

Groundwater beneath Adelaide

Steve Barnett
Principal Hydrogeologist
DEWNR



Government of South Australia

Department of Environment,
Water and Natural Resources



A tale of backyards, bevvies and birdies



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Historical development

- During the early days of Adelaide settlement, water supplies were obtained from the Torrens and other streams
- As the demand for water increased shallow wells were dug adjacent to rivers
- However, these were unreliable and gradually settlers constructed deep wells into the Tertiary aquifers in the "Adelaide Plains Artesian Basin"

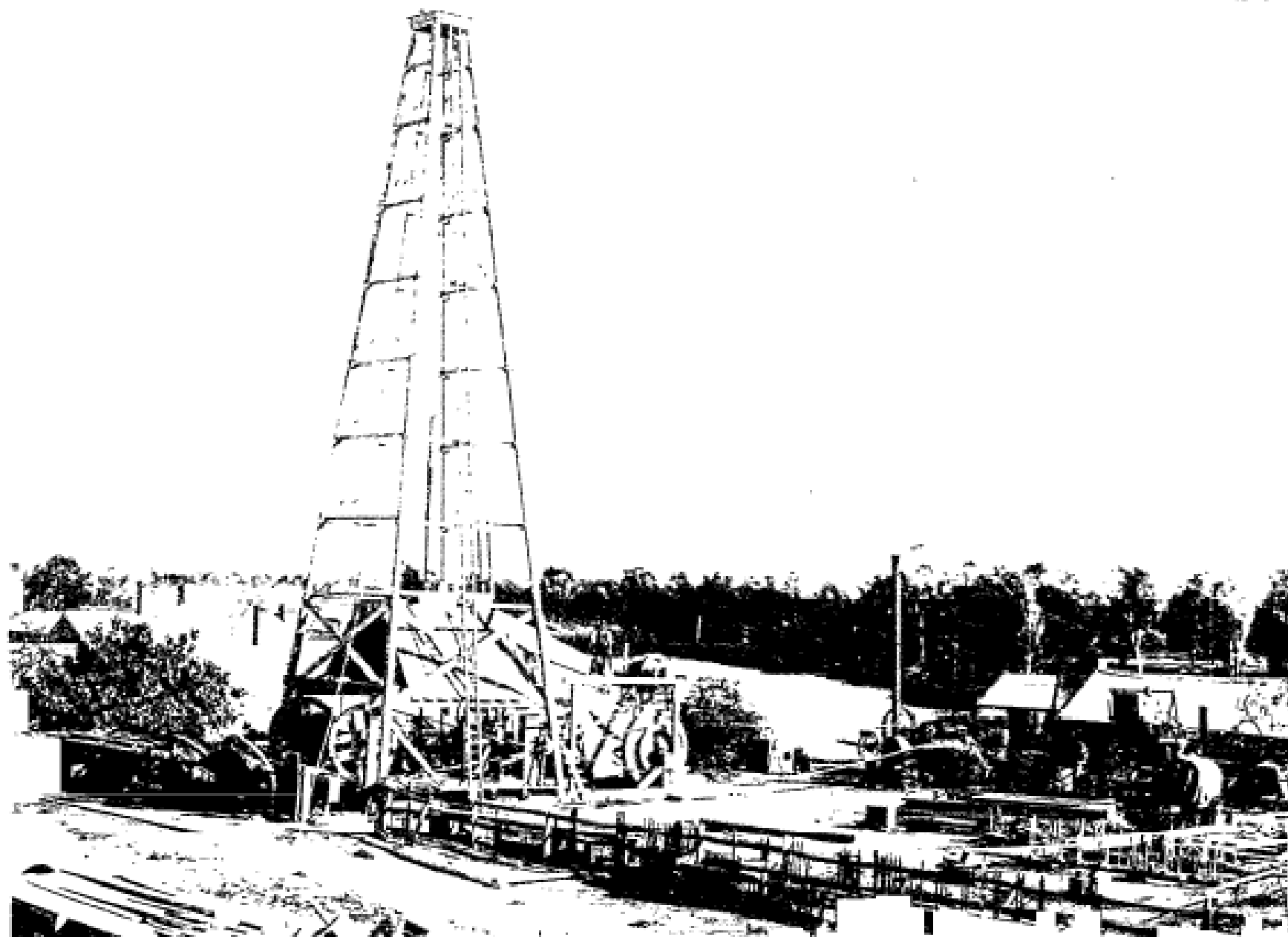


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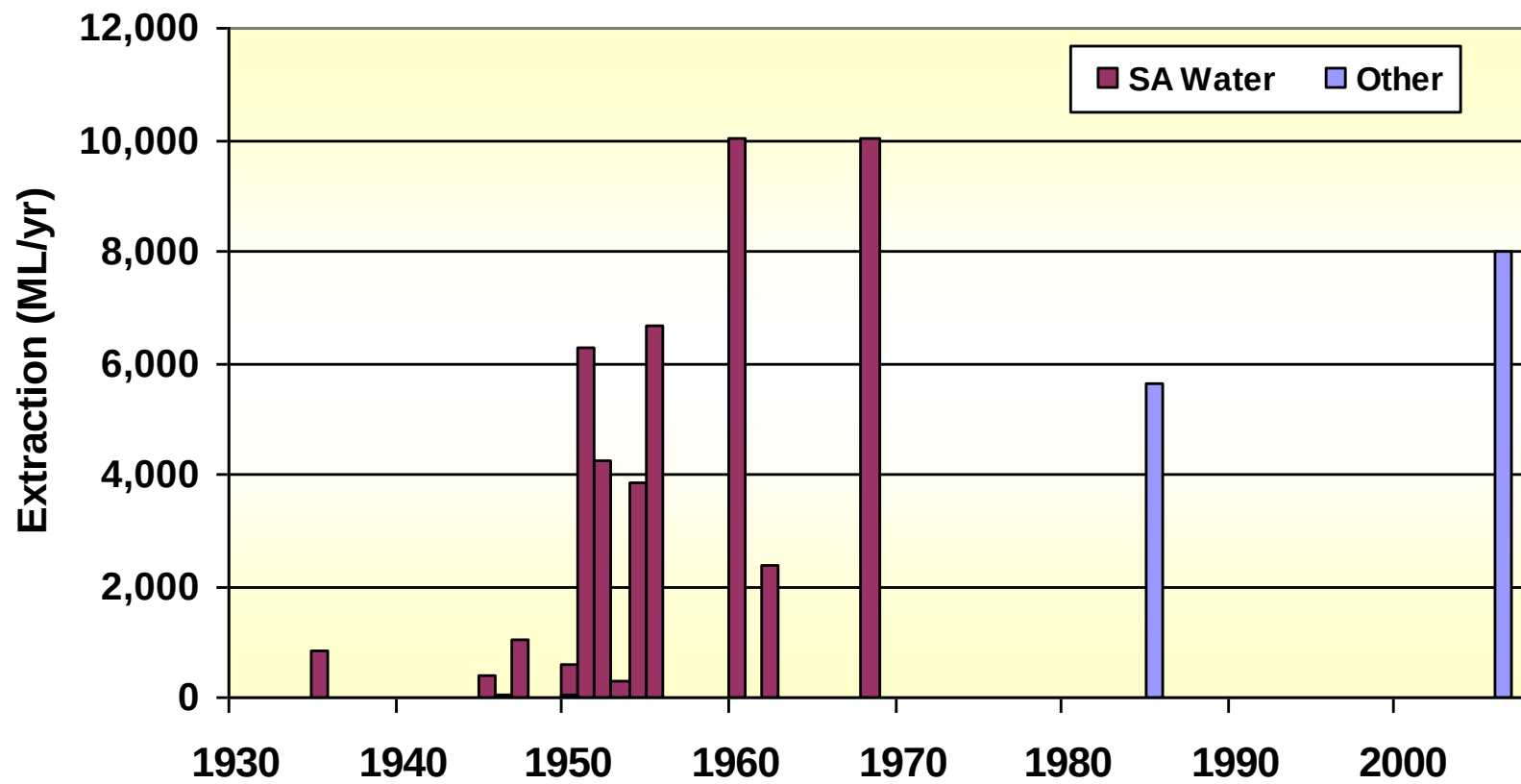


Plate 27: Water boring rig on south bank of River Torrens in the 1880s (Photo: State Library Archives).

