Innovative Groundwater Solutions

Soils & Hydrogeology of the Northern Adelaide Plains

NAIS Community Committee

Wednesday 16th March 2016

Overview

- Soil mapping
- Fractured rock aquifers
- T1 / T2 / T3 / T4 aquifers
- Characteristics of T3 / T4 aquifers
- ASTR research outcomes

Legend

Soil Landscapes of South Australia - Mapping Data

Calcareous soils
- Calcareous loam on rock
- Moderately calcareous loam
- Calcareous loam
- Calcareous loam on clay
- Calcareous gradational clay loam

Shallow soils on calcrete or limestone
- Shallow calcareous loam on calcrete
- Shallow sandy loam on calcrete
- Shallow red loam on limestone
- Shallow loam over red clay on calcrete

Gradational soils with highly calcareous lower subsoil
- Gradational sandy loam
- Gradational loam on rock
- Friable gradational clay loam

Hard red-brown texture contrast soils with alkaline subsoil
- Loam over clay on rock
- Loam over red clay
- Loam over poorly structured red clay
- Hard loamy sand over red clay
- Ironstone gravelly sandy loam over red clay
- Loam over poorly structured clay on rock

Cracking clay soils
- Black cracking clay
- Red cracking clay
- Brown or grey cracking clay

Deep loamy texture contrast soils with brown or dark subsoil
- Loam over brown or dark clay
- Sandy loam over poorly structured brown or dark clay

Sand over clay soils
- Sand over sandy clay loam
- Bleached sand over sandy clay loam
- Thick sand over clay
- Sand over poorly structured clay

Deep sands
- Carbonate sand
- Siliceous sand
- Bleached siliceous sand

Ironstone soils
- Ironstone soil

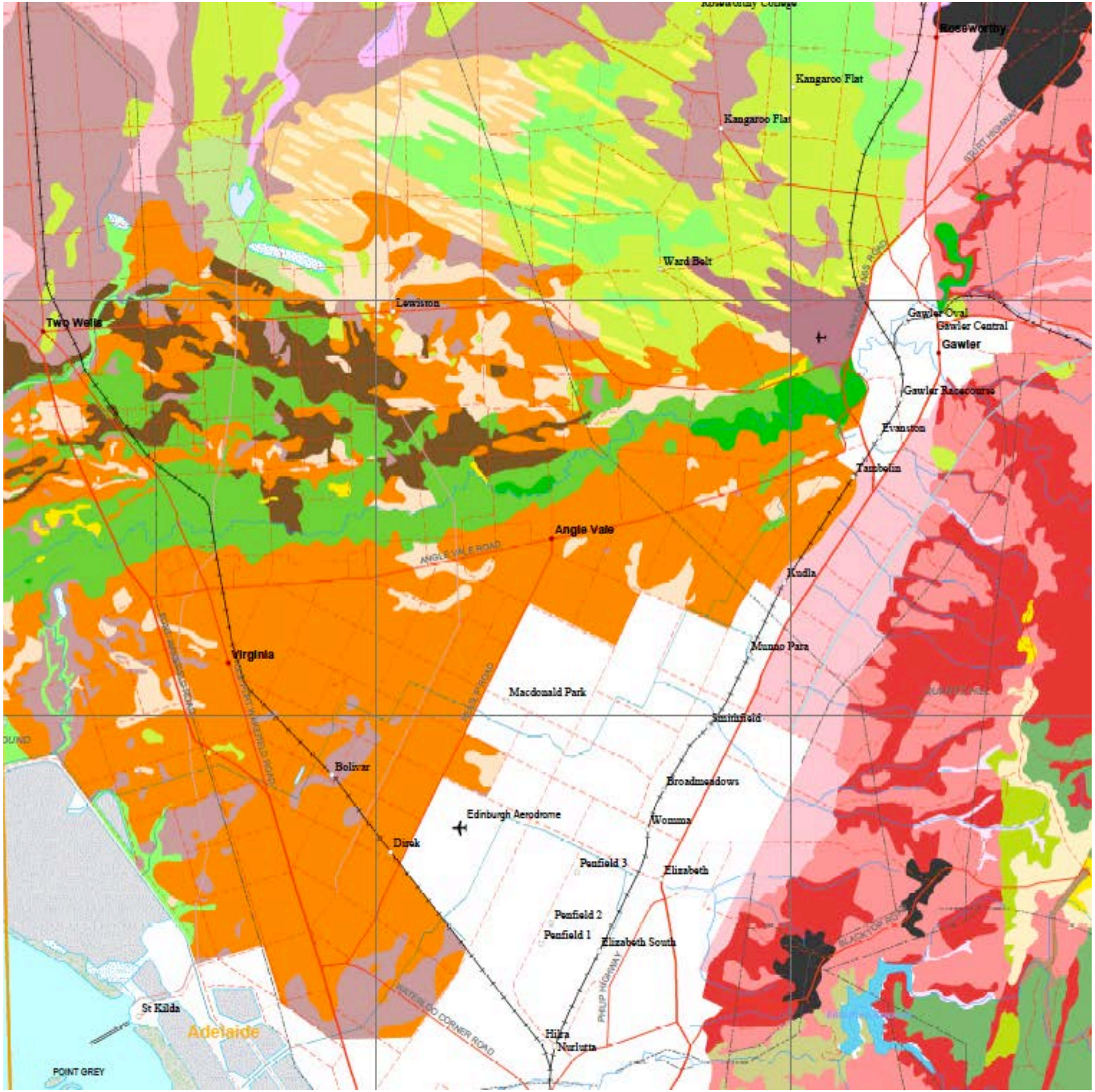
Shallow to moderately deep acidic soils on rock
- Acidic gradational loam on rock
- Acidic loam over clay on rock
- Acidic sandy loam over red clay on rock
- Acidic sandy loam over brown or grey clay on rock
- Acidic gradational sandy loam on rock

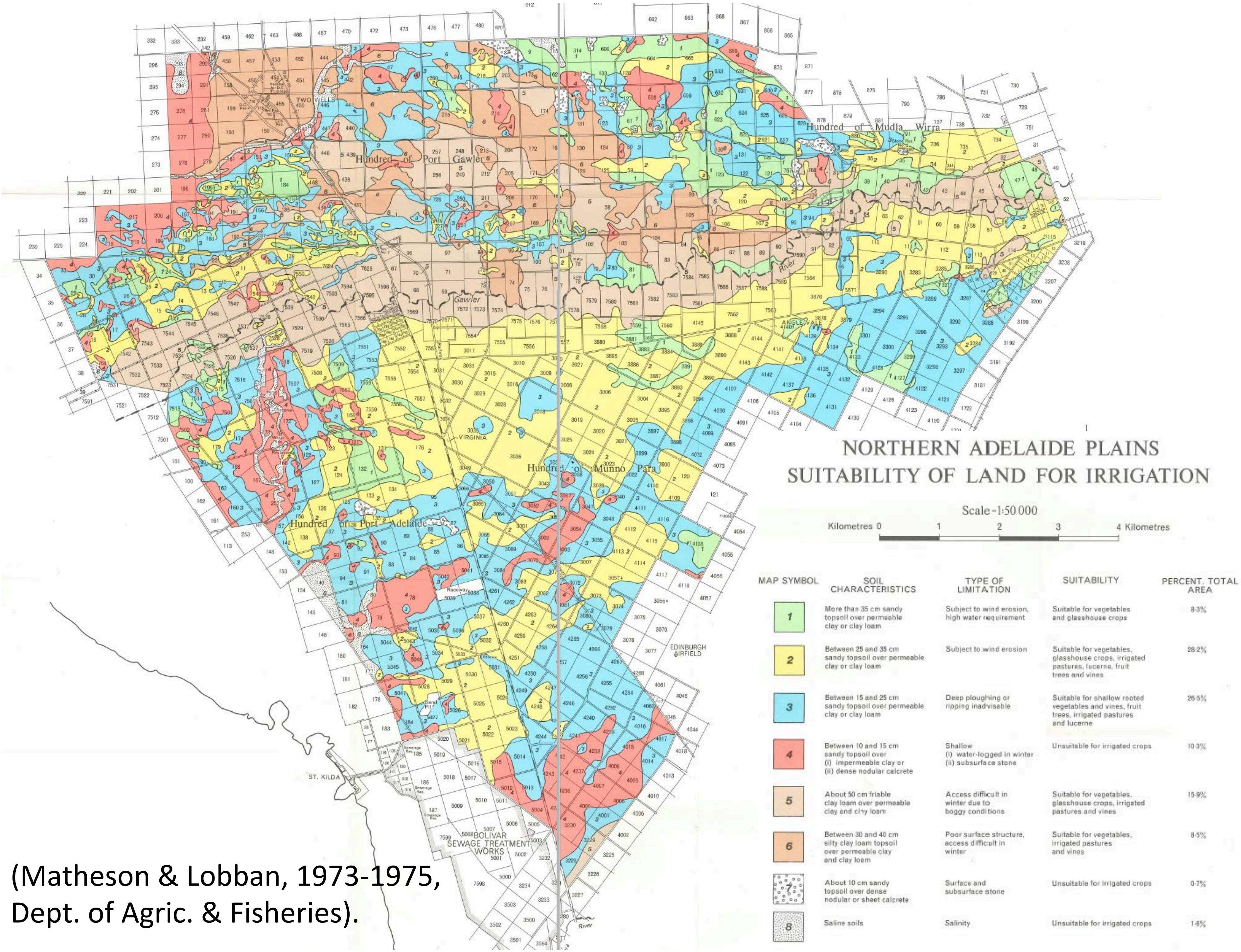
Shallow soils on rock
- Shallow soil on rock

