

Ashland/Chequamegon Bay Shoreland Restoration Project

Quality Assurance Project Plan

EPA Grant Funding Source:
Grant #: GL00E00462-0

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Prepared: 31 October, 2011
Revision #: 4

Approvals:

Date:


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11-11-11


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11-2-11


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11-15-2011


Brea Grace, Director, City of Ashland Dept. Planning
and Development

11/11/11

Elizabeth LaPlante, GLNPO Grant Manager

Louis Blume, GLNPO QA Manager

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Distribution List

- Michael Meyer, WDNR Research Scientist, Project Management and Reporting
- Brick Fevold, WDNR, Research Scientist, Project Design and Implementation
- Brea Grace, Director, City of Ashland Dept. Planning and Development
- Alyssa Core, City of Ashland, Environmental Projects Coordinator
- Cathy Techtmann, U.W. Extension, Project Outreach Coordinator
- Paul Rassmussen, WDNR Scientist, Project Statistician
- Darienne McNamara, Coordinator, NCWMA, Invasive Plant Control
- Tom Fratt, County Conservationist, Ashland County LWCD
- Donalea Dinsmore, WDNR Quality Assurance Coordinator
- Elizabeth La Plante, USEPA, Project Officer
- Sandra Duran, WDNR Grant Specialist

Executive Summary

In this project, we propose to restore 4,100 feet of public shoreland in the City of Ashland, WI, to native plant communities, reduce invasive species, and measure the ecological benefits by quantifying wildlife population responses as well as changes in non-point nutrient loading to Lake Superior. Industrialization of Ashland's waterfront in the early 1900's significantly altered the natural environment of the shoreline. What is now needed is restoration of these post-industrial lands to more natural shorelines to enhance scenic beauty, protect the region's ecology, and provide opportunities for recreation and tourism.

A. Project Organization

Principle Investigator:

Dr. Michael Meyer, Research Scientist, WDNR Bureau of Science Services.

Dr. Meyer has a Ph.D. in Wildlife Ecology and is the project Principle Investigator. Dr. Meyer has 15 years research experience quantifying impacts of human settlement on glacial lakes, as well as developing and testing restoration methods. A manuscript describing the ongoing Wisconsin Shoreland Restoration Project (Lakelines, Spring 2009) is included in proposal uploads. Dr. Meyer is responsible for project management, implementation, and reporting.

Co-Principle Investigator:

Brick M. Fevold, Research Scientist, WDNR Bureau of Science Services.

Mr. Fevold has a B.S. and M.S. in Wildlife Ecology and a Graduate Certificate in GIS (CGIS), and has 18 years experience in applied environmental science including temperate and tropical terrestrial vertebrate research and biological diversity assessment, freshwater wetland inventory and mapping, and geo-spatial database development. Mr. Fevold is a project co-Investigator and is the Project Lead in design and implementation.

Project Collaborators:

Brea Grace, Director, City of Ashland's Department of Planning and Development.

Ms. Grace has been involved with urban planning for 10 years, including land use and environmental controls, brownfield redevelopments, economic development, and grant administration. Ms. Grace will oversee the City of Ashland's partnership, grant project coordination and public outreach.

Alyssa Core, Environmental Projects Coordinator with the City of Ashland.

Ms. Core has a BS in Biology and is a project partner. Her experience includes grant administration, native plant restorations, invasive species control, storm-water pollution monitoring, and public education. Ms. Core will coordinate restoration activities within the City of Ashland municipal framework and assist in restoration implementation and public outreach.

Darienne McNamara, Coordinator, Northwoods Cooperative Weed Management Area.

Ms. McNamara has been involved in managing invasive species for nearly 10 years, including aquatic and terrestrial invasive plants. She has a B.S. in Environmental Studies, and is a Certified Pesticide Applicator. Mrs. McNamara will coordinate the invasive species control workshops.

Cathy Techtman, Professor, Dept. of Community Resource Development, U.W. Extension.

Ms. Techtman has a M.S. in Natural Resource Management, a Secondary Teaching Certification in Biology, and over 25 years of experience in developing and marketing community educational outreach programs. Ms. Techtman will assist with coordination and implementation of the decision maker's workshop, interpretive kiosks, and shoreland restoration blog.

Tom Fratt, Conservationist, Ashland County Land and Water Conservation Department.

Mr. Fratt has a B.S. in Biology and Wildlife Management, and a M.S. in Fisheries Management. Tom works with private landowners and local governments in Ashland County to reduce soil erosion, protect water quality, and improve wildlife habitat. Tom will provide technical expertise on soil and shoreland conservation methods and guidelines.

Figure 1: Project Organizational Chart

Name	Affiliation	Roles and Responsibilities
Mike Meyer	WDNR Science Services	Project Coordinator, Grant Administrator, Project Coordinator, developing contracts and MOUs, data analysis, report writing.
Brick Fevold	WDNR Science Services	Project design and restoration implementation. Design and conduct surveys to quantify ecological benefits. Supervise research assistants. Work with Project Coordinator/Manager to develop long-term monitoring plan.
Alyssa Core	City of Ashland	Coordination of City of Ashland public works project support. Development of kiosks for education and outreach purposes.
Brea Grace	City of Ashland	Coordination of City of Ashland committee and council support of project objectives.
Darienne McNamara	Northwood's Cooperative Weed Management Area	Conduct the invasive species control workshops and work with Project Coordinator to develop long-term treatment plan.
Sandy Duran	WDNR Science Services	Oversee grant expenditures, contracts, financial reporting requirements.

Cathy Techtman	UW Extension	Coordination of education and outreach activities related to stakeholders workshops.
Paul Rasmussen	WDNR Science Services	Review the experimental design and statistical analysis of project surveys.
Randy Lehr	Northland College	Supervise development of project tool kit and website. Sponsor restoration field staff.
Tom Fratt	Ashland County	Provide guidance on appropriate conservation practices at the Chequamegon Bay restoration sites.
Donalea Dinsmore	WDNR Great Lakes Office	Oversight of quality assurance/quality control practices.

Vendors, Contractors and Businesses:

Implementation of this project involves coordination of expertise and services from multiple vendors, including individual businesses that specialize in ecological restoration, native plant propagation, irrigation network installation, and materials supply. The following list categorizes contractors according to their services and/or products. The vendors and private businesses listed here are those selected based on a competitive bid process and/or because they are a competent local or regional business that offer services or products needed by the project. By servicing our project needs through these businesses, we are able to improve wildlife habitat, protect water quality, beautify a regional public resource, and at the same time contribute significantly to the local and regional economy.

Analytical Laboratories:

Soil and Plant Analysis Laboratory; 8542 Mineral Point Road, Verona, WI 53593 Ph.: (608) 262-4364
Wisconsin State Laboratory of Hygiene; 465 Henry Mall, Madison, WI 53706, Ph.: (888)-494-4324

Landscape Design:

Northern Native Plantscapes; 25350 S. Garden Ave., Cable, WI 54821, Ph.: (715) 794-2548

Private Native Plant Nurseries:

Hanson's Garden Village, LLC; 2660 County G, Rhineland, WI 54501, Ph.: (715) 365-2929
Dragonfly Gardens; P.O. Box 192, Amery, Wisconsin 54001, Ph.: (715) 268-7660
Wildflower Woods; Washburn, WI, Ph.: (715) 373-0214
Leaning Pine Nursery; Ph.: (715) 398-5453

DNR State Plant Nurseries:

Hayward Nursery; Rt. 8, P.O. Box 8213, Hayward WI 54843, Ph.: (715) 634-2717

Irrigation Systems/Equipment:

Green Lawn Underground Sprinklers; N 580 Brandenburg Ave., Merrill, WI 54452, Ph.: (715) 539-1133

Tools, Hardware and Supplies:

Ashland Agricultural Center; Ashland, WI, Ph.: (715) 682-2688
Ace Hardware; Ashland, WI, Ph.: (715) 682-2102
Ace Hardware, Woodruff, WI, Ph.: (715)
True Value Hardware; Ashland, WI, Ph.: (715)

Problem Definition/Background

In this project, we propose to restore 4,100 feet of public shoreland in the City of Ashland, WI, to native plant communities, reduce invasive species, and measure the ecological benefits by quantifying wildlife population responses as well as changes in non-point nutrient loading to Lake Superior. Industrialization of Ashland's waterfront began during the mid to late 1800's and over time has significantly altered the natural environment of the shoreline. Lumber mills, wharves for handling coal, ore, limestone, logs, and pulpwood directly and negatively impacted the ecology of a shoreline that once was completely covered by forest and other vegetation. While much of the industrial development ended during the mid 20th century, significant amounts of debris still pollute Ashland's waterfront, including slab wood, large and small concrete sections with exposed rebar, and remnants of former dock facilities. What is now needed is restoration of these post-industrial lands to more natural shorelines to enhance wildlife habitat and scenic beauty, protect the region's ecology, and provide opportunities for recreation and tourism. This proposed work is an extension of ongoing Wisconsin Department of Natural Resources (WDNR) research on inland glacial lakes in Vilas County, WI (the Wisconsin Shoreland Restoration Project), and represents a partnership between WDNR Bureau of Science Services, the City of Ashland, Ashland County Land

and Water Conservation Department, the Northwoods Cooperative Weed Management Area, University of Wisconsin Extension, and Northland College's Sigurd Olson Environmental Institute, Ashland, WI. This partnership recognizes the ecological, economic and social values of a healthy shoreland habitat. The proposed project will be an addition to efforts coordinated through the Fish Creek Watershed Restoration and Management Plan funded through National Fish and Wildlife Foundation's Great Lakes Watershed Restoration Program (GLWRP), and will include: water quality assessments across the City's waterfront, mitigate run-off entering the bay, and demonstrate the best management practices that protect or improve water quality. It will also recognize and align with the priorities, goals, and objectives of the Lake Superior Lakewide Management Plan (LaMP).

Project Objectives

It is our goal to enhance the ecological functioning of City of Ashland Chequamegon Bay shoreland properties through control of invasive plant species, restoration of native plant communities, and reduction of shoreland erosion and nutrient run-off. The ecological benefits of these activities will be quantified by comparing wildlife and ecological response among restored (treated) and un-restored (control) experimental plots. These response measures will be contrasted against an independent stretch of undeveloped shoreline that will be considered as a reference. Results and recommendations for Best Management Practices will be communicated through a coordinated education and outreach effort. Project integrity and transparency will be insured via a rigorous QAPP and GLAS reporting requirements. To meet these goals we have established 4 objectives which are described below, along with specific tasks associated with each objective.

Detailed performance measures:

This project is primarily interested in the following list of likely performance measures.

Outcome indicators: target endpoints and units of measure:

- Total linear length affected by restoration activities: 4100 ft
- Total shoreline area infested by woody invasive species: 0 ft
- Total area reduction in woody invasive plant control: 75-90%
- Percent storm water run-off reduced: no baseline, to be determined

Project/Task Description and Schedule

Project/Task overview

1. Restoration Implementation – Design and Implement Restoration

The restoration design is based on the understanding that both sites are located in Wisconsin's northernmost Ecological Landscape (EL) referred to as the Superior Coastal Plain (SCP) Ecological Landscape. The most noted physiognomic attributes of the Superior Coastal Plain Ecological Landscape include a red lacustrine clay soil plain that slopes down toward the Lake Superior shoreline, and which is separated west to east by a comparatively rugged landscape composed of sandstone escarpments known as the Bayfield Peninsula. The Apostle Islands archipelago is an extension of this physiographic feature. Other environmental conditions that are considered influential in defining this region's ecological landscape include: cooler summer and generally warmer winter temperatures, greater precipitation, and greater exposure to consistently high winds (and wave action) as result of lake-effect seasonal storm events.

Prior to and during early European settlement, the region represented by the lacustrine clays of the SCP Ecological Landscape was almost entirely covered by a mosaic of coniferous and hardwoods forest. These forests reflected a distinctive boreal forest structure and tree species composition composed primarily of white pine, white spruce, balsam fir, paper birch, balsam poplar, trembling aspen, and northern white cedar. The SCP Ecological Landscape contains Wisconsin's northern most natural community structure and composition indicative of boreal forest. Closely related forest community types exist in other portions of this Ecological Landscape where soils, aspect, elevation and exposure to natural disturbance differ. Northern mesic- and dry-mesic forest, continue to be more prevalent on the glacial tills found in the Bayfield Peninsula and the Apostle Islands. Along major rivers, such as the Bad and St. Louis rivers, extensive wetlands occur including lowland forests and freshwater estuaries.

An important aspect of this project includes integrating biodiversity elements (plant spp., genetic stock, range distribution, etc.) into the planting design to allow for climate-induced successional change (or selection) that will not be detrimental to the success of the ecological restoration. With this in mind, planting stock is being sourced from multiple nursery growers located regionally as well as the southern distribution of our native species Midwest range.

