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APPENDIX A

Procedures for continuous water quality monitoring (Sondes and YSI)

UW-Milwaukee – Fish Ecology Laboratory
DISSOLVED OXYGEN MONITORING SOP

Procedures for Continuous Monitoring

1.0 Introduction

1.1 Scope

This Standard Operating Procedure (SOP) is applicable to the continuous monitoring dissolved oxygen, temperature, pH, and conductivity using YSI 6600 and 6600 EDS sondes.

1.2 Purpose

The purpose of this SOP is to provide a framework for the continuous monitoring dissolved oxygen, temperature, pH, and conductivity using YSI 6600 and 6600 EDS sondes as part of the Stream Monitoring Projects. These procedures include detailed instruction on sonde calibration, selection of sonde deployment locations, sonde deployment, sonde retrieval, and sonde data download.

2.0 Definitions

2.1 Aeration Stone: A stone used to diffuse injected air into water.

2.2 Conductivity: The ability of an aqueous solution to carry an electrical current.

2.3 Dissolved Oxygen: A relative measure of the amount of oxygen (O_2) dissolved in the water.

2.4 In-situ: In place. An *in-situ* environmental measurement is one that is taken in the filed, without removal of a sample to the laboratory.

2.5 Material Safety Data Sheets (MSDS): A compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals, health, and physical hazards, exposure limits, and precautions.

2.6 NTU: A unit of measure for the turbidity of water based on the amount of light that is reflected off particles in the water.

2.7 pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

2.8 Turbidity: The cloudiness or haziness of water caused by individual particles that are too small to be seen without magnification.

2.9 Sonde: Water quality monitoring device that is equipped with multiple probes to continuously record stream data.

3.0 Health and Safety Warnings

3.1 Latex gloves must be worn during calibration procedures.

3.2 The standard solutions for calibrating conductivity contain Iodine and Potassium Chloride. When using the standards, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the Material Safety Data Sheets (MSDS) for prompt action, and in all cases seek medical attention immediately.

3.3 The standard solutions for calibrating turbidity contain Styrene divinylbenzene copolymer spheres. While the material is not volatile and has no known physical effects on skin, eyes, or on ingestion, general health and safety precautions should be adopted to minimize unnecessary contact. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately.

3.4 All standard solutions for calibrating pH contain the following compounds:
pH 7 Solutions: Sodium Phosphate (dibasic), Potassium Phosphate (Monobasic), Water.
pH 10 Solutions: Potassium Borate (Tetra), Potassium Carbonate, Potassium Hydroxide, Sodium (di) Ethylenediamine Tetraacetate, Water.
Avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately.

3.5 Field crew members operating in wadable streams and from a boat must wear a personal floatation device.

3.6 Significant risk of injury may exist while deploying sondes in streams. Deployment and retrieval may result in exposure to sewage and bacteriologically contaminated water. All field-sampling personnel must therefore be adequately protected against risk of exposure to such contaminants.

3.7 Field personnel shall wear rubber gloves or suitable hand protection during the collection and handling of sondes.

3.8 While working in the field, the field crew shall carry a complete first-aid kit that provides materials for disinfection and protection of any skin cuts or abrasions and water for washing off chemical exposures. Personnel will promptly attend to any such cuts or abrasions, and seek medical attention if appropriate. Any need for first aid or medical attention shall be recorded in the field log, including information on time and location of any injury to personnel and description of first-aid treatment applied.

3.9 Walking in streams requires the use of waders, preferably with felt soles, and a wading staff. Care should be taken to establish footing before moving forward.

3.10 There shall be no fewer than two people deploying or retrieving a sonde.

3.11 Each field crew should have a cellular phone in case of emergencies.

4.0 Interferences

4.1 Interference may result from using contaminated equipment, solvents, reagents, sample containers, or sampling in a disturbed area.

4.2 Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. Clean and decontaminate all sampling equipment prior to use and between each sampling sites. See the SOP for Laboratory Cleaning of Sampling Equipment and the SOP for Field Cleaning of Sampling Equipment for details on the cleaning and decontamination procedures.

4.3 Interferences can also occur during the course of an unattended deployment. For example, physical damage to probe membranes can be caused by natural or man-made debris; debris such as leaves or plastic can cover probes, or sediment can partially or completely cover probes. Also, oils, paints or other substances in the water may come into contact with probe membranes causing inaccurate readings.

5.0 Personal Qualifications

5.1 Personnel will be trained in the proper use and calibration of all sampling equipment by an experienced person prior to data collection.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the FRSG DO Monitoring Project.

6.0 Materials

6.1 Thermometer with National Institute of Standards and Technology (NIST) trace.
6.2 pH Standards of 7 and 10
6.3 Conductivity standards of 1,000 mS
6.4 Turbidity standards of 0 and 100 NTU
6.5 DI water
6.6 YSI 6600 or YSI 6600 EDS sonde with attached pH, conductivity, DO, and turbidity probes (where applicable)
6.7 Protective cup for sondes
6.8 Protective case for sondes
6.9 YSI 55 DO Meter
6.10 YSI 650 MDS
6.11 Sonde communication cable
6.12 Padlocks
6.13 Keys for padlocks
6.14 Duplicate set of keys
6.15 Bolt cutters
6.16 Bubble wrap
6.17 Meter tape
6.18 Wading staff
6.19 Range finder
6.20 Flowmate stream flow meter
6.21 Ribbon
6.22 Paint
6.23 Buoys
6.24 Waders
6.25 Boat
6.26 Personal floatation jacket
6.27 Disinfectant wipes/hand sanitizer
6.28 Clipboard
6.29 Calibration logs
6.30 Deployment/Retrieval logs
6.31 DO profile field logs
6.32 Pen

7.0 Pre-sampling
- 7.1 Obtain the necessary sampling equipment.
- 7.2 Prepare a schedule and coordinate with staff.
- 7.3 Inspect and calibrate sondes using procedures outlined below. Any damaged equipment not working within manufactures recommended tolerances will be repaired or replaced prior to deployment.

8.0 Procedures
- 8.1 Laboratory sonde calibration procedures
  - 8.1.1 Temperature
    For instrument probes that rely on temperature (pH, DO, and conductivity), the sonde temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the NIST. The reference themometer's accuracy check will be performed at least once a year, and the date and results of the check kept with the instrument. Temperature measurements made by the sonde will be verified with each calibration using the following procedures:
    - 8.1.1.1 Allow a container filled with water and the sonde to come to room temperature.
    - 8.1.1.2 Place a thermometer that is traceable to the NIST into the water and wait for both temperature readings to stabilize. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer within the accuracy of the sensor (+/- 0.15°C). If the measurements do not agree, the instrument may not be working correctly and the manufacturer should be contacted.

  - 8.1.2 Conductivity
    - 8.1.2.1 Rinse the probes and cup with conductivity standard. The probes and cup do not need to be dried in between rinses.
    - 8.1.2.2 Place the cleaned probes into the specific conductivity standard solution, making sure that the specific conductivity probe is fully submerged.
    - 8.1.2.3 Place the display/logger in "Sonde Run" mode, and check the temperature of the standard solution. For calibration of specific conductivity the standard must be at 25°C (± 0.5°C). If the temperature of the solution is not with this range, adjust the solution temperature by placing the container (with lid firmly tightened), into a bath of warmer or colder water (depending on standard's temperature). Check on the progress of temperature change by placing the instrument probes into the solution. Once the temperature falls within ± 0.5°C of 25°C continue the calibration procedure. Return to the display/logger main menu and select "Calibrate" and press enter.
    - 8.1.2.4 Select "Conductivity" and press enter.
    - 8.1.2.5 Select "spCond" and press enter.

8.1.2.6 Enter the standard concentration in mS/cm3 and press enter. The standard concentration that will be used is 1.0 mS/cm3

8.1.2.7 After the specific conductivity reading has stabilized press enter to calibrate. Wait for the "Calibrated" message to appear..

8.1.2.8 Rinse probe with DI water and dry.

8.1.2.9 Record the calibration constant for the conductivity on the calibration sheet. If the conductivity calibration constant is not between 4.5 and 5.5, the standard is contaminated and the calibration process needs be redone. In order to recalibrate, repeat steps 3.2.1 through 3.2.6. However, in step 3.2.7 input uncal when prompted for the standard calibration. This will reset the probe to the factory calibration. Subsequently, follow steps 8.1.2.1 through 8.1.2.8 to recalibrate.

8.1.3 pH

8.1.3.1 Allow the buffered samples to equilibrate to the ambient temperature.

8.1.3.2 Clean all of the probes on the sonde with deionized water. Shake off excess water.

8.1.3.3 Place the probes on the sonde into the pH 7 buffer. Make sure the calibration standard is high enough to fully cover the pH probe.

8.1.3.4 On the display/logger use the up/down arrow keys to highlight the "Calibrate" option and press the enter key.

8.1.3.5 Highlight the "pH" option and press enter.

8.1.3.6 Highlight the "2-point" option and press enter.

8.1.3.7 Input the value of the buffer, which is 7.00 and press enter.

8.1.3.8 Wait for the value of pH to stabilize and then press enter. Record the pH mV reading on the calibration sheet. The pH mV needs to be between -40 and 40 mV.

8.1.3.9 Place the pH probe into a pH buffer of 10.00. Make sure the calibration standard is high enough to fully cover the pH probe.

8.1.3.10 Press any key to continue calibration

8.1.3.11 When prompted, enter the pH of the second buffer, "10.00". Wait for "Calibrated" message, and press any key to continue. Record the pH mV reading on the calibration sheet. The pH mV needs to be between -140 and -220 mV.

8.1.3.12 Rinse probe with Deionized water and shake off excess water.

8.1.3.13 The difference (slope) between the 2 mV values should be between 165 and 180. If it is outside this range, the pH probe will need to be replaced.

8.1.4 Turbidity

8.1.4.1 Inspect the turbidity wiper. If the wiper is dirty, replace the wiper. If the wiper is replaced, make sure to slide a business card underneath the wiper to leave a small amount of space between the probe and the wiper so that the wiper motor does not wear out.

8.1.4.2 Allow the standard samples to equilibrate to the ambient temperature.

8.1.4.3 Clean all of the probes on the sonde with DI water. Shake off excess water.

8.1.4.4 Place the probes on the sonde into the 0.0 NTU standard (which can be deionized water)

8.1.4.5 From the "Calibrate" Menu, on the display/logger, select the "Turbidity" option and press enter.

8.1.4.6 Select the "2-point" option and press enter.

8.1.4.7 Enter "0.0" as the first calibration standard and press enter.

8.1.4.8 Select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and then press the enter key. Be sure the wiper is parked 180º from the sensor.

8.1.4.9 Place the probe in the 10 NTU standard. Do not clean the probe before placing into the second standard.

8.1.4.10 Press enter to continue calibration.

8.1.4.11 Enter "10.0" as the second calibration standard and press enter.

8.1.4.12 Again, select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and then press the enter key. Be sure the wiper is parked 180º from the sensor.

8.1.4.13 Clean all of the probes on the sonde with DI water. Shake off excess water.

8.1.4.14 Insert probes back into the 10.0 NTU standard and make sure it is reading between 9.5 and 10.5 NTU. If the buffer reading is not correct, repeat the calibration procedure.

8.1.5 DO

8.1.5.1 Change the DO membrane. The membrane will need to sit for 6-8 hours after being changed before calibration can be conducted.

8.1.5.2 Clean all of the probes on the sonde with tap water (or clean ambient water). Shake off excess water.

8.1.5.3 Place approximately 1/8 inch of water in the bottom of the calibration cup. Place the probe end of the sonde into the cup. Engage only 1 or 2 threads of the calibration cup to insure the DO probe is vented to the atmosphere. Make sure that the DO and temperature probes are NOT immersed in water and that the calibration cup is not in direct sunlight. Wait approximately 10 minutes so that it equilibrates with the atmosphere.

8.1.5.4 From the calibration menu select the "Dissolved Oxy" option, then the DO% option

8.1.5.5 Read and record the atmospheric pressure obtained from the Pretel on the calibration log. The Pretel reads in inHg so the reading will need to multiplied by 25.4 to get a reading in mmHg

8.1.5.6 Enter the current barometric pressure in mm of Hg.

8.1.5.7 Press enter to accept the calibration. Press enter again to return to the calibration menu.

8.1.5.8 Record the DO charge on the calibration log. The DO charge needs to be between 25 and 75. If it is higher than 75, the probe will need to be reconditioned with the sanding disks. If it is less than 25, the probe will be replaced.

8.1.5.9 Record the DO gain on the calibration log. The DO gain needs to be between 0.7 and 1.7. If it is not between 0.7 and 1.7, recalibrate the DO by following the procedures outlined in Sections 8.1.5.1 through 8.1.5.8.

8.1.6 Date and Time

8.1.7 To verify that the time is correct from the systems menu select "date/time". Press enter to accept. Date and time are always set on Central standard time.

8.1.8 Autosleep

8.1.8.1 To verify that the RS 232 and SDI-12 autosleep are activated, from the advanced menu select "setup"

8.1.8.2 Select RS 232 and SDI 12

8.1.9 DO high/low output tests

8.1.9.1 Select run and then select discrete sample. The DO% should be above 100% and drop with each sample. If the DO% does not drop, the probe is bad and cannot be used. Contact the manufacturer.

8.1.9.2 Press ESC to stop discrete sampling

8.1.10 DO warmup

8.1.10.1 To verify the DO warm-up is on, from the advanced menu select sensor

8.1.10.2 Select DO warm-up, verify the proper number has been inputted (60 in winter, 40 in summer)

8.2 Procedure for selecting sonde deployment locations.

8.2.1 Mount the velocity meter and DO meter onto the wading rod.

8.2.2 At each sampling site, measure the stream width using the range finder. Be sure to approach each sampling location from a downstream location.

8.2.3 After the total stream width is determined, divide the stream width into 10 equal sections. Note the sections must be at least 6 inches apart.

8.2.4 At each equal distant location, measure the total stream depth using a wading rod.

8.2.5 Depending on stream depth, measure DO, temperature and velocity at the appropriate depths below water surface. If the depth is less than 2 feet, measure DO, temperature and velocity at the mid-depth.
  8.2.5.1 If the depth is greater than 2 feet but equal to or less 3 feet, measure DO, temperature and velocity at 1-foot below water surface and 2 feet below water surface.
  8.2.5.2 If the depth is greater than 3 feet but equal to or less 4 feet, measure DO, temperature and velocity at 1 foot below water surface, 2-feet below water surface, and 3 feet below water surface.
  8.2.5.3 If the depth is greater than 4 feet but equal to or less 5 feet, measure DO, temperature and velocity at 1 foot below water surface, 2 feet below water surface, and 4 feet below water surface.
  8.2.5.4 If the depth is greater than 5 feet but equal to or less 6 feet, measure DO, temperature and velocity at 1 foot below water surface, 3 feet below water surface, and 5 feet below water surface.
  8.2.5.5 If the depth is greater than 6 feet but equal to or less 7 feet, measure DO, temperature and velocity at 1 foot below water surface, 3 feet below water surface, and 6 feet below water surface.

8.2.6 Record DO, temperature, and velocity on the field logs.
8.2.7 Data will be analyzed using either Excel or SYSTAT in order to determine the deployment location at each site that is most representative of the entire stream width.

8.3 Field sonde calibration procedures.
Immediately prior to deployment, the calibration of the DO sensor will be re-calibrated using air-saturated water.

8.3.1 Collect a sample of in-situ water in 5-gallon bucket.
8.3.2 Place an aeration stone with pump into the 5-gallon bucket.
8.3.3 After allowing the water to reach saturation, remove the aeration stone and allow the water to equilibrate. Saturation will be checked using a YSI 55 of 550A dissolved oxygen meter.
8.3.4 Place sonde that will be deployed and a second calibration sonde into the bucket.
8.3.5 Allow the sondes to stabilize.
8.3.6 From the calibration menu select the "Dissolved Oxy" option, then the DO% option
8.3.7 Read and record the atmospheric pressure obtained from the Pretel on the calibration log. The Pretel reads in inHg so the reading will need to multiplied by 25.4 to get a reading in mmHg
8.3.8 Enter the current barometric pressure in mm of Hg.
8.3.9 Press enter to accept the calibration. Press enter again to return to the calibration menu.

8.3.10 Record the DO charge on the calibration log. The DO charge needs to be between 25 and 75. If it is higher than 75, the probe will need to be reconditioned with the sanding disks.

8.3.11 Record the DO gain on the calibration log. The DO gain needs to be between 0.7 and 1.7. If it is not between 0.7 and 1.7, recalibrate the DO by following the procedures outlined in Sections 8.2.1 through 8.2.10.

8.4 Sonde deployment procedures.

8.4.1 Check condition of stream for rocks, deep pools, or other hazards before transporting equipment to deployment site.

8.4.2 Inspect the condition of the in-stream housing unit and remove any debris or silt.

8.4.3 Replace the calibration cup with the protective cup and screen.

8.4.4 Arrive at deployment site. Be sure to approach the deployment site from a downstream location.

8.4.5 Use meter tape? to measure the appropriate deployment depth that has been pre-determined. See the Section 8.2 for information on selecting deployment sites.

8.4.6 Place pin through the pre-drilled holes or chain and place pad-lock through hole in pin and lock.

8.4.7 Once pin and lock are secured, gently let go of housing unit, allowing it to settle into stream at pre-determined depth.

8.4.8 Complete "Sonde Deployment Log" while still on-site.

8.5 Verification procedures prior to sonde retrieval.

8.5.1 Immediately prior to each sondes' retrieval a second sonde calibrated by the methods described in Sections 8.1 and 8.3 will be deployed adjacent to the sonde being retrieved.

8.5.2 pH, DO, conductivity and temperature readings from each sonde will be taken. Readings from the adjacent sonde should be taken at the surface and at the depth of the deployed sonde.

8.5.3 At the same depth, the difference between the adjacent measurements and the recorded values by the deployed sonde should not be greater than the quality control goals listed in Table 1. Data not meeting this criterion will be identified. In addition, this data will be corrected for drift.

TABLE 1
Quality Control Goals Between Adjacent Measurements and Deployed Sondes

Parameter	Adjacent measurement accuracy goals
Temperature	0.5ºC
pH	±0.5
Conductivity	±0.15%
DO	±0.7 mg/L
Turbidity	± 5 NTUs

8.6 8.6 Sonde retrieval procedures.

8.6.1 Approach deployment location from a downstream location.

8.6.2 Perform in-stream calibration check using a second calibrated sonde as described in Section 8.5.

8.6.3 Lift downstream end of sonde housing unit and unlock pad-lock. If pad-lock is rusted and will not open, use bolt cutters to remove pad-lock.

8.6.4 Remove pin and lock and carefully remove sonde from housing unit.

8.6.5 Carefully rinse body of sonde with stream water.

8.6.6 Complete "Sonde Retrieval Log".

8.6.7 Replace the probe guard with the calibration cup filled with 0.5 inches of DI water.

8.6.8 Wrap sonde in bubble wrap and place in protective case for transportation to laboratory.

9.0 Sampling Handling, Preservation, and Storage.

All sample measurements are performed *in-situ*, therefore there is no need for sample handling, preservation, preservation, or storage.

10.0 Chain of Custody

All sample measurements are performed *in-situ*, therefore there is no need for chain of custody procedures

11.0 Data Management

11.1 All data and information shall be recorded on the calibration, deployment/ retrieval, and field logs.

11.2 The sampling data is stored at Hey and Associates, Inc. and UW-M for at least 5 years.

12.0 Quality Control/Quality Assurance and Decontamination

12.1 The records generated in the procedure are subject to review during data validation, in accordance with the Quality Assurance Project Plan (QAPP).

13.0 References

13.1 YSI Incorporated, "Environmental Monitoring Systems Operations Manual" (6-Series), www.ysi.com

13.2 USGS. 2000. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S. GEOLOGICAL SURVEY Water-Resources Investigations Report 00–4252

APPENDIX B

Procedures for stage and discharge measurements

Procedures for Stage and Discharge Measurements

1.0 Introduction

1.1 This Standard Operating Procedure (SOP) is applicable to the measurement of stage and discharge as part of the Small Stream Surveys.

1.2 Purpose
The purpose of this SOP is to provide a framework for the stage and discharge monitoring as part of the Fish Habitat Surveys.

2.0 Definitions

2.1 Discharge: The volume of water that passes a given point in a given period of time

2.2 In-situ: In place. An *in-situ* environmental measurement is one that is taken in the field, without removal of a sample to the laboratory.

2.3 Stage: The water-surface elevation referenced to the gage datum. Gage height often is used interchangeably with the more general term "stage," although gage height is more appropriate when used with a reading on a gage. Also, known as gage height.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn.

4.0 Interferences

4.1 Interference may result from selecting an improper stream cross-section, sampling in areas with moving bed material, and operator error due to improper training or use of equipment.

5.0 Personal Qualifications

5.1 Personnel will be pre-trained in all sampling/measuring equipment by an experienced person before initiating the sampling procedure.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP.

5.3 Personnel collecting and reviewing Acoustical Doppler Current Profiler (ADCP) data for discharge measurements must have completed the USGS training class, *Measurement of Streamflow using ADCP's*

6.0 Materials

6.1 Price pygmy meter
6.2 Price AA
6.3 Flowtracker
6.4 Engineering rule or engineering tape
6.5 Weight
6.6 Tagline
6.7 Wading rod
6.8 Tethered boat
6.9 1200 kHz ADCP (Acoustical Doppler Current Profiler)
6.10 Laser Range Finder

6.11 Field logs

7.0 Pre-sampling

7.1 Obtain the necessary sampling equipment.

7.2 Prepare a schedule and coordinate with staff.

8.0 Procedures

8.1 Procedures for measuring stage and discharge when the maximum depth, in the measured cross-section, is less than approximately 3.00 ft.

8.1.1 A reference point (RP) is established on a stable structure (e.g. bridge rail, retaining wall, etc.) and an engineering rule or engineering tape and weight are used to establish a beginning distance from RP to water surface and time of tape down. Distance is noted on a field log.

8.1.2 The technician then extends a tagline at the pre-determined cross section and measures approximately 10-25sections depending on Stream witdth. At each section depth and velocity are measured using a wading rod, and Flowtracker (acoustical) or a Price Pygmy meter. A Price Pygmy meter will only be utilized in shallow water with cobbles. In all other wadeable streams a Flowtracker will be utilized.

8.1.3 These sections are then compiled using the midsection method (Rantz 1982 p.80-82) to determine area, mean velocity, and discharge at that section. Maximum velocity and depth is also calculated. Data is recorded on field log.

8.1.4 When a measurement is completed (approximately 30-60 min) an ending tape down from RP, described in step 1, is used to determine the change in stage during the measurement. This should be low flows so stages are probably going to be stable. However intermediate stage readings are recommended

8.2 Procedures for measuring stage and discharge when the maximum depth in stream is too deep to wade (greater than 3.00 ft).

When the maximum depth in stream is too deep to wade (greater than 3.00 ft) a tethered boat, equipped with 1200 kHz ADCP is towed from the downstream side of bridge to collect data. The USGS (Illinois District) now uses the acoustical instruments almost 100% due to their accuracy and more efficient mode of operation. The following procedures are an abridgement of USGS Office of Surface Water (OSW) policy (http://hydroacoustics.usgs.gov/policy/), used to make an ADCP measurement from a bridge.

8.2.1 A reference point (RP) is established on a stable structure (e.g. bridge rail, retaining wall, etc.) and an engineering rule or engineering tape and weight are used to establish a beginning distance from RP to water surface and time of tape down. Distance is noted on a field log.

8.2.2 The tethered boat is maneuvered close to either the left or right bank. When data is determined to be good (i.e. sufficient to obtain at least two velocity cells of data) a technician is instructed to measure the distance to the nearest edge of water, then once data collection has started, tow the tethered boat to the opposite bank and stop when there are only two velocity cells and measure the ending distance to the bank. Edge distances are measured either through tagline markings, marks on the bridge or by using a laser range finder. The software used in conjunction with the ADCP then gives an accurate profile of the channel. Discharge is then calculated using the data assembled while towing the boat across the stream. A minimum of four transects of the stream are performed and averaged to determine mean discharge. The measured discharge will be the average of the discharges from the four transects. If the discharge for any of the four transects differs more than 5 percent from the measured discharge, a minimum of four additional transects will be obtained and the average of all eight transects will be the measured discharge. Whenever possible, reciprocal transects should be made to reduce potential directional biases. The approximate time to perform this work is 30 minutes per cross-section.

8.2.3 Upon completion of discharge measurement, an ending tape down is performed to determine the change of stage during measurement and time is recorded on field notes.

9.0 Sampling Handling, Preservation, and Storage

All sample measurements are performed *in-situ*, therefore there is no need for sample handling, preservation, preservation, or storage.

10.0 Chain of Custody

All sample measurements are performed *in-situ*, therefore there is no need for chain of custody procedures

11.0 Data Management

11.1 All data and information shall be recorded on the approved USGS discharge forms and provided to Hey and Associates, Inc. as unit value data.

11.2 The data is stored at Hey and Associates, Inc. and UW-M for at least 5 years.

12.0 Quality Control/Quality Assurance and Decontamination

12.1 The records generated in the procedure are subject to review during data validation, in accordance with the Quality Assurance Project Plan (QAPP).

13.0 References

13.1 Rantz, S.E. et al. 1982. Measurement and computation of streamflow -- v. 1, Measurement of stage, and v. 2, Computation of discharge. U.S. Geological Survey Water-Supply Paper 2175. United States Department of Interior, U.S. Geological Survey. Washington D.C. 631 p. http://infotrek.er.usgs.gov/pubs/.

13.2 Lipscomb, S.W. 1995. Quality assurance plan for discharge measurements using broadband acoustic Doppler current profilers. U.S. Geological Survey Open File Report 95-701. 12 p. http://infotrek.er.usgs.gov/pubs/.

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APPENDIX C

Wisconsin Floristic Quality Assessment

DEVELOPMENT OF A FLORISTIC QUALITY ASSESSMENT METHODOLOGY FOR WISCONSIN

Final Report to USEPA - Region V
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EXECUTIVE SUMMARY

The Wisconsin Department of Natural Resources (DNR) is developing a wetland monitoring program to assess the biotic condition of wetlands in Wisconsin, using a suite of complementary assessment tools at both the site-specific and landscape scales. The Wisconsin Floristic Quality Assessment (WFQA) method has been developed to provide an intensive measure of wetland biological integrity at the site level based on the condition of the plant community. The WFQA can also be applied to any tract of land with a developed plant community, including non-wetlands.

The WFQA is an adaptation for use in Wisconsin of the original floristic quality assessment method developed by Floyd Swink and Gerould Wilhelm for the Chicago Region. The basis of floristic quality assessment is the concept of species conservatism, the degree to which a species can tolerate disturbance and its fidelity to undegraded conditions. Conservatism is not always equated with rarity. The method uses the aggregate conservatism of all species found on a site as a measure of the site's intactness, an indication of its ecological integrity.

The method requires the *a priori* assignment of "coefficients of conservatism" to every native vascular plant species in a regional flora, relying on the collective knowledge of a group of experts. The coefficients for the WFQA were assigned by a core group of seven expert Wisconsin botanists, aided by Gerould Wilhelm, and using survey results from a larger group of Wisconsin botanists. The coefficients assigned previously by a group of aquatic ecologists led by Stanley Nichols were accepted for aquatic plants.

The method requires an accurate and complete inventory of vascular flora on a site. The appropriate coefficient is applied to each species, and an average coefficient of conservatism (Mean C) is calculated for the entire site or sample unit. The Floristic Quality Index (FQI) adds a weighted measure of species richness by multiplying the Mean C by the square root of the total number of native species. Higher Mean C and FQI numbers indicate higher floristic integrity and a lower level of disturbance impacts to the site. Mean C and FQI values are affected by the timing, sampling effort, and accuracy of the vegetation inventory and can vary by plant community type. The size and heterogeneity of the assessment area can also affect FQI values. These limitations must be taken into account when interpreting WFQA results.

WFQA is recommended for assessing ambient wetland biological conditions, and for monitoring the effects of restoration and management actions. Periodic assessments carried out in a consistent manner can provide data on long-term trends at a site. WFQA can provide a measure of vegetative integrity as part of a wetland functions and values assessment, but cannot substitute as a stand alone comprehensive functional assessment.

Several important steps remain to be taken to implement the use of the Wisconsin FQA.

1. Test its consistency with other biological assessment methodologies.

2. Test its feasibility for use in a wetland monitoring program.

3. Account for and control sources of variability in designing future monitoring studies using the WFQA, especially for trends monitoring.

4. Provide a computer program to easily calculate FQA statistics.

5. Develop a database of FQA site values, including a range of reference sites by ecoregion and wetland type.

INTRODUCTION

This study builds upon the recommendations of a study funded under a previous USEPA Wetland Grant (#CD985491-01-0) for developing a wetland monitoring program. That study recommended the development of a suite of wetland assessment methods that work at a variety of scales (Bernthal, 2001). The Wisconsin Floristic Quality Assessment (WFQA) is one of three lines of methodology development funded under USEPA Wetland Grant CD97511501-0. Two other complementary methods developed under this EPA grant are summarized in separate publications: ***Refinement and Expansion of Biological Indices for Wisconsin Wetlands*** *(Lillie, et al., 2002) and* ***Development of a Landscape Level Monitoring Methodology Based on Mapping Invasive Species*** *(Bernthal and Willis, in prep.).*

A principal goal of the Clean Water Act is to maintain and restore the physical, chemical and biological integrity of the waters of the United States (33 U.S.C. §1251(a)). Section 305(b) of the Clean Water Act requires states to monitor and report on the condition of their waters, including the maintenance of biological integrity. Biological integrity has been defined as "… the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Karr and Dudley 1981). The concept of ecological integrity and ecosystem health has been described in the following way.

> "A biological system is healthy and has ecological integrity when its inherent potential is realized, its condition is 'stable,' its capacity for self-repair is maintained, and external support for maintenance is minimal. Integrity implies an unimpaired condition or quality or state of being undivided." (Karr 1993)

The Wisconsin DNR Wetland Team has committed to developing an assessment and monitoring program to assess the biological integrity, or condition, of wetlands in Wisconsin (WDNR Wetland Team 2000, Bernthal 2001). Assessing the ecological integrity of the wetland itself contrasts with the broader assessment of "functions and values" or "functional values" that is conducted for impact assessment, typically in a regulatory context. The uses for condition assessment are for management and restoration of wetlands, planning for the preservation of wetlands, development and refinement of wetland water quality standards, and periodic reporting on wetland condition to the public as required under Section 305(b) of the Clean Water Act.

The development of tools for assessing and reporting site condition differs somewhat from the development of long-term trends monitoring tools. Long-term monitoring programs may choose to identify a few key variables that can be consistently measured over time to show environmental trends, such as Secchi-disk readings and ice-on and ice-off dates for lakes. Site assessment methods are more focused on integrating measures of the current state of the system being assessed and thus can be of more immediate relevance to managers and decision-makers. There are trade-offs involved in each approach.

Because the primary uses we envision for wetland assessment and monitoring information are geared toward management, restoration, and planning, we are focusing on condition assessment as the primary goal, with the potential for repeated or periodic assessments to indicate longer-term trends.

The wetland monitoring strategy (Bernthal 2001) calls for developing complementary tools that can be used across the broad spectrum of wetland types at both the site-specific and landscape scale. The department chose to develop a Wisconsin version of the Floristic Quality Assessment as an intensive site-level assessment method for several reasons:

- Floristic quality assessment offers the ability to assess any wetland plant community, giving us a method that can be immediately employed while multi-metric biological integrity indexes are being developed for the wide variety of wetland types present in Wisconsin.

- Floristic quality assessment provides a standard, unbiased, repeatable method, and thus holds promise for monitoring trends over time, and comparing sites within a region.

- Compared to biological indexes requiring extensive laboratory processing, floristic quality assessment can be mainly accomplished directly in the field, although this depends on observer expertise.

- Metrics for plant based biological integrity indexes can be developed that incorporate coefficient of conservatism values as has been done in Ohio (Mack, et al. 2000).

- In addition to wetland assessment, floristic quality assessment can also be used in land management, restoration, and identification, evaluation, and comparison of natural areas. The approach can also be used to assess terrestrial systems, offering a useful tool to a wide range of users.

- Florisitic quality assessment methods have been or are being developed and used in other states including Ohio (Andreas and Lichvar 1995), Illinois (Taft, et al. 1997), and Michigan (Herman, et al. 2001).

Wisconsin Floristic Quality Assessment (WFQA) Method

The Wisconsin Floristic Quality Assessment (WFQA) is an adaptation of the floristic quality assessment method for use in Wisconsin, treating the entire state as a single region. Floyd Swink and Gerould Wilhelm (1979, 1994) developed the original methodology for the Chicago Region, as a standardized, repeatable means of evaluating natural area quality. The method allows for comparing the floristic quality among many sites and for tracking changes at the same site over time, whether undergoing natural succession or being actively managed.

The method is based on the concept of species conservatism. Each native plant species occurring in a regional flora is assigned a coefficient of conservatism (C) representing an estimated probability that a species is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition. The most conservative species require a narrow range of ecological conditions, are intolerant of disturbance, and are unlikely to be found outside undegraded remnant natural areas, while the least conservative species can be found in a wide variety of settings and thrive on disturbance. Coefficients range from 0 (highly tolerant of disturbance, little fidelity to any natural community) to 10 (highly intolerant of disturbance, restricted to pre-settlement remnants). Conceptually this 10-point scale can be subdivided into several ranges. The following description of coefficient ranges combines the discussions presented by Taft, et al. (1997) and Francis, et al. (2000; describing concepts used in Oldham 1995):

> 0-3: taxa found in a wide variety of plant communities and very tolerant of disturbance
>
> 4-6: taxa typically associated with a specific plant community, but tolerate moderate disturbance
>
> 7-8: taxa found in a narrow range of plant communities in advanced stages of succession, but can tolerate minor disturbance
>
> 9-10: taxa restricted to a narrow range of synecological conditions, with low tolerance of disturbance.

Conservatism and rarity, or special conservation concern status, are not always equated, however. Many species of conservation concern are both highly conservative and restricted to specific remnant natural communities. An example is *Chamaesyce polygonifolia*, seaside spurge, a "special concern" species, confined to sandy beaches and dunes along the Great Lakes. It is assigned a conservatism coefficient of 10. In contrast, some rare species are found in highly disturbed areas and are not conservative. An example is *Carex pallescens*, pale sedge, another "special concern" species. It is assigned a conservatism coefficient of 1, because it can be found locally in moist disturbed roadsides, fields, clearings, and borders of woods in the North. In other cases, rare species may now be found increasingly in disturbed habitats in addition to remnant undisturbed sites, as in the case of *Gentiana alba*, yellow gentian, a "threatened species" assigned a coefficient of 7. It is native to deep soil, mesic to moist prairies, but is now also found on roadsides, embankments, old fields, and logging roads. Many conservative species are not at all rare in Wisconsin. An example is *Kalmia polifolia*, swamp laurel, a shrub restricted to bogs, which is assigned a 10, but it is not endangered because bog habitat is still common in northern Wisconsin.

Floristic quality assessment uses two related, but separate, measures: 1) the average coefficient of conservatism or Mean C, and 2) the Floristic Quality Index or FQI. To use the WFQA, the plant community is inventoried or sampled to compile an accurate and complete species list of vascular flora on a site. The choice of a sampling methodology is not dictated. The appropriate coefficient of conservatism is applied to each species, and the mean is calculated for the assessment area.

$$\text{Mean C} = \sum(c_1+c_2+c_3+\ldots c_n)/N \qquad \text{Formula (1)}$$

where c is the coefficient of conservatism for each native species identified on the site and N is the total number of native species inventoried in the assessment area.

The Floristic Quality Index (FQI) is calculated by multiplying the Mean C by the square root of the total number of native species.

$$\text{FQI} = \text{Mean C} * \sqrt{N}$$

or

$$\text{FQI} = \sum(c_1+c_2+c_3+\ldots c_n)/\sqrt{N} \qquad \text{Formula (2)}$$

These values can also be calculated “with adventives” by counting non-native species, but assigning them a value of “0.”

Researchers have debated the relative merits of using Mean C versus FQI. FQI can be biased by size of the site, especially in communities such as sedge meadows, in which species richness is strongly influenced by increasing area (Mathews 2003). Higher FQI values can result on sites where disturbance through part of the area allows weedy species to invade, rather than reflecting higher quality, less disturbed habitat (Rooney and Rogers 2002). Francis, et al. (2000) suggest that by combining Mean C and a measure of species richness, the FQI obscures important information, and suggest looking at each component (Mean C and species richness) separately. Lopez and Fennessy (2002) demonstrated the effectiveness of the FQI (described in their terminology as FQAI – Floristic Quality Assessment Index,) as a plant community-based biological assessment tool by showing a correlation between FQAI score and an independent ranking of disturbance for 20 depressional wetlands in Ohio.

It appears useful to compute and interpret both the Mean C and the FQI value. FQI values will be sensitive to factors that increase species richness, while Mean C relates directly to aggregate conservatism. This enables the assessor to sort out situations where species richness is increased due to factors not related to aggregate conservatism of the site. A good description of the assessment area is necessary to interpret these values. In some cases the user may want to calculate separate values for distinct plant communities on a given site.

Repeated sampling over the course of a growing season will allow the closest approximation of the “true” Mean C and FQI values, but this is not likely to be feasible in many situations. A study of 17 isolated depressional wetlands in Wisconsin, sampled by the same observer during early July and again in mid-August provides an estimate of the effect of sample timing (Judziewicz, 2002). The effect of adding new species from the second site visit increased the cumulative FQI by an average of 8.9% compared to the first visit, while the cumulative Mean C decreased an average of 2.5%. Judziewicz (2002) concludes that for this set of wetlands a single site visit, conducted between mid-June and late August could be sufficient for reasonable results. Lopez and Fennessy (2002) found an average increase of 15 species from summer sampling to combined summer-autumn sampling and found an average increase of three points in the FQI values, but little change in the relative ranking of sites.

DEVELOPMENT OF THE WFQA

The key to the development of a regional floristic quality assessment method is the *a priori* assignment of the coefficient of conservatism for every native species in the regional flora. At the outset, the theoretical limitations inherent in treating the entire state as a single region were recognized. A decision was made, however, to continue on that basis as the most practical approach to completing the development of the method and avoiding the confusion of a proliferation of regional approaches within the state.

In developing the coefficients of conservatism for Wisconsin, an attempt was made to take full advantage of the expertise of botanists working across the state, while basing the final assignments on the collective effort of a smaller core group working face-to-face. This was done to include the experience of a larger group, and to allow the core group to consider the judgement of those who were familiar with a narrower range of Wisconsin flora, or familiar with a smaller localized areas, rather than the entire state.

At the beginning of the project a forum was held to bring together botanists from around the state to discuss the floristic quality assessment methodology, its advantages and limitations and generate a consensus on the desirability of the project. Anton Reznicek, a participant in development of Michigan's floristic quality assessment, presented Michigan's experience in developing and using the method. Gerould Wilhelm discussed the conceptual basis for floristic quality assessment, his experience assisting other states in developing coefficients of conservatism, and the appropriate uses of the method.

A survey was sent to over 30 botanists asking them to assign coefficients to those plants they know well. An Excel spreadsheet provided by the University of Wisconsin Herbarium from its database of 1,788 vascular plant species that are considered native to Wisconsin was provided. Information on these species is displayed as the "Checklist of the Vascular Plants of Wisconsin" on the following web site: **http://www.botany.wisc.edu/wisflora/vindex.asp/.**

To establish a consistent basis for assigning coefficients, guidelines accompanied the survey that outlined the concept of conservatism and gave some examples of ranges of conservatism from earlier efforts (Taft, et al. 1997, Herman, et al. 2001). The difficulty of considering the entire state as a single region was acknowledged and examples from the Michigan report on averaging (Herman, et al. 2001) were included in the survey guidelines. Members of the core group were also sent the survey and guidelines and some submitted preliminary coefficients. This helped them prepare for their intensive meeting.

Twelve respondents submitted preliminary coefficients. Survey responses were compiled and summarized. Out of the 1,788 native species, 1,671 species were assigned a coefficient by at least one person, while 116 went unrated. The final coefficient values were assigned by consensus of the core group of seven botanists and field ecologists from across the state, meeting intensively with a facilitator for two consecutive days. The survey results served as a guide to facilitate the final assignment of coefficients.

For each plant species, the group could consider the average "survey coefficient," the range of survey coefficients, and the number of people who assigned a value. The core group used the survey results, but ultimately based the final assignments on their collective experience with the flora of Wisconsin. Gerould Wilhelm helped the group maintain a consistent focus on the concept of conservatism and aided them in their decisions. For aquatic plants the coefficients assigned previously by a group of aquatic ecologists led by Stanley Nichols were accepted with only a small number of adjustments.

The Wisconsin Floristic Quality Assessment can now be carried out using the coefficient of conservatism values, contained in the table in the Appendix of this report. The table also contains additional plant information: physiognomy, conservation status, and regional wetland indicator status based on the ***National List of Plant Species that Occur in Wetlands: 1988 Wisconsin.*** Mean Coefficient of conservatism and floristic quality index values can be calculated using the coefficients of conservatism published here and Formulas (1) and (2). Coefficients of conservatism and wetland indicator status for Wisconsin vascular flora are available on the University of Wisconsin-Madison Herbarium's "Checklist of the Vascular Plants of Wisconsin" at **http://www.botany.wisc.edu/wisflora/vindex.asp/.**

A computer program is being developed to facilitate use of the WFQA. The program will allow users to enter site location data, plant community type (based on Wisconsin Natural Heritage Inventory classification), enter species occurrences from a catalog in an inventory format or by transect/quadrat entry, with options to enter cover and frequency data. The program will generate reports with FQA statistics.

POTENTIAL USES OF THE WFQA

Floristic quality assessment is capable of being used for a number of applications. Swink and Wilhelm (1994) discuss four applications: 1) identification of Natural Areas, 2) comparisons among different sites, 3) long-term monitoring of natural quality, and 4) monitoring of habitat restoration projects. Research interest in using floristic quality assessment statistics to analyze vegetation sample data is also increasing, often with the purpose of demonstrating differences in plant assemblages in response to environmental variables. (Werner and Zedler 2002, Kercher in preparation, Carpenter unpublished data).

The purpose for developing the WFQA in this project is to:

1. provide a plant community-based intensive site assessment method for wetland biological integrity,

2. provide a tool for monitoring plant community response to restoration and management actions, and

3. provide an intensive measure of one component of an impact assessment methodology for regulatory decision making.

WFQA for Assessing Biological Integrity

The EPA National Wetlands Monitoring Workgroup has been preparing a framework for developing wetland monitoring programs to meet the mandate of the Clean Water Act to report on the biological integrity of the waters of the nation (USEPA 2002, in draft). The Working group has endorsed the concept of a Level 1, 2, 3 approach to monitoring. Level 1 is Landscape Assessment relying on coarse, landscape-scale inventory information, typically gathered through remote sensing and preferably displayed in a geographic information systems (GIS) format. Level 2 is Rapid Assessment at the specific wetland site scale, using relatively simple, rapid protocols for the sake of feasibility. Level 2 assessment protocols are to be validated by and calibrated to Level 3 assessments. Level 3 is Intensive Site Assessment using detailed, intensive ecological evaluation methodologies, particularly research-derived, multi-metric indexes of biological integrity.

Floristic quality assessment was originally developed to provide a method for evaluating natural area quality to support conservation management decisions (Wilhelm and Ladd 1988, Swink and Wilhelm 1994). The method relies on the understanding of individual plant species responses to disturbance, and fidelity to habitat integrity within a given region. Methodologies for assessing biological integrity are based on research efforts that identify a stressor-response relationship between levels of human disturbance and elements of the biological system (Karr and Chu 1997).

