

EPA's Volunteer Monitor's Guide to Quality Assurance Project Plans

Element 1.

**Long-Term  
Five Year: 2013 – 2017  
QUALITY CONTROL / QUALITY ASSURANCE PROJECT PLAN**

**LAY MONITORING PROGRAM FOR LAKE CHAMPLAIN**


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**Element 2.**

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### Element 3. Distribution List

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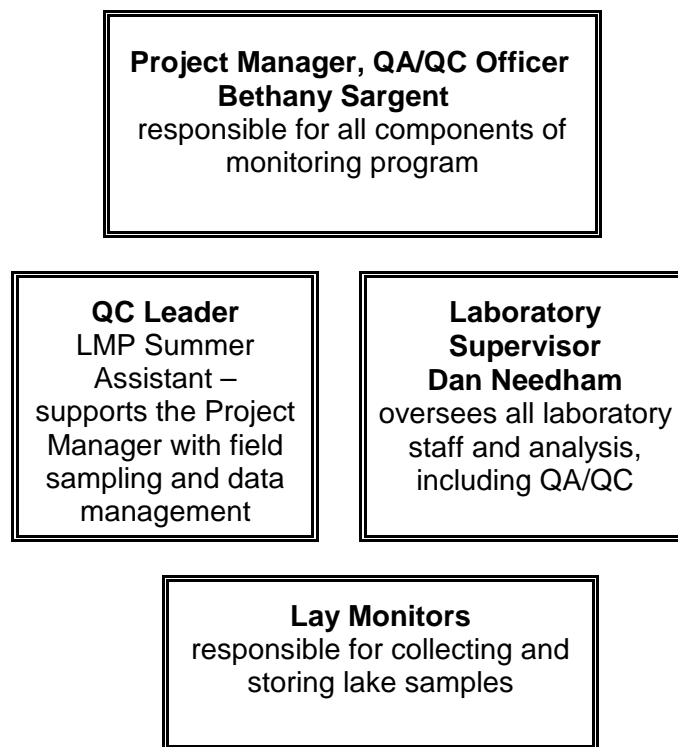
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### Element 4. Project/Task Organization

Figure 1. Organizational Chart



The primary data users are the State DEC, lake associations, and citizen watershed groups.

### Element 5. Problem/Definition/Background

#### General Description

This project is a continuation of the water quality monitoring on Lake Champlain that has been conducted under the Vermont Lay Monitoring Program (LMP) since 1979. Under the LMP, citizen volunteers are trained to measure water clarity and to collect water samples for chlorophyll-a and total phosphorus analysis. Through the use of volunteers, essential baseline water quality data is collected, and lake residents and users are better informed regarding lake biology and lake water quality protection.

## Project Objectives

The principal objectives of this project are: (1) to collect water quality data and incorporate it into the long-term eutrophication monitoring database started in 1979, (2) to use the data for water quality assessment and management decision-making, and to track progress toward compliance with phosphorus criteria adopted in 1991 as Lake Champlain management objectives, and (3) to educate and involve lake users in lake protection.

## Element 6. Project/ Task Description

### Sampling

Sampling is designed to monitor trophic state parameters. Lake Champlain is known to have suffered declines in water quality due to accelerated eutrophication in some regions. The program, therefore, measures nutrient concentration and primary productivity. Although sample collection has occurred at 42 different stations since the beginning of the program in 1979, today the program only uses 37 of these stations as these are located throughout the lake and best represent the broad water quality range that exists in Lake Champlain.

### Sampling Parameters

Each year the monitored stations on Lake Champlain (Table 1) are sampled weekly from Memorial Day through Labor Day for the following:

- Secchi disk transparency reading
- Chlorophyll-a concentration samples
- Total phosphorus concentration sample

A hose sampling method is used for lake stations deeper than four meters, while sub-surface grab samples are taken at shallower stations. The sampling procedure is repeated to collect two chlorophyll-a samples, therefore all chlorophyll-a samples are taken in duplicate at each station and are analyzed separately. Chlorophyll-a water samples are filtered at a lakeside site. Filters are then frozen and stored until pickup by program staff. Total phosphorus water samples are collected in duplicate at least one time during the summer. Monitors take their duplicates during the LMP staff field visits with the monitors. Also at this time, program staff members take an extra phosphorus sample for laboratory analysis of spiked samples (part of the internal lab QA/QC plan). All phosphorus samples are stored in glass test tubes. Program staff transport samples bi-weekly to the DEC Laboratory, currently housed on the University of Vermont campus in Burlington, for processing. (See Appendix A, Vermont Department of Environmental Conservation, Vermont Lay Monitoring Program Manual, 2000.)

