SA Water Drinking Water Quality

January 2000 – July 2012



Amended Version: October 21 2012



Image: Myponga Reservoir

Compiled by Anthony Amis

Thanks to Warren Godson for the idea and support.

Without tax deductible donations this project would never have happened. If you would like more information or would like to make a donation contact <u>anthonyamis@hotmail.com</u> for more details.

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Glossary

ADWG: Australian DrinkingWater Guidelines DBCM: Dibromochloroform BDCM: Bromodichloromethane DBP: Disinfection By-Product DCBM: Dichlorobromoform FoE: Friends of the Earth FoI: Freedom of Information IARC: International Agency for Research on Cancer NDMA: N-nitrosodimethylamine THM: Trihalomethanes WHO: World Health Organisation

Concentrations in Water

mg/L: parts per million (one cup of water in a swimming pool) ug/L: parts per billion (one drop of water in a swimming pool) ng/L: parts per trillion (one thousandth of one drop of water in a swimming pool)

Information About Amended Version of this Report.

This report was initially released via a press release on October 15 2012. The initial version contained an apparent error in the calculation of Monochloramine breaches to the Australian Drinking Water Guidelines. The initial report stated that over 5000 Monochloramine breaches had occurred between the years 2000-2012. This claim was made due to interpreting the Guideline to be 3mg/L (5000 detections of Monochloramines were equal to or above this level). Later communication from SA Water has stated that the guideline should have been interpreted at 4.1mg/L. "In the Friends of the Earth media release, the ADWG monochloramine guideline has been incorrectly applied to the SA Water results which are reported as mg/L total chlorine (guideline 4.1 mg/L)" SA Water email Oct 19 2012.

There is no way to confirm this information pertaining to total chlorine, according to the data contained within the Freedom of Information documentation, but in light of the recent information provided by SA Water, it has been decided to amend this report to include Monochloramine detections above the 4.1 mg/L guideline.

1. Background

On 12 July 2012, Anthony Amis from Friends of the Earth (FoE) Australia sent a Freedom of Information request to SA Water.

The FoE requested: "... details of water quality testing results (including tap water tests) by SA Water or contractors employed by SA Water ... recorded between the dates 1/1/00 to 12/7/12. I also require test results at township sites. Aesthetic guideline results are not required...

Health related criteria would include;

- Ecoli and other microbiological indicators, Cyanobacteria (algal toxins),
- Chlorine based/Chloramination based disinfection by-product chemicals
- Trihalomethanes [Trichloromethane (Chloroform), Dibromochloromethane, Tribromomethane (Bromoform), Bromodichloromethane
- Dichloroacetic Acid, Trichloroacetic Acid, Chloroacetic Acid, Chloral Hyrdrate etc.
- N-nitrosodimethylamine (NDMA), Cyanogen Chloride (as Cyanide)

Other substances also requested would include Fluoride, Chlorite, Chlorate, Cyanide, Nitrate, Nitrite, organic compounds and Radionuclides (including beta and gamma emitting)

Health related criteria for a range of heavy metals including antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, zinc and selenium etc are also requested..."

The FoI request did not request information based on aesthetic guidelines for drinking water, most notably, turbidity, aluminium, colour, pH etc.

On 23 August 2012, Friends of the Earth Australia received a final response from SA Water, with a PDF file containing 9135 pages of test results. We estimate that 694,220 test results were included in the released material. From the test results supplied to FoE only test samples that were above the Australian Drinking Water Guidelines (ADWG) were copied from the released information. If test results were for substances without specific guidelines under the ADWG, World Health Organisation (WHO) Guidelines were used as a fallback and also copied.

From the test results, 4202 samples came in above the ADWG and WHO guidelines. 0.61% of all samples therefore were equal to or breached the guidelines. [However if one takes into account breaches of the WHO Guideline for Bromodichlormethane/Dichloroform, from 15769 samples, 2382 (15.1%) breached the guideline, highlighting FoE's concern for this substance].

Friends of the Earth believes that water consumers should be provided with more detailed information pertaining to the quality of their drinking water. A monthly summary of all water samples could easily be uploaded onto the SA Water website. More detailed information could also be provided concerning the substances tested for and why they are being tested.

Friends of the Earth is also disappointed that the Australian Drinking Water Guidelines, do not have guidelines for individual trihalomethanes, but rather only have guidelines for the sum of four trihalomethanes. This allows for a downgrade of the significance of individual THM compounds such as Bromodichloromethane, whose individual sample readings can effectively be *'swept under the carpet'* or *'watered down'* statistically.

It seems odd that in the case of Bromodichloromethane, this is the chemical affecting most South Australians, particularly in Adelaide, yet how many people have been informed that they are being exposed to this chemical on a daily basis everytime they shower, have a glass of water or cup of tea?

Ideally Friends of the Earth would like to see alternative water treatment plants constructed in South Australia, plants that did not rely on chlorine. These changes will require political will and require the South Australian community to demand them.

It should also be stated that in 2011 Friends of the Earth also applied to SA Water for information concerning the detection of pesticides from the years 1996-2011, including tap sampling. From that information it was determined that

breaches to the 2011 ADWG occurred once with the forestry herbicide Atrazine at South Para Reservoir (30 July 1998) although hundreds of detections below guideline levels were found. It was also determined that SA Water will only test tap water for pesticide residues, if dangerous levels are first found in reservoir supplies. It appears that no tap samples have been tested for pesticides by SA Water. Pesticides were therefore not a subject covered in this report.





Kingscote and Brownlow - Kangaroo Island

The township of Kingscote on Kangaroo Island recorded the most breaches in terms of drinking water between the years 2000 – July 2012. A total of 435 breaches were recorded at Kingscote and 134 breaches at nearby Brownlow. Between them, these 569 breaches represent 13.5% of all the drinking water breaches recorded by SA Water over 12 years. 99.65% of the breaches at Kingscote and Brownlow relate to Chlorine Disinfection Byproducts, mostly Trihalomethanes (THM's).

THM's consist of 4 chemicals: Chloroform, Bromoform, Dibromochloromethane and Bromodichloromethane (BDCM). The Australian Drinking Water Guidelines (ADWG) combine these four substances and then give a guideline level only for the sum of the four. That guideline is 250 parts per billion. The WHO however give guidelines for each of the four substances, with the most toxic, BDCM given a safe drinking water guideline of 60 parts per billion.

The results show that although THM breaches across the SA Water network, between the years 2000 -12, numbered 581, if calculated individually, there were over 3000 individual DBP breaches. For Adelaide this is significant as only 22 breaches to the THM level were found over dozen years that the FoI application covered, but over 800 breaches

occurred for BDCM/Dichlorobromoform over the same time period.

The IARC (International Agency for Research on Cancer) has classified BDCM in Group 2B (possibly carcinogenic to humans). What this could indicate is that many other communities across Australia may have none or low numbers of breaches for THM's, yet could be consuming dangerous levels of individual DBP's and these results are not made public by water authorities. Some DBP's have been linked to bladder cancer and adverse reproductive outcomes. Water authorities test for a handful of DBP's, yet 700 have been discovered. DBP's are created when chlorine used as a disinfectant, combines with organic molecules in the water distribution process.

People are also exposed to DBP's through inhalation when swimming, showering in chlorinated water or by simply turning on a tap. This accumulated exposure is often ignored when setting standards for drinking water. DBP's can be higher first thing in the morning, due to overnight accumulation. It is common practice by water authorities to carry out testing on drinking water after first running taps for 3 minutes. Yet how many people leave a tap running for three minutes in the morning before pouring a glass of water, putting a jug on for tea or coffee and when having a shower?

Chloramination, another form of water treatment used primarily in rural areas, is also used as a means of reducing formation of halogenated disinfection byproducts, yet has also been found to increase concentrations of the genotoxic (damages DNA) NDMA *N*-nitrosodimethylamine. Interestingly NDMA has been detected in the SA Water network, yet sampling is currently only done in a fraction of the communities that are drinking chloraminated water. Chloraminated water has also been reported to aggravate skin, digestive and respiratory ailments.

It is highly unlikely that SA Water will reduce chlorination of drinking water in the near future. To do so could increase the risk of exposing the population to waterborne disease. The safest option for people wanting to avoid the risks of being exposed to chlorine and its by-products is to opt for purchasing a water filter for their home and work place use. A filter using reverse osmosis or granulated carbon would be the best place to start. South Australian's should also start lobbying for alternative disinfectants to chlorine. Other water treatment processes such as Ultraviolet or Ozone whilst not perfect, may also be beneficial.

South Australian's should also be asking the Government and SA Water, why they haven't been informed that they have been consuming drinking water containing possibly carcinogenic substances for much of the past decade and most likely many years earlier as well. It is simply not good enough for Government authorities to know that a situation has existed and not inform the public of the potential risks associated with consuming drinking water with levels of Bromodichloromethane for example, higher than what the World Health Organisation recommends.

South Australia's should also demand to know what the Government and SA Water are doing to reduce the levels of Bromodichlormethane and other THM's in drinking water, how are they being formed and which members of the community face the greatest risk from consuming these substances.

Friends of the Earth has concerns that perhaps many people in the South Australian community may now be suffering the health consequences associated with drinking water that may have contained traces of health damaging chemicals. Of special concern would be the impacts on people with compromised immune systems, pregnant women and young children. A public education campaign about health issues concerning drinking water should be a priority.

Substances Most Detected Breaching Guidelines	Number of Breaches
Bromodichloromethane/Dichlorobromoform	2382
Trihalomethanes	581
Chlorine Total	409
Dibromochloromethane/Dibromochloroform	277
Bromoform	215
Chloral Hydrate	190



Image shows Top Ten Locations for Most breaches to Australian Drinking Water Guidelines (Health) and World Health Organisation for Disinfection By-Products in the SA Water network January 2000 – July 2012.

	Location	Total Breaches
1.	Kingscote/Kangaroo Island	435
2.	Willunga	205
3.	Sellicks Beach	138
4.	Brownlow/Kangaroo Island	134
5.	Emu Bay/Kangaroo Island	129
6.	Victor Harbor	116
7.	Hindmarsh Island	94
8.	Normanville	91
9.	Port Wakefield	85
10.	Carrickalinga	81

The Top Ten communities breaching drinking water guidelines between 2000-2012



The Township of Willunga

Bromodichloromethane/Dichlorobromoform detections at Willunga averaged 66.03ug/L over the 12 year period, meaning that this community was drinking this substance at an average of 11% above safe levels as determined by the World Health Organisation for the best part of a decade (see below). 60Ug/L is regarded as the safe drinking water level.

Bromodichloromethane/Dichlorobromoform Detections



Willunga 2000 - 2012

2000 - 2012



The highest number of drinking water breaches recorded in the urbanised Adelaide region was at Craigmore, with 54 breaches all relating to chlorine disinfection byproducts – mostly Bromodichloromethane/Dichlorobromoform. The graph below highlights 12 years of detections with 60ug/L being the WHO Guideline. Note that over this 12 year period, average Bromodichloromethane/Dichlorobromoform levels were only 7.5% below the guideline.





The Township of Victor Harbor has had chlorine disinfection by-product problems for the best part of the last decade with over one hundred detections over World Health or Australian Drinking Water Guidelines.





January 2000 - July 2012 (Average 76.2ug/L/Guideline 60ug/L)

Victor Harbor residents have been drinking Bromodichloromethane at levels 27% higher than WHO Guidelines for over the past decade.

Victor Harbor THM Totals (250ug/L ADWG)



March 2000 - July 2012

Average Trihalomethane (THM) totals 2000-2012 for Victor Harbor were 228.3ug/L. Although the 12 year average for Bromodichloromethane (marked in blue in graph) exceeded World Health Organisation Standards over a 12 year period by on average 27% a year, THM's overall were 8.7% under Australian Drinking Water Guidelines averaged out over the same period of time. Under the ADWG therefore, high detections of one of these chemicals can in effect be 'diluted' in the sum of the four.

Green = Dibromochloroform

3. Adelaide Summary



The top dozen Adelaide hotspots highlighting locations of suburbs/communities with the most breaches to drinking water quality between 2000-2012.

1 Craigmore. 2 Happy Valley, 3 Seaford Rise, 4 Blakeview, 5 Elizabeth Downs, 6 Andrews Farm, 7 Enfield, 8 Blackwood, 9 Chandlers Hill, 10 Glenalta, 11 Ottoway, 12. Belair

97% of breaches to ADWG/WHO Guidelines over this time period was for the Trihalomethanes, Bromodichloromethane/Dichlorobromoform, yet how many people in Adelaide have even heard of the these substances or known that they have been drinking them? Marked increases have occurred in Bromodichloromethane/Dichlorobromoform detections in 2011/12.

"Carcinogenicity : Bromodichloromethane is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals: Oral exposure to bromodichloromethane caused tumors at several different tissue sites in mice and rats. Administration of bromodichloromethane by stomach tube caused benign and malignant kidney tumors (tubular-cell adenoma and adenocarcinoma) in male mice and in rats of both sexes, benign and malignant liver tumors (hepatocellular adenoma and carcinoma) in female mice, and benign and ma lignant colon tumors (adenomatous polyps and adenocarcinoma) in rats of both sexes (NTP 1987, ATSDR 1989, IARC 1991, 1999). Since bromodichloromethane was listed in the Sixth Annual Report on Carcinogens, additional studies in rats have been identified. Administration of bromodichloromethane in the drinking water increased the combined incidence of

benign and malignant liver tumors (hepatocellular adenoma or carcinoma) in males (George et al. 2002) and caused benign liver tumors (hepatocellular adenoma) in females (Tumasonis et al. 1987).

Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to bromodichloromethane. Several epidemiological studies indicated a possible association between ingestion of chlorinated drinking water (which typically contains bromodichloromethane) and increased risk of cancer in humans, but these studies could not provide information on whether any observed effects were due to bromodichloromethane or to one or more of the hundreds of other disinfection by-products also present in chlorinated water (ATSDR 1989)." (1)



Adelaide Region Total Breaches 2000 - 2012



Also note that chlorine disinfection products can also be released when showering/bathing with chlorinated water or swimming in chlorinated swimming pools. Such exposures add to the overall chlorine disinfection product body burden.



January 2000 - July 2012

ADWG/WHO Breaches Adelaide Region

Overall breaches in Adelaide have increased significantly in 2011-2012.

Bromodichloromethane/Dichlorbromoform Detections



Medindie (Adelaide Suburb) 2000-2012

Typical Adelaide Suburb detections of Bromodichloromethane/Dichlorobromform – showing consistent detections for 12 years, with an average of 50.222ug/L, approximately 16% below, World Health Organisation guidelines of 60ug/L. The ADWG only calculate the sum of 4 trihalomethanes (THM), and have an THM guideline of 250ug/L – the ADWG's do not grant guidelines for single THM's.

4. SA Water Breaches Summary

SA Water Breaches to ADWG (& WHO DBP Guidelines)



January 2000 - July 2012

SA Water ADWG/WHO Breaches 2000-2012



ADWG (Blue)/WHO (Red)

In terms of breaches to the Australian Drinking Water Guidelines, only the blue (as marked in the above graph) are reported as breaches.



Graph above highlighting 69% more breaches would be noted under World Health Organisation Guidelines, with 31% only noted under Australian Drinking Water Guidelines as breaches.



SA Water ADWG/WHO Breaches 2000-2012

Breaches to both the ADWG/WHO Guidelines occur predominantly in areas outside of the Adelaide urban region.



