Recreational Water Quality Program

Annual Report 2018-19

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Derwent Estuary Program

The Derwent Estuary Program (DEP) is a regional partnership between local governments, the Tasmanian State Government, businesses, scientists, and community-based groups to restore and promote our estuary. The DEP was established in 1999 and has been nationally recognised for excellence in coordinating initiatives to reduce water pollution, conserve habitats and species, monitor river health and promote greater use and enjoyment of the foreshore.

Our major sponsors include Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough councils, the Tasmanian State Government, TasWater, Tasmanian Ports Corporation, Norske Skog Boyer, Nyrstar Hobart Smelter and Hydro Tasmania.

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EXECUTIVE SUMMARY

This report presents results of the Derwent Estuary Recreational Water Quality Program (RWQ) 2018-19 season. The RWQ is a joint initiative between six local councils, the State Government of Tasmania and the Derwent Estuary Program (DEP). Water samples were collected weekly at 39 sites throughout the estuary between 1 December 2018 and 31 March 2019 and analysed for the faecal indicator bacteria, enterococci.

The water quality at Swimming Sites during the 2018-19 RWQ season worsened at most beaches compared to the previous season. Throughout the season there were 52 occurrences, spread over 16 of the 18 Swimming Sites, where the enterococci trigger level of 140 MPN 100 mL^{-1} was exceeded. As a result, 44 re-samples were undertaken. The number of re-tests was over double that of the previous season. Of the 18 Swimming Sites, 14 maintained last season's rating, one site improved (Nutgrove Beach (west)) and three sites declined (Howrah Beach (mid), Blackmans Bay Beach (mid), and Nutgrove Beach (east)). Based on water quality results for the past five years, 10 of the 18 Swimming Sites are now classified as having Good water quality, seven are Fair and one is Poor, i.e. Blackman Bay Beach (south).

The water quality at the Environmental Sites was mostly similar to the previous season. For these sites, where re-tests are not conducted, 51 results were recorded above the trigger level of 140 MPN 100 mL^{-1}, which was more than double the number from the previous season. Of the 21 Environmental Sites, 19 maintained their rating, and two sites improved to a better rating (Watermans Dock and MONA Cameron Bay). Based on water quality results for the past five years, 10 of the 21 Environmental Sites are now classified as having Good water quality, six are Fair, and four are Poor.

Rainfall records this season were lower than the long-term average at all four BOM weather stations across the Derwent estuary. While analysis of rainfall and enterococci results suggest a response of high enterococci results (i.e. > 140 MPN 100 mL^{-1}) to rainfall, with 83 % of high results occurring when rain fell in the preceding 48 hours, 17 % of exceedances occurred on days with no rainfall. Also, high rainfall (> 10 mm) didn't guarantee high enterococci, as 6 % of low enterococci results (< 140 MPN 100 mL^{-1}) occurred when preceding rainfall was > 10 mm.

The success of Nutgrove Beach (west) finally shedding its Poor rating after a decade, is an excellent example of how a collaborative investigation (between City of Hobart, TasWater and DEP) into stormwater and sewage systems can result in improvement of water quality at an urban swimming beach. Many lessons of how to investigate a catchment, and deal with problems found, have been learnt, providing inspiration for councils in dealing proactively with beaches suffering with protractive poor water quality.

It has been a busy RWQ season, and one with more public attention than we have previously experienced. The participating parties in the RWQ program intend to harness this additional focus to improve long-term water quality throughout our estuary.

1.1 Post-season actions & recommendations

At the May 2019 post-RWQ season review meeting, which was attended by council Environmental Health Officers (EHOs), TasWater, Environment Protection Authority (EPA), Department of Health (DoH), Analytical Services Tasmania (AST), Public Health Lab (PHL), and DEP, it was agreed that:

- Councils will take a proactive approach to monitoring and investigating beaches with high pollution levels heading into the 2019-20 RWQ season.

- A Fair beach rating is considered a warning signal that water quality might be worsening, and sanitary investigations may be initiated at this time.
- Councils will consider conducting sanitary surveys at all Fair and Poor sites as a standard protocol each Tuesday.
- Winter sampling is only recommended as part of active sanitary investigations.
- DEP will coordinate and facilitate a working group to:
  - develop a framework on how to investigate sources of high enterococci, including the stormwater catchment and its receiving water.
  - attempt to identify a threshold for enterococci discharge at beaches from stormwater outfalls.
- In preparation for developing (the above) framework, the DEP will:
  - contact (TEER) in regard to catchment investigation techniques and development of enterococci 'behaviour' library.
  - work with AST to collate useful information about sterol testing, which appears to be most effective for a targeted investigation of a known problem site, particularly bays where sediment samples are easily taken, and stormwater outfalls, where Sterol analysis is expected to provide information about likely sources of contamination.
  - work with TasWater to coordinate workshop for training and trialing of ATP catchment testing equipment.
  - compile a detailed list of options for investigation into poor water quality, including a summary (pros/cons) of various 'source tracking' techniques, e.g. optical whitening and DNA, Sterols and other investigation tools, such as targeted outfall, sand and sediment sampling, and rainfall impact studies.

In addition to the above actions, which will be progressed over the coming winter, a new Beach Watch Response Protocol is being finalised, which will assist EHOs and council management with their response to sampling results.

Figure 1-1. Intercalibration exercise at Howrah 21 November 2018. Annual exercise where EHOs practise their sampling techniques before the RWQ season begin. Image by H. Bobby.

2 INTRODUCTION

Water quality monitoring of beaches and bays in the Derwent estuary is coordinated by the DEP in collaboration with DoH, EPA and the six councils that border the estuary (Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough). The primary objectives of the program are to coordinate monitoring, investigations and assist councils and the DoH in managing human health risks associated with poor water quality. The DEP's role in the program is to:

- Coordinate recreational water quality monitoring in the Derwent;
- Compile and analyse data, including classification of beaches and bays, annual reporting and analysis of long-term trends;
- Support and facilitate site specific investigations into poor or deteriorating water quality at targeted sites.

The water quality data is made publicly available via the DEP website and Facebook page, weekly during summer (December-March), to allow the community to make informed decisions as to where and when to swim. This data is also used to inform decision-making processes by identifying areas that require improvements in stormwater and wastewater management practices and assets.

2.1 Pathogens and health risks

Water contaminated by sewage and animal faeces may contain pathogenic micro-organisms (bacteria, viruses, protozoa), which pose a health hazard when the water is used for primary contact recreation, such as swimming. Infection may occur by swallowing, inhaling or by direct contact of contaminated water with ears, nasal passages, mucous membranes and cuts in the skin, which allow the pathogens to enter the body (N.Z. Ministry for the Environment, 2002). The most common health conditions associated with primary contact recreation in contaminated water are gastrointestinal disorders, respiratory illnesses, eye, nose and throat infections and skin disorders.

Direct detection of pathogens is not a feasible option for routine assessments since they occur intermittently and are difficult to recover from water. Thus, water samples are analysed for the concentration of more easily detected microorganisms, which may indicate the presence of pathogens, referred to as faecal indicator bacteria (refer to Coughanowr et al. 2015 for more information). In the Derwent estuary, enterococci is sampled as the key faecal indicator bacteria, as required by the Tasmanian Recreational Water Quality Guidelines 2007 (Dept of Health & Human Services, 2007).

2.2 Sources of contamination

Key sources of faecal contamination in coastal waters can include untreated sewage or faecal contamination from a catchment transported via the stormwater system, animal faeces or resuspension of contaminated sediments:

- Stormwater systems in urban areas are often contaminated with sewage. The source for this contamination can be caused by a failure in the wastewater (sewage) system, including overflows during high rainfall events, or direct cross-connections, leakages, or animal faeces in low rainfall (or nor rainfall) events;
- Direct contamination can occur from animal faeces. High density animal aggregations, such as birds or dogs, on beaches can contribute to contamination;
- Resuspension of contaminated sediments by wind or wave action is also a possible source of contamination.

Differentiating between contaminant sources can be very difficult, however regular (and case-based) sanitary surveys, possibly combined with specialist laboratory techniques, such as sterol and DNA testing, can help advance our understanding.

2.3 Recreational water quality guidelines

Swimming and environmental sites in the Derwent estuary are graded as Good, Fair and Poor. This is in accordance with the Recreational Water Quality Guidelines for Tasmania (Dept of Health & Human Services, 2007), which were largely based on the National Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Both guidelines are currently under review. The guidelines are based on aseptic grab sample analysis for the faecal indicator microbial group enterococci, and the Tasmanian guidelines adopt a three-tiered approach to classifying the long-term (5 years of data) quality of a site based on available data. The tiers are:

- *Good*: rolling 5-year 95th Hazen percentile value of < 200 enterococci MPN (Most Probably Number) 100 mL^{-1}.
- *Fair*: rolling 5-year 95th Hazen percentile value of 200 - 500 enterococci MPN 100 mL^{-1}.
- *Poor*: rolling 5-year 95th Hazen percentile value of > 500 enterococci MPN 100 mL^{-1}. In this case, water at these sites is considered to be a threat to public health in the event of primary contact recreation and the particular local council is required to advise the general public and to erect warning signs to this effect.

In addition to long-term site classification, trigger levels have been set to manage public exposure to episodic or emerging water quality issues. If a sample exceeds 140 enterococci MPN 100 mL^{-1}, the council is required to resample, and if two consecutive samples return a result above 280 MPN 100 mL^{-1}, the public must be notified via signage on the beach in question. This signage can only be removed by Council's Authorised Officer in consultation with the Department of Health.

3 RECREATIONAL WATER QUALITY PROGRAM

3.1 Swimming and Environmental sites

Aseptic grab samples are collected each Tuesday by Council and the EPA/DEP from 39 sites throughout the Derwent estuary, during summer and early autumn each year (from 1 December to 31 March). Sites are categorised as either *swimming sites* or *environmental sites* as described below, and locations are shown in Figure 3-1.

- The 18 *swimming sites* monitored this season are in locations where a significant number of people swim or conduct other primary contact recreation. These sites are sampled by Council to provide a basis for public health information.