Task 1-1 Planning and Restoration Design – This is the conceptual design and planning phase of the restoration project, and will take place prior to implementing the restoration activities on the Memorial Park (MP) and Bayview Park (BV) properties managed by the City of Ashland. Prior to conducting the ecological restoration, a thorough assessment will be conducted to determine what native plant communities are suitable for each of the city park sites given soil and other conditions as well as to what extent restoration will occur. Additional planning and design components will include taking into consideration the public-use needs, City staff oversight and coordination, and seasonal and long-term maintenance requirements and costs.

Task 1-2 Restoration Installation – We will draw from a variety of expertise and standard restoration methods, techniques and guidelines to implement a comprehensive restoration effort on approximately 4,100 feet of shoreland area. Technical and professional resources used will incorporate NRCS guidelines as prescribed in the NRCS Biology Technical Note 1, and professional expertise provided by staff representing organizations that include the NRCS, WDNR, Ashland County Land and Water Conservation District, U.W. Extension Service, City of Ashland, Members of the Northwood's Cooperative Weed Management Area (NCWMA) and contracted landscaping specialists. Specific sub-tasks, including a description of how we will address each are listed in section B.

2. Quantifying Ecological Benefits

Our research goal is to demonstrate that ecological restoration of impacted (degraded) lake-shoreland can be a cost-effective land management tool to reconstruct damaged ecological processes resulting from lakeshore clearing of original vegetation, bank compaction, and simplification of local biodiversity. Determining whether the actions associated with ecological restoration of a given unit of land is result of the prescriptive restoration methods is not a straightforward test as implied in techniques using before-after-impact approaches. We will quantify the benefits of the Ashland/Chequamegon Bay Shoreland Restoration by measuring wildlife and physical responses at 2 different geographic scales: 1) a site-level scale to measure response measures associated with terrestrial vertebrate populations, and 2) at an experimental plot-level to quantify measures associated with soil characteristics (biotic and abiotic) and changes in non-point surface-water-nutrient run-off to Chequamegon Bay.

3. Education, Outreach and Stakeholder Involvement

Task 3-1 Invasive Species Control Workshops (concurrent to current park management practices)

Target audiences: Chequamegon Bay residents.

Target dates: Summer and Fall, 2010; Spring, Summer, Fall, 2011.

Activity/output description: A minimum of three terrestrial invasive species control workshops will be hosted to educate and engage local residents in hands-on control. Participants will spend three hours removing invasive species, and learn about the invasive plants at the site. Each person will receive a copy of the new WDNR Pocket Guide to Terrestrial Invasive Plants, along with other printed materials from the Midwest Invasive Plant Network, UW-Extension, WDNR and Northwoods CWMA. Workshops will be modeled after the successful events hosted by the NCWMA in local communities over the past three years, such as the National Public Lands Day events hosted at the Invasive Free Zone in cooperation with the US Fish & Wildlife Service. NCWMA workshops typically draw 15-30 volunteers from all ages and backgrounds, including Master Gardeners, girl/boy scout groups, school students, landowners and other residents who want to learn to identify and control invasive species in their community. As with all NCWMA workshops, IPM will be implemented, using manual and mechanical control methods whenever practical to minimize the use of herbicides. Invasive species workshops will be evaluated based on the percent cover of native species versus invasive species before and after each event, as well as the total number of participants at each event. Each workshop costs approximately \$1600 (coordinator time, marketing materials, herbicide, handouts, refreshments and incentives for volunteers).

Task 3-2 Interpretive Kiosks

Target audience: Community members, tourists.

Target date: Fall, 2011.

Activity/output description: Demonstration projects will be located along Ashland's Waterfront Trail, a popular multi-use non-motorized trail used by Chequamegon Bay community members and tourists, thus we have a significant opportunity to increase the public's awareness of both the project and the importance of restoring native shorelines. Two interpretive "kiosks" will be developed, featuring all-weather standardized signs and mounting framework that are consistent with the City of Ashland's other Lake Waterfront Trail signage, and located at each demonstration site. Signs will include the GLRI symbol and other project partner information. These "place-based" educational tools will feature interpretive messages examining causes of shoreline degradation, particularly the impact of invasive species, climate change, and habitat loss impacting that site. Each sign will explain through text, diagrams, and photos, the specific green infrastructure restoration strategies being used to re-establish natural shorelines at that site and will promote the ecologic, social, and economic benefits of healthy native shorelines. To multiply educational benefits, Northland College environmental education students will be engaged in researching and drafting the interpretive message for each interpretive kiosk under direction of Northland College and UW-Extension interpretive design specialists. Additional signs, not paid for by the grant, may be installed during the restoration start-up to provide more immediate project information and educational outreach.

Task 3-3 Lake Superior Shoreline Restoration Website/Blog

Target audience: Shoreline riparian decision makers, community members, academic institutions, general public

Target date: June, 2011

Activity/output description: A project website will be created, and hosted by Northland College, as a means of providing information about the project via distance education. Links to this site will be established on the "Connecting the Coast" website and the Ashland County Conservation Department website. The website will provide on-line resources to investigate and document the

causes of natural shoreline impairment and its ecologic, economic, and social impacts using the project's demonstration sites as case study examples.

The website will feature photo-point monitoring of the project's demonstration sites to provide a pictorial record of the progress prior to, during, and after restoration. Specific restoration prescriptions and strategies used at each demonstration site will be documented with links to further resources to provide shoreline riparian decision makers both on-line templates and tools to replicate a restoration project on the property they manage. Research-based monitoring results from wildlife, non-point nutrient run-off, biotic surveys, and surface water quality from the control site and restoration sites will be posted on the website to quantify the project's benefits and the impact of native vegetative buffers and erosion control practices on water quality. Under the direction of the Project Coordinator and Northland College specialists, Northland students will develop and implement the monitoring plan and provide data, photographs, and for posting on the website. The website will also include curricula and training materials used in the Shoreline Riparian Decision Makers Workshop and a blog where project updates are featured. Information, announcements, and event listings will be cross posted with the Northwoods Cooperative Weed Management Area electronic newsletter and through the Lake Superior Bi-national Forum's communication tools (electronic newsletter, web-blog, Lake Superior Day, and radio show).

Task 3-4 Lake Superior Shoreline Decision Makers Workshop

Target audiences are public and private land managers who are directly involved in decision making affecting the management of Lake Superior's shoreline resources including:

- local elected officials (town, village, city, county and tribal),
- non-governmental organization representatives and volunteers involved in Lake Superior coastal management,
- Lake Superior Bi-national Program representatives,
- county land conservation departments, and
- Lake Superior private and public riparian land owners.

This workshop will be directed to a regional audience responsible for making riparian management decisions in areas that share the similar red clay plain characteristics and challenges of highly erodible soils, wave induced erosion, and/or a post-industrial waterfront that has undergone significant habitat degradation similar to Ashland, WI. An outreach education position, co-supervised by NC-SOEI and the WDNR, will be sponsored through the Northland College, SOEI to coordinate development and implementation of the workshop. General guidance will be provided by participating collaborators.

Target date: July, 2012.

Activity/output description:

This two-day demonstration workshop will:

- 1) increase the understanding of target audiences in the best management practices using "green infrastructure" and the benefits of restoring Lake Superior shorelines to native habitats to improve ecologic, economic, and social outcomes,
- 2) demonstrate the cost-benefit comparison between a control site and lower and higher cost restoration site models on mitigating issues such as invasive species, ecological function, and non-point source pollution,

- 3) provide specific management strategies and resources to replicate these results based on the types of shoreline riparian habitats managed by target audience groups, using the project's outcomes as the baseline model,
- 4) increase the target audience's ability to initiate shoreline restoration projects by demonstrating restoration techniques and outcomes at the control and demonstration sites, provide training in monitoring protocols, demonstrate vegetative plantings for climate change resiliency, and offer hands-on restoration instruction and resources, and
- 5) provide participants with a "Riparian Restoration" toolkit of best management practices including information and resources to replicate projects in other vulnerable Lake Superior habitats and provide follow-up support.

This workshop will be networked with the Lake Superior Bi-national Forum, Great Lakes City Initiative, Harbor Town Association, the Wisconsin Counties and Wisconsin Towns Associations, University of Wisconsin-Extension, and the Lake Superior National Estuarine Research Reserve in Superior, WI. It will feature impaired habitat restoration resource professionals as workshop speakers and demonstration site experts and to share their expertise on best restoration management practices as well as financial and technical resources available to implement them.

Workshop training will be conducted by the Principal and Co-principle Investigators, staff from Northland College, and by the Ashland County Land and Water Conservation Department and UW-Extension through its Northern Great Lakes Visitor Center Office. Workshop materials, resources, and curricula will be posted on the project's website (concurrently developed) to allow greater accessibility and distance education outreach to target audience members.

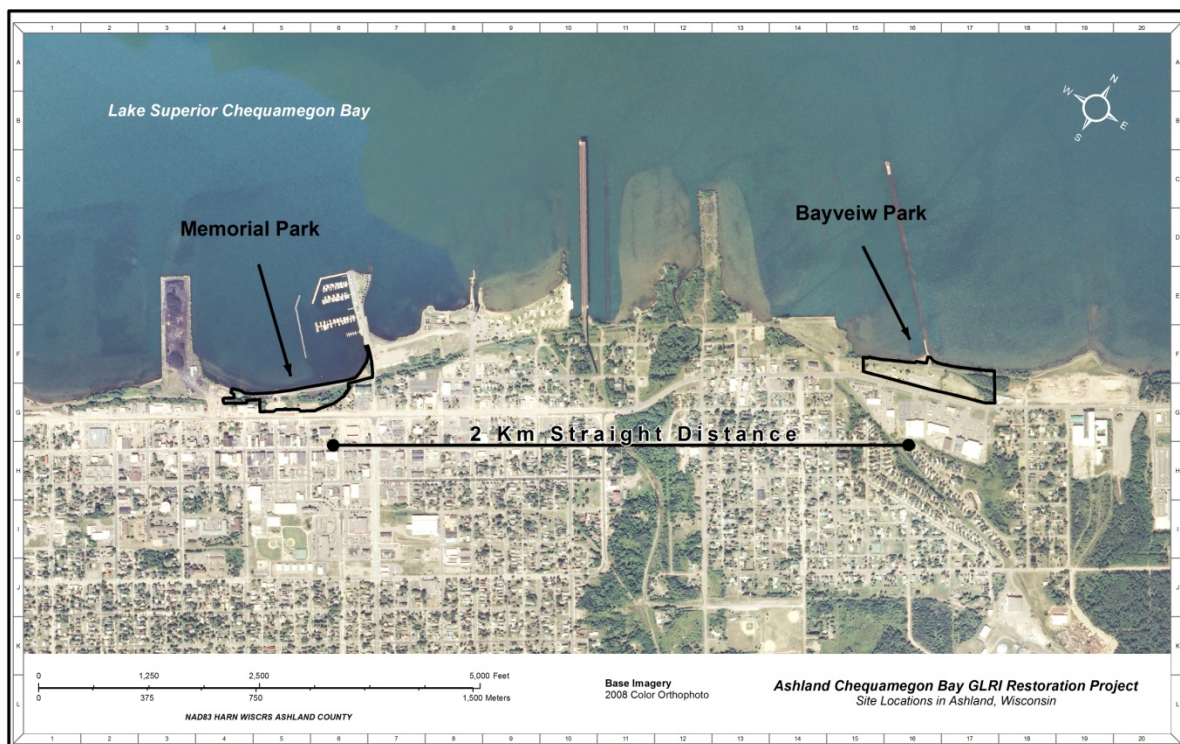
4. Restoration Quality Assurance Assessment

In order to verify that treatment prescriptions have been established successfully for the experimental component, it is necessary to design and implement a 'design implementation study' to measure the success of the restoration component. This is a short-term monitoring effort to measure key aspects relating to the accuracy of plant spp. stocking densities, plant survival (to 2 years), plant-species composition, placement of coarse woody material, as well as the effectiveness of erosion control measures, the effectiveness of the irrigation system and enclosure fencing, and uniformity of invasive species control. Certain measures (e.g., plant growth and/or vigor, and soil moisture) may also be applicable to long-term ecological effects monitoring at the site level.

Geographic Focus

This project is located in the City of Ashland, Ashland County, Wisconsin, and is immediately adjacent to the south shoreline of Lake Superior's Chequamegon Bay. The project boundaries fall within the Fish Creek Watershed representing portions of Ashland and Bayfield counties. The watershed is a mix of forest (60%) and grassland (24%), and contains a large area of inland surface waters (3880 acres of lakes and 292 miles of streams). Nearly half (44%) of the land surface of Fish Creek Watershed is characterized as wetland (2010 Wisconsin Water Quality Report to Congress, WDNR Pub WT-924-2010).