Deep uniform to gradational soils
- Deep sandy loam
- Deep friable gradational clay loam
- Deep hard gradational sandy loam

Wet soils
- Saline soil

Miscellaneous
- Rock
- Not applicable





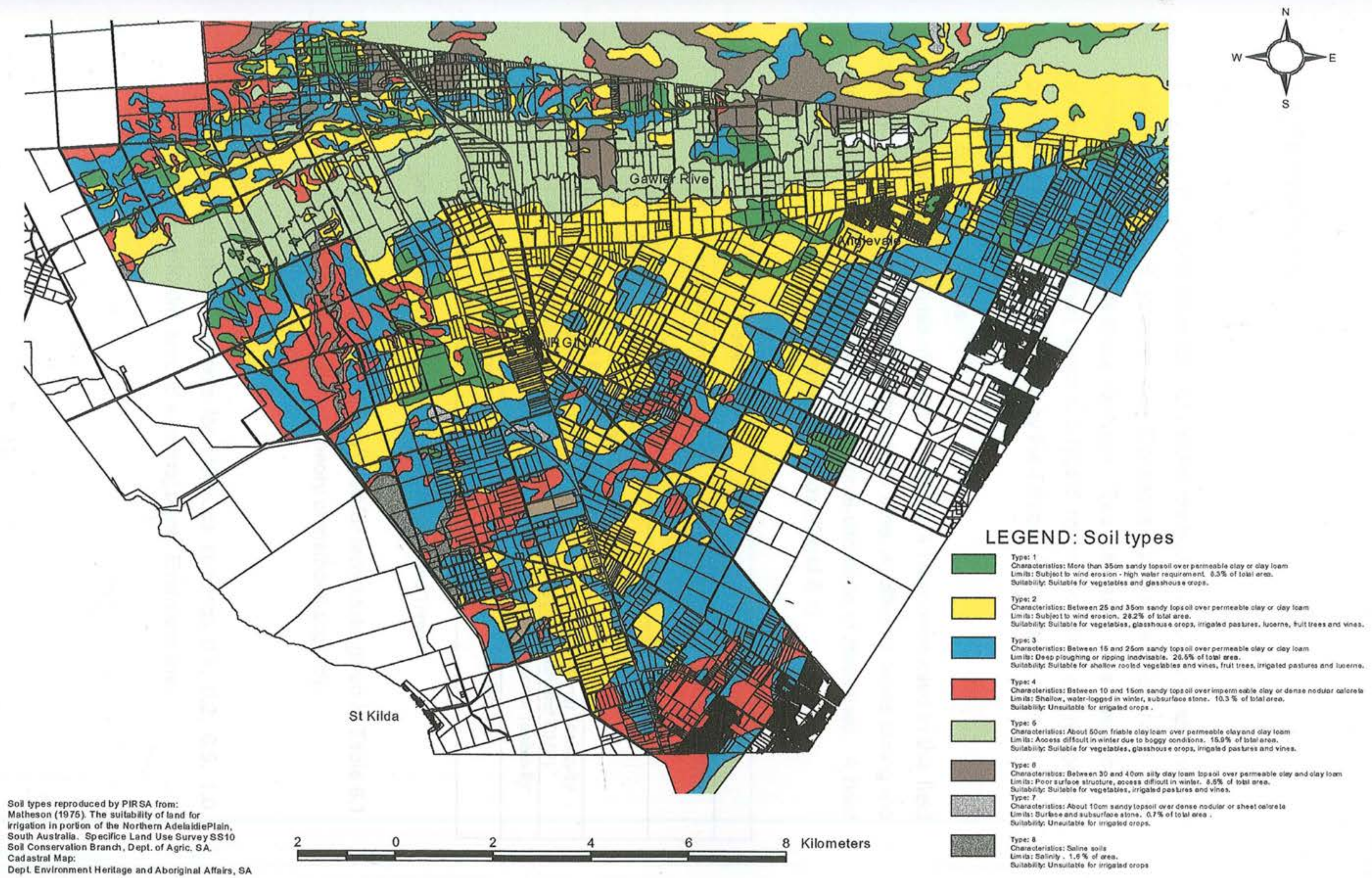
(Matheson & Lobban, 1973-1975, Dept. of Agric. & Fisheries).

