Operation SWIM

Sub-Watershed Investigative Monitoring

Mini - Report

2002 – 2003

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Introduction

Operation SWIM is a program that arose in 1997, to supplement the Annapolis River Guardians Program, both technically and financially. The original idea was to identify and subsequently remedy sources of fecal coliform bacteria in tributaries within the watershed. A report was produced after the initial field season (Montgomery 1997), and gives a comprehensive history of the program. The report also includes sampling protocols, complete results for that year, and recommendations for the program. A report has not been produced since this time, although sampling in the name of Operation SWIM has proceeded.

This mini-report includes results from the 2002 field season, although past data may also be included in some cases. Suggested sampling protocol is also given, as well as instructions on the membrane filtration technique. A list of relevant sources of scientific information pertinent to this program and the water quality coordinator position in general is included. Recommendations on how this program should proceed are also given. This document is meant to function as both a medium for reporting results of the 2002 field season, and as a partial guide for future Water Quality Coordinators at CARP. Hopefully this will ensure consistency in methods and actions for this position, and promote scientific validity.

Results

The tributaries and watercourses that were sampled at least once in 2002 were Belleisle Marsh, Black River, Fales River, Graves Brook, Solomon-Chute Brook, Leonard Brook, Shearer Brook, and Round Hill River.

Graves Brook and Solomon-Chute Brook

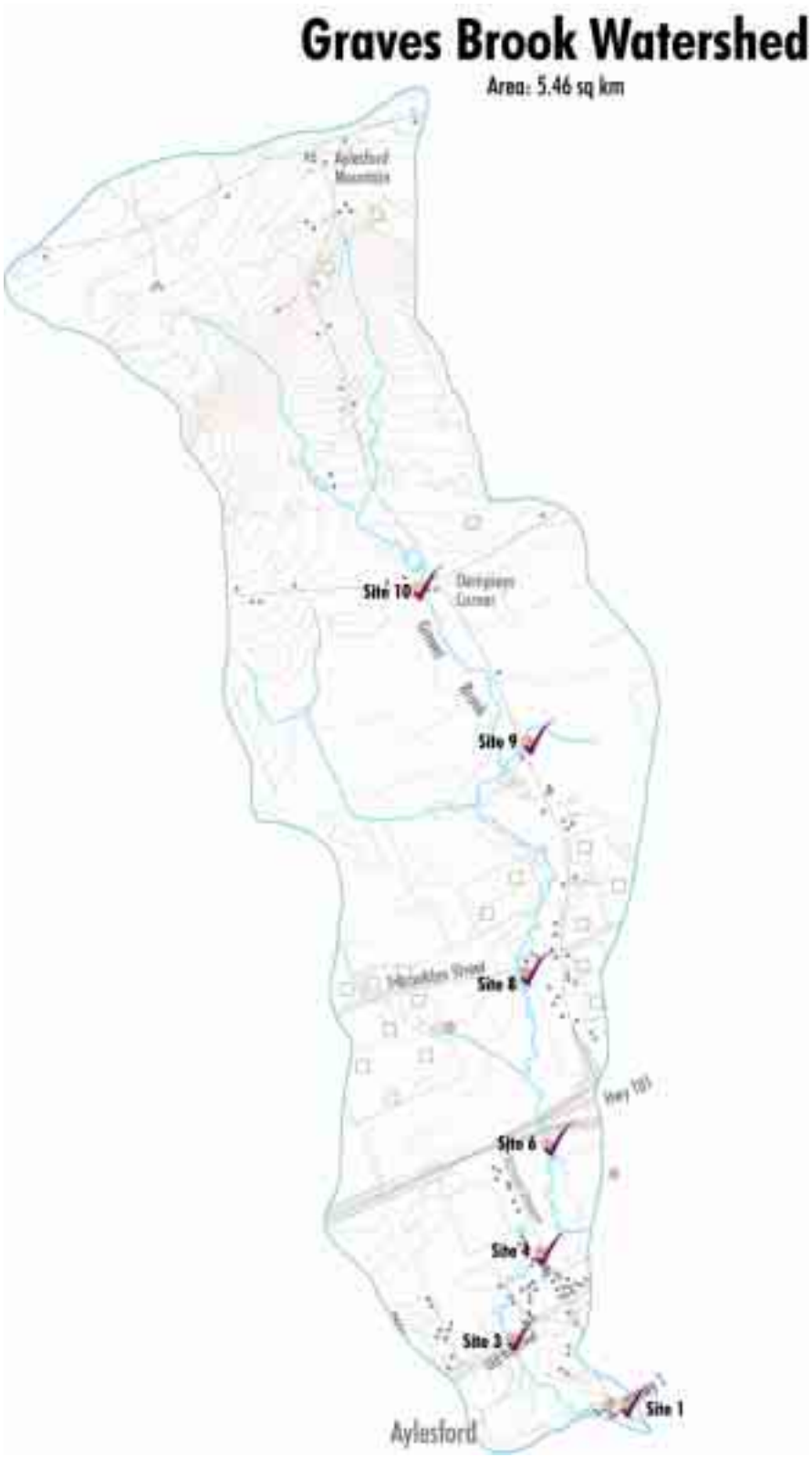
Graves Brook and Solomon-Chute Brook were unfortunately only sampled one time, at a time when the water quality coordinator was becoming acquainted with the position.

Results (2002) from Graves Brook, which runs down the north mountain through agricultural land, the town of Aylesford and enters the Annapolis River west (downstream) of the Victoria Harbour Road bridge, are given in Table 1. Sample locations are given in Map 1, with sites sampled in 2002 are checked. Fecal coliform densities are listed under the date on which the sample was taken, and are in colony forming units (cfu)/100ml of water.

Results (2002) from Solomon-Chute Brook, which runs down from the north mountain through agricultural land, the town of Bridgetown and enters the Annapolis River west (downstream) of the Bridgetown bridge, are also given in Table 1. Sample locations are given in Map 2. The sites sampled in 2002 are checked.

