Water quality in the Simpson Bay Lagoon

A thesis towards the degree of land-based sewage pollution on the Dutch side of the Simpson Bay Lagoon

The Simpson Bay lagoon as seen from the east. Picture taken by Lester v. Slooten.

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Feb-12-2009

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Preface

We are two students studying Integrated Coastal Zone Management at the Van Hall Larenstein Instituut in Leeuwarden, The Netherlands, an University of Applied Sciences. Integrated Coastal Zone Management is a broad vision management study were you learn about a wide variety of coastal zone management issues and how to solve them in a sustainable, environmentally responsible manner. We are now in our third year of our study, where we have to do an internship for a period of a minimum of 18 weeks. This report is the final product of our internship carried out for EPIC (Environmental Protection In the Caribbean).

We very much enjoyed working on this project and learning about Sint Maarten. The following persons we would like to give special thanks:

Mr. Rueben J. Thompson our supervisor, for providing guidance throughout our research.
Mrs. Ans Schoorlemmer and Mr. Paul van der Heijden our mentors, for their guidance and reviewing our work.
Dr. Kathi Shupe for letting us use of the laboratory of the American University of the Caribbean (the AUC) and for helping and teaching us how to do the lab work.
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Mr. Donald Webster for assisting with the GIS map.
Mrs. Baverly for providing us with information.
Mrs. Natalia Collier for revising our report.
Mr. Paul Mooij and Mrs. Jadira Veen for allowing us to interview them about the environmental challenges the island faces.
Ocean Care for showing us around the lagoon.
Budget Marine for providing us with a dinghy.

Without them we would not have been able to meet our goals and objectives.

February-12-2009

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Summary

In this report an answer is given to the following question:
What is the degree of land-based sewage pollution in the Simpson Bay Lagoon and will it exceed the norms given by the Environmental Protection Agency from the US (EPA) and Werkgroep Milieunormering Nederlandse Antillen (WMNA) and at which locations is sewage contaminated water running into the lagoon?

The sewage system on Sint Maarten and around the lagoon is not properly developed yet. Sewage from buildings around the lagoon usually ends up in septic tanks or cesspits, or is directly being discharged. Due to the increase of human development in the last three decades many buildings have extended and often new buildings have been built without proper sewage management. Therefore untreated or poorly treated sewage is often running into the Simpson Bay Lagoon.

Around the lagoon the major gutters, streams and pipes were located, mapped and tested. The sites were tested at the outlet (land-based) and in the lagoon for sewage contamination on: total coliform, fecal coliform, *enterococci spp*., *Staphylococcus aureus*, salinity, temperature, pH, chlorine, phosphate, ammonia, nitrate and nitrite. Not for all parameters a norm is given by the EPA or WMNA.

Especially fecal coliform, e*nterococci spp.* (and in a lesser degree also phosphate) are good indicators for sewage contamination. Based on these parameters a list of most polluted sites was made; table a and b (in this tables number 1 is most polluted). Fecal coliform and *enterococci spp.* have counted more heavily for these tables.

number	area	site
1	Cole Bay	4b
2	Cole Bay	5
3	Cole Bay	4a
4	Cole Bay	9
5	Cole Bay	2
6	Cole Bay	3
7	Cole Bay	7
8	Airport	4
9	Airport	3
10	Cole Bay	1
11	AUC	auc
12	Simpson Bay	1
13	Cole Bay	6
14	Airport	2
15	Airport	1

Table a; top 15 most polluted land-based areas

number	area	site
1	Cole Bay	5
2	Cole Bay	4a
3	Cole Bay	6/7
4	Cole Bay	3
5	Airport	3/4
6	Cole Bay	4b
7	Cole Bay	1
8	Simpson Bay	1
9	Cole Bay	2
10	Cole Bay	9
11	Airport	2
12	Airport	1
13	Mullet Bay Clean Site	

Table b; top 13 most polluted areas in the lagoon

The degree of sewage pollution is high. Test results proof that nearly all the sites that were found are contaminated with sewage. Only at the Mullet Bay clean site no sewage was found. Every other site has exceeded the norm with at least one parameter. Especially in the Cole Bay area the degree of sewage pollution is very high. The averages of fecal coliform and *enterococci spp.* of the different areas can be found in table c.

(numbers per 100 ml)	fecal coliform. norm 200	*enterococci spp.* norm 35 (only for lagoon)
Average Cole Bay	21242	58270
Average Simpson Bay	458	1775
Average Airport	2767	1213
Average Cole Bay (lagoon)	5492	54379
Average Simpson Bay (lagoon)	775	1550
Average Airport (lagoon)	4938	694
Average Cole Bay (land)	36992	61944
Average Simpson Bay (land)	140	2000
Average Airport (land)	287	1731

Table c; averages fecal coliform and *enterococci spp.*

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1. Introduction

Over the past three decades Sint Maarten has faced a tremendous increase in tourism and residents; the island is becoming more and more economically dependent on tourism. The environment on small islands is more delicate then on the mainland because of the limits to natural resources. Therefore there is less room for growth without causing environmental issues.

1.1 Research area

An estuary is an area where saltwater from the ocean or sea mixes with the freshwater that comes from land. Lagoons are a type of estuary. Other types of estuaries include: coastal plain estuaries, tectonic estuaries and fjords. A lagoon is a shallow water-body which is only connected with the ocean by one or more restricted inlets (the Simpson Bay Lagoon has two inlets, one in Sandy Ground and one in Simpson Bay).

1.2 Simpson Bay Lagoon

The Simpson Bay Lagoon is situated in the South-western part of Sint Maarten and is named after John Simpson who was commander of Sint Maarten in 1667. The Simpson Bay Lagoon is divided in a French part and a Dutch part just like the rest of the island (see figure 1).[1]

Figure 1; map Sint Maarten. (from website 1)

[1] Emile van der Borch, 2002, Impacts of human development in the Simpson Bay Lagoon, Sint Maarten

The Simpson Bay Lagoon serves an important ecological function. Sea grasses and mangroves grow in and around the lagoon. All four of the different types of mangroves that occur in the Antilles, grow around the lagoon; Button wood, white, black and red mangroves.
Mangroves, particularly red mangroves, are the nursery for many reef and pelagic fish. Besides this mangroves function as a buffer for land based pollution, erosion, shoreline protection and are an important habitat for other animals. Sea grass beds are important as feeding and nursery grounds, besides that they also stabilize and filter soil and sediments which contributes to the clarity of the water.[1]

1.3 Principal

EPIC is a non-profit, non-governmental organization working towards the protection and conservation of the environment of the Caribbean. The Caribbean is home to hundreds of species found nowhere else. Each island is a unique world of animals and plants. However, because of increasing urban development and tourism causing disturbances, many of these special places, with their unique wildlife, are threatened. Through scientific research, education and action, EPIC is working towards the conservation of key habitats: 1.Scientific research, like bird habitat research and creating a checklist to St. Maarten's birds. 2.Education, like going to St. Maarten's schools giving presentations about the importance of the environment and organizing nature walks. 3.action, like planting new mangroves and stimulating government to make more sustainable, environmentally friendly decisions.

1.4 Love the Lagoon project

From an environmental perspective the Simpson Bay Lagoon area has experienced difficulties caused by the rapid urbanization due to population growth and the rapid growth of tourism, which started about three decades ago. Construction projects around the lagoon sometimes fill in the lagoon and dump wastewater from toilets, bathrooms, laundry and kitchens (sewage) untreated in the lagoon. Boaters and marinas also have a significant impact on the environment: oil and fuel leakages, the discharge of (untreated) sewage water, vessel maintenance, solid waste, runoff water and vessel operations. In order to address these boat and marina based impacts, EPIC has launched its Love the Lagoon project. This project aims to provide guidance on appropriate environmental practices to the maritime industry, boaters, government and non-governmental organizations. The project desires to build partnerships with the various marinas operating in the lagoon and the yachting community to increase awareness of the ecological importance of the lagoon and to create involvement in correcting water pollution issues and with the Love the Lagoon project EPIC is also working towards establishing the Blue Flag Program for marinas. The Blue Flag is an exclusive, voluntary eco-label which will be awarded to beaches or marinas that meet a specific set of criteria concerning environmental information and education, water quality, safety, services and environmental management. The Blue Flag label is recognized by tourists and tour operators as an international symbol of quality.

[1] website 2

Besides the Blue Flag program the Love the Lagoon project also concentrates on surveys with boaters. With the surveys EPIC investigates how the boaters stand towards the environment, what they do with their wastewaters and how they stand towards using a sewage pump-out system. Therefore a questionnaire is completed and a checklist is handed out. On the checklist are best management practices explained for oil and fuel, sewage, cleaning and maintenance, and anchoring and motoring. However one of the comments that the boaters often give when filling in the questionnaire, is that people often see the boaters as big polluters, while the boaters think that they only have a small share in the pollution in the lagoon and that most pollution is coming from land. This is one of the reasons this project was started: to conduct research on the level of land-based pollution in the lagoon.[1]

1.5 Sewage water pollution

Ever since the summer of 1854, when Dr. John Snow first linked sewage-contaminated water at the Broad Street pump with London's worst cholera epidemic, it is known that discharges of untreated sewage can cause disease and even death.[2]

Sewage carries a dangerous cargo of infectious bacteria, viruses, parasites and toxic industrial chemicals, pharmaceuticals, solids, and debris. Therefore sewage should always be treated before it can be safely returned to the ecosystem. When untreated sewage ends up in recreational and drinking water or in groundwater, it takes a severe toll on human health and the environment. "In the reefs off the Florida Keys, 70 percent of Elkhorn corals have been wiped out by white pox disease, which is caused by human intestinal bacteria."[3]

Coral bleaching, which is the reaction of stressed coral polyps that expel their zooxantheallae which leads to a lighter or completely white appearance, can also occur as a result of sewage pollution. This will eventually kill the corals when there is no decrease of the stressor.[4]

Eutrophication will also occur when large amounts of raw sewage ends up in a lake, sea, pond or lagoon. Raw sewage contains a large amount of nutrients (primarily phosphorus, nitrogen, and carbon). When raw sewage runs off into a natural environment like: lakes, seas, ponds and lagoons it is likely to cause an excessive growth of algae because of the overabundance of nutrients (an algae bloom). Algae blooms disturbs the normal functioning of the ecosystem and cause a variety of problems like for example a lack of oxygen during nights and causing cloudy waters which can cause a high mortality rate of fish and other aquatic life. When adding an excess of nutrients in a non-natural way, like the dumping of sewage, it is likely to disturb the relative concentration of nutrients (the Redfield ratio). This ratio for carbon, nitrogen and phosphorus is; C:N:P=106:16:1. Though the concentration of nitrogen in sewage is often higher, it might be for example 106:40:1. When the concentration of nutrients is out if balance it causes an unbalanced growth of algae. When there is more nitrogen available, more flagellates will grow in comparison to diatoms. Flagellates are more often toxic; especially when the nitrate concentration is high because then some flagellates will start to produce toxins whereas

[1] wehsite 3
[2] website 4
[3] website 5
[4] website 6

before they were non-toxic. This phenomenon causes for example the red tides.[1]

1.6 Problem description

Factors and human activities which take place in and around the Simpson Bay Lagoon mentioned such as land reclamation, sewage and urban run-off, illegal waste disposal, wrecks, boating and marina activities and the dumping of car batteries all contribute to the pollution of the area's surface- and groundwater.

Water pollution in general and in this case the pollution of the Simpson Bay Lagoon can have a wide range of causes and effects. Oil and fuel spills from pleasure yachts and ships have the potential to kill birds, turtles, fish and other forms of marine life. Erosion as a result of land reclamation or the removal of mangroves increases siltation and thereby reduces the oxygen available for marine life. Chemicals and heavy metals which end up in the lagoon can accumulate in the fatty tissues of aquatic animals and may eventually end up being absorbed by people through the consumption of contaminated fish.

Water quality in the Simpson Bay Lagoon has been a major concern for both residents and visitors in recent years. Water quality testing and improvement is therefore an essential part of EPIC's Love the Lagoon project. In partnership with Dr. K. Shupe from the American University of the Caribbean (AUC), EPIC has completed water quality research in the Simpson Bay Lagoon.

The sewage system on Sint Maarten and around the lagoon is not properly developed yet. Sewage water is often not treated before it is discharged into the ecosystem including the Simpson Bay Lagoon. Sewage from buildings around the lagoon usually ends up in septic tanks or cesspits, or is directly being discharged. Due to the increase of human development in the last three decades many buildings have extended and many new buildings have been built without proper sewage management. Therefore many of these septic tanks and cesspits have become too small and are overflowing. The amount of raw sewage being directly discharged has also increased.

This research has been set up to investigate the degree of land-based sewage pollution and to investigate where sewage contaminated water is running into the lagoon and what effect this has on the lagoon. Therefore all the land-based water sources need to be mapped and tested and tests need to be conducted in the lagoon as well.

1.7 Research objective

To investigate the degree of land-based sewage pollution and to investigate where sewage contaminated water is running into the Simpson Bay Lagoon and what effect this has on the lagoon.

1.8 Main research question

What is the degree of land-based sewage pollution in the Simpson Bay Lagoon and will it exceed the norms given by the Environmental Protection Agency from the US (EPA) and

[1] website 7

Werkgroep Milieunormering Nederlandse Antillen (WMNA) and at which locations is sewage contaminated water running into the lagoon?

1.9 Sub research questions

- Which gutters, streams and major pipes (land-based sources) are running off into the lagoon?
- Where are the land-based sources and how are they course inland?
- What are the parameters that indicate presence of sewage water?
- Do the gutters, streams and major pipes contain sewage water and to what degree are they polluted with sewage?
- What is the degree of sewage pollution in the lagoon near the land-based sources?

1.10 Reading guide

In chapter 2 is explained which parameters were measured, why they were measured and how they were measured.

In chapter 3 is explained where and how the samples were taken.

In chapter 4 is shown what the norms on the Dutch Antilles are.

In chapter 5 the results of the water testing are presented and analyzed.

In the Conclusion an answer is given to the main research question.

In the Discussion the results and methods of this research are discussed.

2. Parameters and Methodology

2.1 bacterial parameters

Members of the two bacteria groups, coliforms and fecal streptococci, are used as indicators of possible sewage contamination because they are commonly found in human and animal faeces. Although they are generally not harmful themselves, they indicate the possible presence of disease-causing (pathogenic) bacteria and viruses that also live in human and animal digestive systems and occur in faeces. Therefore, their presence in streams suggests that disease-causing microorganisms might also be present. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for coliforms and fecal streptococci instead.[1]

2.1.1 Total coliform

The term total coliform refers to all the bacteria in the coliform group. They originate in the intestinal tract of warm-blooded animals and can be found in their wastes. All species in this group occur in human faeces. Unfortunately some coliform species also naturally occur in the environment, on soil and vegetation for example. This is why total coliform is not a good indicator of sewage pollution and there is no standard (norm) for total coliform for the water in the lagoon (total coliform is still a good indicator for drinking water). By counting the total coliforms and the fecal coliforms it is possible to see how many of the total coliforms are fecal coliforms.[1,2]

Method of testing:

The technique that was used for the total coliform group is the multiple-tube fermentation technique. It is a standard total coliform most probable number test. The results of the tests are reported in terms of the most probable number (MPN). This term is an estimate, based on certain probability formulas. In Appendix I is a table where the MPN can be found at different results. Next to the MPN are a lower and a higher rate visible, which is an estimate with a confidence of 95%.

For the multiple-tube fermentation technique fifteen tubes per test are necessary. The fifteen tubes were split up into three sets of five tubes. The first five tubes contain 10ml double strength of Phenol red Lactose broth (PrLb), the second five tubes contain 9 ml single strength PrLb and the final five tubes contain 9.9ml double strength PrLb.

In the first five tubes (the five tubes with the 10 ml double strength PrLb) 10 ml of sampled water was added. In the second five tubes (the five tubes with 9ml single strength PrLb) 1 ml of sampled water was added. In the last five tubes (the 5 tubes with 9.9ml double strength PrLb) 0.1ml sampled water was added.

Thus the concentration in the first 5 tubes was 1:1. The concentration in the second 5 tubes was thus 1:10 and the concentration in the last five tubes was thus 1:100.

[1] website 8
[2] website 9

A small tube (a Durham tube) was added to all 15 tubes to capture gas. The total coliform group ferments lactose and produces gas after 48hr at 37ºC. Thus after 48 hours in an incubator at 37ºC it can be determined whether or not the water from the water samples contains coliform bacteria. If the red water has turned yellow (fermentation of lactose) and there has been a production of gas in the Durham tube, there is a presence of coliform (see figure 2).

Figure 2; positive reaction: yellow + gas

The tubes with a positive reaction were then counted. With this number the MPN could be looked up on the table as can be seen in Appendix 1.For example: if in the first five tubes (the five tubes with the 10 ml double strength PrLb) all five had a positive reaction, then the first number is a 5. If in the second five tubes (the five tubes with 9ml single strength PrLb) three had a positive reaction, then the second number is 3. If in the last five tubes (the 5 tubes with 9.9ml double strength PrLb) none had a positive reaction then the last number is a 0. The result would then be 5-3-0. In the table (see Appendix I) the most probable number would then be 79 coliform bacteria per 100ml. And there is a 95% confidence that the amount of coliform bacteria is between 25 and 190 bacteria. See table 1.

15 tubes per site.	5 tubes with: 10 ml PrLb, double strength and a Durham tube.	10ml of water sample (1:1)	48 hours in the incubator at a temperature of 37ºC.	Count how many tubes positive reaction. (turned yellow + gas)	Read from the table (see Appendix I) what the most probable number of total coliform bacteria is.
	5 tubes with: 9 ml PrLb, single strength and a Durham tube.	1ml of water sample (1:10)		Count how many tubes positive reaction. (turned yellow + gas)	
	5 tubes with: 9.9ml PrLb, double strength and a Durham tube.	0.1ml of water sample (1:100)		Count how many tubes positive reaction. (turned yellow + gas)	

Table 1; scheme for analyzing total coliform (from: American Public Health Association, 1980, Standard Methods (For examination of water and wastewater), APHA, 15th edition, Washington)

Because the locations were so contaminated the tests could be analyzed after 24 hours instead of 48 hours. After 48 hours there where so many coliform bacteria that they started to consume each other. Some of the tubes that already had completely turned yellow started to turn red again because the amount of bacteria was decreasing as they consumed each other.[1]

Figure 3; positive reaction (yellow), negative reaction (red).

2.1.2 Fecal coliform

Fecal coliform is a group within the total coliform group. Fecal coliform used to be the group of bacteria which was recommended by EPA (the American Environmental Protection Agency) as an indicator for sewage. Unfortunately fecal coliform includes species that are not necessary fecal in origin. This is why EPA started to recommend E-coli (a fecal coliform species but more specifically from humans) and enterococci as better indicators for health risk from water contact. However, fecal coliform is still the parameter in many countries and states. Because the Dutch Antilles will likely use the fecal coliform group as a standard parameter (see tables 3 &4 chapter 4), it was analyzed as well. By testing for fecal coliform, it is possible to see if levels will exceed the norms outlined in the report: " lucht & geluid, water & afvalwater, afval", produced by Werkgroep Milieunormering Nederlandse Antillen, June 11, 2007, with the norms for water quality in the Netherlands Antilles. The standards in this report are not enforced as legislation yet.[2]

Method of testing:

When this project was started fecal coliform was tested as following: 25ml of each water sample was filtered through a filter (it looks like a piece of paper) of 0.45µm. After one water sample is filtered, the filter was put on a medium of Eosin Methylene Blue (EMB) in a petri-dish and preserved at a temperature of 45ºC. After 18 to 24 hours the petri-dish can be analyzed; the filter is divided in little squares which makes it easier to count the amount of fecal coliform colonies that are on the filter. The fecal coliform colonies look metallic green and often have a little circle in them, see figure 4. Duplicates were always taken for a higher significance.

Unfortunately many samples were not useful when 25 ml of water was filtered per plate. Too many colonies were growing on top of each other, which made it impossible to count them, see figure 5. Therefore the samples were diluted to 1:2 and later to 1:5.

[1] From: American Public Health Association, 1980, Standard Methods (For examination of water and wastewater), APHA, 15th edition, Washington

[2] website 8

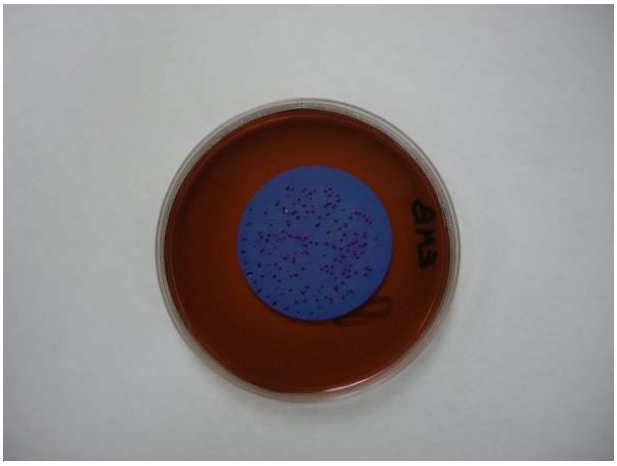


Figure 4; EMB (with filter) countible

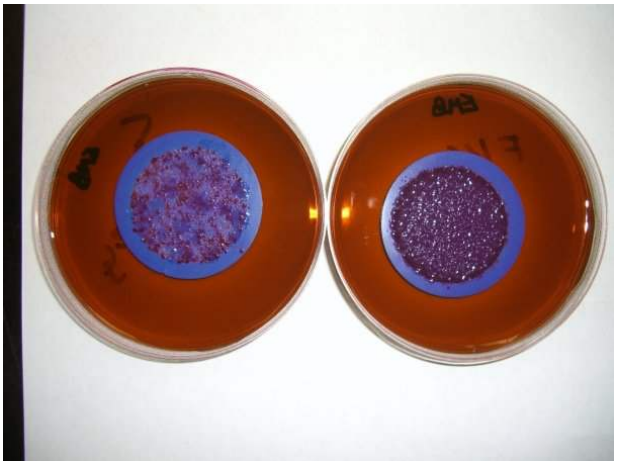


Figure 5; EMB (with filter) too numerous to count

Unfortunately even this was usually an insufficient dilution and the amount of colonies on many plates were still too numerous to count. Therefore amounts of 1.0ml and 0.1ml sample water were plated on Eosin Methylene Blue (EMB) plates and on Mac Conkey (MAC) plates, see figures 6 and 7. After this, most of the time it was possible to count the amount of fecal bacteria. EMB is a medium which is quite specific and almost only fecal coliforms can grow on it. It is easy to recognize the fecal coliform bacteria on an EMB plate. The colonies look metallic green and typically contain a small circle. The MAC plates are not very specific, because many different bacteria could grow on it, but only the fecal should be counted. The fecal coliforms on the MAC plates can be recognized by purple coloration, flatness and the bacteria should be dry (not wet and sticky).

