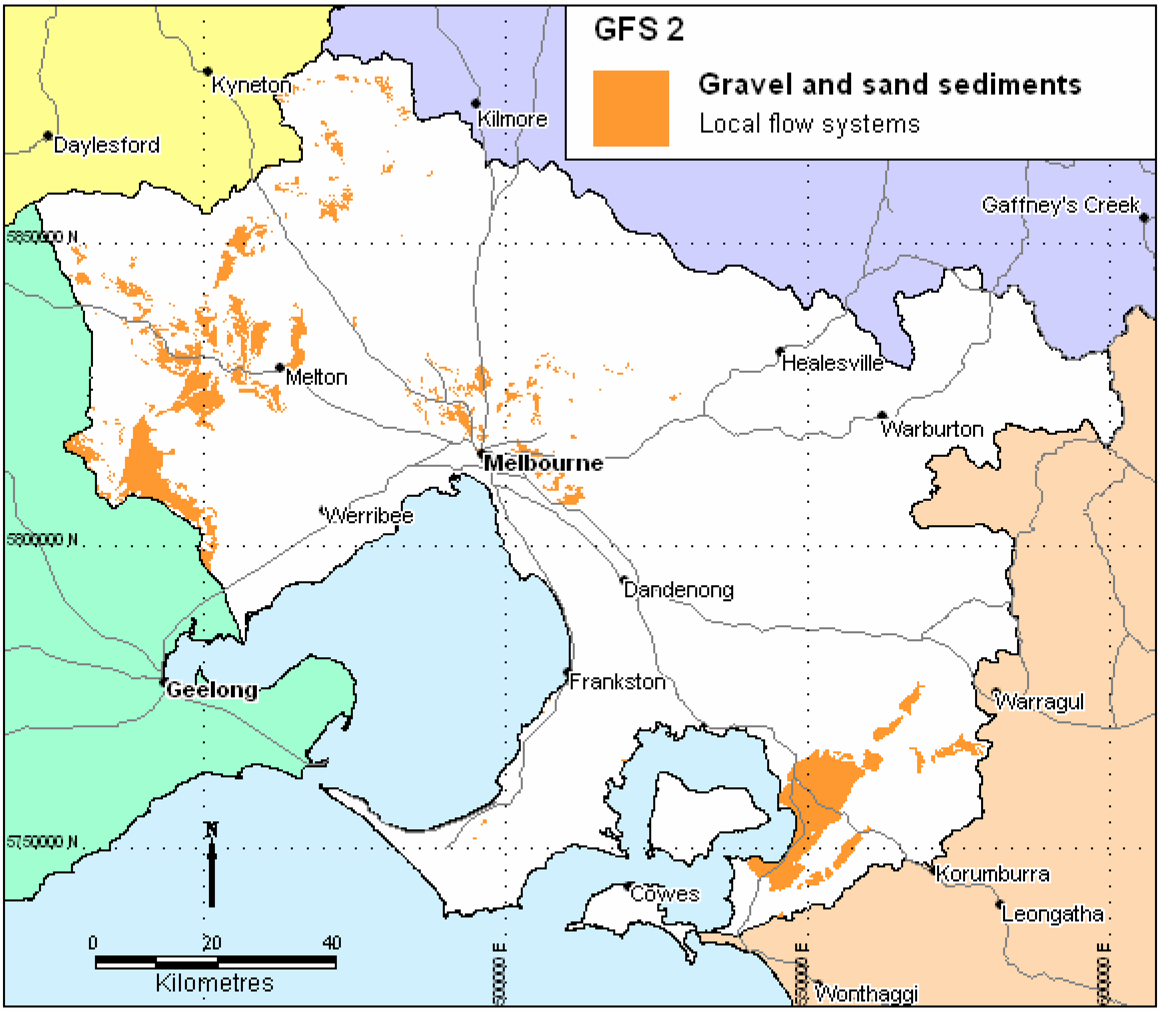
Local flow systems in gravel and sand sediments

Region: Mainly western and south eastern parts of PPWP CMA

Type areas: Lang Lang, Balliang, Melton

Brief description: A variety of relatively discrete sand and gravel deposits of varying geological ages have been grouped together on the basis of their similar hydrogeological character. These include Permian age glacial deposits; remnants of Neogene age gravel deposits which cap the older rocks; sands and gravels which occur as both outwash deposits and sediments interbedded with the volcanics; and Quaternary age outwash deposits from fault scarps.

Groundwater generally moves slowly through the deposits in local flow systems. In the some of the older gravels, the precipitation of iron has cemented the otherwise unconsolidated deposits. The cementation could at least locally, significantly modify flow paths so that groundwater emerges at or near the base of the gravel exposures. These groundwater flow paths may vary from a few metres to hundreds of metres in length. Where the gravels extend under the volcanic flows, some vertical recharge occurs as leakage through the overlying fractured basalt.



Problem statement: Secondary dryland salinity is associated with this GFS at Riddell and near Balliang. The Balliang site is probably the most severe in the PPWP CMA region. The salinity probably results from hydrologic imbalance associated with past landscape change and present land use.

