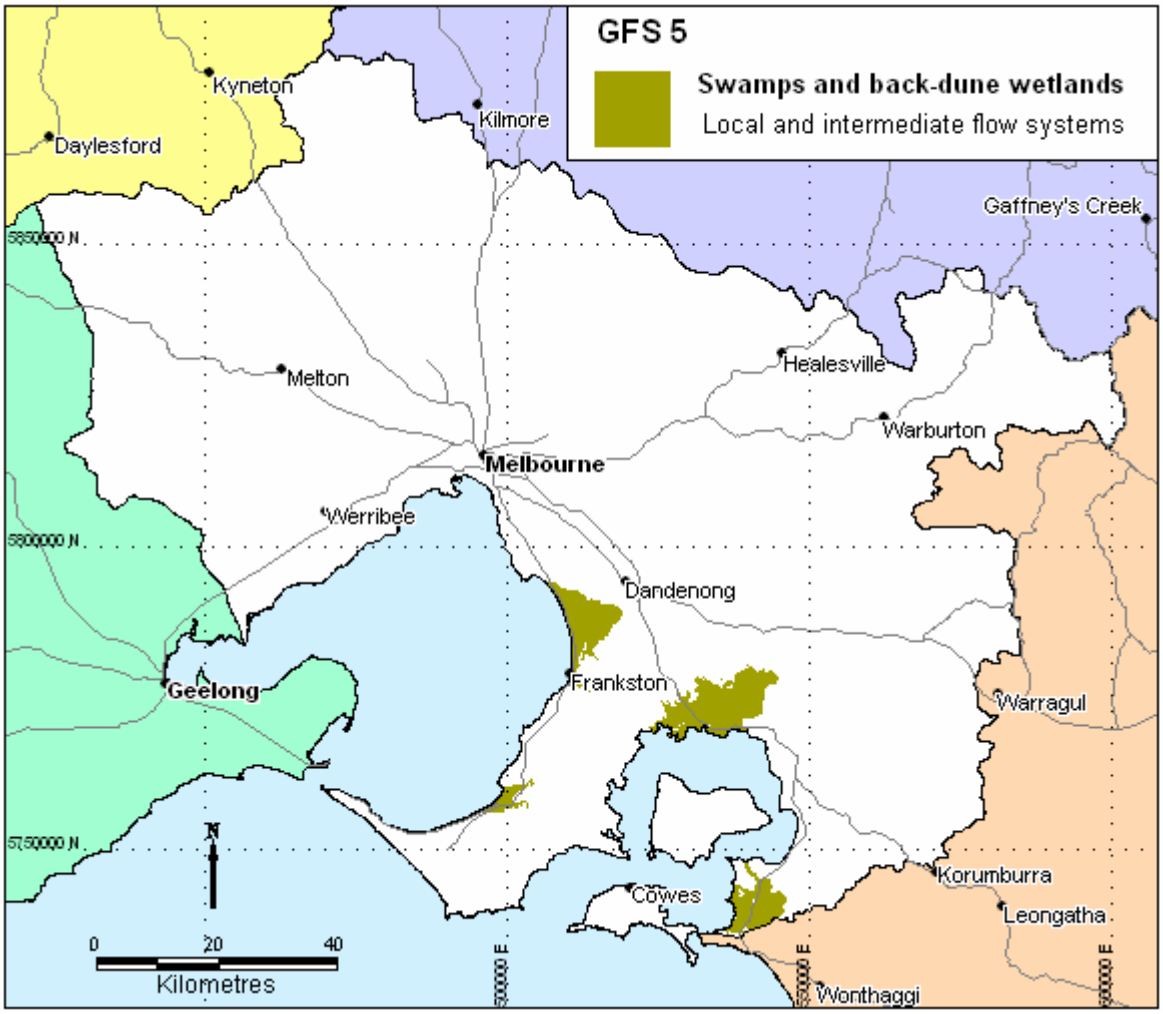
Local and intermediate flow systems in swamps and back-dune wetlands