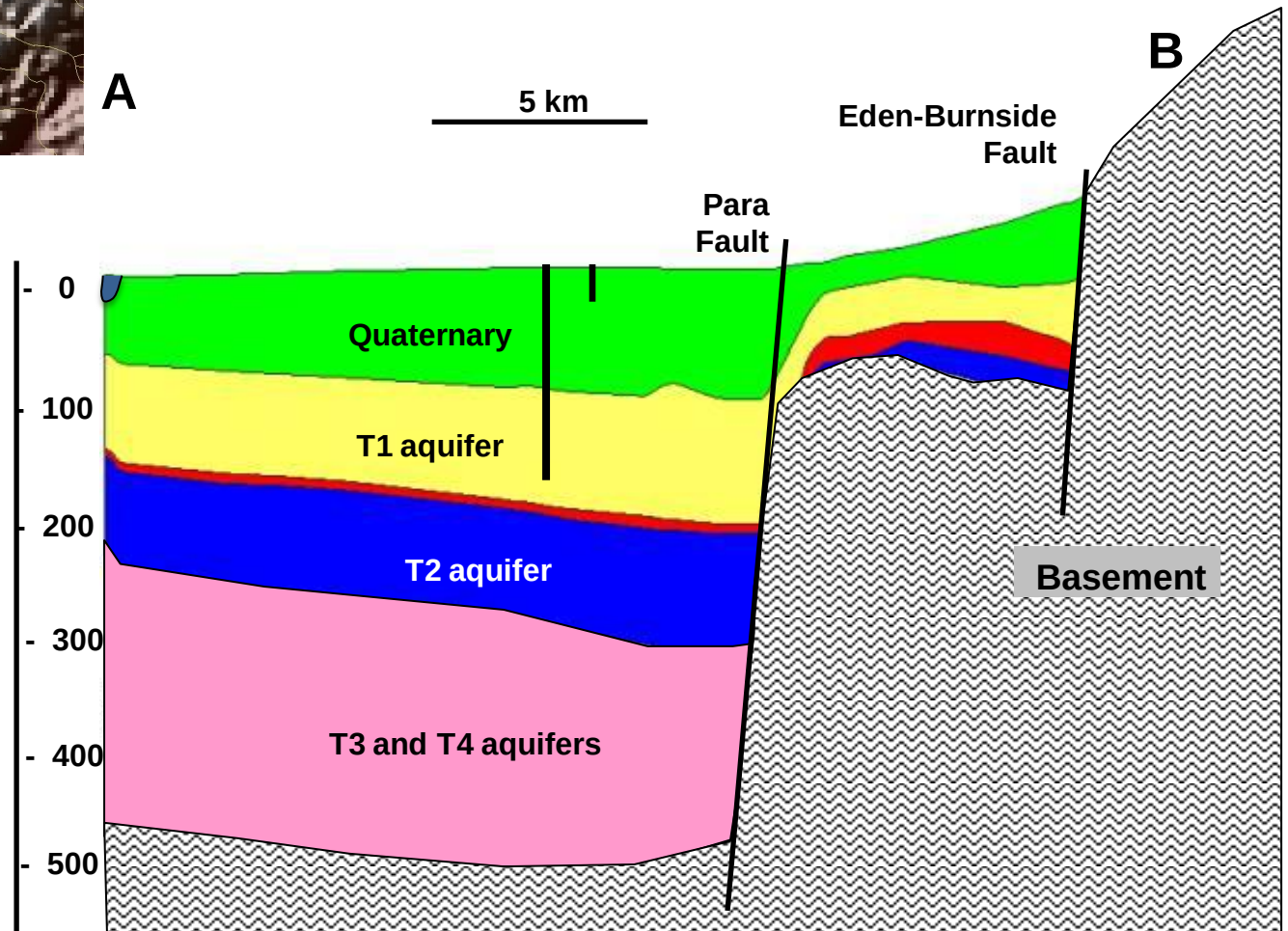
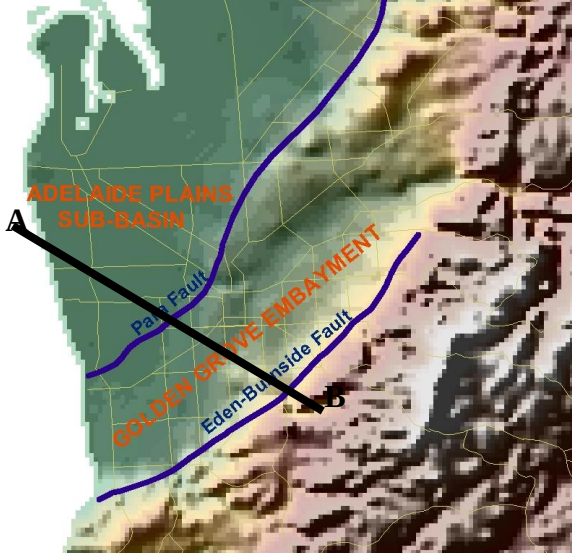


Historical development

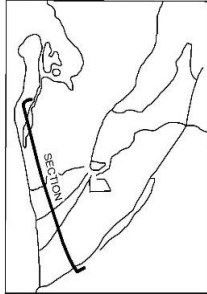
- On several occasions since 1915, it has been necessary to augment the metropolitan water supply with groundwater from ~40 wells
- The latest occasion was in the 1967-1968 summer, when ~ 10,000 ML was pumped from Tertiary aquifers directly into the distribution system during a seven month period
- Horticulture in northeastern and western suburbs was the greatest demand in the 40s and 50s



Hydrogeology



SECTION LOCATION



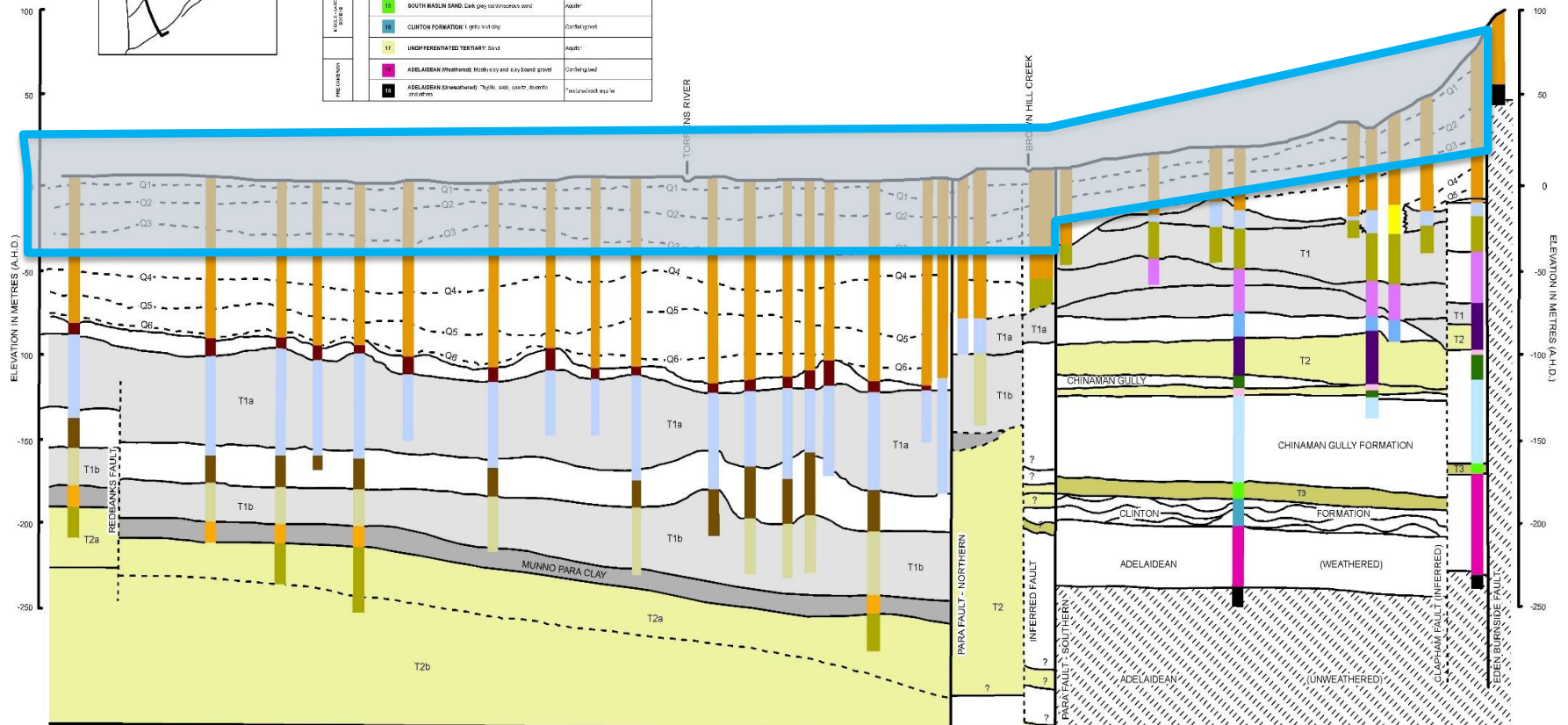
UNIT	DESCRIPTION	REMARKS
1	HIGHWATER CLAY: Clay with mottled bed and green layers	Contains compressed coarser or less fine-grained layers
2	LOWER QUATERNARY CLAY: Dark grey to reddish brown, sandy clay	Confined bed
3	CARRIBROOKE SAND: Fine yellow sand	Aquifer
4	MALLET CREEK SANDSTONE AND DRY CREEK SAND: Grey dark grey	Aquifer
5	CRITCHFIELD FACIES: Fine to medium grained sandstone	Best - confined bed
6	UPPER PORT PHILLIP FORMATION: Yellow and light grey sandstone	Aquifer
7	MURDO PARIA CLAY: Dark grey clay	Confined bed
8	LOWER PORT PHILLIP FORMATION: Light grey to yellow sandstone, clayey sand	Aquifer
9	BURNING MEMBER: Clay, shales, sandstone and silt sand	Confined bed (clay, shales, sandstone, silt and shales)
10	ALONGA CLAY MEMBER: Dark grey clay	Confined bed
11	ALONGA SANDY MEMBER: Light grey to yellow sandstone	Aquifer
12	CHINAMAN GULLY FORMATION: Light grey clay	Confined bed
13	CHINAMAN GULLY FORMATION: Sandstone	Aquifer
14	BLANCHE POINT FORMATION: Clay, silt, sand, fossiliferous	Confined bed
15	SOUTH MOUNTAIN SAND: Dark grey to black sand	Aquifer
16	CLINTON FORMATION: Light grey clay	Confined bed
17	UNDIFFERENTIATED TERTIARY: Sand	Aquifer
18	ADELAIDEAN (weathered): Mottled clay and clay based sand	Confined bed
19	ADELAIDEAN (unweathered): Tuff, clay, sand, gravel, sandstone	Unconsolidated aquifer

QUATERNARY AQUIFERS

First	----- Q1 -----
Second	----- Q2 -----
Third	----- Q3 -----
Fourth	----- Q4 -----
Fifth	----- Q5 -----
Sixth	----- Q6 -----

TERTIARY AQUIFERS

First	T1
Second	T2
Third	T3
Fourth	T4
BEDROCK AQUIFER	
CONFINING BED	



Geological and Hydrogeological Section (Taken from Gerges 2006)

Quaternary

- Top ~50m predominantly clay
- Poor drainage led to piping stormwater to sea
- Contains thin sand aquifers – backyard bores
- Subject to contamination from surface sources, but protects deeper Tertiary aquifers from such contamination
- Subject of most media interest in groundwater beneath Adelaide



