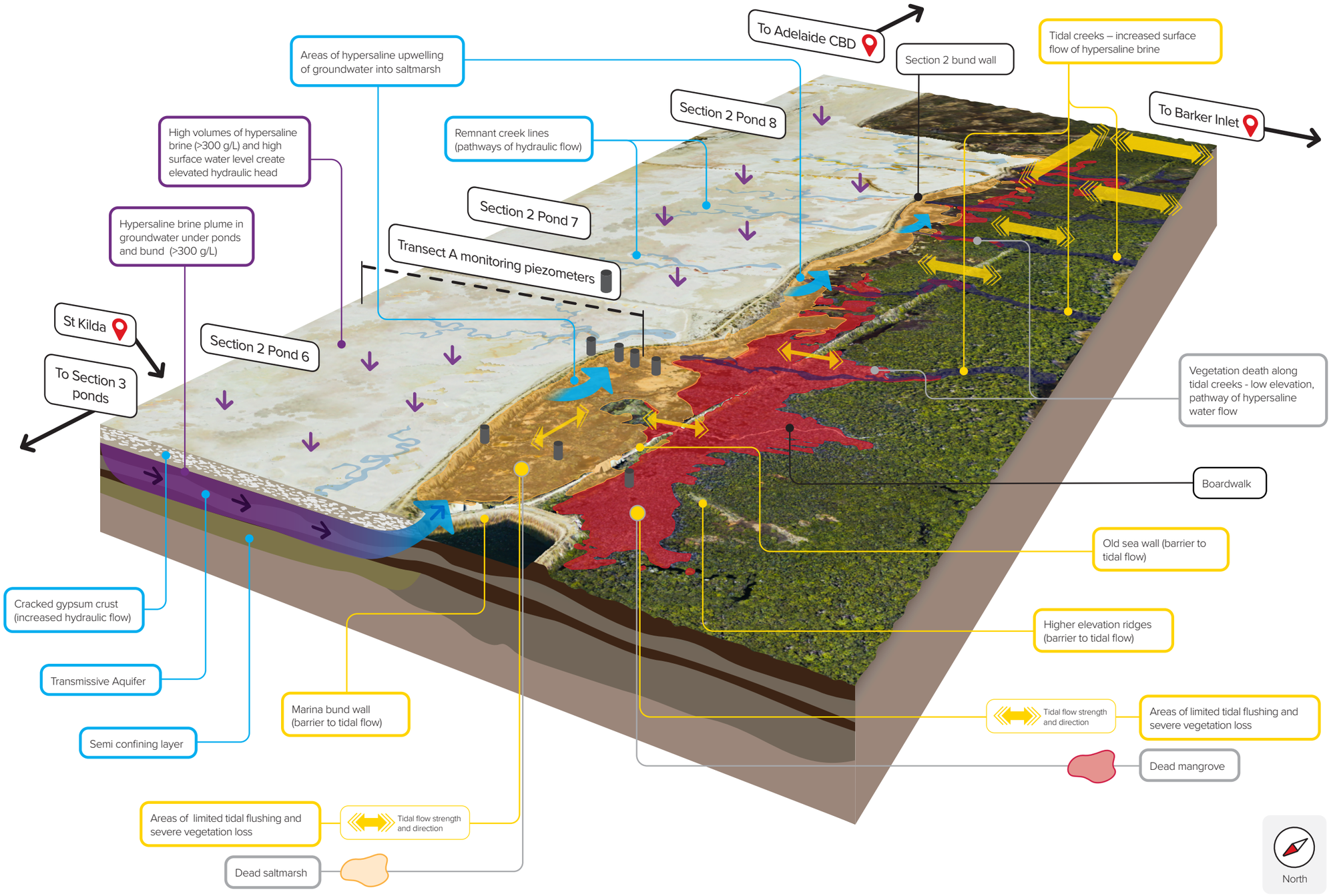
St Kilda mangrove and saltmarsh hypersaline brine contamination 2020 conceptual model

Intertidal Zone Adjacent Section 2

1. Hypersaline brine from Section 3 ponds caused salt input and high groundwater levels in Section 2 ponds.
2. Groundwater flows push hypersaline brine through cracked gypsum crust and transmissive aquifers into impacted area.
3. Geology and topography of the site creates barriers and pathways to tidal flushing of hypersaline brine from impacted area.
4. Exposure to high salinity waters and waterlogged soils caused the death of saltmarsh and mangrove vegetation.