In general higher Mean C and FQI numbers for a site indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. It is likely, however, that the range of floristic quality assessment values will vary by plant community type, limiting comparisons of sites with divergent types. Rooney and Rogers (2002) have demonstrated this for some Wisconsin plant communities. Matthews (2003) concludes that valid comparison of FQI values for wetland plant communities requires similar type, size, heterogeneity, and time of survey.

The Wisconsin Floristic Quality Assessment can be considered a Level 3 method for assessing the biological integrity of the plant community. To be used as such, additional study of reference wetlands must be conducted to establish the range of WFQA values associated with varying levels of disturbance. Such studies should control for wetland plant community type and hydrogeomorphic setting, following the approach of Lopez and Fennessy (2002). Ecoregional variance should also be analyzed, similar to the process employed by Nichols (2001) in analyzing lake aquatic plant communities.

Another approach to be considered is incorporation of FQA components into a vegetation-based multi-metric biological integrity index. FQ(A)I score and metrics derived from "tolerance ranges" based on coefficient of conservatism ranges have been incorporated into the Ohio Vegetation Indices of Biotic Integrity (Mack, et al. 2001).

Floristic quality assessment should be recognized as **one** indicator of biological integrity based on the response of the plant community to disturbance. Ideally other components of ecosystem response in addition to vegetation should be developed into indices of biological integrity. In Wisconsin, multi-metric indices based on plants, macroinvertebrates, zooplankton, and amphibians have been developed for isolated depressional wetlands (Lillie, et al. 2002). However, we lack methodologies for riverine, slope (saturated soils), and lacustrine wetlands. Development of additional indices for other wetland classes will require additional research. In the absence of Level 3 methodologies for these wetland types, WFQA assessments can serve as the best available indicator of biological integrity, and can be used to calibrate the development of Level 2 Rapid Assessment methodologies.

WFQA for Monitoring Response to Restoration and Management Activities

Floristic Quality Assessment can be valuable for restoration evaluation. It can be applied to mitigation projects that occur as a result of regulatory decisions or for evaluating "voluntary" restoration and management activities undertaken by agencies and non-profit conservation groups.

Floristic quality assessment has been required as a monitoring measure for mitigation projects, and in the Chicago region performance standards have been based on FQI and Mean C values. In reviewing project performance, however, the Mitigation Bank Review Team noted that the FQI values set in performance standards were difficult if not impossible to meet. For this reason they no longer use FQA scores as performance standards for mitigation banking projects (Elston, personal communication). Swink and Wilhelm reported that for habitat restoration projects Mean C and FQI values are initially very low, tend to rise steadily in the first years, and tend to stabilize after 4-5 years, with Mean C values between 3.0 and 3.7, and FQI values between 25 and 35 (Swink and Wilhelm, 1994). Mushet, et al. (2002) noted in their study of restored and natural wetland complexes, that restored wetlands rarely exceeded FQI values of 22 while the FQI of natural wetlands in the study rarely dipped below 22. Wilhelm (1993) has suggested that in the Chicago region sites with FQI values above 35 are not "mitigatable" because restoration projects are unlikely to achieve the floristic quality of the site under consideration for a permitted impact. With sufficient reference data it appears that FQA values can be used as one factor both in evaluating permit decisions and setting realistic expectations for compensatory mitigation projects.

Floristic Quality Assessment can also be used to monitor the plant community response to management actions, such as controlled burning. It can be used to track restoration projects, or management of natural areas. The FQA can be used in conjunction with a suite of sampling options, from repeated general site inventories to more quantitative transect designs. Some of these are described in Swink and Wilhelm (1994). With transect studies, additional parameters can be studied, such as calculating a Mean C and FQI for each quadrat, developing the average of these values for a transect and comparing quadrat values to transect values to determine floristic quality across a gradient.

WFQA for Impact Assessment in Regulatory Decision Making

Floristic Quality Assessment results, based on the coefficients developed by Swink and Wilhelm for the Chicago Region (1994) have been reported by consultants as part of impact assessment and evaluations of functional significance of wetlands subject to a permit application or environmental review. The Chicago Region as defined by Swink and Wilhelm includes three southeastern Wisconsin counties. WFQA results will be based on coefficients developed for the entire state. When properly interpreted, they can provide valuable information on the plant community quality and can serve as an indicator of overall ecological integrity. WFQA results can supplement or help document the significance rating of floristic diversity in the Wisconsin Rapid Assessment Methodology. Sampling date and methods must be considered when interpreting results.

WFQA results cannot provide the sole basis for impact analysis for regulatory decisions, because other functions and values must be considered as well as floristic quality. WFQA is not intended to directly assess other wetland functions and values, such as habitat for aquatic life and other wildlife, shoreline stabilization, water quality maintenance, flood and storm water attenuation, and human uses.

ADVANTAGES AND LIMITATIONS OF THE WFQA

The WFQA methodology can be most appropriately used with an understanding of its advantages and acknowledgment of its limitations. These are summarized below.

Advantages

Coupled with accurate, timely, and complete vegetation sampling WFQA offers:

1. A consistent, quantitative measure of plant community integrity.

2. A method that can be used in any plant community (IBI methods are necessarily restricted to a class of similar habitats).

3. A repeatable method that can be used to assess trends.

4. A subjective but expert-based system. Coefficients of conservatism are based on the collective knowledge of those familiar with a regional flora.

5. A simple method that does not require extensive sampling equipment or laboratory processing.

6. A method that can be applied to existing data, such as plant inventories.

Limitations

1. Floristic quality is one aspect of ecological condition; the aggregate conservatism of the plant community. WFQA does not directly assess wildlife habitat structure – some wildlife species can thrive in sites with degraded plant communities. WFQA does not directly assess all wetland functions or human use values. For these reasons WFQA should not be used as a stand-alone method for regulatory purposes.

2. Comparability of results across wetland types is limited. Some wetland types, such as temporary ponds, may have naturally low plant diversity. Lopez and Fennessy (2002) have suggested the need to narrowly define the hydrogeomorphic class in testing the relationship between index scores and a disturbance gradient. This suggests caution in comparing FQI and Mean C scores across wetland types and landscape settings.

3. Results may be strongly affected by observer expertise, restricting the comparability of results between observers of different skill levels. The level of skill required for acceptable results is still unknown. More skilled observers are likely to identify more species and therefore generate higher FQI values. More skilled observers are also likely to find the more conservative species, and would tend to generate higher Mean C values.

4. The time of year and intensity of sampling affect results. Many species will not be observable or identifiable by even the most skilled observer at certain times of the year. Repeated sampling over the course of a growing season will allow the closest approximation of the "true" Mean C and FQI values, but this is not likely to be feasible in many situations.

RECOMMENDATIONS FOR IMPLEMENTATION

This author recommends the use of WFQA for assessing ambient wetland biological condition, for monitoring the effects of restoration and management actions, and for assessing vegetative integrity as part of a functions and values assessment. Several important steps remain to be taken to implement the use of the WFQA. There is a need to:

1. Test its consistency with other biological assessment methodologies.

   As a follow-up to this project, the Wisconsin DNR is currently carrying out a study comparing the results generated by employing the Depressional Wisconsin Wetland Multi Metric Index of Biological Integrity (Depressional WWMBI) and the WFQA on a set of 17 wetlands. Results will be reported in 2003.

2. Test its feasibility of use.

   Several questions about the feasibility of using the WFQA in a monitoring program need to be resolved to better understand how to deploy the method and interpret results. These include the effect of time of year of sampling and observer expertise, and comparability of types from different regions of the state. Though these effects have been reported (Rogers and Rooney, 2002, Judziewicz 2002, Kline, unpublished data 2002) the strength of these effects is not well understood.

3. Account for and control sources of variability in designing future monitoring studies using the WFQA, especially for trends monitoring.

   To the extent possible, when attempting to use WFQA to assess trends, or compare floristic quality among sites, results from the same observer or observers with equivalent expertise should be used, and the sampling methods and area should be consistent. Repeat sampling to assess trends should be done as close as possible to the same date as baseline sampling.

4. Provide a computer program to easily calculate FQA statistics.

   As of this writing a computer program is being developed to calculate floristic quality parameters and is being tested. This program should be made widely available, so that users have a convenient and consistent means of calculating FQA parameters, generated from a single set of conservatism coefficients, based on a single authoritative flora for the state.

5. Develop a database of FQA site values.

FQA parameters are relative values and gain meaning only in relation to baseline and reference data. In order to understand the significance of the Mean C and FQI for a site, the evaluator must know the range of values for that plant community and hydrogeomorphic type in that region. For example, the Mean C and FQI values for a sedge meadow in Waukesha County gain some meaning if one knows the range of Mean C values across the state, and greater meaning if one knows the range of values for sites in the ecoregion of occurrence. There is a need to collect FQA site values as investigations using the method are carried out, whether by the Wisconsin DNR or others, as long as the quality aspects of the data are known, such as the expertise of the observer, the time of observations, and the sampling method used.

A good start to developing the database can be made simply by re-evaluating existing data of known quality and sufficient documentation of site characteristics. Coefficients of conservatism can be applied to existing plant inventory data of known quality to calculate FQA parameters. Much of the higher quality data from highly qualified botanists exist in the files of agencies conducting land inventories especially for those evaluating natural heritage value. It will be important to set criteria for defining plant communities. Site location data and site descriptions can be used to allow analysis by ecoregion and potentially hydrogeomorphic type. The Wisconsin DNR intends to develop a database of FQA site values by re-evaluating existing data, soliciting data from cooperating investigators using the FQA methodology, and by carrying out studies as funding becomes available.

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Appendix

The Wisconsin Floristic Quality Assessment can now be carried out using the coefficient of conservatism values, contained in the table in this Appendix. The table contains:

1) scientific and common names for all Wisconsin vascular plants (Full scientific names may be truncated when space is limited. Species not native to Wisconsin are capitalized),

2) the coefficient of conservatism values discussed in this report,

3) regional wetland indicator status based on the ***National List of Plant Species that Occur in Wetlands: 1988 Wisconsin,***

4) conservation status based on the Natural Heritage Inventory working list, and

5) physiognomy (growth form).

Mean Coefficient of conservatism and floristic quality index values can be calculated using the coefficients of conservatism published here and Formulas (1) and (2) found elsewhere in this report.

APPENDIX D

NHI Rare Plant Field Report Form – 1700-049

State of Wisconsin
Department of Natural Resources
Bureau of Endangered Resources
PO Box 7921, Madison WI 53707-7921

Wisconsin Natural Heritage Inventory

Rare Plant Field Report

Form 1700-049 (R 9/02)

Notice: Completion of this form is voluntary. Data collected will be used to supplement the Wisconsin Natural Heritage Inventory database. Personal information collected on this form will be used to process your request, and is intended to be used to contact you if DNR staff require additional information; it may also be made available to requesters under Wisconsin's Open Records law [ss. 19.31-19.39, Wis. Stats].

Species Name

Location

Site Name (if known)

Office Use

Quadcode

Margin | Dot | Ten, Ten

County | USGS Quad (if known)

Township N | Range ☐ E ☐ W | Section | ¼ Section | ¼ / ¼ Section

Lat N Long W

S N E W

GPS Coordinates (latitude, longitude) | GPS Position Accuracy – meters | GPS Datum | Date Coordinates Taken

Directions to Site and Location of Plant Population in Relation to Landmarks – Please sketch map or include a map copy to clarify location

Landowner Name (if known)

Note: The Natural Heritage Program can not accept data derived from trespass. Gain landowner's permission before entering private property.

Observation Details

Observation Date | Number of Individuals | (select one) ☐ Stems ☐ Clumps ☐ Clones

Estimate the Percentage of the Population Belonging to the Following Categories:

_________ % in Flower / Bud _________ % in Fruit _________ % Sterile Adults _________ % Seedlings / Juveniles

Area Covered by Observed Population

Do you think you saw the whole population? ☐ Full Extent Known ☐ Full Extent Unknown ☐ Uncertain

Habitat Description – Including associated species, community type, slope, aspect, light level, soil moisture and type as known

Office Use

M.USWIHP*

Observation Details (continued)

Current Management

Describe any Evidence of Disturbance or Threats to the Plant Population – Include evidence of predation, logging, succession, etc., and changes since you last saw the population if this is a return visit

Was a Specimen Taken?	If Yes, Collection Number	Herbarium Name
☐ Yes ☐ No		
Was a Photograph Taken?	If Yes, Storage Location	
☐ Yes ☐ No		

Taxonomic Reference(s) Used:

☐ Memory	☐ *Michigan Flora*	☐ *Spring Flora of Wisconsin*
☐ Gleason & Cronquist	☐ Swink & Wilhelm	☐ *Preliminary Reports*
☐ *Wildflowers & Weeds*	☐ *Gray's Manual*	☐ Comparison with verified herbarium specimen
☐ Peterson Guide	☐ Fassett's *Aquatic Plants*	☐ Other – specify: ______

Observer Information

Name(s)	Telephone Number

E-Mail Address	- OR -	Address		
		City	State	ZIP Code

Send completed forms and maps to:

Botanist, Wisconsin Natural Heritage Program
Bureau of Endangered Resources
Department of Natural Resources
PO Box 7921
Madison WI 53707-7921
(608) 266-7012

Office Use
ROW
TRSQ
Prec
Waterbody

APPENDIX E

Invasive Plant Report Form

Wisconsin INVASIVE PLANTS OF THE FUTURE Project

Co-sponsored by the Wisconsin State Herbarium and the Wisconsin Department of Natural Resources

Invasive Plant Report Form

Collection information

State _____ **County** _________________________ **Date collected / observed** __________________

Collector name ____

Street address_________________________________**City** _________________**State** _____ **Zip** ______

Phone ____________________________ **Email** ____

Characteristics & location

Plant name (Common and/or Latin name) ____

Size & density of infestation. Describe spread and estimate numbers

Habitat description. Describe general habitat type such as forest interior, forest edge, old field, prairie, wetland, lakeshore, crop field, pasture, disturbed ground, urban setting type. Is it public or private land?

Location landmarks. Provide enough details so site can be found again. Note nearby landmarks such as city name, roads, intersections, driveways, lake edges and other natural and cultural features.

Geographic coordinates (Complete one. Pinpoint using www.TopoZone.com)

1. Latitude __________________________N **Longitude** __________________________W

2. UTM _____________________________E ________________________________N

3. Township, Range, Section, Part Section ____

Submittal

Mail specimen with its data form to: **Invasive Plants Project, Herbarium, UW-Madison**
430 Lincoln Dr., Madison, WI 53706

Questions? Call **(608) 267-7438** Email: **InvasivePlants@mailplus.wisc.edu**
Website: **http://dnr.wi.gov/invasives/futureplants**

***"Invasive Plants 911"* for Wisconsin**

Based on their invasive behavior in other states and provinces, these six target plants in particular are the ones we are most concerned about. Let us know right away if they have been found in the state.

- Japanese stilt-grass
- Hydrilla
- European frog-bit
- Swallow-wort
- Water chestnut
- Giant hogweed

Notice: Information provided on this form will be used in a statewide volunteer effort to locate, eradicate and monitor selected invasive plants. Your cooperation in reporting these species is much appreciated. Personally identifiable information collected on this form may be provided to requesters as required by Wisconsin's Open Records law [ss. 19.31 - 19.39, Wis. Stats.]. This form is equivalent to DNR form 1700-056.

Version Feb. 2008

APPENDIX F

Forest Stand Summary Form 2400-26

Appendix B

Stand Examination Data Sheet

Form 2400-26
Report 113

WISCONSIN DEPT. OF NATURAL RESOURCES

1. Add	Property Code:	4979	GOVERNOR KNOWLES STATE FOREST
2. Update	Compartment No:	1	
3. Delete	Stand Prefix(s) & No.:	A	3

Exam Date- S.I and B.A measured	5/9/2007			
Primary Type / Size / Density	O	0511	3	
Secondary Type / Size / Density	MR	0511	1	
Understory Type / Size / Density				
Habitat Type	QAp			
Acres	35			
Year of Origin	1929			
Total Height	64			
Mean Stand Diameter	8			
Site Index Species / Site Index	OR	50		
Total Basal Area	94			
Total Volume - Cords / Acre	20			
Total Volume - Bd. Ft / Acre	257			
Major Species	OR	MR	OB	
Species BA	45	26	21	
Species Volume - Cds. / ac.	10	6	3	
Species Volume - Bd. Ft. / ac.	257			
Invasive Species Level	30			
Invasive Species Type	10	18		
Invasive Species Density	1	1		
Soil Type	C			
Management Objective	X			
Last Changed Date	15-May-2007 10:25:31 AM			

Planned Treatments:

Management Prescriptions	Code	1	2	3	Year
Intermediate Treatments : Non-Commercial					
Non-Commercial Thinning	TN				
Non-Commercial Pruning	PR				
Non-Commercial Release	RL				
Non-Commercial Habitat Maintenance	HM	6			2008
Site Preparation	SP				
Artificial Regeneration	PL	1	6	28	2011
Intermediate Treatment - Commercial	T				
Harvest Method					
Even Aged	RE	1			2008
All Aged	RA				

Remarks: 10-May-2007 11:39:57 AM Poor quality oak - oak wilt. Convert to pine mix after harvest

Wisconsin Department of Natural Resources Division of Forestry

www.DNR.wi.gov

190-20

APPENDIX G

WDNR RAM Evaluating Wetland Functional Values Form

January, 2001

____
File or Docket Number

Wisconsin Department of Natural Resources

RAPID ASSESSMENT METHODOLOGY FOR EVALUATING WETLAND FUNCTIONAL VALUES

GENERAL INFORMATION

Name of Wetland/Owner:
Location: County ______________________; ¼, ¼, Section , Township , Range
Project Name:
Evaluator(s):
Date(s) of Site Visit(s):

Description of seasonality limitations of this inspection due to time of year of the evaluation and/or current hydrologic and climatologic conditions (e.g. after heavy rains, snow or ice cover, during drought year, during spring flood, during bird migration):

WETLAND DESCRIPTION

Wisconsin Wetlands Inventory classification:
Wetland Type: shallow open water, deep marsh, shallow marsh, seasonally flooded basin, bog, floodplain forest, alder thicket, sedge meadow, coniferous swamp, fen, wet meadow, shrub-carr, low prairie, hardwood swamp
Estimated size of wetland in acres:

SUMMARY OF FUNCTIONAL VALUES

Based on the results of the attached functional assessment, rate the significance of each of the functional values for the subject wetland and check the appropriate box. Complete the table as a summary.

FUNCTION	**SIGNIFICANCE**				
	Low	Medium	High	Exceptional	N/A
Floral Diversity					
Wildlife Habitat					
Fishery Habitat					
Flood/Stormwater Attenuation					
Water Quality Protection					
Shoreline Protection					
Groundwater					
Aesthetics/Recreation/Education					

List any Special Features/"Red Flags":

SITE DESCRIPTION

I. HYDROLOGIC SETTING

A. Describe the geomorphology of the wetland:

- ❑ Depressional (includes slopes, potholes, small lakes, kettles, etc.)
- ❑ Riverine
- ❑ Lake Fringe
- ❑ Extensive Peatland

B. **Y N** Has the wetland hydrology been altered by ditching, tiles, dams, culverts, well pumping, diversion of surface flow, or changes to runoff within the watershed (circle those that apply)?

C. **Y N** Does the wetland have an inlet, outlet, or both (circle those that apply)?

D. **Y N** Is there any field evidence of wetland hydrology such as buttressed tree trunks, adventitious roots, drift lines, water marks, water stained leaves, soil mottling/gleying, organic soils layer, or oxidized rhizospheres (circle those that apply)?

E. **Y N** Does the wetland have standing water, and if so what is the average depth in inches? _____"
Approximately how much of the wetland is inundated? _____%

F. How is the hydroperiod (seasonal water level pattern) of the wetland classified?

- ❑ Permanently Flooded
- ❑ Seasonally Flooded (water absent at end of growing season)
- ❑ Saturated (surface water seldom present)
- ❑ Artificially Flooded
- ❑ Artificially Drained

G. **Y N** Is the wetland a navigable body of water or is a portion of the wetland below the ordinary high-water mark of a navigable water body? List any surface waters associated with the wetland or in proximity to the wetland (note approximate distance from the wetland and navigability determination). Note if there is a surface water connection to other wetlands.

II. VEGETATION

A. Identify the vegetation communities present and the dominant species.

	floating leaved community dominated by:
	submerged aquatic community dominated by:
	emergent community dominated by:
	shrub community dominated by:
	deciduous broad-leaved tree community dominated by:
	coniferous tree community dominated by:
	open sphagnum mat or bog
	sedge meadow/wet prairie community dominated by:
	other (explain)

B. Other plant species identified during site visit:

III. SOILS

A. NRCS Soil Map Classification: ____

B. Field description:

❑ Organic (histosol)? If so, is it a muck or a peat?

❑ Mineral soil?

- Mottling, gleying, sulfidic materials, iron or manganese concretions, organic streaking (circle those that apply)
- Soil Description: ____
- Depth of mottling/gleying: ____
- Depth of A Horizon: ____
- Munsell Color of matrix and mottles
  - -Matrix below the A horizon (10"depth): ______________________________
  - -Mottles: ____

V. SURROUNDING LAND USES

A. What is the estimated area of the wetland watershed in acres? ____________

B. What are the surrounding land uses?

LAND-USE	ESTIMATED % OF WETLAND WATERSHED
Developed (Industrial/Commercial/Residential)	
Agricultural/cropland	
Agricultural/grazing	
Forested	
Grassed recreation areas/parks	
Old field	
Highways or roads	
Other (specify)	

VI. SITE SKETCH

FUNCTIONAL ASSESSMENT

The following assessment requires the evaluator to examine site conditions that provide evidence that a given functional value is present and to assess the significance of the wetland to perform those functions. Positive answers to questions indicate the presence of factors important for the function. The questions are not definitive and are only provided to guide the evaluation. After completing each section, the evaluator should consider the factors observed and use best professional judgement to rate the significance. The ratings should be recorded on page 1 of the assessment.

SPECIAL FEATURES/"RED FLAGS"

1. **Y N** Is the wetland in or adjacent to an area of special natural resource interest (NR 103.04, Wis. Adm. Code)? If so, check those that apply:

- ❑ Cold water community as defined in s. NR 102.04(3)(b), Wis. Adm. Code, including trout streams, their tributaries, and trout lakes
- ❑ Lakes Michigan and Superior and the Mississippi River
- ❑ State or federal designated wild and scenic river
- ❑ Designated state riverway
- ❑ Designated state scenic urban waterway
- ❑ Environmentally sensitive area or environmental corridor identified in an area-wide water quality management plan, special area management plan, special wetland inventory study, or an advanced delineation and identification study
- ❑ Calcareous fen
- ❑ State park, forest, trail or recreation area
- ❑ State and federal fish and wildlife refuges and fish and wildlife management areas
- ❑ State or federal designated wilderness area
- ❑ Designated or dedicated state natural area
- ❑ Wild rice water listed in ch. NR 19.09, Wis. Adm. Code
- ❑ Surface water identified as an outstanding or exceptional resource water in ch. NR 102, Wis. Adm. Code

2. **Y N** According to the Natural Heritage Inventory (Bureau of Endangered Resources) or direct observations, are there any rare, endangered, or threatened plant or animal species in, near, or using the wetland or adjacent lands? If so, list the species of concern:

3. **Y N** Is the project located in an area that requires a State Coastal Zone Management Plan consistency determination?

Floral Diversity

1. **Y N** Does the wetland support a variety of native plant species (i.e. not a monotypic stand of cattail or giant reed grass and/or not dominated by exotic species such as reed canary grass, brome grass, buckthorn, purple loosestrife, etc.)?

2. **Y N** Is the wetland plant community regionally scarce or rare?

Wildlife and Fishery Habitat

1. List any species observed, evidenced (e.g. tracks, scat, nest/burrow, calls), or expected to utilize the wetland:

2. **Y N** Does the wetland contain a number of diverse vegetative cover types and a high degree of interspersion of those vegetation types?

3. **Y N** Is the estimated ratio of open water to cover between 30 and 70 percent? What is the estimated ratio? ______%

4. **Y N** Does the surrounding upland habitat likely support a variety of animal species?

5. **Y N** Is the wetland part of or associated with a wildlife corridor or designated environmental corridor?

6. **Y N** Is the surrounding habitat and/or the wetland itself a large tract of undeveloped land important for wildlife that requires large home ranges (e.g. bear, woodland passerines)?

7. **Y N** Is the surrounding habitat and/or the wetland itself a relatively large tract of undeveloped land within an urbanized environment that is important for wildlife?

8. **Y N** Are there other wetland areas near the subject wetland that may be important to wildlife?

9. **Y N** Is the wetland contiguous with a permanent waterbody or periodically inundated for sufficient periods of time to provide spawning/nursery habitat for fish?

10. **Y N** Can the wetland provide significant food base for fish and wildlife (e.g. insects, crustaceans, voles, forage fish, amphibians, reptiles, shrews, wild rice, wild celery, duckweed, pondweeds, watermeal, bulrushes, bur reeds, arrowhead, smartweeds, millets...)?

11. **Y N** Is the wetland located in a priority watershed/township as identified in the Upper Mississippi and Great Lakes Joint Venture of the North American Waterfowl Management Plan?

12. **Y N** Is the wetland providing habitat that is scarce to the region?

Flood and Stormwater Storage/Attenuation

1. **Y N** Are there steep slopes, large impervious areas, moderate slopes with row cropping, or areas with severe overgrazing within the watershed (circle those that apply)?

2. **Y N** Does the wetland significantly reduce run-off velocity due to its size, configuration, braided flow patterns, or vegetation type and density?

3. **Y N** Does the wetland show evidence of flashy water level responses to storm events (debris marks, erosion lines, stormwater inputs, channelized inflow)?

4. **Y N** Is there a natural feature or human-made structure impeding drainage from the wetland that causes backwater conditions?

5. **Y N** Considering the size of the wetland area in relation to the size of its watershed, at any time during the year is water likely to reach the wetland's storage capacity (i.e. the level of easily observable wetland vegetation)? [For some cases where greater documentation is required, one should determine if the wetland has capacity to hold 25% of the run-off from a 2 year-24 hour storm event.]

6. **Y N** Considering the location of the wetland in relation to the associated surface water watershed, is the wetland important for attenuating or storing flood or stormwater peaks (i.e. is the wetland located in the mid or lower reaches of the watershed)?

Water Quality Protection

1. **Y N** Does the wetland receive overland flow or direct discharge of stormwater as a primary source of water (circle that which applies)?

2. **Y N** Do the surrounding land uses have the potential to deliver significant nutrient and/or sediment loads to the wetland?

3. **Y N** Based on your answers to the flood/stormwater section above, does the wetland perform significant flood/stormwater attenuation (residence time to allow settling)?

4. **Y N** Does the wetland have significant vegetative density to decrease water energy and allow settling of suspended materials?

5. **Y N** Is the position of the wetland in the landscape such that run-off is held or filtered before entering a surface water?

6. **Y N** Are algal blooms, heavy macrophyte growth, or other signs of excess nutrient loading to the wetland apparent (or historically reported)?

Shoreline Protection

1. **Y N** Is the wetland in a lake fringe or riverine setting? If NO, STOP and enter "not applicable" for this function. If YES, then answer the applicable questions.

2. **Y N** Is the shoreline exposed to constant wave action caused by long wind fetch or boat traffic?

3. **Y N** Is the shoreline and shallow littoral zone vegetated with submerged or emergent vegetation in the swash zone that decrease wave energy or perennial wetland species that form dense root mats and/or species that have strong stems that are resistant to erosive forces?

4. **Y N** Is the stream bank prone to erosion due to unstable soils, land uses, or ice floes?

5. **Y N** Is the stream bank vegetated with densely rooted shrubs that provide upper bank stability?

Groundwater Recharge and Discharge

1. **Y N** Related to discharge, are there observable (or reported) springs located in the wetland, physical indicators of springs such as marl soil, or vegetation indicators such as watercress or marsh marigold present that tend to indicate the presence of groundwater springs?

2. **Y N** Related to discharge, may the wetland contribute to the maintenance of base flow in a stream?

3. **Y N** Related to recharge, is the wetland located on or near a groundwater divide (e.g. a topographic high)?

Aesthetics/Recreation/Education and Science

1. **Y N** Is the wetland visible from any of the following kinds of vantage points: roads, public lands, houses, and/or businesses? (Circle all that apply.)

2. **Y N** Is the wetland in or near any population centers?

3. **Y N** Is any part of the wetland is in public or conservation ownership?

4. **Y N** Does the public have direct access to the wetland from public roads or waterways? (Circle those that apply.)

5. Is the wetland itself relatively free of obvious human influences, such as:

   a. **Y N** Buildings?
   b. **Y N** Roads?
   c. **Y N** Other structures?
   d. **Y N** Trash?
   e. **Y N** Pollution?
   f. **Y N** Filling?
   g. **Y N** Dredging/draining?
   h. **Y N** Domination by non-native vegetation?

6. Is the surrounding viewshed relatively free of obvious human influences, such as:
   a. **Y N** Buildings?
   b. **Y N** Roads?
   c. **Y N** Other structures?

7. **Y N** Is the wetland organized into a variety of visibly separate areas of similar vegetation, color, and/or texture (including areas of open water)?

8. **Y N** Does the wetland add to the variety of visibly separate areas of similar vegetation, color, and/or texture (including areas of open water) within the landscape as a whole?

9. Does the wetland encourage exploration because any of the following factors are present:
   a. **Y N** Long views within the wetland?
   b. **Y N** Long views in the viewshed adjacent to the wetland?
   c. **Y N** Convoluted edges within and/or around the wetland border?
   d. **Y N** The wetland provides a different (and perhaps more natural/complex) kind of environment from the surrounding land covers?

10. **Y N** Is the wetland currently being used for (or does it have the potential to be used for) the following recreational activities? (Check all that apply.)

ACTIVITY	CURRENT USE	POTENTIAL USE
Nature study/photography		
Hiking/biking/skiing		
Hunting/fishing/trapping		
Boating/canoeing		
Food harvesting		
Others (list)		

11. **Y N** Is the wetland currently being used, and/or does it have the potential for use for educational or scientific study purposes (circle that which applies)?

APPENDIX H

NHI Rare Animal Field Report Form – 1700-048

State of Wisconsin
Department of Natural Resources
Bureau of Endangered Resources
PO Box 7921, Madison WI 53707-7921

Wisconsin Natural Heritage Inventory

Rare Animal Field Report

Form 1700-048 (R 1/09)

Notice: Completion of this form is voluntary. Data collected will be used to supplement the Wisconsin Natural Heritage Inventory database. Personal information collected on this form will be used to process your request, and is intended to be used to contact you if DNR staff require additional information; it may also be made available to requesters under Wisconsin's Open Records law [ss. 19.31-19.39, Wis. Stats].

Observation Information

Scientific Name		Common Name
Observation Date	Time ☐ am ☐ pm	Weather Conditions

Nature of Observation:

☐ Sight Record ☐ Road-Kill ☐ Tracks ☐ Song ☐ Collected Specimen – Deposit Location: ____________

☐ Other – please explain: ____________

Location

County	7.5 Minute Quadrangle Name	Township N	Range ☐ E ☐ W	Section	¼ / ¼ Section

GPS Coordinates (latitude, longitude)	GPS Position Accuracy – meters	GPS Datum	GPS'd Date

Directions to Site – Also attach a map of the site (USGS 1:24,000 Topographic Map preferred) and mark the location of the rare species and its boundary (if known). Note: You may print copies of topo maps from the Internet at http://dnr.wi.gov/maps/gis/appwebview.html or http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer (or e-mail the URL). Use 1:24,000 or 1:25,000 scale only.

Landowner Name (if known)

Note: The Natural Heritage Program can not accept data derived from trespass. Please gain landowner's permission before entering private property.

Observation Details

Numbers Observed – Give age and sex if known

Evidence of Reproduction at Site

Behavioral Notes

Observation Details (continued)

Associated Natural Community or Plant Community

Describe Habitat – Include associated plant species

Associated Animal Species – Especially related taxa

Evidence of Disturbance or Threats to the Population or Site

Observer Information

Name(s)

Telephone Number

E-Mail Address

- OR -

Address

City

State

ZIP Code

Send completed form with map to: **Zoologist**
Natural Heritage Inventory
Bureau of Endangered Resources
PO Box 7921
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APPENDIX I

Physical characterization/water quality field data sheet and habitat assessment field data sheet

APPENDIX A:

SAMPLE DATA FORMS FOR THE PROTOCOLS

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APPENDIX A-1:

Habitat Assessment and Physicochemical Characterization Field Data Sheets

Form 1: Physical Characterization/Water Quality Field Data Sheet
Form 2: Habitat Assessment Field Data Sheet - High Gradient Streams
Form 3: Habitat Assessment Field Data Sheet - Low Gradient Streams

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PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION #_________ RIVERMILE_________	STREAM CLASS	
LAT ______________ LONG ______________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE ________ TIME _________ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	**Now**		**Past 24 hours**	**Has there been a heavy rain in the last 7 days?** ❑ Yes ❑ No **Air Temperature**_____ ^{0} C **Other**_____________________________________
	❑	storm (heavy rain)	❑	
	❑	rain (steady rain)	❑	
	❑	showers (intermittent)	❑	
	____%❑	%cloud cover	❑____%	
	❑	clear/sunny	❑	
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)**			
STREAM CHARACTERIZATION	**Stream Subsystem** ❑ Perennial ❑ Intermittent ❑ Tidal **Stream Origin** ❑ Glacial ❑ Non-glacial montane ❑ Swamp and bog ❑ Spring-fed ❑ Mixture of origins ❑ Other__________			**Stream Type** ❑ Coldwater ❑ Warmwater **Catchment Area**__________km^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Other _______________ ❑ Residential **Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources **Local Watershed Erosion** ❑ None ❑ Moderate ❑ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ❑ Trees ❑ Shrubs ❑ Grasses ❑ Herbaceous **dominant species present** ____
INSTREAM FEATURES	**Estimated Reach Length** _______m **Estimated Stream Width** _______m **Sampling Reach Area** _______m^2 **Area in km^2 (m^2x1000)** _______km^2 **Estimated Stream Depth** _______m **Surface Velocity (at thalweg)** _______m/sec **Canopy Cover** ❑ Partly open ❑ Partly shaded ❑ Shaded **High Water Mark** _______m **Proportion of Reach Represented by Stream Morphology Types** ❑ Riffle_______% ❑ Run_______% ❑ Pool_______% **Channelized** ❑ Yes ❑ No **Dam Present** ❑ Yes ❑ No
LARGE WOODY DEBRIS	**LWD** _______m^2 **Density of LWD** _______m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ❑ Rooted emergent ❑ Rooted submergent ❑ Rooted floating ❑ Free floating ❑ Floating Algae ❑ Attached Algae **dominant species present** ____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature**________ ^{0} C **Specific Conductance**________ **Dissolved Oxygen** ________ **pH** ________ **Turbidity** ________ **WQ Instrument Used** _______________ **Water Odors** ❑ Normal/None ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Fishy ❑ Other_________________ **Water Surface Oils** ❑ Slick ❑ Sheen ❑ Globs ❑ Flecks ❑ None ❑ Other_________________________ **Turbidity (if not measured)** ❑ Clear ❑ Slightly turbid ❑ Turbid ❑ Opaque ❑ Stained ❑ Other________
SEDIMENT/ SUBSTRATE	**Odors** ❑ Normal ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Anaerobic ❑ None ❑ Other____________________________________ **Oils** ❑ Absent ❑ Slight ❑ Moderate ❑ Profuse **Deposits** ❑ Sludge ❑ Sawdust ❑ Paper fiber ❑ Sand ❑ Relict shells ❑ Other_________________ **Looking at stones which are not deeply embedded, are the undersides black in color?** ❑ Yes ❑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #__________ RIVERMILE__________	STREAM CLASS	
LAT _______________ LONG _______________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE ________ TIME ________ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION #__________ RIVERMILE__________	STREAM CLASS
LAT _______________ LONG _______________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE _________ TIME _________ AM PM
	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

APPENDIX J

6600 Calibration / field deployment log forms

YSI Sonde Calibration / Field Deployment Log

Sonde / Handheld Serial #:

Study Description:

Set up date/by:	Deployment date/by:	Retrieval date/by:

Deployment Location:

Latitude / Longitude:	Key #:

Report Setup		Data Logger Setup Internal logging
[ ] Date [ ] Time [ ] Temp C [ ] Spec Cond (uS/Cm) [ ] Cond (uS/cm [ ] Resis [ ] TDS (g/L) [ ] Sal ppt [ ] Dosat%	[ ] DO (mg/L) [ ] Docharge [ ] Pressure (Psia) [ ] Depth (m) [ ] pH [ ] pH mv [ ] Turbidity (NTU) [ ] Battery volts [ ] Chlorophyll	Data File Name: Start Date/ Time: End Date/Time: Sample Interval (min):

Initial Sensor Test Information

Conductivity cell constant __________ Range 4.5 to 5.5

If conductivity cell constant is not in range, calibration muct not continue. Go to SpCond calibration and type. "Uncal", read standard, check cell constant . If not in range new standard is needed.

pH MV Buffer 7 ______ range 0 MV +/- 40 MV
pH MV Buffer 10 _______ range -180 MV +/- 40 MV
Run sample in pH standards. Span between pH7 and 10 MV numbers should approximately = 170-180 MV

DO gain ______ Range 0.7 to 1.7
DO charge______ Range 25 to 75

Conduct DO High Low out put test: DO% should start above 100% and drop below 100%
Is the test successful?_______ If not then call YSI and do not use probe.

Notes:

Depth at sonde:

Time at deployment (CST):

Sonde / Handheld #　　　　　　　　　　Location:

Caibration - Initial and Post
(Record readings at stabilization)

Parameter	Standard	Initial Calibration	Extra
Conductivity	1000 uS/Cm		
pH	7.0		
	10.0		
Turbidity	0 NTU		
	100 NTU		
Turbidity Wiper	Changed		
	Parks 180		
ATM Pressure	(mm Hg)		
	Source		
DO	100%		
DO Charge	25 to 75		
DO menbrane changed	Y/N		
Water Depth	Total at Sonde		
	Reading		
Battery Volts	-12		
Initials			

Postcalibration		
Parameter	Handheld	Sonde
Temperature		
Conductivity		
Sp. Conductivity		
pH		
DO mg/L		
DO%		
DO Menbrane damage		
Water Depth		

Postcalibration notes

APPENDIX K

Reference Material

Schuchardt Farms Conservation Plan

Reference Materials

Invasive Species

- Boos et al. A field guide to terrestrial invasive plants in Wisconsin
- Czarapata. 2005. Invasive Plants of the Upper Midwest
- Invasive Plants Association of Wisconsin (IPAW) working list of the Invasive Plants of Wisconsin
- McQuiggin, M.and A. Hager. Milwaukee County Parks. Quick reference guide: phenology and control of common invasive plant species found in southeastern Wisconsin
- Southeastern Wisconsin Invasive Species Consortium (SEWISC) publications
    - Invasive Plants/Widespread Invasive Plants/New Invasive Plants
- Wisconsin Department of Natural Resources publications:
    - Regulated Terrestrial Invasive Plants in WI
    - Common Terrestrial Invasive Plants in WI

Fisheries and Aquatic Resources

- Rantz, S.E. et al. 1982. Measurement and computation of streamflow -- v. 1, Measurement of stage, and v. 2, Computation of discharge. U.S. Geological Survey Water-Supply Paper 2175. United States Department of Interior, U.S. Geological Survey. Washington D.C. 631 p. http://infotrek.er.usgs.gov/pubs/.
- Lipscomb, S.W. 1995. Quality assurance plan for discharge measurements using broadband acoustic Doppler current profilers. U.S. Geological Survey Open File Report 95-701. 12 p. http://infotrek.er.usgs.gov/pubs/.
- United States Geological Survey (USGS). 2005. Techniques of Water Resources Investigations Reports. Book 3: Applications of hydraulics, Section A: Surface-water techniques. (21 chapters). United States Department of Interior, U.S. Geological Survey. Washington D.C. http://water.usgs.gov/pubs/twri/.
- USGS. Date unknown. Surface-Water Quality-Assurance Plan, Illinois District, U.S. Geological Survey, Water Resources Discipline
- USGS Office of Surface Water (OSW) numbered Technical Memorandum http://hydroacoustics.usgs.gov/policy/

Wildlife Habitat

- Dieni, J.S. and S. L. Jones. 2002. A field test of the area search method for measuring breeding bird populations. Journal of Field Ornithology 73:253-257.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. DeSante. 1993. Handbook of field methods for monitoring landbirds. U. S. Forest Service Gen Tech. Report PSW-GTR-144. 41pp.

APPENDIX L

Chapter 5: Habitat Assessment and Physicochemical Parameters of EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition

5 HABITAT ASSESSMENT AND PHYSICOCHEMICAL PARAMETERS

An evaluation of habitat quality is critical to any assessment of ecological integrity and should be performed at each site at the time of the biological sampling. In general, habitat and biological diversity in rivers are closely linked (Raven et al. 1998). In the truest sense, "habitat" incorporates all aspects of physical and chemical constituents along with the biotic interactions. In these protocols, the definition of "habitat" is narrowed to the quality of the instream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems (Karr et al. 1986). The presence of a degraded habitat can sometimes obscure investigations on the effects of toxicity and/or pollution. The assessments performed by many water resource agencies include a general description of the site, a physical characterization and water quality assessment, and a visual assessment of instream and riparian habitat quality. Some states (e.g., Idaho DEQ and Illinois EPA) include quantitative measurements of physical parameters in their habitat assessment. Together these data provide an integrated picture of several of the factors influencing the biological condition of a stream system. These assessments are not as comprehensive as needed to adequately identify all causes of impact. However, additional investigation into hydrological modification of water courses and drainage patterns can be conducted, once impairment is noted.

The habitat quality evaluation can be accomplished by characterizing selected physicochemical parameters in conjunction with a systematic assessment of physical structure. Through this approach, key features can be rated or scored to provide a useful assessment of habitat quality.

5.1 PHYSICAL CHARACTERISTICS AND WATER QUALITY

Both physical characteristics and water quality parameters are pertinent to characterization of the stream habitat. An example of the data sheet used to characterize the physical characteristics and water quality of a site is shown in Appendix A. The information required includes measurements of physical characterization and water quality made routinely to supplement biological surveys.

Physical characterization includes documentation of general land use, description of the stream origin and type, summary of the riparian vegetation features, and measurements of instream parameters such as width, depth, flow, and substrate. The water quality discussed in these protocols are *in situ* measurements of standard parameters that can be taken with a water quality instrument. These are generally instantaneous measurements taken at the time of the survey. Measurements of certain parameters, such as temperature, dissolved oxygen, and turbidity, can be taken over a diurnal cycle and will require instrumentation that can be left in place for extended periods or collects water samples at periodic intervals for measurement. In addition, water samples may be desired to be collected for selected chemical analysis. These chemical samples are transported to an analytical laboratory for processing. The combination of this information (physical characterization and water quality) will provide insight as to the ability of the stream to support a healthy aquatic community, and to the presence of chemical and non-chemical stressors to the stream ecosystem. Information requested in this section (Appendix A-1, Form 1) is standard to many aquatic studies and allows for some comparison among sites. Additionally, conditions that may significantly affect aquatic biota are documented.

5.1.1 Header Information (Station Identifier)

The header information is identical on all data sheets and requires sufficient information to identify the station and location where the survey was conducted, date and time of survey, and the investigators responsible for the quality and integrity of the data. The stream name and river basin identify the watershed and tributary; the location of the station is described in the narrative to help identify access to the station for repeat visits. The rivermile (if applicable) and latitude/longitude are specific locational data for the station. The station number is a code assigned by the agency that will associate the sample and survey data with the station. The STORET number is assigned to each datapoint for inclusion in USEPA's STORET system. The stream class is a designation of the grouping of homogeneous characteristics from which assessments will be made. For instance, Ohio EPA uses ecoregions and size of stream, Florida DEP uses bioregions (aggregations of subecoregions), and Arizona DEQ uses elevation as a means to identify stream classes. Listing the agency and investigators assigns responsibility to the data collected from the station at a specific date and time. The reason for the survey is sometimes useful to an agency that conducts surveys for various programs and purposes.