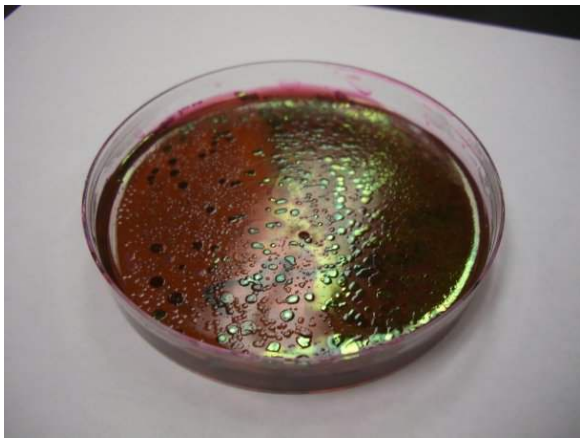


Figure 6; EMB (without filter)

Figure 7; MAC

2.1.3 Enterococci spp.

Enterococci are a subgroup within the fecal streptococcus group. Fecal *streptococcus* generally occur in the digestive systems of humans and other warm-blooded animals. *Enterococci* can survive in salt water as well as in fresh water, therefore they more

closely mimic many pathogens than the other indicators do. *Enterococci* are a group within the larger fecal streptococcus group, but are more human-specific. *Enterococci* are recommended by the EPA as the best indicator of health risks in salt water used for recreation and as a useful indicator in fresh water as well.[1]

Method of testing:
Water of each sample was put on an ENT (entercoccosal) medium (in duplicates). Then these media are preserved in the incubator under a constant temperature of 37ºC. After 24 hours the analysis could start. The white colonies surrounded by a black colour change on the media are *enterococci* bacteria and these were counted. How much water was used can be seen in the test results which can be found in appendix II. At the start of this project 1 ml sample water was used per plate. However, many of the plates had more than 300 colonies, making them statistically invalid because they were too numerous to count.[2] The amount of sample water was decreased from 1ml per plate to 0.5ml, 0.1ml and even 0.05ml per plate.

Figure 8; ENT, countable

Figure 9; ENT, too numerous to count

2.1.4 Staphylococcus aureus

Staphylococcus aureus (from now on: *S. aureus*) is a species within the *Staphylococcus* group. About 30% of humans (in some communities it is almost 50%) are carriers of *S. aureus* without any symptoms. Mostly the *S. aureus* is carried in the nose. *S. aureus* is carried by a large group of the population without any symptoms. However, at low resistance it can cause serious infections, like on a wound or cut, or in general with infants, elderly and ill people. Most commonly *S. aureus* can give skin infections like furuncles (abscesses).

Method of testing:
First 0.1ml of sampled water was put on a medium of Mannitol Salt Agar (MSA) in a petri-dish and preserved at a temperature of 37ºC. After 24 hours the colonies where

[1] website 8
[2] American Public Health Association, 1980, Standard Methods (For examination of water and wastewater), APHA, 15th edition, Washington

inspected. The colonies with the yellow circle and which have the same shape and size are potential *S. aureus* colonies. One of the potential *S. aureus* colonies was isolated and put in a new medium with a Nutrient agar and held in the incubator for about 18 hours so the potential *S. aureas* could grow. After this a couple of the grown potential *S. aureas* were used for an extra confirmatory test (the API Staph test) and put in the incubator again at a temperature of 37ºC. With this test the colonies are tested if to confirm if they are a) *Staphylococcus aureus* b) other *Staphylococcus* species, or c) not a *Staphylococcus* species at all. After 24 hours the strips of the API Staph test were read. In figure 10 the procedure for *S. aureus* can be easily seen.

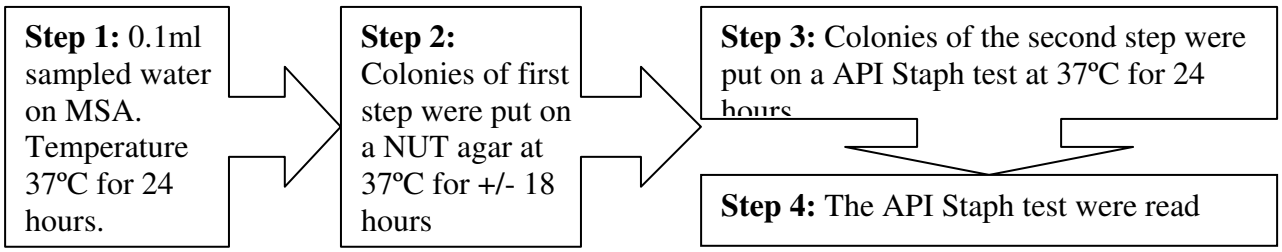


Figure 10; scheme for Staph aureus

2.2 fieldwork tests

The fieldwork tests are defined as all non-bacterial analyses. Temperature, pH, dissolved oxygen and salinity are standard parameters that occur in every marine ecosystem but always within a certain range. If one or more of these parameters lies outside the expected range, it indicates the ecosystem is out of balance. Nutrients are the chemicals that feed the primary organisms, without them no life is possible. Plants and algae require nutrients and in turn provide food for the higher organisms. However, an overabundance or an out of balance proportion of nutrients indicates a compromised ecosystem and possibly sewage pollution. This chapter will describe the purpose and methods for fieldwork tests.

2.2.1 Salinity

Salinity is the presence of soluble salts in soils or waters, in other words the saltiness of soils or water. It is a general term used to describe the presence of elevated levels of different salts such as sodium chloride, magnesium and calcium sulphates and bicarbonates, in soil and water. Lagoons are often brackish or estuarine waters, which means it is mixed with fresh water from land based sources. The salinity in lagoons is therefore lower than in the open seas. Salinity influences the species of plants and animals that can live either in the water or on the shoreline of a lagoon. Estuarine species of fish are tolerant of salinity changes ranging from fresh to brackish to seawater. Other aquatic species are more dependent on salinity for protection from predators or require certain minimal salinities for successful hatching of eggs.
This parameter is especially relevant for this research because salinity also influences the species of bacteria that can live in the water. Some pathogenic bacteria, which are often

present in sewage holding pipes, gutters and streams, are unable to survive or are limited by salt water intolerance.[1,2]

Method of testing:
The salinity was measured with a portable refractometer, see figure 11.

Figure 11; portable refractometer

2.2.2 Temperature

"Human activities should not change water temperatures beyond natural seasonal fluctuations. To do so could disrupt aquatic ecosystems."[3] Good or healthy temperatures are dependent on the type of water body you are monitoring. Often summer heat can cause fish mortalities in ponds because high temperatures reduce available oxygen in the water. Generally the solubility of solids increases with increasing temperature, while gases tend to be more soluble in cold water. "Temperature is a factor in determining allowable limits for other parameters such as ammonia".[4] An important physical relationship exists between the amount of dissolved oxygen in a body of water and its temperature. Simply put, the warmer the water, the less dissolved oxygen. For this reason, heat or "thermal pollution" may be a problem, especially in shallow slow-moving streams, embayments, or small ponds which can get very warm in mid-summer. Most fish simply can't stand warm water and/or low levels of dissolved oxygen. Figure 12 demonstrates this relationship.

[1] website 10
[2] EPA, 1986, Quality criteria for water, Washington
[3] website 11
[4] website 12

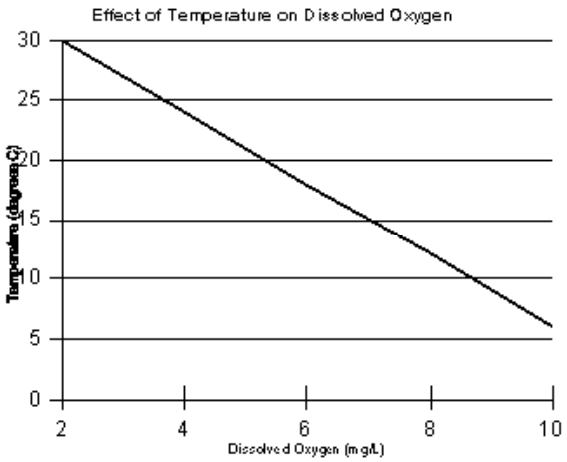


Figure 12; effect of temperature on dissolves oxygen (from website 12)

Temperature can also affect bacterial growth. Bacteria from human faeces, for example, will grow well at body temperature (37°C) but bacteria (e.g. from plants) may be killed at that temperature.[1]

Water quality norms for the Netherlands Antilles indicate that the temperature of water that runs into the lagoon should not be higher than 32ºC and should not exceed more than 1ºC on the natural temperature level. (WMNA)

Method of testing:
The temperature of the water was measured in ºC with a pH/temperature meter. The instrument that was used is a HANNA instrument, pH/EC/TDS Waterproof family, pH meter. More information can be found at website 14.

2.2.3 PH

The pH level indicates the level of acidity or alkalinity (or basic) in liquids. The concentration of the hydrogen ion [H+] in a solution determines the pH.

pH is defined as the negative log-base 10 of the hydrogen ion concentration:

$$pH = - \log_{10} [H+]$$

The pH of a neutral liquid is around 7. Acid liquids have a pH between 0 and 7 and alkaline liquids have a pH between 7 and 14. Big fluctuations in pH are not good for the ecosystem. A pH between 6 and 8 provides a good environment for aquatic life. The most significant environmental impacts of pH involves synergistic effects. "Synergy involves the combination of two or more substances which produce effects greater than their sum."[2].

[1] website 13
[2] website 15

"This process is important in surface waters. Runoff from agricultural, domestic, and industrial areas may contain iron, aluminium, ammonia, mercury or other elements. The pH of the water will determine the toxic effects, if any, of these substances. For example, 4 mg/l of iron will not present a toxic effect at a pH of 4.8. However, as little as 0.9 mg/l of iron at a pH of 5.5 can cause fish to die".[1]

Norms for water quality in the Netherlands Antilles indicate the pH of the water that flows into the lagoon should be between 6 and 8. (WMNA)

Method of testing:
The pH of the water was measured in with a pH/temperature meter. The instrument that was used is a HANNA instrument, pH/EC/TDS Waterproof family, pH meter. More information can be found at website 14.

2.2.4 Chlorine

Chlorine is a greenish-yellow gas that dissolves easily in water. It has a noxious odor that some people can smell at concentrations above 0.3 parts per million. Because chlorine is a disinfectant, it is commonly added to most drinking water supplies and swimming pools and sometimes to wastewater treatment plants as well. Chlorine is widely used as a bleaching agent in textile factories and paper mills and it's an important ingredient in many laundry bleaches. Because chlorine is commonly used it could also occur in the lagoon.[2]

Free chlorine (chlorine gas dissolved in water) is toxic to fish and aquatic organisms, even in very small amounts. However, its dangers are relatively short-lived compared to the dangers of most other highly poisonous substances. This is because chlorine reacts quickly with other substances in water (and forms combined chlorine) or dissipates as a gas into the atmosphere. "If water contains a lot of decaying materials, free chlorine can combine with them to form compounds called trihalomethanes or THMs. Some THMs in high concentrations are carcinogenic to people. Unlike free chlorine, THMs are persistent and can pose a health threat to living organisms for a long time."[2]

"Less than 0.5 mg/L of free chlorine is needed to kill bacteria without causing water to smell or taste unpleasant. Most people cannot detect the presence of chlorine in water at 1.0 mg/L. 1.0 mg/L chlorine is not harmful to people, but it does cause problems for fish if they are exposed to it over a long period of time."[2]
It is important to realize chlorine becomes more toxic as the pH level of the water drops. And it becomes even more toxic when it is combined with other toxic substances such as cyanides, phenols and ammonia. "Combined chlorine is defined as the residual chlorine existing in water in chemical combination with ammonia or organic amines which can be found in natural or polluted waters. Total chlorine is the sum of free and combined chlorine. When chlorinating most potable water supplies, total chlorine is essentially equal to free chlorine since the concentration of ammonia or organic nitrogen compounds

[1] website 15
[2] website 16

(needed to form combined chlorine) will be very low. When chloramines are present in the municipal water supply, then total chlorine will be higher than free chlorine."[1]

Total chlorine (in mg/L)	Effect
0.006	Kills trout fry in two days.
0.01	Recommended maximum for all fish and aquatic life.
0.01	Kills Chinook Salmon and Coho Salmon.
0.01-0.05	Oysters have difficulty pumping water through their bodies.
0.02	Maximum Brook and Brown Trout can withstand.
0.05	Maximum amount that can be tolerated by young Pacific Salmon in the ocean.
0.1	Kills most marine plankton.
0.25	Only the hardiest fish can survive.
0.37	Maximum fish can tolerate.
1.0	Kills oysters.

Table 2; Effects of chlorine on fish and aquatic organisms (from website 16)

Method of testing:
The Chlorine was tested for free and total chlorine with the HACH AquaChek test strips with a 0-10ppm range.[2]

2.2.5 Nitrate and Nitrite

Nitrogen is essential for plant growth, but the presence of excessive amounts in water supplies presents a major pollution problem. Nitrates in conjunction with phosphate stimulate the growth of algae with all the related difficulties associated with excessive algae growth. (See Phosphates). The major routes of entry of nitrogen into bodies of water are municipal and industrial wastewater, septic tanks, animal wastes (including birds and fish), runoff from fertilized agricultural and discharges from car exhausts. Bacteria in water quickly convert nitrites [NO2-] to nitrates [NO 3 -] and this process uses up oxygen. Excessive concentrations of nitrites can produce a serious condition in fish called "brown blood disease" and stimulates growth of toxic dinoflagellate algae. "High amounts of nitrates in drinking water can cause digestive disturbances for people. Nitrite/nitrogen levels below 90 mg/L and nitrate levels below 0.5 mg/L seem to have no affect on warm water fish".[3]

Method of testing:
Nitrite was tested with a test kit. Normally used to measure Nitrite levels in aquaria. (The Salifert NO2 Profi Test, Nitrite Test Kit. Range: 0.1-4 ppm. For more information see website 20).

[1] website 17
[2] webstie 18
[3] website 19

Nitrate was tested with a test kit. Normally used to measure Nitrate levels in aquaria. (The Salifert NO3 Profi test, Nitrate Test Kit. Low range: 0.2-10 ppm and a medium range: 2-100 ppm. For more information see website 21).

2.2.6 Phosphate

Phosphate is an important nutrient for aquatic plants to live. The level of Phosphates found in water is generally 0.1 ppm or less. When the water has become polluted from wastewater (sewage) or excessive drainage from agricultural areas it is usually more than 0.1 ppm. When there is a higher concentration of phosphates than is required for normal aquatic plant growth, a process called eutrophication takes place. Eutrophication is an excess of nutrients which can cause algae blooms and other negative effects. The diversity of the marine organisms will decrease when too many phosphates enter the water.[1]

Method of testing:

The Phosphate was tested with the API Aquarium Pharmaceuticals Freshwater/Saltwater Phosphate $PO4^{3-}$ Test Kit. Normally used to measure Phosphate levels in aquaria. Range: 0-10 ppm. For more information see website 22.

2.2.7 Ammonia

Ammonia and Nitrogen are products of microbiological composition and accepted as chemical evidence of sanitary pollution when encountered in natural waters. Clean natural waters rarely contain more than 0.1 ppm N/L. While sewage, commonly contain 15 to 50 ppm N/L.[2]

Method of testing:

Ammonia was tested for total ammonia (NH3+NH4) with a test kit. (The Salifert NH4 Profi Test, Ammonia Test Kit. Normally used to measure Ammonia levels in aquaria. Range: 0.25-2 ppm. For more information see website 24).

[1] Emile van der Borch, 2002, Impacts of human development in the Simpson Bay Lagoon, Sint Maarten
[2] Website 23

3. Methodology

This chapter describes the method for determining the location of tests and how they were conducted.

3.1 Mapping

A hard copy and a digital map of the lagoon were obtained from the cadastre, the maps date from 1992 (they have no newer version). In the field, copies of Google Earth maps were used and later redrawn on the big hard copy from the cadastre. GPS coordinates were always recorded.

The first thing that was done is locating all the water sources (gutters, pipes and streams that are constantly running) from land that run into the lagoon and map them. The sources were also followed inland and drawn on the map. They were first mapped from the shore and later also from the water because not everything was visible from land and vice versa. Thus a map was created with all the sources that enter into the lagoon and how they course inland.

After that, because of the large number of pipes, it was decided that besides the gutters and streams, only the major pipes would be tested.

Sources were found and tested in different areas: the Cole Bay area (CB), the Simpson Bay area (SB), the airport area (AP), an overflowing septic tank in the Mullet Pond area (septic) and at The American University of the Caribbean (AUC). The sources are numbered from east to west. In addition the runoff from two of the Rosewater treatment systems were tested.

The following sources were found and tested:

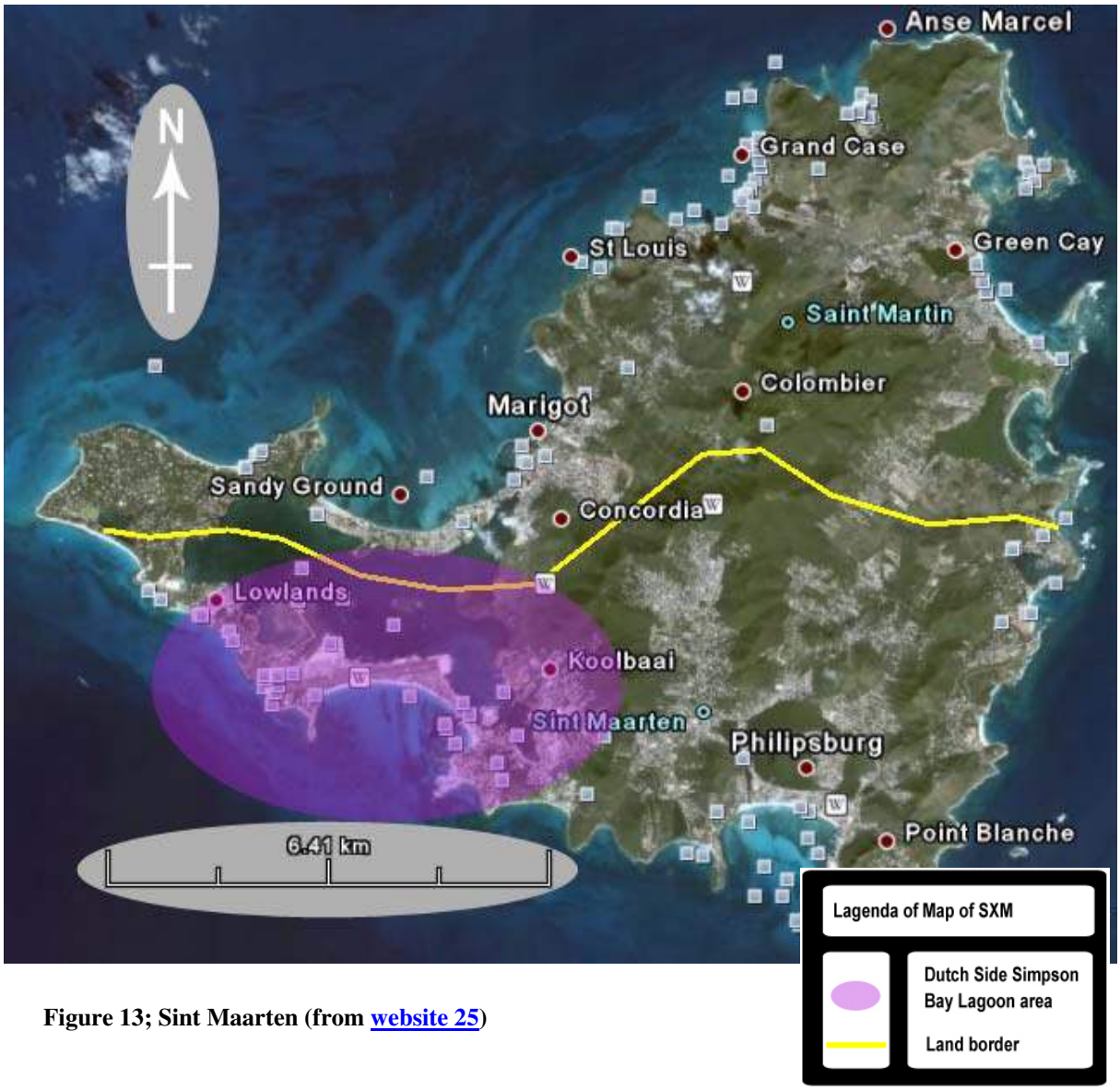


Figure 13; Sint Maarten (from website 25)

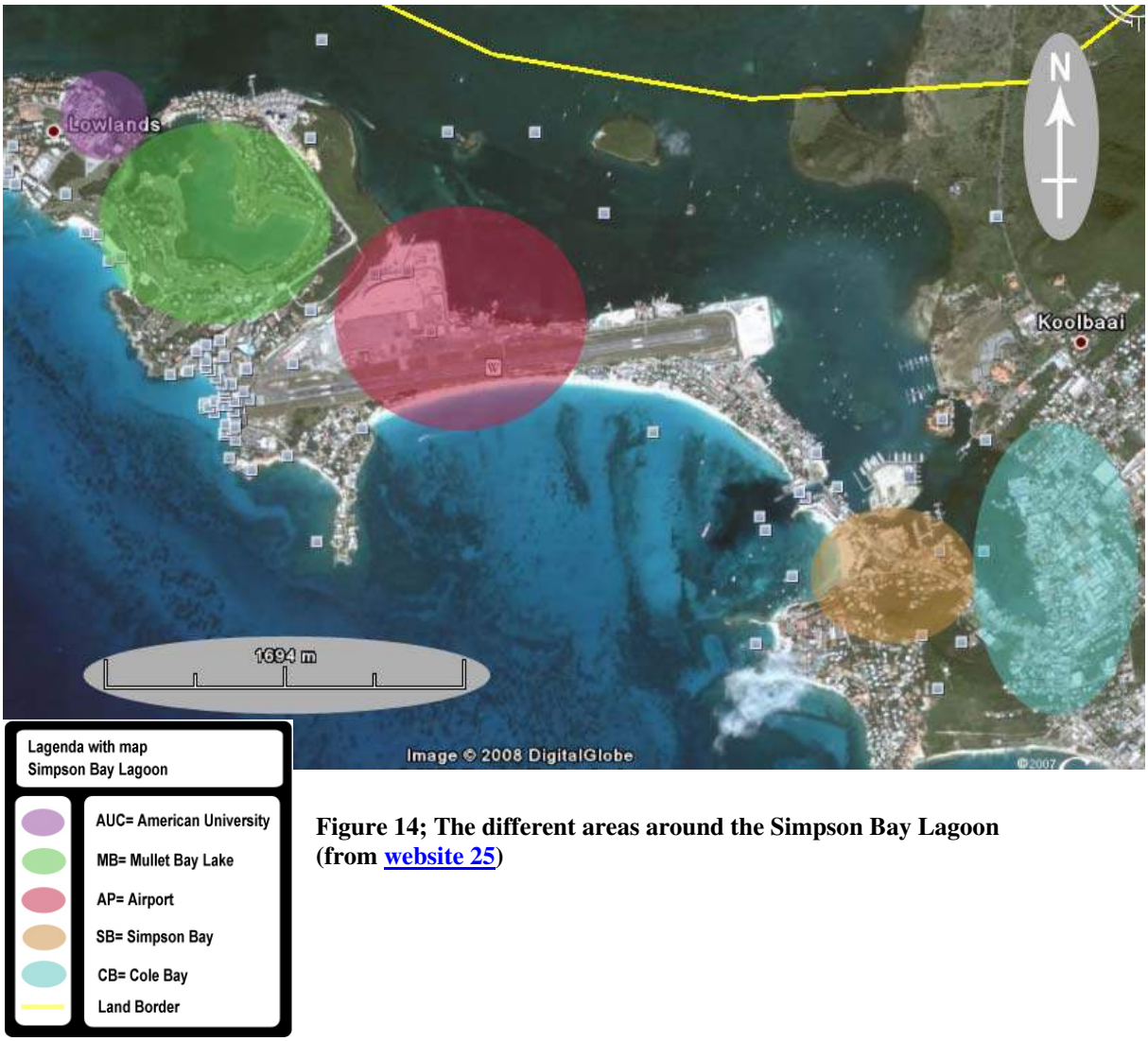


Figure 14; The different areas around the Simpson Bay Lagoon (from website 25)

Figure 15; map of location American University (from website 25)

Pipe coming from the AUC. Not constantly flowing, however when flowing it is flowing hard* with large quantities of wastewater. Water is being treated by the AUC.

