RMCG

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Water and sediment quality assessment Walkerville retarding basin

Final Report

This report has been requested by Russell Kennedy on behalf of South Gippsland Shire Council and is subject to legal professional privilege.

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1 Introduction

1.1 INSTRUCTIONS

This report has been prepared in response to a letter of instruction from Andrew Sherman of Russell Kennedy.

Russell Kennedy acts for the South Gippsland Shire Council in relation to suitability of water captured in the Walkerville Retarding Basin for irrigation and livestock drinking uses on a neighbouring property.

RM Consulting Group Pty Ltd (RMCG) provides in this report an independent expert view of the suitability of the water in the Walkerville Retarding Basin. Particular attention is given to its use for livestock drinking (cattle and sheep) and irrigation (pasture for stock and grapes). This view has been formed through sampling and analysis of both sediment and water within the basin; review of previous sampling data; and a risk assessment of potential inputs (e.g. domestic wastewater).

1.2 SITE BACKGROUND

There is a settlement known as Promontory Views Estate near the small township of Walkerville on the South Gippsland coast.

The stormwater and drainage solution for this settlement includes a retarding basin. Water collected in the basin is accessed by an adjoining property, Ansevata, for irrigation and livestock watering.

Ansevata has indicated concern with use of the stormwater, including:

- That wastewater from the septic systems used in the Promontory Views Estate may be reaching the storm water drainage system.
- That the build-up of silt in the base of the Basin is “toxic” – which is assumed to mean that a component of the silt is expected to impact on water quality and in turn, may impact crops or stock health.

2 Situation Analysis

2.1 STORMWATER CATCHMENT

This discussion is informed by the *Township Land Capability Assessment of the Prom Views Estate – Walkerville* prepared by LandSafe in 2011, as well as spatial/mapping data and an inspection of the area on Friday the 10th of November 2017.

The Walkerville retarding basin captures stormwater from the Peninsula Views Estate. The Estate covers approximately 25 ha, including 380 lots, of which approximately three quarters have dwellings. The retarding basin receives stormwater from the majority, but not the entirety, of the Estate.

There is no reticulated water supply or sewerage. Domestic wastewater is treated and reused/disposed on each individual site. There is potential for domestic wastewater to enter the stormwater system via the following routes:

- Treated wastewater is discharged on the majority of sites to subsurface absorption trenches, irrigation fields or similar. It may then seep through the soil into the stormwater system. The Estate has an undulating topography with soils consisting of a layer of windblown sand overlying a dense clay subsoil. The low permeability of the subsoil can result in a shallow perched watertable. The sand depth varies across the Estate generally in correlation with topography. House construction to date has prioritised the areas with higher elevation and therefore a deeper sand layer.
- Average lot size in the Peninsula Views Estate is relatively small, resulting in limited space for reuse/disposal of wastewater flows. The onsite disposal fields may become overloaded in wet weather or in peak population times.
- Direct discharge of greywater. Older dwellings (pre-1980s) may have split systems, where the blackwater (toilet waste) goes to a septic tank and the greywater (shower, laundry and kitchen wastewater) is discharged directly to subsurface absorption trenches or offsite.
- Direct discharge of secondary treated wastewater. Advice from South Gippsland Shire is that there are three sites with offsite discharge permits. These sites have advanced secondary wastewater treatment systems to ensure the wastewater discharged is of high quality.

However, the risk of stormwater becoming contaminated by domestic wastewater is reduced by:

- Most of the houses are used as holiday homes and therefore only occupied intermittently.
- The use of rainwater tanks is known to result in lower volumes of water use and therefore wastewater production, by comparison to towns with reticulated water supply.[1]
- The houses that have been constructed in recent years have installed secondary treatment systems to increase the quality of wastewater reused or disposed onsite. The EPA and South Gippsland Shire have become more stringent in their requirements for domestic wastewater – for Victoria in general and for the Estate specifically.
- The sandy topsoils provide natural filtration of wastewater prior to potential entry to the drainage collection system. As such they act as another barrier to contaminants entering the retarding basin.

[1] EPA 2016, *Code of Practice – onsite wastewater management*, Publication 891.4

2.2 RETARDING BASIN ENVIRONMENT

The purpose of a stormwater retention basin is to provide a collection point for rainwater that has been shed from a nominated area.

This retarding basin is fenced to stock and the public, with access being through a locked gate to the side of the Walkerville CFA shed.

Whilst onsite, the wildlife encountered included ducks, waterfowl, parrots, snakes and insects. There was no unpleasant odour detected.

Figure 2-1 shows a photo of the basin in November 2017. At the time of this site visit there was extensive weed and grass growth on the Council land surrounding the basin and reed growth particularly in the north-west and south-east corners of the basin itself. The water level in the basin was relatively high.

Figure 2-1: Walkerville stormwater retarding basin – 10 November 2017

Stormwater collected in the Walkerville basin has no treatment prior to entering the basin. However, the lagoon environment itself may provide a level of treatment through:

- Biological consumption of nutrients
- Ultraviolet disinfection by sunlight.

Bird life in particular can contribute pathogens. However, it is understood that these pathogens pose less risk to human and livestock health than pathogens sourced from humans or livestock, as discussed in Section 4.3.