5.1.2 Weather Conditions

Note the present weather conditions on the day of the survey and those immediately preceding the day of the survey. This information is important to interpret the effects of storm events on the sampling effort.

5.1.3 Site Location/Map

To complete this phase of the bioassessment, a photograph may be helpful in identifying station location and documenting habitat conditions. Any observations or data not requested but deemed important by the field observer should be recorded. A hand-drawn map is useful to illustrate major landmarks or features of the channel morphology or orientation, vegetative zones, buildings, etc. that might be used to aid in data interpretation.

5.1.4 Stream Characterization

Stream Subsystem: In regions where the perennial nature of streams is important, or where the tidal influence of streams will alter the structure and function of communities, this parameter should be noted.

Stream Type: Communities inhabiting coldwater streams are markedly different from those in warmwater streams, many states have established temperature criteria that differentiate these 2 stream types.

Stream Origin: Note the origination of the stream under study, if it is known. Examples are glacial, montane, swamp, and bog. As the size of the stream or river increases, a mixture of origins of tributaries is likely.

5.1.5 Watershed Features

Collecting this information usually requires some effort initially for a station. However, subsequent surveys will most likely not require an in-depth research of this information.

Predominant Surrounding Land Use Type: Document the prevalent land-use type in the catchment of the station (noting any other land uses in the area which, although not predominant, may potentially affect water quality). Land use maps should be consulted to accurately document this information.

Local Watershed Nonpoint Source Pollution: This item refers to problems and potential problems in the watershed. Nonpoint source pollution is defined as diffuse agricultural and urban runoff. Other compromising factors in a watershed that may affect water quality include feedlots, constructed wetlands, septic systems, dams and impoundments, mine seepage, etc.

Local Watershed Erosion: The existing or potential detachment of soil within the local watershed (the portion of the watershed or catchment that directly affects the stream reach or station under study) and its movement into the stream is noted. Erosion can be rated through visual observation of watershed and stream characteristics (note any turbidity observed during water quality assessment below).

5.1.6 Riparian Vegetation

An acceptable riparian zone includes a buffer strip of a minimum of 18 m (Barton et al. 1985) from the stream on either side. The acceptable width of the riparian zone may also be variable depending on the size of the stream. Streams over 4 m in width may require larger riparian zones. The vegetation within the riparian zone is documented here as the dominant type and species, if known.

5.1.7 Instream Features

Instream features are measured or evaluated in the sampling reach and catchment as appropriate.

Estimated Reach Length: Measure or estimate the length of the sampling reach. This information is important if reaches of variable length are surveyed and assessed.

Estimated Stream Width (in meters, m): Estimate the distance from bank to bank at a transect representative of the stream width in the reach. If variable widths, use an average to find that which is representative for the given reach.

Sampling Reach Area (m^2): Multiply the sampling reach length by the stream width to obtain a calculated surface area.

Estimated Stream Depth (m): Estimate the vertical distance from water surface to stream bottom at a representative depth (use instream habitat feature that is most common in reach) to obtain average depth.

Velocity: Measure the surface velocity in the thalweg of a representative run area. If measurement is not done, estimate the velocity as slow, moderate, or fast.

Canopy Cover: Note the general proportion of open to shaded area which best describes the amount of cover at the sampling reach or station. A densiometer may be used in place of visual estimation.

High Water Mark (m): Estimate the vertical distance from the bankfull margin of the stream bank to the peak overflow level, as indicated by debris hanging in riparian or floodplain vegetation, and deposition of silt or soil. In instances where bank overflow is rare, a high water mark may not be evident.

Proportion of Reach Represented by Stream Morphological Types: The proportion represented by riffles, runs, and pools should be noted to describe the morphological heterogeneity of the reach.

Channelized: Indicate whether or not the area around the sampling reach or station is channelized (e.g., straightening of stream, bridge abutments and road crossings, diversions, etc.).

Dam Present: Indicate the presence or absence of a dam upstream in the catchment or downstream of the sampling reach or station. If a dam is present, include specific information relating to alteration of flow.

5.1.8 Large Woody Debris

Large Woody Debris (LWD) density, defined and measured as described below, has been used in regional surveys (Shields et al. 1995) and intensive studies of degraded and restored streams (Shields et al. 1998). The method was developed for sand or sand-and-gravel bed streams in the Southeastern U.S. that are wadeable at baseflow, with water widths between 1 and 30 m (Cooper and Testa 1999).

Cooper and Testa's (1999) procedure involves measurements based on visual estimates taken by a wading observer. Only woody debris actually in contact with stream water is counted. Each woody debris formation with a surface area in the plane of the water surface $>0.25\ m^2$ is recorded. The estimated length and width of each formation is recorded on a form or marked directly onto a stream reach drawing. Estimates are made to the nearest 0.5 m , and formations with length or width less than 0.5 m are not counted. Recorded length is maximum width in the direction perpendicular to the length. Maximum actual length and width of a limb, log, or accumulation are not considered.

If only a portion of the log/limb is in contact with the water, only that portion in contact is measured. Root wads and logs/limbs in the water margin are counted if they contact the water, and are arbitrarily given a width of 0.5 m Lone individual limbs and logs are included in the determination if their diameter is 10 cm or larger (Keller and Swanson 1979, Ward and Aumen 1986). Accumulations of smaller limbs and logs are included if the formation total length or width is 0.5 m or larger. Standing trees and stumps within the stream are also recorded if their length and width exceed 0.5 m.

The length and width of each LWD formation are then multiplied, and the resulting products are summed to give the aquatic habitat area directly influenced. This area is then divided by the water surface area (km^2) within the sampled reach (obtained by multiplying the average water surface width by reach length) to obtain LWD density. Density values of 10^3 to 10^4 m^2/km^2 have been reported for channelized and incised streams and on the order of 10^5 m^2/km^2 for non-incised streams (Shields et al. 1995 and 1998). This density is not an expression of the volume of LWD, but rather a measure of LWD influence on velocity, depth, and cover.

5.1.9 Aquatic Vegetation

The general type and relative dominance of aquatic plants are documented in this section. Only an estimation of the extent of aquatic vegetation is made. Besides being an ecological assemblage that responds to perturbation, aquatic vegetation provides refugia and food for aquatic fauna. List the species of aquatic vegetation, if known.

5.1.10 Water Quality

Temperature (°C), Conductivity or "Specific Conductance" (µohms), Dissolved Oxygen (µg/L), pH, Turbidity: Measure and record values for each of the water quality parameters indicated, using the appropriate calibrated water quality instrument(s). Note the type of instrument and unit number used.

Water Odors: Note those odors described (or include any other odors not listed) that are associated with the water in the sampling area.

Water Surface Oils: Note the term that best describes the relative amount of any oils present on the water surface.

Turbidity: If turbidity is not measured directly, note the term which, based upon visual observation, best describes the amount of material suspended in the water column.

5.1.11 Sediment/Substrate

Sediment Odors: Disturb sediment in pool or other depositional areas and note any odors described (or include any other odors not listed) which are associated with sediment in the sampling reach.

Sediment Oils: Note the term which best describes the relative amount of any sediment oils observed in the sampling area.

Sediment Deposits: Note those deposits described (or include any other deposits not listed) that are present in the sampling reach. Also indicate whether the undersides of rocks not deeply embedded are black (which generally indicates low dissolved oxygen or anaerobic conditions).

Inorganic Substrate Components: Visually estimate the relative proportion of each of the 7 sub-strate/particle types listed that are present over the sampling reach.

Organic Substrate Components: Indicate relative abundance of each of the 3 substrate types listed.

5.2 A VISUAL-BASED HABITAT ASSESSMENT

Biological potential is limited by the quality of the physical habitat, forming the template within which biological communities develop (Southwood 1977). Thus, habitat assessment is defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour et al. 1996a). For streams, an encompassing approach to assessing structure of the habitat includes an evaluation of the variety and quality of the substrate, channel morphology, bank structure, and riparian vegetation. Habitat parameters pertinent to the assessment of habitat quality include those that characterize the stream "micro scale" habitat (e.g., estimation of embeddeddness), the "macro scale" features (e.g., channel morphology), and the riparian and bank structure features that are most often influential in affecting the other parameters.

Rosgen (1985, 1994) presented a stream and river classification system that is founded on the premise that dynamically-stable stream channels have a morphology that provides appropriate distribution of flow energy during storm events. Further, he identifies 8 major variables that affect the stability of channel morphology, but are not mutually independent: channel width, channel depth, flow velocity, discharge, channel slope, roughness of channel materials, sediment load and sediment particle size distribution. When streams have one of these characteristics altered, some of their capability to dissipate energy properly is lost (Leopold et al. 1964, Rosgen 1985) and will result in accelerated rates of channel erosion. Some of the habitat structural components that function to dissipate flow energy are:

EQUIPMENT/SUPPLIES NEEDED FOR HABITAT ASSESSMENT AND PHYSICAL/WATER QUALITY CHARACTERIZATION

- Physical Characterization and Water Quality Field Data Sheet*
- Habitat Assessment Field Data Sheet*
- clipboard
- pencils or waterproof pens
- 35 mm camera (may be digital)
- video camera (optional)
- upstream/downstream “arrows” or signs for photographing and documenting sampling reaches
- Flow or velocity meter
- *In situ* water quality meters
- Global Positioning System (GPS) Unit

* It is helpful to copy field sheets onto water-resistant paper for use in wet weather conditions

! sinuosity

! roughness of bed and bank materials

! presence of point bars (slope is an important characteristic)

! vegetative conditions of stream banks and the riparian zone

! condition of the floodplain (accessibility from bank, overflow, and size are important characteristics).

Measurement of these parameters or characteristics serve to stratify and place streams into distinct classifications. However, none of these habitat classification techniques attempt to differentiate the quality of the habitat and the ability of the habitat to support the optimal biological condition of the region. Much of our understanding of habitat relationships in streams has emerged from comparative studies that describe statistical relationships between habitat variables and abundance of biota (Hawkins et al. 1993). However, in response to the need to incorporate broader scale habitat assessments in water resource programs, 2 types of approaches for evaluating habitat structure have been developed. In the first, the Environmental Monitoring and Assessment Program (EMAP) of the USEPA and the National Water-Quality Assessment Program (NAWQA) of the USGS developed techniques that incorporate measurements of various features of the instream, channel, and bank morphology (Meader et al. 1993, Klemm and Lazorchak 1994). These techniques provide a relatively comprehensive characterization of the physical structure of the stream sampling reach and its surrounding floodplain. The second type was a more rapid and qualitative habitat assessment approach that was developed to describe the overall quality of the physical habitat (Ball 1982, Ohio EPA 1987, Plafkin et al. 1989, Barbour and Stribling 1991, 1994, Rankin 1991, 1995). In this document, the more rapid visual-based approach is described. A cursory overview of the more quantitative approaches to characterizing the physical structure of the habitat is provided.

The habitat assessment matrix developed for the Rapid Bioassessment Protocols (RBPs) in Plafkin et al. (1989) were originally based on the Stream Classification Guidelines for Wisconsin developed by Ball (1982) and "*Methods of Evaluating Stream, Riparian, and Biotic Conditions*" developed by Platts et al. (1983). Barbour and Stribling (1991, 1994) modified the habitat assessment approach originally developed for the RBPs to include additional assessment parameters for high gradient streams and a more appropriate parameter set for low gradient streams (Appendix A-1, Forms 2,3). All parameters are evaluated and rated on a numerical scale of 0 to 20 (highest) for each sampling reach. The ratings are then totaled and compared to a reference condition to provide a final habitat ranking. Scores increase as habitat quality increases. To ensure consistency in the evaluation procedure, descriptions of the physical parameters and relative criteria are included in the rating form.

The Environmental Agency of Great Britain (Environment Agency of England and Wales, Scottish Environment Protection Agency, and Environment and Heritage Service of Northern Ireland) have developed a River Habitat Survey (RHS) for characterizing the quality of their streams and rivers (Raven et al. 1998). The approach used in Great Britain is similar to the visual-based habitat assessment used in the US in that scores are assigned to ranges of conditions of various habitat parameters.

A biologist who is well versed in the ecology and zoogeography of the region can generally recognize optimal habitat structure as it relates to the biological community. The ability to accurately assess the quality of the physical habitat structure using a visual-based approach depends on several factors:

- the parameters selected to represent the various features of habitat structure need to be relevant and clearly defined

- a continuum of conditions for each parameter must exist that can be characterized from the optimum for the region or stream type under study to the poorest situation reflecting substantial alteration due to anthropogenic activities

- the judgement criteria for the attributes of each parameter should minimize subjectivity through either quantitative measurements or specific categorical choices

- the investigators are experienced in or adequately trained for stream assessments in the region under study (Hannaford et al. 1997)

- adequate documentation and ongoing training is maintained to evaluate and correct errors resulting in outliers and aberrant assessments.

Habitat evaluations are first made on instream habitat, followed by channel morphology, bank structural features, and riparian vegetation. Generally, a single, comprehensive assessment is made that incorporates features of the entire sampling reach as well as selected features of the catchment. Additional assessments may be made on neighboring reaches to provide a broader evaluation of habitat quality for the stream ecosystem. The actual habitat assessment process involves rating the 10 parameters as optimal, suboptimal, marginal, or poor based on the criteria included on the Habitat Assessment Field Data Sheets (Appendix A-1, Forms 2,3). Some state programs, such as Florida Department of Environmental Protection (DEP) (1996) and Mid-Atlantic Coastal Streams Workgroup (MACS) (1996) have adapted this approach using somewhat fewer and different parameters.

Reference conditions are used to scale the assessment to the "best attainable" situation. This approach is critical to the assessment because stream characteristics will vary dramatically across different regions (Barbour and Stribling 1991). The ratio between the score for the test station and the score for the reference condition provides a percent comparability measure for each station. The station of interest is then classified on the basis of its similarity to expected conditions (reference condition), and its apparent potential to support an acceptable level of biological health. Use of a percent comparability evaluation allows for regional and stream-size differences which affect flow or velocity, substrate, and channel morphology. Some regions are characterized by streams having a low channel gradient, such as coastal plains or prairie regions.

Other habitat assessment approaches or a more rigorously quantitative approach to measuring the habitat parameters may be used (See Klemm and Lazorchak 1994, Kaufmann and Robison 1997, Meader et al. 1993). However, holistic and rapid assessment of a wide variety of habitat attributes along with other types of data is critical if physical measurements are to be used to best advantage in interpreting biological data. A more detailed discussion of the relationship between habitat quality and biological condition is presented in Chapter 10.

A generic habitat assessment approach based on visual observation can be separated into 2 basic approaches—one designed for high-gradient streams and one designed for low-gradient streams. High-gradient or riffle/run prevalent streams are those in moderate to high gradient landscapes. Natural high-gradient streams have substrates primarily composed of coarse sediment particles (i.e., gravel or larger) or frequent coarse particulate aggregations along stream reaches. Low-gradient or glide/pool prevalent streams are those in low to moderate gradient landscapes. Natural low-gradient streams have substrates of fine sediment or infrequent aggregations of more coarse (gravel or larger) sediment particles along stream reaches. The entire sampling reach is evaluated for each parameter. Descriptions of each parameter and its relevance to instream biota are presented in the following discussion. Parameters that are used only for high-gradient prevalent streams are marked with an “a”; those for low-gradient dominant streams, a “b”. If a parameter is used for both stream types, it is not marked with a letter. A brief set of decision criteria is given for each parameter corresponding to each of the 4 categories reflecting a continuum of conditions on the field sheet (optimal, suboptimal, marginal, and poor). Refer to Appendix A-1, Forms 2 and 3, for a complete field assessment guide.

PROCEDURE FOR PERFORMING HABITAT ASSESSMENT

1. Select the reach to be assessed. The habitat assessment is performed on the same 100 m reach (or other reach designation [e.g., 40 x stream wetted width]) from which the biological sampling is conducted. Some parameters require an observation of a broader section of the catchment than just the sampling reach.

2. Complete the station identification section of each field data sheet and habitat assessment form.

3. It is best for the investigators to obtain a close look at the habitat features to make an adequate assessment. If the physical and water quality characterization and habitat assessment are done before the biological sampling, care must be taken to avoid disturbing the sampling habitat.

4. Complete the **Physical Characterization and Water Quality Field Data Sheet**. Sketch a map of the sampling reach on the back of this form.

5. Complete the **Habitat Assessment Field Data Sheet**, in a team of 2 or more biologists, if possible, to come to a consensus on determination of quality. Those parameters to be evaluated on a scale greater than a sampling reach require traversing the stream corridor to the extent deemed necessary to assess the habitat feature. As a general rule-of-thumb, use 2 lengths of the sampling reach to assess these parameters.

QUALITY ASSURANCE PROCEDURES

1. Each biologist is to be trained in the visual-based habitat assessment technique for the applicable region or state.

2. The judgment criteria for each habitat parameter are calibrated for the stream classes under study. Some text modifications may be needed on a regional basis.

3. Periodic checks of assessment results are completed using pictures of the sampling reach and discussions among the biologists in the agency.

Parameters to be evaluated in sampling reach:

1 EPIFAUNAL SUBSTRATE/AVAILABLE COVER

high and low gradient streams

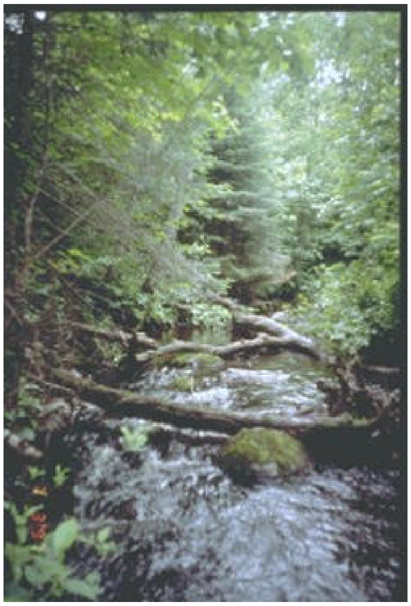
Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most high-gradient streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in high-gradient streams. Riffles and runs offer a diversity of habitat through variety of particle size, and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in low-gradient streams. However, "new fall" will not yet be suitable for colonization.

Selected References

Wesche et al. 1985, Pearsons et al. 1992, Gorman 1988, Rankin 1991, Barbour and Stribling 1991, Plafkin et al. 1989, Platts et al. 1983, Osborne et al. 1991, Benke et al. 1984, Wallace et al. 1996, Ball 1982, MacDonald et al. 1991, Reice 1980, Clements 1987, Hawkins et al. 1982, Beechie and Sibley 1997.

Habitat Parameter	**Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover **(high and low gradient)**	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

1a. Epifaunal Substrate/Available Cover—High Gradient



Optimal Range

Poor Range

1b. Epifaunal Substrate/Available Cover—Low Gradient

Optimal Range (*Mary Kay Corazalla, U. of Minn.*)

Poor Range

2a EMBEDDEDNESS

high gradient streams

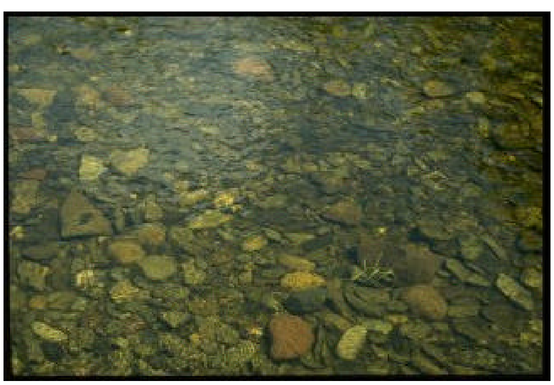
Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of high-gradient streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.

Selected References

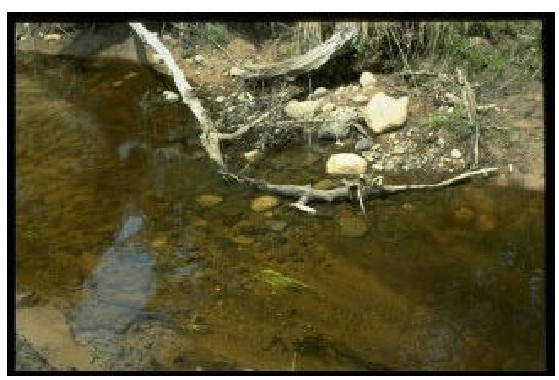
Ball 1982, Osborne et al. 1991, Barbour and Stribling 1991, Platts et al. 1983, MacDonald et al. 1991, Rankin 1991, Reice 1980, Clements 1987, Benke et al. 1984, Hawkins et al. 1982, Burton and Harvey 1990.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
2.a Embeddedness (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2a. Embeddedness—High Gradient



Optimal Range *(William Taft, MI DNR)*



Poor Range *(William Taft, MI DNR)*

2b POOL SUBSTRATE CHARACTERIZATION

low gradient streams

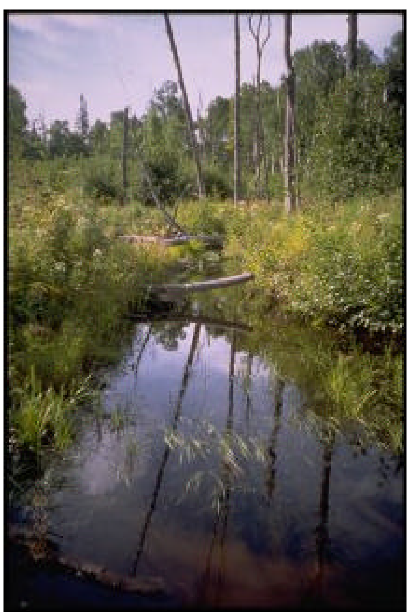
Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel, sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

Selected References

Beschta and Platts 1986, U.S. EPA 1983.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
2b. Pool Substrate Characterization **(low gradient)**	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or submerged vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2b. Pool Substrate Characterization—Low Gradient



Optimal Range
(Mary Kay Corazalla, U. of Minn.)

Poor Range

3a VELOCITY/DEPTH COMBINATIONS

high gradient streams

Patterns of velocity and depth are included for high-gradient streams under this parameter as an important feature of habitat diversity. The best streams in most high-gradient regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

Selected References

Ball 1982, Brown and Brussock 1991, Gore and Judy 1981, Oswood and Barber 1982.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
3a. Velocity/ Depth Regimes **(high gradient)**	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5 m)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

3a. Velocity/Depth Regimes—High Gradient

Optimal Range *(Mary Kay Corazalla, U. of Minn.)*
(arrows emphasize different velocity/depth regimes)

Poor Range *(William Taft, MI DNR)*

3b POOL VARIABILITY

low gradient streams

Rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 m depth separating shallow and deep.

Selected References

Beschta and Platts 1986, USEPA 1983.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
3b. Pool Variability **(low gradient)**	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

3b. Pool Variability—Low Gradient

Optimal Range *(Peggy Morgan, FL DEP)*

Poor Range *(William Taft, MI DNR)*

4 SEDIMENT DEPOSITION

high and low gradient streams

Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

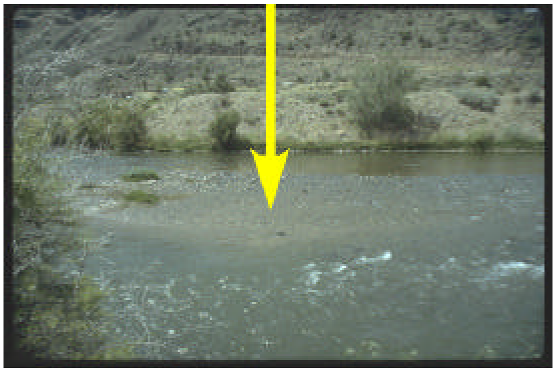
Selected References

MacDonald et al. 1991, Platts et al. 1983, Ball 1982, Armour et al. 1991, Barbour and Stribling 1991, Rosgen 1985.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
4. Sediment Deposition **(high and low gradient)**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4a. Sediment Deposition—High Gradient

Optimal Range



Poor Range
(arrow pointing to sediment deposition)

4b. Sediment Deposition—Low Gradient

Optimal Range

Poor Range
(arrows pointing to sediment deposition)

5 CHANNEL FLOW STATUS

high and low gradient streams

The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high-gradient streams, riffles and cobble substrate are exposed; in low-gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions. This parameter becomes important when more than one biological index period is used for surveys or the timing of sampling is inconsistent among sites or annual periodicity.

Selected References

Rankin 1991, Rosgen 1985, Hupp and Simon 1986, MacDonald et al. 1991, Ball 1982, Hicks et al. 1991.

Habitat Parameter	**Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
5. Channel Flow Status **(high and low gradient)**	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

5a. Channel Flow Status—High Gradient

Optimal Range

Poor Range
(arrow showing that water is not reaching both banks; leaving much of channel uncovered)

5b. Channel Flow Status—Low Gradient

Optimal Range

Poor Range *(James Stahl, IN DEM)*

Parameters to be evaluated broader than sampling reach:

6 CHANNEL ALTERATION

high and low gradient streams

Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred. Scouring is often associated with channel alteration.

Selected References

Barbour and Stribling 1991, Simon 1989a, b, Simon and Hupp 1987, Hupp and Simon 1986, Hupp 1992, Rosgen 1985, Rankin 1991, MacDonald et al. 1991.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration **(high and low gradient)**	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

6a. Channel Alteration—High Gradient

Optimal Range

Poor Range
(arrows emphasizing large-scale channel alterations)

6b. Channel Alteration—Low Gradient

Optimal Range

Poor Range *(John Maxted, DE DNREC)*

7a FREQUENCY OF RIFFLES (OR BENDS)

high gradient streams

Is a way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see 7b). A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In headwaters, riffles are usually continuous and the presence of cascades or boulders provides a form of sinuosity and enhances the structure of the stream. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Selected References

Hupp and Simon 1991, Brussock and Brown 1991, Platts et al. 1983, Rankin 1991, Rosgen 1985, 1994, 1996, Osborne and Hendricks 1983, Hughes and Omernik 1983, Cushman 1985, Bain and Boltz 1989, Gislason 1985, Hawkins et al. 1982, Statzner et al. 1988.

Habitat Parameter	**Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7a. Frequency of Riffles (or bends) **(high gradient)**	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7a. Frequency of Riffles (or bends)—High Gradient

Optimal Range
(arrows showing frequency of riffles and bends)

Poor Range

7b CHANNEL SINUOSITY

low gradient streams

Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in low gradient streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Selected References

Hupp and Simon 1991, Brussock and Brown 1991, Platts et al. 1983, Rankin 1991, Rosgen 1985, 1994, 1996, Osborne and Hendricks 1983, Hughes and Omernik 1983, Cushman 1985, Bain and Boltz 1989, Gislason 1985, Hawkins et al. 1982, Statzner et al. 1988.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7b. Channel Sinuosity **(low gradient)**	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7b. Channel Sinuosity—Low Gradient

Optimal Range

Poor Range

8 BANK STABILITY (condition of banks)

high and low gradient streams

Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Selected References

Ball 1982, MacDonald et al. 1991, Armour et al. 1991, Barbour and Stribling 1991, Hupp and Simon 1986, 1991, Simon 1989a, Hupp 1992, Hicks et al. 1991, Osborne et al. 1991, Rosgen 1994, 1996.

Habitat Parameter	**Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
8. Bank Stability (score each bank) **Note: determine left or right side by facing downstream** **(high and low gradient)**	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

8a. Bank Stability (condition of banks)—High Gradient

Optimal Range
(arrow pointing to stable streambanks)

Poor Range *(MD Save Our Streams)*
(arrow highlighting unstable streambanks)

8b. Bank Stability (condition of banks)—Low Gradient

Optimal Range *(Peggy Morgan, FL DEP)*

Poor Range
(arrow highlighting unstable streambanks)

9 BANK VEGETATIVE PROTECTION

high and low gradient streams

Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the native vegetation for the region and stream type (i.e., shrubs, trees, etc.). In some regions, the introduction of exotics has virtually replaced all native vegetation. The value of exotic vegetation to the quality of the habitat structure and contribution to the stream ecosystem must be considered in this parameter. In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Selected References

Platts et al. 1983, Hupp and Simon 1986, 1991, Simon and Hupp 1987, Ball 1982, Osborne et al. 1991, Rankin 1991, Barbour and Stribling 1991, MacDonald et al. 1991, Armour et al. 1991, Myers and Swanson 1991, Bauer and Burton 1993.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
9. Vegetative Protection (score each bank) **Note: determine left or right side by facing downstream.** **(high and low gradient)**	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

9a. Bank Vegetative Protection—High Gradient

Optimal Range
(arrow pointing to streambank with high level of vegetative cover)

Poor Range
(arrow pointing to streambank with almost no vegetative cover)

9b. Bank Vegetative Protection—Low Gradient

Optimal Range *(Peggy Morgan, FL DEP)*

Poor Range *(MD Save Our Streams)*
(arrow pointing to channelized streambank with no vegetative cover)

10 RIPARIAN VEGETATIVE ZONE WIDTH

high and low gradient streams

Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. For variable size streams, the specified width of a desirable riparian zone may also be variable and may be best determined by some multiple of stream width (e.g., 4 x wetted stream width). Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

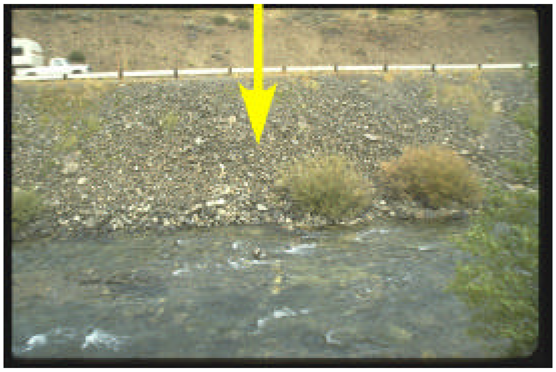
Selected References

Barton et al. 1985, Naiman et al. 1993, Hupp 1992, Gregory et al. 1991, Platts et al. 1983, Rankin 1991, Barbour and Stribling 1991, Bauer and Burton 1993.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
10. Riparian Vegetative Zone Width (score each bank riparian zone) **(high and low gradient)**	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

10a. Riparian Vegetative Zone Width—High Gradient

Optimal Range
(arrow pointing out an undisturbed riparian zone)



Poor Range
(arrow pointing out lack of riparian zone)

10b. Riparian Vegetative Zone Width—Low Gradient

Optimal Range
(arrow emphasizing an undisturbed riparian zone)

Poor Range *(MD Save Our Streams)*
(arrow emphasizing lack of riparian zone)

5.3 ADDITIONS OF QUANTITATIVE MEASURES TO THE HABITAT ASSESSMENT

Kaufmann (1993) identified 7 general physical habitat attributes important in influencing stream ecology. These include:

- channel dimensions
- channel gradient
- channel substrate size and type
- habitat complexity and cover
- riparian vegetation cover and structure
- anthropogenic alterations
- channel-riparian interaction.

All of these attributes vary naturally, as do biological characteristics; thus expectations differ even in the absence of anthropogenic disturbances. Within a given physiographic-climatic region, stream drainage area and overall stream gradient are likely to be strong natural determinants of many aspects of stream habitat, because of their influence on discharge, flood stage, and stream power (the product of discharge times gradient). In addition, all of these attributes may be directly or indirectly altered by anthropogenic activities.

In Section 5.2, an approach is described whereby habitat quality is interpreted directly in the field by biologists while sampling the stream reach. This Level 1 approach is observational and requires only one person (although a team approach is recommended) and takes about 15 to 20 minutes per stream reach. This approach more quickly yields a habitat quality assessment. However, it depends upon the knowledge and experience of the field biologist to make the proper interpretation of observed of both the natural expectations (potentials) and the biological consequences (quality) that can be attributed to the observed physical attributes. Hannaford et al. (1997) found that training in habitat assessment was necessary to reduce the subjectivity in a visual-based approach. The authors also stated that training on different types of streams may be necessary to adequately prepare investigators.

The second conceptual approach described here confines observations to habitat characteristics themselves (whether they are quantitative or qualitative), then later ascribing quality scoring to these measurements as part of the data analysis process. Typically, this second type of habitat assessment approach employs more quantitative data collection, as exemplified by field methods described by Kaufmann and Robison (1997) for EMAP, Simonson et al. (1994), Meador et al. (1993) for NAWQA, and others cited by Gurtz and Muir (1994). These field approaches typically define a reach length proportional to stream width and employ transect measurements that are systematically spaced (Simonson et al. 1994, Kaufmann and Robison 1997) or spaced by judgement to be representative (Meador et al. 1993). They usually include measurement of substrate, channel and bank dimensions, riparian canopy cover, discharge, gradient, sinuosity, in-channel cover features, and counts of large woody debris and riparian human disturbances. They may employ systematic visual estimates of substrate embeddedness, fish cover features, habitat types, and riparian vegetation structure. The time commitment in the field to these more quantitative habitat assessment methods is usually 1.5 to 3 hours with a crew of two people. Because of the greater amount of data collected, they also require more time for data summarization, analysis, and interpretation. On the other hand, the more quantitative methods and less ambiguous field parameters result in considerably greater precision. The USEPA applied both quantitative and visual-based (RBPs) methods in a stream survey undertaken over 4 years in the mid-Atlantic region of the Appalachian Mountains. An earlier version of the RBP techniques were applied on 301 streams with repeat visits to 29 streams; signal-to-noise ratios varied from 0.1 to 3.0 for the twelve RBP metrics and averaged (1.1 for the RBP total habitat quality score). The quantitative methods produced a higher level of precision; signal-to-noise ratios were typically between 10 and 50, and sometimes in excess of 100 for quantitative measurements of channel morphology, substrate, and canopy densiometer measurements made on a random subset of 186 streams with 27 repeat visits in the same survey. Similarly, semi-quantitative estimates of fish cover and riparian human disturbance estimates obtained from multiple, systematic visual observations of otherwise measurable features had signal:noise ratios from 5 to 50. Many riparian vegetation cover and structure metrics were moderately precise (signal:noise ranging from 2 to 30). Commonly used flow dependent measures (e.g., riffle/pool and width/depth ratios), and some visual riparian cover estimates were less precise, with signal:noise ratios more in the range of those observed for metrics of the EPA's RBP habitat score (<2).

The USEPA's EMAP habitat assessment field methods are presented as an option for a second level (II) of habitat assessment. These methods have been applied in numerous streams throughout the Mid-Atlantic region, the Midwest, Colorado, California, and the Pacific Northwest. Table 5-1 is a summary of these field methods; more detail is presented in the field manual by Kaufmann and Robison (1997).

Table 5-1. Components of EMAP physical habitat protocol.

Component	Description
1. Thalweg Profile	Measure maximum depth, classify habitat, determine presence of soft/small sediment at 10-15 equally spaced intervals between each of 11 channel cross-sections (100-150 along entire reach). Measure wetted width at 11 channel cross-sections and mid-way between cross-sections (21 measurements).
2. Woody Debris	Between each of the channel cross sections, tally large woody debris numbers within and above the bankfull channel according to size classes.
3. Channel and Riparian Cross-Sections	At 11 cross-section stations placed at equal intervals along reach length: • **Measure**: channel cross section dimensions, bank height, undercut, angle (with rod and clinometer); gradient (clinometer), sinuosity (compass backsite), riparian canopy cover (densiometer). • **Visually Estimate***: substrate size class and embeddedness; areal cover class and type (e.g., woody) of riparian vegetation in Canopy, Mid-Layer and Ground Cover; areal cover class of fish concealment features, aquatic macrophytes and filamentous algae. • **Observe & Record***: human disturbances and their proximity to the channel.
4. Discharge	In medium and large streams (defines later) measure water depth and velocity @ 0.6 depth (with electromagnetic or impeller-type flow meter) at 15 to 20 equally spaced intervals across one carefully chosen channel cross-section. In very small streams, measure discharge with a portable weir or time the filling of a bucket.

* Substrate size class and embeddedness are estimated, and depth is measured for 55 particles taken at 5 equally-spaced points on each of 11 cross-sections. The cross-section is defined by laying the surveyor's rod or tape to span the wetted channel. Woody

debris is tallied over the distance between each cross-section and the next cross-section upstream. Riparian vegetation and human disturbances are observed 5 m upstream and 5 m downstream from the cross section station. They extend shoreward 10 m from left and right banks. Fish cover types, aquatic macrophytes, and algae are observed within channel 5 m upstream and 5 m downstream from the cross section stations. These boundaries for visual observations are estimated by eye.

Table 5-2 lists the physical habitat metrics that can be derived from applying these field methods. Once these habitat metrics are calculated from the available physical habitat data, an assessment would be obtained from comparing these metric values to those of known reference sites. A strong deviation from the reference expectations would indicate a habitat alteration of the particular parameter. The close connectivity of the various attributes would most likely result in an impact on multiple metrics if habitat alteration was occurring. The actual process for interpreting a habitat assessment using this approach is still under development.

Table 5-2. Example of habitat metrics that can be calculated from the EMAP physical habitat data.

Channel mean width and depth
Channel volume and Residual Pool volume
Mean channel slope and sinuosity
Channel incision, bankfull dimensions, and bank characteristics
Substrate mean diameter, % fines, % embeddedness
Substrate stability
Fish concealment features (areal cover of various types, e.g., undercut banks, brush)
Large woody debris (volume and number of pieces per 100 m)
Channel habitat types (e.g., % of reach composed of pools, riffles, etc.)
Canopy cover
Riparian vegetation structure and complexity
Riparian disturbance measure (proximity-weighted tally of human disturbances)

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APPENDIX M

WDNR Conservation Practice Standard 1002

Site Evaluation for Stormwater Infiltration
(1002)

Wisconsin Department of Natural Resources
Conservation Practice Standards

I. Definition

This standard defines site evaluation procedures to:

1. Perform an initial screening of a *development site*[1] to determine its suitability for infiltration.

2. Evaluate each area within a development site that is selected for infiltration.

3. Prepare a site evaluation report.

II. Purpose

1. Establish methodologies to characterize the site and screen for exclusions and exemptions under Chapter NR 151 Wis. Adm. code.

2. Establish requirements for siting an *infiltration device* and the selection of design infiltration rates.

3. Define requirements for a site evaluation report that insures appropriate areas are selected for infiltration and an appropriate *design infiltration rate* is used.

III. Conditions where Practice Applies

This standard is intended for development sites being considered for stormwater infiltration devices. Additional site location requirements may be imposed by other stormwater infiltration device technical standards.

IV. Federal, State and Local Laws

Users of this standard shall be aware of applicable federal, state and local laws, rules, regulations or permit requirements governing infiltration devices. This standard does not contain the text of federal, state or local laws.

V. Criteria

The site evaluation consists of four steps for locating the optimal areas for infiltration, and properly sizing infiltration devices.

- Step A. Initial Screening.
- Step B. Field Verification of information collected in Step A.
- Step C. Evaluation of Specific *Infiltration Areas*.
- Step D. Soil and Site Evaluation Reporting.

The steps shall coincide, as much as possible, for when the information is needed to determine the following: 1) the potential for infiltration on the site, 2) the optimal locations for infiltration devices, and 3) the design of the infiltration device(s). Steps A and B shall be completed as soon as possible in the approval process. See Consideration VI.M for an example.

Step A. Initial Screening

The initial screening identifies potential locations for infiltration devices. The purpose of the initial screening is to determine if installation is limited by ss. NR 151.12(5)(c)5. or NR 151.12(5)(c)6., and to determine where field work is needed for Step B. Optimal locations for infiltration are verified in Step B.

Information collected in Step A will be used to explore the potential for multiple infiltration areas versus relying on a regional infiltration device. Smaller infiltration devices dispersed around a development are usually more sustainable than a single *regional device* that is more likely to have maintenance and groundwater mounding problems.

The initial screening shall determine the following: Note: Useful references for the existing resource maps and information are listed in Considerations VI.I and J.

1. Site topography and slopes greater than 20%.
2. Site soil infiltration capacity characteristics as defined in NRCS County soil surveys.
3. *Soil parent material.*
4. Regional or local depth to groundwater and bedrock. Use seasonally *high groundwater* information where available.

[1] Words in the standard that are shown in italics are described in VIII. Definitions. The words are italicized the first time they are used in the text.

5. Distance to sites listed on the GIS Registry of Closed Remediation sites within 500 feet from the perimeter of the development site.
6. Distance to sites listed on the Bureau of Remediation and *Redevelopment* Tracking System within 500 feet from the perimeter of the development site.
7. Presence of endangered species habitat.
8. Presence of flood plains and flood fringes.
9. Location of hydric soils based on the USDA County Soil Survey and wetlands from the WDNR Wisconsin Wetland Inventory map.
10. Sites where the installation of stormwater infiltration devices is excluded, due to the potential for groundwater contamination, by chapter NR 151 Wis. Adm. Code.
11. Sites exempted by chapter NR 151 Wis. Adm. Code from the requirement to install infiltration devices.
12. Potential impact to adjacent property.

Step B. Field Verification of the Initial Screening

A. Field verification is required for areas of the development site considered suitable for infiltration. This includes verification of Step A.1, 2, 3, 4, 9, 10 and 11.

B. Sites shall be tested for depth to groundwater, depth to bedrock and *percent fines* information to verify any exemption and exclusion found in Step A.10 and 11. The following is a description of the percent fines expected for each type of soil textural classification.

   1. Several textural classes are assumed to meet the percent fines limitations of Ch. NR 151.12(5)(c)5.i. for both 3 and 5 foot soil layers. These classifications include the sandy loams, loams, silt loams and all the clay textural classifications. *Coarse sand* is the only soil texture that by definition will not meet NR 151.12(5)(c)5.i. limitations for a 3 foot soil layer consisting of 20% fines. Other sand textures and loamy sands may need the percent fines level verified with a laboratory analysis.

   2. Borings and pits shall be dug to verify soil infiltration capacity characteristics and to determine depth to groundwater and bedrock.

C. The following information shall be recorded for Step B:

   1. The date or dates the data was collected.

   2. A legible site plan/map that is presented on paper that is no less than 8 ½ X 11 inches in size and:

      a. Is drawn to scale or fully dimensional.
      b. Illustrates the entire development site.
      c. Shows all areas of planned filling and/or cutting.
      d. Includes a permanent vertical and horizontal reference point.
      e. Shows the percent and direction of land slope for the site or contour lines. Highlight areas with slopes over 20%.
      f. Shows all flood plain information that is pertinent to the site.
      g. Shows the location of all pits/borings included in the report.
      h. Location of wetlands as field delineated and surveyed.
      i. Location of karst features, private wells within 100 feet of the development site, and public wells within 400 feet of the development site.

   3. Soil profile descriptions must be written in accordance with the descriptive procedures, terminology and interpretations found in the Field Book for Describing and Sampling Soils, USDA, NRCS, 1998. Frozen soil material must be thawed prior to conducting evaluations for soil color, texture, structure and consistency. In addition to the data determined in Step B, soil profiles must include the following information for each soil horizon or layer:

      a. Thickness, in inches or decimal feet.
      b. Munsell soil color notation.
      c. Soil mottle or redoximorphic feature color, abundance, size and contrast.
      d. USDA soil textural class with rock fragment modifiers.
      e. Soil structure, grade size and shape.
      f. Soil consistence, root abundance and size.
      g. Soil boundary.
      h. Occurrence of saturated soil, groundwater, bedrock or disturbed soil.

Step C. Evaluation of Specific Infiltration Areas

This step is to determine if locations identified for infiltration devices are suitable for infiltration, and to provide the required information to design the device.