* This is an estimation based on visual observations

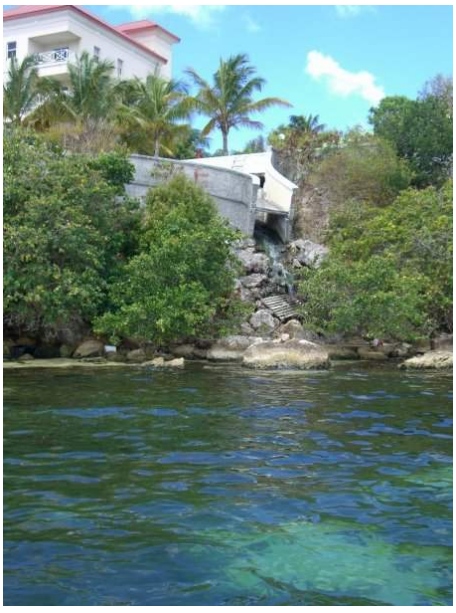


Figure 16; picture of water stream AUC

Figure 17; map of Mullet Bay lake (from website 25)

A constantly overflowing septic tank on the Westside of the Mullet Bay Pond. It is not directly flowing into the pond but is so close to the shore that will most like affect it. Moderate quantity of water*.

* This is an estimation based on visual observations

Figure 18; picture of the septic tank at Mullet Bay lake

Figure 19; map of Airport area (from website 25)

AP-1
First pipe coming from the Juliana Airport, partly under the water surface. Water quantity is fluctuating from low, when almost stagnant, to very high* when flowing.

* This is an estimation based on visual observations

Figure 20; picture of pipe 1 at airport-area

AP-2
Second pipe coming from the Juliana Airport, partly under the water surface. Water quantity is fluctuating from low, when almost stagnant, to very high* when flowing.

* This is an estimation based on visual observations

Figure 21; picture of pipe 2 at airport-area

AP3+4
Two pipes on the north side of The Juliana Airport, partly under the water surface. Water quantity is fluctuating from low, when almost stagnant, to very high* when flowing.

* This is an estimation based on visual observations

Figure 22; picture of pipes 3 & 4 at airport-area

Figure 23; map of Simpson Bay area (from website 25)

The only sample site from Simpson Bay, located between the FedEx and the Sucriere bakery. Moderate quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 24; picture of pipe outlet at Simpson Bay area

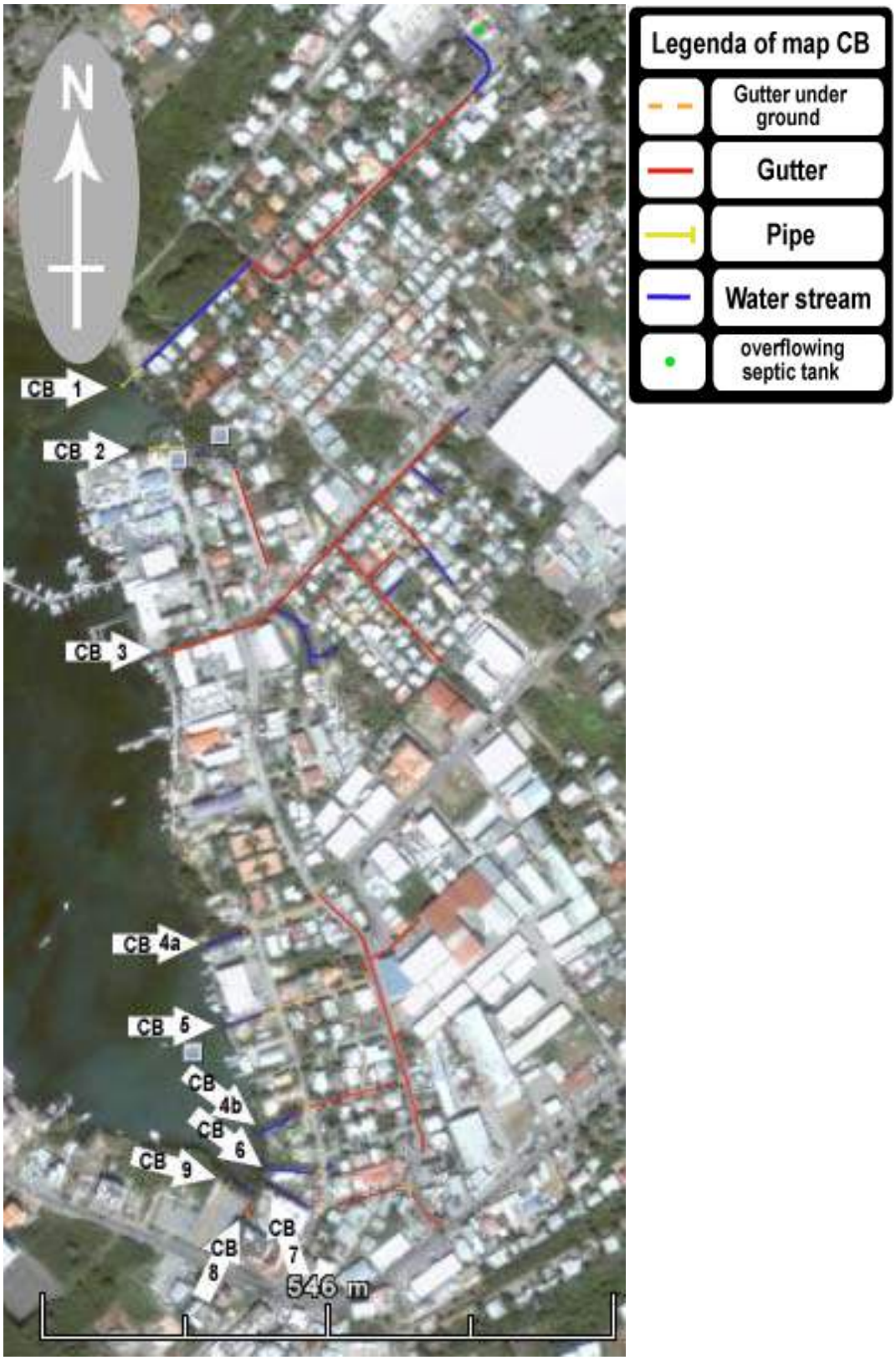


Figure 25; map of Cole Bay area (from website 25)

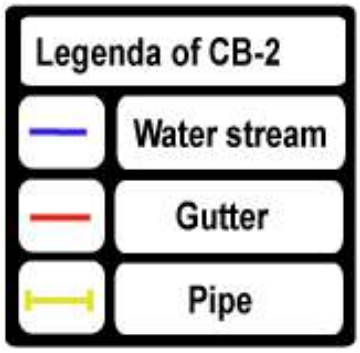
Figure 26; map of Cole Bay area, stream 1 (from website 25)

Figure 27; picture of Cole Bay pipe-outlet 1

The first large pipe in Cole Bay, partly under the water surface. Moderate quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 28; map of Cole Bay area, stream 2 (from website 25)



The second large pipe in Cole Bay, partly under the water surface. Moderate quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 29; picture of Cole Bay pipe-outlet 2

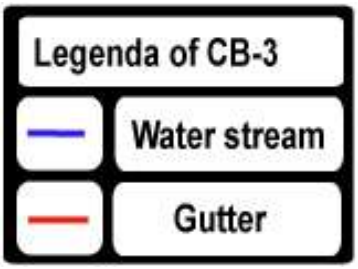


Figure 30; map of Cole Bay area, stream 3 (from website 25)

The third water source in Cole Bay, but the first gutter. Located next to the Montessori school. Very large quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 31; picture of gutter-outlet CB-3

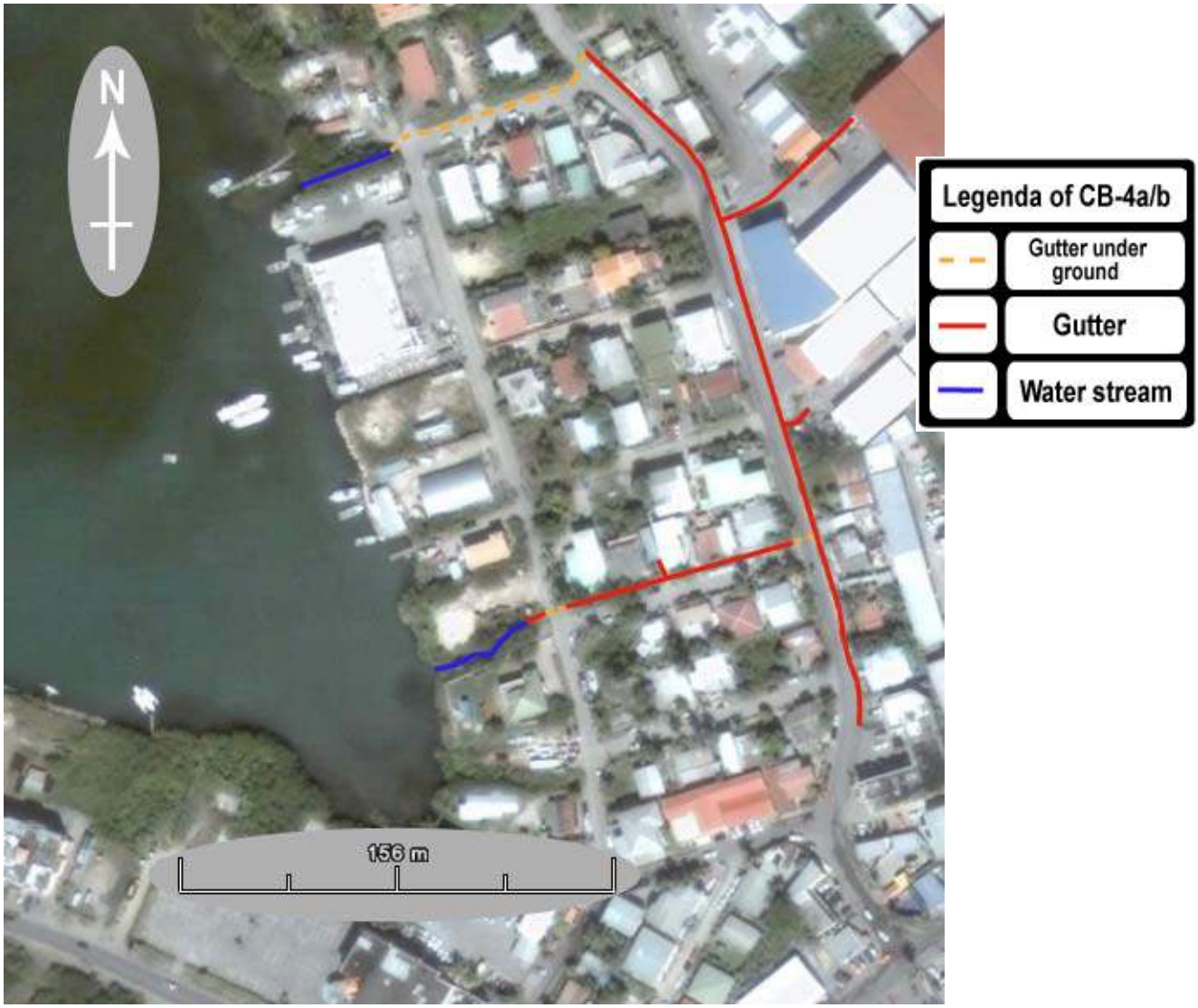


Figure 32; map of Cole Bay area, stream 4 (from website 25)

Figure 33; picture of gutter outlet CB-4a

CB-4a The second gutter outlet in Cole Bay, located next to Budget Marine. Large quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 34; picture of gutter outlet CB-4b

CB-4b The fourth gutter outlet in Cole Bay. Located left of Budget Marine. Moderate quantity* of water flowing out.

* This is an estimation based on visual observations

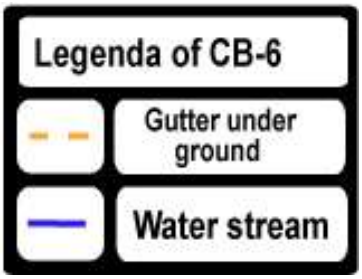
Figure 35; map of Cole Bay area, stream 5 (from website 25)

The third gutter outlet in Cole Bay, located left of Budget Marine. Moderate quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 36; picture of gutter-outlet CB-5

Figure 37; map of Cole Bay area, stream 6 (from website 25)

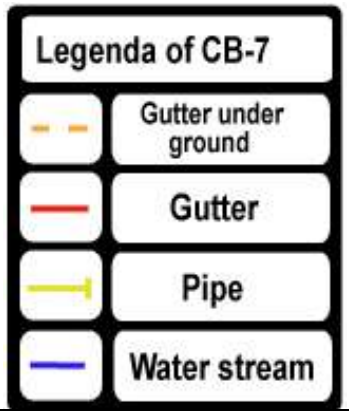


The fifth gutter outlet in Cole Bay, located left of Budget Marine. Large quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 38; picture of gutter-outlet CB-6

Figure 39; map of Cole Bay area, stream 7 (from website 25)



The sixth gutter outlet in Cole Bay, located along the roundabout. Large quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 40; picture of gutter-outlet CB-7

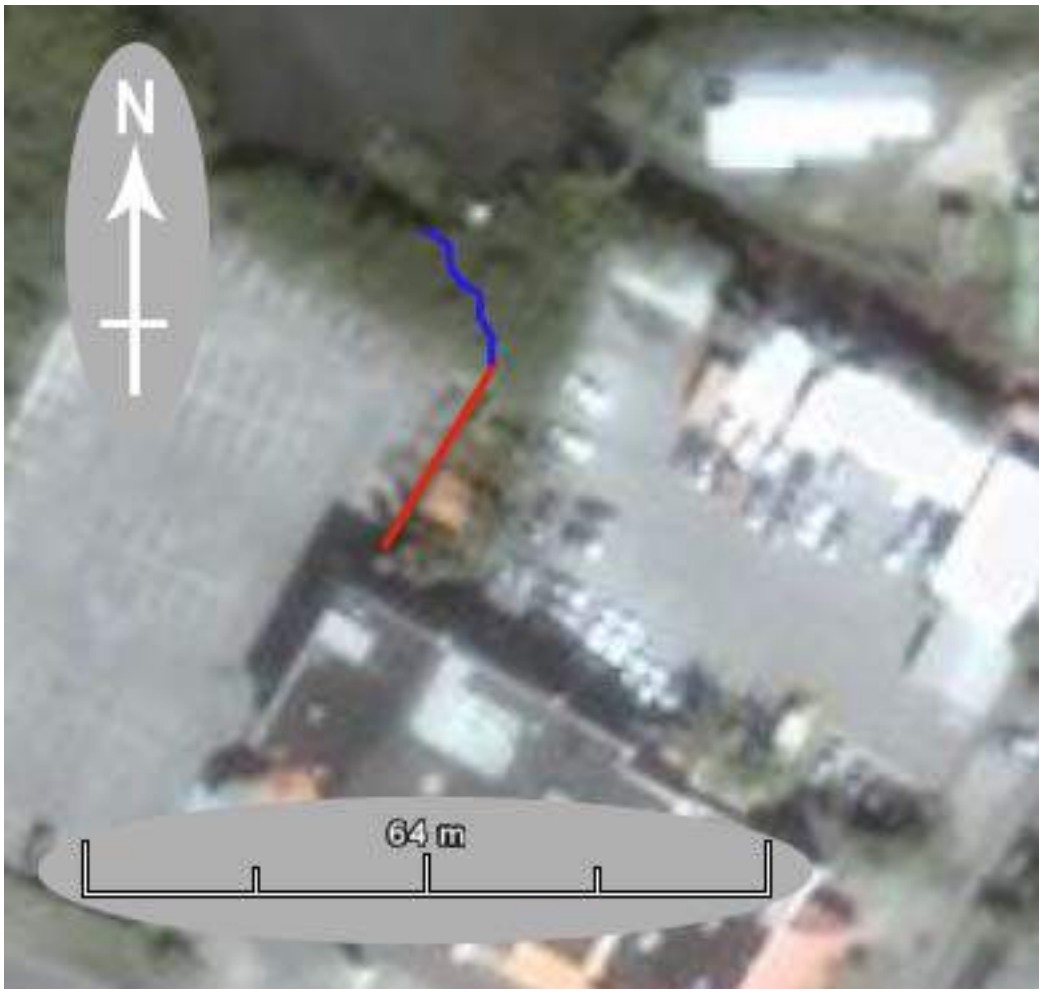
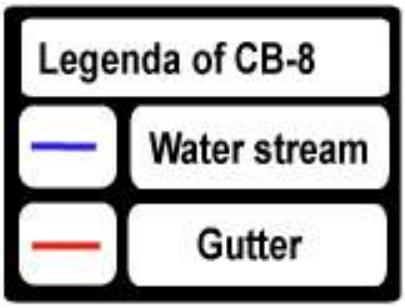
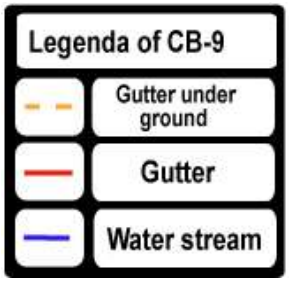


Figure 41; map of Cole Bay area, stream 8 (from website 25)



The smallest gutter tested, dried out halfway through the research. Therefore limited test results. Located behind the Tropical Casino

Figure 42; map of Cole Bay area, stream 9 (from website 25)



The eighth gutter outlet in Cole Bay, located left of the Tropical Casino. Very large quantity* of water flowing out.

* This is an estimation based on visual observations

Figure 43; picture of gutter-outlet CB-9

Rosewater-1
The first pipe with the effluent water from a Rosewater Treatment System in Cole Bay. Low quantity* of water.

* This is an estimation based on visual observations

Rosewater-2
The second pipe with the effluent water from a Rosewater Treatment System in Cole Bay. Low quantity* of water.

* This is an estimation based on visual observations

Figure 44; picture of Rosewater treatment system outlet 1

3.2 Sampling

Samples were always taken with sterile sampling bottles or tubes. As soon as the samples were taken they were put on ice in a coolbox and taken to the lab within an hour. Samples were placed on ice during transportation to prevent further development of bacteria. On each sample day, samples were taken at 5 am and at 5 pm. This time period was chosen so as to include night time sewage dumping.

First samples were taken at the source's

Figure 45; picture of Rosewater treatment system outlet 2

Later tests were also conducted inside the lagoon as well to see what the impacts of pollution from the gutters, streams and major pipes would be on the natural system. And what the effects of brackish water on bacterial growth would be.

Samples were taken at approximately three meters (10 ft) in front of each source at a depth of approximately 30cm.

4. Existing Norms and legislation

The most relevant norms (standards) for water quality in Sint Maarten will be the norms as they are formulated in the report "Lucht & Geluid, Water & Afval Water, Afval", produced by Werkgroep Milieunormering Nederlandse Antillen. The norms which are relevant for the lagoon can be seen in the last column of table 3: "number 3 (6th row) op oppervlaktewater" meaning surface water and table 4 in the last row "Overig" meaning other. These norms are not enforced legislation but are expected to serve as the baseline for legal standards.[1]

Normen lozingen huishoudelijk afvalwater Nederlandse Antillen

Parameter	BOD5	COD	N-tot.	P-tot.	Fecal Coli	Oil / Grease	pH	Salinity	Chloride	Suspended Solids	Temp. Max.	SO4
	mg/l	mg/l	mg N/l	Mg P/l	x/100 ml	mg/l		µS/cm	mg C/l	mg/l	°C	mg/l
1 op riolering	**nvt**	**nvt**	**nvt**	**nvt**	**nvt**	**200**	**6.5-8.5**	**2250**	**150**	**350**	**40**	**350**
2 irrigatie	**50**	**125**	**28**	**5**	**1000**		**6-8**	**2250**	**250**	**50**	**nvt**	**nvt**
3 op opper-vlaktewater	**30**	**150**	**5**	**1**	**200**	**10**	**6-8**	**nvt**	**nvt**	**30**	**32/+1°C**	**nvt**

Toelichting

- nvt = niet van toepassing, geen norm voor deze parameter
- normen uitgedrukt als etmaalmonsters
- temperatuur lozing op oppervlaktewater: max. 32°C én max. 1°C temperatuurverhoging ten opzichte van het natuurlijk niveau
- overige regels lozingen huishoudelijk afvalwater en termijnen: zie tabel III
- verdere toelichting op de tabel: zie Frequently Asked Questions normen water en afvalwater, vraag 3, 6 en 10

Table 3; norms for waste water Dutch Antilles (from Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, Lucht & Geluid, Water & Afvalwater, Afval, Nederlandse Antillen)

[1] from Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, Lucht & Geluid, Water & Afvalwater, Afval, Nederlandse Antillen

normen oppervlaktewater Nederlandse Antillen

Parameters: Watertypen:	Zuurstof (DO) mg/l	N-tot. mg N/l	P-tot. mg P/l	Fecaal Coli x/100 ml	Olie/vet mg/l*	Doorzicht (meter)
Recreatie	>5	0,10	0,02	5	0,5	5-25**
Natuur	>5	0,014	0,003	100	0,1	25
Industrie	>0,8	1,27	0,10	100	3	5
Overig (lagunes, meren, estuaria, overig zee)	>4	0,15	0,02	200	0,5	5-25**

Toelichting

* tevens: geen waarneembare (zichtbare of ruikbare) vervuiling
** sterk afhankelijk van type water
- oppervlaktewater: zeewater en binnenwateren (lagunes, 'ponds', baaien, saliña's e.d.)
- normen zijn grenswaarden die niet overschreden mogen worden, tenzij anders is aangegeven. Zuurstof (DO) is de minimaal toelaatbare waarde
- naast deze normen geldt toepassing van het **stand-still beginsel** (open norm): handhaving huidige kwaliteit indien die beter is dan normen aangeven (zie FAQ Milieunormering Algemeen, vraag 4)
- verdere toelichting op de tabel: zie Frequently Asked Questions vraag 8

Table 4; norms for waste water Dutch Antilles (from Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, Lucht & Geluid, Water & Afvalwater, Afval, Nederlandse Antillen)

For one important parameter there is not a norm formulated by the werkgroep milieunormering. This is the norm for enterococci. The Environmental Protection Agency in the United Stated has formulated a recommendation for a norm for enterococci; 35 colonies per 100ml for waters like the lagoon.[1] *Enterococci* are recommended by the EPA as the best indicator of health risks in salt water used for recreation and as a useful indicator in fresh water as well.[2]

[1] EPA, 1986, Ambient water quality for bacteria, United States
[2] website 8

5. Analyses and results

5.1 Analyses per location

Here are the test results per location. Sometimes there is no norm (see column 5: norm). If there is a norm and it is exceeded the results are bolded. It is possible to have a significant difference between morning and evening results. The water that has been tested often contains very high concentrations of the tested bacteria. Especially in the Cole Bay area (CB) the amount of tested bacteria is so high that it is likely be raw sewage.

