Palestine Lake Watershed Engineering Feasibility Report

Kosciusko County, Indiana

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PALESTINE LAKE WATERSHED ENGINEERING FEASIBILITY REPORT KOSCIUSKO COUNTY, INDIANA

EXECUTIVE SUMMARY

The Palestine Lake Property Owners Association (PLPOA) received an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) grant to complete an engineering feasibility study for up to ten potential project areas located within the Palestine Lake watershed. To be deemed feasible, a project needed to be acceptable to property owners, receive regulatory agency support, be physically constructible, and be environmentally and socially justifiable. A 2008 diagnostic study completed by JFNew identified more than 30 potential water quality improvement projects, based on issues such as invasive plant growth, sedimentation at inlets, high hypolimnetic ammonia concentrations and the presence of high levels of soluble phosphorus. The association worked with the Kosciusko Soil and Water Conservation District (SWCD) and the Natural Resources Conservation Service (NRCS) to identify the top ten sites based on existing knowledge of landowners, qualifications for current government programs, access and benefit to water quality.

Of the ten project sites addressed in the feasibility study, seven projects were identified and deemed feasible. In addition to the seven projects that were determined feasible, two more projects identified during this study were documented as being feasible. The identified potential projects included stabilizing 790 feet of streambank at five locations with cost estimates for design/build ranging from $5,706 to $30,190; a sediment basin with two vegetated swales with estimated costs for design/build at $13,050; and a nine-acre wetland restoration with an estimated cost for design/build at $26,069. The total costs for designing and constructing all the projects are estimated at $134,590.

Four of the ten sites that were selected for investigation were determined to not support a feasible project. At one site access was not granted and therefore no further investigation was completed. At two sites that were investigated, it was determined that a water quality improvement project was not needed. At the fourth site, a potential project was identified, but it was determined that the project may qualify for current conservation programs and the feasibility investigation was terminated.

It is recommended that the PLPOA apply for a LARE grant for the design and construction of a portion of the identified projects. The PLPOA should then continue to pursue the implantation of all the identified projects and continue working with the LARE program to pursue the other potential projects identified during this study.

ACKNOWLEDGEMENTS

The Indiana Department of Natural Resources Division of Fish and Wildlife Lake and River Enhancement (LARE) Program and the Palestine Lake Property Owners Association funded this feasibility project. JFNew assessed project feasibility and environmental impacts, completed preliminary designs of projects, and developed opinions of probable cost for the feasible projects within the identified areas. Mark Whittaker of the Palestine Lake Property Owners Association provided initiative and assistance in getting this project completed. Special thanks are due to Deb Hutnick for donating time and materials to complete the public information handout as in-kind match for this project; Richard Kemper of the Kosciusko County Surveyor's office and Doug Nusbaum with the IDNR LARE program for their assistance in providing information and identifying feasible projects. Thanks to the Palestine Lake Property Owners Association members for their support and watershed landowners for their assistance. Contributors to this project include John Richardson, Mark Pranckus, Tyson Edwards, and Tom Estrem with JFNew.

Cover Photos: Sidebar – Bank Erosion on Cauffman Drain, Top Left – Fish Survey on Cauffmann Drain, Lower Right – Bank Erosion on Cauffman Drain

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PALESTINE LAKE
WATERSHED ENGINEERING FEASIBILITY STUDY
KOSCIUSKO COUNTY, INDIANA

1.0 INTRODUCTION

1.1 Scope of Study

In 2009, the Palestine Lake Property Owners Association (PLPOA) applied for and received funding from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) program to conduct a Watershed Engineering Feasibility Study for projects that were identified during a diagnostic study which was completed in 2008. During the diagnostic study, thirty potential project sites were identified (Figure 1). Funding was available to study ten of these thirty sites with the goal of identifying six feasible projects.

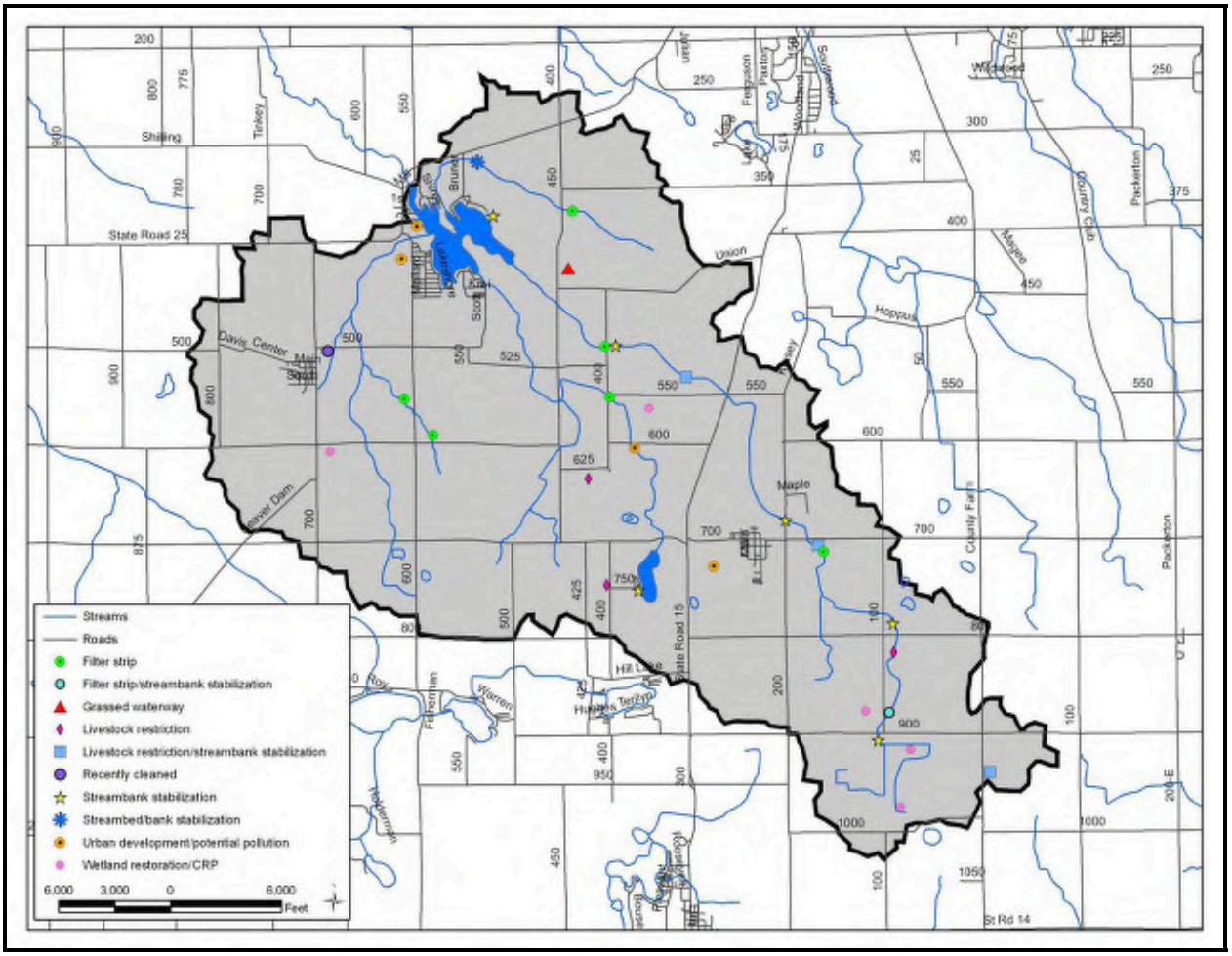

Figure 1. Potential water quality improvement projects identified in diagnostic study.

As noted in the diagnostic study, Palestine Lake currently possesses poor water quality, while Caldwell Lake contains moderate water quality. The biotic communities (algae, plants, fish) exhibit characteristics typically observed within lakes which possess high nutrient concentrations like those present in Palestine and Caldwell lakes. It is unlikely that the lakes can continue to absorb the pollutant loads they are currently receiving. Results from the modeling and lake and stream assessments indicate that current pollutant concentrations and loads, particularly phosphorus, nitrate, organic matter, and bacteria, are of concern for the lakes' long-term health. Lake residents have already noted declines in water clarity following storm events, suggesting sediment is also of concern.

The study also noted that Cauffman Drain (Ring Ditch) and Williamson Ditch delivered more pollutants per acre of watershed than the other Palestine Lake watershed streams. The results suggested that management efforts be focused on these two subwatersheds which would provide the greatest benefit per acre of treatment. Recommendations from the diagnostic study include completing shoreline and streambank stabilization and restoration projects throughout the watershed. Shoreline stabilization projects should focus on those areas where erosion is the most severe.

1.2 Project Purpose

The purpose of this study was to evaluate 10 of the 30 potential projects identified in the diagnostic study with the intent to identify up to six projects that were feasible to move towards construction. A project was deemed feasible if it could physically be constructed, was acceptable to landowners, was economically and ecologically justifiable, and could receive regulatory approval. The feasibility study attempted to ensure project success by investigating all avenues that could potentially cause project failure.

2.0 GENERAL OVERALL PROJECT DESCRIPTION

2.1 Location

Palestine and Caldwell Lakes are 291-acre and 45-acre (117.2-ha and 18.2-ha) lakes, respectively that lie in the south central portion of Kosciusko County, Indiana. The Palestine Lake watershed stretches out to the south and east of Palestine Lake encompassing 20,680 acres (8,245 ha; Figure 2). Water flows from Caldwell Lake into Adams Ditch, which flows northwest to Palestine Lake. Water exits Palestine Lake through Trimble Creek, which is located in the northwest corner of the lake and flows north to the Tippecanoe River. The Tippecanoe River transports water south and west to the Wabash River which eventually discharges water to the Ohio River in southwest Indiana. Palestine and Caldwell lake watershed runoff eventually reaches the Mississippi River in southern Illinois.

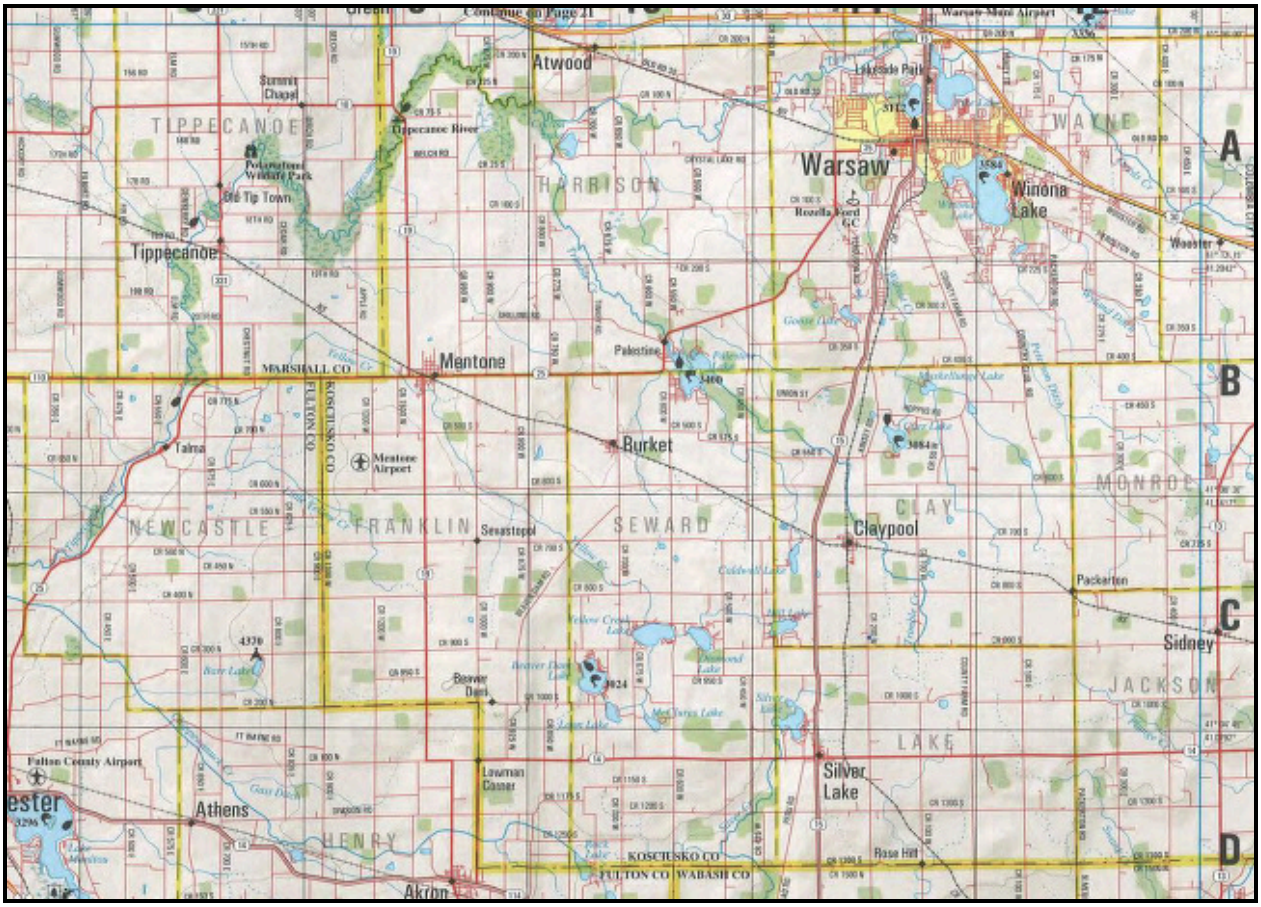

Figure 2. **General location of project area.**

To determine which ten projects would be pursued for feasibility, a meeting was held on April 6, 2009 at the Kosciusko County Soil and Water Conservation District (SWCD) Office in Warsaw. Attendees included Sam St. Clair (Natural Resources Conservation Service), Lorena Kline and Darci Zolman (Kosciusko SWCD), Kent Tracy (IDNR LARE program), and Tyson Edwards (JFNew). The sites identified by the diagnostic study were each evaluated based on possibility of implementation, eligibility for other funding opportunities or programs, and nutrient/sediment reduction benefits. Of the thirty sites evaluated, nine were selected to determine the feasibility of a water quality improvement project at these locations. An additional project site that had been evaluated by the NRCS for a possible project under the wetland reserve program was also added. Table 1 lists the ten potential projects that were chosen for further investigation for this feasibility study with the project type. Site numbers were based on field maps completed during the diagnostic study.

Site Number	Project Type
4	Streambank Stabilization
8	Streambank Stabilization
12	Streambank Stabilization
14	Streambank Stabilization
18	Streambank Stabilization
19	Filter Strip, Buffer
21	Streambed Stabilization
28	Streambank Stabilization
30	Wetland Storage
Knoop Wetland	Wetland Enhancement

Table 1. Ten sites which were selected for investigation of a feasible project.

Eight of these ten sites that were investigated for feasible projects were located within the banks or adjacent to the Cauffman Drain or Magee-Robbins Drain (Figure 3). One site was located near Caldwell Lake, while the remaining site was adjacent to the Sloan-Adams Drain.

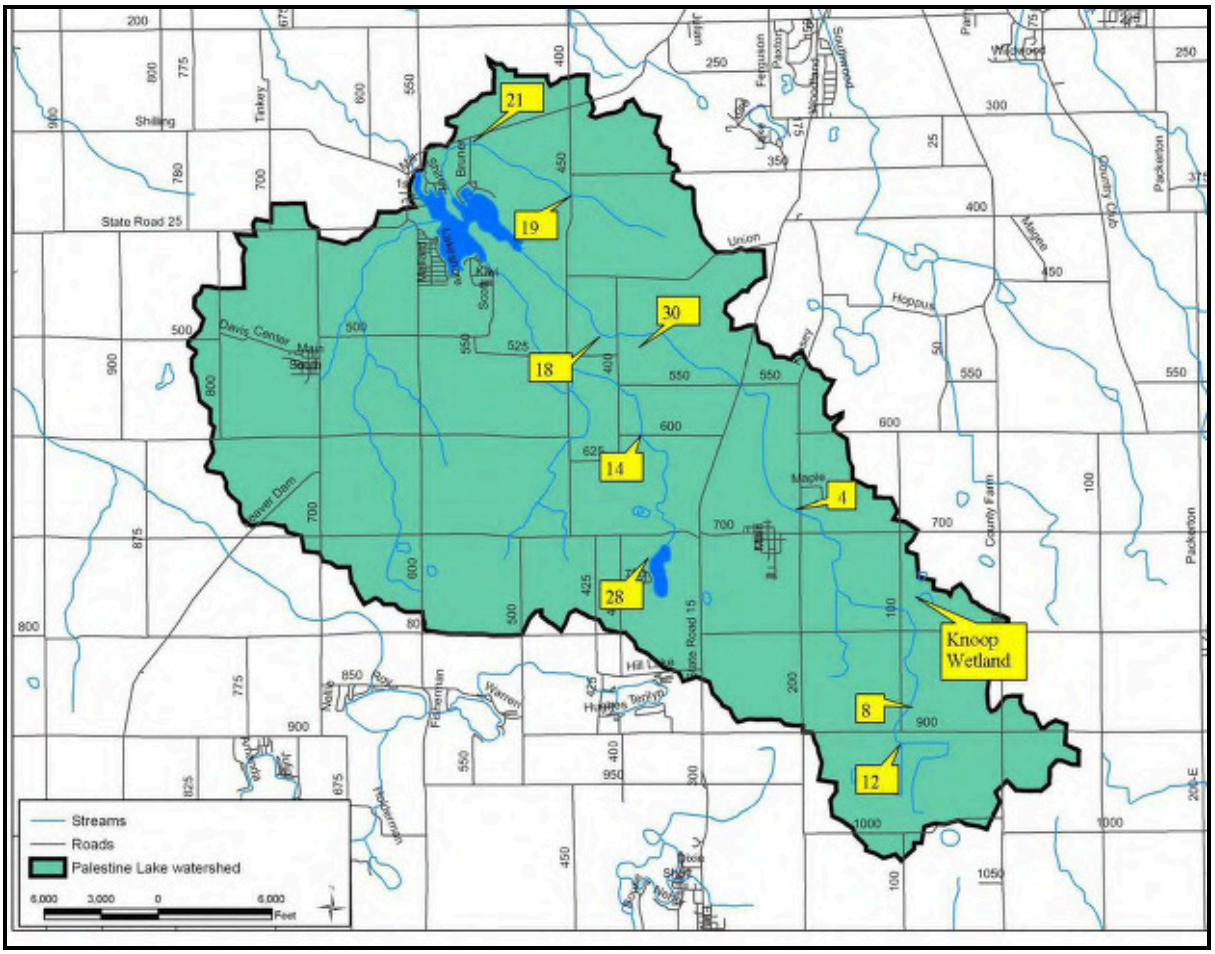

Figure 3. Locations selected for further investigation of potentially feasible projects.

2.2 Terminated feasibility investigations

Four of the ten sites that were selected for investigation were determined to not support a feasible project. These sites included Sites 8, 14, 19, and 30. Although a request for access was sent and followed up on, no response was received from the landowner granting access to Site 14; therefore the investigation was terminated at this point. Sites 8, 19 and 30 were all granted access from the landowner for further investigation. After a site visit to Sites 8 and 19, no water quality issues were identified that deemed further investigation for a potential project. Both of these sites were along legal drains that contained stable vegetated banks at the time of the site visit (Figure 4).

Figure 4. Site 19 showing stable well vegetated banks with adequate buffers.

Site 30 was investigated further and it was determined that although the banks of the Cauffman Drain were stable (Figure 5) a nearby wetland restoration project may improve water quality at this site (Figure 6). After a discussion with the LARE representative, it was decided that although a wetland restoration project might be feasible, this project would better be suited for other government programs.

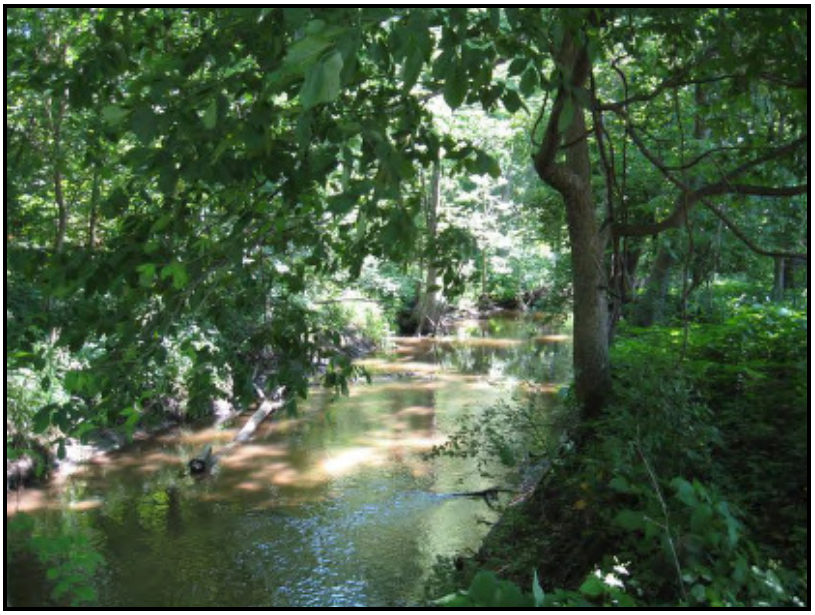

Figure 5. The banks of the Cauffman Drain near Site 30 showing a stable channel with tree lined banks.

Figure 6. Potential wetland restoration project at Site 30.

2.3 Feasible Projects

Out of the ten sites that were investigated, seven identified projects were deemed feasible. For discussion purposes and future tracking of projects, each project was assigned a number based on their chronological order of the original site number that was given. At Site 21, projects that were identified were separated and assigned separate project numbers based on landowners for which the projects were located. Table 2 lists the feasible projects with the site numbers with their previous numbers from the diagnostic study. Details regarding each site that was investigated can be found in section 4.0.

Table 2. Feasible projects showing assigned project numbers

Feasibility No.	Diagnostic No.	Landowner(s)	Project Description
1	4	Ronald Miller	Bank Stabilization w/1 grade control
2	12	Roger Wagoner	Bank Stabilization
3	18	Preston Weed	Bank Stabilization, Rock Chute, 3 grade control
4	21	Joe Hedington	Bank Stabilization and Tile Installation
5	21	James Weaver	Bank Stabilization and 3 grade control
6	28	County HWY	Sediment Trap and 2 Veg. Swales
7	N/A	Gilbert Knoop	NRCS Wetland

2.4 Public Meetings

As part of the optional in-kind match for the LARE grant, the PLPOA hosted and advertised three public meetings with a JFNew representative attending the first meeting and the last meeting. PLPOA hosted and presented information regarding the status of the feasibility study at the second meeting. Complete meeting minutes are located in Appendix A

The first public meeting was held at the Burket Fire Station located on 105 E Walnut Street in Burket, Indiana, on March 21st, at 1:00 p.m. local time. Twenty three members were present at the meeting. During the meeting, JFNew presented information regarding the current engineering feasibility study. The presentation informed the audience of possible projects identified within the project areas which included streambank stabilization and wetland restoration..

The second public meeting was held at the Burket Fire Station located on 105 E Walnut Street in Burket, Indiana, on ___ , at 1:00 p.m. local time. As part of the in-kind match, the PLPOA gave an update on the status of the feasibility study that JFNew was conducting.

The third public meeting was held at the Burket Fire Station located on 105 E Walnut Street in Burket, Indiana, on February 27th 2010 at 1:00 p.m. local time. Twenty-three members were present at the meeting. The purpose of the third public meeting was to present the draft engineering feasibility report and disseminate information regarding the identified projects. Benefits of each proposed project were outlined as well as information regarding the implementation of the project.

2.5 Public Information Handout

As part of the in-kind match for the LARE grant, PLPOA created and distributed a public information handout. The public information handout addressed factual issues concerning the benefits predicted from the proposed project. JFNew provided

information, final review, editing and copy services for the handout. The handouts were available for distribution at organizational events (Appendix A).

3.0 FEASIBILITY ANALYSIS TOOLS

Described below are several tools that are used in one or more of the proposed projects during the feasibility analysis. Several of the tools are environmental or ecological assessment procedures that allow for a site to be classified through quantifying a series of variables. A brief description of the regulatory process in Indiana is also included because the jurisdictional obligation of the regulatory agencies contributes significantly to the feasibility of a project.

3.1 Stream Assessments

Habitat

The Qualitative Habitat Evaluation Index (QHEI) was developed by the Ohio EPA for streams and rivers in Ohio (Rankin, 1989 and 1995). While the Ohio EPA originally developed the QHEI to evaluate fish habitat in streams, IDEM and other agencies routinely utilize the QHEI as a measure of general "habitat" health. Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrate; amount and quality of in-stream cover; channel morphology; extent and quality of riparian vegetation; pool, riffle, and run development and quality; and gradient are the metrics used to determine the QHEI score. Each metric is scored individually then summed to provide the total QHEI score. QHEI scores typically range from 20 to 100.

The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of the entire stream. As such, individual segments may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled in adjacent segments with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of stream segments in Ohio indicate that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 are characteristic of stream conditions that are capable of supporting exceptional warmwater faunas (Ohio EPA, 1999). IDEM indicates that QHEI scores less than 51 indicate poor habitat and may not support the stream's aquatic life use designation (IDEM, 2006).

Biological Assessment

Macroinvertebrates are often used to classify the health of a stream because different species or families respond differently to environmental stress. Macroinvertebrates were sampled using the multihabitat approach detailed in the U.S. Environmental Protection Agency Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd edition (Barbour et al., 1999). This method was supplemented by qualitative picks from substrate and by surface netting. Using data collected during this survey, JFNew calculated IDEM's macroinvertebrate Index of Biotic Integrity (mIBI) (IDEM, unpublished). IDEM's mIBI is a multi-metric index designed to provide a complete

assessment of a stream's biological integrity. Karr and Dudley (1981) define biological integrity as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the best natural habitats within a region."

The mIBI is designed to assess biotic integrity directly through ten metrics which evaluate a macroinvertebrate community's species richness, evenness, composition, and density within the stream. These metrics include the family-level HBI (Hilsenhoff's Family Biotic Index), number of taxa, number of individuals, percent dominant taxa, EPT (*Ephemeropteran*, *Plecopteran*, and *Trichopteran*) index, EPT count, EPT count to total number of individuals, EPT count to Chironomid count, Chironomid count, and number of individuals per number of squares sorted. After data from sampling sites have been collected, values for the ten metrics are compared with corresponding ranges and a rating of 0, 2, 4, 6, or 8 is assigned to each metric. The average of these ratings gives a total mIBI score, the best possible of which is 8. Macroinvertebrate communities in streams scoring less than 2 are considered severely impaired; these streams are rated by IDEM as non-supporting for their aquatic life use designation. Macroinvertebrate communities in streams scoring from 2 to 4 are considered moderately impaired and the associated streams are rated by IDEM as partially supporting their aquatic life use designation. Macroinvertebrate communities scoring from 4 to 6 and from 6 to 8 are rated as slightly impaired and non-impaired, respectively. These streams are designated as fully supporting of their aquatic life use designation as determined by IDEM.

Fish

Fish were sampled according to methods described by Simon (1997). A backpack electrofishing unit was used to sample fish for approximately 225 feet of the stream. The sampled area started approximately 150 feet downstream of the northern edge of the project area and continued upstream through the project site. The reach was electrofished in an upstream manner and all available habitats were sampled. All fish collected were identified and returned back into the stream. Results of the fish sampling were used to calculate a fIBI (Fish Index of Biotic Integrity) score, which was used to assess the quality of the fish community. The fIBI for the Northern Indiana Till Plains uses 12 metrics to calculate a FIBI score. Examples of some of the metrics used include number of species, percent headwater species, number of sensitive species, and percent tolerant species. Each metric receives a score of 1, 3, or 5, with the total maximum possible score being 60. The total score of the twelve metrics is then given an integrity class rating ranging from "excellent" to "no fish." A listing of the attributes associated with each integrity class can be found in Appendix B.

3.2 Wetland Assessments

The National Wetland Inventory (NWI) is a database of wetlands maintained by the U.S. Fish and Wildlife Service to monitor the status and trends of wetlands within the U.S. Wetland data are collected using remote imagery data analysis. In other words, aerial and satellite photographs are interpreted for wetland signatures and characteristics. The wetlands are classified based on a modified Cowardin classification scheme (Dahl

and Bergeson, 2009). The data represent a good starting point for a review of wetlands within a proposed project area.

3.3 Functionality and Impact Determination

To predict the erosion rates of the streambank the Bank Assessment for Non-point source Consequences of Sediment (BANCS) model (Rosgen, 2006) was used. This model uses two bank erosion estimation tools: the Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS). The BANCS model evaluates the bank characteristics and flow distribution along river reaches and maps BEHI and NBS risk ratings commensurate with streambank and channel changes. Annual erosion rates are estimated and then multiplied by the bank height and by a corresponding bank length of a similar condition, providing an estimate of cubic yards and tons of sediment per year. This information can be compared to the annual sediment yield data to apportion the amount of sediment potentially contributed by streambanks.