SA Water Substances Breaching Drinking Water Guidelines

Chlorine Disinfection Byproducts (Brown) = 87.6% Chlorine (Yellow) = 10.1% Monochloramines (Blue) = 1.3% Metals/Elements (Green) = 0.9%

January 2000 - July 2012

5. Substances

5.1 Antimony

ADWG Guideline 0.003mg/L. Antimony shows similar toxic effects as arsenic. Can be a problem with antimony-tin solder.

Between 2000 – 2012, there was one SA Water detection of Antimony that breached the ADWG limit of 0.003mg/L.

29/09/2010 Penneshaw Antimony 0.0031mg/L



Location of Penneshaw marked with yellow dot.

5.2 Arsenic

"Arsenic is bioaccumulative and symptoms may take 10-15 years to develop after expsoure at high levels. Drinking water can be contaminated with inorganic arsenic through wind blown dust, leaching or runoff from soil, rocks and sediment. Groundwater sources such as bores will usually have higher arsenic levels than surface water. In major Australian reticulated water supplies concentrations of arsenic range up to 0.015mg/L, with typical values less than 0.005mg/L". (2)

Between 2000 – 2012, there were 13 SA Water detections of Arsenic that breached the ADWG limit of 0.01mg/L.

7/08/2001 Penola Arsenic 0.014mg/L 9/08/2001 Lameroo Arsenic 0.011mg/L 19/09/2001 Lameroo Arsenic 0.01mg/L 12/03/2003 Lameroo Arsenic 0.013mg/L 12/08/2003 Penola Arsenic 0.039mg/L 16/09/2003 Penola Arsenic 0.012mg/L 13/07/2004 Penola Arsenic 0.012mg/L 23/01/2007 Parilla Arsenic 0.019mg/L 16/10/2007 Parilla Arsenic 0.014mg/L 15/04/2008 Parilla Arsenic 0.011mg/L 25/05/2008 Parilla Arsenic 0.014mg/L 4/08/2009 Parilla Arsenic 0.0171mg/L 1/09/2009 Parilla Arsenic 0.0178mg/L



5.3 Bromodichloromethane/Dichlorobromoform (also see Trihalomethanes)

Bromodichloromethane Guideline: (WHO: 0.06mg/L). The SA Water FoI shows that testing occurred for Dichlorobromoform from 2000 until October 2010. Immediately after, testing then started for Bromodichloromethane in November 2010. These substances are regarded as the same and have been included as such in this report. In terms of drinking water quality for Adelaide and many communities in South Australia,

Bromodichloromethane/Dichlorobromform are easily to chemicals that should be of greatest concern. However the extent of the problem is not widely publicised and in terms of the Australian Drinking Water Guidelines, the incidence of these substances is diluted by the definition of Trihalomethane, where a sum of four substances, Chloroform, Bromoform, Bromodichloromethane and Dibromochloromethane is calculated.

Bromodichloromethane is a Group 2B Possible carcinogen. The Australian Drinking Water Guidelines do not list Bromodichloromethane. Bromodichloromethane is a Trihalomethane. The ADWG has a guideline level of 250ug/L for Trihalomethanes, three times higher than the United States standard. The trihalomethane guideline includes the sum of four different substances.

According to the ADWG "The World Health Organization (WHO) has derived separate guideline values for each compound, but in doing so recognises that the compounds have similar toxicological action. The WHO guideline values for chloroform (0.2 mg/L) and bromodichloromethane (0.06 mg/L) were based on calculations that estimated additional lifetime risks of one fatal cancer per 100,000 people. The use of this approach is questionable because there is evidence that tumours do not occur at low concentrations. The WHO guideline values for bromoform (0.1 mg/L) and dibromochloromethane (0.1 mg/L) were based on different studies and safety factors from those recommended by the NHMRC Standing Committee on Toxicity, although toxicological effects were similar."(3)

Trihalomethanes (THMs) are halogen-substituted single-carbon compounds with the general formula CHX3, where X represents a halogen, which may be fluorine, chlorine, bromine, or iodine, or combinations thereof. The THMs most commonly present in drinking-water are chloroform (CHCl3), bromodichloromethane or dichlorobromomethane (CHBrCl2) (BDCM), dibromochloromethane or chlorodibromomethane (CHClBr2) (DBCM), and bromoform (CHBr3). (4)

"Classical trihalomethanes consist of chloroform (CHCl3), dichlorobromoform (CHCl2Br), dibromochloroform (CHBr2Cl) and bromoform (CHBr3)". (5)

SA Water recorded 725 detections above World Health Organisation Guidelines between January 2010 and July 2012. \sim 34% of all detections were in Adelaide and close surrounds.

November 2010 - July 2012: 20 Highest Number of Detections Above WHO guideline of 0.06mg/L

Willunga 52, Sellicks Beach 37, Nettle Hill 32, Hamley Bridge 23, Hindmarsh Island 22, Victor Harbor 22, Port Parham 21, Carrickalinga 20, Normanville 18, Port Wakefield 18, Myponga 17, Craigmore 14, Aldinga Beach 13, Clarendon 13, Two Wells 11, Emu Bay 10, Encounter Bay 9, Elizabeth Downs 8, Happy Valley 8, Dublin 8,

SA Water Bromodichloromethane (BDCM) detections above WHO Guidelines



November 2010 - July 2012

The International Agency for Research on Cancer (IARC) has classified BDCM in Group 2B (possibly carcinogenic to humans). BDCM gave both positive and negative results in a variety of in vitro and in vivo genotoxicity assays. In an NTP bioassay, BDCM induced renal adenomas and adenocarcinomas in both sexes of rats and male mice, rare tumours of the large intestine (adenomatous polyps and adenocarcinomas) in both sexes of rats and hepatocellular adenomas and adenocarcinomas in female mice. Exposure to BDCM has also been linked to a possible increase in reproductive effects (increased risk for spontaneous abortion or stillbirth). (6)

20/3/00	Kingscote	138ug/L
11/1/01	Swan Reach	131ug/L
29/12/09	Port Wakefield	125ug/L
20/5/03	Kingscote	124ug/L
22/1/02	Kingscote	122ug/L
13/3/12	Clarendon	122ug/L
23/3/12	Myponga	121ug/L
19/12/01	Keith	120ug/L
23/5/02	Kingscote	120ug/L
10/3/11	Hindmarsh Island	118ug/L

SA Water Ten Highest Detections of Bromodichloromethane/Dichlorbromoform Jan 2000 – July 2012.

"Chloroform is considered to be a possible carcinogen in humans, based on limited evidence in experimental animals, and inadequate evidence in humans. Animal studies have shown links between exposure to specific trihalomethanes and liver tumours in mice and kidney tumours in both mice and rats; some studies in humans show data that are consistent with these findings. Human studies are suggesting a link between exposure to trihalomethanes and colorectal cancers.

Human studies also suggest a link between reproductive effects and exposure to high levels of trihalomethanes. However, an increase in the concentration of trihalomethanes could not be linked to an increase in risk, suggesting the need for more studies.

Preliminary animal studies indicate that BDCM and other trihalomethanes that contain bromine may be more toxic than chlorinated trihalomethanes such as chloroform. For this reason, and based on the availability of scientific data for BDCM, a separate guideline was also developed for BDCM. BDCM is considered to be a probable carcinogen in humans, with sufficient evidence in animals and inadequate evidence in humans. Animal studies have shown tumours in the large intestine in rats. Among the four trihalomethanes commonly found in drinking water, BDCM appears to be the most potent rodent carcinogen, causing tumours at lower doses and at more target sites than the other three compounds.

Exposure to BDCM at levels higher than the guideline value has also been linked to a possible increase in reproductive effects (increased risk for spontaneous abortion or stillbirth) above what can normally be expected. Further studies are required to confirm these effects. "(7)



Myponga WTP Outer Metro

Note This is separate distibution network of tap water to that of Myponga Country towns







Myponga Country



Seperate distribution network to Myponga outer urban













Approximate locations of SA Water Bromodichloromethane detections November 2010-July 2012. ~34% of all detections were in Adelaide and surrounds.

Adelaide and Surrounds Bromodichloromethane Breaches 2010-2012: Craigmore 14, Elizabeth Downs 8, Happy Valley 8, Chandlers Hill 7, Salisbury East 7, Andrews Farm 6, Blakeview 6, Enfield 6, Salisbury Heights 6, Salisbury Plain 6, Blackwood 5, Elizabeth North 5, Glen Osmond 5, Salisbury North 5, Aberfoyle Park 4, Adelaide 4, Angle Park 4, Elizabeth Grove 4, Hillbank 4, Largs Bay 4, Lockleys 4, North Haven 4, Ottoway 4, Queenstown 4, Seaton 4, Allenby Gardens 3, Belair 3, Bolivar 3, Brooklyn Park 3, Christie Downs 3, Christies Beach 3, Forestville 3, Glenalta 3, Glenside 3, Hallett Cove 3, Henley Beach 3, Hove 3, Marden 3, Medindie 3, Mitchell Park 3, Morphett Vale 3, Parafield Gardens 3, Pasadena 3, Prospect 3, Redwood Park 3, South Plympton 3, Trott Park 3, Vale Park 3, Woodville 3, Evanston Park 2, Fairview Park 2, Fulham Gardens 2, Golden Grove 2, Gulfview 2, Inglefarm 2, Norwood 2, O'Sullivans Beach 2, Palmer 2, Rose Park 2, Seacliff Park 2, Seaford 2, Seaford Rise 2, Thebarton 2, Tranmere 2, Valley View 2, West Beach 2, West Lakes Shores 2, Wingfield 2, Athelstone 1, Clarence Gardens 1, Croydon Park 1, Eden Hills 1, Flagstaff Hill 1, Glenelg 1, Highbury 1, Hillcrest 1, Kingswood 1, Magill 1, Malvern 1, Marino 1, Marleston 1, Modbury Heights 1, Northfield 1, North Plympton 1, Pooraka 1, Seaview Downs 1, St Agnes 1, Tea Tree Gully 1, Vista 1, Warradale 1, Wattle Park 1, Westbourne Park 1, Windsor Gardens 1, Woodcroft 1, Woodville South 1, Woodforde 1,

Country South Australia Bromodichloromethane Breaches 2010-2012: Willunga 52, Sellicks Beach 37, Nettle Hill 32, Hamley Bridge 23, Hindmarsh Island 22, Victor Harbor 22, Port Parham 21, Carrickalinga 20, Normanville 18, Port Wakefield 18, Myponga 17, Aldinga Beach 13, Clarendon 13, Two Wells 11, Emu Bay 10, Encounter Bay 9, Dublin 8, Goolwa 7, Caloote 6, Monarto 6, Wall Flat 6, Roseworthy 5, Cooltong 4, Cowirra-Neeta 4, Murray Bridge 4, Pompoota 4, Waikerie 4, Blanchetown 3, Brinkley 3, Cadell 3, Kanmantoo 3, Moorook 3, Mypolonga 3, Paringa 3, Swan Reach 3, Willaston 3, Brownlow 2, Callington 2, Glossop 2, Lewiston 2, Mallala 2, Port Noarlunga 2, Barmera 1, Berri 1, Burdett South 1, Cobdogia 1, Eden Valley 1, Kingscote 1, Maitland 1, McLaren Vale 1, Menindie 1, Monteith

1, Nettie Creek 1, Paracombe 1, Parooka 1, St Morris 1,



Approximate locations of Dichlorobromoform detections January 2000 - October 2010. This highlights that Adelaide residents have been exposed to levels of Dichlorobromoform/Bromodichloromethane for more than ten years. Between 2000-2010 in South Australia there were over 1600 breaches to the WHO Guideline levels for Dichlorobromoform. The communities with the ten highest breaches included: Willunga 142, Kingscote 103, Sellicks Beach 96, Normanville 55, Victor Harbor 51, Aldinga Beach 42, Goolwa 41, Craigmore 40, Lock 37, McClaren Vale 31.



Approximate locations of Dichlorobromoform detections above WHO Guidelines January 2000 - October 2010.

Adelaide and Surrounds Dichlorobromoform Breaches 2000-2010: Craigmore 40, Seaford Rise 25, Happy Valley 20, Blakeview 17, One Tree Hill 15, Andrews Farm 15, Clarendon 14, Elizabeth Downs 14, Blackwood 13, Enfield 13, Glenalta 12, Ottoway 12, Belair 10, Christies Beach 10, Aberfoyle Park 9, Eden Hills 9, North Haven 9, Queenstown 9, Medindie 8, West Lakes Shores 8, Allenby Gardens 7, Chandlers Hill 7, Christie Downs 7, Fulham Gardens 7, Hallett Cove 7, Lewiston 7, Wattle Park 7, West Beach 7, Willaston 7, Wingfield 7, Woodcroft 7, Angle Park 6, Croydon Park 6, Elizabeth Grove 6, Evanston Park 6, Henley Beach 6, Ingle Farm 6, Marden 6, O Sullivans Beach 6, Seacliff Park 6, Seaton 6, Woodville South 6, Adelaide 5, Brooklyn Park 5, Glenelg 5, Hillcrest 5, Lockleys 5, Morphett Vale 5, Pasadena 5, Pooraka 5, Port Noarlunga 5, Prospect 5, Thebarton 5, Forestville 4, Glen Osmond 4, Largs Bay 4, Marino 4, Mitchell Park 4, Norwood 4, Rose Park 4, Valley View 4, Underdale 4, Westbourne Park 4, Adelaide Airport 3, Birdwood 3, Gawler 3, Golden Grove 3, Gumeracha 3, Hackam 3, Kent Town 3, Magill 3, Modbury 3, Modbury Heights 3, Northfield 3, Panorama 3, Para Hills West 3, South Brighton 3, Tea Tree Gully 3, Tranmere 3, Trott Park 3, Vista 3, Woodforde 3, Bolivar 2, Elizabeth North 2, Flagstaff Hill 2, Glenside 2, Highbury 2, Kingswood 2, North Plympton 2, Paracombe 2, South Plympton 2, Warradale 2, Windsor Gardens 2, Aldinga Park 1, Clarence Gardens 1, Fairview Park 1, Gepps Cross 1, Hillbank 1, Hove 1, Malvern 1, Marleston 1, Redwood Park 1, Salisbury Heights 1, Salisbury North 1, Salisbury Plain 1, Seaford 1, St Kilda 1, St Morris 1, Vale Park 1, Woodford 1.

Country South Australia Dichlorobromoform Breaches 2000-2010: Willunga 142, Kingscote 103, Sellicks Beach 96, Normanville 55, Victor Harbor 51, Aldinga Beach 42, Goolwa 41, Lock 37, McClaren Vale 31, Carrickalinga 28, Swan Reach 28, Myponga 25, Port Wakefield 25, Wall Flat 25, Blanchetown 24, Port Parham 24, Nettle Hill 23, Encounter Bay 22, Hamley Bridge 21, Mannum 20, Hindmarsh Island 19, Hindmarsh Valley 18, Emu Bay 17, Brinkley 13, Eden Valley 10, Murray Bridge 10, Felixstow 9, Monteith 9, Monarto 8, Brownlow 6, Caloote 6, Mallala 5,

Mypolonga 5, Dublin 4, Pompoota 4, Roseworthy 4, Cowirra-Neeta 3, Erith 3, Keith 3, Two Wells 3, Owen 2, Balaklava 1, Edithburgh 1, Kapunda 1, Karoonda 1, Strathalbyn 1, Tanunda 1, Tintinara 1, Waikerie 1.



