Quality Assurance Project Plan
for
Lilly Creek and Little Duck Creek Watersheds
Watershed Management Plan
in
Madison County, Indiana

A305-5-112

Prepared by:

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Prepared for:

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Section 1: Study Description

Historical Information

The Lilly Creek and Little Duck Creek watersheds include the two 14-digit watersheds that drain Lilly Creek and Little Duck Creek. The Lilly Creek and Little Duck Creek watersheds encompasses all of two 14-digit watersheds including the Pipe Creek-Lilly Creek watershed (HUC 05120201050060) and the Duck Creek-Little Duck Creek watershed (HUC 05120201060020) within the larger West Fork White River basin (HUC 05120201). The watersheds include nearly 22,672 acres or 35 square miles. Drainage from the Lilly Creek watershed flows into Lilly and Pipe Creeks, which combine at the downstream edge of the 14-digit watershed. Likewise, the Little Duck Creek watershed contains the entirety of the Little Duck Creek drainage; however, only a portion of the Big Duck Creek drainage is contained within this 14-digit watershed (Figure 1). Water drains from Lilly Creek to Pipe Creek and from Little Duck Creek to Big Duck Creek. Pipe Creek and Big Duck Creek both flow into the West Fork White River near Perkinsville and Strawtown, respectively.

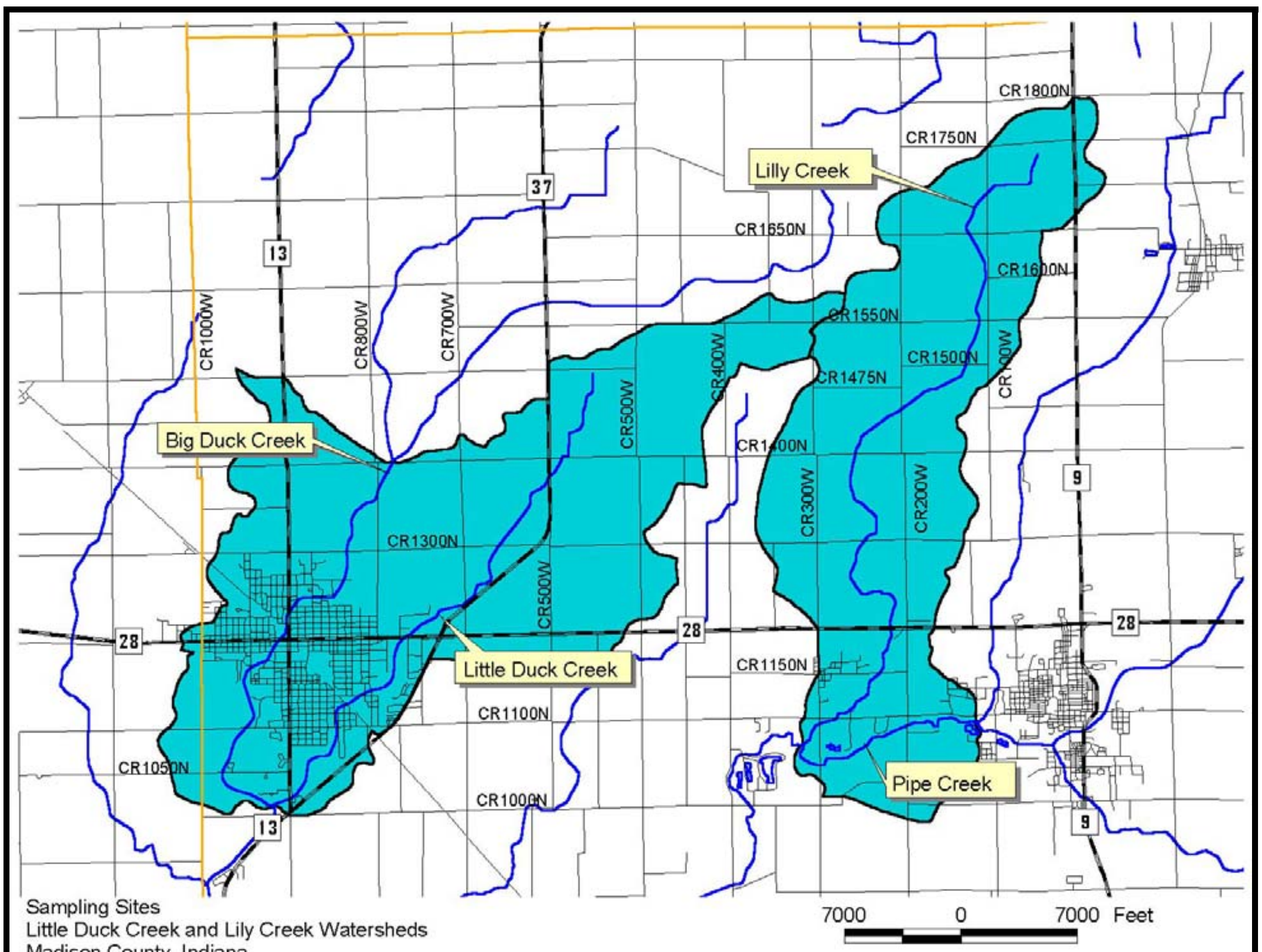


Figure 1. 14-Digit watersheds within the Lilly Creek and Little Duck Creek watersheds.

State and local agencies have conducted a number of water quality studies that focus on waterbodies in the Lilly Creek and Little Duck Creek watersheds. In the 1992-93 305(b) report, IDEM indicated that Lilly Creek was fully supporting for its aquatic life use designation, but was non-supporting for recreational usage due to high *E. coli* concentrations. During the same assessment period, Duck Creek was found to be non-supporting for both is recreational and aquatic life use due to high E. coli concentrations, combined sewer overflows, and wastewater treatment plan by-passes. The 1994-95 305(b) report reported similar results. Sampling completed by IDEM in 2001 indicate that pathogen concentration remain high in both the Lilly Creek and Little Duck Creek watersheds. *E. coli* concentrations greater than the state standard were observed at multiple sample sites throughout both watersheds. Additionally, total phosphorus concentrations were elevated within the Lilly Creek watershed during one sample collection and in the Little Duck Creek watershed on multiple occasions. Pipe Creek, Little Duck Creek, and Big Duck Creek are on the 2004 303(d) list of impaired waterbodies for high pathogen levels. Additionally, Pipe Creek is included on the 303(d) list of impaired waterbodies for impaired biotic communities, PCBs, and mercury.

Recognizing the need to include the entire Lilly Creek and Little Duck Creek watersheds in their ecological restoration efforts, the Madison County SWCD plans to work throughout the entire Lilly Creek and Little Duck Creek watersheds. To this end, the Madison County SWCD, along with watershed stakeholders, will develop a watershed management plan for the Lilly Creek and Little Duck Creek watersheds. Once completed, the plan will help prevent further ecological degradation of the watershed and guide future watershed management efforts to ensure the area's ecological health.

Study Goals

The goal of the sampling/water quality collection portion of this study is to determine the quality of water in the streams of the Lilly Creek and Little Duck Creek watersheds. Chemical, biological, and physical conditions of the selected inlet streams will be documented. The collection of this data will allow for the identification of problem areas, characterization of the watershed, and implementation of broad management decision making for the development of a watershed management plan for the Lilly Creek and Little Duck Creek watersheds. This information will be supplemented with historical data documenting the conditions of the watersheds such as land use, soils, and cultural resources and stakeholder concerns and issues discussed through watershed meetings. Data collected during this sampling will be combined with previously collected data to determine changes in the watersheds and will serve as baseline data for the tracking of water quality improvement success.

In summary, the goal of the sampling/water quality collection portion of this study is to determine the quality of water in the Lilly Creek and Little Duck Creek watersheds. This goal will be achieved with the following actions:

Action 1: Field and laboratory water chemistry data collection at each of the twelve sites four times annually for a two-year sampling period will include dissolved oxygen, temperature, pH, nitrate+nitrite, ammonia, total phosphorus, biological oxygen demand, total suspended solids, and *E. coli*.

Action 2: Collect discharge measurements at each sampling site for each of the four annual sampling events for the two-year sampling period to use in the calculation of pollutant loading.

Action 3: Conduct macroinvertebrate collection twice annually at each of the twelve sample sites over the two-year sampling period to assess the biological community.

Action 4: Conduct habitat assessment at each of the twelve sample sites once during the sampling period to assess physical stream conditions.

Action 5: Analyze chemical, biological, and physical data to allow for comparison with historical data and to provide baseline water quality information.

Action 6: Use chemical, biological, and physical data to evaluate and rank priority areas in the watershed and to develop recommendations for appropriate Best Management Practices to improve watershed water quality.

