ENVIRONMENT REPORT

BEACH WATER QUALITY MONITORING IN PORT PHILLIP BAY – AUTUMN AND WINTER 2008

Publication 1266 December 2008

ARE OUR BEACHES SAFE FOR SWIMMING?

EPA Victoria monitors beach water quality to provide the public with comprehensive and up-to-date information about beach water quality at 36 beaches around Port Phillip Bay.

During the autumn and winter months of 2008, EPA monitored bacteria, heavy metals, organic chemicals and algae on a weekly basis for the first time. These water quality indicators were assessed against the National Health and Medical Research Council (NHMRC) 2008 recreational water quality guidelines.

Beach water quality was generally good in autumn and winter 2008. Only a small percentage of bacterial samples exceeded guidelines at beaches in Greater Melbourne and the Mornington Peninsula (see Table 1). These elevated bacterial levels were associated with rainfall.

Levels of heavy metals and organic chemicals were below guideline levels. Harmful species of algae were not detected.

WHAT DID WE FIND?

Consistent with EPA's long history of monitoring and summer forecasting of beach water quality, the most significant factors affecting beach water quality appear to be rain and the resulting stormwater inputs. This was reflected most clearly in the results of bacterial monitoring. A weak association with rain and stormwater was observed for some of the metals, although this did not result in exceedence of guidelines.

Bacterial levels were higher during and after rainfall (See Figure 7, Appendix 2), especially at beaches with major rivers and creeks close by. Bacteria levels were also found to be higher in winter than in the summer 2007–08, most likely because of higher total rainfall and more rain days in winter.

Overall patterns of bacterial levels were similar to those found during summer. As a general precaution year-round, EPA recommends against swimming near stormwater drains, rivers and other outlets into Port Phillip Bay, especially during and 24 hours after rain. Swimmers should avoid discoloured water.

Table 1: Percentage of samples exceeding guidelines

Beaches	Percentage of samples exceeding NHMRC (2008) recreational water quality guidelines		
	Bacterial indicator	Heavy metals	Organic chemicals
Greater Melbourne	3.8	0	0
Mornington Peninsula	1.6	0	0
Werribee, Geelong and the Bellarine	0	0	0

WHAT AFFECTS BEACH WATER QUALITY?

There is a broad range of natural and man-made influences that can affect beach water quality. Rainfall is a primary cause of poor water quality, resulting in pollutants being washed into the nearest waterways and onto the local beach.

Environmental factors such as sunlight and water temperature may affect die-off of bacteria in marine waters. Other influences on water quality may include pollution from spills, severe weather conditions, shipping, and other human disturbances (such as dredging).

Autumn–winter results detected no difference in beach water quality patterns before and during dredging as part of the Channel Deepening Project.

Figure 1: EPA sampling water quality at Sandridge beach.

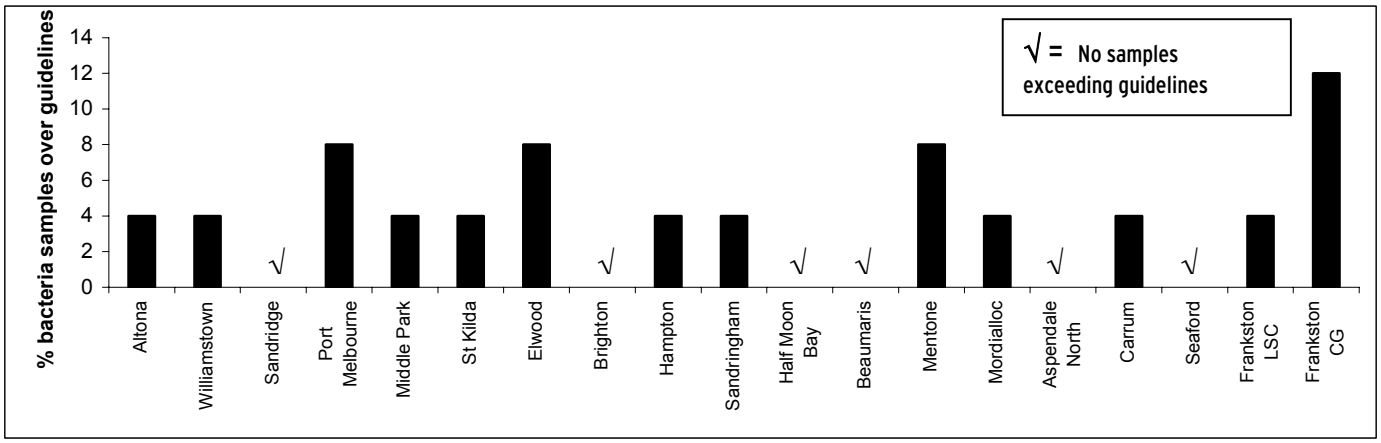

Figure 2: Percentage of bacteria samples exceeding NHMRC (2008) guidelines at beaches in Greater Melbourne. Higher percentage exceedences of guidelines are linked to rainfall.

WHAT IS THE BEACH WATER QUALITY LIKE WHERE I LIVE?

Greater Melbourne

In the Greater Melbourne region, bacterial water quality was good for most beaches. Of the 19 monitored beaches, water quality at six met recreational water quality guidelines for all weeks sampled in autumn and winter (Figure 2). Elevated bacterial levels at other beaches were infrequent and were linked with rainfall (See Table 6, Appendix 3 for individual enterococci results).

Levels of heavy metals were well below guidelines, even during and after rainfall. For most weeks, metals were either below detection limits or were present at very low levels. Organic chemicals were below detection limits for all weeks sampled (See Table 9, Appendix 4 for individual parameter results).