3 Assessment Method

3.1 OBJECTIVES

RMCG has been requested to:

- Design and implement an appropriate sampling program (including methodology, extent and parameters analysed) to understand the quality and volume of silt in the Basin as well as the quality of the water.
- Provide a report advising on the results of the sampling, and our opinion as to:
  - The existence of any levels of pollution or contamination or "toxicity" existing within the silt or the water.
  - The prospect of that pollution or contamination or "toxicity" making its way to the Ansevata site; impacting on stock; and/or impacting on crops.

3.2 RISK ASSESSMENT OF POTENTIAL CONTAMINANTS

A risk-based approach has been taken to the sampling, testing and analysis for this project. We consider the retention basin as part of a system and consider the factors that could lead to contamination occurring in this basin.

Along with the sampling and testing data, information was gathered during a site visit, assessment of Shire database information and a review of mapping information (e.g. topography, lot size, soil/geology mapping). Potential inputs to the retarding basin were considered to understand likely contaminants in the water and sediment. Aspects investigated include drain condition and connectivity, evidence of greywater or septic discharge, and condition of fencing to prevent stock access.

No information has been provided as to the 'toxic' nature of the sediment or water. Professional judgement has been used to determine what testing would be most appropriate to identify components in the sediment or water that could make it unfit for purpose.

Based on the information gathered, a risk-based approach has been used to determine the likelihood that identified contaminants could cause adverse impacts (consequences) on livestock, crop or soil health, when water in the basin is used for irrigation or livestock drinking.

3.3 ASSESSMENT OF RELEVANT GUIDELINES

Industry guidelines have been used to develop the sampling and testing program, and as part of the water and sediment quality assessment. These guidelines include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3, Primary Industries*, 2000 (referred to in this document as the ANZECC Water Quality Guidelines)
- *Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines*, 2013
- EPA Publication 1192 *Tracing faecal contamination in urban drains – toolkit*, 2007
- EPA Publication 891.4 *Code of Practice – onsite wastewater management*, 2016
- EPA Publication IWRG701, *A guide to sampling and analysis of waters, wastewaters, soils and wastes*, 2009.

3.4 SEDIMENT AND WATER SAMPLING

The extent of the sampling was limited by the timeframe available – approximately three weeks. As such, single event sampling was undertaken. Historic sampling has been used to assist with identifying trends – although there are limited parameters that have been tested on multiple occasions.

Grab samples of water and sediment at both the basin inlet and pump-out point were obtained and sent to a NATA accredited laboratory (ALS Scoresby).

Water sampling was conducted using a boom sampler to recover 'grab' samples near the surface, and from bank-edge accessible locations. No 'on water' sampling was considered necessary for this initial screen sampling. Samples were collected by geotechnical engineering firm Tonkin and Taylor.

Sediment samples were collected using a hand-operated piston sampler. Samples were collected at approximately 2 m from the edge, towards the centre of the water body. The piston sampler was advanced to 0.25 m below sediment surface using extension rods.

Samples were transported to the laboratory, under chain of custody documentation.

Decontamination procedures were completed in accordance with AS4482.1-2005 in order to minimise cross-contamination of samples from sampling equipment and comprised removal of sediment adhering to sampling equipment followed by washing.

Results have been compared to historical sampling and testing data provided by the South Gippsland Shire. Data is available from four monitoring sites at the basin, as shown on the map below. Water quality has been tested at various times at all four locations. Sediment quality has been tested at SP2, SP3 and SP4.

Figure 3-1: Basin sampling locations

The water and sediment samples have been tested for a range of parameters including microbial pathogens, nutrients, salinity and heavy metals. Details are provided in Sections 4 and 5.

As there has been no identification as to the specific 'toxic' nature of the sediment, the sampling and testing proposed can be considered an initial screen to determine if there are any general indicators of contaminants in the sediment that could cause harm to stock or irrigated land/crops. The sampling and testing set has been used to determine if further detailed analysis is warranted.

Sampling of stormwater in the drains was not undertaken. This can only be conducted during a rain event and the water quality during an event is likely to have high variability (e.g. first flush will be of different quality to sustained flow). Multiple events would need to be sampled to provide statistically relevant data.

Sampling and testing of drain water quality was undertaken by the South Gippsland Shire following rainfall in September 2017. This has been considered, but given it relates to only one rainfall event, it is difficult to draw meaningful conclusions.

4 Water Quality Analysis

4.1 LIVESTOCK DRINKING GUIDELINES

The quality of the water in the retention basin has been assessed based on criteria outlined in the ANZECC Water Quality Guidelines. Key parameters for livestock are summarised in Table 4-1.

Note that these guidelines are trigger values. Below the trigger value there is minimal risk of adverse effects on animal health. Above the trigger value, investigations are recommended (e.g. of other factors such as age, condition, other dietary sources) to further evaluate the situation. Exceeding a trigger value therefore does not necessarily mean impact to stock health.

