Blue Lake Engineering Feasibility Study

Whitley County, Indiana

May 14, 2008

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BLUE LAKE WATERSHED ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

EXECUTIVE SUMMARY

The Blue Lake Association (BLA) received an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) grant to complete an engineering feasibility study. The goal of the study was to identify feasible projects. This was accomplished as follows: JFNew analyzed potential project sites where sources of pollution may exist, suggested projects that may address pollution, and examined the feasibility of project design and construction. 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.

This study examined the feasibility of five projects within the Blue Lake watershed. The identified or potential projects are: wetland restoration along Maloney Ditch; shoreline stabilization along the two islands and peninsula on the east end of Blue Lake; streambank stabilization along an unnamed tributary on the southeastern corner of Blue Lake; sediment detention basin creation near an agriculture field just south of the residential area along Blue Lake road; and bank stabilization and old pond wetland restoration along an unnamed tributary on the south side of Blue Lake. The wetland restoration project site was not feasible due to lack of access at this time. Therefore, no designs or cost estimates for this project were completed. The shoreline stabilization project involves approximately 715 linear feet of shoreline bioengineering at an estimated cost of $57,320. The streambank stabilization project consists of the installation of three rock grade controls and one cross valley control dam structure. The design and construction of these streambank stabilization projects can be completed at an estimated cost of $8,800 and $68,750, respectively. The scope of the sediment detention basin project was reduced and consists of installation of a rock-lined chute at an estimated cost of $2,640. At the former pond site, two feasible options to protect and improve water quality exist. Option 1 is the installation of a grade control structure to stabilize the bed of upstream basin at the point where the dam or embankment was previously breached. Option 2 involves the removing the existing embankment, reconstructing it, and installing a standpipe and rock spillway to create temporary stormwater storage. The estimated cost of Option 1 is $8,850 while the estimated cost of Option 2 is $27,060. Of the five projects studied, four were deemed feasible with the wetland restoration project being the only one infeasible due to denial of access from the landowner.

Although the wetland restoration project was not deemed feasible at this time due to the circumstances, preliminary review of maps and topographic features indicate that this project might be feasible in the future. If the use of the land or owners of the property changes in the future, this wetland restoration project should be revisited.

It is recommended that the Blue Lake Association apply for a LARE grant for the design and construction of the shoreline stabilization and rock-lined chute projects in 2008 with work to continue through 2009. The Blue Lake Association should then plan to apply for a LARE grant for the design and construction of the rock grade controls and cross valley control dam structure in 2009 with work to continue through 2010. After the Blue Lake Association determines which option they want to pursue, the design and construction of the project at former pond site should occur via grant application and funding in 2010.

ACKNOWLEDGEMENTS

The Indiana Department of Natural Resources Division of Fish and Wildlife Lake and River Enhancement Program and the Blue Lake Association funded this feasibility study. JFNew documented available historical information, assessed project feasibility and environmental impact, and developed opinions of probable cost for the feasible projects identified throughout the watershed. Marc Shoda and Jerry McClure of the Blue Lake Association provided initiative and assistance in getting this study completed. Special thanks are due to Richard Kyler of the Whitley County Soil and Water Conservation District office; Amy Lybarger of the Whitley County Natural Resources Conservation Service office; and Doug Nusbaum with the IDNR LARE program for their assistance in identifying feasible projects and contacting landowners regarding this project. Thanks to the Blue Lake Association members for support and watershed landowners for their assistance. Contributors to this project include Sara Peel, Wayne Stanger, Mark Pranckus, Betsy Ewoldt, Aaron Johnson, Tyson Edwards, and John Richardson with JFNew.

TABLE OF CONENTS

PAGE

1.0 Introduction 1
1.1 Background 1
1.2 Scope of Study 1
1.3 Goals and Objectives 3

2.0 Description of Study Area 3
2.1 Location 3
2.2 Geologic History and Topography 6
2.3 Soils 7
2.4 Land Use 9
2.5 Historical and Existing Watershed-wide Water Quality Improvement Projects 11
2.6 Prior Studies 11

3.0 Potential Water Quality Improvement Projects 12

4.0 Project Review 13
4.1 Wetland Restoration Site 1 13
4.2 Island Shoreline Stabilization Site 2 15
4.3 Bank Stabilization Site 3 24
4.4 Sediment Basin-Rock Chute Site 4 34
4.5 Bank Stabilization and Old Pond Restoration Site 5 38

5.0 Recommendations 45

6.0 Literature Cited 47

TABLE OF FIGURES

PAGE

Figure 1. Engineering feasibility study project locations 2
Figure 2. General location of the Blue Lake watershed 3
Figure 3. Blue Lake watershed 4
Figure 4. Blue Lake subwatersheds 5
Figure 5. Topographical map of the Blue Lake watershed 7
Figure 6. Soil associations in the Blue Lake watershed 8
Figure 7. Highly erodible and potentially erodible soils in the Blue Lake watershed 9
Figure 8. Land use in the Blue Lake watershed 10
Figure 9. Approximate locations of historical water quality improvement projects 11
Figure 10. Potential wetland restoration site upstream of Cozy Comfort Campground 14
Figure 11. Historic size comparison of islands 16
Figure 12. Example of the eroding shoreline along the proposed project site 17
Figure 13. Location of shoreline stabilization along Blue Lake's eastern shoreline 20
Figure 14. Conceptual rock toe and biolog treatment 21
Figure 15. Conceptual coir log treatment 21
Figure 16. Aerial view of Site 3.1, 3.2, and 3.3 located along unnamed tributary into Blue Lake 25
Figure 17. Site 3.1 located alone the right handed side of the picture for the proposed wetland/sediment basin 26
Figure 18. Example of the location for the rock grade controls along the unnamed tributary at Site 3 27
Figure 19. Example of the location for a cross valley control structure at Site 3.3 28
Figure 20. Conceptual rock dam detail 29
Figure 21. Location of proposed rock grade control structures 30
Figure 22. Conceptual cross valley control dam 30
Figure 23. Location of cross valley control dam on tributary to Blue Lake and the location of a wetland (in yellow) potentially affected by project 31
Figure 24. Eroding hillside at Site 4 35
Figure 25. Conceptual design of rock-lined chute 36
Figure 26. Proposed location for rock-lined chute 37
Figure 27. Aerial view of Site 5 39
Figure 28. Example of the eroding stream channel downstream of the old pond at Site 5 40
Figure 29. Potential site for bank stabilization on tributary south of Lake 41
Figure 30. Proposed location for grade control structure on existing pond site and the location of wetlands (in yellow) potentially affected by project 42

TABLE OF TABLES

PAGE

Table 1. Watershed and sub watershed sizes for the Blue Lake watershed 5
Table 2. Detailed land use in the Blue Lake watershed 10
Table 3. Prior studies conducted in the Blue Lake watershed 12
Table 4. Change in size of islands based on aerial photo comparison 17
Table 5. Erosion Intensity Scores from the Erosion Intensity Score Worksheet 19
Table 6. Classification based on Erosion Intensity Scores 19
Table 7. Plant species observed during a September 4, 2007 site visit for the proposed shoreline stabilization project site 22
Table 8. Opinion of probable costs for the shoreline stabilization project on Blue Lake 24
Table 9. HHEI Scores for the tributary assessment reaches as sampled September 6, 2007 32
Table 10. Opinion of probable costs for three rock dams in unnamed tributary 34
Table 11. Opinion of probable costs for the control dam in unnamed tributary 34
Table 12. Opinion of probable costs for rock-lined chute installation 38
Table 13 Opinion of probable costs for Option 1 – design and construction of a grade control at pond project site Site 5 45
Table 13 Opinion of probable costs for Option 2 – design and reconstruction of the embankment at old pond project Site 5 45

TABLE OF APPENDICES

Appendix A. Potential Water Quality Improvement Projects
Appendix B. Landowner Agreements
Appendix C. Environmental Assessments
Appendix D. Early Coordination Information
Appendix E. Design Data

BLUE LAKE WATERSHED ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

1.0 INTRODUCTION

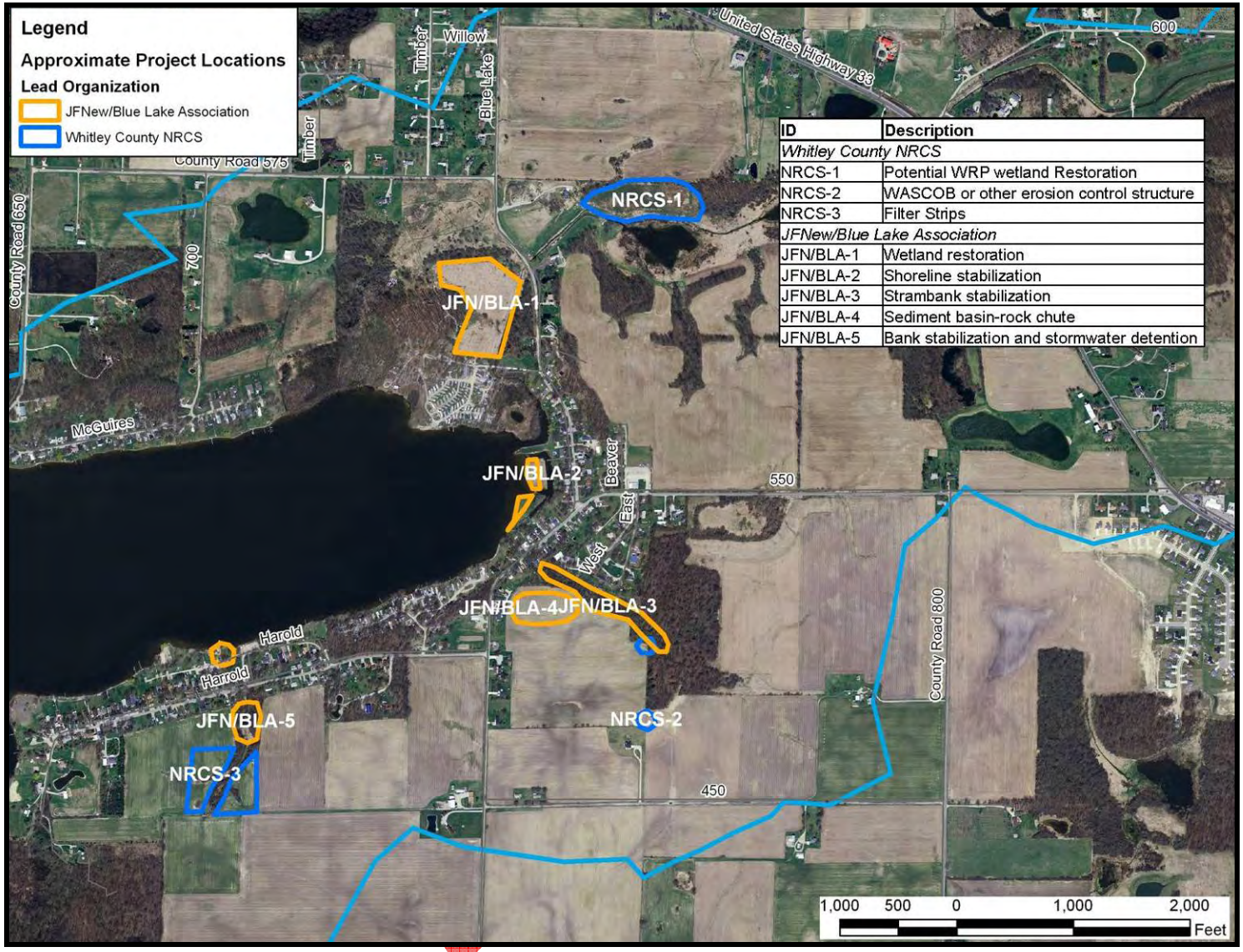
1.1 Background

Blue Lake residents have been proactive in protecting their lake's health. Residents have worked on their own and with natural resource agencies to try to treat problems in the lake and its watershed. These problems include: declining water clarity, increasing nutrient concentrations, and high algal productivity. In 2002, the Blue Lake Association (BLA) applied for and received funding from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) program to conduct a lake and watershed diagnostic study to document existing conditions in the lake and identify potential pollutant sources to the lake. According to the study, water quality in Blue Lake is poorer than most Indiana lakes, with the potential for worsening conditions. Phosphorus modeling indicated that both external and internal sources contribute to the phosphorus loading of Blue Lake. The study recommended implementation of practices both in the watershed and within the lake to improve water quality. The proposed watershed-level activities included: management of stream channels south of Blue Lake, stabilization of islands at the east end of Blue Lake, and wetland restoration. In 2006, the BLA received a feasibility study grant from IDNR LARE to follow-up on recommendations from the diagnostic study. The purpose of the current study is to determine design and construction feasibility for recommended projects in the Blue Lake watershed.

1.2 Scope of Study

The geographic scope of this study included the entire 2,272-acre (919.4-ha) Blue Lake watershed in Whitley County, Indiana with a focus on sites identified in the diagnostic study as potential sites for watershed improvements. These sites were located along the drainages at the southern edge of the lake and along Maloney Ditch near the lake. BLA, JFNew, Whitley County Natural Resource Conservation Service (NRCS), Whitley County Soil and Water Conservation District (SWCD), and a major landowner conducted a driving and walking tour of the watershed streams in March 2007. This tour was completed to identify locations where projects could be implemented that would result in water quality improvements in the lake and its tributaries. Based on the survey's findings, the following projects (Figure 1) were identified:

1. Wetland restoration near Cozy Comforts Campground;
2. Shoreline stabilization on the lakeward side of the islands at the east end of the lake and reconstruction of a culvert outlet;
3. Streambank stabilization along an unnamed tributary on the southeastern corner of Blue Lake;
4. Sediment detention basin creation at the top of a hill west of an unnamed drain south of Blue Lake;
5. Bank stabilization along an unnamed tributary south of Blue Lake and stormwater detention within an existing pond basin site;
6. Wetland restoration along Maloney Ditch east of Blue Lake Road;
7. Water detention structure installation at the top of the unnamed tributary south of Blue Lake;
8. Filter strip installation in field along a wooded area near an unnamed tributary south of Blue Lake.



ID	Description
Whitley County NRCS	
NRCS-1	Potential WRP wetland Restoration
NRCS-2	WASCOB or other erosion control structure
NRCS-3	Filter Strips
JFNew/Blue Lake Association	
JFN/BLA-1	Wetland restoration
JFN/BLA-2	Shoreline stabilization
JFN/BLA-3	Strambank stabilization
JFN/BLA-4	Sediment basin-rock chute
JFN/BLA-5	Bank stabilization and stormwater detention

Figure 1. Engineering feasibility study locations.

JFNew and the BLA agreed to pursue projects 1, 2, 3, 4, and 5, while the Whitley County NRCS agreed to pursue projects 6, 7, and 8. This feasibility study will discuss only the projects for which the BLA and JFNew are responsible.

1.3 Goals and Objectives

The goal of this study was to identify feasible projects that could be designed and implemented within a reasonable time frame. 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 DESCRIPTION OF STUDY AREA

2.1 Location

Blue Lake is a 239-acre (96.7-ha) natural lake that lies in the northeast corner of Whitley County, Indiana (Figure 2). Specifically, the lake is located in Sections 9, 10, 15, and 16 of Township 32 North, Range 10 East in Whitley County. The Blue Lake watershed stretches out to the east and south of the lake encompassing nearly 2,300 acres (930 ha or 3.6 square miles; Figure 3). Water discharges through the lake's outlet in the northwest corner to the Blue River. Water in the Blue River flows southwest and empties into the Eel River south of Columbia City. The Eel River transports water to the Wabash River which eventually discharges into the Ohio River, exiting the state of Indiana.

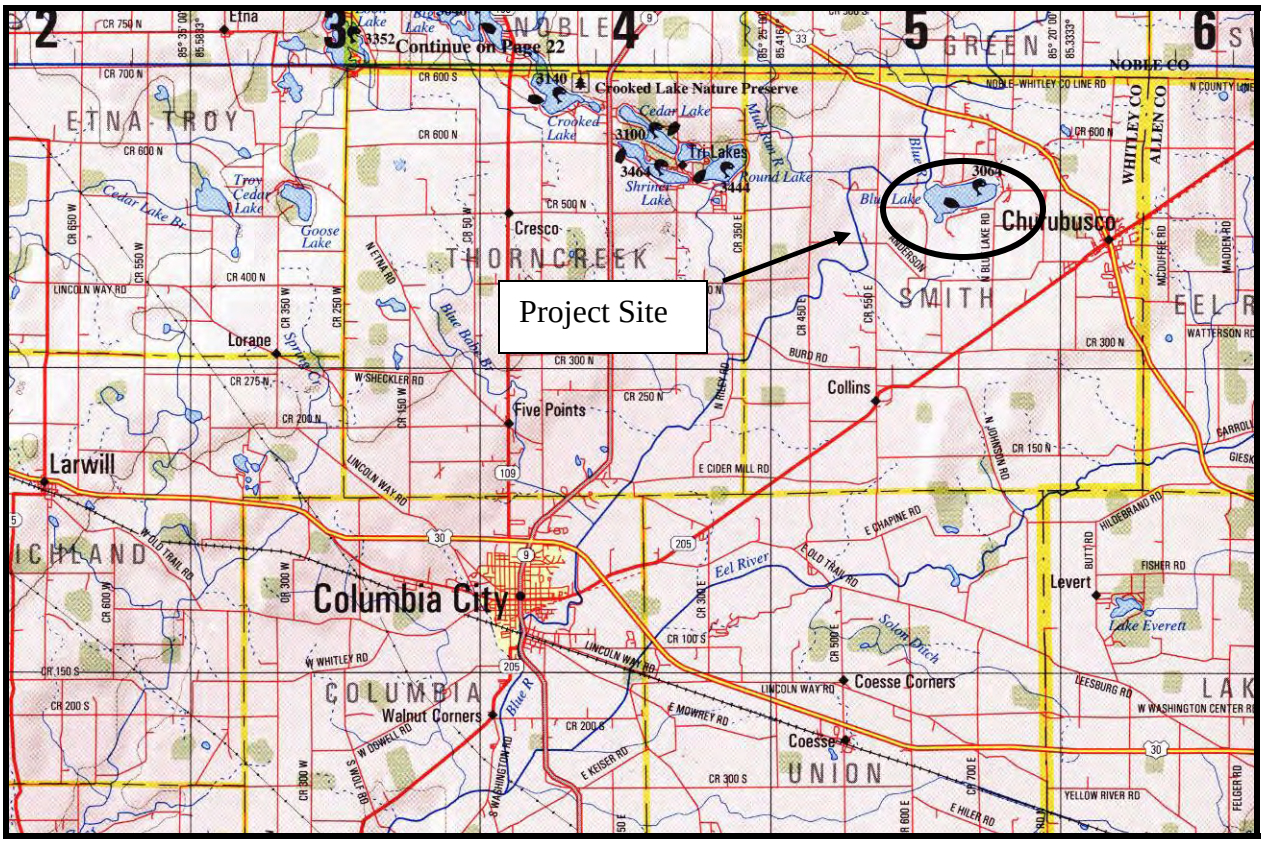


Figure 2. General location of the Blue Lake watershed. Source: DeLorme, 1998.

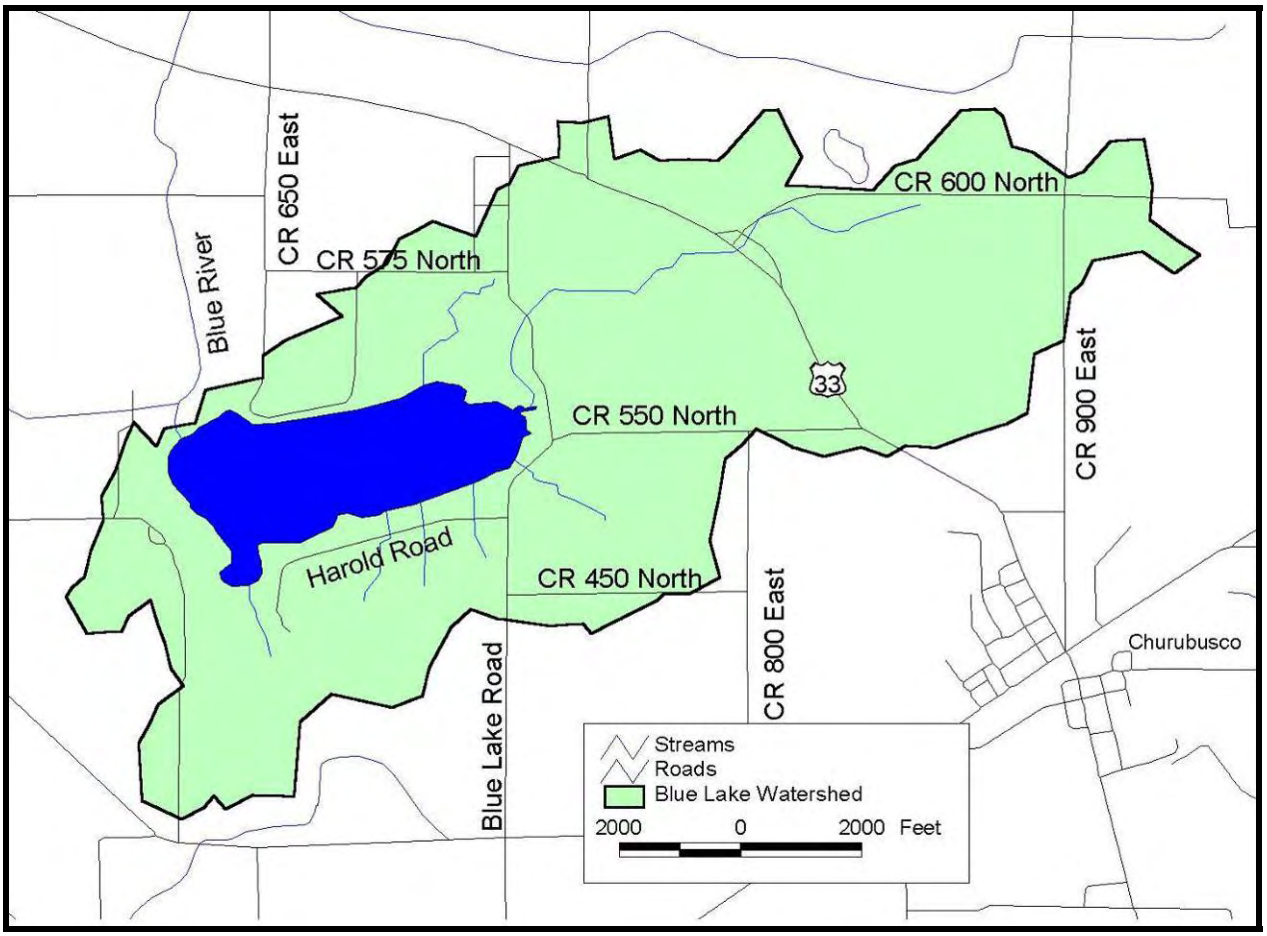


Figure 3. Blue Lake watershed.

Surface water drains to Blue Lake via two primary routes: through Maloney Ditch and via direct drainage. Multiple minor tributaries also drain steep ravines along the southern shoreline of Blue Lake. Maloney Ditch drains approximately 1,010 acres (408.7 ha or 44.5%) of the watershed east and north of Blue Lake (Table 1). This stream empties into Blue Lake in the lake's northeast corner. A series of unnamed tributaries or ravines transport water to Blue Lake along its southern boundary. The largest of these tributaries drains into Horseshoe Bay carrying water from 185.6 acres (75.1 ha), while the second largest carries water from the watershed to the southeast corner of the lake draining 184.5 acres (74.7 ha). The other four small drainages carry water from 1.3 to 6.7% of the Blue Lake watershed. The remaining 28% of the land in the Blue Lake watershed (576.8 acres or 233.4 ha) drains directly to Blue Lake. Figure 4 illustrates the boundaries of each of these sub watersheds of Blue Lake.

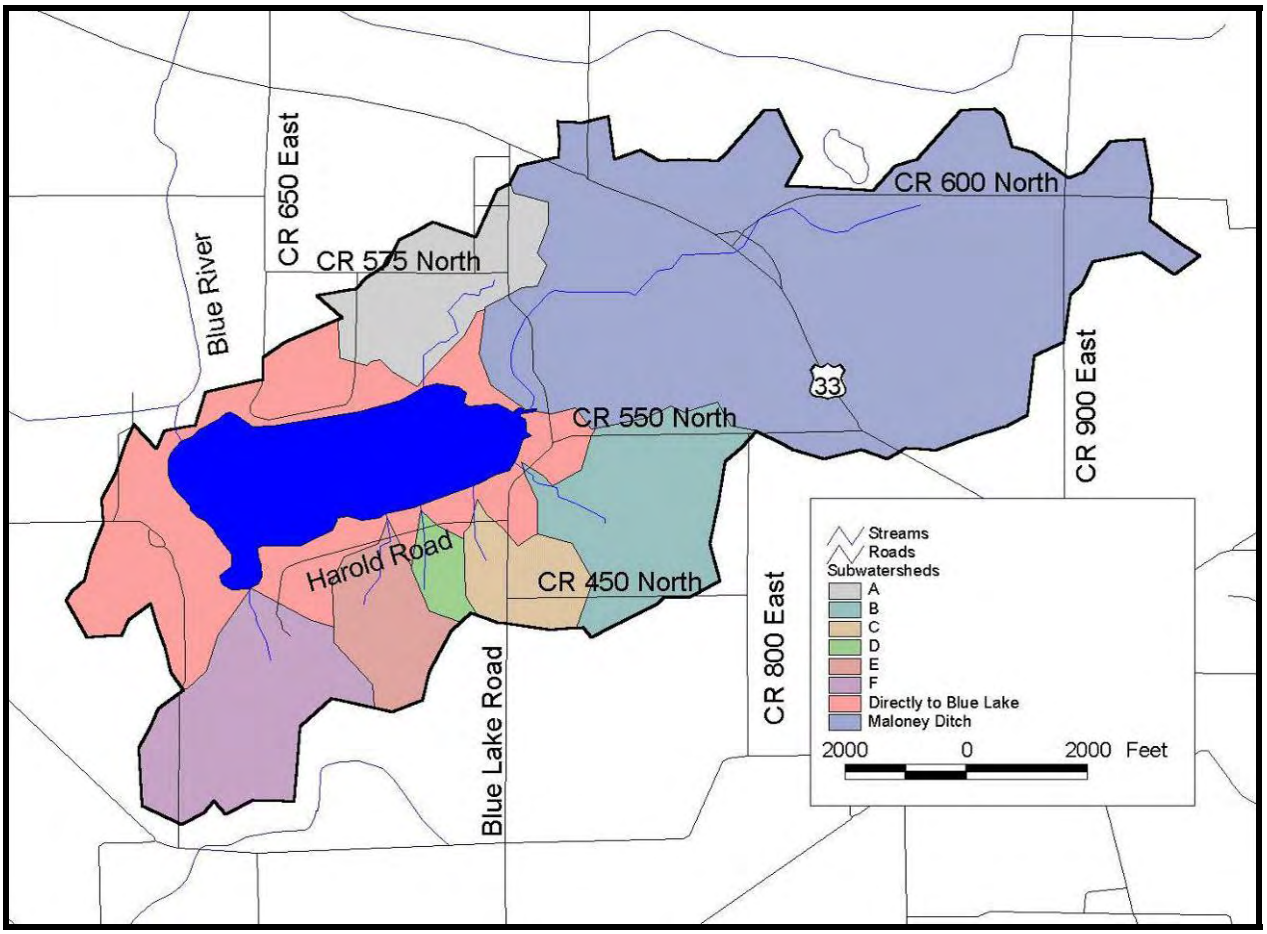


Figure 4. Blue Lake sub watersheds.