NORTHERN ADELAIDE PLAINS
SUITABILITY OF LAND FOR IRRIGATION

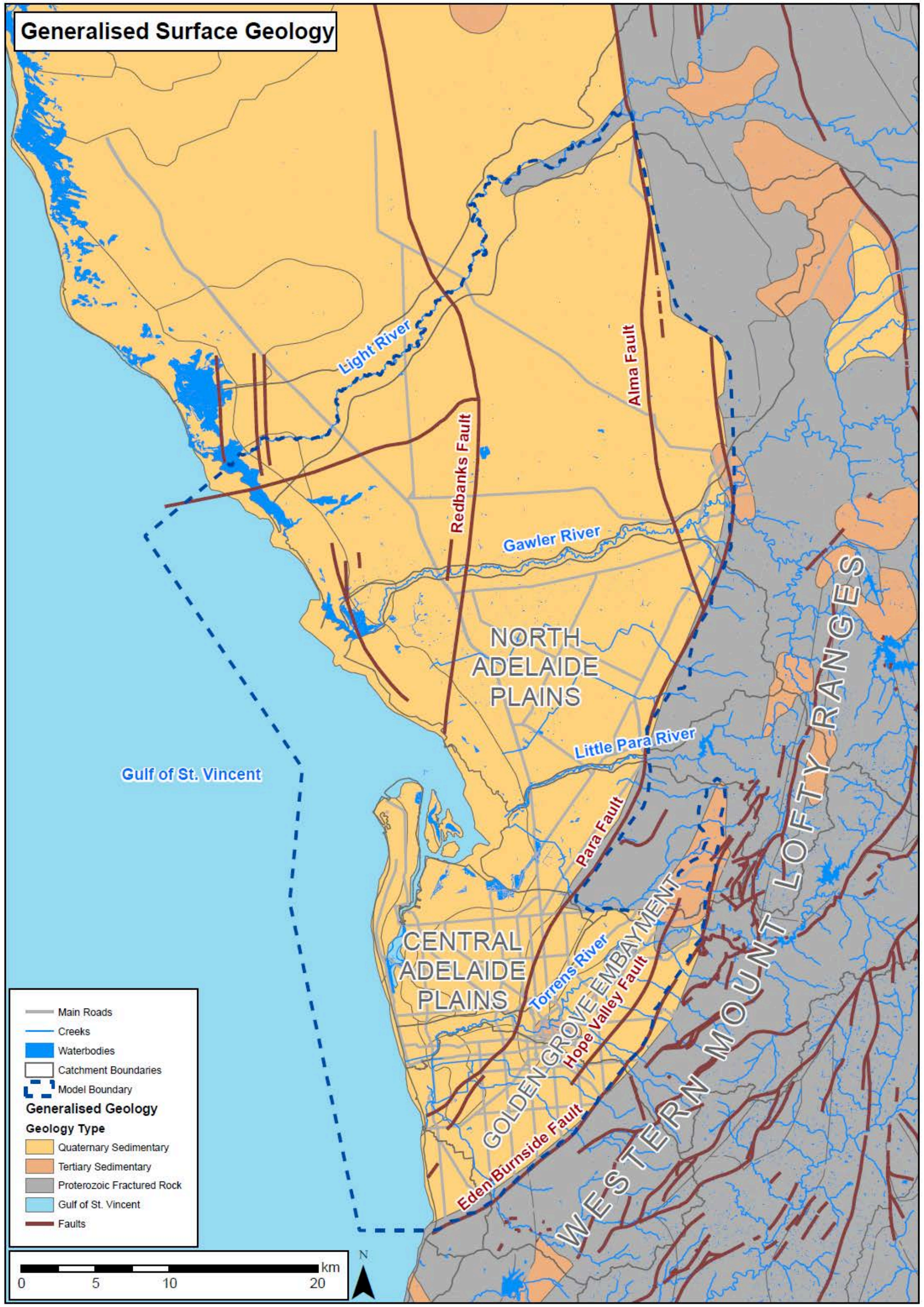
Scale - 1:50 000

Kilometres 0 1 2 3 4 Kilometres

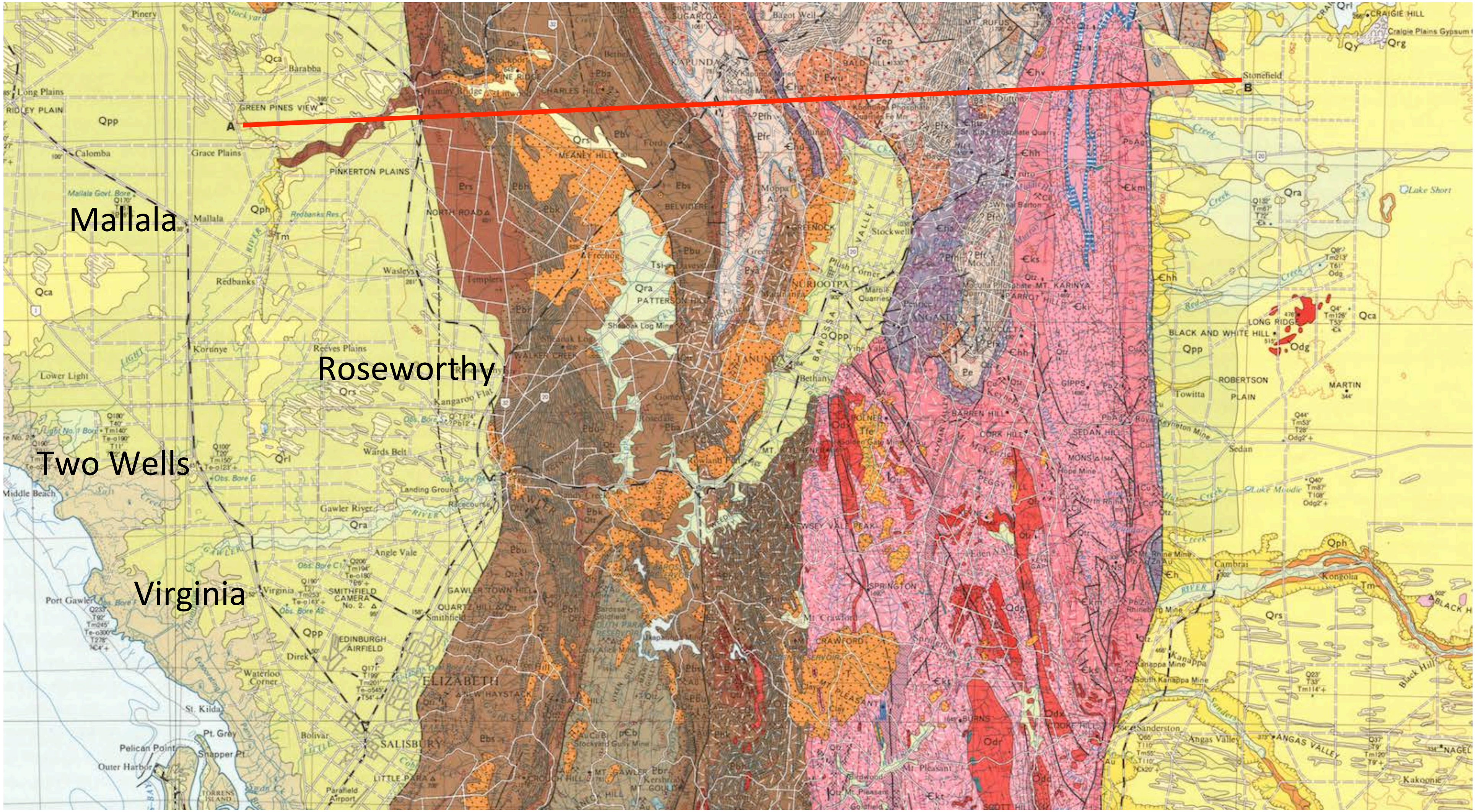
MAP SYMBOL	SOIL CHARACTERISTICS	TYPE OF LIMITATION	SUITABILITY	PERCENT. TOTAL AREA
1	More than 35 cm sandy topsoil over permeable clay or clay loam	Subject to wind erosion, high water requirement	Suitable for vegetables and glasshouse crops	8·3%
2	Between 25 and 35 cm sandy topsoil over permeable clay or clay loam	Subject to wind erosion	Suitable for vegetables, glasshouse crops, irrigated pastures, lucerne, fruit trees and vines	28·2%
3	Between 15 and 25 cm sandy topsoil over permeable clay or clay loam	Deep ploughing or ripping inadvisable	Suitable for shallow rooted vegetables and vines, fruit trees, irrigated pastures and lucerne	26·5%
4	Between 10 and 15 cm sandy topsoil over (i) impermeable clay or (ii) dense nodular calcrete	Shallow (i) water-logged in winter (ii) subsurface stone	Unsuitable for irrigated crops	10·3%
5	About 50 cm friable clay loam over permeable clay and clay loam	Access difficult in winter due to boggy conditions	Suitable for vegetables, glasshouse crops, irrigated pastures and vines	15·9%
6	Between 30 and 40 cm silty clay loam topsoil over permeable clay and clay loam	Poor surface structure, access difficult in winter	Suitable for vegetables, irrigated pastures and vines	8·5%
7	About 10 cm sandy topsoil over dense nodular or sheet calcrete	Surface and subsurface stone	Unsuitable for irrigated crops	0·7%
8	Saline soils	Salinity	Unsuitable for irrigated crops	1·6%