A minimum number of borings or pits shall be constructed for each infiltration device (Table 1). The following information shall be recorded for Step C:

1. All the information under Step B.C.3.

2. A legible site plan/map that is presented on paper no less than 8 1/2 X 11 inches in size and:

   a. Is drawn to scale or fully dimensional.
   b. Illustrates the location of the infiltration devices.
   c. Shows the location of all pits and borings.
   d. Shows distance from device to wetlands.

3. An analysis of groundwater mounding potential is required as per Table 1. The altered groundwater level, based on mounding calculations, must be considered in determining the vertical separation distance from the infiltration surface to the *highest anticipated groundwater elevation* as specified in NR 151. References include but are not limited to Finnemore 1993 and 1995, and Hantush 1967.

4. One of the following methods shall be used to determine the design infiltration rate:

   a. Infiltration Rate Not Measured - Table 2 shall be used if the infiltration rate is not measured. Select the design infiltration rate from Table 2 based on the least permeable soil horizon five feet below the bottom elevation of the infiltration system.

   b. Measured Infiltration Rate - The tests shall be conducted at the proposed bottom elevation of the infiltration device. If the infiltration rate is measured with a *Double-Ring Infiltrometer* the requirements of ASTM D3385 shall be used for the field test.

      The measured infiltration rate shall be divided by a correction factor selected from Table 3. The correction factor adjusts the measured infiltration rates for the occurrence of less permeable soil horizons below the surface and the potential variability in the subsurface soil horizons throughout the infiltration site.

      A less permeable soil horizon below the location of the measurement increases the level of uncertainty in the measured value. Also, the uncertainty in a measurement is increased by the variability in the subsurface soil horizons throughout the proposed infiltration site.

      To select the correction factor from Table 3, the ratio of design infiltration rates must be determined for each place an infiltration measurement is taken. The design infiltration rates from Table 2 are used to calculate the ratio. To determine the ratio, the design infiltration rate for the surface textural classification is divided by the design infiltration rate for the least permeable soil horizon. For example, a device with a loamy sand at the surface and a least permeable layer of loam will have a design infiltration rate ratio of about 6.8 and a correction factor of 4.5. The depth of the least permeable soil horizon should be within five feet of the proposed bottom of the device or to the depth of a limiting layer.

5. To determine if infiltration is not required under NR 151.12(5)(c)6.a., a scientifically credible field test method is required unless the least permeable soil horizon five feet below the bottom of infiltration system is one of the following: sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay. The infiltration rate used to claim the exemption shall be the actual field measurement and shall be used without the correction factors found in Table 3.

Step D. Soil and Site Evaluation Report Contents

The site's legal description and all information required in Steps B and C shall be included in the Soil and Site Evaluation Report. These reports shall be completed prior to the *construction plan* submittal.

Table 1: Evaluation Requirements Specific to Proposed Infiltration Devices

Infiltration Device	Tests Required[1]	Minimum Number of Borings/Pits Required	Minimum Drill/Test Depth Required Below the Bottom of the Infiltration System
Irrigation Systems[2]	Pits or borings	NA[2]	5 feet or depth to *limiting layer*, whichever is less.
Rain Garden[2]	Pits or Borings	NA[2]	5 feet or depth to limiting layer, whichever is less.
Infiltration Trenches (≤ 2000 sq feet impervious drainage area)	Pits or borings	1 test/100 linear feet of trench with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer, whichever is less.
Infiltration Trenches (> 2000 sq ft of impervious drainage area)	• Pits or borings • Mounding potential	1 pit required and an additional 1 pit or boring/100 linear feet of trench, and sufficient to determine variability	Pits to 5 feet or depth to limiting layer Borings to 15 feet or depth to limiting layer
Bioretention Systems	• Pits or borings • Mounding potential	1 test/50 linear feet of device with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer
Infiltration Grassed Swales	Pits or borings	1 test/1000 linear feet of swale with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer
Surface *Infiltration Basins*	• Pits or borings • Mounding potential	2 pits required per infiltration area with an additional 1 pit or boring for every 10,000 square feet of infiltration area, and sufficient to determine variability	Pits to 10 feet or depth to limiting layer Borings to 20 feet or depth to limiting layer
Subsurface Dispersal Systems greater than 15 feet in width.	• Pits or borings • Mounding potential	2 pits required per infiltration area with an additional 1 pit or boring for every 10,000 square feet of infiltration area, and sufficient to determine variability	Pits to 10 feet or depth to limiting layer Borings to 20 feet or depth to limiting layer

[1]Continuous soil borings shall be taken using a bucket auger, probe, split-spoon sampler, or shelby tube. Samples shall have a minimum 2-inch diameter. Soil pits must be of adequate size, depth and construction to allow a person to enter and exit the pit and complete a morphological soil profile description.

[2]Information from Step B is adequate to design rain gardens and irrigation systems.

Table 2: Design Infiltration Rates for Soil Textures Receiving Stormwater

Soil Texture[1]	Design Infiltration Rate Without Measurement inches/hour[2]
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam	0.50
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.03
Silty Clay loam	0.04[3]
Sandy clay	0.04
Silty clay	0.07
Clay	0.07

[1]Use sandy loam design infiltration rates for fine sand, loamy fine sand, very fine sand, and loamy fine sand soil textures.

[2] Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.

[3] Infiltration rate is an average based on Rawls, 1982 and Clapp & Hornberger, 1978.

Table 3: Total Correction Factors Divided into Measured Infiltration Rates

Ratio of Design Infiltration Rates[1]	Correction Factor
1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

[1]Ratio is determined by dividing the design infiltration rate (Table 2) for the textural classification at the bottom of the infiltration device by the design infiltration rate (Table 2) for the textural classification of the least permeable soil horizon. The least permeable soil horizon used for the ratio should be within five feet of the bottom of the device or to the depth of the limiting layer.

Required Qualifications

A. Site Evaluations - Individuals completing site evaluations shall be a licensed professional acceptable to the authority having jurisdiction and have experience in soil investigation, interpretation and classification.

B. Soil Evaluations - Individuals completing the soils evaluation shall be a Soil Scientist licensed by the Department of Regulation and Licensing or other licensed professional acceptable to the authority having jurisdiction.

VI. Considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with this practice but are not required to insure its function are as follows:

A. Groundwater monitoring wells, constructed as per chapter NR 141, Wis. Adm. Code, can be used to determine the seasonal *high groundwater level*. Large sites considered for infiltration basins may need to be evaluated for the direction of groundwater flow.

B. Karst Inventory Forms on file with the Wisconsin Geological and Natural History Survey should be filled out if a karst feature is located within the site.

C. Cation Exchange Capacity (CEC) of the soil can indicate the number of available adsorption sites. Sandy soils have limited adsorption capacity and a CEC ranging from 1-10 meq/100g. Clay and organic soils have a CEC greater than 20 and have a high adsorption rate.

D. Soil organic matter and pH can be used to determine adsorption of stormwater contaminants. A pH of 6.5 or greater is optimal. A soil organic content greater than 1 percent will enhance adsorption.

E. NR 151 provides for a maximum area to be dedicated for infiltration depending upon land use. This cap can be voluntarily exceeded.

F. One or more areas within a development site may be selected for infiltration. A development site with many areas suitable for infiltration is a good candidate for a dispersed approach to infiltration. It may be beneficial to contrast regional devices with onsite devices that receive runoff from one lot or a single source area within a lot, such as rooftop or parking lot.

G. Stormwater infiltration devices may fail prematurely if there is:

1. An inaccurate estimation of the Design Infiltration Rate;
2. An inaccurate estimation of the seasonal high water table;
3. Excessive compacting or sediment loading during construction;
4. No pretreatment for post-development and lack of maintenance.

H. No construction erosion should enter the infiltration device. This includes erosion from site grading as well as home building and construction. If possible, rope off areas selected for infiltration during grading and construction. This will preserve the infiltration rate and extend the life of the device.

I. Resources available for completing Step A. Initial screening:

1. Sites listed on the GIS Registry of Closed Remediation sites. http://gomapout.dnr.state.wi.us/org/at/et/geo/gwur/index.htm
2. Sites listed in the Bureau of Remediation and Redevelopment Tracking System. http://dnr.wi.gov/org/aw/rr/brrts/index.htm
3. Flood plain areas as regulated under s. 87.30, Wis. Stats. and NR 116, NR 30 and NR 31, Wis. Adm. Code.
4. Wetlands as defined in Ch. NR 103, Wis. Adm. Code.
5. Endangered species habitat as shown on National Heritage Inventory County maps
6. Access points and road setbacks as determined by county or municipal zoning plans.
7. Existing reports concerning the groundwater and bedrock. Examples include: Publications from USGS, NRCS, Regional Planning Commissions, DNR, DATCP, DOT, UW system or WGNHS.
8. The Drinking Water and Groundwater pages of the DNR http://dnr.wi.gov/org/water/dwg/
9. The Wisconsin Grain Size Database http:\\www.geology.wisc.edu/~qlab/

J. The development site should be checked to determine the potential for archeological sites. This search may be conducted by state staff for projects required or funded by the state.

K. Slopes 20% or greater are inappropriate for some infiltration devices.

L. Expect to complete the preliminary design work (Criteria Step A through Step C) before the approval process (platting). Once required information is compiled, the initial design work for an infiltration device can begin.

M. The approval process requirements for development sites vary across the state and may also vary within a municipality depending on the number of lots being developed. The timing of Steps A, B, and C might have to be adjusted for the type of approval process. The following is an example of when the steps might be completed for a typical development site requiring a plat. The sequence in the example would comply with the criteria for timing of Steps A, B, and C.

Step A should be completed before the preliminary plat and Step B should be completed before the final plat, or CSM is approved. For regional infiltration devices, and for devices constructed on public right-of-ways, public land or jointly owned land, Step C should be completed before the final plat or final CSM approval.

It can be difficult to select the final location and drainage area for an infiltration device before the use of the lot is known. Sometimes it is more desirable to design an infiltration device for an individual lot after the lot is purchased. For this situation Step C would be completed after the final plat is approved. The information for Step C would be collected when the lot is purchased. To give future devices credit towards achieving the infiltration performance standard, the final plat would contain approximate sizing information for each device. Information from Step A and B would be used to determine the approximate sizing information.

N. The inner ring of the Double-Ring Infiltrometer should be at least 12 inches in diameter.

O. Section NR 151.12(5)(c)5., is included in the administrative code as a means to discourage infiltration of runoff from or into the listed areas, due to potential concerns of groundwater contamination. Although it is not illegal to infiltrate storm water in areas with the listed limitations, DNR will not give credit for this infiltration towards meeting the infiltration requirements of ss. NR 151.12(5)(c)1. or NR 151.12(5)(c)2. Runoff that is infiltrated must be in compliance with s. NR 151.12(5)(c)8., which requires minimizing infiltration of pollutants so that groundwater quality standards are maintained.

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VIII. Definitions

Bioretention systems (Table 1): Bioretention is an infiltration device consisting of an excavated area that is back-filled with an engineered soil, covered with a mulch layer and planted with a diversity of woody and herbaceous vegetation. Storm water directed to the device percolates through the mulch and engineered soil, where it is treated by a variety of physical, chemical and biological processes before infiltrating into the native soil.

Construction Plan (V.Step D): A map and/or plan describing the built-out features of an individual lot.

Coarse sand (V.Step B.B.1): Soil material that contains 25% or more very coarse and coarse sand, and <50% any other one grade of sand.

Design infiltration rate (II.3): A velocity, based on soil structure and texture, at which precipitation or runoff enters and moves into or through soil. The design rate is used to size an infiltration device or system. Rates are selected to be minimal rates for the different types of soils. Selection of minimal rates will provide a robust design and maximize the longevity of the device.

Development site (I.1): The entire area planned for development, irrespective of how much of the site is disturbed at any one time or intended land use. It can be one lot or multiple lots.

Double-ring infiltrometer (V.Step C.4.b): A device that directly measures infiltration rates into a soil surface. The double-ring infiltrometer requires a fairly large pit excavated to depth of the proposed infiltration device and preparation of a soil surface representative of the bottom of the infiltration area.

High groundwater level (V.Step A.4): The higher of either the elevation to which the soil is saturated as observed as a free water surface in an unlined hole, or the elevation to which the soil has been seasonally or periodically saturated as indicated by soil color patterns throughout the soil profile.

Highest anticipated groundwater elevation (V.Step C.3): The sum of the calculated mounding effects of the discharge and the seasonal high groundwater level.

Infiltration areas (V): Areas within a development site that are suitable for installation of an infiltration device.

Infiltration basin (Table 1): An open impoundment created either by excavation or embankment with a flat densely vegetated floor. It is situated on permeable soils and temporarily stores and allows a designed runoff volume to infiltrate the soil.

Infiltration device (II.2): A structure or mechanism engineered to facilitate the entry and movement of precipitation or runoff into or through the soil. Examples of infiltration devices include irrigation systems, rain gardens, infiltration trenches, bioretention systems, infiltration grassed swales, infiltration basins, subsurface dispersal systems and infiltration trenches.

Infiltration trench (Table 1): An excavated trench that is usually filled with coarse, granular material in which stormwater runoff is collected for temporary storage and infiltration. Other materials such as metal pipes and plastic domes are used to maintain the integrity of the trench.

Irrigation system (Table 1): A system designed to disperse stored stormwater to lawns or other pervious areas.

Limiting layer (Table 1): A limiting layer can be bedrock, an aquatard, aquaclude or the seasonal high groundwater table.

Percent fines (V. Step B.B): the percentage of a given sample of soil, which passes through a # 200 sieve.

Rain garden (Table 1): A shallow, vegetated depression that captures stormwater runoff and allows it to infiltrate.

Regional device (V.Step A): An infiltration system that receives and stores stormwater runoff from a large area. Infiltration basins are the most commonly used regional infiltration devices.

Redevelopment (V.Step A.6): Areas where new development is replacing older development.

Soil parent material (V.Step A.3): The unconsolidated material, mineral or organic, from which the solum develops.

Subsurface dispersal systems (Table 1): An exfiltration system that is designed to discharge stormwater through piping below the ground surface, but above the seasonal high groundwater table.

APPENDIX N

Resumes

The GRAEF Team

GRAEF staff will provide a fully integrated team that joins together expertise in environmental habitat and management, conservation planning, and sustainable guidelines for development.

Carolyn Esswein, AICP, CNU-A

Ms. Esswein will serve as the Project Manager. She has managed large-scale planning and redevelopment projects that include broad public participation, complex redevelopment issues, and significant environmental opportunities/constraints, and long-term implementation. She is a certified planner with dual masters degrees in urban planning and architecture, as well as a certified urban designer.

Pat Kressin, ASLA, LEED® AP

Mr. Kressin will serve as the Principal-in-Charge for this project. As a senior landscape architect and leader of the retail/residential development group, he has worked on numerous sustainable development projects - from conceptual guidelines through construction. His expertise includes integrating feasible, high-quality design with preservation of critical environmental features and successful public places to create long-term economic value within a community.

John McCarthy, PE, LEED® AP

Mr. McCarthy is a leading hydrologist and stormwater expert who will help ensure effective environmental and engineering concepts intended to preserve critical environmental features, conform to regulations and permitting requirements, and achieve high quality outcomes.

Tina Myers, PWS

Ms. Myers will contribute her extensive technical expertise in multidisciplinary ecological work such as vegetation surveys, rare species surveys, plant community mapping and assessment, wetland determinations and delineations, wildlife surveys, and wildlife habitat evaluations.

Laura A. B. Giese, PhD, PWS, CF, CSE

Dr. Giese will lend more than 20 years of experience in aquatic resources to the project. Her ecology background, in both forestry and wetland, and diverse scientific interests complement her broad experience in wetland deliniation and functional analyses, mitigation monitoring, and vegetation surveys.

Larry Witzling, PhD, AIA, ASLA

Dr. Witzling will lend his economic development and sustainable urban design experience to this project. He has helped conceive, design, and implement numerous successful development projects in Wisconsin that generate value while being sensitive to the context of the site. His expertise includes national award-winning codes and guidelines for redevelopment, planning, and urban design.

Peter Ferretti, GISP

Mr. Ferretti is a highly experienced cartographic designer, proficent in data manipulation and visualization, as well as depolyment of GIS solutions. He will contribute his experience to the effective collection and analysis of data.

Kristi Jacobs, CNU-A

Ms. Jacobs will provide assistance with all GIS data collection and mapping. She will also lend her extensive knowledge of the City of Sheboygan and the Schuchardt Farms property to the project understanding and the development of concepts.

Tim Ehlinger, PhD
Ecological Research Partners

Dr. Ehlinger will work as a subcontractor to GRAEF (a continuing role) with regard to improving and conserving fish habitat, shoreline restoration, and long-term environmental quality. His extensive project experience spans the areas of reestablishment of native fishes, stream restoration, and watershed planning.

Neal T. O'Reilly, PhD, PH
Ecological Research Partners

Dr. O'Reilly will work as a subcontractor to GRAEF (a continuing role). He specializes in hydrology, water quality modeling, watershed management, aquatic ecology restoration, and environmental permitting.

Carolyn J. Esswein, AICP, CNU-A

Project Manager

Carolyn has over 15 years of experience in urban design and planning. She has worked on numerous projects providing expertise in architectural and urban design, growth management, rural planning, design guidelines, and community development. Her work in comprehensive planning has received state and regional awards.

Education:

M.Arch., 1994
University of Wisconsin-Milwaukee, Milwaukee, WI

M.U.P., 1994
University of Wisconsin-Milwaukee, Milwaukee, WI

B.S., Interior Design, 1990
University of Wisconsin-Madison, Madison, WI

Professional Certifications:

American Institute of Certified Planners

Congress for New Urbanism – Accredited

Professional Affiliations:

American Planning Association, APA

Congress for the New Urbanism, CNU

Adjunct Professor, Urban Planning
University of Wisconsin-Milwaukee, Milwaukee, WI

Redevelopment Plans

Carolyn has made major contributions to many redevelopment projects in Milwaukee and other older urban areas. Her projects have included some of the most challenging redevelopment situations based on traffic impacts, housing diversity, and market influences. In each of these projects, her plans have helped spur successful redevelopment efforts:

- Lindsay Heights (Milwaukee)
- Walnut Circle (Milwaukee)
- City Homes (Milwaukee)
- Gateway Revitalization Plan (Sheboygan)
- West Allis Six Points
- Waukesha Main Street
- Midtown Triangle commercial redevelopment (Milwaukee)

Neighborhood / District Plans (Development Planning)

Carolyn's work involves numerous plans for special districts and neighborhoods. These plans often tackle the most complex and difficult issues surrounding residential and commercial growth and development balanced with environmental protection. They balance investment with environmental preservation, and provide guidance for public and private development initiatives. Some of the more notable plans for which she served as project manager:

- Franklin Crossroads Plan
- New Berlin City Center
- Sheboygan Schuchardt Farms Analysis and Development (ongoing)
- Fond du Lac and North Comprehensive Neighborhood Plan, Milwaukee
- Northwest Side Area Plan, Milwaukee
- Village of Fontana's Downtown Redevelopment Plan including mixed-use and residential developments, lakefront redevelopment, and a redesign of State Highway 167.

Carolyn J. Esswein, AICP, CNU-A

Project Manager

Municipal Planning

Carolyn has assisted communities plan for the future, create long-term visions, and implement those concepts. Her clients include towns, villages, and cities throughout Wisconsin with planning efforts ranging from on-going planning services, redevelopment plans, to managing site specific projects for special districts. The following is a variety of the clients and project types:

- Village of Fontana – On-going planning review and assistance for the CDA
- City of New Berlin – Plan implementation
- Town of Delavan – Plan update and on-going planning assistance

PARK PLANNING

As part of many community planning efforts, the park and recreation system is an integral part of the decision making and planning decisions. Carolyn has prepared a variety of park plans, open space plans, and park master plans with an emphasis on adding value, serving the needs of the residents, and responding to available budgets. Some of the park plans include:

- City of New Berlin – Outdoor Park and Recreation Plan, updated trail system as part of the Comprehensive Plan
- Village of Fontana – Porter Court park plaza, Mill Street Park, and Little Foot Tot Lot
- City of Milwaukee – Various park and open space plans for neighborhood catalytic projects
- City of Milwaukee – Riverside Park updated plan and fundraising opportunities
- Town of Erin – Town Hall Park and Trail System

Codes and Ordinances

Carolyn has helped develop and revise numerous municipal codes and ordinances. These have included:

- New Berlin – Design guidelines for the Commercial Center Development
- Town of West Bend – Zoning code and conservation design recommendations
- Town of Lowell – Zoning code recommendations
- City of Milwaukee – Redevelopment Guidelines

Public Participation

Carolyn gathers public input through various techniques including public workshops, charrettes, web-based surveys, design preference surveys, focus groups, and stakeholder interviews. Recent examples include:

- The public participation process for the New Berlin Comprehensive Plan in which Carolyn conducted 10 neighborhood input sessions, stakeholder interviews, SWOT Analysis with regional leaders, more than 10 neighborhood review meetings, 13 interactive steering committee meetings, project website with email interaction, two open houses, and one public hearing.
- Public participation in the Village of Fontana in Walworth County using a different approach to public participation, with an emphasis on committee meetings for a variety of project types. Carolyn has been working with the Village since 2002 with all committee meetings being public, including a project presentation and discussion about plan development and design direction. Throughout the years there have been selected Saturday public workshops to provide an extended opportunity to interact and gather feedback.

Patrick J. Kressin, ASLA, LEED® AP

Principal-in-Charge
Principal

Pat combines his experience and design expertise with knowledge of social, natural, and behavioral sciences to create functional, aesthetically pleasing and unique master plans to meet project budgets and accentuate the building architecture. His design expertise includes developing large-scale spatial plans and designs that integrate active and passive functions within the natural landscape while using the existing landscape as an amenity. He has significant knowledge and experience with the creation of large landmarks and sustainable developments.

Professional Registration:

Registered Landscape Architect – WI, IL, MI, AZ, VA

Education:

B.S., Landscape Architecture, 1995
University of Wisconsin-Madison, Madison, WI

Professional Certifications:

LEED® Accredited Professional

CLARB Certified – National

Professional Affiliations:

American Society of Landscape Architects, ASLA

U.S. Green Building Council, USGBC

Wisconsin Green Building Alliance, WGBA

International Council of Shopping Centers, ICSC

Western Golf Association, WGA – Par Club

United States Golf Association, USGA

National Golf Foundation, NGF

Urban Land Institute, ULI

Commercial Association of Realtors

Hoffman Corporation Sustainable Office Park, Appleton, WI – Project Landscape Architect: Responsible for site programming, natural resource inventory, site development analysis, and site development master planning for a 30-acre commercial office park that focuses on green architecture and determined sustainable site design objectives. A linked greenway system, termed the "path of discovery," transverses restored forests, prairies, and wetlands, and includes interpretive signage along the passive trail, was one of the major design elements.

West Bend Mutual Insurance, West Bend, WI – Project Landscape Architect: Responsible for master planning and landscape architecture for the development of a major building addition in a rural setting. Highlights of the design include substantial berming that resembles the adjacent kettle moraine, 2-miles of pathways, entry plazas, brick parking areas, courtyards and a major outdoor event space adjacent to a decorative pond and a series of waterfalls.

The Congregation of the Sisters of St. Agnes, Sustainable Master Plan, Fond du Lac, WI – Project Manager and Project Landscape Architect: Responsible for programming, natural resource inventory, site development analysis, and site development master planning of a 300 acre, sustainable, park/campus for the Sisters of St. Agnes. The master plan focused on protecting and improving the experience, and existing natural resources, within the sister's land. Major design elements include restored prairies and forests, creation of wetlands and ponds, and passive pedestrian trails that transverse the entire parcel. All of the proposed elements are designed to be environmentally sensitive, recyclable, and native or organic in nature.

The Legend at Brandybrook Golf Club and Community, Wales, WI – Project Manager, Project Golf Course Architect and Project Landscape Architect: Responsible for programming, site development master planning, site design, golf course design and construction drawings for an environmentally sensitive 18-hole golf course, 225 single-family lot residential community and a 75-unit condominium development, located on 750 acres in the Southern Kettle Moraine. The overall design includes passive, natural, trails that link the golf course and residential areas with the Glacial Drumlin Trail. The country club also included the development of a pool and tennis facility designed to promote family interaction. The pool includes a large zero-depth area, slides, jets, hydro-massage center, and training/lap area.

University of Wisconsin-River Falls, River Falls, WI – Project Landscape Architect: This project was for the new campus student center that is designed to receive a Silver LEED rating. The project involves providing site development programming, master planning, design development, and construction documents for the overall project. The site development associated with this development includes the creation of campus mall that will serve as the heart of the camps and several outdoor terraces to provide more intimate levels of interaction. Additionally the project site is located adjacent to the Kinnickinnic River, a Class 1 cold-water trout stream, which is extremely sensitive to adjacent development. A series of natural and native vegetative buffers and stormwater infiltration and detention systems will be developed throughout the site and through the adjacent roadways and parking areas to eliminate the negative effects of warm stormwater runoff entering the sensitive stream. The project is in the design development phase of design.

West Bend Conservation Community, West Bend, WI – Project Manager and Project Landscape Architect: Responsible for programming, site development master planning, and conceptual site design for a residential community. The 75-acre development includes 150 single-family residential lots located to minimize environmental impacts while internally and externally linking the entire community via a greenway network.

Rolling Ridge Subdivision Development, Pewaukee, WI – Project Landscape Architect: This project was for a site development master plan of a residential community to include 150, 2 – acre lots and a large wetland preservation area. The design eliminated the need for curbs, gutters, and a storm sewer system while providing a passive, environmentally sensitive, community trail system that transverses the preserved wetland and sensitive residential development.

Plexus World Headquarters, Neenah, WI – Project Landscape Architect: Provided landscape architecture design with sustainable principals for a new 104,000 square feet global headquarters. The headquarters is located on the site of the former 7.6-acre Glatfelter paper mill property downtown Neenah.

S.C. Johnson Wax – Building #69, Racine, WI – Project Landscape Architect: Responsible for site programming, site development master planning, and construction documents for a research and development facility, located in an environmentally sensitive setting. The project included protecting existing sensitive elements and restoring several forested areas and a tall grass prairie.

Northcentral Technical College, Health Science Center, Wausau, WI – Project Landscape Architect: Provided LEED certification feasibility assessment, project review, sustainable guidelines, project design review, and ongoing LEED point verification and documentation for a new Health Sciences Center. The project has received a Certified LEED rating.

Menominee Eagle Casino, Kenosha, WI - Project Manager and Project Landscape Architect: This project was for a full Environmental Impact Study evaluating the impacts of a gaming and entertainment facility to the local area. GRAEF provided site analysis, master planning, preliminary design and engineering design services for the redevelopment of Dairyland Greyhound Park into a destination mixed-use regional gaming and entertainment facility.

John T. McCarthy, P.E., LEED® AP

Senior Civil Engineer
Principal

John has 34 years of experience on projects at GRAEF. As a Principal of the firm and the Site Development Team Leader, he provides leadership on many of the firm's site development projects. In addition to his expertise in site development, John has a great deal of experience in stormwater management, sanitary sewer design, and preparation of permit applications for a variety of projects.

Professional Registration:

Professional Engineer – WI, IL, VA

Education:

B.S., Civil Engineering, 1974
Marquette University, Milwaukee, WI

Professional Certifications:

LEED® Accredited Professional

Professional Affiliations:

American Society of Civil Engineers, ASCE

Wisconsin Association of Floodplain, Stormwater, and Coastal Managers, WAFSCM

Publications:

Stormwater Quality Enhancement Associated with Widening of the Tri-State Tollway

Proceedings of the Association of State Floodplain Managers Annual Conference, 1998

Awards:

2008 Volunteer of the Year, Wisconsin DNR, State Parks

2008 Engineer of the Year, Wisconsin Builder Magazine

2006 Engineering in Consulting Practice, ASCE, Wisconsin Section

Romeoville Nature Preserve, Will County, IL – Project Engineer: Directed an analysis of the hydrology impacting the Romeoville Nature Preserve, to facilitate preservation of high quality wetland areas and restoration of degraded sites. Prepared hydrological model, using TR-20 methodology, for the area tributary to the Preserve; developed and evaluated alternatives for remediation; and prepared construction plans for the work.

Lockport Prairie Nature Preserve, Will County, IL – Project Engineer: Directed hydrological studies associated with remediation investigation for Lockport Prairie Nature Preserve. The goal of the overall project is to restore the ecological function of the nature preserve to a more natural state by managing the hydrology of the site. John directed the surface water flow monitoring and the hydrological modeling effort, and prepared the reports describing these efforts.

UWM Innovation Park – Master Planning and Rezoning, Wauwatosa, WI – Project Manager: Developed and evaluated alternative site plans for a proposed $250 million academic campus on an 88-acre site within the Milwaukee County Grounds. Assisted with rezoning and site plan approval process through the City of Wauwatosa. Managed preparation of the overall site survey and certified survey map required to divide the overall property into parcels. Prepared information on infrastructure design and costs for inclusion in an EDA Grant Application. The site plan and rezoning process involved many challenges, including accommodations for monarch butterfly migration through creation of a special habitat zone, investigation of the potential for historical burial sites, and conceptual design of a bio-infiltration system for on-site stormwater management. (2009-0184.01)

University of Wisconsin-Milwaukee Master Plan, Milwaukee, WI – Project Manager: Provided master planning services as part of a national team of architects and planners for the UWM campus. John's work focused on site infrastructure, including sanitary sewer and water service, stormwater management issues, and sustainability. The planning process involved a thorough review of existing conditions at the Kenwood campus and the four existing satellite facilities; and an evaluation of infrastructure needs for future sites and facilities identified in the master planning process.

Pebble Creek Marketplace, Waukesha, WI – Project Manager: Conceptual stormwater management planning for a 76-acre site in the City of Waukesha. The site, which contains 24 acres of wetland adjacent to the Fox River, south of STH 59, involved mixed commercial and residential land uses. The site also included substantial conservancy areas and a park dedication to the City of Waukesha. The plan included the identification of three stormwater management ponds, sized to meet Waukesha County's stormwater requirements for each drainage area.

Wingspread Guest House, Racine, WI – Project Manager: Addition of a new guesthouse to this Frank Lloyd Wright designed facility. Site development work included grading, utilities, and paving. The project incorporates sustainable design concepts, and the site was designed around existing landscape features. Stormwater management used overland flow and preserving of existing drainage patterns to address stormwater quality issues.

Kerry Americas, Beloit, WI – Project Manager: Site design and permitting for an 80 million dollar research, testing, and corporate center on a 125-acre site in the City of Beloit for Kerry Americas. The project included extension of public water and sewer service to the site, and obtaining DNR and Corps permits to relocate a navigable stream that ran through the site. An Environmental Assessment was prepared as part of the permitting process, which also included approval by DNR and FEMA for modifications to the 100-year floodplain, and development of a Letter of Map Revision (LOMR). John prepared the Sustainable Sites credit information for the project, which was submitted for a LEED Silver Certification.

The Legend at Brandybrook Golf Club and Community, Wales, WI – Project Engineer: Analysis and design of comprehensive stormwater management system and chapter 30 permit for 480-acre golf course and subdivision, including multiple retention ponds, stormwater quantity control and quality enhancement, hydrological analysis, flood plain determination, erosion control plans, wetland protection, and floodplain delineation.

SC Johnson, Racine, WI – Project Manager: Site work and utilities for numerous projects over a 12-year period, including building 61 on the Waxdale Campus, the Johnson Worldwide building, north of Waxdale, and the new Waxdale entrance area. The Johnson Worldwide site included a major water feature that functions as a stormwater quality enhancement and flood control facility as well as a major aesthetic and recreational feature. Design included overall site grading, utility services, parking and roadways, and a path system around the ponds. Also included was a comprehensive stormwater management plan for the 140-acre site in the Town of Mount Pleasant, including analysis of impacts from a 500 acre area upstream. The complex plan includes development of regional stormwater management facilities to mitigate impacts of development on the Pike River in Racine County.

Johnson Controls Stormwater BMP's, Glendale, WI – Project Manager: Design of a stormwater re-use facility, and rehabilitation of a reflecting pool for a Platinum LEED rating. Project was associated with remodeling of Johnson Controls facility in the Village of Glendale with a focus on rehabilitating the reflecting pool and fountain system that surrounded the building. Designed a system for intercepting stormwater in a cistern before discharge to the pool, and then using this waste for irrigation of the site landscaping. The design required a complex hydraulic balance with the water levels in the pool, the new filtration system for the pool, and the adjacent creek, which used to back up into the pool, nearly flooding the building.

John T. McCarthy, P.E., LEED® AP

Senior Civil Engineer
Principal

MMSD Headquarters Parking Lot BMPs, Milwaukee, WI – Project Manager: Analysis and design of Best Management Practices (BMPs) for stormwater quality enhancement for the MMSD Headquarters parking lot and site. Involved an analysis of alternative measures to capture and treat stormwater pollutants, and preparation of construction documents for the project, including resurfacing and reconstruction of significant portions of the parking lot and access drives. BMP's included a constructed wetland for stormwater storage and treatment, pervious pavement, catchbasin filtration systems, and a stormwater treatment device.

Milwaukee Art Museum, Milwaukee, WI – Project Manager: Complete site utilities, paving, and grading for this $100 million dollar addition along Milwaukee's lakefront. Included design of a storm sewer system below normal lake level, new water mains to serve the museum and the adjacent parklands, extension of the sanitary sewer system, a stormwater lift station to protect the restaurant on the lake side, a new parking lot north of the museum, and site paving and grading for the Kiley Gardens, at the museum entrance.

Briggs & Stratton Corporation, Statesboro, GA – Project Manager: Stormwater management and erosion control plan for 50 acre industrial site, including design of two stormwater detention basins, and protection of adjacent wetlands from siltation.

Improvements to Detension Basin No. 1 at the Milwaukee County Grounds, Milwaukee County Regional Medical Center, Wauwatosa, WI – Project Manager: Conducted the hydraulic analysis, developed plans, and managed the construction of a 12-acre-foot storm water detention basin expansion. The expanded detention basin, which serves the Milwaukee Regional Medical Center (MRMC), was expanded by excavated new basin area. Challenges included coordinating MRMC, Milwaukee, and MMSD interests on the project, avoiding imparts to Butler Garter Snake Habitat, and reconstructing a culvert on the basin outflow, relieving access by crossing an active railroad track.

Village of Round Lake, Illinois – Project Engineer: Review and approval of Watershed Development Permit applications associated with development within the Village. This activity involved detailed review of hydrological and hydraulic computations, detention basin designs, grading plans, and erosion control plans for compliance with the Village's Unified Watershed Development Ordinance, in accordance with the criteria established by the Lake County Stormwater Management Commission.

Wetland Enhancement Pond, Burlington, WI – Project Manager: Preparation of Section 30 and Chapter 404 permits for a wetland enhancement pond along the Fox River. Project included design of provisions for wetland enhancement and stormwater quality control, along with detailed hydrological and hydraulic computations.

Tri-State Tollway, Illinois State Toll Highway Authority, Deerfield, IL – Project Manager: Preparation of permits and supporting materials for three mile roadway project on the Illinois tollway system, including watershed development permit, IDOT/IDNR flood plain permitting, and mitigation of impacts to wetlands and endangered species.

Tri State Tollway, Illinois State Toll Highway Authority, IL – Project Manager: Provided stormwater management services for three mile tollway project in northern Illinois, including hydraulic and hydrology modeling, design of storm sewer system, erosion control, stormwater quality enhancement, floodplain management, and grading and utility plans.

Tina M. Myers, P.W.S.
Professional Wetland Scientist/Ecologist

Tina's contribution to natural resources projects at GRAEF includes over nine years of extensive experience in multidisciplinary ecological work such as vegetation surveys, rare species surveys, plant community mapping and assessment, wetland determinations and delineations, preparation of wetland mitigation plans, wetland mitigation maintenance and site monitoring, wetland functional assessments, environmental corridor mapping, preparation of Natural Resource Protection Plans, preparation of wetland and waterway permit applications, upland habitat restoration, wildlife surveys, and wildlife habitat evaluations.

Education:

B.S., Biological Aspects of Conservation
University of Wisconsin-Milwaukee, Milwaukee, WI

Professional Certifications:

Professional Wetland Scientist, #1444, Society of Wetland Scientists

Kane County, IL Qualified Wetland Review Specialist #W-058, Kane County Stormwater Management Commission

Lake County, IL Certified Wetland Specialist #C-132

Professional Affiliations:

Wisconsin Wetlands Association

Society of Wetland Scientists

Society of Ecological Restoration

Openlands Land Preservation, Dan McMahon Woods Forest Preserve: Plant Community Mapping and Community Restoration, Cook County IL - Lead Ecologist: Performed a plant community inventory and baseline mapping of existing plant communities within a defined project area of the Preserve. Used the "Chicago Wilderness Terrestrial Community Classification System" (CWTCCS) to classify plant communities found within the Preserve and used the Floristic Quality Assessment (FQA - Wilhelm & Masters) for the Chicago Region to evaluate the quality of the plant communities. Also provided and documented verification of previously mapped soils. GPS technology was the primary tools used to map and characterize plant communities and soils to be incorporated into Geographic Information Systems (GIS) mapping.

The plant community and soil mapping is part of a multiphase project that is expected to continue throughout a ten year period. The purpose of the existing plant community mapping/ inventory and soils verification was to provide baseline information about the current conditions of existing plant communities that would help further guide the restoration process of the Preserve particularly within a rare fen community where habitat for the Federally listed Hine's emerald dragonfly is known to exist.

Openlands Land Preservation, Deer Grove Forest Preserve: Wetland Delineation and Plant Community Restoration, Palatine, IL - Lead Wetland Scientist: As one of the lead Wetland Scientists of a large wetland team, determined the extent of existing wetlands and identified opportunities for restoration and enhancements to wetland and upland plant communities within 628 acres of the Deer Grove Forest Preserve. During the first phase of work, used methods outlined in the 1987 Corps of Engineers Wetlands Delineation Manual for routine delineations which were used to evaluate the presence of existing wetlands and to locate their boundaries. Collected field data which included existing plant community delineation and characterization, as well as site specific soils and hydrologic data. GPS technology was the primary tool used during the fieldwork to map existing wetland boundary data, plant community data, soils data, and hydrological data. Floristic Quality Assessment (FQA - Wilhelm & Masters) for the Chicago Region was used to evaluate plant communities. The next phases of this project will include plant community restoration planning and implementation.

Columbia St. Mary's Hospital: Wetland Investigation, Permitting, and Mitigation Maintenance and Site Monitoring, City of Mequon, Ozaukee County, WI - Lead Wetland Scientist: Delineated and assessed functional values, prepared a report and obtained concurrences from the Corps and the WDNR. Prepared Section 404/401 and Chapter 30 Permits for activities associated with the expansion of the hospital. Conducted post-mitigation vegetative monitoring using qualitative and quantitative methods for evaluating restoration success. Compiled comprehensive plant species lists, documenting the presence of vertebrate wildlife, and recommending management activities to meet mitigation performance standards. Performed wetland mitigation maintenance through selective cutting and herbicide application.

Waukesha Bypass Ecological Investigation, City of Waukesha, Waukesha County, WI - Lead Wetland Ecologist: Conducted an ecological investigation within a proposed transportation corridor that extended from approximately the intersection of I-94 and Hwy TT to the intersection of CTH X (Genesee Road) and STH 59. The purposes of this investigation was to document existing natural resources, and assess their extent and need for further study during the alternatives analysis phase of the project and for other future phases of the project. As part of the ecological investigation, Tina identified and provided a preliminary boundary (via GPS) of jurisdictional wetlands to verify the accuracy of the WDNR's mapped wetlands on the Wisconsin Wetland Inventory. A total of twenty-one wetlands were mapped within the corridor. Additionally, she performed a vegetation meander survey within each wetland and adjacent upland, including a rare plant species survey, and calculated the Floristic Quality Index (FQI) of each plant community using the Wisconsin Floristic Quality Assessment (WFQA) method. Further, she compiled a plant community mapping within the most critical areas within the corridor that are adjacent to Pebble Creek and presented this information to some of the stakeholders of this project.

WE Energies Port Washington Gas Lateral Pipeline: Wetland Delineation and Assessment, Ozaukee & Washington Counties, WI - Lead Wetland Scientist: Performed wetland and natural areas investigations within 100 feet of a proposed, 16.5-mile, lateral pipeline corridor easement from the Village of Jackson in Washington County to the City of Port Washington in Ozaukee County. Identified and delineated wetlands and other jurisdictional waters using methods outlined in the 1987 Corps of Engineers Wetlands Delineation Manual (Corps Manual) and subsequently located wetland boundaries using a GPS. Data collected from field investigations were described in reports and sent to the United States Army Corps of Engineers (Corps) and Wisconsin Department of Natural Resources (WDNR) for concurrence. Assessed functional values of wetlands using the WDNR's Rapid Assessment Methodology for Evaluating Wetland Functional Values (RAM – WDNR, 1994). Also assisted with the preparation of wetland mitigation plans.

Moss American Superfund Site along the Little Menomonee River: Wetland Investigation and Mitigation Monitoring, Milwaukee County, WI: - Lead Wetland Scientist: Conducted a wetland investigation along the Little Menomonee River prior to the realignment of the river due to mitigation of a contaminated portion of the river. Following the cleanup of contaminants, conducted post-mitigation vegetative monitoring in areas that had been seeded. Used qualitative and quantitative methods for evaluating restoration success. Compiled comprehensive plant species lists, documenting the presence of vertebrate wildlife, and recommending management activities to meet mitigation performance standards.

Laura A. B. Giese, Ph.D., PWS, CF, CSE

Restoration Ecologist

Dr. Giese has more than 20 years of experience working in aquatic resources: research, private consulting, and teaching. Dr. Giese's experience includes wetland delineation and functional analyses, stream assessment and restoration, mitigation monitoring, threatened and endangered species surveys, vegetation surveys, and macroinvertebrate sampling. Her ecology background (forestry and wetland) and diverse scientific interests complement the consulting profession. She has authored numerous wetland and forestry technical reports and analysis of impacts to natural resources.

Education:

Ph.D., Forest Biology/Ecology, 2001
Virginia Polytechnic Institute & State University, Blacksburg, VA

M.S., Urban Forestry/Ecology, 1988
University of Illinois-Champaign, Urbana, Illinois

B.S., Forest Biology, 1984
Colorado State University, Fort Collins, CO

Professional Certifications:

Society of Wetland Scientists: PWS #1363

Professional Wetland Delineator #3402 000012

Registered Professional Forester: Maryland #364

Certified Forester: Society of American Foresters #801

Ecological Society of America: Certified Senior Ecologist

U.S. Fish and Wildlife Service, Registered Small Whorled Pogonia, Harperella and Swamp Pink Surveyor

North American Benthological Society, Certified Taxonomist – Family Level

Professional Affiliations:

Society of Wetland Scientists, SWS

Society of American Foresters, SAF

Ecological Society of America, ESA

International Society of Arboriculture, ISA

The Northern Virginia Stream Restoration Bank, Reston, VA – Principal Environmental Scientist: With another firm reviewed pre- and post-construction biological condition assessment reports for urban streams and coordination of riparian buffer monitoring for a 14 mile stream restoration project in Reston, Virginia. Assessed the effect of stream restoration on the macro-benthic invertebrate community and stream condition utilizing guidance established in the "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers," and calculating the Virginia Stream Condition Index (VA-SCI) following the guidance established in "A Stream Condition Index for Virginia Non-Coastal Streams."

Evergreen Rural Village, Loudoun County, VA – Principal Environmental Scientist: With another firm delineated forest stands on a 200+ acre residential development in Loudoun County, Virginia. Delineated forest stand boundaries based on species composition and Society of American Foresters cover types.