Dredging has occurred for intermittent periods since March 2008 in the Yarra River, Hobsons Bay and Port of Melbourne Channel. Beaches from Altona to Beaumaris have been closely monitored before and during dredging. When assessed against guidelines, general water quality patterns have shown no change since dredging began.

How does rainfall affect water quality at Melbourne beaches?

When rain enters the stormwater system it can wash pollutants to the nearest waterway and onto the local beach. Results from autumn and winter sampling have confirmed this pattern, with all instances of elevated bacterial levels linked with rainfall.

Beaches close to river and creek mouths were more likely to exceed guidelines during and after rain. Beaches with stormwater drains close by are also more likely to have their bacterial water quality adversely affected. A list of beaches in the Greater Melbourne area with river and creek mouths close by is provided in Table 2.

For example, the mouth of Kananook Creek is located in between two monitoring sites at Frankston. Levels of bacteria at both Frankston Coast Guard and Frankston Life Saving Club beaches are generally low, although they may be higher after rain. The higher rainfall over winter may have also influenced the size of the plume from the Creek and the degree of impact following rain.

Frankston Coast Guard beach has exceeded guidelines more often over autumn-winter than Frankston Life Saving Club beach (Figure 2). Elevated bacterial levels have occurred on wet days with northerly winds, resulting in pollutants from Kananook Creek being blown in a southerly direction towards the beach at Frankston Coast Guard (Figure 3).

Table 2: Beaches whose water quality is at risk from river and creek inputs during and after rainfall

Rivers and Creeks (distance from beach)	Beaches
Yarra River (<5km)	Williamstown, Sandridge, Port Melbourne, Middle park, St Kilda
Elster Creek (<1.25km)	Elwood
Laverton Creek (<1km)	Altona
Patterson River (<1km)	Carrum
Mordialloc Creek (<1km)	Mordialloc, Aspendale
Kananook Creek (<1km)	Frankston Life Saving Club (LSC) and Coast Guard (CG)

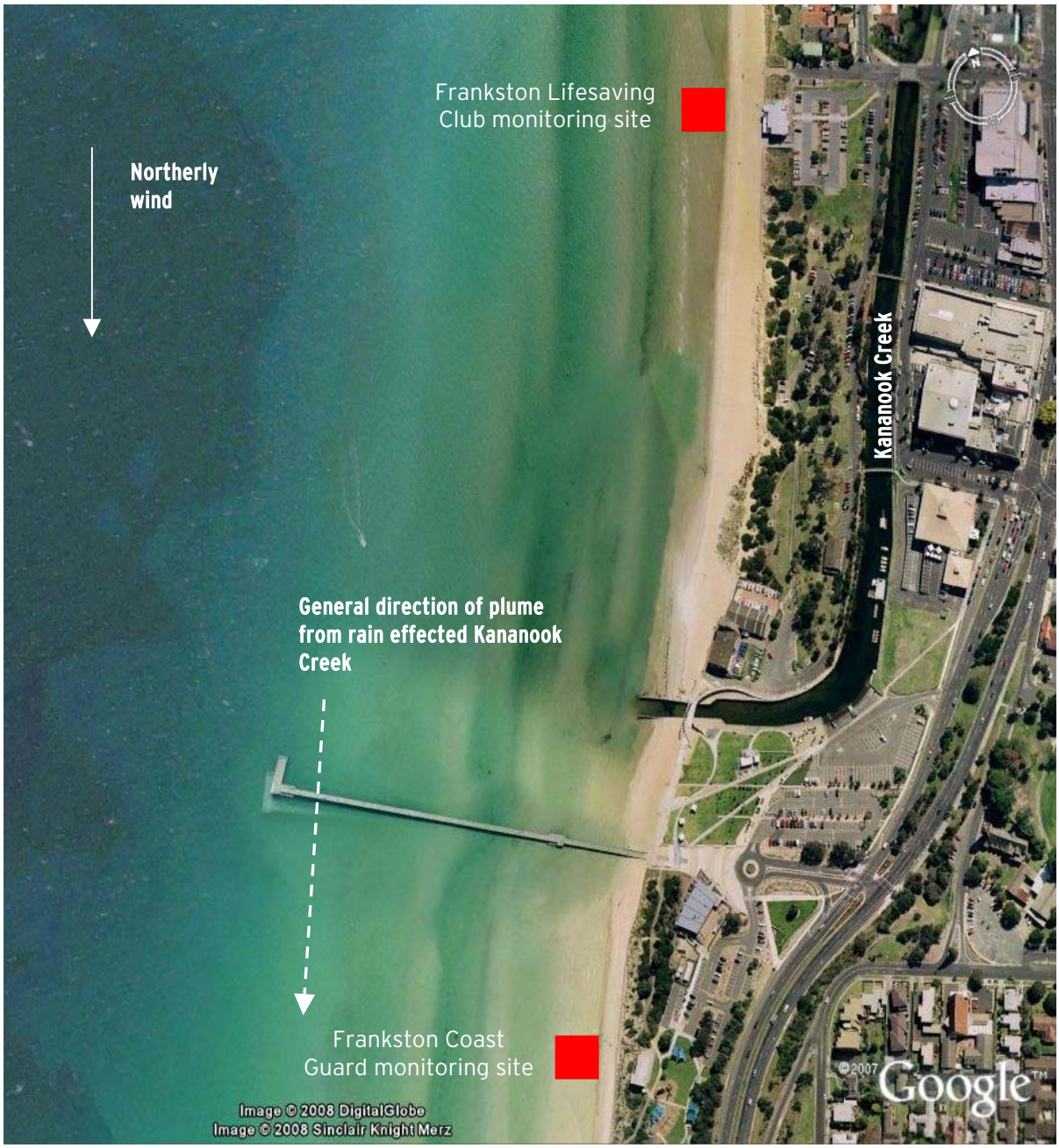

Figure 3: Example of how rainfall, close proximity to a river mouth and northerly winds can elevate bacteria levels at Frankston Coast Guard beach.