Specific project locations occur within Ashland's city limits on 2 city parks officially recognized as Memorial Park (MP) and Bayview Park (BV). See Appendix for site specific project maps.



This proposed work is an extension of ongoing Wisconsin Department of Natural Resources (WDNR) research on inland glacial lakes in Vilas County, WI (the Wisconsin Shoreland Restoration Project), and represents a partnership between WDNR Bureau of Science Services, the City of Ashland, Ashland County Land and Water Conservation Department, the Northwoods Cooperative Weed Management Area, University of Wisconsin Extension, and Northland College's Sigurd Olson Environmental Institute, Ashland, WI.

Project - Term:

GOAL / OBJECTIVE / TASK	2010	2011				2012		
	FA	WI	SP	SU	FA	WI	SP	SU
DEVELOP QAPP & EXPERIMENTAL PROTOCOLS								
CONDUCT INVASIVE SPP WORKSHOPS								
CONDUCT PRE-RESTORATION ASSESSMENT								
IDENTIFY REFERENCE & CONTROL PLOTS								
HIRE SEASONAL STAFF								
SECURE PROJECT CONTRACTORS								
SUBMIT PLANT STOCK ORDERS								
APPLY FOR RELEVANT PROJECT PERMITS								
SECURE PROJECT TOOLS & EQUIPMENT								
DEVELOP SHORELINE RESTORATION WEBSITE								
SUBMIT GLRI INTERIM REPORT								
ESTABLISH EXPERIMENTAL PLOTS								
INSTALL EXCLOSURE FENCING								
INSTALL IRRIGATION SYSTEM								
TEST/CALIBRATE SW RUNOFF EQUIPMENT								
INSTALL INTERPRETIVE PROJECT SIGNS (MP)								
ESTABLISH EXPERIMENTAL PLOT TREATMENTS								
CONDUCT RESTORATION QA ASSESSMENT*								
MODIFY PLOTS BASED ON RQAA RESULTS								
CONDUCT PILOT SW-NUTRIENT RUNOFF MEASURES								
PREPARE/HOLD DECISION MAKER'S WORKSHOPS								
ESTABLISH UPLAND BUFFER ZONE RESTORATION								
HOLD PROJECT PARTNER FORUM								
GLRI FINAL REPORT								
*experimental plots only								

SEASONAL TASK - RESTORATION	APRIL - SEPTEMBER					
	APR	MAY	JUN	JUL	AUG	SEP
1. FINALIZE ALL VENDOR/MATERIALS ORDERS						
2. FABRICATE SW RUNOFF COLLECTORS						
3. IDENTIFY WHOLE LOG WOODY MATERIAL						
4. FABRICATE SOIL BERLESE FUNNEL SETUP						
5. INSTALL INTERIM INTERPRETIVE SIGNS						
6. MOW /BURN RESIDUAL PLANT GROWTH (MP)						
7. IDENTIFY/STAKE/MARK EXP. PLOT CENTERS						
8. ASSESS RESTORATION ZONES						
9. ESTABLISH FENCE PERIMETER (MP ONLY)						
10. IDENTIFY/MARK HARDSCAPE FEATURES						
11. CONTROL EXISTING INV WOODY PLANTS						
12. DEBRIS REMOVAL (ARBOR DAY – MAY 13 TH)						
13. PLANT TREE SEEDLINGS (ARBOR DAY)						
14. INSTALL EXP. PLOTS & COLLECTORS						
15. PREPARE PLANTING ZONES						
16. INSTALL IRRIGATION SYSTEM						
17. INSTALL EXCLOSURE FENCE NETTING						
18. PLANT RESTORATION ZONES						
19. ADD WHOLE LOG WM TO EXP. PLOTS						
20. TEST/CALIBRATE SW RUNOFF EQUIPMENT						
21. CONDUCT AMPHIBIAN SURVEYS						
22. CONDUCT BIRD SURVEY TRANSECTS						
23. CONDUCT VEGETATION SURVEYS						
24. CONDUCT SMALL MAMMAL SURVEYS						
25. IMPROVE/EXPAND INTERPRETIVE TRAIL						
26. MONITOR IRRIGATION SYSTEM						
27. WINTERIZE RESTORATION SITE/EQUIPMENT						
28. CONDUCT FURBEARER SURVEYS	DEC - JAN 2012					

Special Equipment or Supplies

The following list of equipment is considered specialized equipment to meet project needs:

- Surface-water-nutrient run-off collectors
- Automated irrigation timers and controllers
- Deer exclosure fence
- 8-Liter Churn® sample splitter to produce water quality sample partitions
- Multi-parameter water quality meter
- Kelway® Soil pH/Acidity/Temp Probe
- Red-Dragon® propane torch for controlling invasive plants

Personnel, Special Training Requirements or Certifications

The WDNR, its partners and relevant contractors will develop and deliver mandatory and voluntary training sessions to key parties to ensure quality data collection, to the extent practicable.

Mandatory in-person training sessions will be required by the following individuals to ensure quality data collection:

- consultants who will be collecting baseline and post-certification data
- data-entry personnel who will be processing data from inspections and self-certification responses
- QA/QC personnel (additional training may be needed to familiarize staff with the project)

Individuals who will be compiling data for the project each season will be trained in proper data collection and QA procedures. Training will be augmented by pairing with personnel shortly after their tasks have begun, to correct and clarify appropriate procedures.

The Project Coordinator is responsible for ensuring that all personnel involved with data generation (including state personnel, contractors, and partners) have the necessary QA training to successfully complete their tasks and functions. The Project Coordinator will document attendance at all training sessions.

Documentation and Records

All information generated, either directly or indirectly, through this project will be subject to WDNR departmental review and archival standard operating procedures. Information, particularly those obtained via scientific measurement, will be consistent with the requirements and procedures used for data validation and data assessment described in this QAPP. All records will be stored on the WDNR's network server file-based archive (Rhineland) and the Project Coordinator's computer hard-disk.

Field Records

Project field records include all experimental data measurement, observational data and ancillary notation generated during the installation and evaluation of the ecological restoration, experimental manipulation

of study plots at the plot level and wildlife and habitat measures collected at the site level. These records will consist primarily of hand annotated printed field dataforms, hand notation in field notebooks, and digital photography photo-documenting restoration phase and progress as well as photos collected for purposes of evaluating the accuracy in identification of voucher specimens (plant and animal).

Laboratory Records

This project will collect and archive the following laboratory records:

- Soil sample physical and chemical properties (U.W. Soil and Plant Laboratory)
- Surface-water runoff physical and other water quality assessment properties (WSLOH)

All results developed by the WSLOH will be transmitted electronically via internal procedures to the WDNR SWIMS database management system.

Project Records

The project will leverage the utility of multi-media: paper, electronic, and photographic. The project will implement proper document control procedures for all formats to be consistent with WDNR's Quality Management Plan. For instance, hand-recorded data records will be taken with permanent ink, and changes to such data records will be made by drawing a single line through the error with an initial by the responsible person. The Project Coordinator will have ultimate responsibility for any and all changes to records and documents. Similar controls will be put in place to retain original file creation versions and dates for electronic records including digital media.

The WDNR Quality Assurance Officer shall retain all updated versions of a completed QAPP and be responsible for distribution of the current version of the QAPP. An electronic copy of the QAPP will be stored with the project records in SWIMS. The WDNR Quality Assurance Officer and the WDNR Project Coordinator will approve annual updates. The Project Coordinator shall retain copies of all management reports, memoranda, and all correspondence between the WDNR and all project personnel.

Other records/documents

Other records and documents that will be produced in conjunction with this project include:

1. Project conceptual design and development (GIS files and maps, QAPP drafts, EPA project web-reporting, collaborator meetings, correspondence).
2. Restoration installation (contractor receipts/invoices, field logs, employee management, phase completion).
3. Public and private outreach (meetings/workshops, photos, public correspondence, informational materials).
4. Ecological research (monitoring, data collection, sample collection, shipping and lab results, field logs).
5. Project reporting (interim and final reports, publications)

Records will be archived for final disposition in the WDNR-Rhinelanders Headquarters by the Project Coordinator.

Storage of project information

Pursuant to the WDNR's Quality Management Plan, all forms of project management and oversight documentation will be archived in WDNR's network server file-based system and in the Project Coordinator's computer hard-disk as well as on DVD media. Information to be stored includes electronic

correspondence and other electronic documentation including electronic databases and similar spreadsheet products, paper-based documentation, any field survey notebooks, datasheets, and sample handling and management documentation.

Backup of electronic files

Pursuant the WDNR's Quality Management Plan, all forms of project management and oversight documentation will be routinely archived in redundant electronic and file-based repositories, including electronic correspondence and other electronic documentation including electronic databases and similar spreadsheet products, paper-based documentation, field survey notebooks, datasheets, and sample handling and management documentation. Redundant electronic repositories will be updated with project files on a monthly manner on the WDNR's network server file-based archive, the Project Coordinator's computer hard-disk, and one Portable Media storage device.

Final Report

There will be three kinds of reports generated by this project, and include:

1. Regular quarterly report to the EPA
2. Annual progress reports
3. Project final report.

Regular and Annual progress reports will note the status of project activities and identify whether any QA problems were encountered (and, if so, how they were handled). A Project Final Report will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the data should be used. In other words, the project final report will present the final conclusions and results for the project up to the mandated EPA final reporting date. Subsequent results and inferences will be presented in professional and internal publications.

Project File Final Disposition and Record Retention

Pursuant the WDNR's Quality Management Plan, all forms of project management, oversight documentation, field documentation, laboratory records, and all project reporting documents will be archived in the WDNR's physical file-based archives and/or electronic network server file-based system. Additional record retention will include archival in the Project Coordinator's computer hard-disk as well as on DVD media.

B. Measurement/Data Acquisition

Sample Process Design (Experimental Design)

A key task in this project will be to develop a sound statistical methodology for collecting and analyzing project data, in order to draw inferences related to the selected performance measures. The major quality objective will be to collect representative data that accurately reflect the changing conditions of the shoreland areas this project focuses upon. Project data is of two types: (1) observational data, which will be collected by trained WDNR and/or collaborators using established protocols and (2) laboratory analytical results of submitted field samples, which will be provided by accredited laboratories through electronic mail services. Laboratory analytical methods are built upon state laboratory methodology in

accordance with the U.S. EPA and the advice given in EPA's *Generic Guide to Statistical Aspects of Developing and Environmental Results Program* (2003).

1. Restoration Implementation – Design and Implement Restoration

This component involves all aspects relating to the applied methods of ecological restoration techniques and guidelines, and includes: the development of the restoration concept design (plant spp., spp. composition, stocking density, and necessary physical landscaping of terrain and installation of bio-engineered materials) to stock source determination (private/state nurseries), site preparation, invasive plant control, actual planting and installation of bio-engineered landscape products, exclusion fence and irrigation system installation, supplemental watering, necessary re-planting and erosion control, and general site maintenance.

Task 1-2 Restoration Installation – We will draw from a variety of expertise and standard restoration methods, techniques and guidelines to implement a comprehensive restoration effort on approximately 4,100 feet of shoreland area. Technical and professional resources used will incorporate NRCS guidelines as prescribed in the NRCS Biology Technical Note 1, and professional expertise provided by staff representing organizations that include the NRCS, WDNR, Ashland County Land and Water Conservation District, U.W. Extension Service, City of Ashland, Members of the Northwood's Cooperative Weed Management Area (NCWMA) and contracted landscaping specialists. Specific sub-tasks, including a description of how we will address each are listed next.