To achieve the goal of evaluating and ranking priority areas within the watersheds, standardized data collection methodology and analysis will be used for each of the sampling stations. Consistencies in methodology will ensure sampling stations can be compared to one another, enabling the Project Manager to determine which sites are most degraded relative to others in the watershed. Methodologies will follow those established and accepted by the scientific community and regulatory agencies (Indiana Department of Environmental Management (IDEM), Ohio Environmental Protection Agency (OEPA), and U.S. Environmental Protection Agency (USEPA)). For example, macroinvertebrates will be collected to assess the biological community using protocol developed by IDEM for rapid bioassessment. Macroinvertebrate data will then be analyzed using IDEM's macroinvertebrate Index of Biotic Integrity (mIBI). Standardized methodology and analysis will also allow comparisons to be made to past studies within and outside of the Lilly Creek and Little Duck Creek watersheds that have used these methodologies.

Study Site

The project site is the Lilly Creek and Little Duck Creek watersheds encompassing 35 square miles in northwestern Madison County, Indiana (Figure 1). Because the project's goal is to document the ecological conditions in the Lilly Creek and Little Duck Creek watersheds, the study will examine and/or identify the following parameters: 1.Water chemistry (pH, temperature, dissolved oxygen, nitrate+nitrite, ammonia, total phosphorus, total suspended solids, biological oxygen demand, and *E. coli*), 2. Riparian/stream habitat quality, and 3. Biological (aquatic macroinvertebrate) populations in the watershed.

Sampling Design

All parameters (water chemistry, macroinvertebrates, and habitat) will be collected and analyzed at each of the twelve sample sites. Sample sites were selected to achieve an accurate representation of the variety of stream habitat types found within the watershed. Preliminary site selection was based on map analysis. The map analysis consisted of locating tributaries with relatively large watersheds and accessible sampling points (road crossings). This approach was also taken in an attempt to have sampling stations that may be able to indicate which subwatersheds are contributing the most pollutants to the Lilly Creek and Little Duck Creek watersheds. The sampling stations selected based on this map analysis were then field checked by the Madison County SWCD for confirmation of site accessibility and appropriateness for the biological and physical assessment protocols (mIBI and QHEI). Following the field inspection, twelve sampling stations (six per 14-digit watershed) were selected for water chemistry, macroinvertebrate, and habitat assessment. Approximate locations of these sites are shown in Figure 2 and will be georeferenced during the course of the study. Appendix A provides additional details on the site locations. Landowners at these sampling stations will be contacted to obtain permission to conduct sampling in those areas. Should permission be denied, acceptable substitute stations will be selected using the same criteria outlined above. Any changes in sampling locations will be submitted as an addendum to this QAPP.

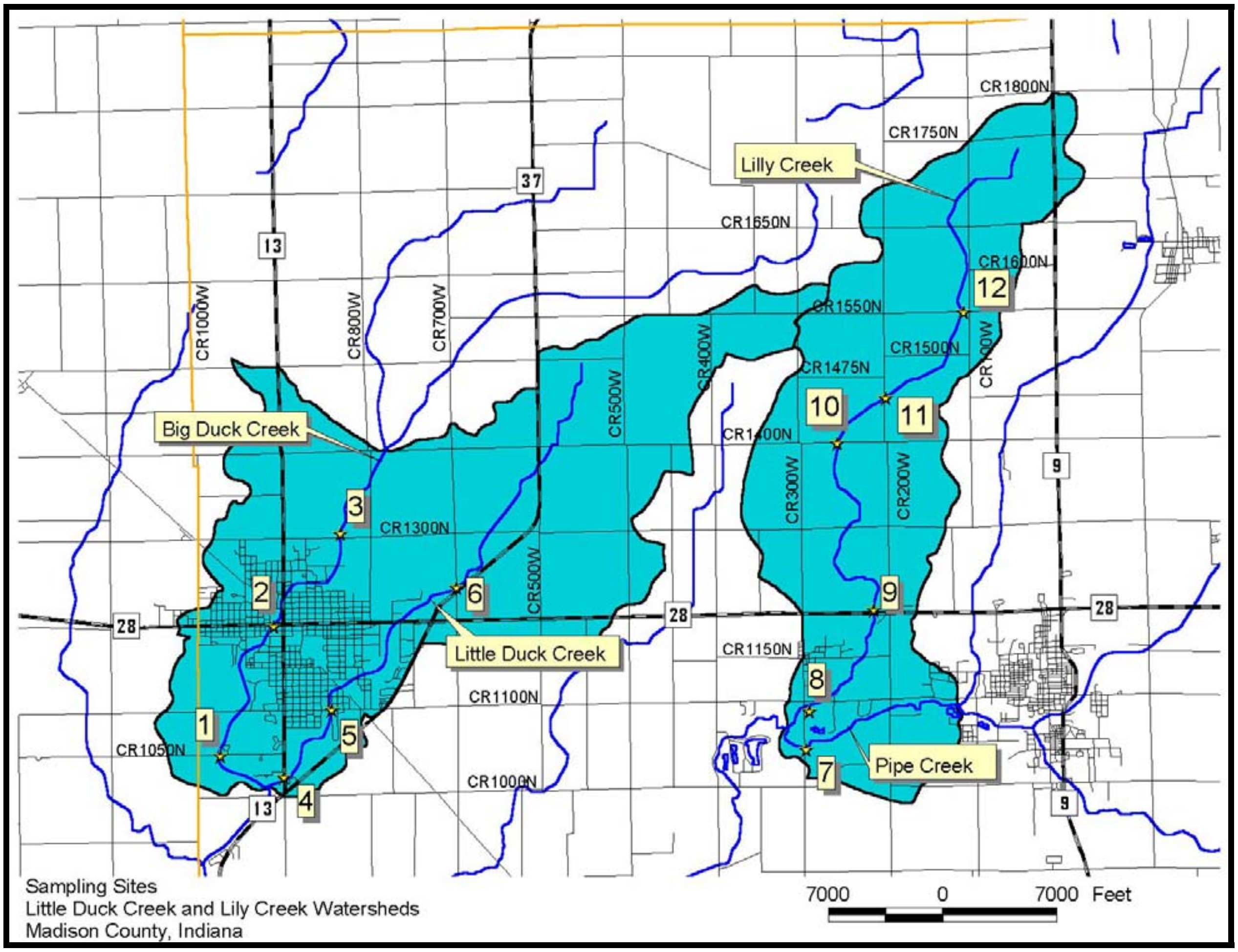


Figure 2. Sampling locations. Appendix A contains detailed sample site information.

JFNew will collect baseline stream water chemistry data at twelve sites within the Lilly Creek and Little Duck Creek watersheds (Figure 2). Specifics detailing sample site selection are included in Section 3. Details about each sample site including location and stream name is included in Appendix A. Water chemistry parameters to be sampled include nitrate+nitrite, ammonia, total suspended solids, total phosphorus, pH, dissolved oxygen, biological oxygen demand, *E. coli*, and temperature. Temperature, pH, and dissolved oxygen will be analyzed *in situ* with field equipment. Discharge will be measured at each site to allow loading calculations and comparison of relative contributions of each of the tributaries.

Water chemistry samples will be collected four times annually during the two-year study period for a total of eight sampling events. Samples will be taken three times during the growing season under base flow conditionas and once during a storm (peak) flow event on an annual basis. Water chemistry sampling events will be timed to capture samples from base flow and peak flow (1" or more of rain in a 24-hour period) events. If soils are saturated by previous storm events, a storm event releasing 0.75" of rain may be sufficient to produce runoff and will be used as a storm event sample. JFNew will use best professional judgment to determine if a rain event of less than 1" qualifies as a storm event. This timing allows collection during a wide range of temporal and seasonal factors that may impact water quality. The water chemistry sampling schedule is flexible to prevent sampling during inappropriate weather or when equipment is not working. Following each sampling event, water chemistry samples will be delivered to the appropriate, contracted laboratory. JFNew will deliver *E. coli* and BOD samples to ESG Laboratories in Indianapolis, Indiana. The remaining samples (nitrate+nitrite, ammonia, total phosphorus, and total suspended solids) will be sent to the Clean Lakes Program (CLP) Laboratory in Bloomington, Indiana for analysis of the remaining parameters. Water chemistry data gathered during this study will be compared to state and USEPA recommended criteria.