Test results				
location	tested for	place/time	result	norm:
CB-1	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	350/100ml	**no norm**
	Fecal coliform	land AM	**408/100ml**	200/100ml*
		land PM	**216/100ml**	200/100ml*
		lagoon AM	**3,925/100ml**	200/100ml*
		lagoon PM	**600/100ml**	200/100ml*
	Enterococcus spp.	land AM	2,250/100ml	**no norm**
		land PM	4,250/100ml	**no norm**
		lagoon AM	**1,900/100ml**	35/100ml**
		lagoon PM	**700/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	27.0°C	max. 32ºC+ 1ºC*
		land PM	30.7°C	max. 32ºC+ 1ºC*
	pH	land AM	7.83	6-8*
		land PM	**8.09**	6-8*
		lagoon AM	8.19	**no norm**
		lagoon PM	8.50	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	0.5	1*
		land PM	0.5	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm
The samples taken from the lagoon ware taken
+/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 5; table with results for Cole Bay 1

Test results				
location	tested for	place/time	result	norm:
CB-2	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	48/100ml	200/100ml*
		land PM	**990/100ml**	200/100ml*
		lagoon AM	**7,375/100ml**	200/100ml*
		lagoon PM	**2,400/100ml**	200/100ml*
	Enterococcus spp.	land AM	71,000/100ml	**no norm**
		land PM	249,000/100ml	**no norm**
		lagoon AM	**300/100ml**	35/100ml**
		lagoon PM	**200/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	27.0°C	max. 32ºC+ 1ºC*
		land PM	29.2°C	max. 32ºC+ 1ºC*
	pH	land AM	7.64	6-8*
		land PM	7.68	6-8*
		lagoon AM	8.07	**no norm**
		lagoon PM	8.56	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**2.0**	1*
		land PM	**2.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm
The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 6; table with results for Cole Bay 2

Test results				
location	tested for	place/time	result	norm:
CB-3	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	**455/100ml**	200/100ml*
		land PM	**485/100ml**	200/100ml*
		lagoon AM	**500/100ml**	200/100ml*
		lagoon PM	**4,033/100ml**	200/100ml*
	Enterococcus spp.	land AM	170,000/100ml	**no norm**
		land PM	8,000/100ml	**no norm**
		lagoon AM	**8,900/100ml**	35/100ml**
		lagoon PM	**400/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	27.1°C	max. 32ºC+ 1ºC*
		land PM	30.0°C	max. 32ºC+ 1ºC*
	pH	land AM	7.75	6-8*
		land PM	**8.18**	6-8*
		lagoon AM	8.22	**no norm**
		lagoon PM	8.45	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**2.0**	1*
		land PM	**5.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm
The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 7; table with results for Cole Bay 3

Test results				
location	tested for	place/time	result	norm:
CB-4a	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	1,600/100ml	**no norm**
	Fecal coliform	land AM	**2,000/100ml**	200/100ml*
		land PM	**67,000/100ml**	200/100ml*
		lagoon AM	**13,500/100ml**	200/100ml*
		lagoon PM	**500/100ml**	200/100ml*
	Enterococcus spp.	land AM	500/100ml	**no norm**
		land PM	10,000/100ml	**no norm**
		lagoon AM	NC***	35/100ml**
		lagoon PM	**100/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	27.7°C	max. 32ºC+ 1ºC*
		land PM	30.2°C	max. 32ºC+ 1ºC*
	pH	land AM	7,69	6-8*
		land PM	**8,22**	6-8*
		lagoon AM	8,18	**no norm**
		lagoon PM	8,54	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	0.5	1*
		land PM	**2.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the Fecal coliform colonies. Next time it should be diluted.

Table 8; table with results for Cole Bay 4a

Test results				
location	tested for	place/time	result	norm:
CB-5	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	1,600/100ml	**no norm**
	Fecal coliform	land AM	**32,500/100ml**	200/100ml*
		land PM	**388,000/100ml**	200/100ml*
		lagoon AM	**12,167/100ml**	200/100ml*
		lagoon PM	**19,000/100ml**	200/100ml*
	Enterococcus spp.	land AM	7400/100ml	**no norm**
		land PM	0/100ml	**no norm**
		lagoon AM	NC***	35/100ml**
		lagoon PM	**400/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	30.4°C	max. 32ºC+ 1ºC*
		land PM	30.8°C	max. 32ºC+ 1ºC*
	pH	land AM	7,10	6-8*
		land PM	7,41	6-8*
		lagoon AM	8.04	**no norm**
		lagoon PM	8.56	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**2.0**	1*
		land PM	**5.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the fecal coliform colonies. Next time it should be diluted.

Table 9; table with results for Cole Bay 5

Test results				
location	tested for	place/time	result	norm:
CB-4b	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	43/100ml	**no norm**
	Fecal coliform	land AM	**102,500/100ml**	200/100ml*
		land PM	**68,500/100ml**	200/100ml*
		lagoon AM	**1,150/100ml**	200/100ml*
		lagoon PM	62/100ml	200/100ml*
	Enterococcus spp.	land AM	210,000/100ml	**no norm**
		land PM	272,000/100ml	**no norm**
		lagoon AM	NC***	35/100ml**
		lagoon PM	**100/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	26.7°C	max. 32ºC+ 1ºC*
		land PM	28.7°C	max. 32ºC+ 1ºC*
	pH	land AM	7,66	6-8*
		land PM	7,65	6-8*
		lagoon AM	7.93	**no norm**
		lagoon PM	8.64	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**5.0**	1*
		land PM	**5.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the fecal coliform colonies. Next time it should be diluted.

Table 10; table with results for Cole Bay 4b

Test results				
location	tested for	place/time	result	norm:
CB-6	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	112/100ml	200/100ml*
		land PM	**392/100ml**	200/100ml*
		lagoon AM	**3,500/100ml**	200/100ml*
		lagoon PM	**10,250/100ml**	200/100ml*
	Enterococcus spp.	land AM	1,900/100ml	**no norm**
		land PM	800/100ml	**no norm**
		lagoon AM	**4,900/100ml**	35/100ml**
		lagoon PM	**700/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	29.0°C	max. 32ºC+ 1ºC*
		land PM	31.0°C	max. 32ºC+ 1ºC*
	pH	land AM	7,27	6-8*
		land PM	7,42	6-8*
		lagoon AM	8.23	**no norm**
		lagoon PM	8.46	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	0.5	1*
		land PM	0.25	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 11; table with results for Cole Bay 6

Test results				
location	tested for	place/time	result	norm:
CB-7	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	200/100ml	200/100ml*
		land PM	**515/100ml**	200/100ml*
		lagoon AM	**3,500/100ml**	200/100ml*
		lagoon PM	**10,250/100ml**	200/100ml*
	Enterococcus spp.	land AM	54,000/100ml	**no norm**
		land PM	29,000/100ml	**no norm**
		lagoon AM	**4,900/100ml**	35/100ml**
		lagoon PM	**700/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	28°C	max. 32ºC+ 1ºC*
		land PM	29.9°C	max. 32ºC+ 1ºC*
	pH	land AM	7,53	6-8*
		land PM	7,60	6-8*
		lagoon AM	8.23	**no norm**
		lagoon PM	8.46	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**5.0**	1*
		land PM	**10.0**	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 12; table with results for Cole Bay 7

Test results				
location	tested for	place/time	result	norm:
CB-8	Total coliform	land AM	≥2,400/100ml	**no norm**
There is no water flowing in this gutter anymore		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	15/100ml	200/100ml*
		land PM	**210/100ml**	200/100ml*
		lagoon AM	**3,000/100ml**	200/100ml*
		lagoon PM	**3,150/100ml**	200/100ml*
	Enterococcus spp.	land AM	54,000/100ml	**no norm**
		land PM	56,100/100ml	**no norm**
		lagoon AM	NC***	35/100ml**
		lagoon PM	**250/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	Temperature	land AM	There is no water flowing in this gutter anymore	max. 32ºC+ 1ºC*
		land PM	31.0°C	max. 32ºC+ 1ºC*
	pH	land AM	There is no water flowing in this gutter anymore	6-8*
		land PM	There is no water flowing in this gutter anymore	6-8*
		lagoon AM	8.22	**no norm**
		lagoon PM	8.50	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	There is no water flowing in this gutter anymore	1*
		land PM	There is no water flowing in this gutter anymore	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the fecal coliform colonies. Next time it should be diluted.

Table 13; table with results for Cole Bay 8

Test results				
location	tested for	place/time	result	norm:
CB-9	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	90/100ml	200/100ml*
		land PM	**1,440/100ml**	200/100ml*
		lagoon AM	**3,000/100ml**	200/100ml*
		lagoon PM	**3,150/100ml**	200/100ml*
	Enterococcus spp.	land AM	24,200/100ml	**no norm**
		land PM	700/100ml	**no norm**
		lagoon AM	NC***	35/100ml**
		lagoon PM	**250/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	**Positive** on *Staphylococcus aureus*	**no norm**
	Temperature	land PM	31.0°C	max. 32ºC+ 1ºC*
	pH	land AM		6-8*
		land PM	**8,05**	6-8*
		lagoon AM	8.22	**no norm**
		lagoon PM	8.50	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM		1*
		land PM		1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the fecal coliform colonies. Next time it should be diluted.

Table 14; table with results for Cole Bay 9

Test results				
location	tested for	place/time	result	norm:
SB-1	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	≥2,400/100ml	**no norm**
		lagoon AM	540/100ml	**no norm**
		lagoon PM	≥2,400/100ml	**no norm**
	Fecal coliform	land AM	175/100ml	200/100ml*
		land PM	105/100ml	200/100ml*
		lagoon AM	**1,200/100ml**	200/100ml*
		lagoon PM	**350/100ml**	200/100ml*
	Enterococcus spp.	land AM	4000/100ml	**no norm**
		land PM	0/ml	**no norm**
		lagoon AM	**2,500/100ml**	35/100ml**
		lagoon PM	**600/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	pH	land AM	7.45	6-8*
		land PM	7.91	6-8*
		lagoon AM	8,28	**no norm**
		lagoon PM	8.36	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**3.5**	1*
		land PM	1.0	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0.25**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 15; table with results for Simpson Bay 1

Test results				
location	tested for	place/time	result	norm:
AP-1	Total coliform	land AM	22/100ml	**no norm**
		land PM	540/100ml	**no norm**
		lagoon AM	13/100ml	**no norm**
		lagoon PM	14/100ml	**no norm**
	Fecal coliform	land AM	44/100ml	200/100ml*
		land PM	50/100ml	200/100ml*
		lagoon AM	0/100ml	200/100ml*
		lagoon PM	0/100ml	200/100ml*
	Enterococcus spp.	land AM	800/100ml	**no norm**
		land PM	900/100ml	**no norm**
		lagoon AM	0/100ml	35/100ml**
		lagoon PM	**300/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	pH	land AM	**8.12**	6-8*
		land PM	**8.20**	6-8*
		lagoon AM	8.21	**no norm**
		lagoon PM	8.34	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**10**	1*
		land PM	0.25	1*
		lagoon AM	**0.25**	0.02*
		lagoon PM	**0**	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 16; table with results for Airport 1

Test results				
location	tested for	place/time	result	norm:
AP-2	Total coliform	land AM	13/100ml	**no norm**
		land PM	<0/100ml	**no norm**
		lagoon AM	920/100ml	**no norm**
		lagoon PM	<0/100ml	**no norm**
	Fecal coliform	land AM	56/100ml	200/100ml*
		land PM	26/100ml	200/100ml*
		lagoon AM	**3,500/100ml**	200/100ml*
		lagoon PM	0/100ml	200/100ml*
	Enterococcus spp.	land AM	1,400/100ml	**no norm**
		land PM	6,400/100ml	**no norm**
		lagoon AM	**500/100ml**	35/100ml**
		lagoon PM	**350/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	pH	land AM	**8,17**	6-8*
		land PM	**8.33**	6-8*
		lagoon AM	8,33	**no norm**
		lagoon PM	8,37	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	0.20	1*
		land PM	0.25	1*
		lagoon AM	**0,25**	0.02*
		lagoon PM	0	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 17; table with results for Airport 2

Test results				
location	tested for	place/time	result	norm:
AP-3	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	26/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	79/100ml	**no norm**
	Fecal coliform	land AM	NC***	200/100ml*
		land PM	**632/100ml**	200/100ml*
		lagoon AM	**18,000/100ml**	200/100ml*
		lagoon PM	0/100ml	200/100ml*
	Enterococcus spp.	land AM	1,900/100ml	**no norm**
		land PM	0/100ml	**no norm**
		lagoon AM	**1,050/100ml**	35/100ml**
		lagoon PM	**1,150/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	pH	land AM	7.79	6-8*
		land PM	**8.36**	6-8*
		lagoon AM	8.15	**no norm**
		lagoon PM	8.34	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	0.20	1*
		land PM	0.50	1*
		lagoon AM	0	0.02*
		lagoon PM	0	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

*** NC means: not countable because too many colonies were growing on top of each other. Unable to concentrate the fecal coliform colonies. Next time it should be diluted.

Table 18; table with results for Airport 3

Test results				
location	tested for	place/time	result	norm:
AP-4	Total coliform	land AM	≥2,400/100ml	**no norm**
		land PM	170/100ml	**no norm**
		lagoon AM	≥2,400/100ml	**no norm**
		lagoon PM	79/100ml	**no norm**
	Fecal coliform	land AM	**480/100ml**	200/100ml*
		land PM	**720/100ml**	200/100ml*
		lagoon AM	**18,000/100ml**	200/100ml*
		lagoon PM	0/100ml	200/100ml*
	Enterococcus spp.	land AM	2,450/100ml	**no norm**
		land PM	0/100ml	**no norm**
		lagoon AM	**1,050/100ml**	35/100ml**
		lagoon PM	**1,150/100ml**	35/100ml**
	Staphylococcus aureus	land AM	no *Staphylococcus aureus*	**no norm**
		land PM	no *Staphylococcus aureus*	**no norm**
	pH	land AM	7.69	6-8*
		land PM	**8.37**	6-8*
		lagoon AM	8.15	**no norm**
		lagoon PM	8.34	**no norm**
	Phosphate** (PO4 3-) in mg/l	land AM	**10.0**	1*
		land PM	0.25	1*
		lagoon AM	0	0.02*
		lagoon PM	0	0.02*

The **bold** marked **results** are exceeding the norm

The samples taken from the lagoon ware taken +/- 3 meters in the lagoon from the land base source

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007,
Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

** From: EPA, 1986, quality criteria for water, Environmental Protection Agency, Washington

Table 19; table with results for Airport 4

Test results			
location	tested for	result	norm:
AUC	Total coliform	≥2,400/100ml	**no norm**
	Fecal coliform	**4150/100ml**	200/100ml*
	Enterococcus spp.	750/100ml	**no norm**
	Temperature	23 ºC	max. 32ºC+ 1ºC*
	pH	7,83	6-8*
	Phosphate** (PO4 3-) in mg/l	0.25	1*

The **bold** marked **result** exceeds the norm

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

Table 20; table with results for the American University of the Caribbean

Test results				
location	tested for	where	result	norm:
Rosewater treatment systems	Total coliform	Rosewater treatment system location 1	≥2,400/100ml	**no norm**
		Rosewater treatment system location 2	≥2,400/100ml	**no norm**
	Fecal coliform	Rosewater treatment system location 1	**>300 (too numerous to count)**	200/100ml*
		Rosewater treatment system location 2	**237,500/100ml**	200/100ml*
	Enterococcus spp.	Rosewater treatment system location 1	0/ml	**no norm**
		Rosewater treatment system location 2	8,450/100ml	**no norm**
	Staphylococcus aureus	Rosewater treatment system location 1	no *Staphylococcus aureus*	**no norm**
		Rosewater treatment system location 2	no *Staphylococcus aureus*	**no norm**
	Temperature	Rosewater treatment system location 1		max. 32ºC+ 1ºC*
		Rosewater treatment system location 2		max. 32ºC+ 1ºC*
	pH	Rosewater treatment system location 1	7,65	6-8*
		Rosewater treatment system location 2	7,96	6-8*
	Phosphate** (PO4 3-) in mg/l	Rosewater treatment system location 1	**>10**	1*
		Rosewater treatment system location 2	**>10**	1*

The **bold** marked **result** exceeds the norm

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

Table 21; table with results for the Rosewater treatment systems

Test results			
location	tested for	result	norm:
clean site, Mullet Bay	Total coliform	4/100ml	**no norm**
	Fecal coliform	2/100ml	200/100ml*
	Enterococcus spp.	0/100ml	**no norm**

The **bold** marked **result** exceeds the norm

* From: Werkgroep Milieunormering Nederlandse Antillen, 2007, Eindrapport Milieunormen, lucht & geluid, water & afvalwater, afval, Nederlandse Antillen

Table 22; table with results for the clean site in Mullet Bay

5.2 Analyses fecal coliform

In this chapter the results of the fecal coliform bacteria are analysed. First a table with all the fecal coliform results is shown. Later charts are plotted and analyzed from this table.

Cole Bay	1	land AM	408
		land PM	216
		lagoon AM	3925
		lagoon PM	600
	2	land AM	48
		land PM	990
		lagoon AM	7375
		lagoon PM	2400
	3	land AM	455
		land PM	485
		lagoon AM	500
		lagoon PM	4033
	4a	land AM	2000
		land PM	67000
		lagoon AM	13500
		lagoon PM	500
	5	land AM	32500
		land PM	388000
		lagoon AM	12167
		lagoon PM	19000
	4b	land AM	102500
		land PM	68500
		lagoon AM	1150
		lagoon PM	62
	6	land AM	112
		land PM	392
		lagoon AM	3500
		lagoon PM	10250
	7	land AM	200
		land PM	515
		lagoon AM	3500
		lagoon PM	10250
	9	land AM	90
		land PM	1440
		lagoon AM	3000
		lagoon PM	3150
Simpson Bay	1	land AM	175
		land PM	105
		lagoon AM	1200
		lagoon PM	350
Airport	1	land AM	44
		land PM	50
		lagoon AM	0
		lagoon PM	0
	2	land AM	56
		land PM	26
		lagoon AM	3500
		lagoon PM	0
	3	land PM	632
		lagoon AM	18000
		lagoon PM	0
	4	land AM	480
		land PM	720
		lagoon AM	18000
		lagoon PM	0
AUC		stream	4150
Mullet Bay		lagoon	2