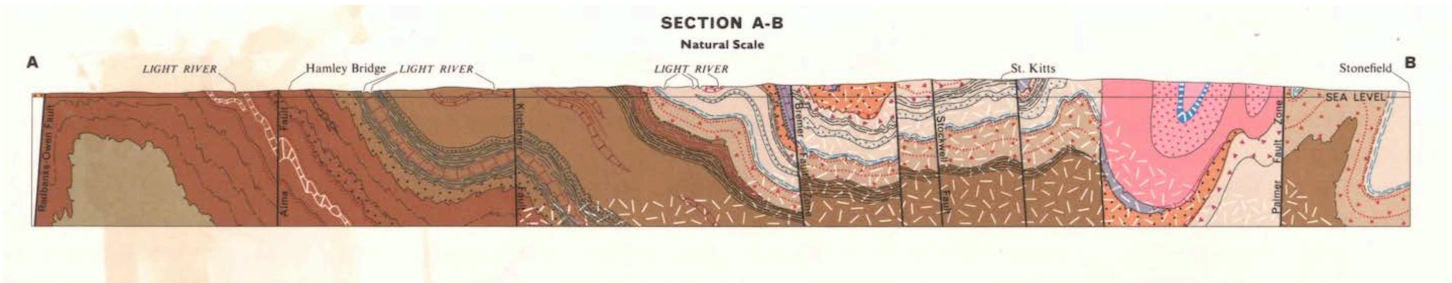


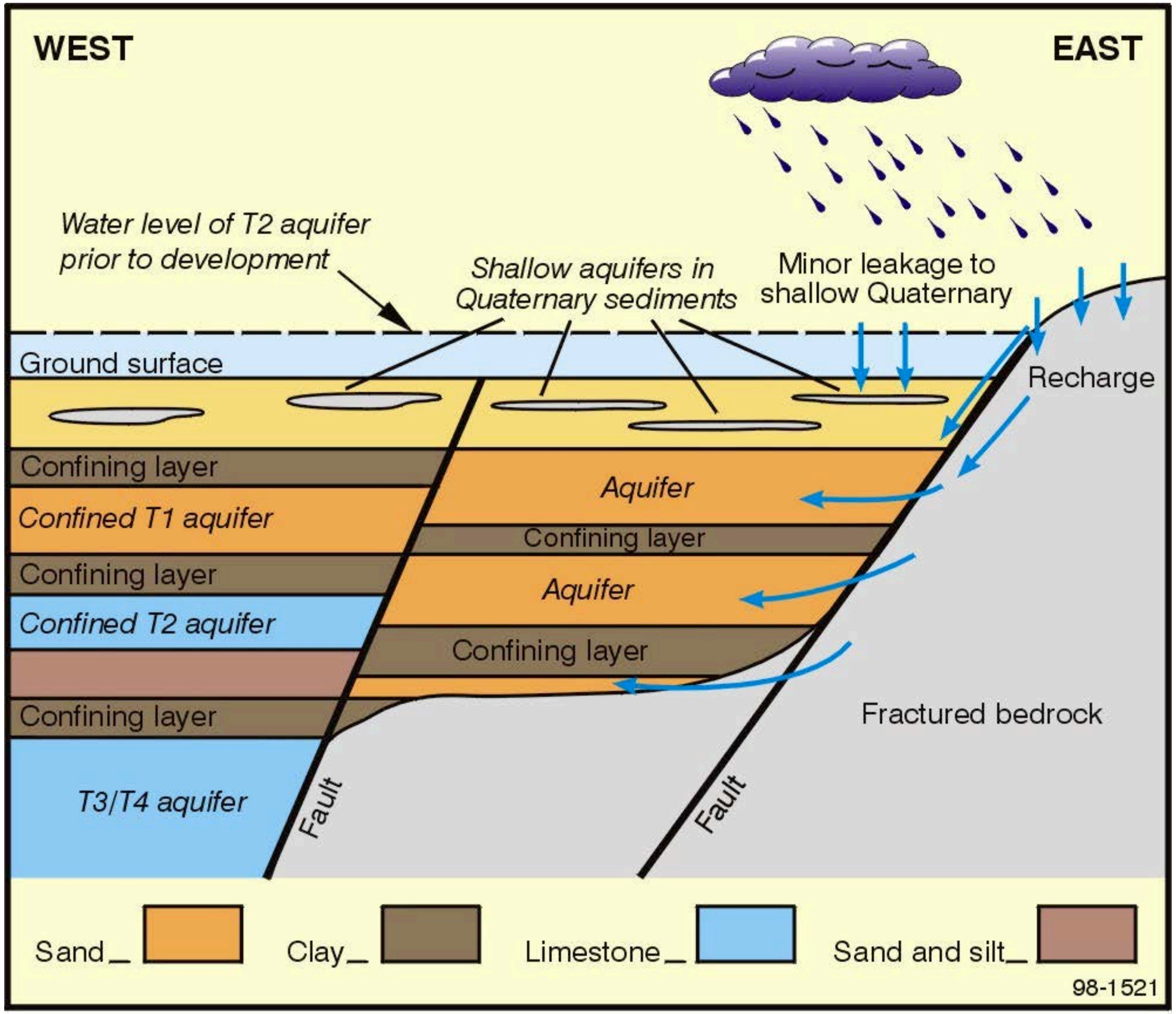
The suitability of land for irrigation in portion of the Northern Adelaide Plain, South Australia (After Matheson, 1975 and Soil Conservation Branch, Dept. of Agric. SA).

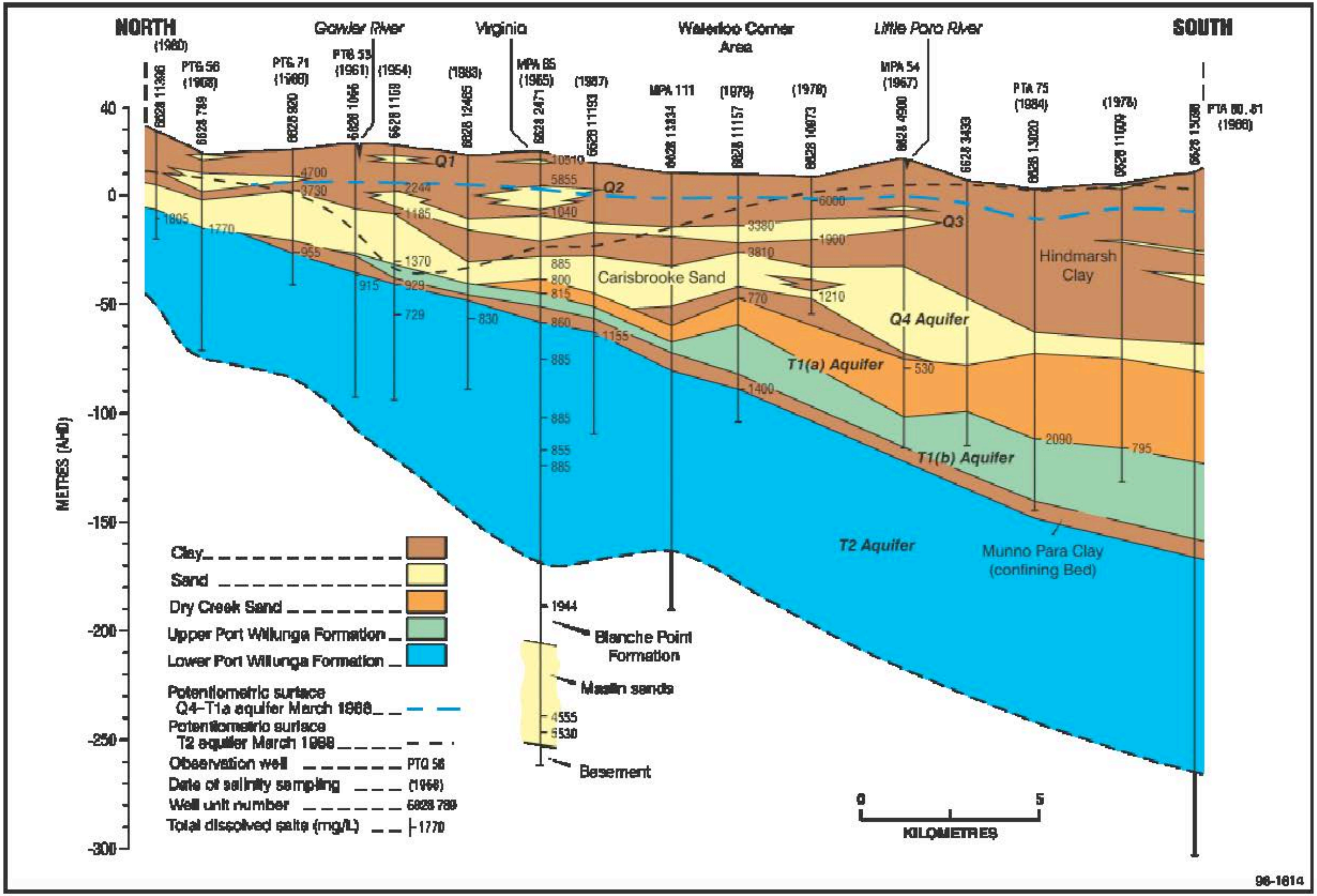


From: Bresciani et al. (2015), *Assessment of Adelaide Plains Groundwater Resources: Summary Report DRAFT*


Mallala
Roseworthy
Two Wells
Virginia
A
B
Stonefield
Pinery
Barabba
Long Plains
RIDLEY PLAIN
GREEN PINES VIEW
Calomba
Grace Plains
PINKERTON PLAINS
Redbanks
Korunye
Lower Light
Reeves Plains
Wards Belt
Gawler River
Angle Vale
Middle Beach
Port Gawler
Direk
EDINBURGH AIRFIELD
Waterloo Corner
ELIZABETH
St. Kilda
Pt. Grey
Pelican Point
Outer Harbor
Bolivar
SALISBURY
LITTLE PARA
Parafield Airport
NURIOOTPA
Stockwell
TANUNDA
Bethany
Springton
Mt. Crawford
Mt Pleasant
BLACK AND WHITE HILL
LONG RIDGE
ROBERTSON PLAIN
Towitta
Sedan
MARTIN
Cambrai
Kongolia
Sanderston
Angas Valley
Kakoonie
CRAIGIE HILL
Lake Short
Lake Moodie