Table 4-1: ANZECC Water Quality Guidelines for livestock and measured values

PARAMETER	UNIT	STOCK WATERING GUIDELINE VALUE	MEASURED AT SP2 (INLET) 10/11/17	MEASURED AT SP4 (CURRENT PUMP-OUT) 10/11/17
Cyanobacteria (blue-green algae)	Microcystis cells/ml	11,500	No algae present	No algae present
	Microcystin-LR toxicity equivalents µg/l	2.3		
Microbial pathogens[2]	Thermotolerant coliforms/100 ml	100	100 *(E. coli)*	35 *(E. coli)*
Total dissolved solids	mg/l	4,000 (2,400 for dairy cattle)	310	320
Sulfate	mg/l	1,000	<20	<20
Aluminium	mg/l	5	0.56	0.61
Fluoride	mg/l	2	0.07	0.06
Calcium	mg/l	1,000	9.1	9.2
Arsenic	mg/l	0.5	0.002	0.002
Boron	mg/l	5	0.04	0.04
Cadmium	mg/l	0.01	<0.0002	<0.0002
Chromium	mg/l	1	0.002	0.002
Cobalt	mg/l	1	<0.001	<0.001
Copper	mg/l	0.5 (sheep) 1 (cattle)	0.002	0.002
Lead	mg/l	0.1	<0.001	<0.001
Mercury	mg/l	0.002	<0.0001	<0.0001
Molybdenum	mg/l	0.15	<0.001	<0.001

[2] The Guidelines consider thermotolerant coliforms (also known as faecal coliforms), while the sampling program has measured *E. coli* (or *Escherichia coli). E. coli* is the most common thermotolerant coliform present in faeces (typically >90%) and studies suggest it is a more reliable indicator of faecal contamination. For practical purposes, they can be used interchangeably.

PARAMETER	UNIT	STOCK WATERING GUIDELINE VALUE	MEASURED AT SP2 (INLET) 10/11/17	MEASURED AT SP4 (CURRENT PUMP-OUT) 10/11/17
Nickel	mg/l	1	0.003	0.003
Zinc	mg/l	20	0.026	0.025
Selenium	mg/l	0.02	<0.001	<0.001
Uranium	mg/l	0.2	Not tested	Not tested
Nitrite (as N)	mg/l	30	<0.01	<0.01
Nitrate (as N)	mg/l	400	0.15	0.26

Laboratory analysis was not required for cyanobacteria (blue-green algae). Algae generally proliferate during summer, and were not present at the sample collection time. Anecdotal evidence suggests there has been no history of algal blooms at the basin (Tim Brown and John Lambert, South Gippsland Shire, pers. comm., 10/11/17). Blooms typically occur on warm days with light to calm winds (summer to autumn) in waters of neutral to alkaline pH containing elevated levels of inorganic phosphorus and nitrogen.[3] Therefore, the level of nutrients in the water can be used to indicate whether algal growth is likely to occur during the summer.

Uranium was not tested. It is not considered a parameter of concern. It can result from mineral processing – which does not occur in the area – or it can occur naturally, particularly in groundwater, which is not used for water supply in Walkerville.

All results were well below the guideline values, with the exception of one sample that indicated *E. coli* at the guideline value. In the past *E. coli* has exceeded the trigger value of 100 orgs/100 ml. As such, a more detailed assessment of microbial pathogens has been undertaken and is discussed below in Section 4.3.

4.2 IRRIGATION GUIDELINES

In Table 4-2, sampling results are compared to the ANZECC Water Quality Guideline trigger values for irrigation.

For most parameters, the guideline values are the long-term trigger values (LTV). For short term irrigation (<20 years) higher guideline limits (STV) apply for some parameters (for example, the STV for aluminium is 20 mg/l, compared to the LTV listed below of 5 mg/l).

[3] ANZECC & ARMCANZ, 2000

Table 4-2: ANZECC Water Quality Guidelines for irrigation and measured values

PARAMETER	UNIT	IRRIGATION GUIDELINE VALUE	MEASURED AT SP2 (INLET) 10/11/17	MEASURED AT SP4 (CURRENT PUMP-OUT) 10/11/17
Microbial pathogens[4]	Thermotolerant coliforms/100 ml	1,000	100 *(E. coli)*	35 *(E. coli)*
pH		6 – 9	7.2	7.1
Salinity - Electrical Conductivity (EC)[5]	µS/cm	<650 very low	460	460
Aluminium	mg/l	5	0.56	0.61
Arsenic	mg/l	0.1	0.002	0.002
Beryllium	mg/l	0.1	<0.001	<0.001
Boron	mg/l	0.5	0.04	0.04
Cadmium	mg/l	0.01	<0.0002	<0.0002
Chromium (VI)	mg/l	0.1 (VI)	0.002 (total)	0.002 (total)
Cobalt	mg/l	0.05	<0.001	<0.001
Copper	mg/l	0.2	0.002	0.002
Fluoride	mg/l	1.0	0.07	0.06
Iron	mg/l	0.2	2.8	3.2
Lead	mg/l	2.0	<0.001	<0.001
Lithium	mg/l	2.5	Not tested	Not tested
Manganese	mg/l	0.2	0.028	0.031
Mercury	mg/l	0.002	<0.0001	<0.0001
Molybdenum	mg/l	0.01	<0.001	<0.001
Nickel	mg/l	0.2	0.003	0.003
Selenium	mg/l	0.02	<0.001	<0.001
Uranium	mg/l	0.01	Not tested	Not tested
Vanadium	mg/l	0.1	0.001	0.002
Zinc	mg/l	2.0	0.026	0.025
Nitrogen	mg/l	5.0	1.5	1.6
Phosphorus	mg/l	0.05	0.14	0.12

The majority of parameters are well below the guideline trigger values for irrigation. The exceptions are:

- Iron exceeds the LTV, but is below the STV of 10 mg/l. Iron can cause problems when it precipitates on irrigation equipment causing clogging of trickle or dripper irrigation systems. It is not an issue with other forms of irrigation. Iron does not pose a risk to soil health (most soils are naturally rich in iron), and the

[4] The trigger value of 1,000 coliforms/100ml applies to: raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); human food crops sold to consumers cooked or processed; pasture and fodder for grazing animals (except pigs and dairy animals); non-food crops (silviculture, turf, cotton etc.). Where grazing of dairy cattle is to occur, a five-day withholding period is required following irrigation.

