Quality Assurance Project Plan for the Work Plan Entitled:
"Huron Chain of Lakes Watershed TMDL Planning Project"

Version 1.4
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Grantee: Huron River Watershed Council for the Livingston County
Drain Commissioner
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☐ Returned for Modifications

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Signature of MDNRE Reviewer   Date

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1.1 Project Organization and Distribution List

Table 1. Personnel, Affiliation and Role/Responsibilities of each in the monitoring project

Personnel	Affiliation	Role/Responsibilities
Christe Alwin	MDNRE	Project Officer
Matt Bolang	Livingston County DC	Grant Administrator
Laura Rubin	HRWC	Program oversight and review
Ric Lawson	HRWC	Program management, data management and reporting, and quality assurance
Debi Weiker	HRWC	Field data collection management, volunteer coordination, and quality control
Denise Maier	Brighton WWTP	Laboratory manager
Livingston WAG members	Local government	Supplemental funding, program review and guidance
Volunteers	HRWC	Assist with field data collection

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Review and Advisory Team
Livingston County Watershed Advisory Group (WAG)
(current contact list included in Appendix 1)

Volunteer Data Collectors
Program volunteers change annually and will assist in data collection under the supervision of Debi Weiker and Ric Lawson. Standard Operating Procedures (SOPs) will be distributed at training, and the QAPP will be made available to them upon request.

All others involved with monitoring will receive a copy of this Quality Assurance Program Plan (QAPP) and any revisions.

1.2   Project Description

This monitoring project aims to establish a baseline water quality dataset, measure the stormwater and non-point source contributions of nutrient and sediment impairments within the Huron Chain of Lakes Watershed system, including the three TMDL areas at Brighton Lake, Ore Lake and Strawberry Lake. More detail on the program is also included on the program website at www.hrwc.org/our-work/water-quality-monitoring/.

1.2.1. Statement of Water Quality Concerns

The Huron Chain of Lakes (HCOL) watershed is a mixture suburban and rural land uses and lies primarily within Livingston County – the fastest growing county in Michigan.   As of 2000, the watershed was 37% urban, 16% active agricultural, and 27% forested or wetlands. As the watershed develops, concerns increase about sprawl, preserving natural features and rural character, and water quality impacts. Some of the streams and lakes in the watershed are being impacted by altered watershed hydrology, excessive nutrients, and poor riparian management, as indicated by several reaches that appear on the state's list of impaired waters as threatened by phosphorus eutrophication.   The Huron River Watershed is home to one-half million people, numerous threatened and endangered plant and animal species, abundant bogs, wet meadows, and remnant prairies of statewide significance. The Huron is the only state designated scenic river in southeast Michigan, it supplies drinking water to 140,000 people, and its watershed contains two-thirds of the public recreational land in southeast Michigan. Protection of the Huron River system is vital to both the physical health of residents and to the economic health of local communities.

However, portions of the system are listed as threatened and may fail to meet minimum water quality standards or provide designated uses in the future if nutrient reductions are not met. Michigan's 303(d) list of impaired and threatened waters identifies three waterbodies in the HCOL that have approved TMDLs for non-point source or municipal separate storm sewer system (MS4) related threats. They are listed below.

HUC	Waterbody	Designated Use	Cause
040900050111	Brighton Lake	Aquatic life and wildlife	Phosphorus (total)
040900050112	Ore Lake	Aquatic life and wildlife	Phosphorus (total)
040900050307	Strawberry Lake	Aquatic life and wildlife	Phosphorus (total)

Three TMDLs have been established in the watershed for phosphorus enrichment. All are connected. Brighton Lake is the most upstream in the South Ore Creek drainage. Ore Lake lies at the confluence of the tributary with the Huron River, and Strawberry Lake is a downstream, naturally formed, in-line lake. Watershed management plans have been developed for the Huron Chain of Lakes (see included map) and, specifically, for Brighton Lake. Models developed for these plans suggest critical areas that are likely pollutant sources, but relatively little monitoring data has been collected for the system. Available data on phosphorus in the Chain of Lakes system includes:
- data collected for TMDL development for Brighton, Ore, and Strawberry Lakes in 1999,
- limited nutrient data from DNRE surveys in 1998 and 2007,
- HRWC monitoring data at two sites in 2009,
- sampling by Green Oak Township at sites in the Davis Creek watershed, and
- twice per year lake sampling through the Cooperative Lakes Monitoring Program in Strawberry and Ore Lakes and a private contract service in Brighton Lake.

In addition to these threatened waters, a TMDL for phosphorus enrichment has been established for Kent Lake, which drains upstream to the Huron Chain of Lakes system. Furthermore, the Huron is listed on the state's Unified Watershed Assessment (UWA) as a Category 1 watershed indicating its high restoration priority. The top threatening impairments listed in the Huron Chain of Lakes are high sediment and nutrient loadings and altered hydrology. The main potential causes of these threatening impairments are related to development without proper stormwater impact planning.

The Livingston County Drain Commissioner (LCDC), with assistance from the Huron River Watershed Council (HRWC) has regularly convened watershed advisory groups (WAGs) for the HCOL watersheds since 2002. The groups now meet quarterly at a joint meeting. The WAG is currently going through a transition phase to determine how to continue implementation of the Huron Chain of Lakes Watershed Management Plan (WMP) absent Phase II requirements for many of the partners. One goal has been to establish grant funding to implement demonstration projects in the watersheds to visually illustrate and document the benefits of stormwater treatment practices designed to capture or otherwise reduce phosphorus loading.

1.2.2   Project Goal

GOAL 1: **Identify hot spots and characterize phosphorus and sediment loading**
Objectives under this goal include:

- develop the implementation priorities for locations, commitments, timeline, and costs; and
- establish a baseline for evaluating the success of implementation projects.

GOAL 2: **Monitor for progress.** Collect, synthesize and disseminate data that complements and expands upon existing data and is useful to the Livingston WAG in improving water quality in the 3 TMDL areas.

Targeted monitoring of potential hot spots will help confirm and better define critical pollutant source areas. The associated loadings of phosphorus will be quantified with initial monitoring. The data also will help to obtain better projections for the likely impact (i.e. loading reductions) of potential projects. It is important to establish a monitoring baseline so that post-project monitoring will have a point of reference.

The monitoring plan and subsequent monitoring also will address the need to establish a better baseline for evaluating the success of future implementation projects, as well as progress toward NPS load reduction targets for TMDLs in the watershed. The project will fill in data gaps by updating phosphorus measurements from previous surveys and sampling new reaches in target drainages. The project will also add to the existing base of information by adding wet weather measures and paired stormwater sampling.

Once measures of phosphorus concentrations and loading, both during various dry weather flow and storm events, are obtained, a baseline will be established that can be used to determine the nature and degree of reduction (or increases) from future projects. This approach has been utilized with great success broadly in the Middle Huron River watershed, where specific phosphorus reductions were measured following the implementation of a phosphorus fertilizer ordinance.

1.3 Project Tasks and Schedule

Following is an annual work plan and schedule for the monitoring program. It is anticipated that this program will be sustained following the completion of the grant period.

Task	Staff Responsible	% of Time	Deliverables & Results (deliverables in italics)
1) Measure stream discharge at long-term sites		35%	
Subtasks			
1.1 Develop and submit QAPP for DNRE approval	Lawson; Weiker		*Approved QAPP*
1.2 Solicit and train volunteer corps to provide additional field support during extreme wet weather events	Weiker;		Trained field support of 5-8 volunteers
1.3 Conduct regular flow estimates long-term sites in conjunction with grab sampling during April - Sept	Lawson; Weiker		Stream discharge data for long-term monitoring sites

1.4 Respond to wet weather events as needed to gain high flow estimates and complete level-discharge curves	Lawson; Weiker		Complete stream discharge data for long-term sites
1.5 Record data and conduct analyses; download data from pressure sensors and gauge stations	Lawson; Weiker		*Database files and analytical results*
1.6 Share data with project partners and develop annual data reports	Lawson; Weiker		*Reports for 2011 field season; press releases; presentations*
1.7 Solicit evaluation of data and draft products from Livingston WAG, HRWC staff	Lawson		
2) Collect water quality samples and field data at selected sites		**50%**	
Subtasks			
2.1 Develop and submit QAPP for DNRE approval	Lawson; Weiker		*Approved QAPP*
2.2 Calibrate equipment prior to field visits	Weiker		Equipment prepared to manufacturers' specs
2.3 Solicit and train volunteer corps to provide additional field support during extreme wet weather events	Weiker;		Trained field support of 5-8 volunteers
2.4 Collect grab samples and record ambient conditions from long-term monitoring sites	Lawson; Weiker		Two sample sets per month from each site plus storm samples; field data for DO, pH, conductivity, temp.
2.5 Collect grab samples at investigative sites upstream from long-term monitoring sites	Lawson; Weiker		Minimum 8 sample sets per month for total phosphorus and TSS
2.6 Deliver samples to Brighton WWTP lab for analysis	Lawson; Weiker		*Water sample analysis data*
2.7 Record data and conduct analyses	Lawson; Weiker		Nutrient and TSS load calculations for all sites; trend analyses of all parameters for sites
2.8 Share data with project partners and develop annual reports	Lawson; Weiker		*Reports for 2011 field season; press releases; presentations*
2.9 Solicit evaluation of data and draft products from Livingston WAG, HRWC staff	Lawson		
3) Administer and Report		**15%**	All required documents and deliverables
Subtasks			
3.1 Develop and submit status reports following WRD guidance	Lawson		*Quarterly status reports*
3.2 Develop and submit final report following WRD guidance at end of project	Lawson		*Draft Report; Final Report* (1 copy to PA and 4 copies to Admin. Unit)

Timetable

The grant project will begin July 2010 and conclude September 2011. The timeline below is established on an annual timeframe, however, to represent a long-term strategy for continuous monitoring activities beyond the scope of this project.