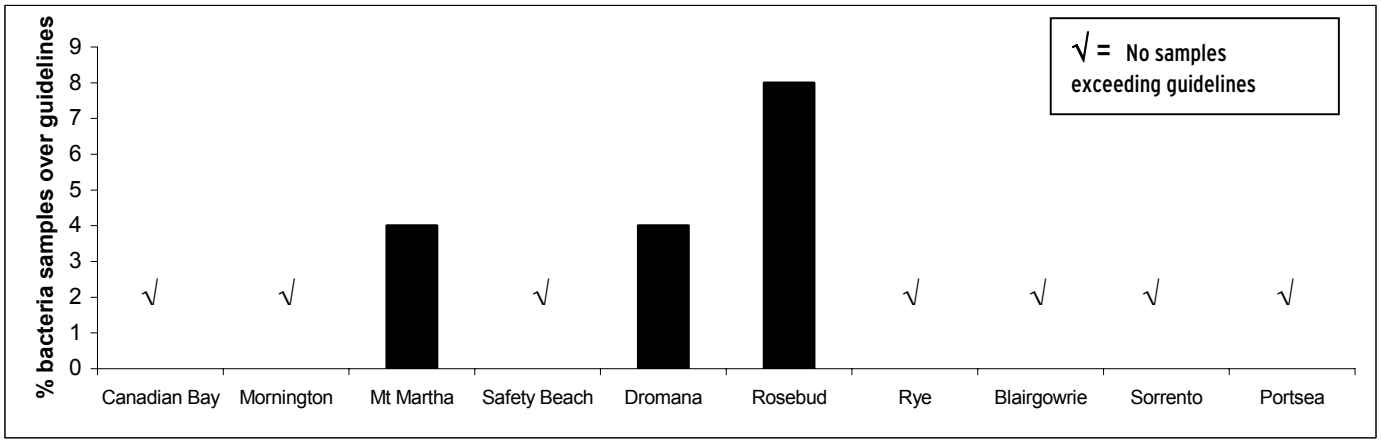

Figure 4: Percentage of bacteria samples exceeding NHMRC (2008) guidelines at Mornington Peninsula beaches.

Mornington Peninsula

In the Mornington Peninsula region, bacterial water quality was very good for most beaches. Of the ten beaches monitored by EPA, water quality at seven met NHMRC (2008) guidelines for all weeks sampled in autumn and winter (Figure 4). Guidelines were exceeded on only a few occasions between March and August and these events were linked with rainfall (See Table 7, Appendix 3 for individual enterococci results).

Dredging in the southern end of Port Phillip Bay started in February 2008 and has involved dredging in the South Channel and the entrance of the Bay. Beaches from Canadian Bay to Portsea and Queenscliff have been closely monitored before and during dredging. When assessed against NHMRC (2008) guidelines, general water quality patterns have shown no change since dredging began.

Figure 5: Bathers on a summer day at Rye beach

Werribee, Geelong and Bellarine Peninsula

Bacterial water quality at beaches in Werribee, Geelong and the Bellarine Peninsula was very good, with water quality results below guidelines for all samples collected in autumn and winter (See Table 8, Appendix 3 for individual enterococci results). Good beach water quality in this region was possibly due to lower rainfall than Greater Melbourne and Mornington Peninsula, and smaller, less-urbanised stormwater catchment areas in the case of the Bellarine Peninsula. For more information on what beaches are monitored in this region refer to Table 3 below.

Table 3: Beaches monitored at Werribee, Geelong and Bellarine Peninsula

City/region – Beaches monitored
Werribee – Werribee South
Geelong – Eastern, St Helens
Bellarine Peninsula – The Dell (Clifton Springs), Portarlington, St Leonards, Queenscliff

BEACH MONITORING IN PORT PHILLIP BAY

Why do we monitor beach water quality?

The monitoring program aims to provide comprehensive and up-to-date information to the community, particularly beach users, about the water quality of Port Phillip Bay beaches.

EPA has been monitoring beach water quality for many years as part of the Beach Report program. Beach Report is a summer-only program that focuses on the forecasting of water quality, with results published in newspapers and on the Beach Report page on EPA's website (www.epa.vic.gov.au/beachreport).

In March 2008, responding to increased community interest, the beach water quality monitoring program was extended to operate year-round and include a wider range of water quality indicators.

What beaches do we monitor?

The program monitors 36 beaches around the Bay, including at least one beach from each of the bayside municipalities and the most popular swimming and recreational beaches for the communities around the Bay (Figure 6).

What do we monitor?

The program monitors a range of biological and chemical water quality indicators on a weekly basis, as follows:

Enterococci – A group of bacteria found in the intestinal tract of warm-blooded animals. The World Health Organisation and the National Health and Medical Research Council recognise these bacteria as the best indicator for marine recreational waters.

Algae – EPA monitors for algal species that may be harmful to the health of swimmers at eight selected beaches.

Heavy metals – EPA monitors nine common heavy metals that are known to have the potential to harm human health following long-term exposure. These metals have in some cases also been previously found in bay waters and include metals such as arsenic, copper and lead.

Organic chemicals – The organic chemicals monitored are used as agricultural pesticides, or are by-products of industrial activities. The chemicals are known to have the potential to harm human health following long-term exposure.