[5] The trigger value given for EC is the lowest water salinity rating and suitable for sensitive crops. Higher irrigation water salinity can be used subject to crop grown, soil characteristics, climate and so on.

STV has been set so that continual irrigation of plants will not expose them to phytotoxic concentrations of iron.

- The LTV for phosphorus is again focussed on bioclogging of equipment. It has been set low enough to restrict algal growth, assuming all other conditions for algal growth are adequate (e.g. sunny, warm and calm conditions and other nutrients also elevated). The STV for phosphorus is a range of 0.8 to 12 mg/l, and the water samples have concentrations well below this. Phosphorus is not expected to build up in soils irrigated with the stormwater to levels where risk to the downstream environment is of concern. Additional phosphorus fertiliser would be required to meet nutrition needs for the crops irrigated.

Lithium and uranium were not tested and are not considered parameters of concern. Higher lithium concentrations tend to be found in association with hot springs in arid hydrogeological conditions. Potential sources of uranium are discussed in Section 4.1 above.

4.3 FURTHER ANALYSIS OF MICROBIAL PATHOGENS

MONITORING TRENDS

Monitoring results for *E. coli* are available since 2012. Results are graphed in Figure 4-1.

The ANZECC Water Quality Guidelines recommend that a median value of thermotolerant coliforms be used. A median value is based on a number of readings generated over a 12-month period from a regular monitoring program. The Guidelines state that investigations of likely causes are warranted when 20% of results exceed four times the median guideline level (400 orgs/100 ml *E. coli*.) in a 12-month period.

Prior to 2016, the sampling results indicated that *E. coli* levels did not exceed the guideline trigger. The median annual level remained below 100 orgs/100 ml *E. coli.*

In 2016, >20% of results exceeded 400 orgs/100 ml *E. coli* for Sampling Point 1. The rolling annual median for Sampling Point 1 also exceeded the guideline limit of 100 orgs/100 ml *E. coli* from May 2016 until early 2017 when regular monitoring at this point ceased.

In 2017, relatively regular monitoring was undertaken at Sampling Point 3. The median result during that calendar year was 63 orgs/100 ml *E. coli.*

Further investigations have been undertaken given the sampling results for 2016. All other years have been below the guideline limits.