- The 21 *environmental sites* monitored this season were selected to provide a broader context for interpretation of Swimming Site results and for other purposes. These sites are sampled by either Council or EPA/DEP were selected based on the following rationale:

  - Bays and coves that are frequently used for secondary contact recreation and/or have foreshore parks;
  - Areas with identified potential sources of faecal contamination;
  - Sites with relatively low risk of contamination, sampled to contextualise Swimming Site results;
  - Sites associated with major swimming events, such as the Trans Derwent Swim.

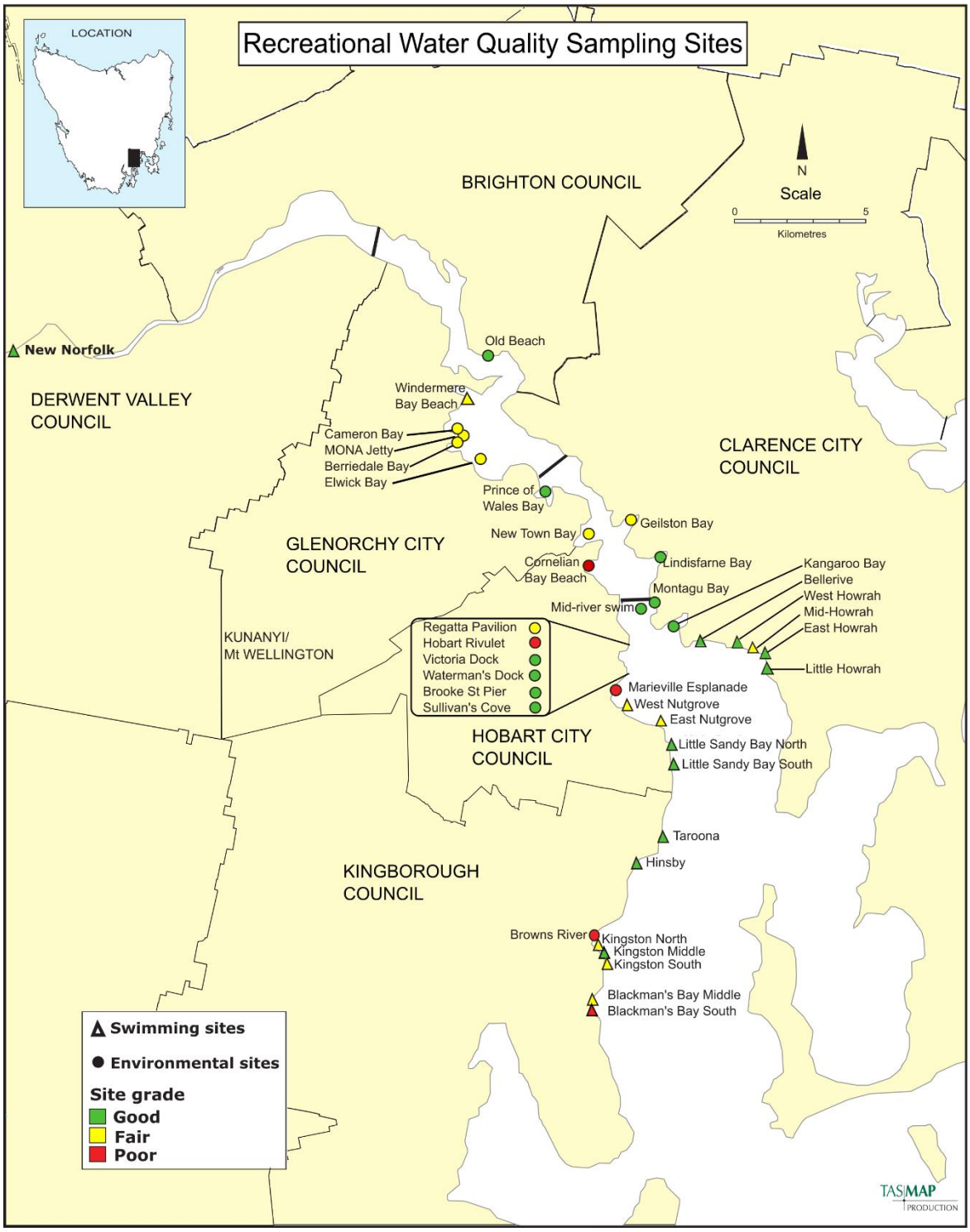


Figure 3-1 Recreational Water Quality sampling sites (Swimming and Environmental sites) with their current water quality classification based on data collected in the summer months between December 2014 and March 2019.

3.2 Sample analysis

All samples are analysed at the Public Health Laboratory (PHL) (St Johns Ave. New Town) using the Enterolert method, which provides confirmed results within 24 hours of analysis. For designated Swimming Sites, if the original sample exceeds the relevant trigger level (Dept of Health & Human Services, 2007), laboratory staff notify the councils so retesting can occur. Results are typically reported between 24 and 48 hours after sample submission to the laboratory.

3.2.1 Uncertainty Measurement

As a National Association of Testing Authorities (NATA) accredited facility, the PHL is required to inform its customers of its ability to provide Measurement Uncertainty (MU) estimations with results.

The PHL explains the MU as follows:

> *All measurements have an inherent uncertainty due to small unavoidable variations in the sample, the media used in testing, the person doing the analysis and all other conditions at the time of analysis. These variations persist despite efforts to standardise measurement conditions, and cannot be eliminated entirely. As a result, repeated tests done on the same sample will give a set of results, each slightly different, grouped around the 'true' value.*
>
> *Measurement Uncertainty is the estimate of the range around a measured value in which the 'true' value occurs for a given level of confidence (the Confidence Interval).*

The MU for the *Enterococci – Enterolert* method is log 0.149 (PHL, 25 March 2019). Prior to the 2017-18 season it was decided that the RWQ program will only require MU reporting for our swimming beaches, and only when a sample fails, but result falls within the MU range of our trigger levels. The MU ranges are currently between 99-197 for the trigger level of 140, and between 199-395 for the trigger level of 280. All other results will continue to be reported as either meeting, or not meeting, the prescribed standards in the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*).

Importantly, if a sample result exceeds a prescribed trigger level the DoH requires it to be retested, no matter whether the result falls within the MU range of that level.

3.3 Inter-calibration exercise

An inter-calibration exercise is organised by the DEP at the start of each season to ensure that all sampling officers are using the same protocols, thus minimising sampler bias. The sampling method is demonstrated, associated protocols are reviewed, and participants simultaneously sample from a designated location. Results are compared to identify any sampler bias and are also useful to better understand the degree of variability between water samples collected from a given site and/or between sites.

3.3.1 Results

On 19 November 2018, environmental health officers from four council partners together with the DEP simultaneously collected a sample each at two sites on Howrah Beach (east).

Results were consistent between samplers and sites. Low results were reported at Site 1 (close to a stormwater outfall), as well as at Site 2 (100 m west of the outfall). Samplers adopted good aseptic grab sampling technique and were aware of potential sources of faecal contamination.

Further discussion of the inter-calibration exercise results is available in the *RWQ Inter-calibration report 2018/19* (Visby, 2018), see Appendix A. The next inter-calibration exercise will be conducted in November 2019.

4 2018-19 RWQ SEASON RESULTS

4.1 Rainfall

Rainfall is a major threat and driver of pollution at beaches and other recreational swimming areas as it generates (potentially contaminated) stormwater runoff and can trigger discharges and overflows from the wastewater (sewerage) system. The water quality of urban beaches and bays can therefore be strongly influenced by stormwater run-off (NHMRC, 2008).

Rainfall data collected and reported by the Bureau of Meteorology (BOM) at four weather stations throughout the Derwent estuary catchment are used to compare rainfall throughout each RWQ season (December to March) against the long-term average rainfall for that period. Observations of daily rainfall are nominally made at 9 am and record the total for the previous 24 hours. Hobart (Ellerslie Rd.), Kingston (Greenhill Dr.), Hobart Airport and New Norfolk (west) have been selected as representative of sampling sites in the Derwent estuary. Rainfall varies across the estuary, with long-term averages for the summer months ranging between 163.4 mm at Hobart Airport to 203.4 mm at Kingston (Greenhill Dr.) in Kingston. There is a significant rainfall gradient across the estuary with higher rainfall on the western vs eastern shore.

Whilst there is variation in amount of rain recorded at each of the BOM weather stations, the general trend has been the same at each of the four stations over the last five years. Rainfall during this period has been predominantly dry, with three drier than average seasons and two wetter than average seasons (Figure 4-1):

- 2014-15: relatively wet summer with above average rainfall
- 2015-16: dry summer with below average rainfall
- 2016-17: dry summer with below average rainfall
- 2017-18: above average rainfall, however, a heavy three-day rainfall event in early December accounted for approximately half of the season's rainfall. Discounting this event, the rest of the season was dry
- 2018-19: dry summer with below average rainfall

During the 2018-19 season, rainfall was significantly lower than the long-term average at all four BOM weather stations. There were five days throughout the sampling season with > 10 mm during a single rain event: 4 December, 17 December, 20 December, 7 February and 25 March. Three of these rainfall records occurred within 72 hours prior to a sampling day: 4 December, 17 December and 26 March. On only one occasion was significant rainfall (> 10 mm) recorded at more than one of the weather stations. On the 17th of December, Hobart (Ellerslie Rd.) and Kingston (Greenhill Dr.) recorded 27.6 mm and 19.2 mm of rain respectively. This rain fell 24-28 hours prior to RWQ sampling. The rest of the season was dry with sporadic light (< 5 mm) rainfall events.

All rainfall data, for the four BOM stations that cover the Derwent estuary, are listed in Appendix B 10.2.1.