Macroinvertebrate sampling will occur twice annually during the two-year study period for a total of four sampling events. The biological sampling event will take place during low flow conditions in the summer, typically the greatest period of environmental stress for aquatic macroinvertebrate communities and in the all, typically the period of lowest stress for the aquatic macroinvertebrate community. Macroinvertebrates will be identified to family level to satisfy the project goal of surveying the entire watershed while staying within the project budget. Several researchers (Hilsenhoff, 1988, USEPA, 1989, and IDEM, Unpublished) have confirmed the appropriateness of using family level identification (vs. species level) to make broad scale management decisions as is the goal with this project. The aquatic macroinvertebrate community will be assessed using the Indiana Department of Environmental Management (IDEM) Rapid Bioassessment protocol (IDEM, unpublished).

Habitat sampling will occur once during the study period unless any of the sites undergo significant alterations. Habitat quality will be assessed using Ohio Environmental Protection Agency (OEPA) Qualitative Habitat Evaluation Index (QHEI) protocol (OEPA, 1989).

This sampling design reflects our sampling goals. Furthermore, the design allows JFNew to meet the goals to determine the quality of water in the Lilly Creek and Little Duck Creek watersheds and to evaluate and rank the conditions of the streams for subwatershed prioritization.

Study Schedule

Sampling station specific chemical, biological, and physical parameters will be sampled periodically throughout the project's two year sampling period (Table 1). Biological sampling will occur once during the summer and once during the fall during each year of the project. Habitat sampling will occur once during the first summer of the project. Chemical sampling will occur four times annually during the two year project. Chemical samples will be collected three times during base flow and once under storm flow conditions on an annual basis. Geolocation of sample sites will occur once during the sampling period.

Table 1. Parameters studied.

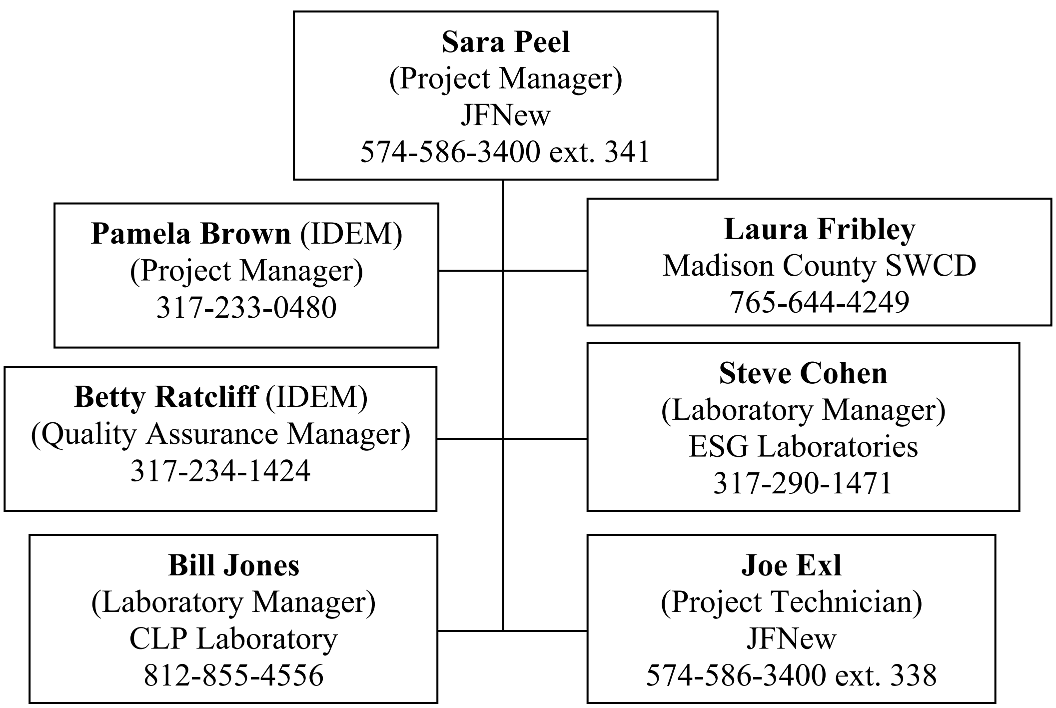
	Type of Sample/ Parameter	Number of Sampling Stations	Sampling Event Frequency	Sampling Period
Biological	Macroinvertebrate	12	4	Summer 2005-Fall 2006
Physical	Habitat	12	1	Summer 2005
Chemical	Water Chemistry*	12	8	Summer 2005-Fall 2006
	Discharge	12	8	Summer 2005-Fall 2006
Geolocation	GPS	8	1	Summer 2005

*Water chemistry samples will be analyzed for temperature, dissolved oxygen, pH, nitrate+nitrite, ammonia, total phosphorus, BOD, total suspended solids, and *E. coli*.

Section 2: Study Organization and Responsibility

Key Personnel

In general, JFNew will be responsible for the design, planning, execution, analysis and documentation of technical aspects of the project. The water-testing laboratories (Indiana Clean Lakes Program Laboratory and ESG Laboratires) will be responsible for chemical water quality analysis. The Madison County SWCD will be responsible for providing forums for public input and documenting the public's concerns and goals. Indiana Department of Environmental Management (IDEM) will provide the overall project guidance and assistance. Specific duties and responsibilities are outlined below.



In general, the Project Technician reports to the Project Manager and Project Manager coordinates with the CLP Laboratory, ESG Laboratories, IDEM Quality Assurance Manager, IDEM Project Manager, and Madison County SWCD.

Project Organization
Project Technician is responsible for:
- QAPP development
- Collection of general watershed parameters
- Collection of historical water quality data
- Geolocation of sampling sites
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate identification
- Habitat sampling
- Data entry for water chemistry, macroinvertebrate, and habitat samples
- Analysis of collected information

Project Manager is responsible for:
- Oversight of Project Technician's duties listed above
- Selection of sampling site locations
- Review water chemistry and habitat field data sheets prior to leaving sampling site
- Implementation of QAPP
- Water chemistry sampling
- Macroinvertebrate sampling
- Macroinvertebrate QA/QC
- Review of water chemistry, macroinvertebrate, and habitat data entry for completeness and accuracy
- Analysis of collected information

Section 3: Data Quality Objectives for Measurement of Data

The project goal is to obtain an overview of water quality in the Lilly Creek and Little Duck Creek watersheds from which a watershed management plan can be developed. Like many projects, this project has financial, temporal, and other constraints. For examples, we will collect physical, biological, and chemical data from each of the streams in the Lilly Creek and Little Duck Creek watersheds. Sites sampled on each of the streams will provide information on the relative pollutant inputs of each subwatershed. This information will prioritize one subwatershed over another subwatershed when evaluating where to spend limited funding. The sampling design will not; however, provide representative data for the whole watershed. Specificity will be sacrificed in order to obtain a greater quantity of general information on of the entire watershed, rather than specific information on a portion of it. For example, family level identification will be used rather than species level of the macroinvertebrate communities. This will allow for the collection of more data per level of effort. Researchers have already confirmed the acceptable use of family level identification to make broad management decisions and prioritize areas for future specific work (USEPA, 1989; IDEM, Unpublished; Hilsenhoff, 1988). Collecting information on this larger scale will allow for the collection of more data for the same cost as the collection of a lesser quantity of data at a small scale. Based on this, the general data quality objectives are to gather representative information on the ecosystem's health at a watershed scale, collect broad, watershed scale data to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future.

Like any project, this project has financial and temporal constraints. The project goal is to document the ecological conditions of the watershed with special emphasis on water quality from which a watershed management plan can be developed. The project's data quality goals are based on this overall project goal. Based on this, the general data quality objectives for measurement of data are to gather representative information on the ecosystem to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future. The data quality objectives for measurement of data are precision, accuracy, representativeness, comparability, and completeness.

DQO: Precision and Accuracy

Field Water Chemistry Parameters

Field equipment will be calibrated in accordance with manufacturer's specifications as detailed in Section 6. Replicate field measurements will be taken with the following field equipment: the Hanna Instruments HI 98129 pH, EC/TDS and temperature meter; the YSI Model 55 dissolved oxygen/temperature meter; and Marsh McBirney model 2000 portable flow meter. One replicate will be taken in every twelve measurements or once per sampling event. Precision will be calculated using the Relative Percent Difference equation:

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

Where:
C = the larger of the two values
C' = the smaller of the two values

The acceptable relative percent difference for field water chemistry parameters is detailed in Table 2. Regular, schedule maintenance in accordance with manufacturer's instructions will be used to insure equipment precision and accuracy.

Field equipment will be calibrated following manufacturers specifications on the day of sample collection. Field equipment use will follow recommended usage by the equipment manufacturer. Expected accuracy measurements for field equipment measurements are those listed by the equipment manufacturers and are displayed in Table 2.