Work Plan Activity	Project Months											
	January	February	March	April	May	June	July	August	September	October	November	December
Task 1) Measure stream discharge at long-term sites												
1.1 Develop and submit QAPP for DNRE approval (update in subsequent years)		▓	▓				2010					
1.2 Solicit and train volunteer corps to provide discharge measurement support			▓	▓				2010				
1.3 Measure discharge across a range of water levels at all sites				▓	▓	▓	▓	▓	▓			
1.4 Respond to wet weather events as needed				▓	▓	▓	▓	▓	▓			
1.5 Record data and conduct analyses; download data from level sensors and gauge stations				▓	▓	▓	▓	▓	▓	▓	▓	
1.6 Share data with project partners and report results	▓											▓
1.7 Solicit evaluation of data and draft products from Livingston WAG, HRWC staff	▓											▓
Task 2) Collect water quality samples and field data at long-term and investigative sites												
2.1 Develop and submit QAPP for DNRE approval (update in subsequent years)		▓	▓				2010					
2.2 Calibrate equipment prior to field visits			▓	▓	▓	▓		▓	▓			

Work Plan Activity	Project Months											
	January	February	March	April	May	June	July	August	September	October	November	December
2.3 Solicit and train volunteer corps to provide field support during baseline monitoring and wet weather events			▓	▓				▓ 2010				
2.4 Collect baseline and investigative grab samples, autosample wet weather events, and record ambient conditions.				▓	▓	▓	▓	▓	▓			
2.5 Deliver samples to Brighton WWTP lab for analysis				▓	▓	▓	▓	▓				
2.6 Record data and conduct analyses				▓	▓	▓	▓	▓	▓	▓	▓	
2.7 Share data with project partners and report results	▓											▓
2.8 Solicit evaluation of data and draft products from Livingston WAG, HRWC staff	▓											▓
Task 3) Administer and Report												
3.1 Develop and submit status reports following WRD guidance	▓			▓			▓			▓		
3.2 Develop and submit annual report to LCDC and partners.	▓	▓	▓									▓

1.4 Training Requirements

The program manager and field manager have been trained in all collection techniques as part of professional education programs. The Technical Advisor is consulted for questions on details and analyses. All volunteer collectors receive training at the beginning of the sampling season and are accompanied by the program or field manager on their first sampling experience. Training includes instruction and demonstration of all field techniques, SOPs and data handling procedures.

2. Measurement and Data Acquisition

2.1. Project Objectives

Objective 1: Establish long-term monitoring sites and collect data during dry and wet weather at tributary sites that are comparable to existing data from previously sampled sites in order to compute loading changes for Total Phosphorus (TP) and Total Suspended Solids (TSS).

Objective 2: Identify phosphorus and sediment loading hot spots to improve targeting of watershed management strategies.

Objective 3: Measure stream discharge (Q) at long-term sites in the Huron Chain of Lakes system during dry and wet weather conditions for use in calculating seasonal load estimates and flow profiles.

Objective 4: Analyze key water quality indicators at tributary sites (TP, TSS, Dissolved Oxygen (DO), conductivity, pH, and temperature) across dry and wet weather conditions to detect trends.

Objective 5: Report data analysis results to the Huron Chain of Lakes community partners, the Livingston WAG and the MDNRE and assist partners with assessment of current BMP implementation and plan future BMPs.

2.2   Project Design

HRWC will conduct stream monitoring from April through September at sites in the Huron Chain of Lakes TMDL watersheds following standard field procedures (see Appendices 2 and 3). Additionally, a set of rotating "investigative sites" will be selected upstream of long-term monitoring sites to allow for pairwise evaluation. The monitoring program is designed to be integrated with TP monitoring data collected from Brighton, Ore and Strawberry Lakes. Initially, this monitoring will be funded for 2010 and 2011 by a TMDL Implementation grant from the state of Michigan. It is intended that monitoring will continue beyond this period with other funding.

Stream discharge and water quality indicators will be measured at each site during dry and wet weather conditions in order to measure ambient conditions and any impacts from stormwater runoff on the sites. Fixed water level loggers will be placed at sites that do not already have gages, on an annual rotating basis to allow for flow profiling across an entire season. Grab samples will be taken at each of the study sites twice monthly. Additional samples will be taken during wet weather events. Water samples will be collected and analyzed in a lab according to US EPA accepted procedures (Brighton Wastewater Treatment Plant).

The initial monitoring sites (Figure 1 and Table 3) are located on major tributaries to the Huron River and TMDL lakes, and represent a mix of land uses. The locations were selected based on their use in past monitoring, by HRWC's Adopt-A-Stream program (macroinvertebrate and habitat data), significant subwatershed phosphorus loading modeling estimates, and a desire to capture the range of subwatershed and upstream conditions. The strategy for site selection going forward is to first estimate loading coming from tributary watersheds, then select investigative sites upstream and collect paired samples. Investigative sites will be selected to isolate potential stormwater sources or distinct land uses. Land use and land cover data have been collected for drainage areas to the monitoring points. These data will be used to help select investigative sampling locations and inform an understanding of relationships between land cover and ecological stream health. A current map of long-term and initial investigative monitoring sites is included as Figure 1. The sites will also be viewable on the program website at www.hrwc.org/our-work/water-quality-monitoring/.

Figure 1. Huron Chain of Lakes Monitoring Sites

Table 3. Proposed initial monitoring sites, and surrounding environments

Site #	Water Body	Cross-street	Environment	Type
HRO3	Kent Lake Dam spillway	Kensington Rd	Island State Recreation Area; parkland, woodlands	Long-term, storm
WC01	Woodruff Creek	Grand River Rd	Woodland, wetlands	Long-term
COL01	Huron River	Hamburg Rd	Woodland, wetlands, low-density residential	Long-term
COL02	Davis Creek	Silver Lake Rd	Woodland, wetlands, private property low-density residential	Long-term, storm
SO01	South Ore Creek	S. Third St	Urban; medium-density residential – upstream of Brighton Lake	Long-term
SO06	South Ore Creek	Hartford Way	Brighton Lake dam, woodland, low-density residential	Long-term, storm
HL01	Horseshoe Lake Drain	Merrill Dr.	Meadow, parkland, RR	Long-term
CC01	Chilson Creek	M36 & Kress Rd	Wetlands, low-density residential, commercial. This site is difficult to sample and is currently under consideration.	Long-term
CC02	Chilson Creek	M36	Wetlands, agriculture, very low-density residential	Investigative, storm
SO02	South Ore Creek	North Street	Urban, industrial, medium-density residential	Investigative, storm

In the event of wet weather, automated samples will be taken at sites with fixed water level loggers or investigative sites upstream. Stream discharge measurements will be taken using data from USGS equipment existing at sites HR03 and COL01. Water level sensors maintained by HRWC will generate continuous data and will be placed at the other long-term sites on an annual rotational basis. Sites targeted for wet weather monitoring will be scheduled first, followed by sites that are given a lower priority. This data will be used for selecting storm samples. Investigative sites located upstream may have flows estimated from these downstream sites based on area ratios. Stream discharge will be measured directly by project and volunteer staff with flow meters and staff gages at all sites to develop stage-discharge rating curves.

In addition to samples taken at the long-term monitoring sites, grab samples will also be taken at 4-5 additional upstream locations each year. Only two such sites have presently been selected. These paired samples will be taken in an attempt to isolate hot spots for phosphorus loading. These investigative sites will be selected with the following criteria in mind:

- critical pollutant source area drainages and tributary drainages with historically high concentrations, loadings;
- subdivision of stormwater discharge points;
- subdrainages that have a predominance of a land use likely.to be pollutant source;
- proximity to a potential source;
- hydrologic position relative to past monitoring; and
- access and logistical constraints.

Overall, the goal of site selection for investigative sites will be to subdivide tributary drainages in source areas to isolate probable hot spots or individual sources and determine their relative

contribution of phosphorus and TSS compared to paired samples from the downstream end of the tributary. Samples from investigative sites will be collected within an hour of downstream samples so that direct comparisons will be valid. When possible, investigative sites will be sampled first to approximate sampling of similar water "cells."

2.3   Sample Collection Methods

Stream monitoring will be conducted twice monthly from April through September at the designated long-term and investigative monitoring sites described in section 2.2. The monitoring teams, consisting of at least two individuals, after picking up equipment at the HRWC offices or other appropriate storage location in Livingston Co., will travel to a pre-designated site and first complete a field data sheet (see Appendix 4) that documents the location, date, time, team members and weather conditions for the current and previous days. The field data sheet is also used to record information about the water samples and the water quality measurement results using the Horiba multiprobe. The team will then travel to any investigative sites on the same tributary stream and collect grab samples from that site. Upon completion of the fieldwork, the monitoring team will deliver grab samples to the City of Brighton Wastewater Treatment Plant (WWTP) laboratory for analysis and return equipment to its storage location. A 'chain-of-custody' form (see Appendix 4) will be completed and submitted to the lab to follow the water samples. Copies of the chain of custody form are returned to HRWC with the lab results. Following subsections describe in detail the parameters to be measured, analytical protocols, equipment to be used, and specific protocols for grab sampling and wet weather sampling.