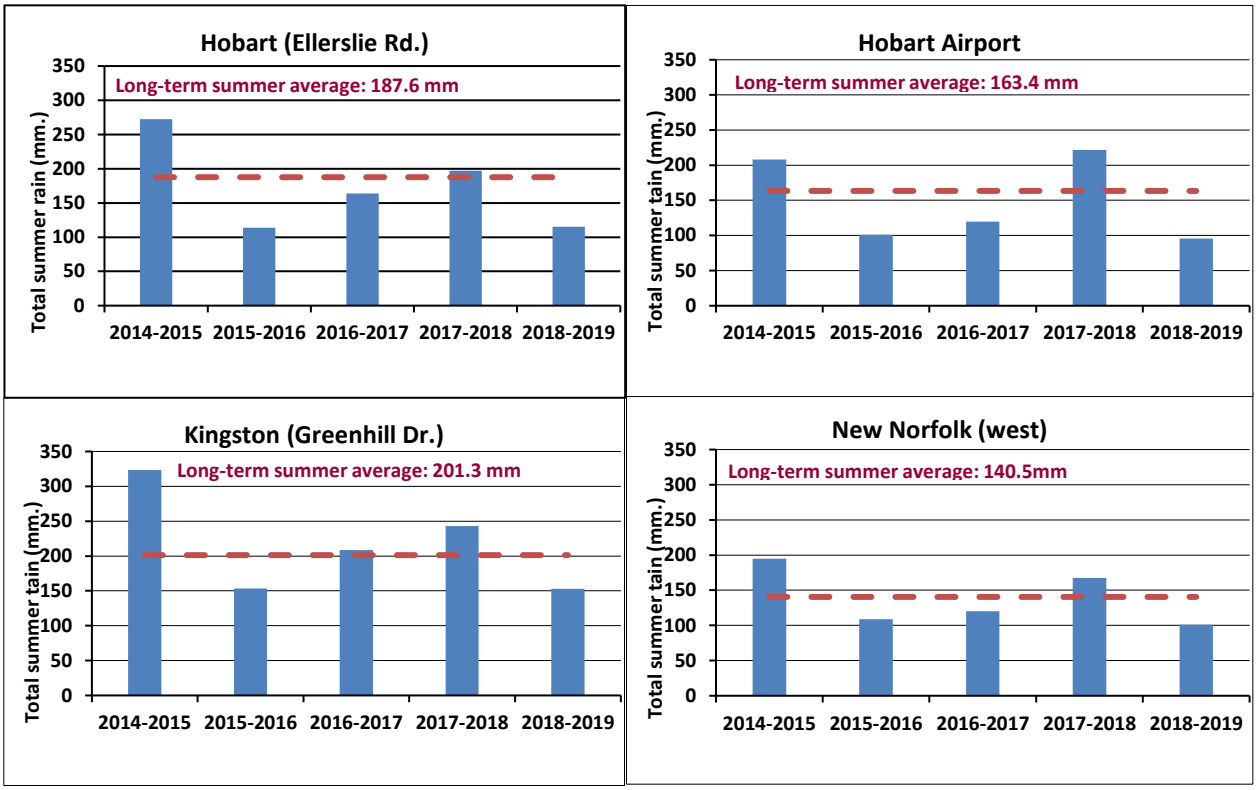


Figure 4-1 Total rainfall (in mm.) at four weather stations in the Derwent estuary catchment during the last five RWQ program seasons (between December and March), as recorded by the Bureau of Meteorology. The long-term average rainfall for the period is indicated in red text and by dotted line.

4.2 Enterococci response to rainfall at swimming sites

It is recognised that water quality at urban beaches can be strongly affected by stormwater runoff due to rainfall. The DEP conducted a preliminary analysis of the season's results to identify possible relationship between enterococci concentration and rainfall.

The analysis includes all enterococci samples across all swimming sites, a total of 303 samples, collected this season. Results were separated into two groups:

- **Group 1**. Results < 140 MPN 100 ml $^{-1}$: 251 samples.
- **Group 2**. Results > 140 MPN 100 ml $^{-1}$: 52 samples.

These two groupings were separately assessed for a possible response to rainfall. Rainfall data was used from the four local BOM stations as outline in Table 1.

Table 1. BOM stations used to analyse possible connections between rainfall and poor water quality at swimming beaches.

BOM stations	Swimming sites
Hobart (Ellerslie Rd.)	Hobart and Glenorchy beaches
Kingston (Greenhill Dr.)	Kingborough beaches
Hobart Airport	Clarence beaches
New Norfolk (west)	Derwent Valley swimming site

Rainfall included rainfall data records collected on the day of sampling as well as those collected 48 hours prior (to 9am).

Group 1. 43 % of the enterococci results (all < 140 MPN 100 ml $^{-1}$) occurred when no rain fell in the preceding 48 hours (Figure 4-2). The other results showed that:

- 50 % of results occurred when the total rainfall in the preceding 48 hours was < 10 mm.
- 6 % of results occurred on days when the total rainfall in the preceding 48 hours was > 10mm.

Group 2. 83 % of enterococci values (all > 140 MPN 100 ml $^{-1}$) occurred when some rain fell in the preceding 48 hours (Figure 4-2):

- 61 % of high enterococci values occurred on days when the total rainfall in the preceding 48 hours was < 10 mm.
- 22 % of high values occurred on days when the total preceding rainfall was > 10 mm.
- 17 % of exceedances occurred on days with no rainfall.

Estuary-wide (at swimming sites) there appears to be a response of high enterococci results (> 140 MPN) to rainfall. 83 % of these high results occurred when rain fell in the preceding 48 hours. However, high rainfall (> 10 mm) didn't guarantee high enterococci, as 6 % of low enterococci results occurred when preceding rainfall was > 10 mm. See Appendix B 10.2.2 for all enterococci results when preceding rainfall was > 10 mm. As described above, rainfall recorded on the day of sampling *was* included in the analyses. This means that rainfall may have fallen after the sampling was conducted, and therefore, the effect of rain could be overestimated. The decision to include 48 hours of rainfall data is based on the DEP recommendations to not swim for 'several days' following heavy rain, as well as to capture significant rainfall events (> 10 mm) that may have occurred more than 24 hours prior to sampling.

It is recommended that this study should be replicated with the five-year data at the individual beach level. It is likely that beaches respond differently depending on the proximity of sampling sites to stormwater outlets, activities in, and topography of, the catchment. Analysing the beaches individually will give an indication of which beaches respond to stormwater run-off, and could assist to inform decision-making and allocation of resources to conducting stormwater works.

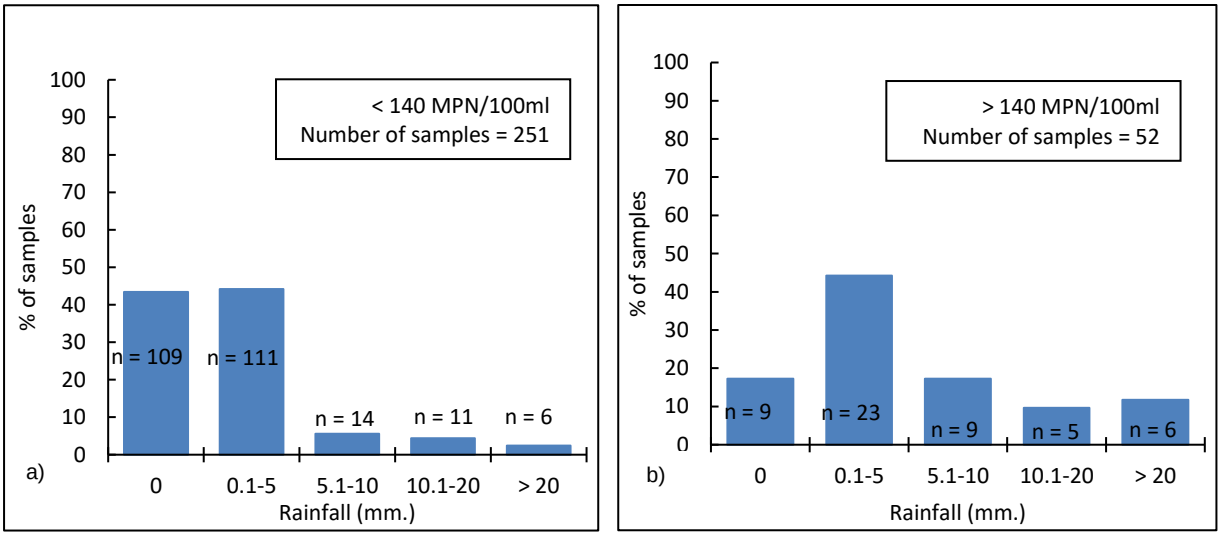


Figure 4-2 Proportion of samples < 140 MPN 100 ml $^{-1}$ (a), and > 140 MPN 100 ml $^{-1}$ (b), that respond to rainfall. Graphs include all enterococci samples collected at swimming sites during the 2018-19 RWQ season.

4.3 Site results

4.3.1 Swimming Sites

During the 2018-19 sampling season, water quality at swimming sites declined. When site grades were updated after the season, ten of the 18 Swimming Sites were graded as Good, a decline from the previous season in which 13 sites were graded as Good. Seven Swimming Sites were graded as Fair, an increase from three in the previous season. Only one Swimming Sites was graded as Poor (Figure 4-3). The decline in Good swimming sites is a break in the trend of the last four years, which had seen an increase in swimming sites graded as Good. This year's results should pose a significant warning to local councils. With seven sites graded as Fair across the estuary, there is an increased risk of additional sites declining towards Poor in coming seasons.

Changes in classification from the 2017-18 season occurred at four sites, with water quality improving at one and declining at three. Notably, Nutgrove Beach (west) improved from Poor to Fair whilst Blackmans Bay Beach (mid), Howrah Beach (mid) and Nutgrove Beach (east) all declined from Good to Fair. Blackmans Bay Beach (south) remained Poor with a further deterioration from the previous season (Figure 4-4).

This season, exceedances of the enterococci trigger level of 140 MPN 100 mL^{-1} at Swimming Sites more than doubled that recorded last season. Fifty-two exceedances and 44 resamples were collected this season compared to 23 exceedances and 20 resamples in the previous season (Appendix C 10.3.1; Weller-Wong and Visby, 2018). This two-fold increase in exceedances is reflected in the decline in Swimming Sites graded as Good.

The two swimming sites with the current best water quality are Hinsby Beach and Little Sandy Bay Beach (south). Hinsby have had two and Little Sandy Bay Beach (south) have had just three exceedances during the last five seasons (Table 2). The swimming site with the poorest water quality at the moment, Blackmans Bay (south), have had eight exceedances above 140 MPN 100 mL^{-1} and 11 over 280 during the last five seasons, 8 of which were recorded this season alone (Table 2 + Appendix C).

See the full enterococci results for all Swimming Sites in 2018-19 in Appendix C 10.3.1, and read more details about Windermere Bay, Blackmans Bay (south) and Nutgrove Beach (west) in Section 5 on Specific Investigations.