3.4 Regulatory Agencies

In Indiana, two state agencies, one federal agency, and one or more branches of local government may be involved in reviewing and approving (permitting) proposed projects. Who reviews and approves of a project is dependent on the location, type, size, and impact of the project. Described below is a brief summary of each agency's jurisdiction and permitting process. More detailed information can be found the publication "Waterways Permitting Handbook" (IDEM, 2008).

Indiana Department of Natural Resources

The IDNR Division of Water regulates various construction activities within, over, and under the state's waterways through various state laws. Specific to most feasibility projects, the IDNR regulates the filling, excavating, and/or modification of lakes and streams through the Lakes Preservation Act and the Flood Control Act. The Lakes Preservation Act provides the IDNR the ability to regulate activities that impact the recreational, natural resource, and scenic beauty values of public freshwater lakes. The Flood Control Act provides the IDNR the ability to regulate activities within the floodway of any waterway to minimize flooding. Typically, these activities include bank protection and work that changes the cross section area of the channel.

Indiana Department of Environmental Management (IDEM)

IDEM regulates the placement of fill in "Waters of the State", which includes lakes, streams, and wetlands through the 401 Water Quality Certification program. Small projects that have minimal impacts such as 300 ft (91 m) or less of streambank or shoreline or 0.1 ac (0.04 ha) of wetland can be permitted under the Regional General Permit (RGP). A RGP requires a notification form and several additional pieces of information. A project is considered authorized (permitted) if the applicant is not contacted by IDEM within 30 days of the date of receipt. Larger impacts require Individual 401 Water Quality Certification, which is a more rigorous application and review process.

U.S. Army Corps of Engineers (COE)
The COE is a federal agency that regulates the placement of fill in "Waters of the U.S.", which includes lakes, streams, and wetlands through the Section 404 of the Clean Water Act. Within the 404 program, there are several different permit types that depend on the size and nature of the proposed activity. A Nationwide General Permit (NGP) is a permit that authorizes activities that have only minimal impact to the aquatic environment. The Regional General Permit (RGP) authorizes activities that impact 1 ac (0.4 ha) or less of "Waters of the U.S." Programmatic General Permits (PGP) authorizes specific activities such as shoreline protection on public freshwater lakes and allows for an IDNR permit to serve as the federal permit, as well.

County Soil and Water Conservation District (SWCD)
Projects that disturb one or more acres (0.4 ha) of ground may require a Rule 5 permit application from the county SWCD office. The Rule 5 permit is meant to prevent and avoid impacts from construction on aquatic resources through the development and implementation of a site-specific erosion control plan.

County Drainage Boards
A stream or drainage within a watershed may be classified as a legal drain where the county drainage board maintains authority of certain activities that can impact conveyance and drainage from the surrounding landscape. Some activities authorized by the drainage board may still require other state and/or federal approval. Conversely, a project may be authorized by the other regulatory agencies; however, because of the nature of the project such as activities that increase detention time, the project may not receive drainage board approval.

4.0 IDENTIFIED WATER QUALITY IMPROVEMENT PROJECTS

Of the ten sites that were evaluated, seven projects were identified and determined to be feasible. Locations for the seven feasible projects are depicted in figure 7 with the associated landowner. Two projects were identified at Diagnostic Site 21, located on Joe Hedington's property and Site 5 which is located on James Weaver's property. Section 4.1 includes a discussion of all ten investigated sites and information supporting the determination.

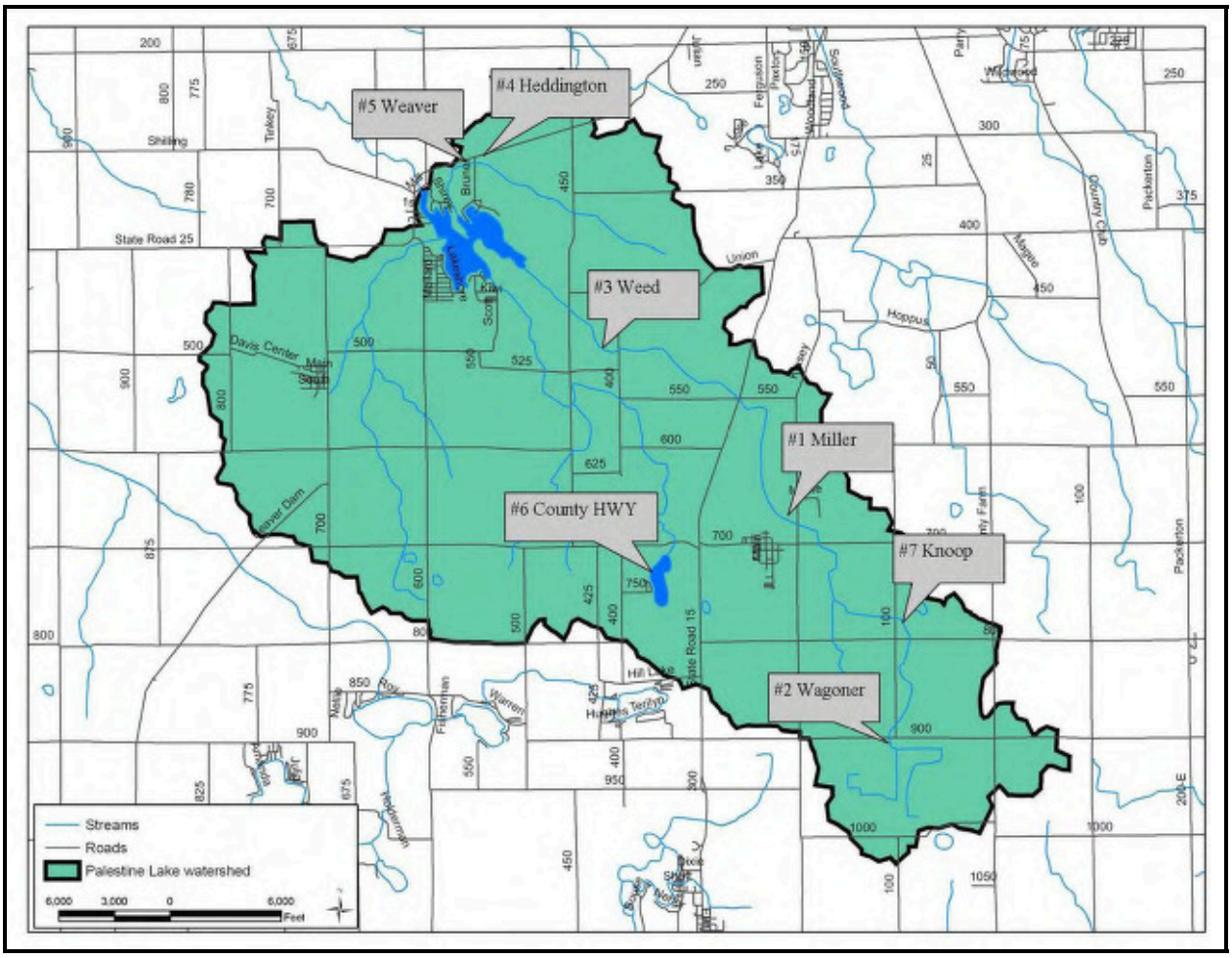

Figure 7. Feasible project locations identified during this study.

4.1 Site 1

4.1.1 Site Description

Cauffman Drain (also known as Ring Ditch) drains the largest portion (35%) of the Palestine Lake Watershed. Cauffman Drain carries water from the southeastern most portion of the watershed. Cauffman Drain is a legal county drain that is maintained by the Kosciusko County Surveyor. The project site located just northwest of Claypool, IN adjacent to Cauffman Drain and downstream of CR 200W (Figure 8).

Figure 8. Location of project #1.

The two parcels of land immediately west of 200W are owned by Ronald and Kathryn Miller. The parcel to the south is owned by the Warsaw Community School System. Cauffman Drain flows west-northwest through these two properties. The Miller's maintain turf grass adjacent to a majority of the project site with a narrow buffer of trees and woodland vegetation (Figure 9). The School has left the majority of the bank and adjacent area in a natural state. An access trail is maintained on the south side of Cauffman Drain.

Figure 9. Example of turf grass adjacent to Cauffman Drain on Miller's property.

4.1.2 Preliminary Design and Conceptual Drawings

Several sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket (Figure 10). A stone toe approximately 2.5 ft by 3 ft high (0.76 m to 0.91 m) would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 290 feet (88.3.9 m) of streambank located in four sections; 85ft (25.90 m), 75ft (22.86 m), 60ft (18.28 m), and 70ft (21.34 m) starting at the east end along Cauffman Drain. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

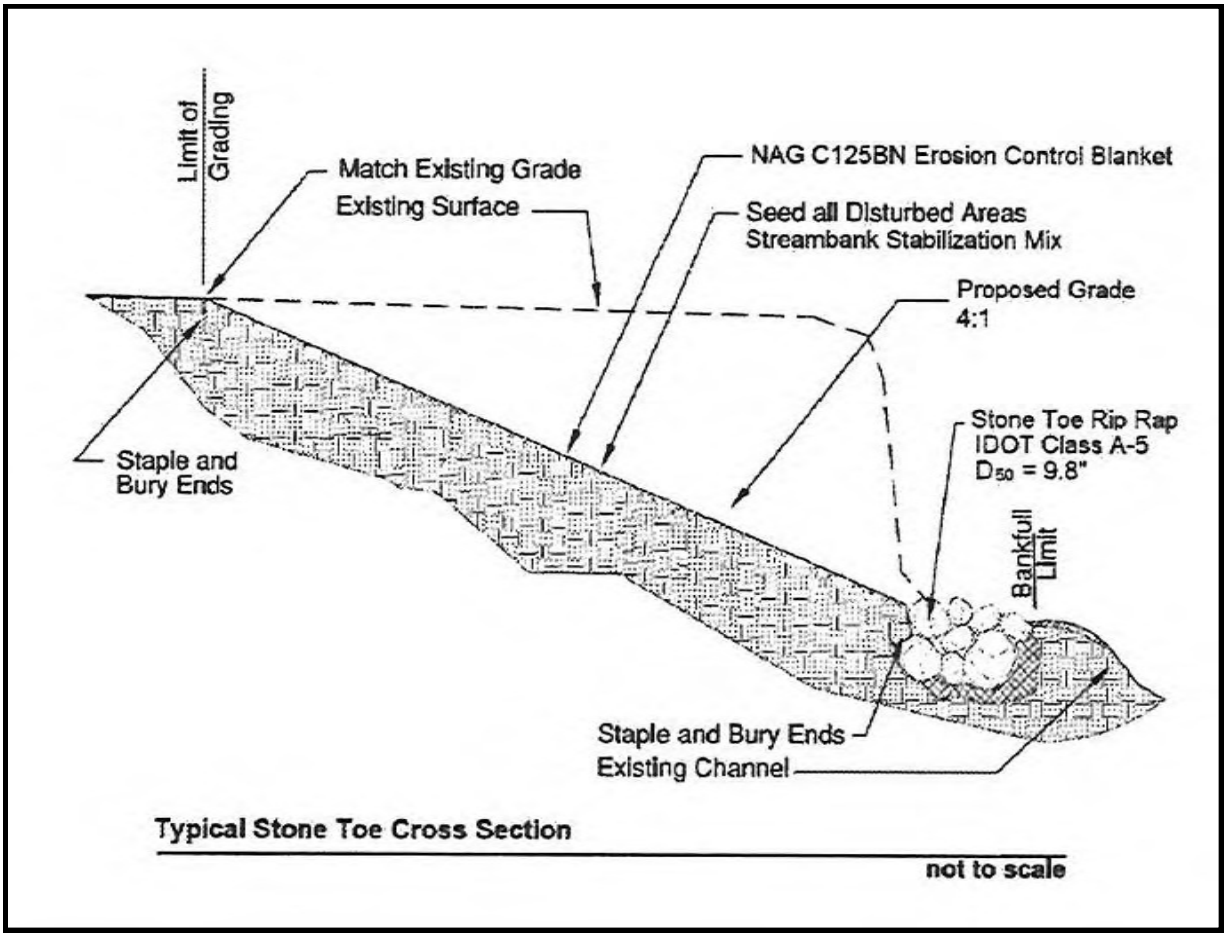

Figure 10. Conceptual design of a bank reshaping with stone toe.

A grade control structure is also proposed to be installed at approximately 200 ft (60.96 m) downstream of the CR 200 W Road crossing. These structures are comprised of stone with an average diameter of 9” (22.86 cm) and are designed to effectively raise the bed elevation of the stream channel. The upstream and downstream ends of the grade control are sloped away from the structure. The grade control is also keyed into the bed and banks to prevent water from flowing around the structure. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. By raising the bottom elevation of the ditch, storm flows have more frequent access to the floodplain. Once in the floodplain, water is spread out and the erosive force on the banks (i.e. velocity and shear stress) is reduced. In the case of a deep ditch, the higher water levels access a wider section of ditch accomplishing the same result. A conceptual drawing of a grade control structure can be found in Figure 11.

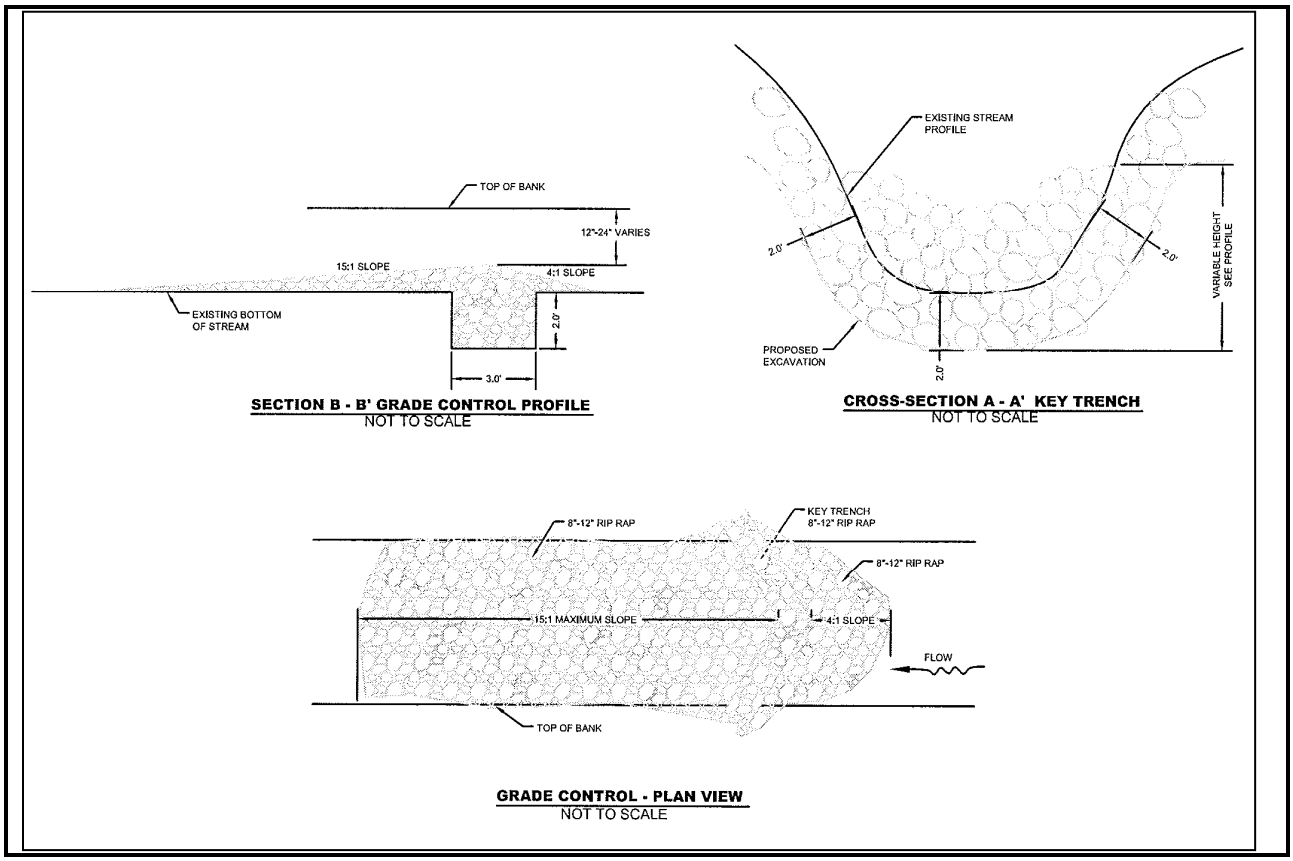

Figure 11. Conceptual drawing of grade control structure to be placed in Cauffman drain.

4.1.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for Site 1 is $24,285. Table 3 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January of a given year, contract construction services, and construct the projects starting in the fall or as permits become available.

Table 3. Opinion of probable costs for the construction of the grade control structure and bank stabilization for Site 1. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$2,112	$2,112
Administrative	1	Each	$1,056	$1,056
Construction Services	1	Each	$11,319	$11,319
9" Rip Rap	170	Tons	$27.50	$4,675
Native Seed for Banks	1	Acre	$330.00	$330
Turf Grass Seed	1	Acre	$110.00	$110
Straw Mulch	50	Each	$3.30	$165
Geotextile Fabric	300	Sq Yd	$1.10	$330
Coir Yarn Matting	600	Sq Yd	$2.20	$1,320
Straw/Coir Erosion Blanket	600	Sq Yd	$1.10	$660
Subtotal				$22,077
Contingency (10% of overall project)				$2,208
Total				***$24,285***

4.1.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.1.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will be minimal, because the scope of the project is to stabilize what is there. Equipment access is gained through a lane on the south side of the Drain and the maintained yard on the north side. There may be small brush and trees that will have to be removed in the process of reshaping the banks of the drain. The owner would likely assist in cleaning up by utilizing the larger trees for firewood. Once the vegetation is reestablished a significant difference in the aesthetics of the site should not be noticeable.

4.1.6 Functionality and Impact Determination

To estimate the amount of sediment that would be deposited into the drain if no action were taken, the BANCS model was used (see section 3.3). This model estimates the annual erosion rates based on the near bank stress and the bank erosion hazard index in cubic yards and tons of sediment lost per year. Table 4 is a summary of the annual streambank erosion estimate for the proposed project site. Data sheets for this model can be found in Appendix D.

Table 4. Total annual streambank erosion estimate for project 1.

CuFt/Yr	CuYds/Yr	Tons/Yr	Tons/Yr/Ft
520.86	**19.29**	**25.08**	**0.09**

4.1.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's National Wetlands Inventory (NWI) map, the wetland within the project area is identified as a seasonally flooded broad leaf deciduous forested palustrine wetland (Figure 12). This wetland is typical of a floodplain wetland which provides storage during storm events and slowly releases the water back into the stream. A majority of this wetland is forested with species that have adapted to the seasonal water fluctuations. The wetland provides wildlife habitat for species such as deer, squirrels, birds, and salamanders. The proposed BMP's would enhance and improve the wetland functions by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 12. Seasonally flooded forested palustrine wetland identified on National Wetland Inventory map. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 5 details the list of the plant species identified during the site visit.

Table 5. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Herbaceous		Woody	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Bloodroot	*Sanguinaria canadensis*	American Elm	*Ulmus americana*
Common Boneset	*Eupatorium perfoliatum*	Basswood	*Tilia americana*
Clearweed	*Pilea pumila*	Black Cherry	*Prunus serotina*
Golden Alexander	*Zizia aurea*	Box Elder	*Acer negundo*
Jewelweed	*Impatiens capensis*	Bush Honeysuckle	*Lonicera spp.*
Kentucky Bluegrass	*Poa pretense*	Eastern Cottonwood	*Populus deltoides*
Old Field Goldenrod	*Solidago nemoralis*	Elderberry	*Sambucus canadensis*
Perennial Ryegrass	*Lolium perenne*	Gooseberry	*Ribes hirtellum*
Scouring Rush	*Equisetum hyemale*	Hackberry	*Celtis occidentalis*
Smooth Brome	*Bromus inermis*	Honey Locust	*Gleditsia triacanthos*
Stinging Nettle	*Urtica dioica*	Multiflora Rose	*Rosa multiflora*
Sweet Cicely	*Myrrhis odorata*	Poison Ivy	*Rhus radicans*
Water Smartweed	*Persicaria punctata*	Red Mulberry	*Morus Rubra*
		Silver Maple	*Acer saccharinum*
		Staghorn Sumac	*Rhus glabra*
		Spicebush	*Lindera benzoin*
		Sugar maple	*Acer saccharum*
		Sycamore	*Platunus occidentalis*
		Virgina Creeper	*Parthenocissus quinquefolia*
		Wild Grape	*Vitis spp.*

4.1.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a Watershed Diagnostic Study for Palestine Lake. As part of this study, water chemistry sampling, *E. coli* sampling, macroinvertebrate sampling, habitat evaluations, and an assessment of in-lake sampling was conducted. Due to the recent nature of this study being completed, the mIBI data from this study was utilized for assessing this site. The mIBI score was 1.6, indicating that the channel is severely impaired to support aquatic life. A site specific QHEI was also completed for this site. The QHEI score was 54.5 and classified the stream as partially supporting of aquatic life use designation (Appendix E). This indicates that the stream showed signs of impaired water quality habitat limiting its potential for diversity of aquatic biota.

4.1.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The existing conditions of the stream show it to be severely impaired. The proposed project will restore habitat and stabilize the streambank without significantly impacting the existing environment. By stabilizing the toe and reshaping the bank, undercutting of the bank will be halted. Native vegetation will be restored on the banks which will provide both fish cover and wildlife habitat. The vegetation will also act as a buffer from runoff caused by other land activities.

4.1.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew). A roadside survey indicated that severe erosion was occurring near this location, which was depositing sediment and nutrients downstream. Access to this site on both banks would prove beneficial because minimal disturbance would be required, if construction were to occur. Heavy equipment could be easily moved into position for construction activities without destroying too many trees and keeping the impacts to the site at a minimum.

4.1.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from Indiana Department of Environmental Management (IDEM) and a Section 404 Permit from United States Army Corp of Engineers (USACOE) will be required because the project areas are “Waters of the United States” and the stone toe and grade control structure would be considered fill. An IDNR permit will not be required because the project is considered a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

4.2 Site 2

4.2.1 Site Description

The headwaters of the Cauffman Drain start forming just south of CR 900 S. The land is owned by Roger Wagoner and the project site is located approximately 500 ft (152.4 m) south of 900 S along the Cauffman Drain (Figure 13).

Figure 13. Location of Site 2.

The land to the west and south are all maintained in agricultural row crops. A very narrow buffer currently exists between the field and the drain (Figure 14). The east and north side of the project site has a narrow buffer of brush with turfgrass, which is maintained adjacent to the brush.

Figure 14. Project site showing narrow buffer adjacent to agriculture field.

4.2.2 Preliminary Design and Conceptual Drawings

The proposed project site consists of approximately 75 feet (22.86 m) of streambank located along Cauffman Drain. This section of streambank showed signs of active erosion along the edge of the field. The vegetation present in this section of the bank consisted mostly of annual species (see section 4.2.7). These annual species indicate that the bank in this area is subjected to extensive annual disturbances that discourage the establishment of perennial species. The proposed solution is to reshape the banks, install a stone toe, and re-seed with a native slope stabilization seed mix covered with an erosion control blanket (Figure 15). A stone toe approximately 2.5 ft (0.76 m) by 2 ft (0.61 m) high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet, which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. Construction would commence after crop harvest to minimize disturbance. Excavated bank material would be graded to blend in with the existing grade. An example of a previously constructed project utilizing similar bank stabilization methods can be found in Figure 16.

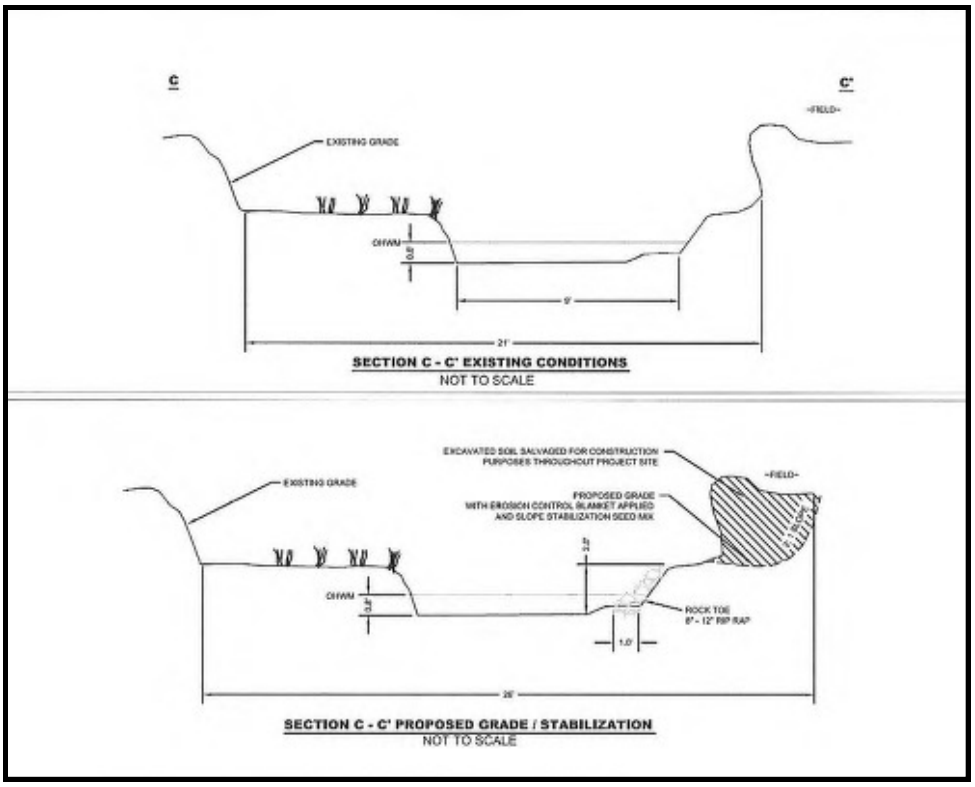

Figure 15. Conceptual design of proposed solution for Site 2.

Figure 16. Example of similar project which was completed in Noble County.

4.2.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for Site 2 is $10,134. Table 6 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January, contract construction services in the summer, and construct the projects starting in the fall after crops have been harvested and as permits become available.

Table 6. Opinion of probable costs for the construction of streambank stabilization for Site 2. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$1,408	$1,408
Administrative	1	Each	$704	$704
Construction Services	1	Each	$5,258	$5,258
Stone for Rock Grade Controls	40	Tons	$27.50	$1,100
Native Seed for Banks	0.5	Acre	$330.00	$165
Geotextile Fabric	75	Sq Yd	$1.10	$83
Coir Yarn Matting	150	Sq Yd	$2.20	$330
Straw/Coir Erosion Blanket	150	Sq Yd	$1.10	$165
Subtotal				$9,213
Contingency (10% of overall project)				$921
Total				***$10,134***

4.2.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.2.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will be minimal, because the scope of the project is to stabilize what is there. Equipment access will be along the west bank adjacent to the agricultural field. Care should be taken to minimize compaction to the agriculture field and delay construction until crops have been harvested in this field.

4.2.6 Functionality and Impact Determination

To estimate the amount of sediment that would be deposited into the drain if no action were taken, the BANCS model was used (see section 3.3). This model estimates the annual erosion rates based on the near bank stress and the bank erosion hazard index in cubic yards and tons of sediment lost per year. Table 7 is a summary of the annual streambank erosion estimate for the proposed project site. Data sheets for this model can be found in Appendix D.

Table 7. Total annual streambank erosion estimate for project #2.

CuFt/Yr	CuYds/Yr	Tons/Yr	Tons/Yr/Ft
45.00	**1.67**	**2.17**	**0.03**

4.2.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's National Wetlands Inventory (NWI) map, there are two types of wetlands near the project area. There were no wetlands identified at the project site. The two that were identified included a seasonally flooded/ saturated emergent palustrine wetland and a shrub scrub/ forested palustrine wetland (Figure 17). Both wetlands provide flood control and wildlife habitat adjacent to Cauffman Drain upstream of the project site.

Figure 17. Seasonally flooded/ saturated emergent palustrine wetland and a shrub scrub/ forested palustrine wetland identified on National Wetland Inventory map.
Source: Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 8 details the list of the plant species identified during the site visit.