Approximate locations of Bromodichloromethane detections breaching World Health Organisation guidelines in Adelaide region. November 2010-July 2012 in Adelaide and surrounds.



Approximate locations of Dichlorobromoform detections breaching World Health Organisation guidelines in Adelaide region. January 2000 – October 2010 in Adelaide and surrounds.

5.4 Bromoform (also see Trihalomethanes)

Bromoform is a chlorine disinfection byproduct and is classed one of the sum of 4 chemicals under Trihalomethanes. As such it is not given a seperate guideline under the ADWG.

According to the ADWG: "The WHO guideline values for bromoform (0.1mg/L) and dibromochloromethane (0.1mg/L) were based on different studies and safety factors from those recommended by the NHMRC Standing Committee on Toxicity, although toxicological effects were similar. It is recommended that future reviews of the guidelines consider the various THM's individually, as data are emerging that suggest that different THMs have different toxic effects. Data were not sufficient at the time of this review to justify individual assessments."(3)

SA Water recorded 215 detections in 17 communities above World Health Organisation Guidelines 2000-12. 69% of breaches were recorded in four communities on Kangaroo Island.

-		
19/2/01	Ceduna	818ug/L
20/2/01	Wudinna	812ug/L
19/3/01	Ceduna	781ug/L
17/4/01	Kimba	608ug/L
21/1/01	Ceduna	550ug/L
22/1/01	Lock	548ug/L
22/2/00	Wudinna	543ug/L
16/1/01	Naracoorte	489ug/L
20/2/01	Kimba	418ug/L
17/4/01	Ceduna	395ug/L

SA Water Ten Highest Detections of Bromoform 2010-2012

SA Water WHO Bromoform Breaches



January 2000 - July 2012

Over half of the increase in Bromoform detections in 2012, come from Kingscote (Kangaroo Island).



WHO Bromoform breaches detected by SA Water 2000-2012.

Bromoform Breaches Total: 2000 - 2012 (215)

- 1. Kingscote 67 (31.1%)
- 2. Brownlow 42 (19.5%)
- 3. Emu Bay 26 (12.1%)
- 4. Ceduna 14
- 5. Penneshaw 14 (6.5%)
- 6. Naracoorte 10
- 7. Kimba 10
- 8. Lock 9
- 9. Wall Flat 7
- 10. Wudinna 6
- 11. Cummins 5
- 12. Streaky Bay 1
- 13. Woodforde 1
- 14. Mannum 1
- 15. Caloote 1
- 16. Tungkillo 1

"Some studies in animals indicate that exposure to high doses of bromoform or dibromochloromethane may also lead to liver and the kidney injury within a short period of time. Exposure to low levels of bromoform or dibromochloromethane do not appear to seriously affect the brain, liver, or kidneys. Other animal studies suggest that typical bromoform or dibromochloromethane exposures do not pose a high risk of affecting the chance of becoming pregnant or harming an unborn baby. However, studies in animals indicate that long-term intake of either bromoform or dibromochloromethane can cause liver and kidney cancer. Although cancer in humans cannot be definitely attributed to these chemicals, it is an effect of special concern, since many people are exposed to low levels of bromoform and dibromochloromethane in chlorinated drinking water.

The International Agency for Research on Cancer (IARC) concluded that bromoform and dibromochloromethane are not classifiable as to human carcinogenicity. The EPA classified bromoform as a probable human carcinogen and dibromochloromethane as a possible human carcinogen." (8)

5.5 Cadmium

ADWG Guideline. 0.002mg/L. The primary route of exposure of cadmium is via contaminated water or food. Fertiliser can be a source of excessive cadmium as can rainwater tanks. It has been linked to cancer, lung disorders, kidney disease and autoimmune disease.

Between 2000-2012, there were 5 detections of Cadmium that breached the ADWG limit of 0.002mg/L.

12/12/2001 Warooka Cadmium 0.0033mg/L 13/12/04 Warooka Cadmium 0.0021mg/L 10/1/05 Warooka Cadmium 0.0023mg/L 14/2/05 Warooka Cadmium 0.0031mg/L 8/3/11 Paskeville 0.0021mg/L



Cadmium detections above ADWG 2000-2012.

5.6 Chloral Hydrate/Trichloroacetalehyde

According to the ADWG: "Based on health considerations, the concentration of chloral hydrate in drinking water should not exceed 0.02mg/L. Chloral hydrate may be formed as a by-product during chlorination of water containing naturally occurring organic material. Contamination of drinking water due to industrial spills is unlikely in Australia but has occurred overseas. In the United States chloral hydrate has been detected in a small number of supplies, with concentrations ranging from 0.00001mg/L (10ng/L) to 0.1mg/L. Chloral hydrate has been used as a sedative amd hypnotic drug in humans at oral doses up to 14mg/kg body weight..."(3)

Between 2000-2012, there were 190 SA Water detections of Chloral Hydrate that breached the ADWG limit of 0.02mg/L (20ug/L). 55% of breaches to ADWG on Lower Murray between Mannum and Goolwa (including Victor Harbor).

18/3/02	Balaklava	88ug/L
17/3/03	Balaklava	58ug/L
2/5/11	Maitland	53.3ug/L
9/2/11	Brinkley	52.9ug/L
9/12/02	Moonta	51ug/L
18/11/10	Caloote	49.9ug/L
26/3/01	Balaklava	49.3ug/L
9/3/11	Brinkley	49.2ug/L
16/5/11	Maitland	46.2ug/L
12/9/00	Moonta	44.7ug/L

Top Ten Levels Recorded by SA Water for Chloral Hydrate 2000-2012.

Chloral Hydrate/Trichloroacetaldehyde



SA Water ADWG Breaches January 2000 - July 2012

Chloral hydrate is a sedative and hypnotic drug. Long-term use of chloral hydrate is associated with a rapid development of tolerance to its effects and possible addiction as well as adverse effects including rashes, gastric discomfort and severe renal, cardiac and hepatic failure.
"No epidemiological or carcinogenic studies were found in humans that associated exposure to chloral hydrate with cancer, despite the fact that chloral hydrate has been used for many decades (and still is used) as a sedative and hypnotic drug in adults and children (specifically for dental procedures). The U.S. EPA (2000) derived an acute oral reference dose of 0.1mg/kg bw per day based on the pharmacologically active dose (250mg, equivalent to 10.7mg/kg bw per day) in humans. This dose is said to be protective for any non-cancer health effects from chronic exposure. However, chloral hydrate has shown some evidence of carcinogenicity in two long-term drinking water bioassays in male mice and in a lifetime study following a single oral dose in male mice. In addition, chloral hydrate was found to be a weak mutagen and clastogen, suggesting that genotoxicity may play a role in the toxicity of chloral hydrate, but at concentrations higher than those expected to be found in the environment. The pharmacological dose of 10.7 mg/kg bw per day is not considered appropriate for the derivation of a health-based value for chloral hydrate in drinking water.

The International Agency for Research on Cancer classified chloral hydrate as Group 3, "not classifiable as to its carcinogenicity to humans," in 1995, based on inadequate evidence in humans and limited evidence in experimental animals (IARC, 1995). The U.S. EPA (2000) classified chloral hydrate as a possible human carcinogen, concluding that the most likely mode of action for the formation of tumours in mice involves interaction with cellular enzymes and proteins, in contrast to direct interaction with DNA. Health Canada has classified chloral hydrate in Group III.B -- possibly carcinogenic to humans (inadequate data in humans, limited data in animals), as defined in Health Canada 1994. There is equivocal evidence of genotoxicity for chloral hydrate." (9)



Map highlighting main chloral hydrate breaches in SA Water network 2000-2012

- 1. Carrickalinga 27
- 2. Encounter Bay 19
- 3. Hindmarsh Island 18
- 4. Brinkley 16

- 5. Victor Harbor 11
- 6. Monteith 11
- 7. Caloote 10
- 8. Monarto 9
- 9. Normanville 8
- 10. Kimba 8

Goolwa 7, Mannum 7, Moonta 6, Murray Bridge 5, Burdett South 5, Balaklava 4, Maitland 3, Lock 2, Burdett 2, Sellicks Beach 2, Yorketown 1, Owen 1, Kingscote 1, Ardrossan 1, Gumeracha 1, Glen Osmond 1, Brooklyn Park 1, Seaton 1, Blanchetown 1



Feb 2009 - June 2012 (22.513ug/L average)

Carrickalinga SA Water Chloral Hydrate Detections (20ug/L Guideline Limit)

5.7 Chlorate

Chlorite and chlorate are disinfection by-products of chlorine dioxide disinfection process.

Between 2000-2012, there were three SA Water detections of Chlorate that breached the WHO Guideline limit of 0.7mg/L. All occurred over 2 day period in February 2012.



22/2/12 Blanchetown 0.85mg/L 22/2/12 Moorook 0.83mg/L 23/2/12 Cadell 0.99mg/L

Chlorate detections above guideline levels.

5.8 Chlorine

ADWG Guideline: 5mg/L (Chlorine in chloraminated supplies 4.1mg/L). Chlorine dissociates in water to form free chlorine, which consists of aqueous molecular chlorine, hypochlorous acid and hypochlorite ion. Chlorine and hypochlorites are toxic to microorganisms and are used extensively as disinfectants for drinking water supplies. Chlorine is also used to disinfect sewage and wastewater, swimming pool water, in-plant supplies, and industrial cooling water.

Between 2000-2012, there were 16 SA Water detections of Chlorine Free that breached the 2011 ADWG Health Limit. The highest level detected at Port Pirie was almost 500% higher than the ADWG.

Chlorine Free Breaches

29/2/00 Naracoorte Chlorine - Free 8.8 6/3/00 Lock Chlorine - Free 5.6 10/3/00 Lenswood Chlorine - Free 6.8 19/4/00 Parilla Chlorine - Free 5 7/6/00 Meningie Chlorine – Free 7.6 26/6/00 Tumby Bay Chlorine - Free 7 31/10/00 Port Pirie Chlorine - Free 23 2/1/01 Streaky Bay Chlorine - Free 6.8 8/1/01 Angaston Chlorine - Free 22 28/11/01 Coonalpyn Chlorine - Free 5.9 12/12/01 Coonalpyn Chlorine - Free 6 13/2/02 Keith Chlorine - Free 5.4 26/6/02 Monarto Chlorine - Free 5.2 23/7/02 Cleve Chlorine - Free 5.4 4/1/08 Mannum Chlorine - Free 6 2/8/11 Wudinna Chlorine - Free 5.9



Location of SA Water Chlorine Free detections above ADWG 2000-2012.

5.9 Chlorine Total

According to the ADWG: "Based on health considerations, the guideline value for total chlorine in drinking water is 5mg/L, except for chloraminated systems, where a guideline value of 4.1mg/L applies.

Chlorine dissociates in water to form free chlorine, which consists of aqueous molecular chlorine, hypochlorous acid and hypochlorite ion. Chlorine and hypochlorites are toxic to microorganisms and are used extensively as disinfectants for drinking water supplies. Chlorine is also used to disinfect sewage and wastewater, swimming pool water, in-plant supplies, and industrial cooling water...

Free chlorine and combined chlorine may be present simultaneously (APHA 2005). The term total chlorine refers to the sum of free chlorine and combined chlorine present in a sample." (3)

Between 2000-2012, there were 409 detections of Chlorine Total above ADWG of 5mg/L (and 4.1mg/L in chloraminated supplies). Top Ten have 69% of all detections.

7/6/00	Meningie	7.8mg/L
10/3/00	Lenswood	7mg/L
21/2/01	Morgan	6.6mg/L
7/2/01	Morgan	6.4mg/L
28/11/01	Coonalpyn	6.3mg/L
12/12/01	Coonalpyn	6.2mg/L
4/1/08	Mannum	6.2mg/L
8/8/01	Morgan	6.1mg/L
12/1/04	Maitland	6mg/L
3/5/04	Clare	6mg/L

Top Ten Levels Recorded by SA Water for Chlorine Total 2000-2012.

SA Water Chlorine (Total) Breaches To ADWG



January 2000 - July 2012



Chlorine Total Detections SA Water above ADWG guidelines 2000-12.

Maitland 69, Morgan 62, Burra North 37, Port Victoria 22, Loxton 20, Clare 19, Ardrossan 16, Eudunda 14, Minlaton 13, Crystal Brook 12,

Coonalpyn 11, Jamestown 11, Port Pirie 11, Port Broughton 7, Yorketown 7, Brinkworth 6, Tailem Bend 6, Blyth 5, Kadina 5, Keith 4, Stansbury 4, Balhannah 3, Bute 3, Nuriootpa 3, Port Vincent 3, Sedan 3, Snowtown 3, Strathalbyn 3, Swan Reach 3, Meningie 2, Mount Barker 2, Auburn 1, Coobowie 1, Gladstone 1, Goolwa 1, Hahndorf 1, Happy Valley 1, Karoonda 1, Lenswood 1, Littlehampton 1, Mannum 1, Monarto 1, Nairne 1, Palmer 1, Parilla 1, Pompoota 1, Port Augusta 1, Port Augusta/Woomera 1, Tintinara 1, Wirrabarra 1, Wudinna 1

Chlorine Total Levels Morgan





January 2000 - July 2012

5.10 Chloroform (also see Trihalomethanes)

Chloroform 0.3mg/L (WHO) - Trihalomethane

According to the ADWG: "In Australia, trihalomethanes are present in drinking water principally as the result of disinfection using chlorination or, to a much lesser extent, chloramination. Chlorine, which produces hypochlorous acid when added to water, can react with naturally occurring organic material, such as humic and fulvic acids, to produce trihalomethanes. The brominated trihalomethanes are produced by the oxidation of bromide present in water to form hypobromous acid, which can then react with organic matter in a similar way. High trihalomethane concentrations may indicate the presence of other chlorination by-products. Chloroform is produced commercially and is an important solvent. It is used in the manufacture of refrigerants, and as an ingredient in pharmaceutical and cosmetic preparations. Brominated trihalomethanes are also produced industrially, but less commonly than chloroform."(3)

"Sources of chloroform in the aquatic environment include paper bleaching with chlorine, chlorination of recreational (pool) water, cooling water and wastewater. Chloroform is present in drinking-water through direct contamination of the source and through formation from naturally occurring organic compounds during chlorination. The rate and degree of formation of chloroform during chlorination are a function primarily of the concentrations of chlorine and humic acid, temperature and pH. Levels vary seasonally, with concentrations generally being greater in summer than in winter (IPCS, 1994a)... Pools are also an important source of exposure to chloroform for swimmers. Based on an experimentally determined relationship, Levesque et al. (1994) estimated that the daily dose of chloroform resulting from a 1-h swim (65 μ g/kg of body weight per day) in conditions commonly found in public swimming pools is 141 times greater than that for a 10-min shower and 93 times greater than that for tap water ingestion. The weight of evidence for genotoxicity is considered negative (IPCS, 1994a)... The weight of evidence for liver tumours in mice is consistent with a threshold mechanism of induction. Although it is plausible that kidney tumours in rats may similarly be associated with a threshold mechanism, there are some limitations of the database in this regard...The most universally observed toxic effect of chloroform is damage to the centrilobular region of the liver. The severity of these effects per unit dose administered depends on the species, vehicle and method by which the chloroform is administered. The lowest dose at which liver damage has been observed is 15 mg/kg of body weight per day administered to beagle dogs in a toothpaste base over a period of 7.5 years. Effects at lower doses were not examined. Somewhat higher doses are required to produce hepatotoxic effects in other species. Effects in the proximal tubules of the kidney cortex have been observed in male mice of sensitive strains and in both male and female rats of several strains. Levels inducing adverse histopathological effects in the range of 30 mg/kg of body weight per day have been reported in some studies in sensitive strains." (10)

Between 2000-2012, there were 12 SA Water detections of Chloroform that breached the 2011 WHO Guideline Limit of 0.3mg/L

Blanchetown 2, Cadell 1, Cooltong 4, Keith 1, Paringa 3, Redwood Park 1

7/11/00 Redwood Park Chloroform 0.303mg/L 9/1/01 Blanchetown Chloroform 0.322mg/L 18/12/01 Keith Chloroform 0.332mg/L 18/1/11 Paringa Chloroform 0.390mg/L 18/1/11 Cooltong Chloroform 0.351mg/L 8/2/11 Blanchetown Chloroform 0.303mg/L 9/2/11 Cadell Chloroform 0.302mg/L 15/2/11 Paringa Chloroform 0.321mg/L 16/2/11 Cooltong Chloroform 0.372mg/L 15/3/11 Paringa Chloroform 0.336mg/L 16/3/11 Cooltong Chloroform 0.304mg/L 13/3/12 Cooltong Chloroform 0.351mg/L



Location of SA Water Chloroform breaches to 2011 WHO Guideline of 0.3mg/L 2000-2012.