Landscape attributes

Geology: Permian fluvioglacial deposits of the Bacchus Marsh Formation (tillites, diamictites, sandstones, mudstones, conglomerates). Neogene fluvial gravels, sands and silts (Tpb, Tpe, Tph, Tpo) including the Haunted Hill Formation, Moorabool Viaduct Formation equivalents and Brighton Group equivalents. Quaternary alluvium (Qra, Qpa), collvium and gully alluvium (Qrc), lagoon and swamp deposits (Qrm).Quaternary colluvium and gully alluvium (Qrc, Qpc)

Topography: Gently sloping piedmont plains, colluvium and scree slopes, river terraces, ridge caps and undulating low hills.

Land Systems:

Central Victorian Uplands

1.1 East Victorian Dissected Uplands

2.1 West Victorian Dissected Uplands – Midlands

South Victorian Uplands

3.3 Moderate Ridge – Mornington Peninsula

3.4 Dissected Fault Block – South Gippsland Ranges

Western Victorian Volcanic Plains

7.1 Undulating Plains – Western District

South Victorian Coastal Plains

8.4 Fans and Terraces – Westernport

South Victorian Riverine Plains

9.1 Present Flood Plain - Gippsland

Regolith: Unconsolidated gravel, sand, silt and clay; ferruginised and silicified gravels and sands; tillite and diamictite.

Annual rainfall: 500 mm to 1650 mm

Dominant mid-1800s vegetation type: Woodland, Forest, Grassland, Rushland, (dependent on location).

Current dominant land uses: Urban and industrial development, waterways, parkland, grazing, cropping, horticulture, conservation.

Mapping method: Outcrop geology, landform, local knowledge

Right:

Salinity at Balliang

Hydrogeology

Aquifer type (porosity): Gravels to fine sands, silts and clays (primary porosity), Ferruginised or silicified rock (secondary porosity).

Aquifer type (conditions): Unconfined, semi-confined to confined.

Hydraulic Conductivity (lateral permeability): Highly variable and largely unknown. Probably ranges from 10^{-4} m/d to 10^{2} m/d, with clayey facies < 1 m/d; sandy facies up to 100 m/d.

Aquifer Transmissivity: Variable, but generally in the moderate range. Estimated to be generally less than 50 m^2/d.

Aquifer Storativity: Variable. Estimated to be from 0.05 to 0.20.

Hydraulic gradient: Estimated to be low (0.001). Could be locally steep at the edges of the gravel caps.

Flow length: Highly variable depending on local conditions. Generally a few tens to hundreds of metres but may be several kilometres in sub-crop (where confined by overlying basalts).

Catchment size: Estimated to be small (<1 Ha to 1000 Ha).

Recharge estimate: Unknown. Possibly 10% to 20% of rainfall where exposed at the surface.

Temporal distribution of recharge: In outcrop, the recharge is seasonal (winter and spring), with significantly more recharge in wetter years. Where overlain by basalts, slow recharge may occur throughout the year.

Spatial distribution of recharge: Catchment wide on outcrops and probably extensive leakage from overlying basalt (GFS 18) in places (eg Melton South).

Aquifer uses: Minor stock and domestic use.

Salinity

Groundwater salinity (TDS): In the range of 1000 mg/L to 10000 mg/L, generally between 3,000 mg/L and 8,000 mg/L.

Salt store: Moderate

Salinity occurrence: Generally at or near the base of the unit. Discharge mostly occurs along the boundaries of the unit and in drainage lines.

Soil Salinity Rating: S2 to S3.

Salt export: Wash off from surface.

Salt impacts: Both on-site and off-site (from wash-off)