Table 23; results of fecal coliform

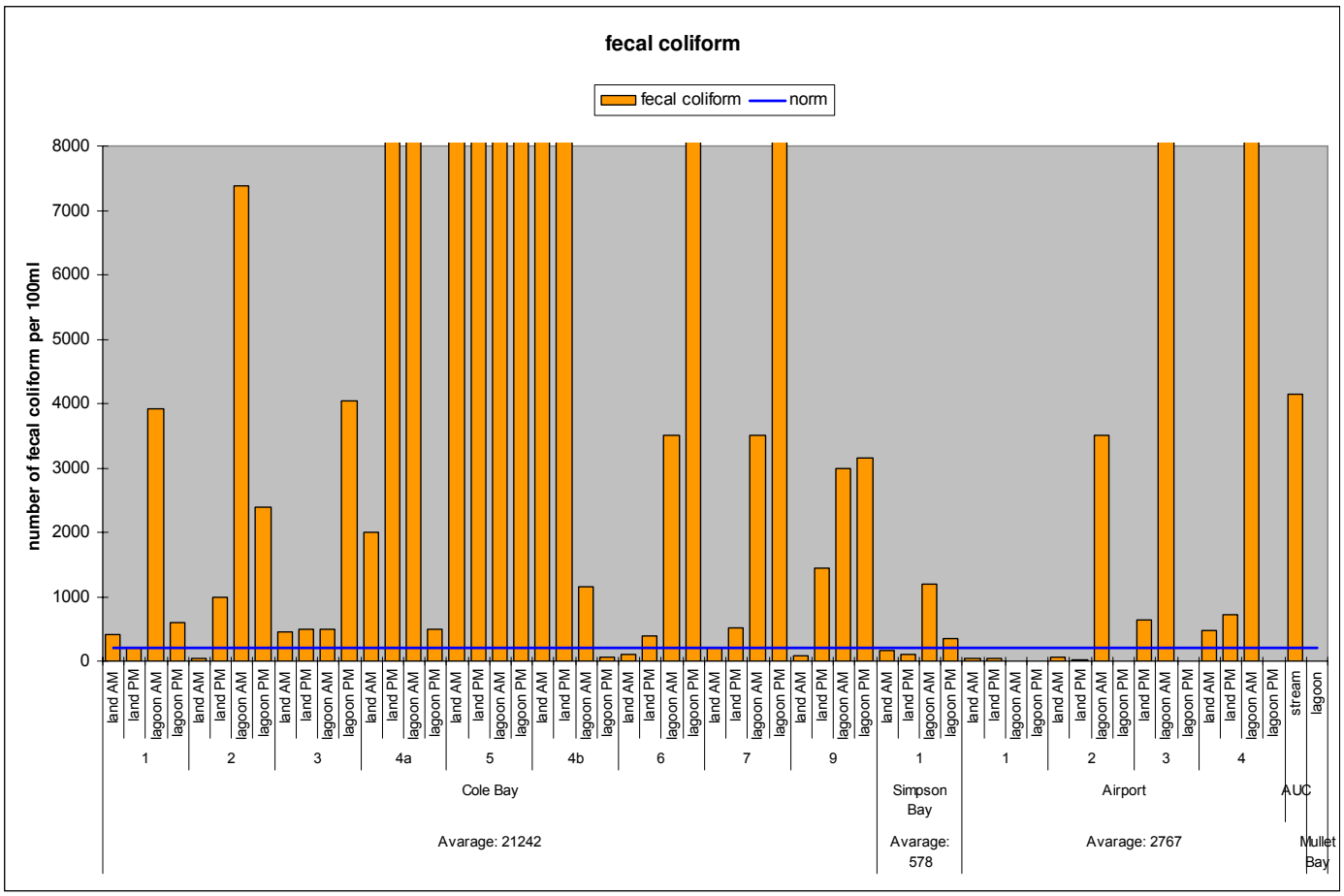
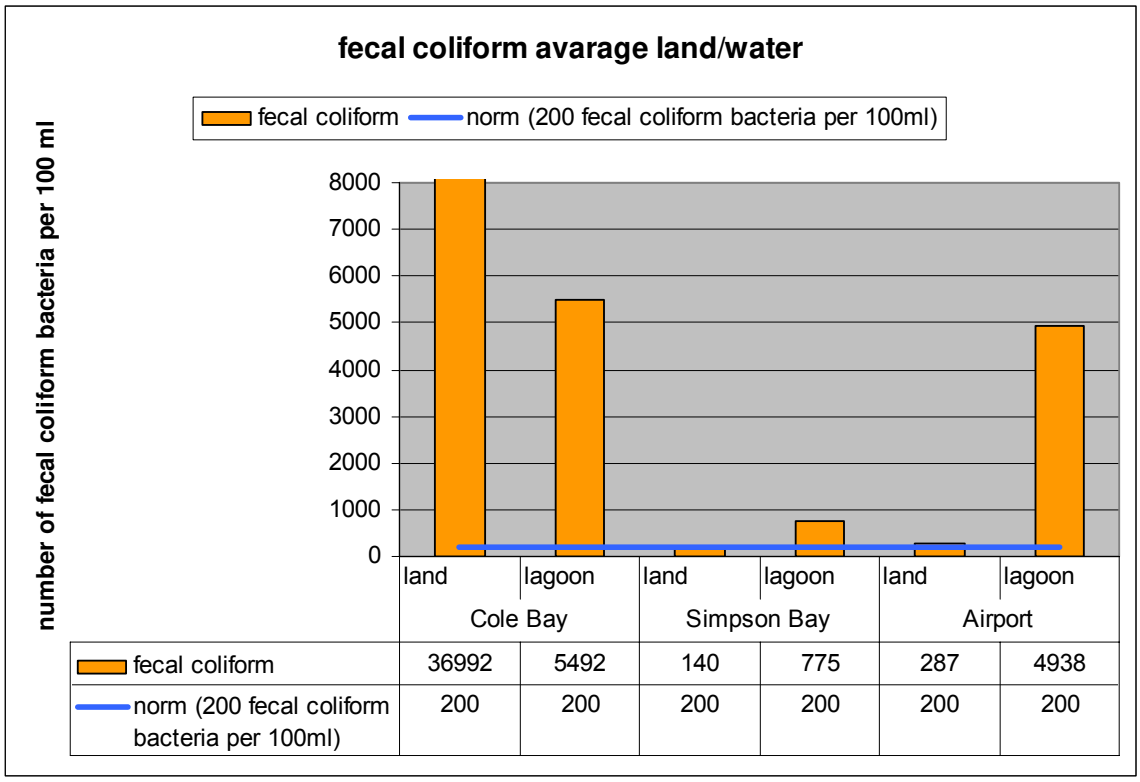


Chart 1; fecal coliform

This chart shows which locations exceed the norm for fecal coliform. All the bars above the blue line exceed the norm of 200 fecal coliform bacteria per 100ml. All the extreme high results are rounded down to 8000. The actual numbers can be found in table nr 23.

The used values have been found by taking the average of each site. Every site has been tested at least twice.

42 of the 57 test results are exceeding the norm. Thus 74% is exceeding the norm. In the worst case (Cole Bay 5 land PM) the norm is exceeded by nearly 2000 times.



	Cole Bay land	Cole Bay lagoon	Simpson Bay land	Simpson Bay lagoon	Airport land	Airport lagoon
fecal coliform	36992	5492	140	775	287	4938
norm (200 fecal coliform bacteria per 100ml)	200	200	200	200	200	200

Chart 2; fecal coliform, the average per land-based sites and lagoon

This chart displays the average number of fecal coliform from the land-based sites compared to the average number of fecal coliforms found in the lagoon. At Cole Bay land the result is rounded down to 8000. All the actual numbers can be found in the table under the orange bars of Chart 2.

From this chart it can be concluded that the Cole Bay area is, compared to the other areas, by far the most polluted (looking at fecal coliform). Cole Bay land exceeds the norm by 185 times. Besides Cole Bay the number of fecal coliform is higher in the lagoon than from the land-based sites.

The average number of fecal coliform for all the land-based locations is 22441 colonies per 100ml and for the Lagoon sites it is 4825 per 100 ml.

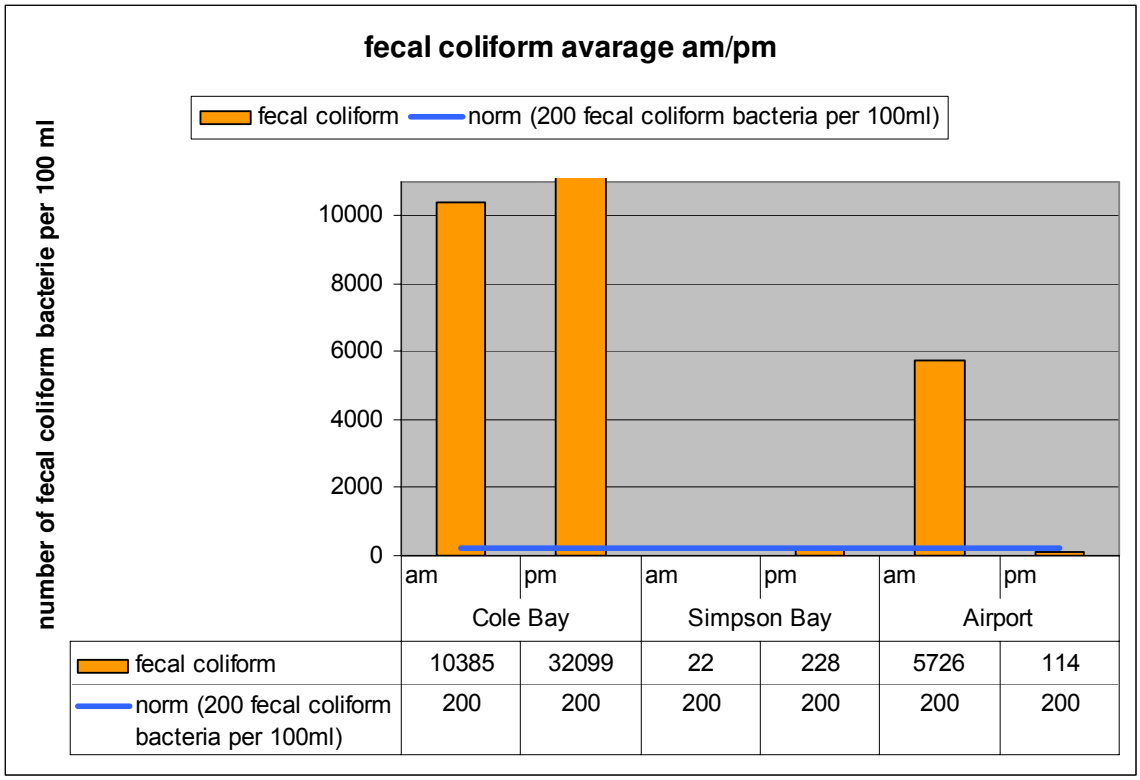


Chart 3; fecal coliform, the average of the morning and evening samples

This chart displays the average number of fecal coliform in the morning compared to the average number found in the evening. Initially samples were taken at 5am and 5pm to get more reliable results, but also to test if there is any difference of pollution in them. The Cole Bay pm result is rounded down to 11000. All the actual numbers can be found in the table under the orange bars of Chart 3.

The average number of fecal coliform of all the tests taken in the morning (AM) is 7919 colonies per 100ml. And for the sites taken in the afternoon (PM): 20702 per 100 ml.

5.3 Analyses enterococci species

area	Site	where/when	number of *enterococcus spp.* (per 100ml)
Cole Bay	1	lagoon AM	1900
		lagoon PM	700
	2	lagoon AM	300
		lagoon PM	200
	3	lagoon AM	8900
		lagoon PM	400
	4a	lagoon AM	>30000
		lagoon PM	100
	5	lagoon AM	>30000
		lagoon PM	400
	4b	lagoon AM	>30000
		lagoon PM	100
	6	lagoon AM	4900
		lagoon PM	700
	7	lagoon AM	4900
		lagoon PM	700
	9	lagoon PM	250
Simpson Bay	1	lagoon AM	2500
		lagoon PM	600
Airport	1	lagoon AM	0
		lagoon PM	300
	2	lagoon AM	500
		lagoon PM	350
	3	lagoon AM	1050
		lagoon PM	1150
	4	lagoon AM	1050
		lagoon PM	1150

Table 24; results of *enterococci species*

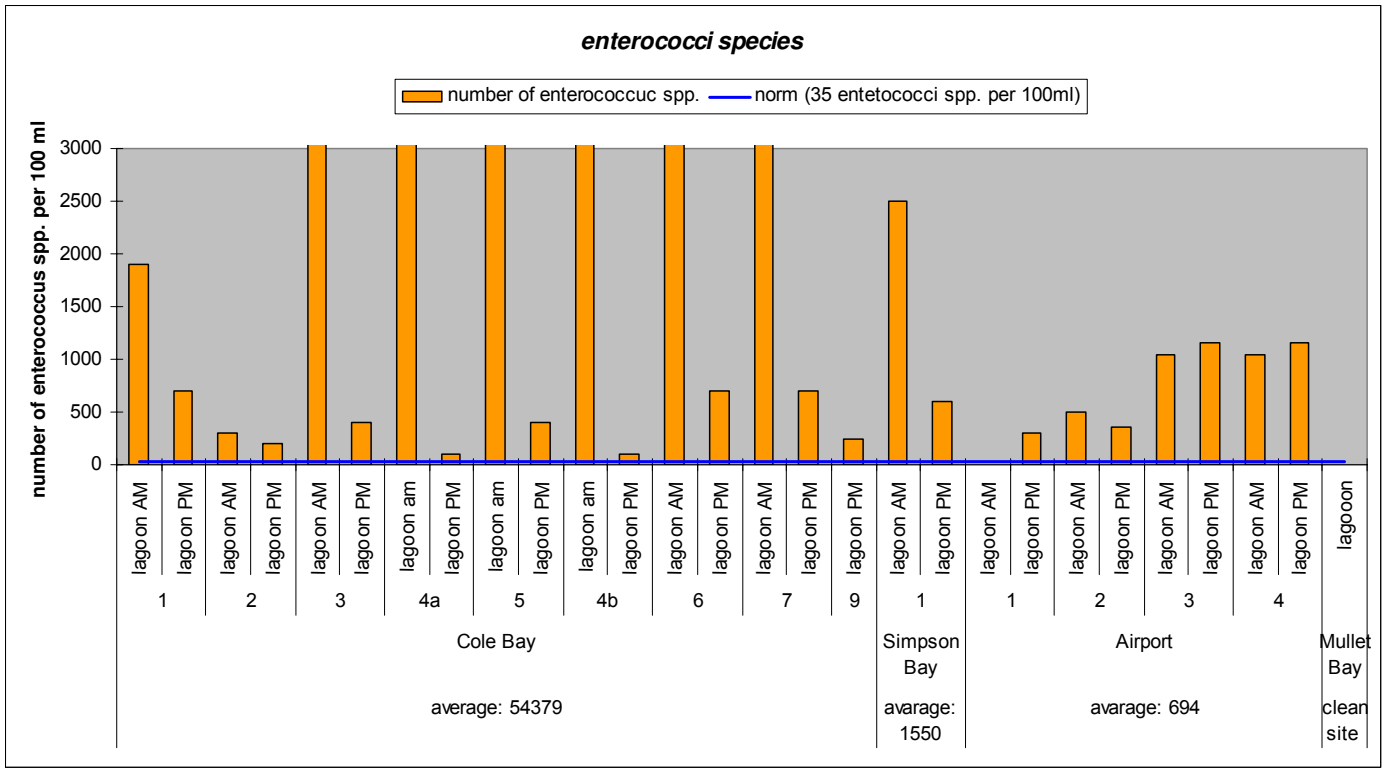


Chart 3; ***enterococci species***

This chart shows which locations exceed the norm for *enterococci*. All the bars above the blue line exceed the norm of 35 *enterococci* species per 100ml. All the extreme high results are rounded down to 3000. The actual numbers can be found in table nr. 24.

In this chart only the results from the lagoon are presented, this because there is no norm for *enterococci* on land-based sources. The used values have been found by taking the average of each site. Every site has been tested at least twice.

In the morning for lagoon 4a, 5 and 4b the results where uncountable when 1ml was plated. This means they had over 300 colonies per plate. Thus at least 30,000 colonies per litre.

26 of the 27 test results are exceeding the norm. Thus 96% is exceeding the norm.

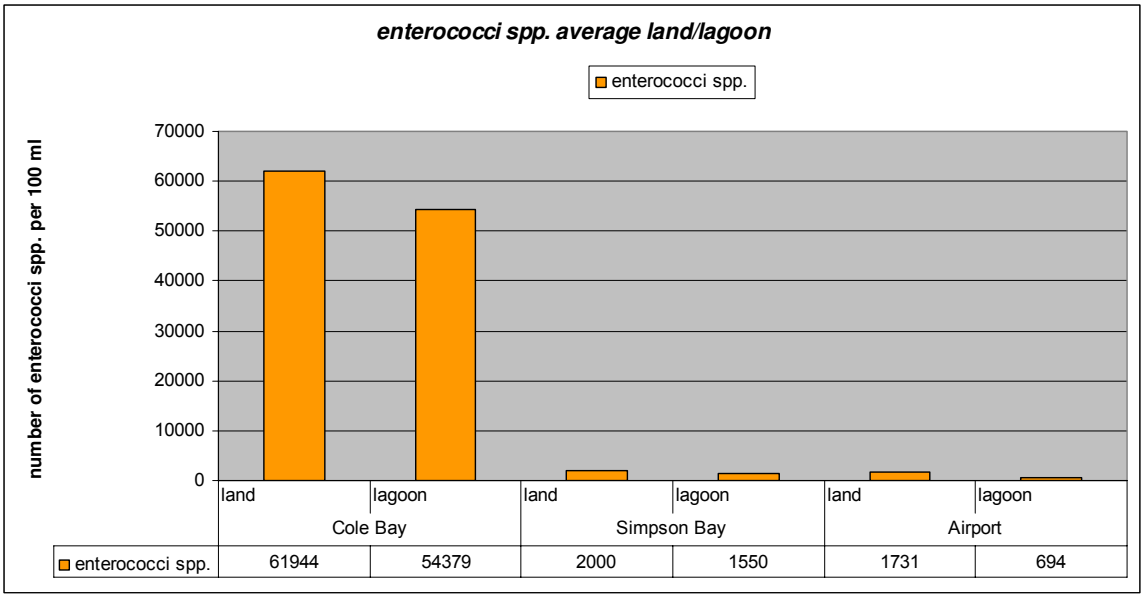


Chart 4; *enterococci spp*, the average per land-based sites and lagoon

This chart displays the average number of *enterococci species* from the land-based sites compared to the average number of *enterococci species* found in the lagoon. There is no norm for the land-based sites.

From this chart it can be concluded that the land-based sites are the most polluted with *enterococci* bacteria and that the Cole Bay area is by far the most polluted. This is probably due to the many households in Cole Bay discharging, likely untreated, sewage in the gutters.

The average number of *enterococci spp*. for all the land-based locations is 39090 colonies per 100ml and for the Lagoon sites it is 33325 per 100 ml.

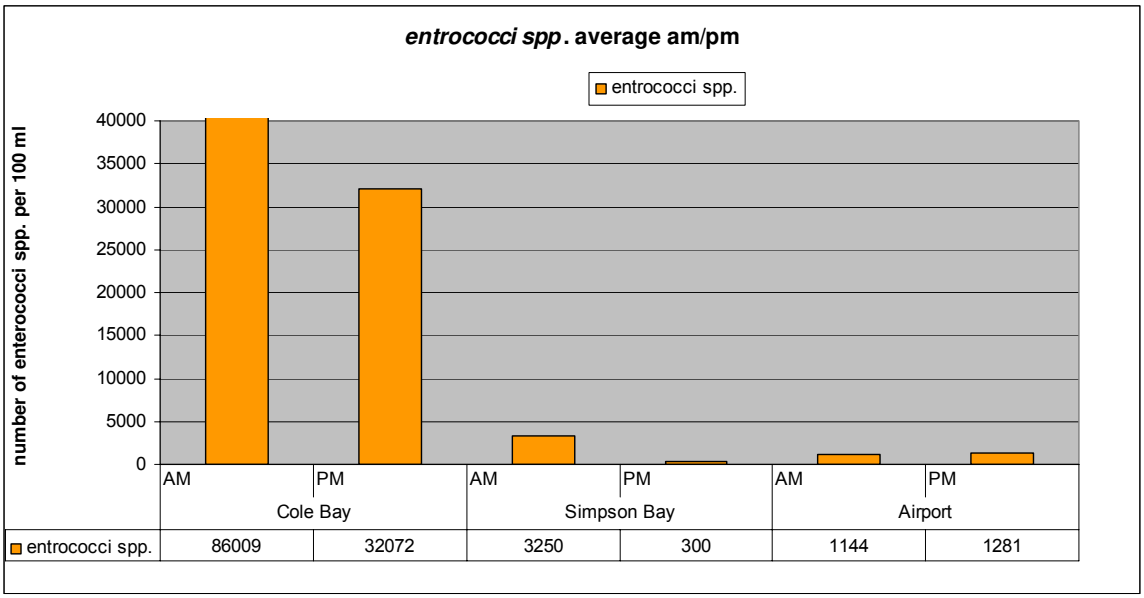


Chart 5; *enterococci spp.*, the average of the morning and evening samples

This chart displays the average number of enterococci species in the morning compared to the average number of enterococci spp. found in the evening. Initially samples were taken at 5am and 5pm to get more reliable results, but also to test if there is any difference of pollution in them.

There is little consistency between the results from the morning and from the afternoon, therefore it is hard to draw any hard conclusions. However it seems that the results from the morning tend to be higher then those in the afternoon. Especially when considering that most of the tested sites are in Cole Bay.

The average number of enterococci spp. from all the tests taken in the morning (AM) is 54733 colonies per 100ml. And for the sites taken in the afternoon (PM): 21005 per 100 ml.

5.4 Analyses pH

Cole Bay	1	land AM	7,83
		land PM	**8,09**
	2	land AM	7,64
		land PM	7,68
	3	land AM	7,75
		land PM	**8,18**
	4a	land AM	7,69
		land PM	**8,22**
	5	land AM	7,1
		land PM	7,41
	4b	land AM	7,66
		land PM	7,65
	6	land AM	7,27
		land PM	7,42
	7	land AM	7,53
		land PM	7,6
	9	land PM	**8,05**
Simpson Bay	1	land AM	7,45
		land PM	7,91
Airport	1	land AM	**8,12**
		land PM	**8,2**
	2	land AM	**8,17**
		land PM	**8,33**
	3	land AM	7,79
		land PM	**8,36**
	4	land AM	7,69
		land PM	**8,37**
AUC		Stream	7,83

Table 25; results of pH

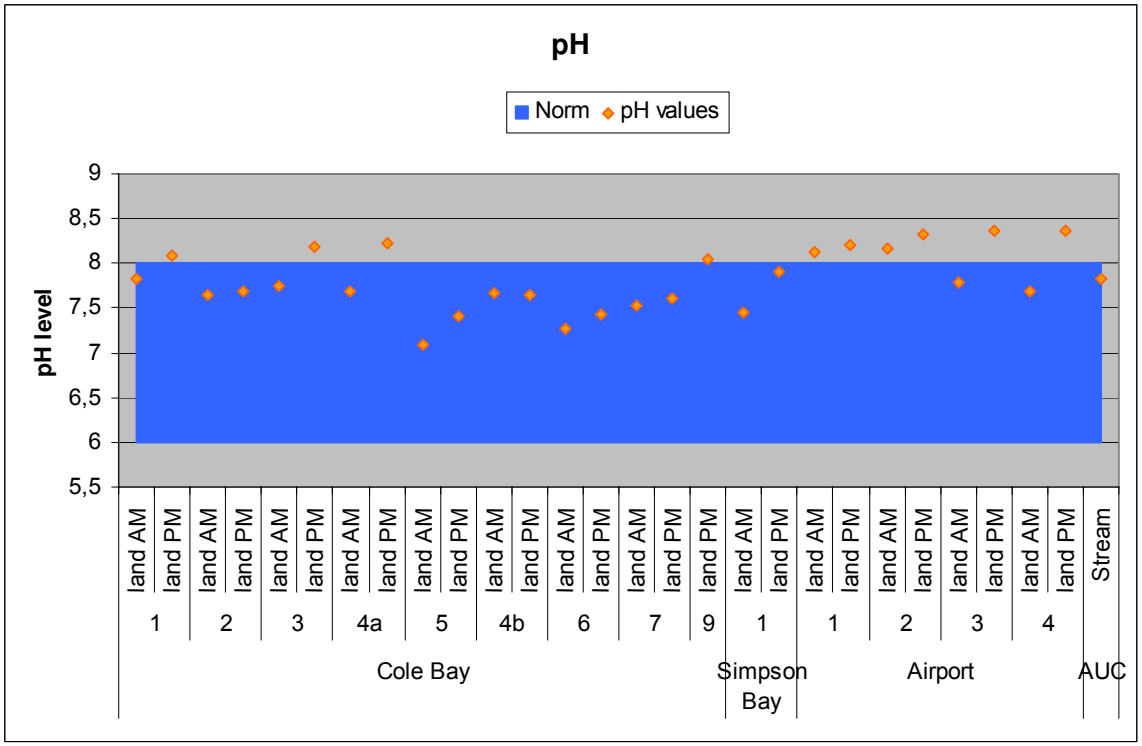


Chart 6; pH, land results

This chart shows the pH values from the land-based sites because there only is a norm for the land (a pH between 6 and 8), not for the lagoon. Notable is that in the airport area most of the results exceed the norm, however this is probably due to salinity. Because the airport pipes are partly under the water surface of the lagoon and are mixing with the salt lagoon water makes the land samples from the airport more salty.