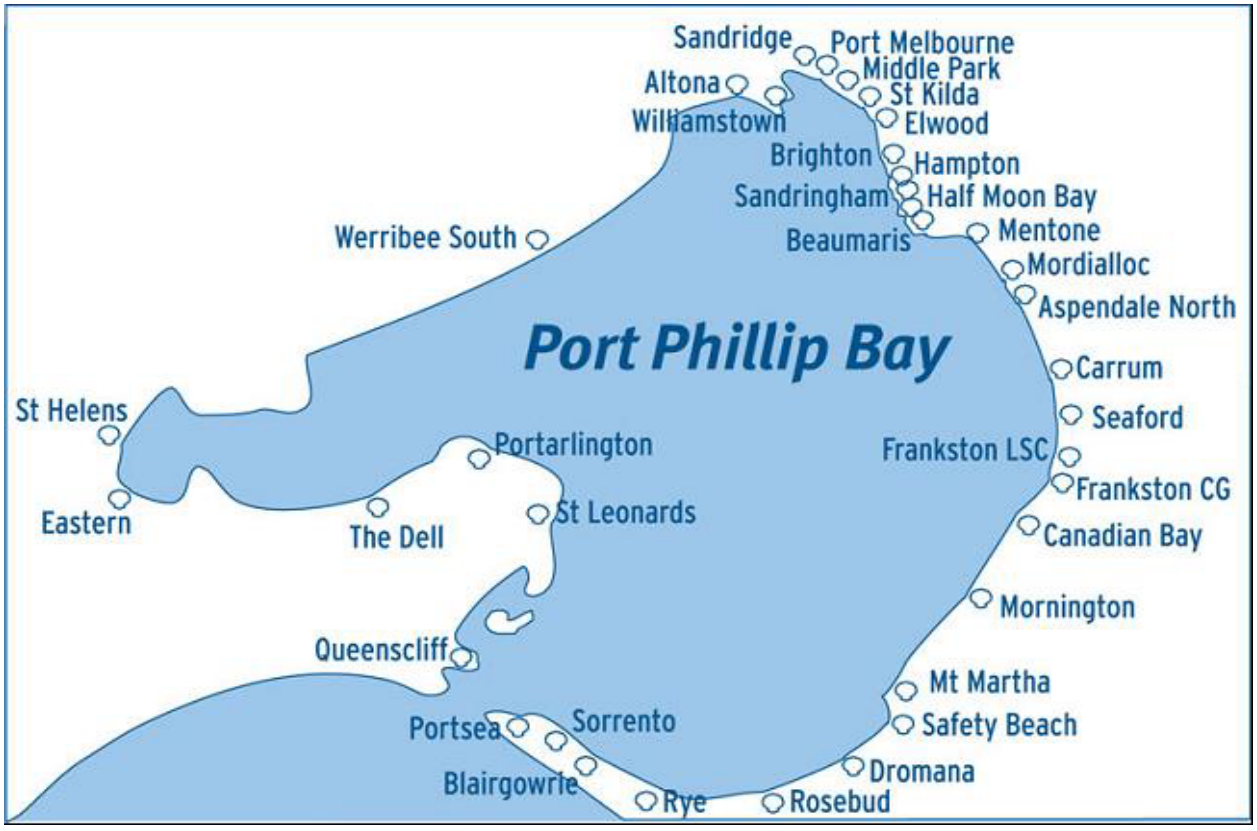

Figure 6: Beaches sampled in Port Phillip Bay. LSC – Life Saving Club; CG – Coast Guard.

Heavy metal and organic chemicals are principally assessed against the National Health and Medical Research Council (NHMRC 2008) *Guidelines for Managing Risks in Recreational Waters*. The guideline levels for heavy metals and organic chemicals are conservative, being based on drinking water guidelines (swallowing the water) rather than swimming activities, where bathers are only likely to ingest small amounts of water. The guidelines recommend that the drinking water guidelines be multiplied by a factor of 10 when assessing recreational water quality.

EPA assesses water quality by comparing results against two trigger levels (Table 4). The investigation trigger is principally based on NHMRC (2008) recommendations.

If triggered three times in a five-week period, an investigation will be initiated. This reflects that the guidelines are based long-term exposure to recreational waters.

The short-term human health levels are based on United States and United Kingdom health advisory levels (See Table 5, Appendix 1 for trigger values) and only need to be triggered once for a management action to be initiated.

EPA relies on expert identification and assessment of algae species found in the beach samples to determine whether there are any species present that may be harmful to the health of swimmers.

Table 4. Water quality trigger levels used by EPA to assess beach water quality

Trigger levels
Investigation level trigger. If exceeded consistently (three or more out of five results), an investigation is commenced to assess the significance of the results and identify likely sources. DHS is advised.
Short-term human health trigger level. The level is developed in consultation with the Department of Human Services and may result in specific advice to beach users.

Did beaches meet policy objectives?

EPA assesses bacterial results against the objectives for primary contact recreation outlined in the *State Environment Protection Policy (Waters of Victoria) 2003* as follows:

- median of 35 enteroccoci/100 mL
- 75th percentile of 150 enteroccoci/100 mL.

In autumn–winter all beaches sampled met policy objectives, except for median enterococci at Mornington beach (Figure 8, Appendix 5). The median enterococci for Mornington beach was generally low (41 orgs/100 mL), although above the objective of 35 orgs/100 mL. No single sample at Mornington exceeded the investigation level trigger for enterococci during autumn-winter. All beaches met 75th percentile objectives (Figure 9, Appendix 5)

These results were similar to summer 2007–08, when all beaches met policy objectives.

FUTURE DIRECTIONS

EPA maintains an ongoing program of beach monitoring for bacterial indicators during summer. This is used to support classification of beaches under the NHMRC guidelines and beach water quality forecasting models used by EPA.

EPA will review the results of the extended beach monitoring program once twelve months of monitoring is available and determine the requirements for further monitoring.

FURTHER INFORMATION

Further information on beach water quality can be found at EPA's website (www.epa.vic.gov.au/). Information available includes:

- weekly water quality results
- annual beach report information bulletins
- during summer, daily beach water quality forecasting on the Beach Report web pages.