SECTION A-B
Natural Scale
A
LIGHT RIVER
Hamley Bridge
LIGHT RIVER
LIGHT RIVER
St. Kitts
Stonefield
B
SEA LEVEL


WEST
EAST
Water level of T2 aquifer prior to development
Shallow aquifers in Quaternary sediments
Minor leakage to shallow Quaternary
Ground surface
Recharge
Confining layer
Confined T1 aquifer
Confining layer
Confined T2 aquifer
Confining layer
T3/T4 aquifer
Aquifer
Confining layer
Aquifer
Confining layer
Fractured bedrock
Fault
Fault
Sand
Clay
Limestone
Sand and silt
98-1521

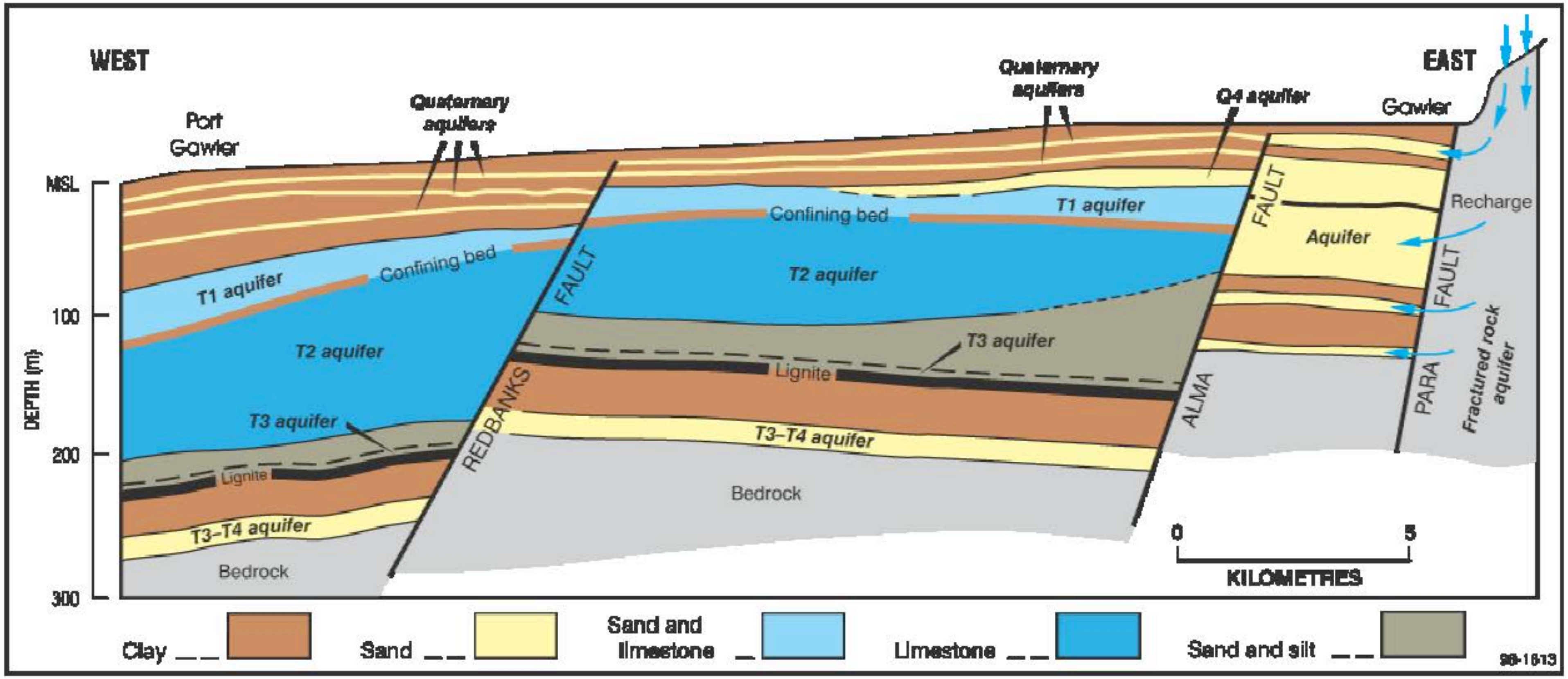


Schematic Cross Section (North-South) of the Northern Adelaide Plains portion of the Adelaide Plains Sub-Basin (From Martin & Hodgkin, 2005; after Zulfic, 2002)