5.11 Dibromochloromethane/Dibromochloroform (also see Trihalomethanes)

A Trihalomethane. 62.5% of WHO Breaches located on Kangaroo Island

21/2/11	Brownlow	175ug/L
7/3/11	Brownlow	156ug/L
14/2/11	Emu Bay	148ug/L
31/1/12	Emu Bay	144ug/L
31/1/12	Emu Bay	144ug/L
26/3/12	Emu Bay	140ug/L
7/12/11	Brownlow	134ug/L
6/2/12	Brownlow	121ug/L
17/1/12	Emu Bay	116ug/L
19/3/12	Brownlow	116ug/L

Top Ten Levels Recorded by SA Water for Dibromochloromethane 2010-2012.

Total Dibromochlromethane breaches 2011-12 (56): Brownlow 14, Kingscote 11, Emu Bay 10, Hindmarsh Island 6, Victor Harbor 6, Nettle Hill 3, Myponga 2, Willunga 2, Goolwa 1, Hamley Bridge 1.





February 2011 - May 2012

SA Water tested for Dibromochloroform from 2000 to May 2010 and then testing ceased. Testing for Dibromochloromethane began in February 2011. No WHO guidelines exist for Dibromochloroform.

"Some studies in animals indicate that exposure to high doses of bromoform or dibromochloromethane may also lead to liver and the kidney injury within a short period of time. Exposure to low levels of bromoform or dibromochloromethane do not appear to seriously affect the brain, liver, or kidneys. Other animal studies suggest that typical bromoform or dibromochloromethane exposures do not pose a high risk of affecting the chance of becoming pregnant or harming an unborn baby. However, studies in animals indicate that long-term intake of either bromoform or dibromochloromethane can cause liver and kidney cancer. Although cancer in humans cannot be definitely attributed to these chemicals, it is an effect of special concern, since many people are exposed to low levels of bromoform and dibromochloromethane in chlorinated drinking water. The International Agency for Research on Cancer (IARC) concluded that bromoform and dibromochloromethane are not classifiable as to human carcinogenicity. The EPA classified bromoform as a probable human carcinogen and dibromochloromethane as a possible human carcinogen." (11)



Dibromochloromethane detections above WHO Guidelines 2011-2012. Over 62% of detections concentrated on Kangaroo Island.



Dibromochloromethane and Dibrochloroform detections >100ug/L 2000-2012.

Total (221): Kingscote 120, Emu Bay 32, Brownlow 31, Port Wakefield 9, Ceduna 6, Port Parham 6, Lock 4, Hindmarsh Island 3, Victor Harbor 3, Wudinna 2, Caloote 1, Encounter Bay 1, Monarto 1, Sellicks Beach 1, Wall Flat 1.

Top Ten Levels Recorded by SA Water for Dibrochloroform 2000-2010.

18/3/03	Kingscote	261ug/L
20/1/03	Kingscote	232ug/L
18/3/03	Kingscote	228ug/L
10/5/04	Kingscote	225ug/L
20/1/03	Kingscote	220ug/L
20/2/01	Kingscote	218ug/L
10/5/04	Kingscote	212ug/L
23/5/02	Kingscote	206ug/L
20/3/00	Kingscote	205ug/L
10/1/05	Kingscote	201ug/L



Kingscote SA Water Dibrochloroform/Dibrochloromethane Detections

Jan 2000 - July 2012 (100ug/L Guideline Level) Average: 97.5

5.12 Dichloroacetic Acid

A chlorine disinfection by-product. Australian Drinking Water Guideline: 0.1mg/L

Chlorine was initially added to drinking water as a means of killing disease causing bacteria including cholera which was responsible for the deaths of millions of people. Its use as a water disinfectant was 'perfected' in the United States in the 1930's. However chlorine does have its own 'problems', such as those related to Disinfection By-Products (DBP's).

There have been over 600 DBP's identified and some have been linked with cancers, adverse birth outcomes and some birth defects. If detected, water authorities need to conduct regular air scouring, flushing of the reticulation system and powder activated carbon dosing. THM's can be present in water as a result of chlorination and to a lesser extent chloramination. Regulated THM's include trichloromethane, bromodichloromethane, dibromochloromethane and bromoform. Total THM's refer to the sum of these four compounds.

In the United States, the EPA limits the total concentration of the four chief constituents (chloroform, bromoform, bromodichloromethane), referred to as total trihalomethanes (TTHM), to 80 parts per million in treated water. In Australian the limit is 250 parts per billion.

Haloacetic acids (HAA's) are also DBP's. 15 HAA's can be formed in the presence of chlorine, bromide and iodide. The most common HAA's are dichloroacetic acid and trichloroacetic acid. (Other HAA's include: bromochloroacetic acid, dibromoacetic acid, monobromoacetic acid.

Other DBP's can include: haloacetonitriles, halogenated furanones, halonitromethanes, cyanogen halides, haloketones, haloaldehydes, halogenated phenols.

Between 2000-2012, there were two SA Water detections of Dichloroacetic acid that breached the 2011 ADWG's

18/6/01 Balaklava Dichloroacetic Acid 106ug/L 17/6/02 Balaklava Dichloracetic Acid 100ug/L



Balaklava Dichloroacetic Acid Detections (100ug/L Guideline)

Average Dichloroacetic Acid detections over dozen year period: 26.12ug/L



Location of Balaklava, the only location where SA Water detected ADWG breaches for Dichloroacetic Acid 2000-2012.

5.13 E.coli

E.coli is a bacterial species belonging to the Coliforms group. It is only found naturally in the digestive tract of warm blooded animals. The presence of E. coli in drinking water is indicative that faecal contamination may have occurred. Because E.coli can survive for brief periods of time outside the gut, they can be used

an an indicator organism for the testing of environmental standards. The regulatory standard is that at least 98% of all samples of drinking water collected in any 12 month period contain no E.coli orgs per 100 millilitres. Sampling frequency is dependent on population and varies in each locality.

Between 2000-2012, SA Water recorded four instances of E.coli levels of more than 100/100ml.

6/2/01 Dublin E.coli 130/100ml 17/4/03 Riverton E.coli >200/100ml 21/5/03 Victor Harbor E.coli >200/100ml 14/7/11 Mannum E.coli 170/100ml



SA Water locations for E.coli breaches 2000-2012.

5.14 Fluoride

According to the ADWG: Based on health considerations, the concentration of fluoride in drinking water should not exceed 1.5mg/L.

Fluoride can be added to water supply's through the 'Flurodose' process. Fluoride is added to water either as fluosilicic acid (sometimes known as hydrofluosilicic acid) or sodium silicofluoride. It is sourced from superphosphate and is soluble. Naturally occurring fluoride is almost insoluble and is known as calcium flouride.

Between 2000-2012, there was one SA Water detection of Fluoride at 1.5mg/L.

9/3/04 Millicent Fluoride 1.5mg/L



Location of Millicent in the state's South East.

5.15 Lead

ADWG Guideline = 0.01 mg/L

Unlike most water contaminants, lead gets into water after it leaves a water treatment plant. Often this contamination is the result of water treatment changes meant to improve water quality that end up altering the water chemistry, destabilising lead-bearing mineral scales that coat service lines and corroding lead solder, pipes, faucets and fixtures. Lead in water has been seen to be a major source of lead exposure. Corrosion from lead based solders in brass fittings and copper pipes is often the source of lead in drinking water. This problem is often worsened by people drinking and cooking with corroded water after a first use particularly in the morning. Lead based solder has been banned in Australia since 1989 so problems are most likely to be associated in businesses and homes with water fittings pre-dating 1989. Lead has been linked to impaired cognitive development in children and a number of other health problems. (Lead can also be a result of dissolution from natural sources).

Between 2000-2012, there were seven SA Water detections of lead that breached the ADWG.

18/9/00 Port Neill Lead 0.03mg/L 27/3/01 Kalangadoo Lead 0.0128mg/L 20/12/07 Cowirra-Neeta Lead 0.0272mg/L 14/10/08 Woodville South Lead 0.014mg/L 7/11/08 Springton Lead 0.0186mg/L 10/3/09 Penola Lead 0.014mg/L 9/3/10 Kingscote Lead 0.0266mg/L



Lead breaches according to SA Water detections 2000-2012.

5.16 Manganese

ADWG Guidelines 0.5 mg/L. ADWG Aesthetic Guideline 0.1 mg/L = 0.5 mg/LManganese is found in the natural environment. Manganese in drinking water above 0.1 mg/L can give water an unpleasant taste and stain plumbling fixtures and laundry.

Between 2000-2012, there was one SA Water detection of Manganese that breached the 2011 ADWG limit.

9/3/10 Kingscote Manganese 0.0266mg/L



Location of Kingscote on Kangaroo Island.

5.17 Mercury

ADWG Health Limit: 0.001mg/L

Mercury, if it enters the ecosystem can transform into the more toxic methylmercury where it can bioaccumulate. Methylmercury is highly toxic to human embryos, fetuses, infants and children. Mercury has numerous sources including old gold mines, where mercury was used in gold recovery process. It has been estimated that 950 tonnes of mercury was deposited into Victorian soil, rivers and streams during the various gold rushes.

Between 2000-2012, there were two SA Water detections of Mercury that breached the 2011 ADWG Health Limit.

19/12/06 Port Lincoln Mercury 0.001mg/L 8/5/12 Renmark Mercury 0.001mg/L



Site of Mercury breaches in South Australian drinking water 2000-2012.

5.18 Monochloramines

According to the ADWG: "Based on health considerations, the concentration of monochloramine in drinking water should not exceed 3mg/L (equivalent to 4.1mg Cl as C12/L).

Some water supplies may also be disinfected through a process called Chloramination where ammonia is added to the water prior to the chlorine, which in turn can create Monochloramines. Sunlight does not degrade Monochloramines to the same extent as chlorine, meaning that water can be stored for longer periods of time.

Between January 2000 and July 2012, SA Water recorded over 50 incidences of Monochloramines breaching or the same as the 2011 ADWG.

SA Water Monochloramine ADWG Breaches



January 2000 - June 2012

Top Ten Levels Recorded by SA Water for Monochloramine 2000-2012.

29/12/05	Morgan	5mg/L
22/2/11	Loxton	5mg/L
16/4/03	Morgan	4.8mg/L
27/2/06	Strathalbyn	4.8mg/L
20/2/06	Strathalbyn	4.7mg/L
22/2/11	Loxton	4.7mg/L
3/5/11	Loxton	4.6mg/L
3/5/11	Loxton Country Lands	4.6mg/L
6/9/11	Kadina	4.6mg/L
Plus 6 detections 4.5mg/L	Loxton, Wallaroo, Kadina, Jervois, Tailem Bend, Loxton Country Lands.	

"Background information on chloramines

Chloramines are produced by combining chlorine and ammonia...Chloramines are weaker disinfectants than chlorine, but are more stable, thus extending disinfectant benefits throughout a water utility's distribution system. They are not used as the primary disinfectant for your water. Chloramines are used for maintaining a disinfectant residual in the

distribution system so that disinfected drinking water is kept safe. Chloramine can also provide the following benefits:

- Since chloramines are not as reactive as chlorine with organic material in water, they produce substantially lower concentrations of disinfection byproducts in the distribution system. Some disinfection byproducts, such as the trihalomethanes (THMs) and haloacetic acids (HAAs), may have adverse health effects at high levels. These disinfection byproducts are closely regulated by EPA. EPA recently reduced the allowable Maximum Contaminant Levels for total THMs to 80 ug/L (250ug/L in Australia) and now limit HAAs to 60 ug/L. The use of chlorine and chloramines is also regulated by the EPA. We have Maximum Residual Disinfectant Levels of 4.0 mg/L for both these disinfectants. However, our concern is not from their toxicity, but to assure adequate control of the disinfection byproducts.
- Because the chloramine residual is more stable and longer lasting than free chlorine, it provides better protection against bacterial regrowth in systems with large storage tanks and dead-end water mains.
- Chloramine, like chlorine, is effective in controlling biofilm, which is a slime coating in the pipe caused by bacteria. Controlling biofilms also tends to reduce coliform bacteria concentrations and biofilm-induced corrosion of pipes.
- Because chloramine does not tend to react with organic compounds, many systems will experience less incidence of taste and odor complaints when using chloramine. (12)

"Chloramine (as CI2) is a water additive used to control microbes, particularly as a residual disinfectant in distribution system pipes. It is formed when ammonia is added to water containing free chlorine. Monochloramine is one form of chloramines commonly used for disinfection by municipal water systems. Other chloramines (di- and tri-) are not intentionally used to disinfect drinking water and are generally not formed during the drinking water disinfection process. Some people who use water containing chloramine in excess of the maximum residual disinfectant level could experience irritating effects to their eyes and nose, stomach discomfort or anemia." (13)

"Although monochloramine has been shown to be mutagenic in some in vitro studies, it has not been found to be genotoxic in vivo. In the absence of data on human cancer and on the basis of inadequate evidence for the carcinogenicity of monochloramine in experimental animals, monochloramine was evaluated by IARC as not classifiable as to its carcinogenicity (Group 3). The US EPA classified monochloramine in group D, not classifiable as to its human carcinogenicity, in that there is inadequate human and animal evidence. IPCS did not consider that the increase in mononuclear cell leukaemia was treatment-related. In the NTP bioassay in two species, the incidence of mononuclear cell leukaemias in female F344/N rats was increased, but no other increases in tumour incidence were observed". (14)



Loxton - Monochloramine Detections 2006-2012

Guideline Value 4.1mg/L

Average Monochloramine levels for Loxton over 6 year period are 3.219mg/L – 21% below the 4.1mg/L ADWG guideline. February – July 2011 marked above guideline levels at Loxton.

^{20/02/0706/11/0710/06/0806/01/0920/07/0901/03/1028/09/1005/04/1111/10/1110/07/12} 03/10/0631/07/0719/02/0816/09/0830/03/0902/11/0908/06/1011/01/1112/07/1122/02/12



SA Water Monochloramine Detections Above ADWG 2000-2012.