Laboratory Water Chemistry Parameters

The Project Manager and Project Technician (or two Project Technicians if the Project Manager is not available) will collect samples in accordance with the contracted laboratories' Quality Assurance/Quality Control (QA/QC) requirements. For all parameters analyzed by ESG Laboratories and the Indiana CLP Laboratory, this will include the collection of one duplicate sample in every twelve samples collected, or one duplicate sample per sampling event. One set of field blank samples (one sample per parameter) will be collected during each sampling trip. Duplicate and field blank sample analysis will occur following the laboratory procedure detailed in the laboratory QA/QC plans (Appendices B and C). The contracted laboratories will implement QA/QC measures to ensure data quality as detailed in the laboratories' QA/QC documents (Appendices B and C). Section 3 of the CLP Laboratory QAPP provides information on the procedures followed for these DQO's. The laboratory standards are sufficient to meet the stated goals of this project. Table 2 summarizes the data quality objectives for measurement of data for the water chemistry parameters. Data not meeting laboratory standards for duplicates or field blanks will be removed from the sample set and will not be used for watershed prioritization.

Biological and Habitat Parameters

To ensure precision, all sampling protocols will be carried out as required in the procedural documentation by qualified individuals. The same field crew, consisting of the Project Manager and a Project Technician (or two Project Technicians if the Project Manager is not present) will sample each site using the same procedure to maintain consistency among sites. The consistency of field personnel and procedural organization will enhance precision by minimizing sampling variability.

Macroinvertebrates will be identified by an experienced and trained Project Technician. The Project Manger will check identification accuracy of at least 10% of the macroinvertebrate specimens identified by the Project Technician. Based on IDEM's sampling and subsampling methodology, each sample will consist of 100 organisms; 10% of each subsample, or 10 organisms, will be checked for accuracy. Any discrepancies between identification will be noted and discussed in order to obtain the correct identification through collaboration on the specific specimen in question. This level of quality control will allow for making broad management decisions. The accuracy and precision in identification is expected to be high given the limited number of technicians involved, their technical expertise, and the level of oversight they receive in the collection and identification of macroinvertebrates. Table 2 outlines the parameters, measurement range, accuracy, and precision of macroinvertebrates evaluation.

Habitat evaluation will be conducted by an experienced/trained Project Manager and a Project Technician (or two Project Technicians if the Project Manager is unavailable). Habitat will be evaluated on an individual basis then compared. Any discrepancies in habitat scoring will be noted and discussed in order to obtain an accurate and precise habitat score through collaboration. If a score can not be determined through collaboration, then the Project Manager's (or Lead Technician if the Project Manger is not present) will be used for scoring purposes. Table 2 outlines the parameters, measurement range, accuracy, and precision of habitat evaluation.

Global Positioning System Parameters

Location coordinate data precision is expected to be high, while accuracy is submeter. Table 2 lists detailed precision and accuracy information for the Trimble Pro XRS GPS.

Table 2. Data quality objectives for measurement of data for field and laboratory methods.

Parameter	Precision	Accuracy	Completeness
pH	RPD<5%	± 0.1	75%
Temperature	RPD<5%	± 2%	75%
Dissolved Oxygen	RPD<5%	± 0.3 mg/l	75%
Flow	RPD <5%	±2% + zero stability zs=±0.03 ft/sec	75%
E. coli	See Appendix C.	See Appendix C.	75%
Ammonia	See Appendix B.	See Appendix B.	75%
Nitrate+nitrite	See Appendix B.	See Appendix B.	75%
Total Phosphorus	See Appendix B.	See Appendix B.	75%
Total Suspended Solids	See Appendix B.	See Appendix B.	75%
Biological Oxygen Demand	See Appendix C.	See Appendix C.	
GPS	High	50 cm ± 1 ppm	100%
Habitat Analysis	High	High	100%
Macroinvertebrates	High	High	100%

DQO: Completeness
In the event that some catastrophic event (i.e. weather anomaly, chemical spill, or other event that would prohibit access to sampling sites) were to take place, the first action taken would be to delay the sampling to a later time that year, in hopes that sampling would occur under more representative conditions. There is flexibility built into the project schedule to allow sampling to occur during favorable conditions, preserving data quality.

Field and Laboratory Water Chemistry Parameters
One hundred percent (100%) collection of field and laboratory water chemistry samples is expected. Sampling locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. However, climatic or other changes beyond the project's control may alter conditions in the watershed. Refusal of landowners to grant access to the property may also limit the sample collection. Equipment malfunction or problems during sample collection and analysis could also limit the amount of water chemistry data over the term of the project. For the Little Duck Creek watershed, Sites 2 and 5 provide information about the developed portion of the watershed; however, Sites 1 and 4 will also provide information on the developed portion of the Little Duck Creek watershed. Therefore, the loss of Sites 2 and 5 will still enable watershed stakeholders to prioritize work in the developed portion of the watershed. Furthermore, the loss of these sample sites would still enable watershed stakeholders to prioritize work in these subwatersheds. Likewise, Sites 10 and 11 in the Lilly Creek watershed provide similar data information on the agricultural area of the watershed. If samples could not be collected at Site 11 watershed stakeholders would not be prevented from prioritizing work in this area. Therefore, loss of three sample sites would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) for water chemistry samples will be acceptable for completion of the project.

$$\%\ \text{completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{72 \times 100\%}{96} = 75\ \%$$

Macroinvertebrate and Habitat Parameters

Again, one hundred percent (100%) collection of macroinvertebrate and habitat samples is expected. Sampling will occur at the same sites as those utilized for water chemistry sample collected. Sample locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. Climatic or other changes beyond the project's control may alter the condition of the watershed; however, since macroinvertebrate and habitat data is being collected once over the lifetime of the project sample collection could be rescheduled to allow for data collection. Still, the refusal of landowners to grant access to the property may also limit the sample collection at the selected sites. Again, the loss of Sites 2, 5, or 11 would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{32 \times 100\%}{48} = 75\ \%$$

Global Positioning System Parameters

The geolocation of the sample sites is not dependent upon the weather or other climatic situations (barring the loss of satellites). Since GPS data can be collected over the length of the project, 100% completeness should be achieved.

DQO: Representativeness

Representativeness is the most important data quality metric in the project since the project objective is to provide watershed scale data. Representativeness of sampling sites was achieved by performing a desktop review of potential sampling sites. Because the number of stream and road crossings within the Lilly Creek and Little Duck Creek watersheds exceeds the number of sites that can be sampled by this project given the limited resources, not all tributaries could be samples. The following criteria were used to narrow the set of potential sites. Potential sites were selected based on accessibility (proximity to a road) and location in the watershed. Potential sites were then field checked by the Madison County SWCD to ensure accessibility to sampling stations and that the variety of physical, riparian, and in-stream habitats in the watershed were all represented in the sampling stations. Landowner permission will confirm potential sampling locations usability as sampling sites. An additional criterion for choosing sites is whether it has been used in historical studies to which this project's data may be compared.

DQO: Comparability

Water chemistry parameters are expected to be comparable to other studies if sampling and laboratory protocols and data quality objectives for measurement of data are similar. Results of this study can be compared to other studies that use this protocol and similar data quality objectives. All laboratory water chemistry analysis will be conducted using common, EPA-approved methods. All chemical data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability. As noted in the Sampling Design section, any non-analogous historical data (data collected under a different protocol with different data quality objectives) used in the study will be cited as such in the final product.

The macroinvertebrate and habitat samples are expected to be comparable because the project will follow macroinvertebrate sampling and habitat assessment procedures set forth by IDEM's Rapid Bioassessment protocol for macroinvertebrates, using the macroinvertebrate Index of Biotic Integrity (IDEM, unpublished) and OEPA's Quality Habitat Evaluation Index (QHEI). Results of this study can be compared to other studies using these protocols. All macroinvertebrate and habitat data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability.

Section 4: Sampling Procedures

The sampling methods and equipment are summarized in Table 2.

Water Chemistry Sampling

Water chemistry samples will be taken at each station to test the parameters listed in Table 2. Temperature, dissolved oxygen, pH, and flow measurements will be made in the field using the following instruments: YSI Model 55 dissolved oxygen/temperature meter; Hanna Instruments HI 98129 pH, EC/TDS and temperatures meter; and the Marsh McBirney Model 2000 portable flow meter. All measurements will be taken according to the standard operating procedures provided by the manufacturer of the equipment. Project biologists will record water chemistry field measurements on standardized field log data sheets (Appendix D). Sampling location, sample number/field ID, date, time, weather, Universal Transverse Mercantor (UTM) coordinates (North American Descent 1983, Zone 16), and any additional field notes will also be recorded on the field sheet.