Graves Brook		Solomon-Chute Brook	
Site #	May 29/02	Site #	May 30/02
1	46	2	TNTC
3	36	3	TNTC
4	71	4	80
6	TNTC	4a	TNTC
8	26	5	105
9	2	6	0
10	3		

Table1:
Fecal coliform densities for Graves Brook and Solomon-Chute Brook for 2002. TNTC is too numerous to count.



Map 1: Graves Brook Watershed Sampling Sites

Round Hill River

Results from the Round Hill River are given in Table 2. Two volunteers sampled this site in 2002. One sampled the "upper" portion of the river, which is sites 1 thru 4 respectively, shown on Map 2. Another volunteer was interested in further downstream portions of the river, which correspond to sites 5 to 7, with sample site #6 being on the Aboiteau Creek. Figure 1 gives graphical representation for the upper section, while Figure 2 gives graphical results for the lower portion of the Round Hill River. The upper and lower sections were sampled together once, on August 20th.

Round Hill River SWIM 2002

Site #	May 29/02	Aug 20/02
1	8	52
2	0	26
3	12	52
4	0	26

Site #	July 3/02	July 16/02	July 30/02	Aug 20/02	Sept 16/02	Geomean	Average	Median
5	35	22	8	50	1	13	23	22
6	36	12	196	1	33	19	56	33
7	24	136	142	57	7	45	73	57

Table 2:
Fecal coliform densities for Round Hill River. Sites 1 through 4 on top, and sites 5 through 7 are on bottom.

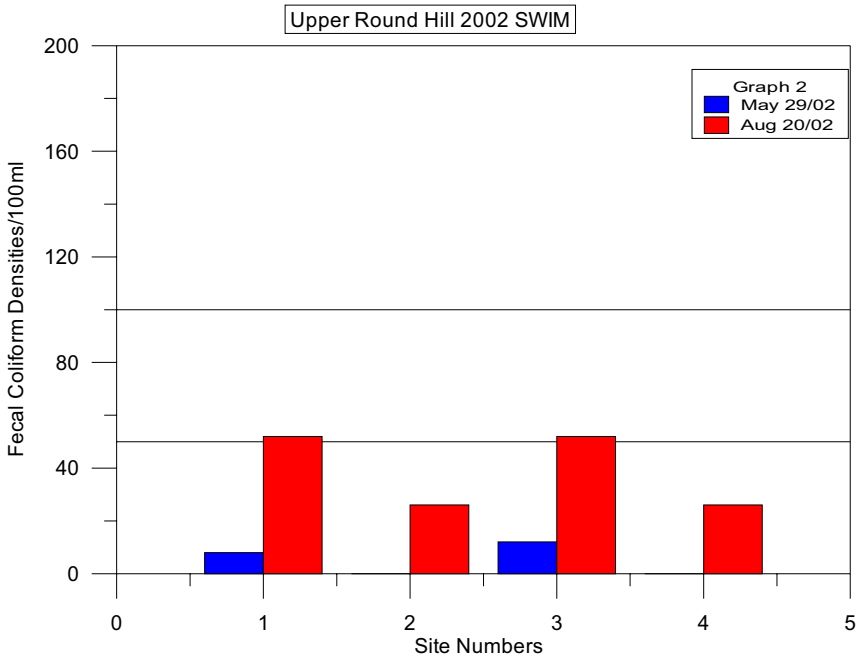


Figure 1:
Graph of fecal coliform densities on the upper portion of the Round Hill River.