10 of the 28 test results are exceeding the norm. Thus 36% is exceeding the norm.

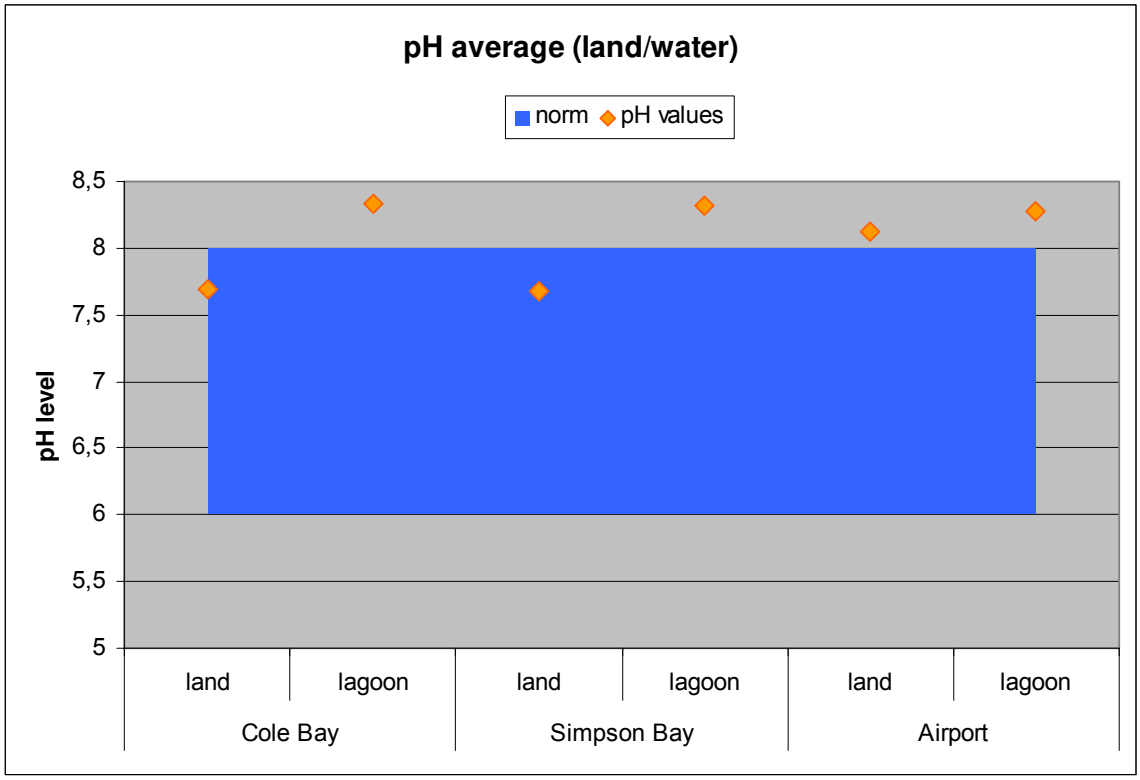


Chart 7; pH, the average per land-based sites and lagoon

In this chart the averages from the lagoon and the land-based sites are compared. What stands out is that the pH in the lagoon is significantly higher. This is due to the salt lagoon water (salt water is more basic).

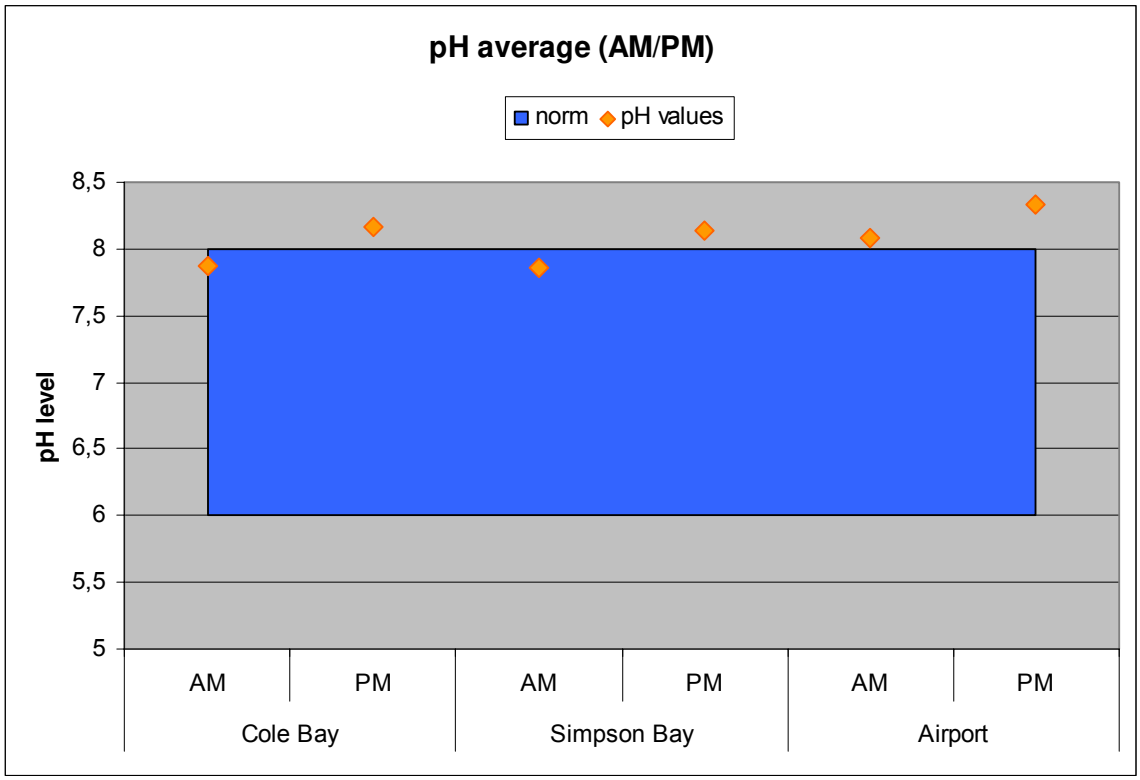


Chart 8; pH, the average of the morning and evening samples

This chart displays the average pH value in the morning compared to the average pH value found in the evening. The average of the results from as well the lagoon as the land-based sites were taken. Notable is that the pH is significantly higher in the afternoon than in the morning. This is probably due to higher salinity. Salt can not vaporise, so if more water is vaporised (a whole day of sun) the water becomes more salty and salt water is more basic (higher pH).

5.5 Analyses phosphate

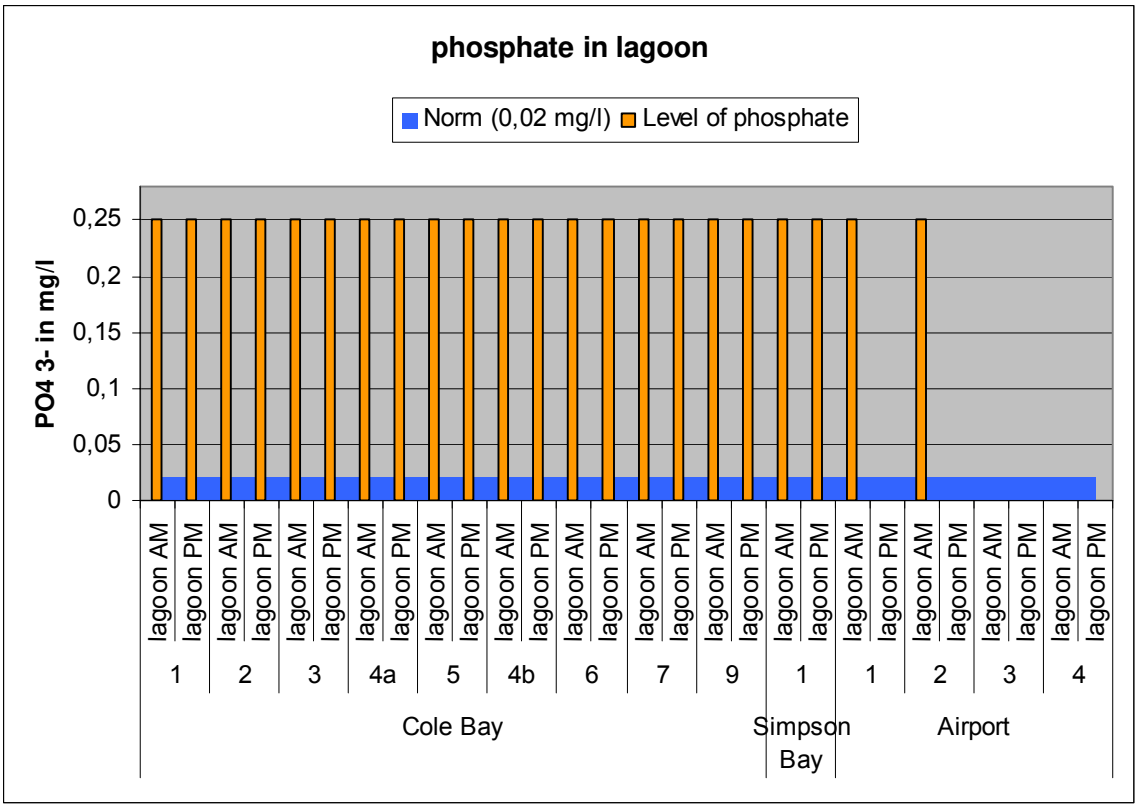


Chart 9; Phosphate, lagoon results

This chart shows which locations exceed the norm for phosphate in the lagoon. All the columns above the blue area exceed the norm of 0.02 mg phosphate per litre. However the test kit had a range from 0 to >10 and with minimum steps of 0.25ml/l, therefore this amount was found a lot. The airport had the least phosphate.

23 of the 29 test results are exceeding the norm. Thus 79% is exceeding the norm.

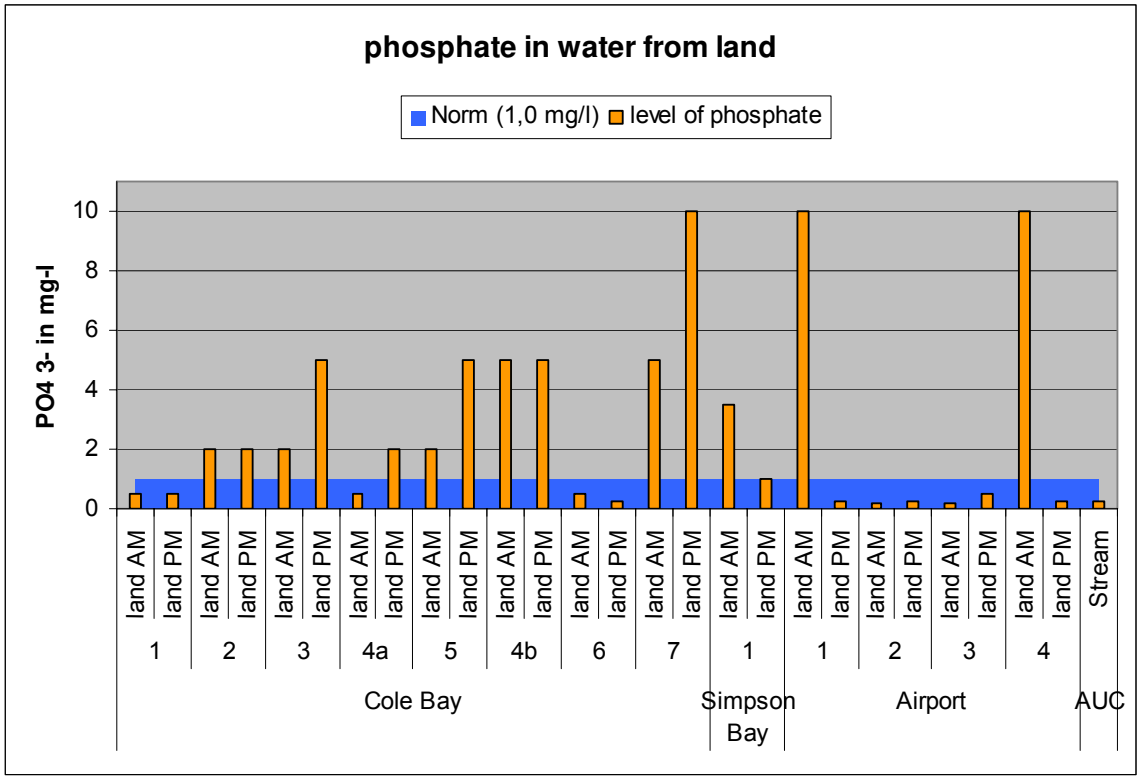


Chart 10; Phosphate, land results

This chart shows which locations exceed the norm of phosphate. Only the land-based results are shown because there is no norm for the lagoon. All the columns above the blue area exceed the norm of 1.0 mg phosphate per litre.

14 of the 27 test results are exceeding the norm. Thus 52% is exceeding the norm.

5.6 Most polluted areas

A top 15 most polluted sites for the land based locations was made, see table 26 Number 1 is the most polluted site and number 15 the least.

number	area	site
1	Cole Bay	4b
2	Cole Bay	5
3	Cole Bay	4a
4	Cole Bay	9
5	Cole Bay	2
6	Cole Bay	3
7	Cole Bay	7
8	Airport	4
9	Airport	3
10	Cole Bay	1
11	AUC	auc
12	Simpson Bay	1
13	Cole Bay	6
14	Airport	2
15	Airport	1

Table 26; top 15 most polluted land based areas

Table 26 is based on the average of the results from fecal coliform, *enterococci* and phosphate, whereas fecal coliform and *enterococci spp* have counted more heavily.

A top 13 most polluted sites for the lagoon locations is made, see table 27 Number 1 is the most polluted site and number 13 the least.

number	area	site
1	Cole Bay	5
2	Cole Bay	4a
3	Cole Bay	6/7
4	Cole Bay	3
5	Airport	3/4
6	Cole Bay	4b
7	Cole Bay	1
8	Simpson Bay	1
9	Cole Bay	2
10	Cole Bay	9
11	Airport	2
12	Airport	1
13	Mullet Bay Clean Site	

Table 27; top 13 most polluted areas in the lagoon

Table 27 is based on the average of the results from fecal coliform, *enterococci* and phosphate, whereas fecal coliform and *enterococci spp.* have counted more heavily. The

locations Cole Bay 6&7 and Airport 3&4 are taken as one sample, because the locations were very close to each other.

6. Conclusion

The objective of this research was to investigate the degree of land-based sewage pollution and to investigate where sewage contaminated water is running into the Simpson Bay Lagoon. From the conducted tests and analyses it can be concluded that the degree of land-based sewage pollution is high. Test results proof that nearly all the land-based sites that were found are contaminated with sewage; only the Mullet Bay clean site is not contaminated with sewage. Especially in the Cole Bay area the degree of sewage pollution is very high (see table 28 and 29).

The most polluted areas are (number 1 is most polluted):

Land-bases sites

number	area	site
1	Cole Bay	4b
2	Cole Bay	5
3	Cole Bay	4a
4	Cole Bay	9
5	Cole Bay	2
6	Cole Bay	3
7	Cole Bay	7
8	Airport	4
9	Airport	3
10	Cole Bay	1
11	AUC	auc
12	Simpson Bay	1
13	Cole Bay	6
14	Airport	2
15	Airport	1

Table 28; top 15 most polluted land-based sites

Sites in the lagoon

number	area	site
1	Cole Bay	5
2	Cole Bay	4a
3	Cole Bay	6/7
4	Cole Bay	3
5	Airport	3/4
6	Cole Bay	4b
7	Cole Bay	1
8	Simpson Bay	1
9	Cole Bay	2
10	Cole Bay	9
11	Airport	2
12	Airport	1
13	Mullet Bay Clean Site	

Table 29; top 13 most polluted sites in the lagoon

Table 28 and 29 are based on the average of the results from fecal coliform, *enterococci* and phosphate, whereas fecal coliform and enterococci have counted more heavily.

All the results (apart from Mullet Bay) do not only exceed the norms but in many cases are exceeding the norm by far, (see table 30).

(numbers per 100 ml)	fecal coliform. norm 200	*enterococci spp.* norm 35 (only for lagoon)
Average Cole Bay	21242	58270
Average Simpson Bay	458	1775
Average Airport	2767	1213
Average Cole Bay (lagoon)	5492	54379
Average Simpson Bay (lagoon)	775	1550
Average Airport (lagoon)	4938	694
Average Cole Bay (land)	36992	61944
Average Simpson Bay (land)	140	2000
Average Airport (land)	287	1731

Table 30; averages fecal coliform and *enterococci spp*.

7. Discussion

In this report there is proven that there is a high degree of sewage pollution in and around the Simpson Bay Lagoon. A large share of this pollution is land-based. However not everything was tested as extended as initially desired.

- Not all the sites were tested for all the parameters due to a lack of reagent for the final tests.
- Not all sites were tested at AM and at PM
- There are still results not countable (NC) or too numerous to count (TNTC). Some sites were so polluted that even after dilution the results were still NC of TNTC.
- The used maps are from 2005 and there have been some topographical changes since then.

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16. http://www.h2ou.com/h2wtrqual.htm
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20. (also websites 21, 22, 24) http://www.marinedepot.com
23. http://kywater.org/ww/ramp/rmtests.htm
25. http://earth.google.com

Appendices

Appendix I: Table used for total coliform

TABLE 908.II. MPN INDEX AND 95% CONFIDENCE LIMITS FOR VARIOUS COMBINATIONS OF POSITIVE RESULTS WHEN FIVE TUBES ARE USED PER DILUTION (10 mL, 1.0 mL, 0.1 mL)

Combination of Positives	MPN Index /100 mL	95% Confidence Limits		Combination of Positives	MPN Index /100 mL	95% Confidence Limits	
		Lower	Upper			Lower	Upper
0-0-0	<0	—	—	4-2-0	22	7	67
0-0-1	2	<0.5	7	4-2-1	26	9	78
0-1-0	2	<0.5	7	4-3-0	27	9	80
0-2-0	4	<0.5	11	4-3-1	33	11	93
				4-4-0	34	12	93
1-0-0	2	<0.5	7	5-0-0	23	7	70
1-0-1	4	<0.5	11	5-0-1	31	11	89
1-1-0	4	<0.5	11	5-0-2	43	15	110
1-1-1	6	<0.5	15	5-1-0	33	11	93
1-2-0	6	<0.5	15	5-1-1	46	16	120
				5-1-2	63	21	150
2-0-0	5	<0.5	13	5-2-0	49	17	130
2-0-1	7	1	17	5-2-1	70	23	170
2-1-0	7	1	17	5-2-2	94	28	220
2-1-1	9	2	21	5-3-0	79	25	190
2-2-0	9	2	21	5-3-1	110	31	250
2-3-0	12	3	28	5-3-2	140	37	340
3-0-0	8	1	19	5-3-3	180	44	500
3-0-1	11	2	25	5-4-0	130	35	300
3-1-0	11	2	25	5-4-1	170	43	490
3-1-1	14	4	34	5-4-2	220	57	700
3-2-0	14	4	34	5-4-3	280	90	850
3-2-1	17	5	46	5-4-4	350	120	1,000
4-0-0	13	3	31	5-5-0	240	68	750
4-0-1	17	5	46	5-5-1	350	120	1,000
4-1-0	17	5	46	5-5-2	540	180	1,400
4-1-1	21	7	63	5-5-3	920	300	3,200
4-1-2	26	9	78	5-5-4	1,600	640	5,800
				5-5-5	≥2,400	—	—

(From: American Public Health Association, 1980, Standard Methods (For examination of water and wastewater), APHA, 15th edition, Washington.)

Appendix II: Test results

This appendix contain all the results from the tests, also from the parameters tested that have no relevant norms.