Sub-tasks:

- a) Development of the restoration conceptual design: Restoration will focus on native plant community plantings and invasive species abatement along approximately 4,100 feet of public shoreline in the City of Ashland, Wisconsin. WDNR Science Services, with expert assistance from the City of Ashland, Members of the Northwoods Cooperative Weed Management Area (NCWMA), and the Ashland County Land and Water Conservation Department, will coordinate the native plant restoration and invasive species control efforts. After factoring in the existing soils and native vegetation for each site, and incorporating climate change adaptation considerations into the restoration, planting plans and erosion control measures will be developed using the standards laid out in the Natural Resources Conservation Service 580 and 643A codes. Plant-stocking density determination and source selection: Planting density guidelines for woodland shoreland habitat will be used as outlined in the Wisconsin Biology Technical Note 1: Shoreland Habitat (NRCS 2002). Plant numbers are calculated based on the area in square feet to be reestablished and the planting densities in the guidelines (see Table 1). Restoration plant species chosen will be consistent with Lake Superior LaMP priorities per habitat/ecosystem goals and objectives, and will reflect the region's native boreal plant community, but also will reflect hardiness, future climate effects, wildlife value (including pollinators), and natural propagation potential.
- b) Restoration site preparation and invasive species control: Selected sites or planting zones with significant amounts of established non-native herbaceous vegetation will be prepared primarily by use of manual removal with limited application of herbicide (glyphosate). In certain areas it may be necessary to smother select areas with tarps and black plastic for 4-8 weeks. Regardless of control method, modular planting zones will receive 100% coverage of an organic mulch to minimize growth of invasive species immediately adjacent to planted stock. Members of the Northwoods Cooperative Weed Management Area, experienced in

- invasive species abatement, will lead community volunteers to complete invasive species removal at all sites before native plant restorations occur.
- c) Planting of trees, shrubs, and herbaceous vegetation species: All trees, shrubs, and herbaceous species will be planted following the professional recommendations of the contracted landscaping specialist(s) and nursery stock providers (private and state). Each individual plant will receive careful evaluation to assess plant species identity and plant health, including vigor, root development, signs of disease and insect infestation and signs of irrecoverable dehydration. Only after a plant stock is deemed healthy and of the correct species will it be planted into the restoration site. In order to relate woody plant survival to source and date of installation, selected trees and shrubs will be affixed with a small weather proof label denoting this information. Soil conditions at both sites consist primarily of clay fill brought in from other locations, however red lacustrine clay soils do occur across most of the northern portion of Ashland County, and are considered native soils to the project area. A majority of plants can tolerate clay soils, although careful attention to planting depth and the size of the hole are considered important to insure good survival. Plant stock providers and experts will be interviewed to determine best approaches and species type to plant.
 - d) Installation of bio-engineered landscape products to control erosion and enhance terrain: Erosion control practices will include the installation of rain gardens and appropriate placement of erosion control materials such as EnviroLoc bags, sediment logs, and biologs. These methods constitute use of “Green Infrastructure” within this project – which is an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes to enhance overall environmental quality and provide utility services. As a general principal, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspire, and/or recycle storm-water runoff.
 - e) Installation of exclusion fence: Where deemed essential, a temporary 8-foot exclusion fence will be installed as a protective measure to minimize human and pet disturbance, and to prevent any potential browsing by deer that reside in the area. The fence will be installed in 2 phases, where phase 1 includes installation of only corner and lateral support posts. During this phase free access will be allowed to all parts of the restoration during the site preparation, experimental plot establishment, installation of the irrigation system (pumps, hoses and sprinklers), and the actual installation of plant stock and other green infrastructure. Once these major actions are completed, and the site is traversed systematically to flush any potential resident deer from the project area, the fence netting will be installed and closed to create the necessary enclosure.
 - f) Installation of an irrigation system for supplemental watering (and treatment application): A professionally installed, automated irrigation sprinkler system will be installed in the Memorial Park restoration site to provide supplemental water to the experimental restoration plots and surrounding buffer areas to insure plant survival. Restoration plantings outside the effective reach of the automated irrigation system will be watered using an accessory hose and sprinkler system that will be attached to one of the irrigation lines or a portable gas-powered pump. This automated irrigation system will include the use of a high-volume 230 volt electric pump that will draw water from the Chequamegon Bay of Lake Superior at a distance of 50 feet from the shoreline. All necessary federal, state and local permits required for this action are in the application process.

As a cost-saving measure, we will not install an automated irrigation system at the Bayview Park restoration site. For watering needs at this site, we will use a portable watering system

consisting of a gas-powered pump, commercial-grade hose, connectors, distribution hub, and sprinkler heads to water all plantings installed at the site. The City of Ashland has also agreed to allow hook-up of our portable irrigation system to one of their spigots that is served by the City's water supply.

- g) Post-restoration installation and seasonal site maintenance: Once the primary restoration sub-tasks and related activities are completed, we will conduct monthly surveys of each restoration site to insure the following:
 - (1) Automated irrigation system is working/sufficient (action: repair/adjust watering)
 - (2) Plant stock is surviving (action: replace morbid plants)
 - (3) Exclosure fence is safe, stable and effective (action: repair or enhance)
 - (4) Produce monthly report on status of restoration site conditions

2. Quantifying Ecological Benefits

Site-level Scale:

Biotic surveys will follow a treatment-control-reference design and include baseline surveys beginning immediately in year two of the 10-year mensurative phase of the restoration. All experimental measures will be conducted at Memorial Park, the primary restoration site. At the site-level scale, the MP restoration site is paired with an impacted stretch of shoreland area that is not restored. This design is commonly used for assessment of habitat restoration projects with subsamples taken at all sites, and where the treatment-control-reference sites are sampled simultaneously (on the same day) over time. Surveys will be repeated annually up to year 3, and at years 5, 7, and 10 as the restoration project matures. The site-level study design will also include a control shoreline that exhibits similar habitat alteration as the treated site does, but does not receive any restoration efforts. A reference site will also be chosen that is undeveloped and in a natural state to serve as an area to provide restoration benchmarks based on empirical data reflective of the local area. Biotic survey results will be compared between the control and restoration sites and measurements will be made by WDNR personnel, its collaborators or contractors annually to year 5. Subsequent site evaluations will be conducted at 7 and 10 years post-treatment to determine whether the restoration goals (relative to reference benchmarks) have been achieved. Specific tasks of site-level ecological measures and their descriptions are listed next.

Task 2-1 Vegetation Sampling – A portion of each shoreland restoration site will be divided into 50 m segments using GIS software, with a 10 m × 10 m vegetation plot selected randomly within each segment for conducting vegetation surveys. A ½” diameter x 24” long metal rebar with a 2 ½” diameter flat washer welded to one end will be used for a permanent survey stake and driven flush with the ground at an inland corner of the vegetation plot. The tops of each marker will be painted with a durable orange paint to facilitate relocating the plot corner for surveys in subsequent years; this site contains industrial waste including discarded re-bar, and erosion-control fabric pins that preclude use of a metal detector as a reliable means to relocate each plot.

Each plot will be divided into four 5 m × 5 m subplots. All living trees and woody plants within the plots (≥ 5 cm diameter at breast height, dbh) will be identified to species and dbh recorded. Two subplots will be randomly chosen and all live deciduous and coniferous saplings and shrubs ≥ 30 cm in height but ≤ 5 cm dbh will be identified to species and tallied. Tree, sapling, and shrub density will be calculated for each plot and the means computed for each treatment. In order to measure canopy cover, gap fraction will be calculated using a digital hemispherical photograph (Nikon Cool Pix 5000

and FC-E8 fisheye converter) at 50 cm above the ground and centered in each plot. Digital hemispherical photographs will be analyzed with the software WinSCANOPY (WinScanopy 2005). A density board or checker board (0.5m x 3m) with 10 cm × 10 cm grid squares will be used to measure understory foliage density and to estimate the percent cover at four different height categories (0-0.3 m, 0.3-1 m, 1-2 m, 2-3 m). Squares at least 50% obstructed by green vegetation will be counted and converted to a relative index of percent cover. The density board will be placed at 1 m, 5 m, and 9 m inland from the transect line and at the edge of each plot. This gives a height and density profile within each plot at three different distances inland from an established transect line serving as a surrogate shoreline. To assess changes in ground cover, herbaceous plants are enumerated within a 1m x 1m quadrat randomly selected within the same 10m x 10m vegetation plots. See Appendix A for a detailed survey protocol: *Methods for Measuring Riparian Habitat Structure and Diversity on Proposed Restoration Lakes in Northern Wisconsin: Wisconsin Shoreland Restoration Project*

Task 2-2 Avian Surveys - A dependent, double-observer 250 m line transect (LT) method will be used to characterize breeding bird communities along the treated, control, and lakeshore reference sites. Bird surveys will be conducted concurrently at both transects during two separate visits in June. Transects will parallel the shoreline and be located at similar elevations and distances from the ordinary high-water mark (OHWM). All birds seen and heard along the inland side of the transect will be recorded and tallied. Bird surveys will be conducted between 0600 and 1000 hrs. Surveys will not be conducted during rain or high winds (>20 km/hr), or when wave noise influenced bird song rates and/or detectability. Bird species diversity, richness and abundance will be calculated for each site. See Appendix B for a detailed survey protocol: *Avian Survey Methods and Line Transect Description for the Ashland/Chequamegon Bay Shoreland Restoration Project*

Task 2-3 Amphibian Surveys- Night calling surveys will be conducted at restoration and control sites to quantify and compare the species richness and abundance of calling frogs and toads. Survey transects will parallel the lake shoreline and be located at similar elevations and distances from the OHWM. Surveys will be conducted from early May to identify species associated with ephemeral wetland habitat such as wood frogs, spring peepers, chorus frogs, while additional surveys would be conducted in early July to identify lake-associated species such as mink, green, leopard, bull, and pickerel frogs. Transects will be conducted on foot during calm nights, and all sites are surveyed the same night, with surveys replicated a minimum of two times during each sampling period. Survey methodology will be aligned with existing Lake Superior amphibian protocols when appropriate. Consultation will occur with the State Herpetologist and GLIFWC biologists when necessary. See Appendix C for a detailed survey protocol: *Protocol for Wisconsin Shoreland Restoration Project Monitoring Green Frog Surveys on Vilas County Lakes*.

Task 2-4 Small Mammal Surveys - Small mammal surveys will be conducted in late June to late July at the treated, control and reference sites. Sherman traps will be placed parallel with the shoreline along a 250 m long transect. Traps will be placed at 10 m intervals along each transect for a total of 26 traps per transect. Each trap is baited with a mixture of rolled oats and peanut butter, and a handful of polyethylene fiber is added for bedding. Traps are covered with an insulating material to provide captured animals with additional protection from inclement weather. Traps are opened for 3 nights at each shoreline, checked every morning and closed, and reopened in the late evening hours. All small mammals will be identified to genus and species when possible. Photographs will be collected for each species to serve both as photographic vouchering and also to aid species identification. Data on sex, reproductive status, physical appearance, and weight will be recorded for each captured animal;

all animals will be released at point of capture. Survey methodology will be aligned with existing Lake Superior small mammal protocols when appropriate. Consultation will occur with WDNR and GLIFWC biologists, when necessary, to facilitate identification of species with similar characteristics. See Appendix D for a detailed survey protocol: *Methods for shoreline small mammal inventory on high-developed and low-development lakes*, Wisconsin Shoreline Restoration Project. Implementation of Task 2-4 is pending additional funding.

Task 2-5 Furbearer Surveys - Winter track surveys will be conducted 48 to 96 hours following snowfalls of greater than or equal to 2.5 cm, at temperatures above 0 degrees F, and with winds less than 10 mph. Transects will be conducted along the same transects for each of the treated, control, and reference sites. Using snow-shoes or cross-country skis, technicians will record and identify all tracks encountered 10 m on each side of each transect. A GPS unit will be used to map transects and to record waypoints when furbearer tracks are encountered. Consultation will occur with WDNR and GLIFWC biologists to facilitate identification of species. See Appendix E for a detailed survey protocol: *Wisconsin Shoreland Furbearer Survey Protocol*. Task 2-5 implementations pending additional funding.

Plot-level Scale:

Experimental Plot Design and Installation

Operating Principle:

The Ashland waterfront along Lake Superior's Chequamegon Bay has a long history of disturbance to its land surface by industrial waste deposits and repeated shoreline modification including displacement of surface soils. The surface soil conditions at the Memorial Park restoration site reflect this disturbance through evidence of existing industrial debris (concrete and asphalt waste) and documented re-contouring of the terrain by heavy equipment that has likely led to decreased soil organic content and soil compaction.

In a previous study by Graczyk et al. 2003 (Hydrology, Nutrient Concentrations, and Nutrient Yields in Near shore Areas of Four Lakes in Northern Wisconsin, 1999–2001), surface water runoff collectors were installed along shoreland zones of interior lakes to compare runoff differences in surface water volume and nutrient concentrations between developed and undeveloped shorelines. In the USGS study, wooded lakeshore areas contributed less surface water runoff and nutrient yields than paired lakeshore areas characterized by low-density rural development.

In this project, we will compare surface water run-off and nutrient yields from sites restored to native plant communities along the City of Ashland Waterfront. We will test whether the plantings reduce surface water and nutrient run-off over time. Following similar methods as Graczyk et al. (2003), we will evaluate water quality parameters by incorporating a modified version of the surface water collectors described in their study into our experimental plots. In our study, we will quantify relative rates of surface-water runoff volume, nutrient loading and contribution of total suspended sediments. Additional measures will include changes in soil physical properties and abundance and diversity in the soil faunal community over time. The notable differences in our runoff collectors from those deployed by Graczyk et al. (2003), is that: 1) they sample a closed and uniformly sized (50 m²) sub-basin, 2) reflect a circular array of slotted pipe to capture runoff regardless of directional flow, and 3) are designed to quantify relative quantities during programmed intervals and durations; this is primarily a result of our need to quantify potentially high surface runoff flow without use of expensive tipping bucket instrumentation that would limit our capacity for increased replication and require a source of higher voltage electricity.