Table 8. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Herbaceous		Woody	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Beggarstick	*Bidens laevis*	Black Raspberry	*Rubus occidentalis*
Canada Thistle	*Cirsium arvense*	Silky Dogwood	*Cornus amomum*
Garlic Mustard	*Alliaria petiolata*		
Giant Ragweed	*Ambrosia trifida*		
Giant Smartweed	*Polygonum pensylvanicum*		
Mullein	*Verbascum thapsus*		
Pokeweed	*Phytolacca americana*		
Marestail	*Conyza canadensis*		
Reed Canary Grass	*Phalaris arundinacea*		
Rice Cutgrass	*Leersia oryzoides*		
Stinging Nettle	*Urtica dioica*		
Switchgrass	*Panicum virgatum*		
Velvetleaf	*Abutilon theophratsii*		
Yellow Foxtail	*Setaria lutescens*		

4.2.8 Biological and Habitat Integrity Survey

The nearest sampling site conducted in the 2008 diagnostic study was more than two miles downstream of this project site, therefore a fish survey was conducted to determine the Index of Biological Integrity (IBI) at this site. A total of 119 individuals were collected from the sampled reach. The sample reach began 150 feet (45.72 m) downstream of the project area and included the proposed project site for a total of 225 feet (68.58 m). The most abundant species collected was black-nosed dace (42%), followed by central mudminnow (34%), and creek chub (24%). The calculated fIBI was 28, which suggests the stream has a poor fish community. A fish community with a poor rating is generally dominated by omnivorous species that are tolerant of impaired environmental conditions and that are found in a variety of habitats. A copy of the fIBI calculation sheet and the field data sheet can be found in Appendix B.

A site-specific QHEI was also completed at this project site. The QHEI score was 22.75 and classified the stream as non-supporting of aquatic life (Appendix E).

4.2.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The existing conditions of the stream indicate that it is severely impaired. The proposed project will restore habitat and stabilize the streambank without significantly impacting the existing

environment. By stabilizing the toe and reshaping the bank, undercutting of the bank will be halted. Native vegetation will be restored on the banks which will provide both fish cover and wildlife habitat. The vegetation will also act as a buffer from runoff caused by the adjacent agricultural activities.

4.2.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew). A roadside survey indicated that severe erosion was occurring near this location, which was depositing sediment and nutrients downstream. Access to this site on both banks would prove beneficial if construction were to occur. Heavy equipment could be easily moved into position for construction activities and keep the impacts to the site at a minimum.

4.2.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from United States Army Corp of Engineers (USACOE) will be required because the project areas are considered “waters of the United States” and the stone toe would be considered fill. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

4.3 Site 3

4.3.1 Site Description

The proposed project is located along the Cauffman drain immediately downstream of County Road 400W. The property is owned by Preston Weed (Figure 18).

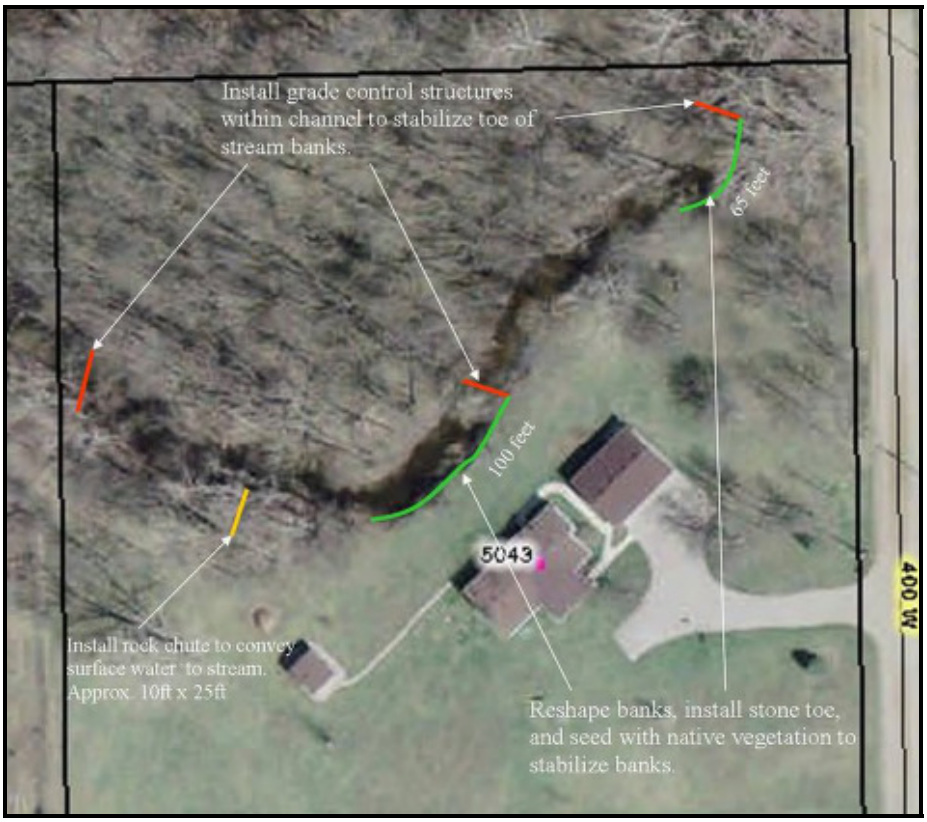

Figure 18. Location of Site 3.

The property to the south of the Cauffman Drain in this area is maintained as a residential yard with turfgrass. Sparse trees line the banks and include species such as black cherry, box elder and mulberry. The north side of the drain is completely wooded with deciduous hardwood species (Figure 19).

Figure 19. Project site showing residential yard and woodland on opposite bank.

4.3.2 Preliminary Design and Conceptual Drawings

The proposed project site consists of approximately 165 feet (50.29 m) of streambank located in two sections along Cauffman Drain. These two sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater (Figure 20). The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket. A stone toe approximately 2.5 ft (0.76 m) by 3 ft (0.91 m) high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade. For a conceptual drawing of the proposed bank stabilization technique refer to Figure 10 in Section 4.1.2.

Figure 20. Location for proposed bank stabilization.

Three grade control structures are proposed to be installed at approximately 100 ft (30.48 m), 300 ft (91.44 m), and 500 ft (152.40 m) downstream of the 400 W Road crossing. Grade control structures are comprised of stone with an average diameter of 9" (22.86 cm) and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. For a conceptual drawing of the grade control structure described refer to Figure 11 in Section 4.1.2.

A small area was identified where concentrated surface runoff enters the stream and is eroding the streambank (Figure 21). To halt the erosion in this section, a rock chute is proposed. A rock chute consists of a geo-textile fabric underlayment with 1.5 -2 ft (45.72 – 60.96 cm) of 9 in (22.86 cm) stone to armor the streambank during the periods of surface runoff (Figure 22). The area is approximately 10 ft by 25 ft (3.04 m by 7.62 m).

Figure 21. Location of proposed rock chute installation.

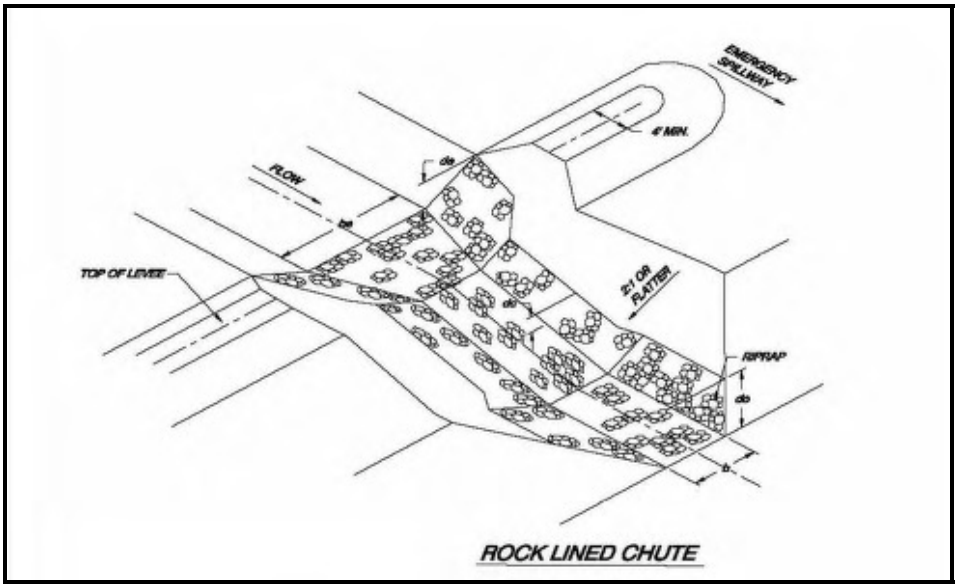

Figure 22. Typical design of rock-lined chute.

4.3.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for Site 3 is $24,678. Table 9 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January, contract construction services in the summer after a grant is awarded, and construct the projects starting in the fall after crops have been harvested and as permits become available.

Table 9. Opinion of probable costs for the construction of the grade control structure, rock-lined chute and bank stabilization for Site 3. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$1,760	$1,760
Administrative	1	Each	$880	$880
Construction Services	1	Each	$13,508	$13,508
9" Rip Rap	165	Tons	$27.50	$4,538
Native Seed for Banks	1	Acre	$330.00	$330
Turf Grass Seed	1	Acre	$110.00	$110
Straw Mulch	30	Each	$3.30	$99
Geotextile Fabric	200	Sq Yd	$1.10	$220
Coir Yarn Matting	300	Sq Yd	$2.20	$660
Straw/Coir Erosion Blanket	300	Sq Yd	$1.10	$330
Subtotal				$22,435
Contingency (10% of overall project)				$2,243
Total				***$24,678***

4.3.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.3.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will be minimal, because the scope of the project is to stabilize what is there. Equipment access will be along the south bank adjacent to the residential yard. Care should be taken to minimize disturbance to the turfgrass and reseed when project is complete.

4.3.6 Functionality and Impact Determination

To estimate the amount of sediment that would be deposited into the drain if no action were taken, the BANCS model was used (see section 3.3). This model estimates the annual erosion rates based on the near bank stress and the bank erosion hazard index in cubic yards and tons of sediment lost per year. Table 10 is a summary of the annual streambank erosion estimate for the proposed project site. Data sheets for this model can be found in Appendix D.

Table 10. Total annual streambank erosion estimate for Site 3.

CuFt/Yr	CuYds/Yr	Tons/Yr	Tons/Yr/Ft
355.50	**13.17**	**17.12**	**0.10**

4.3.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's NWI map, there are wetlands within the project area that are identified as seasonally-flooded broadleaf deciduous, shrub-scrub forested palustrine wetlands (Figure 23). This type of wetland provides flood control and wildlife habitat near the project site. The proposed BMP's would enhance and improve the wetland functions by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 23. Seasonally flooded broad leaf deciduous shrub scrub forested palustrine wetland identified on National Wetland Inventory map. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 11 details the list of the plant species identified during the site visit.

Table 11. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Herbaceous		Woody	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Bloodroot	*Sanguinaria canadensis*	American Elm	*Ulmus americana*
Clearweed	*Pilea pumila*	Basswood	*Tilia americana*
Golden Alexander	*Zizia aurea*	Black Cherry	*Prunus serotina*
Old Field Goldenrod	*Solidago nemoralis*	Box Elder	*Acer negundo*
Perennial Ryegrass	*Lolium perenne*	Hackberry	*Celtis occidentalis*
Smooth Brome	*Bromus inermis*	Honey Locust	*Gleditsia triacanthos*
Stinging Nettle	*Urtica dioica*	Multiflora Rose	*Rosa multiflora*
Sweet Cicely	*Myrrhis odorata*	Poison Ivy	*Rhus radicans*
		Staghorn Sumac	*Rhus glabra*
		Wild Grape	*Vitis spp.*

4.3.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a Watershed Diagnostic Study for Palestine Lake. As part of this study, water chemistry sampling, *E. coli* sampling, macroinvertebrate sampling, habitat evaluations, and an assessment of in-lake sampling was conducted. Due to the recent nature of this study being completed, the mIBI data from this study was utilized for assessing this site. The mIBI score was 1.78, indicating that the channel is severely impaired to support aquatic life. A site-specific QHEI was also completed for this site (Appendix E). The QHEI score was 44 and classified the stream as non-supporting of aquatic life use designation. This indicates that the stream showed signs of impaired water quality habitat limiting its potential for diversity of aquatic biota.

4.3.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The existing conditions of the stream show it to be severely impaired. The proposed project will restore habitat and stabilize the streambank without significantly impacting the existing environment. By stabilizing the toe and reshaping the bank, undercutting of the bank will be halted. Native vegetation will be restored on the banks which will provide both fish cover and wildlife habitat. The vegetation will also act as a buffer from runoff caused by the adjacent agricultural activities.

4.3.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew). A roadside survey indicated that severe erosion was occurring near this location which was depositing sediment and nutrients downstream. Access to this site on the south bank would prove beneficial if construction were to occur. Heavy equipment could be easily moved into position for construction activities and keep the impacts to the site at a minimum.

4.3.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE will be required because the project areas are considered "Waters of the United States" and the stone toe would be considered fill. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

4.4 Site 4

4.4.1 Site Description

The proposed project is located along the Maggee Robbins drain immediately upstream of Bruner Road. The property is owned by Joe Hedington (Figure 24).

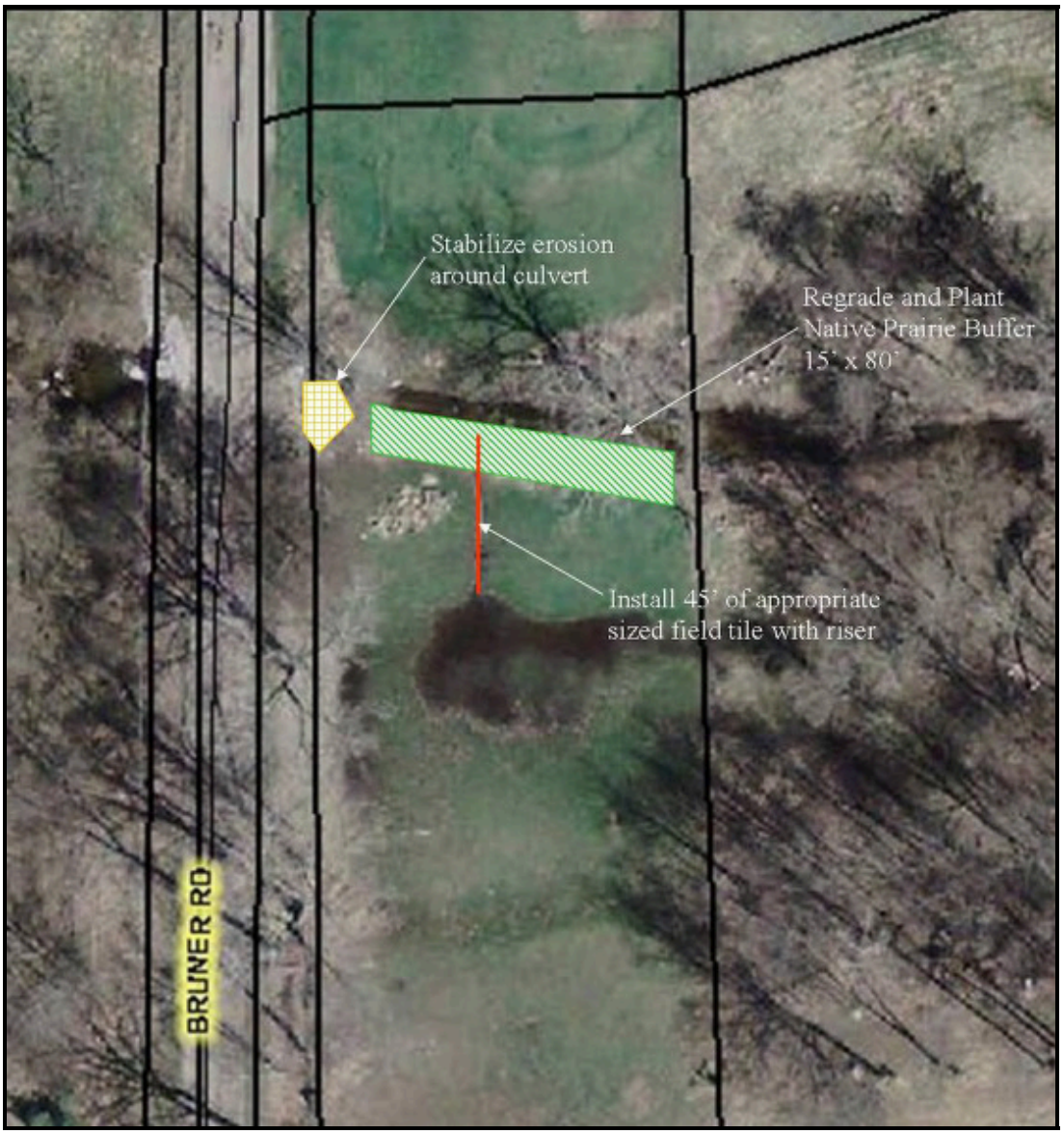

Figure 24. Location of Site 4.

The banks of the Maggee Robbins in this section consist of a very narrow strip of herbaceous vegetation with only a few trees. The north side of the drain is wider than the south side and does not show signs of erosion. The south bank drops approximately 2.5 feet (0.76 m) at a steep angle. The rest of the adjoining property is maintained as turfgrass and mowed on a regular basis (Figure 25).

Figure 25. Project site showing maintained turfgrass adjacent to steep bank on south side of Maggee Robbins Drain.

4.4.2 Preliminary Design and Conceptual Drawings

When the Maggee Robbins Drain overtops its banks, the water is pushed out into the turf areas on this property. A small berm created by excavated spoils, has been placed along the top of the bank on the south side of the drain. This berm has been eroded away where the water reenters the stream from the turfgrass area. The proposed solution is to install approximately 45 feet (13.72 m) of 9-inch (22.86 cm) field tile with a perforated riser to convey stormwater into the adjacent stream (Figure 24). Stone would be placed at the outlet to avoid erosion of the bank at the point of reentry. The riser and tile will allow any floodwater below the height of the berm to flow back into the stream without causing further erosion.

Figure 26. South side of Maggee Robbins Drain showing eroded area through small berm.

The existing south streambank also shows signs of active erosion and a bank with a slope of 1:1. To halt this erosion and stabilize the bank, the proposed solution is to re-slope the bank to a 4:1 slope, re-seed with native plants and install erosion control blanket (Figure 27). The native plants can have roots up to ten feet (3.05 m) which will help to stabilize the bank and provide a buffer for filtering stormwater runoff.

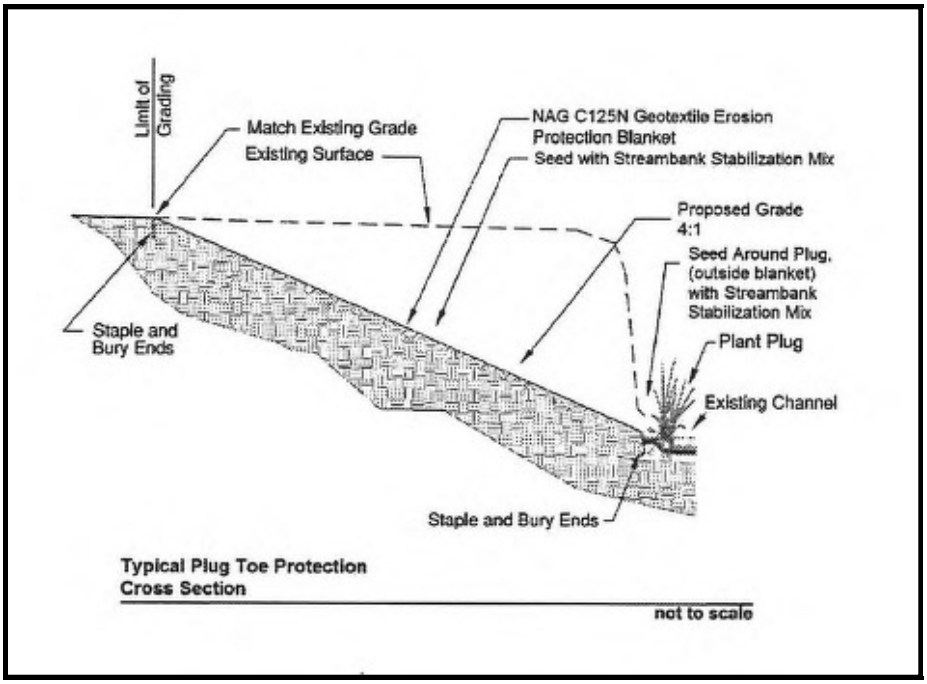

Figure 27. Conceptual design of proposed solution for Site 4.

4.4.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for Site 4 is $5,948. Table 12 details the estimated cost for project purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January 2010, contract construction services in the summer following award of a grant, and construct the projects starting in the fall of the year.

Table 12. Opinion of probable costs for the construction of the bank stabilization and tile installation for Site 4. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design	1	Each	$440	$440
Administrative	1	Each	$440	$440
Construction Services	1	Each	$3,960	$3,960
6' Perforated Field Tile	50	Feet	$1.10	$55
Native Seed for Banks	0.5	Acre	$330	$165
Turf Grass Seed	0.5	Acre	$110	$55
Straw Mulch	15	Each	$3.30	$50
Tile Riser	1	Each	$22.00	$22
Straw/Coir Erosion Blanket	200	Sq Yd	$1.10	$220
Subtotal				$5,407
Contingency (10% of overall project)				$541
Total				***$5,948***

4.4.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.4.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will be minimal, because the scope of the project is to stabilize the existing bank without significantly changing the surrounding land uses. Equipment access will be along the south bank adjacent to the residential yard. Care should be taken to minimize disturbance to the turfgrass and reseed when project is complete.

4.4.6 Functionality and Impact Determination

An estimate of the amount of erosion was not calculated for this site due the small scale of the project. Although, the site was not large enough to fit within the parameters of the modeling technique that was used for the other sites, active erosion is very evident at this site. The proposed solution will stabilize this area and reduce sediment input into the stream especially when combined with other projects in the area. It is recommended that this project be completed in unison with Site 5 to receive the most benefit per cost ratio.

4.4.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's NWI map, there are wetlands within the project area that are identified as seasonally-flooded emergent/ broadleaf deciduous, shrub scrub palustrine wetlands (Figure 28). The wetlands provide flood control and wildlife habitat along the Maggee Robbins Drain. The proposed BMP's would enhance and improve the wetland functions by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 28. Seasonally flooded emergent/ broad leaf deciduous shrub scrub palustrine wetlands identified on National Wetland Inventory map. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 13 details the list of the plant species identified during the site visit.

Table 13. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Herbaceous		Woody	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Agrimony Spp.	*Agrimonia spp.*	Eastern Cottonwood	*Populus deltoides*
Barnyard Grass	*Echinochloa crus-galli*		
Beggarstick	*Bidens laevis*		
Common Boneset	*Eupatorium perfoliatum*		
Common Ragweed	*Ambrosia artemisiifolia*		
Great Blue Lobelia	*Lobelia siphilitica*		
Ox Eye Daisy	*Leucanthemum vulgare*		
Reed Canary Grass	*Phalaris arundinacea*		
Yellow Foxtail	*Setaria lutescens*		
Yellow Nutsedge	*Cypernus esculentus*		

4.4.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a watershed diagnostic study for Palestine Lake. Due to the recent nature of this study being completed, the mIBI data from this study was utilized for assessing this site. The mIBI score was 1.78, indicating that the channel is severely impaired to support aquatic life (JFNew 2008). The QHEI score was 51.5 and classified the stream as partially supporting of aquatic life use designation (JFNew 2008). This indicates that the stream showed signs of impaired water quality habitat limits its potential for diversity of aquatic biota.

4.4.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The existing conditions of the stream show it to be severely impaired. The proposed project will restore habitat and stabilize the streambank without significantly impacting the existing environment. By reshaping the bank, undercutting of the bank will be halted. Native vegetation will be restored on the banks which will provide both fish cover and wildlife habitat. The vegetation will also act as a buffer from runoff caused by the adjacent agricultural activities. The proposed tile and riser will provide an avenue for any floodwater to re-enter the stream without causing erosion in the process.

4.4.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew). A roadside survey indicated that severe erosion was occurring near this location which was depositing sediment and nutrients downstream. Access to this site on the south bank would prove beneficial if construction were to occur. Heavy equipment could be easily moved into position for construction activities and keep the impacts to the site at a minimum.

4.4.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE will be not required because although the project areas are considered “Waters of the United States”, there will be no fill placed below the ordinary high water mark. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km).

4.5 Site 5

4.5.1 Site Description

The proposed project is located along the Maggee Robbins drain immediately downstream of Bruner Road. The property is owned by Jim Weaver (Figure 29).

Figure 29. Location of Site 5.

The banks of the Maggee Robbins in this section are mostly vegetated with woodland species except for the northeast portion of the project area. Within this section, Mr. Weaver maintains a rental house with turfgrass to the top of bank. Sparse black walnut trees can be found on the southwest corner of the maintained lawn. Sparse brushy species vegetate the eroding bank adjacent to the lawn (Figure 30).

Figure 30. Project site looking downstream of Bruner Road at erosion adjacent to maintained lawn on Maggee Robbins Drain.

4.5.2 Preliminary Design and Conceptual Drawings

The existing north streambank shows signs of active erosion and a bank with a slope of 1:1 or greater. The proposed solution is to re-slope the bank to a 4:1 slope, re-seed with native plants, and install erosion control blanket. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 180' of streambank beginning immediately downstream of the culvert under Bruner Road. Approximately 650 cubic yards (496.96 cu m) of bank material will be removed and placed in adjacent uplands and graded to blend in with the existing grade. A conceptual drawing of the bank reshaping can be found in Figure 10 of section 4.1.2.

Grade control structures are comprised of stone with an average diameter of 9 in (22.86 cm) and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. Three grade control structures are proposed to be installed at 100 ft (30.48 m), 200 ft (60.96 m), and 300 ft (91.44 m) downstream of the Bruner Road crossing for this project (Figure 29).

Figure 31. Proposed location for a grade control structure for Site 5.

4.5.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for project #5 is $30,190. Table 14 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January, contract construction services after the grant is awarded, and construct the projects starting in the fall of the year after permits become available.

Table 14. Opinion of probable costs for the construction of the grade control structures and bank stabilization for Site 5. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$2,112	$2,112
Administrative	1	Each	$1,056	$1,056
Construction Services	1	Each	$18,007	$18,007
9" Rip Rap	150	Tons	$27.50	$4,125
Native Seed for Banks	1	Acre	$330.00	$330
Turf Grass Seed	1	Acre	$110.00	$110
Straw Mulch	50	Each	$3.30	$165
Geotextile Fabric	200	Sq Yd	$1.10	$220
Coir Yarn Matting	400	Sq Yd	$2.20	$880
Straw/Coir Erosion Blanket	400	Sq Yd	$1.10	$440
Subtotal				$27,445
Contingency (10% of overall project)				$2,745
Total				***$30,190***

4.5.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.5.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will be minimal, because the scope of the project is to stabilize the existing banks without significantly change to existing land uses. Equipment access will be along the north bank adjacent to the residential yard. A large quantity of earth will be placed in the upland area immediately adjacent to the residence. Care should be taken to reseed the lawn and make sure the area is aesthetically pleasing. Also some trees may need to be removed for the project, but where allowable, leaving a few would improve the appearance of the end product while providing shade and habitat along the stream.

4.5.6 Functionality and Impact Determination

To estimate the amount of sediment that would be deposited into the drain if no action were taken, the BANCS model was used (see section 3.3). This model estimates the annual erosion rates based on the near bank stress and the bank erosion hazard index in cubic yards and tons of sediment lost per year. Table 15 is a summary of the annual streambank erosion estimate for the proposed project site. Data sheets for this model can be found in Appendix D.

Table 15. Total annual streambank erosion estimate for Site 5.

CuFt/Yr	CuYds/Yr	Tons/Yr	Tons/Yr/Ft
283.5	**10.50**	**13.65**	**0.08**

4.5.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's NWI map, there are wetlands within the project area that are identified as seasonally flooded, emergent/ broadleaf deciduous, shrub scrub palustrine wetlands (Figure 32). The wetlands provide flood control and wildlife habitat along the Maggee Robbins Drain. The proposed BMP's would enhance and improve the wetland functions by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 32. Seasonally flooded emergent/ broad leaf deciduous shrub scrub palustrine wetlands. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 16 details the list of the plant species identified during the site visit.

