine Wetland (EVC 10)	Grassland/sedgeland occupies slightly higher ground (>2.0mAHD) with indigenous plants dominating.	Inudation period is too long for grassland health	Monitor depth and lower water level if target period is exceeded.	Inudate every 2-3 years	1 month	April - December	2.00 - 2.20	+100 - 100 mm	High	High

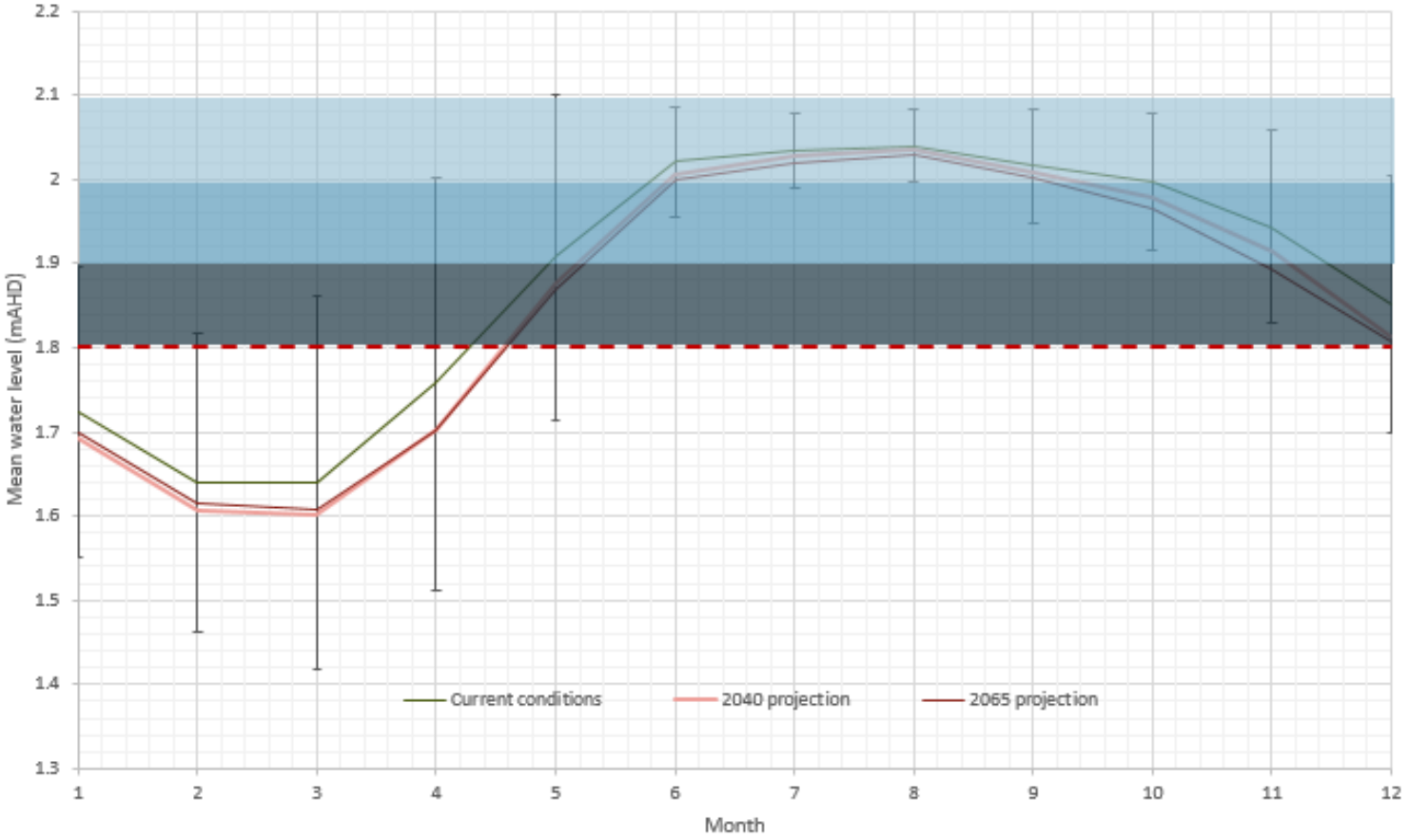
Current hydrological behaviour







Future hydrological behaviour



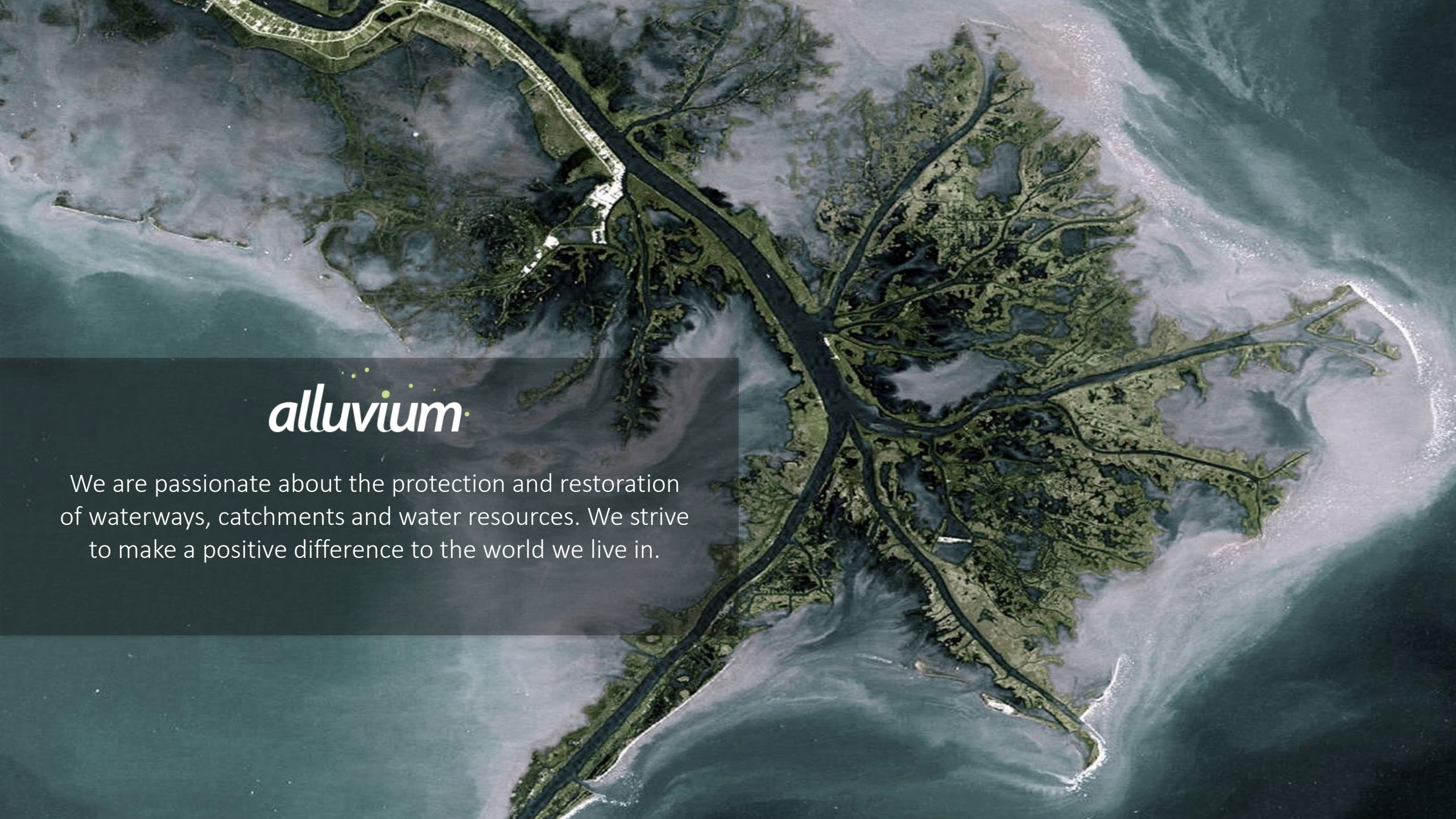
- Median climate change scenario:
  - 5.5 % drop in rainfall
  - 4.1 % increase in evapotranspiration
- Reduction in water depth of 10-20 mm
- Dry shallow zones for an extra 18 days of the year (5% of time)

What do we need to consider under ecohydrology

Hydrological characteristics to consider

We are interested in the seasonal and intra-season hydrology which drives the vegetation response and delivers the habitat outcomes.
Major infrequent flood events are not controlling the ecology.

- Frequency of inundation - Seasonal
  - Intermittent
- Maximum event inundation
  - Duration of Waterlogging
  - Inundation period
- Maximum period between inundation
- Water depth
- Salinity
- Water source
  - Connection to waterway
  - Local catchment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We are passionate about the protection and restoration of waterways, catchments and water resources. We strive to make a positive difference to the world we live in.