Table 1. Watershed and sub watershed sizes for the Blue Lake watershed.

Sub watershed/Lake	Area (acres)	Area (hectares)	Percent of Watershed
Maloney Ditch	1010.2	408.8	49.7%
Unnamed Tributary A (northeast corner)	137.2	55.5	6.7%
Unnamed Tributary B (southeast corner)	184.5	74.7	9.1%
Unnamed Tributary C (south central)	67.3	27.2	3.3%
Unnamed Tributary D (south central)	26.8	10.9	1.3%
Unnamed Tributary E (southwest)	83.6	33.8	4.1%
Unnamed Tributary F (Horseshoe Tributary)	185.6	75.1	9.1%
Area Draining Directly to Blue Lake	576.8	233.4	28.4%
Watershed Draining to Lake	**2,033**	**829.8**	**89.5%**
Blue Lake	239	96.7	10.5%
Total Watershed	**2,272**	**927.3**	**100%**
Watershed to Lake Area Ratio	9.5:1		

2.2 Geologic History and Topography

Blue Lake and its watershed formed during the most recent glacial retreat of the Pleistocene era. The movement and stagnation of the Saginaw and Erie Lobes of the Wisconsin glacial age left behind several end and ground moraines that shaped much of the Blue Lake watershed. The Blue Lake watershed lies in a section of the Eastern Corn Belt Plains Ecoregion and is near the transition to the Southern Michigan/Northern Indiana Drift Plains (Omernik and Gallant, 1988). Schneider (1966) notes that the landforms common in this diverse physiographic region include till knobs and ice-contact sand and gravel kames, kettle holes and lakes, melt water channels lined with outwash deposits or organic sediment, valley trains, outwash plains, and small lacustrine plains. The flat area northwest of Blue Lake likely demarcates the extent of a waterbody that originally covered Blue Lake and the area to the northwest of the lake many years ago. This waterbody has been reduced to only Blue Lake.

The topography of the Blue Lake watershed is typical of the area. The highest areas of the watershed lie along the watershed's southern and eastern edges, where the Erie Lobe of the last glacial age left end moraines. Along the watershed's northeastern boundary, the elevation nears 910 feet (277.4 m) above mean sea level. The ridges along the watershed's southeastern boundary are equally as high, but are much less steep than the ridge along the northeastern watershed boundary. Maloney Ditch, its floodplain, and Blue Lake occupy a lower elevation valley in the watershed. Blue Lake, elevation 850 feet (259.1 m) above mean sea level, is the lowest point in the watershed. Figure 5 presents a topographical relief map of the Blue Lake watershed.

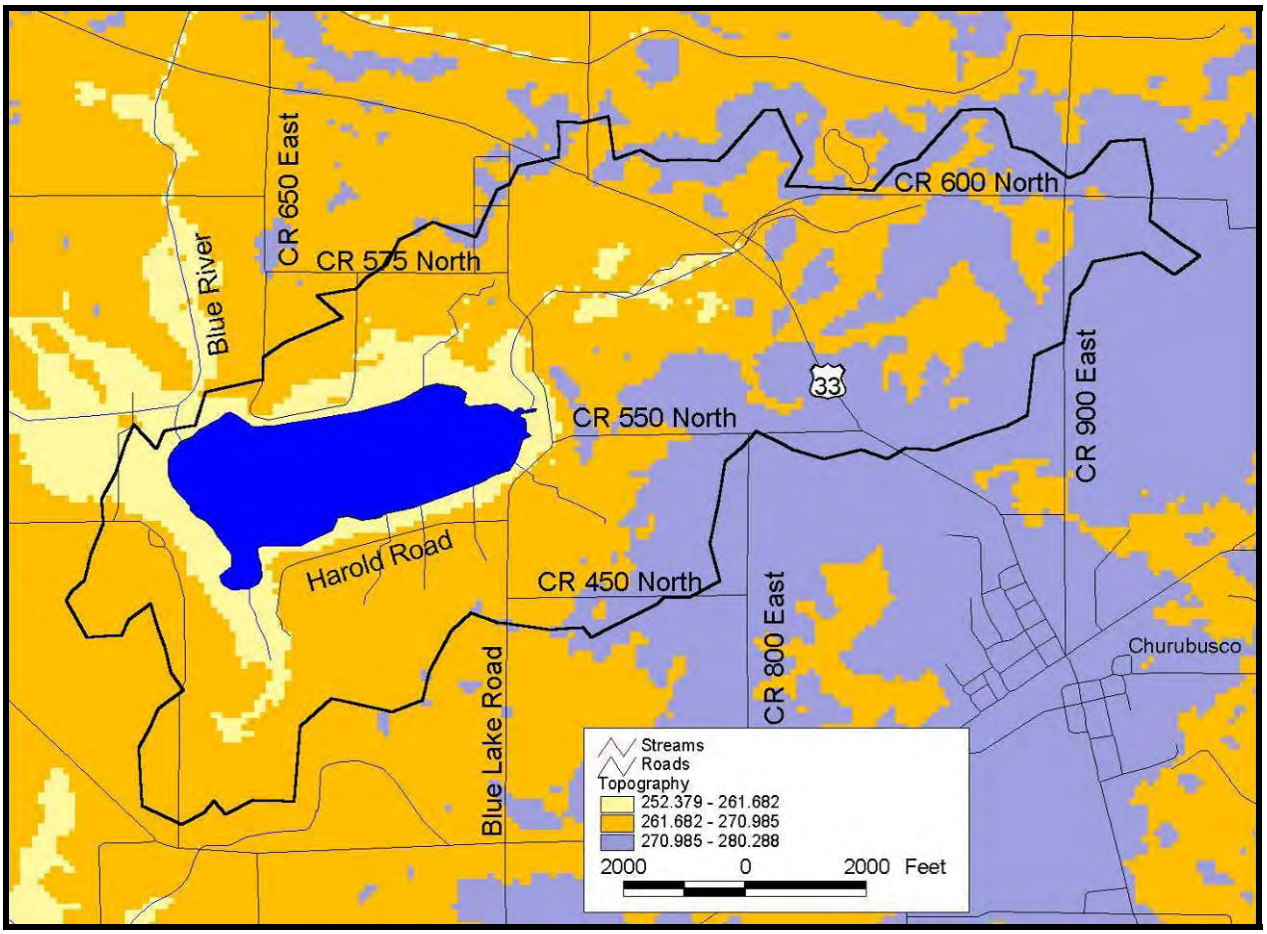


Figure 5. Topographical map of the Blue Lake watershed.

2.3 Soils

The Blount-Pewamo-Glynwood soil association, composed of moderately well-drained to very poorly-drained, nearly-level to moderately-sloping soils formed from glacial till, covers nearly the entire Blue Lake watershed. The remaining 3% of the watershed, bordering Blue Lake and extending south into the southwest corner of the watershed, is composed of the Houghton-Sloan soil association. This association (Figure 6) is composed of very poorly-drained, nearly-level soils formed from organic materials (Reusch, 1990).

As Figure 7 indicates, potentially highly erodible soils cover a substantial portion (813.3 acres (329.1 ha) or nearly 36%) of the Blue Lake watershed. This acreage is spread throughout the watershed. Highly erodible soil exists on approximately 266.3 acres (107.8 ha or nearly 12%) of the watershed. The highly erodible and the potentially highly erodible soils mainly cover areas of the watershed that are currently being used for row crops and pasture or hay fields. No highly erodible or potentially highly erodible soils surround the shoreline of Blue Lake.

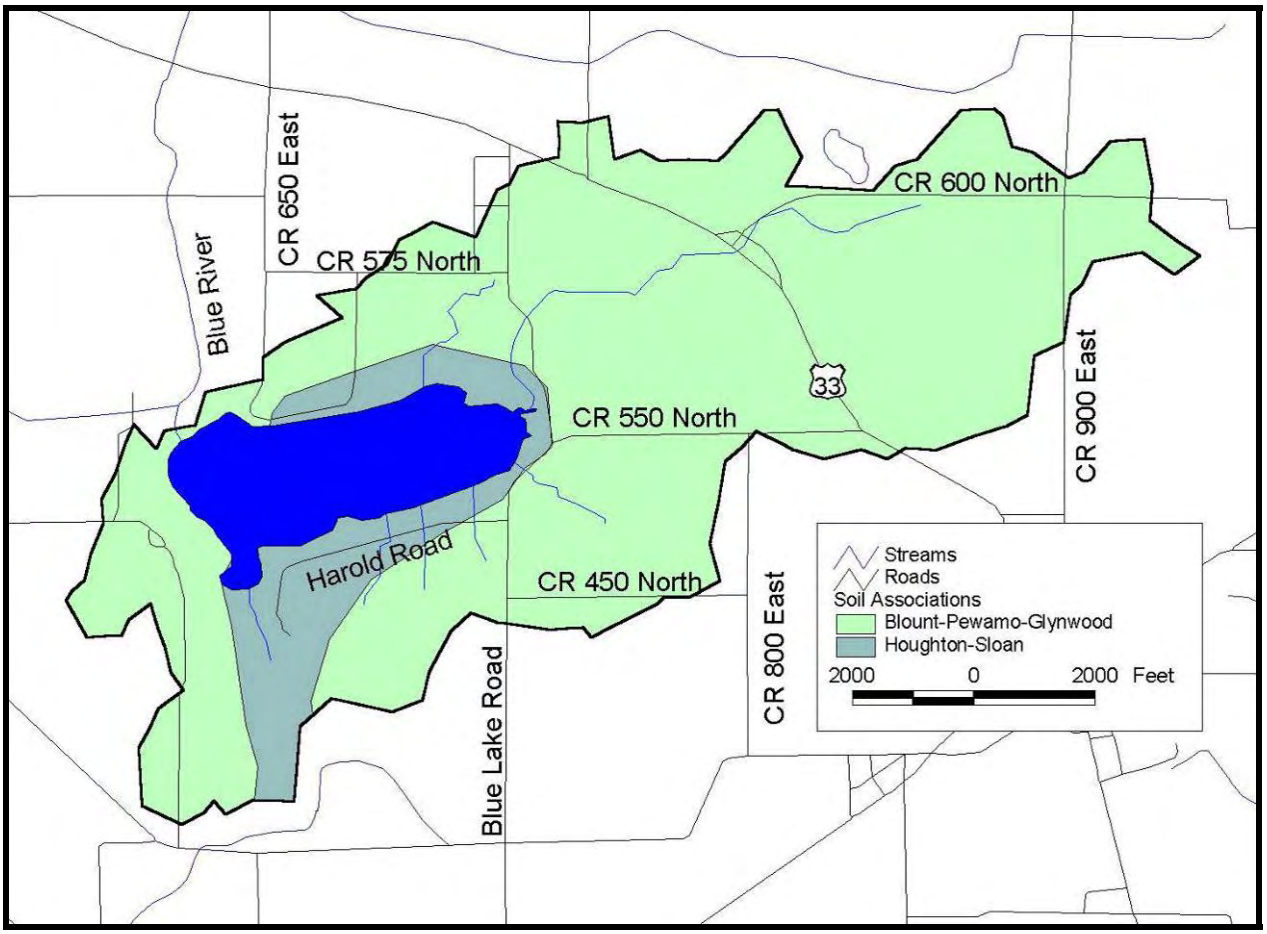


Figure 6. Soil associations in the Blue Lake watershed.

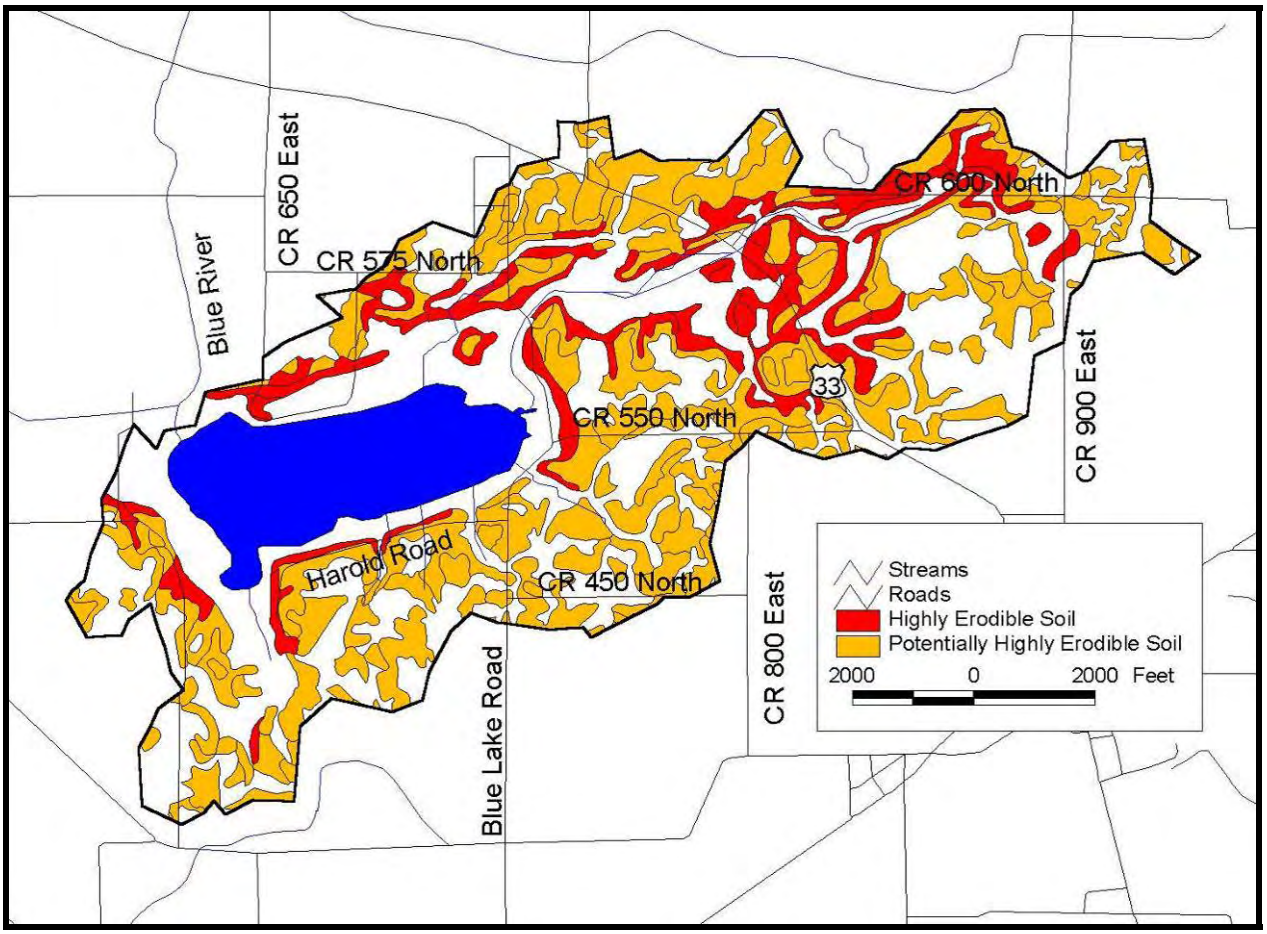


Figure 7. Highly erodible and potentially highly erodible soils within the Blue Lake watershed.

2.4 Land Use

The Blue Lake watershed lies in the southern part of Homoya's Northern Lakes Natural Region, near its transition with the Buffton Till Plain Section of the Central Till Plain Natural Region. As a result, the native floral community of the Blue Lake watershed likely consisted of components of neighboring natural areas and ecoregions in addition to components characteristic of the natural area and ecoregion in which it is mapped. Homoya et al (1985) noted that prior to European settlement, the Northern Lakes Natural Region was a mixture of numerous natural community types, including bog, fen, marsh, prairie, sedge meadow, swamp, seep spring, lake, and deciduous forest.

Figure 8 and Table 2 present current land use information for the Blue Lake watershed. (Land use data from the U.S. Geological Survey (USGS) form the basis of Figure 8.) Like many Indiana watersheds, agricultural land use dominates the Blue Lake watershed, accounting for approximately 75% of the watershed. Row crop agriculture comprises the greatest percentage of agricultural land use at 54.8%, while pasture or hay vegetate another 20%. Most of the agricultural land in the Blue Lake watershed and throughout Whitley County (USDA, 2002) is used for growing soybeans and corn. Natural landscapes, including forests and wetland, cover approximately 11% of the watershed, mostly in small tracts of wooded wetlands or deciduous forest. Open water, including Blue Lake and several small ponds, accounts for another 11% of the watershed. Most of the remaining 3% of

the watershed is occupied by low intensity residential land, with less than 1% of high intensity residential or commercial land. Much of the residential land lies directly adjacent to Blue Lake.

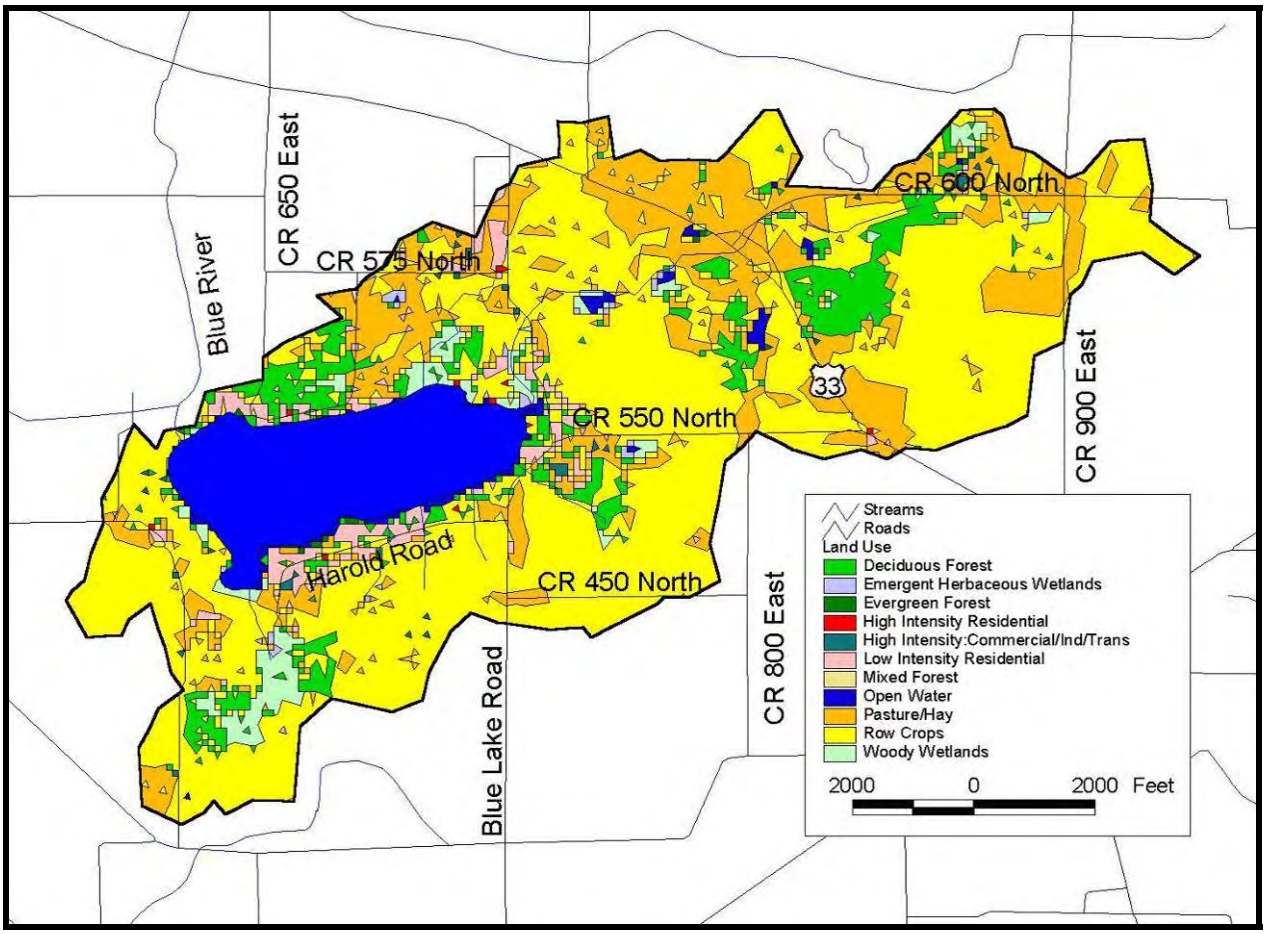


Figure 8. Land use in the Blue Lake watershed.

Table 2. Detailed land use in the Blue Lake watershed.

Land Use	Area (acres)	Area (hectares)	% of Watershed
Row Crops	1245.4	504.2	54.8%
Pasture/Hay	450.4	182.4	19.8%
Open Water	249.7	101.1	11.0%
Deciduous Forest	171.9	69.6	7.6%
Woody Wetlands	67.8	27.5	3.0%
Low Intensity Residential	64.9	26.3	2.9%
Emergent Herbaceous Wetlands	7.8	3.1	0.3%
High Intensity Commercial	7.2	2.9	0.3%
Evergreen Forest	4.4	1.8	0.2%
High Intensity Residential	2.1	0.9	0.1%
Mixed Forest	0.2	0.1	<0.1%
Entire Watershed	**2271.9**	**919.8**	**100.0%**

2.5 Historical and Existing Watershed-wide Water Quality Improvement Projects

Several water quality improvement projects have been completed in the Blue Lake watershed. The residential community surrounding Blue Lake formed the Blue Lake Conservancy District and installed a sewer system to address concerns created by septic system use. The BLA also installed buoys to reduce the negative impact of boating and wave action on the lake's shoreline and reduce shoreline erosion. The Whitley County SWCD assisted in improving the water quality of the lake by installing a number of grassed waterways and water and sediment control basins (WASCOBs) on farmland in the watershed using Clean Water Act Section 319 and Indiana T by 2000 grant money (Amy Lybarger, NRCS, personal communication). Figure 9 details location of these projects. While these practices have slowed the import of sediment to Blue Lake from its watershed, members of the BLA have identified additional areas of concern. Additionally, BLA members spoke with property owners adjacent to the eroding drainages about their interest in participating in a study to look at measures that could occur on their property to protect and improve Blue Lake's water quality. Residents, including one who owns most of the southern watershed, are open to working with the association to implement measures to protect the lake.

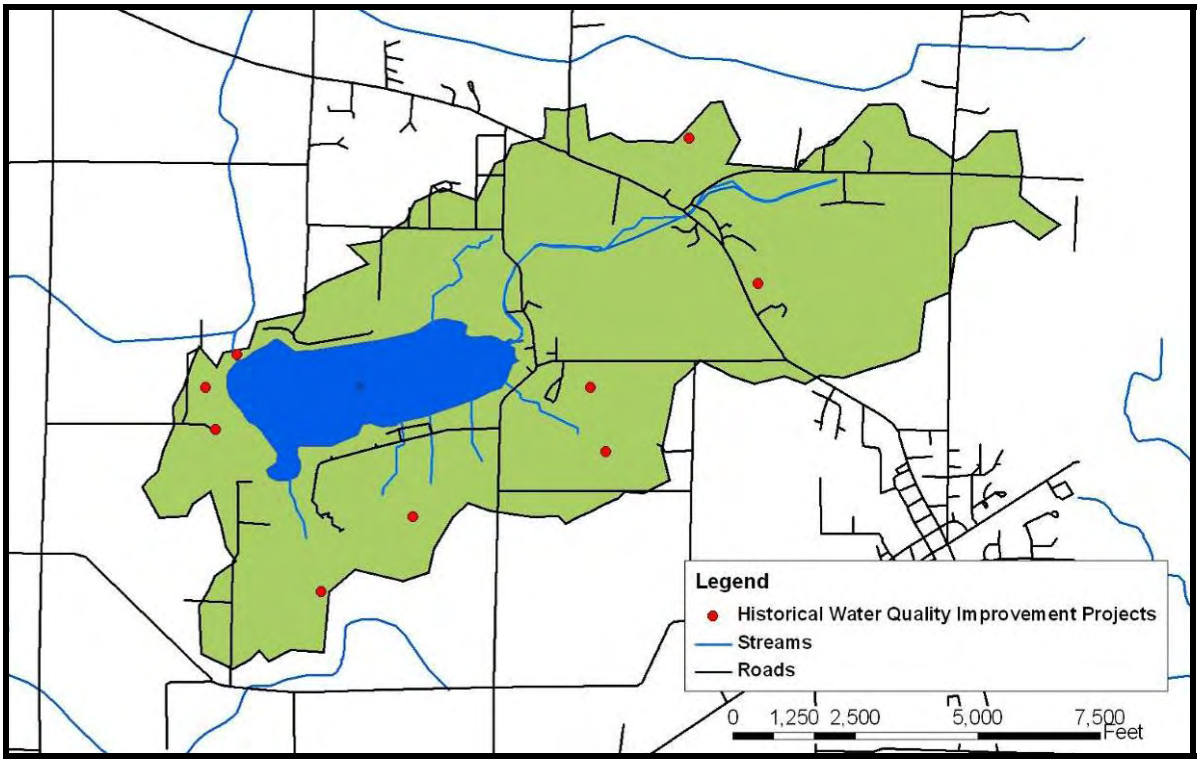


Figure 9. Approximate locations of historical 319-funded water quality improvement projects. Source: Whitley County SWCD

2.6 Prior Studies

Table 3 lists the prior studies conducted in the Blue Lake watershed. Most studies of the lake published prior to 1986 focused on fisheries. In 1986, the Indiana State Pollution Control Board published the first report pertaining to water quality in the lake. The Indiana Clean Lakes Program (CLP) continued to monitor the lake's water quality through periodic sampling of the lake beginning in 1990. The 2006 diagnostic study addressed watershed management of the areas draining into Blue Lake. During the diagnostic study, JFNew examined conditions in the lake and its watershed

with the goal of identifying potential problem areas and making prioritized recommendations to address these problems.