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Backyard bores

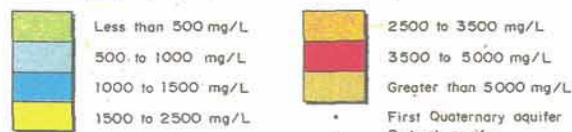
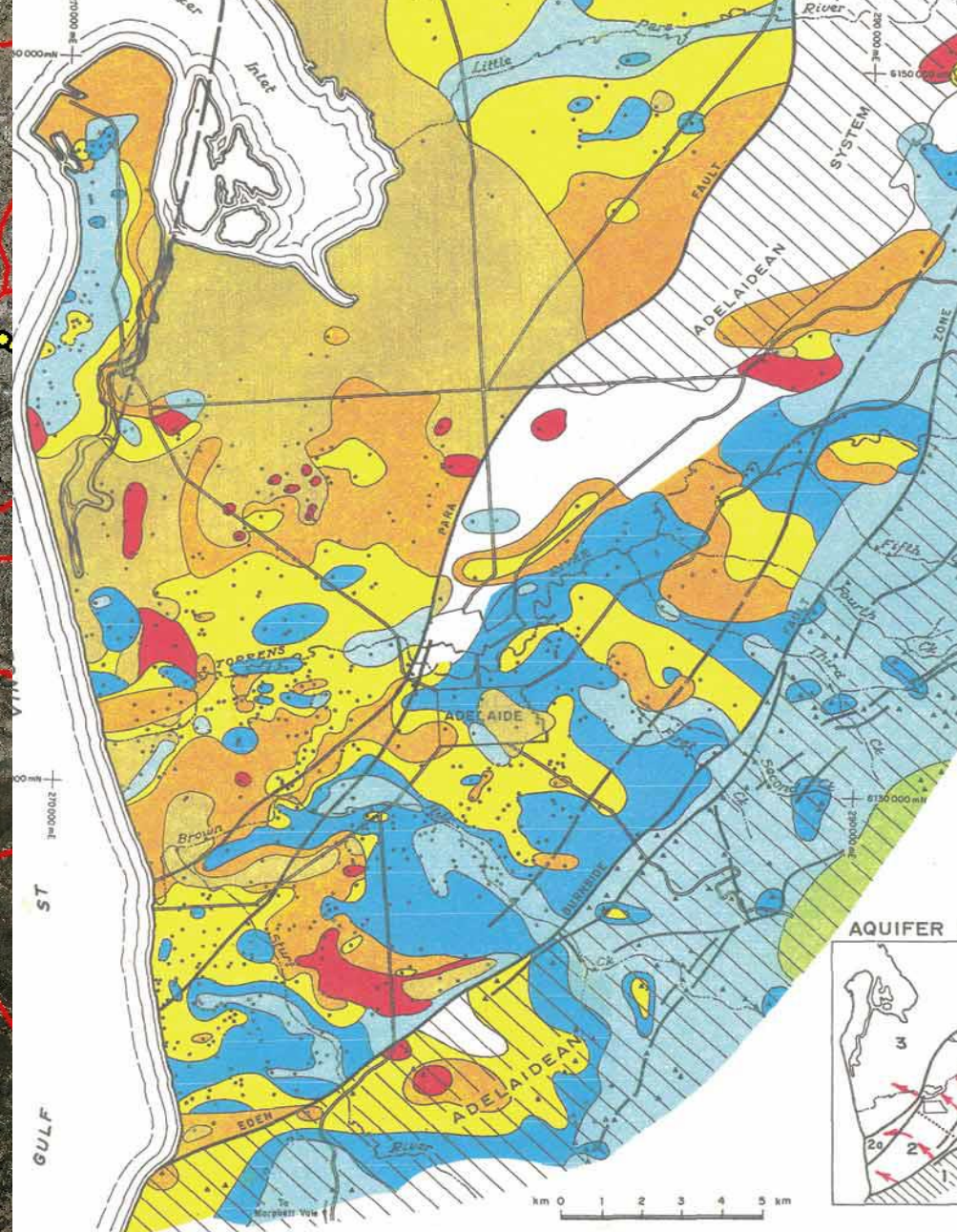
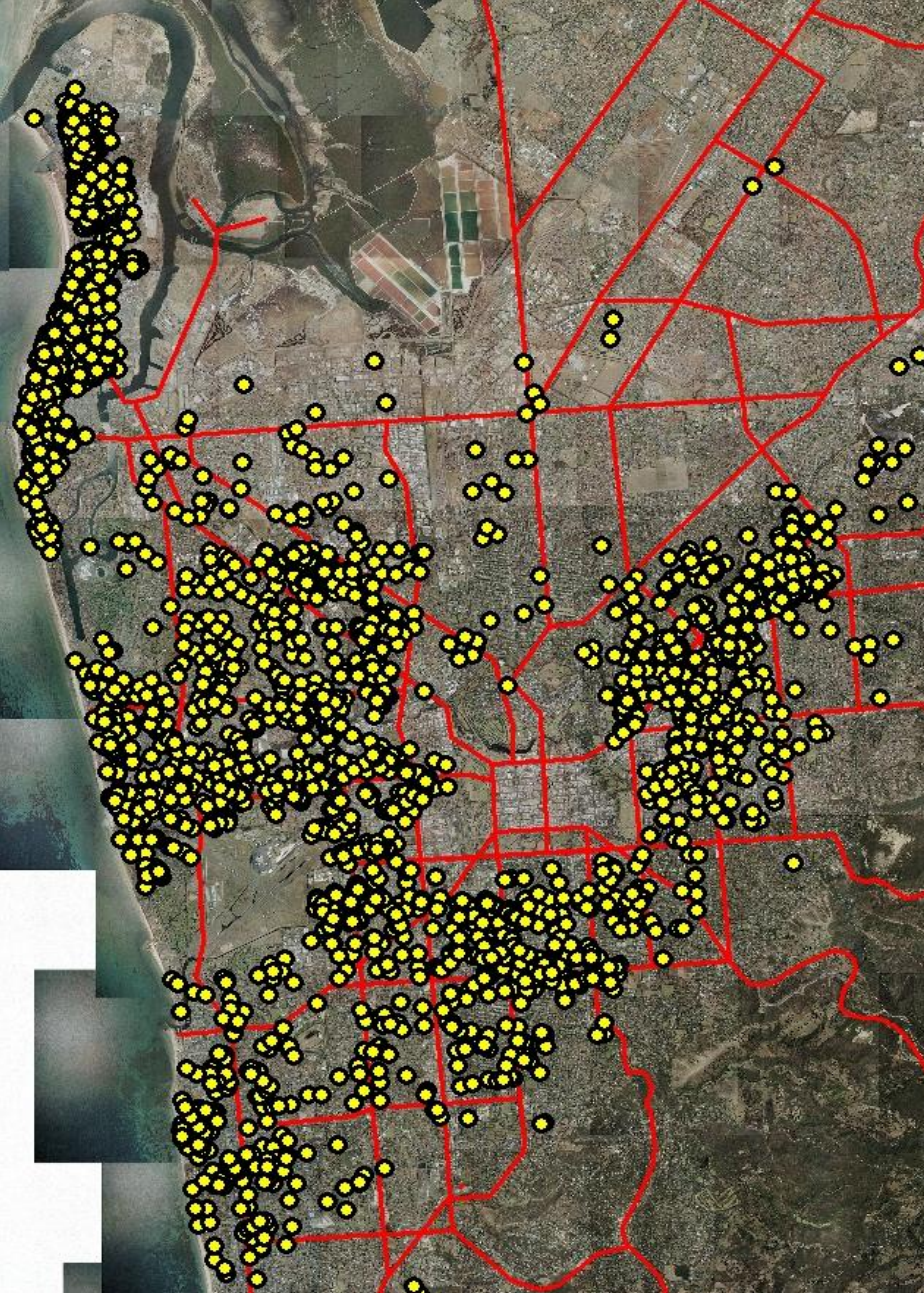
- About 2,000 shallow wells <20m since 1990
- Not licenced, no meters, essentially self managing
- No real adverse trends yet observed
- About 5-10% of total extraction



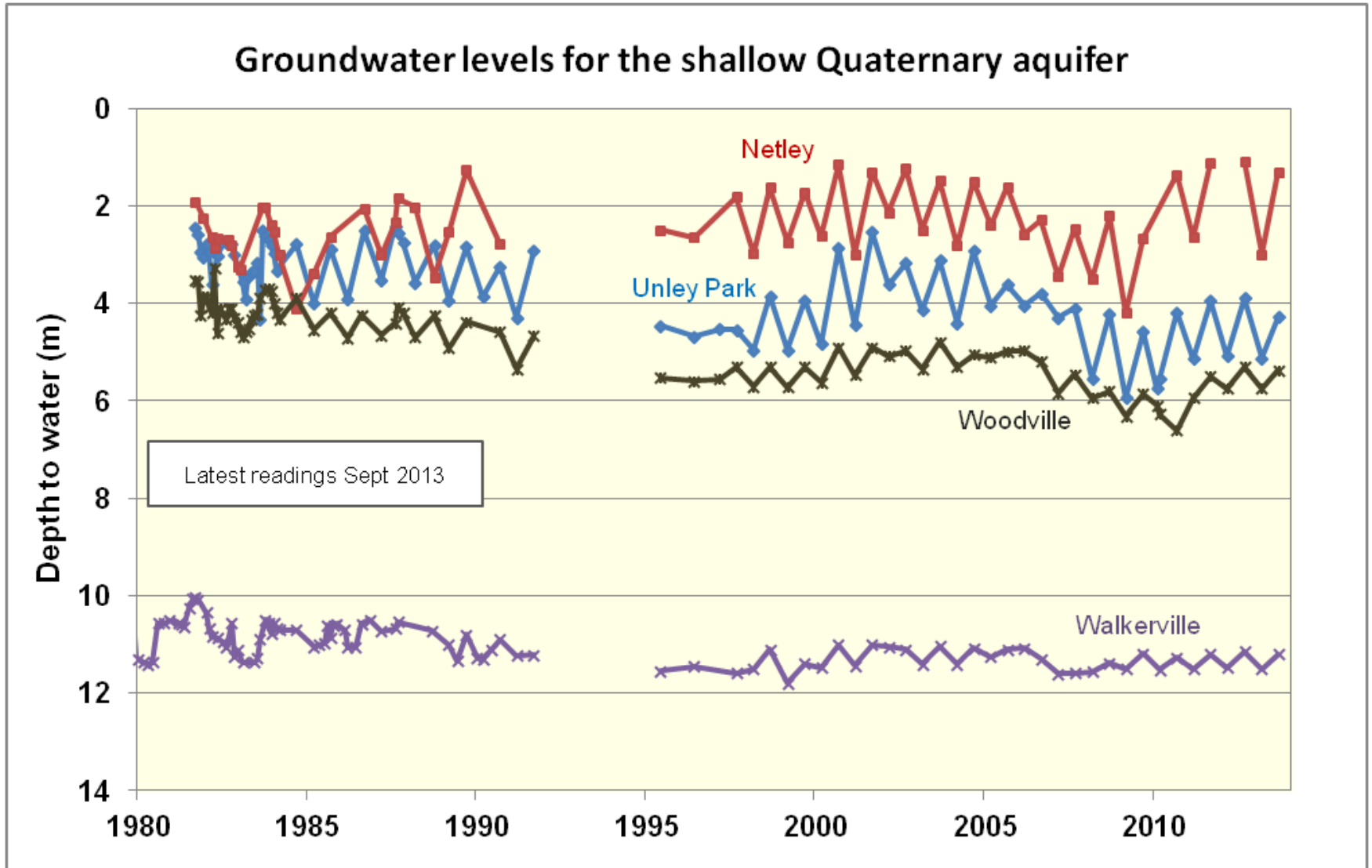
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Backyard bores



"Water Wars in Adelaide"

"Latest figures reveal that many of the top 10 suburbs to sink bores are high-income areas, including Unley Park, St Peters, Toorak Gardens and Malvern.