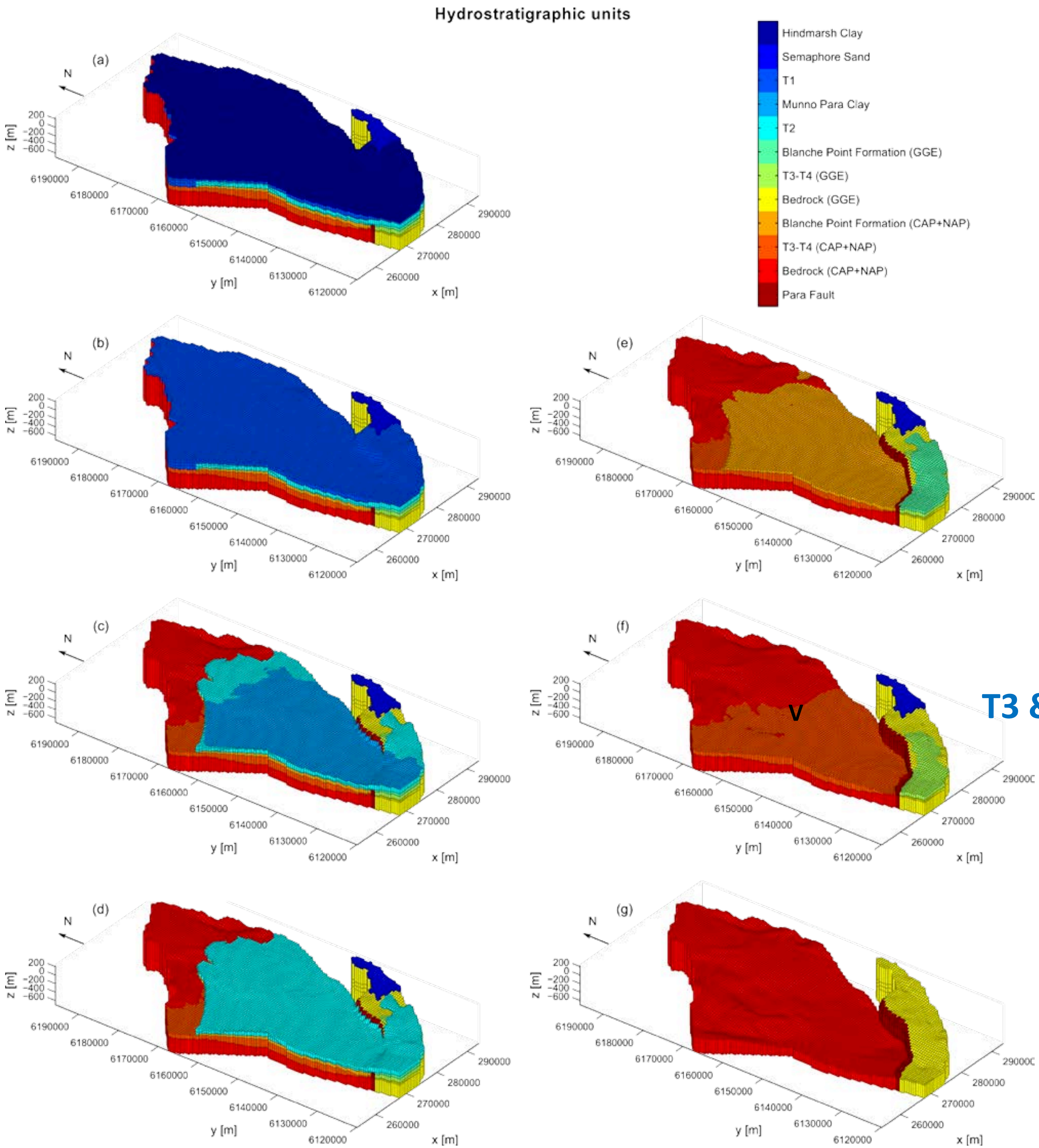
Adelaide Plains Sub-Basin

Stratigraphy	Hydrostratigraphy	Description
Semaphore Sand, modern alluvium and beach gravels	Unconfined Aquifer	thin sand aquifers near coast
Saint Kilda Formation	Unconfined Aquifer	thin sand, shell aquifers near coast
Pooraka Formation	Aquitard	
Keswick Clay	Aquitard	
Hindmarsh Clay	Aquitard, Q1 - Q6 Aquifers	predominantly clay aquitard with interbedded thin sandy confined aquifers
Carisbrooke Sand	Aquifer	confined sandy aquifer, most significant in eastern side of NAP PWA
Dry Creek Sand	T1 Aquifer – T1A Aquifer	confined sandy aquifer, thickening to the south-west
Croydon Facies	T1 Aquifer – T1A Aquifer	semi-confining bed
Port Willunga Formation – Upper Limestone	T1 Aquifer – T1B Aquifer	confined aquifer, thickening to south and south-west
Port Willunga Formation – Munno Para Clay Member	Aquitard	confining bed, absent in north of NAB PWA
Port Willunga Formation – Lower Limestone; Ruwarung Member; Aldinga Member; Pirramimma Sand Member	T2 Aquifer	thick confined aquifer, sandy and thinning in north and north-east of NAB PWA
Chinaman Gully Formation	T3 Aquifer Aquitard,	mainly a confining bed, minor occurrence as a thin sandy aquifer
Blanche Point Formation	Aquitard	mainly confining bed
Tortachilla limestone		
South Maslin Sand	T4 Aquifer	thin confined aquifer
Clinton Formation	Aquitard	confining bed, restricted extent
North Maslin Sands	T4 Aquifer	confined sandy aquifer
Undifferentiated Adelaidean	Fractured Rock Aquifer	mostly localised confined or semi-confined aquifers

From Martin & Hodgkin (2005)



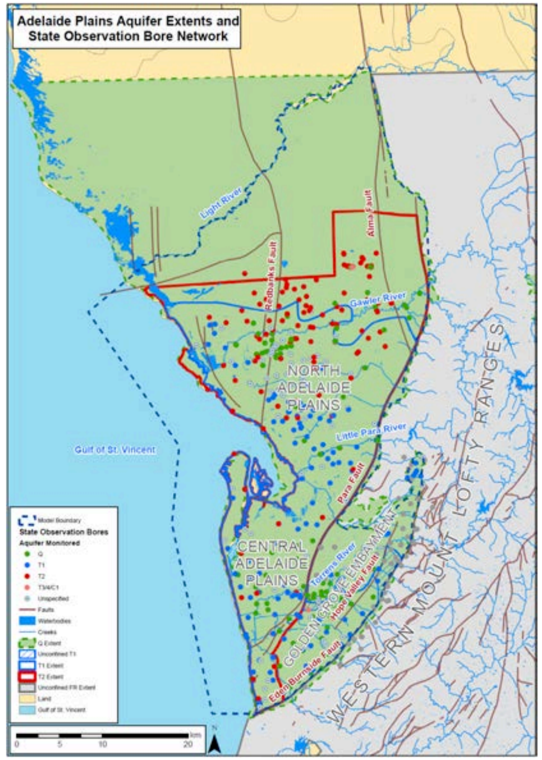
Schematic Cross Section (East-West) of the Northern Adelaide Plains portion of the Adelaide Plains Sub-Basin (From Martin & Hodgkin, 2005; after Zulfic,2002)



T1

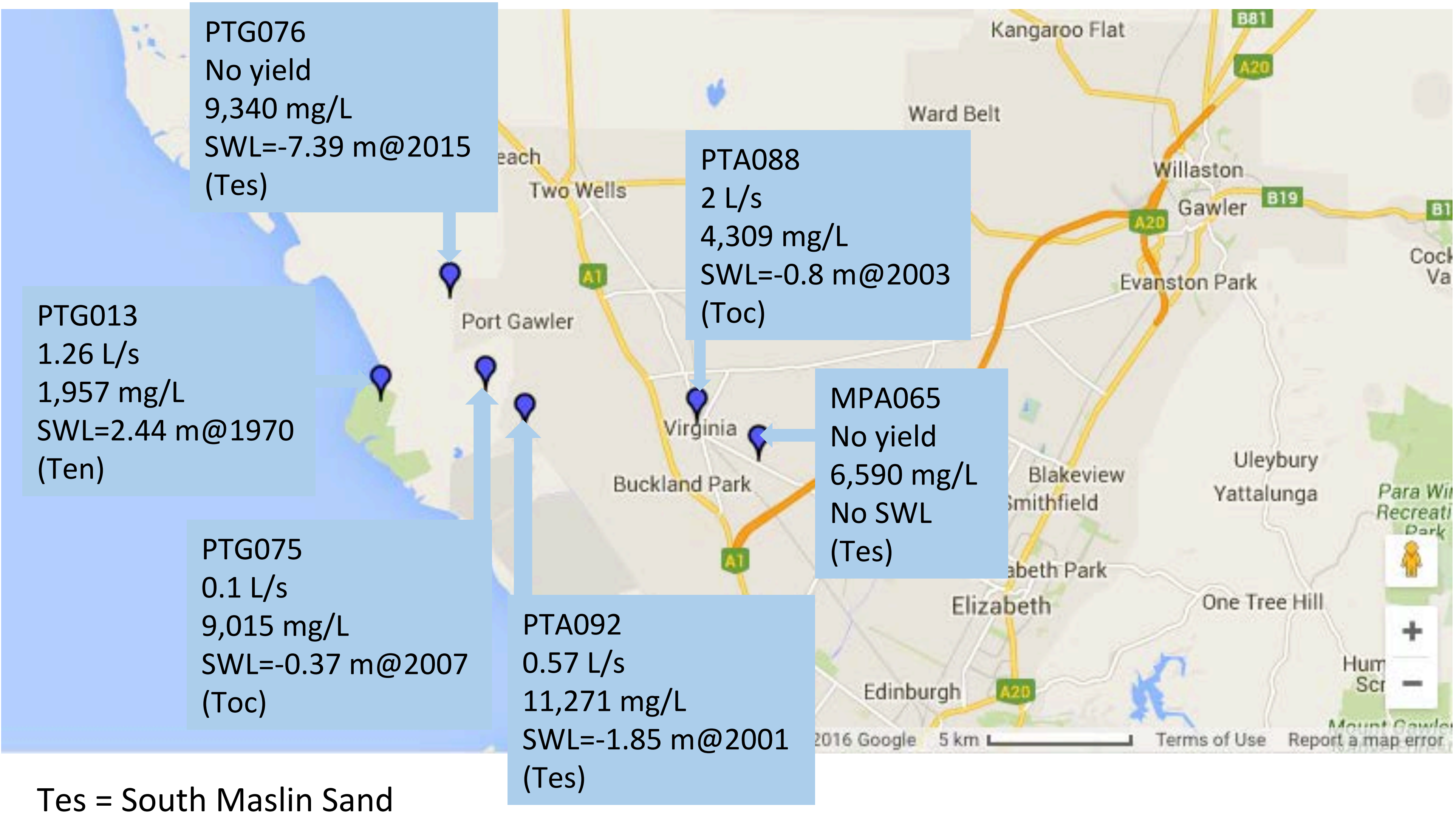
T2

T3 & T4



From:
Bresciani et al. (2015), *Assessment of Adelaide Plains Groundwater Resources: Summary Report DRAFT*