### Timeline

Table 1. Timeline

Date	Task
May – June	Monitor training
June – September	Sample collection
June – August	Monitor quality checks
December	All lab analyses completed and submitted to Project Manager
January	Data entry into project database
March	Final project report

Table 2. Lake Champlain Lay Monitoring Stations

<b>Station</b>	<b>Latitude (deg min)</b>	<b>Longitude (deg min)</b>	<b>Total Depth (m)</b>
01	43 34.26	73 25.57	3
02	43 51.21	73 22.58	3
03	43 57.06	73 24.28	3
04	44 11.03	73 22.52	53
05	44 16.06	73 18.44	107
06	44 25.33	73 13.55	22
07	44 27.59	73 16.38	40
08	44 28.10	73 22.34	50
09	44 32.46	73 19.39	10
10	44 34.55	73 16.52	32
11	44 33.54	73 12.30	23
12	44 40.19	73 14.01	30
13	44 40.48	73 25.00	10
14	44 45.22	73 22.15	14
15	44 45.18	73 18.40	4.5
16	44 45.30	73 13.16	27
17	44 47.07	73 09.44	6
18	44 51.44	73 12.55	15
19	44 56.54	73 20.24	6
20	44 00.48	73 10.26	4
21	44 39.53	73 18.12	9
22	44 55.04	73 11.11	8
23	44 53.09	73 16.28	3.5
24	44 00.01	73 07.33	3
25	44 50.12	73 18.06	4.5
26	44 13.18	73 19.32	2
29	44 50.23	73 17.48	7.5
30	44 58.33	73 12.54	4.5
31	44 38.16	73 15.17	7.5
32	44 38.32	73 22.56	58
33	44 28.49	73 13.90	15
34	44 07.34	73 24.46	45
35	44.39.40	73 24.46	6
36	TBC	TBC	6
37	44 50.74	73 18.67	15

38	44 15.78	73 17.22	8
39	44 16.02	73 17.94	7
40	44 29 11.62	73 14 22.33	12
41	44 25.46	73 16.43	68
42	44 0.38	73 24.38	4

Note: Stations 1, 25, 26, 27 and 28 are no longer used in the Lake Champlain Lay Monitoring Program. TBC = to be calculated

## Element 7. Data Quality Objectives for Measurement Data

### Quantitative QA Objectives

#### Lab QA Protocol

Table 3. QA Objectives for Precision, Accuracy, and Quantitation Limit

Parameter	Sample Matrix	Practical Quantitation Limit (PQL) <sup>a</sup>	Estimated Accuracy (%Recovery) <sup>b</sup>	Estimated Precision (RPD) <sup>c</sup>	Lab RPD
TP	Water	5.0 ug/l	85-115%	14	15 <sup>d</sup>
Chlorophyll-a	Water	0.5 ug/l	-	17	10
Secchi Disk	Water	n/a	n/a	2.5	n/a

<sup>a</sup> PQL is the minimum reported value.

<sup>b</sup> Section 5.0, Vermont Department of Environmental Conservation Laboratory QA Plan, 2007.

<sup>c</sup> Estimated from average relative percent difference of Lay Monitor field duplicates.

<sup>d</sup> RPD for phosphorus calculated from instrument duplicates.

### Qualitative QA Objectives

#### Field QA Protocol

Program staff will accompany each monitor on one normal sampling day and observe monitor technique for error. At this time the sampling procedure is replicated and duplicates are taken by the monitor. An approximate total of 10% of the field samples will be replicated to validate the accuracy of lay monitoring. Monitors are asked to collect a minimum of nine samples (not including the duplicates) during June, July and August, which is approximately 64% of the maximum number of weekly samples possible to collect during these three summer months. A minimum of eight samples is required to calculate a summer mean for the Vermont Lay Monitoring Program (Vermont Lay Monitoring Field Method Manual, 2000).

Completeness: The weekly sampling frequency allows for adequate characterization of productivity conditions in Lake Champlain during the summer.

Comparability: The Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan, including the standard operating procedures, is consistent with current EPA methods. Lake stations are the same ones sampled since 1979 with the following ones being added since then: station 31 added in 1990; stations 32, 33, 34 and 35 added in 1992; station 36 added in 1994; station 37 added in 2003; and stations 38-42 added between 2008-2011.