Waukesha Bypass Ecological Investigation, City of Waukesha, Waukesha County, WI – Restoration Ecologist: Conducted an ecological investigation within a proposed transportation corridor that extended from approximately the intersection of I-94 and Hwy TT to the intersection of CTH X (Genesee Road) and STH 59. The purpose of this investigation was to document existing natural resources, and assess their extent and need for further study during the alternatives analysis phase of the project. As part of the ecological investigation, Laura Giese conducted wetland functional assessments using the Wisconsin Department of Natural Resources (WDNR) Rapid Assessment Methodology (RAM) for Evaluating Wetland Functional Values on twenty-one separate wetlands/wetland complexes; identified high-quality upland habitat; assessed habitat suitability for endangered and threatened species including plants, natural areas, herptefauna, fish and mussels; and identified potential areas for wetland mitigation within and adjacent to the corridor. Further she assisted with plant species survey to determine the Floristic Quality Index

(FQI) using the Wisconsin Floristic Quality Assessment (WFQA) method; and field verification of WDNR wetlands mapped on the Wisconsin Wetland Inventory.

King William Reservoir, City of Newport News, VA – Principal Environmental Scientist: With another firm conducted natural resource studies for waters of the U.S (WOUS) mitigation feasibility for several 100+ acre sites in Caroline and King George Counties, VA. Natural resource studies included waters of the U.S. delineation, U.S. Army Corps of Engineers jurisdictional determination, NRCS wetland determination for agricultural lands (using historic aerial photographs, precipitation data, and field observations; intermittent/perennial stream flow regime determination), survey for federally-threatened species, soil sampling for sulfide hazards and organic matter content, and conceptual wetland restoration/creation design.

Fort A.P. Hill Military Base, Caroline County, VA – Principal Environmental Scientist: With another firm surveyed endangered and threatened species in a 100+ acre section of Fort A.P. Hill military base in Caroline County, Virginia. Conducted surveys for the federally-threatened species swamp pink (Helonias bullata) and small whorled pogonia (Isotria medeoloides). Documented several new small whorled pogonia colonies and individual occurrences.

Fort Belvoir Base Realignment Closure (BRAC), Fort Belvoir Engineer Proving Ground, Fairfax County, VA – Principal Environmental Scientist: With another firm delineated waters of the U.S. (WOUS) and surveyed the federally-threatened small whorled pogonia (Isotria medeoloides) on a 100+ acre military base realignment site in Fairfax County, Virginia. Due to past land use, the landscape was substantially disturbed, resulting in the delineation of many atypical and problem area emergent and forested wetlands. There was a potential for unexploded ordnances challenged hydric soil determination.

Route 7100 Fairfax County Parkway Extension through Fort Belvoir Engineer Proving Grounds, Fairfax County, VA – Principal Environmental Scientist: With another firm surveyed endangered and threatened species for a 1.5 mile roadway alignment in Fairfax County, Virginia. The survey included the federally-threatened small whorled pogonia (Isotria medeoloides). Found first and only recorded small whorled pogonia individual in Fairfax County, VA.

North Fork Wetland Mitigation Bank, Bull Run Wetland Mitigation Bank, Loudoun County Wetland and Stream Mitigation Bank, and Cedar Run Wetland Mitigation Bank, Northern Virginia – Principal Environmental Scientist: With another firm monitored annual wetland mitigation for several wetland mitigation banks in Northern Virginia (North Fork: 125 acres, Bull Run: 50 acres, Loudoun County: 100+ acres [3 separate tracts of land] and Cedar Run: 715 acres [9 separate tracts of land]). Coordinated and Reviewed hydrology and vegetation monitoring. Authored mitigation monitoring annual reports and submit to federal and state regulatory agencies.

Piedmont Wetland Research Program, Sponsored by the Peterson Family Foundation, Fairfax County, VA – Principal Environmental Scientist: With another firm initiated and managed the Piedmont Wetland Research Program. Through Research Grants awarded to Virginia colleges and universities, the PWRP's mission is to improve wetland creation and restoration in the Virginia Piedmont Region. Interaction and data sharing between the different research projects enhanced the potential applicability of their research findings.

Lawrence Witzling, Ph.D., AIA, ASLA

Senior Planner
Principal

Dr. Witzling has over 35 years experience in urban design, land use planning and architecture. His design work has won national awards for urban design from Progressive Architecture, the American Institute of Architects, and the Congress for the New Urbanism.

Prior to GRAEF, Dr. Witzling was President of Planning & Design Institute, Inc. (PDI), a firm he founded in 1988.

Education:

Ph.D., City and Regional Planning, 1976
Cornell University, Ithaca, NY

Bachelor of Architecture, 1967
Cooper Union, Manhattan, NY

Professional Affiliations:

American Institute of Architects, AIA

American Society of Landscape Architects, ASLA

American Society of Landscape Architects, ASLA – Wisconsin Chapter

American Planning Association, APA

American Planning Association, APA – Wisconsin Chapter

Congress for the New Urbanism, CNU

Planning for Sustainable Communities

Dr. Witzling has been involved in issues regarding sustainability for more than a decade. He has worked on neighborhood sustainability issues in Racine, Kenosha, and Milwaukee. He was a featured speaker at a tri-state regional conference on sustainable housing design held at Wingspread (part of the Johnson Foundation Conference Center in Racine, WI). In addition he has taught continuing education classes on sustainable development. His work includes:

- Three national design competitions addressing issues of sustainable architecture (Pittsburgh Convention Center, Chicago Public Schools, and a concept competition for sustainable communities sponsored by the AIA's Committee On The Environment).
- A region-wide design and planning charrette for the Menomonee Valley that resulted in a publication describing the valley's future and how it can be developed in a sustainable manner.
- Coordination of two expert panels on environmental quality issues, bringing together national and international experts to lead the Johnson Controls green building initiative in health, comfort, and productivity.

Environmental Planning and Design

Dr. Witzling has designed and helped implement numerous conservation projects that preserve large agricultural areas. He has also developed numerous land use plans, which have dramatically increased the number of square miles of guaranteed open space in Wisconsin. He has worked on neighborhood conservation issues in Racine, Kenosha, and Milwaukee. He has taught continuing education classes on sustainable development. Some of his projects in this area include:

- Park plans for Kenosha's lakefront
- Master plan for the Milwaukee County lakefront
- Conservation plans in Grafton, Mequon, Germantown, and Sun Prairie
- Agricultural preservation strategies for the Town of Windsor

Lawrence Witzling, Ph.D., AIA, ASLA

Senior Planner
Principal

Urban Design and Development

Dr. Witzling has been involved in urban design and development project for over three decades, garnering several national awards for his work from Progressive Architecture, the Congress for the New Urbanism and the American Institute of Architects. These projects range from downtown and district plans to the design of unique public places. His work is characterized by respect for the local context and a concern for blending traditional and time-tested concepts with innovative approaches matching today's needs. His work includes both public and private sector projects including conservation subdivisions, district and neighborhood plans, mixed-use development, pattern books, form-based and hybrid codes, regulating plans, and entitlement procedures. His expertise includes developing initial concepts as well as assisting throughout the implementation process. Dr. Witzling's completed planning efforts include:

- Plans for Milwaukee's lakefront
- Kenosha's Downtown Plan
- West Bend Riverfront Development
- Milwaukee's Park East Development
- Downtown West Bend Riverfront
- Stevens Point Downtown and Riverfront
- New Berlin's City Center
- West Allis Redevelopment
- Numerous urban design competitions
- Sun Prairie's West Prairie Village
- Conservation developments in rural areas
- Madison's Old University Avenue Redevelopment

Economic Development

Dr. Witzling has worked on economic development issues throughout Wisconsin. This work has included preparing analyses of TIF districts, generating concepts for new property development, estimating the value and benefit of area-wide build outs, meeting with developers to promote new projects, negotiating project outcomes, conducting cost-revenue analyses and conducting cost of service analyses. Dr. Witzling's work also emphasizes private development projects that are feasible and can be readily implemented by owners and municipalities. Among others, these projects have included:

- TIF analysis in the Village of Twin Lakes
- Cost-revenue analysis for freeway interchange development in Caledonia
- Cost of service analysis for the Town of Mukwonago conservation developments
- Freeway project development in the City of Sun Prairie
- Downtown redevelopment for the City of Milwaukee
- Riverfront redevelopment in the City of Milwaukee
- Rivershores Development in West Bend
- Downtown Waukesha

Public Participation

Dr. Witzling has conducted a broad variety of public participation efforts for over 30 years beginning with his published analysis of presentation techniques for maximizing public understanding and participation in neighborhood planning. He has pioneered methods for the use of:

- Physical models
- Visual preference techniques
- Graphic visualization methods
- Charrettes and workshops
- Survey design (from testing through implementation)
- Use of on-line surveys
- Stakeholder interviews
- Focus groups

His participation work ranges from small residential streets to large scale planning efforts for metropolitan areas. The subject of his participatory plans include:

- Comprehensive plans
- Neighborhood and district plans
- Downtowns and main streets
- Tax incremental financing (TIF) plans
- Industrial development
- Design guidelines
- Environmental improvements

Peter C. Ferretti, GISP

GIS Specialist

Peter Ferretti has nine years of experience as a GIS Professional overseeing operations, managing data, performing analysis, developing custom applications, and mapping for the end user. He is a highly experienced cartographic designer, proficent in data manipulation and visualization, as well as depolyment of GIS solutions. In addition to desktop GIS, Peter is proficent in web based technologies including ArcServer, ArcIMS, Flash, and Google APIs.

Professional Registration:

Geographic Information Systems Certificate Institutue (GISCI)

Education:

Diploma in Web Design / Web Develoment, 2009
The Art Instute of Pittsburgh

B.S. Geograhy; Minor in Computer End User Technologies, December 2002
University of Wisconsin-Whitewater

Certificate in Geographic Information Systems, July 2004
Pennsylvania State University

Professional Affiliations:

Wisconsin Land Information Assoication (WLIA)

Geospatial Information & Technology Association (GITA)

50 State GIS Initiative
- Elected committee member

Illinois GIS Association (ILGISA)

Technical Proficencies

Mr. Ferretti has technical experience using a wide range of GIS software and hardware. Utilizing the industry's standard ESRI Suite, he is capable of using advanced geo-processing techniques to analyze and visualize data. When in the field, Mr. Ferretti has extensive experience using Trimble GPS hardware and associated tools to locate, measure and record most any geographic feature.

Software Knowledge:

- ESRI ArcInfo 9 & 10, ArcExplorer, ArcReader
- ArcInfo Extensions including: PLTS, Network Analyst, Tracking Analyst, 3D Analyst and Spatial Analyst
- ArcGISServer & ArcIMS
- TerraSync & Pathfinder Office
- AutoCAD
- Sketchup
- Flex, Flash, Google API, Javascript, Perl, MySQL, SQL, PHP, HTML, ArcObjects, Visual Basic

Hardware Familiarity:

- Trimble GeoExplorer 6000, R8, XH, XT and Yuma GPS units
- RoadVista Retroreflectometer
- TruePulse 360 Laser Rangefinder
- TrimPix geotagging imagery

Data Analysis and Visualization

Mr. Ferretti leads GRAEF's team in data analysis and visualization. Through the integration of hardware, software, and data, he is able to capture and manage a wide range of geographically referenced information. He then analyzes and interprets the collected data, helping others to understand relationships, patterns, and trends. Through this process, Mr. Ferretti answers questions and solves problems by compiling at data that is quickly understood and easily shared.
In a recent analysis for the City of Waukesha, Mr. Ferretti combined topography, soil composition and land use patterns to develop runoff curve numbers. Visualizing the results helped the City understand potential storm water concerns.

Peter C. Ferretti, GISP

GIS Specialist

Geographic Data Capture / GPS

Mr. Ferretti has spent several years as a field crew chief and coordinator of geographic data capture projects. Utilizing Trimble GPS sub-foot accuracy equipment, he inventories a wide variety of features, incorporating the detailed attribution and associated photography needed to create a robust GIS dataset. His experience ranges from the complete inventory of water, storm and sanitary systems to the recording of wetland boundaries and other environmental assets. Additionally, Mr. Ferretti has experience coordinating sign inventories, including the gathering of retroreflectivity readings that meet FHWA standards and implementing barcode systems for sign asset management.

Mr. Ferretti was responsible for the coordination, execution and QAQC of a township-wide geographic feature inventory. Results of the project included: the collection of over 5,081 storm sewer structures with attribution and 8,324 associated photos; 534 roadway signs with retroreflectivity readings; and 503 lighting features. The collected data was then processed for quality assurance before being imported into the Township's existing asset management system.

Municipal GIS

Mr. Ferretti's experience in Municipal GIS includes working with communities to develop and maintain their own GIS programs. Collaborating closely with administrative leaders, Mr. Ferretti is able to listen to needs, make informed recommendations, and provide services which become a valuable tool for the community.

Municipal GIS Services include:

- Web Mapping Applications
- GPS Asset / Facility Mapping and Management
- Database Design and Maintenance
- School and Fire District Boundary Mapping
- 911 / Dispatch Mapping
- Document Archive and Retrieval Systems
- Vehicle Tracking / Fleet Management
- Website Development / Community Outreach Portals

Web Development / Programming

In addition to traditional GIS services, Mr. Ferretti also has a background in web-based technologies. Using ArcServer, Google API's and/or ArcIMS, Mr. Ferretti develops mapping solutions to give remote users access to otherwise inaccessible GIS data. In addition to web mapping, Mr. Ferretti creates complete websites including the use of online databases programmed in MySQL. Focusing on outreach and user interaction, he designs for the end user and creates interfaces which are both simple to use and professionally designed.

Web Technologies include:

- ArcServer / Flex / ArcIMS Web based Mapping
- Google API's
- Community Outreach Portals
- MySQL Databases
- PHP, ASP, Javascript, Flash, CSS, HTML, XML

Database Planning, Design, Implementation and Maintenance

Mr. Ferretti's experience includes the development of a wide range of databases in several environments including ArcGIS, MySQL and Mircorsoft Access. Within these structure types, Mr. Ferretti plans, designs and maintains large datasets, while ensuring data is organized and efficiently retrievable wherever needed. Recently Mr. Ferretti was tasked with designing a database to aid in the planning and budgeting of a municipality's ten-year road program. The database cataloged many characteristics of the roadways (by segment) ranging from dimensions and conditions to material costs and inflation. Utilizing the database, the client could generate reports to summarize high-priority repair areas and identify which projects could be targeted within the annual municipal budget.

Kristi Jacobs, CNU-A

Assistant Planner

Kristi Jacobs joined GRAEF after gaining several years of diverse work experience in related fields, including several years with Office of University Architects, Planners, and Transportation at the University of Wisconsin-Milwaukee. Her work experience includes comprehensive planning, neighborhood and corridor planning, space design and management, site and building design, park and trail design, statistical analysis, facilities management and municipal planning.

Education:

Masters in Urban Planning, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

Masters in Architecture, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

Certificate in Real Estate Development, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

B.S., Architectural Studies, 2005
University of Wisconsin-Milwaukee, Milwaukee, WI

Certificate in Urban Planning, 2005
University of Wisconsin-Milwaukee, Milwaukee, WI

Professional Affiliations:

American Planning Association, APA

Wisconsin Chapter of the American Planning Association, WAPA

American Institute of Architects, AIA

Congress of New Urbanism, CNU

Neighborhood Revitalization

Ms. Jacobs has worked on neighborhood revitalization efforts with several community groups, primarily in the City of Sheboygan. In conjunction with City staff, she has organized outreach efforts at the neighborhood and community-wide level, designed to generate interest and support for neighborhood associations. Outreach efforts have included public information meeting, listening workshops, and door-to-door surveys. The input gathered during public meetings is then synthesized into a series of action steps, guiding residents as they move towards a formal neighborhood association.

In addition to neighborhood organization, Ms. Jacobs provides educational assistance to residents, identifying funding opportunities for home improvement and providing contact information for various City of Sheboygan services. She also works within the City departments to enhance coordination between neighborhood-related departments, including Police, Fire, Neighborhood Inspection, and Planning & Development, and enhance their presence within the community.

GIS Mapping & Design Visualizations

Ms. Jacobs utilizes GIS technology to analyze and communicate data effectively in the form of maps, diagrams, and 3-dimensional visualizations. Using her technical abilities, she is able to clearly communicate a broad range of information with data-driven maps, including: site conditions, existing and future property information, and conceptual development plans. In addition to mapping, Ms. Jacobs has experience in creating effective 3-d models of conceptual development for a variety of projects, including:

- Village of Germantown: Holy Hill subdivision
- City of West Allis: several redevelopment projects

Kristi Jacobs, CNU-A

Assistant Planner

Urban Design & Property Development

Ms. Jacobs' experience at GRAEF includes developing design strategies for a variety of mixed-use town centers, redevelopment efforts in both large and small communities, as well as corresponding design guidelines. This includes meeting with and providing guidance to municipalities and developers, suggesting design alternatives, and performing zoning analyses. She has also conducted detailed site analyses, including parking utilization, pro formas, and used this information to develop achievable design solutions.

Project examples include:

- City of Milwaukee's 27th Street Corridor Alternatives
- MacArthur Square Redevelopment Master Plan
- City of New Berlin 2020 Comprehensive Plan
- City of Muskego: Midtown Development
- City of Stevens Point: Downtown Redevelopment
- Village of Grafton: Lumberyard Site

Comprehensive Planning

Ms. Jacobs has assisted with the development of several comprehensive plans for municipalities in urban, suburban, and rural settings. Duties on these projects include preparation of public outreach and educational materials, statistical analysis, and research into historical and existing conditions. Kristi also prepares many of the critical diagrams, illustrations, computer visualizations and animations used to depict projects.

Project examples include:

- City of Franklin
- Village of Greendale
- City of New Berlin

Public Participation

Ms. Jacobs' experience in public participation includes the creation and facilitation of outreach materials for a variety of public and private stakeholders, image preference surveys, resident and business surveys, and the outcomes.

Project examples include:

- Village of Cottage Grove
- Kinnickinnic River Neighborhood Plan
- City of New Berlin

Technical Skills

ArcGIS
AutoCAD
Google SketchUP
Adobe InDesign
Adobe Illustrator
Adobe Photoshop

Timothy J Ehlinger, PhD

Ecological Research Partners

Dr. Ehlinger is an associate professor of Biological Sciences at the University of Wisconsin-Milwaukee where he teaches aquatic ecology, fisheries, and conservation. He is the former director of the UWM Interdisciplinary Major in Conservation and Environmental Science.

Education:

Postdoctoral Studies 1987-90
University of Toronto

Ph.D. in Zoology, 1986
Michigan State University

M.S. in Ecology 1980
Northwestern University

B.S. in Biology, 1979
Northwestern University

Professional Experience:

25 years post PhD

21 years in Wisconsin

Professional Affiliations:

Ecological Society of America

American Fisheries Society

Society for Restoration Ecology

Professional Awards:

Received the Henry C. Greene Award for Innovative Approaches to Restoration from the Aldo Leopold Society, in recognition of work done on Allenton Creek (2003)

Past President of the Wisconsin Chapter of the American Fisheries Society

Dr. Ehlinger has over 30 years of experience in the fields of aquatic ecology and fisheries biology, with the past 20 years spent working in Wisconsin. His research through the University of Wisconsin-Milwaukee is focused on understanding the habitat requirements, ecology, reproduction and conservation of freshwater fishes. His extensive project experience spans the areas of reestablishment of native fishes, stream restoration, and watershed planning. He has scientific expertise in fish behavior, population and community assessments, in addition to physical habitat and water nutrient chemistry analyses. His experience includes the use of hydraulic modeling for channel/habitat design for fish passage and stream restoration, environmental impact assessments, use-attainability analyses, and the formulation of watershed management plans. His projects frequently are conducted to support the development of remediation or restoration designs, and he has interacted extensively with regulatory agencies as part of the permitting process.

Wisconsin Department of Transportation (WDOT), Allenton Creek Stream Relocation & Wetland Restoration - Contractor: This project included the biological assessment, channel design and permitting for the relocation of a 500 meter section of creek with diverse tamarack conifer wetland and enhancement of a native strain brook trout population in Washington County, Wisconsin. The work included the design, construction and monitoring for fish passage into and out from the project area..

Village of Mount Pleasant Wisconsin, Pike River Storm Water and Stream and Corridor Restoration Project - Contractor and Consultant: This project began by participation at the request of the client in a formal legal facilitation process with WDNR regarding a Chapter 30 permit that was initially denied for a flood control project. An environmental assessment review and analysis was conducted. Based upon this work a new design for channel restoration with features for fish enhancement was developed, permitted and is currently under construction.

United States Environmental Protection Agency, Development of Risk Classification System for Diagnosis of Biological Impairment in Upper Midwest Watersheds - Co-Prinicipal Investigator: This project created a regionalized model to determine ecosystem vulnerability to watershed changes, assisting in the design of monitoring systems to access potential watershed impacts of development, and identify watershed restoration opportunities. This was a competitive grant awarded by the EPA/NSF Science to Achieve Results (STAR) Program.

Arjo Wiggins / Appleton Papers Inc., Ecosystem-based Rehabilitation Plan for the Lower Fox River, Wisconsin - Sub-contractor: This project reviewed and evaluated the research and modeling related to the PCB clean up for the Natural Resources Damage Assessment (NRDA) and Resource Inventory Feasibility Study (RIFS) on behalf of the client. Work included examination and evaluation of the impacts of dams, nutrient pollution, habitat loss, exotic species and toxins (including PCBs) on the biodiversity and fish communities of the Lower Fox River. Restoration plans and designs for fish passage were prepared.

US Fish and Wildlife Service (USFWS) and Nature Conservancy, Factors Influencing the Distribution, Abundance, and Reproductive Success of the Threatened Longear Sunfish in Wisconsin - Contractor: This project developed a strategy for restoring threatened species in the Mukwonago River watershed, including provision for fish passage at 3 dams.

Illinois Environmental Protection Agency Use Attainability Analysis for the Lower Des Plaines River, Illinois - Sub-Contractor: This project identified and prioritized the hydrological, thermal, and chemical stressors responsible for limiting fish and aquatic integrity under the guidelines of the Clean Water Act. Contributions included data analysis, synthesis and evaluation of biological data and modeling, resulting in the reclassification of stream segments impacted by dams, locks and navigation.

Perrier Group of America, Environmental Assessment and Permit Application for a High-capacity Well, Big Spring, Wisconsin - Sub-Contractor: This highly controversial project involved working with a diverse group of stakeholders to conduct a Resource assessment for a proposed a high-capacity well and spring water bottling plant in Adams County, Wisconsin. As part of this project, stream and wetland restoration plans to facilitate fish restoration were prepared and implemented.

Great Lakes Protection Fund, Degradation and Recovery in Urban Watersheds- Principal Investigator: This project conducted an intensive examination of the hydrological, limnological, and biological consequences of stream flow manipulations in Southeastern Wisconsin in order to identify the critical factors required for the restoration of fish species and ecological function.

US Trade and Development Agency (USTDA), The Ecological Reconstruction and Business Assessment Strategy for Sustainable Development in Areas Affected by Mine Closures in Gorj County, Romania - Project Co-director: Work included resource assessment and the creation of an ex-ante evaluation tool for prioritization of proposed economic development projects.

Neal T. O'Reilly, Ph.D., PH

Ecological Research Partners

Dr. O'Reilly has over 30 years of water resource experience, with specialization in hydrology, water quality modeling, watershed management, lake management, aquatic ecology restoration, and environmental permitting. Neal has undergraduate degrees in Aquatic Biology and Geology, a master's degree in Civil and Environmental Engineering, and a doctorate degree in Environmental Engineering and Environmental Law. In addition to being an engineer, Dr. O'Reilly is a licensed Professional Hydrologist in the State of Wisconsin. Dr. O'Reilly was employed for fifteen years by the Wisconsin Department of Natural Resources prior to becoming a private consultant. As part of the project team he will assist with regulatory agency coordination, and review potential project for compliance with federal, state and local regulations.

Education:

Ph.D. Environmental Engineering, Marquette University, 2007

M.S. Environmental Engineering, Marquette University, 1999

B.S. Aquatic Biology and Environmental Geology, University of Wisconsin-Oshkosh, 1977

Professional Experience:

31 years in Wisconsin

Professional Registration:

Wisconsin Professional Hydrologist, No. 111-110

Professional Affiliations:

ASCE

North American Lake Management Society

City of Neenah Glatfelter Paper Mill Redevelopment Project: Assisted the City of Neenah in the acquisition of environmental permits for the redevelopment of an abandoned paper mill site on the Fox River in Wisconsin. The project included preparation of permit applications, erosion control and stormwater management plans, environmental assessments, and negations with regulatory staff at the Wisconsin Department of Natural Resources and U. S. Army Corps of Engineers.

City of Neenah West Canal Project: Facilitation of state and federal permits for the filling in of an abandoned navigation canal to allow construction of a new office tower and parking structure. The project included preparation of permit applications, erosion control and stormwater management plans, environmental assessments, and negations with regulatory staff at the Wisconsin Department of Natural Resources and U. S. Army Corps of Engineers.

Lower Des Plaines River Use Attainability Analysis and Classification: Preparation of a Use Attainability Analysis under Federal Regulation 40 CFR 131 for the Lower Des Plaines River in Chicago, Illinois. The study area includes one of the most industrialized river sections in America, and the project involved several groundbreaking issues related to implementation of the clean water act. Based on a detailed analysis of water quality and aquatic resource data. The project team recommended a new classification for the water body that compiled with the Clean Water Act. Water quality standards for the new designation were developed. As part of the project acted as the facilitator for an advisory committee made up of stakeholders and several special topic sub-committees.

Alto Creek Wetland Restoration Project: Creation of a series of low-head dam structures to improve water quality treatment in the Alto Creek watershed of Fox Lake, Wisconsin. The project involved construction of four low-head weir structures designed to force runoff to spread into the riparian floodplain vegetation during small and moderate sized storms. In addition to water

William P. Mueller
Curriculum Vitae

1242 S. 45th St.
Milwaukee, WI 53214
414-698-9108
E-mail: wpmueller1947@gmail.com

Education:

- Master of Science in Geography; University of Wisconsin-Milwaukee, May 2002.
  Physical Geography and Environmental Studies emphasis.
- Bachelor of Arts degree; University of Wisconsin-Milwaukee, December 1996.
  Major: Biological Aspects of Conservation.

Grants received:

- Coordinated Bird Monitoring 2011: US Fish & Wildlife Service: digitizing datasets for western Lake Michigan shoreline areas, for Western Great Lakes Bird and Bat Observatory – with Dr. Noel Cutright and Dr. Jill Hapner
- State Wildlife Grant 2011: bat monitoring; Western Great Lakes Bird and Bat Observatory
- Coordinated Bird Monitoring Grant, US Fish & Wildlife Service, February 2010, with Dr. Noel Cutright, Dr. Jelle Gehring, and Dr. Nancy Seefelt. Offshore Great Lakes Waterfowl and Waterbird Monitoring
- Citizen-based Monitoring Partnership Program Grants, WDNR, 2006, 2007, and 2010. (Milwaukee BIOME Project/MCAMMP).
- Neotropical Migratory Bird Conservation Act Grant, USFWS, 2006 (MCAMMP).
- Wisconsin Society for Ornithology Grants 2006 and 2007 (MCAMMP).
- Wisconsin Society for Ornithology Scholarships, 1999 and 2000.
- Zoological Society of Milwaukee County - Graduate Research Grant in Wildlife Conservation; 2000.

Work History - Conservation, Natural Resources, and Research Activities:

- Ornithologist and Conservation Biologist, Western Great Lakes Bird and Bat Observatory – December 2010 to present

- Ornithologist and Conservation Biologist, Cedarburg Science, LLC – February 2009 to present

- Owner/operator natural history tour business: Land, Water, and Sky Tours - 2005 to present.

- Project Coordinator, the Milwaukee BIOME Project (formerly the Milwaukee County Avian Migration Monitoring Partnership (MCAMMP)

- Environmental scientist, Natural Resources Consulting, Inc. April 2008, to February 2009.

- Contract writing position for The Wisconsin Important Bird Areas program. Co-authored site accounts for the recently-published book Important Bird Areas of Wisconsin: Critical Sites for the Conservation and Management of Wisconsin's Birds. 2007. Y. Steele, ed. Wisconsin Department of Natural Resources.

- Contract writing position for the Wisconsin Department of Natural Resources, preparing species accounts and habitat plans for the Wisconsin Bird Conservation Initiative All-bird Plan. June 2003 to early 2007.
- Chair of Issues Committee of Wisconsin Bird Conservation Initiative (WBCI; online at http://www.wisconsinbirds.org), September 2003 to present.
- Conservation Chair of Wisconsin Society for Ornithology, June 2003 to present.
- Conducted bird surveys (point counts), and submitted written report of findings in the Cedarburg Bog for the University of Wisconsin-Milwaukee Field Station. June-July of 2006, and June-July of 2007.
- Graduate teaching assistantship, Department of Geography, University of Wisconsin-Milwaukee, spring semester, 2001; (Taught Physical Geography laboratory sections, Geography 120).
- Planned and organized (with A. Paulios, WBCI Coordinator-[WDNR Wildlife Management]) gull management symposium "Planning for Gulls in Your Community", http://www.wisconsinbirds.org/gull.htm March 11, 2004, in Milwaukee, WI; cosponsored by WBCI and the Wisconsin Society for Ornithology.
- Member of State Comprehensive Wildlife Conservation Plan Advisory Team, early 2004 to early 2005.
- Taught bird study course, University of Wisconsin Extension, University of Wisconsin-Waukesha, 1500 N. University Drive, Waukesha, WI 53188; spring and fall semesters, 1999.
- Organized statewide avian road mortality study in Wisconsin in 1999, with 90 cooperators in 64 of Wisconsin's 72 counties. (See Publications. Two papers resulting from this study have been published.)
- Participant in Wisconsin Breeding Bird Atlas, a project of the Wisconsin Society For Ornithology; 1995 through 1999; on atlas blocks in Calumet, Chippewa, Door, and Fond du Lac Counties.

Selected Publications:

- W.P. Mueller and J. Peterson. Checklist of the Birds of Wisconsin. *The Passenger Pigeon*; Journal of the Wisconsin Society for Ornithology, Vol. 73, No. 2, Summer 2011, pp.131-142.
- Kapfer, J.M., W.P. Mueller, B. R. Bub, and J. R. Englehardt. Response of nesting Ospreys (*Pandion haliaetus*) to maintenance activities along transmission lines in central Wisconsin. *The Passenger Pigeon*, Journal of the Wisconsin Society for Ornithology, Vol. 72, No. 1, Spring 2010. pp. 3-11
- William P. Mueller and Cindy Kowalchuk. "Annotated Checklist – The Birds of Wisconsin". *The Passenger Pigeon*, Journal of the Wisconsin Society for Ornithology, Vol. 71, No. 3, Fall 2009, pp.239-281.
- Site accounts (with T. Gostomski) for Important Bird Areas of Wisconsin: Critical Sites for the Conservation and Management of Wisconsin's Birds. 2007. Y. Steele, ed. Wisconsin Department of Natural Resources.
- Vargo, T. L., O. D. Boyle, C. A. Lepczyk, W. P. Mueller, and S. E. Vondrachek. Citizens behind the science: the use of citizen volunteers in urban bird research. *In* Lepczyk, C.A., and P.S. Warren, eds. New Directions in Urban Bird Ecology and Conservation. Studies in Avian Biology. *In press.*
- "Issues Papers" of the Issues Committee of the Wisconsin Bird Conversation Initiative; all online at http://www.wisconsinbirds.org/IssuesPapers.htm :
    - ❖ Climate Change and Birds. By William Mueller, Scott Diehl, Christopher Lepczyk and Joel Trick.
    - ❖ Wind Power and Birds: Wisconsin Bird Conservation Initiative - Policy and Guidelines, by Wm. P. Mueller, N. Cutright, S. Diehl, K. Etter Hale, J. Trick. 2005.

- The Effects of Free-ranging Cats on Birds in Wisconsin: Wisconsin Bird Conservation Initiative Issues and Guidelines, by C.A. Lepczyk, S. Diehl, N. Cutright, K. Etter Hale, Wm. P. Mueller, J. Trick. 2006.

- "Threshold of Pane", by William Mueller and Scott Diehl, in *Wisconsin Natural Resources* magazine, April 2006. Volume 30, No. 2, pp. 17-19. Also online at http://dnr.wi.gov/wnrmag/html/stories/2006/apr06/pane.htm
- "Return of the Loud Redheads", by Richard King and William Mueller, in *Wisconsin Natural Resources* magazine. August 2005. Volume 29, No. 4, pp. 14-17. Also online at http://dnr.wi.gov/wnrmag/html/stories/2005/aug05/red.htm
- Species accounts: the Wisconsin Bird Conservation Initiative and Wisconsin Department of Natural Resources published an online set of species accounts for Wisconsin's birds during 2007. Each species account contains sections on status, monitoring and population information, life history, habitat selection, habitat availability, population concerns, management, research needs, information sources, and literature cited. The following species accounts were prepared by WPM for this project and submitted to editors during 2003-2006. Some have been published online, and are now available at: http://www.wisconsinbirds.org/plan/species/list.htm Examples of those accounts already published online and available at this link are: Spruce Grouse, Red-headed Woodpecker, Short-eared Owl.
- Avian Influenza Fact Sheet, by William P. Mueller. 2005. Online at the WBCI website, at http://www.wisconsinbirds.org/avianflu.htm
- "Birds of Milwaukee County, Wisconsin – 1840s to the Present: Historical and Present-day Ornithology and Management", by William P. Mueller and John H. Idzikowski. *The Passenger Pigeon*, Journal of the Wisconsin Society for Ornithology, Vol. 66, No. 4, Winter 2004, pp.341-350.
- "Seasonal Timing of Highway Mortality of Birds in Wisconsin – 1999", by William P. Mueller. *The Passenger Pigeon*, Journal of the Wisconsin Society for Ornithology; Vol. 65, No. 3, Fall 2003, pp. 139-147.
- "The Population Decline of the Red-headed Woodpecker in Wisconsin and Illinois", by William P. Mueller. *Meadowlark: A Journal of Illinois Birds* Vol. 11, No. 4, 2002, pp. 130-132.
- "Vehicle-caused Mortality of the Red-headed Woodpecker in Wisconsin", by William P. Mueller. *The Passenger Pigeon*, Journal of the Wisconsin Society for Ornithology; Vol. 63, No. 4, Winter 2001, pp. 261-263.
- "An Assessment of Age Determination Methods for Captured Passerine Birds", by William P. Mueller and Charles M. Weise, University of Wisconsin-Milwaukee *Field Station Bulletin*, Vol.29, No. 1, Spring 1996, pp.21-27.

Skills:

- Directing conservation advocacy for a statewide committee with multiple partners (WBCI Issues Committee; see http://www.wisconsinbirds.org/Issues.htm).
- Managing and coordinating a research team with 9 partners from agencies and academia, and more than 50 volunteers; grant-writing, and team-building (MCAMMP).
- Trained in the use of the following software: Microsoft Word, Excel, PowerPoint; Geographic Information Systems (GIS) and Remote Sensing software: ESRI's ArcView 3.2.
- Trained in aerial photo use for Geographic Information Systems.
- Trained in bird census techniques: point counts, road and walking breeding bird surveys.

Thesis:

- "The Biogeography and Recent Decline of the Red-headed Woodpecker in Wisconsin". Abstract: The Red-headed Woodpecker (*Melanerpes erythrocephalus*), a species found throughout eastern North America, is in decline over much of its geographic range. This study describes the current and historic geographic range and status of the Red-headed

Woodpecker in North America and Wisconsin, and examines possible reasons for the recent decline of its population in Wisconsin. I test the hypothesis that habitat loss and interference competition with the European Starling (*Sturnus vulgaris*) are significant factors in the decline of the Red-headed Woodpecker. I also examine additional possible reasons for the noted population decline, including vehicle-caused mortality and the influence of the loss of the American elm (*Ulmus americana*) to Dutch elm disease. Results of hypothesis tests determined habitat loss is correlated with population decline of the Red-headed Woodpecker. With the limited data set used in this study, no correlation between numbers of European Starling and decline of Red-headed Woodpecker could be established. Historical road mortality data compared with that found in 1999, and data for elm losses suggest possible links to Red-headed Woodpecker decline, but limited data preclude confirmation.

Selected Presentations:

- Guest lecturer, "Wind Power and Effects on Wildlife". Kettle Moraine State Forest – Henry Reuss Ice Age Center, Feb. 11, 2010.
- Guest lecturer, "Changes in Populations, Distribution, and Abundance of Wisconsin's Bird Species". Riveredge Nature Ceter, Feb 2, 2010
- Guest Lecturer, Winter Birds of Wisconsin. Friends of Grant Park, Dec 12, 2009.
- Guest Lecturer, "Raptors of Wisconsin". Oshkosh Bird Club, May 5, 2009.
- Guest lecturer, UW-Milwaukee Conservation and Environmental Studies Program, February 25, 2009. "Changes in Populations, Distribution, and Abundance of Wisconsin's Bird Species".
- The MCAMMP Project: Citizens Behind the Science; presented as part of the Citizen Science Symposium at the Ecological Society of America Annual Meeting, Milwaukee, August 9, 2008.
- Guest lecturer, "The Red-headed Woodpecker and Dead Wood: Life and Death in an Oak Woodland". Milwaukee Audubon Society Natural Landscapes Conference. Cardinal Stritch College, Glendale, WI. Feb. 18, 2006.
- Presenter, Citizen-based Monitoring Conference, Manitowish Waters, WI, October 21, 2005. "Wisconsin Bird Conservation Initiative: Citizen Science: Past, Present, and Future Efforts in Wisconsin". (Written by Bill Mueller and Andy Paulios).
- Guest lecturer, "The Biogeography and Recent Decline of The Red-headed Woodpecker in Wisconsin." This presentation given at: Riveredge Nature Center, Newburg, WI, March 7, 2000; Horicon Marsh Bird Club, Horicon, WI, January 18, 2001; UW-Milwaukee Geography Colloquium, April 2002; Urban Ecology Center, Milwaukee, WI, July 9, 2002; Hoy Audubon Society, Racine, WI, July 10, 2003; Ned Hollister Bird Club, Beloit, WI, November 9, 2003; Sheboygan Audubon Society, Sheboygan, WI, March 11, 2004; Plymouth Bird and Nature Club, Plymouth, WI, April 20, 2004; Lake Park Friends, Lake Park, Milwaukee, March 20, 2005.

References:

- Owen Boyle, PhD. Southeastern Regional Ecologist, Wisconsin Department of Natural Resources – Bureau of Endangered Resources. 414-263-8681. E-mail: Owen.Boyle@Wisconsin.gov
- Noel J. Cutright, PhD. Emeritus Senior Terrestrial Ecologist for We-Energies). Past president of the Wisconsin Society for Ornithology. 414-221-2179. E-mail: noel.cutright@we-energies.com
- Michael J. Day, PhD. Professor and Former Department Chair - Department of Geography, University of Wisconsin-Milwaukee. 414-229-3942; Fax: 414-229-3981; Email: mickday@uwm.edu
- Karen Etter Hale, Chair, Wisconsin Bird Conservation Intiative (WBCI); and Executive Secretary, Madison Audubon Society. 222 S Hamilton St, Suite 1, Madison, WI 53703-3201. 608/255-2473. E-mail: masoffice@mailbag.com

INFORMATION ON: NOEL J. CUTRIGHT

Retired as a Senior Terrestrial Ecologist with We Energies in Milwaukee in April 2006 after 28+ years and now has an Emeritus Scientist relationship with the company.

Founded the Western Great Lakes Bird and Bat Observatory located at the Forest Beach Migratory Preserve in Ozaukee County, Wisconsin in 2010.

Received his BA from Miami Univ. (Ohio) in botany, MS from Cornell Univ. in plant pathology, and PhD from Cornell Univ. in wildlife science in 1973.

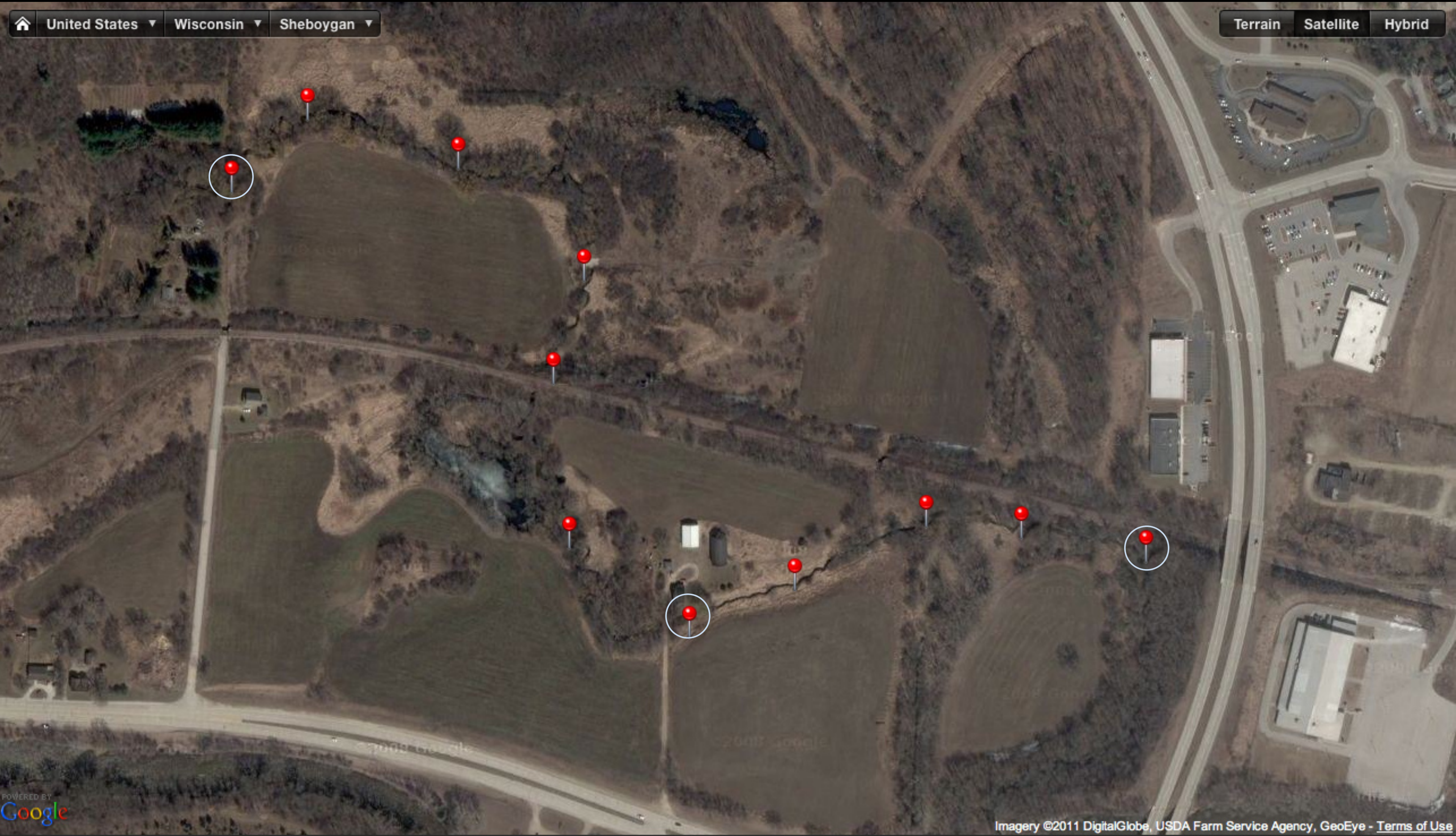
Past-President and current Historian of the Wisconsin Society for Ornithology, Founder of the Riveredge Bird Club, Board member for the Ozaukee Washington Land Trust, and Steering Committee member for the Wisconsin Bird Conservation Initiative.