Approach/Plot Treatment Description:

The original intent for incorporating plot-level experiments in this study design was to artificially create a closed sampling area to quantify surface-water-nutrient runoff measures. By doing so, we created an opportunity to expand our original research scope to include a treated and control plot comparison study at a microcosm scale, providing us with an independent approach to monitor changes in ecological responses when it is not possible to conduct the ‘before’ baseline surveys using before-impact survey methodology.

Specifically, we propose to install a total of 12, 4-meter radius (50 m²) circular experimental plots (Appendix F.) to artificially define a uniform area for which to quantify: 1) relative amounts of surface-water-nutrient run-off, 2) relative changes in soil total organic content and other physical and chemical properties, 3) soil micro-arthropod abundance and species richness, and 4) conduct a cost-benefit evaluation comparing high- and low- cost planting alternatives. The 12 experimental plots will be distributed across the Memorial Park restoration site in 4 blocks, each block consisting of 3 experimental plots assigned one of three possible treatments (complete randomized block design) and where each treatment is replicated four times. Ashland’s Memorial Park (western site) will contain the 12 experimental plots in 4 groups of 3-treatment (H, L, N) replicates (Appendix G). Assignment of experimental treatments to each of the study plots is described next.

In our study design, experimental plots will be blocked in sets of three treatments (plots) to account for variation in site location and conditions related to soil type, soil moisture, historical disturbance, and existing vegetation. Restoration treatments (H, L, N) will be systematically assigned to plots within each block following random selection of the No Planting (control) plot. Experimental plots are oriented west to east in a more or less staggered array so that no plot is positioned directly upslope of another. Plots are separated by a minimum of four meters. Beginning from the east end of the array, the control treatment for each block will be assigned randomly followed by a random selection of the next treatment between the remaining two plots. The final plot for each block is assigned the remaining treatment option. This approach incorporates a rule that no two controls can be adjacent to one another in order to force a systematic separation of each of the high-density and low-density treatments by a control in order to avoid the effects associated with a large un-restored area of landscape. This process is continued east to west through the remaining plots to produce an array of twelve plots (4 blocks of 3 plots each) where each treatment is replicated 4 times.

Biological, physical, and water quality sampling will be conducted at each of the 50 m² circular experimental plots where each are assigned one of three possible restoration treatments as part of a complete randomized block design. The three restoration treatments include: 1) High Density (H) - standard lakeshore restoration methods following NRCS Biology Technical Note 1 guidelines to plant potted trees, shrubs and forbs at a high stocking density, 2) Low Density (L) - application of the same methods described in the high density treatment but trees and shrubs are planted at a low density and 3) No Planting (N) or control-passive naturalization, where no restoration efforts are conducted allowing for passive recruitment and naturalization (except for control of invasive plants). The No Planting treatment effectively serves as the experimental control where they receive no active restoration, though are exposed to potential wind-blown seeds and other organisms as are the density treatment plots. Other similar exposures shared by all treatments include: invasive plant control, supplemental watering, garbage and industrial debris removal, insect herbivory and disease, rodent herbivore, and the exclusion of ungulate herbivory.

In addition to plantings of native plants in each of the H and L treatments, plots receiving each stocking density will also include restoration effort reflecting conventional methods used in restoring native communities. These methods include: planting of potted nursery stock (trees, shrubs, herbaceous plants), placing plants in clusters of multiple individuals of the same species and/or in combination with compatible community associates, soil augmentation with weed-free topsoil and organic compost.

Following planting, the bases of all trees and shrubs are covered with organic mulch to prevent weed growth, increase organic matter, maintain cooler soil temperatures, maintain moist soils, and to facilitate relocation of the plant within existing vegetation.

Experimental Plot Amendment:

We will also install one artificial “pit and mound” feature in each density treatment plot in an effort to add topographic variation characteristic of woodlands. Pit-mound topography features will be constructed by hand utilizing existing plot substrate and bio-engineered materials (envirolok® bags/logs), and will cover approximately 10% of total plot area (50m²). Terrain, or topographic amendment includes use of standard landscape engineering techniques enhanced by the addition of ‘whole log’ woody material including 1 high-, 1 medium-, and 1 low decay class whole log, each approximately 10”-14” minimum diameter. Whole-log woody material will represent at least 2 of 8 tree species characteristic of a boreal or northern dry-mesic forest community along Lake Superior’s Chequamegon Bay Shoreline. These tree species include: trembling aspen, (*Populus tremuloides*), big-tooth aspen (*P. grandidentata*), balsam poplar (*P. balsamifera*), white birch (*Betula papyrifera*), white pine (*Pinus strobus*), white spruce (*Picea glauca*), northern white cedar (*Thuja occidentalis*), and balsam fir (*Abies balsamea*). Tree species selected as cut whole logs is also based on availability, susceptibility to decay, intact-bark retention, and potential to achieve a diameter at breast height (dbh) greater than 10 inches diameter.

Task 2-6 Experimental Plot Installation: – Individual plots will be created by installing approximately 80 feet of 6-inch wide, plastic landscape edging in a circular shape to define a 50 m² area (4-m radius circle). Plastic edging will be manually buried 3-4 inches deep and anchored by steel stakes. Edging ends will be overlapped by 4 inches to insure that water flowing down-slope within the plot does not escape where the edging meets. Edging joints will be connected using plastic dowel material provided with the product. See Appendix F for an illustration of the circular plot design.

A ½-inch steel rod with a large diameter metal cap will be used to permanently mark the plot center so it can be visually relocated in subsequent years by both sight and, if necessary by the use of a metal detector. As part of the edging installation method, a clay-based soil delivered from a regional location will be used to fill in the space along the edging created by the shovel. The soil will be tamped in and covered by hardwood mulching to minimize erosion effects due to installation efforts. When installation is complete, a 50 m² area circular plot will be visible by the 2-inch erect black plastic edging with a steel rod marking the plot center. This process will be repeated for the remaining plots.

Experimental Plot Materials:

- Landscaping Edging (black) 6" x 20 feet (incl. stakes)
- ½" x 24" steel stake (to mark plot center)
- Clay-based soil
- Hardwood mulch

Experimental Plot Location:

Actual plot centers will be documented by averaging three geographic coordinates measured using a GPS device with 3-5 meter accuracy. Plot center locations will be initially determined by visually assessing a geo-referenced 2008 true-color digital ortho-photograph at a scale of 1-inch equals 100 feet in GIS to insure that all plots are placed along similar slope, aspect, vegetation and historical disturbance. One block of plots (western most) will be separated from the remaining site blocks to allow for a viewing corridor from U.S. Highway 2 toward a local marina as requested by the City of Ashland. All plots are distributed equally along two different elevation profiles (upper slope and

lower slope). When installation is complete, all plots for each block will be associated with a common contiguous open area characterized by similarity in herbaceous cover, soil type, slope, aspect, elevation, and historical disturbance.

Experimental Plots with Surface-Water Runoff Collectors:

All 12 plots (4 blocks) will be selected to conduct surface-water-nutrient runoff measures to quantify relative rates of surface-water runoff volume and water quality parameters, including ammonia, nitrate plus nitrite, total Kjeldahl nitrogen, total phosphorus, total dissolved phosphorus, and total suspended sediments. We will do this by installing runoff collectors inspired by an approach used by Graczyk et al. (2003) and modified to best work with our circular experimental plots and lacustrine clay soils to define the surface area of the watershed while at the same time minimize effects of plot-induced erosion along steep grades.

In our design we use a runoff collector fabricated out of a simple surface drain pvc coupler to serve as the primary collector of surface water flow. This surface drain is then partially buried at the lowest point of each experimental plot where it connects via 2" ID PVC pipe to drain to an external collection container of approximately 4.5-liter volume capacity. A non-absorbent, stainless steel wool pad is inserted into the surface drain port to screen-out larger debris from entering the collection container buried outside and below plot-surface elevation. The collection container consists of a 40 inch length of 3-inch ID PVC that is permanently capped at one end and fitted with a removable screw cap and coupler at the opposite (top) end. This container is housed inside another PVC pipe of 4-inch ID to function as a well casing to facilitate removal and replacement of the 3-inch collection container. The entire collection container and casing system is buried in a hole augured into the soil that allows the collector to be positioned lower in elevation than the runoff collector pipes. The collection container, casing, and associated components (described next) will be housed inside a partially buried irrigation control box (or lidded 5-gallon plastic pale) to protect the components from weather and disturbance.

In order to measure relative rates of surface-water runoff volume across all 12 experimental plots, we will install a timer-controlled automatic irrigation sprinkler system to produce a controlled precipitation event that applies a uniform amount and duration of water across all plots and blocks during monthly scheduled experimental runoff trials. By controlling the precipitation events and to accommodate the need to artificially irrigate the restoration site we can control precipitation input and collection time (i.e., implementing systematic sub-sampling), and avoid the problem of over-filling the collection container during active sampling as described in the USGS technical report cited previously. As a future option, we are considering devising a low-voltage (battery) digital timer-controlled flow-control valve that can be pre-set to open a valve at a selected frequency and duration in order to sub-sample precipitation events (artificial or natural) uniformly across all plots. However, for 2011, we will be installing a passive collection system in all plots that accepts all runoff (artificial and natural) entering the surface collectors.

Since we know that our collection containers will fill to capacity during high natural precipitation events between runoff trials, we have incorporated into our design a Y-splitter that allows excess runoff to continue flowing down slope of the plot. The Y-splitter is installed in-line between the surface collectors and the final collection container where one outlet hose is aligned to let water flow unimpeded into the collection container by gravity and the second outlet hose is curled into a pigtail with the end extending outside and down slope of the protective housing to allow excess runoff to continue outside the plot. Runoff flow outside the plot will be diffused to minimize erosive actions by passing through a perforated hose meandered down-slope. As we acquire experience implementing our runoff trials under site conditions and through calibration and testing, we anticipate that adjustments may be necessary to develop the final collector system. In addition to measuring

surface-water runoff volume, we will collect surface-water runoff samples to submit to the Wisconsin State Laboratory of hygiene located in Madison, Wisconsin to quantify water quality parameters (ammonia, nitrate plus nitrite, Kjeldahl nitrogen, total phosphorus, total dissolved phosphorus, and total suspended sediments). All samples will be processed through a 8-liter churn sample splitter in order to homogenize the total volume prior to distributing aliquots into separate sample bottles for additional processing (acidification/filtering) as required by the WSLOH. We will collect water quality samples monthly and during major rain events for analysis during the months July through September for years 2011 and May through September in 2012. Surface-water runoff volume will be quantified weekly by measuring the depth of water contained inside the calibrated collection container. Following runoff volume measurements and sample preparation for analyses of water quality, the entire runoff collector system will be inspected for proper functioning, and prepared for the next sampling event (screens cleaned, the collection container emptied, brushed and rinsed with distilled water and replaced back into the housing unit).

Task 2-6 Evaluate cost-benefits associated with restoration investment by comparing low- and high-cost stock plantings of native vegetation – Visual assessment of historic and recent lakeshore restoration efforts suggests that conventional prescriptions for restoration planting (stocking density and species richness) using a minimal stocking density may require a significant amount time (decades) post-restoration installation to achieve a level of vegetative structural integrity (complete ground cover, shrub twig and limb overlap, and tree crown cover) considered characteristic of natural shorelines along northern forested lakes. In this study, two of the three experimental treatment prescriptions (H, L, N) will represent different levels of investment to test whether planting advanced plant stock (larger, potted plants, high cost) can lead to quicker and/or enhanced response measures over that of bare-root trees and shrubs combined with herbaceous plant seed (low cost). In this and in all other plot studies, the third treatment is a control that receives no active planting. Here it is important to point out that our control treatment at the plot-level is different than control treatments established in other lakeshore restoration studies in that the property owner (City of Ashland) will not be conducting management (mowing, pruning or other trimming) to insure an open viewing corridor that is typical of the private shoreland owner. Control plots in this study will be allowed to regenerate naturally (passively) with the exception that invasive plant control will be conducted as part of the larger site-restoration goal to replace exotic species with native species. Though the S treatment represents the lower of the two planting costs, it does entail a higher level of site preparation prior to planting.