Risk

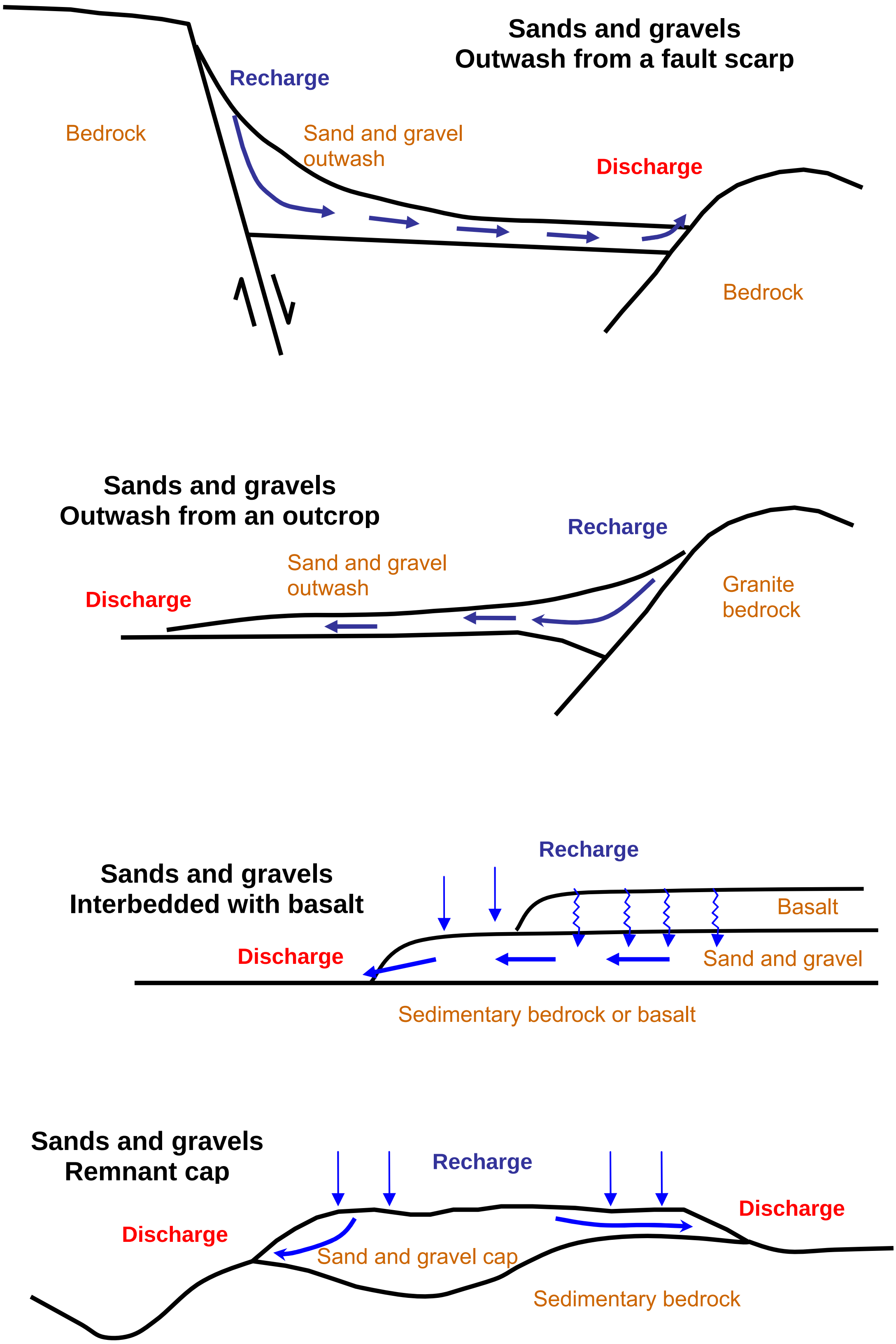
Soil salinity hazard: Moderate to High (scalding).

Water salinity hazard: Moderate.

Assets at risk: Water quality and aquatic biodiversity of Little River and Emu Creek, agricultural land (Balliang, Riddell, Lancefield).

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

Conceptual models



A variety of conceptual models for salinity processes in different geological settings. The common theme is the lateral flow of groundwater through the sand and gravel GFS.

Management Options

This is a geologically and climatically diverse GFS, though the known salinity hazard is mostly confined to the Balliang and Riddell districts. Although the hydrogeological processes causing the salinity at Balliang are uncertain (is the granitic bedrock/regolith the source, or does it provide a barrier to converging groundwater flow?) the system is believed to have reached quasi- equilibrium, and the salinity may no longer expand significantly. Substantial treatment programs are in place at the site. A particular consideration at Balliang is whether the extent of salinity will substantially worsen, and, if not, whether the costs and benefits of recharge control methods to ameliorate the discharge site can be argued.

In other areas such as Riddell there has been little or no specific investigation of salinity processes.

The management comments offered below assume that groundwater flow in the gravel and sand sediments contribute to salinity.

Dryland agriculture options for managing salinity in local flow in the **gravel and sand sediments** **Salinity focus: Balliang, Riddell**		
Options	**Treatments**	**Comments**
Biological Management of recharge	Perennial pastures	Moderate to high impact – rainfall below 600 mm (Balliang) so recharge control should be possible. Also offers reduction of runoff and waterlogging
	Crop management	Low to moderate impact– incorporate pasture phase
	Trees/woody vegetation	Moderate– lucerne or trees would be beneficial in all aspects of recharge, runoff and waterlogging control
Engineering intervention	Surface drainage	Low– disposal issues
	Groundwater pumping	Moderate – technically possible given acceptable permeability in sands/gravels. However, disposal issues
Productive uses of saline land and water	Salt tolerant pastures	Moderate to high impact– where site conditions are not too eroded
	Halophytic vegetation	Moderate impact– relatively dry climate (Balliang) so could be conducive to stabilising scalded areas
	Saline aquaculture	Low to moderate impact– possibility at Balliang if sufficient volumes of saline groundwater
	Salt harvesting	Low impact– groundwater is not sufficiently saline
	Others	See OPUS database (NDSP)

Management implications given projected land use

Though the Balliang region is targeted as a zone for possible waste water re-use (irrigation), such developments will tend to occur on the higher quality soils of the adjacent basalt plains.