Completed a breeding bird marathon, the Quad 30 Campaign (www.quad30campaign.org) in 2004. Served as Senior Editor for the *Atlas of the Breeding Birds of Wisconsin*. Received the Silver Passenger Pigeon and Green Passenger Pigeon Awards from the Wisconsin Society for Ornithology. Received a Lifetime Achievement Award in 2007 for Citizen-based Monitoring Efforts from the Wisconsin Department of Natural Resources, a Lifetime Achievement Award from Gathering Waters Conservancy in 2010, and the 1st Annual Lorrie Otto Memorial Award from Milwaukee Audubon in 2011.

APPENDIX O

Sondes Location

YSI Sonde and Temperature Logger Locations (21-Jul-2011)



APPENDIX P

Conservation Plan Proposal

June 22, 2011

Prepared for the City of Sheboygan

Proposal for Development of Conservation Plan for the Schuchardt Farms Property

1961 - 2011

CELEBRĀTE!

Table of Contents

GRĀEF

50th 1961-2011 CELEBRĀTE!

One Honey Creek Corporate Center
125 South 84th Street, Suite 401
Milwaukee, WI 53214-1470
414 / 259 1500
414 / 259 0037 fax
www.graef-usa.com

GRAEF

collaborate / formulate / innovate

June 21, 2011

Chad Pelishek
Development Manager
City of Sheboygan
828 Center Avenue, Suite 104
Sheboygan, WI 53081

PROPOSAL: Development of a Conservation Plan for the Schuchardt Farms Property

The GRAEF team fully integrates the best expertise in site feasibility analysis, development, and environmental management. GRAEF views the Schuchardt Farms project as an opportunity to continue assisting Sheboygan in the development of a high quality conservation development that balances the environmental amenities with the economic potential of the site. Our familiarity with the site, environmental expertise, and track-record of developing high quality projects that integrate conservation practices is key to the successful analysis of the property.

For this proposal, GRAEF is teamed with Ecological Research Partners LLC, a firm of research scientists specializing in aquatic systems and watershed analysis. Their mission is to help clients develop innovative tools and tackle complex issues related to environmental management and ecological restoration.

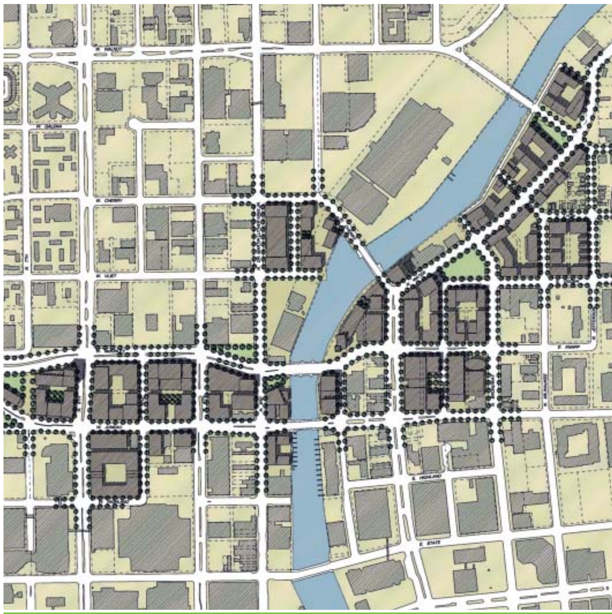
In addition to firm overviews for GRAEF and Ecological Research Partners, this proposal also contains resumes, service descriptions, and project examples that demonstrate the GRAEF team's expertise and experience on similar projects. We view service to the City of Sheboygan and the DNR as an opportunity to continue our strong partnership and assist the City in developing a model conservation development.

Sincerely,

Pat Kressin, ASLA, LEED-AP
Principal-in-Charge

Carolyn J Esswein, AICP, CNU-A
Associate, Project Manager

Firm History & Capabilities



GRAEF began as an individual partnership founded as a structural engineering firm in 1961. The fledgling company was named Graef, Anhalt, Schloemer–Consulting Engineers. In 1967, with a workforce of fifteen employees, the company incorporated and expanded its services to include civil and municipal areas.

Today, now employing more than 280 employees in six offices, GRAEF offers its clients a full range of services that include planning, structural, public works, transportation, environmental/ natural resources, MEP, and architectural design and construction services.

Milwaukee Office (Headquarters):

One Honey Creek Corporate Center
125 South 84th Street
Suite 401
Milwaukee, WI 53214-1470
Phone: 414-259-1500
Fax: 414-259-0037

Land and Water Resource Services

GRAEF staff consists of engineers and scientists dedicated to providing innovative, cost-effective results. Our staff of ecologists, biologists, wetland scientists, soil scientists, hydrologists, hydrogeologists, geologists, chemists and planners bring a broad range of knowledge and experience to project challenges. Keeping projects on schedule, while successfully meeting regulatory milestones, is a top priority of our team. We view all of our projects through the clients' eyes, understanding the importance of environmental issues to the community at large.

Planning & Landscape Architecture

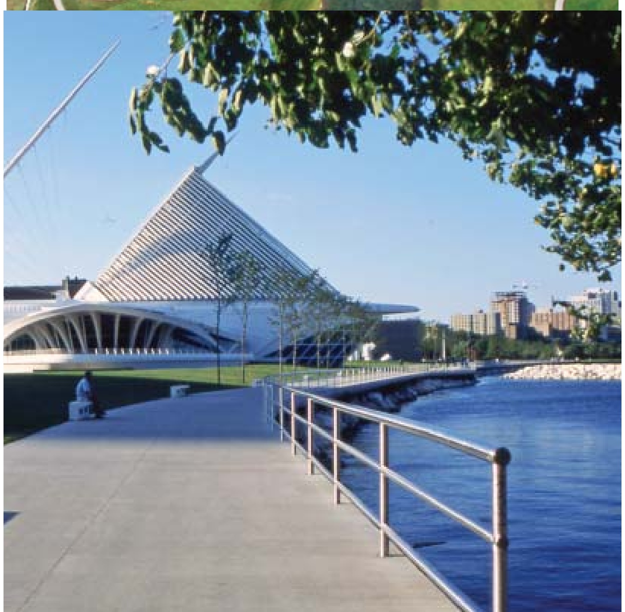
GRAEF planners and landscape architects have extensive experience with projects ranging from small parks to large community master plans. Our vast knowledge allows us to assist our clients with every stage of the design process; from project programming and visioning through construction. We pride ourselves on creating designs that meet all of our clients functional and economic needs while providing unique, aesthetically pleasing solutions. Some of our creative solutions include streetscapes, communities, parks, plazas, gardens, atriums, golf courses, water fountains and waterfronts.

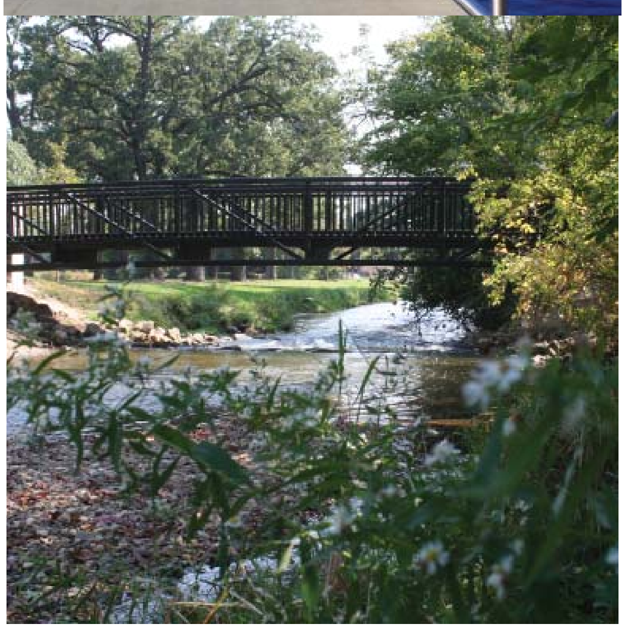
Civil Engineering

The public works engineering staff at GRAEF is well qualified to help municipal clients solve a wide range of challenges. Ranging in size from individual sites to large regional developments, our varied project experience offers a clear understanding of municipal operations and the sensitivities involved with public projects.

Structural Engineering

Our structural engineers provide a wide range of design and investigative services for all types of projects, with quality being the foundation of every project. Our commitment to creating high caliber, efficient designs is achieved through skilled personnel and personal attention during every phase of the project.





Firm Capabilities Continued

Transportation Engineering

Our transportation engineers and technicians have experience providing designs in both urban and rural settings. Whether a roadway or bridge, traffic study or streetscape, attention to cost, historical significance, citizen input, and aesthetics are key factors in obtaining public acceptance and approval.

Field Services

GRAEF field services provides testing and inspection, as well as Geographic Systems Information (GIS) services, including GPS, surveying and mapping, site analysis, data conversion and application development. We are proud to offer our clients a complete package of design, testing, and inspection from a single source. Our experienced personnel using state-of-the-art equipment enhances all of our service areas and assures a project with outstanding results.

Industrial Architectural Design Services

GRAEF offers a full range of architectural services for industrial clients. Our experience in pre-design planning assures a functional floor plan on which we can then base a facility design. In addition, our landscape architects work with all public and private clients to provide holistic designs that blend site and buildings in an appealing manner.

Mechanical/Electrical/Plumbing Engineering

GRAEF mechanical, electrical and plumbing (MEP) engineers have experience working with large industrial, municipal and governmental facilities, and commercial developments of all kinds. MEP group services begin in the initial concept and planning phases and extend through final system start up and beyond. The MEP group is highly skilled in all phases of analysis, design and construction of power distribution and lighting design.

Technical Expertise

GRAEF effectively serves the project needs of our clients with comprehensive skills in a wide range of technical fields.

Environmental

- Air and Noise Analysis
- Asbestos/Lead Management
- Brownfields
- Natural Resource Assessments
- Permitting
- Program Management/Planning
- Real Estate Due Diligence
- Soil/Groundwater Remediation
- Watershed Management
- Wetland Services

Planning

- Comprehensive Planning
- Urban Design
- Master Planning
- Main Street Redevelopment
- Corridor Redevelopment
- Property Development
- Plan Reviews
- Strategies for Sustainability
- Economic Development

Landscape Architecture

- Site Planning/Design
- Community Planning
- Urban Design
- Streetscapes
- Parks and Recreational Facilities
- Golf Course Development
- Sustainable Design
- Quarry Architecture

Civil

- GIS and Computer Modeling
- Potable Water Systems
- Water Resource Management
- Site Development
- Stormwater Systems
- Subdivisions
- Utility System Expansions
- Wastewater Systems

Transportation

- Curb and Gutter/Sidewalks
- Harbors and Marinas
- Pavement Design
- Railroad Spurs
- Relocation and Reconstruction
- Right-of-Way Services
- Roundabout Design

Structural

- BIM (Building Information Modeling)
- Bridges
- Buildings
- Building Exteriors
- Foundations
- Forensic Analyses/ Investigations
- Parking Structures
- Process
- Structural Systems

Industrial Architecture

- Additions
- Buildings
- Building Facades
- Parking Structures
- Renderings
- Renovations
- Roof Systems

Field Services

- ALTA Surveys
- GPS Surveying
- Construction Management, Inspection, Staking
- Land Surveys and Mapping
- Right-of-Way Plats
- Subdivision Platting
- Topographic and Site Surveys

Mechanical/Electrical/ Plumbing and Commissioning

- Communication and Alarm Systems
- Fire Protection Systems
- HVAC Systems
- Interior and Exterior Lighting
- Plumbing Systems
- Power Distribution
- Process Piping and Gas Systems
- Ventilation and Exhaust Systems
- Total Building Commissioning
- LEED® Accredited Services
- Energy Modeling and Audits
- Smoke Control System Inspections
- Construction Management

Operations Consulting

- Lean Manufacturing Design
- Plant Layout
- Process and Product Flow Analysis
- Process Utility Design
- Quality Control
- Set-up Reduction
- Staging and Material Logistics
- Work Cell Design

Ecological Research Partners LLC

Where science meets society

Ecological Research Partners LLC was formed in 2009 to integrate cutting-edge academic research with practical environmental and ecological applications. Started by a group of research scientists, Ecological Research Partners' mission is to develop innovative tools to assist resource managers and policy makers in tackling the complex issues related to environmental management and ecological restoration. The firm specializes in aquatic systems and watershed analysis, with expertise in the areas of:

- Environmental Impact Assessment
- Use Attainability Analyses and TMDL
- Biological and Ecological Indicators
- Ecological and Human Health Risk Assessment
- Statistical and Probability Analyses
- Habitat Restoration Design
- Lake Management
- Watershed Ecology and Non-point Pollution
- Innovative GIS Tool Development
- Stakeholder Engagement & Communications
- Policy Development
- Assessment, Analysis & Modeling of:
  - Ecological and Biotic Integrity
  - Water Quality
  - Habitat Quality and Suitability
  - Fish and Aquatic Invertebrates
  - Fish Passage
  - Streambed and Bank Stability

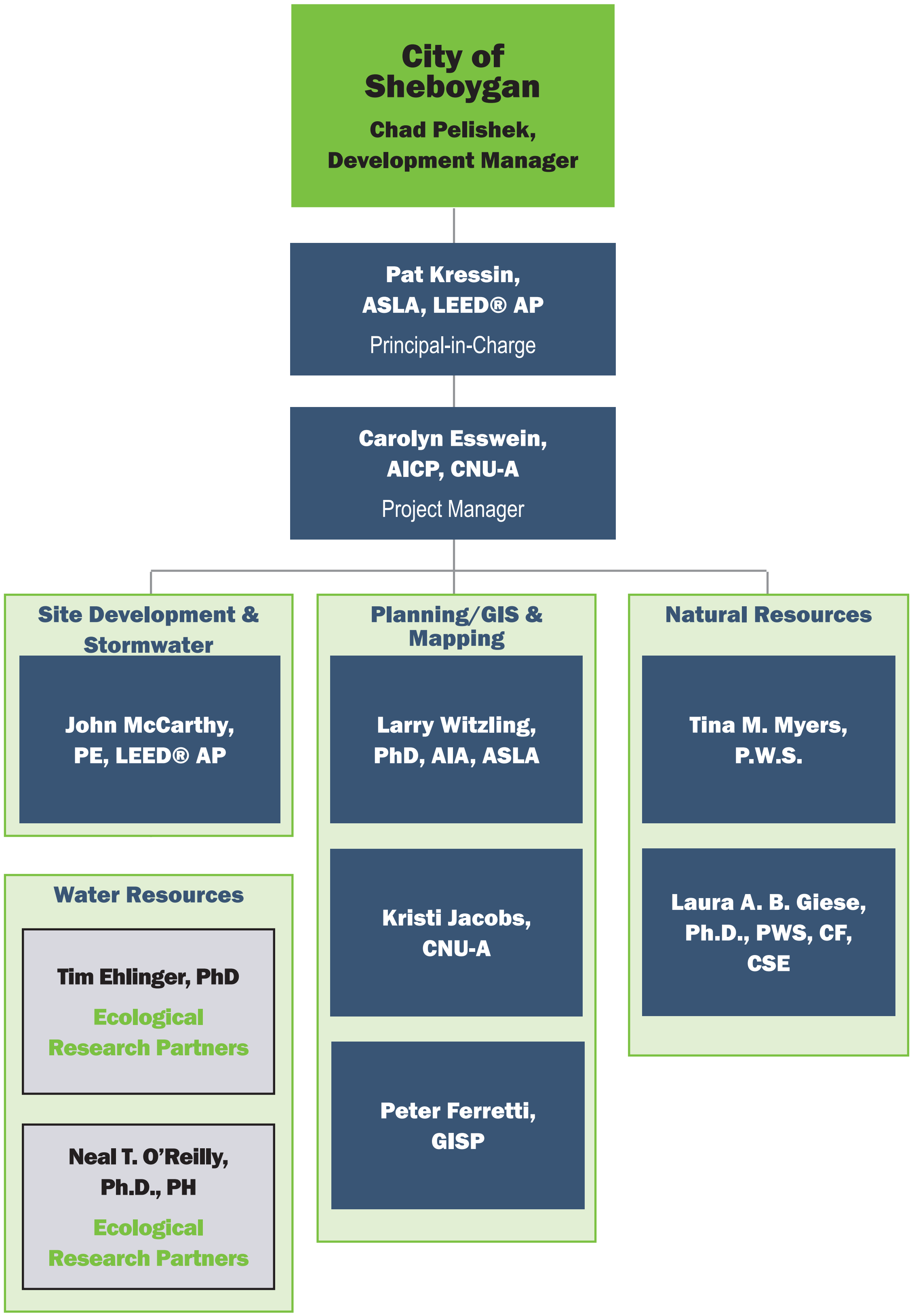
Ecological Research Partners LLC is registered as a Small Business with the Milwaukee Metropolitan Sewerage District.

To find out more on how Ecological Research Partners can assist you, contact:

Timothy J. Ehlinger, Ph.D.
Ecological Research Partners LLC
4634 N. 105th Street
Wauwatosa, WI 53225

Phone: 414.243.7672
Email: tehlinger.erp@wi.rr.com

Organizational Chart



The GRAEF Team

GRAEF staff will provide a fully integrated team that joins together expertise in environmental habitat and management, conservation planning, and sustainable guidelines for development.

Carolyn Esswein, AICP, CNU-A
Ms. Esswein will serve as the Project Manager. She has managed large-scale planning and redevelopment projects that include broad public participation, complex redevelopment issues, and significant environmental opportunities/constraints, and long-term implementation. She is a certified planner with dual masters degrees in urban planning and architecture, as well as a certified urban designer.

Pat Kressin, ASLA, LEED® AP
Mr. Kressin will serve as the Principal-in-Charge for this project. As a senior landscape architect and leader of the retail/residential development group, he has worked on numerous sustainable development projects - from conceptual guidelines through construction. His expertise includes integrating feasible, high-quality design with preservation of critical environmental features and successful public places to create long-term economic value within a community.

John McCarthy, PE, LEED® AP
Mr. McCarthy is a leading hydrologist and stormwater expert who will help ensure effective environmental and engineering concepts intended to preserve critical environmental features, conform to regulations and permitting requirements, and achieve high quality outcomes.

Tina Myers, PWS
Ms. Myers will contribute her extensive technical expertise in multidisciplinary ecological work such as vegetation surveys, rare species surveys, plant community mapping and assessment, wetland determinations and delineations, wildlife surveys, and wildlife habitat evaluations.

Laura A. B. Giese, PhD, PWS, CF, CSE
Dr. Giese will lend more than 20 years of experience in aquatic resources to the project. Her ecology background, in both forestry and wetland, and diverse scientific interests complement her broad experience in wetland deliniation and functional analyses, mitigation monitoring, and vegetation surveys.

Larry Witzling, PhD, AIA, ASLA
Dr. Witzling will lend his economic development and sustainable urban design experience to this project. He has helped conceive, design, and implement numerous successful development projects in Wisconsin that generate value while being sensitive to the context of the site. His expertise includes national award-winning codes and guidelines for redevelopment, planning, and urban design.

Peter Ferretti, GISP
Mr. Ferretti is a highly experienced cartographic designer, proficent in data manipulation and visualization, as well as depolyment of GIS solutions. He will contribute his experience to the effective collection and analysis of data.

Kristi Jacobs, CNU-A
Ms. Jacobs will provide assistance with all GIS data collection and mapping. She will also lend her extensive knowledge of the City of Sheboygan and the Schuchardt Farms property to the project understanding and the development of concepts.

Tim Ehlinger, PhD
Ecological Research Partners

Dr. Ehlinger will work as a subcontractor to GRAEF (a continuing role) with regard to improving and conserving fish habitat, shoreline restoration, and long-term environmental quality. His extensive project experience spans the areas of reestablishment of native fishes, stream restoration, and watershed planning.

Neal T. O'Reilly, PhD, PH
Ecological Research Partners

Dr. O'Reilly will work as a subcontractor to GRAEF (a continuing role). He specializes in hydrology, water quality modeling, watershed management, aquatic ecology restoration, and environmental permitting.

Carolyn J. Esswein, AICP, CNU-A

Project Manager

Carolyn has over 15 years of experience in urban design and planning. She has worked on numerous projects providing expertise in architectural and urban design, growth management, rural planning, design guidelines, and community development. Her work in comprehensive planning has received state and regional awards.

Education:

M.Arch., 1994
University of Wisconsin-Milwaukee, Milwaukee, WI

M.U.P., 1994
University of Wisconsin-Milwaukee, Milwaukee, WI

B.S., Interior Design, 1990
University of Wisconsin-Madison, Madison, WI

Professional Certifications:

American Institute of Certified Planners

Congress for New Urbanism – Accredited

Professional Affiliations:

American Planning Association, APA

Congress for the New Urbanism, CNU

Adjunct Professor, Urban Planning
University of Wisconsin-Milwaukee, Milwaukee, WI

Redevelopment Plans

Carolyn has made major contributions to many redevelopment projects in Milwaukee and other older urban areas. Her projects have included some of the most challenging redevelopment situations based on traffic impacts, housing diversity, and market influences. In each of these projects, her plans have helped spur successful redevelopment efforts:

- Lindsay Heights (Milwaukee)
- Walnut Circle (Milwaukee)
- City Homes (Milwaukee)
- Gateway Revitalization Plan (Sheboygan)
- West Allis Six Points
- Waukesha Main Street
- Midtown Triangle commercial redevelopment (Milwaukee)

Neighborhood / District Plans (Development Planning)

Carolyn's work involves numerous plans for special districts and neighborhoods. These plans often tackle the most complex and difficult issues surrounding residential and commercial growth and development balanced with environmental protection. They balance investment with environmental preservation, and provide guidance for public and private development initiatives. Some of the more notable plans for which she served as project manager:

- Franklin Crossroads Plan
- New Berlin City Center
- Sheboygan Schuchardt Farms Analysis and Development (ongoing)
- Fond du Lac and North Comprehensive Neighborhood Plan, Milwaukee
- Northwest Side Area Plan, Milwaukee
- Village of Fontana's Downtown Redevelopment Plan including mixed-use and residential developments, lakefront redevelopment, and a redesign of State Highway 167.

Carolyn J. Esswein, AICP, CNU-A
Project Manager

Municipal Planning
Carolyn has assisted communities plan for the future, create long-term visions, and implement those concepts. Her clients include towns, villages, and cities throughout Wisconsin with planning efforts ranging from on-going planning services, redevelopment plans, to managing site specific projects for special districts. The following is a variety of the clients and project types:

- Village of Fontana – On-going planning review and assistance for the CDA
- City of New Berlin – Plan implementation
- Town of Delavan – Plan update and on-going planning assistance

PARK PLANNING
As part of many community planning efforts, the park and recreation system is an integral part of the decision making and planning decisions. Carolyn has prepared a variety of park plans, open space plans, and park master plans with an emphasis on adding value, serving the needs of the residents, and responding to available budgets. Some of the park plans include:

- City of New Berlin – Outdoor Park and Recreation Plan, updated trail system as part of the Comprehensive Plan
- Village of Fontana – Porter Court park plaza, Mill Street Park, and Little Foot Tot Lot
- City of Milwaukee – Various park and open space plans for neighborhood catalytic projects
- City of Milwaukee – Riverside Park updated plan and fundraising opportunities
- Town of Erin – Town Hall Park and Trail System

Codes and Ordinances
Carolyn has helped develop and revise numerous municipal codes and ordinances. These have included:

- New Berlin – Design guidelines for the Commercial Center Development
- Town of West Bend – Zoning code and conservation design recommendations
- Town of Lowell – Zoning code recommendations
- City of Milwaukee – Redevelopment Guidelines

Public Participation
Carolyn gathers public input through various techniques including public workshops, charrettes, web-based surveys, design preference surveys, focus groups, and stakeholder interviews. Recent examples include:

- The public participation process for the New Berlin Comprehensive Plan in which Carolyn conducted 10 neighborhood input sessions, stakeholder interviews, SWOT Analysis with regional leaders, more than 10 neighborhood review meetings, 13 interactive steering committee meetings, project website with email interaction, two open houses, and one public hearing.
- Public participation in the Village of Fontana in Walworth County using a different approach to public participation, with an emphasis on committee meetings for a variety of project types. Carolyn has been working with the Village since 2002 with all committee meetings being public, including a project presentation and discussion about plan development and design direction. Throughout the years there have been selected Saturday public workshops to provide an extended opportunity to interact and gather feedback.

Patrick J. Kressin, ASLA, LEED® AP

Principal-in-Charge
Principal

Pat combines his experience and design expertise with knowledge of social, natural, and behavioral sciences to create functional, aesthetically pleasing and unique master plans to meet project budgets and accentuate the building architecture. His design expertise includes developing large-scale spatial plans and designs that integrate active and passive functions within the natural landscape while using the existing landscape as an amenity. He has significant knowledge and experience with the creation of large landmarks and sustainable developments.

Professional Registration:

Registered Landscape Architect – WI, IL, MI, AZ, VA

Education:

B.S., Landscape Architecture, 1995
University of Wisconsin-Madison, Madison, WI

Professional Certifications:

LEED® Accredited Professional

CLARB Certified – National

Professional Affiliations:

American Society of Landscape Architects, ASLA

U.S. Green Building Council, USGBC

Wisconsin Green Building Alliance, WGBA

International Council of Shopping Centers, ICSC

Western Golf Association, WGA – Par Club

United States Golf Association, USGA

National Golf Foundation, NGF

Urban Land Institute, ULI

Commercial Association of Realtors

Hoffman Corporation Sustainable Office Park, Appleton, WI – Project Landscape Architect: Responsible for site programming, natural resource inventory, site development analysis, and site development master planning for a 30-acre commercial office park that focuses on green architecture and determined sustainable site design objectives. A linked greenway system, termed the "path of discovery," transverses restored forests, prairies, and wetlands, and includes interpretive signage along the passive trail, was one of the major design elements.

West Bend Mutual Insurance, West Bend, WI – Project Landscape Architect: Responsible for master planning and landscape architecture for the development of a major building addition in a rural setting. Highlights of the design include substantial berming that resembles the adjacent kettle moraine, 2-miles of pathways, entry plazas, brick parking areas, courtyards and a major outdoor event space adjacent to a decorative pond and a series of waterfalls.

The Congregation of the Sisters of St. Agnes, Sustainable Master Plan, Fond du Lac, WI – Project Manager and Project Landscape Architect: Responsible for programming, natural resource inventory, site development analysis, and site development master planning of a 300 acre, sustainable, park/campus for the Sisters of St. Agnes. The master plan focused on protecting and improving the experience, and existing natural resources, within the sister's land. Major design elements include restored prairies and forests, creation of wetlands and ponds, and passive pedestrian trails that transverse the entire parcel. All of the proposed elements are designed to be environmentally sensitive, recyclable, and native or organic in nature.

The Legend at Brandybrook Golf Club and Community, Wales, WI – Project Manager, Project Golf Course Architect and Project Landscape Architect: Responsible for programming, site development master planning, site design, golf course design and construction drawings for an environmentally sensitive 18-hole golf course, 225 single-family lot residential community and a 75-unit condominium development, located on 750 acres in the Southern Kettle Moraine. The overall design includes passive, natural, trails that link the golf course and residential areas with the Glacial Drumlin Trail. The country club also included the development of a pool and tennis facility designed to promote family interaction. The pool includes a large zero-depth area, slides, jets, hydro-massage center, and training/lap area.

University of Wisconsin-River Falls, River Falls, WI – Project Landscape Architect: This project was for the new campus student center that is designed to receive a Silver LEED rating. The project involves providing site development programming, master planning, design development, and construction documents for the overall project. The site development associated with this development includes the creation of campus mall that will serve as the heart of the camps and several outdoor terraces to provide more intimate levels of interaction. Additionally the project site is located adjacent to the Kinnickinnic River, a Class 1 cold-water trout stream, which is extremely sensitive to adjacent development. A series of natural and native vegetative buffers and stormwater infiltration and detention systems will be developed throughout the site and through the adjacent roadways and parking areas to eliminate the negative effects of warm stormwater runoff entering the sensitive stream. The project is in the design development phase of design.

West Bend Conservation Community, West Bend, WI – Project Manager and Project Landscape Architect: Responsible for programming, site development master planning, and conceptual site design for a residential community. The 75-acre development includes 150 single-family residential lots located to minimize environmental impacts while internally and externally linking the entire community via a greenway network.

Rolling Ridge Subdivision Development, Pewaukee, WI – Project Landscape Architect: This project was for a site development master plan of a residential community to include 150, 2 – acre lots and a large wetland preservation area. The design eliminated the need for curbs, gutters, and a storm sewer system while providing a passive, environmentally sensitive, community trail system that transverses the preserved wetland and sensitive residential development.

Plexus World Headquarters, Neenah, WI – Project Landscape Architect: Provided landscape architecture design with sustainable principals for a new 104,000 square feet global headquarters. The headquarters is located on the site of the former 7.6-acre Glatfelter paper mill property downtown Neenah.

S.C. Johnson Wax – Building #69, Racine, WI – Project Landscape Architect: Responsible for site programming, site development master planning, and construction documents for a research and development facility, located in an environmentally sensitive setting. The project included protecting existing sensitive elements and restoring several forested areas and a tall grass prairie.

Northcentral Technical College, Health Science Center, Wausau, WI – Project Landscape Architect: Provided LEED certification feasibility assessment, project review, sustainable guidelines, project design review, and ongoing LEED point verification and documentation for a new Health Sciences Center. The project has received a Certified LEED rating.

Menominee Eagle Casino, Kenosha, WI - Project Manager and Project Landscape Architect: This project was for a full Environmental Impact Study evaluating the impacts of a gaming and entertainment facility to the local area. GRAEF provided site analysis, master planning, preliminary design and engineering design services for the redevelopment of Dairyland Greyhound Park into a destination mixed-use regional gaming and entertainment facility.

John T. McCarthy, P.E., LEED® AP

Senior Civil Engineer
Principal

John has 34 years of experience on projects at GRAEF. As a Principal of the firm and the Site Development Team Leader, he provides leadership on many of the firm's site development projects. In addition to his expertise in site development, John has a great deal of experience in stormwater management, sanitary sewer design, and preparation of permit applications for a variety of projects.

Professional Registration:

Professional Engineer – WI, IL, VA

Education:

B.S., Civil Engineering, 1974
Marquette University, Milwaukee, WI

Professional Certifications:

LEED® Accredited Professional

Professional Affiliations:

American Society of Civil Engineers, ASCE

Wisconsin Association of Floodplain, Stormwater, and Coastal Managers, WAFSCM

Publications:

Stormwater Quality Enhancement Associated with Widening of the Tri-State Tollway

Proceedings of the Association of State Floodplain Managers Annual Conference, 1998

Awards:

2008 Volunteer of the Year, Wisconsin DNR, State Parks

2008 Engineer of the Year, Wisconsin Builder Magazine

2006 Engineering in Consulting Practice, ASCE, Wisconsin Section

Romeoville Nature Preserve, Will County, IL – Project Engineer: Directed an analysis of the hydrology impacting the Romeoville Nature Preserve, to facilitate preservation of high quality wetland areas and restoration of degraded sites. Prepared hydrological model, using TR-20 methodology, for the area tributary to the Preserve; developed and evaluated alternatives for remediation; and prepared construction plans for the work.

Lockport Prairie Nature Preserve, Will County, IL – Project Engineer: Directed hydrological studies associated with remediation investigation for Lockport Prairie Nature Preserve. The goal of the overall project is to restore the ecological function of the nature preserve to a more natural state by managing the hydrology of the site. John directed the surface water flow monitoring and the hydrological modeling effort, and prepared the reports describing these efforts.

UWM Innovation Park – Master Planning and Rezoning, Wauwatosa, WI – Project Manager: Developed and evaluated alternative site plans for a proposed $250 million academic campus on an 88-acre site within the Milwaukee County Grounds. Assisted with rezoning and site plan approval process through the City of Wauwatosa. Managed preparation of the overall site survey and certified survey map required to divide the overall property into parcels. Prepared information on infrastructure design and costs for inclusion in an EDA Grant Application. The site plan and rezoning process involved many challenges, including accommodations for monarch butterfly migration through creation of a special habitat zone, investigation of the potential for historical burial sites, and conceptual design of a bio-infiltration system for on-site stormwater management. (2009-0184.01)

University of Wisconsin-Milwaukee Master Plan, Milwaukee, WI – Project Manager: Provided master planning services as part of a national team of architects and planners for the UWM campus. John's work focused on site infrastructure, including sanitary sewer and water service, stormwater management issues, and sustainability. The planning process involved a thorough review of existing conditions at the Kenwood campus and the four existing satellite facilities; and an evaluation of infrastructure needs for future sites and facilities identified in the master planning process.

Pebble Creek Marketplace, Waukesha, WI – Project Manager: Conceptual stormwater management planning for a 76-acre site in the City of Waukesha. The site, which contains 24 acres of wetland adjacent to the Fox River, south of STH 59, involved mixed commercial and residential land uses. The site also included substantial conservancy areas and a park dedication to the City of Waukesha. The plan included the identification of three stormwater management ponds, sized to meet Waukesha County's stormwater requirements for each drainage area.

Wingspread Guest House, Racine, WI – Project Manager: Addition of a new guesthouse to this Frank Lloyd Wright designed facility. Site development work included grading, utilities, and paving. The project incorporates sustainable design concepts, and the site was designed around existing landscape features. Stormwater management used overland flow and preserving of existing drainage patterns to address stormwater quality issues.

Kerry Americas, Beloit, WI – Project Manager: Site design and permitting for an 80 million dollar research, testing, and corporate center on a 125-acre site in the City of Beloit for Kerry Americas. The project included extension of public water and sewer service to the site, and obtaining DNR and Corps permits to relocate a navigable stream that ran through the site. An Environmental Assessment was prepared as part of the permitting process, which also included approval by DNR and FEMA for modifications to the 100-year floodplain, and development of a Letter of Map Revision (LOMR). John prepared the Sustainable Sites credit information for the project, which was submitted for a LEED Silver Certification.

The Legend at Brandybrook Golf Club and Community, Wales, WI – Project Engineer: Analysis and design of comprehensive stormwater management system and chapter 30 permit for 480-acre golf course and subdivision, including multiple retention ponds, stormwater quantity control and quality enhancement, hydrological analysis, flood plain determination, erosion control plans, wetland protection, and floodplain delineation.

SC Johnson, Racine, WI – Project Manager: Site work and utilities for numerous projects over a 12-year period, including building 61 on the Waxdale Campus, the Johnson Worldwide building, north of Waxdale, and the new Waxdale entrance area. The Johnson Worldwide site included a major water feature that functions as a stormwater quality enhancement and flood control facility as well as a major aesthetic and recreational feature. Design included overall site grading, utility services, parking and roadways, and a path system around the ponds. Also included was a comprehensive stormwater management plan for the 140-acre site in the Town of Mount Pleasant, including analysis of impacts from a 500 acre area upstream. The complex plan includes development of regional stormwater management facilities to mitigate impacts of development on the Pike River in Racine County.

Johnson Controls Stormwater BMP's, Glendale, WI – Project Manager: Design of a stormwater re-use facility, and rehabilitation of a reflecting pool for a Platinum LEED rating. Project was associated with remodeling of Johnson Controls facility in the Village of Glendale with a focus on rehabilitating the reflecting pool and fountain system that surrounded the building. Designed a system for intercepting stormwater in a cistern before discharge to the pool, and then using this waste for irrigation of the site landscaping. The design required a complex hydraulic balance with the water levels in the pool, the new filtration system for the pool, and the adjacent creek, which used to back up into the pool, nearly flooding the building.

John T. McCarthy, P.E., LEED® AP

Senior Civil Engineer
Principal

MMSD Headquarters Parking Lot BMPs, Milwaukee, WI – Project Manager: Analysis and design of Best Management Practices (BMPs) for stormwater quality enhancement for the MMSD Headquarters parking lot and site. Involved an analysis of alternative measures to capture and treat stormwater pollutants, and preparation of construction documents for the project, including resurfacing and reconstruction of significant portions of the parking lot and access drives. BMP's included a constructed wetland for stormwater storage and treatment, pervious pavement, catchbasin filtration systems, and a stormwater treatment device.

Milwaukee Art Museum, Milwaukee, WI – Project Manager: Complete site utilities, paving, and grading for this $100 million dollar addition along Milwaukee's lakefront. Included design of a storm sewer system below normal lake level, new water mains to serve the museum and the adjacent parklands, extension of the sanitary sewer system, a stormwater lift station to protect the restaurant on the lake side, a new parking lot north of the museum, and site paving and grading for the Kiley Gardens, at the museum entrance.

Briggs & Stratton Corporation, Statesboro, GA – Project Manager: Stormwater management and erosion control plan for 50 acre industrial site, including design of two stormwater detention basins, and protection of adjacent wetlands from siltation.

Improvements to Detension Basin No. 1 at the Milwaukee County Grounds, Milwaukee County Regional Medical Center, Wauwatosa, WI – Project Manager: Conducted the hydraulic analysis, developed plans, and managed the construction of a 12-acre-foot storm water detention basin expansion. The expanded detention basin, which serves the Milwaukee Regional Medical Center (MRMC), was expanded by excavated new basin area. Challenges included coordinating MRMC, Milwaukee, and MMSD interests on the project, avoiding imparts to Butler Garter Snake Habitat, and reconstructing a culvert on the basin outflow, relieving access by crossing an active railroad track.

Village of Round Lake, Illinois – Project Engineer: Review and approval of Watershed Development Permit applications associated with development within the Village. This activity involved detailed review of hydrological and hydraulic computations, detention basin designs, grading plans, and erosion control plans for compliance with the Village's Unified Watershed Development Ordinance, in accordance with the criteria established by the Lake County Stormwater Management Commission.

Wetland Enhancement Pond, Burlington, WI – Project Manager: Preparation of Section 30 and Chapter 404 permits for a wetland enhancement pond along the Fox River. Project included design of provisions for wetland enhancement and stormwater quality control, along with detailed hydrological and hydraulic computations.

Tri-State Tollway, Illinois State Toll Highway Authority, Deerfield, IL – Project Manager: Preparation of permits and supporting materials for three mile roadway project on the Illinois tollway system, including watershed development permit, IDOT/IDNR flood plain permitting, and mitigation of impacts to wetlands and endangered species.

Tri State Tollway, Illinois State Toll Highway Authority, IL – Project Manager: Provided stormwater management services for three mile tollway project in northern Illinois, including hydraulic and hydrology modeling, design of storm sewer system, erosion control, stormwater quality enhancement, floodplain management, and grading and utility plans.

Tina M. Myers, P.W.S.

Professional Wetland Scientist/Ecologist

Tina's contribution to natural resources projects at GRAEF includes over nine years of extensive experience in multidisciplinary ecological work such as vegetation surveys, rare species surveys, plant community mapping and assessment, wetland determinations and delineations, preparation of wetland mitigation plans, wetland mitigation maintenance and site monitoring, wetland functional assessments, environmental corridor mapping, preparation of Natural Resource Protection Plans, preparation of wetland and waterway permit applications, upland habitat restoration, wildlife surveys, and wildlife habitat evaluations.

Education:

B.S., Biological Aspects of Conservation
University of Wisconsin-Milwaukee, Milwaukee, WI

Professional Certifications:

Professional Wetland Scientist, #1444, Society of Wetland Scientists

Kane County, IL Qualified Wetland Review Specialist #W-058, Kane County Stormwater Management Commission

Lake County, IL Certified Wetland Specialist #C-132

Professional Affiliations:

Wisconsin Wetlands Association

Society of Wetland Scientists

Society of Ecological Restoration

Openlands Land Preservation, Dan McMahon Woods Forest Preserve: Plant Community Mapping and Community Restoration, Cook County IL - Lead Ecologist: Performed a plant community inventory and baseline mapping of existing plant communities within a defined project area of the Preserve. Used the "Chicago Wilderness Terrestrial Community Classification System" (CWTCCS) to classify plant communities found within the Preserve and used the Floristic Quality Assessment (FQA - Wilhelm & Masters) for the Chicago Region to evaluate the quality of the plant communities. Also provided and documented verification of previously mapped soils. GPS technology was the primary tools used to map and characterize plant communities and soils to be incorporated into Geographic Information Systems (GIS) mapping.

The plant community and soil mapping is part of a multiphase project that is expected to continue throughout a ten year period. The purpose of the existing plant community mapping/ inventory and soils verification was to provide baseline information about the current conditions of existing plant communities that would help further guide the restoration process of the Preserve particularly within a rare fen community where habitat for the Federally listed Hine's emerald dragonfly is known to exist.

Openlands Land Preservation, Deer Grove Forest Preserve: Wetland Delineation and Plant Community Restoration, Palatine, IL - Lead Wetland Scientist: As one of the lead Wetland Scientists of a large wetland team, determined the extent of existing wetlands and identified opportunities for restoration and enhancements to wetland and upland plant communities within 628 acres of the Deer Grove Forest Preserve. During the first phase of work, used methods outlined in the 1987 Corps of Engineers Wetlands Delineation Manual for routine delineations which were used to evaluate the presence of existing wetlands and to locate their boundaries. Collected field data which included existing plant community delineation and characterization, as well as site specific soils and hydrologic data. GPS technology was the primary tool used during the fieldwork to map existing wetland boundary data, plant community data, soils data, and hydrological data. Floristic Quality Assessment (FQA - Wilhelm & Masters) for the Chicago Region was used to evaluate plant communities. The next phases of this project will include plant community restoration planning and implementation.

Columbia St. Mary's Hospital: Wetland Investigation, Permitting, and Mitigation Maintenance and Site Monitoring, City of Mequon, Ozaukee County, WI - Lead Wetland Scientist: Delineated and assessed functional values, prepared a report and obtained concurrences from the Corps and the WDNR. Prepared Section 404/401 and Chapter 30 Permits for activities associated with the expansion of the hospital. Conducted post-mitigation vegetative monitoring using qualitative and quantitative methods for evaluating restoration success. Compiled comprehensive plant species lists, documenting the presence of vertebrate wildlife, and recommending management activities to meet mitigation performance standards. Performed wetland mitigation maintenance through selective cutting and herbicide application.

Waukesha Bypass Ecological Investigation, City of Waukesha, Waukesha County, WI - Lead Wetland Ecologist: Conducted an ecological investigation within a proposed transportation corridor that extended from approximately the intersection of I-94 and Hwy TT to the intersection of CTH X (Genesee Road) and STH 59. The purposes of this investigation was to document existing natural resources, and assess their extent and need for further study during the alternatives analysis phase of the project and for other future phases of the project. As part of the ecological investigation, Tina identified and provided a preliminary boundary (via GPS) of jurisdictional wetlands to verify the accuracy of the WDNR's mapped wetlands on the Wisconsin Wetland Inventory. A total of twenty-one wetlands were mapped within the corridor. Additionally, she performed a vegetation meander survey within each wetland and adjacent upland, including a rare plant species survey, and calculated the Floristic Quality Index (FQI) of each plant community using the Wisconsin Floristic Quality Assessment (WFQA) method. Further, she compiled a plant community mapping within the most critical areas within the corridor that are adjacent to Pebble Creek and presented this information to some of the stakeholders of this project.

WE Energies Port Washington Gas Lateral Pipeline: Wetland Delineation and Assessment, Ozaukee & Washington Counties, WI - Lead Wetland Scientist: Performed wetland and natural areas investigations within 100 feet of a proposed, 16.5-mile, lateral pipeline corridor easement from the Village of Jackson in Washington County to the City of Port Washington in Ozaukee County. Identified and delineated wetlands and other jurisdictional waters using methods outlined in the 1987 Corps of Engineers Wetlands Delineation Manual (Corps Manual) and subsequently located wetland boundaries using a GPS. Data collected from field investigations were described in reports and sent to the United States Army Corps of Engineers (Corps) and Wisconsin Department of Natural Resources (WDNR) for concurrence. Assessed functional values of wetlands using the WDNR's Rapid Assessment Methodology for Evaluating Wetland Functional Values (RAM – WDNR, 1994). Also assisted with the preparation of wetland mitigation plans.