Unley Park, in which 35 well permits were issued in the 14 months to November, has a median weekly household income of \$1637.

Suburbs such as Findon and Gepps Cross, which have median weekly household incomes of around \$700, secured only one permit each.

It draws a clear line between those who are affluent and those who are needy. It's actually creating water wars in Adelaide when it's unnecessary."

"In Dec 2007, the Government announced a temporary ban on new backyard bores to stem the explosion in numbers which is ravaging underground water supplies."



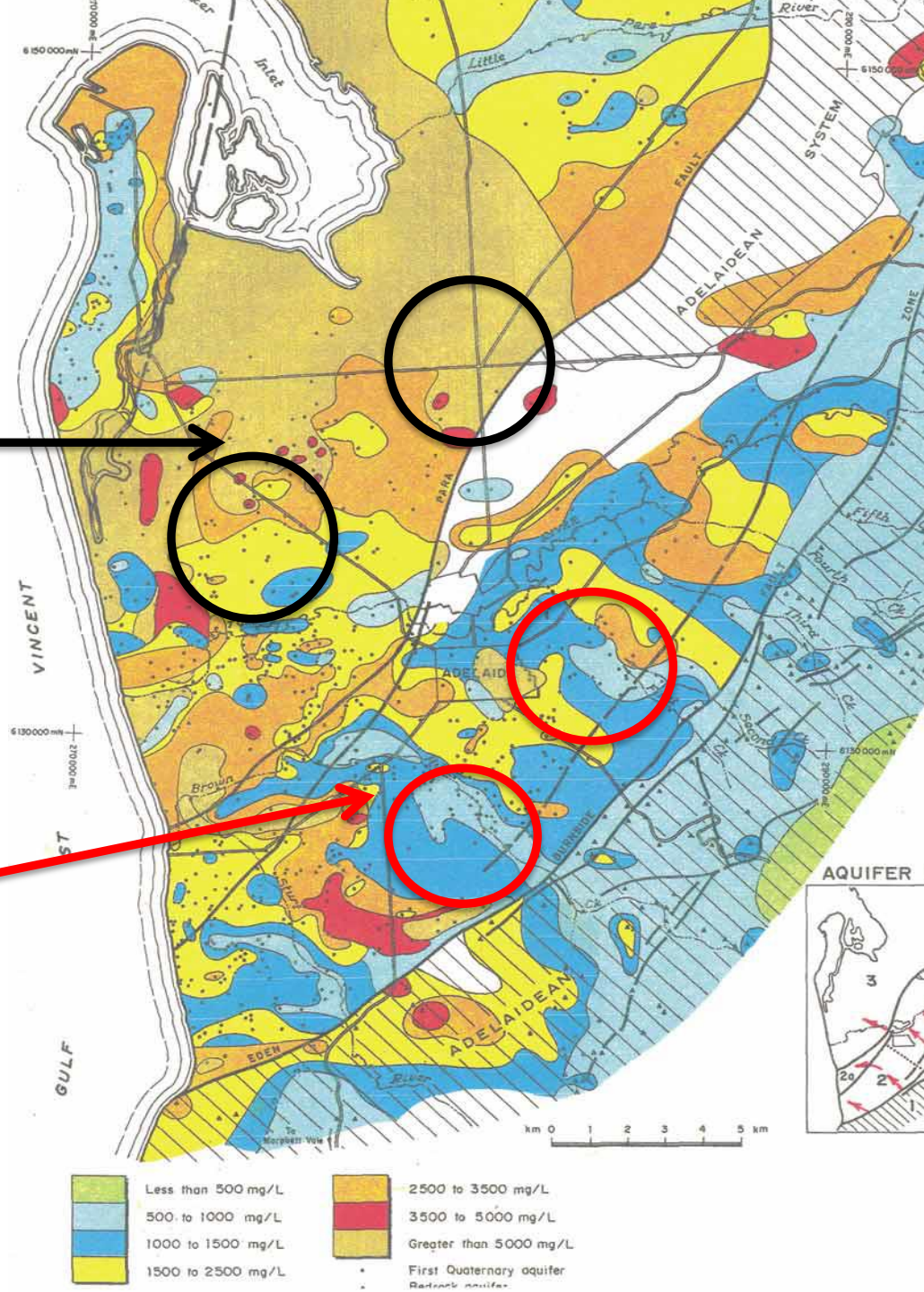
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Low income areas
(2 permits)

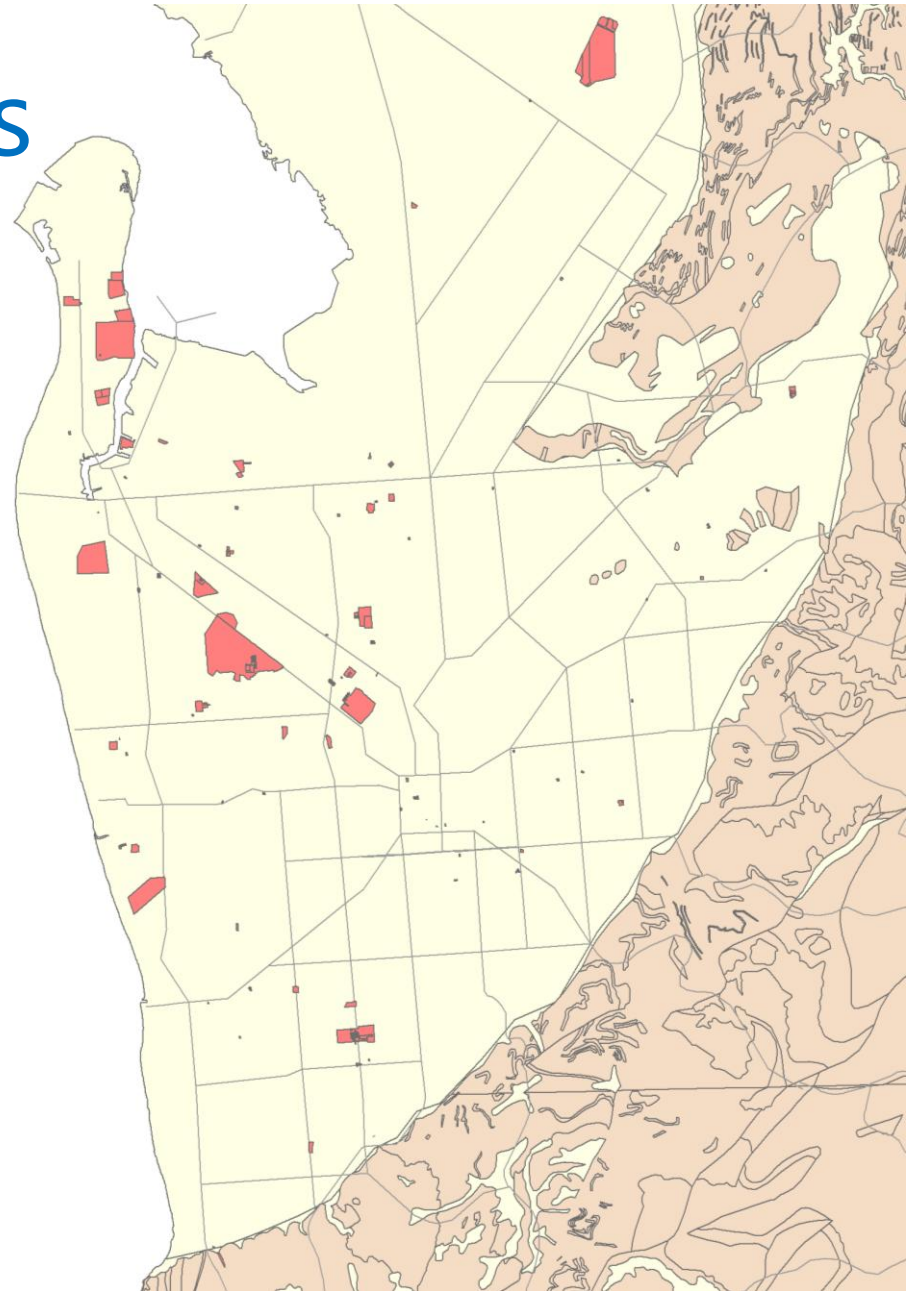
High income areas
(35 permits)



Groundwater contaminated sites

Investigated known
sites

Thousands of potential
sites





Air testing for Clovelly Park homes

Updated Thu Dec 13, 2012 4:27pm AEDT

The Environment Protection Authority (EPA) says Monroe Australia has arranged for air quality testing inside nine homes at Clovelly Park in Adelaide's southern suburbs.



SUNDAY NEWS ADDITION
Sunday 6/1/2013
Page: 10
Section: General News
Region: Adelaide
Circulation: 271,293
Type: Capital City Daily
Size: 1,230.24 sq.cms.
Frequency: —S—

Move us out, plead 'terrified' residents



BRYAN LITTLELY
INVESTIGATIONS EDITOR

CONCERNED Clovelly Park residents, living with contamination in their streets have called for urgent and full disclosure of the risks they face.

Homeowner Justin and Jenni Pearce, who are parents of toddlers, say they have requested financial assistance to relocate from car parts manufacturer Monroe Australia – which owns the industrial site linked to a groundwater contamination plume affecting the area.