Representativeness: Stations 1 – 42 were selected to represent the broad range of water quality conditions in the lake. Stations 1, 25, 26, 27 and 28 have been officially dropped from the program. Preliminary results from the Lake Champlain Diagnostic Feasibility Study indicated that these stations were not suitably located for long term water quality trend detection by the Lake Champlain Lay Monitoring Program.

### Performance and System Audits

The LMP staff will inform monitors of any technique errors during quality assurance visits. Staff will review with and demonstrate to monitors the proper technique when necessary. Staff will read monitor

comments on data sheets bi-weekly and monitor questions will be answered and assistance given when needed. Monitors will be encouraged to call staff with any problems they have with any aspect of the program.

Performance and system audits for laboratory analytical centers are detailed in the Laboratory Quality Assurance Plan (VT DEC, 2013) and are the responsibility of the Laboratory Supervisor.

## **Element 8. Training Requirements and Certification**

The LMP Assistant is trained in all aspects of the program by the Project Manager. Typically a new LMP Assistant will spend two weeks shadowing the Project Manager in the many aspects of the program. Additionally, the LMP Assistant is given a copy of the Lay Monitoring Program Assistant Guide (Picotte, 2002) to read and to have on hand in the field.

All Lake Champlain Lay Monitors are trained in the sampling procedures at their lake station by the LMP staff and a list of trained monitors is maintained by the Project Manager. During training all parts of the sampling procedure are explained in detail and demonstrated. The LMP staff and the monitor take turns performing each part of the sampling procedure. Sections which present difficulties to the monitors are repeated several times until they are comfortable sampling on their own. Monitors are given the data sheet to fill out and to use as a guide to the sampling steps. All sampling steps are written on a laminated card and the monitors are reminded to refer to these steps when sampling. Monitors are encouraged to take notes on procedures and follow along in the LMP Manual as well. Trainings typically take two to four hours for monitors, depending on the location of their station.

## **Element 9. Documentation and Records**

Monitors are trained to use the program's data sheets and equipment when sampling. Data sheets and samples are properly stored until program staff picks them up once every two weeks (Vermont Department of Environmental Conservation, Lay Monitoring Program Manual, 2000).

### **Sample Custody Procedures**

Samples will be collected from monitors by program staff and brought to the lab bi-weekly in labeled containers. Program staff is responsible for logging the samples into the lab data management system where a unique identification number is assigned to each sample. Program staff then deliver the sample containers to the appropriate storage area or analytical lab. Individual analysts are responsible for retrieving samples from the storage areas for analysis. Samples will not be used for enforcement purposes. All data results are maintained in the VTDEC Watershed Management Division database management system.

## **Element 10. Sampling Process Design**

### **Sampling Site Distribution**

The current 23 monitoring stations are distributed throughout the lake (Table 2) and represent a broad range of water quality conditions.

## **Element 11. Sampling Methods Requirements**

Sampling methods are covered in Element 6 of this QA/QC plan and described in the Vermont Department of Environmental Conservation, Lay Monitoring Program Manual (2000).



Table 4. Sampling Method and Quantity Requirements

Location of Weekly Sampling	Sampling Method	Analysis Parameter	Sample Volume (ml)	Sample Container	Field Procedures
Lake Champlain Stations 02, 03, 20, 23, 24, 30, 35, 36, 42	Secchi Disk	Transparency	-	-	observation
	Sub-Surface Grab	TP	50	Glass tube	none
		Chlorophyll-a	100	Filter paper, (Glass Microfibre particular retention 1.6um)	filtration
Lake Champlain Stations 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 29, 31, 32, 33, 34, 37, 38, 39, 40, 41	Secchi Disk	Transparency	-	-	observation
	Hose Sample	TP	50	Glass tube	none
		Chlorophyll-a	100	Filter paper (Glass Microfibre particular retention 1.6um)	filtration

### Element 12. Sample Handle and Custody Requirements

Reference – Element 9 of this QA/QC Plan.

### Element 13. Analytical Methods Requirements

#### Sample Analysis

Table 5. Parameter Table

Parameter	Number of Samples <sup>a</sup>	Sample Matrix	DEC (SOP) Reference <sup>b</sup>	EPA Analytical Method	Sample Preservation	Holding Time
TP	572	water	1.6	4500-P H <sup>c</sup>	none	28 days
Chlorophyll-a	1144	water	5.4	445 Revision 1.2 <sup>d</sup>	freeze, dark	21 days

<sup>a</sup> Includes field QC samples from Program Staff.