Flow measurements will be taken utilizing protocols outlined in Marsh-McBirney (1990). A tape measure will be staked across the width of the channel prior to any measurements being taken. If the stream is less than two inches (2") deep, then multiple point velocity measurements will be taken throughout the width of the channel. Channel depths will be measured at a minimum of five points across the channel. Discharge will be calculated using the following formula:

$$\text{Discharge} = \frac{\left(\Sigma d_i\right)}{(n+1)}\ w*v$$

where d equals stream depth, n equals the number of streams depths measured, w equals the width of the stream, and v equals the velocity of the stream (0.9 times the fastest velocity recorded). This equation has been modified from EPA (1997).

If the stream is greater than two inches in depth, then the trapezoid channel method will be utilized to calculate stream discharge. The interval width, thus the number of flow measurements recorded across the channel, is determined by the channel width. If the channel width is less than fifteen feet, then the interval width will be equal to the stream width divided by five. If the channel is greater than fifteen feet wide, then the interval width will be equal to the channel width multiplied by 0.1. Stream depths will be recorded at the right and left edges of the predetermined trapezoid (SI_o and SI_1). Flow measurements will be recorded at the midpoint of each trapezoid ($SI_{1/2}$). All data will be recorded on the data sheet included in Appendix D. Discharge will be calculated using a calibrated Excel spreadsheet to minimize data errors involved in performing hand calculations.

Grab samples will be collected for the remaining water chemistry parameters (nitrate+nitrite, ammonia, total phosphorus, total suspended solids, BOD, and *E. coli)*. Samples will be placed in prepared containers supplied by the Indiana CLP laboratory in Bloomington, Indiana and ESG Laboratories in Indianapolis, Indiana (Table 3). The laboratories will provide the appropriate preservative in the pre-packaged containers as necessary. Sample collection will proceed in a manner similar to that outlined in *EPA Volunteer Stream Monitoring: A Methods Manual* (1997). One member of the field crew will wade to the center of the stream's thalweg to collect the water sample. The crewmember will invert a clean sample bottle (an extra one, not one used for sample storage) from the laboratory into the stream's thalweg. At a depth of approximately 8 to 12 inches below the water surface, the crewmember will turn the bottle into the current to allow for collection of water. (If the stream at the sampling station is shallower than 16 inches, water collection will occur mid-way between the water's surface and the stream bottom.) Once the bottle is full, the crewmember will scoop the bottle up toward the surface. Water in this bottle will be poured into the sample containers provided by the analytical laboratories.

The sample containers will be labeled as outlined in the proceeding section, stored on ice and transported to the appropriate laboratory for analysis. *E. coli* and BOD samples will be stored on ice and transported to ESG Laboratories in Indianapolis. Required chain of custody procedures as outlined in ESG Laboratories' QA/QC plan (Appendix C) will be followed. All other samples (nitrate+nitrite, ammonia, total phosphorus, and total suspended solids) will be stored on ice and shipped to the CLP Laboratory in Bloomington, Indiana. Required chain of custody procedures as outlined in the laboratory's QA/QC plan (Appendix B) will be followed. Water chemistry samples will be processed at both labs using the laboratory's standard operating protocol (see Table 3). All eight water chemistry samples collection events will follow this protocol for each of the twelve sample sites, duplicates, and field blanks. Analytical results from the water quality labs will be based on their schedule, but are anticipated within 2-3 weeks of sample collection.

Table 3. Sampling procedures.

Parameter	Sample Frequency	Sample Container*	Sample Volume	Holding Time
pH	8	N/A	N/A	N/A
Temperature	8	N/A	N/A	N/A
Dissolved Oxygen	8	N/A	N/A	N/A
Flow	8	N/A	N/A	N/A
E. coli	8	HDPE Nalgene	100 ml	6 hours†
Ammonia	8	HDPE Nalgene	125 ml	28 days
Nitrate+nitrite	8	HDPE Nalgene	125 ml	28 days
Total Phosphorus	8	Glass Media	125 ml	48 hours
BOD	8	HDPE Nalgene	500 ml	7 days
Total Suspended Solids	8	HDPE Nalgene	1000 ml	7 days
GPS	1	N/A	N/A	N/A
Macroinvertebrates	4	Clean, wide-mouth plastic collection jugs containing 70-80% alcohol	N/A	7 days
Habitat Analysis	1	N/A	N/A	N/A

*Sample containers will be provided and preserved by the contracted laboratory. ESG Laboratories will provide and preserve containers for *E. coli* and BOD sampling. The CLP Laboratory will provide and preserve sample bottles for all remaining laboratory parameters.
†This value refers to the maximum time between sample collection and analysis, not the holding time from the time the sample arrives at the lab. That holding time is 2 hours.

Macroinvertebrate Sampling

Methods for sampling macroinvertebrates will follow standard methods established by IDEM's Rapid Bioassessment protocol. Two samples using a 1 × 1 meter, 600 μm kick net will be performed at each of the sample stations. Since the water is no more than chest deep at any one site, each site lends itself to the use of a kick net. Organisms collected in the net will be placed in clean, wide-mouth plastic collection jugs containing 70-80% alcohol and stored on ice. Macroinvertebrate samples will be transported on ice to the JFNew laboratory immediately following collection of the samples. Macroinvertebrate samples will be identified and checked within one week of collection to limit any potential deterioration of the identifying features of the organisms. During the identification and confirmation time period, macroinvertebrate samples will be stored on ice or in a refrigerated cooler. Macroinvertebrate identification results will be recorded on data sheets (Appendix E).

Habitat Evaluation

Habitat evaluation will be conducted at each station using Ohio EPA's Quality Habitat Evaluation Index (QHEI). The field crew will adhere to OEPA QHEI standard procedures. Assessments will be made by the field crew and noted on QHEI data sheets (Appendix F).

Section 5: Custody Procedures

Field sampling data and data sheets used for water chemistry field sampling will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

The field crew consisting of the Project Manager and Project Technician (or two Project Technicians if the Project Manager is not present) will collect the water chemistry samples using the procedure outlined in Section 4. Samples will be labeled with the sampling location, sample number (same as "Field ID" on the laboratory Chain of Custody Record), date and time of collection, sample parameters, and sampler name(s). This information along with the project name and project number will be recorded on the laboratories' Chain of Custody Records (Appendices B and C). Appendices B and C contain blank Chain of Custody Records for the CLP laboratory and ESG Laboratories, respectively.

E. coli samples will be stored on ice and transported within 6 hours to the ESG Laboratories. The Project Manager (or Project Technician if the Project Manager is not a member of the field crew) will sign the Chain of Custody Record in the presence of the laboratory technician when samples are released to the laboratory. ESG Laboratories will review sample labels and remove any samples from the dataset that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on laboratory bench sheets after all checks have been completed. A copy of the chain of custody form will accompany sample result documents from ESG Laboratories. The report from ESG Laboratories is expected within 2-3 weeks of sampling.

All other water chemistry samples will be analyzed by the CLP laboratory. These samples will be stored on ice and transported to the laboratory within 24 hours of sample collection. The Project Manager or Lead Project Technician will sign the Chain of Custody form prior to shipping the samples to the CLP laboratory. Clean Lakes Program staff will review sample labels and remove any samples from the data set that cannot be attributed to specific samples, have not been properly preserved, or that exceed the maximum holding time. The report from the CLP laboratory is expected within one month of sampling. A copy of the chain of custody form will accompany sample results.

The field crew consisting of the Project Manager and Project Technician (or two Project Technicians if the Project Manager is not present) will use IDEM's Rapid Bioassessment protocol to collect macroinvertebrates samples. All macroinvertebrates removed from the sites will be placed in wide-mouth plastic containers with a preservative and labeled with the sample location, sample number, date and time of collection, sample parameter, and sampler(s) name(s). Sample bottles will be stored on ice. Samples will be transported to the JFNew laboratory and stored in a cooler until identification is completed. Identification will be completed within one week of sampling. Identifications will be made by a Project Technician and checked for accuracy by the Project Manager using the following taxonomic references: Merritt and Cummins (1996), McCafferty (1981), Thorp and Covich (1991) and Pennak (1978). Appendix E contains the data sheet to be used for macroinvertebrate identification. Macroinvertebrates and data sheets used during identification will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Habitat measurements will be noted on the QHEI data sheet like those located in Appendix F. Samples are not collected as part of this procedure. Habitat assessment data sheets will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Section 6: Calibration Procedures and Frequency

Calibration measures will be performed on all field equipment to be used (where appropriate) based upon the manufacturers recommendations as outlined in the users manual for each individual piece of equipment. Field equipment that cannot be calibrated, such as a tape measure, will not be calibrated. Field equipment calibration will be performed the day of sampling prior to its use in the field. The YSI Model 55 oxygen and temperature probe is auto-calibrated based on the altitude and salinity of the sample prior to time of use. The Hanna Instruments HI 98129 ph, EC/TDS and temperature meter is calibrated using Fisher calibration buffer (pH 4.0 and 7.0). The Marsh McBirney Model 2000 flow meter is calibrated by the manufacturer prior to shipping. If equipment cannot be properly calibrated, then sampling will be rescheduled. If the GPS can not be properly calibrated, then GPS measurements will be recorded at a later date following proper calibration and all other sampling will proceed as scheduled. See Appendix B for Indiana CLP laboratory and Appendix C for ESG Laboratories calibration procedures and frequency.