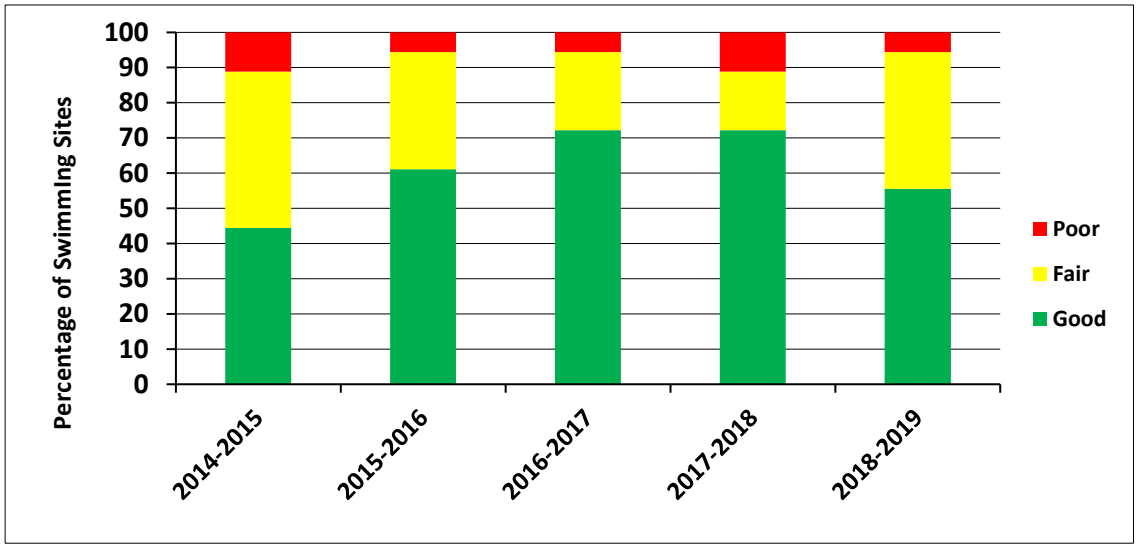


Figure 4-3 Proportion of Swimming Sites graded as Good, Fair, and Poor in the last five RWQ seasons.

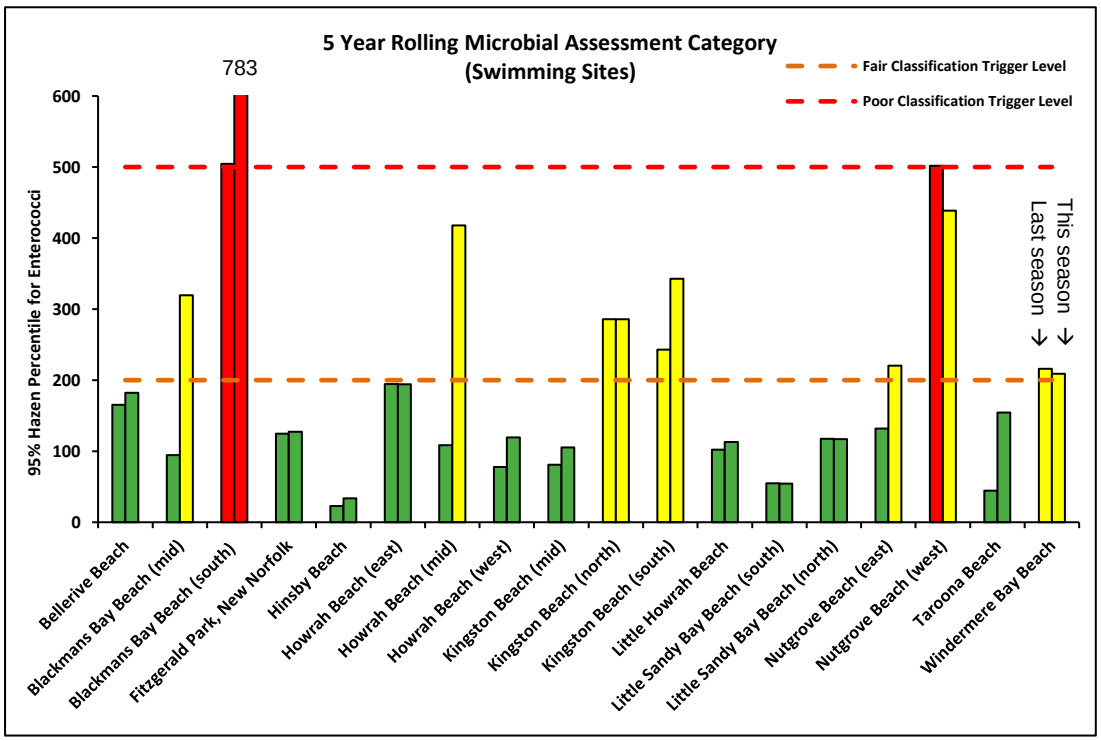


Figure 4-4: Comparison of rolling 5-year Hazen percentile enterococci result for Swimming Sites. Each site is presented as a pair of results, where the left bar represents 2017-18 RWQ season results, while the right bar represents 2018-19 season result. Green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL^{-1}), red denotes Poor (> 500 MPN 100 mL^{-1}), and the classification trigger lines are indicated with dotted lines. * indicates that less than five years of data is available, thus those results are less robust.

4.3.2 Environmental Sites

During the 2018-19 sampling season, water quality at the Environmental Sites remained similar to the previous season. Ten of the 21 sites were graded as Good, one more than the previous season, seven sites were graded as Fair, one more the previous season and four sites were graded as Poor, two less than the previous season (Figure 4-5). This is consistent with the trend of the last four years, which has seen a relative period of stability in the water quality results at Environmental Sites.

Despite a significant decrease in number or exceedances recorded this season, there was little change in water quality. During the season, there were 51 occurrences where the enterococci trigger level of 140 MPN 100 mL^{-1} was exceeded, which is 22 occurrences less than the previous season (Appendix C 10.3.2; Weller-Wong and Visby, 2018).

After this season, changes in classification occurred at just two sites, both of which were an improvement from the previous season. MONA Cameron Bay improved from poor to fair, bearing in mind there has not yet been five years of data recorded at this site, whilst Waterman's Dock made a significant improvement from poor to good (Figure 4-6). The improvement at Watermans Dock is due to several high results in the 2013-14 season no longer being included in the 5-year rolling Hazen percentile.

As in the previous years, the sites with the best water quality were Mid-river Derwent Swim, Kangaroo Bay, Sullivan's Cove and Montagu Bay. Sullivan's Cove and Kangaroo Bay both had only one exceedance > 140 MPN 100 mL^{-1} over the past five seasons, whilst Montagu Bay and Mid River Swim had none. The sites with the poorest water quality, with no changes from last year, were Cornelian Bay Beach, Browns River and the mouth of the Hobart Rivulet. Browns River and Hobart Rivulet has the most

exceedances > 280 MPN 100 mL^{-1} in last five years, recording 33 and 28 respectively. Sampling at Cornelian Bay is intermittent due to tide levels, which makes the results from the site less robust (Appendix C).

See the full enterococci results for all Environmental Sites in Appendix C 10.3.2.

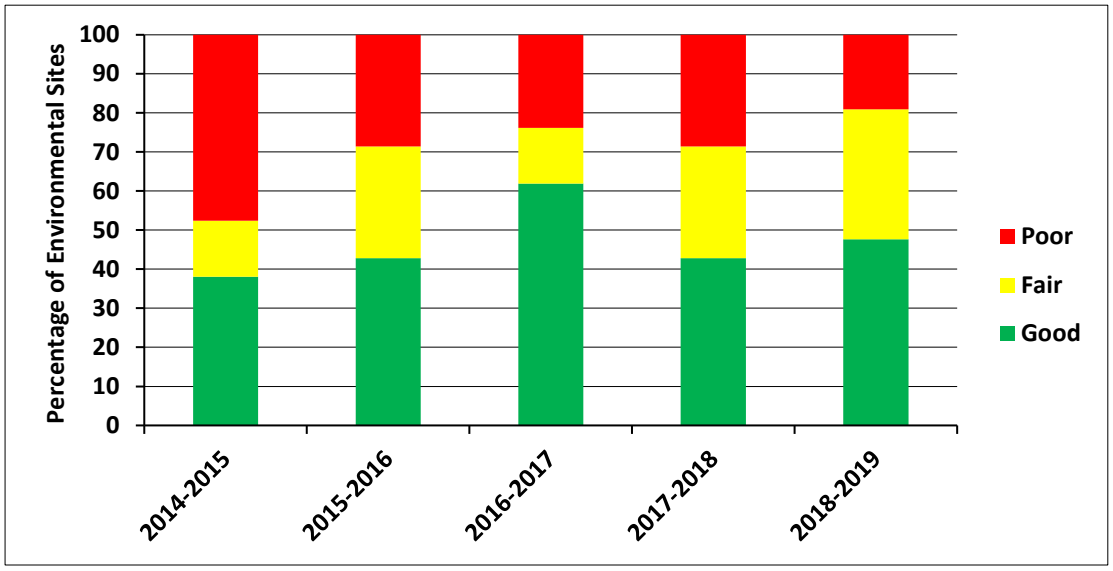


Figure 4-5 Proportion of Environmental Sites graded as Good, Fair, and Poor in the last five RWQ seasons.