5.19 NDMA

According to the ADWG: "Based on health considerations, the concentration of NDMA in drinking water should not exceed 0.0001mg/L (100ng/L). Action to reduce NDMA is encouraged, but must not compromise disinfection, as nondisinfected water poses significantly greater risk than NDMA...

There are no data in the public domain or peer reviewed literature on NDMA in Australian drinking water distribution systems and water treatment plants. Anecdotal evidence suggests a bi-modal distribution, with several water authorities indicating that NDMA is present at levels at or near the limit of determination of 1 to 2 ng/L, whereas preliminary sampling and analysis by other authorities indicates levels in the range of 60-90 ng/L. A recent report from South Australia has indicated that NDMA may originate from rubber components of newly commissioned drinking water pipelines, regardless of the disinfectant used. This may account at least partly for the divergent results reported by different water suppliers." (3)

SA Water detected NDMA 442 detections >3ng/L between August 2007 and July 2012 in ten regions. Ten of these samples were above the NDMA level specified in the 2011 ADWG. 9 detections were at differing sampling locations in the Lower Lakes region and one detection, the highest recorded (140ng/L) was at Keith in November 2010. 80% of the breaches to the ADWG occurred during November 2011.

24/2/10 Lower Lakes 130ng/L 3/11/10 Lower Lakes 110ng/L 3/11/10 Lower Lakes 100ng/L 3/11/10 Lower Lakes 100ng/L 3/11/10 Lower Lakes 120ng/L 3/11/10 Lower Lakes 110ng/L 17/11/10 Keith 140ng/L 17/11/10 Lower Lakes 130ng/L 1/12/10 Lower Lakes 100ng/L 5/7/11 Lower Lakes 100ng/L

N-Nitrosodimethylamine (NDMA) can be created through water treatment via cholorination or chloramination or organic nitrogen containing waste water. NDMA is highly toxic and a suspected carcinogen. It was widely discovered in groundwater in California in the late 1970's as a by-product unsymmetrical dimethylhydrazine (UDMH), which is a component of rocket fuel that requires NDMA for its synthesis. Eight other nitrosamines of interest in drinking and recycled water are: N-nitrosodiethylamine (MDEA), N-nitrosodi-n-propylamine (NDPA), N-nitrosodi-n-butylamine (NDBA), N-nitrosomethylethylamine (NMEA), N-nitrosomorpholine (Nmor), N-nitrosopiperidine (Npip), N-nitrosopyrrolidine (NPyr) and N-nitrosodiphenylamine ((NDPha). The ADWG for NDMA is 0.1ug/L (0.0001mg/L).

"More recently, rubber components such as valves and joiners/0-rings that are used in treatment plant pumps and in distribution systems have been found to leach significant levels of nitrosamines into the water supply (Morran et al., 2011). .. In Australia, chloramination is widely practiced and in South Australia the South Australian Water Corporation implemented a routine monitoring program for NDMA in four systems in 2007. From these results it is clear that the levels in the distribution system vary considerably with time, indicating a seasonal influence due to variations in detention time controlled by demand. There was also evidence of a strong influence of water quality during a period of high flow, colour and turbidity in the river feeding the treatment plants. However, the average concentration of NDMA of more than 750 samples analysed from 2007 to present was low, < 20ng/L. Knight et at. (2011) recently reported nitrosamine data from five drinking water treatment plants in South-East Queensland. Three of these plants practice chloramination, one uses chlorination, and the other a combination of ozone and chlorine for disinfection. " (15)

"Nitrosamines, particularly N-nitrosodimethylamine (NDMA), are receiving increased attention from water authorities, as emerging disinfection by-products of concern in potable water supplies...The results of this study to date gives support for achieving reduction of NDMA levels by reducing the amount of polyDADMAC dosing in normal plant operation. The most effective strategy to reduce the product water NDMA levels was to employ an extended chlorine contact time prior to ammonia addition during the chloramination process. This proved most effective for the water supply in this study and resulting in only a small increase in trihalomethane formation. In addition, this study has identified the filters as a potential major source of NDMA precursor material which may outweigh the impact of optimising the coagulation process on NDMA reduction." (16)

SA Water NDMA Detections >3ng/L



August 2007 - July 2012

The locations in this graph are the only locations where SA Water currently test for NDMA.



SA Water Lower Lakes NDMA Detections

December 2009 - July 2012

Lower Lakes Detections started 22/12/09 with an average detection level of 62.5ng/L.



SA Water NDMA detection sites 2007 – 2012. Red marks breaches to ADWG.

5.20 Nickel

ADWG Health Guideline 0.02mg/L. A chemical element and silvery white corrosion resistant metal with a golden tinge. 60% of nickel production is used in nickel steel (particularly stainless steel). In water, mainly a problem with nickel plated fittings. Main releases to the environment are from the burning of fossil fuels and in waste discharges from electroplating industries.

SA Water recorded one incident between 2000-2012 where Nickel breached the 2011 ADWG.

20/12/07 Cowirra-Neeta 0.0282mg/L



Location of Cowirra-Neeta – site of SA Water's only Nickel breach 2000-2012.

5.21 Selenium

ADWG Guideline 0.01mg/L. An element and non-metal mainly found in sulphide ores such as pyrite. 50% of selenium used in the world, is for glass production. "Selenium and selenium salts are widespread in the environment. Selenium is released from natural and human-made sources, with the main source being the burning of coal. Selenium is also a by-product of the processing of sulfide ores, chiefly in the copper refining industry. The major use of selenium is in the manufacture of electronic components. It is used in several other industries, and selenium compounds are used in some insecticides, in hair shampoos as an anti-dandruff agent, and as a nutritional feed additive for poultry and livestock." (3)

SA Water recorded 5 incidents of Selenium breaching the 2011 ADWG's between 2000-2012.

13/03/2000 12:01 Warooka CT 7 McKenzie Av Selenium - Total 0.015 mg/L 11/09/2000 10:55 Warooka CT 7 McKenzie Av Selenium - Total 0.013 mg/L 12/03/2001 12:15 Warooka CT 7 McKenzie Av Selenium - Total 0.01 mg/L 8/04/2003 11:54 Port Pirie CT 341 Senate Rd Selenium - Total 0.012 mg/L 19/09/2011 10:35 Warooka CT 7 McKenzie Av Selenium - Total 0.0124 mg/L



Map showing Warooka and Port Pirie.

5.22 Trichloroacetic acid

ADWG level 0.1mg/L

A chlorine disinfection by-product. Australian Drinking Water Guideline: 0.1mg/L

Chlorine was initially added to drinking water as a means of killing disease causing bacteria including cholera which was responsible for the deaths of millions of people. Its use as a water disinfectant was 'perfected' in the United States in the 1930's. However chlorine does have its own 'problems', such as those related to Disinfection By-Products (DBP's).

There have been over 600 DBP's identified and some have been linked with cancers, adverse birth outcomes and some birth defects. If detected, water authorities need to conduct regular air scouring, flushing of the reticulation system and powder activated carbon dosing. THM's can be present in water as a result of chlorination and to a lesser extent chloramination. Regulated THM's include trichloromethane, bromodichloromethane, dibromochloromethane and bromoform. Total THM's refer to the sum of these four compounds.

In the United States, the EPA limits the total concentration of the four chief constituents (chloroform, bromoform, bromodichloromethane), referred to as total trihalomethanes (TTHM), to 80 parts per million in treated water. In Australian the limit is 250 parts per billion.

Haloacetic acids (HAA's) are also DBP's. 15 HAA's can be formed in the presence of chlorine, bromide and iodide. The most common HAA's are dichloroacetic acid and trichloroacetic acid. (Other HAA's include: bromochloroacetic acid, dibromoacetic acid, monobromoacetic acid.

Other DBP's can include: haloacetonitriles, halogenated furanones, halonitromethanes, cyanogen halides, haloketones, haloaldehydes, halogenated phenols.

Between 2000-2012, SA Water detected one sample of Trichloroacetic acid that breached the 2011 ADWG's.

17/05/2012 9:02 Mannum 116 ug/L

(Testing for Trichloroacetic acid started at Mannum in 2011. During 2011/12, the average level detected at Mannum was 38ug/L (0.038mg/L).



Location of Mannum

5.23 Trihalomethanes

SA Water recorded 581 breaches to the ADWG in the period January 2000 to July 2012.

Australian Drinking Water Guideline: 0.250mg/L

SA Water Trihalomethane ADWG Breaches



January 2000 - July 2012

Top Ten Levels Recorded by SA Water for Trihalomethanes 2000-2012.

20/2/01	Wudinna	1064ug/L
19/2/01	Ceduna	996ug/L
19/3/01	Ceduna	994ug/L
17/4/01	Kimba	722ug/L
21/1/02	Ceduna	688ug/L
22/1/02	Lock	655ug/L
16/1/01	Lock	599ug/L
22/2/00	Wudinna	568ug/L
17/4/01	Ceduna	541ug/L
19/12/01	Keith	540ug/L

Chlorine was initially added to drinking water as a means of killing disease causing bacteria including cholera which was responsible for the deaths of millions of people. Its use as a water disinfectant was 'perfected' in the United States in the 1930's. However chlorine does have its own 'problems', such as those related to Disinfection By-Products (DBP's).

There have been over 600 DBP's identified and some have been linked with cancers, adverse birth outcomes and some birth defects. If detected, water authorities need to conduct regular air scouring, flushing of the reticulation system and powder activated carbon dosing. THM's can be present in water as a result of chlorination and to a lesser extent chloramination. Regulated THM's include trichloromethane, bromodichloromethane, dibromochloromethane and bromoform. Total THM's refer to the sum of these four compounds.

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bromodichloromethane, and dibromodichloromethane), referred to as total trihalomethanes (TTHM), to 80 parts per million in treated water. In Australian the limit is 250 parts per billion.

Haloacetic acids (HAA's) are also DBP's. 15 HAA's can be formed in the presence of chlorine, bromide and iodide. The most common HAA's are dichloroacetic acid and trichloroacetic acid. (Other HAA's include: bromochloroacetic acid, dibromoacetic acid, monobromoacetic acid.

Other DBP's can include: haloacetonitriles, halogenated furanones, halonitromethanes, cyanogen halides, haloketones, haloaldehydes, halogenated phenols.



Total 2012(581): Kingscote 130, Brownlow 39, Emu Bay 34, Port Wakefield 30, Hindmarsh Island 26, Victor Harbor 22, Port Parham 21, Goolwa 19, Encounter Bay 17, Hamley Bridge 15, Myponga 15, Ceduna 13, Blanchetown 12, Wall Flat 12, Lock 11, Normanville 10, Paringa 10, Clarendon 9, Willunga 9, Swan Reach 8, Monarto 7, Penneshaw 7, Caloote 6, Carrickalinga 6, Cooltong 6, Dublin 6, Kimba 5, Brinkley 4, Eden Valley 4, Nettle Hill 4, Wudinna 4, Cadell 3, Callington 3, Glossop 3, Kanmantoo 3, Mypolonga 3, Palmer 3, Berrie 2, Aldinga Beach 2, Chandlers Hill 2, Cowirra-Neeta 2, Murray Bridge 2, Pompoota 2, Sellicks Beach 2, Woodville South 2, Ardrossan 1, Belair 1, Brooklyn Park 1, Cummins 1, Gulfview Heights 1, Happy Valley 1, Hindmarsh Valley 1, Ingle Park 1, Karoonda 1, Keith 1, Kingston 1, Maitland 1, Marden 1, Monash 1, Moorook 1, Paracombe 1, Prospect 1, Redwood Park 1, Renmark 1, Tintinara 1, Tungkillo 1, Two Wells 1, Wattle Park 1, West Lakes Shores 1.

THM Breaches ADWG 2010 - July 2012 • Kangaroo Island • Elsewhere

Kangaroo Island's share of THM breaches has decreased since 2010, however THM breaches have increased significantly as a whole, with the new 'THM capital' being Hindmarsh Island.

"Classical trihalomethanes consist of chloroform (CHCl3), dichlorobromoform (CHCl2Br), dibromochloroform (CHBr2Cl) and bromoform (CHBr3)" Epidemiological studies have been conducted to evaluate the association from exposure to chlorinated surface water with several adverse outcomes: cancer, cardiovascular disease, and adverse reproductive outcomes, including neutral birth defects. Recent studies have reported increased incidence of decreased birth weight, prematurity, intrauterine growth retardation, and neural tube defects with chlorinated water and in some cases, THMs (AWWA, 1999). In their study, Chang et al (2000) reported that DBPs are potential carcinogenic and teratologenic substances. According to Singer et al (1999), some of these compounds have been found to be carcinogenic or to cause adverse reproductive or developmental effects in animal studies while others have been shown to be mutagenic and hepatotoxic. However, no evidence of reproductive or developmental effects has been reported for chlorine as reported by Cohn et al (1999)" (17)

"Trihalomethanes (THM) are a class of organic compounds. The four chemical species known as THMs are chloroform (CHCl3), bromdichlormethane (CHBrCl2), dibromchlormethane (CHBr2Cl) si bromoform (CHBr3) (Teskoy et al., 2008). In drinking water, the maximum allowed level for total THM (TTHMs) in the European Union is 100 µg/L, the maximum allowable values varying widely from one country to another (including the European Union Member States). In Austria, Switzerland and Luxembourg, the TTHMs regulatory limit in drinking water is 30, 25, 50 µg/L, respectively (Golfinopoulos, Nikolaou, 2005)." (18)

Why and how are THMs formed?

"When chlorine is added to water with organic material, such as algae, river weeds, and decaying leaves, THMs are formed. Residual chlorine molecules react with this harmless organic material to form a group of chlorinated chemical compounds, THMs. They are tasteless and odorless, but harmful and potentially toxic. The quantity of byproducts formed is determined by several factors, such as the amount and type of organic material present in water, temperature, pH, chlorine dosage, contact time available for chlorine, and bromide concentration in the water. The organic matter in water mainly consists of a) humic substance, which is the organic portion of soil that remains after prolonged microbial decomposition formed by the decay of leaves, wood, and other vegetable matter; and b) fulvic acid, which is a water soluble substance of low molecular weight that is derived from humus". (19)

"What are the health effects of THMs? According to a University of Florida report, exposure to THMs may pose an increased risk of cancer. According to Rebekah Grossman, two THMs, chloroform and dibromochloromethane, are carcinogens; and another THM, bromodichloromethane, has been identified as a mutagen, which alters DNA. Mutagens are considered to affect the genetics of future generations in addition to being carcinogenic. A California study indicates that THMs may be responsible for reproductive problems and miscarriage. The study found a miscarriage rate of 15.7 percent for women who drank five or more glasses of cold water containing more than 0.075

mg/l TTHM, compared to a miscarriage rate of 9.5 percent for women with low TTHM exposure. In addition to these risks, TTHMs are linked to bladder cancer, heart, lungs, kidney, liver, and central nervous system damage."(19)



SA Water THM breaches 2000 – July 2012.

"Chemical in South Australian drinking water above recommended health guidelines May 22 2011 [The article also failed to mention that in 2008 Goolwa, Victor Harbor & Clare exceedeed THM levels].

PEOPLE are drinking water that is regularly contaminated with a chemical at levels above safe guidelines. Trihalomethane in water for homes in the Barossa, Fleurieu, Riverland and Kangaroo Island last year regularly rose above the Australian Drinking Water Guideline of 250 micrograms per litre (ug/l).