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Key findings: St Kilda mangrove and saltmarsh hypersaline brine contamination 2020

In 2020, the South Australian Government became aware of the death of saltmarsh and mangrove vegetation near St Kilda, adjacent Section 2 of the Dry Creek Salt Fields. The University of Adelaide has developed a conceptual model of the area to summarise relevant scientific knowledge of the hydrology and ecology of the site, determine likely environmental impact pathways, identify knowledge gaps and provide potential future management options.

Key findings:

- The increase in the surface water level in Section 2 ponds of the saltfield from December 2019 to October 2020, due to discharge from Section 3, increased the recharge to the groundwater mound under the ponds. Surface cracking of the gypsum crust in the ponds further enhanced transport of surface water to the groundwater mound. The elevated groundwater mound under the ponds in Section 2 increased the hydraulic gradient towards the intertidal zone.
- Upon refill, the pond surface water became extremely hypersaline due to a combination of highly saline input water and dissolution of surface salts from the surface of Section 2 ponds.
- Due to hydraulic connectivity with the pond surface water, the groundwater underneath the ponds also became extremely hypersaline. This groundwater moved towards the intertidal zone under the increased hydraulic gradient.
- There are numerous hydraulic pathways of groundwater flow from the ponds to the intertidal zone, including remnant creek lines and transmissive sediments under the bund wall.
- As sediments became hypersaline and waterlogged in the intertidal zone, vegetation (saltmarsh, mangrove) death occurred rapidly. This was observed from mid to late 2020.
- Spatial satellite analysis determined retrospectively that 24 hectares of vegetation death was recorded in the intertidal zone adjacent Section 2, including 9 hectares of mangrove, 10 hectares of saltmarsh, and nearly 5 hectares of bare, sparsely vegetated, and aquatic ecosystems. It is likely there is a greater area which recorded vegetation stress following impact between the recorded dead vegetation zone and the healthy vegetation zone.
- It is probable that other ecosystem impacts occurred, like stress or acute toxicity to benthic invertebrates and fish communities, as well as changes in sediment/soil physical characteristics, however, there is currently no available ecosystem data to quantitatively assess these impacts.
- Once the surface water level reduced in Section 2, the recharge to the groundwater mound underneath the ponds in Section 2 decreased and the hydraulic gradient to the adjacent intertidal zone reduced. Less hypersaline groundwater was moving towards the intertidal area and tidal flushing diluted surficial sediment salinity in the intertidal zone.
- Sediments and tidal flushing are highly heterogenous and spatially variable across the intertidal zone of the affected area. Barriers (bunds, chenier ridges, sea wrack) to tidal flushing limit some sediments from benefiting from dilution by tidal water. This also reduce the ability of vegetation in these areas to recover from hypersalinity impact.
- Fine grained sediments (muds/clays), sediments in low elevation areas, deeper sediments and those close to the Section 2 bund remain higher in salinity than higher elevation, surface and coarser sediments further away from the Section 2 bund, some of which have returned to preimpact salinity.
- Hypersaline water has been flushed from some surficial sediments, however, there is no recent data on the salinity of deeper sediments.
- Seedling emergence and regeneration has been observed in some limited areas (high saltmarsh), and propagules have been observed in the mangrove area since spring 2021, but the lack of recent vegetation survey data makes the quantitative analysis of vegetation recovery trends impossible. It is also unclear whether saltmarsh and mangrove species can survive once roots extend into deeper sediment layers (due to residual hypersalinity in the subsurface sediments).
- While there was sufficient information to develop a broad-scale conceptual model there were some knowledge gaps relating to spatial and temporal resolution of data and site characteristics.

Reference: *St Kilda mangrove and saltmarsh hypersaline brine contamination 2020.* Report Prepared for the Department for Environment and Water, by The University of Adelaide. December 2022.

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