Existing T3/T4 Obswells



Tes = South Maslin Sand
Ten = North Maslin Sand
Toc = Chinaman Gully Fm

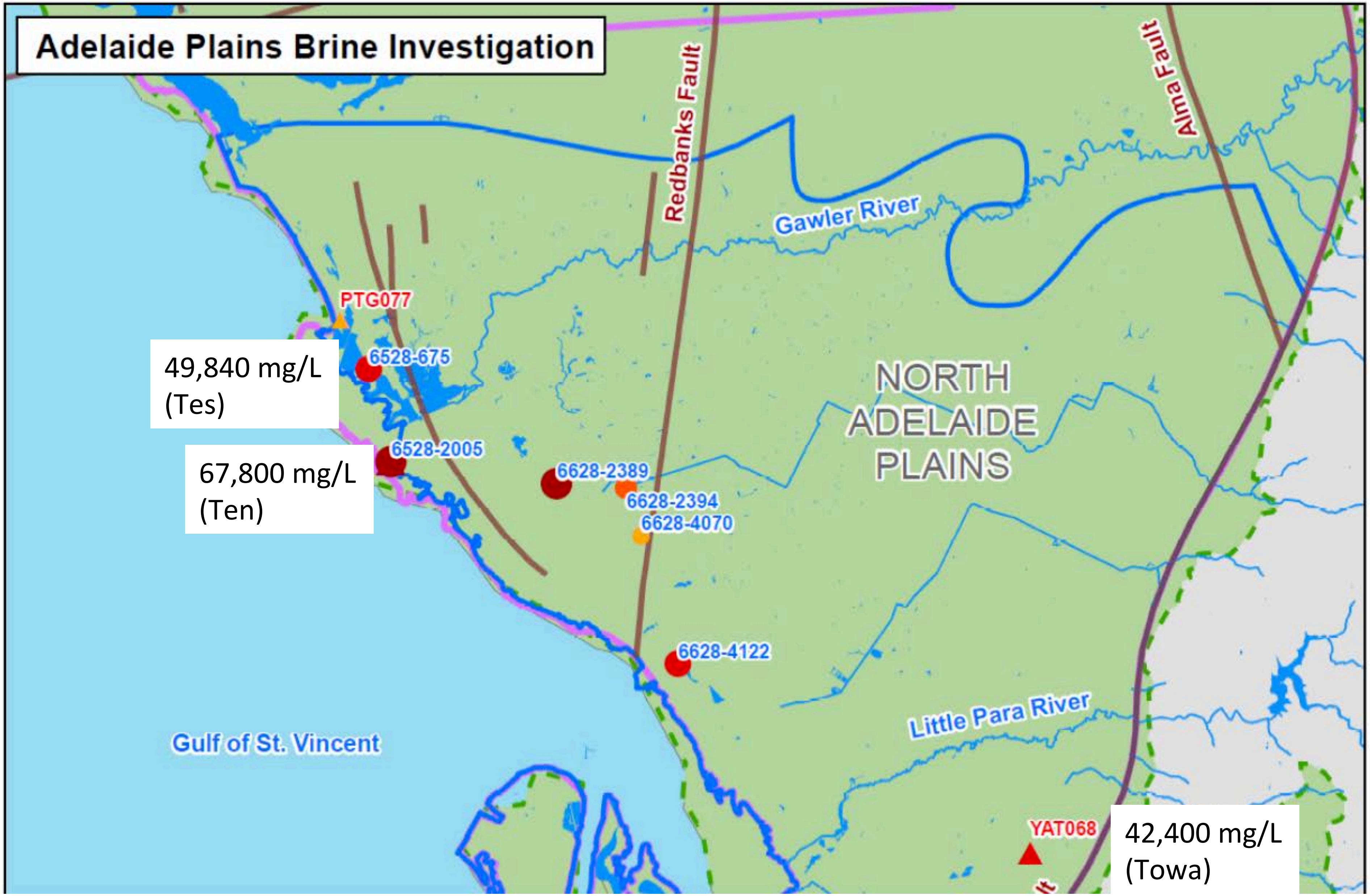


Figure 8 Locations of saline groundwater across the Adelaide Plains with size and shape indicating salinity (mg L-1). Marker symbol indicate if sample has a hydrochemical signature of hypersaline water (triangles) or unknown (circles). The samples span different aquifers but are mostly from the T3, T4 and FRA aquifers, and were taken between 1966 and 2005

Table 13 Summary of T3 Aquifer information (zone 2)

Well Location and Number	Depth to Top of Aquifer (m)	Aquifer Thickness (m)	Salinity (mg/L)	Water level (m)	Supply (L/sec)	Remarks
Edwardstown No. 755	186	9	15850	3	<1	Investigation well completed – South Maslin Sand (Unit 15)
Mitcham Railway Station No. 16	238	4-26	4500	52	?	Investigation well completed – South Maslin Sand (Unit 15)
St James Reserve No. 17	226	5	8410	–	–	Investigation well completed – South Maslin Sand (Unit 15)

Gerges (2006)

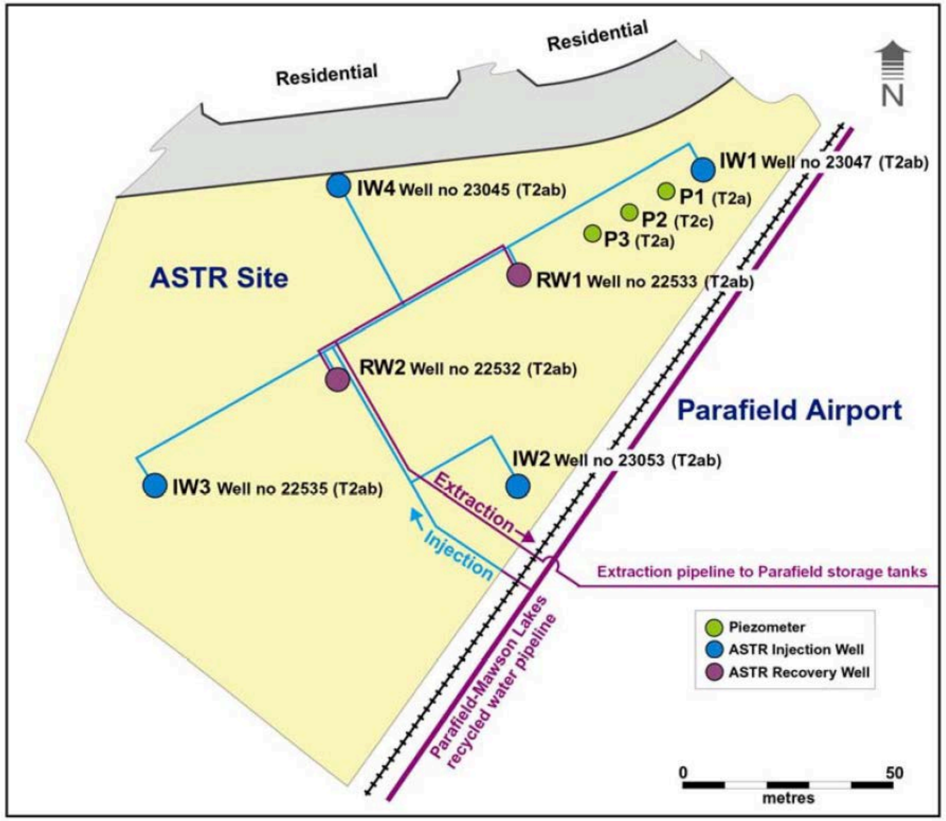
Table 14 Summary of T4 Aquifer information

Well Name	Depth to Top of Aquifer (m)	Aquifer Thickness (m)	Salinity (mg/L)	Water Level (m)	Supply (m^3/day)	Remarks
Allenby Gardens	532	39	100 000 to 140 000 see full analysis	25	61 tested 38 tested	Max DD ~ 5 m; unable to test this well at high yield because of casing size restriction (3") max DD ~ 1.8m
G M Michell	~432	15	~ 30 000 to 40 000	3.5	~ 160	Bedrock salinity in order of 50 000 mg/L
Grange	500	39 SMS	Not known	Not known	Not known	Drilled by Beach Petroleum Co.
Elizabeth Oval	345	7	16 100	14	12.5 L/sec	
Dry Creek	~438	25-62	79 000 to 88 000	Flowing 6-18m above ground	10 L/sec	Investigation/ production well
Port Gawler MESA investigations	254	36	~21 000	Flowing 9 m above ground	Flowing ~5 L/sec	Bedrock salinity 50 000 mg/L at 318m below ground
Port Gawler Penrice	300 330	17 SMS 15 NMS	55 000	Flowing ?2-5m above ground	~ 40 L/sec	Completed as production well in both South and North Maslin Sands
Minda Home No. 773	414	26	40 700	Flowing 21m above ground	Flow 4 L/sec	Investigation well, completed in South Maslin Sand (Unit 15)
Fish Farm Pelican Point	?356	?9	~ 2800	Flowing ?10m above ground	1-2 L/sec	located on the up ---- side of Red Bank Fault extension poor supply large drawdown aquifer material are very poorly sorted and contains large amount of clay and lignitic clay