2.3.1 Parameters to be Measured

The following parameters will be measured at each site:

*   Water level and discharge (in cubic feet per second)
*   Total Phosphorus (TP in mg/l)
*   Total Suspended Solids (TSS in mg/l)
*   Dissolved oxygen (in mg/l)
*   Water temperature (in degrees Celsius)
*   Conductivity (in micro Siemens)
*   pH

All parameters will be collected during each sampling event, with the exception of water discharge. See the discussion in section 2.3.4 for water discharge procedures. Also, only water level (later downloaded discharge), TP and TSS will be collected during storm events. Table 3 below includes analytical specifics for each parameter.

Table 4. Analytical specifics for measured parameters

Parameter	Method	Detection Limit/Range	Sample Volume (ml)	Bottle Type	Preserva-tive	Hold Time
Total phosphorus	SM 4500-P-E*	0.01 mg/L	100 min	plastic	none	48 hrs[†]
Total Suspended solids	SM 2540 D	0.1 ppm	500 min	plastic	none	none

Dissolved Oxygen	Horiba U-10 water quality probe	0.0 - 19.9 mg/l	NA; measured with field instrument
Conductivity	Horiba U-10	0 - 100 mS/cm	NA; measured with field instrument
pH	Horiba U-10	0 - 14 pH	NA; measured with field instrument
Temperature	Horiba U-10	0 - 50 °C	NA; measured with field instrument
Flow	Marsh-McBirney Flomate 2000	-0.5 to +19.99 ft/sec	NA; measured with field instrument

* Ascorbic acid method using Genesys 20 Spectophotometer.
† If refrigerated, or indefinitely if frozen within 12 hours.

2.3.2 Equipment

A Horiba U-10 Water Quality Checker multiparameter monitoring instrument will be used to collect additional parameters including pH, DO, conductivity and temperature.

Water flow measurements will be made using a top-setting rod, that allows all adjustments to be made from above water, with a Marsh McBirney Flo-Mate (Model 2000) portable flow meter.

 "WaterMark" Style C stream gauges, graduated to hundredths and marked at every foot and every tenth, will be used.

HOBO pressure loggers (model U20-001-01) from Onset Computer Corporation (www.onsetcomp.com), will be installed at long-term sites on a rotating basis at sites without other water level recording equipment. They will be used to measure water pressure, which will be converted to water level using a barometric pressure compensation program.

Samples will be collected in 1000 ml plastic bottles.

2.3.3 Grab Sampling

Collectors will obtain a sufficient supply of sample bottles, pre-marked labels, a cooler (with freezer pack), and field data sheets. They will follow sampling protocols (see Appendix 2) to collect grab samples and deliver to the laboratory for analysis. One duplicate sample will be collected for approximately every ten sampling sets.

2.3.4 Flow Monitoring

Water level and discharge will be recorded in two ways. Two sites: HR03 and COL01 have USGS stations installed. At these sites, water levels and discharge will be recorded along with time during each sampling event. Water level and discharge information will later be downloaded and recorded on field sheets and entered into the database. No further flow information will be collected at this site.

Two to three additional sites will have HOBO pressure loggers installed. These will be set to record pressure and temperature every 10 minutes. Pressure is converted to water level by adjusting for barometric pressure following procedures included in the HOBO data logger user guide, which is kept on file at the HRWC offices. Barometric pressure data will be obtained from weather stations reported through www.weatherunderground.com. A station will be selected based on closest proximity to the in stream HOBO loggers. Logger pressure data are converted to water level using the compensation tool (algorithm) in the HOBO software. Water level data points will be converted to discharge by developing rating curves for each site by collecting at

least seven flow measurements spanning the range of water levels, following flow procedures included in the Appendix 3.

For the remaining sites, staff gauges will be installed. Rating curves similar to those for pressure loggers will be established for each of these gauges to translate a staff gauge level reading into a discharge estimate as indicated in the flow procedures in the Appendix 3.

2.3.5 Wet-Weather Monitoring

In addition to the twice monthly monitoring at each location, a minimum of one wet weather event will be sampled at each site with continuous water level monitoring. Following analysis, subsequent events will be monitored for sites based on data need and availability of resources. The actual number of events sampled will depend on the frequency of suitable wet weather events, thus, the distribution of events sampled is difficult to predict.

Some investigative sites may also be sampled for wet weather discharge. Targeting of investigative sites for wet weather sampling will be based on previous baseline results and the availability of water level loggers at downstream sites. Discharge data will be estimated from downstream site discharge data using drainage area ratios.

In general, wet weather events will be identified as precipitation events predicted to yield a minimum of 0.2 inches within 24 hours. Mobilization will occur when storms of the desired magnitude are predicted, based on available hourly forecast predictions. However, a "dry" period of <0.1 inches of rainfall over 48 hours should precede the potential wet weather event before a site qualifies for event sampling. This general criterion is being used to ensure that the samples collected are representative of runoff events. Tributaries respond differently to storms, however, and the true measure will be to determine if the flow in the target tributary has returned to levels near those that preceded the previous wet weather event. This may require less or more than 48 hours.

Samples will be collected using a programmable autosampler, starting at the onset of a storm and spanning a period not to exceed 24 hours. Four to six samples for analysis will be selected based on the discharge profile of the storm event hydrograph. Samples will be selected to represent the diversity of flow conditions during the wet weather event. At least two samples will be obtained on the rising side of the hydrograph or near the peak.

In addition to the six sample sets, one duplicate will be collected for each wet weather sampling event for quality assurance and analysis of sample variance. Specific guidance for storm event sampling is included in the sampling SOP included in the Appendix 2.

2.4   Data Quality Objectives

Accuracy and precision statistics for each of the measured parameters are included in Table 5 below.

Table 5. Accuracy and precision of measured parameters

Parameter	Accuracy	Repeatability/ Precision
Total Phosphorus	2.8% (from spikes)	3.5%
Total Suspended Solids	.0001 mg/l (from blanks)	19.6%
Dissolved Oxygen	0.1 mg/l	$\pm$0.1 mg/l
Conductivity	0-1 mS/cm: 0.01 mS/cm	1%/F.S.

	1-10 mS/cm: 0.1 mS/cm 10-100 mS/cm: 1 mS/cm	
pH	0.1 pH	±0.05 pH
Temperature	1°C	±0.3°C
Flow	± 2% of reading ± 0.05 ft/sec	± 0.05 ft/sec

For lab-analyzed chemical parameters, accuracy objectives are to stay within 10% using blanks and spikes. Precision objectives are to stay within 10% for all but TSS, and within 20% for TSS using field duplicates. These objectives will be monitored at the lab across all samples analyzed at the lab – both those run for the HRWC, as well as those for other programs. Running control plots are monitored to stay within accuracy and precision boundaries. The lab maintains a separate QAPP for their lab procedures. This can be reviewed or obtained upon request. The lab participates in U.S. EPA's Discharge Monitoring Quality Assurance (DMQA) program, as well, where DMQA analysts annually audit a number of procedures including those for TP and TSS. Also, as part of compliance with the lab's NPDES permit, the lab allows for periodic Compliance Sampling Inspections by DNRE permit compliance staff. The last inspection was in 2007 and covered TP and TSS procedures.

Additionally, a relative percent difference (RPD) will be calculated for each field and duplicate sample pair as a measure of sample site variance for each parameter. Running program mean RPDs will be kept and reported. Any individual RPDs more than 1 standard deviation above the mean will be flagged and reported as potentially unreliable. Samples more than 2 sd away from the mean will result in nullification of that sample set.

For field parameters, the following objectives will apply.

2.4.1   Precision

Volunteers attend both classroom-style and field training to learn the procedures and protocol for collecting water quality data and measuring flow/discharge. Volunteer teams are then observed in the field periodically to audit monitoring activities. Rechecks of flow measurements selected randomly along the channel transect are used to determine precision of monitoring teams' technique.

2.4.2   Accuracy

No standards exist for field estimation of stream discharge, so efforts are made to reduce measurement error. New volunteers and student interns will receive training that includes practice in the stream. They will then take water samples, measure water quality parameters and flow in teams of two or three members, accompanied by trainers on their first outing for stream monitoring. Periodically trainers will accompany them as an additional check on proper technique and sampling protocol.

2.4.3   Representativeness

Monitoring sites have been selected to be representative of the chemical concentrations and loads entering the three TMDL areas from tributaries. As such the measures should be the cumulative impact from each tributary. By taking baseflow samples at regular intervals, the dataset should be representative of the conditions at the output of these tributaries. Including storm samples should allow for calculation of a representative set of loadings for each tributary.

2.4.4   Comparability

Standard procedures are being followed for all measures, which have been and are being utilized in other watersheds. This should allow for results that are comparable to measurements of the same parameters elsewhere.

2.4.5   Completeness

Our objective is to complete multiple measurements of discharge at sufficient water levels to develop a rating curve for each staff gauge or level sensor installed at each monitoring site. We expect to collect samples twice per month at all monitoring sites for base flow and a wet weather event for each. Following validation by the project and field managers, the objective is to maintain results that are 95% valid and at least 90% completeness according to the above outcome objectives.

2.5   Quality Control Procedures

All field equipment and lab equipment will be calibrated with a frequency consistent with procedures in each instrument's manual. Dates on all calibration chemicals will be inspected and chemicals replaced as needed. As indicated previously, field duplicates and blanks will be collected and analyzed for laboratory parameters for use in calculated accuracy and precision. Each will be collected and analyzed at a frequency of one for every ten samples. Relative % differences will be reported for each along with the monitoring data.