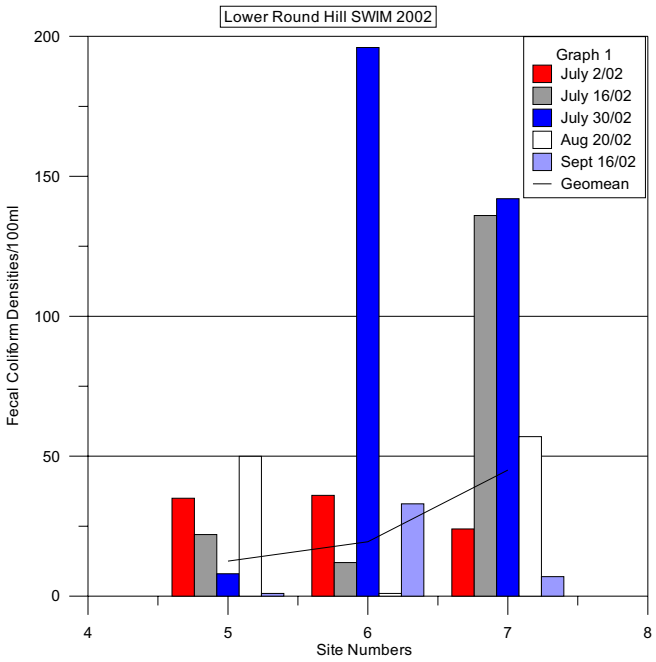
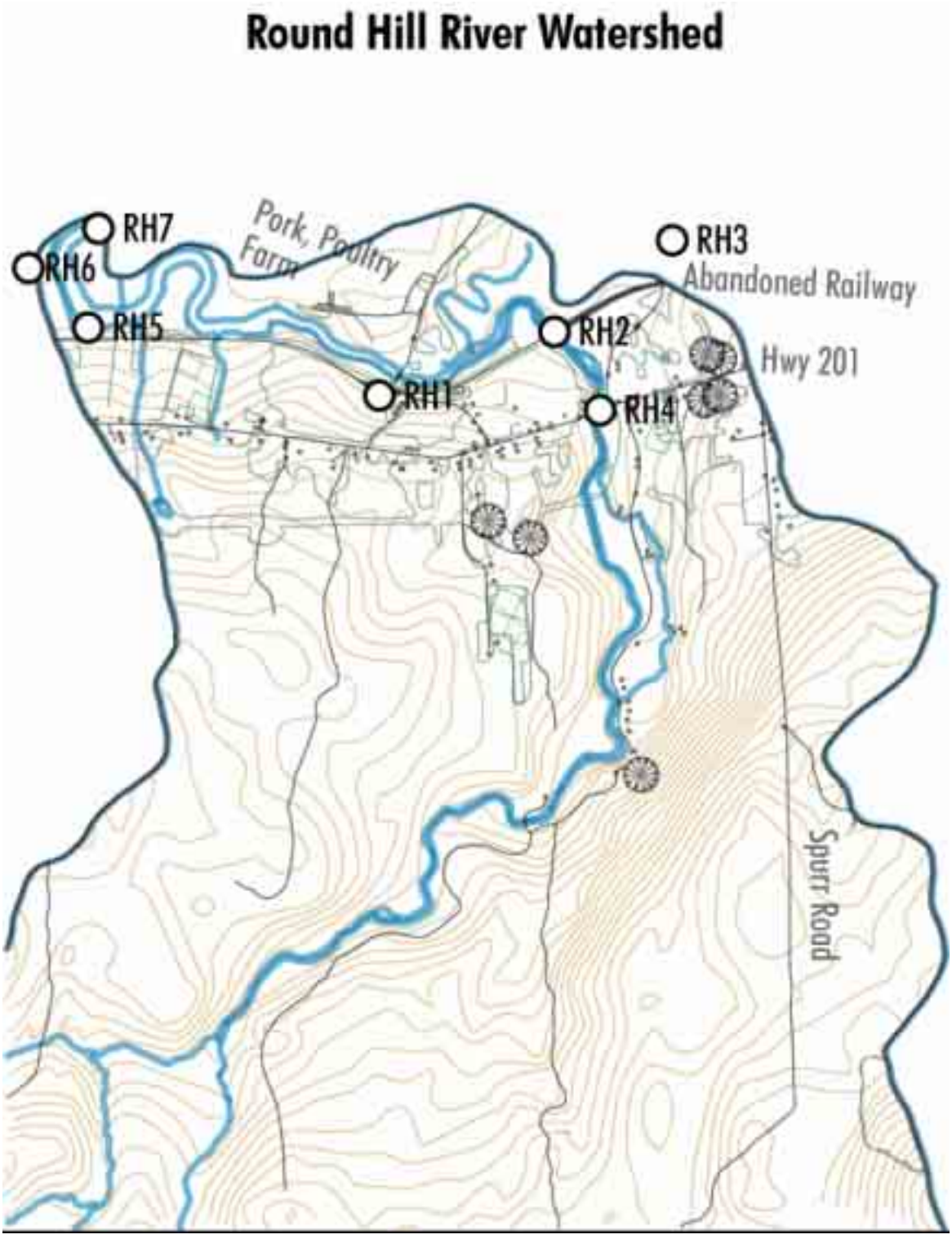


Figure 2:
Graph of fecal coliform densities on the lower portion of the Round Hill River.



Map 2: Round Hill River Sampling Sites

Belleisle Marsh

Results (2002) from Belleisle Marsh, which is a Ducks Unlimited constructed wetland, are given in Table 3 and accompanying graph in Figure 3. Three ponds and two sample sites along the drainage watercourse were sampled three times by an Operation SWIM volunteer in 2002.

Belleisle Marsh SWIM 2002

Site #	Aug. 6/02	June 5/02	July 9/02	Geomean	Average	Median
10	284	81	8	57	124	81
20	72	20		38	46	46
30	35	16	12	19	21	16
40	20	26	30	25	25	26
50	90	17	40	39	49	40

Table 3:
Fecal coliform densities for Belleisle Marsh, 2002

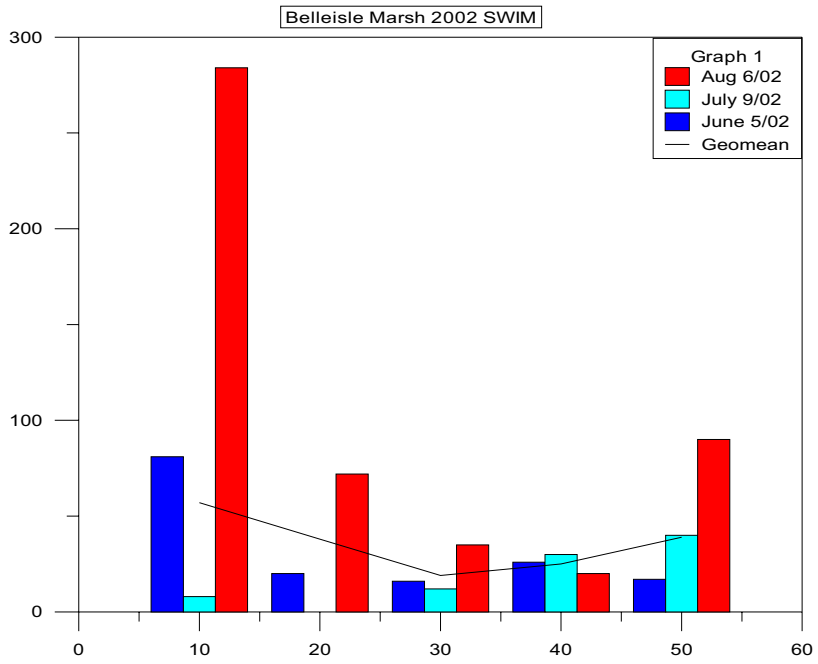


Figure 3:
Graph of fecal coliform densities for 2002, with geometric mean.