Table 16. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Common Name	Scientific Name	Common Name	Scientific Name
Agrimony Spp.	*Agrimonia spp.*	Black Cherry	*Prunus serotina*
Cocklebur	*Xanthium strumarium*	Black Raspberry	*Rubus occidentalis*
Giant Ragweed	*Ambrosia trifida*	Black Walnut	*Juglans nigra*
Kentucky Bluegrass	*Poa pretense*	Box Elder	*Acer negundo*
Pokeweed	*Phytolacca americana*	Bush Honeysuckle	*Lonicera spp.*
Stinging Nettle	*Urtica dioica*	Hackberry	*Celtis occidentalis*
Tall Fescue	*Festuca arundinacea*	Multiflora Rose	*Rosa multiflora*
Yellow Foxtail	*Setaria lutescens*	Poison Ivy	*Rhus radicans*
		Slippery Elm	*Ulmus rubra*
		Staghorn Sumac	*Rhus glabra*
		Willow spp.	*Salix Spp.*

4.5.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a watershed diagnostic study for Palestine Lake. Due to the recent nature of this study being completed, the mIBI data from this study was utilized for assessing this site. The mIBI score was 1.78, indicating that the channel is severely impaired to support aquatic life (JFNew 2008). A site-specific QHEI was also completed for this site. The QHEI score was 43.5 and classified the stream as non-supporting of aquatic life use designation (Appendix E). This indicates that the stream showed signs of impaired water quality and habitat limits its potential for diversity of aquatic biota.

4.5.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The existing conditions of the stream show it to be severely impaired. The proposed project will restore habitat and stabilize the streambank without significantly impacting the existing environment. By stabilizing the toe and reshaping the bank, undercutting of the bank will be halted. Native vegetation will be restored on the banks which will provide both fish cover and wildlife habitat. The vegetation will also act as a buffer from runoff caused by the adjacent residential land use activities.

4.5.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew, 2008). A roadside survey indicated that severe erosion was occurring near this location, which was depositing sediment and nutrients downstream. Access to this site on the north bank would prove beneficial if construction were to occur. A large portion of the project is located adjacent to a residential yard. Heavy equipment could be easily moved into position for construction activities and keep the impacts to the site at a minimum.

4.5.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE will be required because the project areas are considered "waters of the United States" and the stone toe would be considered fill. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

4.6 Site 6

4.6.1 Site Description

The proposed project is located along Caldwell Lake Drive. The property is located between two residences and provides an inlet for drainage in the area. The Kosciusko County Highway department maintains authority over this parcel to allow the drains to discharge in to Caldwell Lake (Figure 33). The north side of the property is lined with mature pine trees that provide a screen between the residences (Figure 34). A waste disposal dumpster has also been placed on a gravel pad near the edge of the road (figure 35). Toward the lake, a pier system has been placed for the resident's boat mooring needs.

Figure 33. Location of Site 6.

Figure 34. Project site showing outlet and pine tree screen.

Figure 35. Project site showing dumpster location and disturbed area next to Caldwell Lake road.

Drainage from the road during rain events is causing erosion to the adjacent soils and transporting it into the Lake. The tile lines coming into the lake have accumulated sediment and during large storm events are most likely flushed out. Along with this sediment, broken concrete and rip rap have been placed near the outlet. Local residents have also dumped lawn debris along the banks of this swale.

4.6.2 Preliminary Design and Conceptual Drawings

Sediment has accumulated near the outlet of the existing pipes to the point of nearly clogging one of them (Figure 36).

Figure 36. Outlet near Caldwell Lake road showing sediment accumulation from road and tile outlets.

The proposed solution is to install a sediment trap that is approximately 15 ft x 20 ft long x 3 ft deep (4.57 m x 6.10 m x 0.91 m) immediately adjacent to the outfall of the pipes. The sediment trap will allow large particle sediment to settle out before entering Caldwell Lake (Figure 37). Stone would be used to stabilize the areas where water is entering and exiting the sediment trap. The disturbed areas surrounding the sediment trap would be graded and seeded with a native species seed mix.

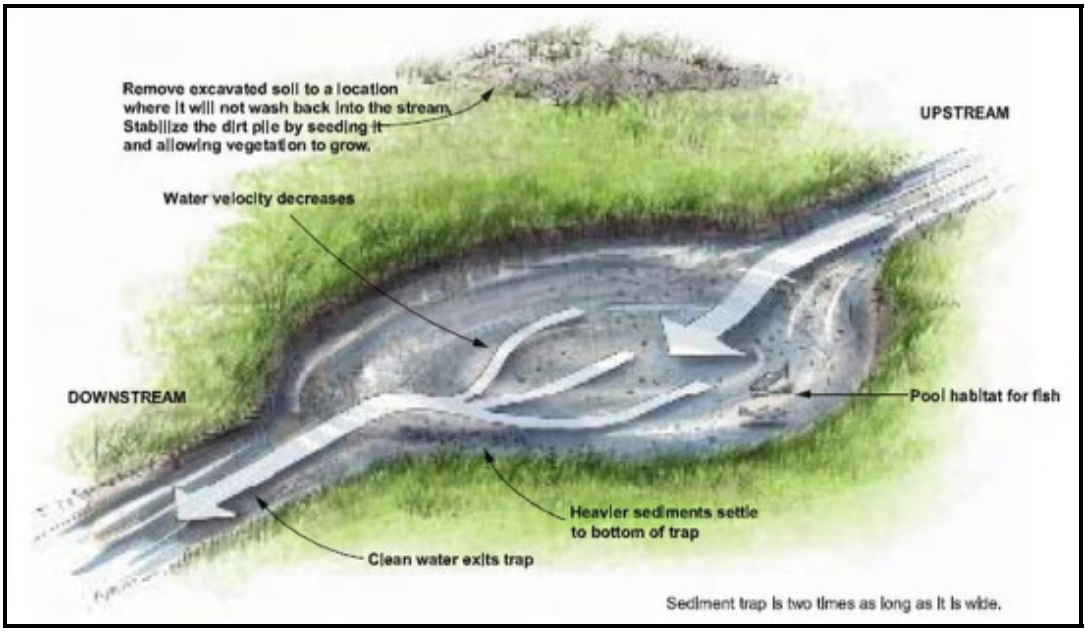

Figure 37. Conceptual design of a sediment trap proposed for Site 6.

The area along Caldwell Lake Drive shows signs of active erosion with sand and gravel entering the lake during storm events and the existing waterway, where the tiles outlet to the lake, has become filled with sediment. The proposed solution for these two areas is to install a vegetated swale (Figure 38; Figure 39). The vegetated swales utilize native vegetation to trap sediment and filter nutrients before entering the lake. The swale above the proposed sediment trap should reduce the sand and gravel inputs into the basin, while the proposed swale at the outlet of the sediment trap will help reduce and filter the suspended sediment. The swales will be graded, covered with erosion control blanket, seeded with a native seed mix, and planted with native plugs 2 ft (0.61 m) on center.

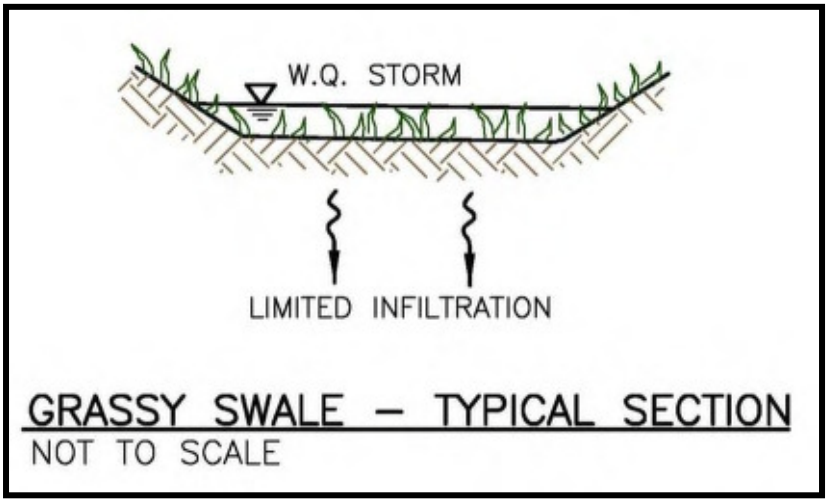

Figure 38. Conceptual design of a vegetated swale proposed for Site 6

Figure 39. Proposed location for vegetated swale.

4.6.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for project #6 is $13,050. Table 17 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January, contract construction services in the summer after being awarded a grant, and construct the projects starting in the fall.

Table 17. Opinion of probable costs for the construction of the sediment trap and vegetated swales for Site 6. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$2,112	$2,112
Administrative	1	Each	$1,408	$1,408
Construction Services	1	Each	$5,962	$5,962
Seed - Swales	0.5	Acre	$330.00	$165
Seed - Turf	0.5	Acre	$110.00	$55
Straw Mulch	10	Each	$3.30	$33
Straw/Coir Erosion Blanket	250	Each	$1.10	$22
Native Plugs	490	Each	$2.20	$1,078
9" Rip Rap	35	Tons	$27.50	$963
Geotextile Fabric	60	Sq Yds	$1.10	$66
Subtotal				$11,864
Contingency (10% of overall project)				$1,186
Total				***$13,050***

4.6.4 Easement and Land Availability Determination

After providing the owners with a description of the purpose of the feasibility study and the benefits to the lake, landowner permission was obtained for accessing the site for field work during the conceptual design phase. Following completion of a conceptual design, landowners were sent information describing the design and were asked for

their written permission to proceed with the final design and construction, if funds became available. Copies of the signed landowner agreements are in Appendix C.

4.6.5 Unusual Physical and Social Costs

The identified unusual physical costs associated with design and construction of the proposed projects will include long term maintenance associated with the sediment trap. Sediment traps usually have to be cleaned out every five to seven years. The location of the sediment trap next to the road will allow an excavator to load sediment directly into a truck for hauling to a designated disposal site. An education period may be warranted to educate local residents of the best management practices and to keep them from using the area as a yard waste disposal area.

4.6.6 Functionality and Impact Determination

An estimate of the amount of sediment input was not calculated for this site. The projects proposed at this site are designed as end of the pipe measures. The purpose of these structures is to capture and treat sediment and nutrients before they enter the lake. The sediment trap will allow large particles with attached nutrients to settle out while the vegetated swales are designed to capture fine particles and absorb nutrients. The goal is to return cleaner water into the adjacent lake.

4.6.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's NWI map, Caldwell Lake is classified as a permanently flooded, unconsolidated bottom, limnetic lacustrine wetland (Figure 40). This is a deep lake habitat type wetland that is capable of supporting a fish community. The proposed BMP's would enhance and improve the lake by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 40. Permanently flooded unconsolidated bottom limnetic lacustrine wetland identified on National Wetland Inventory map. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

A qualitative plant survey was performed to determine the plant community within and surrounding the identified wetlands present at the time of the site visit October 7, 2009. Table 18 details the list of the plant species identified during the site visit.

Table 18. Plant species observed during October 7, 2009 site visit along the stream within the proposed project site.

Herbaceous		Woody	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Arrowhead	*Saggitaria latifolia*	Silver Maple	*Acer saccharinum*
Barnyard Grass	*Echinochloa crus-galli*	Red Pine	*Pinus resinosa*
Beggarstick	*Bidens laevis*		
Kentucky Bluegrass	*Poa pretense*		
Pickerelweed	*Pontederia cordata*		
Reed Canary Grass	*Phalaris arundinacea*		
Sedge spp.	*Carex spp.*		
Yellow Foxtail	*Setaria lutescens*		

4.6.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a watershed diagnostic study for the Palestine Lake watershed. As part of this study, Caldwell Lake was assessed using the Indiana Trophic State Index (TSI) which condenses water quality data into a single, numeric index. Different index (or eutrophy) points are assigned for various water quality concentrations. The index total, or TSI, is the sum of individual eutrophy points for a lake. The TSI score for Caldwell Lake was 25 (Table 19) which indicates the lake is mesotrophic to eutrophic in nature. This indicates that Caldwell Lake has an excess of nutrients and is very productive as a result.

Table 19. Water quality characteristics of Caldwell Lake, June 19, 2007.

Parameter	Epilimnetic Sample	Hypolimnetic Sample	Indiana TSI Points (based on mean values)
pH	8.2	7.3	-
Alkalinity	201 mg/L	262 mg/L	-
Conductivity	487 mhos	348 mhos	-
Secchi Depth Transparency	4.1 meters	-	0
Light Transmission @ 3 ft.	15.4%	-	4
1% Light Level	19.7 feet	-	-
Total Phosphorous	0.02 mg/L	0.494 mg/L	4
Soluble Reactive Phosphorous	0.010* mg/L	0.425 mg/L	4
Nitrate-Nitrogen	0.835 mg/L	0.103 mg/L	2
Ammonia-Nitrogen	0.040 mg/L	1.296 mg/L	3
Organic Nitrogen	0.804 mg/L	1.359 mg/L	3
Turbidity	1.1 NTU	-	-
Oxygen Saturation @ 5ft.	91%	-	0
% Water Column Oxic	42%	-	3
Plankton Density	6,416/L	-	2
Blue-Green Dominance	44.5 %	-	0
Chlorophyll a	3.48 g/L	-	-
		TSI score	25

4.6.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The proposed project will disturb areas that have already been largely impacted by previous disturbances. The vegetated swales will provide additional flowers for nectaring wildlife species and provide habitat for reptiles and amphibians. The sediment trap will replace the areas of broken concrete and may provide habitat for fish fingerlings in the pool; however it is not intended to be fish habitat. The proposed best management practices will also help reduce the amount of nutrients entering Caldwell Lake.

4.6.10 Justification of Site Selection

The general site location was selected based on the recommendations of the diagnostic study completed in 2008 (JFNew). A roadside survey indicated that severe erosion was occurring near this location which was depositing sediment and nutrients into Caldwell Lake. The location provides good access for maintenance and removal of accumulated sediment.

4.6.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE will be required because the project would likely be considered “Waters of the United States” and the stone basin and outflow structures would be considered fill. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

4.7 Knoop Wetland, Site 7

4.7.1 Site Description

The proposed project is located east of CR 100 W and just north of CR 800 S on a property owned by Gilbert Knoop. The landowner has applied for the Wetland Reserve Program with the NRCS, but his application has not been approved and probably will not be in the near future. He has a large clay tile draining a deep pothole in a pasture field north of his house (Figure 41).

Figure 41. Location of Site 7.

4.7.2 Preliminary Design and Conceptual Drawings

The proposed wetland would require the construction of two small levees and the installation of two water level control structures (Figure 42). These levees would restore the wetland to approximately nine acres (3.64 ha). Two sections of existing field tile would be crushed while a stone chute would be installed to facilitate runoff from the adjacent field. Approximately five acres (2.02 ha) of native prairie would be installed to act as a buffer with approximately four acres (1.62 m) also planted with native trees and shrubs. These native plantings will provide wildlife habitat while also infiltrating water from the surrounding landscape.

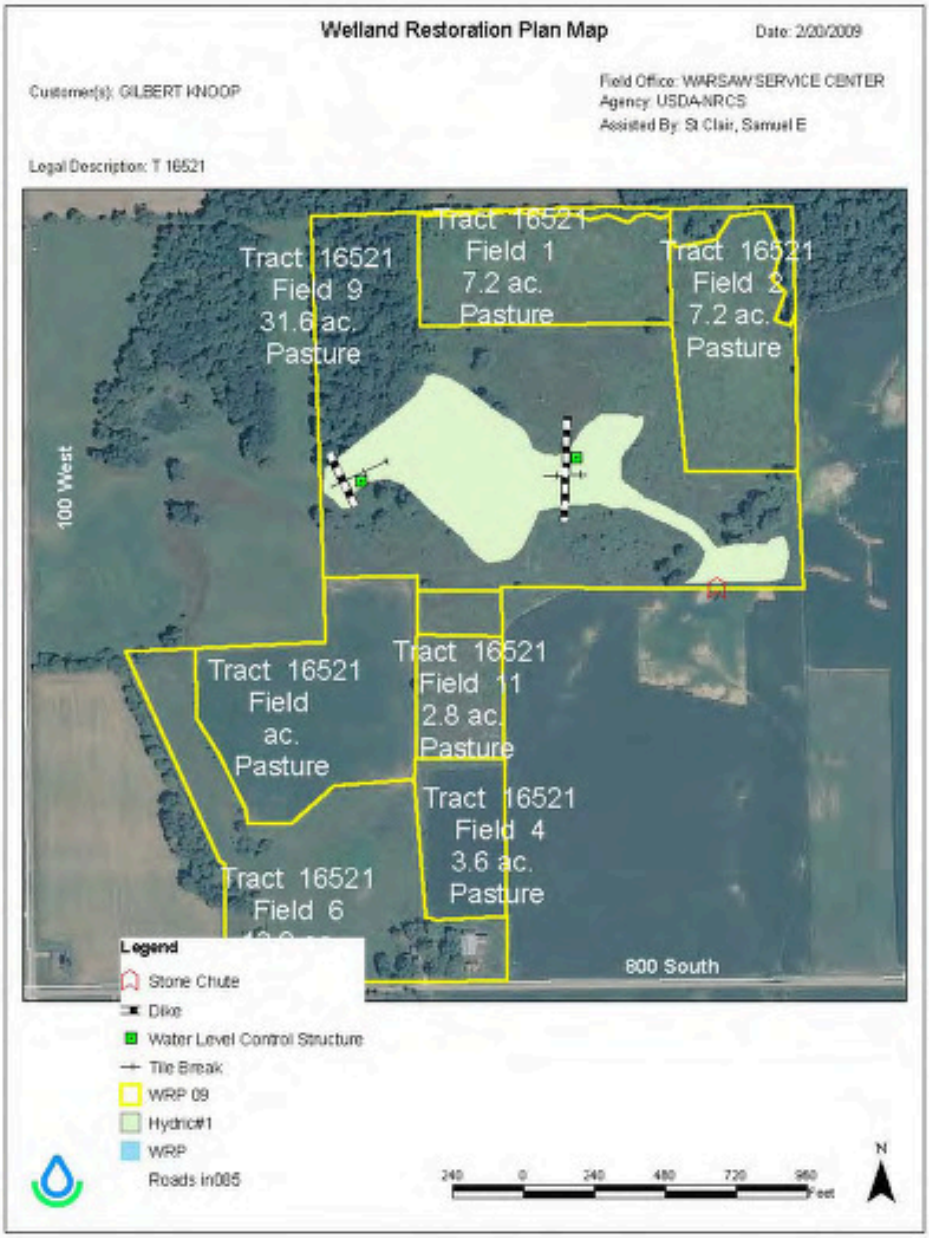

Figure 42. Conceptual design of Site 7.

4.7.3 Probable Costs and Proposed Timelines

The probable cost for the permitting, construction and maintenance of the projects for project #7 is $26,069. Table 20 details the estimated cost for project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management. Construction services include machinery, loading, hauling, labor, and expenses associated with the installation of the materials as proposed.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the PLPOA apply for construction funding in January, contract construction services in the summer after being awarded a grant, and construct the projects starting in the fall.

Table 20. Opinion of probable costs for the construction of the wetland for project #7. Item cost includes delivery and installation.

Item	Quantity	Unit	Unit Cost	Total
Final Design and Permitting	1	Each	$3,520	$3,520
Administrative	1	Each	$2,112	$2,112
Construction Services	1	Each	$10,780	$10,780
Water Level Control Box	2	Each	$1,100	$2,200
9' Rip Rap	5	Tons	$27.50	$138
Prairie Seed	5	Acres	$770	$3,850
Trees	500	Each	$2.20	$1,100
Subtotal				$23,700
Contingency (10% of overall project)				$2,370
Total				***$26,069***

4.7.4 Easement and Land Availability Determination

The landowner has applied for the WRP through the Kosciusko County NRCS office. The NRCS has his application on file, which would serve as permission to implement this project if it was funded.

4.7.5 Unusual Physical and Social Costs

The identified unusual physical and social cost would include changing the land use in this area. In its existing condition, the land is marginally available for farming practices and has been used for limited grazing. By constructing the berms and crushing tile, the proposed future condition of this area will not allow for any farming activities to take place.

4.7.6 Functionality and Impact Determination

Wetlands act as a sponge during storm events by soaking up large quantities of water and releasing it slowly over a period of time. The design of this wetland will include some areas that have open water. This design also facilitates the removal of nutrients through the established wetland community. The location of this wetland project lends itself well to capturing and treating stormwater runoff before it enters Cauffman Drain. By reducing the first flush of rainwater into Cauffman Drain, this project should reduce the downstream effects of stormwater on the banks of Cauffman Drain.

4.7.7 Wetland Functional Assessment

According to a review of the United States Fish and Wildlife Service's NWI map, there are two types of wetlands within the project area that are identified as seasonally flooded, saturated emergent, palustrine wetland and intermittently exposed, unconsolidated bottom, palustrine wetland (Figure 43). Both wetlands provide flood control and wildlife habitat adjacent to the Cauffman Drain. The proposed restoration would enhance and improve the wetland functions by filtering nutrients, increasing infiltration, reducing erosion and increasing habitat complexity and native species composition in this area.

Figure 43. Seasonally flooded saturated emergent palustrine wetland and intermittently exposed unconsolidated bottom palustrine wetland identified on National Wetland Inventory map. **Source: U.S. Fish and Wildlife Service. http://www.fws.gov/wetlands/**

4.7.8 Biological and Habitat Integrity Survey

In April 2008, JFNew completed a watershed diagnostic study for the Palestine Lake watershed. Due to the recent nature of this study being completed, the mIBI data from this study was utilized for assessing this site. The sampling site was located on Cauffman Drain downstream of the project site at the intersection of CR 700 S. The mIBI score was 1.6, indicating that the channel is severely impaired to support aquatic life (JFNew 2008). QHEI score was 58 and classified the stream as non-supporting of aquatic life use designation (JFNew, 2008). This indicates that the stream showed signs of impaired water quality habitat limiting its potential for diversity of aquatic biota.

4.7.9 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The proposed project will enhance the existing marginally wet areas. The restored wetlands will provide wildlife habitat while also improving water quality downstream.

4.7.10 Justification of Site Selection

The general site location was selected based on an application made by the landowner to the NRCS. The landowner is requesting financial assistance in completing this water quality improvement project. The NRCS has limited funding for these types of projects and may not be funded due to competition from higher priority projects.

4.7.11 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE will be required because the project areas are "Waters of the United States" and the earthen berms would be considered fill. An IDNR permit will not be required because the project would fall under an exemption as a reconstruction or maintenance project located on an open regulated drain with total length of the drain being less than ten miles (16.09 km). A copy of the letters sent to the regulatory agencies requesting early coordination review of the proposed project can be found in Appendix F.

5.0 ADDITIONAL PROJECTS

While completing the investigation for the above outlined projects, other potentially feasible projects were identified. The following is a brief description of these projects that would help in the quest for improving water quality within the Palestine Lake watershed.

5.1 Weaver Property

To access the back portion of his property, Jim Weaver has placed a large culvert with stone across the Maggee Robbins Drain. This culvert has overtopped several times over the past 30 years. Each time this occurs, sediment from the access road is washed downstream (Figure 44).

Figure 44. Eroding Crossing located on Cauffman Drain just west of Site 5.

The landowner has fabricated a truck trailer to use as a bridge that would solve the erosion issue while providing more capacity through this section (Figure 45). JFNew has contacted the County Surveyor and he is in favor of the proposed solution and said it was the preferred method.

Figure 45. Potential solution to failing crossing designed by landowner; use the trailer as a bridge to replace culvert.

JFNew recommends that the Palestine Lake Property Owners Association continue to monitor this project and support the landowner in any way they can. The project is located just west of Site 5 along the Maggee Robbins Drain directly behind the Weaver house on S.R. 25.

5.2 Miller Property Site 1

Downstream of Site 1, several additional sections of streambank exhibited erosion (Figure 46). The land is still owned by the Millers and there is access trail along the south bank that is maintained by the owner. The access to the stream itself may be somewhat limited, but may be worth pursuing options such as grade controls or instream structures to assist in stabilizing the banks.

JFNew recommends that the Palestine Lake Property Owners Association maintain a relationship with the landowner and once the original projects have been completed investigate these areas further for potential projects.

Figure 46. Additional erosion identified along Cauffman Drain just west of Site 1.

6.0 DETERMINATION OF FUNDING SOURCES

Each feasible project will be eligible to receive additional LARE funding for final design and construction. It is recommended that each project is constructed under a "design-build" scenario because enough information is known about each of the projects that a final design without a significant amount of additional time and resources is achievable. Projects can be completed over a course of several years to ease the financial burden to the organization and to increase the likelihood that a grant application will get funded.

The PLPOA should network with the other non-profit lake and water quality organizations within the Tippecanoe River watershed to stay abreast of funding opportunities. At times, governmental organizations make certain watersheds priorities for short-term and focused work i.e. Great Lakes Restoration Initiative and NRCS Priority Watershed programs. Networking with other groups working in the Tippecanoe River watershed may allow the PLPOA to take advantage of any additional funds available.

7.0 PROJECT CONCLUSION AND RECOMMENDATIONS

The Palestine Lake Property Owners Association and area residents are currently working on their own and with natural resource agencies to address water quality issues and goals outlined in the diagnostic study for this area. This study has addressed only a small portion of the issues related to water quality within the watersheds of Palestine Lake and Caldwell Lake. Efforts must continue on a broad scale in order to make a difference in the watersheds that make up the headwaters of the Tippecanoe River. The following is a list of recommendations that are specific to information gathered during this study and should be addressed in the near future:

1. Apply for a LARE grant in 2011 for the design and construction of Project 7. Apply for IDEM and USACE permits in the summer of 2011 with construction of projects to begin in the fall of 2011 or as soon as permits are acquired

2. Repeat the LARE application process in 2012 for one or more the remaining projects. The number of projects each year can be determined by the financial and institutional resources of the organization.

3. Continue to work on education efforts and stream bank restoration opportunities throughout the watershed. To assist with this effort, establish a dialog with the Natural Resource Conservation Service office and the landowners of various parcels where stream restoration projects are possible. A long-term, trusting relationship with these landowners may result in conservation and/or restoration project implementation.

4. Continue to pursue individual BMPs recommended in the diagnostic study and follow up on additional projects that were identified for future funding opportunities.

5. Continue to work with landowners and the local soil and water conservation district (SWCD) to install buffer strips and filter strips recommended in the diagnostic study.

8.0 LITERATURE CITED

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APPENDIX A

PUBLIC MEETING NOTES AND HANDOUTS
PALESTINE LAKE WATERSHED ENGINEEERING FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

Palestine Lake Property Owners' Association Meeting
March 21, 2009

The meeting began shortly after 1:00 at the Burket fire station. Twenty-three members were present. The minutes from the previous meeting on October 11, 2008 were read followed by an update by treasurer, Debbie Hutnick. Two deposits had been made and one withdrawal for mailing expenses, leaving a balance (as of February 28, 2009) of $6,222.72.

Former secretary, Gwenn Tucker, submitted posters to be placed in local businesses and at other sites. The following places were suggested: The Bull Dog Saloon, the bait shop, boat launch area, Ace Hardware, Marsh grocery store, and the laundromat in Warsaw.

A report was given on the possibility of having individuals pay to have the lake area in front of their property sprayed by Burnworth Pond Management, Inc. from Huntington, IN. We would need 50 people to commit to this. The cost would be approximately $52 for 35 feet of treated area. Spraying would first need to be approved by the DNR, which could take up to three weeks to get. Names and e-mail addresses were collected from those interested in participating in this.

Thanks were extended to Aimee Daniel for writing and sending out the last newsletter.

Tyson Edwards from JF New presented an update on the feasibility study. His presentation showed the sites that have been identified as areas that are affecting the quality of our lake and explained what would need to be done at those sites to help improve the water quality of our lake. The goal is to select approximately ten sites to pursue work on.

Respectfully submitted,
Ruth Cozza, Secretary

Palestine Lake Property Owners' Association Meeting
February 27, 2010

The meeting began shortly after 1:00 at the Burket fire station. Twenty-three members were present. Unfortunately, President Mark Whittaker could not attend today's meeting. Deb Hutnick, treasurer, opened the meeting.

The minutes from the last meeting on October 17, 2009 were read by secretary, Ruth Cozza.

Deb Hutnick gave the following treasurer's report:

Beginning 9/30/09	$4323.62
Deposits	$14473.86
Expenses	$49.00
Balance 1/31	$18748.48
JF New inoices	$13833.86
actual balance	$4914.62

Ken Germeck presented the association with a check for $500 from The Fabric of America Fund that he secured for us through his employment at BP America. The association applauded Ken for successfully acquiring this much needed money for us! We are asking everyone to investigate possibilities for other funds through their employment, etc.

It was brought to everyone's attention that Don Pierce and James Koby passed away. Our condolences are extended to these families.