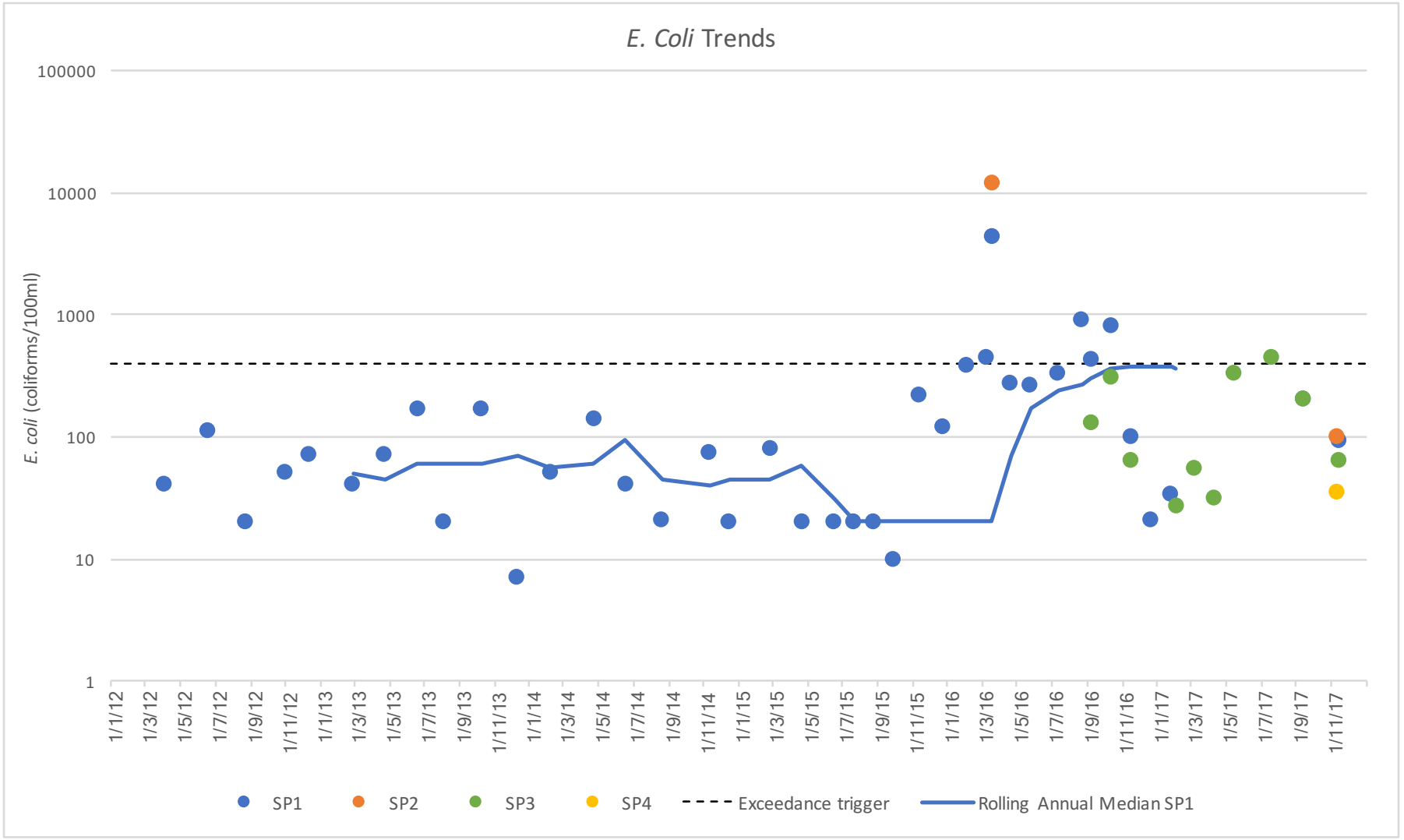

Figure 4-1: Monitoring results for *E. coli*

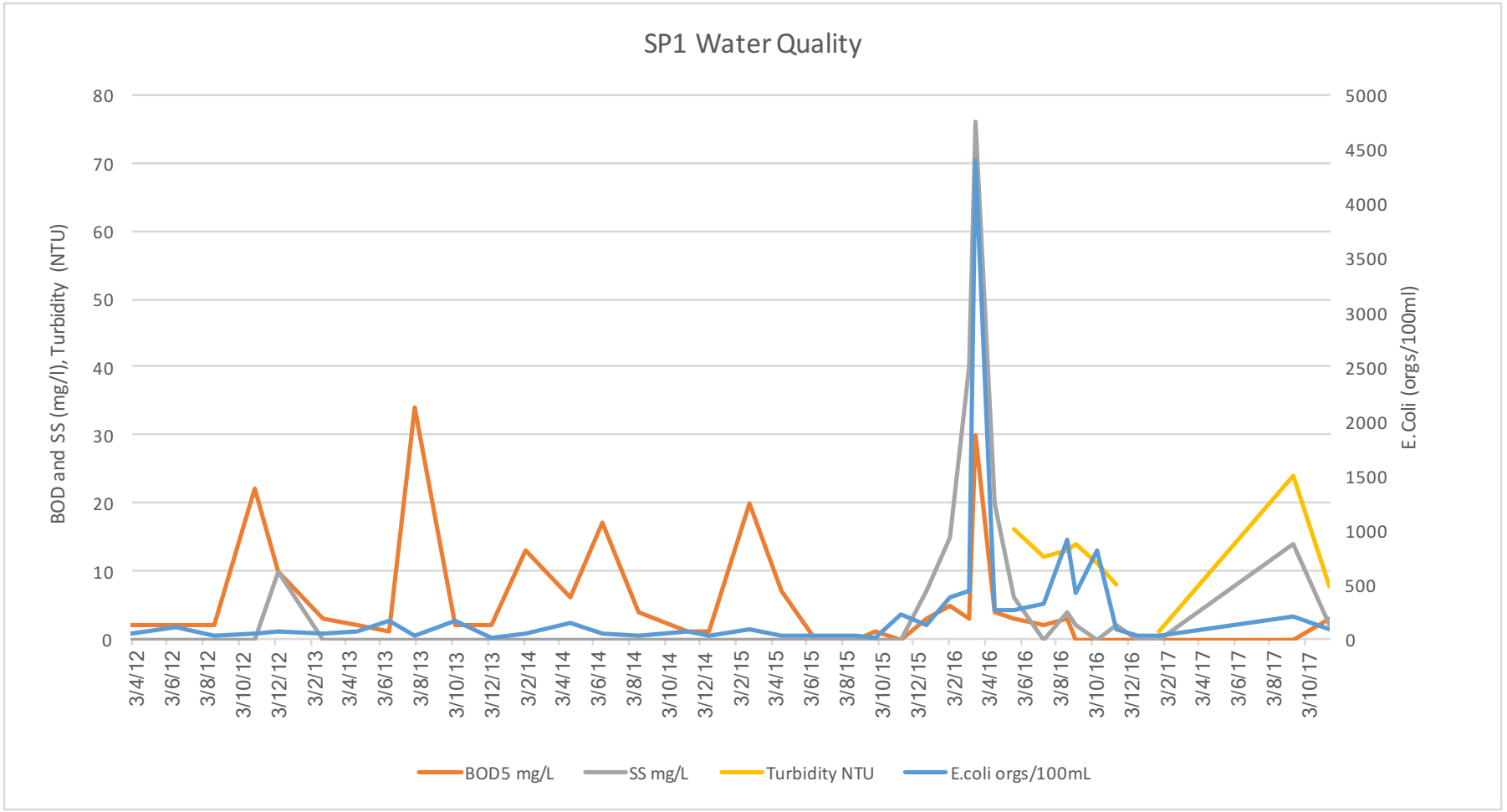

Figure 4-2: Comparison of Monitoring Parameters at SP1

COMPARISON WITH OTHER PARAMETERS

For Sampling Point 1, which has the most data available, comparison has been made between *E. coli* and other available monitoring data (including turbidity, pH, biological oxygen demand (BOD) and suspended solids (SS)), refer to Figure 4-2.

There is no clear correlation between *E. coli* results and the other parameters, with the exception of a corresponding spike in BOD, SS and *E. coli* in March 2016.

