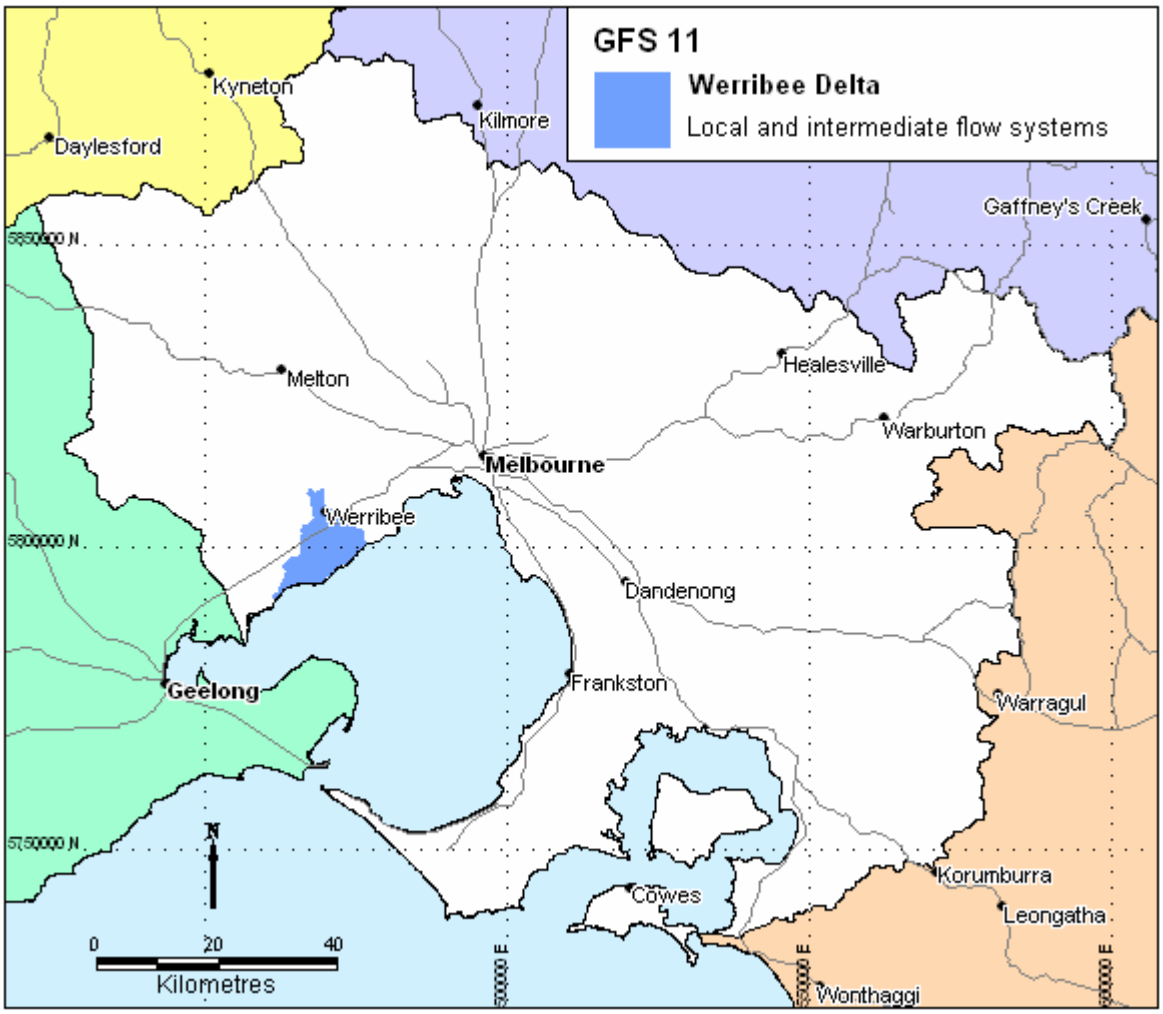
Local and intermediate flow systems in the Werribee Delta

Region: South western PPWP CMA region

Type areas: Werribee, Werribee South

Brief description: The Werribee Delta has formed since the Pliocene by the accumulation of sediment carried by the Werribee River. Although of mixed provenance, the majority of sediments have been derived from the erosion of the Rowsley (Parwan) Valley (refer to GFS 12) over the past 4 million years. The sediments form a discrete GFS hydraulically connected to the underlying basalts (GFS 18) and Brighton Group (GFS 10).