Mark Prancus is our new representative from JFNew. Mark often worked with Tyson Edwards (our former representative) on projects for our lake. He attended today's meeting to update us on the feasibility study that he has involved in for our lake. Below are highlights from the study:

- 30 sites were identified in the Diagnostic Study
- The Feasibility Study narrowed these 30 down to 7 (May 2009)
- Many of these sites involve bank stabilization to keep soil, along with its accompanying nutrients, from flowing into the lake
- The individuals who own these sites have been contacted and are willing to allow the projects to be done on their property
- The following are the sites and approximate costs to fix them:
    - Site 1 – Miller Bank Stabilization $24,285
    - Site 2 – Wagoner Bank Stabilization $10,612
    - Site 3 – Weed Bank Stabilization $24,678
    - Site 4 - Hedington Bank Stabilization $5,706

- Site 5 – Weaver Bank Stabilization $30,190
- Site 6 – County Highway Stormwater Treatment $13, 050
- Site 7 – Knoops Wetland Restoration $26,069

Total $134,590

Where do we go from here? The next step would be for us to apply for the Design-Build Grant. The LARE grant would cover 75% of the cost and our association would be responsible for approximately $33,650. We did not apply for this grant this year because we did not have the available funds. We could focus our efforts on one or two of the above projects per year. Mark recommended the Knoops Wetland Restoration since there is a lot of attention being given to wetlands. ***He encouraged all of us to seek grants and/or additional funding through any organization that supports wetlands.*** He also recommended sites 4 and 5 since they are near each other and visible from Highway 25. More people would see that work was being done because these two sites are along Highway 25. There might also be some savings since the sites are near each other. We could also save up to 20% through in-kind matching. We would need to donate our services, equipment, etc. to the projects for this. This would help save us money. Holding three PLPOA meetings this year was part of the in-kind services this year that saved us money.

Mark also recommended that if we chose to only do a few sites each year, that we keep in contact with the landowners of the other sites and the LARE project manager.

The application for the Design-Build Grant is due January 15th of each year. Notification is given by July.

After Mark's presentation, discussions were held on the beaver problem and dredging. Along with the weed treatment that Burnworth Pond Management will do, it was suggested that we could use copper sulfate in the months after the last treatment in June. Property owners who were interested in this put their name on a list. Dave Hutnick has already begun to investigate prices and will continue to do so. ***If you were not able to attend the meeting and would be interested in purchasing some copper sulfate, please let us know as soon as possible.***

The need to seek funds was discussed and everyone was strongly urged to go online, etc. to search for any and all possibilities to raise the money that is needed to improve the quality of our lake. We also need to get the word out to more property owners and get them motivated to join our efforts. It is impossible for one or two people to do all the work and put in the number of hours needed to search for funding sources. Anyone who has any ideas, information, etc. is asked to e-mail them to Debbie or Ruth. They will e-mail these to everyone in the association. Some ideas that were mentioned include: selling a cookbook, hosting a chicken roaster in town, approaching those who come here for tournaments.

We have made progress and can only see our efforts through if more people get involved. We can't let all that we have accomplished this far stop now! Please let us know your ideas and search results as soon as possible!

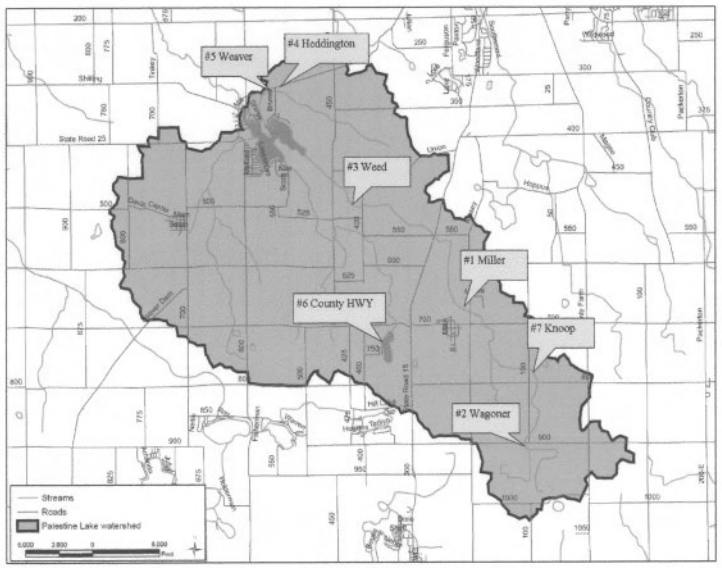
Together we can accomplish great things for the future of Palestine Lake!

Palestine Lake Property Owners Property Association (PLOPA)

PALESTINE LAKE WATERSHED ENGINEERING FEASIBILITY STUDY

2009 INDR Lake and River Enhancement (LARE) Project

INITIAL GOALS FOR STUDY: To study areas surrounding the lake where erosion, sediment, and nutrient problems are occurring And develop solutions that are feasible from a technical standpoint and a landowner cooperation standpoint.



Seven out of ten sites deemed feasible:

1. 6715 S 200 W Claypool, IN-Ronald & Kathryn Miller
2. 10477 S Packerton Rd Claypool. IN-Roger & Carla Wagoner
3. 5043 S 400 W Claypool, IN-Preston & Ashley Weed
4. 3120 S S.R. 25 Warsaw, IN-Joe & Linda Hedington
5. PO Box 1922 Warsaw, IN-James & Linda Weaver
6. 2936 E Old Rd 30-Kosciusko Cty Hwy Dept.
7. Knoop Wetland

Sections of stream bank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, reseed with native plants and install erosion control blankets. Stone toes would be installed at the base of the banks to prevent undercutting. Native plants can have roots up to ten feet which will stabilize the banks and provide a buffer for filtering stormwater runoff. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with existing grade. Some areas were identified where concentrated surface runoff enters the stream and is eroding the streambank. A rock chute is proposed to halt erosion.

In another area field tile with a perforated riser would be installed to convey stormwater into the adjacent stream. Erosion is occuring around the top of an existing culvert. Installing rip rap around the culvert to armor the soil from erosion would be done.

Lastly, installing a sediment trap to allow particle sediment to settle out before entering and exiting the sediment trap. The disturbed areas surrounding the sediment trap would be graded and seeded with native species seed mix.

PALESTINE LAKE WATERSHED ENGINEERING FEASIBILITY STUDY

When JF New conducted the fish survey the "Central Mud Minnow" was found. The mud minnow is a very tolerant species which indicates that the stream it was living in (Caufmann Drain) is of low quality due to erosion, nutrients, clearing, farming, and other human activities.

The table shows how much soil is lost at the relevant project sites. Annual erosion rates are estimated and then multiplied by the bank height and by corresponding bank length of a similar condition, providing an estimate of cu yards and tons of sediment per year. This information can be compared to the annual sediment yield data to apportion the amount of sediment potentially contributed by.

	Total Erosion			
Project #	CuFt/Yr	CuYds/Yr	Tons/ Yr	Tons/Yr/F t
1	**520.86**	**19.29**	**25.08**	**0.09**
2	**45.00**	**1.67**	**2.17**	**0.03**
3	**355.50**	**13.17**	**17.12**	**0.10**
5	**283.50**	**10.50**	**13.65**	**0.08**
Total	**1204.86**	**44.63**	**58.02**	**0.30**

APPENDIX B

FISH SURVEY DATA
PALESTINE LAKE WATERSHED ENGINEEERING FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

J.F. New Fishery Survey
Field Datasheet

Water Body: Cauffman Ditch
Project #: 060849.01
Crew Members: TLE, TBE
Site/ Transect: 12

Date: 10-7-09 **Time:** 10:30am
Project Name: Palestine Lake Feasibility
Equipment: Backpack
Effort: 671 sec 225 feet

Sp.: CMM

No. Indiv.	Lengths
4	
7	
14	
11	
4	
1	
Σ 41	

Sp.: CRC

No. Indiv.	Lengths
5	
2	
7	
9	
1	
4	
Σ 28	

Sp.: BND

No. Indiv.	Lengths
13	
12	
15	
7	
2	
1	
Σ 50	

Sp.:

No. Indiv.	Lengths

Sp.:

No. Indiv.	Lengths

Sp.:

No. Indiv.	Lengths

Sp.:

No. Indiv.	Lengths

Sp.:

No. Indiv.	Lengths

119 individuals

J.F. New & Associates, Inc.
Aquatics Unit

IBI CALCULATION

(< 20 miles^2 drainage (Headwater Stream))
Northern Till Plains

STREAM/LOCATION: Cauffman Ditch
CR 100W/900S Kosciusko County

DRAINAGE AREA (mile^2): 2.4

PROJECT # 060849.01

COLLECTION DATE: 10/7/2009

Metric	# or %	Score
# of Species	3	1
# of DMS sp.	0	1
% Headwater sp.	33	3
# Minnow sp.	2	3
# of Sensitive sp.	0	1
% Tolerant Individuals	100	1
% Omnivore Individuals	34	1
% Insectivores Individuals	0	1
% Pioneer sp.	33	3
Catch per Unit Effort	119	5
% Simple Lithophils Individuals	42	3
% DELT Individuals	0	5

Sample Distance (ft or m)	225 ft
Sample Time (sec or min)	671 sec
Sample Method	Backpack
IBI Score	28
Integrity Class	Poor

Table 1. Attributes of Index of Biotic Integrity (IBI) classification, total IBI scores, and integrity classes from Karr *et al.* (1986).

Total IBI score	Integrity Class	Attributes
58-60	Excellent	Comparable to the best situation without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of age (size) classes; balance trophic structure.
48-52	Good	Species richness somewhat below expectations, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress.
40-44	Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g. increasing frequency of omnivores and other tolerant species); older age classes of top predators may be rare.
28-34	Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
12-22	Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.
0	No Fish	Repeated sampling finds no fish.

abundance and condition The twelve original Index of Biotic Integrity metrics reflect insights from several perspectives and cumulatively are responsive to changes of relatively small magnitude, as well as broad ranges of environmental degradation.

Since the metrics are differentially sensitive to various perturbations (e.g. siltation or toxic chemicals), as well as various degrees or levels of change within the range of integrity, conditions at a site can be determined with considerable accuracy. The interpretation of the index scoring is provided in six narrative categories which have been tested in the midwestern United States (Karr 1981; Table 1).

Several of the metrics are drainage size dependent and require calibration to determine numerical scores (Tables 2-3). Drainage size effects were determined by evaluating trends in species or proportions of individuals with increasing (log adjusted) drainage area. The

APPENDIX C

LANDOWNER COORESPONDENCE
PALESTINE LAKE WATERSHED ENGINEEERING
FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

JFNew
Full-Service Ecological Solutions™

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Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

July 20, 2009

Ronald and Kathryn Miller
6715 S 200 W
Claypool, IN 46510

Dear Mr. and Mrs. Miller:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake, an area on your property was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on information gathered from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Re-slope and re-vegetate streambank: Several sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket. (See the enclosed map and pictures.) A stone toe approximately 2.5 ft by 3 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 255 feet of streambank located in four sections along Cauffman Drain. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived

sediment. One grade control structure is proposed to be installed at approximately 200 ft downstream of the 200 W Road crossing.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

Ronald E Miller Signature

Ronald E Miller Printed Name

7-22-09
Date

JFNew
Full-Service Ecological Solutions™

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Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

August 3, 2009

Roger and Carla Wagoner
10477 S Packerton Road
Claypool, IN 46510

Dear Mr. and Mrs. Wagoner:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake, an area on your property was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on information gathered from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Re-slope and re-vegetate streambank: One section of streambank showed signs of active erosion along the edge of the field. The proposed solution is to reshape the banks, install a stone toe, and re-seed with a native slope stabilization seed mix covered with an erosion control blanket. (See the enclosed map and pictures.) A stone toe approximately 2.5 ft by 2 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 75 feet of streambank located along Cauffman Drain. Construction would commence after crop harvest to minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

Roger Wagoner Signature

Roger Wagoner Printed Name

8-26-09
Date

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www.jfnew.com

July 20, 2009

Preston and Ashley Weed
5043 S 400 W
Claypool, IN 46510

Dear Mr. and Mrs. Weed:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake, an area on your property was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on information gathered from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Re-slope and re-vegetate streambank: Two sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket. (See the enclosed map and pictures.) A stone toe approximately 2.5 ft by 3 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 165 feet of streambank located in two sections along Cauffman Drain. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. Three grade control structures are proposed to be installed

at approximately 100 ft, 300 ft, and 500 ft downstream of the 400 W Road crossing.

Rock Chute: A small area was identified where concentrated surface runoff enters the stream and is eroding the streambank. To halt the erosion in this section, a rock chute is proposed. A rock chute consists of a geo-textile fabric underlayment with 8"-12" of 6" stone to armor the streambank during the periods of surface runoff. The area is approximately 10' by 25'.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

Preston Singleton Signature

Preston Singleton Printed Name

9-24-09
Date

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July 20, 2009

Joe and Linda Hedington
3120 S S.R. 25
Warsaw, IN 46580

Dear Mr. and Mrs. Hedington:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake, an area on your property was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on your input and from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Install field tile outlet and perforated riser on south side of the Maggee Robbins Drain: The existing berm created by excavated spoils has been eroded away where the water exits this area. This erosion will continue, if not addressed. The proposed solution is to install approximately 45' of field tile with a perforated riser to convey stormwater into the adjacent stream. (See the enclosed map and pictures.)

Re-slope and re-vegetate south streambank: The existing south streambank shows signs of active erosion and a bank with a slope of 1:1. The proposed solution is to re-slope the bank to a 4:1 slope, re-seed with native plants and install erosion control blanket. (See the enclosed map and pictures.) The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff.

Culvert Erosion: Erosion is occurring around the top of the existing culvert under Bruner Road on the east side. The proposed project is to stabilize this erosion by installing limestone rip rap around the culvert to armor the soil from erosion.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

Joe Hedington Signature

JOE HEDINGTON Printed Name

8/25/09
Date

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Fax: 574-586-3446

Tyson Edwards
Ecological Resource Specialist
tedwards@jfnew.com

July 20, 2009

James and Linda Weaver
PO Box 1922
Warsaw, IN 46581

Dear Mr. and Mrs. Weaver:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake, an area on your property was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on information gathered from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Re-slope and re-vegetate north streambank: The existing north streambank shows signs of active erosion and a bank with a slope of 1:1 or greater. The proposed solution is to re-slope the bank to a 4:1 slope, re-seed with native plants, and install erosion control blanket. (See the enclosed map and pictures.) The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 180' of streambank beginning immediately downstream of the culvert under Bruner Road. Approximately 650 cubic yards of bank material will be removed and placed in adjacent uplands and graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. Three grade control structures are proposed to be installed at 100 ft, 200 ft, and 300 ft downstream of the Bruner Road crossing.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

James G Weaver Signature

JAMES G WEAVER Printed Name

10-7-09
Date

KOSCIUSKO COUNTY HIGHWAY DEPARTMENT
2936 E. Old Road 30
Warsaw, Indiana 46582

ph: 574-372-2356
fax: 574-372-2357

Date: September 25, 2009

To: JF New

Fax: 574-586-3446

From: John Ingle

Re: Caldwell Lake Project

See attached

Number of pages - including cover sheet: 3

JFNew
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August 23, 2009

Kosciusko County Highway Department
Attn: John Ingle
2936 E. Old Road 30
Warsaw, IN 46582

Dear Mr. Ingle:

The Palestine Lake Property Owner Association (PLPOA) is undertaking a feasibility study to reduce sediment and nutrient loading to the lake. The study focuses on areas surrounding the lake where erosion, sediment, and nutrient problems are occurring and develops solutions that are feasible from a technical standpoint and a landowner cooperation standpoint. During an initial tour of Palestine Lake Watershed, an area located next to Caldwell Lake and adjacent to Caldwell Lake Drive was identified as a potential location for a sediment reduction project. JFNew staff and I later followed up with a site visit on June 25th to determine potential solutions. The proceeding paragraph details the proposed project based on your input and from the site visit. For the project to continue into the design phase, the PLPOA needs your written signature stating that you understand and agree with the conceptual idea of the project. At this point, your signature is a commitment to your willingness to consider the project and to move forward with turning a conceptual idea into a detailed design that can be later constructed, if funds become available.

Install sediment trap near outlet pipes adjacent to Caldwell Lake Drive: Sediment has accumulated near the outlet of the existing pipes to the point of nearly clogging one of them. The proposed solution is to install a sediment trap that is approximately 15 ft wide X 20 ft long X 3 ft deep immediately adjacent to the outfall of the pipes. (See the enclosed map and pictures.) The sediment trap will allow large particle sediment to settle out before entering Caldwell Lake. Stone would be used to stabilize the areas where water is entering and exiting the sediment trap. The disturbed areas surrounding the sediment trap would be graded and seeded with a native species seed mix.

Install vegetated swales: The area along Caldwell Lake Drive shows signs of active erosion with sand and gravel entering the lake during storm events. The existing waterway, where the tiles outlet to the Lake, has become filled with sediment. (See the enclosed map and pictures.) The proposed solution for these areas is to install a vegetated swale. The vegetated swales utilize native vegetation to trap sediment and filter nutrients before entering the lake. The swale

above the proposed sediment trap should reduce the sand and gravel inputs into the basin, while the proposed swale at the outlet of the sediment trap will help reduce and filter the suspended sediment. The swales will be graded, covered with erosion control blanket, seeded with a native seed mix, and planted with native plugs.

The PLPOA would be responsible for all costs associated with the design and construction of this project including site preparation, construction, and clean-up. By signing this letter, you indicate that a detailed design can occur. Before and during the design phase, your input into the design will be considered. We will contact you to let you know when we have received funding for the design project and the proposed project timeline.

Please sign below and return in the stamped envelope. Enclosed is a copy for your records. If you have any questions before signing, please contact me at 708-833-0623 (cell) or 574-586-3400 (office). I will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Palestine Lake Property Owners Association and their work to improve the water quality of Palestine Lake can be directed to Mark Whittaker, president (574-215-2549.)

Thank you,

Tyson Edwards

Tyson Edwards
Ecological Resource Specialist

I agree with the proposed conceptual design as it has been explained to me by the Palestine Lake Property Owners Association (PLPOA) and/or their representative, JFNew, and by the documentation they have provided. I agree that the conceptual design is feasible to me and that the PLPOA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

John M. Ingle _____ Signature

John M. Ingle _____ Printed Name

09/25/2009
Date

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JFNew
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Walkerton, Indiana

www.jfnew.com

May 27, 2009

Jerry and Lois Johnson
6894 S 200 W
Claypool, IN 46510

Dear Mr. and Mrs. Johnson:

After meeting with representatives from the Natural Resources Conservation Service (NRCS) and the Soil and Water Conservation District (SWCD) the wetland project that I had mentioned to you appears to qualify for one of their programs. Therefore, the wetland will not be included as part of the feasibility study. However, another potential project has been identified on a parcel located just east of 400 W and north of 550 S along the Cauffman drain.

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

Please sign the bottom of this letter either granting us access permission or denying us permission. The letter can be returned in the provided postage-paid envelope. We would like to have letters returned by June 12th, if possible. If we haven't received a notice one way or the other, JFNew or the PLPOA may follow-up with you. If you would like to be notified by phone prior to any assessment, please indicate the number that you may be contacted at during business hours.

I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

_X_ Yes, I grant permission to access my property

____ No, I do not grant permission to access my property

Lois Johnson X 574-566-2873
or cell: 574-268-4633

Lois Johnson (Printed Name)

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May 27, 2009

Todd and Janice Martin
4815 S 400 W
Claypool, IN 46510

Dear Mr. and Mrs. Martin:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just west of 400 W along the Cauffman Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

Please sign the bottom of this letter either granting us access permission or denying us permission. The letter can be returned in the provided postage-paid envelope. We would like to have letters returned by June 12th, if possible. If we haven't received a notice one way or the other, JFNew or the PLPOA may follow-up with you. If you would like to be notified by phone prior to any assessment, please indicate the number that you may be contacted at during business hours.

I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

X Yes, I grant permission to access my property

____ No, I do not grant permission to access my property

Todd Martin x

Todd D. MARTIN (Printed Name)

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May 27, 2009

Preston and Ashley Weed
5043 S 400 W
Claypool, IN 46510

Dear Mr. and Mrs. Weed:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just west of 400 W along the Cauffman Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

Please sign the bottom of this letter either granting us access permission or denying us permission. The letter can be returned in the provided postage-paid envelope. We would like to have letters returned by June 12th, if possible. If we haven't received a notice one way or the other, JFNew or the PLPOA may follow-up with you. If you would like to be notified by phone prior to any assessment, please indicate the number that you may be contacted at during business hours.

I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

___ Yes, I grant permission to access my property

___ No, I do not grant permission to access my property

Ashley B. Weed x

Ashley Weed (Printed Name)

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May 27, 2009

Robert and Ruth Voreis
6950 S 250 W
Claypool, IN 46510

Dear Mr. and Mrs. Voreis:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just east of 200 W and north of 700 S along the Cauffman Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

✓ Yes, I grant permission to access my property

___ No, I do not grant permission to access my property

Ruth Voreis x Robert Voreis

Ruth Voreis (Printed Name) Robert Voreis

5/31/09

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Madison, Wisconsin

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May 27, 2009

Thomas and Gail Shively
1698 W Maple Ln
Claypool, IN 46510

Dear Mr. and Mrs. Shively:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just east of 200 W along the Cauffman Drain at the southern portion of your property boundary. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

____ Yes, I grant permission to access my property

✓ No, I do not grant permission to access my property

Tom Shively x

Tom Shively (Printed Name)

JFNew
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Walkerton, Indiana 46574
Phone: 574-586-3400 ext. 325
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Native Plant Nursery:
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www.jfnew.com

May 27, 2009

Ronald and Kathryn Miller
6715 S 200 W
Claypool, IN 46510

Dear Mr. and Mrs. ~~Hoffman~~ Miller:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just west of 200 W along the Cauffman Drain which extends through your property. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

_X_ Yes, I grant permission to access my property

____ No, I do not grant permission to access my property

Ronald Miller x

_____ (Printed Name)

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May 27, 2009

David and Susan Vercauteren
6732 S 200 W
Claypool, IN 46510

Dear Mr. and Mrs. Vercauteren:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just east of 200 W along the Cauffman Drain at the southern portion of your property boundary. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

X Yes, I grant permission to access my property

____ No, I do not grant permission to access my property

Dave Vercauteren X

DAVE VERCAUTEREN (Printed Name)

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May 27, 2009

Roger and Carla Wagoner
10477 S Packerton Road
Claypool, IN 46510

Dear Mr. and Mrs. Wagoner:

After meeting with representatives from the Natural Resources Conservation Service (NRCS) and the Soil and Water Conservation District (SWCD) the wetland project that I had mentioned to you appears to qualify for one of their programs. Therefore, the wetland will not be included as part of the feasibility study. However, another potential project has been identified on a parcel located just south of the intersection of 100 W and 900 S along the Cauffman drain.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

X Yes, I grant permission to access my property

___ No, I do not grant permission to access my property

Roger Wagoner x

Roger Wagoner (Printed Name)

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Madison, Wisconsin

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Walkerton, Indiana

www.jfnew.com

May 27, 2009

Todd and Lisa Hoffman
5640 W 950 S
Silver Lake, IN 46982

Dear Mr. and Mrs. Hoffman:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just west of 100 W and North of 900 S along the Cauffman Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

X Yes, I grant permission to access my property

____ No, I do not grant permission to access my property

Todd Hoff X

Todd Hoffman (Printed Name)

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Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

May 27, 2009

Yeiter and Son Incorporated
7650 W Snyder Road
Warsaw, IN 46580

Dear Mr. Yeiter:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just west of 450 W and south of 350S along the Magee Robbins Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

There is no obligation on your part to participate. This letter is only meant to ask your permission to access your property. If you grant us permission, we would walk the property in June, assess whether or not a project to reduce nutrients and sediments is feasible, take some measurements necessary for design, and then develop some preliminary sketches for your review. If you agree with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the PLPOA and the Indiana Department of Natural Resources. The PLPOA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

X Yes, I grant permission to access my property

___ No, I do not grant permission to access my property

Larry Yeiter X

Larry YEITER (Printed Name)

574 252 9121

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Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

May 27, 2009

Ralph and Margaret Montel
3227 W 350 S
Warsaw, IN 46580

Dear Mr. and Mrs. Montel:

JFNew is an environmental consultant hired by the Palestine Lake Property Owners Association (PLPOA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Palestine Lake watershed. A preliminary review of the area around Palestine Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Palestine Lake. The specific parcel that is being considered is located just east of 450 W and south of 350S along the Magee Robbins Drain. Typically, projects will be funded by grant money the PLPOA receives through various state or federal programs.

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I can be contacted at the number above, email, or cell phone at (708) 833-0623 if you have any questions. Thank you for your consideration.

Tyson Edwards
Ecological Resource Specialist

____ Yes, I grant permission to access my property

X No, I do not grant permission to access my property

Ralph Montel x

RALPH MONTEL (Printed Name)

APPENDIX D

BANCS MODEL DATA
PALESTINE LAKE WATERSHED ENGINEEERING FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

Worksheet 3-13. Summary form of annual streambank erosion estimates for various study reaches.