Section 7: Sample Analysis Procedures

Table 4 summarizes the analytical procedures for each water chemistry parameter. Each laboratory has the capability, as shown in their respective Quality Assurance documents (Appendices B and C), to analyze the water samples according to the procedures listed in Table 4.

Table 4. Analytical procedures.

Matrix	Parameter	Method	Detection Limits
Water	pH	Hach pH meter	0.1
Water	Temperature	YSI Model 55	1°C
Water	Dissolved Oxygen	YSI Model 55	0.1 mg/l
Water	Flow	Marsh McBirney Model 2000 portable flow meter	0.1 ft/s
Water	*E. coli*	Standard Method 9223B	N/A
Water	Ammonia	Alkaline phenol and hypochlorite method	0.03 mg/l
Water	Nitrate+nitrite	Cadmium reduction method	0.10 mg/l
Water	Total Phosphorus	Standard Method 4500-P F	0.01 mg/l
Water	Total Suspended Solids	Standard Method 2540 D	1 mg/l
Water	Biological Oxygen Demand	EPA 405.1	1 mg/L
Geolocation	GPS	Trimble Pathfinder Pro XRS	submeter
Substrate	Macroinvertebrates	IDEM	N/A
Habitat	Habitat Analysis	OEPA QHEI	N/A

All procedures that will be used to analyze the macroinvertebrate samples and QHEI assessments will strictly adhere to the IDEM Rapid Bioassessment protocol or the OEPA QHEI protocol, respectively. Because these tools were designed to make rapid assessments at large scales, the use of these tools will enable the achievement of project goals. In general, detection limits are not applicable to the biological and physical habitat assessment used in this project. However, small organisms (smaller than 600 μm) may not be collected due to mesh size of the sampling net. Similarly, the field picker may overlook small organisms caught in the net. Nets will be double checked to prevent this. Table 4 provides an overview of the analytical procedures.

Section 8: Quality Control Procedures

Quality control will be achieved by strict adherence to written protocol. To achieve precision in field measurements, replicate measurements will be taken. Replicate measurements for each field parameter will be taken at one of the twelve sampling sites for each sampling event. To achieve accuracy in field measurements, equipment will be properly maintained and equipment calibration will occur as detailed in Section 6. To achieve precision in laboratory measurements, duplicate samples will be collected one time in twelve samples or once per sampling trip. The contracted laboratories have established control limits for all quality control checks established by their protocols (Appendices B and C). To achieve accuracy in laboratory measurements, field blanks collected concurrently with sample collection will be analyzed. Field blank collection will ensure that no outside contamination occurs during the process of sample bottle preparation or sample collection. Additional laboratory QA/QC checks for accuracy and precision will be implemented by ESG Laboratories and the CLP Laboratory (Appendices B and C). Field work will be performed by the same crew at each site. The Project Manger or Lead Technician will ensure consistency in sample collection and field work. This quality control procedure will allow for comparison to be made among sampling sites, and thus, achieve the project's goals of identifying hot spots within the watershed for more targeted intensive management.

Quality control in the field will be obtained by adherence to procedures detailed in Sections 3 and 4. This quality control includes replicate samples, equipment calibration, and adherence to procedures as detailed in Section 3. Quality control of laboratory water chemistry analysis will be performed as outlined in the respective laboratories' QA/QC plans (Appendices B and C). This quality control includes use of field replicates, lab duplicates, split samples, field blanks, reference standards, and method blanks where appropriate. This level of quality control is sufficient to achieve project goals.

Quality control of macroinvertebrate identification will be achieved by having a single initial identifier of each sample with 10% of each sample being checked by the Project Manager. Inaccuracies greater than 25% of the checked portion will trigger reevaluation of the entire sample unless deemed unnecessary. (For example, technician is consistently misidentifying one family; in that case, only the individuals of that family will be reevaluated.) Consistency in protocol will allow for comparisons to be made among sample sites and thus achieve the project goals of identifying priority areas within the watershed for targeted intensive management.

Independent QHEI assessments will be made by each member of the field crew to ensure precision and accuracy of habitat assessment. Any differences in assessments will be averaged, if possible, based on the metric. Where averaging of a metric is not possible, the value given by the Project Manager will be accepted. Fieldwork will be performed by the same crew at each site. The Project Manager will ensure consistency in sample collection and fieldwork.

Section 9: Data Reduction, Analysis, Review, and Reporting

Data Reduction

Field data sheets will be inspected for completeness and signed by the Project Manager or Lead Project Technician before leaving the site. The Project Manager or Lead Project Technician will calculate the RPD before leaving the site to ensure the precision data quality objectives for measurement of data for the field measurements are met. It will be assumed that accuracy data quality objective of field measurements are met if there is no problem with equipment calibration. The field data sheet contains fields showing whether the RPD met the data quality objective, if calibration was completed, if the measurement was taken (completeness), and if protocol was followed (comparability). Data from the field data sheets and macroinvertebrate identification data sheets will be used to calculate both a macroinvertebrate Index of Biotic Integrity (mIBI) and QHEI to indicate the biological integrity or habitat quality of the aquatic system at the specific sites studied. The Project Manager will review macroinvertebrate identification. Field measurements using electronic instrumentation need no further reduction. Data reduction in the laboratory will be done in accordance with Indiana CLP laboratory and ESG Laboratories QA/QC protocol (Appendices B and C).

Data Analysis

Discharge and loadings will be calculated using an electronic spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Madison County SWCD to minimize errors involved with performing hand calculations. Once the raw data has been reviewed by the Project Manger, discharge will be calculated using methodology detailed in Section 4 (Marsh McBirney, 1990). Once discharge has been calculated, the pollutant load will be calculated by multiplying the specific site discharge by the concentration of a pollutant found at that site. Pollutant loads among sites will be compared to identify which sites provide the greatest load of pollutant to the Lilly Creek and Little Duck Creek watersheds.

Data Review

The Project Technician will enter all data into a computerized spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Madison County SWCD. The Project Manager will review data entry for completeness and errors.

Data Reporting

ESG Laboratories and the CLP laboratory will provide sample results with qualifying information for any results which fall outside of the control limits. A copy of the chain of custody form will accompany laboratory results.

The Project Manager will be responsible for report production and distribution. The Project Technicians will provide assistance in these tasks. The report will contain the data results, interpretation of the data, Best Management Practice proposals for existing watershed conditions, a compilation of watershed stakeholders' concerns and goals, and proposals for future development in the watershed.

Section 10: Performance and System Audits

Specific audits such as those conducted on the contracting laboratories by outside auditors are not applicable to this type of project. Such audits are not necessary to achieve the project goals given the scope of this study and the intended use of the data. However, the following checks and oversight will be utilized to ensure data quality:

- The Project Manager will provide oversight to all technical staff ensuring strict adherence to all protocols.
- Field data sheets will be reviewed for completeness prior to leaving the field.
- Two individuals will make QHEI assessments at each site.

Both the CLP laboratory and ESG Laboratories has built in audits (Appendices B and C). The Project staff is open to IDEM's audits upon IDEM's request. The Project Manager will conduct a system audit following the first sampling event and at the end of the project to ensure data quality objectives for measurement of data are met.

Section 11: Preventative Maintenance

JFNew will utilize a dissolved oxygen meter/thermometer (YSI Model 55), pH meter (Hanna Instruments HI 98129), flow meter (Marsh McBirney Model 2000 portable flow meter), global positioning system (Trimble Pathfinder Pro XRS), tape measure, and kicknet for water quality sampling. To keep these instruments and equipment in proper working order, all maintenance will be performed as outlined in the users manuals provided with the equipment where appropriate. Additional batteries for the dissolved oxygen meter and GPS, a separate thermometer, and replacement dissolved oxygen membranes will be present in the field for any necessary field repairs. An additional set of collection bottles and nets will be taken along on each sampling trip (where applicable). Preventative maintenance in each respective laboratory is covered in Appendices B and C.