Alternatively, information can be accessed through the EPA Information Centre:

40 City Road, Southbank, Victoria 3006

GPO Box 4395QQ, Melbourne, Victoria 3001

Telephone 03 9695 2700

Facsimile 03 9695 2710

ACKNOWLEDGEMENTS

EPA wishes to thank the following organisations for their ongoing support of the summer beach water quality monitoring program and the extension of the program into autumn–winter 2008:

- Bayside municipalities
- Department of Human Services
- Life Saving Victoria
- Melbourne Water.

APPENDICES

APPENDIX 1: Water quality indicators and trigger levels that EPA used to assess water quality during autumn-winter

Table 5: Water quality indicators monitored, their units and trigger levels used to assess water quality

Water quality parameters	Units	Investigation level	Short-term human health level
Enterococci	orgs/100 mL	500	3500
Algae – species considered harmful to swimmers.	cells/mL	1000	Requires expert assessment following identification of the species present.
Arsenic	µg/L	70	300
Cadmium	µg/L	20	400
Chromium	µg/L	500	10000
Copper	µg/L	20,000	20,000
Lead	µg/L	100	500
Manganese	µg/L	5000	10,000
Mercury	µg/L	10	20
Nickel	µg/L	200	10000
Zinc	µg/L	30,000	60,000
Endosulfan	µg/L	0.5	900
Aldrin	µg/L	0.1	3
Dieldrin	µg/L	0.1	5
Chlordane	µg/L	0.1	600
DDT	µg/L	0.6	2000
Heptachlor + Heptachlor epoxide	µg/L	0.5	100
Hexachlorobenzene	µg/L	0.5	50
PCBs (total)	µg/L	1	1400

APPENDIX 2: Effect of rainfall on bacterial levels in Port Philip Bay

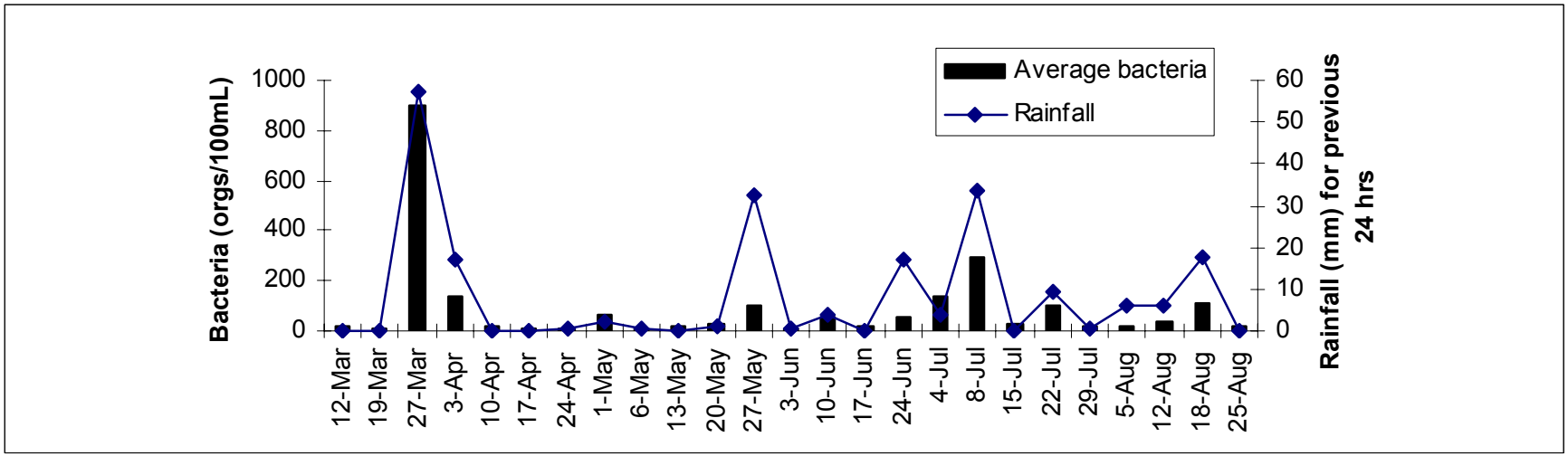

Figure 7: Comparison of average number of enterococci bacteria (orgs/100mL) at Bay beaches with rainfall for previous 24 hours during autumn and winter 2008. Rainfall data is the average rainfall around the Bay taken from the Bureau of Meteorology's Cerberus, Moorabbin, Melbourne, Laverton and Avalon all weather stations.