The Pearce want to move their family out of the suburb until a full and open assessment of the pollution risks is done.

The area is also troubling their neighbours in Ash Ave and Chestnut Court. To demand answers, letter-dropping, the area and writing to relevant ministers and departments to push for more information as some of their Housing Trust home neighbours get news they may soon be moved.

The Pearce family – who have owned their Ash Ave home for 15 years but moved in only three years ago – have from the Environment

Protection Authority suggested chemicals, including the known carcinogen vinyl chloride, could pose a risk to residents.

Although tests have been done on properties owned by SA Health and Housing SA, none has been done on privately owned homes. Ms Pearce said she had been given no health advice from government authorities or the factors linked to the contaminated groundwater plume that has sparked the risk.

"We are a young family, with two beautiful children aged under three, and our boys play in the garden every day," Ms Pearce said.

"But now we have to abandon our venge patch due to the contamination."

"We are seriously concerned that we have been exposed to these toxic chemicals for a long period of time. The risk of health problems caused by the contamination is horrific."

"As parents of young children, we are devastated and terrified."

Ms Pearce highlighted the fact that a significant number of SA Health-owned properties at the top of

her street were abandoned and demolished in 2009 because toxic vapours at dangerous levels had been detected in them.

Her immediate neighbour, Cheryl Boyce, 60, has requested a Housing SA home transfer after 22 years living in Ash Ave.

"I don't really want to move but over the last 12 months I've been having increased health complications following open heart surgery," Ms Boyce said.

"I only recently asked Housing SA for a transfer. They made the paperwork available almost straight away and they have indicated they will be able to move me pretty much straight away."

Other SA Housing tenants say their requests for transfers have been declined and many were waiting on news of tests before they decided if they want to move.

Environment Minister Paul Gait's office has acknowledged they received the Pearce family's letter this week.



PHOTO: EPA is trying to confirm the contamination source
MAP: Solomontown 5540

MAP: SA

ASH AVENUE

1. HT Status unknown
2. P. Resident of 3 years. Wants help to move if there is a health risk.
3. HT Status unknown
4. HT 22 years. Has asked for transfer and believes SA Housing will comply.
5. HT 20 years. Happy to stay. No issues.
6. HT 20 years. Trying to transfer.
7. HT Status unknown.
8. HT 10 years. Staying.
9. HT Status unknown
10. HT 14 years. Likely wants a move if contamination found.
11. HT. No known issues
12. HT 9 years. No concerns and likes living there.
13. P. Not home.
14. HT. House transfer rejected.
15. P. Not home.

CHESTNUT COURT

1. HT. Health SA accommodation site. Vacated and demolished 2009 over health risks associated with toxic vapours.
2. HT. Not home.
3. HT 7 months. House recently vapour tested. Will want a transfer if toxins detected.
4. HT. Resident says the issue is a "big best-up".
5. HT. Short term resident. Consider a transfer if children are at risk.
6. HT 8 years. Requested transfer in 2009. Home now being refused.
7. HT 7 years. Never advised of 2009 tests. Wants to move if house is dangerous to health.
8. HT 22 years. Currently testing and wants to move.
9. HT 23 years. Tests suggest no danger. Would want to move if danger found.
10. HT 3 years. Wants to stay if safe. No health advice offered.
11. HT. Not home.
12. HT Status unknown.
13. HT 23 years. Tests in 2009 were clear but resident believes there is an issue. Would leave if a suitable transfer was offered.
14. HT 6 years. Concerned about health impacts.
15. HT 4 years. Positive test for vapours in 2009. Trying to get out.
16. HT 12 years. Will try to get out if it is dangerous.
17. HT 16 years. Concerned about family's health.
18. HT 22 years. Adult brother not concerned, sister would like a move.
19. HT 24 years. No concerns. No desire to move.
20. Gateway to Mitsubishi.
21. HT 30 years. No issues.

Vapours removal effort continues

Clare Hesketh

Posted Wed Jul 20, 2011 9:47am AEST

The Environment Protection Authority (EPA) says it will know soon if air purification equipment is successfully removing dangerous vapours from Port Pirie homes.

Testing in the Solomontown area in March found vapours had entered houses from contaminated groundwater at a gasworks site.

Five of 38 home



Adelaide Advertiser
Friday 20/5/2011
Page: 8
Section: General
Region: Adelaide
Type: Capital City
Size: 33.45 sq.cms.
Frequency: MTWTFSS

PORT PIRIE HOMES High toxin levels

TWO homes in Port Pirie have recorded the carcinogenic chemical, benzene. The results come after soil and January identified a toxic inogens from a former gasworks site.

Holden groundwater contaminated at Elizabeth site



GROUNDWATER contamination from Holden's Elizabeth site has spread to neighbouring commercial areas.

Tests seek contamination source

By Clare Hesketh

Posted Thu Feb 2, 2012 8:39am AEDT

The Environment Protection Authority (EPA) says it may remove air purifiers from five homes at Port Pirie sooner than expected, if air and soil testing results are favourable.

The purifiers were put in the houses at Solomontown last May to help tackle benzene vapour levels.

The chemical is suspected to have entered the homes from contaminated groundwater from a former gasworks site.

Peter Dolan of the EPA says testing has been trying to confirm the source.



PHOTO: EPA is trying to confirm the contamination source
MAP: Solomontown 5540

Solvents found in Elizabeth contamination check

Updated Thu Aug 9, 2012 12:30pm AEST

Groundwater and soil testing near Holden's plant in northern Adelaide has found evidence of two solvents.

Holden has been testing since contamination was found near the Elizabeth plant and in the surrounding residential area last year.

The company has now sent letters to 95 properties in the area and will do soil tests at 20.

Environment Protection Authority (EPA) manager of site contamination, Andrew Pruszkinski, said the vapour found is thought not to be a health risk.

"Solvents that were used in the past for all sorts of industrial purposes were volatile in nature, that means they give off a gas," he said.

"When it goes down into groundwater, the gas can then come back up through the soil profile to the surface. The results we have to date do not suggest that there's a risk to health. This is a precautionary measure to make sure that that's the case."



PHOTO: Holden said it no longer used the solvents and was doing all it could to deal with the issue (ABC News)

RELATED STORY: Groundwater contamination prompts EPA warning

RELATED STORY: Chemicals spread beneath Holden plant

MAP: SA

The EPA establishes Groundwater Prohibition Areas around identified contaminated sites to prohibit people with both registered and unregistered bores (>30m deep) from using groundwater