<sup>b</sup> Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013), Appendix A – Laboratory Standard Operating Procedures (March and June 2005 SOP)

<sup>c</sup> Standard Methods for the Examination of Water and Wastewater, 21<sup>st</sup> Edition (2005)

<sup>d</sup> In Vitro Determination of Chlorophyll-a and Pheophytin-a in Marine and Freshwater Algae Fluorescence, 1997. National Exposure Research of Research and Development, USEPA.

### Element 14. Quality Control Requirements

#### Laboratory Analytical Procedures

Reference – Sections 11 and 14 of Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013)

## Field Samples

Lake Champlain has 42 lay monitoring stations (37 remain in use, and 23 are currently being sampled by the LMP). They were selected to represent the broad range of water quality conditions in the lake.

Monitors are required to collect two different water samples, sample A and sample B from a separate sampling at their respected stations.

Collecting chlorophyll-a samples: The two samples (A and B) are filtered (100 mls each) and are assigned a unique laboratory identification number upon arrival at the lab. The samples are analyzed as individual chlorophyll-a samples and two separate results are reported.

Collecting phosphorus samples: A 50 ml portion of sample B, stored in a glass test tube, is analyzed for total phosphorus. Total phosphorus water samples are collected in duplicate at least one time during the summer (approximately 10% of all phosphorus samples). Duplicate phosphorus samples are collected from a 50 ml portion of sample bottle A and a 50 ml portion from sample bottle B, with the sample from bottle A being labeled as the duplicate. The phosphorus duplicates are collected by the monitors during the LMP staff field visits with the monitors. During the annual LMP staff visits with the lay monitors, additional duplicate samples (minimum of 10 %) are taken for the laboratory staff to use as part of their quality assurance program, which includes a sample for analyzing spiked samples. The LMP staff will fill two 50 ml test tubes, one with lake water from sample bottle A to be used by the lab for spikes, and the other with lake water from sample bottle B, also for lab use.

RPD of Monitor Duplicate Samples:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

RPD = relative percent difference

C<sub>1</sub> = larger of the two observed values

C<sub>2</sub> = smaller of the two observed values

Due to logistical constraints in picking up and delivering samples to the laboratory, it is not always possible to analyze all chl-a and TP samples within the prescribed 21- and 28-day hold times, although every effort will be made to do so. These samples will be properly stored throughout this time. A remark field in the database will be used to identify samples analyzed in the laboratory past their hold times so that appropriate data screening may be applied if deemed necessary at the time the data are statistically analyzed and reported.

Reference – Vermont Department of Environmental Conservation, Lay Monitoring Program Manual (2000)

## Corrective Action

Upon joining the Lay Monitoring Program, all monitors are given a copy of the Vermont Lay Monitoring Program Manual, which contains explanations, graphics, and checklists for proper sampling techniques. Monitors will be asked to review this manual and also be reminded that the sampling procedures are listed on a laminated card to be used while sampling in the field. Monitors are required to follow the LMP sampling procedures to participate in the LMP program and are visited (checked) annually by program staff.

For laboratory use, corrective actions are defined in Section 15 of the Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013).

## Element 15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

## **Laboratory Analysis QA/QC – Calibration Procedures, Analytical Procedures and Preventive Maintenance**

Reference – Section 8, 9, and 13 of Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013)

### **Field Sampling Equipment**

The Vermont DEC supplies all the equipment except for a boat and anchor to the volunteer monitors. Before any equipment is supplied to a volunteer, it is carefully checked by LMP staff. Secchi disk lines are measured and marked off in meters. Hoses are also marked off in meter increments. All Nalgene 500 ml sample bottles (each monitor is given a sample bottle “A” and “B”), hand filtering apparatuses, graduated cylinders, 5 gallon buckets, and hoses are acid washed (10% solution of sulfuric acid) and thoroughly rinsed before being given to monitors. The 50 ml glass test tubes are disposable and provided clean and new from the DEC Laboratory. All equipment is checked during the annual LMP staff field visits with monitors. On a rotational basis, hoses are collected from the monitors and acid washed by LMP staff before being returned to monitors. The monitors who plan to return to the program for the next season are asked to store the equipment during the winter months. Monitors are given written directions on properly storing equipment during the winter months. New filter papers, glass test tubes, and data sheets are provided at the start of each sampling season.