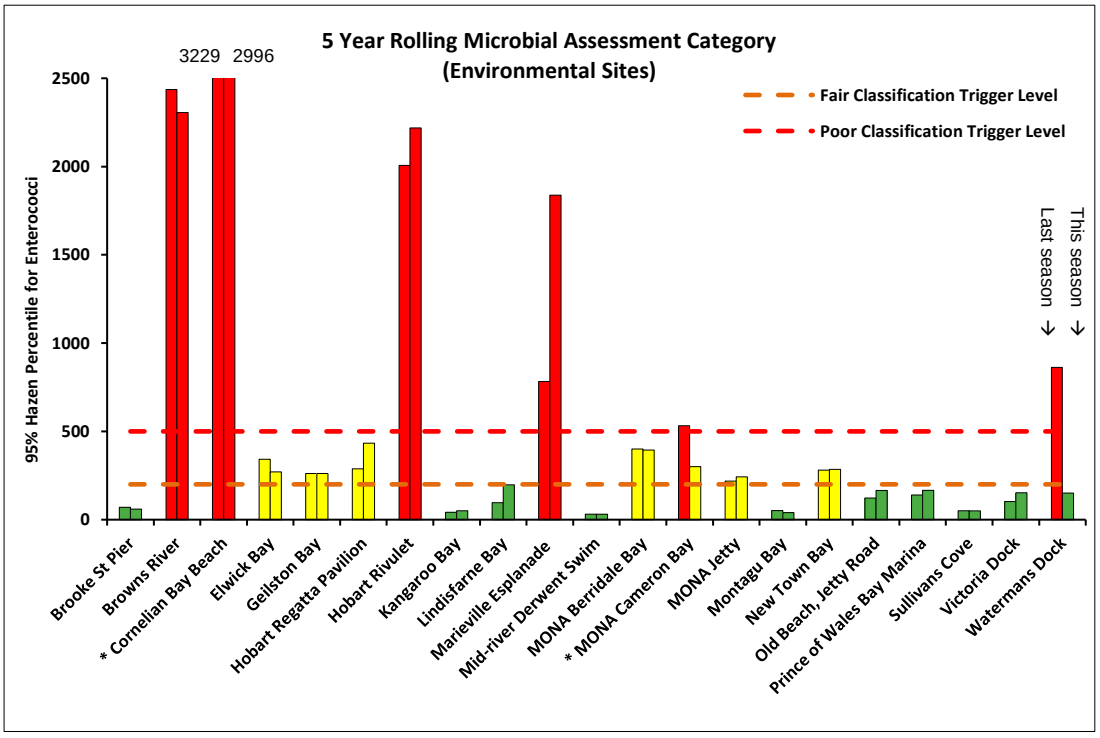


Figure 4-6 Comparison of rolling 5-year Hazen percentile enterococci result for Environmental Sites. Each site is presented as a pair of results, where the left bar represents 2017-18 RWQ season results, while the right bar represents 2018-19 season result. Green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL-1), red denotes Poor (> 500 MPN 100 mL^{-1}), and the classification trigger lines are indicated with dotted lines. * indicates that less than five years of data is available, thus those results are less robust.

Table 2. RWQ program 2018-19 season results, with data collected in the summer months between December 2014 and March 2019. Colours refers to Tasmanian *Recreational Water Quality Guidelines* (Dept of Health & Human Services, 2007) using rolling 5-year Hazen percentile for enterococci where green denotes Good (< 200 MPN 100 mL^{-1}), yellow denotes Fair (200 - 500 MPN 100 mL^{-1}), and red denotes Poor (> 500 MPN 100 mL^{-1}). Number of samples with enterococci readings between 140 and 280 MPN 100 mL^{-1}, > 280 MPN 100 mL^{-1}, > 140 in 2018-19 and total number of samples, for same 5-year period are also shown.

		5-year Hazen percentile enterococci	Samples between 140 and 280	Samples > 280	Total number of samples
Swimming Sites	Bellerive Beach	182	4	1	86
	Blackmans Bay Beach (mid)	320	3	5	85
	Blackmans Bay Beach (south)	783	8	11	85
	Fitzgerald Park, New Norfolk	127	1	1	78
	Hinsby Beach	34	2	0	85
	Howrah Beach (east)	194	3	3	86
	Howrah Beach (mid)	418	2	8	86
	Howrah Beach (west)	119	0	3	86
	Kingston Beach (mid)	105	2	1	85
	Kingston Beach (north)	286	4	5	85
	Kingston Beach (south)	343	5	5	85
	Little Howrah Beach	113	0	3	86
	Little Sandy Bay Beach (south)	54	3	0	86
	Little Sandy Bay Beach (north)	117	3	1	86
	Nutgrove Beach (east)	220	6	3	86
	Nutgrove Beach (west)	439	4	5	86
	Taroona Beach	154	0	4	85
	Windermere Bay Beach	209	2	3	79
Environmental Sites	Brooke St Pier	60	0	2	73
	Brown's River	2305	14	33	84
	* Cornelian Bay Beach	2997	7	15	52
	Elwick Bay	271	3	4	78
	Geilston Bay	262	5	2	73
	Hobart Regatta Pavilion	433	6	7	72
	Hobart Rivulet	2218	14	28	73
	Kangaroo Bay	50	1	1	73
	Lindisfarne Bay	197	1	3	73
	Marieville Esplanade	1839	15	16	87
	Mid-river Derwent Swim	31	2	0	72
	MONA Berriedale Bay	394	4	7	68
	*MONA Cameron Bay	300	2	2	47
	MONA Jetty	242	1	4	77
	Montagu Bay	40	1	0	72
	New Town Bay	285	4	4	73
	Old Beach, Jetty Road	166	3	2	80
	Prince of Wales Bay Marina	166	3	2	73
	Sullivans Cove	50	0	1	72
	Victoria Dock	153	2	2	73
	Waterman's Dock	151	1	3	73

***** Indicates < 5 years of data available. Cornelian Bay is monitored intermittently, when conditions allow.

5 SPECIFIC INVESTIGATIONS

While water quality at most beaches is currently classified as Good to Fair, previous and current monitoring has identified issues at several sites that merit further investigation. Water quality investigations are ongoing at various sites, including the Howrah beaches (Clarence City Council), Blackmans Bay and Kingston beaches (Kingborough Council) as discussed below. Nutgrove Beach (west) is a prime example of the benefits intensive works on a stormwater system can have, improving its classification from Poor to Fair at the conclusion of the 2018-19 season.

5.1 Nutgrove Beach (west)

Nutgrove Beach (west) is a successful example of how a collaborative investigation into stormwater and sewage systems can result in improvement of water quality at an urban swimming beach. Nutgrove Beach (west) has had a poor recreational water quality rating for many years due to faecal contamination transported to the beach via the Lipscombe rivulet and stormwater outfall. Over the summers of 2016-17 and 2017-18 a collaborative investigation between TasWater, CoH and the DEP took place to identify the source of contamination and rectify problems found.

The investigation included additional end-of-pipe and targeted street sampling; tracking for anthropogenic tracers; hydraulic sewer modelling / pipe pressurisation; dye testing; as well as CCTV investigations. Results from those investigations confirmed a sewerage signal in the stormwater from the Lipscombe Rivulet; a crack was discovered in a sewerage pipe causing sewerage to enter gravel surrounding the stormwater pipe at a crossover point; several possible sagging/compromised sewer pipe joints were detected; as were two cross connections at private properties. During the spring summer of 2017-18 TasWater undertook significant repairs and pipe re-alignment and the council removed two direct sewage to stormwater cross connections they had located.

Sampling results, post-works, have shown in a marked improvement in water quality with the rolling 5-year 95th Hazen percentile value for enterococci improving from Poor to Fair at the end of the 2018-19 season. This is a great success story for a beach with a legacy of poor water quality and a shining example of how collaborative investigations and persistence can result in good water quality outcomes.

5.2 Windermere Bay Beach

Windermere Bay Beach has historically had relatively poor water quality. In recent years the water quality has improved somewhat, however it is likely that this is due to an extended period of below average rainfall over the past four years. GCC has previously sampled along the Faulkner's River in order to investigate a potential link between the water quality in the rivulet and the beach, however this was discontinued in 2017 due to low flows, and the result were inconclusive.

Following the return to the Fair category last season, GCC, TasWater and the DEP (with funding from DoH) initiated a collaborative 'special study' in attempt to identify possible sources of contamination at Windermere Bay Beach. Throughout this 2018-19 season the DEP and GCC took additional samples along a transect from Faulkner's Rivulet to Windermere Bay Beach, plus an additional sample further south of the Windermere Bay Beach site, in attempt to better understand the influence of contaminated stormwater coming out of Faulkner's Rivulet on the beach. The results of this additional sampling will be combined with investigations of the stormwater system around Kestrel Street and CCTV investigations in the surrounding sewage system by TasWater. This investigation is ongoing.

5.3 Howrah Beach

Previous investigations have confirmed that recreational water quality at Howrah Beach is highly susceptible to stormwater contamination. This season resulted in a return to Fair for Howrah Beach, which is a reminder that continued works are required to improve the beach water quality.

In 2015 TasWater commenced an investigation into the capacity and potential risk sites in their network to assess whether sewerage is contributing to faecal contamination at the beach. Following on from this work the CCC allocated funding for targeted stormwater sampling and associated investigations, such as opening stormwater lids and taking samples during dry and wet conditions.

Multiple point-sources of contamination have since been identified by CCC and broken and blocked sewage infrastructure has since been fixed by TasWater. Stormwater investigations are continuing in the Howrah beach catchment.

5.4 Blackmans Bay and Kingston Beach

Last season water quality declined to poor and this season the water quality has continued to decline. The closure of Blackmans Bay (south) at the end of the 2018-19 season received significant community and media attention. In November 2018, KC commenced a significant sampling regime at Blackmans Bay and Kingston Beach taking both recreational water and stormwater outfall samples. This data is publicly available on the Kingborough Council website. The sampling program has been extended past the conclusion of the standard RWQ sampling program.

KC and TasWater have established a working group focused on identifying contamination sources and providing solutions in the Kingston and Blackmans Bay stormwater catchments. CCTV monitoring identified broken sewer pipes upstream of both the Illawarra Rd and Flowerpot Cres. stormwater outfalls which have since been rectified. KC also identified cross-connections as well as tree root infiltration into the stormwater pipes upstream of the Flowerpot Cres. outfall and the cross-connections have since been rectified. KC are currently trialling a temporary system to disperse stormwater flowing out of the Illawarra Rd. stormwater outfall to reduce freshwater pooling on the beach which they are hopeful will reduce the number of seagulls gathering on the beach. Investigations in the Blackmans Bay and Kingston Beach stormwater catchments continue.

6 RELATED MATTERS

6.1 Predictive modelling

As we only test the water quality of our beaches and bays on Tuesdays, it is not possible to say with certainty what the water quality will be like on the weekends, which is when most people swim. We partly remedy this by providing more generic advice on the classification of beaches based on the long-term monitoring, along with the standing advice to avoid swimming in the Derwent for several days after heavy rain.