Task 2-7 Surface-water and non-point nutrient run-off measures – We will test the effects of plant stocking density (Green Infrastructure concepts) on surface-water run-off and nutrient loading at only our Memorial Park restoration site. Effects of constructed vegetative buffers on surface-water runoff and nutrient loading to Lake Superior will be assessed as part of a repeated measures, randomized complete block design (RCB), with parameters measured in treated (restored; at either H or L) and control (un-restored; N) experimental plots. Relative measures of surface-water run-off and nutrient loading will be collected systematically across the 12 experimental plots. The amount of surface-water runoff will be estimated by installing run-off collector devices as described above. The quantity of run-off is to be measured directly from the collection vessel manually with a calibrated ruler. The quality of surface water will be determined from analyses of the runoff collected by the sampling system. Samples from each plot will be delivered to the Wisconsin State Laboratory of Hygiene in Madison where they will be analyzed for total phosphorus, total dissolved phosphorus, ammonium nitrogen, nitrate and nitrite nitrogen, total Kjeldahl nitrogen, and suspended sediment. It is estimated that eight samples per year per monitoring site will be analyzed. Statistical comparisons of the pairs of treated and control data will reveal if any hydrologic or water-quality changes have occurred as a result of restoration plantings. Refer to *Task 2-7 Surface-water and non-point nutrient run-off*

measures – Quantitative Protocols, Sample Preparation and Analysis’ under ‘Sampling Method Requirements’ in this section for protocols and more details relating to accuracy and calibration.

Sample Analysis, Method and Handling:

<u>Analysis</u>	<u>Method</u>	<u>LOQ</u>	<u>LOD*</u>	<u>Units</u>	<u>Preservative/Handling**</u>
ammonia nitrogen	EPA 350.1	0.048	0.015	mg/L	pH < 2 with H ₂ SO ₄
nitrate + nitrite	EPA 353.2	0.061	0.019	mg/L	pH < 2 with H ₂ SO ₄
total Kjeldahl nitrogen	EPA 351.2	0.040	0.140	mg/L	pH < 2 with H ₂ SO ₄
total phosphorus	EPA 365.1	0.016	0.005	mg/L	pH < 2 with H ₂ SO ₄
total phosphorus, dissolved	EPA 365.1	0.016	0.005*	mg/L	0.45 micron filtering then pH reduced to < 2 with H ₂ SO ₄
total suspended sediments	SM 2540D	7	2	mg/L	none

* Detection limits based on minimum sample size for each parameter. Actual detection limits may vary based on the amount of sample that can be collected and/or filtered. ** All samples will be placed in a cooler filled w/ice for shipping via next day carrier.

Tasks 2-8 Soil moisture and carbon sequestration – A common result of lakeshore disturbance associated with the removal of vegetative cover is the loss of soil organic matter, soil compaction and a reduced capacity in soil moisture retention. Under natural conditions organic matter becomes a component of the soil matrix where varying rates in soil moisture and decomposition, size of woody material, and site disturbance (including fire) influence the net amount of total carbon that becomes sequestered in the deeper layers of the soil horizon complex. For this test, a soil aliquot will be extracted from of the soil samples collected for arthropod measures (Task 2-8), and that represent each of our experimental plots. The extracted soil samples will be placed in plastic sampling bags and shipped to the State Laboratory of Hygiene for analysis of total carbon content. We will also quantify soil pH and moisture content at each experimental plot using a Kelway® Soil Tester and following the same sampling strategy. Refer to *Tasks 2-8 Soil moisture and carbon sequestration – Quantitative Protocols, Sample Preparation and Analysis* under ‘Sampling Method Requirements’ in this section for protocols and more details relating to accuracy and calibration.

Task 2-9 Soil arthropod abundance and species richness – Soil invertebrates contribute toward soil health in forested landscapes by contributing organic matter and important nutrients, soil aeration and mechanical decomposition that improve both soil fertility and soil porosity. Disturbed landscapes (cleared shorelines) typically reflect impoverished soil faunal community structure as result of frequent disturbance to the soil layer and/or absence of sufficient groundcover. We will collect 4 intact soil plug samples, each equivalent to a ¼ - liter volume and six-inch depth from plot locations selected in a stratified-random manner along the central radius of each of the plots quarter quadrants. Samples will be individually analyzed for arthropod abundance and species richness as well as pooled for a total-plot index to soil invertebrate abundance and species richness. Soil arthropod abundance and species richness will be quantified using a Berlese-Tullgren funnel that relies on temperature and moisture gradients to passively force soil organisms lower and lower in the sample strata until they

fall from the funnel into a collection jar filled with 85% ethanol. A low-wattage bulb is applied at the soil sample surface at the top of the Berlese-Tullgren funnel after the soil sample has been transferred from the field sampling container to the Berlese-Tullgren funnel. Each sample will be allowed 3 days of exposure in the Berlese-Tullgren funnel to insure all arthropods have dropped from the sample. Soil arthropods will be identified to the family, genus or species taxonomic level when possible. Refer to: *Task 2-9 Soil arthropod abundance and species richness – Quantitative Protocols, Sample Preparation and Analysis* under ‘Sampling Method Requirements’ in this section for protocols and more details relating to accuracy and calibration.

3. Education, Outreach and Stakeholder Involvement

Task 3-1 Invasive Species Control Workshops (consistent to current park management practices)

Target audiences: Chequamegon Bay residents, school groups

Target dates: Summer and Fall, 2010; Spring, Summer, Fall, 2011, spring 2012

Activity/output description: Three terrestrial invasive species control workshops will be hosted to educate and engage local residents in hands-on control. Participants will spend three hours removing invasive species, and learn about the invasive plants at the site. Each person will receive a copy of the new WDNR Pocket Guide to Terrestrial Invasive Plants, along with other printed materials from the Midwest Invasive Plant Network, UW-Extension, WDNR and Northwoods CWMA. Workshops will be modeled after the successful events hosted by the NCWMA in local communities over the past three years, such as the National Public Lands Day events hosted at the Invasive Free Zone in cooperation with the US Fish & Wildlife Service. NCWMA workshops typically draw 15-30 volunteers from all ages and backgrounds, including Master Gardeners, girl/boy scout groups, school students, landowners and other residents who want to learn to identify and control invasive species in their community. As with all NCWMA workshops, IPM will be implemented, using manual and mechanical control methods whenever practical to minimize the use of herbicides. Invasive species workshops will be evaluated based on the percent cover of native species versus invasive species before and after each event, as well as the total number of participants at each event. Each workshop costs approximately \$1600 (coordinator time, marketing materials, herbicide, handouts, refreshments and incentives for volunteers).

Task 3-2 Interpretive Kiosks

Target audience: Community members, tourists.

Target date: Fall, 2011.

Activity/output description: Demonstration projects will be located along Ashland’s Waterfront Trail, a popular multi-use non-motorized trail used by Chequamegon Bay community members and tourists, thus we have a significant opportunity to increase the public’s awareness of both the project and the importance of restoring native shorelines. Two interpretive “kiosks” will be developed, featuring an all-weather standardized signs and mounting framework that are consistent with the City of Ashland’s other Lake Waterfront Trail signage, and located at the Memorial Park restoration site. Signs will include the GLRI symbol and other project partner information. These “place-based” educational tools will feature interpretive messages examining causes of shoreline degradation, particularly the impact of invasive species, climate change, and habitat loss impacting that site. Each sign will explain through text, diagrams, and photos, the specific green infrastructure restoration strategies being used to re-establish natural shorelines at that site and will promote the ecologic, social, and economic benefits of healthy native shorelines. To multiply educational benefits, Northland College environmental education students will be engaged in researching and drafting the interpretive message for each interpretive kiosk under direction of Northland College and UW-Extension interpretive design specialists. Temporary signs, not paid for by the grant, could be installed during the restoration start-up to provide more immediate project information and educational outreach.

Task 3-3 Lake Superior Shoreline Restoration Website/Blog

Target audience: Shoreline riparian decision makers, community members, students, the general public

Target date: May, 2011

Activity/output description: A project website will be created, and hosted by Northland College, as a means of outreaching information about the project via distance education. Links to this site will be established on the “Connecting the Coast” website and the Ashland County Conservation Department website. The website will provide on-line resources to investigate and document the causes of natural shoreline impairment and its ecologic, economic, and social impacts using the project’s demonstration sites as case study examples.

The website will feature photo-point monitoring of the project’s demonstration sites to provide a pictorial record of the progress prior to, during, and after restoration. Specific restoration prescriptions and strategies used at each demonstration site will be documented with links to further resources to provide shoreline riparian decision makers both on-line templates and tools to replicate a restoration project on the property they manage. Research-based monitoring results from wildlife, non-point nutrient run-off, biotic surveys, and surface water quality from the control site and restoration sites will be posted on the website to quantify the project’s benefits and the impact of native vegetative buffers and erosion control practices on water quality. Under the direction of the Project Coordinator and Northland College specialists, Northland students will develop and implement the monitoring plan and provide data, photographs, and for posting on the website. The website will also include curricula and training materials used in the Shoreline Riparian Decision Makers Workshop and a blog where project updates are featured. Information, announcements, and event listings will be cross posted with the Northwoods Cooperative Weed Management Area electronic newsletter and through the Lake Superior Bi-national Forum’s communication tools (electronic newsletter, web-blog, Lake Superior Day, and radio show).

Task 3-4 Lake Superior Shoreline Decision Makers Green Infrastructure Workshop

Target audiences are public and private land managers who are directly involved in decision making affecting the management of Lake Superior’s shoreline resources including:

- local elected officials (town, village, city, county and tribal),
- non-governmental organization representatives and volunteers involved in Lake Superior coastal management,
- Lake Superior Bi-national Program representatives,
- county land conservation departments, and
- Lake Superior private and public riparian land owners.

This workshop will be directed to a regional audience responsible for making riparian management decisions in areas that share the similar red clay plain characteristics and challenges of highly erodible soils, wave induced erosion, and/or a post-industrial waterfront that has undergone significant habitat degradation similar to Ashland, WI. An outreach education position, co-supervised by NC-SOEI and the WDNR, will be sponsored through the Northland College, SOEI to coordinate development and implementation of the workshop. General guidance will be provided by participating collaborators.

Target date: September, 2011.

Activity/output description:

This two day demonstration workshop will:

- increase the understanding of target audiences (see above) of the best management practices using “green infrastructure” and the benefits of restoring Lake Superior shorelines to native habitats to improve ecologic, economic, and social outcomes,
- demonstrate the cost-benefit comparison between a control site and lower and higher cost restoration site models on mitigating issues such as invasive species, ecological function, and non-point source pollution,
- provide specific management strategies and resources to replicate these results based on the types of shoreline riparian habitats managed by target audience groups, using on the project’s outcomes as the baseline model,
- increase the target audience’s ability to initiate shoreline restoration projects by demonstrating restoration techniques and outcomes at the control and demonstration sites, provide training in monitoring protocols, demonstrate vegetative plantings for climate change resiliency, and offer hands-on restoration instruction and resources,
- provide participants with a “Riparian Restoration” toolkit of best management practices including information and resources to replicate projects in other vulnerable Lake Superior habitats and provide follow-up support.

This workshop will be networked with the Lake Superior Bi-national Forum, Great Lakes City Initiative, Harbor Town Association, the Wisconsin Counties and Wisconsin Towns Associations, University of Wisconsin-Extension, and the Lake Superior National Estuarine Research Reserve in Superior, WI. It will feature impaired habitat restoration resource professionals as workshop speakers and demonstration site experts and to share their expertise on best restoration management practices as well as financial and technical resources available to implement them.

Workshop training will be conducted by the Principal Investigator, Northland College, and by the Ashland County Land and Water Conservation Department and UW-Extension through its Northern Great Lakes Visitor Center Office. Workshop materials, resources, and curricula will be posted on the project’s website (concurrently developed) to allow greater accessibility and distance education outreach to target audience members.

4. Restoration Quality Assurance Assessment

Task 4-1 Monitor accuracy of implementing the restoration conceptual design – This task involves tracking restoration implementation to insure that actions are in agreement with the restoration plan and its stated goals and objectives, as well as meeting compliance with the Natural Resources Conservation Service 580 and 643A codes. Specific results tracked include length of shoreline that receives the restoration treatment prescribed in the restoration plan, and the installation of experimental plots, fence and irrigation system.

Task 4-2 Document accuracy of plant-stocking density and plant species identification – The experimental plots and buffer restoration area will be evaluated at a site- and plot-level and to confirm that the correct stocking density has been achieved. This evaluation will consist of a post-restoration estimation of stocking density by counting of all planted and existing native trees, shrubs, and herbaceous plants within each 50 m² experimental plot and a set of randomly selected plots within the restoration buffer area. Concurrent to counting, all plant species taxonomic identification will be re-

assessed for accuracy. Data forms and other records will be established to specifically facilitate this review process.