Reference – Vermont Lay Monitoring Program Manual, 2000

### **Element 16. Instrument Calibration and Frequency**

Reference – Element 15 of this QA/QC Plan

### **Element 17. Inspection and Acceptance Requirements for Supplies**

All monitoring supplies used are either the exact same make as equipment used in past years, or are comparable replacement products. Most of the sampling equipment used is purchased through the laboratory supplier, VWR Scientific, to ensure consistent use of the exact same filter paper, sample bottles, graduated cylinders, and other field supplies needed. The hoses and rope purchased are non-stretch. Annual records of all equipment purchased and used by the LMP are kept to ensure consistency in selecting any new sampling equipment.

Reference – Element 15 of this QA/QC Plan and the Vermont Lay Monitoring Program Manual, 2000

### **Element 18. Data Acquisition Requirements**

Monitors are provided with Watershed Management Division Vermont Lake Maps that show the locations of the sampling stations, along with GPS coordinates. Monitors are trained by LMP staff to locate their sampling stations using these maps and, when possible, the GPS coordinates.

### **Element 19. Data Management**

All sampling results are maintained in the VTDEC Watershed Management Division database management system.

Reference – Element 9 of this QA/QC Plan

### **Element 20. Assessments and Response Actions**

Reference – Element 7 and Element 14 of this QA/QC Plan

## **Element 21. Reports**

Data for each monitoring station will be summarized and compiled into an annual report for distribution to volunteer monitors, state agencies, and organizations and individuals interested in Lake Champlain's water quality. This annual final report is the responsibility of Bethany Sargent, Project Manager.

## **Element 22. Data Review, Validation and Verification Requirements**

### **Data Reduction**

Reference – Section 10 of Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013)

## **Element 23. Validation and Verification Methods**

The validation of laboratory data is the primary responsibility of the Lab Supervisor utilizing methods documented in Section 10 of the Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013).\*

At the program level, the Project Manager validates the data according to the following process: Secchi disk readings and total phosphorus concentrations from each lake are reviewed and compared to previous year's data. If any samples seem unusually high or low, then the monitor data sheets are checked for that day's sampling comments (monitors might be called as well) and the Laboratory Staff is consulted about possible errors. All samples where monitors used questionable techniques, or where they noted problems with sampling or sample storage, and where chemists noted problems, are not validated and the data not used.

To average both the chlorophyll-a duplicates for a single concentration value, the two samples must be evaluated according to the following:

If  $H/L < 2.5$ , then both values are kept.

If  $H/L > 2.5$  lab and data sheets are checked for an explanation,

- if the lake is eutrophic or if algal blooms were present, both values are kept.
- if there is no written reason, then both values are tossed.
- if only one value is questionable, that value will be tossed and the other used.

\*Reference – Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan (2013), Section 9.

\*\*H = high concentration, L = low concentration

## **Element 24. Reconciliation with Data Quality Objectives**

The LMP is a cooperative effort between the Vermont DEC and lake users to collect essential baseline water quality data on Vermont lakes. Monitors are asked to collect a minimum of nine samples during June, July and August – a minimum number of eight is needed to calculate summer means. If fewer than eight samples are collected during the summer months, no annual mean can be calculated for that year and the data is used to describe only current water quality conditions, and not for long term trend analysis. Monitors on more than 91 lakes in Vermont have participated in the LMP and have contributed substantially to the understanding of water quality conditions in Vermont lakes.

Reference – Element 14 of this QA/QC Plan

Reference – Vermont Lay Monitoring Program Manual, 2000

## References

Standard Methods for the Examination of Water and Wastewater. 21<sup>st</sup> Edition. 2005 (EPA Analytical Method, 4500-PF 445 Revision 1.2)

In Vitro Determination of Chlorophyll-a and Pheophytin-a in Marine and Freshwater Algae Fluorescence, 1997. National Exposure Research of Research and Development, USEPA.

