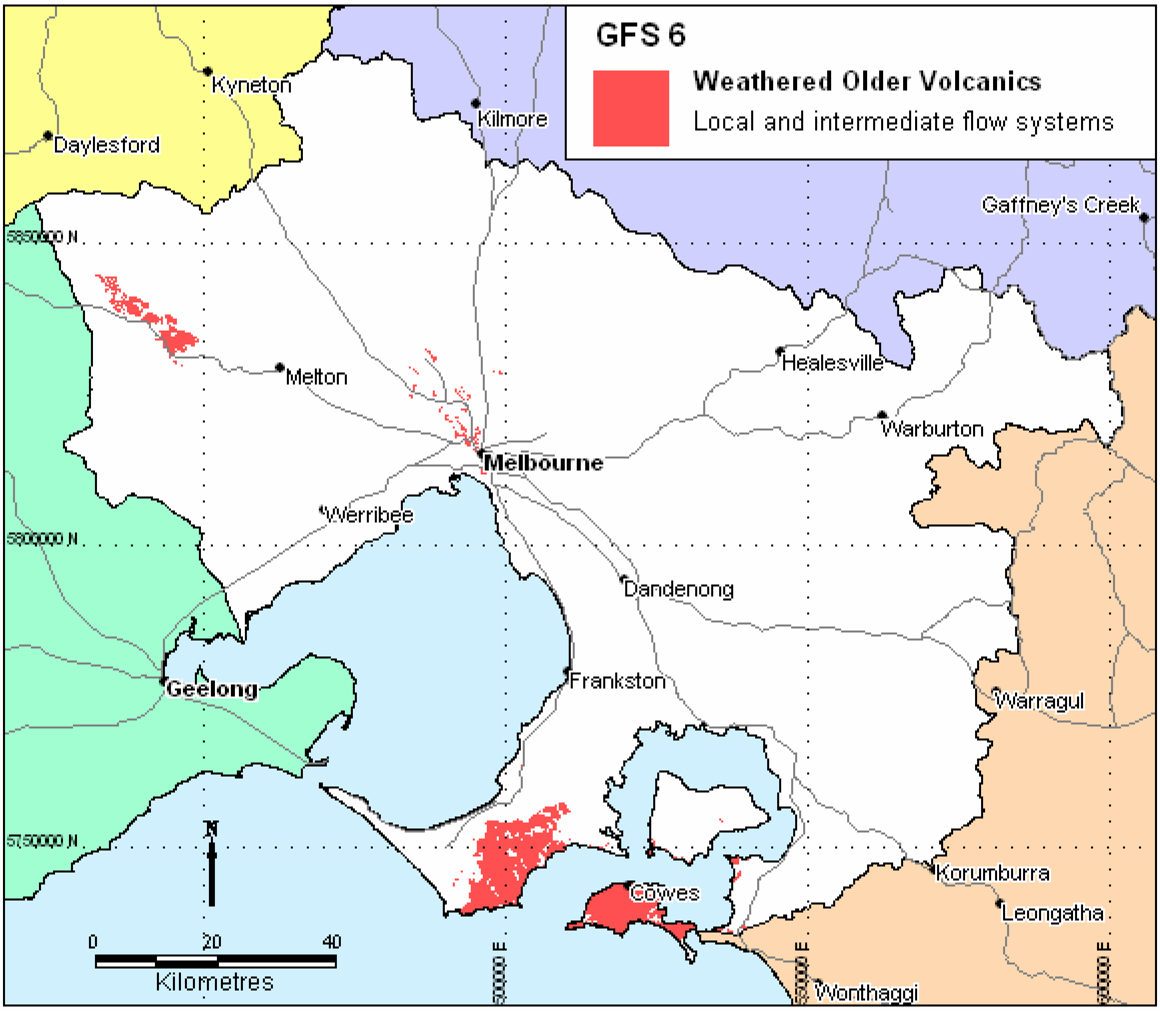
Local and intermediate flow systems in weathered Older Volcanics