Problem statement: The Werribee Delta GFS is one of the most challenging groundwater management areas of Australia. Groundwater is used for irrigation supporting a major horticultural industry on the eastern portion of the delta (east of the Werribee River). The delta to the west of the Werribee River used for land treatment of sewage and has extensive sewage treatment lagoons. Connections to deeper aquifers, along with tidal and river influences complicate the hydraulics of the system. Salinity has been mapped adjacent to the lower Werribee River and on the western edge of the GFS. A proposed water re-use project has the potential to significantly impact on this GFS.

Landscape attributes

Geology: Quaternary flood plain deposits (Qpw), alluvium (Qra), colluvium and gully alluvium (Qrc) and lagoon and swamp deposits (Qrm).

Topography: Plain with minor undulations, river channel and estuary.

Land Systems:

South Victorian Coastal Plains	Western Victorian Volcanic Plains
8.5 Barrier Complexes – Discovery Bay, Gippsland Lakes	*7.1 Undulating Plains – Western District*

Regolith: Unconsolidated to weakly consolidated silt, sand and minor gravels. Large areas of disturbed ground and fill in the near-surface.

Annual rainfall: 500 mm

Dominant mid-1800s vegetation type: Predominantly Grassland with some Heathland and Woodland

Current dominant land uses: Urban and industrial development, sewage treatment lagoons, horticulture, government research station, conservation areas, recreational developments, part of government aviation base.

Mapping method: Outcrop geology

Irrigated horticulture, Diggers Road, Werribee South

Hydrogeology

Aquifer type (porosity): Unconsolidated sand, silt and clay (primary porosity).

Aquifer type (conditions): Unconfined to semi-unconfined.

Hydraulic Conductivity (lateral permeability): Extremely variable. Probable range from 10^{-6} m/d to 10^{2} m/d, with clayey facies less than 1 m/d and sandy facies 10 m/d to 15 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 0.01 to 0.1.

Hydraulic gradient: Very low to low (0.002), except around pumped wells.

Flow length: Generally short, but highly variable depending on local conditions and influences of groundwater extraction. Ranges from a few metres up to one or two kilometres.

Catchment size: Delta covers about 50 km^2. Groundwater catchments are smaller.

Recharge estimate: Estimated to be 5% to 10% of rainfall, with additional increments from irrigation.

Temporal distribution of recharge: Seasonal (winter and spring), with more recharge in wetter years. Evidence of higher recharge during irrigation season.

Spatial distribution of recharge: Aerially distributed catchment wide direct rainfall infiltration recharge; enhanced local recharge under treatment lagoons; irrigation return and probable upward leakage from underlying aquifer.

Aquifer uses: Irrigation, predominately for market gardens, stock and domestic use from shallow bores.

Salinity

Groundwater salinity (TDS): Low. Generally in the range of 500 mg/L to 3000 mg/L

Salt store: Low.

Salinity occurrence: Low-lying area (river channel) adjacent to the lower Werribee River estuary at Werribee South (mostly primary), and a small area east of Little River.

Soil Salinity Rating: Moderate. S1, S2; some minor S3.

Salt export: Wash off from surface.

Salt impacts: Mostly on site, with some off-site impact on the lower Werribee River.