2.6   External Data Acquisition

The data collected under this monitoring program will be included in annual reports. Additional water quality datasets from outside sources will be reviewed for comparison, but no meta-analyses will be conducted unless the analysis is discussed with MDNRE and program partners.

USGS Real-time Water Data is used to obtain discharge data from stations HR03 and COL01. The initial data posted is provisional and subject to adjustment throughout the April – September field season. Final posting of discharge data for the season is generally completed by November and the provisional data recorded on field datasheets are checked and updated if necessary.

In order to compute water level using the HOBO pressure sensors, a barometric pressure record covering the period of monitoring is necessary. Barometric pressure data is available from a wide network of weather stations via the Weather Underground at www.weatherunderground.com. The nearest station to the location of each sensor will be selected as the barometric pressure source. The data will be regularly downloaded from the website and processed for import into the software that accompanies the pressure sensor. The software uses an algorithm to use the barometric pressure data to compensate for the atmospheric portion of the pressure measurement recorded by the sensor and compute a water level from the remaining pressure. Since the compensation is a relative computation tied to an initial water level measurement at the time of installation, either raw or elevation-corrected barometric pressure can be used.

3.   Data Validation and Reporting

3.1   Data Review, Validation and Verification

Upon completion of field sampling, collectors will deliver samples to the lab, where labels will be matched to the chain-of-custody form before the lab signs off on the transfer. The data forms

will be delivered to HRWC offices where they will be reviewed by the program or field manager for completeness. All equipment will be signed back in and check for completeness. The program manager will download any water level and discharge measures and record those on the data forms prior to initialing the data forms. If any data or equipment is discovered missing, the project manager will make an effort to recover at the time of turn-in. If this is not possible, the data gap will be noted on the data form. Collectors will be instructed on any procedures that were not properly followed. A determination will then be made on the validity of the data collection. If necessary, the collection will be rescheduled.

3.2   Reconciliation with DQOs

Upon receipt of data from laboratory analysis, the results of field blanks and duplicates will be evaluated to confirm that accuracy and precision objectives are being met. Individual samples will be evaluated against aggregate means. Any exceedences will be reported to the laboratory and corrective actions will be requested, if necessary. Further, individual samples will be evaluated with lab staff to determine if any should be deemed invalid. At the end of the sampling season, lab data accuracy and precision statistics will be computed for the dataset in aggregate. A completeness statistic will also be computed as a percentage of samples validated against the total of samples collected. Any violations of DQOs will be included as caveats in data analysis reports.

3.3   Data Management

Once data are collected from the field, they are entered into the program database. The database is an Access database that is integrated with other monitoring data collected by the HRWC. The database helps to reduce data entry error by allowing for rapid comparison of new data with historical data to determine if any entries are missing or outside the normal range. Such entries will be rechecked for data entry error or sampling or analytical anomalies. The database is housed on the HRWC server, which is backed up nightly on-site and twice per month off-site. The data are compiled and analyzed in Excel to calculate statistics and trends for each site for the measured parameters.

3.4   Reporting

Monitoring, quality control evaluation and data analysis progress will be reported quarterly to the DNRE Project Officer. Following a comprehensive analysis of the full dataset each year, the results will be synthesized into a final report for electronic distribution to the MDNRE, Water Resources Division (WRD), community partners of the Livingston WAG at quarterly meetings, and on the HRWC website. Data collected as part of this grant project will be reported separately to the DNRE Project Officer. All data will be submitted to the DNRE Project Officer at the close of the grant.

3.5   Audits

The necessity of field audits is limited as the field manager accompanies volunteer collectors on a regular basis. In addition, sampling teams will be reset each year to provide for comparison of results from different collectors. The program manager will also conduct field samples on occasion as an additional level of program evaluation.

Any systemic problems discovered through this process by either manager will be discussed and retraining will be scheduled for collectors as needed to address problems. Other programmatic corrective actions will be taken as necessary and communicated to volunteer

collectors. If necessary, this program QAPP will be updated with revised procedures. All problems will be reported via quarterly reports to the MDNRE project officer.

4.   Appendices

Included with this document are the following appended documents:

1.   Livingston Watershed Advisory Group contact list (as of July 2010)
2.   Field sampling and wet weather procedures
3.   Flow monitoring procedures
4.   Data Forms
          a. 2010 Field Data Form
          b. Wet Weather Field Data Form
          c. Flow Monitoring Form
          d. Chain of Custody Form

Contact List: Livingston County WAGs

Members:

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Huron River Watershed Council
Nutrient Monitoring Sampling Program

<u>Stream Water Sampling Protocol for Routine and Storm Events</u>

<u>Equipment and Forms</u>

1 liter bottles for basic water samples
Sterile bags for e.coli water samples (Washtenaw sites only)
Sterile latex gloves (Washtenaw only)
Bottle labels
Pencil
Clipboard
Black Sharpie pen
Cooler and freezer pack

One gallon jug with rope for high water level sampling (if necessary)

<u>Data Sheet packs</u>:
Field Data Sheet
Wet Weather Data Sheet (if needed)
Flow Data Sheet
Chain of Custody Form

<u>Determining when to sample</u>

You will be sent a schedule at the beginning of the sampling season that will indicate the monitoring dates for each site from April through September. These are the regular or baseflow monitoring dates. The schedule may be updated throughout the sampling season. If you are not involved in storm sampling, this schedule will be all you need to determine when to sample.

If you will be involved in storm sampling, you will need to keep apprised of the daily weather forecast to be aware of approaching storms. Check the radar online (see links sent via e-mail) or on television as the storm approaches to get a sense of its intensity and size. You can also check the USGS gage data for a number of sites to see where the water level is as the storm comes in. If it looks like the storm has the intensity or size to produce modest rain (1/4" or more), get your equipment and materials prepared. If you are unsure, call Ric or Debi. One of them may send an alert or call you to indicate that the storm is large enough to sample. If you are designated to sample a site and cannot make it, please contact one of the HRWC managers or another sampler (see contact list). Proceed to the site with enough time to arrive prior to initial rainfall.

<u>Storm Sampling Procedures</u>:

HRWC Nutrient Sampling Procedures for Baseflow and Storm Events

Before going out, Ric or Debi will instruct you on duplicate collection procedures. Follow the instructions on set up and use of the autosampler. If you are collecting a duplicate sample, follow the grab sample procedures below. Following retrieval of the samples, return to HRWC offices and staff will help you select and process samples for analysis using the "HOBO Water Level Logger Download and Data Processing Procedures."

Water Sampling Procedure

1. At the sampling location (or prior to collection, especially if storm sampling), date and label the sampling bottles and e.coli sterile sampling bags (if necessary).
2. Fill out the field data sheet information section.
3. Record the time and take water samples for TSS, Total P and nitrate/nitrite (Washtenaw only) using either the grab or jug method. During storm sampling, collect samples for parameters as directed by HRWC staff.
4. Place the samples in the cooler.
5. Read the staff gauge (the scale affixed to the culvert wall or wooden post) and record the water level height on both the field data sheet and flow data sheet (middle column only). Record the time that the water level was measured.
6. Describe the weather conditions and note any unusual circumstances at the site on the field data sheet.
7. Take the water samples to the designated lab: City of Ann Arbor Water Treatment Plant, located on Sunset Rd off Newport Rd., if in Washtenaw County; City of Brighton Waste Water Treatment Plant lab off of Chilson Rd., if in Livingston.
8. Fill out the Chain of Custody form and take the samples to the laboratory. Give the samples and Chain of Custody form to the laboratory staff.
9. Return completed forms and equipment to the HRWC @ the NEW Center (1100 N. Main St., Ste. 210, Ann Arbor) or Brighton lab (Livingston).

Grab Method procedure for water sampling

1. Wade into the water to mid-stream in the main stream flow, face in the upstream direction, and avoid any sediment disturbed from your stream entry.
2. For bottle samples, remove the cap from the sampling bottle and fill the bottle approximately 1/4 full of water. Do this at an arms-length distance in front of where you are standing, again making sure not to disturb the sediments.
3. Shake the bottle, rinsing down the insides of the bottle, and empty the rinse water behind where you are standing.
4. Repeat the bottle rinse 2 more times.
5. Fill the bottle to near the top and screw on the cap.
6. For e. coli samples, follow the instructions below.

Jug Method procedure for water sampling

If the water is too deep or flowing too fast to wade out into the stream, use the gallon jug and attached rope to collect water for each sample.

1. Stand on the streambank or a bridge or culvert over the stream close to the water level sensor.
2. Put on a pair of sterile gloves for e. coli sampling.
3. Keeping hold of the end of the rope, toss the jug into the middle of the stream.
4. Flip the rope to spin the jug over and fill with water.
5. Pull the jug in, empty and repeat. You must rinse out the jug 3 times before collecting the water for a sample.
6. Follow the Grab Method above, using water from the jug and making sure to still rinse out the sample bottles before filling the bottle with the sample for the lab. Also make sure to keep the water sample mixed by swirling before pouring into the sample bottle. You do not need to rinse the sterile e. coli bags.

THE JUG METHOD SHOULD BE USED FOR SAMPLING AT BRIDGE SITES, AND MAY ALSO BE USED AT OTHER SITES IF THE WATER LEVEL IS TOO HIGH FOR SAFE WADING.