Table 3. Prior studies conducted in the Blue Lake watershed.

Year	Organization	Topic	Study/Report
1976	IDNR	Fisheries	Fish Management Report, Blue Lake, Whitley County, Indiana
1979	IDNR	Fisheries	Fish Management Report, Blue Lake, Whitley County, Indiana
1980	IDNR	Fisheries	An evaluation of musky stockings in northeast Indiana
1982	IDNR	Fisheries	Fish Harvest and Fishing Pressure at Blue Lake
1983	IDNR	Fisheries	Largemouth bass population size and mortality in two natural lakes
1984	IDNR	Fisheries	The largemouth bass and bluegill populations in Blue and Round Lakes
1986	ISPCB	Water Quality	Indiana Lake Classification System and Management Plan
1990	IDEM, CLP	Water Quality	Indiana Clean Lakes Program Assessment
1995	IDEM, CLP	Water Quality	Indiana Clean Lakes Program Assessment
1998	IDEM, CLP	Water Quality	Indiana Clean Lakes Program Assessment
1999	IDNR	Fisheries	An angler creel survey at Blue Lake, Whitley County
2004	IDEM, CLP	Water Quality	Indiana Clean Lakes Program Assessment
2004	IDEM	Water Quality	Data from assessment of impaired biotic communities in the Upper Eel River and Blue Lake watersheds
2006	JFN	Watershed Management	Blue Lake Diagnostic Study

CLP=Clean Lakes Program
IDEM=Indiana Department of Environmental Management
ISPCB=Indiana State Pollution Control Board
JFN=J.F. New and Associates
IDNR=Indiana Department of Natural Resources

3.0 POTENTIAL WATER QUALITY IMPROVEMENT PROJECTS

The goals of a visual watershed inspection are to identify, target, and select areas of concern and future management options. A driving tour of Blue Lake watershed and walking tours of streams were conducted in March 2007. The tours included the BLA, JFNew, the Whitley County SWCD, the Whitley County NRCS, and a resident farmer who owns a significant portion of land within the watershed. During these tours, the eight potential water quality improvement projects identified in the diagnostic study were revisited to determine if significant changes occurred since the completion of the 2006 study and to identify any additional projects to improve water quality (Figure 1). Specifics regarding each of the projects are listed in Appendix A. Please refer to this appendix for information regarding the identified issue and potential solutions associated with each project.

All of the potential projects were discussed during the watershed tour in March 2007. During this tour and in subsequent conversations, it was determined that the NRCS would pursue any projects that could be funded using Farm Bill funds, such as the Wetland Reserve Program (WRP) and the Conservation Reserve Program (CRP). This included projects 6, 7, and 8. Specifically, these projects target wetland restoration, WASCOB construction, and filter strip installation. JFNew agreed to pursue projects 1, 2, 3, 4, and 5. Specifically, these projects target wetland restoration, shoreline stabilization, streambank stabilization, and stormwater detention structure construction. All other identified projects were deemed to not be serious enough issues to address at this point in time. These remaining project sites will be monitored in the future to make sure that they do not become significant impacts to Blue Lake water quality.

4.0 PROJECT REVIEW

4.1 Wetland Restoration (Site 1)

4.1.1 Site Description and Alternatives

A potential wetland restoration site was identified at the northeast side of the lake on a parcel owned by Schloss Herberstine, Inc. from Fort Wayne, Indiana (Figure 1). This parcel included the Cozy Comfort Campground, which is located on the southern property boundary along the lakeshore, and a permanent residence. The eastern portion of the property is dissected by Maloney Ditch. The property is bordered on the north by a row of deciduous trees and on the west by an isolated woodlot. The proposed wetland restoration site is located in a low-lying, open area adjacent to Maloney Ditch (Figure 10). During the watershed tour, the potential wetland site was dominated by reed canary grass (*Phalaris arundinacea*), an indicator of hydrology, which suggests that this area is currently a wetland. Based on field observations, aerial photography, and soil maps, this site would have the potential to be restored to a higher quality wetland habitat that provided increased benefits to Blue Lake. Currently, the lower quality wetland is filtering water flowing directly through it. A potential restoration project could re-direct Maloney Ditch into the wetland and allow it to spill into the wetland to provide stormwater treatment before emptying into Blue Lake.

Figure 10. Potential wetland restoration site upstream of Cozy Comfort Campground.

4.1.2 Easement and Land Availability Determination

The landowner was contacted regarding the possibility of restoring a wetland on their property. The landowner responded with denial of access to his property at this time. A copy of the landowner response is included in Appendix B.

4.1.3 Preliminary Design and Conceptual Drawings

Preliminary designs and conceptual drawings have not been developed. If the landowner decides to restore part of their property to a higher quality wetland habitat, then preliminary designs and conceptual drawings should be developed, until then the area will continue to provide some stormwater filtration

4.1.4 Permit Requirements

No permits are required at this time.

4.1.5 Wetland Functional Assessment
Wetland functional assessments were not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

4.1.6 Biological and Habitat Integrity Survey
A biological and habitat integrity survey was not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

4.1.7 Environmental Impact Assessment
An environmental impact assessment was not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

4.1.8 Unusual Physical and Social Costs
Physical and social costs associated with this project were not determined due to the denial of access to the property and because a specific wetland restoration project is not being pursued at this time.

4.1.9 Opinions of Probable Cost and Proposed Time Line
Probable costs associated with wetland restoration were not determined during the course of this study. If the landowner becomes interested in pursuing wetland restoration opportunities in the future, it is recommended that they contact the Blue Lake Association.

4.2 Shoreline Stabilization (Site 2)
4.2.1 Site Description and Alternatives
The shoreline stabilization site is located on the east side of the lake on publicly-owned property within the boundaries of the lake (Figure 1). The specific area includes two islands and a peninsula, which have been modified through historic dredging operations and channel maintenance activities. For the purpose of this study, the three parcels will be referred to as the south island (south parcel), the north island (center parcel) and the peninsula (north parcel; Figure 11). These publicly-owned parcels are utilized for recreational activities, such as picnicking and fishing by local residents and the boating public as there is no public access to these parcels from shore. The majority of the property is vegetated by a mix of turf grass and sparse deciduous trees. Local residents maintain the area and in some locations mowing occurs down to the waterline. Stones and concrete pieces have been placed along the shoreline in various locations in attempts to slow erosion of the shoreline, primarily along the south island.

Figure 11. Historic size comparison of Blue Lake islands, 1957 and 2005 aerial photographs.
Source: 2005 Aerial obtained from http://earth.google.com/; 1957 Aerial from Indiana Historical Archives, Whitley County.

Residents use the south island more than the peninsula or the north island due to its connectivity to the mainland. Additionally, two small foot bridges allow residents access to the main lake. The lakeward side of the south island contains a thin strip of herbaceous vegetation and sparse shrubs along the shoreline. Species such as reed canary grass, swamp milkweed, and buttonbush were noted during a September site visit (Table 7). A larger vegetated buffer (approximately 6 foot (1.8 meters)) is present along the leeward side of the island with sparse deciduous trees located on the northeast end of this island.

The north island is primarily vegetated with cool season grasses and is utilized the least of the three parcels. The lakeward side of this island is sparsely vegetated with the majority of it being exposed soil and gravel. The inlet and channel sides exhibit slightly more vegetation with a mix of shrubs along the shoreline.

The peninsula is long and narrow forming a point in the lake. This point is highly exposed to the elements and exhibits minimal shoreline vegetation. Approximately 50 feet (15.2 meters) back on either side of the point, the shoreline is also sparsely vegetated with exposed soil.

Due to the location of these parcels on the east end of the lake, prevailing winds from the west create substantial wave action along this shoreline. These natural conditions and wave action from boating activity caused erosion along portions of the shoreline. Figure 11 demonstrates the surface area of the island in 2005 as compared to the outline of the historic size taken from a 1957 aerial photograph. The area of the north island decreased nearly 45% during this 48 year period. The south island decreased in size by 29% and the peninsula decreased by 20% (Table 4). The turbulence created by wave action against the shoreline causes the toe of the slope to erode and

sediment to mobilize; thereby increasing the transfer of nutrients from the sediment-water interface to the water column. Turf grass, such as that found on the south island, provides very little shoreline protection (Figure 12). During mild winters, frequent freeze and thaw cycles play a significant role by causing ice to build up along this shoreline. As the ice advances and recedes, it collects sediment, which then is released into the water column during the spring rains. All of these factors increase the erosive activities which occur along this shoreline.

Table 4. Change in size of islands based on aerial photo comparison.

Location	1957		2005		% Change	Shoreline Recession		Shoreline Perimeter Lost	
	ft²	m²	ft²	m²					
North Island	75,830	7045	41,792	3883	>45%	136 ft	41.5 m	1,053 ft	321 m
South Island	56,582	5257	42,007	3903	>29%	64 ft	19.5 m	615 ft	187.5 m
Peninsula	19,212	1785	15,419	1432	>20%	15 ft	4.6 m	593 ft	180.7 m

Source: 2005 aerial obtained from http://earth.google.com/; 1957 Aerial from Indiana Historical Archives, Whitley County.

Figure 12. Example of the eroding shoreline along the proposed project site. Note how the turf-grass along the bottom picture is slumping providing very little shoreline protection.

Initial conversations between the BLA and JFNew included the possibility of restoring the islands to a size similar to those present in 1957. The BLA was in favor of this option because they considered the islands a valuable resource to the lake and restoration of them to a historical benchmark important. The combination of the amount of material to required to restore the islands to the 1957 level, approximately 12,000 cubic yards (9,200 cubic meters), plus the difficulty in accessing the islands with land-based equipment makes the project cost prohibitive. The restoration could be feasible if it occurred in conjunction with a sediment removal project from another part of the lake. During a sediment removal project, material would be removed from other areas of the lake where it

has accumulated and would be pumped to the islands via a hydraulic dredge operated from a specialized boat. Cost would be reduced because the material used would be a by-product of another operation with very little extra handling time or effort. The LARE program has sediment removal funding program, which could help pay for a portion of the project with the remaining of the cost being covered by a LARE construction grant. However, during the evaluation process, the IDNR LARE program staff requested that the restoration of the island's to an increased size not be pursued due to the potential high cost and complicated regulatory issues associated with a significant amount of Blue Lake that would be filled in as a result (Doug Nusbaum, personal communication). For this reason, restoration to a historic benchmark was deemed infeasible.

Stabilization of the eroded shoreline is recommended to reduce sediment and sediment-attached pollutant delivery to Blue Lake. Various techniques were evaluated to stabilize the shoreline. Hard-armoring, using concrete or sheet pile walls was considered and later abandoned. This option was considered infeasible due to the high cost associated with this treatment and the potential loss of aquatic habitat and recreational opportunities along the shoreline which would occur following installation. A structure design that incorporates natural materials was chosen because it offers the benefit of sediment and nutrient loading reduction and habitat and recreational access enhancement, while providing an educational example of shoreline naturalization for others around the lake.

The islands and the peninsula will continue to erode if no action is taken to stabilize them. The forces that are creating the erosion, wind and wave action, are not going subside. The loss of surface area to the islands and peninsula is not the only result. The eroding material is distributed into different areas of Blue Lake reducing the habitat and water quality for the entire lake.

4.2.2 Easement and Land Availability Determination

Site visits occurred in May 2007 and September 2007. Although these parcels are publicly-owned, access by land is limited by the surrounding private landowners. Written permission is not required to visit the project site from the lake due to the site being publicly owned. However, materials cannot be brought to the site from the lakeward side easily and effectively; therefore, adjacent landowner permission to cross their property during construction is necessary. Landowner permission was obtained for accessing the site by land after providing the owners with a conceptual description of the techniques to be used and the benefits to the lake. No landowner permission letters are required to construct the shoreline stabilization treatments on the islands and peninsula because they are publicly-owned and the BLA is sponsoring and supporting the project. The peninsula can be accessed from Blue Lake Road through a right-of-way. The north and south islands will be accessed through several landowners' property that are active in the BLA and support the project.

4.2.3 Preliminary Design and Conceptual Drawings

To quantify the degree of erosion along the identified shoreline, an erosion intensity score was calculated using the Wisconsin Department of Natural Resources Erosion Intensity (EI) Score Worksheet. The EI score is utilized by the WDNR to assist in the evaluation of shoreline stabilization permit applications and to help permit applicants design appropriate shoreline stabilization techniques based on general characteristics of the site (Wisconsin DNR code NR 328.01(1)). EI scores are site based on bank characteristics, such as height, bank composition, and vegetation composition; local site influences, such as proximity to boating channels; and the location of the site in relation to the overall lake setting, such as average fetch, shoreline geometry, and orientation. Each category is scored individually and tallied for a total score. The total EI score

allows individuals to determine what technique (biological, integrated, or hard armoring) is appropriate to stabilize their shoreline (Table 5). The score also classifies the shoreline into one of three energy types, which, in turn, helps determine the recommended stabilization technique. A low energy shoreline is one that score 47 or less. These types of shoreline require biological treatment such as the installation of native plants to re-vegetate and stabilize a shoreline. Scores of 48 to 67 indicate a medium energy shoreline which necessitates an integrated treatment. An integrated treatment would use native plants, erosion control products, and limited amounts of stone. A shoreline that scores greater than 67 is considered a high energy shoreline. In these situations, hard armoring, such as rock and concrete seawalls, would be appropriate treatments.

Table 5. Classifications based on Erosion Intensity Scores.

EI Score	Type of Shoreline	Recommended Treatment
<47	Low Energy	Biological
48 - 67	Medium Energy	Integrated
>67	High Energy	Hard Armoring

The EI scores for the three parcels adjacent to Blue Lake are included in the Table 6. Individual EI scoring worksheets are included in Appendix C. Based on the EI scores, the locations were classified as low energy shorelines where a biological shoreline treatment technique would be appropriate. The scores were calculated using measurements that were taken during low water levels in September 2007. If the water levels had been higher when the measurements were taken, the scores would likely increase by three to five points for each site. These score changes result in the shoreline being classified as medium energy sites. Given the amount of historical shoreline erosion documented previously in this section and low water levels that may have led to an underestimate of the EI score, it is recommended that a majority of the shoreline be treated as a medium energy shoreline and utilize integrated treatments.

Table 6. Erosion Intensity Scores from the Erosion Intensity Score Worksheet.

Location	Erosion Intensity Score	Recommended Treatment
Peninsula	46	Biological
North Island	39	Biological
South Island	43	Biological

The conceptual design incorporates the use of two techniques: 1) a rock toe with coir logs, commonly known as biologs, planted with native vegetation and 2) coir logs planted with native vegetation without the rock toe. Coir logs are manufactured logs constructed from natural materials and designed to absorb wave energy, which allows vegetation to become established. As the constructed material degrades over time, the deep-rooted native vegetation will be present to prevent shoreline erosion. The native species planted in the coir logs and seeded along the shoreline will be selected based on their ability to withstand a variety of water levels and have a deep-root structure.

In total, 715 feet (218 meters) of stabilization is proposed along the lakeshore (Figure 13). This includes 385 feet (117 meters) on the south island; 275 feet (84 meters) of shoreline will require a rock toe with coir log-native plant treatment with the remaining 110 feet (34 meters) will require coir log-native plant treatment. Stabilization along the north island and the peninsula requires the rock

toe with plant coir log treatment. In total, 150 feet (46 meters) of the north island and 180 feet (55 meters) of the peninsula will be stabilized using the rock toe with a coir log planted with native vegetation treatment.

Figure 13. Location of proposed shoreline stabilization along Blue Lake's eastern shoreline.

A rock toe with coir log treatment is proposed for construction along approximately 605 feet (184 m) of the shoreline (Figure 13). This treatment is proposed to occur along portions of the shoreline where the most severe erosion is located. A rock toe consisting of approximately 68 cubic yards (52 cubic meters) of fieldstone will be installed approximately 2 to 3 feet (0.6 to 0.9 meters) out into the lake to a height approximately 1 foot (0.3 meters) above the current lake level (Figure 14). The rock toe is designed to dissipate wave energy, thereby preventing further shoreline erosion along this portion of the shoreline. The toe will also be used as the base for the coir log installation. Coir logs will be staked into place using wood stakes measuring 3 feet (0.9 meters) in length and planted with native wetland plant species plugs. The area behind the coir logs will be graded to match the surrounding topography, seeded with native plant species, and covered with biodegradable erosion control material. Native woody vegetation will be incorporated into the layer between the rock toe and the coir logs in the form of bare-root shrubs. The shrubs will provide long-term scour protection, lateral stability, and overhead cover for invertebrates and juvenile fish.

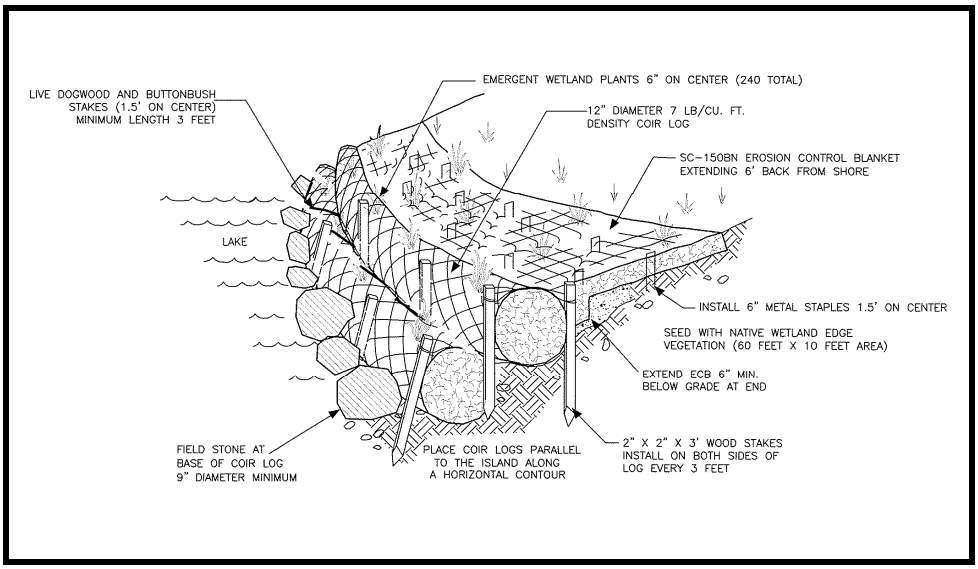


Figure 14. Conceptual rock toe and coir log-native vegetation treatment.

A second bioengineering technique will utilize coir logs to protect and enhance approximately 110 feet (34 meters) of shoreline along the eastern portion of the south island (Figure 13). The logs will be staked in place using wooden stakes measuring 3 feet (0.9 meters) in length at the average water level and planted with native wetland vegetation (Figure 15). The coir logs will be back-filled with soil and the surrounding shoreline will be re-graded to match the existing shoreline. Seeding with native plant species and erosion control material installation will accompany coir log installation.

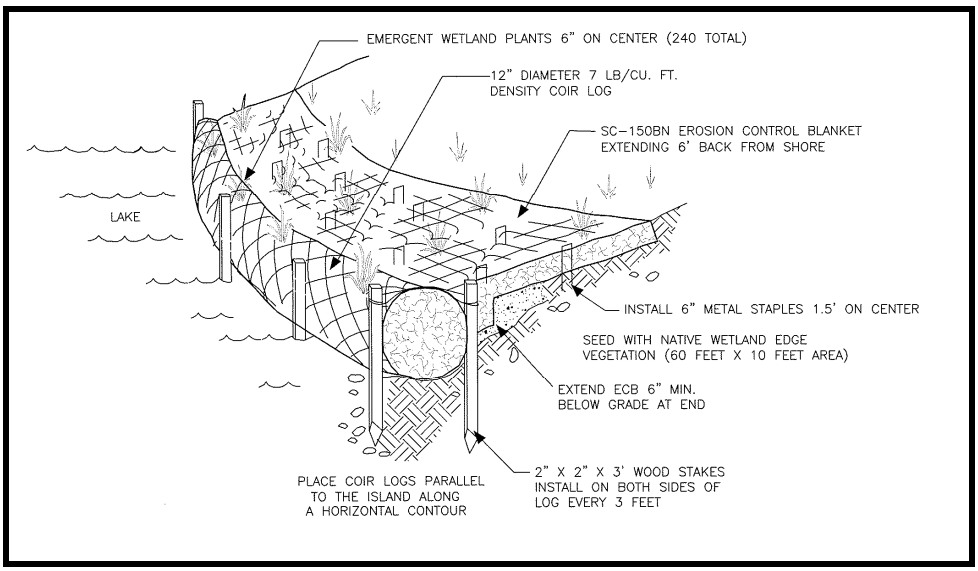


Figure 15. Conceptual coir log-native vegetation treatment.

4.2.4 Permit Requirements

An Indiana Department of Natural Resources Lakes Preservation permit will be required for the proposed project. A Section 401 Water Quality Certification from the Indiana Department of Environmental Management (IDEM) and a Section 404 Permit from the U.S. Army Corps of Engineers (ACOE) will be required because Blue Lake is a "waters of the United States." All three

regulatory agencies were contacted during the early coordination process; however, at the present time, no response has been obtained by the ACOE. Both the IDNR and IDEM support the project and view it as a permit-able project. See Appendix D for information regarding early coordination with the regulatory agencies.

4.2.5 Wetland Functional Assessment

The proposed project site is along the shoreline of Blue Lake in an area that transitions from an open water area with depths of 1 to 3 feet (0.3 to 0.9 meters) to a thin strip of un-maintained vegetation into an upland of turf grass. Along portions of the project site, several wetland plant species were present, including swamp milkweed (*Asclepias incarnata*), dogbane (*Apocynum* species), reed canary grass (*Phalaris arundinacea*), and jewel weed (*Impatiens capense*). Upland species, including Queen Anne's lace (*Daucus carota*), ragweed (*Ambrosia artemisiifolia)*, and red clover (*Trifolium pretense*), were also present along the shoreline. The remaining portion of the project is vegetated by turf grass. The wetland function of this area is to buffer the shoreline against erosion, provide habitat for aquatic biota and terrestrial species that use the lake-fringe for feeding and nesting activities. The proposed shoreline treatments will enhance and improve the wetland functions by reducing shoreline erosion and increasing habitat complexity and native species composition in this area.

4.2.6 Biological and Habitat Integrity Survey

No formal biological or habitat integrity survey was performed along the shoreline of Blue Lake. A qualitative plant survey was performed to determine the plant community present at the time of the site visit (September 2007). Table 7 details the list of the plant species identified during the site visit. The proposed site currently consists of an eroding shoreline vegetated by a mixture of native and exotic species. Both of the proposed treatments will improve and enhance the existing habitat.

Table 7. Plant species observed during a September 4, 2007 site visit to the proposed shoreline stabilization project site.

Common Name	Scientific Name	Common Name	Scientific Name
American lotus	*Nelumbo lutea*	Evening primrose	*Oenothera biennis*
American pondweed	*Potamogeton nodosus*	Goldenrod	*Solidago* spp.
Arrowhead	*Sagittaria latifolia*	Hardstem bulrush	*Scirpus acutus*
Asiatic dayflower*	*Commelina communis*	Hybrid cattail*	*Typha x glauca*
Black willow	*Salix nigra*	Jewel weed	*Impatiens capensis*
Blue vervain	*Verbena hastata*	Nodding bur-marigold	*Bidens cernua*
Broad leaf cattail	*Typha latifaolia*	Nodding smartweed	*Polygonum lapathifolium*
Buttonbush	*Cephalanthus occidentalis*	Peach leaf willow	*Salix amygdaloides*
Canada thistle*	*Cirsium arvense*	Pickerel weed	*Pontederia cordata*
Chairmaker's rush	*Scirpus pungens*	Purple loosestrife*	*Lythrum salicaria*
Cocklebur*	*Xanthium strumarium*	Reed canary grass*	*Phalaris arundinacea*
Common bur reed	*Sparganium eurycarpum*	Rice cut grass	*Leersia oryzoides*
Common duckweed	*Lemna minor*	Sandbar willow	*Salix interior*
Common ragweed	*Ambrosia artemisiifolia*	Sedge species	*Carex* species
Creeping charlie*	*Glechoma hederacea*	Swamp milkweed	*Asclepias incarnata*
Dock	*Rumex* spp.	Tall nettle	*Urtica procera*
Eelgrass	*Vallisneria americana*	White water lily	*Nymphaea tuberosa*

*Denotes exotic plant species.