South Gippsland Shire noted that there may be a correlation between water depth and water quality (Tim Brown and John Lambert, South Gippsland Shire, pers. comm., 10/11/17). Depth in the basin is not recorded at the time of sampling. However, photos are generally taken of the basin, so approximate depth can be inferred from these. When the basin water level is very low, the sediment is more likely to be mobilised into the water column through wind and wave action. This would increase turbidity and suspended solids levels as shown in the following photo – the water is looking "muddy". However, the correlation with *E. coli* is less clear. It is recommended that water levels are monitored when *E. coli* is sampled in future – refer to Section 8 for further details.

Figure 4-3: Walkerville stormwater retarding basin – 2 March 2016

MICROBIAL SOURCE TRACKING

It is noted that the Livestock Drinking Guideline value for microbial pathogens is 100 thermotolerant coliforms/100 ml. Previous testing indicates that the basin water can exceed this value on occasion.

Thermotolerant coliforms (and/or *E. coli*) are used as an indicator organism. Indicator organisms are used to verify water quality, as monitoring for specific bacterial pathogens is complex, expensive and time consuming. *E. coli* is an indicator of faecal contamination, but does not specifically indicate that pathogens are present.

Faecal contamination can originate from several sources. However, pathogens only originate from a subset of these. Also, faecal contamination may be sourced from multiple hosts, but human-infective (or stock-infective) pathogens are commonly found in only a subset of these.[6]

Sources of human faecal contamination pose a greater risk to public health than non-human sources.[7] Where the faecal source is human – i.e. sewage – the fraction of human infectious pathogenic strains is 1.0. Whereas the fraction is much lower for non-human sources. Cross-species transmission is influenced by genetic distance between different species, geographical range, and other interaction barriers.

The fraction of human infectious pathogenic strains in seagull faeces has been roughly estimated at 0.2. Noting, however, that this will be site specific and related to factors such as feeding patterns of the seagulls.[8] Based on this, combined with other factors such as persistence of different pathogens in the environment, the median illness risk associated with human sewage is approximately two orders of magnitude higher than that associated with seagulls.[9]

Similarly, the risk of transmittal to livestock is greatest in surface waters which are directly accessible by stock or which receive runoff or drainage from intensive livestock operations or human wastes.[10]

As such, microbiological source tracking (MST) has been conducted to determine the likelihood that the thermotolerant coliforms in the water are from human or animal sources. The basic assumption of microbial source tracking is that there are characteristics unique to the faecal bacteria from a particular host. Most of these target key genes can be “fingerprinted” or tied to a type of mammal, human or bird.

Test parameters and results are outlined in Table 4-3.

6 World Health Organization, 2016
7 EPA Victoria, 2007
8 Schoen ME, Ashbolt NJ, 2010
9 World Health Organization, 2016
10 ANZECC & ARMCANZ, 2000

Table 4-3: Microbial Source Tracking Test Parameters

TEST PARAMETER	SP2 (INLET) 10/11/17	SP4 (CURRENT PUMP-OUT) 10/11/17	SP2 (INLET) 18/3/16
Colilert (2000) - *E. coli* MPN Colilert orgs/100 ml	100	35	12000
Enterolert - Enterococci MPN Enterolert orgs/100 ml	52	6	-
Bacteroidales - Bacteroidales PCR	Detected	Detected	Not detected
Bacteroidales - Human Bacteroides QPCR copies/L	Not detected	Not detected	Not detected
Bacteroidales - Animal Bacteroides QPCR copies/L	33,000	280,000	Not detected
MST-1 - Total Weighted Risk	0.25	0.25	-
MST-1 - Risk Ranking	Medium	Medium	-
MST-2 - Human Bacteroides Marker Abundance	Low	Low	Low
MST-2 - Animal Bacteroides Marker Abundance	Medium	Medium	Low

The key risk identified for stormwater at Walkerville is the potential for domestic wastewater contamination. As such the presence of human faecal bacteria is the focus. The testing did not detect any human bacteroides and the marker abundance was considered Low.

Secure fencing is in place around the retarding basin. Therefore, the animal bacteroides identified are unlikely to be from livestock. The source is expected to be the birdlife on the basin. This poses a lower risk to livestock or human health than inputs from stock or humans respectively.

5 Sediment Quality Analysis

Sediments can be both a source and a sink for contaminants. They influence surface water quality, and can potentially impact the aquatic food chain through benthic biota (organisms that live on the surface of the sediment and in some subsurface layers). If the sediment is removed from the basin in future, it could also impact land where it is reused or disposed.

The sediment guideline values have been set to protect ecological values and they take a precautionary approach. Exceedance of a guideline value does not necessarily mean the sediment is toxic. Exceedance is a trigger for further investigation.

Sediment sampling was undertaken by South Gippsland Shire on 18 April 2017 at SP3 near the basin outlet (or overflow point). A further two samples were taken on 10 November 2017 at SP2 (the stormwater inlet) and SP4 (the current pump-out point). Results are compared to guideline values in the table below.