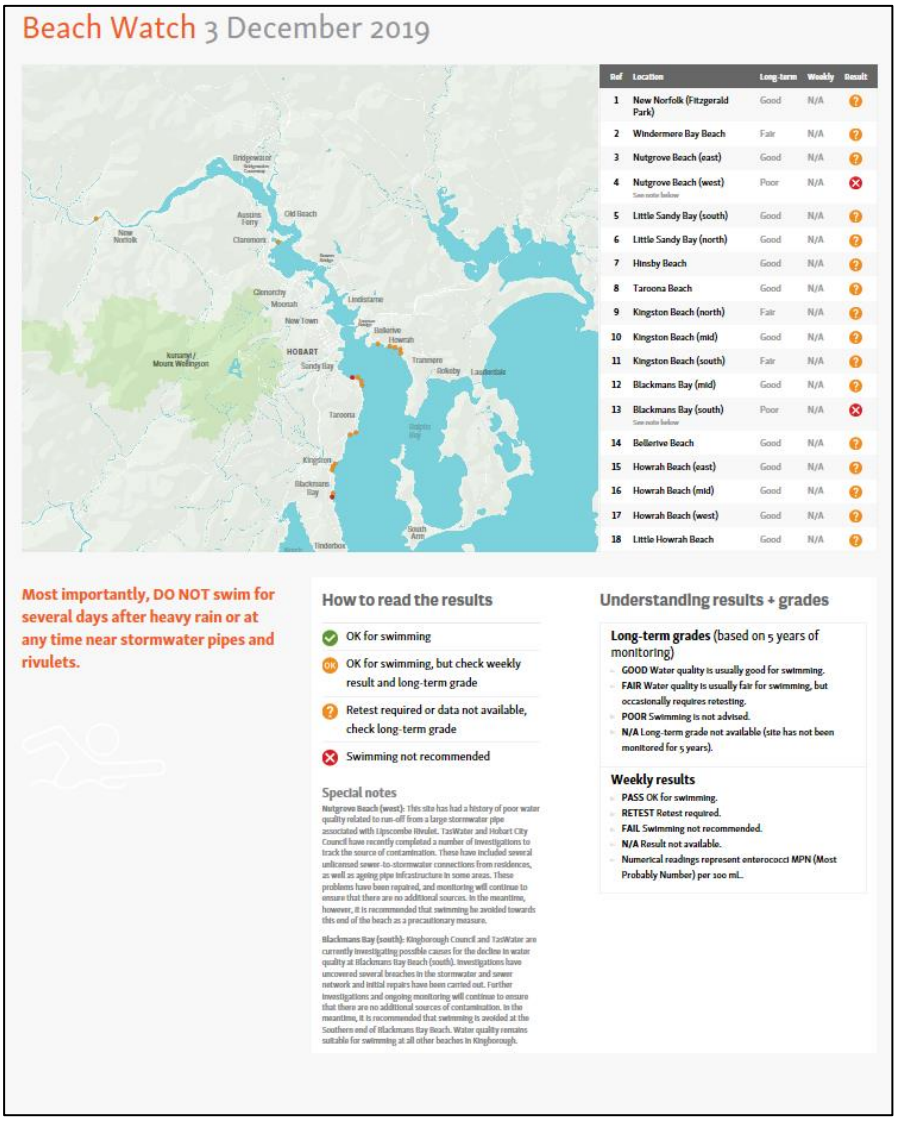
Numerous beaches interstate and overseas are now providing the swimming public with a predicted forecast of the water quality for each day. Forecasts are generally produced using a combination of historical water quality data, past and predicted rainfall, and cloud cover conditions, but may also include simulations of the tide and wind-driven currents. The DEP are interested in trialing forecasting at some of our popular swimming beaches.

7 COMMUNICATIONS

7.1 Website

Weekly RWQ results were reported via the DEP website on the Beach Watch page. The page was viewed by nearly 19,500 people over the course of the RWQ season, an increase of nearly 15,000 views compared to the previous season. The page allows the viewer to locate weekly sampling results and long-term rating for a particular beach by clicking on an interactive map or looking at a table.

Swimming and Environmental sites continue to be reported under the labels *Beach Watch* (Figure 7-1) and *Bay Watch*.



Ref	Location	Long-term	Weekly	Result
1	New Norfolk (Fitzgerald Park)	Good	N/A	
2	Windermere Bay Beach	Fair	N/A	
3	Nutgrove Beach (east)	Good	N/A	
4	Nutgrove Beach (west)	Poor	N/A	
5	Little Sandy Bay (south)	Good	N/A	
6	Little Sandy Bay (north)	Good	N/A	
7	Hinsby Beach	Good	N/A	
8	Taroona Beach	Good	N/A	
9	Kingston Beach (north)	Fair	N/A	
10	Kingston Beach (mid)	Good	N/A	
11	Kingston Beach (south)	Fair	N/A	
12	Blackmans Bay (mid)	Good	N/A	
13	Blackmans Bay (south)	Poor	N/A	
14	Bellerive Beach	Good	N/A	
15	Howrah Beach (east)	Good	N/A	
16	Howrah Beach (mid)	Good	N/A	
17	Howrah Beach (west)	Good	N/A	
18	Little Howrah Beach	Good	N/A	

Figure 7-1 Swimming Sites reported on the DEP website under the label Beach Watch during the 2018-19 season. No data is shown as the image was taken after the season had concluded.

7.2 Facebook

Weekly RWQ results were shared on the DEP Facebook page www.facebook.com/derwentestuary (Figure 7-2). The number of Facebook views increased significantly from the previous season. The best result was 6,900 views, more than 4 times the most viewed post last season. On average, RWQ results were viewed by 300 people, triple the number of average views in the previous season. The

number of views was maximised when shared, for example, the post that reached the most viewers was shared 30 times. Site visitation was likely bolstered by publicity surrounding the beach Watch program this season, see section 7.3.

Next year we will continue to improve our Facebook postings, aiming for updated weekly photos and focusses on individual beaches or regions. Councils and other stakeholders are encouraged to share DEP posts. All environmental health officers are warmly invited to share photos from their sampling days for this purpose so that we can hopefully reach more people with our results.

7.3 Media

This season there has been significant media attention surrounding the Beach Watch program following the decline of Blackmans Bay (south) to poor at the end of last season, and the continued poor results throughout this season. There were 10 media reports through-out the season, most of which focused on the poor water quality results at Blackmans Bay (south) and Nutgrove Beach (west). It is likely that the spikes in website and facebook page traffic throughout the season were associated with current media releases.

7.4 Weekend advisory

The most important message that we need to convey to the swimming public, is to not swim after heavy rains, due to the water quality of urban beaches and bays being often strongly influenced by stormwater run-off (NHMRC, 2008). We keep an eye on the weekend forecasts and can put out an advisory on the DEP website and Facebook page when necessary, e.g. when recent or predicted rainfall is greater than 10 mm. This 'protocol' was conducted throughout the season (Figure 7-2).

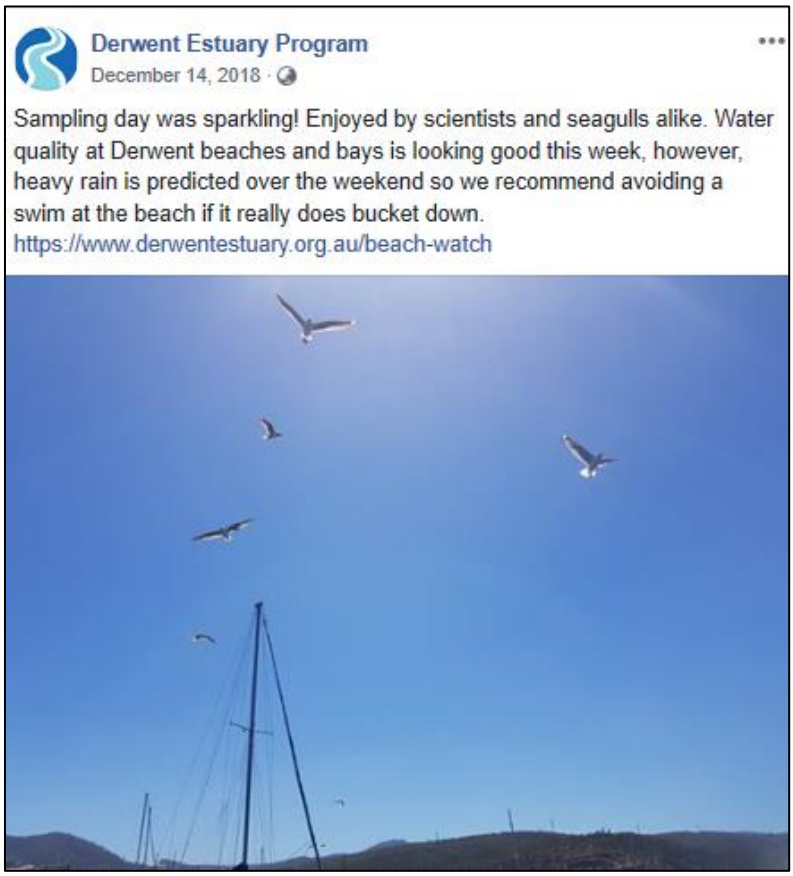


Figure 7-2 DEP Facebook posting from December 14, 2018 referring to the weekly RWQ results on the DEP website.

7.5 Signage

The RWQ signage installed at Derwent swimming beaches is a useful source of information for beach users. The DEP recommends that local councils conduct an annual review of signage in their municipality to ensure that all signs are located in the most appropriate locations (i.e. visible to most visitors), are in good condition (e.g. free of graffiti), and that they are replaced with new signs as required (e.g. when the water quality category changes).
In light of this season's rating changes, it is suggested that the following signage updates take place before next summer:

- Nutgrove Beach west (from poor to fair)
- Nutgrove Beach east (from good to fair)
- Blackmans Bay beach (from good to fair)
- Howrah Beach mid (from good to fair)

8 ACKNOWLEDGEMENTS

The DEP would like to sincerely thank all council environmental health officers and other council staff who have contributed to this RWQ season, as well as EPA staff who have assisted with boating requirements. Many thanks also go the staff at the Public Health Laboratory and the Department of Health for their ongoing participation and friendly support, and our industry partners, including Norske Skog and TasWater.