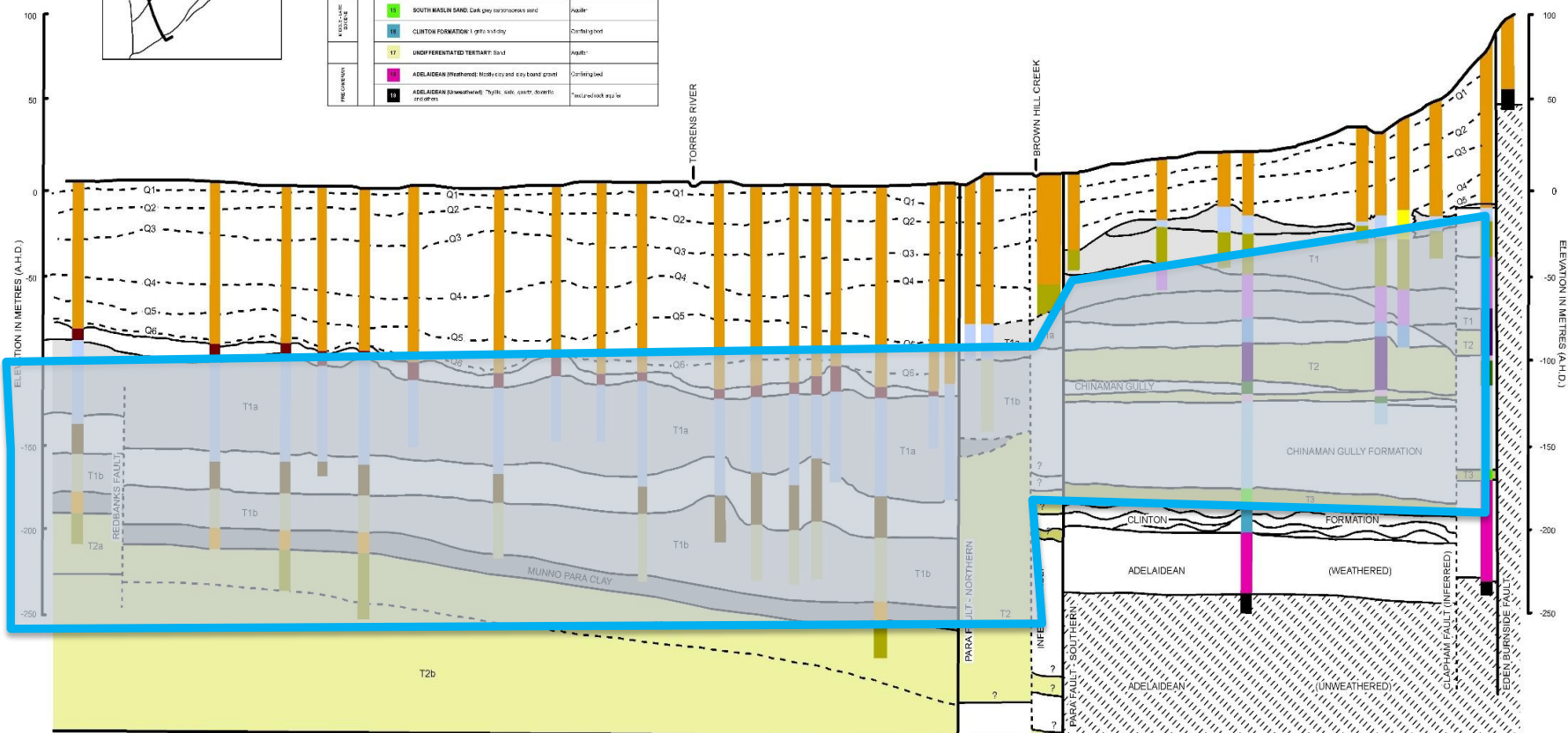
No new permits issued



UNIT	LITHOLOGY	FACIES	REMARKS	CORRELATION	LITHOLOGY	FACIES	REMARKS	CORRELATION
FLUORIDE	15	HIGHWAY CLAY: Clay with embedded sand and gravel layers			15	HIGHWAY CLAY: Clay with embedded sand and gravel layers	Generally composed of silty clay with some gravel	
	16	LOWER QUATERNARY CLAY: Dark grey to reddish brown, silty clay			16	LOWER QUATERNARY CLAY: Dark grey to reddish brown, silty clay	Continued	
	17	CARBONERO SAND: Fine yellow sand			17	CARBONERO SAND: Fine yellow sand	quartz	
	18	HULLET COAL: SILTSTONE AND FINE CREEK SAND: Grey, silty clay			18	HULLET COAL: SILTSTONE AND FINE CREEK SAND: Grey, silty clay	quartz	
	19	CHOCOMA FACIES: Fresh brown, silty clay, silty sand			19	CHOCOMA FACIES: Fresh brown, silty clay, silty sand	Dark, silty clay and sand	
	20	UPPER PORT WILLIAMS FORMATION: Yellow to light grey, silty sand			20	UPPER PORT WILLIAMS FORMATION: Yellow to light grey, silty sand	quartz	
	21	MURRAY SAND CLAY: Dark tan grey clay			21	MURRAY SAND CLAY: Dark tan grey clay	Continued	
	22	UPPER PORT WILLIAMS FORMATION: Light grey to yellow, silty sand, silty clay			22	UPPER PORT WILLIAMS FORMATION: Light grey to yellow, silty sand, silty clay	Continued	
	23	BEAVERBANK KNEE: Clay with shales and silty sand			23	BEAVERBANK KNEE: Clay with shales and silty sand	Continued (partly shales and shales)	
	24	ALONGA CLAY/WEATHER: Dark grey clay			24	ALONGA CLAY/WEATHER: Dark grey clay	Continued	
FLUORIDE	25	ALONGA SANDY MEMBER: Light grey to brown, low-medium			25	ALONGA SANDY MEMBER: Light grey to brown, low-medium	quartz	
	26	CHOCOMA GULLY FORMATION: Light grey to brown, low-medium			26	CHOCOMA GULLY FORMATION: Light grey to brown, low-medium	Continued (partly shales and shales)	
	27	CHOCOMA GULLY FORMATION: Red and black			27	CHOCOMA GULLY FORMATION: Red and black	quartz	
	28	ELANOR POINT FORMATION: Clay, shaly, tan, silty, silty sand, silty clay			28	ELANOR POINT FORMATION: Clay, shaly, tan, silty, silty sand, silty clay	Continued	
FLUORIDE	29	SOUTH WILSON SAND: Dark grey, silty sand, silty clay			29	SOUTH WILSON SAND: Dark grey, silty sand, silty clay	quartz	
	30	CLINTON FORMATION: Light grey to brown, low-medium			30	CLINTON FORMATION: Light grey to brown, low-medium	Continued (partly shales and shales)	
	31	UNDIFFERENTIATED TERTIARY: Silty			31	UNDIFFERENTIATED TERTIARY: Silty	quartz	
	32	ALANOR (Weathered): Reddish clay and sand, silty sand			32	ALANOR (Weathered): Reddish clay and sand, silty sand	Continued	
FLUORIDE	33	ALANOR (Weathered): Reddish clay and sand, silty sand			33	ALANOR (Weathered): Reddish clay and sand, silty sand	Continued	
	34	ALANOR (Weathered): Reddish clay and sand, silty sand			34	ALANOR (Weathered): Reddish clay and sand, silty sand	Continued (partly shales and shales)	

First	-----Q1-----
Second	-----Q2-----
Third	-----Q3-----
Fourth	-----Q4-----
Fifth	-----Q5-----
Sixth	-----Q6-----

First	T1
Second	T2
Third	T3
Fourth	T4
BEDROCK AQUIFER	
CONFINING BED	



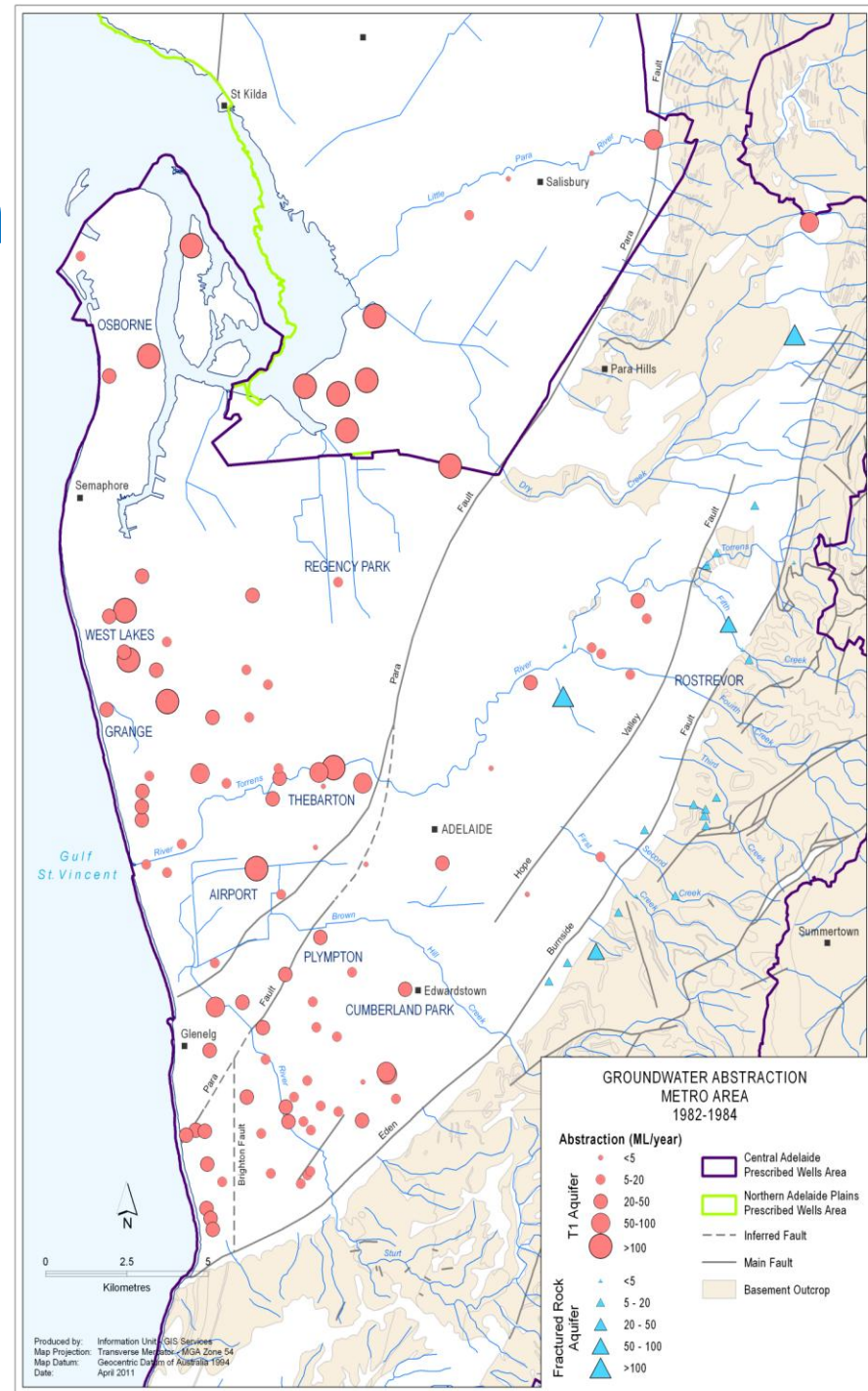
Geological and Hydrogeological Section (Taken from Gerges 2006)