Region: South eastern PPWP CMA region

Type areas: Carrum, Tooradin, Dromana

Brief description: Calcareous and siliceous coastal dunes along the eastern shore of Port Phillip Bay from Mordialloc to Frankston impound the clay, silt, sand and shell deposits of the Carrum Swamp. Estuarine and swampy deposits occur on the eastern shore of Dromana Bay and along the northern shore of Westernport Bay, where they form the Koo-wee-rup Swamp. The lower Bass River forms a small coastal plain on a lowland bounded by the Corinella Fault to the north and the Bass Fault to the south. These alluvial, paludal, littoral and estuarine deposits comprising aeolian sand dunes, beach barriers, raised beaches, estuarine sands, muds, and shell beds are grouped together as one local groundwater flow system. The Carrum and Koo-wee-rup swamps are located at the down-basin ends of underlying intermediate to regional flow systems and probably receive significant input via vertically upward flow from the underlying more productive aquifers.



Problem statement: Permanent and ephemeral groundwater occurs in shallow local flow systems. The salinity is probably derived from evaporation of shallow saline groundwater, exacerbated by the clearing of coastal vegetation such as the removal of Mangroves and Melaleuca swamps. Tidal influences, the movement of the seawater / freshwater boundary and groundwater pumping for irrigation complicates the dynamics of these systems. On the Bass plain, over 400 hectares of secondary salinity have been mapped generally associated with small, shallow depressions in topography.

Salinity associated with this GFS is probably underestimated, especially in the estuarine areas close to the shore. Primary saline areas such as Rutherford Inlet and Quail Island are environmental assets. Seawater intrusion resulting from groundwater pumping is also a potential salinity management issue.

Landscape attributes

Geology: Quaternary calcareous aeolian deposits (Qpd), aeolian coastal dunes, dune sand and minor swamp deposits (Qrd), colluvium and gully alluvium (Qrc), lagoon and swamp deposits (Qrm), Quaternary alluvium (Qra).

Topography: Coastal dunes and barrier dunes, backdune marshland and estuarine flats. Riverine plain of the lower Bass River, merging to a coastal plain, with minor undulations.

Land Systems:

South Victorian Uplands

3.3 Moderate Ridge – Mornington Peninsula

South Victorian Coastal Plains

8.4 Fans and Terraces – Western Port

8.5 Barrier Complexes – Discovery Bay, Gippsland Lakes

South Victorian Riverine Plains

9.1 Present Flood Plain – Gippsland

With some:

Central Victorian Uplands

1.1 East Victorian Dissected Uplands

South Victorian Uplands

3.3 Dissected Fault Block – South Gippsland Ranges

Regolith: Generally thin, discrete spatial deposits of unconsolidated shell beds, sand, silt, and clay forming a complex three-dimensional regolith.

Annual rainfall: 650 mm to 1000 mm

Dominant mid-1800s vegetation type: Predominantly Sedgeland, Shrub, Woodland, Hedgeland, Rushland and Scrub with outskirts of Grassland, Woodland and Forest. Mangrove forests along the coastal shores.

Current dominant land uses: Urban and industrial development, rural residential development, coastal development, natural and man-made coastal waterways, conservation reserves, parkland, grazing, cropping, horticulture.

Mapping method: Outcrop geology and landform.

Right:

Mangrove environment on the saline (estuarine) mudflats at Cannons Creek.

Hydrogeology

Aquifer type (porosity): Unconsolidated sand, silt and clay with minor shell beds and gravels (primary porosity).

Aquifer type (conditions): Unconfined.

Hydraulic Conductivity (lateral permeability): Extremely variable. Probable range from 10^{-5} m/d to 10^{2} m/d, with clayey facies < 1 m/d; sandy facies up to 100 m/d.

Aquifer Transmissivity: Variable, in the moderate range. Estimated to be generally less than 20 m^2/d.

Aquifer Storativity: Extremely variable. Estimated to be from 0.05 to 0.2.

Hydraulic gradient: Varies with landscape. Very low to low in swamps and backdune wetlands, and moderate in dunes.

Flow length: Generally short, but highly variable depending on local conditions. Ranges from a few metres up to a kilometre.

Catchment size: Generally small (<1 Ha to 100 Ha).