9 REFERENCES

- Bureau of Meteorology (2017) BOM Climate Data Online. Accessed 7 December 2017, from http://www.bom.gov.au/climate/data/.
- Coughanowr C.A., Whitehead J., Whitehead S., Einoder L.E., Taylor U., Weeding B. (2015) The State of the Derwent estuary 2015. A review of environmental data from 2009 to 2014. Derwent Estuary Program (Hobart, Australia).
- Dept of Health & Human Services (2007) Recreational Water Quality Guidelines (Public Health Act 1997). (Hobart, Australia).
- N.Z. Ministry for the Environment (2002) Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment (Wellington, New Zealand).
- NHMRC (2008) Guidelines for Managing Risks in Recreational Water. (Canberra, Australia).
- Visby I. (2018) RWQ Inter-calibration report 2018/19.
- Weller-Wong A., Visby I. (2018) Recreational Water Quality Program, Annual Report 2017/18. Derwent Estuary Program (Hobart, Australia).

10 APPENDIX

10.1 Appendix A - RWQ Intercalibration report 2018-19

Executive Summary

Recreational Water Quality (RWQ) monitoring in the Derwent estuary is conducted and reported in accordance with the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*). In order to ensure consistency of sampling methods and to assess the degree of variability between samples and samplers, the Derwent Estuary Program (DEP) coordinates an annual inter-calibration exercise.

On 19 November 2018, environmental health officers from four council partners together with the DEP simultaneously collected a sample each at two sites on Howrah Beach (east). Results were consistent between samplers and sites. Low results were reported at Site 1 (close to a stormwater outfall), as well as at Site 2 (100 m west of the outfall).

Introduction

The RWQ monitoring is conducted and reported in accordance with the Recreational Water Quality Guidelines 2007 (*Public Health Act 1997*). The guidelines recommend classifying primary contact recreation beaches using 5-year 95th Hazen percentile values for the faecal indicator bacteria enterococci:

- Good (surveillance mode) = < 200 MPN/100 mL.
- Fair (alert mode) = 200 - 500 MPN/100 mL.
- Poor (action mode) = > 500 MPN/100 mL.

The long-term beach classification guidelines do not take into account the possible influence of variability in the data due to differences in sampling techniques between samplers, or possible heterogeneity of the sampled water body. The RWQ program uses data provided by a number of different council environmental health officers, which increases the risk of variability due to sampling technique. Thus, the primary objective of the annual inter-calibration exercise is to review and practice sampling methods at the start of each season, in order to improve consistency of results. A secondary objective is to gain a better understanding of water quality at a particular site.

Methodology

Participants

The DEP (Inger Visby) coordinated the participation of the following:

- City of Hobart/Clarence City Council (Yvette Wierenga)
- City of Hobart (Elzette Mustonen)
- Clarence City Council (Andrew Foreshore)
- Glenorchy City Council (Tracy Tavasz)
- Kingborough Council (Micheal Steele)
- Public Health Services (Helena Bobbi)
- DEP (Akira Weller-Wong)

Location

Site 1 was off the beach near the stormwater outfall at the eastern end of Howrah Beach, and Site 2 was approx. 100 m. further west along the beach. An additional sample was taken by the DEP only, directly by the stormwater outfall on the beach, to assess this as a potential source of contamination (Figure 1).

Figure 1. Location of the three sites sampled for the RWQ inter-calibration exercise on 19 November 2018 at Howrah Beach (east).

Method

Field sheets were completed by entering wind speed, wind direction, date and time of sampling. Any general observations were also noted, such as discolouration, odour, construction activity, boat presence, density of wildlife, evidence of faeces, proximity to stormwater outfalls or any other matters which might influence results. Bottles were labelled with the site, time, and the sampler's name.

All samplers concurrently collected a single sample at each site from an approximate water depth of 0.3 m. Bottles were only opened immediately prior to collecting the sample. Once the bottle cap had been removed, care was taken to ensure that this was not contaminated by fingers or by contact with surfaces. The bottle was quickly plunged to the required sampling depth, then it was tilted upward with the mouth pointed upward. The sample was brought to the surface and a portion of the sample tipped out so that the level in the sample container was at the bottle collar. The sample lid was screwed tightly shut before removing it from the sample pole and the sample was placed upright in a chilled esky ready for transport to the laboratory (Public Health Laboratory in New Town). Samples were delivered to the laboratory immediately upon completion of the inter-calibration event.

In addition to water sampling, Clarence City Council and the DEP also compared *in-situ* water quality multi-probes, a Horiba Water Quality Checker U-10 (CCC) and a YSI EXO3 Multiparameter Sonde (DEP). The calibrated multi-probes were deployed to the

same surface depth of water at Site 1, until data readings stabilised. Temperature, pH, conductivity, and dissolved oxygen readings were compared.

Safety

Wader safety was discussed, and it became apparent that not everybody had experience with wearing waders, which can be hazardous if water gets inside them, e.g. from boat wake or when bending to take water sample.

POST-EXERCISE: DEP shared information about a Wader Safety Course run by Seafood & Maritime Training on 7th December.

Rain, wind, tide conditions

According to the weather stations at Ellerslie and Hobart Airport (Bureau of Meteorology 2018) there was negligible rain in the three proceeding days.

At the time of sampling, the wind was north/northwest, with wind speeds ~ 24 km/hr (Bureau of Meteorology 2018), and the tide was outgoing at ~ 0.84 m (WillyWeather 2018).

Results

The enterococci results from Site 1 varied between 20 and < 10 MPN/100 mL. At Site 2 all results were < 10 MPN/100 mL. At the stormwater outlet the result was 135 MPN/100 mL (Table 1).

The results from the multi-probe comparison were comparable (Table 2). The equipment was not set for all the same parameters. Regarding DO, the 110 % (air saturation) compares well to 8.3 mg/L.

Table 1: Summary of enterococci concentration results (MPN/100 mL) sampled on 19 Nov 2018

Sampler	Site 1: Beach by the outfall	Site 2: 200m Beach 100 m west of outfall
Glenorchy	20	< 10
Hobart	10	< 10
Clarence	< 10	n/a
Kingborough	< 10	< 10
DEP	20	< 10

Sampler	Directly by the outfall
DEP	135

Table 2: Summary from multi-probe comparison exercise on 19 Nov 2018.

Multi-probe	Temperature (°C)	pH	Conductivity mS/cm	DO (%)	DO (mg/L)	Turbidity (NTU)
YSI (DEP)	16.1	8.01	48.9	110	n/a	n/a
Horiba (CCC)	16.0	8.15	50.3	n/a	8.3	2

Conclusions

The water quality was excellent at both sites. The sampling results demonstrated fairly homogeneous water quality conditions at both locations, with little variability.

Given that urban stormwater drains are a known source of faecal contamination, the higher enterococci results from samples collected at Site 1 were expected, but results were still very low compared with the sample collected directly by the pipe, indicating significant dilution over a relatively short distance. The difference between the < 10 and 20 MPN/100 mL results at this site suggests there is only little variability in the flow path and dilution rates.

The results from Site 2 suggests that at 100 m. distance from the stormwater outfall the flow from the drain has been completely diluted.

The multiprobe comparison, between DEP and Clarence City Council, continues to be valuable to ensure that equipment is used correctly and calibrations are performed regularly.

Samplers adopted good aseptic grab sampling technique, removing bottle lids at the last moment before collecting a sample, protecting the bottle and lid from contamination, labelling bottles correctly and storing samples in a chilled esky for subsequent transport to the laboratory. Samplers were aware of potential sources of faecal contamination.

Acknowledgements

Thank you very much to all the environmental health officers who participated in this session with great enthusiasm and willingness to share their knowledge and experiences, and to the local councils for valuing and prioritising the program. Thank you to Helena Bobbi for the photos.

References

Bureau of Meteorology, 2018. Climate Statistics for Australian locations: Climate data online, Commonwealth of Australia Bureau of Meteorology. http://www.bom.gov.au/climate/data/ accessed 22 Nov 2018.

Recreational Water Quality Guidelines 2007. Public Health Act 1997 https://www.dhhs.tas.gov.au/__data/assets/pdf_file/0014/53321/2007_RWQG.pdf

Willy Weather, 2018. Hobart Tide Times and Heights. https://tides.willyweather.com.au/tas/hobart/hobart.html accessed 22 Nov 2018.

10.2 Appendix B – Rainfall data

10.2.1 Rainfall across the Derwent estuary

	Rainfall (mm)															
	Hobart				Airport				Greenhill				NN west			
Date	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar
1st	2.2	0	0	0	4.8	0	1.4	0	1.4	0	1.4	0	0.4	0	1.4	0
2nd	2.4	0	0	0	2	0	0	0	5.2	0	0	0	6.8	0	0	0
3rd	0.2	0	0	0	0.2	0	0	0	0.8	0	0	0	1.4	0	0	0
4th	7.6	0	0	0	3.6	0	0.2	0.2	10	0	0.2	0	8.6	0	0	0
5th	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6th	0	0	0	2.2	0.2	0	0.6	1.6	0	0	0.2	3.8	0	0	0	1.6
7th	0	0	26.2	1.6	0	0	13.6	2.6	0	0	29	1.8	0	0	19	1.4
8th	0	0	4.6	0.2	0	0	8.6	0	0	0	7.6	0	0	0	2.6	0
9th	0	0	0	3	0.4	0	0	2.4	0	0.4	0	3	0	0	0.8	0
10th	0	0	0.2	2.4	0	0	0.4	1.4	0	0.2	1	2.2	0	0.2	0	0.2
11th	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
12th	0	0	1.8	0.2	0	0	8	0.4	0	1.2	1.8	1.2	0	1.6	3	0.4
13th	0	0.2	1.8	0.2	0	0	4.4	0.2	0	0	3.4	1.8	0	0	0	1.4
14th	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0.2	0
15th	0	0	0	0	0	0	0	0	0.2	0	0	0	0.2	0	0.2	0
16th	2	0	0	0	0.8	0.4	0	0	6.6	0.2	0	0	3	0	0	0
17th	27.6	0	0	0	0.6	0.2	1.6	0	19.2	0	0.2	0	4.6	0	0	0
18th	1.6	0	0.2	0	2.6	0.2	0	0	4	0	0	0	0.2	0.2	0	0
19th	0.2	0	0	0	0	1.6	0	0	1	1	0	0	0	0.4	0	0
20th	12.6	0	0	1	12.4	0	0	0.6	12.4	0	0	2.8	13	0	0	0
21st	1.2	0	0	0	1.4	0	0	0	1.8	0	0.6	0	2.2	0	0	0
22nd	1.2	0	0	0.4	1.8	0	0.4	0.4	3.2	0	0.2	1.8	9	0	0	0
23rd	0	0	0	0	0.2	0	0	0	0	0.2	0	0.2	0	0	0	0
24th	0	0.2	0	0.4	0	0	0	0.4	0	0	0	0.4	0	0	0	2.4
25th	0	0	0	2.2	0	0	0	0.2	0	0	0	11	0	0	0	4.4
26th	0	0	0.4	2.8	0	0	1.2	0.2	0	0	1.4	2	0	0	0	5.2
27th	0	0	0.2	0	0	0	0	0.2	0	0.4	0	0	0	0	0	0
28th	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29th	2.2	0		0	0.8	0		0	2.2	0		0	2.6	0		0
30th	0	0		1.6	0	0		4	0	0		1.6	0	0		3
31st	0	0		0	0	5.8		0	0	0.6		0.2	0	0		0

Preceding sampling date

Rainfall > 10mm

Figure 10-1 Daily rainfall (up to 9 am) from December-March at four BOM weather stations near the Derwent estuary.