Black River

Results (2002) from the Black River, which runs through agricultural lands and the residential communities of Torbrook and Tremont on the south side of the Annapolis, are given in Table 4 with accompanying graphs given in Figure 4. This River was sampled four times by the Water Quality Coordinator in 2002. Sites 21 and 25 were not sampled all four times in 2002, and site 40 is on a tributary of the Black River. Map 3 gives the sample locations of the Operation SWIM sites in 2002. Current numbering protocol for 2002 starts with site #10 as the sample taken nearest to the Annapolis River.

Black River 2002 SWIM

Site #	Aug 19/02	Aug 27/02	July 16/02	Sept 18/02	Geomean	Average	Median
10	87	66	86	118	87	89	86.5
20	103	100	60	108	90	93	101.5
30	153	43	88	134	94	105	111
50	66	33	102	112	71	78	84
60	3	30	118	81	30	58	55.5
70	43	138	70	60	71	78	65
80	20	15	21	63	25	30	20.5
21		43		102	66	73	72.5
25		166			166	166	166
40	220	240	400	112	221	243	230

Table 4:
Fecal coliform densities for Black River 2002.

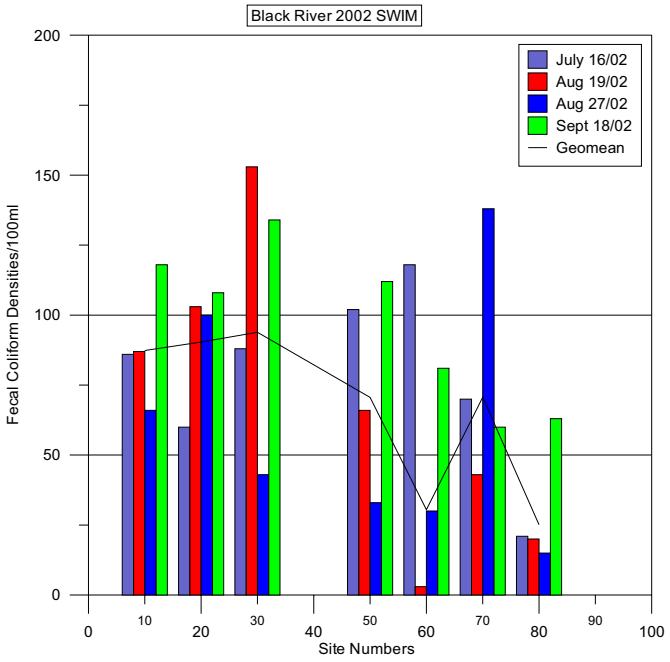
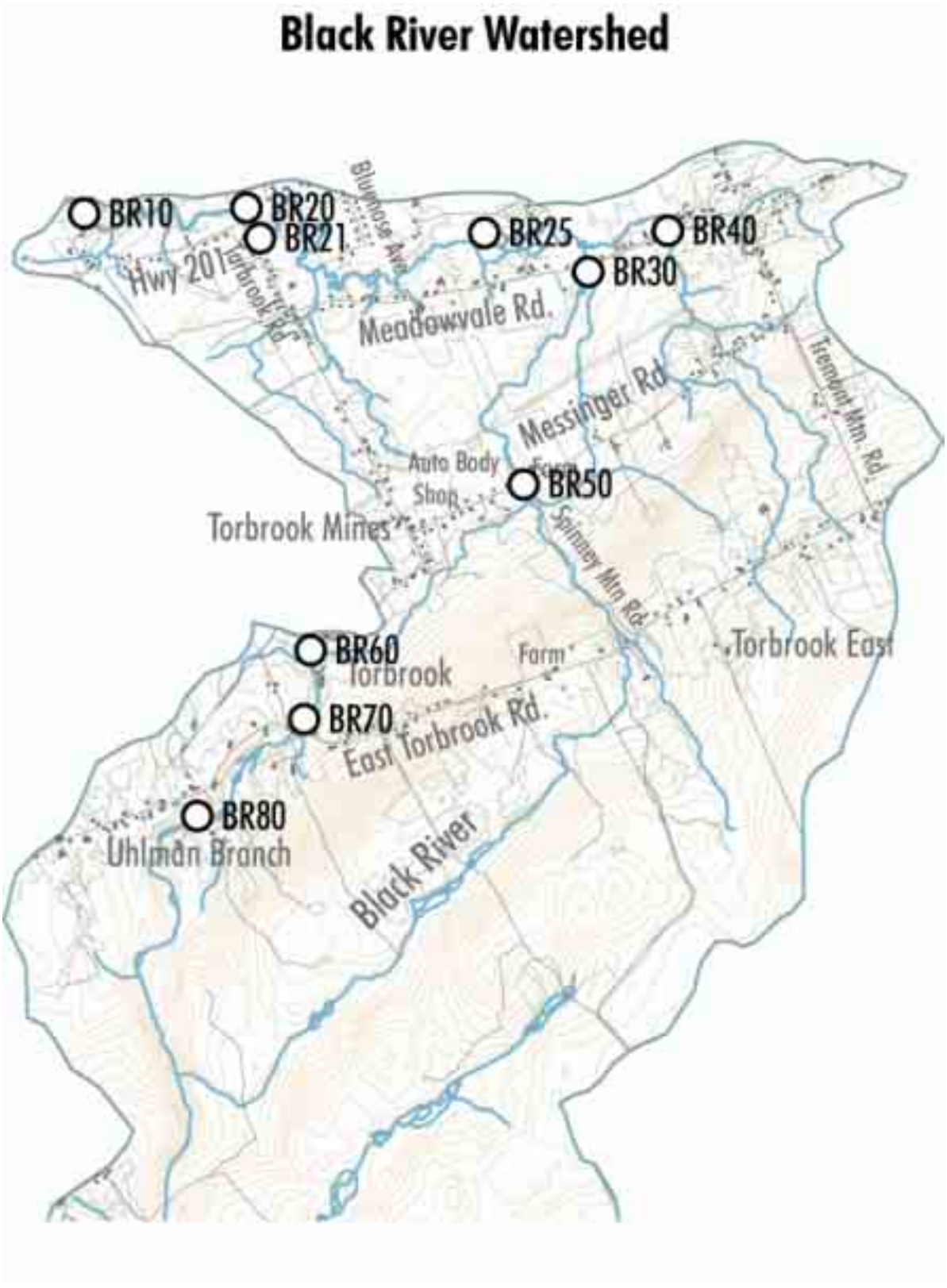