4.2.7 Environmental Impact Assessment

The environmental impacts associated with the proposed project include the disturbance to the existing plant community; the addition of fill material into a lake; the temporary disturbance of the shoreline; and potential impacts to any endangered, threatened and rare (ETR) species present at the site. The plant community present along the shoreline consists of a mixture of native and exotic species. The native species that are present are not of high, rare, or unique quality. The proposed treatments will improve the diversity of the overall plant community. The stone that is placed below the current water level elevation will provide shoreline stability and habitat for invertebrates and juvenile fish.

JFNew biologists did not observe or collect any endangered, threatened, or rare flora or fauna during any site visit. A search of the Indiana DNR's Natural Heritage Database showed two ETR species being previously identified in the Blue Lake watershed: one mussel species and one turtle species. The chance that either of these species would be negatively impacted by the proposed projects is fairly small. The mussel, the purple lilliput (*Toxolasma lividus*), primarily exists in lakes, while the Blanding's turtle (*Emydoidea blandingii*) is located primarily along lake edges and in marshy habitat. Both of these species would benefit from improved water quality and increased native vegetation.

4.2.8 Unusual Physical and Social Costs

The only identified unusual physical and social cost of the proposed project includes the temporary loss of recreational opportunities within and near the site boundaries. Construction could occur over a period of one to two weeks depending upon the weather and site conditions. If construction coincided with a summer holiday, an increase chance of user conflict exists. Every attempt should be made to reduce the loss of recreational opportunities.

4.2.9 Opinions of Probable Cost and Proposed Time Line

The opinion of probable cost for the construction of 605 feet of rock toe with coir log treatment and 110 feet of coir log treatment along the shoreline on the east shoreline of Blue Lake is approximately $57,320. Table 8 details the estimated cost for developing final designs, project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Construction services include machinery, labor, and expenses associated with the installation of the materials as shown in Figures 14 and 15. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management.

Table 8. Opinion of probable costs for design and construction of the shoreline stabilization project on Blue Lake. Items costs include delivery and installation.

Item	Cost	Unit	Quantity	Total
Final Design and Permitting	$3,000	each	1	$3,000
Construction Services	$16,000	each	1	$16,000
Administrative Services	$3,200	each	1	$6,500
Mobilization/Demobilization	$6,000	each	1	$6,000
Stone	$30	ton	102	$3,060
Soil	$10	ton	95	$950
Erosion fabric	$1.20	square yard	544	$650
Coir logs	$20	linear foot	715	$14,300
Custom seed mix	$800	acre	0.75	$600
Wetland plugs	$1.50	each	700	$1,050
Contingency	10% of total			$5,211
Total				**$57,320**

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the BLA apply for design-build funding in January 2008 and if a LARE grant is awarded, contract design-build services in the fall of 2008. Materials should be placed on the islands during the winter of 2008-2009 to alleviate impacts from heavy equipment during soft ground conditions. Construction should occur the following spring of 2009 or as soon as weather conditions permit.

4.3 Bank Stabilization (Site 3)

4.3.1 Site Description and Alternatives

An unnamed tributary that enters Blue Lake from the southeastern corner (Figure 1) drains an area of 184.5 acres (75 ha) and comprises 9.1% of the total Blue Lake watershed (Table 1). The reach assessed during the current feasibility study includes approximately 2,500 linear feet (762 meters) of stream channel from the mouth of this tributary south and east to its origination in a woodlot owned by Scott Anderson. The stream generally contains flowing water to a depth of 6 inches (15 centimeters) with a width of 2 to 4 feet (0.6 to 1.2 meters).

Historically, forests vegetated by oak, black walnut, ash, beech, maple, sycamore, and tamarack trees covered much of the subwatershed. Prairies and marshes covered the remainder of the drainage area (Baskins, Forster, and Company, 1876). Following settlement, the subwatershed was cleared and converted to agricultural use. More recently, the landscape has been altered again to accommodate residential land use. A large portion of this stream flows through a mixed deciduous forest comprised mostly of ash, cherry, and maple trees. The remainder of the stream flows through a residential area adjacent to the lake. Currently, the stream drains a mix of agricultural and residential land before entering Blue Lake.

Flashy streams are often subjected to greater peak flows as a result of the volume and velocity of surface runoff (Ferguson and Deak, 1994). Rapidly fluctuating water levels and high flow volumes increase the erosive force of the water resulting in streambank and bed erosion. As water erodes material at the toe of the slope, the streambanks become unstable. This results in the sloughing of bank material. This material is then carried downstream and deposited in areas of lower velocity.

The erosion and deposition of instream material continues until sediments and sediment-attached nutrients eventually reach Blue Lake.

In an attempt to slow the process of erosion, a water and sediment control basin (WASCOB) was constructed in the upper reaches of the stream. The WASCOB is located along the edge of an agricultural field and was constructed in the 1990s. Despite its presence, sediment and sediment-attached pollutants are still reaching Blue Lake from this tributary. The diagnostic study indicated that additional stormwater structures and streambank stabilization techniques are necessary to provide increased stabilization downstream of the area where the WASCOB currently exists. Within this tributary, JFNew identified three sites where potential projects targeted at reducing sediment loading to Blue Lake could occur (Figure 16).

Figure 16. Aerial view of Site 3.1, 3.2, and 3.3 located along unnamed tributary into Blue Lake.

The first site (3.1) is located between the concrete box culvert and the beginning of the channel into the lake (Figure 17). At this site, JFNew considered a constructed wetland/sediment basin to help reduce the stream's velocity and allow any sediment to settle out of the water column before entering the channel to Blue Lake. To accomplish this, the last 50 feet (15 meters) of stream channel would be re-graded below the current elevation. The constructed wetland or sediment basin would measure approximately 30 feet by 50 feet (9 by 15 meters) with less than one foot (0.3 meters) of permanent water level of storage depth (Wayne Stanger, personal communication). Based on the

limited size, continuous maintenance would be required; however, the site is not easily accessible using heavy equipment because the spacing between houses adjacent to the site. Therefore, the project at this sub-site is not cost effective. No other options were formally developed because the site has limited space. From an economical and physical standpoint, all projects at this location were determined to be infeasible.

Figure 17. Proposed location for a constructed wetland/sediment basin (right-hand side of the picture) at Site 3.1.

The second site (3.2) encompasses the eroding, incised stream channel located upstream of the Blue Lake Road bridge (Figure 18). JFNew evaluated the feasibility of installing a series of rock grade controls along the channel. Initial surveys indicated that the site would require three grade controls to adequately reduce the grade and velocity of this stream to acceptable levels. (See Appendix E for design details.) The stream presently carries between a five and ten year storm event. This means that based on the stream channel dimensions and watershed characteristics, such as slope, land use, and soils, storm events yielding precipitation amounts up to those storms that typically occur on a five to ten year frequency will not overtop the bank. A stream channel that carries a five to ten year storm event usually becomes incised and erodes as it has in this case because the stream cannot dissipate the energy of the stormwater into the floodplain. The installation of rock grade controls at this site will reduce the capacity of the stream channel to carry less than a two-year storm event. If the grade controls are not constructed properly, then frequent out-of-bank flows and further potential for erosion as runoff reenters the channel will likely result (Wayne Stanger, personal communication). Conversely, once the channel is reconnected to its floodplain, it will routinely overtop its banks and dissipate energy in its floodplain. Once in the floodplain, sediment and sediment-attached nutrients will deposit in the floodplain, thereby, reducing sediment and nutrient loading to Blue Lake.

Figure 18. Example of the location for rock grade controls along the unnamed tributary at Site 3.2.

The third site (3.3) is located directly upstream of Site 3.2 where the stream channel developed a multiple braid pattern and contains several meanders of a short linear distance. Within this section, the stream valley narrows and the density of trees along the riparian area increases (Figure 19). Initially, multiple cross valley dam structures were considered for installation at Site 3.3; however, after reviewing topographical information and considering equipment access and cost, it was determined that one structure could be designed to capture more stormwater than multiple dams. (See Appendix E for design details.) One cross valley control dam structure will capture and store stormwater from approximately 109 acres (44 hectares) of watershed and release stormwater downstream either through a standpipe during small events or through a standpipe and emergency spillway during larger events.

Figure 19. Example of the location for a cross valley control structure at Site 3.3.

An alternative solution for both Site 3.2 and 3.3 is to take no action. Under this option, the streambanks will continue to erode and banks continue to slough along the length of the stream. This option will not result in any improvements of instream water quality nor will the delivery of sediment and sediment-attached pollutants be reduced. The best alternative to address streambank and bed erosion in this tributary is to install the cross valley control structure (Site 3.3) and rock grade control structures in the upper reach of the stream (Site 3.2).

4.3.2 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. Two landowners are involved with Site 3.2 and Site 3.3. At this time, one landowner returned a signed copy of the landowner agreement, while the second landowner has not. Copies of the signed and unsigned landowner agreements are in Appendix B. JFNew and the BLA will continue to pursue the remaining landowner's permission and a signed copy will be included in the final feasibility report.

4.3.3 Preliminary Design and Conceptual Drawings

Grade controls (rock dams) are designed to effectively raise the bed elevation of the stream channel to a level where the 2-year flow fills the channel banks. This results in backing water up to the next upstream grade control during a high flow event. Figure 20 depicts a typical cross sectional view of a grade control. Over a period of time, sediment that is suspended in the water column during channel inundation will be deposited in the slack water areas between grade controls. Over time, the sediment deposition will raise the stream bed elevation. By controlling or reducing the grade of this stream, water velocity will decrease, thereby allowing sediment and sediment-attached pollutants to

drop out of the water column. Additionally, 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 will spread out and the erosive force on the banks (i.e. velocity and shear stress) will be reduced.

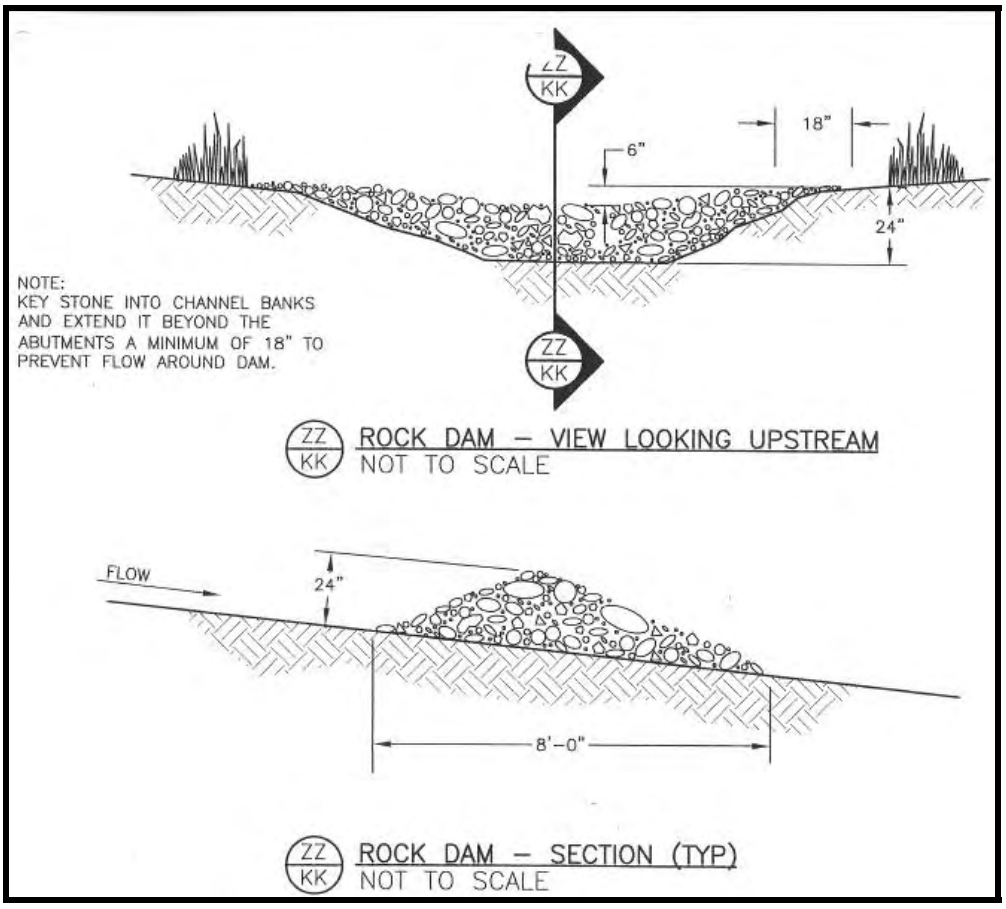


Figure 20. Conceptual grade control (rock dam) detail.

Figure 21 shows the locations where a series of three rock dams are proposed to be installed. Rock dams typically consist of rock with an average diameter of 6 inches or greater installed in a stream or ditch to a predetermined height. 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.

Figure 21. Proposed location for rock grade control structures.

The proposed cross valley control dam structure is designed to accumulate stormwater. . Once accumulated, the structure will slowly release stormwater over a rock-lined chute and back into the stream (Figure 22). During a storm event, sediment that is suspended in the water column during channel inundation will be deposited in the slack water area behind the control dam structure.

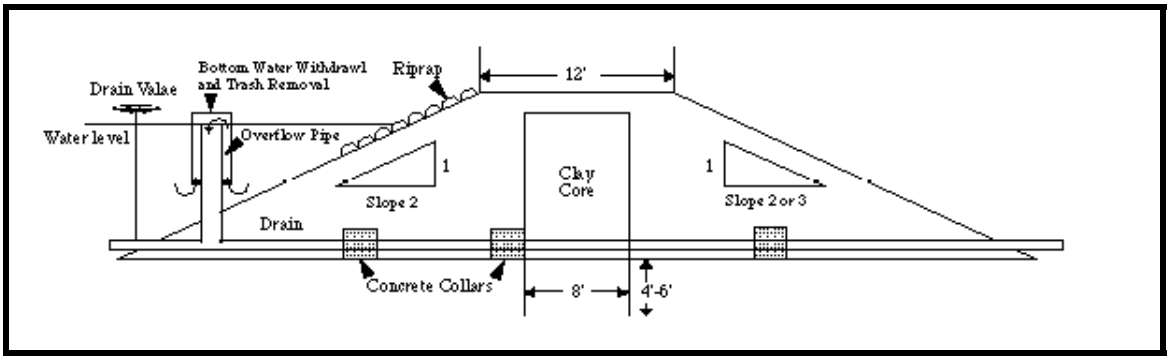


Figure 22. Conceptual cross valley control dam structure.

Figure 23 shows the location where the cross valley control dam would be located. A 6-inch (15-centimeter) pipe with an 18-inch (46-centimeters) riser is proposed to drain the storage portion of the runoff with an approximate drawdown time of 26 hours. Runoff from greater than the storage volume will be passed over the embankment through a rock chute spillway. This structure, in

combination with the rock grade controls downstream, has the potential to reduce the sediment entering the lake during frequent storm events.

A 2-year, 5-year, and 10-year 24-hour storm events would deliver 9.1, 14.3, and 17.8 acre-feet, respectively (13,500,21,200, 26,400 cubic meters) of runoff into a basin. However, the basin can store only 3.9 acre-feet (4,800 cubic meters). The storage of only 43, 27, and 22% of the runoff from 2-year, 5-year, and 10-year storm events limits the effectiveness of the basin to completely settle out sediments and sediment-attached pollutants. The basin will likely fill during the first part of the storm event when sediment loading is low and, when of greatest concern, the basin will pass sediment downstream through the overflow structure without retention as the basin will be full. Although, the low watershed area to lake area ratio indicates any watershed improvements will improve and protect the water quality within Blue Lake. With homes below the embankment, it will be necessary to confirm the DNR regulations and dam classifications. It may be necessary to design the structure with a fifty-year storm spillway.

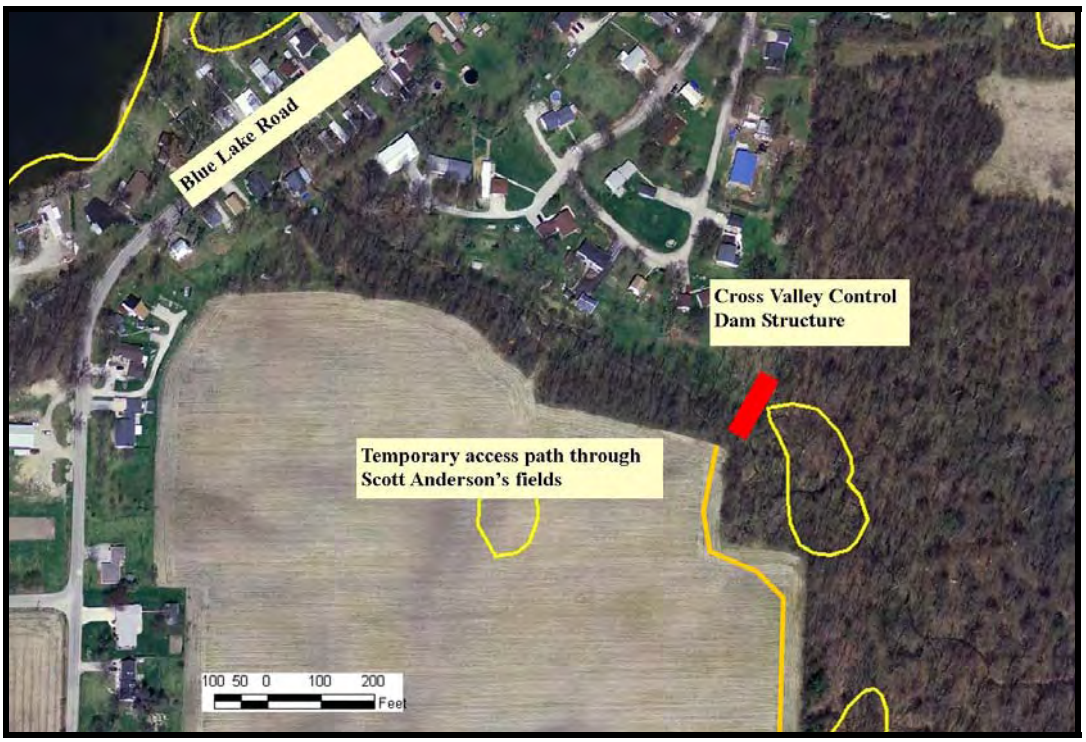


Figure 23. Location of proposed cross valley control dam structure on tributary to Blue Lake and the location of a wetland (in yellow) potentially affected by project.

4.3.4 Permit Requirements

A Section 401 Water Quality Certification from the IDEM and a Section 404 Permit from the ACOE will be required because this tributary is a "waters of the United States". An IDNR permit will not be required because the drainage area is less than one square-mile. Additionally, construction will not occur within a half-mile of the outlet of Blue Lake. All three regulatory agencies were contacted during the early coordination process; however, at the present time, no response has been obtained by the ACOE. IDEM viewed the rock grade controls for Site 3.2 as a permit-able activity. There was concern from IDEM that the cross valley grade control structure was not a permit-able activity because it might negatively affect the upstream wetland and that it would be considered in-

line detention, which is not regularly allowed by IDEM. Providing additional information to IDEM, including a pre-application meeting should be considered prior to the BLA moving forward with the construction of Site 3.3. See Appendix D for information regarding early coordination with the regulatory agencies.

4.3.5 Wetland Functional Assessment

According to the United States Fish and Wildlife Service's National Wetlands Inventory (NWI), there is a 0.8 acre (0.3 hectare) seasonally-flooded, forested wetland upstream of the proposed cross valley control dam structure (Figure 23). The wetland provides flood control and wildlife habitat. These functions will not be negatively impacted by the project. The flood control capacity of the wetland will be increased by the installation of the control dam structure. The wildlife habitat will not be negatively impacted because physical disturbance to the site will be limited to the footprint of the control dam structure.

4.3.6 Biological and Habitat Integrity Survey

Stream habitat was evaluated on September 6, 2007 using the Headwater Habitat Evaluation Index (HHEI). The HHEI was developed by the Ohio EPA for Ohio streams with drainage areas measuring less than one square-mile (259 hectares) and a maximum pool depth measuring less than 16 inches (40 centimeters; Ohio EPA, 2002). The Ohio EPA developed the HHEI to classify small streams and drainages into one of three groups. The groups are Class I (an ephemeral stream with a normally dry channel and little to no aquatic life); Class II (a stream with flowing water or isolated pools for an extended period of time and dominated by warm water-adapted aquatic biota); and Class III (a flowing stream comprised of cool and cold water-adapted aquatic biota). The HHEI is the first step of a three phase evaluation to accurately classify a stream. The second two phases involve biological assessments at different levels of taxonomic scale. The HHEI evaluates three habitat variables to assign an HHEI score. Substrate composition, including the dominate type of substrate, such as sand, silt, and gravel, and the total number of substrates, bankfull width, and maximum pool depth are evaluated to develop an HHEI score. This information can then be used to classify the stream into one of the three previously mentioned classes (Class I, Class II, or Class III). HHEI scores range from 9 to 100.

The HHEI metric score for the project site is listed in Table 9. The datasheet is included in Appendix C. The habitat assessed in this tributary received a score of 39, which indicates that the stream habitat is classified as a Class II intermittent stream. The HHEI score indicates that habitat may be one factor impairing aquatic life in the stream. The lack of hard substrate, shallow maximum pool depth, and a narrow bankfull width characterize the habitat at this reach.

Table 9. HHEI Scores for the tributary assessment reaches as sampled September 6, 2007.

Site	Substrate Score	Max Pool Depth	Bankfull Score	Total Score
Maximum Possible Score	40	30	30	**100**
Unnamed Tributary	9	15	15	**39**

4.3.7 Environmental Impact Assessment

Environmental considerations relevant to the proposed project include: impacts to streams and wetlands; flooding; endangered, threatened, and rare species; water quality; stream habitat; and stream biota. Specifically, the environmental impacts associated with this project include: the

addition of fill material to a "waters of the United States", the temporary disturbance of the streambed and bank during construction, and the potential for increased flooding on adjacent farm fields and residential areas if structures are not designed or constructed properly. The proposed project can proceed with a minimal negative impact to the environment. JFNew biologists did not observe or collect any endangered, threatened, or rare flora or fauna during any site visit. A search of the Indiana DNR's Natural Heritage Database showed two ETR species previously identified in the Blue Lake watershed: one mussel species and one turtle species. The chance that either of these species would be negatively impacted by the proposed projects is fairly small. Rather than negatively impacting the environment, installing grade controls and a cross valley control dam structure in proposed locations will reduce erosion along the length of the stream, thereby reducing sediment loading into the channel and, ultimately, into the lake.

4.3.8 Unusual Physical and Social Costs

The identified unusual physical and social costs associated with design and construction of the proposed project is accessing the proposed project sites through landowner's property, working with the landowner to determine material locations, and potential monitoring and maintenance. For construction of the control dam structure, clay soil will be required to construct the embankment dam properly. Unless an agreement is reached with the landowner to use a portion of the crop field as a borrow area, clay soils will have to be brought in from off-site. Bringing materials in from off-site will likely increase the cost of embankment construction by five times what it would be if on-site fill material are used. The BLA should be responsible for monitoring and maintaining the grade controls and the cross valley dam structure.

4.3.9 Opinions of Probable Cost and Proposed Time Line

The opinion of probable cost for the final design, permitting, and construction of three rock grade controls and the cross valley control dam structure is approximately $77,550 (Tables 10 and 11). Cost estimates were developed for each sub-site (3.2 and 3.3) independently. If the BLA attempted both project at the same time, there will likely be a cost savings because permitting and administrative services for each project could be combined. Additionally, costs to the lake association could be further reduced if an agreement could be reached between a nearby landowner would donate the use of their property as a borrow pit for soil in construction of the control dam structure. Tables 10 and 11 detail the estimated cost for developing final designs, project permitting, purchasing materials, constructing the project, and cleaning-up the site following construction. Construction services include machinery, labor, and expenses associated with the installation of the materials as shown in Figures 20 and 22. Administrative services include bid development, subcontractor identification, contract development, communication, construction oversight, report preparation, and project management.

The recommended project timeline is based on LARE grant funding cycles. It is recommended that the BLA apply for design-build funding in January 2009, contract design-build services in 2009, and design and construct the project starting in the fall of 2009 or as permits become available.

Table 10. Opinion of probable costs for design and construction of three rock grade controls in the unnamed tributary to Blue Lake. Items costs include delivery and installation.

Item	Cost	Unit	Quantity	Total
Final Design and Permitting	$2,000	Each	1	$2,000
Administrative Services	$1,000	Each	1	$1,000
Construction Services	$2,500	Each	1	$2,500
Mobilization/Demobilization	$1,000	Each	1	$1,000
Riprap	$20	Ton	60	$1,200
Seed and Erosion Control	$100	Each Dam	3	$300
Contingency	10% total			$800
Total				**$8,800**

Table 11. Opinion of probable costs for the control dam in unnamed tributary. Items costs include delivery and installation.

Item	Cost	Unit	Quantity	Total
Final Design and Permitting	$3,000	Each	1	$3,000
Administrative Services	$6,500	Each	1	$6,500
Construction Services	$37,000	Each	1	$9,250
Earthen Fill	$15	Cubic Yard	1850	$27,750
Mobilization/Demobilization	$4,000	Each	1	$4,000
Clearing	$5,000	Acre	0.4	$2,000
Riprap	$20	Ton	200	$8,000
Basin Drain	$1,500	Each	1	$1,500
Seed and Erosion Control	$1,000	Acre	0.5	$500
Contingency	10% total			$6,250
Total				**$68,750**

4.4 Sediment Basin-Rock Chute (Site 4)

4.4.1 Site Description and Alternatives

The project site is located south of Blue Lake Road approximately 300 feet (91 meters) southwest of the unnamed tributary previously discussed (Site 3). This site consists of an eroding hillside (Figure 1 and 24). The problem is the result of concentrated stormwater, which flows through the lowest point in the topography creating and increasing existing erosion. From talking with the landowner, a nick or gully point formed in the past and with each storm event, the erosion increased resulting in additional sediment loading into Blue Lake. The initial conceptual design included creation of a sediment basin at the top of the hill that would store stormwater and slowly release it down the hill. The design was expanded to include the installation of a WASCOB on the adjacent agricultural field owned by Scott Anderson to store additional stormwater before it would reach the sediment basin. In theory, both practices would reduce the volume and velocity of stormwater through the erosion point. A field survey followed by a desktop analysis revealed that the surrounding watershed was too large for the size of sediment basin and WASCOB that could be feasibly constructed at this site. The sediment basin would be constricted by utility poles on one side and a wooded area on the other (Figure 24). The WASCOB would be limited in size due to the topography. Two different sized WASCOBs were investigated as alternate designs; however, both WASCOB sizes were determined to be infeasible due to the limited storage time for water and lack of sediment treatment.