Side notes Bacterial tests		
*		where is the sample taken; in the gutter/stream or +/-3 meter of land in the lagoon.
**	Total coliform	PrLb stands for: Phenol red Lactose broth
	Fecal coliform	EMB stands for: Eosin Methylene Blue
		MAC stands for: Mac Conkey
	Enterococcus spp.	ENT stands for: Entercoccosal Media (= Bile Esculia Agar)
	I	MSA stands for: Mannitol Salt Agar
		15 tubes for each location: 5 tubes with 10ml of phenol red lactose broth on 10ml of the sample,
***	Total coliform	5 tubes with 10ml on 1ml and 5 tubes with 10ml on 0.1ml. So 1:1, 1:10 and 1:100.
	Fecal coliform, filtered	Filtered through a filter of 0.45µm
****		n.a. means not applicable
*****		These are the results directly from the plates or tubes
******		These are the results multiplied for the final results
*******		These are the final results as is can be used
		The results that are **bold** are exceeding the norm, except for total coliform because there is no norm
		NC means: not countable because too many colonies were growing on top of each other.
********		Unable to concentrate the Fecal coliform colonies. Next time it should be diluted.
*********		>300 colonies on a plate is not statistically valid (according to dr. Shupe). This should be diluted next time

Fieldwork tests	
*	
**	Phosphate (PO4 3-) in ppm, mg/L
***	Nitrite (NO2) in ppm, mg/l
****	Nitrate*** (NO3) in ppm, mg/l
*****	Ammonia**** (NH3) in ppm, mg/l
******	These temperatures were not taken in the field, but in the lab
*******	o.o.r. = out of reagent

Bacterial tests											
location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-1	Total coliform	18° 2'13.01"N, 63° 5'7.01"W	land	12-May-08	5:10	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 2'13.01"N, 63° 5'7.01"W		12-May-08	17:05	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	12-Jun-08	5:15	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				12-Jun-08	17:00	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 1/5 tubes		350/100ml
	Fecal coliform	18° 2'13.01"N, 63° 5'7.01"W	land	12-May-08	5:10	EMB	25ml filtered	no	95/25ml	380/100ml	408/100ml
									109/25ml	436/100ml	
		18° 2'13.01"N, 63° 5'7.01"W		12-May-08	17:05	EMB	25ml filtered	no	58/25ml	232/100ml	216/100ml
									50/25ml	200/100ml	
			lagoon	12-Jun-08	5:15	MAC	0.1 ml plated	no	5/0.1ml	5000/100ml	3925/100ml
									5/0.1ml	5000/100ml	
						MAC	1ml plated	no	22/1ml	2200/100ml	
									35/1ml	3500/100ml	
				12-Jun-08	17:00	MAC	1ml plated	no	2/1ml	200/100ml	600/100ml
									10/1ml	1000/100ml	
	Enterococcus spp.	18° 2'13.01"N, 63° 5'7.01"W	land	12-May-08	5:10	ENT	1ml plated	no	22/ml	2200/100ml	2250/100ml
									23/ml	2300/100ml	
		18° 2'13.01"N, 63° 5'7.01"W		12-May-08	17:05	ENT	1ml plated	no	36/ml	3600/100ml	4250/100ml
									49/ml	4900/100ml	
			lagoon	12-Jun-08	5:15	ENT	1ml plated	no	8/ml	800/100ml	1900/100ml
									30+/ml (water spot)	3000+/100ml (water spot)	

										10/ml	1000/100ml
	Staphylococcus aureus	18° 2'13.01"N, 63° 5'7.01"W	land	12-May-08	5:10	MSA	0.1ml plated	n.a.	no *Staphylococcus aureus*		
		18° 2'13.01"N, 63° 5'7.01"W		12-May-08	17:05	MSA	0.1ml plated	n.a.	no *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-1	18° 2'13.01"N, 63° 5'7.01"W	land	27-Jun-08	5:00	7.83	27.0°C	15	0/0	0.5	0.25	10	o.o.r*******
		land	26-Jun-08	17:09			30	0/0	0.5	0.25	1	<0.25
		land	27-Jun-08	17:11	8.09	30.7°C						
		lagoon	12-Jun-08	5:15	8.19	21.3°C******	42	0/0	0.25	0.0	0.0	<0.25
		lagoon	12-Jun-08	17:00	8.50	23.7°C******	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-2	Total coliform	18° 2'10.40"N, 63° 5'6.60"W	land	22-May-08	5:06	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 2'10.40"N, 63° 5'6.60"W		22-May-08	17:06	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	12-Jun-08	5:16	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				12-Jun-08	17:01	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml

	Fecal coliform	18° 2'10.40"N, 63° 5'6.60"W	land	22-May-08	5:06	EMB	25ml filtered	1 : 2	3/12.5ml	24/100ml	48/100ml
									9/12.5ml	72/100ml	
		18° 2'10.40"N, 63° 5'6.60"W		22-May-08	17:08	EMB	50ml filtered	1 : 5	103/10ml	1030/100ml	990/100ml
									95/10ml	950/100ml	
			lagoon	12-Jun-08	5:16	MAC	0.1ml plated	no	10/0.1ml	10000/100ml	7375/100ml
									13/0.1ml	13000/100ml	
						MAC	1ml plated	no	23/1ml	2300/100ml	
									42/1ml	4200/100ml	
				12-Jun-08	17:01	MAC	0.1ml plated	no	5/0.1ml	5000/100ml	2,400/100ml
									1/0.1ml	1000/100ml	
						MAC	1ml plated	no	12/1ml	1200/100ml	
	Enterococcus spp.	18° 2'10.40"N, 63° 5'6.60"W	land	27-Jun-08	5:03	ENT	0.1ml plated	no	63/0.1ml	63000/100ml	71000/100ml
									79/0.1ml	79000/100ml	
		18° 2'10.40"N, 63° 5'6.60"W		26-Jun-08	17:11	ENT	0.1ml plated	no	244/0.1ml	244000/100ml	249000/100ml
									254/0.1ml	254000/100ml	
			lagoon	12-Jun-08	5:16	ENT	1ml plated	no	4/ml	400/100ml	300/100ml
									1/ml	100/100ml	
				12-Jun-08	17:01	ENT	1ml plated	no	0/ml	0/100ml	200/100ml
									3/ml	300/100ml	
	Staphylococcus aureus	18° 2'10.40"N, 63° 5'6.60"W	land	22-May-08	5:06	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 2'10.40"N, 63° 5'6.60"W		22-May-08	17:08	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-2	18° 2'10.40"N, 63° 5'6.60"W	land	27-Jun-08	5:03	7.64	27.0°C	25	0/0	2.0	0.5	10	o.o.r*******

	18° 2’10.40”N, 63° 5’6.60”W	land	26-Jun-08	17:11			25	0/0	2.0	0.25	5	0.25	
		land	27-Jun-08	17:13	7.68	29.2°C							
		lagoon	12-Jun-08	5:16	8.07	20.9°C******	42	0/0	0.25	0.0	0.0	<0.25	
		lagoon	12-Jun-08	17:01	8.56	22.3°C******	40	0/0	0.25	0.0	0.0	<0.25	

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-3	Total coliform	18° 2'4.18"N, 63° 5'6.25"W	land	12-May-08	5:19	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 2'4.18"N, 63° 5'6.25"W		12-May-08	17:11	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 2'4.18"N, 63° 5'6.25"W	land	22-May-08	5:16	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 2'4.18"N, 63° 5'6.25"W		22-May-08	17:14	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	12-Jun-08	5:20	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				12-Jun-08	17:05	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 2'4.18"N, 63° 5'6.25"W	land	12-May-08	5:19	EMB	25ml filtered	no	NC******** NC********		NC********
		18° 2'4.18"N, 63° 5'6.25"W		12-May-08	17:11	EMB	25ml filtered	no	NC******** NC********		NC********
		18° 2'4.18"N, 63° 5'6.25"W	land	22-May-08	5:16	EMB	50ml filtered	1 : 5	50/10ml	500/100ml	455/100ml

										41/10ml	410/100ml	
		18° 2'4.18"N, 63° 5'6.25"W		22-May-08	17:14	EMB	50ml filtered	1 : 5		50/10ml	500/100ml	485/100ml
										47/10ml	470/100ml	
			lagoon	12-Jun-08	5:20	MAC	0.1ml plated	no		1/0.1ml	1000/100ml	500/100ml
										0/0.1ml	0/100ml	
				12-Jun-08	17:05	MAC	0.1ml plated	no		7/0.1ml	7000/100ml	4033/100ml
										4/0.1ml	4000/100ml	
						MAC	1ml plated	no		11/0.1ml	1100/100ml	
	Enterococcus spp.	18° 2'4.18"N, 63° 5'6.25"W	land	12-May-08	5:19	ENT	1ml plated	no		>300/ml*********	statistically invalid	statistically invalid
										>300/ml*********	statistically invalid	
		18° 2'4.18"N, 63° 5'6.25"W		12-May-08	17:11	ENT	1ml plated	no		>300/ml*********	statistically invalid	statistically invalid
										>300/ml*********	statistically invalid	
		18° 2'4.18"N, 63° 5'6.25"W	land	22-May-08	5:16	ENT	0.1ml plated	no		180/0.1ml	180000/100ml	170000/100ml
										160/0.1ml	160000/100ml	
		18° 2'4.18"N, 63° 5'6.25"W		22-May-08	17:14	ENT	0.1ml plated	no		12/0.1ml	12000/100ml	8000/100ml
										5/0.1ml	5000/100ml	
			lagoon	12-Jun-08	5:20	ENT	1ml plated	no		80/ml	8000/100ml	8900/100ml
										97/ml	9700/100ml	
				12-Jun-08	17:05	ENT	1ml plated	no		2/ml	200/100ml	400/100ml
										7/ml	700/100ml	
	Staphylococcus aureus	18° 2'4.18"N, 63° 5'6.25"W	land	22-May-08	5:16	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*			
		18° 2'4.18"N, 63° 5'6.25"W		22-May-08	17:14	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*			

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
	18° 2'4.18"N,											

	18° 2'4.18"N, 63° 5'6.25"W	land	26-Jun-08	17:15			25	0/0	5.0	0.25	2	0.5
		land	27-Jun-08	17:16	8.18	30.0°C						
		lagoon	12-Jun-08	5:20	8.22	20.8°C******	42	0/0	0.25	0.0	0.0	<0.25
		lagoon	12-Jun-08	17:05	8.45	22.7°C******	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-4a	Total coliform	18° 1'55.46"N, 63° 5'3.69"W	land	12-May-08	5:29	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-4a		18° 1'55.46"N, 63° 5'3.69"W		12-May-08	17:17	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-4a			lagoon	12-Jun-08	5:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-4a				12-Jun-08	17:09	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 4/5 tubes		1600/100ml
CB-4a	Fecal coliform	18° 1'55.46"N, 63° 5'3.69"W	land	12-May-08	5:29	EMB	25ml filtered	no	81/25ml	324/100ml	346/100ml
									92/25ml	368/100ml	
CB-4a		18° 1'55.46"N, 63° 5'3.69"W		12-May-08	17:17	EMB	25ml filtered	no	NC********		NC********
									NC********		
CB-4a		18° 1'55.46"N, 63° 5'3.69"W	land	27-Jun-08	5:17	EMB	0.1 ml plated	no	4/0.1ml	4000/100ml	2000/100ml
									0/0.1ml	0/100ml	
CB-4a		18° 1'55.46"N, 63° 5'3.69"W		26-Jun-08	17:40	EMB	0.1ml plated	no	75/0.1ml	75000/100ml	67000/100ml
									59/0.1ml	59000/100ml	
CB-4a			lagoon	12-Jun-08	5:25	MAC	0.1ml plated	no	14/0.1ml	14000/100ml	13500/100ml

									13/0.1ml	13000/100ml	
CB-4a				12-Jun-08	17:09	MAC	0.1 ml plated	no	1/0.1ml	1000/100ml	500/100ml
									0/0.1ml	0/100ml	
							1ml plated	no	5/1ml	500/100ml	
CB-4a	*Enterococcus spp.*	18° 1'55.46"N, 63° 5'3.69"W	land	12-May-08	5:29	ENT	1ml plated	no	6/ml	600/100ml	500/100ml
									3/ml	300/100ml	
CB-4a		18° 1'55.46"N, 63° 5'3.69"W		12-May-08	17:17	ENT	1ml plated	no	110/ml	11000/100ml	10000/100ml
									90/ml	9000/100ml	
CB-4a			lagoon	12-Jun-08	5:25	ENT	1ml plated	no	NC********	NC********	NC********
									NC********	NC********	
CB-4a				12-Jun-08	17:09	ENT	1ml plated	no	1/ml	100/100ml	100/100ml
									0/ml	0/100ml	
CB-4a	*Staphylococcus aureus*	18° 1'55.46"N, 63° 5'3.69"W	land	12-May-08	5:29	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
CB-4a		18° 1'55.46"N, 63° 5'3.69"W		12-May-08	17:17	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-4a	18° 1'55.46"N, 63° 5'3.69"W	land	27-Jun-08	5:17	7.60	27.7°C	25	0/0	0.5	0.01	0.2	o.o.r*******
	18° 1'55.46"N, 63° 5'3.69"W	land	26-Jun-08	17:40			30	0/0	2.0	0	0	<0.25
		land	27-Jun-08	17:20	8.22	30.2°C						
		lagoon	12-Jun-08	5:25	8.18	21.9°C******	42	0/0	0.25	0.0	0.0	<0.25
		lagoon	12-Jun-08	17:09	8.54	22.3°C******	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests											
location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-5	Total coliform	18° 1'53.10"N, 63° 5'2.94"W	land	12-May-08	5:35	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'53.10"N, 63° 5'2.94"W		12-May-08	17:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	12-Jun-08	5:28	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				12-Jun-08	17:11	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 4/5 tubes		1600/100ml
	Fecal coliform	18° 1'53.10"N, 63° 5'2.94"W	land	12-May-08	5:35	EMB	25ml filtered	no	46/25ml	184/100ml	162/100ml
									35/25ml	140/100ml	
		18° 1'53.10"N, 63° 5'2.94"W		12-May-08	17:25	EMB	25ml filtered	no	NC********		NC********
									NC********		
		18° 1'53.10"N, 63° 5'2.94"W	land	27-Jun-08	5:21	EMB	0.1 ml plated	no	2/0.1ml	2000/100ml	32500/100ml
									63/0.1ml	63000/100ml	
		18° 1'53.10"N, 63° 5'2.94"W		26-Jun-08	17:43	EMB	0.1ml plated	no	340/0.1ml	340000/100ml	388000/100ml
									436/0.1ml	436000/100ml	
			lagoon	12-Jun-08	5:28	MAC	0.1ml plated	no	18/0.1ml	18000/100ml	12167/100ml
									11/0.1ml	11000/100ml	
						MAC	1ml plated	no	75/1ml	7500/100ml	
				12-Jun-08	17:11	MAC	0.1ml plated	no	21/0.1ml	21000/100ml	19000/100ml
									17/0.1ml	17000/100ml	
	Enterococcus spp.	18° 1'53.10"N, 63° 5'2.94"W	land	12-May-08	5:35	ENT	1ml plated	no	74/ml	7400/100ml	7400/100ml
									73/ml	7300/100ml	
		18° 1'53.10"N, 63° 5'2.94"W		12-May-08	17:25	ENT	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	

			lagoon	12-Jun-08	5:28	ENT	1ml plated	no	NC********	NC********	NC********
									NC********	NC********	
				12-Jun-08	17:11	ENT	1ml plated	no	4/ml	400/100ml	400/100ml
									3/ml	300/100ml	
	Staphylococcus aureus	18° 1'53.10"N, 63° 5'2.94"W	land	12-May-08	5:35	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'53.10"N, 63° 5'2.94"W		12-May-08	17:25	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-5	18° 1'53.10"N, 63° 5'2.94"W	land	27-Jun-08	5:21	7.10	30.4°C	10	0/0	2.0	0	0	o.o.r*******
	18° 1'53.10"N, 63° 5'2.94"W	land	26-Jun-08	17:43			9	0/0	5.0	0	0	1.0
		land	27-Jun-08	17:22	7.41	30.8°C						
		lagoon	12-Jun-08	5:28	8.04	21.4°C******	42	0/0	0.25	0.0	0.0	<0.25
		lagoon	12-Jun-08	17:11	8.56	22.1°C******	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-4b	Total coliform	18° 1'50.08"N, 63° 5'2.08"W	land	12-May-08	5:41	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'50.08"N, 63° 5'2.08"W		12-May-08	17:30	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	12-Jun-08	5:32	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml

				12-Jun-08	17:13	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 2/5 and 0/5 tubes		49/100ml
	Fecal coliform	18° 1'50.08"N, 63° 5'2.08"W	land	12-May-08	5:41	EMB	25ml filtered	no	2/25ml	6/100ml	6/100ml
									1/25ml	4/100ml	
		18° 1'50.08"N, 63° 5'2.08"W		12-May-08	17:30	EMB	25ml filtered	no	NC********		NC********
									NC********		
		18° 1'50.08"N, 63° 5'2.08"W	land	27-Jun-08	5:25	EMB	0.1 ml plated	no	115/0.1ml	115000/100ml	102500/100ml
									90/0.1ml	90000/100ml	
		18° 1'50.08"N, 63° 5'2.08"W		26-Jun-08	17:44	EMB	0.1ml plated	no	32/0.1ml	32000/100ml	68500/100ml
									105/0.1ml	105000/100ml	
			lagoon	12-Jun-08	5:32	MAC	0.1ml plated	no	0/0.1ml	0/100ml	1150/100ml
									2/0.1ml	2000/100ml	
						MAC	1ml plated	no	16/1ml	1600/100ml	
									10/1ml	1000/100ml	
				12-Jun-08	17:13	EMB	25ml filtered	no	12/25ml	48/100ml	62/100ml
									19/25ml	76/100ml	
	Enterococcus spp.	18° 1'50.08"N, 63° 5'2.08"W	land	12-May-08	5:41	ENT	1ml plated	no	>300/ml*********	statistically invalid	statistically invalid
									>300/ml*********	statistically invalid	
		18° 1'50.08"N, 63° 5'2.08"W		12-May-08	17:30	ENT	1ml plated	no	>300/ml*********	statistically invalid	statistically invalid
									>300/ml*********	statistically invalid	
		18° 1'50.08"N, 63° 5'2.08"W	land	22-May-08	5:23	ENT	0.1ml plated	no	285/0.1ml	285000/100ml	222000/100ml
									192/0.1ml	192000/100ml	
		18° 1'50.08"N, 63° 5'2.08"W		22-May-08	17:22	ENT	0.1ml plated	no	125/0.1ml	125000/100ml	212500/100ml
									>300/0.1ml*********	statistically invalid	
		18° 1'50.08"N, 63° 5'2.08"W	land	27-Jun-08	5:25	ENT	0.05ml plated	no	120/0.05ml	240000/100ml	210000/100ml
									90/0.05ml	180000/100ml	

		18° 1'50.08"N, 63° 5'2.08"W		26-Jun-08	17:44	ENT	0.05ml plated	no	169/0.05ml	338000/100ml	272000/100ml
									103/0.05ml	206000/100ml	
			lagoon	12-Jun-08	5:32	ENT	1ml plated	no	NC********	NC********	NC********
									NC********	NC********	
				12-Jun-08	17:13	ENT	1ml plated	no	1/ml	100/100ml	100/100ml
									1/ml	100/100ml	
	Staphylococcus aureus	18° 1'50.08"N, 63° 5'2.08"W	land	22-May-08	5:23	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'50.08"N, 63° 5'2.08"W		22-May-08	17:22	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-4b	18° 1'50.08"N, 63° 5'2.08"W	land	27-Jun-08	5:25	7.66	26.7°C	14	0/0	5.0	0.5	5	o.o.r*******
	18° 1'50.08"N, 63° 5'2.08"W	land	26-Jun-08	17:44			20	0/0	5.0	0.5	5	0.5
		land	27-Jun-08	17:24	7.65	28.7°C						
		lagoon	12-Jun-08	5:32	7.93	22.6°C******	42	0/0	0.25	0.0	0.0	<0.25
		lagoon	12-Jun-08	17:13	8.64	22.5°C******	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-6	Total coliform	18° 1'48.26"N, 63° 5'1.50"W	land	12-May-08	5:48	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'48.26"N, 63° 5'1.50"W		12-May-08	17:35	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml

CB-6/7			lagoon	19-Jun-08	5:51	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				19-Jun-08	17:58	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 1'48.26"N, 63° 5'1.50"W	land	12-May-08	5:48	EMB	25ml filtered	no	16/25ml	64/100ml	112/100ml
									40/25ml	160/100ml	
		18° 1'48.26"N, 63° 5'1.50"W		12-May-08	17:35	EMB	25ml filtered	no	68/25ml	272/100ml	392/100ml
									128/25ml	512/100ml	
CB-6/7			lagoon	19-Jun-08	5:51	MAC	1ml plated	no	42/ml	4200/100ml	3500/100ml
									28/ml	2800/100ml	
				19-Jun-08	17:58	MAC	1ml plated	no	105/ml	10500/100ml	10250/100ml
									100/ml	10000/100ml	
	Enterococcus spp.	18° 1'48.26"N, 63° 5'1.50"W	land	12-May-08	5:48	ENT	1ml plated	no	26/ml	2600/100ml	1900/100ml
									12/ml	1200/100ml	
		18° 1'48.26"N, 63° 5'1.50"W		12-May-08	17:35	ENT	1ml plated	no	6/ml	600/100ml	800/100ml
									10/ml	1000/100ml	
CB-6/7			lagoon	19-Jun-08	5:51	ENT	1ml plated	no	43/ml	4300/100ml	4900/100ml
									55/ml	5500/100ml	
				19-Jun-08	17:58	ENT	1ml plated	no	7/ml	700/100ml	700/100ml
									6/ml	600/100ml	
	Staphylococcus aureus	18° 1'48.26"N, 63° 5'1.50"W	land	12-May-08	5:48	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'48.26"N, 63° 5'1.50"W		12-May-08	17:35	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests												
location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)

CB-6	18° 1'48.26"N, 63° 5'1.50"W	land	27-Jun-08	5:28	7.27	29.0°C	17	0/0	0.5	o.o.r*******	0	o.o.r*******
	18° 1'48.26"N, 63° 5'1.50"W	land	26-Jun-08	17:47			25	0/0	0.25	0	0	0.25
		land	27-Jun-08	17:25	7.42	31.0°C						
CB-6/7		lagoon	19-Jun-08	5:51	8.23	29.5°C	40	0/0	0.25	0.0	0.0	<0.25
		lagoon	19-Jun-08	17:58	8.46	31.3°C	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests											
location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-7	Total coliform	18° 1'47.05"N, 63° 5'0.80"W	land	22-May-08	5:30	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'47.05"N, 63° 5'0.80"W		22-May-08	17:28	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-6/7			lagoon	19-Jun-08	5:51	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				19-Jun-08	17:58	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 1'47.05"N, 63° 5'0.80"W	land	22-May-08	5:30	EMB	50ml filtered	1 : 5	39/10ml	390/100ml	200/100ml
									1/10ml	10/100ml	
		18° 1'47.05"N, 63° 5'0.80"W		22-May-08	17:28	EMB	50ml filtered	1 : 5	46/10ml	460/100m	515/100ml
									57/10ml	570/100ml	
CB-6/7			lagoon	19-Jun-08	5:51	MAC	1ml plated	no	42/ml	4200/100ml	3500/100ml
									28/ml	2800/100ml	
				19-Jun-08	17:58	MAC	1ml plated	no	105/ml	10500/100ml	10250/100ml
									100/ml	10000/100ml	

	Enterococcus spp.	18° 1'47.05"N, 63° 5'0.80"W	land	22-May-08	5:30	ENT	0.5ml plated	no	176/0.5ml	35200/100ml	40400/100ml
									228/0.5ml	45600/100ml	
		18° 1'47.05"N, 63° 5'0.80"W		22-May-08	17:28	ENT	0.5ml plated	no	168/0.5ml	33600/100ml	29300/100ml
									125/0.5ml	25000/100ml	
		18° 1'47.05"N, 63° 5'0.80"W	land	27-Jun-08	5:31	ENT	0.1ml plated	no	57/0.1ml	57000/100ml	54000/100ml
									51/0.1ml	51000/100ml	
		18° 1'47.05"N, 63° 5'0.80"W		26-Jun-08	17:49	ENT	0.1ml plated	no	26/0.1ml	26000/100ml	29000/100ml
									32/0.1ml	32000/100ml	
CB-6/7			lagoon	19-Jun-08	5:51	ENT	1ml plated	no	43/ml	4300/100ml	4900/100ml
									55/ml	5500/100ml	
				19-Jun-08	17:58	ENT	1ml plated	no	7/ml	700/100ml	700/100ml
									6/ml	600/100ml	
	Staphylococcus aureus	18° 1'47.05"N, 63° 5'0.80"W	land	22-May-08	5:30	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'47.05"N, 63° 5'0.80"W		22-May-08	17:28	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-7	18° 1'47.05"N, 63° 5'0.80"W	land	27-Jun-08	5:31	7.53	28°C	7	0/0	5.0	4	100	o.o.r*******
	18° 1'47.05"N, 63° 5'0.80"W	land	26-Jun-08	17:49			5	0/0	10	4	100	1.0
		land	27-Jun-08	17:27	7.60	29.9°C						
CB-6/7		lagoon	19-Jun-08	5:51	8.23	29.5°C	40	0/0	0.25	0.0	0.0	<0.25
		lagoon	19-Jun-08	17:58	8.46	31.3°C	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests											
location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-8	Total coliform	18° 1' 47.30"N, 63° 5'3.60"W	land	22-May-08	5:34	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1' 47.30"N, 63° 5'3.60"W		22-May-08	17:33	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-8/9			lagoon	19-Jun-08	5:49	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				19-Jun-08	17:48	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 1' 47.30"N, 63° 5'3.60"W	land	22-May-08	5:34	EMB	50ml filtered	1 : 5	3/10ml	30/100ml	15/100ml
									0/10ml	0/100mml	
		18° 1' 47.30"N, 63° 5'3.60"W		22-May-08	17:33	EMB	50ml filtered	1 : 5	18/10ml	180/100ml	210/100ml
									24/10ml	240/100ml	
CB-8/9			lagoon	19-Jun-08	5:49	MAC	1ml plated	no	30/ml	3000/100ml	3000/100ml
									30/ml	3000/100ml	
				19-Jun-08	17:48	MAC	1ml plated	no	27/ml	2700/100ml	3150/100ml
									36/ml	3600/100ml	
	Enterococcus spp.	18° 1' 47.30"N, 63° 5'3.60"W	land	22-May-08	5:34	ENT	0.5ml plated	no	244/0.5ml	48800/100ml	54000/100ml
									296/0.5ml	59200/100ml	
		18° 1' 47.30"N, 63° 5'3.60"W		22-May-08	17:33	ENT	0.5ml plated	no	288/0.5ml	57600/100ml	56100/100ml
									273/0.5ml	54600/100ml	
CB-8/9			lagoon	19-Jun-08	5:49	ENT	1ml plated	no	NC********		NC********
									NC********		
				19-Jun-08	17:48	ENT	1ml plated	no	0/ml	0/100ml	250/100ml
									5/ml	500/100ml	
	Staphylococcus aureus	18° 1' 47.30"N, 63° 5'3.60"W	land	22-May-08	5:34	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