APPENDIX 3: Autumn and winter 2008 enterococci results

Table 6: Enterococci results (orgs/100 mL) from Greater Melbourne beaches

Beach	12-Mar	19-Mar	27-Mar	3-Apr	10-Apr	18-Apr	24-Apr	1-May	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	4-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	6-Aug	12-Aug	18-Aug	25-Aug
Altona	10	<10	85	650	170	<10	30	31	98	<10	10	41	10	41	20	<10	41	150	<10	140	<10	20		<10	<10	31
Williamstown	<10	10	4600	20	10	10	<10	<10	<10	<10	10	63	<10	<10	10	<10	<10	20	<10	31	<10	<10		<10	<10	<10
Sandridge	20	10	200	52	10	<10	<10	20	<10	10	20	<10	20	20	<10	10	10	<10	<10	41	120	<10		<10	<10	<10
Port Melbourne	<10	20	11000	520	<10	<10	<10	<10	<10	10	41	10	10	<10	<10	<10	10	10	<10	120	52	10		10	10	<10
Middle Park	<10	<10	1200	110	<10	<10	<10	<10	<10	10	10	84	<10	<10	<10	10	<10	<10	<10	74	41	10		41	<10	<10
St Kilda	200	<10	5500	74	<10	<10	<10	<10	<10	<10	20	20	<10	<10	<10	<10	51	31	270	180	10	<10		41	<10	10
Elwood	20	<10	2100	51	<10	52	<10	<10	<10	<10	62	20	<10	31	<10	20	10	52	<10	1200	<10	86		20	<10	<10
Brighton	<10	<10	200	52	<10	<10	<10	<10	<10	<10	20	41	<10	<10	<10	10	<10	110	<10	<10	<10	<10		10	<10	<10
Hampton	<10	<10	1100	62	<10	<10	<10	<10	<10	<10	10	52	<10	<10	<10	<10	<10	10	<10	20	<10	<10		20	<10	<10
Sandringham	<10	<10	310	52	20	10	<10	910*	<10	<10	<10	10	<10	10	10	20	20	200	<10	10	<10	<10		<10	<10	<10
Half Moon Bay	<10	<10	63	86	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10	30	<10	20	<10	<10	<10	<10		10	<10	<10
Beaumaris	<10	30	380	290	63	<10	<10	20	20	<10	52	94	<10	10	10	240	<10	10	<10	360	<10	<10		<10	<10	<10
Mentone	<10	<10	570	31	<10	10	<10	<10	<10	<10	<10	1900	10	31	<10	74	<10	41	<10	290	<10	<10		<10	<10	<10
Mordialloc	<10	<10	2700	52	52	<10	<10	41	<10	<10	10	260	<10	20	<10	140	<10	110	<10	430	<10	<10		<10	<10	<10
Aspendale North	<10	<10	<10	180	<10	<10	<10	<10	<10	<10	30	20	<10	<10	52	41	<10	52	<10	140	<10		<10	240	<10	<10
Carrum	<10	10	51	63	<10	10	<10	10	<10	<10	52	<10	<10	20	<10	110	3700	52	<10	84	<10		<10	190	<10	10
Seaford	<10	<10	240	63	<10	<10	<10	<10	<10	<10	10	10	<10	<10	<10	20	20	<10	<10	10	<10		30	150	<10	<10
Frankston LSC	<10	<10	400	110	10	20	<10	<10	<10	<10	10	20	51	10	10	52	31	30	41	90	<10		20	94	720	<10
Frankston CG	<10	<10	<10	41	<10	10	<10	930*	<10	<10	150	20	<10	390	120	550	20	8700	<10	<10	<10		<10	160	31	<10

* High reading most likely due to 4.2 mm of rain recorded at Moorabbin rain gauge on the day of sampling.

Rainfall (mm) (from 9 am to 9 am on the previous day)

Melbourne	0	0	28.6	4.4	0	0	0	0	0.4	0	0.6	2.4	0	0	0	0.2	0.6	5	0	2.4	0.0	0.2	1.2	0.6	0.4	0.0
Moorabbin	0	0	12.4	6	0	0	0	0	0	0	0.4	15	0	0.6	0	11.4	1.2	10.8	0	3.4	0.0	1.4	0.0	0.0	1.6	0.0

Blue ≤35 orgs/100mL	Green >35 and ≤150 orgs/100 mL	Yellow >150 and ≤ 500 orgs/100 mL	Orange >500 orgs/100 mL

Table 7: Enterococci results (orgs/100 mL) from Mornington Peninsula beaches

Beach	12-Mar	19-Mar	27-Mar	3-Apr	10-Apr	18-Apr	24-Apr	1-May	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	4-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug	18-Aug	25-Aug
Canadian Bay	30	<10	<10	31	<10	<10	<10	74	10	<10	20	10	10	<10	<10	20	41	200	<10	<10	<10	73	52	130	<10
Mornington	<10	10	160	31	<10	<10	63	<10	10	360	10	<10	96	280	41	52	74	140	330	<10	86	63	<10	300	41
Mt Martha	10	<10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	20	<10	74	<10	10	<10	10	<10	1100	<10
Safety Beach	<10	<10	140	41	10	<10	<10	<10	10	<10	<10	20	<10	<10	10	110	<10	<10	<10	31	10	10	52	110	10
Dromana	10	<10	190	360	<10	<10	<10	<10	<10	<10	30	740	<10	52	<10	20	10	41	<10	<10	10	<10	31	74	31
Rosebud	<10	<10	63	1200	<10	<10	<10	10	30	<10	41	20	<10	440	30	120	<10	10	10	<10	<10	<10	<10	1000	240
Rye	10	<10	10	170	<10	<10	<10	10	<10	<10	10	<10	<10	41	63	20	<10	31	<10	10	<10	<10	10	120	<10
Blairgowrie	<10	<10	<10	63	10	<10	<10	<10	<10	<10	20	<10	<10	10	<10	<10	20	<10	<10	<10	<10	10	<10	140	<10
Sorrento	<10	<10	10	20	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	20	<10	10	<10	<10	<10	<10	<10	<10	10	<10
Portsea	<10	<10	20	290	<10	<10	<10	<10	<10	<10	<10	20	<10	<10	<10	<10	20	30	<10	<10	<10	<10	10	20	<10

Rainfall (mm) (from 9 am to 9 am on the previous day)

Cerberus 24hr	0	0	11	5	0	0	0.4	0	0	0	0	8	0.4	2	0	5.2	2.2	7.6	0	0.0	0.2	4.6	4.6	13.8	0.2

Blue ≤35 orgs/100mL	Green >35 and ≤150 orgs/100 mL	Yellow >150 and ≤ 500 orgs/100 mL	Orange >500 orgs/100 mL

Table 8: Enterococci results (orgs/100 mL) from Werribee, Geelong and Bellarine Peninsula beaches