Figure4:
Graph of fecal coliform densities of main stem Black River sites for 2002



Map 3: Black River Watershed Sampling Sites

Fales River

Results (2002) from the Fales River, which accepts effluent from the Greenwood Sewage Treatment Plant, and enters the Annapolis River west of Greenwood and Kingston. The results are given in Table 5 with accompanying graphs given in Figure 5. Sites 11 and 15 were not taken on all sampling occasions. This River, which CARP has recently completed fish habitat restoration, was sampled three times by the water Quality Coordinator in 2002. Map 4 shows the samples sites for the Fales River.

Fales River SWIM 2002

Site #	Aug. 14/02	July. 29/02	Sept. 10/02	Geomean	Average	Median
10	317	334	214	283	288	317
20	114	60	140	99	105	114
21	74	44	6	27	41	44
22	90	72	3	27	55	72
23	97	52	6	31	52	52
30	47	85	12	36	48	47
31	15	35	5	14	18	15
32	66	212	96	110	125	96
40	3	1	1	1	2	1
11			89	89	89	89
15	119		82	99	101	100.5

Table 5:
Fecal coliform densities for Fales River 2002. Note site 32 is taken on a tributary of the Fales River

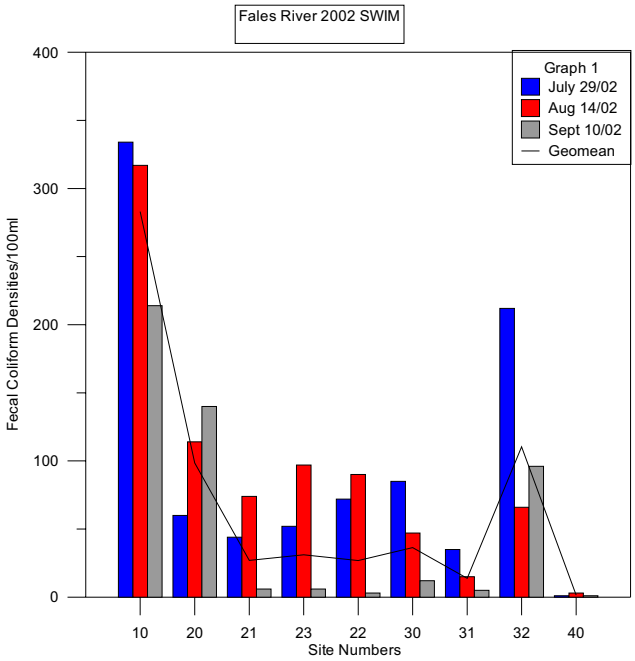
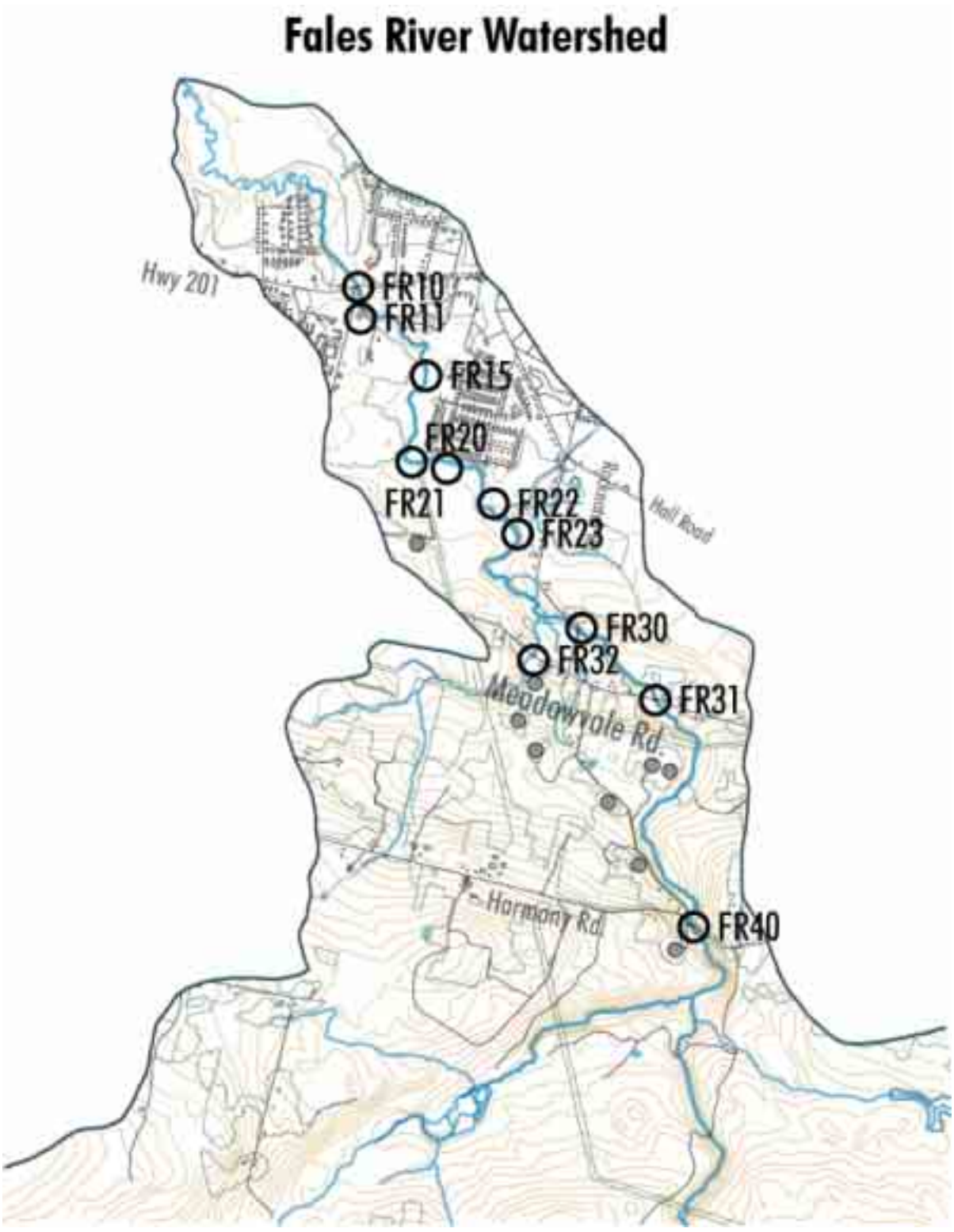