Water sampling for E. coli (Washtenaw sites only)

1. Put on a pair of sterile gloves.
2. Open the sterile sampling bag by removing the plastic top along the perforated line.
3. Take hold of the tabs near the top of the bag and open it. **DO NOT TOUCH THE INSIDE OF THE BAG.**
4. Dip the bag into the water upstream of where you are standing (or from a water collection bucket) and fill it half full.
5. Swing the bag around the wired top a couple of times and then twist tie the top of the bag to close and seal it.

Duplicate Samples
1. If you are instructed to collect a duplicate sample, bring an extra bottle and label it with "DUPLICATE" for the site name. Include the remaining information, including a parameter designated by Ric or Debi, but leave out the time.
2. Collect an additional stream sample as you normally would, following the previous procedures.
3. Record the extra sample on the field datasheet.
4. **DO NOT INDICATE THE SITE NAME OR TIME FOR THE SAMPLE ON THE CHAIN-OF-CUSTODY FORM**.
5. Turn in the sample along with the rest to the lab.

Additional Information

Water samples taken between 7 AM and 2:30 PM can be dropped off at either lab using the main entrance gate. In Ann Arbor, there is a phone box outside the gate to call security to let you into the facility. The laboratory is on the second floor of the main building. Please check in at the desk before going on to the laboratory.

HRWC Nutrient Sampling Procedures for Baseflow and Storm Events

If you take samples after 4 PM during the week, or anytime during the weekend, you will have to:

1. go to the Delivery Entrance gate to drop off the samples if in Washtenaw. Your names have been given to security to allow you access to the facility. If you are sampling at night, you may keep the samples overnight in the cooler and deliver them to the lab the next morning.
2. If in Livingston, you should freeze your samples until they can be delivered to the lab during normal business hours.

If you have any problems dropping off samples, call Ric @ 734-330-0508, or, if he does not answer, call Debi @ 734-426-5762.

2010 Stream Nutrient Monitoring Program

Huron River Watershed Council

Baseline Sampling Procedure

1. On the day before sampling, call or email Debi Weiker at 734-426-5762 or dweiker@hrwc.org to confirm.

2. Check the weather and temperature, and record information on the field data sheet.

3. Pick up supplies/equipment and sign them out at the Brighton Waste Water Treatment Plant laboratory, which opens at 7 a.m.

4. Take a water sample bottle, Horiba, depth-setting rod and flow meter, waders (if necessary), data sheets, clipboard and other sampling materials to the stream access location.

5. At the sampling location, record the date and time of sampling on the label of the sampling bottle.

6. Collect the water sample, using the bucket or in-stream grab method. **Remember to: 1) face upstream, 2) avoid touching bottle lip or collecting stirred up sediment, and 3) rinse 3 times before taking a sample.**

7. Using the Horiba, take the temperature, dissolved oxygen, conductivity and pH readings and record on the field data sheet.

8. Make note of any unusual conditions at the site, such as high flow, unusual turbidity, water color, etc.

9. *If measuring flow:* Using the Marsh McBirney flow meter, measure the waters' depth and velocity along a transect of the stream or river channel *(see attached data sheet for flow instructions).*

10. Place the water samples in the cooler with ice packs and take them to the Brighton Water Treatment Plant laboratory. Carefully fill out the Chain of Custody form and leave with lab staff.

11. Return the monitoring equipment to the laboratory, along with the field data sheets. Sign in the equipment and put the data sheets in the folder.

Autosampler procedures: programming and protocol for rain event sampling

<u>Programming</u>

Press the green "on" button.
Select "new program" (white button on top of keypad)
Questions will appear:

Program delay?	– press no
Timed mode?	- press yes
Interval = _ _ _ _ minutes;	- press "0 0 6 0" on keypad for 60 minutes setting; then press yes
Discrete mode?	- press no
Bottles per sample?	- press yes
Bottles per sample = 1?- press yes	
Change volume?	- press no (set for 1 liter)
Intake rinses?	- press yes
Rinse cycles = 2	- press yes
Intake faults?	- press no
Enter ID#	
ID = 0001	- press yes

Message on screen: SET UP COMPLETE
                                  -ready to start-

To check the program settings: press "display feedback". Question displayed: review results? - press no. Question displayed: review program? - press yes. The following output will be displayed:

        Timed mode
        Interval = 60 minutes
        Discrete mode
        1 bottle per sample
        Volume = 1000 ml
        Autocalibrate
        2 intake rinses
        Special output:
        Event output
        ID# = 0001

At this point: either turn the unit off by pressing the red "off" button, or press "start program" to initiate the autosampling program.

**Note: After samples have been taken, you can display feedback and select "review results" by pressing yes. The display will tell you how many samples have been taken, how many samples are remaining, and the bottle position for the next sample.

<u>Rain event protocol</u>

Take the autosampler unit (3 pieces, plus locks, chain, strap for securing the water intake line) to the site. If it is a warm day and the unit will be exposed, pick up a bag of ice on the way to the site. Set up the autosampler near the stream channel on reasonably flat ground. Uncoil the water sampling tube so that it lies unkinked on the ground, generally sloping down to the stream and not over any major obstacles. Place the intake end into the water. Secure the water intake tube to some type of sturdy support near the streambank edge using the black strap. Do not allow the intake structure to lie on the bottom of the stream; keep it upright in the water column, if possible. Note: the water intake line must slope downwards from the autosampler to the stream so that the water pump can properly calculate sample volume.

If ice was purchased, dump it into the center of the bottles section (bottom of unit), making sure not to allow any ice to fall into any sample bottles. Assemble the autosampler by placing the control unit/intake apparatus on top of the bottle-holding case. It can only fit snuggly together one way, which will allow the latch closures to snap shut. Begin filling out the field datasheet for the sampling event.

Turn on the unit and select "start program" and record the time. You will hear the intake wand (tube that moves to the correct sample/bottle position) move to position #1, bottle #1. You can "display feedback" to verify that that the autosampling program has been initiated. Press the "halt program" button (button 2). Press the "take sample" button and record the time on the data sheet where it asks if a "forced" sample was taken. (The answer is yes.) This sample will serve as the first sample of the storm series.

Remove the controller unit section of the autosampler from the bottle containment section, cap the filled sample bottle and remove it from position 1 in the bottle order. Take the clean bottle from position 24 and place it in auto-position 1; put the capped bottle 1 in position 24 and replace programming unit back on of top the bottle section. Then press the "resume program" button (button 3) and note the time on the data form. Put the cover over the programming section of the autosampler, close the latches and secure 2 of them with the small locks provided. Close the latches between the programming and bottle-holding sections and secure 2 of these latches with the small locks provided. Finally, run the heavy chain around the middle section of the unit and through the handles of both the programming and bottle sections of the autosampler and then around a large fixed object (i.e. tree) and secure with the large lock.

From this point, the program should take over and autosample every 60 minutes (or whatever sampling interval was chosen). There are only 24 bottles and if the program is set up to take a sample every 60 minutes, you must return to stop the program and retrieve the unit within 23 hours. Unit retrieval time should be adjusted based on the sample interval chosen.

<u>Duplicates</u>

If duplicates are to be taken at the beginning of the storm series, these will be collected near the same time as the first manual sample is taken with the autosampler. These duplicates will be grab samples, and they will be stored inside the bottle section of the autosampler for the duration of the sample cycle.

<u>Completing autosampling cycle and unit retrieval</u>

Pick up the data sheet, keys and bottle caps from the HRWC office. After arriving at the site, unlock the heavy security chain and remove the cover from the control unit. Stop the program (button 2). Press the "bottle advance" button (button 4); press the "take sample" button (button 8), record the time on the datasheet. This will be the final manual sample taken by the unit. Turn the power off. At this time take a grab sample from the stream and record the time.

Unlatch and remove the program control unit from the bottle case and retrieve the water intake tube from the stream. Gently coil the tube up around the unit for transportation. Secure bottle caps on all the sample bottles that have water in them. The disassembled unit and water samples are now ready for transportation. Return water samples, equipment and supplies to the office. Sample selection for lab analyses will be done after reviewing flow data for the rain event.

Flow measurement procedures:

<u>Safety Procedures:</u>

- RULE OF 10: Unsafe wading conditions exist if the maximum velocity (in ft/sec) multiplied by the depth (on the staff gauge) exceeds 10. The velocity can be estimated prior to actual measurement by extending the top-setting rod into the channel while standing on the bank.
- IMPORTANT: Personal flotation devices will ALWAYS be worn by everyone on the team in marginal/high flows. Waders must be cinched tight with a belt or short rope. A sturdy 20' polypro rope can be used as a steadying device. NEVER attach the rope to anything, including a tree!
- A buddy system will always be used when working in the water. This means that at least one person will always be on shore with a cell phone. The flow meter stays on shore; it is never worn by the wader.
- When the force of the water is too strong and/or the footing too uncertain, we will use a cable-way system with a weighted current meter. (See instruction manual.)

- Volunteers will be told to wear protective clothing in areas with poison ivy.

<u>Standard Operating Procedure:</u>

[1] Use of the current meter: Assemble the current meter by loosening the thumbscrew on the sensor bulb, sliding it (completely) onto the rod and tightening. Avoid handling the bulbous end, since oils and grease can occlude it. Using the up/down arrow key, set the meter to average readings over a period of at least 15 seconds unless the measurement time needs to be shorter because the water level is changing. Be sure the meter is reading in ft/sec and not meters/sec by pressing both the on and off buttons simultaneously.

[2] Measuring velocity:
Secure a measuring tape stretched across the stream at the selected site.