Beach	12-Mar	19-Mar	27-Mar	2-Apr	3-Apr	10-Apr	18-Apr	24-Apr	1-May	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	4-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug	18-Aug	25-Aug
Werribee South	<10	<10	10		<10	<10	<10	<10	10	<10	<10	10	<10	<10	<10	20	<10		10	<10	<10	10	<10	<10	<10	<10	<10
Queenscliff	<10	<10	20	20		<10	<10	<10	<10	<10	<10	<10	41	10	<10	<10	<10	20		<10	10	<10	<10	<10	<10	<10	10
St Leonards	10	<10	160	10		<10	<10	<10	<10	10	<10	20	30	<10	20	41	<10	210		52	<10	<10	<10	52	<10	<10	<10
Portarlington	<10	<10	20	20		10	<10	20	<10	<10	<10	31	<10	<10	86	20	30	240		31	<10	20	10	<10	10	<10	<10
The Dell	20	<10	270	63		<10	<10	<10	<10	20	<10	<10	<10	<10	140	<10	63	130		120	<10	63	<10	<10	41	<10	<10
Eastern	20	<10	460	180		<10	<10	<10	<10	<10	<10	41	<10	<10	20	<10	<10	63		52	<10	<10	<10	<10	<10	<10	<10
St Helens	20	<10	52	10		<10	98	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	10		<10	10	<10	<10	<10	<10	10	<10

Rainfall (mm) (from 9 am to 9 am on the previous day)

Laverton	0	0	3.6	0	1.4	0	0	0	0.8	0	0	0.2	7	0	0.8	0	0	1.8	0	7	0	1.6	0.0	0.0	0.2	0.4	0.0
Avalon	0	0	1.4	0	0.2	0	0	0.4	1.6	0.2	0	0	0.2	0	0.4	0.2	0	2.2	0	3.2	0	2.0	0.2	0.0	0.4	1.2	0.0

Blue ≤35 orgs/100mL	Green >35 and ≤150 orgs/100 mL	Yellow >150 and ≤ 500 orgs/100 mL	Orange >500 orgs/100 mL

APPENDIX 4: Median heavy metal and organic chemical results across all monitored beaches (μ/L). Individual beach results are available at www.epa.vic.gov.au

Table 9: Median heavy metal and organic chemical levels for Port Phillip Bay in autumn and winter 2008[5]

Heavy Metals and Organic Chemicals	12-Mar	19-Mar	27-Mar	2-Apr[1]	3-Apr[2]	10-Apr	17-Apr[2]	18-Apr[1]	24-Apr	1-May	6-May	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul[1]	4-Jul[2]	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug[3]	6-Aug[4]	12-Aug	18-Aug	25-Aug
Arsenic	3.2	3.6	3.8	3.1	3.6	3.0	3.1	3.9	3.0	3.0	2.5	2.8	2.7	2.7	2.9	3.0	3.2	2.9	3.9	2.8	3.4	3.0	3.2	2.6	2.9	2.5	2.8	2.8	2.8
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	<0.5	<0.5	1.3	1.8	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.9	<0.5	<0.5	<0.5	1.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	2	<1	2	<1	<1	<1	<1	<1	<1	<1
Lead	<0.2	<0.2	<0.2	0.3	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.2	<0.25	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	6.6	7.8	13.2	24.0	11.0	5.6	4.9	12.6	5.3	5.0	4.5	3.8	5.3	4.3	5.3	4.6	4.9	5.2	12.0	3.8	4.7	5.0	8.3	4.2	4.6	2.3	4.1	3.5	3.2
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	1.0	1.0	1.2	2.9	1.6	0.9	<0.5	1.0	<0.5	0.8	0.9	0.7	0.7	<0.5	0.8	1.0	1.0	0.7	2.0	1.0	1.0	0.9	1.7	0.8	1.1	<0.5	0.9	1.2	0.9
Zinc	<5	<5	<5	<5	9	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5
Endsulfan	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chlordane	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DDT	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor + Heptachlor epoxide	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexchlorobenzene	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCBs (total)	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

1. Median of results at six beaches in Geelong region. 2. Median of results at 30 beaches in Greater Melbourne and Mornington Peninsula region. 3. Median of results at 21 beaches in Greater Melbourne, Werribee, Geelong and Bellarine Peninsula. 4. Median of results at 15 beaches in Mornington Peninsula region. 5. Between 12 March and 1 May organic chemicals were only tested at eight Greater Melbourne beaches.

Combined rainfall (mm) (from 9 am to 9 am on the previous day) from Avalon, Laverton, Melbourne, Moorabbin and Cerberus all weather stations

Port Philip Bay	0	0	57	12	17	0	0	0	1	2	1	0	1	33	0	4	0	17	32	4	34	0	9	0	6	3	6	17	0

Below investigation level	Above Investigation level	Above Short-Term Human Health Level

APPENDIX 5: Summary graphs of enterococci compliance with EPA State Environment Protection Policy (SEPP) (Waters of Victoria) 2003 objectives