Moss American Superfund Site along the Little Menomonee River: Wetland Investigation and Mitigation Monitoring, Milwaukee County, WI: - Lead Wetland Scientist: Conducted a wetland investigation along the Little Menomonee River prior to the realignment of the river due to mitigation of a contaminated portion of the river. Following the cleanup of contaminants, conducted post-mitigation vegetative monitoring in areas that had been seeded. Used qualitative and quantitative methods for evaluating restoration success. Compiled comprehensive plant species lists, documenting the presence of vertebrate wildlife, and recommending management activities to meet mitigation performance standards.

Laura A. B. Giese, Ph.D., PWS, CF, CSE

Restoration Ecologist

Dr. Giese has more than 20 years of experience working in aquatic resources: research, private consulting, and teaching. Dr. Giese's experience includes wetland delineation and functional analyses, stream assessment and restoration, mitigation monitoring, threatened and endangered species surveys, vegetation surveys, and macroinvertebrate sampling. Her ecology background (forestry and wetland) and diverse scientific interests complement the consulting profession. She has authored numerous wetland and forestry technical reports and analysis of impacts to natural resources.

Education:

Ph.D., Forest Biology/Ecology, 2001
Virginia Polytechnic Institute & State University, Blacksburg, VA

M.S., Urban Forestry/Ecology, 1988
University of Illinois-Champaign, Urbana, Illinois

B.S., Forest Biology, 1984
Colorado State University, Fort Collins, CO

Professional Certifications:

Society of Wetland Scientists: PWS #1363

Professional Wetland Delineator #3402 000012

Registered Professional Forester: Maryland #364

Certified Forester: Society of American Foresters #801

Ecological Society of America: Certified Senior Ecologist

U.S. Fish and Wildlife Service, Registered Small Whorled Pogonia, Harperella and Swamp Pink Surveyor

North American Benthological Society, Certified Taxonomist – Family Level

Professional Affiliations:

Society of Wetland Scientists, SWS

Society of American Foresters, SAF

Ecological Society of America, ESA

International Society of Arboriculture, ISA

The Northern Virginia Stream Restoration Bank, Reston, VA – Principal Environmental Scientist: With another firm reviewed pre- and post-construction biological condition assessment reports for urban streams and coordination of riparian buffer monitoring for a 14 mile stream restoration project in Reston, Virginia. Assessed the effect of stream restoration on the macro-benthic invertebrate community and stream condition utilizing guidance established in the "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers," and calculating the Virginia Stream Condition Index (VA-SCI) following the guidance established in "A Stream Condition Index for Virginia Non-Coastal Streams."

Evergreen Rural Village, Loudoun County, VA – Principal Environmental Scientist: With another firm delineated forest stands on a 200+ acre residential development in Loudoun County, Virginia. Delineated forest stand boundaries based on species composition and Society of American Foresters cover types.

Waukesha Bypass Ecological Investigation, City of Waukesha, Waukesha County, WI – Restoration Ecologist: Conducted an ecological investigation within a proposed transportation corridor that extended from approximately the intersection of I-94 and Hwy TT to the intersection of CTH X (Genesee Road) and STH 59. The purpose of this investigation was to document existing natural resources, and assess their extent and need for further study during the alternatives analysis phase of the project. As part of the ecological investigation, Laura Giese conducted wetland functional assessments using the Wisconsin Department of Natural Resources (WDNR) Rapid Assessment Methodology (RAM) for Evaluating Wetland Functional Values on twenty-one separate wetlands/wetland complexes; identified high-quality upland habitat; assessed habitat suitability for endangered and threatened species including plants, natural areas, herptefauna, fish and mussels; and identified potential areas for wetland mitigation within and adjacent to the corridor. Further she assisted with plant species survey to determine the Floristic Quality Index

(FQI) using the Wisconsin Floristic Quality Assessment (WFQA) method; and field verification of WDNR wetlands mapped on the Wisconsin Wetland Inventory.

King William Reservoir, City of Newport News, VA – Principal Environmental Scientist: With another firm conducted natural resource studies for waters of the U.S (WOUS) mitigation feasibility for several 100+ acre sites in Caroline and King George Counties, VA. Natural resource studies included waters of the U.S. delineation, U.S. Army Corps of Engineers jurisdictional determination, NRCS wetland determination for agricultural lands (using historic aerial photographs, precipitation data, and field observations; intermittent/perennial stream flow regime determination), survey for federally-threatened species, soil sampling for sulfide hazards and organic matter content, and conceptual wetland restoration/creation design.

Fort A.P. Hill Military Base, Caroline County, VA – Principal Environmental Scientist: With another firm surveyed endangered and threatened species in a 100+ acre section of Fort A.P. Hill military base in Caroline County, Virginia. Conducted surveys for the federally-threatened species swamp pink (Helonias bullata) and small whorled pogonia (Isotria medeoloides). Documented several new small whorled pogonia colonies and individual occurrences.

Fort Belvoir Base Realignment Closure (BRAC), Fort Belvoir Engineer Proving Ground, Fairfax County, VA – Principal Environmental Scientist: With another firm delineated waters of the U.S. (WOUS) and surveyed the federally-threatened small whorled pogonia (Isotria medeoloides) on a 100+ acre military base realignment site in Fairfax County, Virginia. Due to past land use, the landscape was substantially disturbed, resulting in the delineation of many atypical and problem area emergent and forested wetlands. There was a potential for unexploded ordnances challenged hydric soil determination.

Route 7100 Fairfax County Parkway Extension through Fort Belvoir Engineer Proving Grounds, Fairfax County, VA – Principal Environmental Scientist: With another firm surveyed endangered and threatened species for a 1.5 mile roadway alignment in Fairfax County, Virginia. The survey included the federally-threatened small whorled pogonia (Isotria medeoloides). Found first and only recorded small whorled pogonia individual in Fairfax County, VA.

North Fork Wetland Mitigation Bank, Bull Run Wetland Mitigation Bank, Loudoun County Wetland and Stream Mitigation Bank, and Cedar Run Wetland Mitigation Bank, Northern Virginia – Principal Environmental Scientist: With another firm monitored annual wetland mitigation for several wetland mitigation banks in Northern Virginia (North Fork: 125 acres, Bull Run: 50 acres, Loudoun County: 100+ acres [3 separate tracts of land] and Cedar Run: 715 acres [9 separate tracts of land]). Coordinated and Reviewed hydrology and vegetation monitoring. Authored mitigation monitoring annual reports and submit to federal and state regulatory agencies.

Piedmont Wetland Research Program, Sponsored by the Peterson Family Foundation, Fairfax County, VA – Principal Environmental Scientist: With another firm initiated and managed the Piedmont Wetland Research Program. Through Research Grants awarded to Virginia colleges and universities, the PWRP's mission is to improve wetland creation and restoration in the Virginia Piedmont Region. Interaction and data sharing between the different research projects enhanced the potential applicability of their research findings.

Lawrence Witzling, Ph.D., AIA, ASLA

Senior Planner
Principal

Dr. Witzling has over 35 years experience in urban design, land use planning and architecture. His design work has won national awards for urban design from Progressive Architecture, the American Institute of Architects, and the Congress for the New Urbanism.

Prior to GRAEF, Dr. Witzling was President of Planning & Design Institute, Inc. (PDI), a firm he founded in 1988.

Education:

Ph.D., City and Regional Planning, 1976
Cornell University, Ithaca, NY

Bachelor of Architecture, 1967
Cooper Union, Manhattan, NY

Professional Affiliations:

American Institute of Architects, AIA

American Society of Landscape Architects, ASLA

American Society of Landscape Architects, ASLA – Wisconsin Chapter

American Planning Association, APA

American Planning Association, APA – Wisconsin Chapter

Congress for the New Urbanism, CNU

Planning for Sustainable Communities

Dr. Witzling has been involved in issues regarding sustainability for more than a decade. He has worked on neighborhood sustainability issues in Racine, Kenosha, and Milwaukee. He was a featured speaker at a tri-state regional conference on sustainable housing design held at Wingspread (part of the Johnson Foundation Conference Center in Racine, WI). In addition he has taught continuing education classes on sustainable development. His work includes:

- Three national design competitions addressing issues of sustainable architecture (Pittsburgh Convention Center, Chicago Public Schools, and a concept competition for sustainable communities sponsored by the AIA's Committee On The Environment).
- A region-wide design and planning charrette for the Menomonee Valley that resulted in a publication describing the valley's future and how it can be developed in a sustainable manner.
- Coordination of two expert panels on environmental quality issues, bringing together national and international experts to lead the Johnson Controls green building initiative in health, comfort, and productivity.

Environmental Planning and Design

Dr. Witzling has designed and helped implement numerous conservation projects that preserve large agricultural areas. He has also developed numerous land use plans, which have dramatically increased the number of square miles of guaranteed open space in Wisconsin. He has worked on neighborhood conservation issues in Racine, Kenosha, and Milwaukee. He has taught continuing education classes on sustainable development. Some of his projects in this area include:

- Park plans for Kenosha's lakefront
- Master plan for the Milwaukee County lakefront
- Conservation plans in Grafton, Mequon, Germantown, and Sun Prairie
- Agricultural preservation strategies for the Town of Windsor

Lawrence Witzling, Ph.D., AIA, ASLA

Senior Planner
Principal

Urban Design and Development

Dr. Witzling has been involved in urban design and development project for over three decades, garnering several national awards for his work from Progressive Architecture, the Congress for the New Urbanism and the American Institute of Architects. These projects range from downtown and district plans to the design of unique public places. His work is characterized by respect for the local context and a concern for blending traditional and time-tested concepts with innovative approaches matching today's needs. His work includes both public and private sector projects including conservation subdivisions, district and neighborhood plans, mixed-use development, pattern books, form-based and hybrid codes, regulating plans, and entitlement procedures. His expertise includes developing initial concepts as well as assisting throughout the implementation process. Dr. Witzling's completed planning efforts include:

- Plans for Milwaukee's lakefront
- Kenosha's Downtown Plan
- West Bend Riverfront Development
- Milwaukee's Park East Development
- Downtown West Bend Riverfront
- Stevens Point Downtown and Riverfront
- New Berlin's City Center
- West Allis Redevelopment
- Numerous urban design competitions
- Sun Prairie's West Prairie Village
- Conservation developments in rural areas
- Madison's Old University Avenue Redevelopment

Economic Development

Dr. Witzling has worked on economic development issues throughout Wisconsin. This work has included preparing analyses of TIF districts, generating concepts for new property development, estimating the value and benefit of area-wide build outs, meeting with developers to promote new projects, negotiating project outcomes, conducting cost-revenue analyses and conducting cost of service analyses. Dr. Witzling's work also emphasizes private development projects that are feasible and can be readily implemented by owners and municipalities. Among others, these projects have included:

- TIF analysis in the Village of Twin Lakes
- Cost-revenue analysis for freeway interchange development in Caledonia
- Cost of service analysis for the Town of Mukwonago conservation developments
- Freeway project development in the City of Sun Prairie
- Downtown redevelopment for the City of Milwaukee
- Riverfront redevelopment in the City of Milwaukee
- Rivershores Development in West Bend
- Downtown Waukesha

Public Participation

Dr. Witzling has conducted a broad variety of public participation efforts for over 30 years beginning with his published analysis of presentation techniques for maximizing public understanding and participation in neighborhood planning. He has pioneered methods for the use of:

- Physical models
- Visual preference techniques
- Graphic visualization methods
- Charrettes and workshops
- Survey design (from testing through implementation)
- Use of on-line surveys
- Stakeholder interviews
- Focus groups

His participation work ranges from small residential streets to large scale planning efforts for metropolitan areas. The subject of his participatory plans include:

- Comprehensive plans
- Neighborhood and district plans
- Downtowns and main streets
- Tax incremental financing (TIF) plans
- Industrial development
- Design guidelines
- Environmental improvements

Peter C. Ferretti, GISP

GIS Specialist

Peter Ferretti has nine years of experience as a GIS Professional overseeing operations, managing data, performing analysis, developing custom applications, and mapping for the end user. He is a highly experienced cartographic designer, proficent in data manipulation and visualization, as well as depolyment of GIS solutions. In addition to desktop GIS, Peter is proficent in web based technologies including ArcServer, ArcIMS, Flash, and Google APIs.

Professional Registration:

Geographic Information Systems Certificate Institutue (GISCI)

Education:

Diploma in Web Design / Web Develoment, 2009
The Art Instute of Pittsburgh

B.S. Geograhy; Minor in Computer End User Technologies, December 2002
University of Wisconsin-Whitewater

Certificate in Geographic Information Systems, July 2004
Pennsylvania State University

Professional Affiliations:

Wisconsin Land Information Assoication (WLIA)

Geospatial Information & Technology Association (GITA)

50 State GIS Initiative
- Elected committee member

Illinois GIS Association (ILGISA)

Technical Proficencies

Mr. Ferretti has technical experience using a wide range of GIS software and hardware. Utilizing the industry's standard ESRI Suite, he is capable of using advanced geo-processing techniques to analyze and visualize data. When in the field, Mr. Ferretti has extensive experience using Trimble GPS hardware and associated tools to locate, measure and record most any geographic feature.

Software Knowledge:

- ESRI ArcInfo 9 & 10, ArcExplorer, ArcReader
- ArcInfo Extensions including: PLTS, Network Analyst, Tracking Analyst, 3D Analyst and Spatial Analyst
- ArcGISServer & ArcIMS
- TerraSync & Pathfinder Office
- AutoCAD
- Sketchup
- Flex, Flash, Google API, Javascript, Perl, MySQL, SQL, PHP, HTML, ArcObjects, Visual Basic

Hardware Familiarity:

- Trimble GeoExplorer 6000, R8, XH, XT and Yuma GPS units
- RoadVista Retroreflectometer
- TruePulse 360 Laser Rangefinder
- TrimPix geotagging imagery

Data Analysis and Visualization

Mr. Ferretti leads GRAEF's team in data analysis and visualization. Through the integration of hardware, software, and data, he is able to capture and manage a wide range of geographically referenced information. He then analyzes and interprets the collected data, helping others to understand relationships, patterns, and trends. Through this process, Mr. Ferretti answers questions and solves problems by compiling at data that is quickly understood and easily shared.
In a recent analysis for the City of Waukesha, Mr. Ferretti combined topography, soil composition and land use patterns to develop runoff curve numbers. Visualizing the results helped the City understand potential storm water concerns.

Peter C. Ferretti, GISP

GIS Specialist

Geographic Data Capture / GPS

Mr. Ferretti has spent several years as a field crew chief and coordinator of geographic data capture projects. Utilizing Trimble GPS sub-foot accuracy equipment, he inventories a wide variety of features, incorporating the detailed attribution and associated photography needed to create a robust GIS dataset. His experience ranges from the complete inventory of water, storm and sanitary systems to the recording of wetland boundaries and other environmental assets. Additionally, Mr. Ferretti has experience coordinating sign inventories, including the gathering of retroreflectivity readings that meet FHWA standards and implementing barcode systems for sign asset management.

Mr. Ferretti was responsible for the coordination, execution and QAQC of a township-wide geographic feature inventory. Results of the project included: the collection of over 5,081 storm sewer structures with attribution and 8,324 associated photos; 534 roadway signs with retroreflectivity readings; and 503 lighting features. The collected data was then processed for quality assurance before being imported into the Township's existing asset management system.

Municipal GIS

Mr. Ferretti's experience in Municipal GIS includes working with communities to develop and maintain their own GIS programs. Collaborating closely with administrative leaders, Mr. Ferretti is able to listen to needs, make informed recommendations, and provide services which become a valuable tool for the community.

Municipal GIS Services include:

- Web Mapping Applications
- GPS Asset / Facility Mapping and Management
- Database Design and Maintenance
- School and Fire District Boundary Mapping
- 911 / Dispatch Mapping
- Document Archive and Retrieval Systems
- Vehicle Tracking / Fleet Management
- Website Development / Community Outreach Portals

Web Development / Programming

In addition to traditional GIS services, Mr. Ferretti also has a background in web-based technologies. Using ArcServer, Google API's and/or ArcIMS, Mr. Ferretti develops mapping solutions to give remote users access to otherwise inaccessible GIS data. In addition to web mapping, Mr. Ferretti creates complete websites including the use of online databases programmed in MySQL. Focusing on outreach and user interaction, he designs for the end user and creates interfaces which are both simple to use and professionally designed.

Web Technologies include:

- ArcServer / Flex / ArcIMS Web based Mapping
- Google API's
- Community Outreach Portals
- MySQL Databases
- PHP, ASP, Javascript, Flash, CSS, HTML, XML

Database Planning, Design, Implementation and Maintenance

Mr. Ferretti's experience includes the development of a wide range of databases in several environments including ArcGIS, MySQL and Mircorsoft Access. Within these structure types, Mr. Ferretti plans, designs and maintains large datasets, while ensuring data is organized and efficiently retrievable wherever needed. Recently Mr. Ferretti was tasked with designing a database to aid in the planning and budgeting of a municipality's ten-year road program. The database cataloged many characteristics of the roadways (by segment) ranging from dimensions and conditions to material costs and inflation. Utilizing the database, the client could generate reports to summarize high-priority repair areas and identify which projects could be targeted within the annual municipal budget.

Kristi Jacobs, CNU-A
Assistant Planner

Kristi Jacobs joined GRAEF after gaining several years of diverse work experience in related fields, including several years with Office of University Architects, Planners, and Transportation at the University of Wisconsin-Milwaukee. Her work experience includes comprehensive planning, neighborhood and corridor planning, space design and management, site and building design, park and trail design, statistical analysis, facilities management and municipal planning.

Education:

Masters in Urban Planning, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

Masters in Architecture, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

Certificate in Real Estate Development, 2009
University of Wisconsin-Milwaukee, Milwaukee, WI

B.S., Architectural Studies, 2005
University of Wisconsin-Milwaukee, Milwaukee, WI

Certificate in Urban Planning, 2005
University of Wisconsin-Milwaukee, Milwaukee, WI

Professional Affiliations:

American Planning Association, APA

Wisconsin Chapter of the American Planning Association, WAPA

American Institute of Architects, AIA

Congress of New Urbanism, CNU

Neighborhood Revitalization

Ms. Jacobs has worked on neighborhood revitalization efforts with several community groups, primarily in the City of Sheboygan. In conjunction with City staff, she has organized outreach efforts at the neighborhood and community-wide level, designed to generate interest and support for neighborhood associations. Outreach efforts have included public information meeting, listening workshops, and door-to-door surveys. The input gathered during public meetings is then synthesized into a series of action steps, guiding residents as they move towards a formal neighborhood association.

In addition to neighborhood organization, Ms. Jacobs provides educational assistance to residents, identifying funding opportunities for home improvement and providing contact information for various City of Sheboygan services. She also works within the City departments to enhance coordination between neighborhood-related departments, including Police, Fire, Neighborhood Inspection, and Planning & Development, and enhance their presence within the community.

GIS Mapping & Design Visualizations

Ms. Jacobs utilizes GIS technology to analyze and communicate data effectively in the form of maps, diagrams, and 3-dimensional visualizations. Using her technical abilities, she is able to clearly communicate a broad range of information with data-driven maps, including: site conditions, existing and future property information, and conceptual development plans. In addition to mapping, Ms. Jacobs has experience in creating effective 3-d models of conceptual development for a variety of projects, including:

- Village of Germantown: Holy Hill subdivision
- City of West Allis: several redevelopment projects

Kristi Jacobs, CNU-A
Assistant Planner

Urban Design & Property Development
Ms. Jacobs' experience at GRAEF includes developing design strategies for a variety of mixed-use town centers, redevelopment efforts in both large and small communities, as well as corresponding design guidelines. This includes meeting with and providing guidance to municipalities and developers, suggesting design alternatives, and performing zoning analyses. She has also conducted detailed site analyses, including parking utilization, pro formas, and used this information to develop achievable design solutions.

Project examples include:

- City of Milwaukee's 27th Street Corridor Alternatives
- MacArthur Square Redevelopment Master Plan
- City of New Berlin 2020 Comprehensive Plan
- City of Muskego: Midtown Development
- City of Stevens Point: Downtown Redevelopment
- Village of Grafton: Lumberyard Site

Comprehensive Planning
Ms. Jacobs has assisted with the development of several comprehensive plans for municipalities in urban, suburban, and rural settings. Duties on these projects include preparation of public outreach and educational materials, statistical analysis, and research into historical and existing conditions. Kristi also prepares many of the critical diagrams, illustrations, computer visualizations and animations used to depict projects.

Project examples include:

- City of Franklin
- Village of Greendale
- City of New Berlin

Public Participation
Ms. Jacobs' experience in public participation includes the creation and facilitation of outreach materials for a variety of public and private stakeholders, image preference surveys, resident and business surveys, and the outcomes.

Project examples include:

- Village of Cottage Grove
- Kinnickinnic River Neighborhood Plan
- City of New Berlin

Technical Skills
ArcGIS
AutoCAD
Google SketchUP
Adobe InDesign
Adobe Illustrator
Adobe Photoshop

Timothy J Ehlinger, PhD

Ecological Research Partners

Dr. Ehlinger is an associate professor of Biological Sciences at the University of Wisconsin-Milwaukee where he teaches aquatic ecology, fisheries, and conservation. He is the former director of the UWM Interdisciplinary Major in Conservation and Environmental Science.

Education:

Postdoctoral Studies 1987-90
University of Toronto

Ph.D. in Zoology, 1986
Michigan State University

M.S. in Ecology 1980
Northwestern University

B.S. in Biology, 1979
Northwestern University

Professional Experience:

25 years post PhD

21 years in Wisconsin

Professional Affiliations:

Ecological Society of America

American Fisheries Society

Society for Restoration Ecology

Professional Awards:

Received the Henry C. Greene Award for Innovative Approaches to Restoration from the Aldo Leopold Society, in recognition of work done on Allenton Creek (2003)

Past President of the Wisconsin Chapter of the American Fisheries Society

Dr. Ehlinger has over 30 years of experience in the fields of aquatic ecology and fisheries biology, with the past 20 years spent working in Wisconsin. His research through the University of Wisconsin-Milwaukee is focused on understanding the habitat requirements, ecology, reproduction and conservation of freshwater fishes. His extensive project experience spans the areas of reestablishment of native fishes, stream restoration, and watershed planning. He has scientific expertise in fish behavior, population and community assessments, in addition to physical habitat and water nutrient chemistry analyses. His experience includes the use of hydraulic modeling for channel/habitat design for fish passage and stream restoration, environmental impact assessments, use-attainability analyses, and the formulation of watershed management plans. His projects frequently are conducted to support the development of remediation or restoration designs, and he has interacted extensively with regulatory agencies as part of the permitting process.

Wisconsin Department of Transportation (WDOT), Allenton Creek Stream Relocation & Wetland Restoration - Contractor: This project included the biological assessment, channel design and permitting for the relocation of a 500 meter section of creek with diverse tamarack conifer wetland and enhancement of a native strain brook trout population in Washington County, Wisconsin. The work included the design, construction and monitoring for fish passage into and out from the project area..

Village of Mount Pleasant Wisconsin, Pike River Storm Water and Stream and Corridor Restoration Project - Contractor and Consultant: This project began by participation at the request of the client in a formal legal facilitation process with WDNR regarding a Chapter 30 permit that was initially denied for a flood control project. An environmental assessment review and analysis was conducted. Based upon this work a new design for channel restoration with features for fish enhancement was developed, permitted and is currently under construction.

United States Environmental Protection Agency, Development of Risk Classification System for Diagnosis of Biological Impairment in Upper Midwest Watersheds - Co-Prinicipal Investigator: This project created a regionalized model to determine ecosystem vulnerability to watershed changes, assisting in the design of monitoring systems to access potential watershed impacts of development, and identify watershed restoration opportunities. This was a competitive grant awarded by the EPA/NSF Science to Achieve Results (STAR) Program.

Arjo Wiggins / Appleton Papers Inc., Ecosystem-based Rehabilitation Plan for the Lower Fox River, Wisconsin - Sub-contractor: This project reviewed and evaluated the research and modeling related to the PCB clean up for the Natural Resources Damage Assessment (NRDA) and Resource Inventory Feasibility Study (RIFS) on behalf of the client. Work included examination and evaluation of the impacts of dams, nutrient pollution, habitat loss, exotic species and toxins (including PCBs) on the biodiversity and fish communities of the Lower Fox River. Restoration plans and designs for fish passage were prepared.

US Fish and Wildlife Service (USFWS) and Nature Conservancy, Factors Influencing the Distribution, Abundance, and Reproductive Success of the Threatened Longear Sunfish in Wisconsin - Contractor: This project developed a strategy for restoring threatened species in the Mukwonago River watershed, including provision for fish passage at 3 dams.

Illinois Environmental Protection Agency Use Attainability Analysis for the Lower Des Plaines River, Illinois - Sub-Contractor: This project identified and prioritized the hydrological, thermal, and chemical stressors responsible for limiting fish and aquatic integrity under the guidelines of the Clean Water Act. Contributions included data analysis, synthesis and evaluation of biological data and modeling, resulting in the reclassification of stream segments impacted by dams, locks and navigation.

Perrier Group of America, Environmental Assessment and Permit Application for a High-capacity Well, Big Spring, Wisconsin - Sub-Contractor: This highly controversial project involved working with a diverse group of stakeholders to conduct a Resource assessment for a proposed a high-capacity well and spring water bottling plant in Adams County, Wisconsin. As part of this project, stream and wetland restoration plans to facilitate fish restoration were prepared and implemented.

Great Lakes Protection Fund, Degradation and Recovery in Urban Watersheds- Principal Investigator: This project conducted an intensive examination of the hydrological, limnological, and biological consequences of stream flow manipulations in Southeastern Wisconsin in order to identify the critical factors required for the restoration of fish species and ecological function.

US Trade and Development Agency (USTDA), The Ecological Reconstruction and Business Assessment Strategy for Sustainable Development in Areas Affected by Mine Closures in Gorj County, Romania - Project Co-director: Work included resource assessment and the creation of an ex-ante evaluation tool for prioritization of proposed economic development projects.

Neal T. O'Reilly, Ph.D., PH

Ecological Research Partners

Dr. O'Reilly has over 30 years of water resource experience, with specialization in hydrology, water quality modeling, watershed management, lake management, aquatic ecology restoration, and environmental permitting. Neal has undergraduate degrees in Aquatic Biology and Geology, a master's degree in Civil and Environmental Engineering, and a doctorate degree in Environmental Engineering and Environmental Law. In addition to being an engineer, Dr. O'Reilly is a licensed Professional Hydrologist in the State of Wisconsin. Dr. O'Reilly was employed for fifteen years by the Wisconsin Department of Natural Resources prior to becoming a private consultant. As part of the project team he will assist with regulatory agency coordination, and review potential project for compliance with federal, state and local regulations.

Education:

Ph.D. Environmental Engineering, Marquette University, 2007

M.S. Environmental Engineering, Marquette University, 1999

B.S. Aquatic Biology and Environmental Geology, University of Wisconsin-Oshkosh, 1977

Professional Experience:

31 years in Wisconsin

Professional Registration:

Wisconsin Professional Hydrologist, No. 111-110

Professional Affiliations:

ASCE

North American Lake Management Society

City of Neenah Glatfelter Paper Mill Redevelopment Project: Assisted the City of Neenah in the acquisition of environmental permits for the redevelopment of an abandoned paper mill site on the Fox River in Wisconsin. The project included preparation of permit applications, erosion control and stormwater management plans, environmental assessments, and negations with regulatory staff at the Wisconsin Department of Natural Resources and U. S. Army Corps of Engineers.

City of Neenah West Canal Project: Facilitation of state and federal permits for the filling in of an abandoned navigation canal to allow construction of a new office tower and parking structure. The project included preparation of permit applications, erosion control and stormwater management plans, environmental assessments, and negations with regulatory staff at the Wisconsin Department of Natural Resources and U. S. Army Corps of Engineers.

Lower Des Plaines River Use Attainability Analysis and Classification: Preparation of a Use Attainability Analysis under Federal Regulation 40 CFR 131 for the Lower Des Plaines River in Chicago, Illinois. The study area includes one of the most industrialized river sections in America, and the project involved several groundbreaking issues related to implementation of the clean water act. Based on a detailed analysis of water quality and aquatic resource data. The project team recommended a new classification for the water body that compiled with the Clean Water Act. Water quality standards for the new designation were developed. As part of the project acted as the facilitator for an advisory committee made up of stakeholders and several special topic sub-committees.

Alto Creek Wetland Restoration Project: Creation of a series of low-head dam structures to improve water quality treatment in the Alto Creek watershed of Fox Lake, Wisconsin. The project involved construction of four low-head weir structures designed to force runoff to spread into the riparian floodplain vegetation during small and moderate sized storms. In addition to water quality benefits the project was designed to facilitate northern pike spawning. The weir structures were designed with fish passageways. The project included acquiring of permits from federal, state and local units of government, and construction observation.

City of Elgin Riverfront Project, City of Elgin, Illinois:

The project involved design and permitting of riverfront improvements along the Fox River in downtown Elgin, Illinois. As part of the project a river walk was designed along the bank on the river. The river walk included replacement of concrete and sheet pile armoring with natural vegetation. At the toe of the bank habitat for Small Mouth Bass was integrated into the toe stabilization. In the river larger boulders were placed to provide fish cover during high flows. A fish passageway and canoe chute was designed for integration into the Kimble Street Dam. The project included acquiring of permits from federal, state and local units of government.

Monches Millpond Dam Replacement Planning:

Prepared a conceptual design for the replacement of the Monches Millpond Dam to be coordinated with the replacement of a county highway bridge. Facilitated an intergovernmental agreement between the North Lake Management District, Waukesha County Highway Department and the Town of Merton. Negotiated with the Wisconsin Department of Natural Resources to identify state regulatory requirements and final design criteria. Conducted an evaluation of floodplain impacts using HEC-RAS and a dam break analysis.

Oconomowoc River Stabilization Project:

Preparation of stream restoration project for the Oconomowoc River below the recently removed Funk's Dam, including a feasibility study of alternatives and preparation of final plans and specifications, bidding documents and regulatory permits. A fish passageway for Northern Pike, Smallmouth Bass and Slender Madtom (Noturus exilis) an endangered species was integrated into the site design.

Menomonee River Valley Conservation Project:

Evaluation of the potential of returning the channelized sections of the Menomonee River and its banks to a more natural state, creating of wetlands and improving recreational access to the river. The project includes construction of one of the first wetland restoration projects located in a major downtown urban center. As part of the project a fish passageway and fish ladder were designed.

Similar Projects

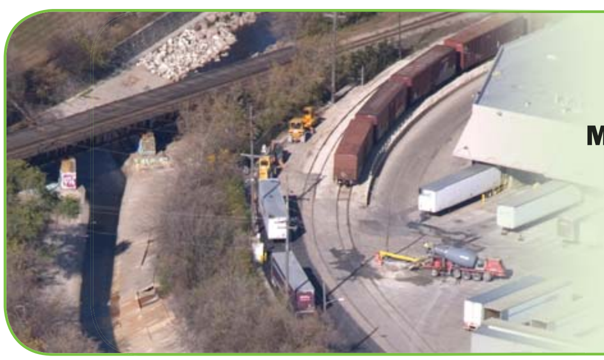
GRAEF has included a variety of projects that encompass the breadth of expertise within the team. Additionally, three of these projects have been highlighted as project references, including:

Bartlett Ravine Openlands Preserve
Bob Megquier
Openlands / CorLands

rmegquier@corlands.org
312.863.6272

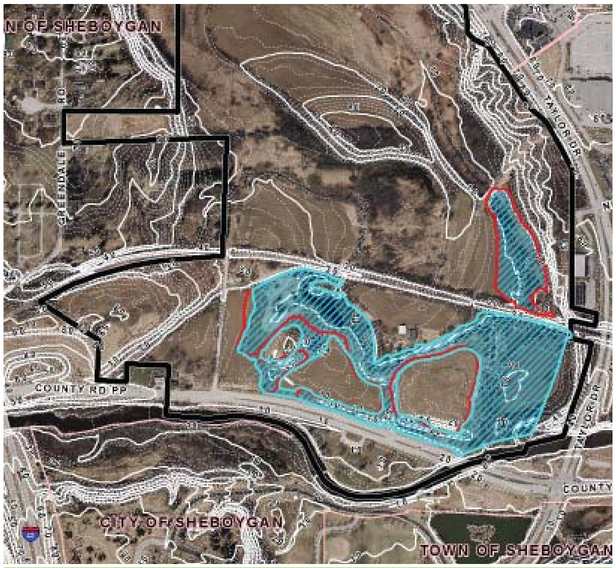
Wade House Historic Site Visitor Center & Carriage Museum
Joe Sokal
Wisconsin Department of Administration, Division of State Facilities

Joe.sokal@wisconsin.gov
608.266.2608



Menomonee River Fish Passage
Tom Chapman
Milwaukee Metropoitan Sewerage District

TChapman@mmsd.com
920.886.6240



Schuchardt Farms Property Site Analysis

Client:

City of Sheboygan

Location:

Sheboygan, WI

Site Feasibility Analysis

GRAEF worked with the City of Sheboygan to prepare a site feasibility analysis for the 205 acre site and determine how the site could be developed to serve as a high quality conservation office park. Conditions reviewed include:

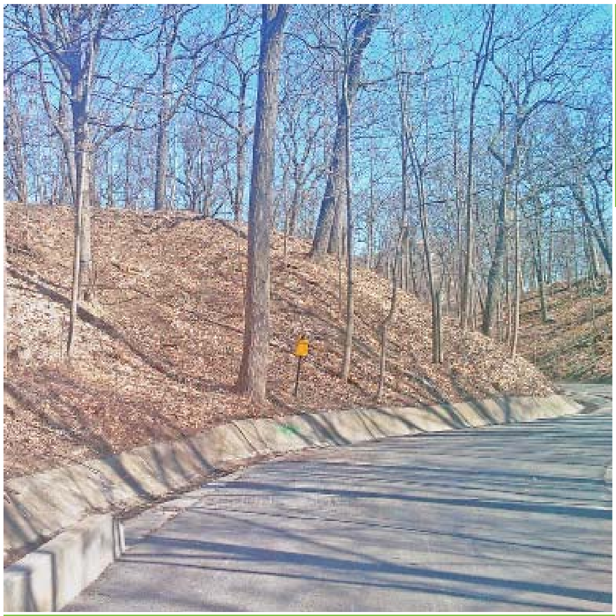
- Environmental restrictions
- Utility services
- Topography and storm water management
- Archaeological sites
- Threatened and endangered species
- Soil conditions
- Zoning review and impacts
- Traffic access management.

Based on the existing conditions, and discussions with the City, GRAEF prepared a conceptual diagram indicating how the parcel could be developed, including recommendations for utility services, site access, and parcel configurations. The combination of environmental features and proximity to the interstate make this site an ideal location for an office park or mixed-use development.

Green Development

Integrating environmental features and views into projects often increases the value of the project while protecting high quality habitats. What could be viewed as development constraints can be integrated into a trail system, storm water treatment system, or enhanced views which add value to the overall development and can serve as a precedent for conservation development practices.

GRAEF



Bartlett Ravine Openlands Preserve

Client:

Openlands

Location:

Fort Sheridan, IL

Services:

Master Restoration Plan

Infrastructure Improvements

Plant Community Restoration

Best Management Practices

Project Data:

Lead Consultant: GRAEF

Subconsultants: CDF and W-K

The GRAEF team was retained by Openlands to prepare a restoration plan for the Bartlett Ravine in 2008. The overriding goal of the project was to find a balance between ecological restoration and maintenance of the infrastructure that both serves the surrounding residential community and stabilizes the geomorphology of the ravine. Our highest priority was to identify and protect remnant plant assemblages on the side slopes of the ravine that were being threatened by gradually increasing shade from invasive trees and shrubs. This shady habitat was causing a die-back of fibrous-rooted native sedges and grasses and ultimately the destabilization of surface soils. Also of high concern was the potential global failure of concave sections of the side slopes because one area had experienced this failure in the recent past.

A master restoration plan was completed and implemented in the winter of 2008 – 2009. The restoration plan included a timeline of activities and specifications, including an estimate of costs for infrastructure improvements and plant community restoration.

In addition to slope erosion, Bartlett Ravine showed signs of infrastructure deterioration including failure of the road pavement and the underlying storm sewer at the ravine bottom. The causes included excessive volumes of stormwater runoff conveyed to the ravine via storm sewers and overland flow down the ravine side slopes. A hydraulic model of the existing storm sewer system was developed to determine specific causes. The model was analyzed under varying recurrence interval storm events to determine the capacity of the existing system. The results indicated there were several portions that were under capacity. This work prompted the client to hire a contractor to scope and clean the existing storm sewer system. GRAEF worked with the contractor to identify sections of the system that were displaced or were being encroached by root systems or other debris. Once complete, GRAEF began developing design and construction solutions for specific sections of the system.

Solutions to slope erosion within the ravine were developed by GRAEF through hydrologic calculations that determined the rate and volume of flow discharging to the ravine slopes. Mitigative measures such as rain gardens and detention were analyzed to determine possible reductions in the quantity of the storm water being discharged to the ravine. Best Management Practices were also reviewed and proposed at the downstream end of the ravine to reduce the rate and volume of flow that was causing erosion.

Wade House Historic Site Visitor Center & Carriage Museum

Client:

State of Wisconsin

Department of Administration

Services:

Environmental Impact Statement

Master Planning

Natural Resources

Landscape Architecture

Civil Engineering

Structual Engineering

Location:

Greenbush, WI

Project Data:

35,000 SF Learning & Visitor Center Using Low-Impact Design Principles

GRAEF worked with the State of Wisconsin Department of State Facilities and the Wisconsin Historical Society on the development of a 35,000 square-foot Visitor Center and Carriage Museum at the Wade House Historical Site in Greenbush, WI. In addition to the historical significance one of the major project goals is to accurately display what rural Wisconsin would have looked like during the early 1900s. This is planned to begin as soon as visitor enter the facility as they will be transported "back in time" thought the historical and carriage exhibits within the building as well as through the design of the adjacent landscape. As the guests enter the rear courtyard they will be treated to vistas of a traditional Wisconsin Farmstead as they wait for a horse drawn carriage of sleigh depending on the season. The horse drawn experience will begin with a traditional Plank Road and will include a tour of the restored landscape including the crossing of the Mullet River, a class II trout stream. The tour will allow all visitors to experience a traditional Wisconsin community as they would have during this time period.

To accomplish these goals the master planning had to begin with the identification and protection of the ASNRI waterway and the adjacent wetlands and upland plant communities. It was the intent of this project to be good stewards of the land, so the upmost care was taken to preserve and enhance these truly unique environments. This development utilizes several low impact development techniques, such as walkout buildings, pervious convertible exterior spaces that result in reduced grading and increase infiltration. Additionally a complex storm water system was designed to improve the water quality and to reduce the temperature of the storm water as it eventually reaches the Mullet River. Furthermore the entire site will be planted with native plants and will include reclamation of all exposed boulders into several stone fences. This project will become a landmark project for the State Historical Society and will become a model for low impact development within rural Wisconsin. The project is planned to be completed in the Fall of 2012.

GRAEF

Menomonee River Fish Passage

Client:

Milwaukee Metropolitan Sewerage District

Subconsultants:

Ecological Research Partners

Services:

Channel Hydraulic Modeling

Fish Passage Analysis & Design

Channel Redesign

Structural Engineering

Permitting Assistance

Report Preparation

Location:

Milwaukee, WI

GRAEF provided hydraulic modeling and channel design services for the removal of 1,100 linear feet of concrete channel lining on the Menomonee River from the Wisconsin Avenue Bridge north to the end of concrete at the downstream limits of the Milwaukee Metropolitan Sewerage District's (MMSD) Drop Structure Removal project. Project goals included: the removal of the failing concrete channel lining, maintaining existing flood flow conveyance capacity without increasing downstream flood elevations, and the successful passage of fish species through the reach and into the miles of upstream tributary areas for spawning and recreation fishing. This project is funded in large part by a grant from the Great Lakes Restoration Initiative, as well as MMSD, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service.

This reach of the Menomonee River is approximately 75 feet wide with stone retaining walls and a trapezoidal concrete channel bottom. The stone walls were installed by the Works Progress Administration (WPA) in the 1930's and the concrete channel lining was installed in the late 1960's. The concrete channel lining has served a useful purpose in the conveyance of flood flows greater than what would be expected of the channel with a natural channel lining. However, the concrete has reached the end of its useful life and is in need of significant maintenance or replacement. In addition, the concrete channel lining has increased river velocities in this reach to a level that is insurmountable by most fish species and has become a stopping point for the migration of fish upstream.

GRAEF worked with Ecological Research Partners to evaluate the potential of returning the channelized sections of the Menomonee River and its banks to a more natural state, creating of wetlands and improving recreational access to the river. Using the current "Effective" HEC-RAS model, GRAEF considered several alternatives for concrete removal and fish passage enhancement. The preferred alternative approved by MMSD, WDNR, and SEWRPC was for the complete removal from concrete and the installation of a naturalized boulder lining for the channel bottom and installation of a series or riffles and pools to manage river velocities and allow the passage of fish to the upstream tributary areas.

The overall project also included permitting with the WDNR for work in a navigable stream, review of historic and endangered species potential, an environmental site assessment, and a materials management plan for the removal and disposal of potentially contaminated materials removed during construction. Ecological Research Partners' contributed to the construction of one of the first wetland restoration projects located in a major downtown urban center. As part of the project a fish passageway and fish ladder were designed.

McMahon Woods Forest Preserve

Client:

Openlands Land Preservation

Services:

Wetland and Savannah Prairie Restoration

Management Planning

GIS Database Creation

Groundwater Analysis

Rare Species Habitat Protection and Enhancement

Secondary Source Investigation

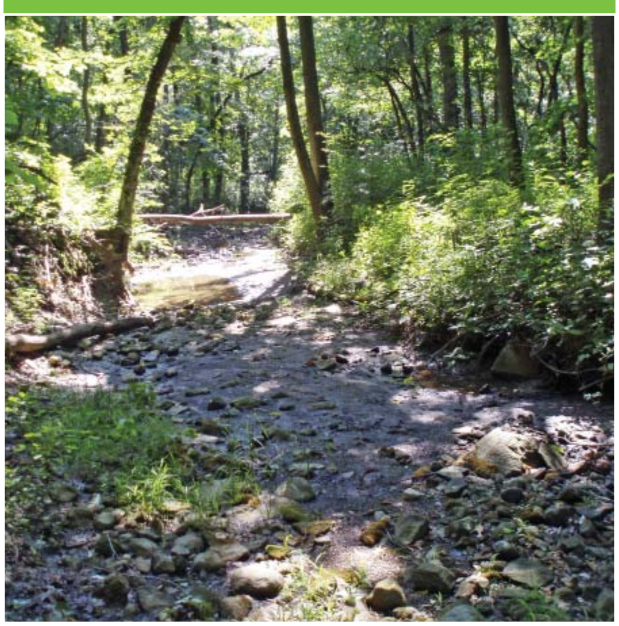
Location:

Southwest Cook County, IL

Project Data:

470-acre Site

15-acre Fen Habitat



GRAEF evaluated natural resources at the McMahon Woods Forest Preserve to plan the restoration, enhancement and protection of unique plant communities that include rare species habitat. Central to the study was a rare groundwater-fed wetland complex (fen) in the central portion of the site that is a known habitat for Hines Emerald Dragonfly, a federally endangered insect species. The evaluation team included wetland scientists, biologists, soil scientists, hydrologists, hydrogeologists, and ecologists.

GRAEF developed a restoration and maintenance strategy that provides a sustained environment for target rare species and for conservative plant communities that may provide habitat for other, yet to be identified rare species. As a result, both floral and faunal diversity within the preserve will be improved for future generations. Additionally, GRAEF completed annual vegetation monitoring and developed an ongoing analytical and tracking tool to assist the Forest Preserve District of Cook County (FPDCC) in monitoring the health and development of these restored communities and predicting potential outcomes of future restoration strategies prior to implementation.