Set the meter on FPA to average the readings every 15 seconds. Record the gauge level and the time on the data sheet (see sample, appended) immediately before, and again immediately after, taking the velocity readings.

The first measurement is the location on the tape of the edge of the water, right or left (REW or LEW), looking downstream. Then, move to the first distance in the water and measure the depth with the top-setting rod, which will then be used to position the current meter sensor to the appropriate depth. Flow is measured 0.6 of the depth of water (from the water surface) for depths less than 2.5 feet. For stream depths greater then 2.5 feet, flow is measured at 0.2 and also at 0.8 of the stream depth.

The wader must be oriented upstream, holding the top-setting rod vertical, the current meter sensor pointed directly upstream parallel and into the flow. Once the sensor depth is set, step back to stand at arm's length to the side in order not to interfere with the movement of water. If there is a noticeable difference in flow on either side of the wading rod, stand on the side of the rod that has the slower flow. Currents created around the meter need to settle down before measuring the flow. Start the flow measurement by pressing the ON button.

Negative readings are recorded as the negative value, not as zero.

Generally, it is easiest to measure along the tape at constant distance intervals. However, the intervals must be shorter wherever the velocity changes very much. If there are portions of the stream in which the majority of flow appears to be occurring then it is necessary to have more measurements in those sections. The number of measurements in larger streams will be at least 20 and the intention is to have no more than 5% of the flow in any one measurement. However, the distances should be at least 0.4 foot apart, so in small streams we aim for 15 – 20 measurements, with the lower number of measurements only when the flow is changing rapidly or in a very narrow stream.

IMPORTANT! Be sure to measure the edge of the water following the flow readings.

Equipment for measuring flow:
1.   Top-Setting Wading Rod graded to tenths of feet
2.   Pencils (soft when it is raining)
3.   Fiberglass Measuring Tape graded to tenths of feet
4.   Marsh-McBirney current meter ("Flo-Mate") with extra batteries (2 D size) & screwdriver
5.   Data sheets on a clipboard
6.   Maps ([1] of the sites & [2] a road map)
7.   Laminated photo of the Gauge and a dry-erase marker & binoculars
8.   A watch (could be on your cell phone)
9.   Your cell phone (turned on)
10.   Study Sign (nice, but optional)
11.   Waders (size is on the chest pocket) with a tight belt

In high water (Could be after the storm):
12.   Life Vest for measurements in deep water
13.   Safety rope for stability (never attached to a person)
14.   Crane Contraption (in the shed) and laminated Conversion Table

Staff Phone numbers: Door Code: # - 0 - 1 - 6 – 4
        Office is 769-5123, X11 or 14
Paul Steen: 734) 709-6589   Joan Martin, home: 734) 994-4203

    How the Marsh-McBirney Flow Meter Works:
    The sensor end of the meter is producing a magnetic field.
    Stream water can conduct electricity since it contains dissolved ions.
    Therefore, a voltage is induced into the water as it flows past the magnetic field.
    The variation in velocity of the water changes the voltage in a direct relationship to the flow.
    Three little carbon electrodes in the upstream end of the sensor sense the induced voltage and translate that into the velocity reading.

BATTERIES:
Three captive screws in the bottom of the meter hold the cover on the batteries.

HOBO Water Level Logger Download and Data Processing Procedures

Updated September 2, 2010

Getting Data from a HOBO in the Field

Before heading out to a field site, make sure you have the HOBO Waterproof Shuttle and a key to unlock the logger housing from the stilling well (at the site).

1. When you get to the site, unlock the logger housing and remove it from the well. Unscrew the bottom to reveal the sensor.
2. Unscrew the black plastic end cap (attached by line to logger housing) from the logger by turning it counter-clockwise. DO NOT REMOVE THE METAL SENSOR END CAP.
3. Make sure the communication end of the shuttle is clean. You may need to detach, clean, then reattach the coupler for the logger, and ensure that it is seated properly.
4. Attach the coupler to the shuttle
5. Insert the logger into the coupler with the flat on the logger aligned with the arrow on the coupler label (see diagram). Gently twist the logger to be sure that it is properly seated in the coupler (it should not turn).
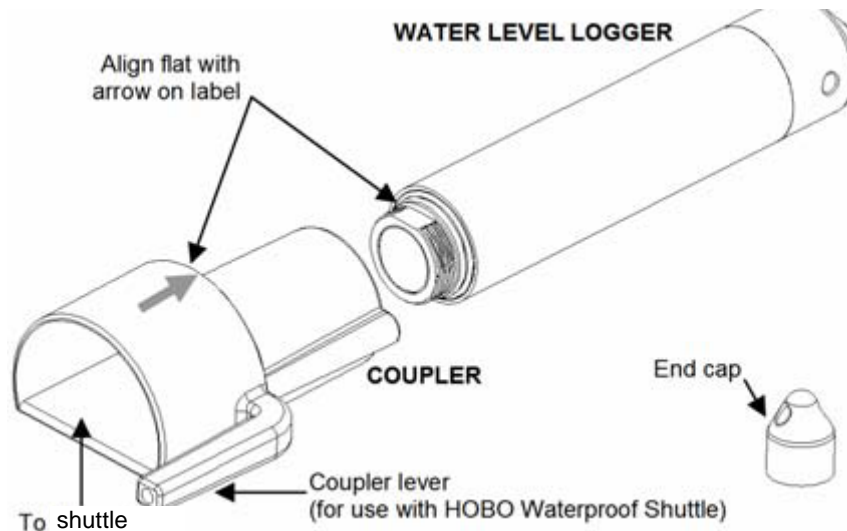

6. Momentarily press the coupler lever. Readout should begin immediately. The amber LED blinks continuously while readout and relaunch are in progress. Do not remove the logger when the amber LED is blinking.
7. After reading out the logger, the shuttle synchronizes the logger's clock to the shuttle's internal clock and relaunches the logger, using the description, channels to log, logging interval, and other settings that are already in the logger. (If the logger was launched with multiple logging intervals, the final defined logging interval will be used.)
8. When the relaunch has completed, the green LED blinks for 15 minutes, or until you momentarily press the coupler lever to stop it. If the red LED blinks instead, there was an error, and the logger may have stopped. Call Ric (769-5123 x609, or 330-0508) or refer to "Troubleshooting" in the manual for details.
9. Remove the logger from the coupler, and replace the end cap and housing cover. Do not overtighten the PVC logger housing cover. Replace the logger probe into the stilling well and secure the lock.

Offloading data to the host computer (Ric's Computer)

You can offload the data stored in the shuttle even when the batteries are depleted. Take the following steps:

1. Turn on the computer and launch HOBOware.
2. Connect the shuttle to a host computer running HOBOware using the USB connector (see diagram below). **Note: HRWC's shuttle is missing the center cap, so peel duct tape back instead.**
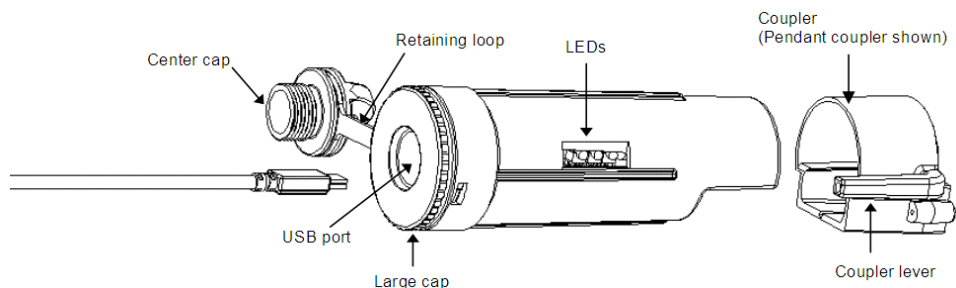
3. Choose **Manage Shuttle** from the Device menu and you should see a window similar to the one below:
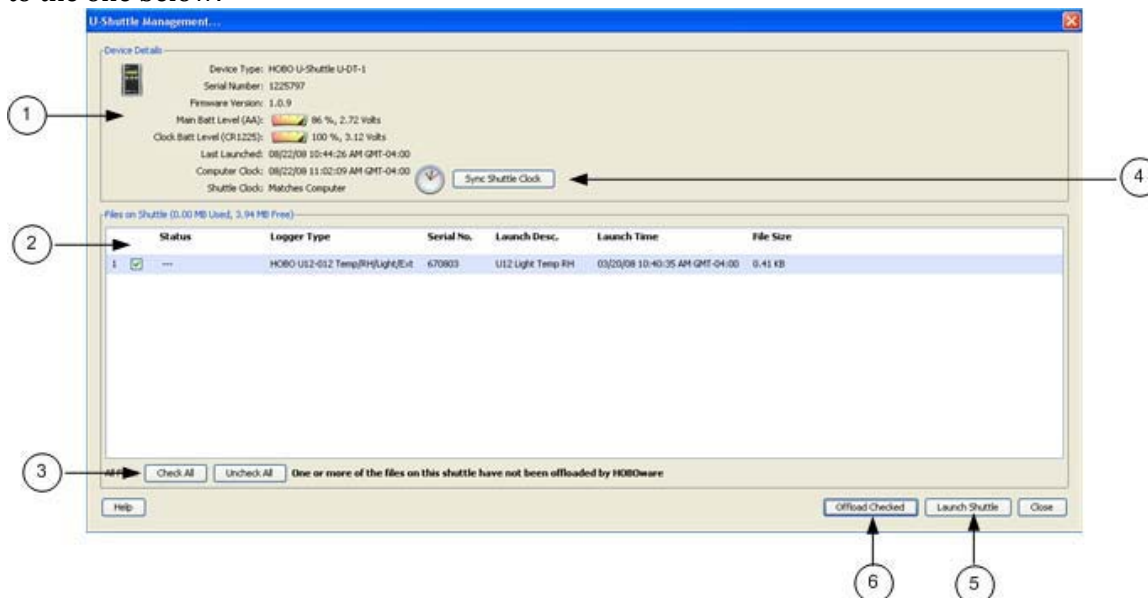
4. Check the battery status (1) and shuttle clock (4). If the battery is in the red zone or if the shuttle clock is off by more than a few minutes, contact Ric. You may sync the clock.
5. Choose files to offload:
   Only the files that have not previously been offloaded *and saved* are selected by default in (2). To check or uncheck individual files, click the checkbox next to each file. Use the **Check All** and **Uncheck All** buttons next to **Previously Offloaded Files** and **New Files** (**Not Offloaded**) to control the selection of these groups of files. (3)
6. To automatically delete files from a Waterproof Shuttle after you offload and save them, enable the **Delete Contents Upon Offload** option. Files will be automatically deleted only after you successfully save them to the host computer.
7. Offload Files
   Click the **Offload Checked** button (6) to begin offloading the datafiles.
   Once offloading begins, the **Offload Checked** button will change to **Cancel Offload**. When offloading is complete, the **Files on Shuttle** panel on the Shuttle Management window will change to a **Files Offloaded From Shuttle** panel.
8. You can now save the files to your computer.
   Save Folder:

The default location for the save is indicated in the **Save Folder** box. To change to another location, click **Choose** and browse to the location. Please save files to the following directory: H:\Project\MHWI\Data\2010 monitoring\Flow\HOBO data. HOBOware should add a directory with the date and time of download in the name. That's fine. Ensure, though, that it does not place this into a second download directory.

9. Check the files you want to save and click **Save Checked.**
10. After you are sure that the files have been saved, they should be deleted from the shuttle. You can then disconnect the shuttle.

Open and Plot Data

1. Click the Open icon on the toolbar, or choose *Open Datafile* from the **File** menu. Select a file or multiple files and click **Open**.
2. The Plot Setup window will open. Select only the **Abs Pres** series and click **Plot**. A plot of the pressures should appear.

Select Event Sample Points

1. Use the **Select Zoom Tool** to select and zoom into the wet weather event in the pressure record.
2. Deciding on sample points.
   If all went well with the autosampler, you should have hourly samples from throughout the wet weather event to select. We can send up to six samples to the lab. In general, we want to get at least one sample before the hydrograph (yes, technically it is just pressures at this point) increases, 1-2 on the rising portion of the hydrograph, 1 sample close to the event peak, and one somewhere on the tail. Additional samples should be spread to attempt to achieve relatively even sample distribution over time. If a duplicate grab sample was collected, then it's partner must also be one of the lab samples.

3. Get the initial sample time from the autosampler memory or the field data sheet. Each subsequent sample should have been collected 1 hour to the minute following the first sample.

4. Select sample points that match collection times from the autosampler. Example: The image below depicts a simple wet weather event with sample points following the above principles. The initial sample (#1) time was 6:30 pm on 5/12/10, so samples must be selected that fall on the half-hour. The first sample to be sent to the lab would be 7:30 am on 5/13, the next 4 selected occurred every hour after the first, and the last sample selected occurred at 1:30 pm. You can use the **Crosshair Tool** to select points on the hydrograph. A red line will appear to indicate the point selected, and the box on the right will display the time and pressure.

Appendix 3. Flow Monitoring Procedures
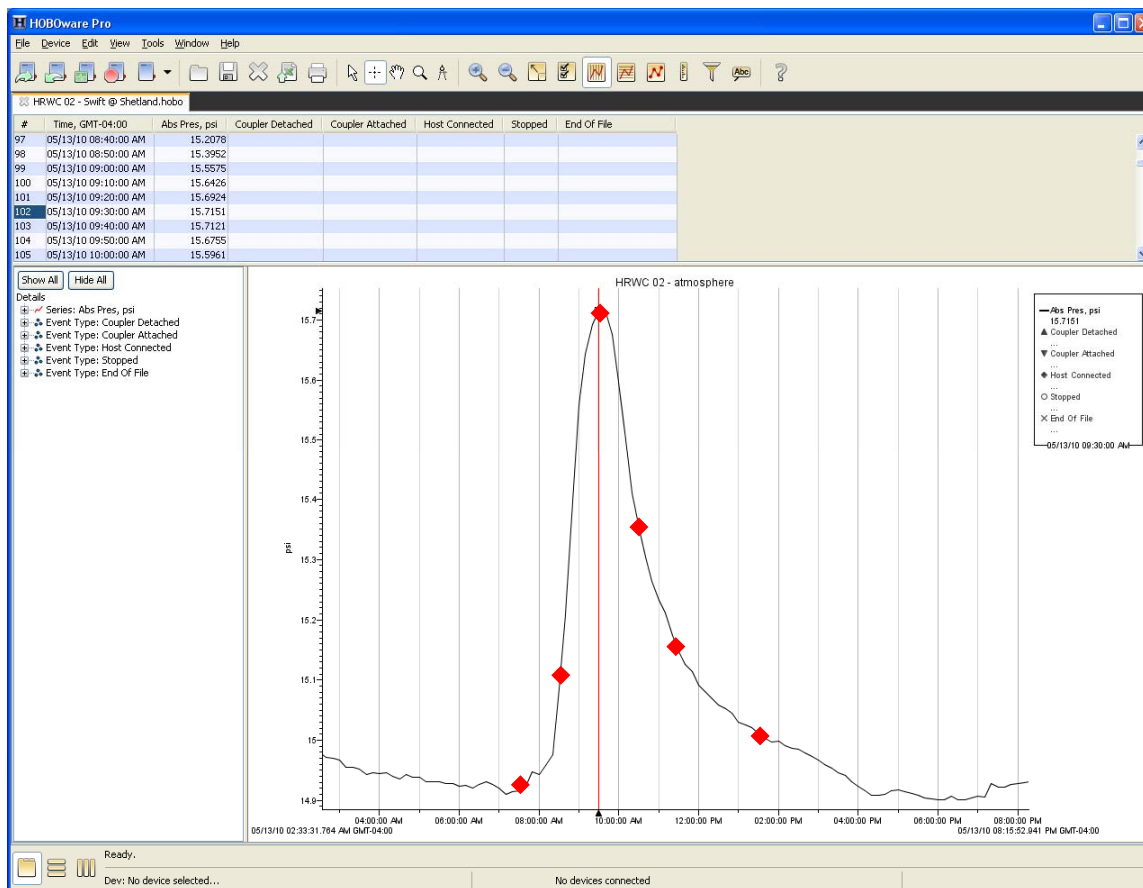
5. Record the selected sample times on the **Storm Sample Data Sheet.** To determine the bottle numbers, you will need to count the bottles off through time until you get to the times you have selected for lab samples. Thus, with the example, sample bottle numbers 14, 15, 16, 17, 18 and 20 would be selected for lab analysis and recorded on the data sheet.
6. You now may proceed to process the samples to take to the lab. If a duplicate grab sample was collected, you may wish to process a different sample point for the other parameters. For example, if a duplicate TP sample was collected at the beginning, but the storm did not occur for hours, the first autosampler bottle should be processed for TP (and TSS), but a different sample may be selected for *E. coli*.

Processing Pressure into Water Level and Discharge Data

Beyond using the pressure readings to select storm sample points, the pressure data eventually need to be converted into discharge (flow) measurements so that we can have a flow record for the site to evaluate, and also to generate pollutant loading estimates.

1. Open a datafile in HOBOware Pro. Start with the first sequential data file in a series for a given site.
2. Run the "Barometric Compensation Assistant." Select fluid density "derived from Temp Channel, assuming fresh water." You will run this twice.
   a. First, use the reference water level and time measured at the beginning of the data record. You can get this from the monitoring database. Select the barometric datafile that should be found in H:\Project\Monitoring-general\Hydrology\Flow measurement\. Create the series. On the final plot setup, select only "water level" to be displayed. View the water level chart and note any data discrepancies for later adjustment.
   b. If you are happy with the above display, open the same file again. This time, when you run the barometric assistant, use the reference water level and time from the END of the data record. Everything else is done the same.
3. Export these files to excel with different names. Open the "beginning" file, and then copy and paste the water levels from the "end" file into a new column. Delete all the records before and after the sensor went into the water. Correct any data discrepancies after consulting Ric.
4. Using an existing flow data file as a guide, compute the sensor "drift" or difference between the begin and end records. Compute the final "corrected" water levels for each record. You now have a set of water levels for the site.

5. Repeat this process for subsequent data sets (time periods).
6. Add sequential records to the end of the first set to develop a complete record of water levels.
7. Open the discharge curve file that was developed for the site (see procedure below if no curve exists) and verify that the curve has been recently updated. Add a new column for "discharge" in the water level file. Copy the discharge curve equation as a formula in excel, where x = water level. Fill the formula down to complete the discharge record.

Generating Discharge Curves

Over time we collect discharge measures at a range of water levels for each flow site. The purpose of this is to generate a discharge curve to estimate discharge from any future water level.