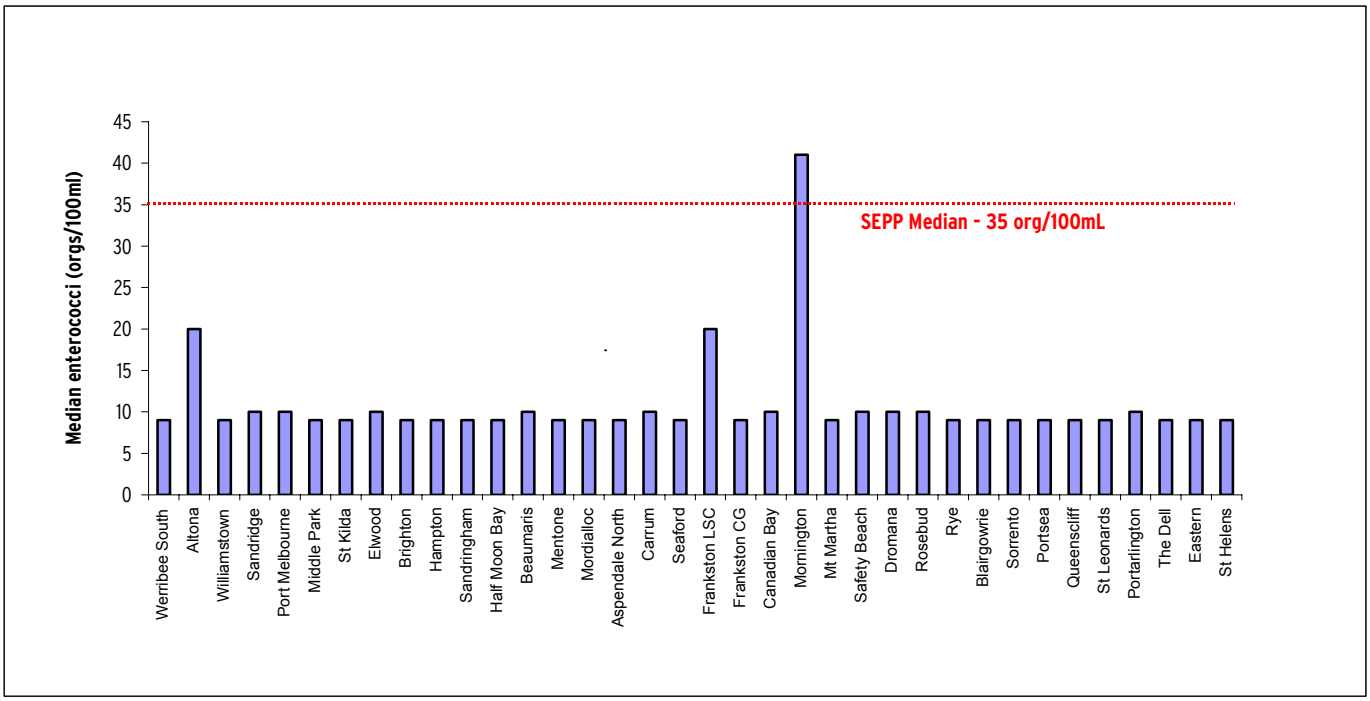

Figure 8: Compliance of autumn and winter 2008 enterococci levels (orgs/100 mL) to median objectives.

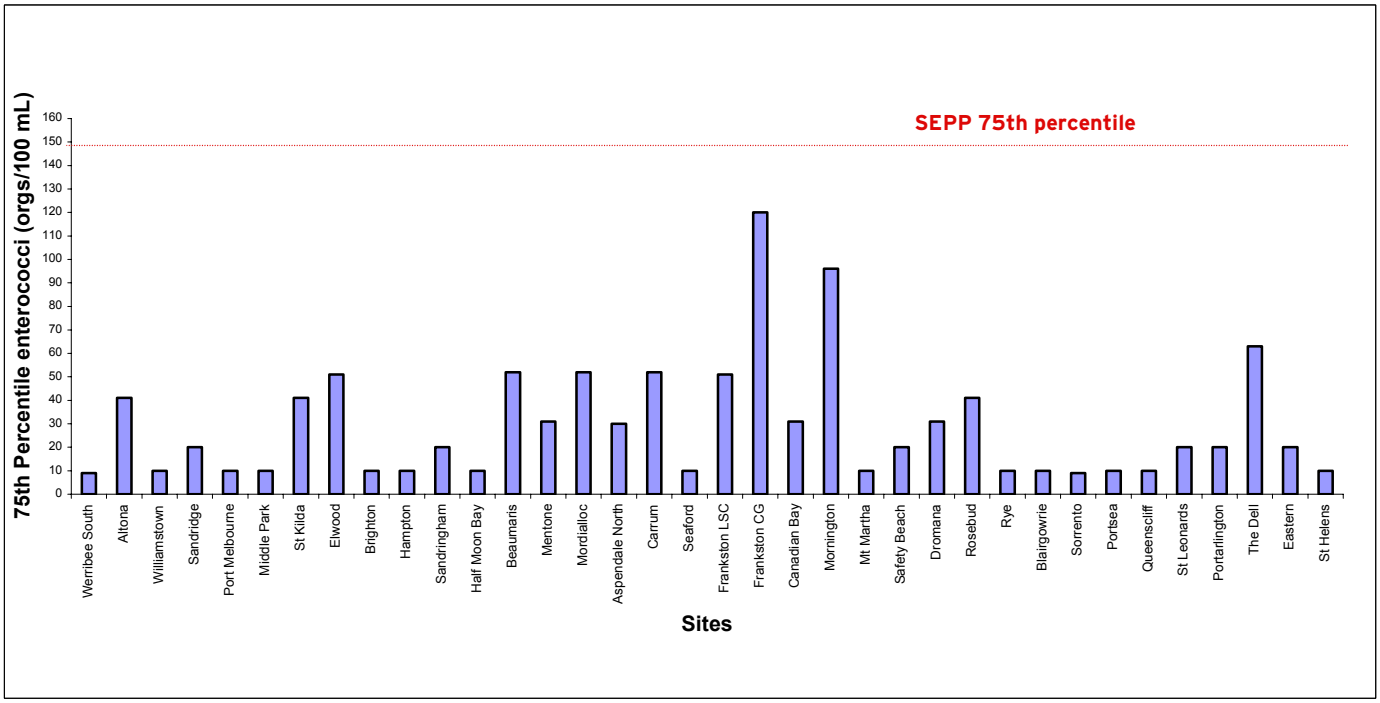

Figure 9: Compliance of autumn and winter 2008 enterococci levels (orgs/100 mL) to 75th percentile objectives.