Stream:				Location: Site 4			
Graph Used:		Total Bank Length (ft): 290				Date: 10/7/09	
Observers: TLE TBE			Valley Type:			Stream Type:	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	**BEHI rating (Worksheet 3-11) (adjective)**	**NBS rating (Worksheet 3-12) (adjective)**	**Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)**	**Length of bank (ft)**	**Study bank height (ft)**	**Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)**	**Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}**
1. 1	Very high	low	.25	85	6.5	138.13	0.08
2. 2	Very high	low	.25	75	5.5	103.13	0.07
3. 3	Extreme	low	.4	60	5	120	0.10
4. 4	Very high	Mod	.4	70	5.7	159.6	0.11
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	520.86	
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					**Total Erosion (yds^3/yr)**	19.29	
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}					**Total Erosion (tons/yr)**	25.08	
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					**Total Erosion (tons/yr/ft)**	0.09	

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:		Location:	Site 4
Station:	1 UPS Site	Observers:	TLE, TBE
Date:	10-7-09	Stream Type:	Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	6.5 (A)	Bankfull Height (ft) =	2.7 (B)	(A) / (B) =	2.4 (C)	8.5
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3 (D)	Study Bank Height (ft) =	6.5 (A)	(D) / (A) =	0.5 (E)	4
Weighted Root Density (G)						
		Root Density as % =	30 (F)	(F) x (E) =	15 (G)	8.5
Bank Angle (H)						
				Bank Angle as *Degrees* =	90 (H)	8
Surface Protection (I)						
				Surface Protection as % =	25 (I)	6.5

Bank 85'

Bank Material Adjustment:

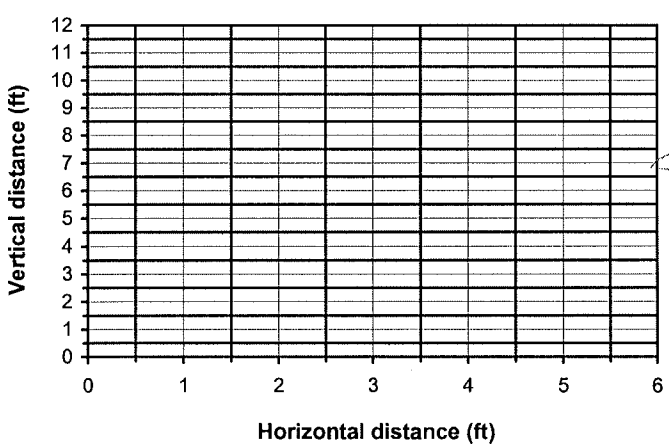
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

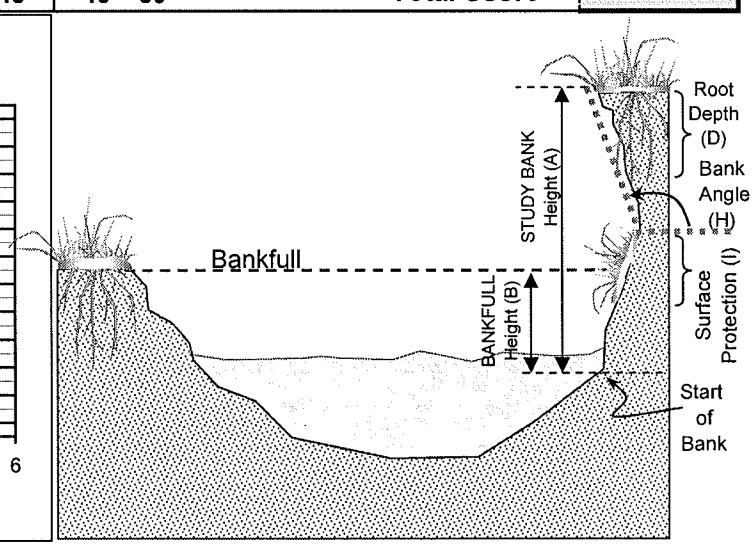
Bank Material Adjustment 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 5

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Very High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		45.5

Bank Sketch





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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:		Location:	
Station: Site 4 Location 1		Stream Type:	Valley Type:
Observers:			Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1)	Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
	Extensive deposition (continuous, cross-channel).....NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress: low

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	3.2	2.8	1.14	1.14

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: low

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:		Location:	
Station: Site 4 location 2		Observers: TLE TBE	
Date: 10/7/09	Stream Type:	Valley Type:	

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	5.5 (A)	Bankfull Height (ft) =	2 (B)	(A) / (B) =	2.75 (C)	9
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3 (D)	Study Bank Height (ft) =	5.5 (A)	(D) / (A) =	0.5 (E)	4
Weighted Root Density (G)						
		Root Density as % =	30 (F)	(F) × (E) =	15 (G)	6.5
Bank Angle (H)						
				Bank Angle as *Degrees* =	80 (H)	6
Surface Protection (I)						
				Surface Protection as % =	15 (I)	8.5

Bank Length 75'

Bank Material Adjustment:

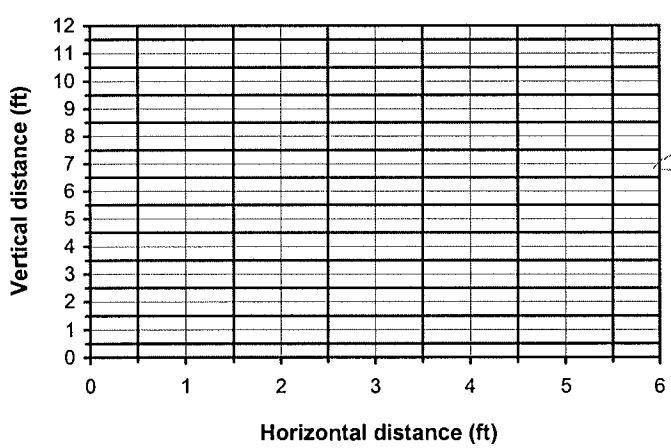
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

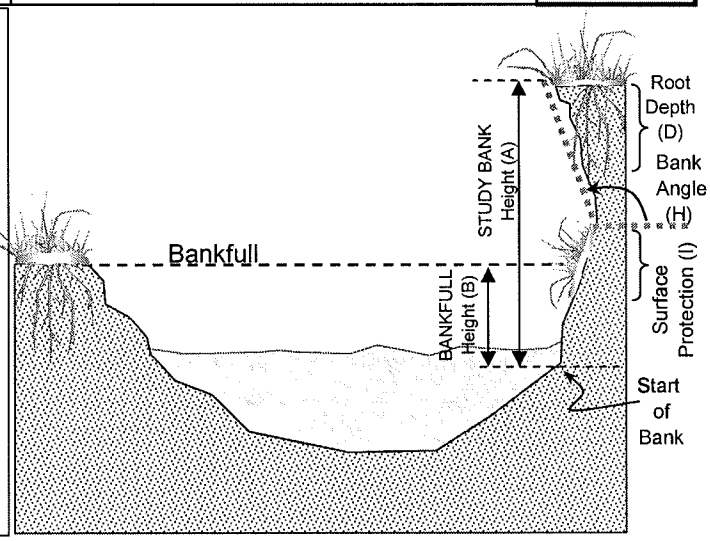
Bank Material Adjustment 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 5

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	Very High / 44

Bank Sketch





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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1) Transverse and/or central bars-shortand/or discontinuous.....	NBS = High / Very High
Extensive deposition (continuous, cross-channel).....	NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow.....	NBS = Extreme

Level II

(2) Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3) Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4) Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: Low

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
2	1.8	1.1	1.1

(6) Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7) Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:	Location:
Station: Site 4 location 3	Observers: TLE TBE
Date: 10/7/09 Stream Type:	Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	5 (A)	Bankfull Height (ft) =	2 (B)	(A) / (B) =	2.5 (C)	8.5
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	2.5 (D)	Study Bank Height (ft) =	5 (A)	(D) / (A) =	0.5 (E)	4
Weighted Root Density (G)						
Root Density as % =	30 (F)			(F) x (E) =	15 (G)	8.5
Bank Angle (H)						
Bank Angle as *Degrees* =	90 (H)					8
Surface Protection (I)						
Surface Protection as % =	15 (I)					8.5

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

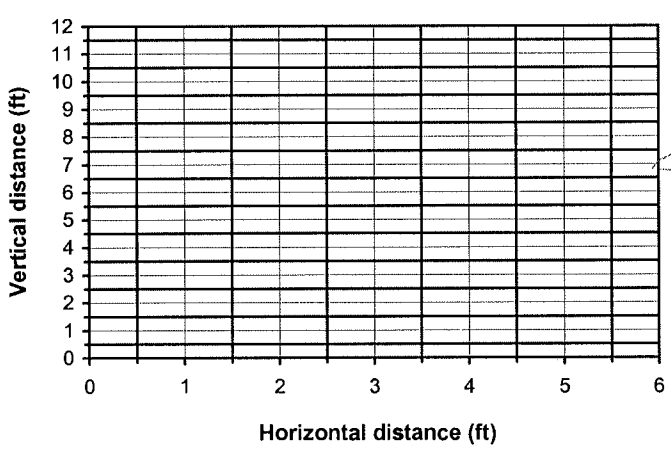
Bank Material Adjustment 5

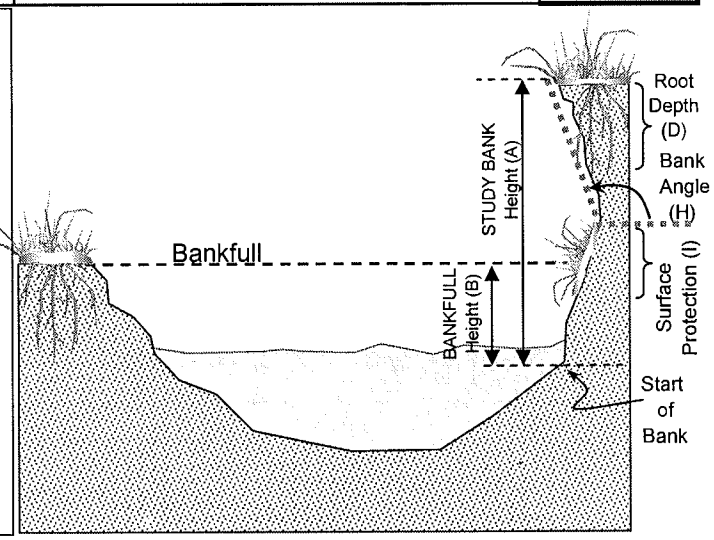
Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 5

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score** Extreme 47.5

Bank Sketch





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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:		Location: Site 4	
Station: #3		Stream Type:	Valley Type:
Observers: TLE TBE			Date: 10/7/09

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1)	Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
	Extensive deposition (continuous, cross-channel).....NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

(2) Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3) Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4) Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: low

Bank Length 60'

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
3	2.5	1.2	1.2

(6) Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7) Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:	Location:
Station: Site 4 location 4	Observers: TLE TBE
Date: 10/7/09 Stream Type:	Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	5.7 (A)	Bankfull Height (ft) =	2.2 (B)	(A) / (B) =	2.6 (C)	8.5
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3.5 (D)	Study Bank Height (ft) =	5.7 (A)	(D) / (A) =	0.6 (E)	3.5
Weighted Root Density (G)						
		Root Density as % =	15 (F)	(F) x (E) =	9 (G)	8.5
Bank Angle (H)						
				Bank Angle as *Degrees* =	80 (H)	6
Surface Protection (I)						
				Surface Protection as % =	10 (I)	9

Bank Material Adjustment:

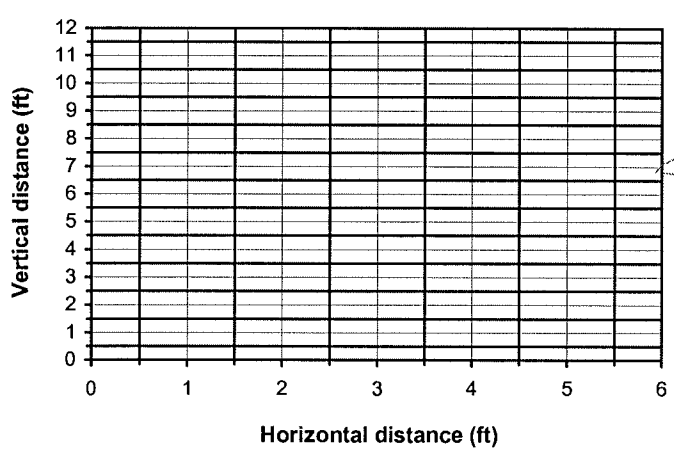
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

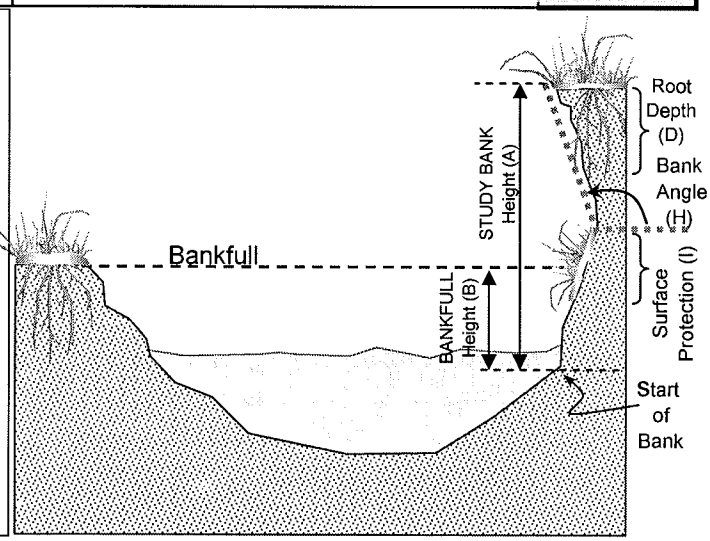
Bank Material Adjustment 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 5

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Very High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		45.5

Bank Sketch





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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:		Location:	
Station: Site 4 location 4		Stream Type:	Valley Type:
Observers:			Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1)	Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
	Extensive deposition (continuous, cross-channel).....NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress

Bank Length 70'

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	2.8	1.7	1.6	1.6

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating Moderate

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Worksheet 3-13. Summary form of annual streambank erosion estimates for various study reaches.

Stream: Cauffman Ditch				Location: Site 12			
Graph Used:		Total Bank Length (ft):				Date: 10/7/09	
Observers: TLE TBE			Valley Type:			Stream Type:	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	**BEHI rating (Worksheet 3-11) (adjective)**	**NBS rating (Worksheet 3-12) (adjective)**	**Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)**	**Length of bank (ft)**	**Study bank height (ft)**	**Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)**	**Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}**
1. 1	Moderate	Low	0.15	75	4	45	0.03
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	45	
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					**Total Erosion (yds^3/yr)**	1.67	
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}					**Total Erosion (tons/yr)**	2.17	
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					**Total Erosion (tons/yr/ft)**	0.03	

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream: Cauffman Ditch		Location:	
Station: Site 12		Observers: TLE TBE	
Date: 10/7/09	Stream Type:	Valley Type:	

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	4 (A)	Bankfull Height (ft) =	2.8 (B)	(A) / (B) =	1.4 (C)	5.5
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	.5 (D)	Study Bank Height (ft) =	4 (A)	(D) / (A) =	0.1 (E)	8.5
Weighted Root Density (G)						
		Root Density as % =	20 (F)	(F) × (E) =	2 (G)	9.5
Bank Angle (H)						
				Bank Angle as *Degrees* =	50 (H)	3.5
Surface Protection (I)						
				Surface Protection as % =	80 (I)	2

Bank length 75'

Bank Material Adjustment:

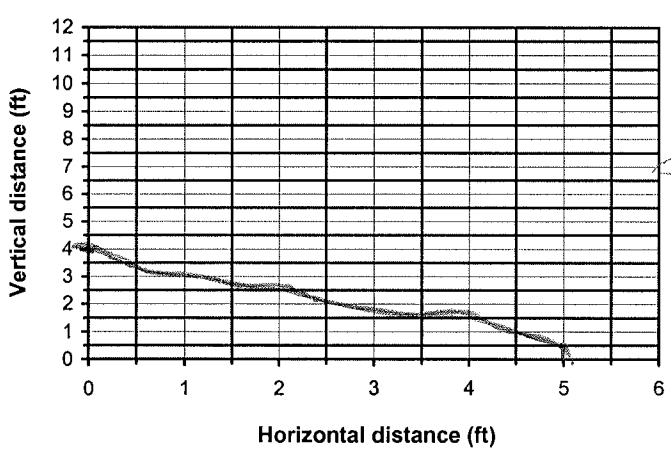
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

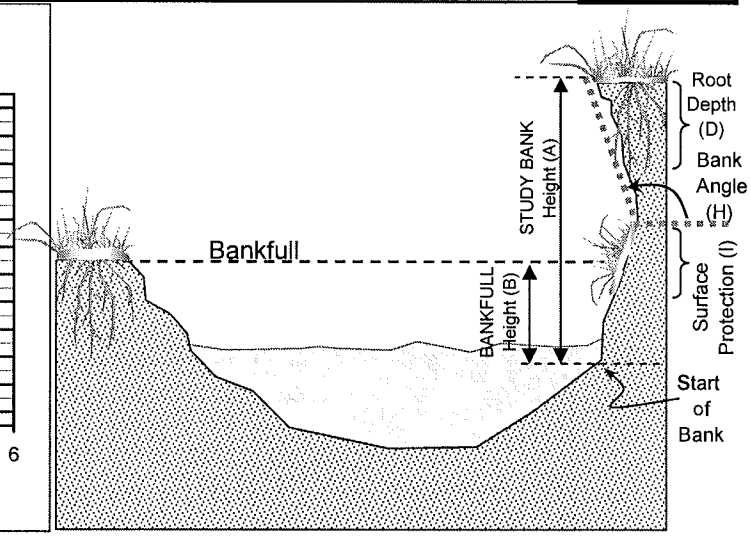
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	Moderate / 29

Bank Sketch





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Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Cauffman Location: Site 12

Station: Stream Type: Valley Type:

Observers: TLE TBE Date: 10/7/09

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1)	Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
	Extensive deposition (continuous, cross-channel).....NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress: Low

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	3.5	2.4	1.46	1.46

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

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3, 3.5, 2.5, 12, 1

Worksheet 3-13. Summary form of annual streambank erosion estimates for various study reaches.

Stream:				Location: Site 18			
Graph Used:		Total Bank Length (ft): 165				Date: 10-7-09	
Observers: TLE TBE			Valley Type:			Stream Type:	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	**BEHI rating (Worksheet 3-11) (adjective)**	**NBS rating (Worksheet 3-12) (adjective)**	**Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)**	**Length of bank (ft)**	**Study bank height (ft)**	**Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)**	**Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}**
1. 1	Very high	low	.25	65	6.8	110.5	0.08
2. 2	High	low	.25	100	9.8	245	0.12
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	355.5	
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					**Total Erosion (yds^3/yr)**	13.17	
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}					**Total Erosion (tons/yr)**	17.12	
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					**Total Erosion (tons/yr/ft)**	0.10	

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:		Location:	
Station: Site 18 #1		Observers:	
Date: 10-7-09	Stream Type:	Valley Type:	

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	6.8 (A)	Bankfull Height (ft) =	2.2 (B)	(A) / (B) =	3.1 (C)	9.5
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	2.5 (D)	Study Bank Height (ft) =	6.8 (A)	(D) / (A) =	.4 (E)	5
Weighted Root Density (G)						
Root Density as % =	5 (F)			(F) × (E) =	2 (G)	9.5
Bank Angle (H)						
Bank Angle as *Degrees* =	70 (H)					5
Surface Protection (I)						
Surface Protection as % =	5 (I)					10

Bank Material Adjustment:

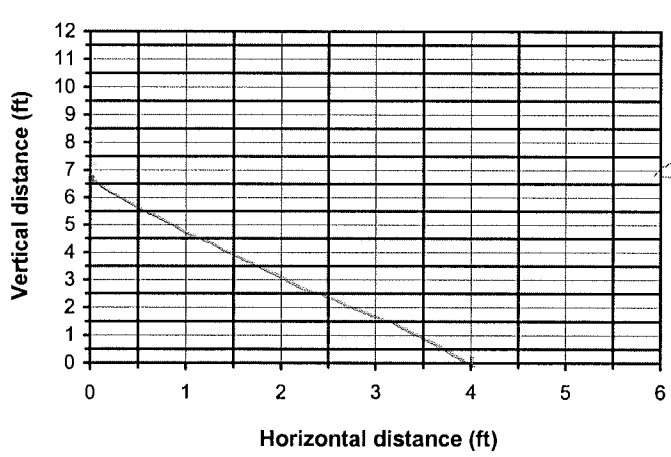
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

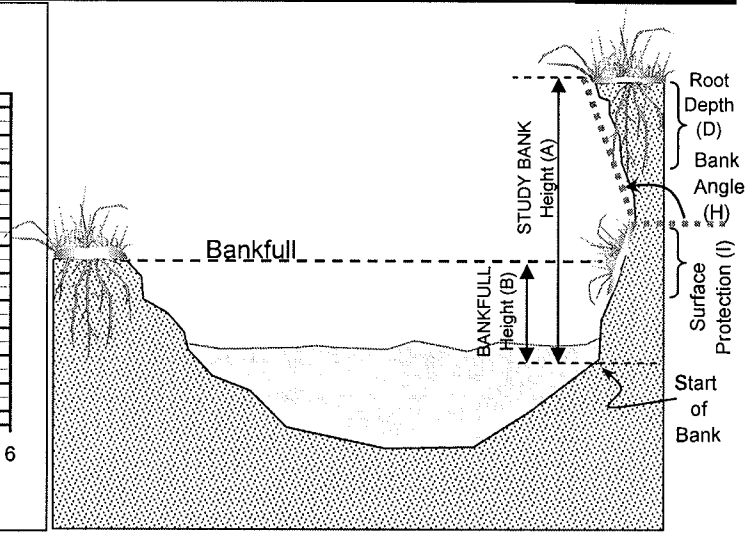
Bank Material Adjustment 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Very High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		44

Bank Sketch





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Bank length 65'

Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Site 18 Proj 3 Stream Type: Valley Type:

Observers: TBE + TLE Date: 10-7-09

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1) Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
Extensive deposition (continuous, cross-channel).....NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

(2) Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3) Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4) Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: Low

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
4.2	3.2	1.3	Low

(6) Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7) Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream: Site 18 #2 100 ft	Location:
Station:	Observers:
Date: TLE + TBE Stream Type:	Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	9.8 (A)	Bankfull Height (ft) =	2.6 (B)	(A) / (B) =	3.8 (C)	10
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	4.5 (D)	Study Bank Height (ft) =	9.8 (A)	(D) / (A) =	0.46 (E)	4
Weighted Root Density (G)						
Root Density as % =	10 (F)			(F) x (E) =	4.6% (G)	9
Bank Angle (H)						
Bank Angle as *Degrees* =	70 (H)					5
Surface Protection (I)						
Surface Protection as % =	50 (I)					4.5

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

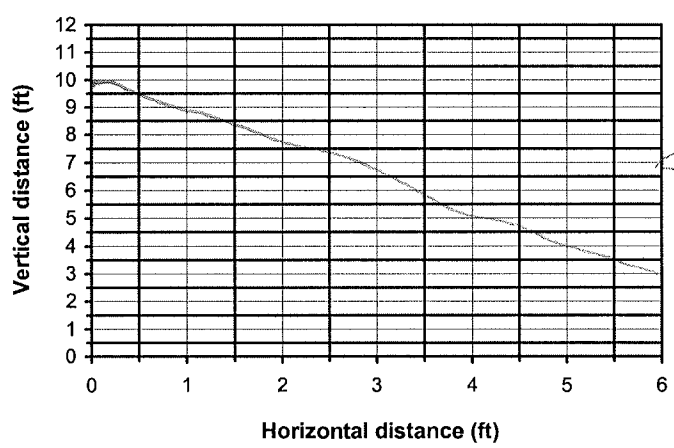
Bank Material Adjustment 5.

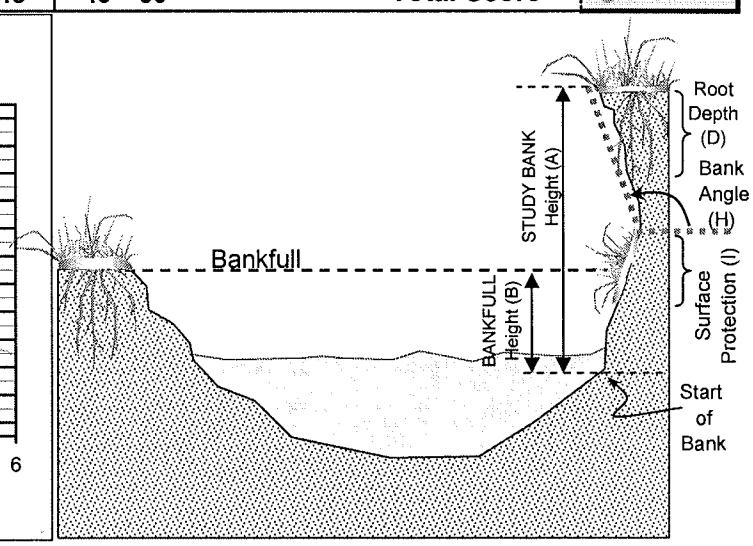
Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: High 37.5

Bank Sketch





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100 Ft Bank length

Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Site 18 A1	Location:	
Station:	Stream Type:	Valley Type:
Observers: TLE + TBE		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S).....	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1)	Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
	Extensive deposition (continuous, cross-channel).....NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

(2) Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3) Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4) Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: low

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
3.9	3.9	1	1

(6) Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7) Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

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Worksheet 3-13. Summary form of annual streambank erosion estimates for various study reaches.

Stream:				Location: Site 21 B			
Graph Used:		Total Bank Length (ft): 180				Date: 10/7/09	
Observers: TLE TBE			Valley Type:			Stream Type:	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	**BEHI rating (Worksheet 3-11) (adjective)**	**NBS rating (Worksheet 3-12) (adjective)**	**Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)**	**Length of bank (ft)**	**Study bank height (ft)**	**Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)**	**Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}**
1. 1	Very high	Low	0.25	180	6.3	283.5	0.08
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	283.5	
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}					**Total Erosion (yds^3/yr)**	10.5	
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}					**Total Erosion (tons/yr)**	13.65	
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}					**Total Erosion (tons/yr/ft)**	0.08	

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Worksheet 3-11. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating. Use **Figure 3-7** with BEHI variables to determine BEHI score.

Stream:		Location:	21 B
Station:		Observers:	TLE TBE
Date:	10-7-09	Stream Type:	Valley Type:

						BEHI Score (Fig. 3-7)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	6.3 (A)	Bankfull Height (ft) =	1.6 (B)	(A) / (B) =	3.9 (C)	10
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3 (D)	Study Bank Height (ft) =	6.3 (A)	(D) / (A) =	0.5 (E)	4
Weighted Root Density (G)						
		Root Density as % =	10 (F)	(F) × (E) =	5 (G)	9.5
Bank Angle (H)						
				Bank Angle as *Degrees* =	70 (H)	5
Surface Protection (I)						
				Surface Protection as % =	10 (I)	9

Bank Material Adjustment:

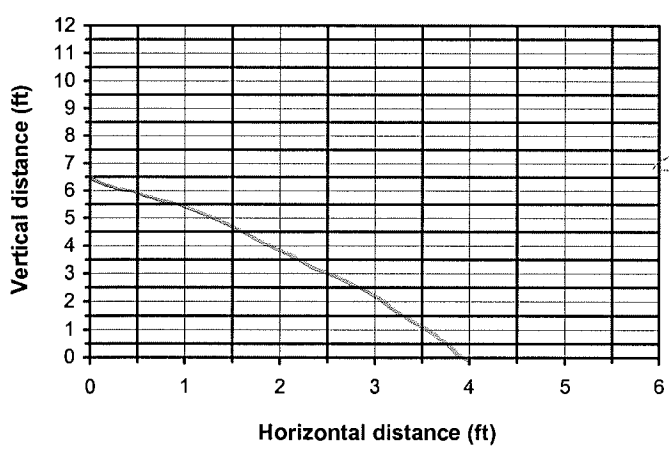
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

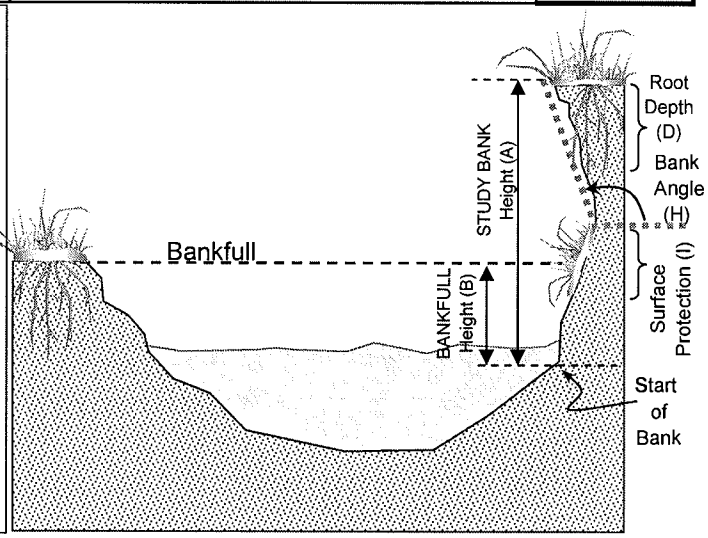
Bank Material Adjustment 5

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		Very high 42.5

Bank Sketch





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Length 180 ft

Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location: 218

Station: Stream Type: Valley Type:

Observers: TLE/BE Date: 10/7/08

Methods for Estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS.....	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf}).....	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p/ S).....	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif}).....	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb}/τ_{bkf}).....	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient.....	Level IV	Validation

Level I

(1) Transverse and/or central bars-shortand/or discontinuous.....NBS = High / Very High
Extensive deposition (continuous, cross-channel).....NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow.....NBS = Extreme

Level II

(2) Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3) Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4) Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: Low

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
2	1.8	1.11	1.11

(6) Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7) Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

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APPENDIX E

QHEI DATA
PALESTINE LAKE WATERSHED ENGINEEERING FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	bioSample #	Stream Name	Location
		Cauffman Drain	Site 4

Surveyor	Sample Date	County	Macro SampleType	Habitat Complete	QHEI Score:
TLE, TBE	10-7-09	Kosciusko		☐	54.5

1-Substrate (20 points maximum)

Substrate Score: 13.5

Check 1 Predominant Pool & 1 Predominant Riffle

Check all that are present — P=Pool, R=Riffle

Predominant P	Predominant R		Present P	Present R	Predominant P	Predominant R		Present P	Present R
☐	☐	Bldrs/Slabs(10)	☐	☐	☐	☐	Hardpan(4)	☐	☐
☐	☐	Boulders(9)	☐	☐	☐	☐	Detritus(3)	☐	☐
☐	☐	Cobble(8)	☐	☐	☐	☐	Muck(2)	☐	☐
☐	☒	Gravel(7)	☐	☐	☐	☐	Silt(2)	☐	☐
☒	☐	Sand(6)	☐	☐	☐	☐	Sludge(1)	☐	☐
☐	☐	Bedrock(5)	☐	☐	☐	☐	Artificial(0)	☐	☐

Substrate Quality (check only 1, or check 2 and AVERAGE)

Substrate Origin

☐ Limestone(1)	☐ Hardpan(0)	☐ Lacustrine(0)
☒ Tills(1)	☐ Sandstone(0)	☐ Shale(-1)
☐ Wetlands(0)	☐ Rip/Rap(0)	☐ Coal fines(-2)

Silt Cover	Embeddedness
☐ Silt heavy(-2)	☐ Extensive(-2)
☐ Silt moderate(-1)	☒ Moderate(-1)
☒ Silt normal(0)	☒ Low/Normal(0)
☐ Silt free(1)	☐ None(1)

NOTE: ignore sludge originating from point sources; score based on natural substrates

☐ >4 substrates present(2)

Comments:

2-Instream Cover (20 points maximum

Instream Cover Score: 8

Type (check ALL that apply)

☐ Undercut banks(1)	☐ Deep pools(2)	☐ Oxbows(1)
☐ Overhanging vegetation(1)	☒ Rootwads(1)	☐ Aquatic macrophytes(1)
☒ Shallows(in slow water)(1)	☐ Boulders(1)	☒ Logs and woody debris(1)
☐ Rootmats(1)		

Amount (check only 1, or 2 and AVERAGE)

☐ Extensive >75% (11)
☒ Moderate 25-75% (7)
☒ Sparse 5-25% (3)
☐ Nearly absent <5% (1)

Comments:

3-Channel Morphology (20) (check only one per category, OR two and AVERAGE)

Channel Score: 12

Sinuosity	Development	Channelization	Stability	Modifications/Other	
☐ High (4)	☐ Excellent (7)	☐ None (6)	☐ High (3)	☐ Snagging	☐ Impound
☐ Moderate (3)	☒ Good (5)	☒ Recovered (4)	☒ Moderate (2)	☐ Relocation	☐ Islands
☒ Low (2)	☒ Fair (3)	☐ Recovering (3)	☐ Low (1)	☐ Canopy Removal	☐ Leveed
☐ None (1)	☐ Poor (1)	☐ Recent or no recovery (1)		☐ Dredging	☐ Bank shaping
				☐ One side channel modifications	

Comments:

4-Riparian Zone & Bank Erosion (10 points maximum)

Riparian Score: 6

Left/Right banks looking downstream (For each category, check only one per bank, OR two per bank and AVERAGE).