Table 5-1: Sediment Quality Guideline Values

PARAMETER	UNIT	GUIDELINE VALUE	MEASURED AT SP3 (OUTLET) 18/4/17	MEASURED AT SP2 (INLET) 10/11/17[11]	MEASURED AT SP4 (CURRENT PUMP-OUT) 10/11/17
Antimony	mg/kg	2.0	Not tested	Not tested	Not tested
Cadmium	mg/kg	1.5	<0.2	<0.2	<0.2
Chromium[12]	mg/kg	80	<1.0	<1.0	<1.0
Copper	mg/kg	65	7	24	8
Lead	mg/kg	50	11	13	13
Mercury	mg/kg	0.15	<0.05	<0.05	<0.05
Nickel	mg/kg	21	7	30	9
Silver	mg/kg	1.0	<5	<5	<5
Zinc	mg/kg	200	36	190	25
Arsenic	mg/kg	20	<5	8	<5
Tributyltin	µg/kg	9.0	Not tested	Not tested	Not tested
Total PAHs	µg/kg	10,000	<0.1	<0.4	<0.1
Total DDT	µg/kg	1.2	<0.05	<0.2	<0.05
DDE	µg/kg	1.4	<0.05	<0.2	<0.05
DDD	µg/kg	3.5	<0.05	<0.2	<0.05
Chlordane	µg/kg	4.5	<0.05	<0.2	<0.05
Dieldrin	µg/kg	2.8	<0.05	<0.2	<0.05
Endrin	µg/kg	2.7	<0.05	<0.2	<0.05
Lindane	µg/kg	0.9	<0.05	<0.2	<0.05

[11] The SP2 sample was relatively moist (60% moisture content) and as a result the limit of reporting for many parameters was higher than for the other sample.

[12] Sampling results are for total hexavalent chromium, rather than total chromium.

PARAMETER	UNIT	GUIDELINE VALUE	MEASURED AT SP3 (OUTLET) 18/4/17	MEASURED AT SP2 (INLET) 10/11/17[11]	MEASURED AT SP4 (CURRENT PUMP-OUT) 10/11/17
Total PCBs	µg/kg	34	<0.1	<0.4	<0.1
TPHs (total petroleum hydrocarbons)	mg/kg	280	<140	<630	<140

The results show that all analytes tested are lower than the sediment guideline values, with the following exceptions:

- Silver results are inconclusive. Silver was analysed at a limit of reporting higher than the guideline value. The actual laboratory results for the samples were 0.03 mg/kg (Brad Snibson, ALS, pers. comm., November 24, 2017) but the confidence interval for the testing method means they can only report to 5 mg/kg. Water quality results indicate very low levels of silver <0.001 mg/l. It is not noted as a heavy metal of particular risk to livestock health or irrigation water use – there is no ANZECC guideline value for silver. There is unlikely to be toxic levels of silver in the sediment. Sources of silver are generally ore processing, photography, dentistry and electronics.
- The guideline trigger value for nickel was exceeded for one sediment sample. However, this sample was still below the SQG-High value for nickel which is 52 mg/kg. Above this level there would be a high probability of effects. Nickel levels in the water samples are well below the ANZECC guidelines for livestock drinking and irrigation use.
- The result for total petroleum hydrocarbons (TPHs) was inconclusive for one sample. This sediment sample had a relatively high moisture level resulting in the limit of reporting being higher than the guideline limit. This is due to insufficient sediment being available for testing, rather than an indication of the presence of TPHs.

Antimony was not tested in any of the sediment samples and is not considered a parameter of concern. As antimony is naturally occurring in the environment, people are exposed to relatively small amounts every day in air, food and water. Sources of antimony at toxic levels result from mining or processing of its ores and in the production of antimony metal and alloys. Neither occurs in proximity to Walkerville.

6 Risk Assessment

A risk assessment provides an evaluation of the potential risks posed by the stormwater or sediment in the basin to stock and crop health. The risk assessment is provided in Table 6-1. Any assumptions, uncertainties or unknown information has been noted in the table comments.

This is a qualitative estimation of risk. Likelihood and consequence measures are combined to estimate risk as per the process outlined in Appendix 1.

Table 6-1: Risk assessment

	POTENTIAL CONTAMINANTS	LIKELIHOOD	CONSEQUENCE	RISK ASSESSED	COMMENT
Water Quality	Pathogens and parasites – human origin	Unlikely There is a possibility from domestic wastewater – particularly given small lot sizes. However there are multiple treatment barriers between houses and Ansevata – including the basin itself.	Minor May cause minor stock illness, but no evidence of this occurring to date.	Low	*E. coli* has exceeded the guideline trigger value on occasion. However, microbial source tracking indicates there is a low risk this is due to human bacteroides.
	Pathogens and parasites – animal origin	Almost certain (birds)	Insignificant Lower range of infective pathogens than from humans or livestock.	Low	The *E. coli* levels in the retarding basin are most likely a result of inputs from birdlife. This poses a lower risk to livestock or human health than inputs from stock or humans.
		Rare (livestock) Due to fencing.	Minor May cause minor stock illness, but no evidence of this occurring to date.	Low	
	Nutrients	Unlikely From domestic wastes, garden fertilisers, plant material. Multiple treatment barriers between houses and Ansevata – including the basin itself.	Minor Beneficial to crops. Excess levels can lead to algal blooms.	Low	Low levels measured in basin. Fertiliser likely to be required at reuse site to ensure adequate crop growth.