Figure 5:
Graph of fecal coliform densities for the Fales River: 2002, with geometric means. Note Site 32 is on a tributary of the Fales River.



Map 4: Fales River Watershed Sampling Sites

Shearer and Leonard Brook

Results from Leonard and Shearer Brook are given in Tables 6 and 7 respectively. Leonard Brook was sampled once with a volunteer, and then four more times with a student at AGRG. Shearer Brook was also sampled with the student from AGRG. These results have been incorporated into a land-use report on these two brooks. For further details and a copy of the report contact Alex Mosher or Tim Webster at AGRG. Map 5 gives past sample sites for Leonard Brook, as well as sample sites for the AGRG project. Map 6 gives sample sites for the AGRG project on Shearer Brook.

Map 5: Past sample sites for Leonard Brook, as well as sample sites for the AGRG project

Map 6: Sample sites for the AGRG project on Shearer Brook

Discussion of Operation SWIM Tributaries

Graves Brook

Graves Brook is a small tributary that runs through large tracts of agricultural land near Aylesford, and had very little water in it, even in May when sampling was done. This site unfortunately was only sampled once in 2002, and speculating on this one sample population is not advisable. However, it can be seen that sample number 6 gave the highest fecal coliform densities on this particular day. It is downstream a pasture that was active at the time of sampling.

Solomon-Brook

Solomon-Chute Brook was also unfortunately only sampled once. High fecal coliform densities occur at all sites, except site 6, which is near the spring fed source. The count at this point is 0. Sample sites 2, 3, 4a, 4, and 5 all have elevated counts, some due possibly to beaver activity in the area (sites 3 and 5), with other sites near agricultural land (sites 4a, 4). Bridgetown is on a central sewer system, and high counts at site 2 on this particular day are of concern. Investigations into whether these high counts are a result of transport of fecal coliforms from upstream, or from a localized source is warranted

Fales River

The Fales River accepts effluent from the Greenwood and area sewage treatment plant. Samples were taken above and below the effluent pipe on all three sampling occasions. The treatment plant seems to be working well in reducing fecal coliform load to the Fales River, as the counts above and below is similar, excepting the sample day of September 10th. Even on this day the fecal coliform densities were only 140 cfu/100ml. It should be noted that during the summer months there is an abundance of plant and algae material downstream of the effluent, and elevated nitrate and phosphate concentrations.

Sample site 32 also has consistently higher fecal coliform counts, although this is taken on a tributary of the Fales River, and has very low flow in the summer months. The cause of these counts is unknown at this time.

The concern on this river is that the farthest downstream site sampled, site #10, has consistently high counts. There is a storm drainpipe immediately upstream (left bank) and upon sampling (#11) this gave lower counts than at site #10. Site #15 was also added to investigate the problem, but again the counts were lower here. Investigation of the river between site 15 and site 10 revealed large amounts of aquatic wildlife, including numerous beaver dams, muskrat habitat and waterfowl. These are thought to be the main contributor to the high counts at site #10 on the Fales River. A pipe was also noted between these two sites. It was not discharging at the time, and is thought to be an old storm drainpipe of some type. Its function should be investigated. There are a few houses on the left bank upstream of site 10, but there were no signs that they contribute to the problem.

Black River

The Black River has been investigated extensively over the years, including a report written in 2000 (Annis). As a result, investigators for the same sample site location have employed different numbering systems. River Guardians sample sites 19B, 19I and 19H correspond to 2002 Operation SWIM sites BR20, BR30 and BR40, respectively. The Black River needs to be examined on a site by site basis. Site# 10, furthest downstream has slightly lower counts than site #20. This suggests low input of fecal coliform along this section of river. Site # 20 has counts of 100 or over, three

out of four times in 2002. Likely sources include a large beaver dam that is upstream of this site. Another possible source includes malfunctioning septic systems from near-by residences, although a stream survey showed no evidence of these. It is also suspected that the Black River has a high sediment load that would facilitate transport of fecal coliforms and from upstream sources. Site #30 has variable counts ranging from 43 to 153 cfu/100ml. The suspected culprit is unrestricted access of livestock to the river, which is known to occur upstream of this site. Another less likely possibility is aquatic wildlife, as there is considerable forested land immediately upstream of this site. Site #50 has counts ranging 33 to 112, and on average was lower than the sites downstream, and higher than the sites upstream. This site also has unrestricted access to the river, as a fence runs across at this point. No cattle were observed during the 2002 field season, although evidence of cattle was observed. Site #60 has wide ranging counts from 3 to 118. The river has a cattle pasture on the left bank approximately 30m upstream of this site. This pasture is fenced from the river about 1 to 2m from the bank, but there is an insufficient riparian zone established. Site #70 has counts that range from 43 to 138, slightly higher than expected in an area that is so rural. There is an unknown pipe immediately upstream of this sample site. It was not observed discharging during the 2002 field season. Malfunctioning or non-existent septic systems are a possibility here, as well as contamination from aquatic wildlife. Site #80, the furthest upstream, consistently has the lowest counts, which range from 20 to 63. Of note is the Torbrook Construction and Debris disposal site that is further up the Uhlman Branch Road.