Recharge estimate: Unknown, but would vary with the rainfall, landscape (soil-landform) and land-use at any location.

Temporal distribution of recharge: Seasonal (winter and spring), with more recharge in wetter years. Extensive periods of soil waterlogging may add to local recharge.

Spatial distribution of recharge: Catchment wide with probable contributions from upward leakage from lower aquifers in places.

Aquifer uses: Limited, if any use. Most groundwater is extracted from the more productive aquifers at depth.

Salinity

Groundwater salinity (TDS): Generally in the range of 3,000 mg/L to 10,000 mg/L, but variable from fresh (<1,000 mg/L) to seawater (>30,000 mg/L).

Salt store: Moderate or high in swampy conditions.

Salinity occurrence: Significant areas of primary salinity. Secondary salinity occurs as considerable expansion of primary salinity, and in low lying and flat areas, drainage lines, swampy wetlands, base of dunes and areas of seawater intrusion.

Soil Salinity Rating: S1 to S3

Salt export: Wash off from surface.

Salt impacts: Mostly on-site. Some impacts off-site (eg. Bass River).

Risk

Soil salinity hazard: Moderate to high.

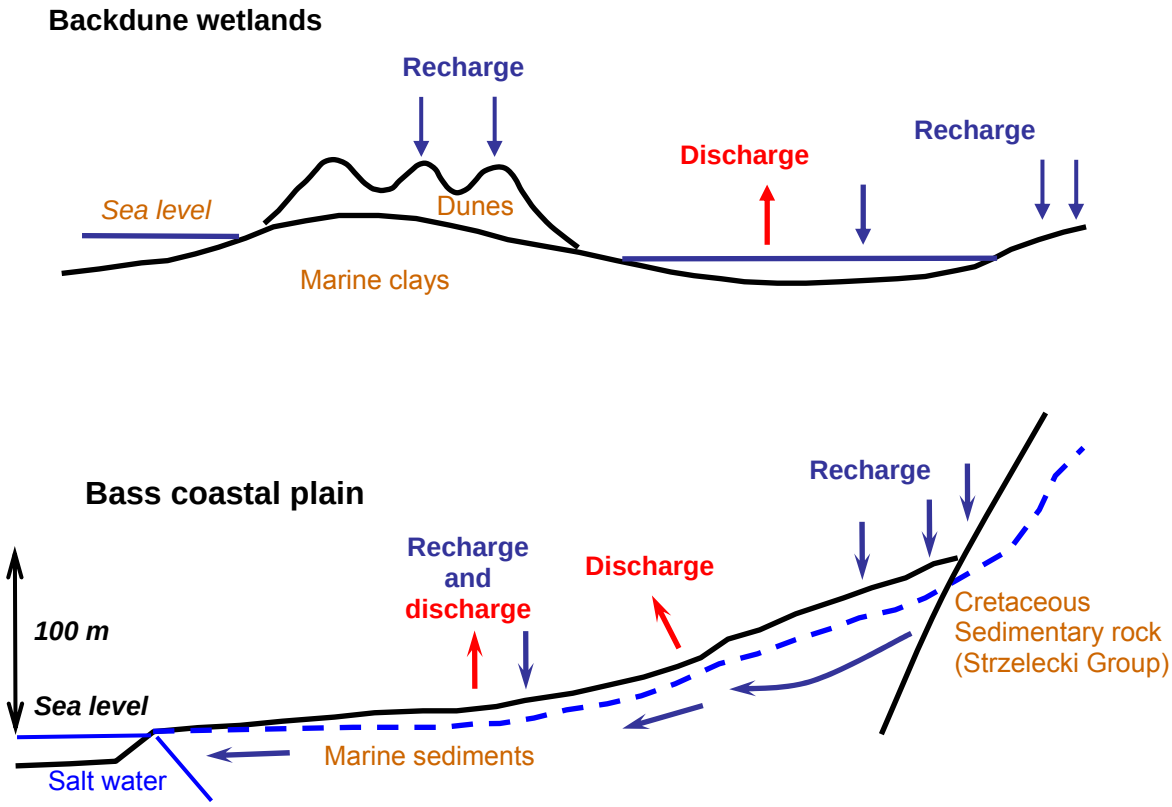
Water salinity hazard: Moderate to high.