Appendix E contains design data that was used to evaluate the site. It was concluded that both a WASCOB and a sediment basin would fill too quickly during a storm event and allow the untreated stormwater carrying sediment to flow over both structures and enter the lake through overland flow.

Figure 24. Eroding hillside present at Site 4.

After stormwater storage and treatment options were exhausted, it was determined that the best option to reduce erosion at this site was to install a rock chute at the point of erosion (Figure 24). The rock chute will function to convey the water down the hillside and limit the erosion potential. The treatment does not reduce the sediment coming from the adjacent farm fields.

Currently, Scott Anderson practices no-till farming on the majority of his corn and soybean acres including the adjacent field, which helps to reduce erosion and sediment transport when compared to traditional tillage methods. Additional water quality benefits could be obtained by converting the adjacent field to a permanent cover such as grassland, pasture, or woods, or enrolling the parcel in a government conservation program such as the Conservation Reserve Program (CRP). The BLA should work with the local NRCS office and Mr. Anderson to evaluate his interest any programs.

Another alternate solution is to take no action. If no action is taken, the hillside will continue to erode and contribute to sediment loading to Blue Lake. Given the proximity of a house to the eroding hillside, no action may result in the loss of a residential yard and a decrease in the aesthetic quality of the residence.

4.4.2 Easement and Land Availability Determination

Landowner permission was obtained for accessing the site for field work during the conceptual design phase after providing the owner with a description of the purpose of the feasibility study and the benefits to the lake. After a conceptual design was completed, the landowner was sent information describing the design and was asked for his written permission to proceed with the final

design and eventually construction, if funds became available. A copy of the signed landowner agreement is in Appendix B.

4.4.3 Preliminary Design and Conceptual Drawings

Rock-lined chutes consist of a layer of rip-rap or glacial field stone placed over geotextile fabric to protect the soils where a concentrated flow of water exists (Figure 25). Typically, the entry point of the rock chute is keyed below the existing grade to inhibit undermining of the chute. At this site, a rock-lined chute will prevent further erosion to the hillside, reduce sediment into the lake, and guide water down the slope to the base of the hill. The chute will be excavated into the hill to the appropriate dimensions to convey stormwater up to the volume expected from a storm event that occurs every 25 years (See Appendix E for design details).

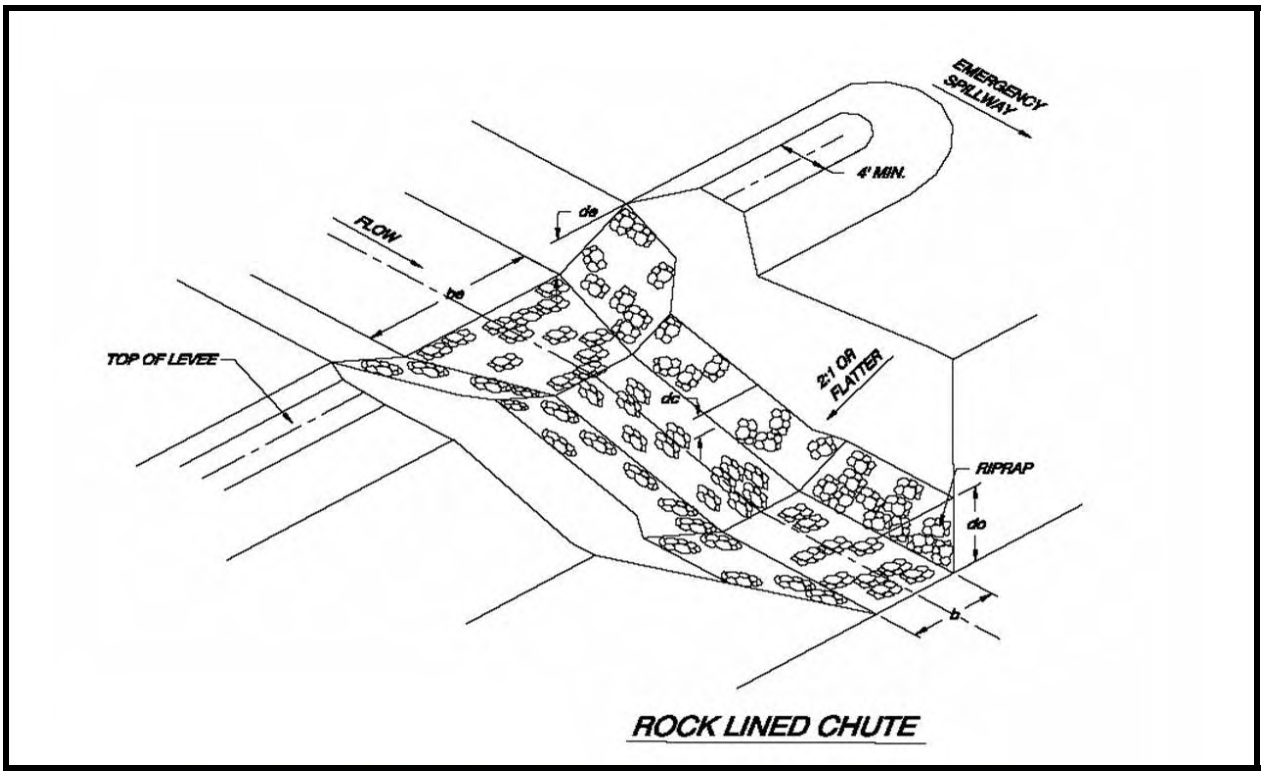


Figure 25. Conceptual design of a rock-lined chute.

Figure 26 shows the location of the proposed rock-lined chute. For this site, a rock-lined chute installed at the existing point of erosion (Figure 24) is the recommended solution. The proposed rock chute will utilize 6-inch (15-cm) riprap and will measure 12 feet (4 meters) wide by 34 feet (10 meters) in length. The rock lining will stop the bank erosion, but will have little effect on reducing sediment loading to Blue Lake caused by land use and watershed characteristics upstream of the chute. Attempts were made to address watershed-based and water quality issues during the conceptual design phase; however, it cannot be addressed at this time.

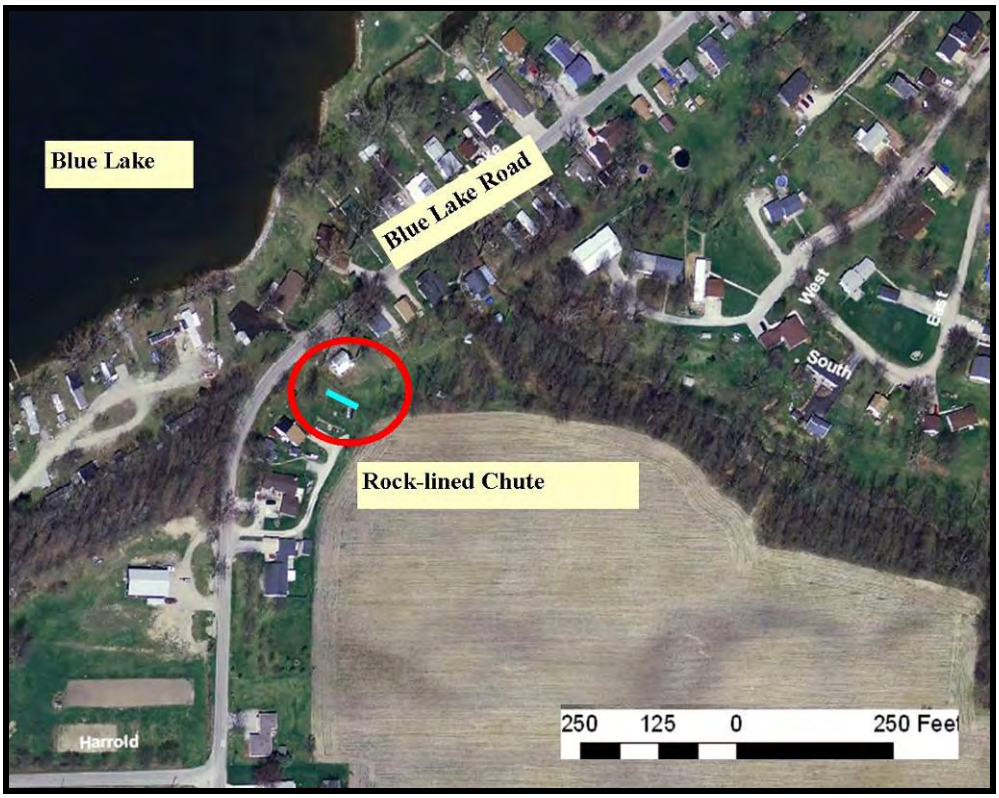


Figure 26. Proposed location for rock-lined chute.

4.4.4 Permit Requirements

No permits will be required for the rock-lined chute.

4.4.5 Wetland Functional Assessment

No wetlands are located within the vicinity of the project site.

4.4.6 Biological and Habitat Integrity Survey

The impacts to habitat associated with the project site are limited due to the lack of habitat. Residential properties, including the project site, are primarily vegetated by turf grass. The wooded stream corridor located to the east of the project site will not be disturbed during construction. The project site consists of a mix of cool season grasses, such as timothy, orchard grass and fescue, and forbs, such as goldenrod, aster, and burdock.

4.4.7 Environmental Impact Assessment

There will be limited environmental impact associated with this project. The Dunn property is in primarily residential land use.

4.4.8 Unusual Physical and Social Costs

The unusual physical and social costs for this project include the access and construction of the structure and potentially monitoring and maintenance. There are homes located on either side of the erosion area and a sewer line is located approximately 30 feet (9 meters) downhill of the erosion area. If excavation occurs outside of the project limits, equipment access and construction activities need to be planned to minimize the potential for utility damage. The landowner should be

responsible for monitoring the project and work directly with the BLA to determine maintenance responsibilities.

4.4.9 Opinions of Probable Cost and Proposed Time Line

The opinion of the probable cost for rock-lined chute construction is approximately $2,640. This estimate includes final design and construction of a rock-lined chute at the Dunn property (Table 12). Due to the low cost of the project, it is recommended that the BLA either include this project in a LARE grant application with another project, such as the shoreline stabilization project, or work directly with the landowner to construct the project. This project should proceed when funding becomes available to complete the effort and should be timed to minimize potential damage from large vehicles on soft ground.

Table 12. Opinion of probable costs for design and construction of the rock-lined chute. Items costs include delivery and installation.

Item	Cost	Unit	Quantity	Total
Final Design	$200	each	1	$200
Administrative Services	$700	each	1	$600
Construction Services	$1,000	each	1	$1,000
Riprap	$20	ton	20	$400
Seeding and Site Cleanup	$200	each	200	$200
Contingency	10% of total			$240
Total				**$2,640**

4.5 <u>Bank Stabilization and Old Pond Wetland Restoration Site 5</u>

4.5.1 Site Description and Alternatives

Site 5 is located along an unnamed tributary located on the south side of Harrold Road west of the public access ramp. The tributary originates upstream of a former pond owned by Scott Anderson. The stream continues north toward the lake for approximately 1,500 feet (457.2 m; Figure 27). The tributary is surrounded by a wooded riparian buffer. After the stream crosses Harrold Road, it enters a culvert for approximately 280 feet (85.3 m) before daylighting again approximately 75 feet (22.9 m) immediately upstream of Blue Lake. The tributary drains a subwatershed on the southwest section of the lake and accounts for 4.1% of the Blue Lake watershed (Table 1).

Figure 27. Aerial view of drainage associated with Site 5.

The first area of concern (5.1) is the former pond located near the headwaters of this drainage. Historically, a pond was contained within this drainage; however, landowner concerns resulted in the dam being breached and the basin drained. Because of this breach and the continued flow of water through this area, erosion is occurring were the dam was breached. Erosion has the potential to continue through the dam and move upstream into the former basin releasing sediment and sediment-attached nutrients downstream to Blue Lake. Addressing the erosion at the dam has the potential to positively benefit both the channel directly downstream of the pond and the channel at the mouth of the culvert. At a minimum, a rock grade control structure should be installed across the channel at the dam breach to stabilize the channel and prevent erosion from continuing upstream (Option 1). This option does very little to alleviate the erosion downstream; however, the problem should not get any worse if Option 1 is implemented. A second option (Option 2) is to repair the dam to store stormwater and slowly release it downstream into the existing channel through the use of a standpipe and tile. Option 2 has the potential to reduce the velocity and volume of stormwater, which helps alleviate or reduce downstream erosion issues and allows for increased sediment and sediment-attached pollutant storage within the existing pond basin. During the conceptual design phase, the landowner was receptive to the idea of repairing the dam structure to increase water storage; however, he was not interested returning the area to an open water pond. Any design would have to temporarily store water and release it downstream.

The second area of concern at Site 5 (5.2) is the approximate 250 feet (76.2 m) of stream channel upstream of Harrold Road and downstream of the old pond basin. The channel along the reach is eroding and becoming incised (Figure 28). Initially, the conceptual design included the installation of a series of rock grade controls to stabilize the stream bed and bank and allow access to the

floodplain. It was determined after a field inspection that rock grade controls within the 250 feet of stream would have a minimal effect on reducing erosion due to the limited size and high sinuosity of the channel and lack of support from one adjacent landowner. To effectively stabilize the banks, the volume and velocity of water coming from the upper part of the watershed needs to be reduced. Additionally, until the downstream landowner is willing to participate in the project, this portion of the project is infeasible.

If none of the available options for sites 5.1 or 5.2 are pursued by the BLA (the no-action alternative), the stream channel will continue to erode at the current rate. Eventually, the channel will erode back through the breach area and continue through the former pond basin. This will result in sediment and sediment-attached pollutants entering Blue Lake. If the land use in the watershed changed from row-crop agriculture to permanent cover, a no-action alternative might be feasible because stormwater volume and velocities would be reduced; however, the probability that will happen is extremely low due to currently high commodity prices.

Figure 28. Example of the eroding stream channel downstream of the old pond at Site 5.

Finally, the third area of erosion exists immediately upstream of Blue Lake. The streambanks just upstream of Blue Lake possess mild erosion with the greatest amount of erosion occurring at the transition between the culvert and the open channel (Figure 29). Along the left downstream bank, shrubs stabilize the channel with their root structure. These treatments were determined to have a low benefit-to-cost ratio. The right downstream bank is dominated by turf grass, which has shallow roots; however, limited erosion was observed along this portion of the stream. The erosion that is occurring at the mouth of the culvert can be addressed by working on reducing the velocity and volume of stormwater moving through the channel from the upper part of the watershed. Potential treatments to stabilize the banks at this site include a rock toe or bank re-grading and vegetation establishment. The installation of a small amount of riprap is considered to be the only option to correct the minor erosion present at this reach. However, this does nothing to reduce the volume of

sediment already in the stream. Potential treatment at this site is also limited because the stream lies on a property line. One landowner allowed permission for an initial survey, while the other did not respond to a request for permission and could not be contacted. Any improvements at this location would provide minimal benefits in reducing the erosion in this stream. This coupled with the lack of landowner agreement, results in this project being considered infeasible.

At this third area, a no-action alternative will result in continued erosion at the mouth of the culvert. There is also the potential for additional erosion downstream if the channel moves due to the build up of sediment within the channel. If Option 2 for the upstream basin (Site 5.1) is constructed, the erosion at the mouth of the culvert may decrease as a result of decreased stormwater volume and velocities due to retention upstream.

Figure 29. Potential site for bank stabilization on tributary south of Lake.

4.5.2 Easement and Land Availability Determination

One individual currently owns the parcel of land where the old pond restoration project is proposed. Presently, the property owner has no definite plans for the existing pond site and surrounding area; therefore, the land is available for design and construction of the proposed project. A signed copy of the landowner permission letter for the implementation of the project as conceptually designed is included in Appendix B. One of the landowners downstream of the pond was not interested in participating in the feasibility study. There was mention during a BLA meeting in December 2007 that the landowners might reconsider and want to work with the BLA in the future. When the project moves to the design phase, it may be worthwhile to determine the downstream landowner's interest at that time.

4.5.3 Preliminary Design and Conceptual Drawings

Option 1 includes construction of a grade control structure at the point of the dam breach (Figure 30). The structure is designed to maintain the current pool elevation. The grade control structure will

be constructed of stone, either standard revetment riprap or glacial field stone, and keyed into the sides of the earthen dam and below the grade of the stream bed. The grade control structure will prevent a head cut from moving through the dam and sending fine sediment and sediment-attached pollutants to the lake.

Figure 30. Proposed location for either Option 1 or Option 2 feasibility projects and locations of wetlands (in yellow) potentially affected by project.

Option 2 consists of reconstructing the embankment (or dam) across the valley and installing it to approximately a height of 8 feet (2.4 m). A standpipe will be installed within the basin. This standpipe will be used to release water downstream through a tile into the stream channel. Additionally, an emergency spillway will be constructed to handle a 25-year storm event to release water over the dam during major storm events. The anticipated drawdown time for the dam will be approximately 22 hours and store approximately 3.1 acre-feet (3,823 cubic meters) of water (Appendix E).

If Option 2 is pursued by the BLA, the dam should be reconstructed by removing the majority of the current embankment and rebuilding it within the same footprint. This is necessary because large trees are present in and on the berm with roots exposed in the breach area. To simply remove the trees will leave behind roots to decay creating tunnels and weakening the embankment. Material from the existing dam can be used to rebuild the dam if it is free of debris and woody material. The remaining fill can be taken from the basin, if constructed during dry conditions.

At this point, neither option has been selected by the BLA. The landowner is receptive to both conceptual ideas, which will help to reduce sedimentation into Blue Lake. Option 2 offers the

additional benefit of stormwater detention; however, there is an increased cost associated with it. From discussions with the BLA, work at this project site will be pursued in a few years (approximately 2009-2010) after a couple of other projects have been completed. When the BLA is ready to pursue the project at the old pond site, they should consider both options and make a decision based on cost and benefit to Blue Lake water quality.

4.5.4 Permit Requirements

A Clean Water Act Section 401 Water Quality Certification from IDEM and a Section 404 Permit from USACOE are required because the unnamed tributary is a "waters of the United States". An IDNR permit will not be required because the drainage area is less than one square-mile. Additionally, construction will not occur within a half-mile of the outlet of Blue Lake. All three regulatory agencies were contacted during the early coordination process; however, at the present time, no response has been obtained by the ACOE. IDEM will require additional information, including the age of the structure and when it was breached before they make their final decision. Because Site 5.1 is an existing site, it may qualify for a permit when similar activities for new construction would not. A pre-application meeting should be considered prior to the BLA moving forward with the construction of Site 5.1. See Appendix D for information regarding early coordination with the regulatory agencies.

4.5.5 Wetland Functional Assessment

According to the NWI, a 2.2 acre (0.8 hectare) area upstream of the cross valley control dam structure is classified as two different wetland types (Figure 30). The area directly upstream of the proposed structure location is classified as a 0.8 acre (0.3 hectare) pond, while the more headwaters wetland is classified as a 1.3 acre (0.5 hectare) seasonally-flooded, emergent wetland. Both wetlands provide flood control and wildlife habitat. These functions will not be negatively impacted by the project. The flood control capacity of the wetland will be either maintained by Option 1 or increased by Option 2. The wildlife habitat will not be negatively impacted because physical disturbance to the site will be limited to either the dam breach area (Option 1) or the embankment area (Option 2). As part of the embankment reconstruction, material will likely be taken from the pond basin. Currently, the basin is dominated reed canary grass (*Phalaris arundinacea*), which is a low quality, exotic plant species with relatively little wildlife habitat value. As part of the final design for Option 2, the disturbed areas of the wetland will be seeded with a more diverse mix of native wetland vegetation that currently exists at the site, which will increase the wildlife habitat value.

4.5.6 Biological and Habitat Integrity Survey

No formal biological or habitat integrity survey was performed. A qualitative plant survey was performed to determine the plant community present at the time of the site visit (May 2007). Large trees, such as cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), and willow (*Salix* species), are growing on the embankment. Filamentous algae, curly-leaf pondweed (*Potamogeton crispus*), and duckweed (*Lemna* species) grow within the existing pond basin, while cattails (*Typha latifolia*), reed canary grass (*Phalaris arundinacea*), and blue vervain (*Verbena hastata*) vegetate the pond's shoreline.

4.5.7 Environmental Impact Assessment

Environmental considerations relevant to the proposed project include: wetlands; endangered, threatened, and rare (ETR) species; water quality; flooding; stream habitat; and stream biota. Both options will have a minimal negative impact to environmental factors. A search of the Indiana DNR's Endangered, Threatened, or Rare Species database resulted in two species being found

within the Blue Lake watershed: one mussel species and one turtle species. The chance that either of these species would be negatively impacted by either option is fairly small.

For both options, flooding will either remain the same or decrease due to stormwater storage. The grade control structure will be sized such that the current pool elevation is maintained. Neither Option 1 nor Option 2 will increase the existing pond basin size, which could flood areas higher in the watershed, nor decrease the size of the pond basin, which could flood areas lower in the watershed. Since periodic inundation or flooding of the areas within the pond basin currently occurs, it is likely that this natural water storage regime will continue. Option 2 will temporarily increase the amount of standing water following a rain event; however, the structure is designed to drawdown within 22 hours after a rain event. Both options will stabilize the existing pond basin, preventing a potential pulse of sediment and nutrient-laden water from moving downstream.

The stone used to build the grade control structure of Option 1 and the spillway for Option 2 will offer aquatic biota in-stream habitat within the stream channel. Blue Lake water quality will be protected as sediment and sediment-attached pollutants are prevented from entering the water column or fall out of suspension within the existing pond, thereby reducing sediment and sediment-attached pollutant loading downstream and, ultimately, in Blue Lake. For both options, construction activities such as excavation and modification of the stream channel and/or failed embankment and localized disturbance to the riparian zone have the potential to impair both water quality and habitat temporarily. Proper erosion control techniques, as well as, planning construction during seasonally dry periods should minimize the negative impacts of either option.

4.5.8 Unusual Physical and Social Costs

Unusual physical and social costs associated with design and construction of this project include: avoiding wetland areas, attaining access to the project site, avoiding transport of sediment and sediment-attached pollutants downstream during construction, and removing the remaining failed embankment structure, and potentially monitoring and maintaining the sites. A wetland is located upstream of the embankment, every attempt should be made to minimize disturbance to the wetland. The site will be accessed through an existing agricultural field, which requires that the project be constructed following fall harvest and prior to spring tillage activities. Either the grade control installation or the embankment re-construction should occur when the site conditions are relatively dry to minimize disturbance. Portions of the remaining failed dam structure will be incorporated into the newly constructed grade control. However, some of portions of the dam will need to be moved from their existing positions to ensure that the structure of the grade control conforms to the project design. Any movement of the existing failed dam structure will occur within the temporary barrier to minimize the transport of sediment and sediment-attached pollutants downstream. The BLA should be responsible for monitoring and maintaining the structures within the site and work directly with the landowner to coordinate any maintenance activities.

4.5.9 Opinions of Probable Cost

The opinion of probable cost for Option 1 is $8,850 for a grade control structure through the existing embankment (Table 13). The option of probable cost for Option 2 is $27,060 for the reconstruction of the existing embankment and the installation of a standpipe and rock spillway (Table 14).

The recommended project timeline is based on the LARE grant funding cycles. It is recommended that the BLA apply for design-build funding in January 2010, contract design-build services in 2010, and design and construct the project in the fall of 2010 post crop harvest.

Table 13. Opinion of probable cost for Option 1 – design and construction of a grade control at the old pond project Site 5.

Item	Cost	Unit	Quantity	Total
Final Design	$2,000	each	1	$2,000
Administrative Services	$1,500	each	1	$1,500
Construction Services	$2,000	each	1	$2,000
Clearing	$5,000	acre	0.1	$500
Riprap (9 inch)	$30	ton	40	$1200
Excavation for Grade Control	$6	cubic yard	75	$450
Seeding and Site Cleanup	$1,000	acre	0.40	$400
Contingency	10% of total			$800
Total				**$8,850**

Table 14. Opinion of probable cost for Option 2 – design and re-construction of the embankment at the old pond project Site 5.

Item	Cost	Unit	Quantity	Total
Final Design and Permitting	$3,000	each	1	$3,000
Administrative Services	$3,000	each	1	$3,000
Construction Services	$2,000	each	1	$2,000
Clearing	$5,000	acre	0.35	$1,750
Riprap (9 inch)	$30	ton	160	$4,800
Mixed Gravel	$20	ton	15	$300
Excavation for Dam – on site soil	$5	cubic yard	1350	$6,750
Excavation for Core Trench	$6	cubic yard	175	$1,050
Basin Drain	$1,550	each	1	$1,550
Seeding and Site Cleanup	$1,000	acre	0.40	$400
Contingency	10% of total			$2,460
Total				**$27,060**

5.0 RECOMMENDATIONS

1. Apply for a LARE grant in 2008 for the design and construction of recommended shoreline stabilization project (Site 2). Begin design of project in spring of 2008 and place materials on-site during the winter of 2008-09 in preparation of construction in spring of 2009.

2. Apply for a LARE grant in 2008 for the design and construction of the rock-lined chute (Site 4). Begin design of the project in the summer of 2008 with construction to begin in the fall of 2008.