Riparian width L	R	(per bank)	Erosion/Runoff-Floodplain quality (past 100 ft Riparian) L	R	(most predominant per bank)	L	R		Bank Erosion L	R	(per bank)
☐	☐	Wide >50m (4)	☒	☐	Forest, Swamp (3)	☐	☐	Conservation Tillage (1)	☐	☐	None or little (3)
☒	☐	Moderate 10-50m (3)	☐	☐	Shrub or Old field (2)	☐	☐	Urban or Industrial (0)	☒	☒	Moderate (2)
☐	☐	Narrow 5-10m (2)	☐	☒	Residential, Park, New field (1)	☐	☐	Mining, Construction (0)	☐	☐	Heavy/Severe (1)
☐	☒	Very narrow <5m (1)	☐	☐	Fenced pasture (1)	☐	☐	Open Pasture/Rowcrop (0)			
☐	☐	None (0)									

Comments:

5a-Pool/Glide Quality (12 points maximum

Pool/Glide Score: 5

Max pool depth (check one)	Morphology (check only one, OR check two and AVERAGE)	Pool/Run/Riffle current velocity (check all that apply)	
☐ >1m (6)	☐ Pool width > riffle width (2)	☐ Eddies (1)	☐ Torrential (-1)
☐ 0.7-1m (4)	☐ Pool width = riffle width (1)	☒ Fast (1)	☐ Interstitial (-1)
☒ 0.4-0.7m (2)	☒ Pool width < riffle width (0)	☒ Moderate (1)	☐ Intermittent (-2)
☐ 0.2-0.4m (1)		☒ Slow (1)	☐ No pool (0)
☐ <0.2m (pool=0)			

Comments:

5b-Riffle/Run Quality (8) (check only one per category, OR two and AVERAGE)

Riffle/Run Score: 4

Riffle/run depth (check one)	Riffle/run substrate	Riffle/run embeddedness	
☐ Generally>10cm, Max>50cm (4)	☐ Stable-e.g. cobble, boulder (2)	☐ Extensive (-1)	☒ Normal/Low (1)
☒ Generally>10cm, Max<50cm(3)	☐ Mod. stable-e.g. pea gravel (1)	☐ Moderate (0)	☐ None (2)
☐ Generally 5-10cm (1)	☒ Unstable-e.g. sand, gravel (0)		☐ No riffle (0)
☐ Generally<5cm (riffle=0)			

Comments:

6-Gradient (10 points maximum)

Gradient Score: 6

Average width: 12 Gradient: 6.5 (ft/mile) Drainage Area: 6.6 (square miles)

Comments:

Width 12
BFW = 18

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	bioSample #	Stream Name	Location

Surveyor	Sample Date	County	Macro SampleType	☐ Habitat Complete	QHEI Score:

Impacts/Miscellaneous

Major Suspected Impacts (Check all that apply)

- ☐ None
- ☐ Industrial
- ☐ WWTP
- ☒ Agricultural
- ☐ Livestock
- ☐ Silviculture
- ☐ Construction
- ☐ Urban Runoff
- ☐ Suburban
- ☐ Channelization
- ☒ Riparian Removal
- ☐ Flow Alteration
- ☐ CSOs
- ☐ Mining
- ☐ Landfills
- ☐ Natural

Pollution Impact Comments:

Miscellaneous QHEI Information

Subjective rating (1-10):
Aesthetic rating (1-10):
Canopy Cover (% Open):

% Riffle:
% Run:
% Glide:
% Pool:

Is reach representative of stream? Yes

General QHEI Notes:

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample # | bioSample # | Stream Name | Location: Canfman Ditch Site 12

Surveyor | Sample Date | County: TLE, TBA 11-7-09 Kosciusko | Macro SampleType | ☐ Habitat Complete | **QHEI Score:** 22.75

1-Substrate (20 points maximum)

Substrate Score: 8

Check 1 Predominant Pool & 1 Predominant Riffle

Check all that are present — P=Pool, R=Riffle

Predominant P	Predominant R		Present P	Present R	Predominant P	Predominant R		Present P	Present R
☐	☐	Bldrs/Slabs(10)	☐	☐	☐	☐	Hardpan(4)	☐	☐
☐	☐	Boulders(9)	☐	☐	☐	☐	Detritus(3)	☐	☐
☐	☐	Cobble(8)	☐	☐	☐	☐	Muck(2)	☐	☐
☐	☐	Gravel(7)	☐	☐	☒	☐	Silt(2)	☐	☒
☐	☒	Sand(6)	☒	☐	☐	☐	Sludge(1)	☐	☐
☐	☐	Bedrock(5)	☐	☐	☐	☐	Artificial(0)	☐	☐

Substrate Quality (check only 1, or check 2 and AVERAGE)

Substrate Origin: ☐ Limestone(1) ☐ Hardpan(0) ☐ Lacustrine(0) ☒ Tills(1) ☐ Sandstone(0) ☐ Shale(-1) ☐ Wetlands(0) ☐ Rip/Rap(0) ☐ Coal fines(-2)

Silt Cover: ☐ Silt heavy(-2) ☒ Silt moderate(-1) ☐ Silt normal(0) ☐ Silt free(1)

Embeddedness: ☐ Extensive(-2) ☐ Moderate(-1) ☒ Low/Normal(0) ☐ None(1)

NOTE: ignore sludge originating from point sources; score based on natural substrates

☐ >4 substrates present(2)

Comments:

2-Instream Cover (20 points maximum

Instream Cover Score: 1

Type (check ALL that apply): ☐ Undercut banks(1) ☐ Deep pools(2) ☐ Oxbows(1) ☐ Overhanging vegetation(1) ☐ Rootwads(1) ☐ Aquatic macrophytes(1) ☐ Shallows(in slow water)(1) ☐ Boulders(1) ☐ Logs and woody debris(1) ☐ Rootmats(1)

Amount (check only 1, or 2 and AVERAGE): ☐ Extensive >75% (11) ☐ Moderate 25-75% (7) ☐ Sparse 5-25% (3) ☒ Nearly absent <5% (1)

Comments:

3-Channel Morphology (20) (check only one per category, OR two and AVERAGE)

Channel Score: 7

Sinuosity	Development	Channelization	Stability	Modifications/Other	
☐ High (4)	☐ Excellent (7)	☐ None (6)	☐ High (3)	☐ Snagging	☐ Impound
☐ Moderate (3)	☐ Good (5)	☐ Recovered (4)	☐ Moderate (2)	☐ Relocation	☐ Islands
☒ Low (2)	☐ Fair (3)	☒ Recovering (3)	☒ Low (1)	☐ Canopy Removal	☐ Leveed
☐ None (1)	☒ Poor (1)	☐ Recent or no recovery (1)		☐ Dredging	☒ Bank shaping
					☐ One side channel modifications

Comments:

4-Riparian Zone & Bank Erosion (10 points maximum)

Riparian Score: 3.75

Left/Right banks looking downstream (For each category, check only one per bank, OR two per bank and AVERAGE).

Riparian width (per bank): ☐ ☐ Wide >50m (4) ☐ ☐ Moderate 10-50m (3) ☐ ☐ Narrow 5-10m (2) ☒ ☒ Very narrow <5m (1) ☐ ☐ None (0)

Erosion/Runoff-Floodplain quality (past 100 ft Riparian) (most predominant per bank): ☐ ☐ Forest, Swamp (3) ☐ ☐ Shrub or Old field (2) ☐ ☒ Residential, Park, New field (1) ☐ ☐ Fenced pasture (1) ☐ ☐ Conservation Tillage (1) ☐ ☐ Urban or Industrial (0) ☐ ☐ Mining, Construction (0) ☒ ☐ Open Pasture/Rowcrop (0)

Bank Erosion (per bank): ☐ ☒ None or little (3) ☒ ☐ Moderate (2) ☐ ☐ Heavy/Severe (1)

Comments:

5a-Pool/Glide Quality (12 points maximum

Pool/Glide Score: 0

Max pool depth (check one): ☐ >1m (6) ☐ 0.7-1m (4) ☐ 0.4-0.7m (2) ☐ 0.2-0.4m (1) ☒ <0.2m (pool=0)

Morphology (check only one, OR check two and AVERAGE): ☐ Pool width > riffle width (2) ☐ Pool width = riffle width (1) ☒ Pool width < riffle width (0)

Pool/Run/Riffle current velocity (check all that apply): ☐ Eddies (1) ☐ Fast (1) ☐ Moderate (1) ☐ Slow (1) ☐ Torrential (-1) ☐ Interstitial (-1) ☐ Intermittent (-2) ☒ No pool (0)

Comments:

5b-Riffle/Run Quality (8) (check only one per category, OR two and AVERAGE)

Riffle/Run Score: 0

Riffle/run depth (check one): ☐ Generally>10cm, Max>50cm (4) ☐ Generally>10cm, Max<50cm(3) ☐ Generally 5-10cm (1) ☒ Generally<5cm (riffle=0)

Riffle/run substrate: ☐ Stable-e.g. cobble, boulder (2) ☐ Mod. stable-e.g. pea gravel (1) ☒ Unstable-e.g. sand, gravel (0)

Riffle/run embeddedness: ☐ Extensive (-1) ☐ Moderate (0) ☐ Normal/Low (1) ☐ None (2) ☒ No riffle (0)

Comments:

6-Gradient (10 points maximum)

Gradient Score: 10

Average width: 7' *Gradient:* 16.1 *(ft/mile)* *Drainage Area:* 2.4 *(square miles)*

Comments:

BFW = 15'
Wetted = 6-7'

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	bioSample #	Stream Name	Location

Surveyor	Sample Date	County	Macro SampleType	☐ Habitat Complete	QHEI Score:

Impacts/Miscellaneous

Major Suspected Impacts (Check all that apply)

- ☐ None
- ☐ Industrial
- ☐ WWTP
- ☒ Agricultural
- ☐ Livestock
- ☐ Silviculture
- ☐ Construction
- ☐ Urban Runoff
- ☐ Suburban
- ☒ Channelization
- ☒ Riparian Removal
- ☐ Flow Alteration
- ☐ CSOs
- ☐ Mining
- ☐ Landfills
- ☐ Natural

Pollution Impact Comments:

Miscellaneous QHEI Information

Subjective rating (1-10):
Aesthetic rating (1-10): 3
Canopy Cover (% Open): 100

% Riffle:
% Run:
% Glide:
% Pool:

Is reach representative of stream? Yes

General QHEI Notes:

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample # | bioSample # | Stream Name | Location: Site 18

Surveyor: JBK | Sample Date: 10/7/09 | County: Kosciusko | Macro SampleType | ☐ Habitat Complete | QHEI Score: 44

1-Substrate (20 points maximum)

Substrate Score: 11

Check 1 Predominant Pool & 1 Predominant Riffle

Check all that are present — P=Pool, R=Riffle

Predominant P	Predominant R		Present P	Present R	Predominant P	Predominant R		Present P	Present R
☐	☐	Bldrs/Slabs(10)	☐	☐	☐	☐	Hardpan(4)	☐	☐
☐	☐	Boulders(9)	☐	☐	☐	☐	Detritus(3)	☐	☐
☐	☐	Cobble(8)	☐	☐	☐	☐	Muck(2)	☐	☐
☒	☐	Gravel(7)	☐	☐	☐	☐	Silt(2)	☐	☐
☐	☒	Sand(6)	☒	☐	☐	☐	Sludge(1)	☐	☐
☐	☐	Bedrock(5)	☐	☐	☐	☐	Artificial(0)	☐	☐

Substrate Quality (check only 1, or check 2 and AVERAGE)

Substrate Origin: ☐ Limestone(1) ☐ Hardpan(0) ☐ Lacustrine(0) ☒ Tills(1) ☐ Sandstone(0) ☐ Shale(-1) ☐ Wetlands(0) ☐ Rip/Rap(0) ☐ Coal fines(-2)

Silt Cover: ☐ Silt heavy(-2) ☒ Silt moderate(-1) ☐ Silt normal(0) ☐ Silt free(1)

Embeddedness: ☒ Extensive(-2) ☐ Moderate(-1) ☐ Low/Normal(0) ☐ None(1)

NOTE: ignore sludge originating from point sources; score based on natural substrates

☐ >4 substrates present(2)

Comments:

2-Instream Cover (20 points maximum

Instream Cover Score: 1

Type (check ALL that apply) 0

☐ Undercut banks(1) ☐ Deep pools(2) ☐ Oxbows(1)
☐ Overhanging vegetation(1) ☐ Rootwads(1) ☐ Aquatic macrophytes(1)
☐ Shallows(in slow water)(1) ☐ Boulders(1) ☐ Logs and woody debris(1)
☐ Rootmats(1)

Amount (check only 1, or 2 and AVERAGE)

☐ Extensive >75% (11)
☐ Moderate 25-75% (7)
☐ Sparse 5-25% (3)
☒ Nearly absent <5% (1)

Comments:

3-Channel Morphology (20) (check only one per category, OR two and AVERAGE)

Channel Score: 9

Sinuosity	Development	Channelization	Stability	Modifications/Other	
☐ High (4)	☐ Excellent (7)	☐ None (6)	☐ High (3)	☐ Snagging	☐ Impound
☐ Moderate (3)	☐ Good (5)	☒ Recovered (4)	☒ Moderate (2)	☐ Relocation	☐ Islands
☒ Low (2)	☐ Fair (3)	☐ Recovering (3)	☐ Low (1)	☐ Canopy Removal	☐ Leveed
☐ None (1)	☒ Poor (1)	☐ Recent or no recovery (1)		☐ Dredging	☐ Bank shaping
				☐ One side channel modifications	

Comments:

4-Riparian Zone & Bank Erosion (10 points maximum)

Riparian Score: 7

Left/Right banks looking downstream (For each category, check only one per bank, OR two per bank and AVERAGE).

Riparian width (per bank)

L	R	
☐	☒	Wide >50m (4)
☐	☐	Moderate 10-50m (3)
☐	☐	Narrow 5-10m (2)
☒	☐	Very narrow <5m (1)
☐	☐	None (0)

Erosion/Runoff-Floodplain quality (past 100 ft Riparian) (most predominant per bank)

L	R	
☐	☒	Forest, Swamp (3)
☐	☐	Shrub or Old field (2)
☒	☐	Residential, Park, New field (1)
☐	☐	Fenced pasture (1)

L	R	
☐	☐	Conservation Tillage (1)
☐	☐	Urban or Industrial (0)
☐	☐	Mining, Construction (0)
☐	☐	Open Pasture/Rowcrop (0)

Bank Erosion (per bank)

L	R	
☐	☒	None or little (3)
☒	☐	Moderate (2)
☐	☐	Heavy/Severe (1)

Comments:

5a-Pool/Glide Quality (12 points maximum

Pool/Glide Score: 6

Max pool depth (check one)
☐ >1m (6)
☒ 0.7-1m (4)
☐ 0.4-0.7m (2)
☐ 0.2-0.4m (1)
☐ <0.2m (pool=0)

Morphology (check only one, OR check two and AVERAGE)
☐ Pool width > riffle width (2)
☒ Pool width = riffle width (1)
☐ Pool width < riffle width (0)

Pool/Run/Riffle current velocity (check all that apply)
☐ Eddies (1) ☐ Torrential (-1)
☐ Fast (1) ☐ Interstitial (-1)
☐ Moderate (1) ☐ Intermittent (-2)
☒ Slow (1) ☐ No pool (0)

Comments:

5b-Riffle/Run Quality (8) (check only one per category, OR two and AVERAGE)

Riffle/Run Score: 0

Riffle/run depth (check one)
☐ Generally>10cm, Max>50cm (4)
☐ Generally>10cm, Max<50cm(3)
☐ Generally 5-10cm (1)
☒ Generally<5cm (riffle=0)

Riffle/run substrate
☐ Stable-e.g. cobble, boulder (2)
☐ Mod. stable-e.g. pea gravel (1)
☒ Unstable-e.g. sand, gravel (0)

Riffle/run embeddedness
☐ Extensive (-1) ☐ Normal/Low (1)
☐ Moderate (0) ☐ None (2)
☒ No riffle (0)

Comments:

6-Gradient (10 points maximum)

Gradient Score: 10

Average width: 15 Gradient: 6.5 (ft/mile) Drainage Area: 10.4 (square miles)

Comments:

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	bioSample #	Stream Name	Location
		SHC 18	

Surveyor	Sample Date	County	Macro SampleType	☐ Habitat Complete	QHEI Score:

Impacts/Miscellaneous

Major Suspected Impacts (Check all that apply)

- ☐ None
- ☐ Industrial
- ☐ WWTP
- ☒ Agricultural
- ☐ Livestock
- ☐ Silviculture
- ☐ Construction
- ☐ Urban Runoff
- ☐ Suburban
- ☐ Channelization
- ☐ Riparian Removal
- ☐ Flow Alteration
- ☐ CSOs
- ☐ Mining
- ☐ Landfills
- ☐ Natural

Pollution Impact Comments:

Miscellaneous QHEI Information

Subjective rating (1-10):
Aesthetic rating (1-10): 4
Canopy Cover (% Open): 40

% Riffle:
% Run:
% Glide:
% Pool:

Is reach representative of stream? YES

General QHEI Notes:

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample # | bioSample # | Stream Name | Location: Sur 21 B

Surveyor: TBE | Sample Date: 10-7-09 | County: Roscinsko | Macro SampleType | ☐ Habitat Complete

QHEI Score: 43.5

1-Substrate (20 points maximum)

Substrate Score: 12

Check 1 Predominant Pool & 1 Predominant Riffle

Check all that are present — P=Pool, R=Riffle

Predominant P	Predominant R		Present P	Present R		Predominant P	Predominant R		Present P	Present R
☐	☐	Bldrs/Slabs(10)	☐	☐		☒	☐	Hardpan(4)	☐	☐
☐	☐	Boulders(9)	☐	☐		☐	☐	Detritus(3)	☐	☐
☐	☐	Cobble(8)	☐	☐		☐	☐	Muck(2)	☐	☐
☐	☒	Gravel(7)	☐	☐		☐	☐	Silt(2)	☒	☐
☐	☐	Sand(6)	☒	☒		☐	☐	Sludge(1)	☐	☐
☐	☐	Bedrock(5)	☐	☐		☐	☐	Artificial(0)	☐	☐

Substrate Quality (check only 1, or check 2 and AVERAGE)

Substrate Origin: ☐ Limestone(1) ☐ Hardpan(0) ☐ Lacustrine(0) ☒ Tills(1) ☐ Sandstone(0) ☐ Shale(-1) ☐ Wetlands(0) ☐ Rip/Rap(0) ☐ Coal fines(-2)

Silt Cover: ☐ Silt heavy(-2) ☐ Silt moderate(-1) ☒ Silt normal(0) ☐ Silt free(1)

Embeddedness: ☐ Extensive(-2) ☐ Moderate(-1) ☒ Low/Normal(0) ☐ None(1)

NOTE: ignore sludge originating from point sources; score based on natural substrates

☐ >4 substrates present(2)

Comments:

2-Instream Cover (20 points maximum

Instream Cover Score: 4

Type (check ALL that apply)

☐ Undercut banks(1) ☐ Deep pools(2) ☐ Oxbows(1)
☐ Overhanging vegetation(1) ☐ Rootwads(1) ☐ Aquatic macrophytes(1)
☐ Shallows(in slow water)(1) ☐ Boulders(1) ☒ Logs and woody debris(1)
☐ Rootmats(1)

Comments:

Amount (check only 1, or 2 and AVERAGE)

☐ Extensive >75% (11)
☐ Moderate 25-75% (7)
☒ Sparse 5-25% (3)
☐ Nearly absent <5% (1)

3-Channel Morphology (20) (check only one per category, OR two and AVERAGE)

Channel Score: 9

Sinuosity	Development	Channelization	Stability	Modifications/Other	
☐ High (4)	☐ Excellent (7)	☐ None (6)	☐ High (3)	☐ Snagging	☐ Impound
☐ Moderate (3)	☐ Good (5)	☒ Recovered (4)	☐ Moderate (2)	☐ Relocation	☐ Islands
☒ Low (2)	☒ Fair (3)	☐ Recovering (3)	☒ Low (1)	☐ Canopy Removal	☐ Leveed
☐ None (1)	☒ Poor (1)	☐ Recent or no recovery (1)		☐ Dredging	☐ Bank shaping
				☐ One side channel modifications	

Comments:

4-Riparian Zone & Bank Erosion (10 points maximum)

Riparian Score: 5.5

Left/Right banks looking downstream (For each category, check only one per bank, OR two per bank and AVERAGE).

Riparian width L	Riparian width R	(per bank)	Erosion/Runoff-Floodplain quality (past 100 ft Riparian) L	R	(most predominant per bank)	L	R		Bank Erosion L	R	(per bank)
☒	☐	Wide >50m (4)	☒	☐	Forest, Swamp (3)	☐	☐	Conservation Tillage (1)	☐	☐	None or little (3)
☐	☐	Moderate 10-50m (3)	☐	☐	Shrub or Old field (2)	☐	☐	Urban or Industrial (0)	☒	☐	Moderate (2)
☐	☒	Narrow 5-10m (2)	☐	☒	Residential, Park, New field (1)	☐	☐	Mining, Construction (0)	☐	☒	Heavy/Severe (1)
☐	☐	Very narrow <5m (1)	☐	☐	Fenced pasture (1)	☐	☐	Open Pasture/Rowcrop (0)			
☐	☐	None (0)									

Comments:

5a-Pool/Glide Quality (12 points maximum

Pool/Glide Score: 5

Max pool depth (check one)

☐ >1m (6)
☐ 0.7-1m (4)
☒ 0.4-0.7m (2)
☐ 0.2-0.4m (1)
☐ <0.2m (pool=0)

Morphology (check only one, OR check two and AVERAGE)

☐ Pool width > riffle width (2)
☐ Pool width = riffle width (1)
☒ Pool width < riffle width (0)

Pool/Run/Riffle current velocity (check all that apply)

☐ Eddies (1) ☐ Torrential (-1)
☒ Fast (1) ☐ Interstitial (-1)
☒ Moderate (1) ☐ Intermittent (-2)
☒ Slow (1) ☐ No pool (0)

Comments:

5b-Riffle/Run Quality (8) (check only one per category, OR two and AVERAGE)

Riffle/Run Score: 2

Riffle/run depth (check one)

☐ Generally>10cm, Max>50cm (4)
☐ Generally>10cm, Max<50cm(3)
☒ Generally 5-10cm (1)
☐ Generally<5cm (riffle=0)

Riffle/run substrate

☐ Stable-e.g. cobble, boulder (2)
☒ Mod. stable-e.g. pea gravel (1)
☐ Unstable-e.g. sand, gravel (0)

Riffle/run embeddedness

☐ Extensive (-1) ☐ Normal/Low (1)
☒ Moderate (0) ☐ None (2)
☐ No riffle (0)

Comments:

6-Gradient (10 points maximum)

Gradient Score: 6

Average width: 10' Gradient: 9.9 (ft/mile) Drainage Area: 2.7 (square miles)

Comments:

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	bioSample #	Stream Name	Location
			Site 21 B

Surveyor	Sample Date	County	Macro SampleType	☐ Habitat Complete	QHEI Score:
TBE					

Impacts/Miscellaneous

Major Suspected Impacts (Check all that apply)

- ☐ None
- ☐ Industrial
- ☐ WWTP
- ☒ Agricultural
- ☐ Livestock
- ☐ Silviculture
- ☐ Construction
- ☐ Urban Runoff
- ☐ Suburban
- ☐ Channelization
- ☐ Riparian Removal
- ☐ Flow Alteration
- ☐ CSOs
- ☐ Mining
- ☐ Landfills
- ☐ Natural

Pollution Impact Comments:

Miscellaneous QHEI Information

Subjective rating (1-10):

Aesthetic rating (1-10): 2

Canopy Cover (% Open): 50

% Riffle: 70

% Run: 10

% Glide: 10

% Pool: 10

Is reach representative of stream?

General QHEI Notes:

APPENDIX F

EARLY COORDINATION REVIEW REQUEST
PALESTINE LAKE WATERSHED ENGINEEERING FEASIBILITY REPORT
KOSCIUSKO COUNTY, INDIANA

JFNew

JFNew
Full-Service Ecological Solutions™

708 Roosevelt Rd
Walkerton, Indiana 46574
Phone: 574-586-3400
Fax: 574-586-3446

Tyson Edwards
Ecological Resource Specialist
tedwards@jfnew.com
Mobile: 708-833-0623

Corporate Office:
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Chicago, Illinois

Indianapolis, Indiana

Ann Arbor, Michigan

Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

October 22, 2009

Paul Hauser
USACE, Detroit District
2422 Viridian Drive, Ste 101
South Bend, IN 46628

RE: Early coordination for proposed water quality improvement projects

Dear Mr. Hauser,

The Palestine Lake Property Owners Association (PLPOA) is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in the Palestine Lake watershed in Kosciusko County. Five of the proposed projects may require regulatory permits based on the conceptual designs. As part of the feasibility study, PLPOA is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Project locations are described below and in the project description. All projects are located in Kosciusko County, IN.

Project 1 – Miller Property, Clay Township 31 N Range 6 E Section 17

Project 2 – Wagoner Property, Lake Township 31 N Range 6 E Section 33

Project 3 – Weed Property, Seward Township 31 N Range 5 E Sections 12

Project 5 – Weaver Property, Harrison Township 32 N Range 5 E Sections 33

Project 7 – Knoop Property, Clay Township 31 N Range 6 E Sections 22

Construction would be funded by grants over several years. Additionally, a portion of the projects would likely have separate and independent permit applicants due to the location of the projects.

Please review and provide your comments about the projects to be included in the final draft of the feasibility study. Comments may be submitted directly to me at the address provided on the left hand side of the letter or via email at tedwards@jfnew.com. We would appreciate your comments by December 15, 2009.

Sincerely,

Tyson Edwards

CC: JFN 060849.01

JFNew
Full-Service Ecological Solutions™

708 Roosevelt Rd
Walkerton, Indiana 46574
Phone: 574-586-3400
Fax: 574-586-3446

Tyson Edwards
Ecological Resource Specialist
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Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

October 22, 2009

Elizabeth Pelloso
Indiana Department of Environmental Management
401 Water Quality Section
WQ 65-42
100 N. Senate Ave.
Indianapolis, IN 46204-2251

RE: Early coordination for proposed water quality improvement projects

Dear Ms. Pelloso,

The Palestine Lake Property Owners Association (PLPOA) is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in the Palestine Lake watershed in Kosciusko County. Five of the proposed projects may require regulatory permits based on the conceptual designs. As part of the feasibility study, PLPOA is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Project locations are described below and in the project description. All projects are located in Kosciusko County, IN.

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Project 7 – Knoop Property, Clay Township 31 N Range 6 E Sections 22

Construction would be funded by grants over several years. Additionally, a portion of the projects would likely have separate and independent permit applicants due to the location of the projects.

Please review and provide your comments about the projects to be included in the final draft of the feasibility study. Comments may be submitted directly to me at the address provided on the left hand side of the letter or via email at tedwards@jfnew.com. We would appreciate your comments by December 15, 2009.

Sincerely,

Tyson Edwards

CC: JFN 060849.01

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Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

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October 22, 2009

Indiana Department of Natural Resources
Christie Stanifer, Environmental Coordinator
402 West Washington St, Room W264
Indianapolis, IN 46204-2641

RE: Early coordination for proposed water quality improvement projects

Dear Ms. Stanifer,

The Palestine Lake Property Owners Association (PLPOA) is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in the Palestine Lake watershed in Kosciusko County. Five of the proposed projects may require regulatory permits based on the conceptual designs. As part of the feasibility study, PLPOA is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Project locations are described below and in the project description. All projects are located in Kosciusko County, IN.