A guideline of 100ug/l for THMs is set by the EU. A THM, Dibromochloromethane, was one of the compounds of concern detected in Edwardstown groundwater after 2200 residents were warned by SA Health and the Environment Protection Authority in February to not use the water, contaminated by the former Hills Industries site. In the worst case, water from [samples] at the Barossa water treatment plant had a maximum THM level of 368ug/l. The Barossa plant failed to meet the health compliance target in 23 per cent of the tests.

Water from the Happy Valley treatment plant did not comply with the THM guideline 30 per cent of the time, while Myponga water treatment plant water failed test 26 per cent of the time and had an average THM level of 230ug/l - marginally below the accepted level.

But SA Water and SA Health say the water is safe and while action is being taken to reduce THMs in our water, it will not be done in a way that compromises disinfection. SA Water head of Water Quality and Environment Dr John Howard said reducing THMs is "encouraged, but must not compromise disinfection, as nondisinfected water poses significantly greater risks than THMs". "SA Water has a close working relationship with SA Health," Dr Howard said. "Throughout the 2009-10 reporting period SA Health advised us that, 'appropriate responses were instituted to all reported incidents and as such none of the incidents associated with drinking water supplies were considered to represent a public health risk, or to require public notification'."

SA's Chief Scientist, Professor Don Bursill, said it was considered good practice to keep to below the guideline levels with regard to THMs, but the priority for drinking water was disinfection.

He said that in the mid-1970s, it was thought that chloroform, one of four compounds in the group of THMs, was a carcinogen and that triggered tough standards for THMs in drinking water.

"The health community is less concerned with (THMs) than they used to be," Prof Bursill said. "It started as a concern 22about 40 years ago and as research has progressed, it has been found to be less of a risk."There is debate over the actual health risk posed by THMs and while there is a belief by some health agencies that they could cause some forms of cancer, research has not been able to prove this.SA Water has moved to reduce the level of THMs in water on Kangaroo Island and from Myponga reservoir by aerating it.

Dr Howard said elevated levels of THMs were generally caused by warmer weather and unique characteristics of the source water, including the amount of natural organic matter.

SA Water recently modified the offtake at Middle River Reservoir and installed an aeration system at Kingscote. A statement from SA Health said: "The concentrations of THMs in South Australian drinking water supplies will not result in health impacts for consumers." (20)



THM breaches in Adelaide region 2000-12. Compare these to the number of WHO breaches for Bromodichloromethane/Dichlorobromoform over the same time period. By combining the four substances into THM results, this dilutes the significance of the potential impacts of the single compounds.



Myponga Country THM Breaches








Myponga WTP Outer Metro Note This is separate distibution network of tap water to that of Myponga Country towns



6. Kingscote (Kangaroo Island)

Kingscote Drinking Water Breaches 2000 - 2012



ADWG (Blue), WHO (Red)

The 2012 data was up to July only, the main problem still appears to be Bromoform. It appears that the new MIEX plant has reduced concentrations of BDCM.

7/12/05: Mike Rann announced a new \$4.5m MIEX (Magnetic Iron Exchange) plant to be built on Kangaroo Island at the Middle River water treatment plant. MIEX reduces organic carbon in the water, thereby meaning less chlorine is used. Construction began November 2006. "*The Middle River-Kingscote treated water supply has high THM concentrations with levels consistently above the ADWG value of 250 micrograms per litre (ug/L). Since 2000 the majority of THM results from the two sampling locations at Kingscote have been between 300ug/L and 500ug/L. Special dispensation has been granted by DH for the current non-compliance with the ADWG THM Health Parametre on the understanding that this is being addressed and a solution is forthcoming. Apart from Myponga (which is a lesser issue and is currently being investigated) there are no THM issues with any of SA Water's other systems." (21)*

Kingscote Drinking Water Breaches







Reductions to Bromodichloromethane appear to have occurred since the new water treatment plant has been constructed on Kangaroo Island, however there have been over 20 detections of Bromoform above 100ug/L (WHO Guideline level) in 2012 (see graph below).



THM detections Kingscote 2000 - June 2012





THM detections at Kingscote. Note peaks in summer 2007-2011.

12 year average = 239.4ug/L. Average 2000-2008 = 308.3ug/L Average 2009-2012 = 185.2ug/L





Nearby Brownlow continues to have THM problems.

7. References

(1) Source: Report on Carcinogens, Twelfth Edition (2011) http://ntp.niehs.nih.gov/go/roc12

(2) http://www.health.qld.gov.au/ph/documents/ehu/2676.pdf

(3) Australian Drinking Water Guidelines - National Health and Medical Research Centre

(4) <u>http://www.who.int/water_sanitation_health/dwq/chemicals/THM200605.pdf</u>

(5) http://etd.lib.metu.edu.tr/upload/12605587/index.pdf

(6) <u>http://www.who.int/water_sanitation_health/dwq/chemicals/trihalomethanes_summary_statement.pdf</u>

(7) <u>http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/trihalomethanes/guide-eng.php</u>

(8) <u>http://www.atsdr.cdc.gov/phs/phs.asp?id=711&tid=128</u>

(9) <u>http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/chloral_hydrate-chloral/health-sante-eng.php</u>

(10)Trihalomethanes in Drinking Water. Background Document for Development of WHO Guidelines for Drinking Water Quality.

(11) http://www.atsdr.cdc.gov/phs/phs.asp?id=711&tid=128

(12) <u>http://www.epa.gov/region9/water/chloramine.html</u>

(13) http://water.epa.gov/drink/contaminants/basicinformation/disinfectants.cfm

(14) Monochloramine in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality 2004

(15)Source: NDMA ATT

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(17)APPLICATION OF INDIGENOUS MATERIALS IN DRINKING WATER TREATMENT. Herbert Mpagi Kalibbala May 2007. kth.diva-portal.org/smash/get/diva2:12360/FULLTEXT01

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(19) http://www.nesc.wvu.edu/ndwc/articles/QandA/OTsp99 Q A.pdf

(20) <u>http://www.adelaidenow.com.au/news/south-australia/chemical-in-south-australian-drinking-waterabove-recommended-health-guidelines/story-e6frea83-1226060712014</u>

(21) Middle River Water Treatment Plant MIEX Retrofit 234th Report of the Public Works Committee SA Parliament 27 Jan 2006. http://www.docstoc.com/docs/22899068/MIDDLE-RIVER-WATER-TREATMENT-PLANT-MIEX-RETROFIT

8. Appendicies

Town/Suburb Total Breaches January 2000 – July 2012 (including substances) [*Adelaide Urban]

1.	Kingscote	435	 2011: Bromodichloromethane 1, 2003: Bromoform 1, 2004: Bromoform 4, 2005: Bromoform 5, 2006: Bromoform 2, 2007: Bromoform 6, 2008: Bromoform 20, 2010: Bromoform 9, 2012: Bromoform 20, 2010: Chloral Hydrate 1, 2011: Dibromochloromethane 4, 2012: Dibromochloromethane 7, 2010: Lead 1, 2010: Manganese 1, 2000: THM's 10, 2001: THM's 12, 2002: THM's 12, 2003: THM's 10, 2004: THM's 9, 2005: THM's 12, 2006: THM's 13, 2007: THM's 11, 2008: THM's 25, 2009: THM's 3, 2010: THMs 6, 2011: THM's 1, 2012: THMs 6, 2000: Dibromochloroform 6, 2001: Dibromochloroform 10, 2002: Dibromochloroform 12, 2003: Dibromochloroform 11, 2006: Dibromochloroform 8, 2005: Dibromochloroform 11, 2008: Dibromochloroform 7, 2000: Dibromochloroform 10, 2010: Dibromochloroform 7, 2000: Dibromochloroform 10, 2010: Dibromochloroform 12, 2002: Dibromochloroform 10, 2010: Dibromochloroform 12, 2002: Dibromochloroform 10, 2001: Dibromochloroform 12, 2002: Dichlorbromoform 10, 2005: Dichlorbromoform 13, 2006: Dichlorbromoform 14, 2007: Dichlorbromoform 13, 2006: Dichlorbromoform 10, 2009: Dichlorbromoform 9, 2008: Dichlorbromoform 10, 2009: Dichlorbromoform 2
2.	Willunga	205	2010: Bromodichloromethane 4, 2011: Bromodichloromethane 29, 2012: Bromodichloromethane 19, 2012: Dibromochloromethane 2, 2007: THM's 1, 2008: THM's 1, 2010: THMs 1, 2012: THMs 6, 2000: Dichlorobromoform 4, 2001: Dichlorbromoform 11, 2002: Dichlorbromoform 10, 2003: Dichlorbromoform 16, 2004: Dichlorbromoform 9, 2005: Dichlorbromoform 13, 2006: Dichlorbromoform 16, 2007: Dichlorbromoform 19, 2008: Dichlorbromoform 21, 2009: Dichlorbromoform 12, 2010: Dichlorbromoform 11
3.	Sellicks Beach	138	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 24, 2012: Bromodichloromethane 12, 2011: Chloral Hydrate 1, 2012: Chloral Hydrate 1, 2011: THM's 1, 2012: THMs 1, 2007: Dibromochloroform 1, 2000: Dichlorobromoform 6, 2001: Dichlorbromoform 13, 2002: Dichlorbromoform 9, 2003: Dichlorbromoform 6, 2004: Dichlorbromoform 10, 2005: Dichlorbromoform 7, 2006: Dichlorbromoform 8, 2007: Dichlorbromoform 8, 2008: Dichlorbromoform 10, 2009: Dichlorbromoform 6, 2010: Dichlorbromoform 13
4.	Brownlow	134	2011: Bromodichloromethane 2, 2008: Bromoform 14, 2009: Bromoform 2, 2010: Bromoform 12, 2011: Bromoform 2, 2012: Bromoform 12, 2011: Dibromochloromethane 7, 2012: Dibromochloromethane 7, 2007: THM's 1, 2008: THM's 16, 2009: THM's 4, 2010: THMs 8, 2011: THM's 4, 2012: THMs 6, 2007: Dibromochloroform 1, 2008: Dibromochloroform 17, 2009: Dibromochloroform 6, 2010: Dibromochloroform 7, 2008: Dichlorbromoform 5, 2009: Dichlorbromoform 1
5.	Emu Bay	129	2010: Bromodichloromethane 3, 2011: Bromodichloromethane 7, 2008: Bromoform 13, 2008: Bromoform 4, 2010: Bromoform 6, 2011: Bromoform 2, 2012: Bromoform 1, 2011: Dibromochloromethane 3, 2012: Dibromochloromethane 7, 2008: THM's 12, 2009: THM's 12, 2010: THMs 6, 2011: THM's 3, 2012: THMs 1, 2008: Dibromochloroform 11, 2009: Dibromochloroform 14, 2010: Dibromochloroform 7, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 6, 2010: Dichlorbromoform 7

6.	Victor Harbor	116	2010: Bromodichloromethane 2, 2011: Victor Harbor 13, 2012: Bromodichloromethane 7, 2002: Chloral Hydrate 1, 2003: Chloral Hydrate 1, 2004: Chloral Hydrate 1, 2005: Chloral Hydrate 2, 2006: Chloral Hydrate 1, 2009: Chloral Hydrate 1, 2010: Chloral Hydrate 2, 2011: Chloral Hydrate 2, 2011: Dibromochloromethane 2, 2012: Dibromochloromethane 4, 2003: E.coli 1, 2003: THM's 2, 2004: THM's 1, 2006: THM's 1, 2007: THM's 2, 2008: THM's 2, 2009: THM's 1, 2010: THMs 4, 2011: THM's 4, 2012: THMs 5, 2007: Dibromochloroform 2, 2009: Dibromochloroform 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 4, 2003: Dichlorbromoform 3, 2006: Dichlorbromoform 4, 2007: Dichlorbromoform 6, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 7, 2010: Dichlorbromoform 11
7.	Hindmarsh Island	94	2010: Bromodichloromethane 2, 2011 Bromodichloromethane 13, 2012: Bromodichloromethane 7, 2009: Chloral Hydrate 6, 2010: Chloral Hydrate 10, 2011: Chloral Hydrate 2, 2011: Dibromochloromethane 2, 2012: Dibromochloromethane 4, 2009: THM's 4, 2010: THMs 11, 2011: THM's 6, 2012: THMs 5, 2009: Dibromochloroform 2, 2010: Dibromochloroform 1, 2009: Dichlorbromoform 8, 2010: Dichlorbromoform 11
8.	Normanville	91	2010: Bromodichloromethane 2, 2011: Normanville 11, 2012: Bromodichloromethane 5, 2009: Chloral Hydrate 2, 2010: Chloral Hydrate 3, 2011: Chloral Hydrate 3, 2006: THM's 2, 2007: THM's 2, 2009: THM's 1, 2010: THMs 3, 2011: THM's 1, 2012: THMs 1, 2000: Dichlorobromoform 3, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 4, 2003: Dichlorbromoform 4, 2004: Dichlorbromoform 5, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 8, 2010: Dichlorbromoform 13
9.	Port Wakefield	85	2010: Bromodichloromethane 3, 2011: Bromodichloromethane 13, 2012: Bromodichloromethane 2, 2008: THM's 2, 2009: THM's 8, 2010: THMs 12, 2011: THM's 7, 2012: THMs 1, 2008: Dibromochloroform 1, 2009: Dibromochloroform 6, 2010: Dibromochloroform 2, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 11, 2010: Dichlorbromoform 10, 2012: Monochloramines 3
10.	Carrickalinga	81	2010: Bromodichloromethane 2, 2011: Bromodichloromethane 13, 2012: Bromodichloromethane 5, 2009: Chloral Hydrate 7, 2010: Chloral Hydrate 8, 2011: Chloral Hydrate 7, 2012: Chloral Hydrate 5, 2007: THM's 1, 2009: THM's 1, 2010: THMs 3, 2011: THM's 1, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 6, 2010: Dichlorbromoform 11
11.	Goolwa	76	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 3, 2000: Chloral Hydrate 1, 2009: Chloral Hydrate 1, 2010: Chloral Hydrate 3, 2011: Chloral Hydrate 2, 2001: Total Chlorine 1, 2012: Dibromochloromethane 1, 2001: THM's 1, 2002: THM's 2, 2003: THMs 3, 2004: THM's 1, 2005: THM's 1, 2007: THM's 2, 2008: THM's 1, 2009: THM's 2, 2010: THMs 1, 2011: THM's 3, 2012: THMs 2, 2000: Dichlorobromoform 4, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 3, 2003: Dichlorbromoform 4, 2004: Dichlorbromoform 4, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 4, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 4, 2010:

			Dichlorbromoform 4
12.	Morgan	75	2000: Total Chlorine 11, 2001: Total Chlorine 16, 2002: Total Chlorine 14, 2003: Total Chlorine 8, 2004: Total Chlorine 3, 2005: Total Chlorine 2, 2006: Total Chlorine 5, 2009: Total Chlorine 1, 2011: Total Chlorine 1, 2012: Total Chlorine 1, 2003: Monochloramine 2, 2005: Monochloramine 2, 2006: Monochloramines 5, 2009: Monochloramines 1, 2011: Monochloramines 2, 2012: Monochloramines 1
13.	Maitland	74	2011: Bromodichloromethane 1, 2011: Chloral Hydrate 3, 2000: Total Chlorine 23, 2001: Total Chlorine 8, 2002: Total Chlorine 22, 2003: Total Chlorine 9, 2004: Total Chlorine 7, 2011: THM's 1
14.	Meningie	73	2000: Chlorine – Free 1, 2000: Total Chlorine 1, 2003: Total Chlorine 1
15.	Port Parham	72	 2010: Bromodichloromethane 2, 2011: Bromodichloromethane 14, 2012: Bromodichloromethane 5, 2008: THM's 3, 2009: THM's 5, 2010: THMs 7, 2011: THM's 5, 2012: THMs 1, 2008: Dibromochloroform 2, 2009: Dibromochloroform 3, 2010: Dibromochloroform 1, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 9, 2010: Dichlorbromoform 11
16.	Encounter Bay	69	2010: Bromodichloromethane 2, 2011: Bromodichloromethane 4, 2012: Bromodichloromethane 3, 2008: Chloral Hydrate 1, 2009: Chloral Hydrate 5, 2010: Chloral Hydrate 9, 2011: Chloral Hydrate 5, 2008: THM's 1, 2009: THM's 4, 2010: THMs 8, 2011: THM's 2, 2012: THMs 2, 2009: Dibromochloroform 1, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 10, 2010: Dichlorbromoform 11
17.	Lock	64	2000: Bromoform 1, 2001: Bromoform 2, 2002: Bromoform 3, 2007: Bromoform 2, 2008: Bromoform 1, 2010: Chloral Hydrate 1, 2012: Chloral Hydrate 1, 2000: Chlorine – Free 1, 2000: THM's 1, 2001: THM's 2, 2002: THM's 3, 2007: THM's 2, 2008: THM's 3, 2007: Dibromochloroform 2, 2008: Dibromochloroform 2, 2008: Dichlorbromoform 19, 2009: Dichlorbromoform 12, 2010: Dichlorbromoform 6
18.	Nettle Hill	62	2010: Bromodichloromethane 2, 2011: Bromodichloromethane 16, 2012: Bromodichloromethane 14, 2012: Dibromochloromethane 3, 2012: THMs 4, 2007: Dichlorbromoform 4, 2008: Dichlorbromoform 4, 2009: Dichlorbromoform 3, 2010: Dichlorbromoform 12
19.	Hamley Bridge	60	2010: Bromodichloromethane 2, 2011: Bromodichloromethane 13, 2012: Bromodichloromethane 8, 2012: Dibromochloromethane 1, 2009: THM's 2, 2010: THMs 5, 2011: THM's 3, 2012: THMs 5, 2008: Dichlorbromoform 3, 2009: Dichlorbromoform 7, 2010: Dichlorbromoform 11
20.	Myponga	59	2011: Bromodichloromethane 10, 2012: Bromodichloromethane 7, 2012: Dibromochloromethane 2, 2005: THM's 1, 2006: THM's 1, 2007: THM's 2, 2009: THM's 1, 2011: THM's 4, 2012: THMs 6, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 5, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 3, 2009: Dichlorbromoform 4, 2010: Dichlorbromoform 4
21.	Aldinga Beach	57	2011: Bromodichloromethane 7, 2012: Bromodichloromethane 6, 2008: THM's 1, 2012: THMs 1, 2000: Dichlorobromoform 4, 2001: Dichlorbromoform 5, 2002: Dichlorbromoform 2, 2003: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 5, 2006: Dichlorbromoform 5, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 6, 2009: Dichlorbromoform 6

22.	Craigmore*	54	 2010: Bromodichloromethane 2, 2011: Bromodichloromethane 9, 2012: Bromodichloromethane 3, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 3, 2005: Dichlorbromoform 11, 2006: Dichlorbromoform 9, 2007: Dichlorbromoform 8, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 3, 2010: Dichlorbromoform 3
23.	Wall Flat	51	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 3, 2008: Bromoform 6, 2009: Bromoform 1, 2005: THM's 1, 2006: THM's 3, 2007: THM's 4, 2009: THM's 1, 2011: THM's 3, 2009: Dibromochloroform 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 12, 2007: Dichlorbromoform 11
24.	Blanchetown	43	2011: Bromodichloromethane 3, 2012: Chloral Hydrate 1, 2012: Chlorate 1, 2001: Chloroform 1, 2011: Chloroform 1, 2000: THM's 2, 2001: THM's 5, 2002: THM's 2, 2011: THM's 3, 2000: Dichlorobromoform 4, 2001: Dichlorbromoform 12, 2002: Dichlorbromoform 8
25.	Swan Reach	42	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2004: Total Chlorine 1, 2005: Total Chlorine 2, 2000: THM's 1, 2001: THM's 5, 2011: THM's 2, 2000: Dichlorobromoform 4, 2001: Dichlorbromoform 8, 2002: Dichlorbromoform 6, 2003: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 3, 2007: Dichlorbromoform 2
26.	Burra North	38	2000: Total Chlorine 3, 2001: Total Chlorine 24, 2002: Total Chlorine 8, 2003: Total Chlorine 1, 2011: Total Chlorine 1, 2011: Monochloramines 1
27.	Brinkley	36	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2010: Chloral Hydrate 3, 2011: Chloral Hydrate 8, 2012: Chloral Hydrate 5, 2006: THM's 1, 2011: THM's 3, 2006: Dichlorbromoform 7, 2007: Dichlorbromoform 2, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 3
28.	Clarendon	36	 2010: Bromodichloromethane 1, 2011: Bromodichloromethane 7, 2012: Bromodichloromethane 5, 2006: THM's 1, 2009: THM's 1, 2010: THMs 2, 2011: THM's 1, 2012: THMs 4, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 2, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 3, 2010: Dichlorbromoform 3
29.	Loxton	36	2011: Total Chlorine 20, 2011: Monochloramines 16
30.	Monarto	34	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 3, 2010: Chloral Hydrate 6, 2011: Chloral Hydrate 2, 2012: Chloral Hydrate 1, 2002: Chlorine – Free 1, 2002: Total Chlorine 1, 2009: THM's 1, 2011: THM's 2, 2012: THMs 4, 2009: Dibromochloroform 1, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 8
31.	Ceduna	33	2000: Bromoform 1, 2001: Bromoform 6, 2002: Bromoform 5, 2011: Bromoform 1, 2012: Bromoform 1, 2001: THM's 5, 2002: THM's 5, 2011: THM's 2, 2012: THMs 1, 2001: Dibromochloroform 3, 2002: Dibromochloroform 3
32.	Mannum	32	2008: Bromoform 1, 2011: Chloral Hydrate 1, 2012: Chloral Hydrate 6, 2008: Chlorine – Free 1, 2008: Total Chlorine 1, 2011: E.coli 1, 2012: Trichloroacetic Acid 1, 2001: Dichlorbromoform 5, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 3, 2006: Dichlorbromoform 7, 2007: Dichlorbromoform 4
33.	McLaren Vale	32	2012: Bromodichloromethane 1, 2000: Dichlorobromoform 7, 2001:

			Dichlorbromoform 6, 2002: Dichlorbromoform 5, 2003: Dichlorbromoform 4, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 4, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 1
34.	Caloote	30	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 2, 2008: Bromoform 1, 2010: Chloral Hydrate 3, 2011: Chloral Hydrate 2, 2012: Chloral Hydrate 5, 2010: THMs 1, 2011: THM's 4, 2012: THMs 1, 2007: Dibromochloroform 1, 2006: Dichlorbromoform 1, 2007: Dichlorbromoform 4, 2009: Dichlorbromoform 1
35.	Happy Valley*	30	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 4, 2004: Total Chlorine 1, 2012: THMs 1, 2000: Dichlorobromoform 2, 2001: Dichlorbromoform 5, 2002: Dichlorbromoform 4, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 3, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 1
36.	Seaford Rise*	27	2011: Bromodichloromethane 2, 2000: Dichlorobromoform 2, 2001: Dichlorbromoform 6, 2002: Dichlorbromoform 4, 2003: Dichlorbromoform 3, 2004: Dichlorbromoform 4, 2005: Dichlorbromoform 4, 2006: Dichlorbromoform 2
37.	Penneshaw	26	2010: Antimony 1, 2000: Bromoform 7, 2001: Bromoform 6, 2002: Bromoform 3, 2003: Bromoform 2, 2000: THMs's 5, 2002: THM's 2
38.	Monteith	24	2012: Bromodichloromethane 1, 2010: Chloral Hydrate 1, 2011: Chloral Hydrate 3, 2012: Chloral Hydrate 7, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 3, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1
39.	Blakeview*	23	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 3, 2012: Bromodichloromethane 2, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 3, 2006: Dichlorbromoform 5, 2007: Dichlorbromoform 2, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 2
40.	Kimba	23	2000: Bromoform 3, 2001: Bromoform 4, 2002: Bromoform 3, 2010: Chloral Hydrate 1, 2011: Chloral Hydrate 4, 2012: Chloral Hydrate 3, 2000: THM's, 1, 2001: THM's 3, 2002: THM's 1
41.	Elizabeth Downs*	22	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 3, 2012: Bromodichloromethane 4, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 3, 2006: Dichlorbromoform 3, 2007: Dichlorbromoform 3, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 2
42.	Port Victoria	22	2000: Total Chlorine 10, 2002: Total Chlorine 8, 2003: Total Chlorine 1, 2004: Total Chlorine 3
43.	Andrews Farm*	21	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 2, 2001: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 3, 2006: Dichlorbromoform 5, 2007: Dichlorbromoform 3, 2010: Dichlorbromoform 2
44.	Murray Bridge	21	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2006: Chloral Hydrate 2, 2010: Chloral Hydrate 1, 2011: Chloral Hydrate 1, 2012: Chloral Hydrate 1, 2011: THM's 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2
45.	Ardrossan	19	2011: Chloral Hydrate 1, 2008: Monochloramines 1, 2011: THM's 1,

			2000: Total Chlorine 6, 2001: Total Chlorine 2, 2002: Total Chlorine 3, 2003: Total Chlorine 1, 2004: Total Chlorine 4
46.	Clare	19	2000: Total Chlorine 1, 2001: Total Chlorine 12, 2002: Total Chlorine 5, 2004: Total Chlorine 1
47.	Dublin	19	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 5, 2012: Bromodichloromethane 2, 2001: E.coli 1, 2005: THM's 1, 2010: THMs 1, 2011: THM's 2, 2012: THMs 2, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2008: Dichlorbromoform 1, 2009: Dichlorbromoform 1
48.	Enfield*	19	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 4, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 3
49.	Hindmarsh Valley	19	2007: THM's 1, 2004: Dichlorbromoform 4, 2005: Dichlorbromoform 3, 2006: Dichlorbromoform 5, 2007: Dichlorbromoform 5, 2008: Dichlorbromoform 1
50.	Blackwood	18	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 2, 2001: Dichlorbromoform 5, 2002: Dichlorbromoform 4, 2003: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
51.	Chandlers Hill*	16	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 4, 2012: Bromodichloromethane 2, 2012: THMs 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 1
52.	Paringa	16	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2011: Chloroform 3, 2010: THMs 3, 2011: THM's 5, 2012: THMs 2
53.	Eden Valley	15	2011: Bromodichloromethane 1, 2004: THM's 1, 2011: THM's 3, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 8, 2005: Dichlorbromoform 1
54.	Glenalta*	15	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 1
55.	One Tree Hill	15	2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2002: Dichlorbromoform 2, 2003: Dichlorbromoform 4, 2004: Dichlorbromoform 4, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1
56.	Ottoway*	15	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1
57.	Two Wells	15	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 4, 2012: Bromodichloromethane 6, 2012: THMs 1, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 2
58.	Belair*	14	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 2, 2012: THMs 1, 2001: Dichlorbromoform 4, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2010: Dichlorbromoform 1

59.	Cooltong	14	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 2, 2012: Chloroform 2, 2011: Chloroform 2, 2010: THMs 1, 2011: THM's 3, 2012: THMs 2
60.	Eudunda	14	2000: Total Chlorine 1, 2001: Total Chlorine 9, 2002: Total Chlorine 3, 2003: Total Chlorine 1
61.	Wudinna	14	2000: Bromoform 1, 2001: Bromoform 3, 2002: Bromoform 2, 2011: Chlorine – Free 1, 2011: Total Chlorine 1, 2000: THM's 1, 2001: THM's 2, 2002: THM's 1, 2001: Dibromochloroform 2
62.	Aberfoyle Park*	13	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 4, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 1
63.	Coonalpyn	13	2001: Chlorine – Free 2, 2001: Total Chlorine 2, 2002: Total Chlorine 2, 2003: Total Chlorine 2, 2004: Total Chlorine 5
64.	North Haven*	13	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 1
65.	Port Pirie	13	2000: Chlorine – Free 1, 2001: Total Chlorine 10, 2002: Total Chlorine 1, 2003: Selenium 1
66.	Queenstown*	13	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 2
67.	Christies Beach*	12	2011: Bromodichloromethane 3, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 1
68.	Crystal Brook	12	2000: Total Chlorine 1, 2001: Total Chlorine 9, 2003: Total Chlorine 1, 2004: Total Chlorine 1
69.	Medindie*	12	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2009: Dichlorbromoform 1
70.	Adelaide*	11	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 4, 2004: Dichlorbromoform 1
71.	Cowirra-Neeta	11	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 2, 2007: Lead 1, 2007: Nickel 1, 2011: THM's 2, 2006: Dichlorbromoform 1, 2007: Dichlorbromoform 2
72.	Jamestown	11	2001: Total Chlorine 10, 2002: Total Chlorine 1
73.	Keith	11	2001: Total Chlorine 1, 2002: Chlorine – Free 1, 2002: Total Chlorine 3, 2001: Chloroform 1, 2010: NDMA, 1, 2001: THM's 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1
74.	Minalton	11	2001: Total Chlorine 1, 2002: Total Chlorine 5, 2003: Total Chlorine 1, 2004: Total Chlorine 3, 2002: Monochloramine 1
75.	Mypolonga	11	2011: Bromodichloromethane 3, 2011: THM's 3, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 3, 2007: Dichlorbromoform 1
76.	Naracoorte	11	2000: Bromoform 2, 2001: Bromoform 2, 2003: Bromoform 2, 2004: Bromoform 1, 2008: Bromoform 1, 2009: Bromoform 1, 2010: Bromoform 1, 2000: Chlorine – Free 1

77.	Seaton*	11	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2012: Chloral Hydrate 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2
78.	West Lakes Shores*	11	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2012: THMs 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 1
79.	Woodville South*	11	2012: Bromodichloromethane 1, 2008: Lead 1, 2012: THMs 2, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 3
80.	Allenby Gardens*	10	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 1
81.	Angle Park*	10	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 2
82.	Brooklyn Park*	10	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2012: Chloral Hydrate 1, 2012: THMs 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 1
83.	Christie Downs*	10	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
84.	Eden Hills*	10	2010: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 3, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 2, 2006: Dichlorbromoform 1
85.	Elizabeth Grove*	10	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 2, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 1, 2010: Dichlorbromoform 1
86.	Glen Osmond*	10	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 2, 2011: Chloral Hydrate 1, 2000: Dichlorobromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1
87.	Hallett Cove*	10	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2
88.	Marden*	10	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2012: THMs 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2010: Dichlorbromoform 1
89.	Pompoota	10	2011: Bromodichloromethane 4, 2012: Total Chlorine 1, 2011: THM's 2, 2005: Dichlorbromoform 1, 2007: Dichlorbromoform 2
90.	Willaston	10	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2005: Dichlorbromoform 1,2006: Dichlorbromoform 2, 2007: Dichlorbromoform 2, 2010: Dichlorbromoform 2
91.	Felixstow	9	2001: Dichlorbromoform 2, 2002: Dichlorbromoform 2, 2004:

			Dichlorbromoform 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
92.	Fulham Gardens*	9	2011: Bromodichloromethane 2, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2, 2010: Dichlorbromoform 1
93.	Henley Beach*	9	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 2
94.	Ingle Farm*	9	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2000: THM's, 1, 2000: Dichlorobromoform 2, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2010: Dichlorbromoform 1
95.	Lewiston	9	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 1, 2010: Dichlorbromoform 1
96.	Lockleys*	9	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 2, 2003: Dichlorbromoform 1, 2009: Dichlorbromoform 1
97.	Lower Lakes	9	2010: NDMA 8, 2011 NDMA 1
98.	Morphett Vale*	9	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2007: Dichlorbromoform 1
99.	Prospect*	9	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2012: THMs 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 1
100.	Tailem Bend	9	2003: Total Chlorine 1, 2004: Total Chlorine 2, 2011: Total Chlorine 1, 2012: Total Chlorine 2, 2011: Monochloramines 1, 2012: Monochloramines 2
101.	Wattle Park*	9	2011: Bromodichloromethane 1, 2000: THM's 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 1, 2007: Dichlorbromoform 1
102.	West Beach*	9	2011: Bromodichloromethane 2, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 2
103.	Wingfield*	9	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2010: Dichlorbromoform 1
104.	Woodcroft*	9	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 2
105.	Cadell	8	2011: Bromodichloromethane 3, 2012: Chlorate 1, 2011: Chloroform 1, 2011: THM's 3
106.	Evanston Park*	8	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2005: Dichlorbromoform 2, 2006: Dichlorbromoform 3, 2007: Dichlorbromoform 1

107.	Largs Bay*	8	2011: Bromodichloromethane 4, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
108.	Mitchell Park	8	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2003: Dichlorbromoform 2, 2004: Dichlorbromoform 1
109.	O'Sullivan's Beach*	8	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2009: Dichlorbromoform 1
110.	Parilla	8	2007: Arsenic 2, 2008: Arsenic 2, 2009: Arsenic 2, 2000: Chlorine – Free 1, 2000: Total Chlorine 1
111.	Pasadena*	8	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2006: Dichlorbromoform 1
112.	Roseworthy	8	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 2, 2006: Dichlorbromoform 2, 2007: Dichlorbromoform 1, 2010: Dichlorbromoform 1
113.	Salisbury East*	8	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 3, 2006: Dichlorbromoform 1
114.	Seacliff Park*	8	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1
115.	Warooka	8	2001: Cadmium 1, 2004: Cadmium 1, 2005: Cadmium 2, 2000: Selenium 2, 2001: Selenium 1, 2011 Selenium 1
116.	Yorketown	8	2000: Total Chlorine 1, 2003: Total Chlorine 1, 2004: Total Chlorine 5, 2002: Chloral Hydrate 1
117.	Balaklava	7	2000: Chloral Hydrate 1, 2001: Chloral Hydrate 1, 2002: Chloral Hydrate 1, 2003: Chloral Hydrate 1, 2001: Dichloracetic Acid 1, 2002: Dichloracetic Acid 1, 2002: Dichlorbromoform 1
118.	Croydon Park*	7	2012: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1
119.	Elizabeth North*	7	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 3, 2007: Dichlorbromoform 1, 2010: Dichlorbromoform 1
120.	Forestville*	7	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2010: Dichlorbromoform 1
121.	Mallala	7	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2007: Dichlorbromoform 2, 2010: Dichlorbromoform 1
122.	Mitchell Park*	7	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2003: Dichlorbromoform 2, 2004: Dichlorbromoform 1
123.	Moonta	7	2000: Chloral Hydrate 3, 2002: Chloral Hydrate 1, 2003: Chloral Hydrate 2, 2011: Monochloramines 1
124.	Port Broughton	7	2000: Total Chlorine 2, 2001: Total Chlorine 3, 2002: Total Chlorine 1, 2003: Total Chlorine 1
125.	Port Noarlunga*	7	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2, 2002:

			Dichlorbromoform 1, 2004: Dichlorbromoform 1
126.	Redwood Park*	7	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 2, 2000: Chloroform 1, 2000: THM's 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1
127.	Salisbury Heights*	7	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 4, 2000: Dichlorobromoform 1
128.	Salisbury Plain*	7	2011: Bromodichloromethane 4, 2012: Bromodichloromethane 2, 2006: Dichlorbromoform 1
129.	Thebarton*	7	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 2
130.	Brinkworth	6	2001: Total Chlorine 5, 2003: Total Chlorine 1
131.	Burdett South	6	2012: Bromodichloromethane 1, 2011: Chloral Hydrate 1, 2012: Chloral Hydrate 4
132.	Cummins	6	2000: Bromoform 1, 2001: Bromoform 2, 2002: Bromoform 2, 2001: THM's 1
133.	Glenelg*	6	2011: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2004: Dichlorbromoform 1
134.	Hillcrest*	6	2011: Bromodichloromethane 1, 2000: Dichlorobromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1
135.	Kanmantoo	6	2011: Bromodichloromethane 3, 2011: THM's 3
136.	Modbury Heights*	6	2011: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 1
137.	Moorook	6	2011: Bromodichloromethane 3, 2012: Chlorate 1, 2011: THM's 2
138.	Norwood*	6	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2010: Dichlorbromoform 1
139.	Palmer*	6	2011: Bromodichloromethane 2, 2007: Total Chlorine 1, 2011: THM's 3
140.	Rose Park*	6	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1
141.	Salisbury North*	6	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 2, 2006: Dichlorbromoform 1
142.	Strathalbyn	6	2001: Total Chlorine 1, 2006: Total Chlorine 2, 2006: Monochloramines 2, 2001: Dichlorbromoform 1
143.	Trott Park*	6	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2005: Dichlorbromoform 1, 2009: Dichlorbromoform 1
144.	Valley View*	6	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2005: Dichlorbromoform 1
145.	Blythe	5	2001: Total Chlorine 4, 2002: Total Chlorine 1
146.	Bolivar*	5	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 2, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1
147.	Callington	5	2011: Bromodichloromethane 2, 2010: THMs 1, 2011: THM's 2

148.	Glenside*	5	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1
149.	Glossop	5	2011: Bromodichloromethane 2, 2011: THM's 3
150.	Golden Grove*	5	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1
151.	Hillbank*	5	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 2, 2007: Dichlorbromoform 1
152.	Kadina	5	2011: Total Chlorine 5
153.	Marino*	5	2011: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2006: Dichlorbromoform 1
154.	Modbury*	5	2000: Dichlorobromoform 2, 2002: Dichlorbromoform 2, 2004: Dichlorbromoform 1
155.	Penola	5	2001: Arsenic 1, 2003 Arsenic 2, 2004 Arsenic 1, 2009: Lead 1
156.	Pooraka*	5	2000: Dichlorobromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 2, 2005: Dichlorbromoform 1
157.	South Plympton*	5	2010: Bromodichloromethane 1, 2011: Bromodichloromethane 2, 2001: Dichlorbromoform 1, 2009: Dichlorbromoform 1
158.	Tranmere*	5	2012: Bromodichloromethane 2, 2001: Dichlorbromoform 2, 2004: Dichlorbromoform 1
159.	Waikerie	5	2011: Bromodichloromethane 3, 2012: Bromodichloromethane 1, 2009: Dichlorbromoform 1
160.	Westbourne Park*	5	2011: Bromodichloromethane 1, 2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1
161.	Woodforde*	5	2011: Bromodichloromethane 1, 2008: Bromoform 1, 2000: Dichlorobromoform 1, 2003: Dichlorbromoform 1, 2010: Dichlorbromoform 1
162.	Gumeracha	4	2000: Chloral Hydrate 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1
163.	Hove*	4	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2002: Dichlorbromoform 1
164.	Karoonda	4	2003: Total Chlorine 1, 2001: THM's 1, 2001: Dichlorbromoform 1, 2012: Monochloramines 1
165.	Magill*	4	2011: Bromodichloromethane 1, 2002: Dichlorbromoform 1, 2009: Dichlorbromoform 1, 2010: Dichlorbromoform 1
166.	Northfield*	4	2011: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2003: Dichlorbromoform 1, 2006: Dichlorbromoform 1
167.	Paracombe	4	2011: Bromodichloromethane 1, 2001: THM's 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1
168.	Stansbury	4	2002: Total Chlorine 1, 2003: Total Chlorine 1, 2004: Total Chlorine 2
169.	Tea Tree Gully*	4	2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1
170.	Underdale*	4	2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1
171.	Vale Park*	4	2011: Bromodichloromethane 2, 2012: Bromodichloromethane 1, 2010: Dichlorbromoform 1
172.	Vista*	4	2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2003:

			Dichlorbromoform 1, 2005: Dichlorbromoform 1
173.	Adelaide Airport	3	2002: Dichlorbromoform 1, 2004: Dichlorbromoform 1, 2005: Dichlorbromoform 1
174.	Balhannah	3	2002: Total Chlorine 2, 2003: Total Chlorine 1
175.	Berri	3	2011: Bromodichloromethane 1, 2011: THM's 2
176.	Birdwood	3	2000: Dichlorobromoform 1, 2001: Dichlorbromoform 2
177.	Bute	3	2001: Total Chlorine 3
178.	Erith	3	2006: Dichlorbromoform 1, 2007: Dichlorbromoform 1, 2008: Dichlorbromoform 1
179.	Fairview Park*	3	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1, 2002: Dichlorbromoform 1
180.	Flagstaff Hill*	3	2012: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1
181.	Gawler	3	2006: Dichlorbromoform 1, 2007: Dichlorbromoform 2
182.	Hackam*	3	2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1
183.	Highbury*	3	2011: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1
184.	Kent Town*	3	2001: Dichlorbromoform 2, 2002: Dichlorbromoform 1
185.	Kingswood*	3	2011: Bromodichloromethane 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
186.	Lameroo	3	2001: Arsenic 2, 2003: Arsenic 1
187.	Meningie	3	2000: Chlorine – Free 1, 2000: Total Chlorine 1, 2003: Total Chlorine 1
188.	Mount Barker	3	2004: Total Chlorine 1, 2011: Total Chlorine 1, 2011: Monochloramines 1
189.	North Plympton*	3	2010: Bromodichloromethane 1, 2001: Dichlorbromoform 1, 2004: Dichlorbromoform 1
190.	Nuriootpa	3	2002: Total Chlorine 1, 2003: Total Chlorine 2
191.	Owen	3	2003: Chloral Hydrate 1, 2003: Dichlorbromoform 1, 2007: Dichlorbromoform 1
192.	Panorama*	3	2000: Dichlorobromoform 1, 2001: Dichlorbromoform 1, 2002: Dichlorbromoform 1
193.	Parafield Gardens*	3	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 2
194.	Para Hills West*	3	2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1, 2010: Dichlorbromoform 1
195.	Port Vincent	3	2000: Total Chlorine 1, 2002: Total Chlorine 2
196.	Seaford*	3	2011: Bromodichloromethane 2, 2004: Dichlorbromoform 1
197.	Sedan	3	2001: Total Chlorine 1, 2003: Total Chlorine 1, 2009: Total Chlorine 1
198.	Snowtown	3	2001: Total Chlorine 3
199.	South Brighton*	3	2002: Dichlorbromoform 1, 2005: Dichlorbromoform 1, 2006: Dichlorbromoform 1
200.	Tintinara	3	2004: Total Chlorine 1, 2001: THM's 1, 2001: Dichlorbromoform 1
201.	Walleroo	3	2011: Monochloramines 3
202.	Warradale*	3	2012: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2001:

			Dichlorbromoform 1
203.	Windsor Gardens*	3	2011: Bromodichloromethane 1, 2000: Dichlorobromoform 1, 2002: Dichlorbromoform 1
204.	Auburn	2	2001: Total Chlorine 2
205.	Burdett	2	2011: Chloral Hydrate 1, 2012: Chloral Hydrate 1
206.	Clarence Gardens*	2	2011: Bromodichloromethane 1, 2006: Dichlorbromoform 1
207.	Gulfview*	2	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1
208.	Hahndorf	2	2011: Total Chlorine 1, 2011: Monochloramines 1
209.	Lenswood	2	2000: Chlorine – Free 1, 2000: Total Chlorine 1
210.	Littlehampton	2	2011: Total Chlorine 1, 2011: Monochloramines 1
211.	Loxton Country Lands	2	2011: Monochloramines 2
212.	Malvern*	2	2012: Bromodichloromethane 1, 2005: Dichlorbromoform 1
213.	Marleston*	2	2012: Bromodichloromethane 1, 2006: Dichlorbromoform 1
214.	Nairne	2	2011: Total Chlorine 1, 2011: Monochloramines 1
215.	Parooka*	2	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1
216.	St Morris*	2	2012: Bromodichloromethane 1, 2002: Dichlorbromoform 1
217.	Streaky Bay	2	2002: Bromoform 1, 2001: Chlorine – Free 1
218.	Tungkillo	2	2008: Bromoform 1, 2011: THM's 1
219.	Woodville*	2	2011: Bromodichloromethane 1, 2012: Bromodichloromethane 1
220.	Aldinga Park	1	2001: Dichlorbromoform 1
221.	Angaston	1	2001: Chlorine – Free 1
222.	Athelstone*	1	2011: Bromodichloromethane 1
223.	Barmera	1	2011: Bromodichloromethane 1
224.	Cleve	1	2002: Chlorine – Free 1
225.	Cobdogia	1	2011: Bromodichloromethane 1
226.	Coobowie	1	2000: Total Chlorine 1
227.	Denmark	1	2012: Lead 1
228.	Edithburgh	1	2000: Dichlorobromoform 1
229.	Gepps Cross*	1	2005: Dichlorbromoform 1
230.	Gladstone	1	2004: Total Chlorine 1
231.	Gulfview Heights*	1	2012: THMs 1
232.	Jervois	1	2012: Monochloramines 1
233.	Kalangadoo	1	2001: Lead 1
234.	Kapunda	1	2001: Dichlorbromoform 1
235.	Kingston	1	2011: THM's 1
236.	Menindie	1	2010: Bromodichloromethane 1
237.	Millicent	1	2004: Fluoride 1
238.	Monash	1	2011: THM's 1
239.	Nettie Creek	1	2011: Bromodichloromethane 1

240.	Paskeville	1	2011: Cadmium 1
241.	Port Augusta	1	2003: Total Chlorine 1
242.	Port Augusta/Woomer a	1	2001: Total Chlorine 1
243.	Port Lincoln	1	2006: Lead 1
244.	Port Neill	1	2000: Lead 1
245.	Renmark	1	2011: THM's 1
246.	Riverton	1	2003: E.coli 1
247.	Rosenorthy	1	2010: Bromodichloromethane 1
248.	Seaview Downs*	1	2011: Bromodichloromethane 1
249.	Springton	1	2008: Lead 1
250.	St Agnes*	1	2012: Bromodichloromethane 1
251.	St Kilda	1	2005: Dichlorbromoform 1
252.	Tanunda	1	2002: Dichlorbromoform 1
253.	Tumby Bay	1	2000: Chlorine – Free 1
254.	Wirrabarra	1	2001: Total Chlorine 1
255.	Woodford*	1	2002: Dichlorbromoform 1