The work was completed in coordination with Openlands, FPDCC, the U.S. Army Corps of Engineers Chicago District, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency and other state and local parties.

Lockport Prairie Nature Preserve

Client:

Openlands Land Preservation

Services:

Flow Monitoring

Ground water Elevation Monitoring (seven years)

Surface Water Modeling

Water Budget Evaluation

Ecological Gap Evaluation

Railway Sediment Study

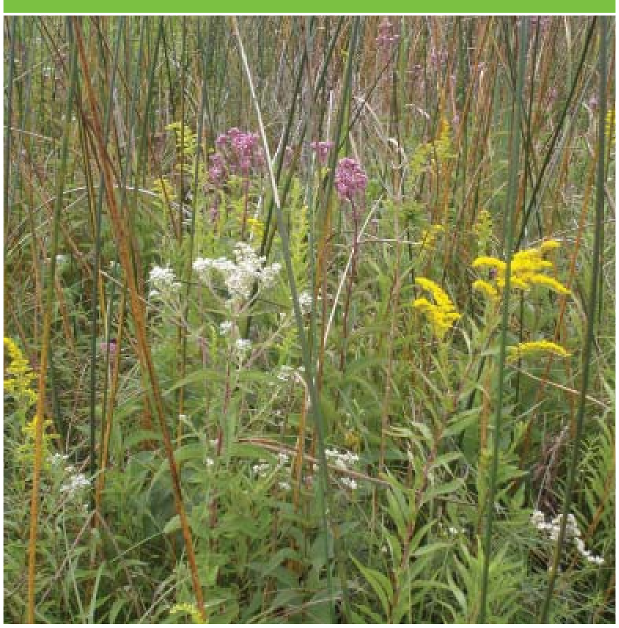
Evaluation of Rivulet Thermal Data

Land Use Analysis

Ground Water Model

Location:

Lockport, IL



Lockport Prairie Nature Preserve currently contains the highest concentration of high-quality dolomite prairie in the state of Illinois. The ecosystem is supplied by ground water from a dolomite aquifer that crops out along a 40-foot high bluff. Ground water enters through seeps along the bluff, and then the seepage water flows across the site through rivulets that traverse the dolomite prairie.

GRAEF was selected to evaluate the surface and subsurface hydrology supplying the habitats. GRAEF installed nine monitoring well nests with 27 wells and 23 well points and measured surface water flows at four culverts and four rivulets. The monitoring work was part of an overall effort coordinated by the U.S. Army Corps of Engineers in conjunction with the Corporation for Open Lands, the US Fish and Wildlife Service and the Forest Preserve District of Will County. GRAEF prepared both surface and ground water models of the site to evaluate the mechanics of flow, analyze water budgets, and evaluate future threats to the long-term sustainability of the preserve habitats.

GRAEF performed an ecological data gap analysis in order to determine what suites of information were needed to properly manage the preserve to assure its long-term sustainability. The data gap evaluation included biological data, surface water data, ground water data, geological data and soils data. Recommendations were made to the Lockport Prairie Technical Advisory Team based on the most critical data gaps.

In addition, GRAEF evaluated the land use in the vicinity of the preserve to evaluate how development trends will impact the sustainability of the preserve habitats. Three zones were identified immediately west of the preserve, based on the potential for impacting a change on the hydrology of the preserve. GRAEF evaluated Best Management Practices (BMPs) for ground water discharge and developed a plan to optimize recharge within the preserve recharge zone.

Midewin Tallgrass Prairie Ecological Restoration

Client:

Openlands Land Preservation

Services:

Plant Assessment

Wetland Delineation

Hydrological Assessment

Hydrologic Monitoring

Plant and Animal Monitoring

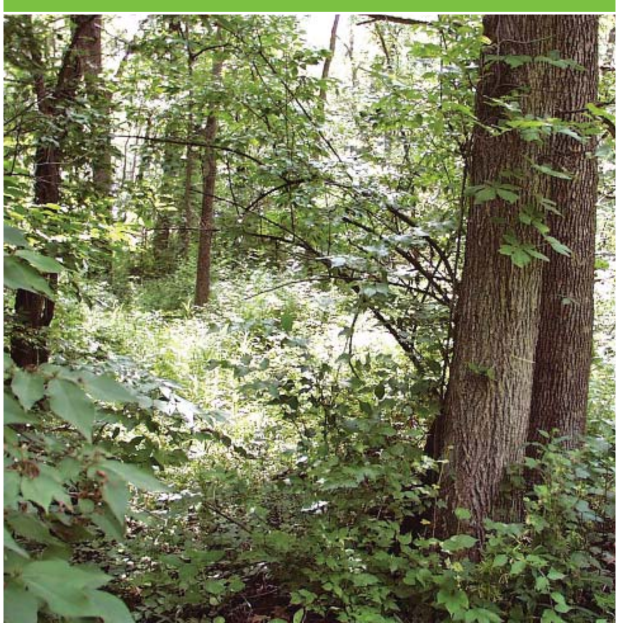
Brush and Tree Removal

Herbiciding

Ecological Restoration, Planning & Research

Location:

Will County, IL



The Prairie Creek Area project within the Midewin National Tallgrass Prairie involved soil mapping, soil moisture, meteorlogical groundwater and vegetative monitoring before and after selective removal of woody vegetation in the shrub and tree strata. This vegetation was within a corridor associated with a tributary to Prairie Creek near its confluence with the Kankakee River in Will County, IL. The bulk of the woody vegetation targeted for removal was comprised of invasive plant species.

The goal of the project was to improve diversity of native plant species in the understory and restore nutrient and water cycling that is more balanced to the plant communities. GRAEF provided monitoring of meteorological conditions, vegetation, soil moisture, and hydrological patterns on the site in an adjacent control area as well as in the area where woody vegetation was removed. GRAEF's role was to map the soil series, monitor for baseline conditions, and document soil moisture and groundwater changes over a two year period following the plant removals.

After two years of monitoring, the various data sets were statistically analyzed to verify if there were differences between the experimental and control areas. Sufficient data was collected to demonstrate if statistically significant changes occurred during the growing season that were not present before and after the growing season.

Deer Grove Forest Preserve

Client:

Openlands Land Preservation

Location:

Northwest Cook County, IL

Services:

Subsurface Drainage Design

Wetland Delineation & Mitigation

Restoration & Enhancement Concepts and Design

Hydrologic & Drainage Analysis

Topographic Survey

Drain-Tile Review

Natural History Evaluation

Project Data:

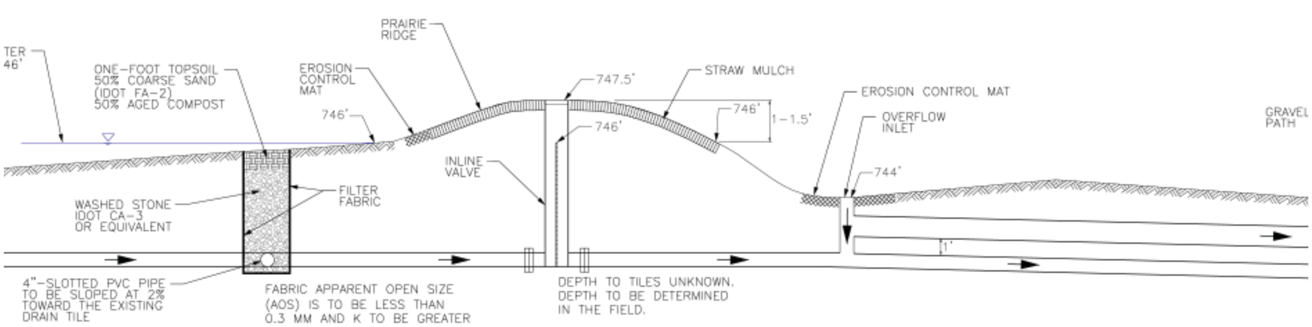
1,800 acre site

GRAEF evaluated the natural resources at Deer Grove Forest Preserve near Palatine, IL. Deer Grove was identified as a possible site to compensate for permitted losses of wetlands as a result of the expansion of O'Hare International Airport. The goals for this project were to develop a restoration and maintenance strategy that met the compensation requirements for offsite wetland impacts, enhanced rare species habitat, and restored conservative plant communities.

The impacts of selected hydrologic restoration on wetland hydrology were evaluated by monitoring the response of wetlands to temporary drain tile blocking. Based on the hydrologic responses, plans and specifications were prepared to guide the restoration. Hydrologic restoration efforts included blocking tile systems, modifying culvert elevations, constructing shallow berms, installing water control structures and underdrains, and installing small water impoundment structures to counteract historical ditching.

Cultural features immediately adjacent to the restoration areas required creative methods to prevent hydrologic impact to these features from the restoration efforts. Primarily, the Forest Preserve District was concerned with flooding of trails and recreational areas. As a result, overflow structures and subdrains were added to the designs to maintain dry conditions at the trails and paths adjacent to the restoration areas.

Because multiple agencies were involved, GRAEF's plans met the conflicting restoration requirements of the site owners (the Forest Preserve District of Cook County), the client, the US Fish and Wildlife Service, and the Corps of Engineers.



Romeoville Prairie

Client:

Openlands Land Preservation

Location:

Will County, IL

Services:

Hydrological Assessment

Hydrologic Monitoring

Ecological Restoration, Planning and Research

GRAEF was retained to assess the causes of the degradation of a Nature Preserve, and to develop remediation alternatives. The assessment primarily focused on the impacts to the Nature Preserve from offsite stormwater drainage. Arresting and reversing the encroachment of low-quality species into the high-quality wetland area was a key element of the project that required controlling surface water discharges to the Preserve. Design of additional water control structures required detailed knowledge of the amount of water and the pollutant load that the upland areas delivered to the Preserve.

The first phase of the project involved performance of a preliminary investigation for the site, with the goal of gathering, reviewing, and summarizing readily available background information for the prairie. Phase 2 of the assessment was a detailed investigation and analysis of the hydrology and hydrogeology of the Preserve. A detailed vegetation survey of the high quality wetlands within the north prairie area was performed.

Topographic and other land use data collected during Phase 1 were integrated with the hydrological and vegetative data collected during Phase 2 to create a comprehensive database for the Preserve, in GIS format. Phase 3 consisted of the preparation of plans and specifications for earthwork and surface water control structures. Phase 4 consisted of hydrologic monitoring before, during and after implementation of the restoration efforts.

Liberty Prairie - Oak Openings

Client:

Openlands Land Preservation

Location:

Lake County, IL

Project Data:

100-foot Wide Stream Corridor

Services:

Wetland and Stream Restoration

Ecological Restoration

Invasive Species Monitoring

Streambank Monitoring

The Liberty Prairie Conservancy (LPC) received a grant from Openlands - Wetland Restoration Fund to continue ecological restoration of the Oak Openings Riparian Corridor, a 100-foot wide corridor contiguous with Bull's Brook. Surveys of pre-existing conditions have indicated a shrub layer dominated by non-native, invasive species which include common buckthorn (Rhamnus cathartica) and honeysuckle (Lonicera sp.). Dense shade has precluded the establishment of a significant herbaceous layer within the bed of Bull's Brook, on its bank, and on riparian upland slopes. The restoration program outlined by the LPC within the grant application for the riparian corridor identifies two main components - vegetation management and the use of bioengineering techniques for streambank stabilization and habitat improvement.

GRAEF was retained to monitor the Liberty Prairie - Oak Openings Riparian Corridor and determine the efficacy of restoration efforts. GRAEF efforts included monitoring the stability of stream cross sections at three locations, qualitatively assessing wildlife habitat at five locations, and measuring water quality and flow discharge within the stream.

GRAEF used a Swoffer current velocity meter to collect depth and velocity data at three stream cross sections. The depth and velocity data were used to calculate discharge at the three sections. Changes in discharge along the stream segment were used to infer surface water/groundwater interactions. The numerous data sets were integrated to assess the overall condition of the stream.

Little Menomonee River Realignment

Client:

Weston Solutions, Inc.

Location:

Milwaukee, WI

Services:

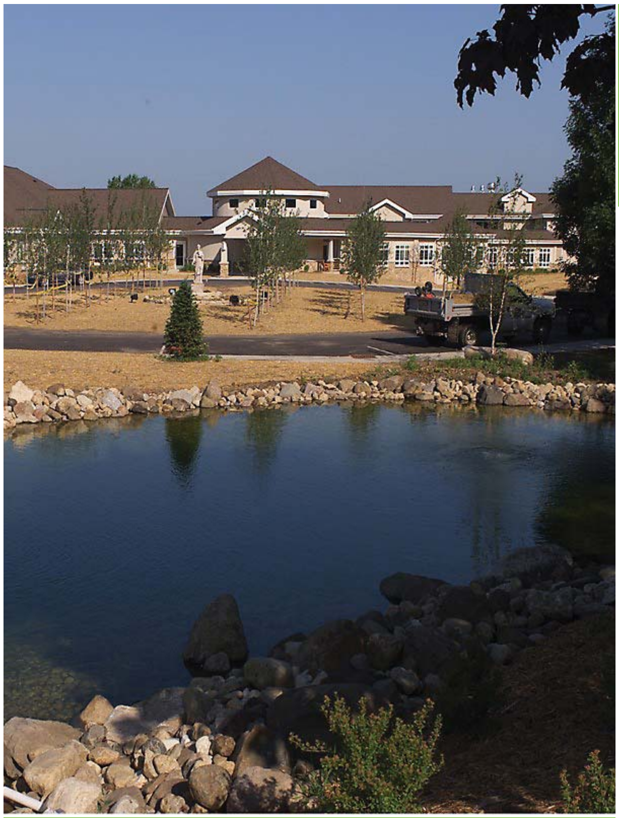
Wetland Delineation

Rare Species Surveys

Vegetation Monitoring

GRAEF conducted wetland delineations, rare species surveys, and vegetation monitoring within the 100-year floodplain of an approximately 5-mile stretch of the Little Menomonee River in the City of Milwaukee, Wisconsin. The study area consisted of Reaches 1 through 5 of the Little Menomonee River from Brown Deer Road to just south of Silver Spring Drive. The focus of this Superfund Project was the clean up of a contaminated stretch of river due to leachate from a former creosote wood treatment plant. The clean up was carried out by realigning the Little Menomonee River and reseeding the new banks within the construction corridor with a native seed mix. Prior to the rehabilitation of the river, GRAEF delineated and mapped wetland boundaries and located rare species as part of the process to determine the new alignment of the river.

Following the realignment of the Little Menomonee River and plant community reseeding, GRAEF conducted vegetation monitoring along Reaches 1 through 3 to measure the progress and analyze the success of the plant community restoration. Presence of the planted species, percent cover, and species diversity were the metrics used to evaluate the success of the reseeding. This data was collected at randomly selected quadrants at set sampling transects. Comprehensive plant species lists were also collected for each of the reaches.



Congregation of the Sisters of St. Agnes Sustainable Master Plan

GRAEF worked with the Sisters of St. Agnes and the Hoffman Corporation to design a sustainable master plan and congregation campus for the Sisters of St. Agnes. The unique site contains both natural and cultural amenities, which provide many exciting sustainable design opportunities. The site is located partially atop the Niagara Escarpment, which create numerous stream channels that flow throughout the property. This site has been home to the Sisters for over one hundred years and contains numerous religious monuments and sacred sites including a public cemetery.

To buffer the expanding city of Fond du Lac and maintain the peaceful beauty of the site, GRAEF landscape architects , wetland ecologists, and plant specialists are helping the Sisters to restore the site to native vegetative communities. Some of these restoration projects include large areas of non-native mowed lawn that will be restored to native prairie grasses and wildflowers, navigable and perennial stream channels that will be restored and enhanced, invasive plants will be removed from wetland areas, and remnant oak and hickory forests will be expanded. Walking paths will link these different natural areas of the site with the new convent campus. The overall campus development included the development of a new convent and office complex, an ecological hermitage village, a labyrinth, the restoration of the Niagara Escarpment, a recreated oak-hickory forest and many acres of restored native prairie.

A major design goal was to plan and design the development to take advantage of all of the natural site features while reducing the impact on the natural landscape. The buildings were developed with the site and offer fantastic views of Lake Winnebago and audible sensations of a natural stream. The site was developed utilizing only native plants and includes a restored tall-grass prairie with a network of walking trails connecting the entire campus. The entire development was designed to create a legacy of sustainable development that will live on in the sisters' name, and promote their strong beliefs and connection to nature.

Client:

The Hoffman Corporation

Location:

Fond du Lac, WI

Services:

Landscape Architecture

Master Planning

Sustainable Design

Project Data:

327 Acres

Sustainable Site Design in Two Phases

University of Wisconsin-River Falls Student Center

GRAEF provided landscape design, site/civil engineering, structural engineering and sustainable design for the student activities center at the University of Wisconsin-River Falls. Students partially funded the project and required that the building meet the U.S. Green Building Council's Silver level of LEED certification. GRAEF developed design strategies to achieve LEED points for sustainable sites while remaining within the budget.

The site made achieving LEED site points extremely challenging. The project included a significant amount of new parking and the only available location was adjacent to a trout stream and wetlands. GRAEF studied several alternatives for achieving LEED points related to stormwater management and site disturbance, while facilitating the City of River Falls, United States Army Corps of Engineers and Wisconsin Department of Natural Resources permitting. A small parking lot to serves the needs of the building and additional parking was placed elsewhere. Stormwater control for the entire site is handled through a system of interconnected infiltration basins that allows stormwater to be absorbed into the soil. These basins are used as landscaped medians within the parking lot. A large portion of the stormwater is collected in cisterns and reused.

Client:

State of Wisconsin–Division of State Facilities

Location:

River Falls, WI

Services:

Site/Civil Engineering

Landscape Architecture

Structural Engineering

Sustainable Design

Project Data:

140,000 square feet

$20 million project cost

Followed LEED® Silver guidelines

GRAEF

West Bend Mutual Insurance Expansion

Client:

West Bend Mutual

Services:

Master Planning

Structural Engineering

Site/Civil Engineering

Landscape Architecture

Location:

West Bend, WI

Project Data:

214,000 square feet addition

$57 million project cost

Award:

2010 WIASLA Merit Award, General Design

West Bend Mutual Insurance's headquarters is located on 160 acres of restored natural prairies and woodlands in West Bend, Wisconsin. GRAEF provided structural engineering, civil engineering and landscape architecture for an addition which doubles the company's amount of space. West Bend Mutual added 214,000 square feet, three stories and a 440-car parking structure to its existing building. A major challenge of the addition was to create the site to look as if all of the improvements have been in place for many years.

Several outdoor spaces were created that will allow for entertaining, contemplation and recreation. A central courtyard was also designed to provide for more intimate gatherings. The landscape features an outdoor hospitality plaza which overlooks a naturalized pond and waterfall, a central outdoor courtyard, and rolling hills planted with native grasses and forbs.

West Bend Mutual's campus addition includes a 440-space parking ramp, outside parking, and a 20,000 square foot detached support building. The parking structure is cast-in-place, post tensioned and intended to blend the structure in with the site's topography.

Hoffman Corporate Headquarters

Client:

Hoffman Corporation, Inc.

Location:

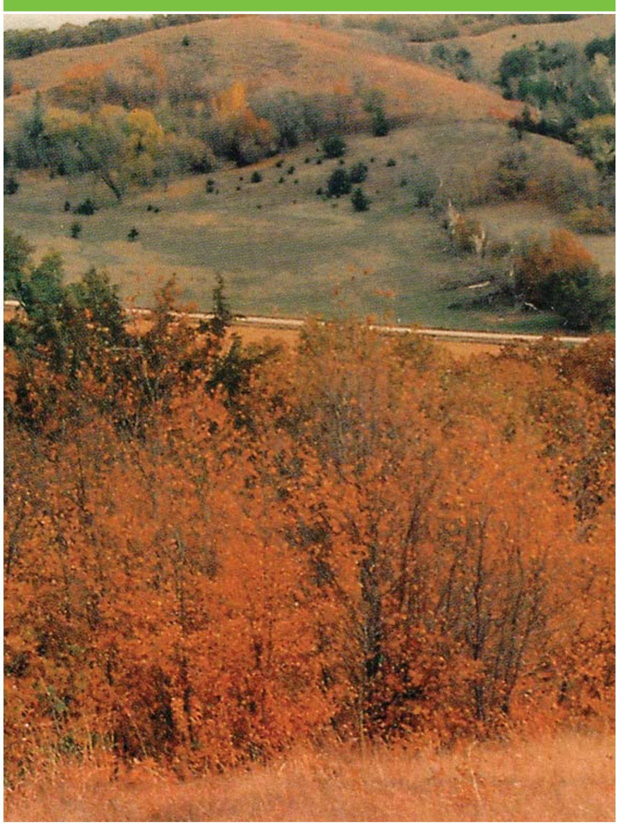
Greenville, WI

Services:

Sustainable Design

Project Data:

28-acre office park



GRAEF provided sustainable oversight on the development of a new, sustainable corporate headquarters for Hoffman Corporation, Inc. on one of four parcels of a 28-acre office park in Greenville, Wisconsin. The facility sets the stage for future development planning and construction or restoration/enhancement on the site.

Oversight for sustainable practices included:

- Maintaining a green, sustainable vision and perspective throughout the project
- Served as the sustainable site design leaders
- Permitting of innovative activities
- Critical review on all aspects of construction and design
- Created education and community linkages for Hoffman's corporate park theme "A Path of Discovery"
- Short and long-term site maintenance plans
- Public relations and corporate image

In addition, GRAEF staff designed the site to include native wetland, oak savanna and tall grass prairie, mixed hardwoods, and mixed conifer communities that surrounded the site. Planting design and specific species lists and cost estimates were provided.

The Legend at Brandybrook

GRAEF was responsible for the development of a golf club and community on a rural, 428-acre parcel of land located within the Kettle Moraine. This club is a truly family-oriented development that will be the model of future private club development.

The development of the golf course and residential community was created with the intention of eliminating disturbance to existing forests, wetlands, and several spring-fed tributaries. During the natural resource inventory and analysis, 85 acres of wetlands were identified, cataloged, and delineated. The design of the master plan also allowed GRAEF to take advantage of the natural topography for stormwater control and treatment. Stormwater features included retention ponds, dry detention basins, created wetlands, infiltration swales, and level spreaders to protect the Brandy Brook.

This development not only includes a fantastic playable destination-type golf course and a wonderful residential community, it is also one of the first examples of how a golf course and community can be designed to actually enhance, preserve and improve the environment. Many government bodies are currently using this development as a model for environmentally conscious development.

A total of 85 acres of wetlands were delineated on the project site by GRAEF scientists and their fuctional values were assessed. Wetlands on the site were determined to be "groundwater-fed," and two areas were identified as calcareous fens, a very rare type of wetland plant community that is provided special protection under Wisconsin Administrative Code. GRAEF developed a site design that minimized wetland impact and resulted in no loss of wetland acreage. A WEPA/NEPA Type II Environmental Analysis was prepared for the Wisconsin Department of Natural Resources.

Client:

Kuhlman, Inc.

Location:

Wales, WI

Services:

Wetland Investigation & Delineation

Plant & Animal Assessment

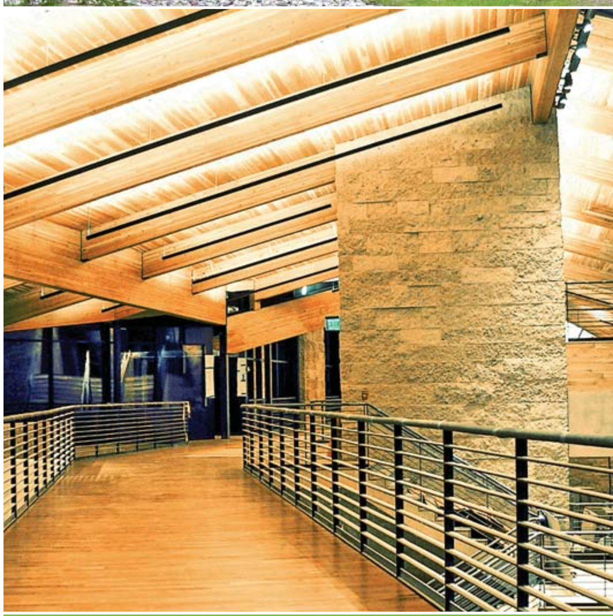
Phase II Environmental Impact Assessment

Stormwater Engineering

Project Data:

428-acre Site

85-acre Wetland Delineation



Indian Community School and Community Center

Client:
Indian Community School of Milwaukee

Location:
Franklin, WI

Services:
Site/Civil Engineering
Structural Engineering
Environmental Engineering

Project Data:
172 acres
160,000 square feet
$50 million project cost

The Indian Community School of Milwaukee is constructed on a 172-acre wooded site in Franklin, Wisconsin. Designed by Antoine Predock, the recipient of the 2006 AIA Gold Medal, this unique facility is as fundamental to the site as the ancient bur oak and shagbark hickory trees that were preserved by thoughtful planning and design. The facility is home to a grade school and community center with classroom space, library, gymnasium, auditorium, cafeteria, administrative office space and meeting rooms.

GRAEF provided site/civil and structural engineering, surveying, and environmental services, including a Phase I environmental assessment, wetland delineations and tree survey. The 160,000 square foot building follows the natural contours of the site, creating organic shapes. The building shape combined with the flying copper roof and large glass enclosed gathering spaces posed some interesting structural design challenges. Due to the complexity of the project, our structural team developed a three-dimensional model of the entire building. Plans, elevations, and section drawings were generated from the model. The model was presented to the architect to minimize design conflicts and provide the basis for additional analytical models needed for the design.

Village of Fontana Conservation & Sustainable Development

Client:

Fontana Community Development Authority

Location:

Fontana, WI

Environmental Protection

GRAEF planners and landscape architects worked with Cedarburg Science and the Community Development Authority to design several environmental and park areas in the Village. Emphasis was on environmental protection of the watershed, creeks, and tributaries which all contribute to the natural beauty of the area and Lake Geneva water quality. An Environmental Enhancement Plan was set priorities for protection, enhancement, and maintenance.

Landscaping Details

Native species were selected for all landscape areas and street trees, with an emphasis on minimizing long-term maintenance needs. The street trees provide a variety of fall colors along the boulevard in the Fall, and are compatible with the soil types. Special attention was given to landscaping and shading an adjacent cold-water stream (Class I trout stream) to protect the fish and wildlife habitats.

Pedestrian-Friendly Character

A path, partially funded through a WisDOT grant, is located along the west side of the highway with links to the lakefront, elementary school, and active recreation area. Pedestrian-scaled lights and landscape features enhance the overall character of the boulevard. GRAEF worked with the Village engineers to extend adjacent sidewalks and improve the safety of all the connecting streets.

Before and after photos, left, show the significant change and value added to the community.

GRAEF

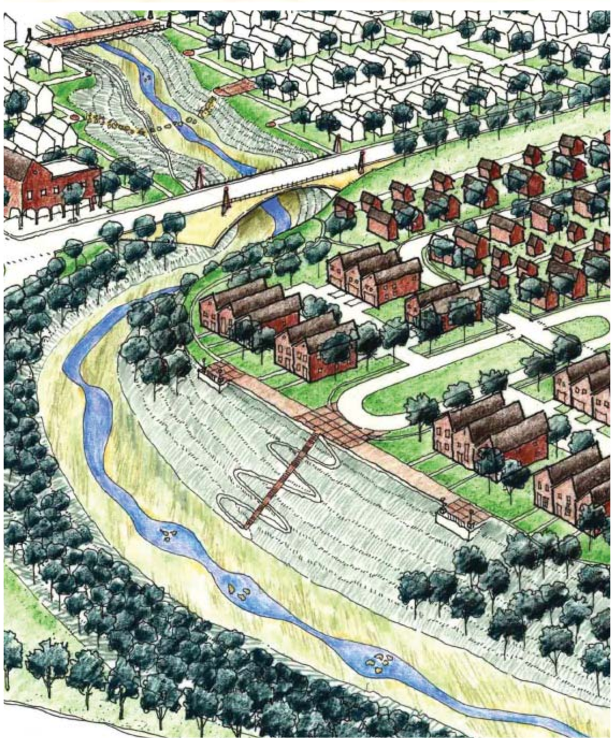
Kinnickinnic River Corridor Neighborhood Plan

Client:

Milwaukee Metropolitan Sewage District (MMSD)

Location:

Milwaukee, WI



Project

GRAEF planners developed neighborhood plans and public educational materials to assist in the redesign and channelization of the Kinnickinnic River. Located in a dense urban area, the river has flooded several times causing enormous property damage as well as major safety problems. The new plans will also require property acquisitions in the area – a major concern for local residents.

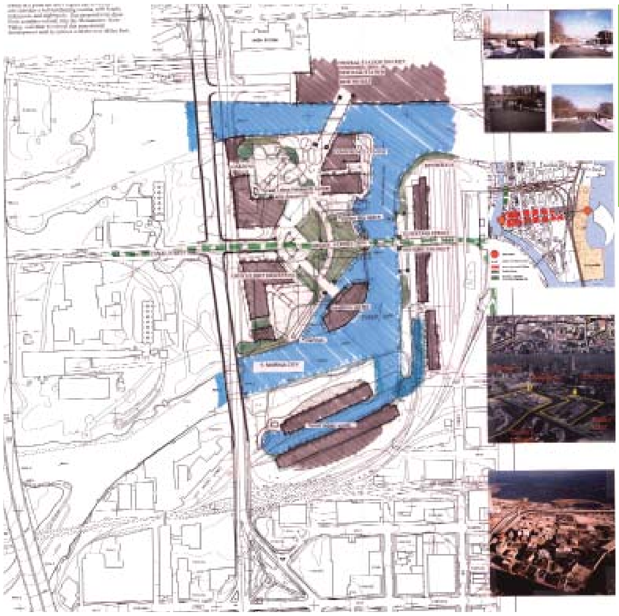
Participation Process

GRAEF planners have developed concepts that have helped explain the challenges and opportunities to a highly diverse neighborhood. The work has included open house presentations, surveys, PowerPoint presentations, focus group meetings, and highly detailed graphics. The audiences have include home-owners, whose houses may be acquired for new plans, as well as neighborhood residents, businesses, elected officials, community leaders and other professionals involved in the project.

Planning Outcome

Public input led to specific changes in concepts and the current plan has received support from many individuals and groups within this diverse neighborhood. The final plan will document the public participation process and offer well-illustrated options to the numerous challenges and opportunities presented by the redesign of the Kinnickinnic river channel.

Menomonee Community Public Participation

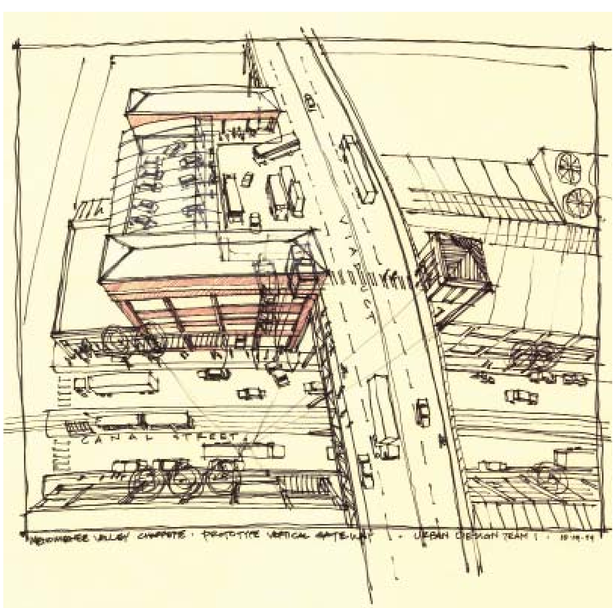


Client:

Menomonee Valley Partners

Location:

Milwaukee, WI



Project

GRAEF planners assisted the Menomonee Valley Partners and other community groups in a multi-year project to involve numerous community groups, local leaders, technical experts, and the general public in generating new concepts for the revitalization of the Menomonee River Valley.

Community Workshop/Charrette

This effort involved numerous public meetings and a 50-person workshop/charrette in which new concepts were crested for the Menomonee River and the associated land use options. In addition to the workshop/charrette, other participatory techniques used by GRAEF planners included: open houses, web-based publications, stakeholder interviews, surveys, and a variety of techniques for facilitating group discussion. The final outcome led to a major effort to redevelop the valley follow seven specific principles for sustainable revitalization.

National Design Competition

The next step was the development of a community-sponsored national design competition which designers from around the world to create concepts for a signature effort to revitalize the river and the industrial park. GRAEF planners prepared the successful grant proposal to the National Endowment for the Arts and managed the competition process, including community input and public education. The winning solution was implemented and new industrial development; along with major riverfront improvements have been implemented.

Scope of Required Services

The Schuchardt Property study area is approximately 205 acres and is bordered by CTH PP and the Sheboygan River on the south, Greendale Road on the west, Erie Avenue on the north, and South Taylor Drive on the east. The site is split in the north south direction by an existing railroad controlled by Union Pacific, as well as Willow Creek runs through the site. Willow Creek is considered an Area of Special Natural Interest (ASNRI) by the Wisconsin Department of Natural Resources (WDNR) and requires specific permitting processes. Further, based on previous studies, there are approximately 60 acres of delineated wetlands within the property with the remaining land comprised of upland area (primarily farmland). The area is bordered by residential development on the west, and commercial development to the north and east. The current site has a few homestead sites with various areas for farming and significant areas of grassy marsh lands.

In May 2011, GRAEF worked with the City of Sheboygan to complete a site feasibility analysis for the Schuchardt property. The site has recently been annexed from the Town of Sheboygan and the Conservation Plan represents the next major step in developing a plan that promotes economic development and job growth, while protecting and enhancing the natural amenities offered by the site. The following scope includes the items outlined in the RFP Scope of Services, as well as additional tasks that GRAEF believes will ensure a successful planning process.

TASK 1: REVIEW OF PREVIOUS REPORTS AND ONGOING EFFORTS

As an initial task, GRAEF will review past reports, studies, maps, aerial photographs, and topographical information provided by the City of Sheboygan to understand previous investigations of the site. Based on the review of materials, the GRAEF team will prepare a summary of: critical findings, potential impacts on preservation and development, proposed preservation and development recommendations, and a list of any additional data that is needed. Items to review will include recommendations, and a list of any additional data that is needed. Items to review:

- Wetland delineations
- Topographic survey with river cross sections
- Preliminary FEMA floodplain analysis
- Natural heritage inventory review
- Site development regulations and limiting factors
- Willow Creek stream assessments

Additionally, information relating to the ongoing “Sheboygan AOC Pathway to Delisting Habitat BUI’s Survey and Assessment” project will be reviewed by the entire team.

The information obtained during the initial review of information will be used to inform field investigations in later tasks and gain a more thorough understanding of the site and potential critical resource issues.

TASK 2: ORIENTATION MEETING (Added Task)

Following the review of previous reports and ongoing efforts, GRAEF will conduct an orientation meeting with City and DNR staff to review the findings of Task 1, discuss the proposed scope and schedule, and determine if additional data is needed prior to GRAEF conducting their field work.

TASK 3. HABITAT ASSESSMENTS - FIELD INVESTIGATION

Task 3a: Preparation of Base Map Materials

In preparation for the field investigation, GRAEF will prepare a preliminary plant community map using existing GIS data such as soils, topography, wetlands (GIS shapefile from Thompson delineation) and aerial photographic signatures. The maps will be downloaded into a GeoXH 600 series Global Positioning System and used to verify and if necessary, refine plant community boundaries in the field.

Task 3b: Preparation of a Quality Assurance Project Plan (QAPP)

GRAEF will prepare a QAPP following the guidance presented in United States Environmental Protection Agency (USEPA) document entitled EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5, March 2001).

Task 3c: Inventory and Assessment

Utilizing the basemap developed in Task 3a, GRAEF and Ecological Research Partners will complete an inventory of streams, wetland and upland plant communities, preparing plant species lists and noting dominant, invasive, and rare/notable species and/or plant community presence and location. We will classify the various plant communities using the Wisconsin Natural Heritage Inventory Natural Community Classification system. The team will assess habitat quality and potential wildlife and fish use, and document wildlife observed during the field investigation. Digital photographs will be utilized to document existing conditions and make note of potential restoration areas.

Task 3d: Forestry Reconnaissance – Field Investigation

GRAEF will perform a forest stand investigation and summarize findings according to the procedures outlined in the Public Forest Lands Handbook to the extent practicable. As part of the investigation, GRAEF will complete a stand examination data sheet (Form 2400-26) or similar form for each stand to determine forest composition, habitat type, forest health, and concentration of invasive species. Based on an approximation of 50 forested acres comprised of four different forest stand types, 12 tenth-acre plots will be established to obtain field data. Plot center will be GPS-located. GRAEF's data collection will include species identification, number of trees per acre, basal area (using 10BAF), average stand diameter, evidence of insect/disease, and invasive species percent cover. Trees of significant size and quality will be noted. Forest classification will be based on both the Forest Habitat types listed in the Public Forest Lands Handbook and the Wisconsin Natural Heritage Inventory Natural Community Classification system.

Task 3e: Wetland Functional Assessments – Field Investigation

GRAEF will perform functional assessments on the five wetland areas previously delineated by Thompson and Associates, referenced as A through E, in their October 22, 2009 Wetland Report. On-site review of the wetland habitats will use the Rapid Assessment Methodology for Evaluating Wetland Functional Values (RAM – WDNR, 1994).

TASK 4: PLANT COMMUNITY MAPPING AND REPORT PREPARATION

GRAEF will prepare a report that documents the field investigations conducted in Tasks 3, including a description of the plant communities and their overall quality. Rationale and methods that were used will also be described. Other supporting documents will include completed RAM (wetland assessment) forms, plant species lists with calculated FQI's, and forest stand examination data sheets. A detailed Plant Community map will be prepared to supplement the report. Additionally, GRAEF will supplement the report with a recent aerial photograph, GRAEF's site photographs, and three additional maps: (i) Site Location Map; (ii) Wisconsin Wetland Inventory Map (excerpt); and (iii) a Soils Map.

TASK 5: CONSERVATION AND RESTORATION PRIORITIES

Based on report findings, field work, and discussions with the City and the DNR, GRAEF and Ecological Research Partners will identify critical areas to conserve and/or restore. We will prepare a diagram illustrating the proposed conservation/restoration areas, along with potential linkages, access, and priorities for which areas shall be restored. Priority discussion will focus on current environmental conditions, existing habitat, potential impact to the environment based on site work, scenic views and values, and the effect conservation/restoration may have on the wildlife, plant community and project identity.

TASK 6: IDENTIFICATION OF STORMWATER INFILTRATION AREAS

GRAEF will overlay the NRCS soil mapping information over the Schuchardt Farms Property and will review the soil data for infiltration potential of the plotted soil types using the WDNR, Standard 1002. Based on this review we will determine the potential and the location for stormwater infiltration. We will recommend appropriate storm water BMPs for the site and future development to promote conservation and protection of the natural resources.

TASK 7: STAKEHOLDER AND REVIEW MEETINGS

Input from the project stakeholders will be crucial to the successful implementation of the Conservation Plan. GRAEF recommends an integrated participation approach in order to gain feedback throughout the project. The following approach can be discussed and revised as needed at the Orientation Meeting in Task 2.

Task 7a: Stakeholder Interviews

GRAEF will conduct 4 to 5 stakeholder interviews to gather input about the property, priorities, challenges, and vision. This will take place within one half-day session at the City Hall and can be one-on-one interviews or group interviews with the identified partners.

Task 7b: Committee and Staff Meetings (2 meetings)

As part of an ongoing review process, GRAEF will: (1) Conduct a review meeting with the committee and staff to discuss the stakeholder input and initial field work results; present field work findings and implications. (2) Present the Draft Conservation Plan to the committee and staff for input and direction.

TASK 8: DRAFT CONCEPT PLAN

GRAEF will prepare a Draft Concept Plan identifying areas to be preserved/restored, proposed roads, critical site access points, proposed trail system, development parcels, potential building sites, utility access, stormwater management and features, and phasing. The Plan will outline total proposed acres for preservation and development.

In addition to emphasizing development strategies designed to conserve and restore natural amenities within the site, GRAEF will also utilize their development expertise to promote implementable recommendations to support work force development and sustainable economic development within the City.

TASK 9: CONSERVATION PLAN

A Conservation Plan, which summarizes the activities of Tasks 1 through 8 will be prepared. It will synthesize all of the activities and will document the process for completing the field work, habitat assessments and the rationale for prioritizing areas for conservation, restoration or development. The plan will include GIS maps of the data collected, assessments and a draft concept plan.

TASK 10: COMMON COUNCIL PRESENTATION AND FINAL PLAN

GRAEF will present the revised Conservation Plan to the Common Council for discussion and approval. GRAEF will make minor edits as directed by the Council and provide 20 Final Report copies and digital files to the City.

OPTIONAL TASKS

OPTIONAL TASK A: GPS REFINEMENT OF PLANT COMMUNITIES

Using a Global Positioning System, GRAEF will refine (if necessary) plant community boundaries that were preliminarily depicted using aerial photograph signature alone. Also, the team will use GPS to document smaller plant communities that may have been missed by aerial review.

OPTIONAL TASK B: STORMWATER INFILTRATION FIELD INVESTIGATION (IF REQUIRED)

If the soils appear to be suitable for infiltration based on the analysis, further investigation is required to determine the specific locations and infiltration rates achievable. We will work with a qualified soil boring consultant to dig and evaluate 5 test pits on site. The information will be summarized in a written report.

OPTIONAL TASK C: PERMITTING AND PLAN FOR CONSTRUCTION

After the concept draft master plan is completed a plan for permitting, engineering and construction phasing and sequencing is critical for protection of the natural resources. We will determine the appropriate permits required, present engineering solutions for infrastructure construction to limit the impact on the natural resources and develop a construction sequencing and phasing plan to reduce soil erosion and protect the watershed.

OPTIONAL TASK D: DESIGN GUIDELINES AND ZONING

A plan for conservation of the natural resources is the first step in creating a high quality development like this. The next step, just as critical to the project's success, is setting the design standards and guidelines for the development of the individual parcels. These guidelines will set forth important items which may include property line setbacks, Floor Area Ratios, landscape surface ratios, height limitations, maximum parking ratios, storm water management expectations, site lighting, architectural requirements and perhaps LEED certification.

Proposed Timeline

	Task	Week 1	2	3	4	5	6	7	8	9	10	11	12
1	**Previous Reports Review**												
	Review of Previous Reports and Ongoing Efforts	■											
2	**Orientation Meeting**												
	Orientation Meeting	■											
3	**Habitat Assessments - Field Investigation**												
3a	Base Map Materials		■										
3b	Quality Assurance Project Plan			■									
3c	Inventory and Assessment			■	■								
3d	Forestry Reconnaissance			■	■								
3e	Wetland Functional Assessments			■	■								
4	**Plant Communities**												
	Plant Community Mapping and Report Preparation				■	■							
5	**Conservation and Restoration**												
	Conservation and Restoration Priorities					■	■						
6	**Stormwater**												
	Identification of Stormwater Infiltration Areas				■	■	■						
7	**Input Meetings**												
7a	Stakeholder Meetings				■								
7b	Review Meetings					■				■			
8	**Draft Concept Plan**												
	Draft Concept Plan						■	■	■				
9	**Conservation Plan**												
	Draft Conservation Plan							■	■	■	■		
10	**Common Council Presentation & Final Plan**												
10a	Common Council Presentation											■	
10b	Final Plan												■

Additional level of effort

	Task	Week 1	2	3	4	5	6	7	8	9	10	11	12
	GPS Refinement of Plant Communities					■							
	Stormwater Infiltration Field Investigation						■						
	Permitting and Plan for Construction										■	■	
	Design Guidelines and Zoning										■	■	■