3. Apply for a LARE grant in 2009 for the design and construction of rock grade controls and cross valley control dam (Site 3). Begin design of the projects in the fall of 2009 with

construction to begin in the fall of 2009 – winter of 2010 with completion prior to farming activities starting or as soon as permits are acquired.

4. Revisit feasibility options at Site 5 and decide which option to pursue (fall of 2009). Apply for a LARE grant in 2010 for the design and construction of the selected option at Site 5. Begin design of the project in the fall of 2010 with construction to begin the fall of 2010 – spring 2011.

5. Continue to work on education efforts and wetland 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 BMPs and wetland restoration projects were recommended. A long-term, trusting relationship with these landowners may result in conservation and/or restoration project implementation.

6. Continue to pursue individual BMPs recommended in the diagnostic study. Use the shoreline stabilization as an example for lake residents who want to stabilize their shoreline.

6.0 LITERATURE CITED

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APPENDICES

BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

APPENDIX A:

POTENTIAL WATER QUALITY IMPROVEMENT PROJECTS

BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

Blue Lake Feasibility Project Descriptions
Following March 13, 2007 Watershed Tour

NOTE: The purpose of this document is to demonstrate the process used during project identification and follow-up. A complete discussion of the projects pursued by JFNew and the Blue Lake Association can be found in the body of the feasibility report.

Project 1 (NRCS-1) – Wetland Restoration along the Maloney Ditch, east of Blue Lake Road.
Description:
Create a five-acre wetland in a farm field adjacent to Maloney Ditch.

Responsibility: Amy Lybarger, Whitley County, NRCS.

Project 2 (NRCS-2) – Water detention structure at the top of the Drain No. 1.
Description:
Create a water detention structure of some type at the top of Drain No. 1 to slow runoff from adjacent farm fields into the drain.

Responsibility: Amy Lybarger, Whitley County, NRCS will pursue potential design and funding options with landowner.

Project 3 (NRCS-3) – Filter strips in field along wooded area near Drain No. 4.
Description:
Install filter strips in the farm field along the wooded area near Drain No. 4.

Responsibility: Amy Lybarger, Whitley County, NRCS will pursue design and funding options with landowner.

Project 4 (JFN/BLA-1) – Potential wetland restoration near Cozy Comforts Campground, west of Blue Lake Road.
Description:
Restore approximately 4 acres of wetland along Maloney Ditch. Wetland vegetation consists primarily of reed canary grass. Design will look at the potential of routing ditch through wetland and provide filtering before bringing back into existing channel.

Responsibility: JFNew and Blue Lake Association.

Next Actions: Obtain landowner permission to survey property (BLA), Review available topographic information (JFN), Survey site to determine feasibility and collect design data (JFN)

Project 5 (JFN/BLA-2) – Shoreline restoration on the lakeward side of the islands at the southeast corner of the lake (Drain No. 1).
Description:

Stabilize the eroding shoreline on the lakeward side of the two islands using bioengineering techniques. Typically solutions will focus on establishing a rock toe prevent undercutting from wave action; re-grading and stabilizing the shoreline with a biodegradeable erosion control material, and planting a buffer of native vegetation to provide long-term erosion control. The potential to restore the island to its historical size will be evaluated.

Responsibility: JFNew and Blue Lake Association.

Next Actions: Obtain landowner permission to survey property (BLA), Survey site to determine feasibility of site and collect design data (JFN)

Project 6 (JFN/BLA-3) – Stabilize the bank along Drain No. 1 including including any eroding tributaries.
Description:
Stabilize the eroding banks along Drain No. 1 using a series of in-stream structures such as grade controls.

Responsibility: JFNew and Blue Lake Association.

Next Actions: Obtain landowners permission to survey property (BLA), Survey site to determine feasibility of site and collect design data (JFN)

Project 7 (JFN/BLA-4) – Create a stormwater detention structure at the top of the hill adjacent to active erosion area, west of Drain No. 1.
Description:
Create a stormwater detention structure that will retain stormwater and allow for sediment and nutrients to settle out. The eroding hillside will be repaired.

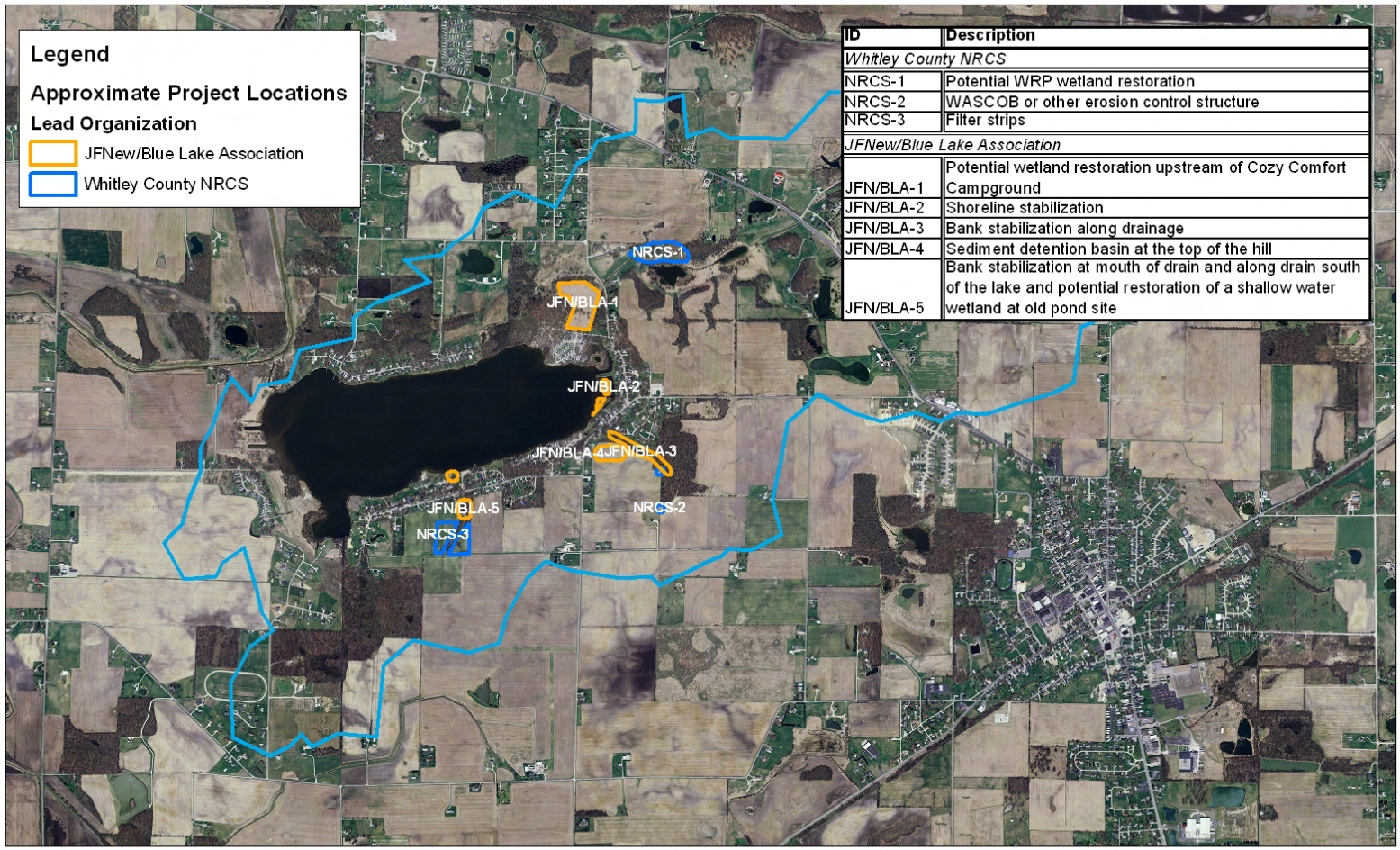
Responsibility: JFNew and Blue Lake Association.

Next Actions: Obtain landowners permission to survey property (BLA), Survey site to determine feasibility of site and collect design data (JFN)

Project 8 (JFN/BLA-5) – Stabilize the banks along Drain No. 4 and restore the existing pond site to a shallow water wetland.
Description:
Stabilize the eroding banks along Drain No. 4 using a series of in-stream structures such as grade controls. Evaluate the potential for creating a shallow water wetland within the footprint of the existing abandoned pond area.

Responsibility: JFNew and Blue Lake Association.

Next Actions: Obtain landowners permission to survey property (BLA), Survey site to determine feasibility of site and collect design data (JFN)



ID	Description
Whitley County NRCS	
NRCS-1	Potential WRP wetland restoration
NRCS-2	WASCOB or other erosion control structure
NRCS-3	Filter strips
JFNew/Blue Lake Association	
JFN/BLA-1	Potential wetland restoration upstream of Cozy Comfort Campground
JFN/BLA-2	Shoreline stabilization
JFN/BLA-3	Bank stabilization along drainage
JFN/BLA-4	Sediment detention basin at the top of the hill
JFN/BLA-5	Bank stabilization at mouth of drain and along drain south of the lake and potential restoration of a shallow water wetland at old pond site

Proposed Projects in the Blue Lake Watershed

0 1,550 3,100 6,200 9,300 Feet

APPENDIX B:

LANDOWNER AGREEMENTS
BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

Site 1 - wetland restoration

April 30, 2007

Schloss Herbstein, Inc.
2042 Broadway
Ft. Wayne, IN 46802

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

Mark Pranckus

Aquatic Biologist

mpranckus@jfnew.com
Mobile: 574-229-8723

Dear Sirs:

JFNew is an environmental consultant hired by the Blue Lake Association (BLA) to complete a feasibility study for implementing nutrient and sediment reduction projects in the Blue Lake watershed. A preliminary review of the area around Blue Lake identified your parcel of property as one we would like to consider for potential projects to improve the water quality of Blue Lake. Typically, projects will be funded by grant money the BLA 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 May, 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 concur with the general nature of the project, we will include it with cost estimates in a feasibility report to be submitted to the BLA and the Indiana Department of Natural Resources. The BLA will use the report to prioritize projects for funding, seek additional grants for those projects, and implement feasible projects.

Please call me or 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 May 16th, if possible. If we haven't received a notice one way or the other, JFNew or the BLA may follow-up with you. If you have any questions, please contact me or Jerry McClure (260-693-0875) with the BLA.

Thank you for your consideration.

Mark Pranckus
Aquatic Biologist

____ Yes, I grant permission to access my property

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

_____X

Brian Schaper (Printed Name)

JFNew
From Native Seed to Ecological Solutions

708 Roosevelt Rd
Walkerton, Indiana 46574
Phone: 574-586-3400 ext. 338
Fax: 574-586-3446

Mark Pranckus

Aquatic Biologist

mpranckus@jfnew.com
Mobile: 574-229-8723

Corporate Office:

Walkerton, Indiana

Chicago, Illinois

Indianapolis, Indiana

Ann Arbor, Michigan

Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:

Walkerton, Indiana

www.jfnew.com

December 5, 2007

Robert and Linda LeFever
4430 E. South Dr.
Churubusco, IN 46723

RE: Blue Lake Feasibility Study

Dear Robert and Linda:

Over the past year, the Blue Lake Association (BLA) initiated a feasibility study to reduce sedimentation and nutrient loading to the lake. The feasibility study focused on areas surrounding the lake and within the watershed where erosion, sediment deposition, and nutrient loading are causing problems and developed solutions that are feasible from both a technical standpoint and from a landowner cooperation standpoint. During an initial tour of the watershed, an area on your property was identified as a potential location for a sediment reduction project. Wayne Stanger and JFNew later followed up with a site visit to determine potential solutions. The proceeding paragraphs detail the proposed project. For the project to continue into the design phase, the BLA 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.

Construct Three Rock Grade Control Structures at Site 3

The conceptual design at Site 3 is to construct rock grade controls at three locations as shown on the enclosed map. The grade controls help stabilize the eroding stream channel by reducing the velocity and erosive potential of stormwater. Sediment is further reduced by increasing the stream's access to the adjacent floodplain where sediments can settle out of the water column before reaching the lake.

During construction, material delivery and equipment access will be required through your property. After construction is complete, any temporary access road or material landing area will be returned to its previous condition. Construction of the project would occur during the late fall to early spring time and potentially be constructed in conjunction with work occurring further upstream.

The BLA 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 Wayne Stanger (574-536-9879) or me. We will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Blue Lake Association and their work to improve the water quality of Blue Lake can be directed to Marc Shoda, lake association president (260-424-4792.)

Thank you,

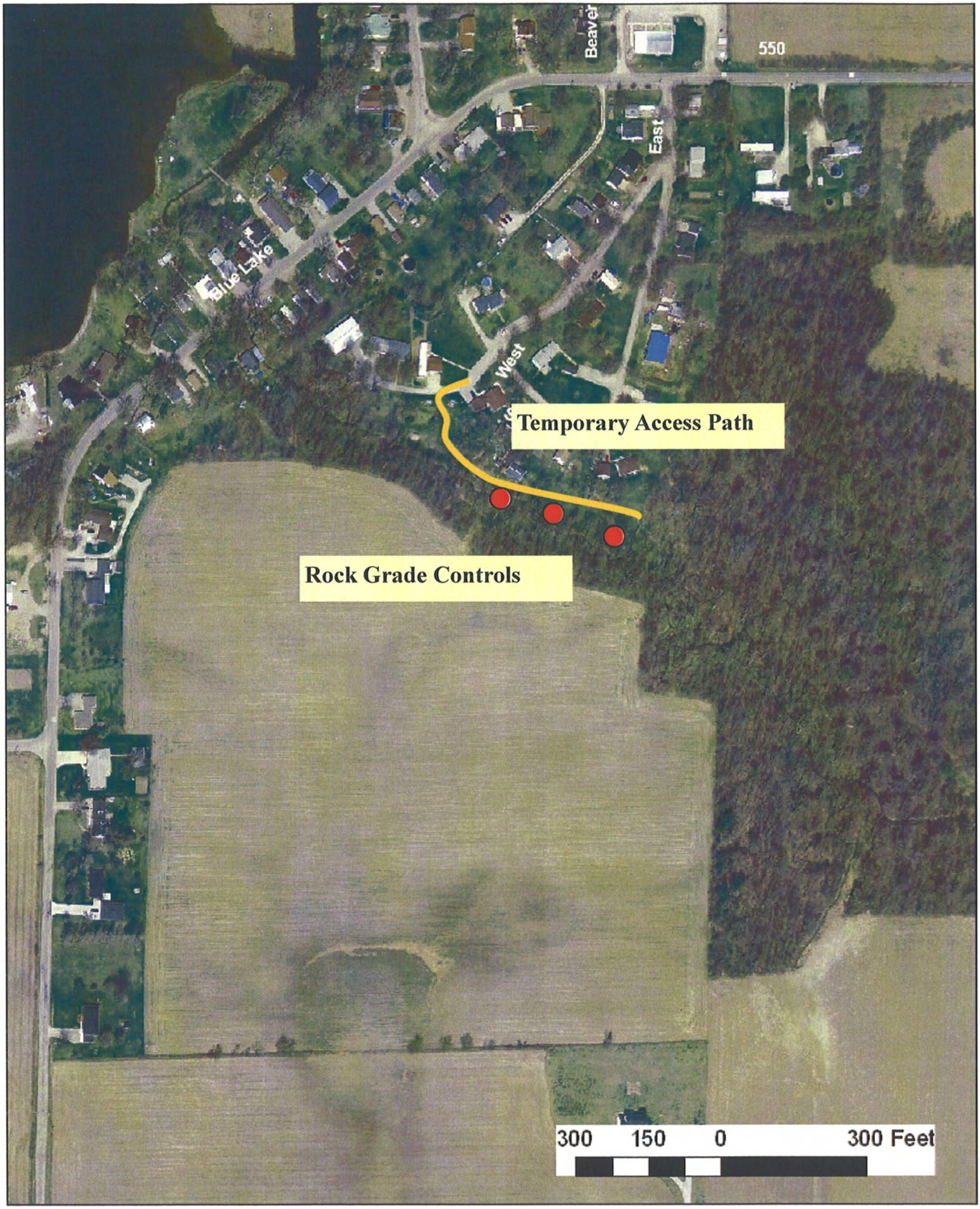
Mark Pranckus

I agree with the proposed conceptual design as it has been explained to me by the Blue Lake Association (BLA) and/or their representatives, JFNew and Wayne Stanger, and by the documentation they have provided. I agree that the conceptual design is feasible to me, will result in no cost to me, and that the BLA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

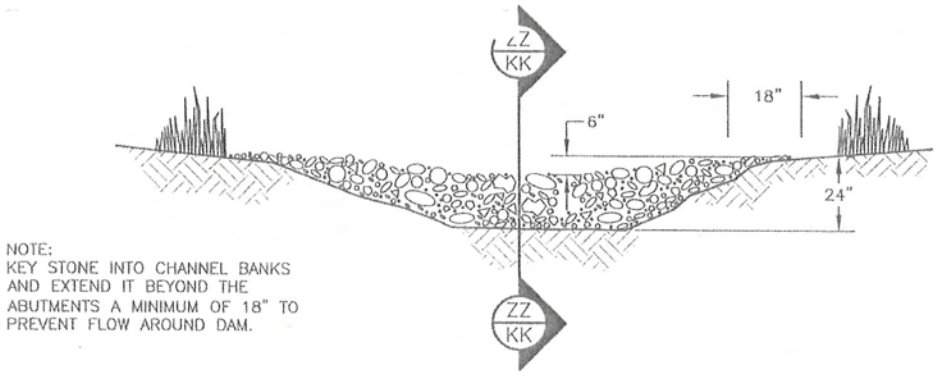
_____

_____

_____
Date

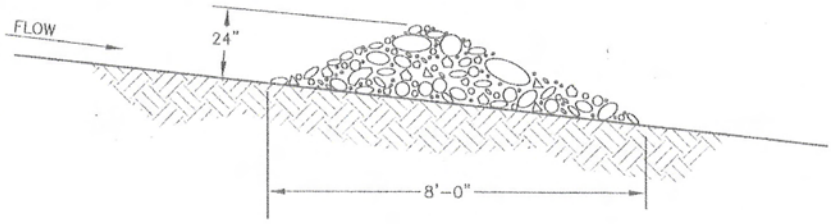


Site No. 3—Rock Grade Control Locations



NOTE:
KEY STONE INTO CHANNEL BANKS AND EXTEND IT BEYOND THE ABUTMENTS A MINIMUM OF 18" TO PREVENT FLOW AROUND DAM.

ZZ/KK ROCK DAM – VIEW LOOKING UPSTREAM
NOT TO SCALE



ZZ/KK ROCK DAM – SECTION (TYP)
NOT TO SCALE

Stephen - L:\Drawings\CAD Standard Dwgs\Details\c\Creek DAM DETL.dwg - Wed, 28 Apr 2004 - 7:58

Examples of a Rock Grade Controls

JFNew
From Native Seed to Ecological Solutions

708 Roosevelt Rd
Walkerton, Indiana 46574
Phone: 574-586-3400 ext. 338
Fax: 574-586-3446

Mark Pranckus

Aquatic Biologist

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Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

December 5, 2007

Scott Anderson
4925 E. 800 E.
Churubusco, IN 46723

RE: Blue Lake Feasibility Study

Dear Scott:

Over the past year, the Blue Lake Association (BLA) initiated a feasibility study to reduce sediments and nutrient loading to the lake. The feasibility study focused on areas surrounding the lake and within the watershed where erosion, sediment deposition, and nutrient loading are causing problems and developed solutions that are feasible from both a technical standpoint and from a landowner cooperation standpoint. During an initial tour of the watershed, several areas on your property were identified as potential locations for sediment reduction projects. Wayne Stanger and JFNew later followed up with a site visit to determine potential solutions. The proceeding paragraphs detail the proposed projects. For the projects to continue into the design phase, the BLA needs your written signature stating that you understand and agree with the conceptual idea of the projects. 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.

Construct a Cross-Valley Control Dam at Site 3
The conceptual design at Site 3 is to construct a cross valley control dam at the location shown in the enclosed map. The structure will capture water from the watershed during a storm event and release it downstream through the use of a vented riser and tile. Large storm events will utilize a rock spillway. Design data indicate that the basin will draw down within 26 hours after a 10-year 24-hour storm event. For larger events, this will be slightly longer and for smaller events, slightly shorter. Trees will be removed to prepare the dam area and provide equipment access; however, tree removal will be kept to a minimum. The dam will be approximately 6 ft high, 125 ft long, and 8 ft wide at the top of the berm. Earthen material used to construct the dam as well as rock for the spillway will be brought in for an outside source.

During construction, material delivery and equipment access will be required through your field. After construction is complete, any temporary access road or material landing area within the field will be returned to its previous condition. Construction of the project will occur during the late fall to early spring time, as to not interrupt your farming activities. If you have any other suggestions about the timing of the construction project, the BLA would be interested to hear them.

Construct a Cross-Valley Control Dam at Site 5 (Former Pond Site)
The conceptual design at Site 5 is similar to Site 3. The location can be seen on the enclosed map. The existing earthen berm will not be used as part of the dam because the trees and associated roots could negatively impact the long-term stability of the dam. Instead, the conceptual design calls for trees to be removed from the existing embankment and for it to be torn down to remove the rootwads. The dam will be rebuilt using material from the existing embankment and material coming from the basin. The structure will capture water from the watershed during a storm event and release it downstream through the use of a vented riser and tile. Design data indicate that the basin will draw down within 22 hours after a 10-year 24-hour storm event. For larger events, this will be slightly longer and for smaller

events, slightly shorter. Trees will be removed to prepare the dam area and provide equipment access; however, tree removal will be kept to a minimum. The dam will be approximately 7 ft high, 90 ft long, and 8 ft wide at the top of the berm.

During construction, material delivery and equipment access will be required through your field. After construction is complete, any temporary access road or material landing area within the field will be returned to its previous condition. Construction of the project will occur during the late fall to early spring time, as to not interrupt your farming activities. If you have any other suggestions about the timing of the construction project, the BLA would be interested to hear them.

As it currently stands, the BLA would look to design and construct Site 3 the Fall/Winter 2009 and Site 5 in Fall/Winter 2010 given the current availability of funding from the Indiana Department of Natural Resources Lake and River Enhancement Program. You would be contacted prior to any survey or design work to confirm your continued participation.

The BLA 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 Wayne Stanger (574-536-9879) or me. We will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Blue Lake Association and their work to improve the water quality of Blue Lake can be directed to Marc Shoda, lake association president (260-424-4792.)

Thank you,

Mark Pranckus

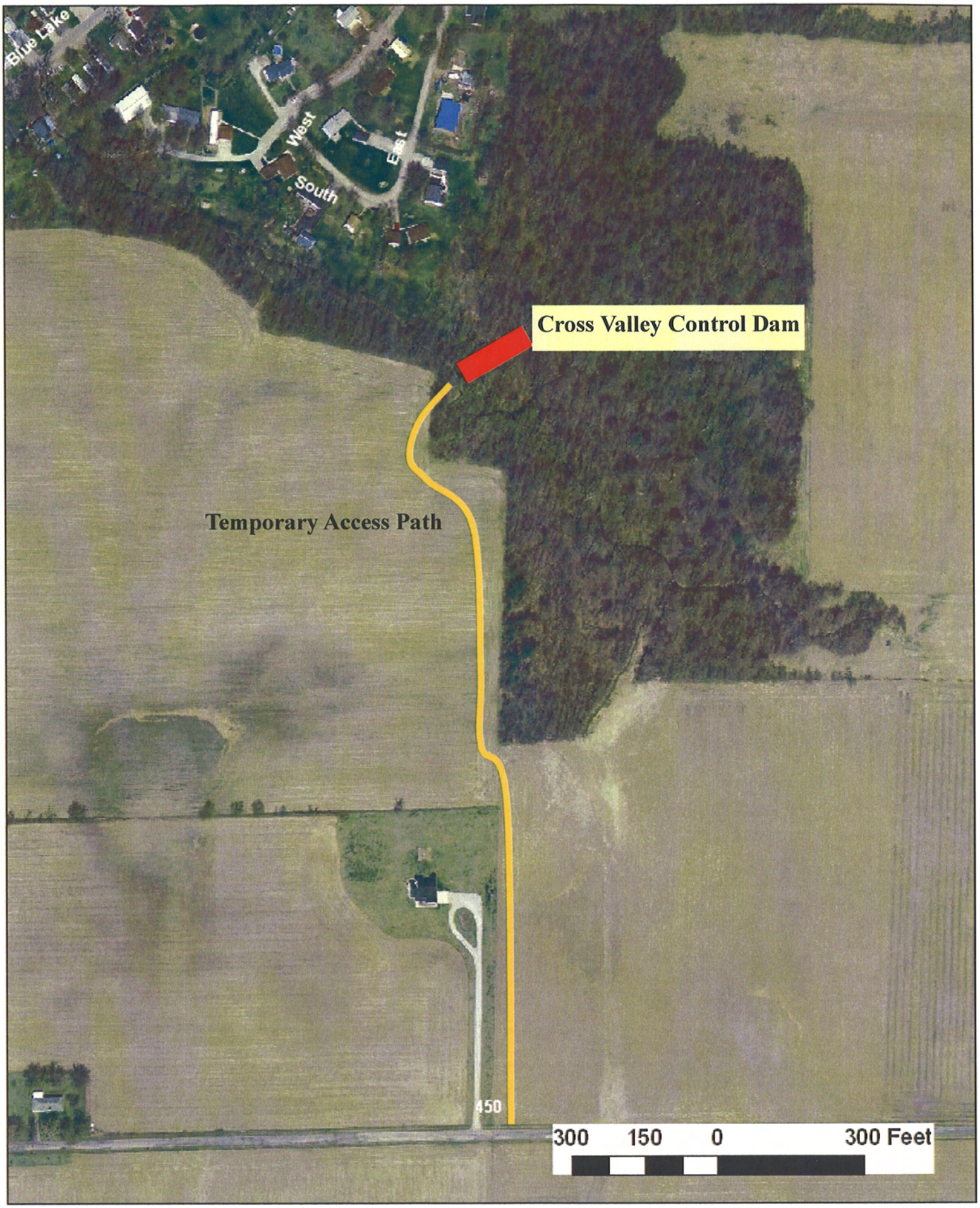
I agree with the proposed conceptual design as it has been explained to me by the Blue Lake Association (BLA) and/or their representatives, JFNew and Wayne Stanger, and by the documentation they have provided. I agree that the conceptual design is feasible to me, will result in no cost to me, and that the BLA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

Scott D. Anderson

12-10-07
Date

Site #3 Control dam is on Property that Belongs to Robert LeFever if located at this point while a lot of water would be backed up on to me. If he doesn't want the dam it may be feasible to move it.
Scott

JFNew
From Native Seed to Ecological Solutions



Site No. 3 –Cross Valley Control Dam

Site No. 5—Cross Valley Control Dam at Former Pond Site

JFNew
From Native Seed to Ecological Solutions

708 Roosevelt Rd
Walkerton, Indiana 46574
Phone: 574-586-3400 ext. 338
Fax: 574-586-3446

Mark Pranckus

Aquatic Biologist

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Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:

Walkerton, Indiana

www.jfnew.com

December 5, 2007

Greg Dunn
5159 N Blue Lake Rd.
Churubusco, IN 46723

RE: Blue Lake Feasibility Study

Dear Greg:

Over the past year, the Blue Lake Association (BLA) initiated a feasibility study to reduce sedimenation and nutrient loading to the lake. The feasibility study focused on areas surrounding the lake and within the watershed where erosion, sediment deposition, and nutrient loading are causing problems and developed solutions that are feasible from both a technical standpoint and from a landowner cooperation standpoint. During an initial tour of the watershed, an area on your property was identified as a potential location for a sediment reduction project. Wayne Stanger and JFNew later followed up with a site visit to determine potential solutions. The proceeding paragraphs detail the proposed project. For the project to continue into the design phase, the BLA 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 a Rock Chute at Site 4

The conceptual design at Site 4 is to install a rock-lined chute along the hillside where erosion is occurring at your property near 5118 N. Blue Lake Rd. The chute will reduce sediment into the lake and guide water down the slope to the base of the hill. The chute will be excavated into the hill to the appropriate dimensions to handle a 25-year storm event.