NMS = North Maslin Sand SMS = South Maslin Sand

Gerges (2006)

ASTR at Salisbury



Kremer et al. (2010)

377 ML flushing, followed by 30 ML injection and 106 ML recovery

Residence time before recovery >150 days

Mean residence time of injectant 255-306 days

ASTR at Salisbury

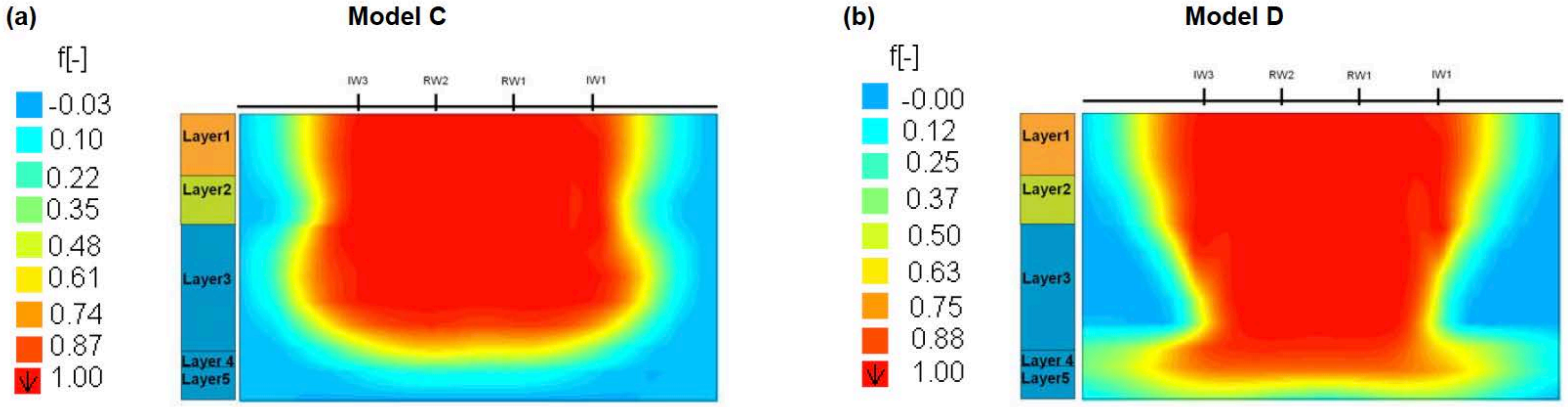


Figure 20 Cross-sectional distribution of mixing fraction at the end of the injection period simulated with models C (a) and D (b). Horizontal scale: 300 m, vertical scale: 60 m.

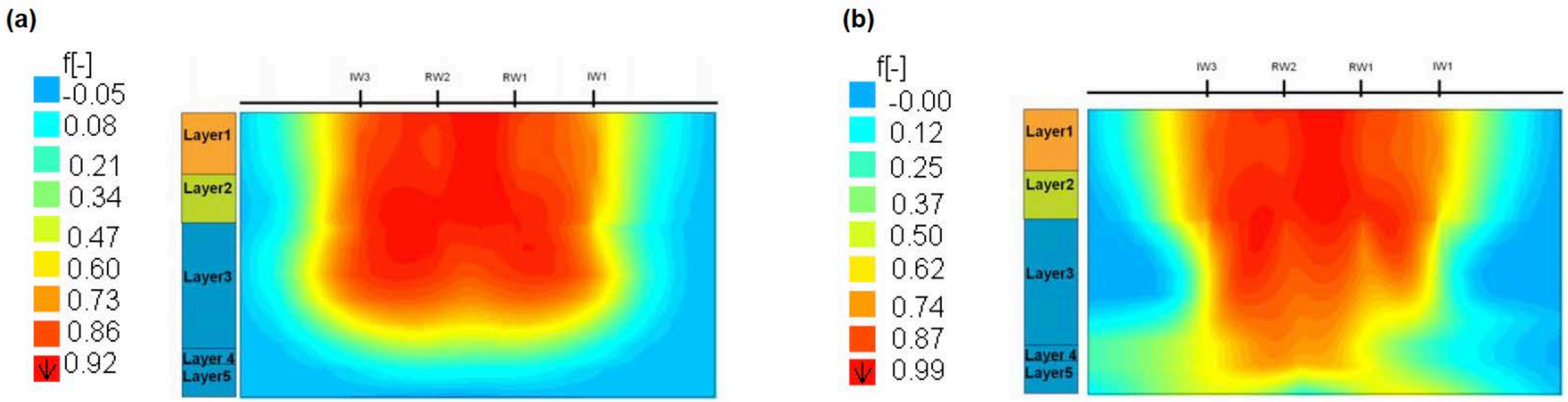
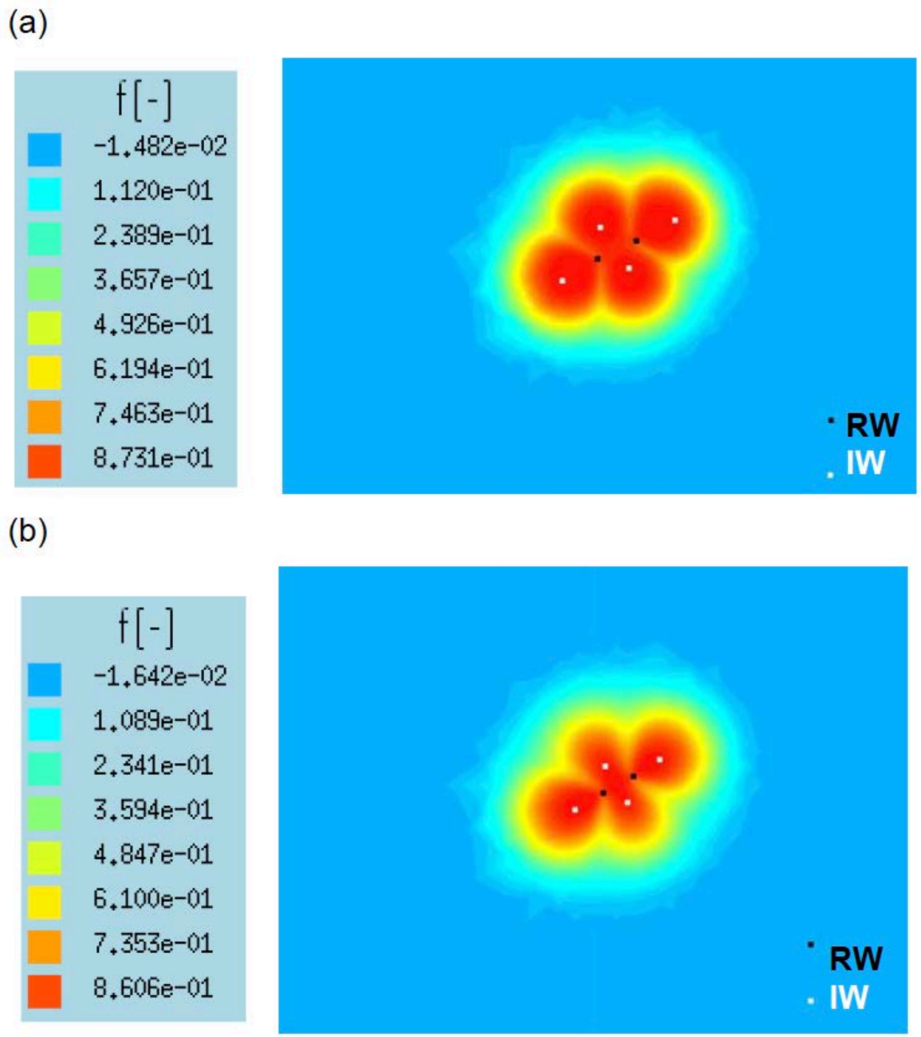


Figure 21 Cross-sectional distribution of mixing fraction at the end of the recovery period simulated with models C (a) and D (b). Horizontal scale: 300 m, vertical scale: 60 m.

Kremer et al. (2010)

ASTR at Salisbury



Kremer et al. (2010)

Simulated mixing fraction after 6th injection and recovery phases