Section 12: Data Quality Assessment

DQO: Precision and Accuracy

As stated in the Study Goals in Section 1, the goal of the project is to document the physical, biological, and chemical condition of the Lilly Creek and Little Duck Creek watersheds. Collected data will be utilized to identify priority areas in the watershed that may be contributing more non-point source pollutants to the Lilly Creek and Little Duck Creek watersheds. Data quality controls outlined in the sections above will be sufficient to meet the objectives of the study. Data quality assessments conducted by the contracting laboratories will be sufficient to meet the objectives of the project (Appendices B and C). Laboratory analysis of precision and accuracy checks, including control levels for duplicate and replicate samples and field and laboratory blanks, will be kept on file in the contract laboratories. All laboratory data will be assessed by ESG Laboratories and the CLP Laboratory to determine if data quality falls within the required precision and accuracy levels specified by each laboratory (Appendices B and C). The laboratories will follow established protocols to determine if data is valid. Any data that is determined to not meet laboratory quality control guidelines will not be reported or used for subwatershed prioritization. All QA/QC measures for each run of the samples will be included with the lab's final data analysis and will be included as an appendix in the final report.

Field measurements and biological and habitat data will be accepted as valid provided no significant problems occur during calibration and sampling. Field water chemistry measurements will be repeated if precision failures are observed (RPD>5%). Data that does not meet precision goals will not be included in sample analysis and subwatershed prioritization. The accuracy of field measurements and biological and habitat data will not be quantified. However, the data will be acceptable provided that no significant problems occurred during equipment calibration or sampling. Sampling will be rescheduled if problems occur during equipment calibration. Field measurements will be repeated if difficulties occur during sampling.

DQO: Completeness
All data determined to be accurate and precise will be considered valid and will be reported even if completeness objectives are not met. Due to flexibility in scheduling of sampling events, 75-100% completeness is anticipated. If for some reason (such as ones outlined in previous sections) 100% collection of samples is not possible, the data will be evaluated to determine whether the watershed has been sufficiently represented in the data collection to date.

DQO: Representativeness
Meeting the goal of representation is of primary importance since it is one of the study's goals. Data will be evaluated for representativeness based primarily on the following criteria: all sampling stations have been sampled at least once and water chemistry samples have been collected during storm and base flow events. Those criteria are listed in order of importance. The first one listed will have more importance in deciding whether the project is complete despite not having collected 100% of the samples. Any decisions to deem the project complete without 100% collection of data will be made by the Project Manager. The IDEM Project Manager will be included in all such decisions.

DQO: Comparability
Data collected during this study will meet comparability requirements if standard operating procedures as outlined in Section 4 are followed. Water chemistry data will be comparable with other data collected using the same protocol. Likewise, macroinvertebrate and habitat data will be comparable to IDEM data only if the standard operating procedures are followed. If problems occur during sample collection that requires the use of non-standardized operating procedures, then that data will be evaluated for comparability. This will likely result in the removal of this data from the data set.

Section 13: Corrective Action

Should extraordinary events occur that could adversely affect the collection of accurate, representative data (extreme climatic conditions, chemical spill, etc.) testing shall be rescheduled during the same year when conditions are more favorable. The data can then be analyzed so that reports can be written. Since water chemistry sampling is to be done eight times, macroinvertebrate sampling conducted four times, and habitat one time during the study period, it is feasible to schedule sampling at a time when conditions permit within the project's timeframe. If, for reasons beyond the project's control, samples cannot be collected during the project's timeframe, the prohibitive conditions will be noted and discussed with the IDEM Project Manager.

The CLP laboratory and ESG Laboratories corrective actions that will be taken for the chemical water quality analysis are noted in Appendices B and C. Although it is not anticipated, should data received from the CLP laboratory or ESG Laboratories be unusable given the project's data goals, another sampling event will occur to replace effected data. Assurance from the CLP laboratory and/or ESG Laboratories that similar problems in data quality will not be repeated will be obtained prior to submission of any samplings.

Less than 75% accuracy of the checked portion (10%) of the macroinvertebrate sample will trigger corrective actions for the macroinvertebrate identification. Such corrective actions could include discussion with sampler and identifier to determine the source of error, re-identification of part of or the entire sample, and/or discarding an unusable sample where appropriate. Any habitat data collected according to standard operating protocols will meet the data collection objectives. Corrective actions are not applicable to this form of assessment.

Section 14: Quality Assurance Reports

Quality Assurance reports will be submitted to IDEM's Watershed Management Section every three months as part of the Quarterly Progress Report and/or Final Report. Any problems that are found with the data will be documented in the quarterly reports. Quality assurance issues that may be addressed in the quarterly report include, but are not limited to the following:

- Assessment of such items as data accuracy and completeness
- Results of performance and/or systems audit
- Significant QA/QC problems and recommended solutions
- Discussion of whether the QA objectives were met and the resulting impact on decision making
- Limitations on use of the measurement data

If no QA/QC problems arise, this will be noted in the report.

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APPENDIX A

Sampling Station Locations

WATER QUALITY SAMPLING FIELD LOG SHEET

SITE NUMBER AND LOCATION: ____

DATE: ____________________ PROJECT NAME: ______________________________

TIME: _____________

FIELD CREW: __________________________________

WEATHER CONDITIONS: ____

OTHER OBSERVATIONS: ____

EQUIPMENT CALIBRATION (Date): _____________________

FIELD PARAMETERS	REPLICATE (if taken)	
pH: ____________	pH: ___________	RPD = _______
Temperature: _______________	Temperature: ___________	RPD = _______
Dissolved Oxygen: ___________	Dissolved Oxygen: _______	RPD = _______
DO % Saturation: ____________	DO % Saturation: _______	RPD = _______
Total Dissolved Solids: _________	TDS: ______	RPD= _______
Calculated Flow: _____________		

Relative Percent Difference (RPD)= $\frac{(sample_1 - sample_2)}{((sample_1 + sample_2)/2)}$

LAB PARAMETERS

E. coli: ____

Ammonia: ____

Nitrate: ____

Total Suspended Solids: ____

Total Phosphorus: ____

BOD: ____

Field Crew Leader Signature: _____________________

Site	Watershed	Creek	Location	Observed Flora	General Land Use	Creek bottom	Approx Width (ft) (4/19/05)	Approx Depth (in) (4/19/05)
1	Little Duck Creek	Big Duck Creek	1050 N. Approximately 1/2 mile W of SR 13.	Wooded	Suburban	Rocky	15-20	12-24
2	Little Duck Creek	Big Duck Creek	S B Street. Just W. oF S 13th. Bridge #606	S. woody. N. grassy	Urban/ Residential	Rip rap	(5/13/05) 10	(5/13/05) 12
3	Little Duck Creek	Big Duck Creek	1300 N. ½ mile W. of 800 W.	N. shrubby/grassy. S. wooded		muddy with scattered rocks	12	9-15
4	Little Duck Creek	Little Duck Creek	900 W (SR 13) just N. of SR 37	Woody vegetation	Urban	Rock	10-15	12
5	Little Duck Creek	Little Duck Creek	1100 N. Bridge #55	Woody vegetation	Urban	Rock	10	8
6	Little Duck Creek	Little Duck Creek	700 N. and SR 37	N. woody vegetation. S. grass and fenced	Agricultural	Mud. Some rocks	(5/31/05) 10	(5/31/05) 12
7	Lilly Creek	Pipe Creek	300 W 1/2 mile S of 1100 N. Bridge.	Mostly wooded on sides.	Suburban/ Agricultural. Residential on one side, ag. on other.	Gravelly/ rocky/ sandy bottom	15 - 25	24
8	Lilly Creek	Lilly Creek	300 W. Just S of 1100 N. Bridge.	Wooded along sides.	Agricultural	Rocky	15	12
9	Lilly Creek	Lilly Creek	Hwy 28, 1/4 mile west of 200 W. Bridge.	Grassy sides of bank.	Pasture	Muddy with large rocks.	10 - 12.	
10	Lilly Creek	Lilly Creek	1400 N, 1/2 mile E of 300 W. Bridge # 11.	Wooded along stream, but grassy on northeast side of creek.	Agricultural	Muddy/ some big rocks.	10 - 22	24 -36
11	Lilly Creek	Lilly Creek	200 N. 1/4 mile S of 1475 N.	Mostly wooded.	Agriculture	Sandy/ clay bottom	15-20	12-15
12	Lilly Creek	Lilly Creek	1550 N and 100 W. Bridge.	All grass up to edge (north of field). South of bridge: grassy/ woody vegetation.	Agriculture	Rock	(5/31/05) 36	(5/31/05) 6