Distribution of groundwater extraction

T1 and T2 aquifers

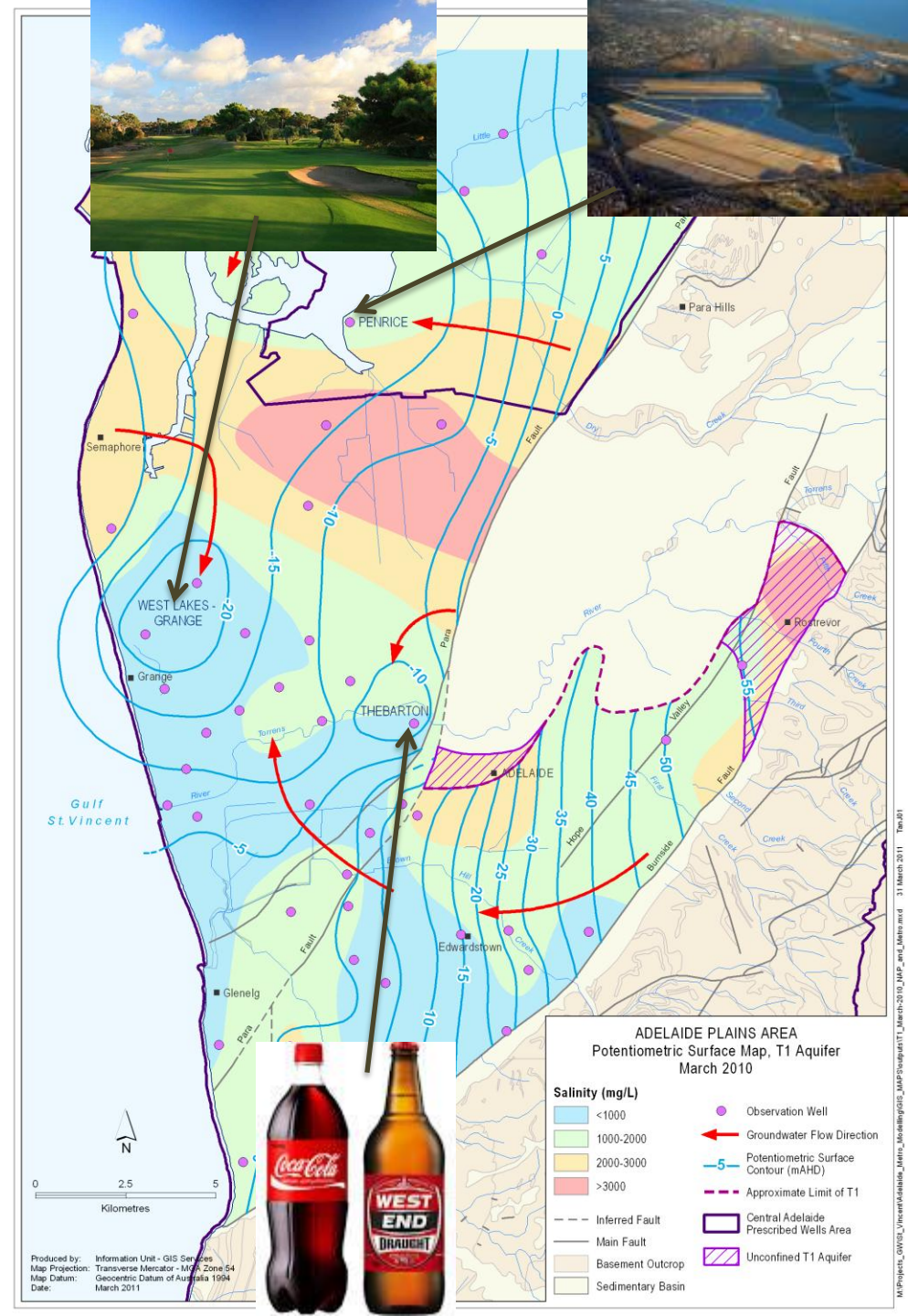
Exact volumes not known with certainty

Limited potential for significant increased demand



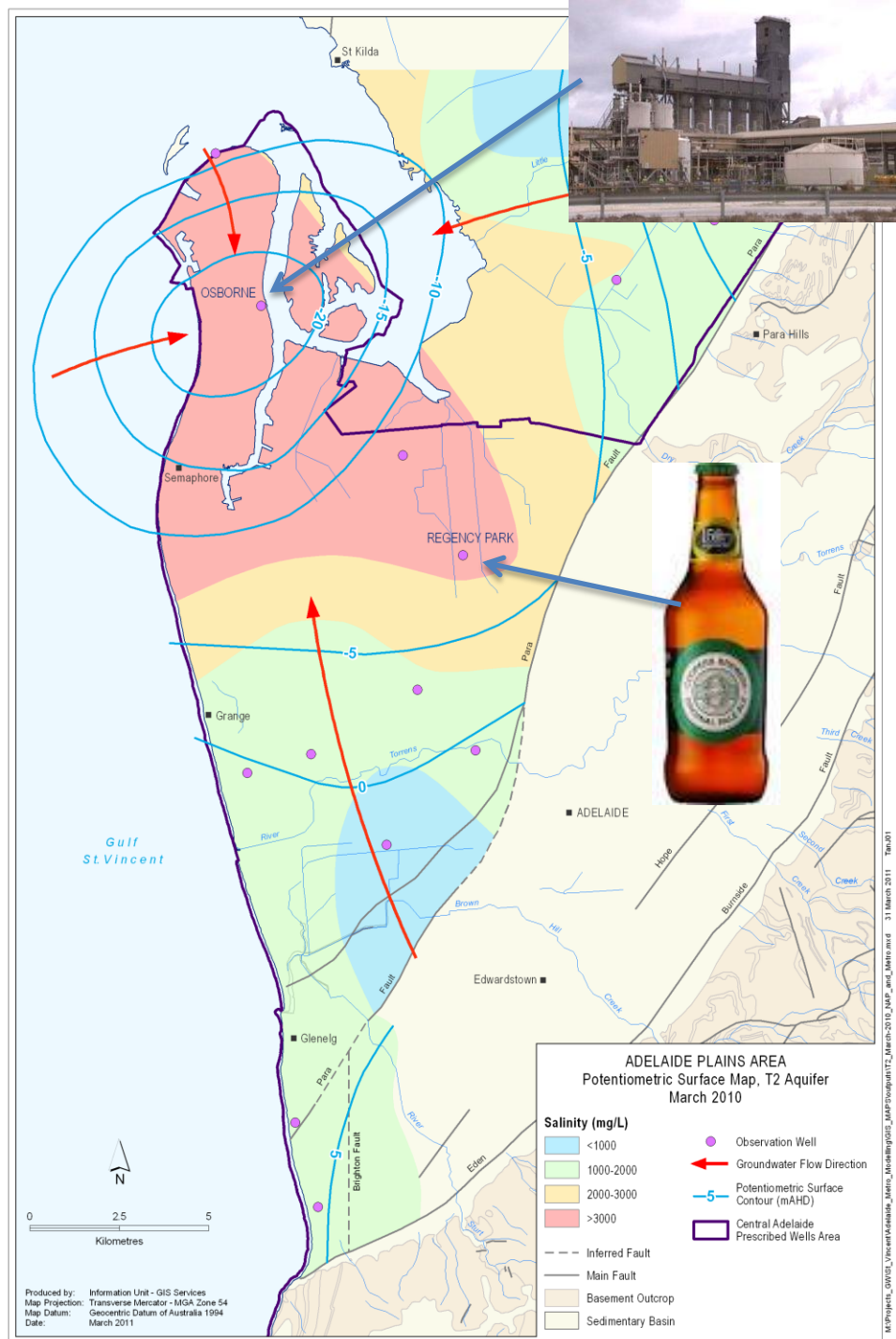
Groundwater Flow and Salinity – T1 aquifer

- Long-standing cone of depression corresponds to the location of pumping centres at Penrice, Thebarton and golf courses in the Grange–West Lakes area
- The pressure levels never fully recover due to the continuous industrial pumping during winter
- Groundwater salinity below 1000 mg/L reflects the flowpaths from the recharge areas.



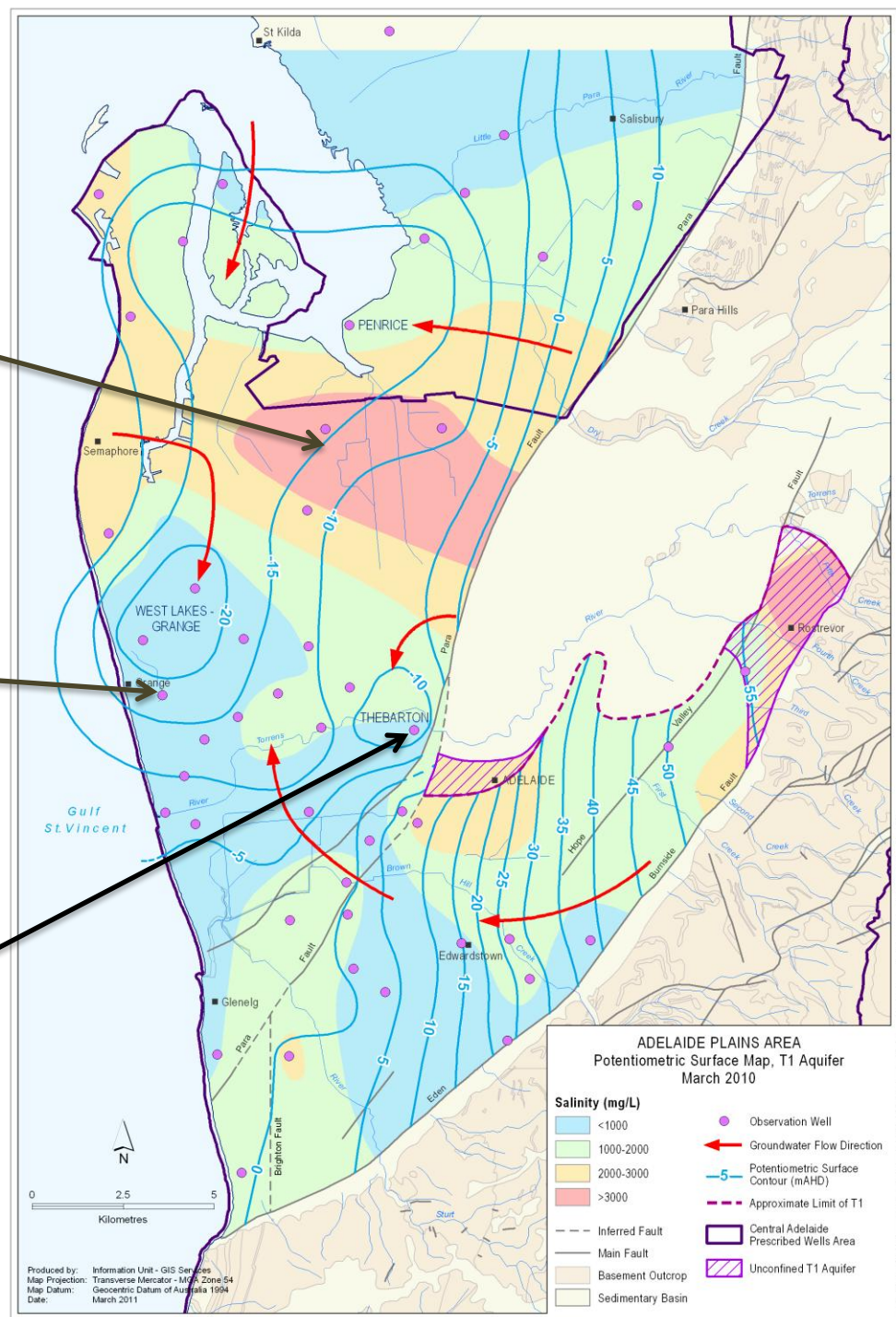
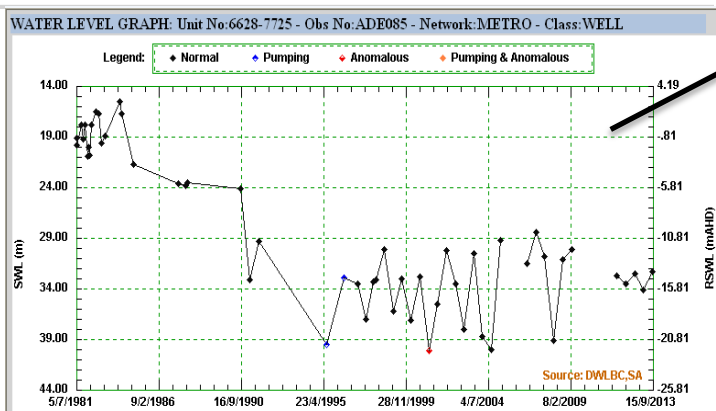
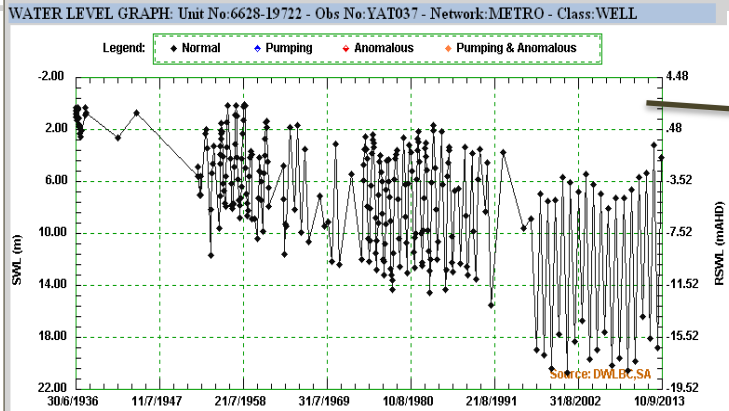
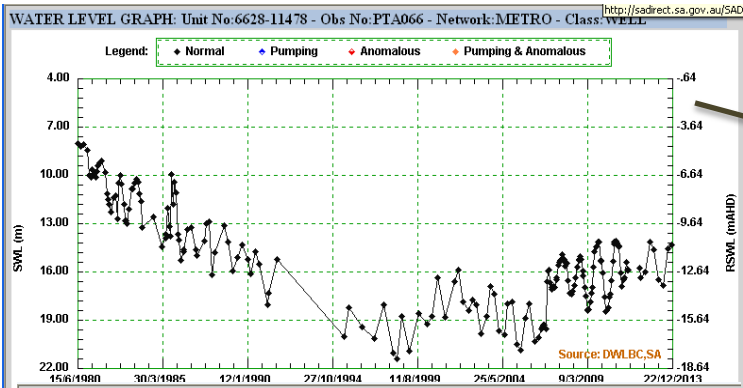
Groundwater Flow and Salinity – T2 aquifer