Assets at risk: Urban and engineering infrastructure (Dromana), conservation wetlands and reserves (Warneet, Quail Island), water quality and aquatic biodiversity, agricultural land (Koo-wee-rup, Carrum Downs-Lyndhurst, Bass plain).

Responsiveness to land management: Varied, but generally should be very responsive. In both Koo-wee-rup and Carrum swamps the influence of deeper systems (vertical upward leakage) and the management of irrigation and groundwater resources (overpumping deeper aquifers) is more significant than

land management on a seasonal or annual basis, so the response of the system to land management is low to moderate.

Conceptual models



Salinity (S1) on the Bass coastal plain

Management Options

Swamps impounded by dune sediments and estuarine plains are naturally waterlogged and primary saline (brackish) environments, formally dominated by Melaleuca and Mangrove vegetation. On the basis of their natural condition, it is unrealistic for waterlogging and salinity to be eliminated from these landscapes. Reintroduction of the salt tolerant indigenous vegetation may reduce secondary expansion of waterlogging and salinity. Unless properly managed, the regional influence of groundwater pumping from underlying aquifers may create problems in both the health of primary sites (drying of swamps) and secondary expansion of salinity (seawater intrusion contaminating aquifers).

A significant focus on land management in this GFS will be to maintain biodiversity values in the dune confined swamplands and coastal estuarine areas. Indigenous halophytic ecologies generally have a high conservation value, and are especially important in the larger estuarine wetlands of Port Phillip Bay and Western Port Bay.

Secondary salinisation tends to be low grade (e.g. S1 across the Bass Plains), so maintenance of healthy pastures (preferably with perennial habit) may somewhat limit seasonal waterlogging that exacerbates the development of soil salinity in these areas.

Dryland agriculture options for managing salinity in local flow in the **swamps and back-dune wetlands**

Salinity focus: Bass Plain, Tyabb East, Mt. Martha

Options	Treatments	Comments
Biological Management of recharge	Perennial pastures	Low impact– rainfall above 700 mm, some uncertainty in responsiveness
	Crop management	Low impact– generally not significant land use in these landscapes, and rainfall above 700 mm
	Trees/woody vegetation	Low to moderate impact– some potential for recharge and waterlogging control on plains/swamps, but requiring high density revegetation (unlikely)
Engineering intervention	Surface drainage	Low to moderate impact– Need to be sensitive to natural swampland health. Low topographic gradients for drainage. Disposal issues, though some areas could conceivably outfall to coast
	Groundwater pumping	Low impact– Need to be sensitive to natural swampland health, as well as impacts associated with possible incursion of seawater interface
Productive uses of saline land and water	Salt tolerant pastures	Low to moderate impact– Could be useful to stabilise secondary expansion, but care required so as not to introduce invasive species in sensitive areas
	Halophytic vegetation	Low to moderate impact– naturally adapted to swamps, estuarine plains
	Saline aquaculture	Low impact– not suited to local environs. Often low grade severity and relatively limited in extent
	Salt harvesting	Low impact– groundwater is not sufficiently saline
	Others	Consider revegetating low lying areas with indigenous waterlogging and salt tolerant trees (e.g. Melaleuca). See OPUS database (NDSP)

Management implications given projected land use

Urban development pressures are significant along the Frankston – Mordialloc coast, including the salinity affected areas represented in this GFS (e.g. Mordialloc Creek). Where urban development does extend it may need to be engineered to withstand local conditions, and may need to be managed in a way to avoid applying additional hydrological loadings across the landscape. Depending upon the current and predicted future extent of the salinity hazard it may be preferable to limit infrastructure development in some areas.

In the Cannons Creek – Tooradin area the expansion of coastal and rural residential development ("lifestyle properties") needs to be carefully planned to avoid freshwater (stormwater and nutrient) loading on the primary saline mudflats which are a significant environmental asset.

Salinity (primary) along the Mordialloc Creek (Wells Road Aspendale)