Risk

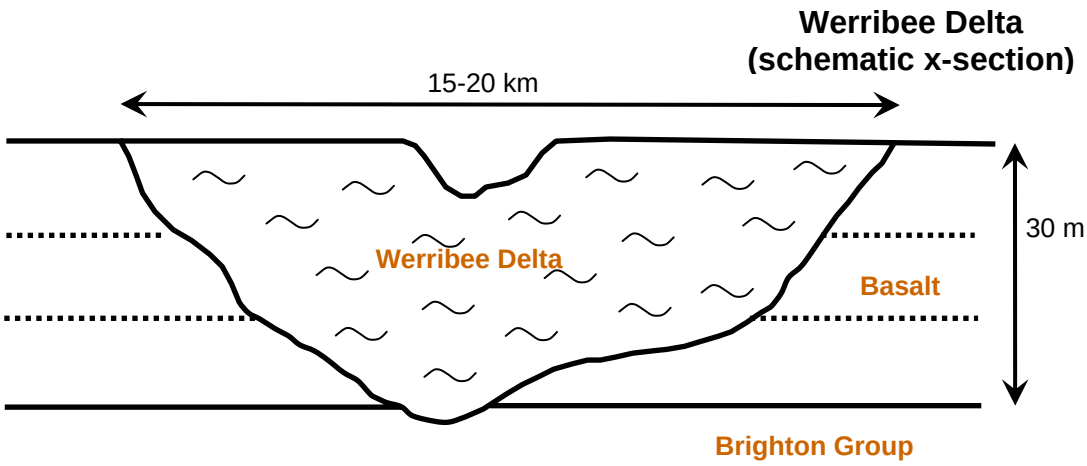
Soil salinity hazard: Low

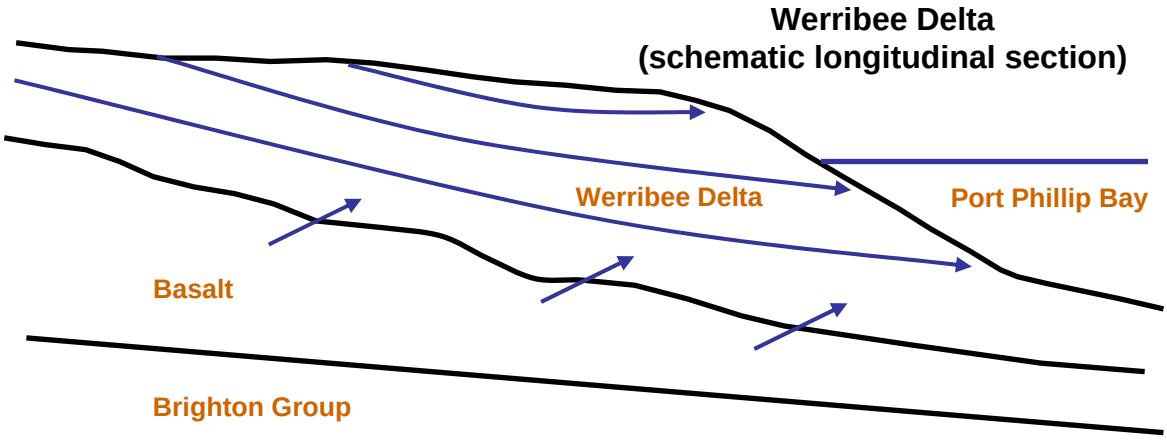
Water salinity hazard: Low

Assets at risk: Horticultural industry, urban and engineering infrastructure, water quality of the groundwater resource

Responsiveness to land management: Complex, since the influences of groundwater irrigation, sewage lagoons, tidal influences of Port Phillip Bay, groundwater-surface water interactions (eg. Werribee River), hydraulic connection to aquifers at depth and the impact of growing urban development are greater influences than traditional land management salinity solutions.

Conceptual model





Salinity along the alluvial flats adjacent to the Werribee River at South Werribee.

Management Options

At present, salinity is limited to the area adjacent to the river channel and is probably mostly primary salinity associated with the tidal influences in the estuary. Apart from stabilising these isolated salt affected areas, the significance and threat of salinisation is probably limited, given the intensive development of the delta. However, the irrigation, the sewage lagoons, the adjacent fixed seawater (and hence groundwater) head, and the convergence of groundwater flow from multiple aquifers, combine to create the potential for the development of salinity in the long term. In the shorter term, a significant management issue relates to protection of the beneficial groundwater resource residing in the delta sediments. In the longer term the continued application of irrigation water, both groundwater and recycled water, may accumulate salts in the soil through evapotranspiration.

Dryland agriculture options for managing salinity in local and intermediate flows in the **Werribee Delta**.

Salinity focus: lower Werribee River, western edge of GFS

Options	Treatments	Comments
Biological Management of recharge	Perennial pastures	Low impact– not likely to be applicable given current intensive land use regime
	Crop management	Low impact– not likely to be applicable given current intensive land use regimes
	Trees/woody vegetation	Low impact– not likely to be significant option given current intensive land use regimes
Engineering intervention	Surface drainage	Moderate impact– where surface waterlogging is as issue could outfall directly into Port Phillip Bay
	Groundwater pumping	Low impact– complex issue given current groundwater extraction and potential for seawater intrusion
Productive uses of saline land and water	Salt tolerant pastures	Moderate to high impact– to stabilise and aesthetically improve salt affected areas
	Halophytic vegetation	Low impact– climate and environs not likely to be conducive
	Saline aquaculture	Low impact– discharge sites only minor in extent
	Salt harvesting	Low impact– groundwater is not sufficiently saline
	Others	See OPUS database (NDSP)

Management implications given projected land use

The current intensive land use regimes on the delta are likely to continue. Planning on the basis of land suitability should occur to optimise the placement of such developments in order for their own protection, and to limit potential salinity impacts on neighbouring developments.