Task 4-3 Invasive species control monitoring – The experimental plots and buffer restoration area will be surveyed to quantify with 10% accuracy the percent area covered by invasive species. A 1-m² vegetation sampling quadrat will be used to quantify percent cover of woody and herbaceous invasive species cover at randomly selected sites within each experimental plot and for selected areas in the buffer restoration area. Information will be collected on data forms designed specifically for this task, and results will be tabulated to serve as an ISC management decision tool.

Task 4-4 Monitoring correctness of planting – Once restoration plantings have been completed, a systematic survey will be conducted to quantify a running tally and proportion of plants that do and do not meet the established standards for correct installation (root collar at surface, soil filled in and tamped, mulch added, correct clumping distribution, neighbor-species compatibility, etc.). This information will be used as a management tool to take corrective action to confirm that all plant stock has been installed according to a minimum standard.

Task 4-5 Erosion control monitoring – Installation of bio-engineered landscape products to control erosion and enhance terrain: Erosion control practices will include the installation of rain gardens and appropriate placement of erosion control materials such as EnviroLoc bags, sediment logs, and biologs. These methods constitute use of “Green Infrastructure” within this project – which is an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes to enhance overall environmental quality and provide utility services. As a general principal, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspire, and/or recycle storm-water runoff.

Task 4-6 Monitoring effectiveness of the exclusion fence – At monthly intervals, the enclosure fence will be completely surveyed for due repairs and/or enhancement.

Task 4-7 Monitoring effectiveness of automated and manual irrigation systems – At monthly intervals, the automated irrigation system will be assessed for acceptable performance. If performance is considered un-acceptable, the contracting vendor will be notified to schedule a site visit to evaluate necessary repairs. In case of system failure, the backup portable system will be used to provide irrigation.

Sampling Method Requirements

There are 3 general types of sampling in this project. The first, includes visual surveys considered observational in nature, and primarily include those conducted at the site level. These surveys require an experienced individual(s) that possess an expertise in the identification of the region’s flora and fauna communities, and a thorough understanding of the limitations in the methodology. The second type, includes those measures conducted in-situ using calibrated scientific equipment (e.g., water quality testing meter, soil pH meter). These measures are highly dependent upon the user’s competency in equipment use, and knowledge on equipment calibration and maintenance. The third type involves sampling that requires submission of samples collected in-situ that are to be shipped to an analytical laboratory for rigorous certified analyses using specialized equipment. Each type of sampling requires a specific set of protocols and quality control standards to insure data quality.

Preparation of data collection instruments

All data collection instruments will be subject to routine inspection, calibration and quality assurance testing to insure the collection of high-quality and representative data. Data collection instruments will be prepared in accordance with the guidance on data collection instruments provided in EPA's *Generic Guide to Statistical Aspects of Developing an Environmental Results Program* (2003).

Task 2-7 Surface-water and non-point nutrient run-off measures – Quantitative Protocols, Sample Preparation and Analysis

Surface-water runoff volume

Sampling procedure: Runoff volume will be collected inside an approximately 4.5 liter volume PVC fabricated container calibrated to a known volume/centimeter depth with 100 milliliter accuracy. Measurements will be quantified visually using a straight metric ruler that registers a wet-line mark. Samples with volumes less than 1-liter will be quantified by transferring the volume of runoff into a graduated cylinder, including sediments. Once measurements have been conducted and recorded, the container contents will be emptied either on the down-slope portion of the study plot if no water quality samples are to be collected or into a 4-liter churn sample splitter to produce sample aliquots for analysis at the WSLOH. Any remaining volume will be discarded outside the plot. The collection container will be brushed and rinsed with distilled water and replaced inside the protective casing.

Water quality sampling and analysis

A 4-liter Churn Sample Splitter will be used to produce homogeneous sample aliquots for nutrient and suspended sediment analysis conducted at the WSLH. One sample will consist of a 250 ml volume that is unfiltered and preserved with H_2SO_4 for nutrient analysis (ammonia, nitrate + nitrite, total Kjeldahl nitrogen, and total phosphorus). A 60 ml volume will be prepared for analysis of total dissolved phosphorus by running the sample volume through a 0.45 micron nylon filtration system (Luer Lock syringe and disposable nylon filter) and preserved with H_2SO_4 . A third sample will consist of a 500 ml volume that is not filtered or preserved, but placed immediately on ice in a cooler for analysis of total suspended sediments. Each bottled sample will be labeled with plot ID, date and time, fixative and placed into a new locking plastic bag, sealed and placed on ice in a cooler that is sealed closed with shipping tape (when sampling is complete). Shipping method used will be via next-day delivery to the WSLOH for analytical processing. Chain of custody forms will not required.

Equipment and supplies: 250 ml, 60 ml and 500 ml PP sampling jars, H_2SO_4 solution, 0.45 micron filtration syringes, and cooler will be provided by the WSLOH. Additional supplies include: permanent marker, labels, locking plastic bags, sealing and shipping tape and ice.

Clean-sampling procedure: Each runoff collection container will be washed internally with a brush and rinsed with distilled water off-site prior to installation in an experimental plot. Subsequent sampling will be preceded by washing and rinsing only the collection container with distilled water. Prior to and between sampling events, the 4-liter churn sample splitter will be washed internally and externally with a non-phosphorus/nitrogen based detergent then rinsed well. Following rinsing, a 1:5 dilution of $H_2SO_4:H_2O$ will be used to chemically flush the interior of the churn splitter and rinsed well with distilled water.

Preservation requirements: all sample bottles will be prepared with a H_2SO_4 solution by the WSLOH prior to shipment. No preservative is added to the sample part to be analyzed for total suspended sediments. A cooler filled to $\frac{1}{4}$ volume of crushed ice will be used to store and ship all samples to the WSLOH.

Sample volume/parameter: 250 ml, ammonia, nitrate plus nitrite, kjeldahl nitrogen, total nitrogen, and total phosphorus. A 60 ml volume for total dissolved phosphorus and 500 ml is required for total suspended sediments. A maximum of 3 runoff samples per year (once per month per plot for 12 plots for July-September for a total of 36 samples) per experimental plot plus 3 samples per year for the irrigation source (irrigation line or pump source) and one duplicate/block/month (total of 12 samples) will be analyzed for a maximum of 51 samples/year to represent the 12 experimental plots plus irrigation source and duplicate controls. We will use data collected during 2011 to specify our sampling strategy for 2012 to account for variation and minimum sub-sample needs.

Location measurements: Geographic coordinates of plot centers are determined by averaging three geographic coordinates measured using a GPS device with 3-5 meter accuracy. GPS coordinates are georeferenced in GIS and 2008 ortho-rectified aerial photograph.

Degree of accuracy: laboratory sample analysis accuracy per parameter follows that of WSLOH 1992 laboratory and EPA 350.1, 353.2, 351.2, 365.1, and SM 2540D standard operating procedures.

Field quality control samples: Duplicate partitions will be prepared to compare analytical consistency. Additional control samples will represent distilled water processed through the sampling collector systems.

Tasks 2-8 Soil moisture and carbon sequestration – Quantitative Protocols, Sample Preparation and Analysis

Sampling procedure: Four randomly sampled plugs of soil will be collected from each of the 12 experimental circular plots at a point randomly selected along a radial axis within the bounds of its 45 degree arc for each quarter quadrant. Soil plugs will be collected using a standard 1" inside diameter soil probe to extract approximately 2 cups volume of intact soil down to a 15 cm depth. Each sub-plot sample will be transferred into the same 1-quart volume locking plastic bag that includes an all-weather label permanently marked with plot and quadrant ID, data and time, and collector name. All samples will be placed immediately into a chilled cooler for storage and transport to the U.W. Soil and Plant Analysis Laboratory located in Monona, WI. Soil analysis will be conducted on a composite sample for each plot. This procedure will be conducted during August of each year 2011 - 2012, and repeat sampling will continue periodically through 2020 with WDNR funding.

Equipment and supplies: Standard 1" soil probe; 1-quart locking plastic bags, permanent marker and label, gel-ice packs, cooler, packaging tape

Clean-sampling procedure: The soil probe will be washed on-site using the irrigation hose and rinsed with distilled water, then towel-dried prior to and between field sample collections. The locking plastic bags will be used new as provided by the manufacturer.

Sample container: 1-quart volume locking plastic bag

Preservation requirements: Cooler filled with ¼ volume of cubed ice.

Sample volume/parameter: 1-liter composite sample, total phosphorus, total nitrogen, total carbon, % organic matter, % clay, % silt, % sand. A total of 1 composite soil samples per year per experimental plot (late summer sampling) will be analyzed for a total of 12 samples/year representing 12 experimental plots.

Location measurements: Geographic coordinates of plot centers are determined by averaging three geographic coordinates measured using a GPS device with 3-5 meter accuracy. GPS coordinates are geo-referenced in GIS and 2008 ortho-rectified aerial photograph.

Degree of accuracy: laboratory sample analysis accuracy per parameter follows that of the U.W. Plant and Soil laboratory specifications.

Field quality control samples: 3 samples per shipment will consist of composite samples derived from duplicates of 3 experimental plots.

Task 2-9 Soil arthropod abundance and species richness – Quantitative Protocols, Sample Preparation and Analysis

Sampling procedure: A randomly selected plug of soil will be collected for each of the 12 experimental plots from one of the same locations that are randomly selected for soil carbon and chemical analysis (see description above). Soil plugs will be collected using a 10 cm inside diameter alloy can to extract approximately a ½ liter volume of intact soil down to a 15 cm depth. Each sub-plot sample and its alloy can will be transferred into the same 1-gallon (64 oz.) volume perforated locking plastic bag that includes an all-weather label permanently marked with plot and quadrant ID, data and time, and collector name. Soil biotic analysis will include use of a Berlese funnel to extract soil arthropods for quantification of relative species richness and abundance. This procedure will be conducted during July and August for 2011/2012. Repeat sampling will occur every 3 years through 2020 pending WDNR funding.

Equipment and supplies: 10 cm inside diameter alloy can (1/sample); 1-gallon perforated locking plastic bag (300ct), permanent marker and label; Berlese funnel including heat lamps, stand and ethanol bottle.

Clean-sampling procedure: The garden bulb planter(s) will be cleaned and rinsed, and towel-dried prior to and between field sample collection. Locking plastic bags will be used new as provided by the manufacturer and perforated to allow for air exchange during transport. The Berlese funnel system will be washed to remove all previous sample material.

Sample container: 1-gallon volume perforated locking plastic bag

Preservation requirements: Cooler filled with ¼ volume of frozen re-useable freezer packets.

Sample volume/parameter: 1-gallon composite sample, arthropod abundance, arthropod species richness, % forest-dwelling species. A total of 12 samples during 2011 and 24 samples during 2012 will be analyzed at an off-site location that has controlled atmosphere and lighting.

Location measurements: Geographic coordinates of plot centers are determined by averaging three geographic coordinates measured using a GPS device with 3-5 meter accuracy. GPS coordinates are geo-referenced in GIS and 2008 ortho-rectified aerial photograph.

Degree of accuracy: laboratory sample analysis accuracy per parameter follows that of laboratory specifications.

Field quality control samples: There will be no quality control sampling.

Task 2-9 In-situ Measurements: Quantitative Protocols, Sample Preparation and Analysis

*Surface-water-nutrient runoff*Tests:

- (A) Analog precipitation (rain + irrigation) gauges to develop an index to surface flow (Q) threshold.
- (B) Surface (15cm depth) soil temperature to develop an index to surface flow (Q) water temperature.
- (C) Surface soil pH to develop an index to the acid neutralizing capacity of the soil.

Methods: Install 4 (1 per 90 degree quadrant) 250 ml capacity analog precipitation gauges at equidistant points in each experimental plot. Rain gauges will be emptied prior to, and quantified after each experimental runoff trial (and/or after major rain events to estimate the volume of water entering each of the 12 experimental plots due to artificial or natural precipitation. By quantifying precipitation in this manner simultaneous to measuring volume deposited into the collection vessel, the threshold Q can be predicted for future rain events to conduct on-site sample collection.

Parameters: Precipitation volume (ml) (± 0.1 ml); Soil temperature @15cm depth (C) (± 0.5); Soil pH (± 0.05)

Calibration Needs: precipitation gauge volume and increment precision will be confirmed using a calibrated volumetric beaker. All precipitation gauges will be tested for accuracy and precision.

Quality Assurance Requirements: Equipment is maintained for optimal performance. Observers will be paired with the supervisor on a randomly selected subset of plots during each sampling event to insure adherence to protocol.