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Project 2 – Wagoner Property, Lake Township 31 N Range 6 E Section 33

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Project 7 – Knoop Property, Clay Township 31 N Range 6 E Sections 22

Construction would be funded by grants over several years. Additionally, a portion of the projects would likely have separate and independent permit applicants due to the location of the projects.

Please review and provide your comments about the projects to be included in the final draft of the feasibility study. Comments may be submitted directly to me at the address provided on the left hand side of the letter or via email at tedwards@jfnew.com. We would appreciate your comments by December 15, 2009.

Sincerely,

Tyson Edwards

CC: JFN 060849.01

Tyson Edwards

From: Jones, Miriam R [MiJones@dnr.IN.gov]
Sent: Friday, November 06, 2009 11:04 AM
To: Tyson Edwards
Subject: ER#14458- Kosciusko County

Dear Mr. Edwards:

This is a standard informational email in response to your request for an Environmental Review, which was received on October 26, 2009 for the following project:

Proposed water quality improvement projects(Miller, Wagoner, Weed, Weaver, and Knoop properties); LARE feasibility study.

We would like you to know that the review is in process and a formal response will be forthcoming. Please refer to the ER number in the subject line on all future correspondence regarding this project.

If you have any questions or comments, please contact myself or Christie Stanifer at cstanifer@dnr.in.gov, or at the numbers below.

Miriam R. Jones
Environmental Secretary
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Palestine Lake, Lake and River Enhancement (LARE) Program Engineering Feasibility Study Project Descriptions

Background

Within the Palestine Lake watershed, eight locations for water quality improvement projects have been identified. Five of the sites require early coordination from regulatory agencies because they involve activities that fall within one or more agencies' jurisdiction. The five sites are all in Kosciusko County. The Miller, Wagoner, Weed and Knoop projects are located along the Caufman Drain while the Weaver project is located on the Magee-Robbins Drain. Both of these drains are maintained under the Kosciusko Surveyor's office. Four of these projects are intended to stabilize the streambanks by using a variation of techniques including the installation of a stone toe, bank reshaping, and grade control structures. One project is proposed to enhance a wetland to provide storage and stormwater treatment. The feasibility of constructing these projects is being investigated by JFNew and the Palestine Lake Property Owners Association as part of a grant from the IDNR LARE program. Figure 1 displays the general locations of the project areas.

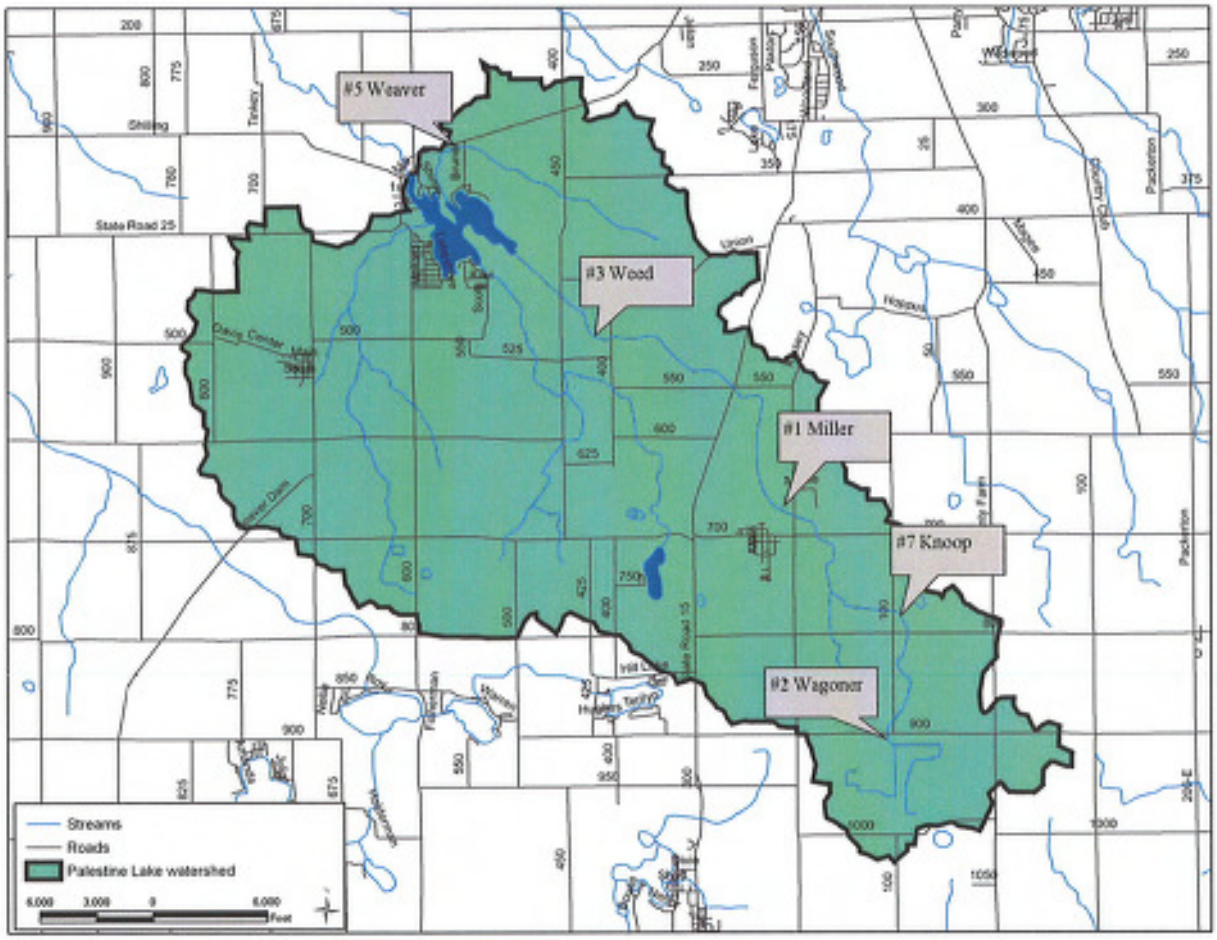

Figure 1. Location of potentially feasible projects in the Palestine Lake watershed.

Detailed below is a description of the existing site and information about the proposed project. For consistency between the feasibility report and the early coordination process, the project numbers assigned in the report are also referenced here. Projects 4, 6, and 8 in the feasibility report do not require regulatory permits; therefore, they are not included here.

We request written comments on the proposed conceptual designs as they pertain to your agency's jurisdiction. Your comments will be documented in the feasibility report. Based on your feedback, specific items or concepts for a particular project may be adjusted to obtain regulatory approval, if necessary.

Project #1 – Miller – Bank Stabilization and Grade Control
Project #1 is located on the property of Ronald Miller and Warsaw Community Schools on the west side of 200W and northeast of Claypool, IN. The Cauffman Drain (Ring Ditch) drains 7,286 acres of the Palestine Lake watershed and drains directly into Palestine Lake. Erosion of the stream banks is caused by peak stormwater discharge from the surrounding agricultural areas.

Re-slope and re-vegetate streambank: Several sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket. A stone toe approximately 2.5 ft wide by 3 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 255 feet of streambank located in four sections along Cauffman Drain. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. One grade control structure is proposed to be installed at approximately 200 ft downstream of the 200 W Road crossing.

Figure 1: Plan View
Project #1-Miller Property
Palestine Lake Association
Kosciusko County, IN

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060849.01

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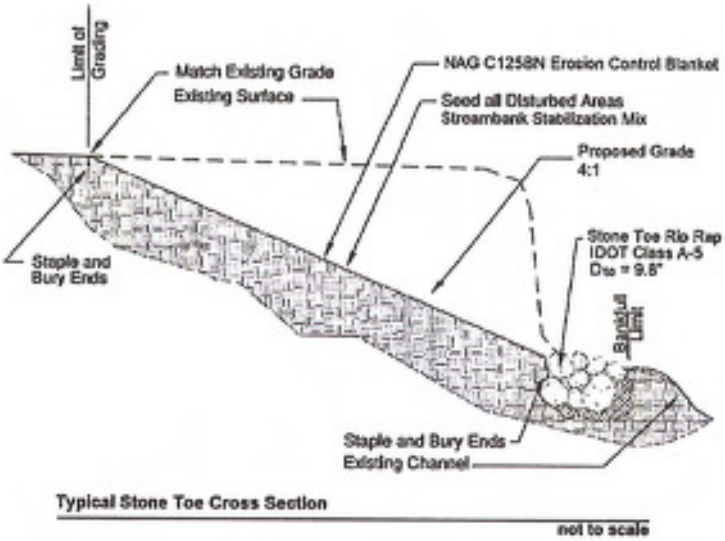
Proposed site for stone toe and reshaping banks on south side of stream.



Proposed site for stone toe and reshaping banks on north side of stream.

Proposed site for grade control structure, 200 feet downstream of culvert.

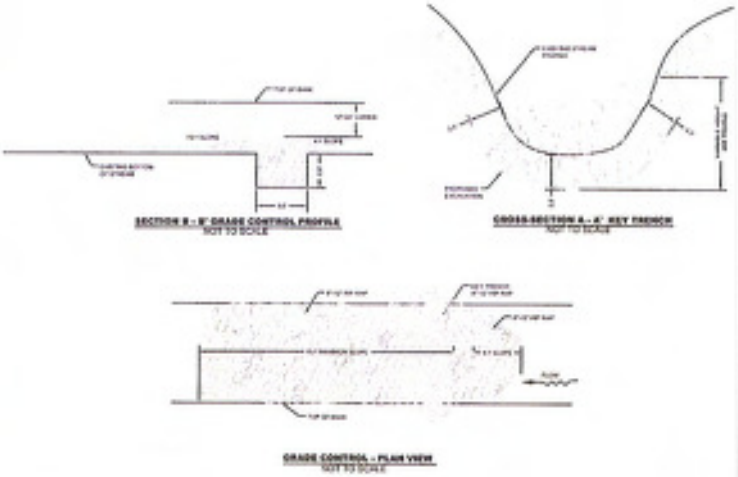


Figure 2: Site Photos and Examples
Project #1-Miller Property
Palestine Lake Association
Kosciusko County, IN

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Project #2 – Wagoner – Bank Stabilization

Project #1 is located on the property of Roger Wagoner just south of the intersection of 900S and 100W on the Cauffman Drain in Kosciusko County, IN. Bank erosion and sedimentation were occurring on the corner of the stream where a minimal buffer exists along the adjacent agricultural field.

Re-slope and re-vegetate streambank: The proposed solution is to reshape the banks, install a stone toe, and re-seed with a native slope stabilization seed mix covered with an erosion control blanket. A stone toe approximately 2.5 ft by 2 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 75 feet of streambank located along Cauffman Drain. Construction would commence after crop harvest to minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

Figure 1: Plan View
Project #2-Wagoner Property
Palestine Lake Association
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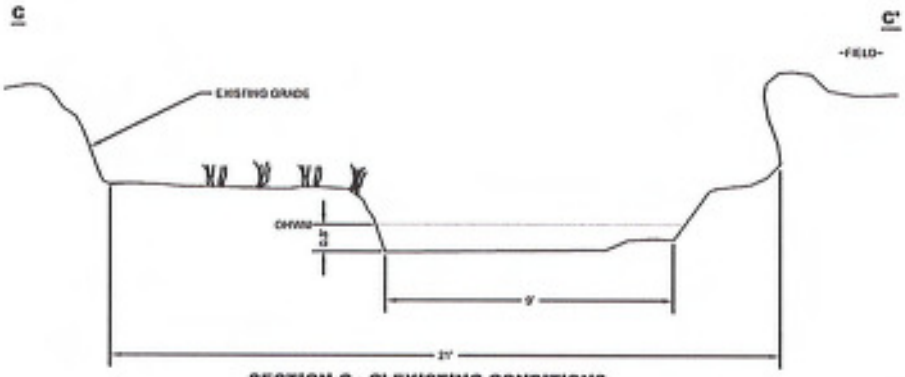
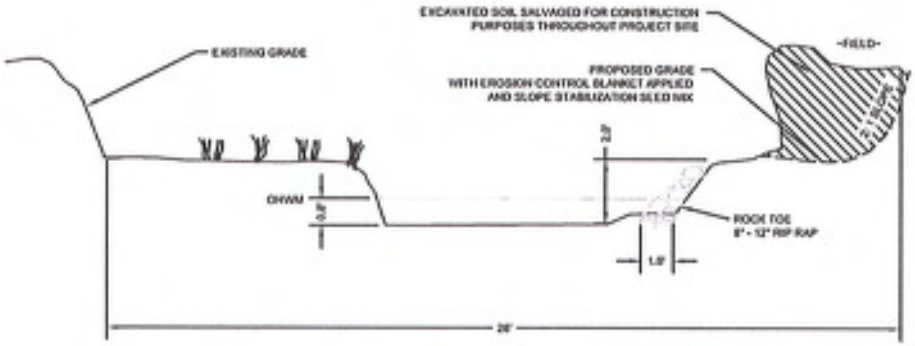
Proposed project site at corner of ditch

Example of stone toe installation with shelf



SECTION C - C' EXISTING CONDITIONS
NOT TO SCALE



SECTION C - C' PROPOSED GRADE / STABILIZATION
NOT TO SCALE

Typical design of regrading and installation of stone toe

Figure 2: Site Photos and Examples
Project #2-Wagoner Property
Palestine Lake Association
Kosciusko County, IN

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Project #3 – Weed – Bank Stabilization, Rock Chute, and Grade Control
Project #3 is located on the property of Preston Weed just north of the intersection of 525S and 400W on the Cauffman Drain in Kosciusko County, IN. Severe bank erosion and undercutting are occurring within this section of the Cauffman Drain.

Re-slope and re-vegetate streambank: Two sections of streambank show signs of active erosion and banks with a slope of 1:1 or greater. The proposed solution is to reshape the banks, re-seed with native plants, and install erosion control blanket. A stone toe approximately 2.5 ft by 3 ft high would be installed at the base of the bank to prevent undercutting. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 165 feet of streambank located in two sections along Cauffman Drain. Precautions would be made to stabilize existing trees and minimize disturbance. Excavated bank material would be graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. Three grade control structures are proposed to be installed at approximately 100 ft, 300 ft, and 500 ft downstream of the 400 W Road crossing.

Rock Chute: A small area was identified where concentrated surface runoff enters the stream and is eroding the streambank. To halt the erosion in this section, a rock chute is proposed. A rock chute consists of a geo-textile fabric underlayment with 8"-12" of 6" stone to armor the streambank during the periods of surface runoff. The area is approximately 10' by 25'.

Figure 1: Plan View
Project #3-Weed Property
Palestine Lake Association
Kosciusko County, IN

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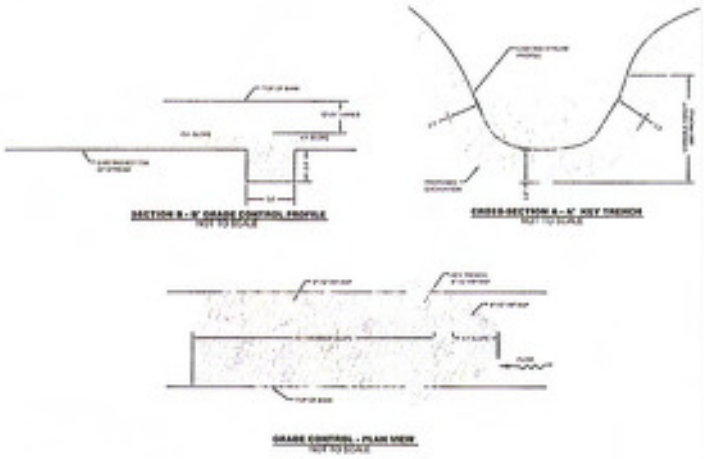
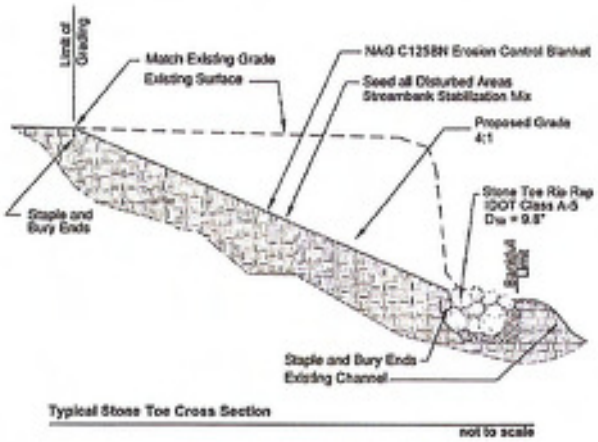
Possible location for grade control structure.

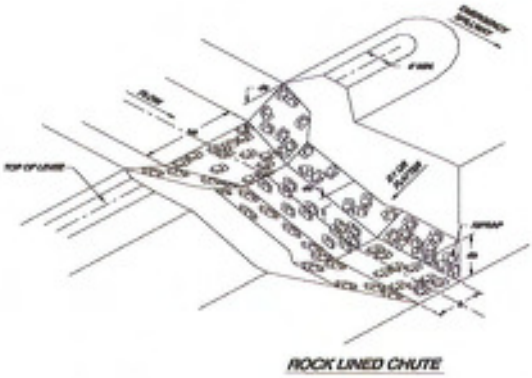


Typical grade control structure design.

Left downstream bank showing steep bank with erosion.



Area proposed for stabilization with rock chute.



Typical of rock chute.

Figure 2: Site Photos and Examples
Project #3-Weed Property
Palestine Lake Association
Kosciusko County, IN

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Project #5 – Weaver – Bank Stabilization and Grade Control

Project #5 is located on the property of James Weaver immediately downstream of Bruner Road on the Magee-Robbins Drain in Kosciusko County, IN. Severe bank erosion and undercutting are occurring within this section of the Magee-Robbions Drain.

Re-slope and re-vegetate north streambank: The existing north streambank shows signs of active erosion and a bank with a slope of 1:1 or greater. The proposed solution is to re-slope the bank to a 4:1 slope, re-seed with native plants, and install erosion control blanket. The native plants can have roots up to ten feet which will help to stabilize the bank and provide a buffer for filtering stormwater runoff. The proposed project site consists of approximately 180' of streambank beginning immediately downstream of the culvert under Bruner Road. Approximately 650 cubic yards of bank material will be removed and placed in adjacent uplands and graded to blend in with the existing grade.

Grade Control Structures: These structures are comprised of stone with an average diameter of 6" and are designed to effectively raise the bed elevation of the stream channel. By controlling or reducing the grade of the stream, the reduction in velocity will reduce the erosive potential of the water against the banks, thereby decreasing bank undercutting and removing the sources of in-stream derived sediment. Three grade control structures are proposed to be installed at 100 ft, 200 ft, and 300 ft downstream of the Bruner Road crossing.

Figure 1: Plan View
Project #5-Weaver Property
Palestine Lake Association
Kosciusko County, IN

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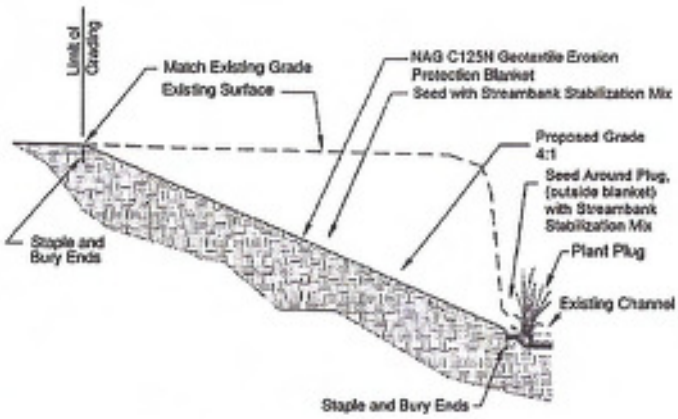
North bank just downstream of culvert showing steep bank with erosion.

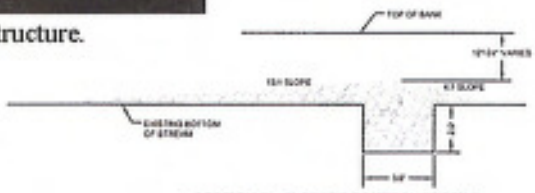


Typical Plug Toe Protection
Cross Section

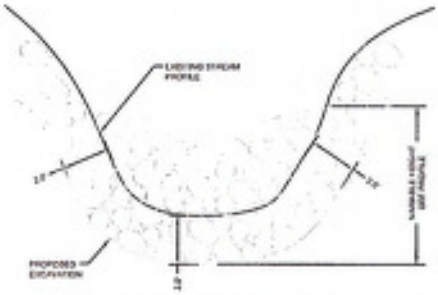
not to scale

Typical of streambank stabilization technique proposed for this section.

Possible location for grade control structure.



SECTION B - B' GRADE CONTROL PROFILE
NOT TO SCALE



CROSS-SECTION A - A' KEY TRENCH
NOT TO SCALE

Typical grade control structure design.

GRADE CONTROL - PLAN VIEW
NOT TO SCALE

Figure 2: Site Photos and Examples
Project #5-Weaver Property
Palestine Lake Association
Kosciusko County, IN

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Project #7 – Knoop – Bank Stabilization and Grade Control

Project #7 is located on the property of Gilbert Knoop, which is located just to the east of Cauffman Drain (Trimble Creek) and north of 800S in Kosciusko County, IN. The project consists of installing two earthen berms approximately 200ft and 300ft in length with water level control structures to enhance the existing wetland and provide storage and treatment of stormwater runoff from adjacent agricultural land. Existing tiles within the wetland will be dismantled to improve the hydrology within the restored wetland.

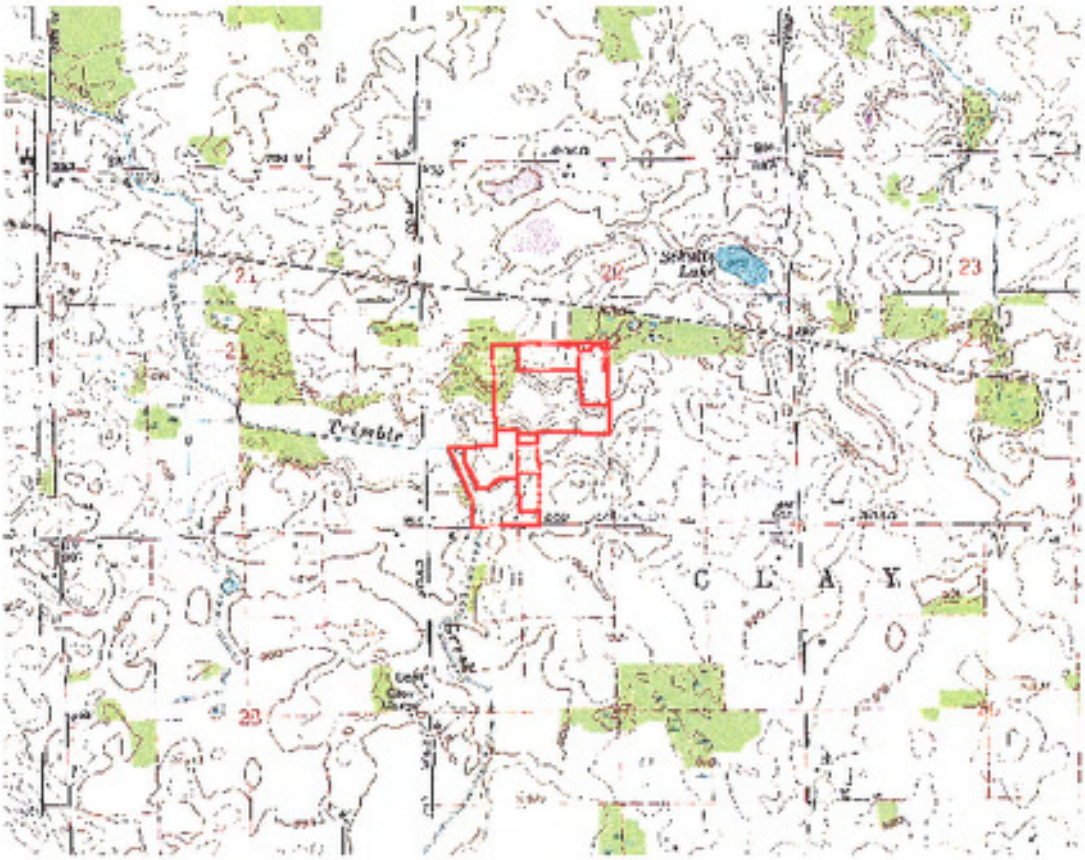


Figure 1. Location of Gilbert Knoop Property

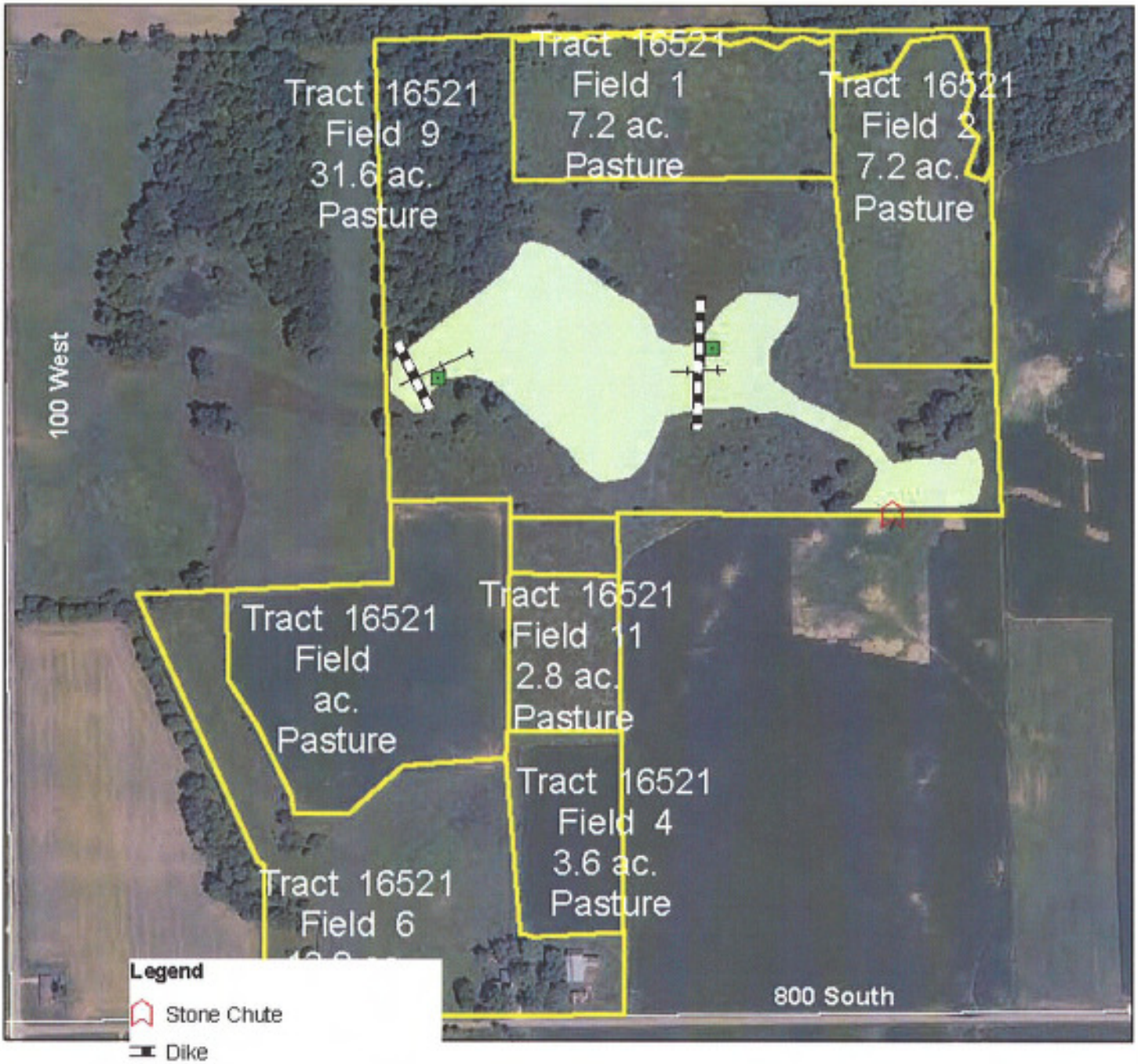
Wetland Restoration Plan Map

Date: 2/20/2009

Customer(s): GILBERT KNOOP

Field Office: WARSAW SERVICE CENTER
Agency: USDA-NRCS
Assisted By: St Clair, Samuel E

Legal Description: T 16521



Legend

- Stone Chute
- Dike
- Water Level Control Structure
- Tile Break
- WRP 09
- Hydric#1
- WRP
- Roads in085

240 0 240 480 720 960 Feet

N