Site #40 is located on a tributary of the Black River was not running to the main stem when the sampling took place. The sites counts are consistently high and this is addressed in the River Guardians water quality report.

Site #21is slightly upstream of site #20, and was taken to determine whether a bird population under the bridge at site #20 played a role in the fecal coliform counts. Site# 21 was lower on one sampling occasion and comparable on another, and it is thought that the bird population does not play a significant role in counts at site #20.

Site #25 was taken between sites 20 and 30 on the main stem of the Black River, to gain a more comprehensive coverage of the river. It was only taken once, however, due to the difficulty in reaching this site. The sample was taken downstream of a residence on the right bank and resulted in a count of 166.

Round Hill River

The Round Hill River has been sampled numerous times in the past, and thus the numbering system has been left as is for the 2002 sampling season. In the past sites 1 thru 4 have been sampled. In 2002, a new volunteer became interested of a portion of river downstream of sites 1 thru 4. These were called 5, 6, and 7 respectively. It is interesting to note that sites 5, 6, and 7 are all downstream of a large farming operation, as well as pasture land, and sites 1 through 4 are all upstream of this area. Traditionally, and it can be seen again in 2002, that sample sites 1 through 4 yield relatively low fecal coliform densities, which would be expected of sites with low development. Sites 5 through 7 are relatively low. These sites are taken in larger volumes of water that is saline and tidal, and may help keep the counts lower. These sites were predominately taken at times when there was little rain.

Recommendations for Operation SWIM

Operation SWIM was initiated to identify sources of fecal coliform contamination in the Annapolis River watershed. The variability of fecal coliform densities found in surface waters, due to numerous factors in the environment, make this an extremely difficult task, especially if volunteers are required to do the bulk of the sampling. That being said, Operation SWIM can play a role in helping to identify sources of fecal coliform contamination, if there are established sampling and analysis techniques employed to this end.

- A numbering system must be established and adhered to. In the past, multiple numbering and combination number/letter systems have been used, sometimes two or three different on the same watercourse. The system employed in 2002 is a logical one that is transferable and expandable. The furthest sample station/site downstream (closest to the Annapolis River) is referred to as 10, and every subsequent site upstream is then referred to as 20, 30, 40 and so on. If the investigator feels there is a need to add sites, then a maximum of 8 sites can then be added between 10 and 20, or whatever the case may be. This eliminates the need for adding letters to the number system, and also will keep the system consistent, throughout the watershed.
- Volunteers should never be turned down if they would like to participate. However, CARP is not a free water testing service. It must be initially explained to the volunteer that this type of testing has to be done more than once, more than once a year, and usually every couple of weeks to start. The reasons for wanting to test a certain stream or brook should also be ascertained. It they do not have a particular watercourse in mind, the water quality coordinator can direct them, preferably to one in their area.
- Accurate record keeping must be employed. Reports should be written annually and include maps with site numbers, status of the sampling, and analysis of the watercourse. Results, besides being kept accurately on the field sheets (2002 sheets in Appendix A), should be transferred to an electronic medium, be it an Access database or excel spreadsheet.
- Complete laboratory procedure for the Membrane filtration technique is given in Appendix B. These should be adhered to. Scientific support for this protocol and others are listed in Appendix C.
- Mapping needs to be vastly improved. A GIS would be invaluable to this end. When searching for things, in this case potential sources of fecal coliform contamination, maps are essential, in not only identifying sources but also recording the information for prosperity.
- A work plan needs to be established for each field season. It should be possible for the coordinator to sample two or three watercourses personally and also facilitate volunteer sampling at the same time. Do not over extend resources, or many tributaries may be sampled only once, which is not the goal.
- Field procedures must be adhered to and related to any volunteers that come into the program. A reference field protocol is given in Appendix D. This will ensure consistency in field sampling and valid results.
- SWIM was started to support River Guardians sampling in terms of identifying sources of fecal contamination that were being recorded by the River Guardians. However, SWIM sampling tributary locations often were not selected to best support the River Guardians results. In other words, tributaries that got sampled were often downstream of established River Guardians sites. It is recommended a methodical approach be taken when selecting tributaries for SWIM. Whenever possible, tributaries that discharge directly upstream of River Guardians sites should be chosen. Also, special attention should be given to sewage treatment plant effluent to ascertain the amounts of fecal contamination contributed by each individual STP. These effluents discharge both into the main stem of the Annapolis River, as well as various tributaries.

Location: ____________________
Date: ____________________
Sampled By: ____________________

Controls:

Negative: ____________ Positive: ____________

FIELD

Sample #	Time 24hrs	Temp°C	Comments

Sample #	Time 24hrs	Temp°C	Comments

LABORATORY

Sample #	ml filtered	#colonies	#cfu/100ml	Comments

Sample #	ml filtered	#colonies	#cfu/100ml	Comments

Precipitation 24hrs __________
48hrs __________
72hrs __________

Incubation Temp: __________
Media Lot: __________
Sterilization Equipment: __________