During construction, material delivery and equipment access will be required through your property. After construction is complete, any temporary access road or material landing area will be returned to its previous condition. BLA will work with you to determine the appropriate time for construction once a design is complete.

The BLA 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 Wayne Stanger (574-536-9879) or me. We will be happy to answer any questions you may have about the proposed idea or the feasibility/design/construction process. Questions about the Blue Lake Association and their work to improve the water quality of Blue Lake can be directed to Marc Shoda, lake association president (260-424-4792.)

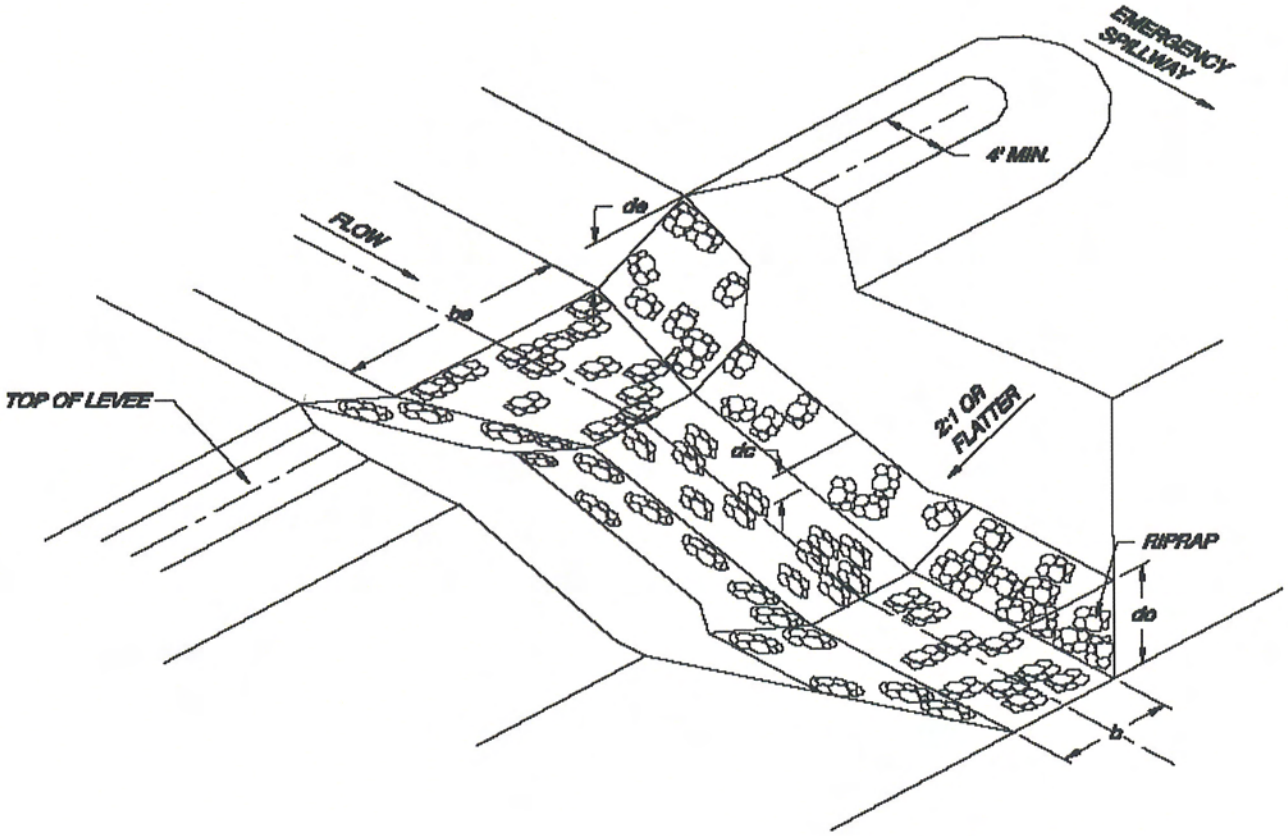
Thank you,

Mark Pranckus

I agree with the proposed conceptual design as it has been explained to me by the Blue Lake Association (BLA) and/or their representatives, JFNew and Wayne Stanger, and by the documentation they have provided. I agree that the conceptual design is feasible to me, will result in no cost to me, and that the BLA shall proceed to develop detailed plans to construct this project. I grant access to the site to allow for proper design of this project.

12/12/2007
Date

Site No. 4 Rock-lined Chute



ROCK LINED CHUTE

Examples of a Rock-lined Chute

APPENDIX C:

ENVIRONMENTAL ASSESSMENTS

BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

Unofficial Text (See Printed Volume). Current through date and Register shown on Title Page.

Peninsula

TABLE 1. EROSION INTENSITY (EI) SCORE WORKSHEET.

Applicants and department staff shall use this worksheet to calculate erosion intensity pursuant to s. NR 328.08 (2).

SHORELINE VARIABLES	DESCRIPTIVE CATEGORIES Erosion Intensity Value is Located in Parenthesis on Left Side of Each Category Box							ASSIGNED EI
AVERAGE FETCH[1]–, average distance (miles). across the open water to the opposite shore measure 45° other side of the perpendicular to the shoreline.	(0) <1/10	(2) 1/10 –1/3	(4) 1/3–1	(7) 1 –3	(10) 3–10	(13) 10–30	(16) >30	2
DEPTH AT 20 FEET, depth of water (feet) 20 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			2
DEPTH AT 100 FEET, depth of water (feet) 100 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			2
BANK HEIGHT[2], height of bank (feet), measure from toe of the bank to top of the bank–lip.	(1)<1	(2) 1–5	(3) 5–10	(4) 10–20	(5) >20			2
BANK COMPOSITION composition and degree of cementation of the sediments	(0) rock, marl, tight clay, well cemented sand (dig with a pick)	(7) soft clay, clayey sand, moderately cemented (easily dug with a knife)	(15) uncemented sands or peat (easily dug with your hand)					7
INFLUENCE OF ADJACENT STRUCTURES, likelihood that adjacent structures are causing flank erosion at the site	(0) no hard armoring on either adjacent property	(1) hard armoring on one adjacent property	(2) hard armoring on both adjacent properties	(3) hard armoring on one adjacent property with measurable recession	(4) hard armoring on both adjacent properties with measurable recession adjacent to both structures			0
AQUATIC VEGETATION[3] type and abundance of vegetation occurring in the water off the shoreline	(0) rocky substrates unable to support vegetation	(1) dense or abundant emergent, floating or submerged vegetation	(4) scattered or patchy emergent, floating or submergent vegetation	(7) lack of emergent, floating or submergent vegetation				4
BANK VEGETATION, type and abundance of the vegetation occurring on the bank face and immediately on top of the bank lip	(0) bank composed of rocky outcropping unable to support vegetation	(1) dense vegetation, upland trees, shrubs and grasses, including lawns	(4) clumps of vegetation alternating with areas lacking vegetation	(7) lack of vegetation (cleared), crop or agricultural land				1
BANK STABILITY, The degree to which bank and adjacent area (within 10 feet of the bank–lip) is stabilized by natural ground, shrub, and canopy vegetation (outside a 10' pier access corridor). Human disturbance is typified by tree removal, brushing, mowing, and lawn establishment.	(0) established lawn with few canopy trees	(1) established lawn with moderate to dense canopy trees	(4) moderate to dense natural ground vegetation and canopy trees with shrub layer substantially reduced; or few canopy trees with moderate to dense natural shrub layer.	(7) moderate to dense canopy trees with moderate to dense natural shrub layer; or other natural features prevents establishment of vegetation.				4
SHORELINE GEOMETRY general shape of the shoreline at the point of interest plus 200 yards on either side.	(1) coves or bays	(4) irregular shoreline or straight shoreline	(8) headland, point, or island					8
SHORE ORIENTATION[4] geographic direction the shoreline faces	(0) < 1/3 mile fetch	(1) north to east to south–southeast (349°–360°, 1°–168°)	(4) south to west–southwest (169°–258°)	(8) west to north–northwest (259°–349°)				8
BOAT WAKES[5] proximity to and use of boat channels	(1) no channels within 100 yards, broad open water body, or constricted shallow water body; or channels within no–wake zones	(6) thoroughfare within 100 yards carrying limited traffic, or thoroughfare 100 yards to ½ mile offshore carrying intensive traffic	(12) thoroughfare within 100 yards carrying intensive traffic (unregulated boating activity)					6
EROSION INTENSITY SCORE (EI)								46

Note: Table 1 is adapted from Knutson, P. L., H. H. Allen, and J. W. Webb, 1990. "Guidelines for Vegetative Erosion Control on Wave–Impacted Coastal Dredged Material Sites, "Dredging Operations Technical Support Program Technical Report D–90–13,U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180, 35 pp.

North Island

Biolog only portion of island

Unofficial Text (See Printed Volume). Current through date and Register shown on Title Page.

TABLE 1. EROSION INTENSITY (EI) SCORE WORKSHEET.

Applicants and department staff shall use this worksheet to calculate erosion intensity pursuant to s. NR 328.08 (2).

SHORELINE VARIABLES	DESCRIPTIVE CATEGORIES Erosion Intensity Value is Located in Parenthesis on Left Side of Each Category Box							ASSIGNED EI
AVERAGE FETCH[1]–, average distance (miles), across the open water to the opposite shore measure 45° other side of the perpendicular to the shoreline.	(0) <1/10	(2) 1/10 –1/3	(4) 1/3–1	(7) 1 –3	(10) 3–10	(13) 10–30	(16) >30	2
DEPTH AT 20 FEET, depth of water (feet) 20 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			2
DEPTH AT 100 FEET, depth of water (feet) 100 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			2
BANK HEIGHT[2], height of bank (feet), measure from toe of the bank to top of the bank–lip.	(1)<1	(2) 1–5	(3) 5–10	(4) 10–20	(5) >20			2
BANK COMPOSITION composition and degree of cementation of the sediments	(0) rock, marl, tight clay, well cemented sand (dig with a pick)	(7) soft clay, clayey sand, moderately cemented (easily dug with a knife)	(15) uncemented sands or peat (easily dug with your hand)					7
INFLUENCE OF ADJACENT STRUCTURES, likelihood that adjacent structures are causing flank erosion at the site	(0) no hard armoring on either adjacent property	(1) hard armoring on one adjacent property	(2) hard armoring on both adjacent properties	(3) hard armoring on one adjacent property with measurable recession	(4) hard armoring on both adjacent properties with measurable recession adjacent to both structures			0
AQUATIC VEGETATION[3] type and abundance of vegetation occurring in the water off the shoreline	(0) rocky substrates unable to support vegetation	(1) dense or abundant emergent, floating or submerged vegetation	(4) scattered or patchy emergent, floating or submergent vegetation	(7) lack of emergent, floating or submergent vegetation				1
BANK VEGETATION, type and abundance of the vegetation occurring on the bank face and immediately on top of the bank lip	(0) bank composed of rocky outcropping unable to support vegetation	(1) dense vegetation, upland trees, shrubs and grasses, including lawns	(4) clumps of vegetation alternating with areas lacking vegetation	(7) lack of vegetation (cleared), crop or agricultural land				1
BANK STABILITY, The degree to which bank and adjacent area (within 10 feet of the bank–lip) is stabilized by natural ground, shrub, and canopy vegetation (outside a 10' pier access corridor). Human disturbance is typified by tree removal, brushing, mowing, and lawn establishment.	(0) established lawn with few canopy trees	(1) established lawn with moderate to dense canopy trees	(4) moderate to dense natural ground vegetation and canopy trees with shrub layer substantially reduced; or few canopy trees with moderate to dense natural shrub layer.	(7) moderate to dense canopy trees with moderate to dense natural shrub layer; or other natural features prevents establishment of vegetation.				4
SHORELINE GEOMETRY general shape of the shoreline at the point of interest plus 200 yards on either side.	(1) coves or bays	(4) irregular shoreline or straight shoreline	(8) headland, point, or island					8
SHORE ORIENTATION[4] geographic direction the shoreline faces	(0) < 1/3 mile fetch	(1) north to east to south–southeast (349°–360°, 1°–168°)	(4) south to west–southwest (169°–258°)	(8) west to north–northwest (259°–349°)				4
BOAT WAKES[5] proximity to and use of boat channels	(1) no channels within 100 yards, broad open water body, or constricted shallow water body; or channels within no–wake zones	(6) thoroughfare within 100 yards carrying limited traffic, or thoroughfare 100 yards to ½ mile offshore carrying intensive traffic	(12) thoroughfare within 100 yards carrying intensive traffic (unregulated boating activity)					6
EROSION INTENSITY SCORE (EI)								39

Note: Table 1 is adapted from Knutson, P. L., H. H. Allen, and J. W. Webb, 1990. "Guidelines for Vegetative Erosion Control on Wave–Impacted Coastal Dredged Material Sites, "Dredging Operations Technical Support Program Technical Report D–90–13,U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180, 35 pp.

South Island

Rock toe + biolog section

Unofficial Text (See Printed Volume). Current through date and Register shown on Title Page.

TABLE 1. EROSION INTENSITY (EI) SCORE WORKSHEET.

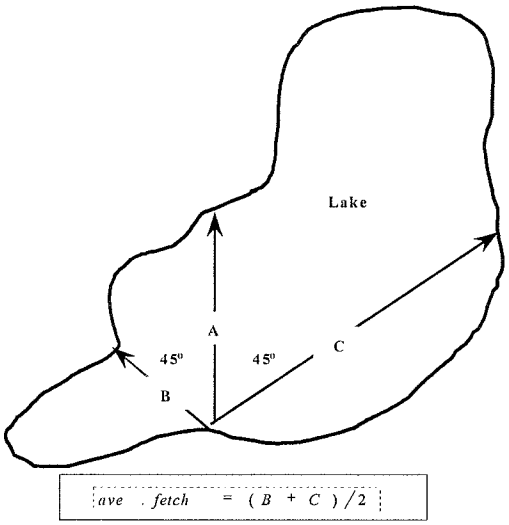
Applicants and department staff shall use this worksheet to calculate erosion intensity pursuant to s. NR 328.08 (2).

SHORELINE VARIABLES	DESCRIPTIVE CATEGORIES Erosion Intensity Value is Located in Parenthesis on Left Side of Each Category Box							ASSIGNED EI
AVERAGE FETCH[1]–, average distance (miles), across the open water to the opposite shore measure 45° other side of the perpendicular to the shoreline.	(0) <1/10	(2) 1/10 –1/3	(4) 1/3–1	(7) 1 –3	(10) 3–10	(13) 10–30	(16) >30	4
DEPTH AT 20 FEET, depth of water (feet) 20 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			1
DEPTH AT 100 FEET, depth of water (feet) 100 feet from shoreline	(1) <1	(2) 1–3	(3) 3–6	(4) 6–12	(5) >12			2
BANK HEIGHT[2], height of bank (feet), measure from toe of the bank to top of the bank–lip.	(1)<1	(2) 1–5	(3) 5–10	(4) 10–20	(5) >20			2
BANK COMPOSITION composition and degree of cementation of the sediments	(0) rock, marl, tight clay, well cemented sand (dig with a pick)	(7) soft clay, clayey sand, moderately cemented (easily dug with a knife)	(15) uncemented sands or peat (easily dug with your hand)					7
INFLUENCE OF ADJACENT STRUCTURES, likelihood that adjacent structures are causing flank erosion at the site	(0) no hard armoring on either adjacent property	(1) hard armoring on one adjacent property	(2) hard armoring on both adjacent properties	(3) hard armoring on one adjacent property with measurable recession	(4) hard armoring on both adjacent properties with measurable recession adjacent to both structures			0
AQUATIC VEGETATION[3] type and abundance of vegetation occurring in the water off the shoreline	(0) rocky substrates unable to support vegetation	(1) dense or abundant emergent, floating or submerged vegetation	(4) scattered or patchy emergent, floating or submergent vegetation	(7) lack of emergent, floating or submergent vegetation				4
BANK VEGETATION, type and abundance of the vegetation occurring on the bank face and immediately on top of the bank lip	(0) bank composed of rocky outcropping unable to support vegetation	(1) dense vegetation, upland trees, shrubs and grasses, including lawns	(4) clumps of vegetation alternating with areas lacking vegetation	(7) lack of vegetation (cleared), crop or agricultural land				1
BANK STABILITY, The degree to which bank and adjacent area (within 10 feet of the bank–lip) is stabilized by natural ground, shrub, and canopy vegetation (outside a 10' pier access corridor). Human disturbance is typified by tree removal, brushing, mowing, and lawn establishment.	(0) established lawn with few canopy trees	(1) established lawn with moderate to dense canopy trees	(4) moderate to dense natural ground vegetation and canopy trees with shrub layer substantially reduced; or few canopy trees with moderate to dense natural shrub layer.	(7) moderate to dense canopy trees with moderate to dense natural shrub layer; or other natural features prevents establishment of vegetation.				0
SHORELINE GEOMETRY general shape of the shoreline at the point of interest plus 200 yards on either side.	(1) coves or bays	(4) irregular shoreline or straight shoreline	(8) headland, point, or island					8
SHORE ORIENTATION[4] geographic direction the shoreline faces	(0) < 1/3 mile fetch	(1) north to east to south–southeast (349°–360°, 1°–168°)	(4) south to west–southwest (169°–258°)	(8) west to north–northwest (259°–349°)				8
BOAT WAKES[5] proximity to and use of boat channels	(1) no channels within 100 yards, broad open water body, or constricted shallow water body; or channels within no–wake zones	(6) thoroughfare within 100 yards carrying limited traffic, or thoroughfare 100 yards to ½ mile offshore carrying intensive traffic	(12) thoroughfare within 100 yards carrying intensive traffic (unregulated boating activity)					6
EROSION INTENSITY SCORE (EI)								43

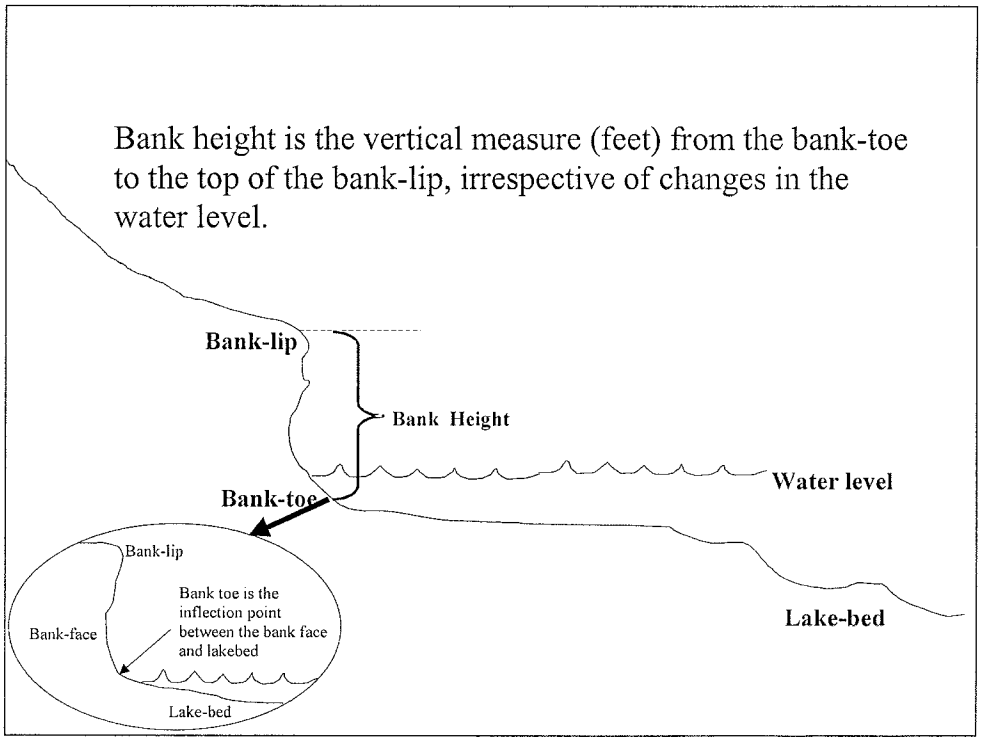
Note: Table 1 is adapted from Knutson, P. L., H. H. Allen, and J. W. Webb, 1990. "Guidelines for Vegetative Erosion Control on Wave–Impacted Coastal Dredged Material Sites, "Dredging Operations Technical Support Program Technical Report D–90–13,U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180, 35 pp.

Note: Table 1 is adapted from Knutson, P. L., H. H. Allen, and J. W. Webb, 1990. "Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites, "Dredging Operations Technical Support Program Technical Report D-90-13,U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180, 35 pp.

[1] Average fetch: The following diagram describes the calculation of average fetch.

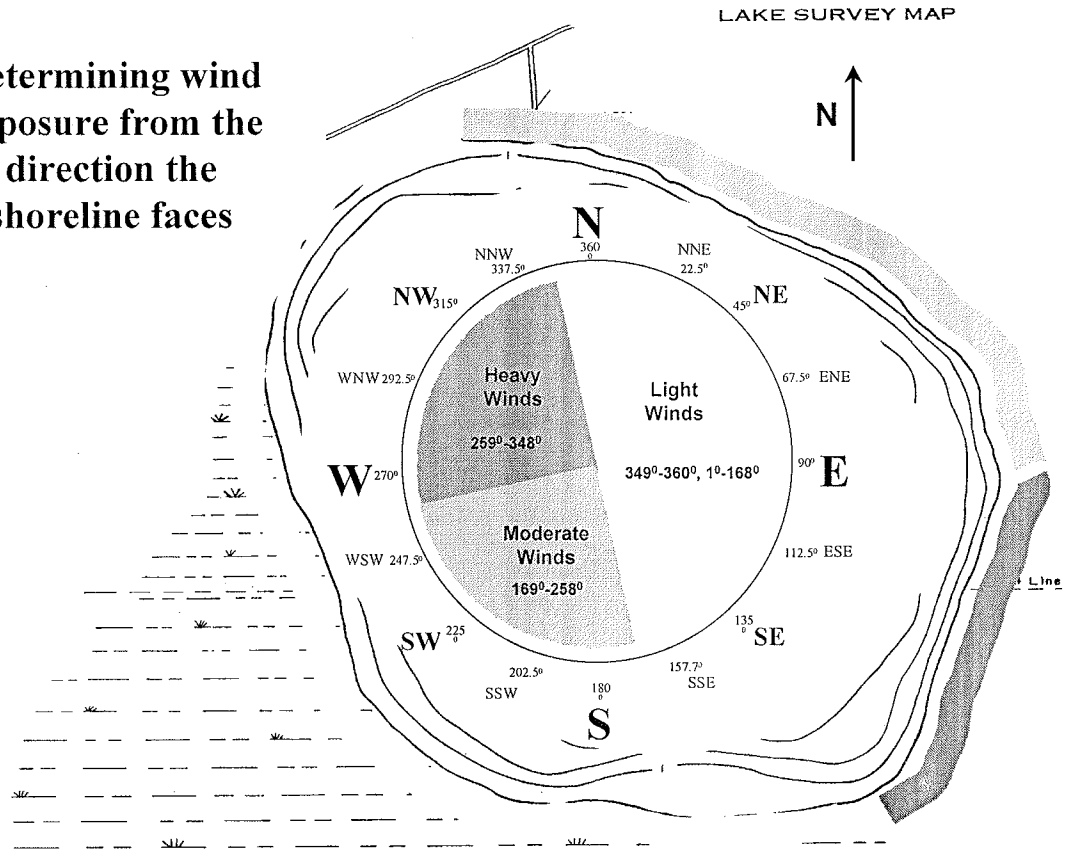


[2] Bank height: The following diagram describes the features of the bank for the purpose of accurately measuring bank height



[3]Aquatic vegetation: Dense or abundant means that on average 50-100% of the bottom is visually obstructed by plants during the growing season, defined by the dates June 1 through September 15. Scattered or patchy means that on average 1-49% of the bottom is visually obstructed by plants during the growing season, defined by the dates June 1 through September 15. Absent means that on average < 1% of the bottom is visually obstructed by plants during the growing season, defined by the dates June 1 through September 15.