	18° 1' 47.30"N, 63° 5'3.60"W		22-May-08	17:33	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*	

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-8	18° 1' 47.30"N, 63° 5'3.60"W		There is no water flowing in this gutter anymore									
	18° 1' 47.30"N, 63° 5'3.60"W											
CB-8/9		lagoon	19-Jun-08	5:49	8.22	29.5°C	40	0/0	0.25	0.0	0.0	<0.25
		lagoon	19-Jun-08	17:48	8.50	31.4°C	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
CB-9	Total coliform	18° 1'47.70"N, 63° 5'4.50"W	land	22-May-08	5:37	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'47.70"N, 63° 5'4.50"W		22-May-08	17:32	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
CB-8/9			lagoon	19-Jun-08	5:49	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				19-Jun-08	17:48	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 1'47.70"N, 63° 5'4.50"W	land	22-May-08	5:37	EMB	50ml filtered	1 : 5	4/10ml	40/100ml	90/100ml
									14/10ml	140/100ml	
		18° 1'47.70"N,		22-May-08	17:32	EMB	50ml filtered	1 : 5	150/10ml	1500/100ml	1440/100ml

		63° 5'4.50"W									
									138/10ml	1380/100ml	
CB-8/9			lagoon	19-Jun-08	5:49	MAC	1ml plated	no	30/ml	3000/100ml	3000/100ml
									30/ml	3000/100ml	
				19-Jun-08	17:48	MAC	1ml plated	no	27/ml	2700/100ml	3150/100ml
									36/ml	3600/100ml	
	Enterococcus spp.	18° 1'47.70"N, 63° 5'4.50"W	land	22-May-08	5:37	ENT	0.5ml plated	no	93/0.5ml	18600/100ml	24200/100ml
									149/0.5ml	29800/100ml	
		18° 1'47.70"N, 63° 5'4.50"W		22-May-08	17:32	ENT	0.5ml plated	no	4/0.5ml	800/100ml	700/100ml
									3/0.5ml	600/100ml	
CB-8/9			lagoon	19-Jun-08	5:49	ENT	1ml plated	no	NC********		NC********
									NC********		
				19-Jun-08	17:48	ENT	1ml plated	no	0/ml	0/ml	250/ml
									5/ml	500/ml	
	Staphylococcus aureus	18° 1'47.70"N, 63° 5'4.50"W	land	22-May-08	5:37	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'47.70"N, 63° 5'4.50"W		22-May-08	17:32	MSA	0.1ml plated	n.a.	**Positive** on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
CB-9	18° 1'47.70"N, 63° 5'4.50"W											
	18° 1'47.70"N, 63° 5'4.50"W											
		land	27-Jun-08	17:30	8.05	31.0°C						
CB-8/9		lagoon	19-Jun-08	5:49	8.22	29.5°C	40	0/0	0.25	0.0	0.0	<0.25
		lagoon	19-Jun-08	17:48	8.50	31.4°C	40	0/0	0.25	0.0	0.0	<0.25

Bacterial tests											
location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
SB-1	Total coliform	18° 1'53.01"N, 63° 5'16.00"W	land	30-May-08	5:01	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
		18° 1'53.01"N, 63° 5'16.00"W		30-May-08	17:00	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
			lagoon	19-Jun-08	5:44	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 2/5 tubes		540/100ml
				19-Jun-08	17:44	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Fecal coliform	18° 1'53.01"N, 63° 5'16.00"W	land	30-May-08	5:01	EMB	50ml filtered	1 : 5	4/10ml	40/100ml	175/100ml
									31/10ml	310/100ml	
		18° 1'53.01"N, 63° 5'16.00"W		30-May-08	17:00	EMB	50ml filtered	1 : 5	10/10ml	100/100ml	105/100ml
									11/10ml	110/100ml	
			lagoon	19-Jun-08	5:44	MAC	0.1ml plated	no	1/0.1ml	1000/100ml	1200/100ml
									1/0.1ml	1000/100ml	
						MAC	1ml plated	no	16/ml	1600/100ml	
									12/ml	1200/100ml	
				19-Jun-08	17:44	MAC	0.1ml plated	no	0/0.1ml	0/100ml	350/100ml
									1/0.1ml	1000/100ml	
						MAC	1ml plated	no	1/ml	100/100ml	
									3/ml	300/100ml	
	Enterococcus spp.	18° 1'53.01"N, 63° 5'16.00"W	land	30-May-08	5:01	ENT	0.1ml plated	no	4/0.1ml	4000/100ml	4000/100ml
									4/0.1ml	4000/100ml	
		18° 1'53.01"N, 63° 5'16.00"W		30-May-08	17:00	ENT	0.1ml plated	no	0/0.1ml	0/ml	0/ml
									0/0.1ml	0/ml	

			lagoon	19-Jun-08	5:44	ENT	1ml plated	no	20/ml	2000/100ml	2500/100ml
									30/ml	3000/100ml	
				19-Jun-08	17:44	ENT	1ml plated	no	4/ml	400/100ml	600/100ml
									7/ml	700/100ml	
	Staphylococcus aureus	18° 1'53.01"N, 63° 5'16.00"W	land	30-May-08	5:01	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 1'53.01"N, 63° 5'16.00"W		30-May-08	17:00	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
SB-1	18° 2'13.01"N, 63° 5'7.01"W	land	30-May-08	5:01	7.45	23.4°C******		0/0	3.5	0.0	0.0	<0.25
	18° 2'13.01"N, 63° 5'7.01"W	land	30-May-08	17:00	7.91	23.0°C******		0/0	1.0	0.0	0.0	<0.25
		lagoon	19-Jun-08	5:44	8.28	29.3°C	40	0/0	0.25	0.0	0.0	<0.25
		lagoon	19-Jun-08	17:44	8.36	30.7°C	41	0/0	0.25	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
AP-1	Total coliform	18° 2'38.15"N, 63° 6'39.60"W	land	30-May-08	5:22	PrLb	1:1, 1:10 and 1:100	n.a.	4/5, 2/5 and 0/5 tubes		22/100ml
		18° 2'38.15"N, 63° 6'39.60"W		30-May-08	17:13	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 2/5 tubes		540/100ml
			lagoon	19-Jun-08	5:31	PrLb	1:1, 1:10 and 1:100	n.a.	4/5, 0/5 and 0/5 tubes		13/100ml

				19-Jun-08	17:32	PrLb	1:1, 1:10 and 1:100	n.a.	3/5, 2/5 and 0/5 tubes		14/100ml
	Fecal coliform	18° 2'38.15"N, 63° 6'39.60"W	land	30-May-08	5:22	EMB	25ml filtered	no	8/25ml	32/100ml	44/100ml
									14/25ml	56/100ml	
		18° 2'38.15"N, 63° 6'39.60"W		30-May-08	17:13	EMB	25ml filtered	no	14/25ml	56/100ml	50/100ml
									11/25ml	44/100ml	
			lagoon	19-Jun-08	5:31	MAC	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
				19-Jun-08	17:32	MAC	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
	Enterococcus spp.	18° 2'38.15"N, 63° 6'39.60"W	land	30-May-08	5:22	ENT	1ml plated	no	8/ml	800/100ml	800/100ml
									8/ml	800/100ml	
		18° 2'38.15"N, 63° 6'39.60"W		30-May-08	17:13	ENT	1ml plated	no	10/ml	1000/100ml	900/100ml
									8/ml	800/100ml	
			lagoon	19-Jun-08	5:31	ENT	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
				19-Jun-08	17:32	ENT	1ml plated	no	5/ml	500/100ml	300/100ml
									1/ml	100/100ml	
	Staphylococcus aureus	18° 2'38.15"N, 63° 6'39.60"W	land	30-May-08	5:22	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 2'38.15"N, 63° 6'39.60"W		30-May-08	17:13	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
AP-1	18° 2'10.40"N, 63° 5'6.60"W	land	30-May-08	5:22	8.12	25.3°C******		0/0	10.0	0.1	2.0	<0.25

	18° 2’10.40”N, 63° 5’6.60”W	land	30-May-08	17:13	8.20	24.1°C******		0/0	0.25	0.0	0.0	<0.25	
		lagoon	19-Jun-08	5:31	8.21	29.6°C	41	0/0	0.25	0.0	0.0	<0.25	
		lagoon	19-Jun-08	17:32	8.34	30.3°C	41	0/0	0.0	0.0	0.0	<0.25	

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
AP-2	Total coliform	18° 2'41.88"N, 63° 6'40.07"W	land	30-May-08	5:27	PrLb	1:1, 1:10 and 1:100	n.a.	4/5, 0/5 and 0/5 tubes		13/100ml
		18° 2'41.88"N, 63° 6'40.07"W		30-May-08	17:16	PrLb	1:1, 1:10 and 1:100	n.a.	0/5, 0/5 and 0/5 tubes		<0/100ml
			lagoon	19-Jun-08	5:29	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 3/5 tubes		920/100ml
				19-Jun-08	17:30	PrLb	1:1, 1:10 and 1:100	n.a.	0/5, 0/5 and 0/5 tubes		<0/100ml
	Fecal coliform	18° 2'41.88"N, 63° 6'40.07"W	land	30-May-08	5:27	EMB	25ml filtered	no	22/25ml	88/100ml	56/100ml
									6/25ml	24/100ml	
		18° 2'41.88"N, 63° 6'40.07"W		30-May-08	17:16	EMB	25ml filtered	no	5/25ml	20/100ml	26/100ml
									8/25ml	32/100ml	
			lagoon	19-Jun-08	5:29	MAC	0.1ml plated	no	3/0.1ml	3000/100ml	3500/100ml
									4/0.1ml	4000/100ml	
						MAC	1ml plated	no	28/ml	2800/100ml	
									42/ml	4200/100ml	
				19-Jun-08	17:30	MAC	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
	Enterococcus spp.	18° 2'41.88"N,	land	30-May-08	5:27	ENT	1ml plated	no	22/ml	2200/100ml	1400/100ml

		63° 6'40.07"W										
									6/ml	600/100ml		
		18° 2'41.88"N, 63° 6'40.07"W		30-May-08	17:16	ENT	1ml plated	no	63/ml	6300/100ml	6400/100ml	
									65/ml	6500/100ml		
			lagoon	19-Jun-08	5:29	ENT	1ml plated	no	6/ml	600/100ml	500/100ml	
									4/ml	400/100ml		
				19-Jun-08	17:30	ENT	1ml plated	no	0/ml	0/ml	350/100ml	
									7/ml	700/ml		
	Staphylococcus aureus	18° 2'41.88"N, 63° 6'40.07"W	land	30-May-08	5:27	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*			
		18° 2'41.88"N, 63° 6'40.07"W		30-May-08	17:16	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*			

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
AP-2	18° 2'4.18"N, 63° 5'6.25"W	land	30-May-08	5:27	8.17	25.1°C******		0/0	0.20	0.0	0.0	<0.25
	18° 2'4.18"N, 63° 5'6.25"W	land	30-May-08	17:16	8.33	23.2°C******		0/0	0.25	0.05	1.0	<0.25
		lagoon	19-Jun-08	5:29	8.33	29.6°C	40	0/0	0.25	0.0	0.0	0.25
		lagoon	19-Jun-08	17:30	8.37	30.4°C	41	0/0	0.0	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
AP-3	Total coliform	18° 2'45.70"N, 63° 6'44.96"W	land	30-May-08	5:33	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml

		18° 2'45.70"N, 63° 6'44.96"W		30-May-08	17:22	PrLb	1:1, 1:10 and 1:100	n.a.	4/5, 2/5 and 1/5 tubes		26/100ml
AP-3/4			lagoon	19-Jun-08	5:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
				19-Jun-08	17:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 3/5 and 0/5 tubes		79/100ml
	Fecal coliform	18° 2'45.70"N, 63° 6'44.96"W	land	30-May-08	5:33	EMB	25ml filtered	no	NC********		NC********
									NC********		
		18° 2'45.70"N, 63° 6'44.96"W		30-May-08	17:22	EMB	25ml filtered	no	141/25ml	564/100ml	632/100ml
									175/25ml	700/100ml	
AP-3/4			lagoon	19-Jun-08	5:25	MAC	0.1ml plated	no	21/0.1ml	21000/100ml	18000/100ml
									15/0.1ml	15000/100ml	
				19-Jun-08	17:25	MAC	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
	Enterococcus spp.	18° 2'45.70"N, 63° 6'44.96"W	land	30-May-08	5:33	ENT	1ml plated	no	25/ml	2500/100ml	1900/100ml
									13/ml	1300/100ml	
		18° 2'45.70"N, 63° 6'44.96"W		30-May-08	17:22	ENT	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
AP-3/4			lagoon	19-Jun-08	5:25	ENT	1ml plated	no	10/ml	1000/100ml	1050/100ml
									11/ml	1100/100ml	
				19-Jun-08	17:25	ENT	1ml plated	no	10/ml	1000/100ml	1150/100ml
									13/ml	1300/100ml	
	Staphylococcus aureus	18° 2'45.70"N, 63° 6'44.96"W	land	30-May-08	5:33	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
		18° 2'45.70"N, 63° 6'44.96"W		30-May-08	17:22	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
AP-3	18° 1'55.46"N, 63° 5'3.69"W	land	30-May-08	5:33	7.79	25.3°C******		0/0	0.20	2.0	50.0	<0.25
	18° 1'55.46"N, 63° 5'3.69"W	land	30-May-08	17:22	8.36	24.0°C******		0/0	0.50	0.0	0.0	<0.25
AP-3/4		lagoon	19-Jun-08	5:25	8.15	29.6°C	41	0/0	0.0	0.1	2.0	<0.25
		lagoon	19-Jun-08	17:25	8.34	30.3°C	41	0/0	0.0	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
AP-4	Total coliform	18° 2'45.75"N, 63° 6'45.09"W	land	30-May-08	5:35	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Total coliform	18° 2'45.75"N, 63° 6'45.09"W		30-May-08	17:23	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 4/5 and 1/5 tubes		170/100ml
AP-3/4	Total coliform		lagoon	19-Jun-08	5:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
	Total coliform			19-Jun-08	17:25	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 3/5 and 0/5 tubes		79/100ml
	Fecal coliform	18° 2'45.75"N, 63° 6'45.09"W	land	30-May-08	5:35	EMB	25ml filtered	no	NC******		480/100ml
									120/25ml	480/100ml	
		18° 2'45.75"N, 63° 6'45.09"W		30-May-08	17:23	EMB	25ml filtered	no	189/25ml	756/100ml	720/100ml
									171/25ml	684/100ml	
AP-3/4			lagoon	19-Jun-08	5:25	MAC	0.1ml plated	no	21/0.1ml	21000/100ml	18000/100ml
									15/0.1ml	15000/100ml	

				19-Jun-08	17:25	MAC	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
	Enterococcus spp.	18° 2'45.75"N, 63° 6'45.09"W	land	30-May-08	5:35	ENT	1ml plated	no	32/ml	3200/100ml	2450/100ml
									17/ml	1700/100ml	
		18° 2'45.75"N, 63° 6'45.09"W		30-May-08	17:23	ENT	1ml plated	no	0/ml	0/100ml	0/100ml
									0/ml	0/100ml	
AP-3/4	*Enterococcus spp.*		lagoon	19-Jun-08	5:25	ENT	1ml plated	no	10/ml	1000/100ml/ml	1050/100ml/ml
									11/ml	1100/100ml/ml	
				19-Jun-08	17:25	ENT	1ml plated	no	10/ml	1000/100ml/ml	1150/100ml/ml
									13/ml	1300/100ml/ml	
	Staphylococcus aureus	18° 2'45.75"N, 63° 6'45.09"W	land	30-May-08	5:35	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		
	Staphylococcus aureus	18° 2'45.75"N, 63° 6'45.09"W		30-May-08	17:23	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
AP-4	18° 1'53.10"N, 63° 5'2.94"W	land	30-May-08	5:35	7.69	24.9°C******		0/0	10.0	2.0	50.0	<0.25
	18° 1'53.10"N, 63° 5'2.94"W	land	30-May-08	17:33	8.37	23.4°C******		0/0	0.25	0.0	0.0	<0.25
AP-3/4		lagoon	19-Jun-08	5:25	8.15	29.6°C	41	0/0	0.0	0.1	2.0	<0.25
		lagoon	19-Jun-08	17:25	8.34	30.3°C	41	0/0	0.0	0.0	0.0	<0.25

Bacterial tests

location	Tested for	coordinates of	Where*	Sample date	Sample	Solution/	Method***	Dilution****	results	Results 2******	Final

	the sample site		time	medium**		1*****		results*******

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
AUC		land	25-Jun-08	13:50	7.83	22.7°C******	65	0/0	0.25	0	25	<0.25

Bacterial tests

location	Tested for	coordinates of the sample site	Where*	Sample date	Sample time	Solution/ medium**	Method***	Dilution****	results 1*****	Results 2******	Final results*******
Rosewater treatment system 1	Total coliform	18° 2'0.55"N, 63° 5'6.17"W	pipe	30-May-08	16:38	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
Rosewater treatment system 2		18° 2'1.35"N, 63° 5'6.17"W	pipe	30-May-08	16:45	PrLb	1:1, 1:10 and 1:100	n.a.	5/5, 5/5 and 5/5 tubes		≥2,400/100ml
Rosewater treatment system 1	Fecal coliform	18° 2'0.55"N, 63° 5'6.17"W	pipe	30-May-08	16:38	EMB	25ml filtered	no	NC********		NC********
									NC********		
Rosewater treatment system 2		18° 2'1.35"N, 63° 5'6.17"W	pipe	30-May-08	16:45	EMB	25ml filtered	no	NC********		NC********
									NC********		
Rosewater t treatment system 2		18° 2'1.35"N, 63° 5'6.17"W	pipe	26-Jun-08	17:22	EMB	0.1 ml plated	no	160/0.1ml	160000/100ml	237500/100ml
									315/0.1ml	315000/100ml	
Rosewater treatment system 1	*Enterococcus spp.*	18° 2'0.55"N, 63° 5'6.17"W	pipe	30-May-08	16:38	ENT	1ml plated	no	0/ml	0/ml	0/ml
									0/ml	0/ml	
Rosewater treatment system 2		18° 2'1.35"N, 63° 5'6.17"W	pipe	30-May-08	16:45	ENT	1ml plated	no	102/ml	10200/100ml/ml	8450/100ml
									67/ml	6700/100ml/ml	
Rosewater treatment system 1	*Staphylococcus aureus*	18° 2'0.55"N, 63° 5'6.17"W	pipe	30-May-08	16:38	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*		

Rosewater treatment system 2	18° 2'1.35"N, 63° 5'6.17"W	pipe	30-May-08	16:45	MSA	0.1ml plated	n.a.	negative on *Staphylococcus aureus*	

Fieldwork tests

location	coordinates of the sample site	Where*	Sample date	Sample time	pH	Temperature	Salinity	Chlorine total/free	Phosphate** (PO4 3-)	Nitrite*** (NO2)	Nitrate**** (NO3)	Ammonia***** (NH3)
Rosewater treatment system 1	18° 2'0.55"N, 63° 5'6.17"W	pipe	30-May-08		7.65	24.1°C******		0/0	>10	4	100	0.5
Rosewater treatment system 2	18° 2'1.35"N, 63° 5'6.17"W	pipe	30-May-08		7.96	23.2°C******		0/0	>10	0	0	1.0
Rosewater treatment system 2	18° 2'1.35"N, 63° 5'6.17"W	pipe	26-Jun-08	17:22			3	0/0	>10	0	0	1.0

Side notes Bacterial tests

*		where is the sample taken; in the gutter/stream or +/-3 meter of land in the lagoon.
**	Total coliform	PrLb stands for: Phenol red Lactose broth
	Fecal coliform	EMB stands for: Eosin Methylene Blue
		MAC stands for: Mac Conkey
	Enterococcus spp.	ENT stands for: Entercoccosal Media (= Bile Esculia Agar)
	Staphylococcus aureus	MSA stands for: Mannitol Salt Agar
		15 tubes for each location: 5 tubes with 10ml of phenol red lactose broth on 10ml of the sample,
***	Total coliform	5 tubes with 10ml on 1ml and 5 tubes with 10ml on 0.1ml. So 1:1, 1:10 and 1:100.
	Fecal coliform, filtered	Filtered through a filter of 0.45µm
****		n.a. means not applicable
*****		These are the results directly from the plates or tubes
******		These are the results multiplied for the final results
*******		These are the final results as is can be used
		The results that are **bold** are exceeding the norm, except for total coliform because there is no norm
********		NC means: not countable because too many colonies were growing on top of each other.

	Unable to concentrate the Fecal coliform colonies. Next time it should be diluted.
*********	>300 colonies on a plate is not statistically valid (according to dr. Shupe). This should be diluted next time

Fieldwork tests	
*	
**	Phosphate (PO4 3-) in ppm, mg/L
***	Nitrite (NO2) in ppm, mg/l
****	Nitrate*** (NO3) in ppm, mg/l
*****	Ammonia**** (NH3) in ppm, mg/l
******	These temperatures were not taken in the field, but in the lab
*******	o.o.r. = out of reagent