Date Filtered: __________
Time Filtered: __________
Filtered By: __________

Date Counted: __________
Time Counted __________
Counted By: __________

Appendix B – Membrane Filtration Technique CARP

1. Sterilize the work surface with alcohol. Wash hands or wear gloves.
2. Sterilize filter apparatus prior to sample filtration, either with 70% alcohol or in Ultraviolet Light sterilization box for at least ten minutes.
3. Set up the filter apparatus by placing the filter holder in the suction flask.
4. Using sterile forceps (sterilize in flame from alcohol burner) place a membrane filter on the filter support assembly.
5. Attached sterile filtration unit (magnetic).
6. Run a negative water control (100ml sterile distilled water – "before"). Turn on vacuum until water is completely filtered.
7. Rinse filter apparatus with 20-30ml of sterile distilled water. Use spray bottle to rinse down sides of filter apparatus.
8. Turn off vacuum.
9. Squirt 2ml of m-FC ampoule (this is premeasured) onto absorbent pad in petri dish.
10. After removing filter funnel, remove membrane filter and place filter face up on media (m-FC with rosolic acid) soaked absorbent pad in 47mm petri dish with sterile forceps.
11. Ready to start processing water samples.
12. Pour the appropriate amount of test sample water into filter apparatus after shaking the sample bag or bottle 20 to 30 times. Apply vacuum.
13. Rinse filter apparatus with 20 -30 ml of sterile distilled water, turn off vacuum then place membrane filter face up on media (m-FC with rosolic acid) soaked absorbent pad in 47 mm petri dish.
14. Sterilize filter apparatus for 2 to 3 minutes in UV box, to prevent organism carry-over.
15. Repeat steps 12, 13 and 14 until all water samples are processed.
16. Upon completion of filtration of test samples, run a positive control with known source of *E.coli*. Appropriate amount is 1colony mixed in 50ml of sterile distilled water, and then 0.5ml of this mixture diluted in 199.5ml of sterile distilled water.
17. Rinse, sterilize and run another negative water control ("after").
18. Place petri dishes face down in 44.5°C air incubator for 24hrs +- 2 hrs.
19. Verify temperature, and after the appropriate amount of incubation time, count the colonies. 20-60 colony forming units (cfu) on the plate is ideal. Dark blue colonies are enumerated and represent *E. Coli*.

Notes: Always use aseptic technique. Keep accurate records.
Be careful with equipment, and respect the laboratory, as some equipment and all lab space is not CARP's.
Complete information on this technique and others can be found in " Info on fecal coliforms" file.
Do not overflow vacuum flask.

Appendix C – Scientific and Support and Information Sources – Water Quality Coordinator Position

Mike Brylinsky – Aquatic Ecologist – Acadia University - Official scientific advisor for this position. Contact (902) 585-1509, mike.brylinsky@acadiau.ca

Greg Benzanson – Microbiologist – Acadia University – Involved with Bacteriological source tracking project for CARP. E.coli strains for postive controls can be obtained here. Contact (902) 585- 1594, greg.benzanson@acadiau.ca

Trefor Reynoldson – Acadia University/Environment Canada – Everything you ever wanted to know about Canadian Aquatic Biomonitoring Network. Contact (902) 585-1638, trefor.reynoldson@acadiau.ca

Mike Parker – East Coast Aquatics/ Board Member - Sediment Monitoring Support. (902) 665 –4682 mrsparker@ns.simpatico.ca

Bob Rowe – Department of Environment and Labour – Former project team member, knowledge of sewage treatment plants. (902) 679-6086, rowerj@gov.ns.ca

Brad Langille – Department of Environment and Labour – Inspector Specialist/ Board Member – (902) 679-6086, langilbd@gov.ns.ca

Geoff Mercer – Environment Officer, Canadian Forces Base Greenwood, 765-1494

Stuart MacDonald – Nova Scotia Power Inc. Manager Tidal Power Plant, 532-2306.

Websites in Resources for WQC (Favourites on COMP11)

http://deq.state.wy.us/wqd/watershed/10574-doc.pdf -Manual of Standard Operating Procedures for Sample Collection and Analysis - Wyoming

http://www.epa.gov/region9/lab/sops/sop1103.html Info on Colilert

http://www.dal.ca/~cwrs/cwrs/onsite/phs4rpt.htm Info on On-site wastewater technology

http://app.hach.com/coaExpDateweb/customer_coaExpDt_request.asp – Expiry dates for Hach products (DO test)

http://www.dasc.vt.edu/jones/Streams.htm – Riparian Zone site

http://www.buzzardsbay.org/ Great general information site

http://www.epa.gov/owow/monitoring/vol.html – Excellent resource for volunteer monitoring programs

http://www.epa.gov/teachers/curriculumwater.htm –Water curriculum for presentations

http://www.ecy.wa.gov/programs/wq/plants/management/joysmanual/4oxygen.html – Dissolved Oxygen information

http://www.riverwatch.org/ - Another great general information source

http://www.cst.cmich.edu/centers/mwrc/resources.htm – Nitrogen and phosphate information

http://www.agric.gov.ab.ca/sustain/water/final_wq_guide.html –Introductory guide to surface water quality monitoring

http://oh.water.usgs.gov/micro/lab.html –Analytical and Field procedures for Standard Bacterial Indicators

http://snr.uvm.edu/sal/ecoli/pages/waterqu.htm – Page on Bacterial water quality

http://www.atl.ec.gc.ca Links to other ACAP sites and projects.

Appendix D – Field Procedures

Whirl Pak bags (supplier – CanadaWide) are used to collect water samples for Operation SWIM. These are affordable, simple to use and sterile. Collection of water samples should initially be taken along the length of a watercourse to help identify problem areas. Repeat sampling of the watercourse should take place in a timely manner so that a higher sample population can be acquired. Initially identify sites based on accessibility, and suspected contamination areas. Sampling above and below suspected pollution sources is recommended. This may entail walking the stream, which is preferably done in pairs. Always ask for landowner permission for access even when in the watercourse.

When taking samples, some volunteers use a sampling device such as a can on a string. This practice should be discouraged due to the possibility of organism carry-over. Whenever possible, it is preferable to take the samples from in the stream. Mid-stream, at a depth of 15 to 30cm is standard. Always approach the sample site from downstream and be careful not to disturb the sediment at the sample location. A space should be left at the top of each whirl pak bag so that the samples can be shaken and mixed before laboratory processing. Samples should be labeled correctly and kept cool. Processing should take place within 24 hours of collection.

When relatively high fecal coliform densities are discovered, an effort should be made to examine areas upstream of these sites to determine possible sources of contamination.