- Long-standing cone of depression corresponds to the location of pumping centres at Osborne and Regency Park
- Groundwater salinity below 1000 mg/L reflects recharge mostly by lateral flow



Groundwater Trends

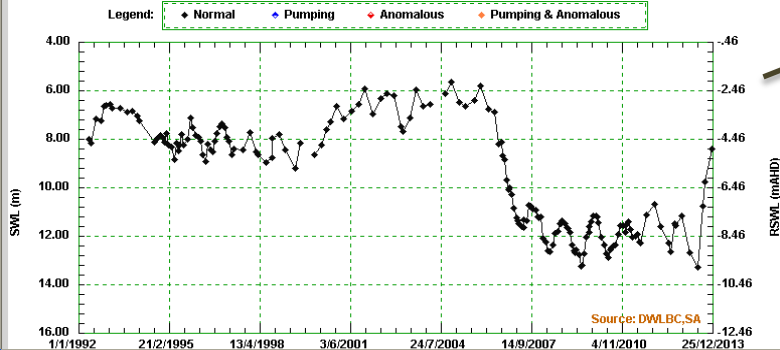
– T1 aquifer



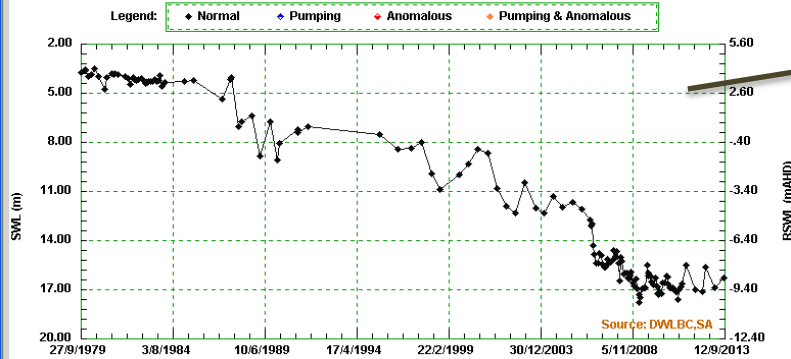
Groundwater Trends

– T2 aquifer

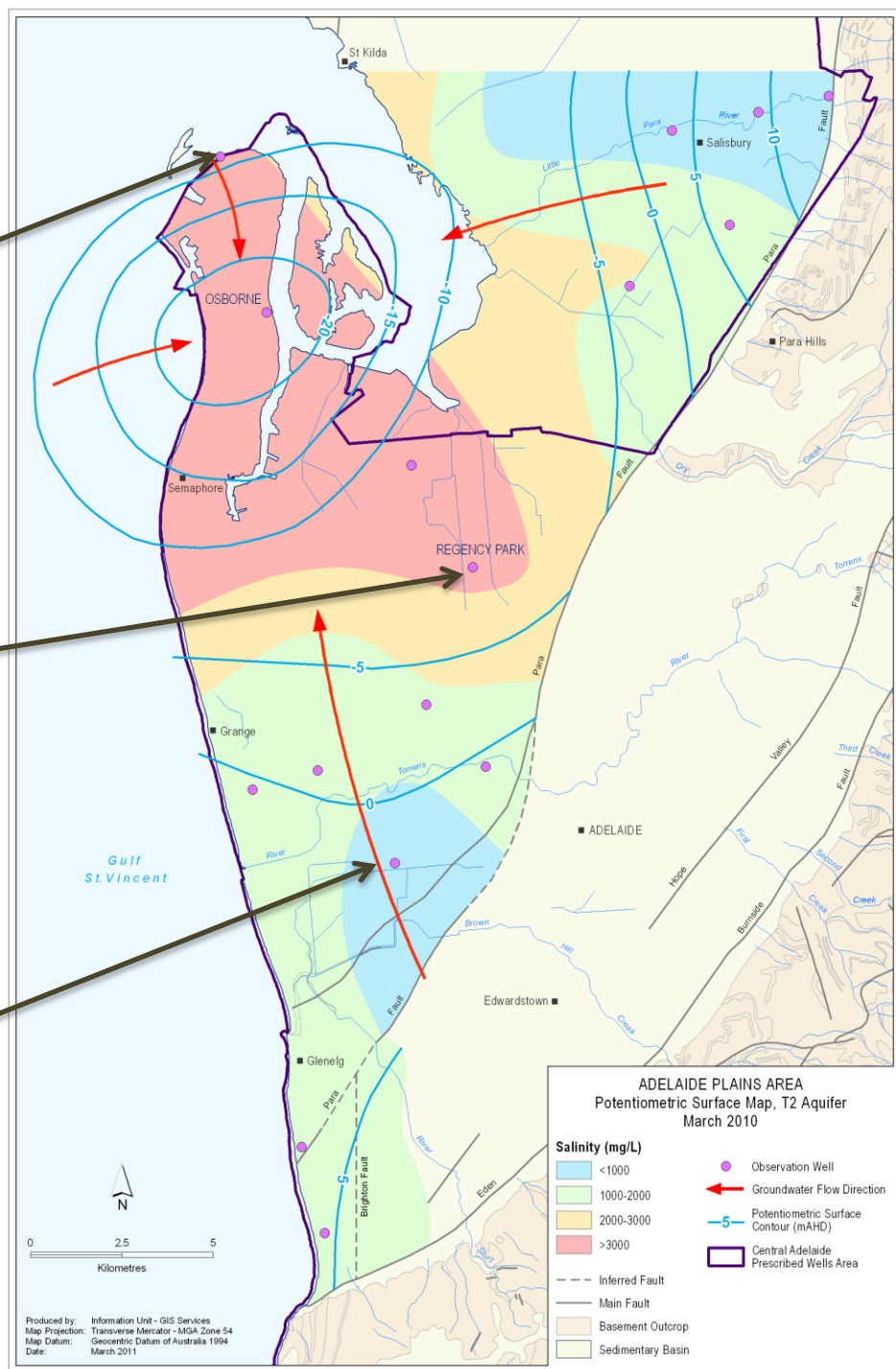
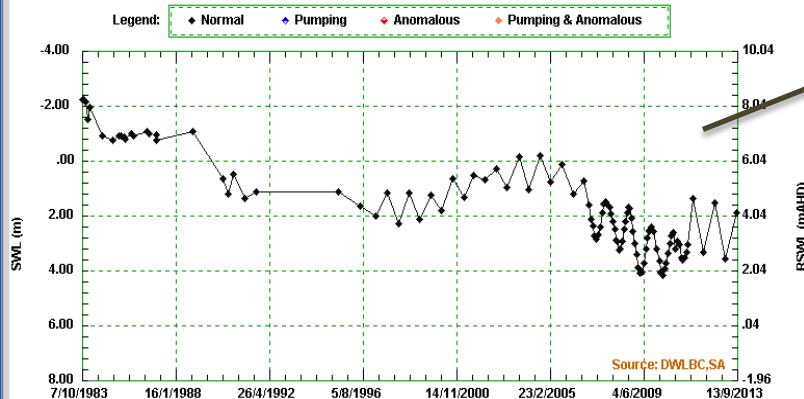
WATER LEVEL GRAPH: Unit No:6528-254 - Obs No:PTA040 - Network:METRO - Class:WELL



WATER LEVEL GRAPH: Unit No:6628-8899 - Obs No:YAT053 - Network:METRO - Class:WELL



WATER LEVEL GRAPH: Unit No:6628-12452 - Obs No:ADE146 - Network:METRO - Class:WELL



Managed Aquifer recharge

- Very successful in northern suburbs where lots of space form wetland treatment of stormwater
- Options limited elsewhere due lack of open space – need smarter options
- Injection of significant volumes of water into deeper confined aquifers likely to lead to artesian conditions over large areas
- Headworks of many bores not designed for this



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ASR Where ?

Where are we now ?

- Very good understanding of hydrostratigraphy (Gerges)
- Flow and solute transport model platform that can be upgraded by additional data and understanding
- Most recharge to Tertiary aquifers occurs laterally across faults from Hills FRA
- No evidence yet of active sea water intrusion



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20,000 years ago



Data gaps ?

- Nature of flow across faults
- Leakage between aquifers
- Risk of sea water intrusion



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QUESTIONS?



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