1. Transfer the set of measured water levels and discharge estimates from the program database for a given site. You will create a table with the following fields: date, time, water level (ft), discharge (cfs).
2. Review the data for outliers. Consult with Ric if any are found to determine if these measures should be included or not.
3. Create a scatter plot of water level and discharge data as in the figure below.
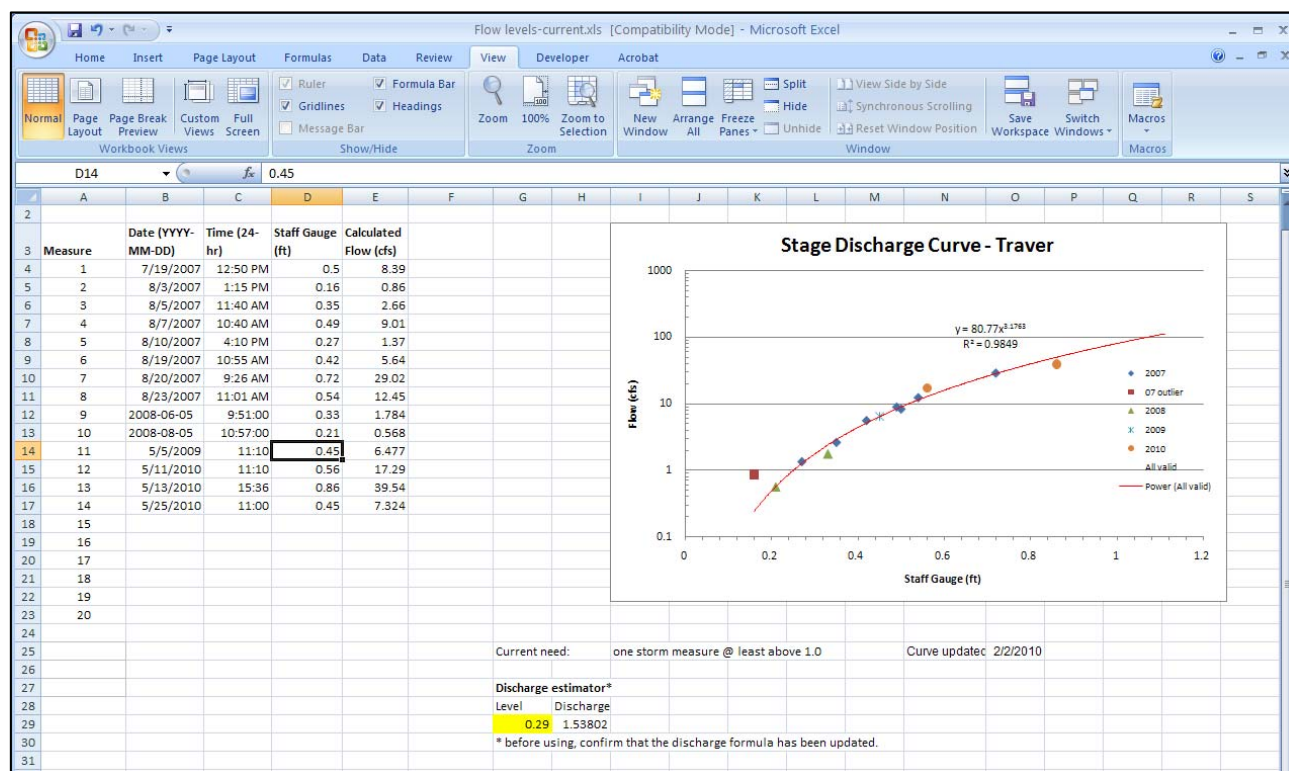
4. Add a "trendline" to the chart after at least seven valid measures have been taken. The curve should be based only on valid data points. Include the curve equation and R-square. Select the curve form that provides the highest R-square or "best fit." The resulting equation can be used to estimate discharge from water level.

Huron River Watershed Council

Stream Nutrient Monitoring Program
FIELD DATA SHEET

Investigators: _____

Stream
Name: _____

SITE #: _____

STAFF
GAUGE: _____ (in decimals)

TOTAL PHOSPHORUS AND TOTAL SUSPENDED SOLIDS

Collection		Lab Submission	
Date:	Time:	Date:	Time:

QUESTIONS:

What TYPE of field measurement was used? Circle one: GRAB / BUCKET

Was the bottle rinsed with stream water 3x, and water tossed downstream?   Y   /   N

What is the DESCRIPTION for this sample? Circle one: INVESTIGATIVE / BASELINE

Were the TP samples frozen or refrigerated overnight?   Y   /   N

     If so, location?   _____

{ STAFF GAUGE READING }

In boxes and picture below, write numbers and draw water level you see on the staff gauge.

First whole number above the water (1.0, 2.0, etc)

___.0

First digit above the water.

SITE PARAMETERS:

HORIBA MEASUREMENT:

Water temperature (°C)	
Conductivity (mS)	
pH	
Dissolved oxygen	

Weather in past 24 hours:

_____ Storm (heavy rain)

_____ Rain (steady rain)

_____ Showers (intermittent rain)

_____ Overcast

_____ Clear/Sunny

Comments:

Huron
River
Watershed
Council

2010 Stream Nutrient Monitoring Program

STORM SAMPLE DATA SHEET

Stream name/Site #: ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

Investigators: ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

Comments:

	Auto-sampler Deployment		Auto-sampler Retrieval
Date		**Date**	
Start Time		**Time auto-sampler halted**	
Water Level @ Start (ft)		**Water Level @ Start (ft)**	
Grab Samples Collected (#)		**Grab Samples Collected (#)**	
End Water Level		**End Water Level**	
End Time		**End Time**	

Was a "forced" sample collected @ autosampler? **Y / N**   **Time:** _____
Was a forced sample collected @ after halt? **Y / N**   **Time:** _____
Was a data logger downloaded and redeployed? **Y / N**
Final sample number _____

- -

To be completed @ office:

Number of incomplete samples _____

SAMPLES DELIVERED TO LAB:

Bottle #	Date/Time Collected	Sample Label	Parameter(s)

Waterproof paper – if this sheet is white.

Time samples delivered to lab:_____

Flow Datasheet

Site Name: _____ **on Creek:** _____   **Team Members:** _____

Date: _____   **Recorder's Name:**_____

| Distance on tape measure (feet & tenths)	Water's Depth	Velocity (ft/sec) (negative is ok)
Edge of Water:	0	0
Edge of Water:	0	0

*Gauge Reading at Start:

Time:_____   Height:_____

In boxes and picture below, write numbers and draw water level you see on the staff gauge. Draw two lines if gauge changed while you were measuring flow, indicating start and finish levels:

___.0

First whole number above the water (1.0, 2.0, etc.).

First digit above the water.
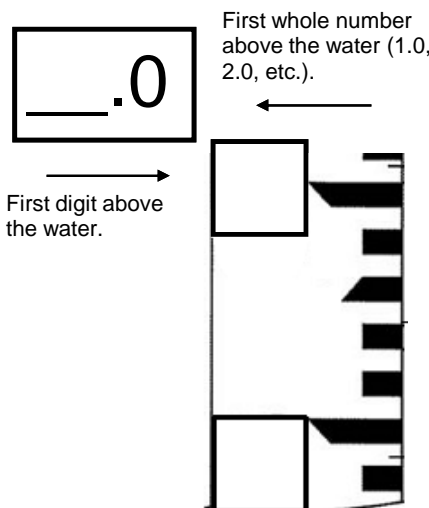
*Gauge Reading at Finish:

CIRCLE: *same* or *higher* or *lower*

Time:_____   Height:_____

REMINDERS
1. Start each flow reading by pressing the ON key.
2. Shorten the distance between readings when the depth changes!
3. Please read the tape from low numbers to high numbers.
4. Don't forget to record edge of water at both sides.

QUESTIONS (circle your answer):

1. Bank at which you began measurements, looking DOWNSTREAM: **Left   Right**

2. Has it rained in the past 3 days? **Yes   No**

3. Over how many seconds is the meter averaging readings? **10   15**   (Use 10 ONLY during rapid level change; press arrow keys to change).

4. What watch was used to tell the time? _____

5. Are the readings in ft/sec? **Yes   No**
(if no, press On&Off keys simultaneously to change)

6. Is the meter set on FPA? **Yes   No** (If no, press both ARROW keys simultaneously to change)

7. Was the rod set for each depth? **Yes   No**

8. How close was the rod from the person in the stream?_____

9. Was the rod vertical, with the sensor pointing into the flow? **Yes   No**

Waterproof Paper - If this sheet is white!

Phone number: HRWC (734) 769-5123, ext.13

Appendix 4. Data Forms

CHAIN OF CUSTODY DOCUMENT

Huron River Watershed Council
Protecting the river since 1965

1100 N. Main Street Suite 210
Ann Arbor, MI 48104
(734) 769-5123
www.hrwc.org

Please send results to:	HRWC
	1100 N Main Street Suite 210
	Ann Arbor, MI 48104
	Attn: Debi Weiker; dweiker@hrwc.org and rlawson@hrwc.org

Purchase Order #		Notes: SOURCE OF SAMPLE
LABORATORY IN CHARGE OF ANALYSIS: Brighton WWTP		
TEL: 810.227.9479 CONTACT: Denise Maier		

| Sample # | Collection | | Type | | Description | No. of containers | PARAMETERS | |
	Date	Time	Comp	Grab			TSS	Total Phosphorus

Relinquished by:	Date/Time:	Received by:
Relinquished by:	Date/Time:	Received by:
Relinquished by:	Date/Time:	Received by:
Relinquished by:	Date/Time:	Received by:

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