Environmental Protection Agency. 1996. The Volunteer Monitor's Guide to Quality Assurance Project Plans

Vermont Department of Environmental Conservation Laboratory Quality Assurance Plan, 2013. Waterbury, VT

Vermont Department of Environmental Conservation, Vermont Lay Monitoring Program Manual, 2000. Waterbury, VT

Vermont Department of Environmental Conservation, Vermont Lay Monitoring Assistant Guide, 2002. Waterbury, VT

Appendix A. Lake Names and Locations

<b>NAME</b>	<b>Lat DD.MM</b>	<b>Long DD.MM</b>	<b>Total Depth of Station #1 (meters)</b>
AMHERST	4349	7371	21
ARROWHEAD MTN.	4440	7306	7.6
BEEBE (HUB)	4344	7311	12
BLISS	4421	7230	4.5
BOMOSEEN	4339	7313	18.2
BUCK	4428	7224	9.2
BURR (SUD)	4346	7311	4.6
CARMI	4458	7252	11
CASPIAN	4435	7219	30
CEDAR	4415	7308	3.8
CHIPMAN	4324	7302	3.4
COLE	4309	7248	3.0
COLES	4450	7221	6.4
CRYSTAL (BARTON)	4444	7209	30.5
CURTIS	4423	7230	7.6
DANBY	4322	7303	2.0
DERBY	4457	7207	5.2
DUNMORE	4354	7305	30
EAST LONG	4427	7221	30
ECHO (CHARLES)	4452	7200	39
ECHO (HUB)	4345	7311	12.2
EDEN	4443	7230	11.9
ELFIN	4328	7259	11
ELLIGO	4436	7221	30.3
ELMORE	4432	7232	5.2
FAIRFIELD	4451	7259	13
FAIRLEE	4353	7214	15

<b>NAME</b>	<b>Lat DD.MM</b>	<b>Long DD.MM</b>	<b>Total Depth of Station #1 (meters)</b>
FERN	4352	7304	12.7
FOSTERS	4432	7221	3.9
GLEN	4340	7314	18.3
GREAT AVERILL	4459	7142	30
GREAT HOSMER	4442	7222	13
GREEN RIVER RES.	4438	7231	28
GREENWOOD	4427	7225	9
GROTON	4416	7216	13
HALLS	4405	7207	9
HARVEYS	4418	7208	40
HOLLAND	4459	7156	11.5
HORTONIA	4345	7312	18
INDIAN BROOK RES.	TBC	TBC	7.6
IROQUOIS	4422	7305	10
ISLAND	4448	7152	12
JOES (DANVILLE)	4425	7213	15
LOWELL	4313	7246	7.3
LYFORD	4427	7215	6.1
MAIDSTONE	4439	7139	30
MARTINS	4418	7213	5.5
MEMPHREMAGOG	4459	7213	8.3
MEMPH. – SOUTH BAY	4492	7221	5
METCALF	4444	7253	7.6
MILES	4427	7149	16.7
MIRROR	TBC	TBC	32
MOREY	4355	7209	11
NELSON (CALAIS)	4424	7227	29
NICHOLS	4427	7221	24
NINEVAH	4328	7245	3.5
NORTH MONTPELIER	4419	7227	3.6

<b>NAME</b>	<b>Lat DD.MM</b>	<b>Long DD.MM</b>	<b>Total Depth of Station #1 (meters)</b>
PARAN	4256	7314	7
PARKER	4443	7214	12
PEACHAM	4420	7216	15
PENSIONER	4452	7203	12
PERCH (BENSON)	4345	7317	9.1
PINNEO	4339	7226	3
RAPONDA	4253	7249	4.8
RESCUE	4327	7242	27
RUNNEMEDE	4329	7223	2.9
ST. CATHERINE	4328	7313	20
ST. CATHERINE - LITTLE	TBC	TBC	2
SABIN (WOODBURY)	4424	7225	5.2
SALEM	4456	7206	18
SEYMOUR	4454	7159	48
SHADOW (GLOV)	4440	7213	42.4
SHELBURNE	4423	7310	7.6
SILVER (BAR)	4344	7237	9.5
SOUTH (EDEN)	4441	7232	20
SPRING (SHREWS)	4330	7255	26
STAR	4325	7249	2
STRATTON	4306	7258	5
SUNRISE	4346	7316	13
SUNSET (BENSON)	4345	7316	32
SUNSET (BROOK)	4402	7236	8.5
TICKLENAKED	4411	7206	15.4
VALLEY	4426	7226	21
WAPANACKI	4433	7224	2
WILLOUGHBY	4445	7204	21.3
WINONA	4410	7305	2



<b>NAME</b>	<b>Lat DD.MM</b>	<b>Long DD.MM</b>	<b>Total Depth of Station #1 (meters)</b>
WOODFORD	4253	7304	7.6
WOODWARD	4334	7246	14

TBC = to be calculated.