Region: South eastern, central and western PPWP CMA region

Type areas: South east Mornington Peninsula, Phillip Island, Pentland Hills

Brief description: Sporadic volcanic eruptions commenced with the break-up of Australia and Antarctica during the Cretaceous and continued to almost the present day. The oldest of these eruptions (~ 60 Ma) formed basalts which were subsequently covered by Cainozoic sediments and later exposed by erosion in the Pentland Hills region. About 20 million years later voluminous eruptions during the Palaeogene formed extensive basalt deposits now exposed at Phillip Island and the south eastern region of the Mornington Peninsula. These have been grouped into one GFS on the basis of their similarity, being aquifers in which saline water is transmitted through the fractures of the weathered basalts in local flow and intermediate systems.



Problem statement: Over 1300 hectares of salinity associated with this GFS has been mapped on Phillip Island, and a small patch (~ 2Ha) at Flinders. The salinity has been associated with clearing of the native vegetation, although anecdotal accounts suggest that many of the saline areas were waterlogged (and may have been saline groundwater discharge areas) before widespread land-use change (Thomas & Bluml, 1992). Salts accumulate by evaporation of groundwater discharge into valley-floor alluvium. This process has probably accelerated since the disturbance of the natural ecology of the discharge zones.

Landscape attributes

Geology: Older Volcanic basalts (Tvo) and Quaternary alluvium (Qra)

Topography: Moderately dissected landscape with deep valleys (Pentland Hills), and rolling hills to undulating plains, with shallow valleys (Phillip Island).

Land Systems:

Central Victorian Uplands

1.1 East Victorian Dissected Uplands

2.1 West Victorian Dissected Uplands – Midlands

Western Victorian Volcanic Plains

7.1 Undulating Plains – Western District

South Victorian Uplands

3.3 Moderate Ridge – Mornington Peninsula

Regolith: Moderately weathered to completely weathered basalts, minor tuff and agglomerate. Slightly weathered to fresh, fractured basalt, at depth.

Annual rainfall: 550 mm to 1000 mm

Dominant mid-1800s vegetation type: Forest, Woodland and Scrub (minor Rushland)

Current dominant land uses: Predominately grazing, with expanding urban and rural residential development. Minor areas of waterways, parklands, urban and industrial development (Melbourne suburbs), with some horticulture and conservation areas.

Mapping method: Outcrop geology

Hydrogeology

Aquifer type (porosity): Fractured rock and saprock (secondary porosity); Volcaniclastic sediments, saprolite and clay soil (primary porosity).

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

Hydraulic Conductivity (lateral permeability): Probably less than 1 m/d.

Aquifer Transmissivity: Probably less than 20 m^2/d. A value of 1 m^2/d has been published from a test at Tullamarine (Shugg, 1975)

Aquifer Storativity: Less than 0.05.

Hydraulic gradient: Probably moderate to locally steep in valleys.

Flow length: Probably ranges from less than one kilometre to a maximum of ten kilometres.

Catchment size: Small for local systems (<10 Ha); intermediate systems probably depend on cross-formational flow.

Recharge estimate: Unknown. At Phillip Island, infiltration varies from >750mm/day to <7mm/day (Thomas & Bluml, 1992).

Temporal distribution of recharge: Seasonal (winter and spring), with more recharge in wetter years.

Spatial distribution of recharge: A map of "recharge" areas based on soil infiltration rates has been published (Thomas & Bluml, 1992). Higher infiltration rates were recorded on the cleared hills with loam soils. The relationship between infiltration and recharge has not been established. It is probable that recharge would be catchment wide in outcrop, with contributions from cross-formation flow at depth.

Aquifer uses: Minor. Mostly stock water.

Salinity

Groundwater salinity (TDS): Melbourne area 4,000 to 19,000 mg/L TDS. On Phillip Island salinity measured as EC indicates a range from < 500mg/L to 12,000 mg/L (600 µS/cm – 20,000 µS/cm).

