Installation of Flood Drainage Network
Major flood drainage works, including Bagotville Barrage built in 1971
Exposure of Acid Sulfate Soils
Impact of Acid Sulfate Soils

- Poor water quality
- Degraded ecosystems
- Acid scalds
- Fish kills

Source: Northern Star

Richmond River fish kills

Iron in Hendersons Drain

High Acidity in Jumbo Drain

* Courtesy of Environment Canada (www.ns.ec.gc.ca)
Prioritising Tuckean Swamp

**Surface Water Factor**
- **Drainage**
  - Long, deep, wide drainage network
  - Low-lying land
- **Hydrology**
  - Large catchment, high flow
  - Small catchment, low flow

**Groundwater Factor**
- **Groundwater**
  - High hydraulic conductivity
  - Low hydraulic conductivity
- **Water Quality**
  - Low pH < 4 (history of acid)
  - Near neutral pH > 6 (no acid history)
- **Acidic Soils**
  - Shallow acidic layer (above drain invert and MSL)
  - Deeper acid layer (below drain invert and low tide elevation)
Prioritising Tuckean Swamp – Acidic Soils

- Highly acidic soils mostly found in lowest lying areas.
- Acidic soils are generally close to the surface.
- Acid groundwater flows into drains
Prioritising Tuckean Swamp – Water Quality

• Highly acidic water all through Hendersons Drain, lower Slatteries Drain and Jumbo Drain

• More neutral pH from Marom Drain, Tucki Canal and Stibbards Creek
Prioritising Tuckean Swamp – Topography

- Significant area below mean sea level (0 m AHD)
- Lowest areas around the Nature Reserve and Slatteries/Meerschaumvale/Jumbo drains
- North west corner is typically higher elevation
Prioritising Tuckean Swamp

• Highest priority areas:
  – Upper Slatteries
  – Meerschaumvale/Jumbo
  – Hendersons Drain around the Nature Reserve
Options to remediate ASS area – Groundwater Manipulation

- Using weirs or bunds to raise the water level in the drain above the ASS layer
- Reduces the hydraulic gradient between the groundwater and surface water
- Results in reduced acid export
Options to remediate ASS area – Tidal flushing

- Marine water naturally contain bi-carbonates which can neutralise acid
- Saltwater assists in-drain vegetation management
- Better flushing capacity due to daily tides
- Increased fish passage
Options to remediate ASS area – Wet Pasture

Re-flooding (freshwater) the land to keep the groundwater table above the ASS layer

Changing land practices can allow the land to be continue to be productive

Particularly useful in areas with extreme hydraulic conductivity (slow groundwater movement)
Options to remediate ASS area – Drain Reshaping

- Shallow and widen drains, so the bottom of the drain is above the ASS layer
- Changing the drain shape allows the total capacity to remain similar, but can reduce acid export
Assessing Tuckean Swamp Drainage Options

- Establish a “base case”
  - The floodplain as it functions today
  - Understanding the way water flows, how often the floodplain is wet etc.
  - Verify against data collected in the field over the last 12 months

- Scenarios → “what if” cases
  - Understand the consequence if any changes to the drainage systems occur
  - NOT a commitment to on-ground works, but will support better and more informed management of the area
  - in some cases the model is used to test extreme scenarios to understand the “worst case” impacts
  - May inform further investigations
Cross-sections

Ground level checks
What impacts do we need to understand?

- Does the drainage of the floodplain change? By how much?
- How do water levels in the drains change, and what impact does this have on groundwater levels?
- Are there any changes to drainage times during nuisance catchment scale floods?
- What are the changes to long-term hydrology?
- Where do tidal waters go? At what concentration?
- On-ground mitigation measures
Option 1: Optimise Current Management of Sluice Gates

Aim:
Optimise how to manage the existing sluice gates without impacting upstream landholders.

- Neutralisation capacity available from the salinity in the tidal flows
- Improve flushing
- Unwanted tidal inundation
- Altered drain water levels
Option 2: Existing Floodgates, 0.2 m increase in Richmond water levels

Aim:
Test the sensitivity of the current managed to changing water levels downstream (i.e. sea level rise)

- Increasing drain water levels would decrease acid drainage
- Altered tidal flushing
- Altered in-drain storage
- Reduced drainage gradient
Option 3: Installation of weir structures at the end of Slatteries or Meerschaumvale Drain

Aim:
Target high priority areas.
Weirs hold groundwater table up → reduce acid drainage

- Elevated groundwater table
- Improved downstream water quality
- Elevated surface water levels upstream of the structures
- Altered drainage
- Increase residence time
Option 4: Reshaping Major Drains

Aim:
Make drains shallower and wider. This maintains flood mitigation capacity, but increases the bottom of the drain above the acid layer.

• Hold groundwater table higher
• Less diffusive acid generation into the drains
• Any impacts to flood conveyance needs to be assessed
• Altered groundwater table Increases the foot print of the drains
Option 5: Diversion of Catchment Inflows – Slatteries Drain

Aim:
Flows from the upstream catchment into Slatteries Drain are conveyed relatively quickly from the floodplain through the drain. Using a bund or weir, flows could be actively redirected to allow more floodplain inundation in this area

- Increase groundwater table, reduces acid generation
- Increase inundation time for highly acidic areas
- Increased retention times
- Altered nuisance flood capacity
- Altered nuisance flood storage
Option 6: Hinge open Bagotville Barrage floodgates

Aim:
Install a system that allows the gates on the barrage to be open during targeted (non-flood) periods. This would allow controlled tidal inflows, but allow the gates to be shut when Richmond River levels are expected to increase.

- Acid buffering capacity from tidal flows
- Better flushing
- Saltwater infiltration assess in management of in-drain vegetation
- Increase average water level in the Nature Reserve+

- Unwanted tidal inundation
- Altered flood storage
- Altered flow conveyance
Option 7: Hinge gates, introduce new structures to minimise upstream impacts

Aim:
Using the results of option 6, assess what structures (new floodgate, levies, etc) would be required to mitigate any impacts

- Acid buffering capacity from tidal flows
- Better flushing
- Saltwater infiltration assess in management of in drain vegetation in Hendersons Drain
- Increase average water level in the Nature Reserve
- Altered flood storage
- Altered flow conveyance