LC1	Lilly Creek	Lilly Creek Alternate	1150 N. East of Orestes. Bridge # 43. W of 200 W.	Woody area	Semi-rural	Muddy/rocky	22	24-36
LDC1	Little Duck Creek	Little Duck Creek Alternate	1300 N just W. of SR 37	N. woody on one side, mostly grass. S. grassed	Agricultural	gravelly-S	(5/31/05) 4-10	(5/31/05) 10
BDC1	Little Duck Creek	Big Duck Creek Alternate	1400 N west of 700	grassy above bridge, tree lined below banks	Agricultural	lots of rip rap	12	12-24

APPENDIX B

ESG Laboratories
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX C

Indiana Clean Lakes Program QAPP
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX D

Water Quality Sampling Data Sheets

WATER QUALITY SAMPLING FIELD LOG SHEET

SITE NUMBER AND LOCATION: ____

DATE: ____________________ PROJECT NAME: ______________________________

TIME: _____________

FIELD CREW: __________________________________

WEATHER CONDITIONS: ____

OTHER OBSERVATIONS: ____

EQUIPMENT CALIBRATION (Date): _____________________

FIELD PARAMETERS	REPLICATE (if taken)	
pH: ____________	pH: ___________	RPD = _______
Temperature: _______________	Temperature: ___________	RPD = _______
Dissolved Oxygen: ___________	Dissolved Oxygen: _______	RPD = _______
DO % Saturation: ____________	DO % Saturation: _______	RPD = _______
Total Dissolved Solids: _________	TDS: ______	RPD= _______
Calculated Flow: _____________		

Relative Percent Difference (RPD)= $\frac{(sample_1 - sample_2)}{((sample_1 + sample_2)/2)}$

LAB PARAMETERS

E. coli: ____

Ammonia: ____

Nitrate: ____

Total Suspended Solids: ____

Total Phosphorus: ____

BOD: ____

Field Crew Leader Signature: _____________________

Discharge Measurement

Site:______________________________ Date:____________ Time:___________
Project #:__________________________ Project Name:____________________
Crew Members:____________________ Equipment:______________________
Physical Site Description:____
GPS Coordinates:______________________________

If the stream is <2" deep:
Stream Width:_____feet
Stream Depths: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____feet
U: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ft/s
U_{max}:_____ft/s

If the stream is >2" deep:
Stream Width (W):_____feet
Interval Width (IW) (If W<15', then IW=W/5. If W>15, then IW=W*0.1):_____feet

Segment	**SI_0** Location	Depth (ft)	**SI_1** Location	Depth (ft)	**½ IW** Location	Depth (ft)	**$U_{0.4}$** Set Depth	Rate (ft/s)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Field Crew Leader Signature: ______________________

APPENDIX E

Qualitative Habitat Evaluation Index (QHEI) Data Sheets

STREAM: ______________ **RIVER MILE:** __________ **DATE:** __________ **QHEI SCORE** [ ]

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) — **SUBSTRATE SCORE** [ ]

TYPE			POOL	RIFFLE				POOL	RIFFLE
[ ]	[ ]	BLDER/SLAB(10)	___	___	[ ]	[ ]	GRAVEL(7)	___	___
[ ]	[ ]	BOULDER(9)	___	___	[ ]	[ ]	SAND(6)	___	___
[ ]	[ ]	COBBLE(8)	___	___	[ ]	[ ]	BEDROCK(5)	___	___
[ ]	[ ]	HARDPAN(4)	___	___	[ ]	[ ]	DETRITUS(3)	___	___
[ ]	[ ]	MUCK/SILT(2)	___	___	[ ]	[ ]	ARTIFIC(0)	___	___

SUBSTRATE ORIGIN (all)
- [ ] LIMESTONE(1)
- [ ] RIP/RAP(0)
- [ ] TILLS(1)
- [ ] HARDPAN(0)
- [ ] SANDSTONE(0)
- [ ] SHALE(-1)
- [ ] COAL FINES(-2)

SILT COVER (one)
- [ ] SILT-HEAVY(-2)
- [ ] SILT-MOD(-1)
- [ ] SILT-NORM(0)
- [ ] SILT-FREE(1)

Extent of Embeddedness (check one)
- [ ] EXTENSIVE(-2)
- [ ] MODERATE(-1)
- [ ] LOW(0)
- [ ] NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______________________________

2) INSTREAM COVER: — **COVER SCORE** [ ]

TYPE (Check all that apply)
- [ ] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)
- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______________________________

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) — **CHANNEL SCORE** [ ]

SINUOSITY
- [ ] HIGH(4)
- [ ] MODERATE(3)
- [ ] LOW(2)
- [ ] NONE(1)

DEVELOPMENT
- [ ] EXCELLENT(7)
- [ ] GOOD(5)
- [ ] FAIR(3)
- [ ] POOR(1)

CHANNELIZATION
- [ ] NONE(6)
- [ ] RECOVERED(4)
- [ ] RECOVERING(3)
- [ ] RECENT OR NO RECOVERY(1)

STABILITY
- [ ] HIGH(3)
- [ ] MODERATE(2)
- [ ] LOW(1)

MODIFICATION/OTHER
- [ ] SNAGGING
- [ ] RELOCATION
- [ ] CANOPY REMOVAL
- [ ] DREDGING
- [ ] ONE SIDE CHANNEL MODIFICATION
- [ ] IMPOUND
- [ ] ISLAND
- [ ] LEVEED
- [ ] BANK SHAPING

COMMENTS: ______________________________

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) — **RIPARIAN SCORE** [ ]

River Right Looking Downstream

RIPARIAN WIDTH (per bank)

L	R	(per bank)
[ ]	[ ]	WIDE >150 ft.(4)
[ ]	[ ]	MODERATE 30-150 ft.(3)
[ ]	[ ]	NARROW 15-30 ft.(2)
[ ]	[ ]	VERY NARROW 3-15 ft.(1)
[ ]	[ ]	NONE(0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L	R	(most predominant per bank)	L	R	(per bank)
[ ]	[ ]	FOREST, SWAMP(3)	[ ]	[ ]	URBAN OR INDUSTRIAL(0)
[ ]	[ ]	OPEN PASTURE/ROW CROP(0)	[ ]	[ ]	SHRUB OR OLD FIELD(2)
[ ]	[ ]	RESID.,PARK,NEW FIELD(1)	[ ]	[ ]	CONSERV. TILLAGE(1)
[ ]	[ ]	FENCED PASTURE(1)	[ ]	[ ]	MINING/CONSTRUCTION(0)

BANK EROSION

L	R	(per bank)
[ ]	[ ]	NONE OR LITTLE(3)
[ ]	[ ]	MODERATE(2)
[ ]	[ ]	HEAVY OR SEVERE(1)

COMMENTS: ______________________________

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — **NO POOL = 0** — **POOL SCORE** [ ]

MAX.DEPTH (Check 1)
- [ ] >4 ft.(6)
- [ ] 2.4-4 ft.(4)
- [ ] 1.2-2.4 ft.(2)
- [ ] <1.2 ft.(1)
- [ ] <0.6 ft.(Pool=0)(0)

MORPHOLOGY (Check 1)
- [ ] POOL WIDTH>RIFFLE WIDTH(2)
- [ ] POOL WIDTH=RIFFLE WIDTH(1)
- [ ] POOL WIDTH<RIFFLE WIDTH(0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)
- [ ] TORRENTIAL(-1)
- [ ] FAST(1)
- [ ] MODERATE(1)
- [ ] SLOW(1)
- [ ] EDDIES(1)
- [ ] INTERSTITIAL(-1)
- [ ] INTERMITTENT(-2)

COMMENTS: ______________________________

RIFFLE SCORE [ ]

RIFFLE/RUN DEPTH
- [ ] GENERALLY >4 in. MAX.>20 in.(4)
- [ ] GENERALLY >4 in. MAX.<20 in.(3)
- [ ] GENERALLY 2-4 in.(1)
- [ ] GENERALLY <2 in.(Riffle=0)(0)

RIFFLE/RUN SUBSTRATE
- [ ] STABLE (e.g., Cobble,Boulder)(2)
- [ ] MOD.STABLE (e.g., Pea Gravel)(1)
- [ ] UNSTABLE (Gravel, Sand)(0)
- [ ] NO RIFFLE(0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] EXTENSIVE(-1)
- [ ] MODERATE(0)
- [ ] LOW(1)
- [ ] NONE(2)
- [ ] NO RIFFLE(0)

COMMENTS: ______________________________

6) GRADIENT (FEET/MILE): _____ **% POOL** _____ **% RIFFLE** _____ **% RUN** _____ **GRADIENT SCORE** [ ]