Salt store: Low to moderate. A few local areas of high level salting recorded on Phillip Island.

Salinity occurrence: Valley floor, usually associated with the alluvium in waterlogged and poorly drained areas.

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

Salt export: Both baseflow to streams and wash-off from surface.

Salt impacts: Both on-site and off-site.

Risk

Soil salinity hazard: High.

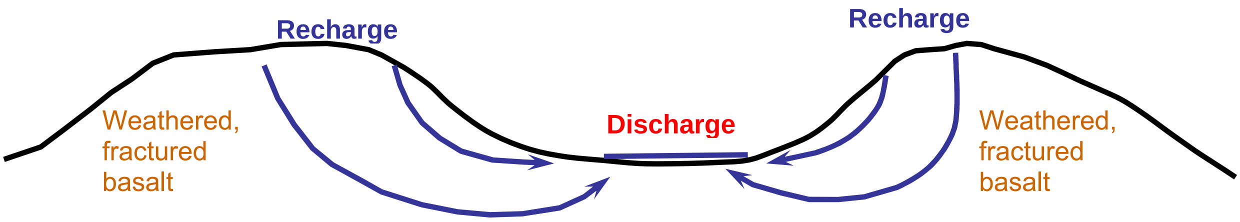
Water salinity hazard: High.

Assets at risk: Agricultural land (estimated increase of 20Ha/yr on Phillip Island), conservation areas and urban and road infrastructure.

Responsiveness to land management: Largely unknown, but thought to be moderate to high.

Conceptual model

Weathered Older Volcanics (Phillip Island)



Salinity (S1) at Phillip Island

Management Options

Widespread salinity on Phillip Island is well documented and generally related to the natural waterlogging of the poorly-drained low-lying areas of the landscape. The salinity may be primary in part, since Melaleuca stands once dominated in these low lying areas, often characterised by waterlogged alluvial clays.

The replanting of the salt-tolerant, woody vegetation suited to the swampy conditions would likely control (but not remove) the expansion of salinity in the low lying salt prone areas. Effective management of salinity through recharge control is unlikely to be achieved given the natural landscape hydrology, and it would effectively require the re-establishment of broadscale wooded vegetation. Stabilisation of discharge sites and limiting run-on to these areas are considered more suitable treatment options.

Dryland agriculture options for managing salinity in local flow in the **weathered Older Volcanics**

Salinity focus: Phillip Island

Options	Treatments	Comments
Biological Management of recharge	Perennial pastures	Low to moderate impact– rainfall too high for significant impact from pastures alone. Perennial pastures offer a level of run-off and waterlogging and control
	Crop management	Low impact– generally not significant land use in these landscapes, and rainfall above 700 mm
	Trees/woody vegetation	Low to moderate impact– plantings where possible will assist in reducing run-off into waterlogged depressions, but effective recharge control would require mass planting (unlikely)
Engineering intervention	Surface drainage	Low impact– cost and disposal issues (waterway health) need to be considered.
	Groundwater pumping	Low impact– cost and disposal issues (waterway health). Low permeability alluvials and weathered basalt not conducive to high yield pumping.
Productive uses of saline land and water	Salt tolerant pastures	Moderate to high impact– waterlogging tolerance required on alluvial flats.
	Halophytic vegetation	Low impact– climate not likely to be conducive
	Saline aquaculture	Low to moderate impact– there may be limited opportunities where there is sufficient groundwater, and where offsite salinity and nutrient issues can be managed
	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

Planning for the expansion of urban development on Phillip Island needs to consider the significant areas of salinisation across the island. Where urban development occurs, or is planned, it may need to be engineered to withstand local saline conditions, and may need to be designed to avoid applying additional hydrological loadings across the landscape. Infrastructure development on the waterlogged alluvials needs to be minimised and designed to withstand the saline environment.