10.2.2 Enterococci result on high rainfall days

Date	Swimming site	Weather station (BOM)	Rainfall (mm.)	Enterococci (MPN/100 mL)
04-Dec-18	Blackmans Bay Beach (mid)	Kingston	10.8	0
04-Dec-18	Blackmans Bay Beach (south)	Kingston	10.8	0
04-Dec-18	Hinsby Beach	Kingston	10.8	0
04-Dec-18	Taroona Beach	Kingston	10.8	0
04-Dec-18	Kingston Beach (mid)	Kingston	10.8	0
04-Dec-18	Kingston Beach (north)	Kingston	10.8	0
04-Dec-18	Kingston Beach (south)	Kingston	10.8	0
18-Dec-18	Little Sandy Bay Beach (south)	Hobart	29.4	41
18-Dec-18	Little Sandy Bay Beach (north)	Hobart	29.4	98
18-Dec-18	Nutgrove Beach (east)	Hobart	29.4	189
18-Dec-18	Nutgrove Beach (west)	Hobart	29.4	41
18-Dec-18	Blackmans Bay Beach (mid)	Kingston	24.2	74
18-Dec-18	Blackmans Bay Beach (south)	Kingston	24.2	457
18-Dec-18	Hinsby Beach	Kingston	24.2	< 10
18-Dec-18	Taroona Beach	Kingston	24.2	556
18-Dec-18	Kingston Beach (mid)	Kingston	24.2	169
18-Dec-18	Kingston Beach (north)	Kingston	24.2	345
18-Dec-18	Kingston Beach (south)	Kingston	24.2	275
12-Feb-19	Bellerive Beach	Hobart Airport	12.4	10
12-Feb-19	Howrah Beach (east)	Hobart Airport	12.4	389
12-Feb-19	Howrah Beach (mid)	Hobart Airport	12.4	537
12-Feb-19	Howrah Beach (west)	Hobart Airport	12.4	< 10
12-Feb-19	Little Howrah Beach	Hobart Airport	12.4	650
26-Mar-19	Blackmans Bay Beach (mid)	Kingston	12.0	318
26-Mar-19	Blackmans Bay Beach (south)	Kingston	12.0	1281
26-Mar-19	Hinsby Beach	Kingston	12.0	10
26-Mar-19	Taroona Beach	Kingston	12.0	110
26-Mar-19	Kingston Beach (mid)	Kingston	12.0	160
26-Mar-19	Kingston Beach (north)	Kingston	12.0	520
26-Mar-19	Kingston Beach (south)	Kingston	12.0	749

Figure 10-2 Enterococci concentration recorded when cumulative rainfall was > 10 mm in the 48 hours to 9 am on the day of sampling, plus rainfall on the day of sampling (i.e. from 9 am Sunday to 9 am Wednesday).

10.3 Appendix C – 2018/19 results for Swimming and Environmental sites

10.3.1 Swimming Sites

Date	HCC				CCC					KC							GCC	DVC	
	Little Sandy Bay Beach (south)	Little Sandy Bay Beach (north)	Nutgrove Beach (east)	Nutgrove Beach (west)	Bellerive Beach	Howrah Beach (east)	Howrah Beach (mid)	Howrah Beach (west)	Little Howrah Beach	Blackmans Bay Beach (mid)	Blackmans Bay Beach (south)	Hinsby Beach	Taroona Beach	Kingston Beach (mid)	Kingston Beach (north)	Kingston Beach (south)	Windermere Bay Beach	Fitzgerald Park, New Norfolk	No.excedences over 140 MPN
04-Dec-18	52	20	10	<10	10	<10	<10	98	20	<10	10	10	<10	<10	10	10	41	10	0
11-Dec-18	<10	<10	<10	<10	<10	<10	20	<10	10	<10	109	<10	<10	<10	<10	<10	20	<10	0
18-Dec-18	41	98	189	41	275	52	213	364	20	74	457	<10	556	169	345	275	73	135	9
27-Dec-18	10	10	<10	52	31	<10	52	30	<10	<10	733	10	63	10	20	146			2
02-Jan-19	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	31	<10	<10	<10	10		<10	0
08-Jan-19	<10	52	373	<10	175	52	350	<10	<10	9804	4611	161	52	97	256	75	121	62	7
15-Jan-19	10	63	10	20	20	10	<10	10	<10	52	305	<10	20	<10	171	<10	20	<10	2
22-Jan-19	20	10	216	134	41	98	10	41	<10	195	20	10	287	31	52	20	10	20	3
29-Jan-19	<10	<10	<10	10	10	10	31	<10	10	<10	132	<10	<10	<10	10	10	20	20	0
05-Feb-19	41	336	<10	<10	<10	<10	<10	10	<10	20	145	<10	<10	20	31	<10	<10	20	2
12-Feb-19	10	96	161	146	10	389	537	<10	650	10	327	145	884	<10	<10	30	52	20	8
19-Feb-19	<10	20	1054	405	<10	41	388	119	86	31	134	20	41	20	<10	161	20	108	4
26-Feb-19	<10	20	10	<10	<10	52	323	121	<10	161	52	<10	<10	20	<10	10	131	<10	2
05-Mar-19	31	<10	<10	10	<10	20	<10	20	<10	122	<10	41	10	<10	<10	31	<10	20	0
12-Mar-19	<10	73	<10	<10	<10	51	41	<10	31	350	31	<10	<10	20	<10	30	31	10	1
19-Mar-19	31	10	20	75	<10	<10	31	10	10	<10	187	10	<10	94	235	<10	31	20	2
26-Mar-19	173	52	350	1823	110	97	350	63	487	318	1281	10	110	160	520	749	31	30	10
																		Total	52

Figure 10-3 2018-19 RWQ season swimming site results listed under each local council. Results are enterococci MPN per 100 mL.

10.3.2 Environmental Sites

Date	Environmental Site 2018-19																					
	Brooke St Pier	Browns River	Cornelian Bay Beach *	Elwick Bay	Geilston Bay	Hobart Regatta Pavilion	Hobart Rivulet	Kangaroo Bay	Lindisfarne Bay	Marieville Esplanade	Mid-river Derwent Swim	MONA Berridale Bay	MONA Cameron Bay*	MONA Jetty	Montagu Bay	New Town Bay	Old Beach, Jetty Road	Prince of Wales Bay Marina	Sullivans Cove	Victoria Dock	Watermans Dock	No.excedences over 140 MPN
04-Dec-18	<10	464	10	20	10	201	422	<10	<10	134	<10	31	20	20	<10	52	96	<10	<10	<10	160	4
11-Dec-18	<10	31	213	<10	<10	20	41	<10	<10	10	<10	41	41	<10	<10	41	591	<10	<10	<10	20	2
18-Dec-18	31	776	288	31	10	446	2224	10	84	247	30		51	86	20	31	63	<10	31	<10	85	5
27-Dec-18		52	86							108												0
02-Jan-19	<10	388	<10		<10	<10	73	<10	<10	31	<10				<10	10	10	<10	10	<10	<10	1
08-Jan-19	<10	63	336	146	<10	10	86	<10	20	<10	<10		10	<10	<10	<10	<10	10	<10	<10	<10	2
15-Jan-19	10	110	537	52	20	145	266	10	<10	10	30		10	10	10	10	10	<10	<10	<10	10	3
22-Jan-19	<10	520	253	10	10	63	31	<10	40	878	<10		135	288	10	10	199	<10	<10	<10	<10	5
29-Jan-19	<10	63		10	<10	<10	<10	<10	<10	31	10		20	<10	<10	10	<10	<10	<10	<10	10	0
05-Feb-19	<10	51	121	<10	20	10	364	<10	609	10	<10	<10	10	<10	<10	10	<10	31	<10	10	<10	2
12-Feb-19	<10	1222	336	63	122	2595	63	52	455	383	<10	161	10	31	<10	1236	30	169	20	1160	98	9
19-Feb-19		148	298	20						4611		98	41	10			41					3
26-Feb-19	10	63	882	<10	<10	41	512	<10	<10	223	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	20	3
05-Mar-19	<10	10	135	10	<10	173	332	<10	<10	<10	<10	<10	10	<10	<10	<10	20	10	<10	<10	<10	2
12-Mar-19	41	1467	20	31	10	<10	41	<10	<10	187	<10	20	20	<10	<10	175	<10	52	<10	20	<10	3
19-Mar-19	<10	132	364	10	<10	<10	98	10	20	6893	<10		<10	<10	<10	10	<10	<10	10	<10	20	2
26-Mar-19	10	4352	201	31	31	272	594	10	132	8664		30	10	30	<10	122	73	109	20	10	<10	5
																						51

Figure 10-4 2018-19 RWQ season Environmental Site results - enterococci MPN per 100 mL.

***** Indicates < 5 years of data available. Cornelian Bay is monitored intermittently, when conditions allow.