Soil carbon and chemical analysis

Tests: In-situ soil pH and temperature (to compliment laboratory analysis)

Methods: A Kelway® Soil Tester will be used to measure soil pH and temperature along a 15cm depth profile by inserting the tester probe at a point 15cm further out along the randomly selected point selected for soil sampling for laboratory analysis.

Parameters: Soil pH, soil Temp (C), soil moisture (%)

Calibration Needs: The tester will be calibrated following manufacturer's specifications.

Quality Assurance Requirements: A well-mixed composite sample of clean sand will be created and partitioned into 3 separate samples to evaluate tester performance in consistent measurements to represent high sand content soil types. For high content clay soil types, clay will be acquired, mixed with de-ionized water, allowed to set for 15 minutes, and then mixed again prior to separating into 3 separate samples to repeat the above test. An accuracy of 0.05% will be considered acceptable. Equipment is maintained for optimal performance. Observers will be paired with the supervisor on a randomly selected subset of plots during each sampling event to insure adherence to protocol.

Soil biotic analysis (optional)

Tests: Occurrence of terrestrial (on soil surface) arthropods, description of litter type and % cover. (to compliment soil arthropod laboratory analysis).

Methods: This test is conducted concurrent to the vegetation sampling and relies upon the same sample site location as determined in that test. However, prior to determining plant species richness and % cover,

the soil surface is searched for existing arthropods, insect nests or burrows. All arthropods found are collected using an aspirator and transferred into a labeled glass jar containing 70% ethanol.

Parameters: Arthropod species richness and abundance

Calibration Needs: None

Quality Assurance Requirements: Observers will be paired with the supervisor on a randomly selected subset of plots during each sampling event to insure adherence to protocol.

Sample Handling and Custody Requirements

Field samples (soil and water) will be handled and managed following the technical guidelines described in the specific sampling protocol developed for each response measure listed in section B. Upon completion of sample collection, the associated sample information (sample ID, date/time, location, collector ID) will be documented into an electronic sampling database to track sample custody and handling history. Subsequent analytical results associated with each sample will be entered into an electronic database, which will be reviewed by the WDNR Data Quality Officer. Electronic database components and their data will be migrated into the WDNR's Surface Water Information Management System (SWIMS), an Oracle® based database management system.

Analytical Requirements

This project will follow well-recognized statistical analytical methods and SOP for survey samples. All results developed by the WSLOH will be transmitted electronically via internal procedures to the WDNR SWIMS database management system.

Sample Analysis, Method and Handling:

<u>Analysis</u>	<u>Method</u>	<u>LOQ</u>	<u>LOD*</u>	<u>Units</u>	<u>Preservative/Handling**</u>
ammonia nitrogen	EPA 350.1	0.048	0.015	mg/L	pH < 2 with H ₂ SO ₄
nitrate + nitrite	EPA 353.2	0.061	0.019	mg/L	pH < 2 with H ₂ SO ₄
total Kjeldahl nitrogen	EPA 351.2	0.040	0.140	mg/L	pH < 2 with H ₂ SO ₄
total phosphorus	EPA 365.1	0.016	0.005	mg/L	pH < 2 with H ₂ SO ₄
total phosphorus, dissolved	EPA 365.1	0.016	0.005*	mg/L	0.45 micron filtering then pH reduced to < 2 with H ₂ SO ₄
total suspended sediments	SM 2540D	7	2	mg/L	none

* Detection limits based on minimum sample size for each parameter. Actual detection limits may vary based on the amount of sample that can be collected and/or filtered. ** All samples will be placed in a cooler filled w/ice for shipping via next day carrier.

Data Acquisition Requirements (Non-direct Measurements)

This project will rely upon secondary data to conduct landscape assessment, project planning, and climate data analyses as they relate to in-situ sampling methodology.

Table 1: Non-Direct Measurements (i.e., Secondary Data)

Data Sources	Intended Use	Rationale for Use	Acceptance Criteria
WDNR-GIS Data	Site map generation	Landscape assessment, project planning	All records are pre-approved for use.
Ashland County-GIS Data	Site map generation	Landscape assessment, project planning	All records are accepted 'as-is.'
Ashland County-Wetland Delineation Report	Site assessment	Landscape assessment, project planning	All records are accepted 'as-is.'
Ashland County-Biocell Retention Basin Report	Site assessment	Landscape assessment, project planning	All records are accepted 'as-is.'
Ashland County-Agricultural Climate Data	Environmental Variables Monitoring	Landscape assessment, Data Analysis	All records are accepted 'as-is.'

Quality Control Requirements

This project will undertake the following specific steps to measure/estimate the effect of data errors, consistent with WDNR's Quality Management Plan.

Crosschecking data

Primary data collection forms will be designed in such a way to allow internal crosschecking of data by comparing answers of different questions to each other, and such crosschecking will be automatic for electronically entered data. Further, post-certification inspections will offer the opportunity to compare inspection results with self-certification results, if the facilities sampled have submitted self-certification forms.

Data anomalies

Procedures for handling data anomalies (such as outliers and missing data) will be handled based on guidance prepared in the project-specific statistical methodology.

Instrument/Equipment Testing, Inspection and Maintenance

The WDNR and/or its collaborators will conduct routine and regular instrument/equipment inspection and maintenance relating to the following activities:

- Surface-water-nutrient run-off collectors – weekly, each run-off collector will be tested to confirm accuracy in results of calibrated measurements of standardized volume flow-through into

the collector device. Automated, digital timers (if used) will be tested weekly to confirm proper performance and synchronized timing.

- Kelway® Soil pH/Acid/Temp Probe – weekly, each Kelway® probe will be cross-calibrated following manufacturer’s guidelines to validate accuracy in results.
- Automated irrigation timers and controllers – weekly, all components of the automated irrigation system will be inspected and assessed for accuracy in timing and amount of supply delivery.
- Deer enclosure fence – weekly, all components of the fence will be inspected for structural integrity and necessary repairs.

Instrument/Equipment Calibration and Frequency

The WDNR and/or its collaborators will conduct routine and regular instrument calibration relating to the following activities:

- Surface-water-nutrient run-off collectors – weekly, each run-off collector will be tested to confirm accuracy in results of calibrated measurements of standardized volume flow-through into the collector device. Automated, digital timers will be tested weekly to confirm proper performance and synchronized timing.
- Kelway® Soil pH/Acid/Temp Probe – weekly, each Kelway® probe will be cross-calibrated following manufacturer’s guidelines to validate accuracy in results.
- Automated irrigation timers and controllers – weekly, all components of the automated irrigation system will be inspected and assessed for accuracy in timing and amount of supply delivery.

Non-Direct Measurements (I.e., Secondary Data)

This project will rely upon secondary data to conduct landscape assessment, project planning, and climate data analyses as they relate to in-situ sampling methodology.

Table 2: Non-Direct Measurements (i.e., Secondary Data)

Data Sources	Intended Use	Rationale for Use	Acceptance Criteria
WDNR-GIS Data	Site map generation	Landscape assessment, project planning	All records are pre-approved for use.
Ashland County-GIS Data	Site map generation	Landscape assessment, project planning	All records are accepted ‘as-is.’
Ashland County-Wetland Delineation Report	Site assessment	Landscape assessment, project planning	All records are accepted ‘as-is.’
Ashland County-Biocell Retention Basin Report	Site assessment	Landscape assessment, project planning	All records are accepted ‘as-is.’
Ashland County-Agricultural Climate Data	Environmental Variables Monitoring	Landscape assessment, Data Analysis	All records are accepted ‘as-is.’

Data Management

As part of this project, WDNR will develop a data management strategy, and amend the QAPP based upon a strategy incorporating realized data management needs. The Project Coordinator is responsible for ensuring that the strategy is developed and that the QAPP is amended to reflect that strategy. The strategy will be consistent with the existing WDNR's Quality Management Plan. Once amended, this QAPP section on data management will provide information on the following issues:

- Data management scheme, from field to final use and storage
- Standard recordkeeping and tracking practices, and document control system (citing relevant agency documentation)
- Data handling equipment/procedures that will be used to process, compile, analyze, and transmit data reliably and accurately
- Individuals responsible for elements of the data management scheme
- Process for data archival and retrieval

Procedures for entering hand-written data into the database will follow standard quality assurance procedures (e.g., 100% verification using independent double key entry), consistent with WDNR's Quality Management Plan. Detailed quality assurance procedures for data entry and acceptance will be prepared during the development and implementation of a data management strategy. All laboratory water quality results developed by the WSLOH will be transmitted electronically via internal procedures to the WDNR SWIMS database management system.

C. Assessment/Oversight

Assessments and Response Actions

The Quality Assurance Officer will conduct a review of the data collection procedures pursuant to reviewing the Quality Assurance Project Plan, and report findings to the Project Coordinator, who will take corrective action (if any is necessary) before the data collection task begins. Further, the Project Coordinator will thoroughly review with staff all data collection procedures after beginning their respective implementation tasks to identify emerging/unanticipated problems and take corrective action. Data assessment and procedures are written into each sampling objective description. At the end of each season, or as needed, all sampling strategies will be reviewed for adequacy, and revised as needed in order to meet data quality standards and sampling objectives.

Reports to Management

Three kinds of reports will be prepared: readiness reviews (described above), regular quarterly and annual progress reports, and project final report. Progress reports will note the status of project activities and identify whether any QA problems were encountered (and, if so, how they were handled). Project final report will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the data should be used.

Table 3: Project QA Status Reports

Type of Report	Frequency	Preparer	Recipients
Amended QAPP	Once, before primary data collection begins	WDNR Project Coordinator	All recipients of original QAPP
Readiness Review	Before each major data collection task	WDNR QA Officer	WDNR Project Coordinator, CBSRP
Progress Report (GLAS)	Quarterly	WDNR	GLAS
Progress Report	Annually	WDNR	U.S. EPA Project Officer (Copying US EPA OPEI), stakeholders
Final Project Report	Once	WDNR	U.S. EPA Project Officer (Copying US EPA OPEI), stakeholders

D. Data Validation and Usability

Data Review, Validation, or Verification

This QAPP shall govern the operation of the project at all times. Each responsible party listed in Section A4 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed at least annually to ensure that the project will achieve all intended purposes. All the responsible persons listed in Section A4 shall participate in the review of the QAPP. The Project Coordinator and the Quality Assurance Officer are responsible for determining that data are of adequate quality to support this project. The project will be modified as directed by the Project Coordinator. The Project Coordinator shall be responsible for the implementation of changes to the project and shall document the effective date of all changes made.

It is expected that from time to time ongoing and perhaps unexpected changes will need to be made to the project. The Project Coordinator shall authorize all changes or deviations in the operation of the project. Any significant changes will be noted in the next report to EPA, and shall be considered an amendment to the QAPP. All verification and validation methods will be noted in the analysis provided in the final project report.

To confirm that QA/QC steps have been handled in accordance with the QAPP, a readiness review will be conducted before key data collection/analysis steps, and data handling reports will be prepared after each step. These reviews and reports will be consistent with WDNR's Quality Management Plan. Standard statistical tests (described below in Section D3) will be used to determine the extent to which inferences can be drawn from the sample data.

Reconciliation with Data Quality Objectives

Data quality objectives included in this project reflect standard methods used in quantifying ecological benefits across time and space for a period that extends beyond the terms of the 2012 EPA project term relating to restoration installation and educational outreach. Specifically, the metrics of primary interest to the Project Coordinator are those ecological response measures (water quality, vertebrate richness, canopy cover) that reflect change across time as they relate to plant growth, plant survival and other attributes associated with time since restoration installation.

Project-specific statistical methodology will include the use of a variety of data synthesis and analytical procedures (and software) necessary to generate metrics used in statistical hypothesis testing. All statistical procedures will be in accordance with the WDNR's Quality Management Plan and EPA's Generic Guide to Statistical Aspects of Developing an Environmental Results Program (2003).

Anticipated statistical procedures and tests used in this project, include:

- Tukey's T-test
- Logistic Regression
- General Linear Model (GLM)
- Analysis of Variance (ANOVA) and Covariance (ANCOVA)

In order to minimize influence of experimental error, all data will be reviewed and screened for quality assurance purposes. If data quality indicators do not meet the project's requirements as outlined in this QAPP, the data will be archived but not included in statistical procedures, and all necessary re-sampling will occur. The Overall Project Coordinator will determine the cause of the failure (if possible), and make the decision to discard the data and re-sample. If the failure is tied to the analyses, calibration and maintenance techniques will be reassessed as identified by the appropriate personnel (laboratory or field). If the failure is associated with the sample collection, the sampling methods and procedures will be reassessed and re-sampling performed, if necessary. Corrective action will be undertaken by all parties to address specific problems as they arise.

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