	POTENTIAL CONTAMINANTS	LIKELIHOOD	CONSEQUENCE	RISK ASSESSED	COMMENT
Water Quality	Salts	Unlikely Shallow groundwater. Detergents.	Insignificant High rainfall and sandy topsoils will ensure salt does not accumulate in root zone.	Low	Very low levels measured in basin.
	Metals	Rare No industry or mining in stormwater catchment. Possibly trace amounts e.g. lead and zinc from roads; copper from domestic pipes.	Minor/Moderate Varies depending on metal in question.	Low	Sampling results indicate metals at very low levels.
	Blue-green algae (cyanobacteria)	Rare No history of algal blooms at site. Not all algal blooms are toxic.	Moderate Direct ingestion by stock can lead to weakness/lethargy and in serious cases respiratory failure.	Low	Refer to 4.1 for further discussion.
Sediment Quality	Metals and metalloids	Rare No industry or mining in stormwater catchment. Possibly trace amounts e.g. lead and zinc from roads; copper from domestic pipes.	Minor/Moderate Varies depending on metal in question.	Low	Sampling results indicate sediment is non-toxic.
	Organic chemicals	Rare Inappropriate disposal of garden chemicals, paint, solvents, petrochemicals.	Minor/Moderate Varies depending on chemical in question.	Low	Sampling results indicate sediment is non-toxic.

7 Conclusions

The risk assessment identified a low risk for all potential contaminants of water and sediment quality.

Our opinion is that the stormwater in the retarding basin is suitable for the purposes of irrigation of pasture and crops, and for livestock drinking.

It is noted that the guideline values have been exceeded on occasion. However, exceedance of a guideline value is a trigger for further investigation, and this further investigation suggests minimal risk for livestock drinking and irrigation.

In particular, sampling in 2016 has indicated *E. coli* at levels above the guideline value for livestock drinking (median 100 orgs/100 ml). Given the basin is fenced, the *E. coli* is not expected to be from livestock. There is a possibility of contamination from domestic wastewater. However, there are multiple treatment barriers between the houses and Ansevata – including the basin itself. Microbial source tracking has been undertaken. This did not detect any human bacteroides in the stormwater basin. It is deduced that the source is birdlife on the basin. This poses a lower risk to livestock or human health than inputs from stock or humans respectively.

A summary of the risk assessment is provided in the following table. This has taken sampling results into account as well as broader information gathered during a site visit, assessment of Shire database information and a review of mapping information (e.g. topography, lot size, soil/geology mapping).

Table 7-1: Summary of risk assessment

	CONTAMINANT	RISK ASSESSMENT
Water quality	Pathogens & parasites – human origin	Low
	Pathogens & parasites – animal origin	Low
	Nutrients	Low
	Salts	Low
	Metals	Low
	Blue-green algae	Low
Sediment quality	Metals and metalloids	Low
	Organic chemicals	Low

8 Recommendations

Given the low risk levels identified, recommendations for ongoing monitoring are minimal.

It is suggested that South Gippsland Shire continues with monitoring of *E. coli*, turbidity, pH, suspended solids and biological oxygen demand. This should be undertaken on regular basis – for example, monthly or bi-monthly. We recommend sampling at SP4 (refer to Figure 3-1) near the current pump out point.

In addition, a water level gauge could be installed at the basin to track depth. This can be used to assess if there is any correlation between depth and *E. coli*. If a correlation is identified, management of water levels could be used to improve the water quality extracted for livestock and irrigation use.

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Appendix 1: Risk Assessment Process

Qualitative Measures of Likelihood

DESCRIPTOR	EXAMPLE DESCRIPTION
Rare	May occur only in exceptional circumstances.
Unlikely	Could occur in unusual circumstances.
Possible	Might occur or should be expected to occur.
Likely	Will probably occur.
Almost certain	Is expected to occur.

Qualitative Measures of Consequence or Impact

DESCRIPTOR	EXAMPLE DESCRIPTION
Insignificant	Insignificant impact or not detectable.
Minor	Livestock Health – Minor impact for small population (stock growth rate slowed for single or small number of animals). Crops Irrigated – Minor impact to crop (small decrease in yield quantity/quality). Produce Quality – Contaminated produce has minor human health impact (minor illness requiring medical treatment, or causing lost work time). Soil Health – Potentially harmful to soils with impacts contained onsite and can be rehabilitated.
Moderate	Livestock Health – Minor impact for large population (growth rate slowed for numerous animals). Crops Irrigated – Moderate impact to crop (large decreased in yield). Produce Quality – Contaminated produce has moderate human health impact (serious illness with hospitalisation, or multiple minor illnesses). Soil Health – Potentially harmful to local soils and potential for off-site impacts.
Major	Livestock Health – Major impact for small population (single or small number of animal deaths). Crops Irrigated / Produce – Total crop failure. Produce Quality – Contaminated produce has major human health impact for small population (life threatening illness).

DESCRIPTOR	EXAMPLE DESCRIPTION
	Soil Health – Potentially lethal to local soil ecosystem; widespread onsite and offsite impacts.
Catastrophic	Livestock Health – Major impact for large population (numerous animal deaths). Produce Quality – Contaminated produce has major human health impact for large population (e.g. death or multiple life-threatening injuries). Soil Health – Offsite impacts potentially lethal to regional ecosystem or threatened species, soils rendered toxic for decades.

Qualitative Risk Assessment

LIKELIHOOD	CONSEQUENCES				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	High	High
Unlikely	Low	Low	Moderate	High	Very high
Possible	Low	Moderate	High	Very high	Very high
Likely	Low	Moderate	High	Very high	Very high
Almost certain	Low	Moderate	High	Very high	Very high

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