[4] Shoreline Orientation: The following lake map shows an example of accurately determining shoreline orientation



[5]Boating: A thoroughfare is identified as physical narrowing of the waterbody that by its nature intensifies boating activity near the shore. Thoroughfares which are 250 yards or wider are not scored 12 points, unless the depth contours of the thoroughfare constricts boating activity in close proximity to one shore, and the traffic is intensive. Intensive traffic is defined by a location where at least 50% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 60 car-trailer units. Limited traffic is defined by a location where at least 30% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 40 car-trailer units.

ADDITIONAL STREAM INFORMATION (This information must also be completed)

QHEI PERFORMED? ☐ Yes ☒ No OHEI Score _____ If Yes, Attach Completed QHEI Form

DOWNSTREAM DESIGNATED USE(S)

☐ WWH Name _____ Distance from Evaluated Stream _____
☐ CWH Name _____ Distance from Evaluated Stream _____
☐ EWH Name _____ Distance from Evaluated Stream _____

MAPPING: ATTACH COPIES OF MAPS, INCLUDING THE ENTIRE WATERSHED AREA. CLEARLY MARK THE SITE LOCATION

USQS Quadrangle Name _____ NRCS Soil Map Page _____ NRCS Soil Map Stream Order _____

County Whitley Township/City _____

MISCELLANEOUS

Base Flow Conditions? ☐ Yes ☐ No Date of Last Precipitation _____ Quantity _____

Photograph Information _____

Elevated Turbidity? ☐ Yes ☒ No Canopy (% open) 25

Were samples collected for water chemistry? ☐ Yes ☒ No Lab Number (Note lab sample no. or id and attach results)

Field Measures - Temp (˚C) _____ Dissolved Oxygen (mg/l) _____ pH (S.U.) _____ Conductivity (µmhos/cm) _____

Is the sampling reach representative of the stream? ☒ Yes ☐ No If not, please explain _____

Additional comments/description of pollution impacts _____

BIOTIC EVALUATION

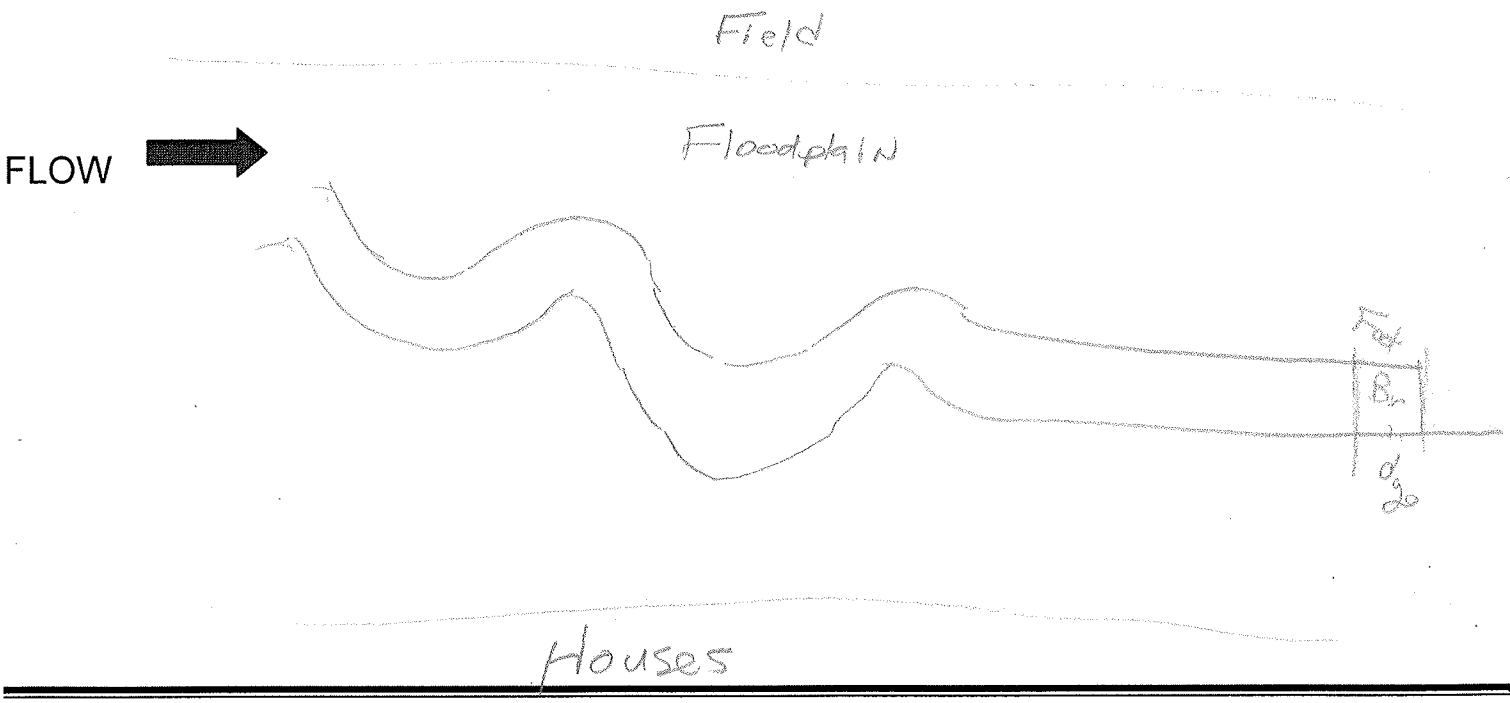
Performed? ☐ Yes ☐ No (If Yes, record all observations. Voucher collections optional. NOTE: all voucher samples must be labeled with the site ID number. Include appropriate field data sheets from the Primary Headwater Habitat Assessment Manual)

Fish Observed? ☐ Yes ☐ No Voucher? ☐ Yes ☐ No Salamanders Observed? ☐ Yes ☐ No Voucher? ☐ Yes ☐ No

Frogs or Tadpoles Observed? ☐ Yes ☐ No Voucher? ☐ Yes ☐ No Aquatic Macroinvertebrates Observed? ☐ Yes ☐ No Voucher? ☐ Yes ☐ No

Comments Regarding Biology _____

DRAWINGS AND NARRATIVE DESCRIPTION OF STREAM REACH (This must be completed)
Include important landmarks and other features of interest for site evaluation and a narrative description of the stream's location.



Primary Headwater Habitat Evaluation Form

HHEI Score (sum of metrics 1, 2, 3): 39

SITE NAME/LOCATON: Blue Lake – Unnamed Drain into Lake from the South
SITE NUMBER: 1 RIVER BASIN: DRAINAGE AREA ($m1^2$):
LENGTH OF STREAM REACH (ft): 200' LAT: LONG: RIVER CODE: RIVER MILE:
DATE: 9/6/07 SCORER: WP COMMENTS:

NOTE: Complete All Items On This Form – Refer to "Field Evaluation Manual for Ohio's PHWH Streams" for Instructions

STREAM CHANNEL ☒ **NONE / NATURAL CHANNEL** ☐ **RECOVERED** ☐ **RECOVERING** ☐ **RECENT OR NO RECOVERY**

MODIFICATIONS

1. **SUBSTRATE (Estimate percent of every type of substrate present.** Check *ONLY* two predominant substrate *TYPE* boxes (Max of 32). Add total number of significant substrate types found (Max of 8). Final metric score is sum of boxes A & B.

TYPE		PERCENT	TYPE		PERCENT
☐☐	BLDR SLABS **[16 pts]**		☐☐	SILT **[3 pt]**	
☐☐	BOULDER (>256 mm) **[16 pts]**		☐☐	LEAF PACK/WOODY DEBRIS **[3 pts]**	16
☐☐	BEDROCK **[16 pt]**		☐☐	FINE DETRITUS **[3 pts]**	5
☐☐	COBBLE (65-256 mm) **[12 pts]**		☐☒	CLAY OR HARDPAN **[0 pt]**	80
☐☐	GRAVEL (2-64 mm) **[9 pts]**		☐☐	MUCK **[0 pts]**	
☐☒	SAND (<2mm) **[6 pts]**	5	☐☐	ARTIFICAL **[3 pts]**	

Total of Percentages of Bldr Slabs, Boulder, Cobble, Bedrock

SCORE OF TWO MOST PREDOMINATE SUBSTRATE TYPES (A) 6 + 0 = 6

TOTAL NUMBER OF SUBSTRATE TYPES (B) 3

HHEI Metric Points

Substrate Max = 40: 9 (A+B)

2. **MAXIMUM POOL DEPTH** ***(Measure the maximum pool depth within the 61 meter (200 ft) evaluation reach at the time of evaluation.*** Avoid plunge pools from road culverts or stormwater pipes) (Check *ONLY* one box)

☐ >30 centimeters **[20 pts]**
☐ 22.5 – 30 cm **[30 pts]**
☐ >10 – 22.5 cm **[25 pts]**
☒ >5 cm – 10 cm **[15 pts]**
☐ <5 cm **[5 pts]**
☐ NO WATER OR MOIST CHANNEL **[0 pts]**

COMMENTS: MAXIMUM POOL DEPTH (centimeters): 9cm

Pool Depth Max = 30: 15

3. **BANK FULL WIDTH (Measured as the average of 3-4 measurements)** (Check *ONLY* one box)

☐ >4.0 meters (>13') **[30 pts]**
☐ >3.0 m – 4.0 m (>9' 7" – 13' **[25 pts]**
☐ >1.5 m – 3.0 m (>9' 7" – 4' 8") **[20 pts]**
☒ >1.0 m – 1.5 m (>3' 3" – 4' 8" **[15 pts]**
☐ ≤ 1.0 m (≤ 3' 3") **[5 pts]**

COMMENTS: AVERAGE BANKFULL WIDTH (meters): 41

Bankfull Width Max = 30: 15

This information must also be completed

RIPARIAN ZONE AND FLOODPLAIN QUALITY ☆**NOTE: River Left (L) and Right (R) as looking downstream**☆

RIPERIAN WIDTH (Per Bank)	L	R	FLOODPLAIN QUALITY (Most Predominant per Bank)	L	R	
Wide >10 m	☐	☐	Mature Forest, Wetland	☐	☐	Conservation Tillage
Moderate 5 – 10 m	☒	☒	Immature Forest, Shrub or Old Field	☒	☐	Urban or Industrial
Narrow <5 m	☐	☐	Residential Park, New Field	☐	☒	Open Pasture, Row Crop
None	☐	☐	Fenced Pasture	☐	☐	Mining or Construction

COMMENTS:

FLOW REGIME (At Time of Evaluation) (Check *ONLY* one box)

☒ Stream Flowing
☐ Subsurface Flow with Isolated Pools (Interstitial)
☐ Moist Channel, Isolated Pools, No Flow (Intermittent)
☐ Dry Channel, No Water (Ephemeral)

COMMENTS:

SINUOSITY (Number of bends per 61 m (200 ft) of channel) (Check *ONLY* one box)

☐ None ☐ 1.0 ☒ 2.0 ☐ 3.0
☐ 0.5 ☐ 1.5 ☐ 2.5 ☐ >3

STREAM GRADIENT ESTIMATE

☐ Flat (0.5 ft/100 ft) ☒ Flat to Moderate ☐ Moderate (2 ft/100 ft) ☐ Moderate to Severe ☐ Severe (10 ft/100 ft)

APPENDIX D:

EARLY COORIDATION WITH REGULATORY AGENCIES

BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

JFNew
Full-Service Ecological Solutions™

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

Mark Pranckus
Aquatic Biologist
mpranckus@jfnew.com
Mobile: 574-229-8723

Corporate Office:
Walkerton, Indiana

Chicago, Illinois

Indianapolis, Indiana

Ann Arbor, Michigan

Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

March 10, 2008

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

RE: Early Coordination for Proposed Water Quality Improvement Projects

Dear Christie,

The Blue Lake Association near Churubusco in Whitley County, Indiana is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in Blue Lake. Four proposed projects (Section 11,14, and 15, Range 10 E, Township 32 N) will require regulatory permits based on the conceptual designs. As part of the feasibility study, the Blue Lake Association is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Construction would be funded by grants over several years from the LARE program.

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 mpranckus@jfnew.com. We would appreciate your comments by April 15, 2008.

Thanks,

Mark Pranckus

CC: JFNew File 031119.01

JFNew
Full-Service Ecological Solutions™

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

Mark Pranckus
Aquatic Biologist
mpranckus@jfnew.com
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Ann Arbor, Michigan

Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

March 10, 2008

Brad Baldwin
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 Brad,

The Blue Lake Association near Churubusco in Whitley County, Indiana is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in Blue Lake. Four proposed projects (Section 11,14, and 15, Range 10 E, Township 32 N) will require regulatory permits based on the conceptual designs. As part of the feasibility study, the Blue Lake Association is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Construction would be funded by grants over several years from the LARE program.

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Thanks,

Mark Pranckus

CC: JFNew File 031119.01

JFNew
Full-Service Ecological Solutions™

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Grand Haven, Michigan

Cincinnati, Ohio

Madison, Wisconsin

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

March 25, 2008

Army Corps of Engineers
Louisville District
Engineering and Technical Services
P.O Box 59
Louisville, KY 40201-0059

RE: Early Coordination for Proposed Water Quality Improvement Projects

To whom it may concern,

The Blue Lake Association near Churubusco in Whitley County, Indiana is completing an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program-funded feasibility study to improve water quality in Blue Lake. Four proposed projects (Section 11,14, and 15, Range 10 E, Township 32 N) will require regulatory permits based on the conceptual designs. As part of the feasibility study, the Blue Lake Association is requesting your preliminary comments on the proposed projects. Enclosed is a brief description of the proposed projects including identified impacts to aquatic resources. Construction would be funded by grants over several years from the LARE program.

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 mpranckus@jfnew.com. We would appreciate your comments by April 30, 2008.

Thanks,

Mark Pranckus

CC: JFNew File 031119.01

Project Background

The Blue Lake Association near Churubusco in Whitley County, Indiana received a grant from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program to study the feasibility of the several projects to improve water quality for Blue Lake and aquatic resources within Blue Lake. Four projects were identified that will require regulatory permits based on the conceptual designs prior to construction. Each project is described in scope and impact below. Basic supporting figures are included for evaluation purposes. The objective of this early coordination is to solicit agency feedback about the purposed projects. This information should not be viewed as any form of an application to complete the outlined activities. A formal application will follow after construction funding has been obtained by the Blue Lake Association.

Project Locations

All projects are located within the Blue Lake watershed near Churubusco in Whitley County, Indiana (Figure 1).

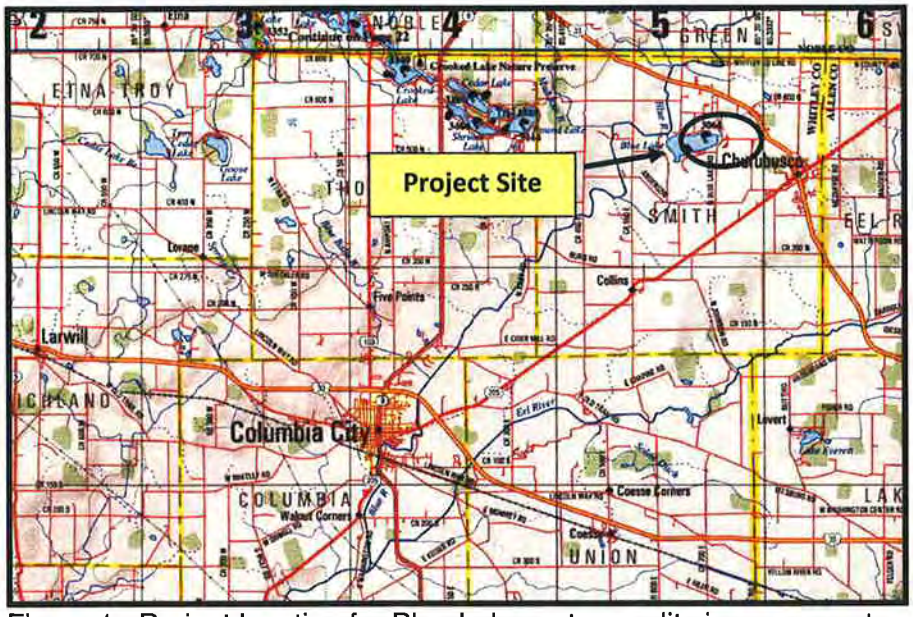


Figure 1. Project location for Blue Lake water quality improvement projects.

Site 1 – Shoreline Stabilization

Three islands along the east end of Blue Lake are eroding due to wind and wave action (Figure 2). Aerial photo analysis indicates that the islands have decreased in size between 20 – 45% since 1957. The conceptual design will be to stabilize 714 feet of shoreline using two different bioengineering techniques (Figures 3 and 4).

Figure 2. Example of the erosion occurring on the one of the islands on the east end of Blue Lake, Whitley County, Indiana.

Figure 3. Map indicating the lengths and treatment types for shoreline stabilization project at Blue Lake, Whitley County, Indiana.

The first treatment (shown in red on Figure 3) is a rock toe and coir log treatment, which will be applied to 605 feet of shoreline. The rock toe will project approximately 2 feet lakeward from the toe of slope and have a height of approximately 1 foot from the lake bottom (Figure 4). Directly behind the rock toe, 12-inch diameter coir logs will be installed in an end-to-end fashion against the bank. The coir logs will be staked into place using wooded stakes and planted with native vegetation. The eroding shoreline behind the coir logs will be graded to match the surrounding elevation, seeded to native vegetation, and covered with erosion control material.

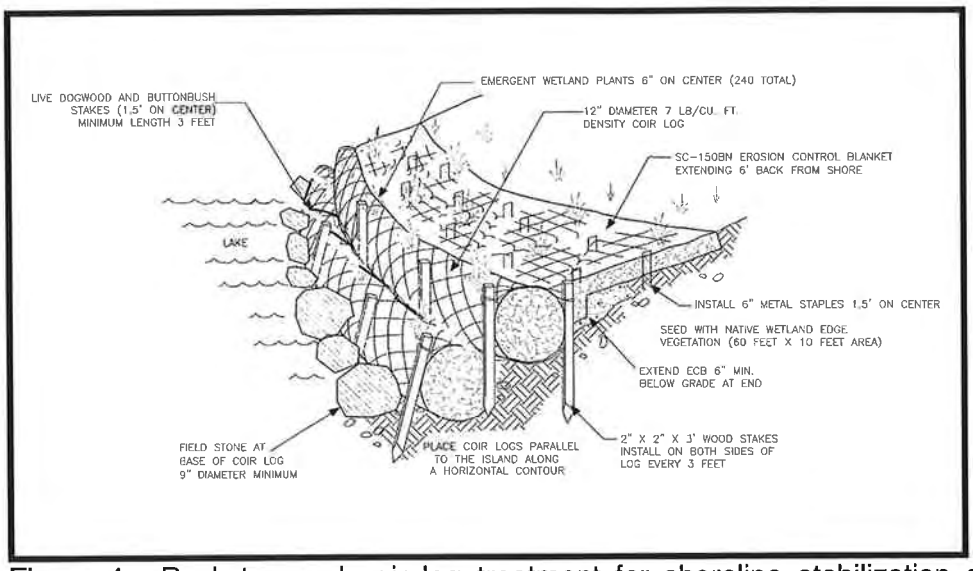


Figure 4. Rock toe and coir log treatment for shoreline stabilization at Blue Lake, Whitley County, Indiana.

The second treatment (shown in blue on Figure 3) will use a coir log staked to the toe of slope and planted with vegetation along 110 feet of shoreline. Twelve-inch diameter coir logs will be installed in an end-to-end fashion against the shoreline (Figure 5). The area directly behind the logs will be graded to match the existing elevation, seeded with native vegetation, and covered with erosion control material.

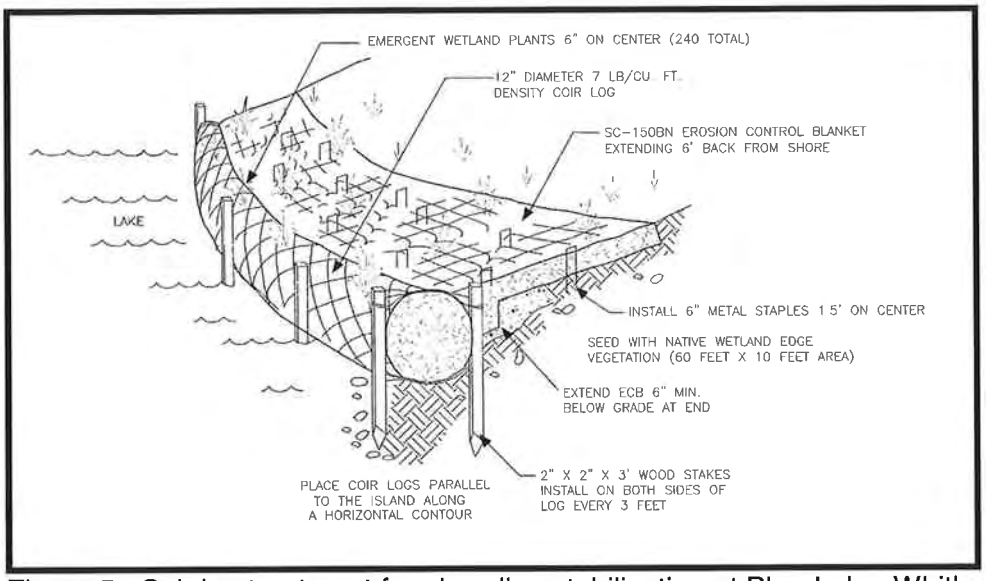


Figure 5. Coir log treatment for shoreline stabilization at Blue Lake, Whitley County, Indiana.

Site 2 – Rock grade controls along an eroding channel

An unnamed tributary enters Blue Lake at the southeastern corner of the lake (Figure 6). The channel drains 184.5 acres of the Blue Lake watershed. The channel is approximately two to four feet wide with an average depth of three feet (Figure 7). The conceptual design is to install a series of three rock grade controls to reduce stream velocity and allow for greater access to the floodplain.

Figure 6. Example of the eroding channel entering Blue Lake, Whitley County, Indiana.

Figure 7. Proposed location of rock grade controls at Blue Lake, Whitley County, Indiana.

Each grade control will consist of approximately 4 cubic yards of rock installed in the channel (Figure 8). Each structure will have a height of approximately 1.5 feet at the highest point and a width of approximately 4 feet. Total length of the structure will be approximately 28.5 feet including fore slope and back slope.

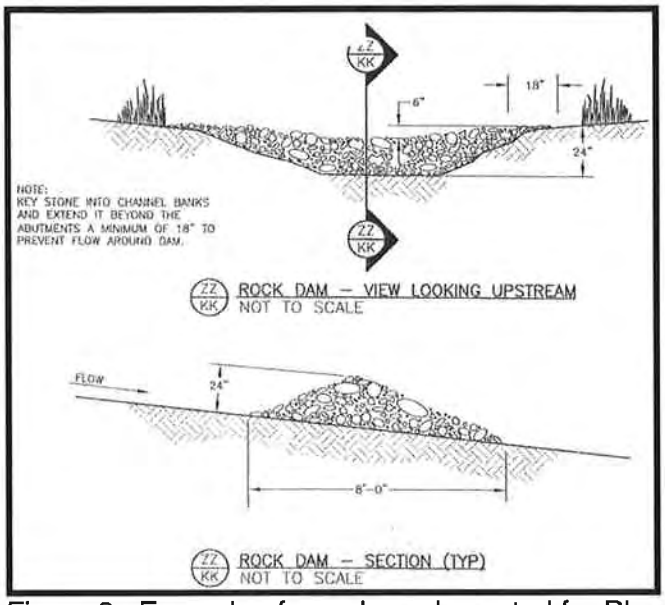


Figure 8. Example of a rock grade control for Blue Lake, Whitley County, Indiana.

Site 3 – Cross Valley Control Dam Structure

Site 3 is located upstream of the proposed grade controls. At this point in the drainage, the channel forms multiple braids that have shallow depth (Figure 9). The treatment consists of an earthen berm built across the valley to slow the flow stormwater and release it through a water control structure into the channel downstream (Figure 10).

Figure 9. Location of proposed cross valley control dam structure for Blue Lake, Whitley County, Indiana

Figure 10. Aerial view of the location of proposed cross valley control dam structure. Note areas is in yellow indicate NWI wetlands.

The earthen berm will be constructed in an upland location with only the portion that crosses the stream channel being negatively impacted by fill material. Directly upstream of the cross valley control dam structure is an area mapped as an NWI wetland. During initial field visits, there was no evidence to contradict this classification. Prior to the permit application, the area will be delineated using standard wetland delineation techniques to determine the exact wetland boundary in order to minimize the impact of the earthen berm. In general, the earthen berm will increase the wetland hydrology in the area directly upstream of the berm.

Site 4 – Repair of a Former Pond Basin Berm

Site 4 is located in the south central portion of the Blue Lake watershed and consists of a berm that was previously constructed to create a pond/wetland basin (Figure 12). Previously, the landowner breached the berm to reduce the standing water elevation due to trespassing by local children that were using it as a swimming area. The outlet of the pond flows into a stream channel that flows for approximately 1500 feet before emptying into Blue Lake. The proposed conceptual design has two options. Option 1 is to stabilize the breached area with a rock grade control set at the current elevation of the stream bottom. The rock grade control will be approximately 15 tons of fill below the Ordinary High Water Mark (OWHM) and measure approximately 30 feet long by 8 feet wide by 1.5 feet high at the highest point. Option 2 is to rebuild the breached berm and install a water control structure within the basin to slowly release stormwater downstream. The final standing water elevation will not change from the existing condition. Reconstruction of the berm will occur within the current footprint of the berm.

Upstream of the exisiting berm, there are two areas designated as NWI wetlands. Prior to any permit application, the area will be delineated using standard wetland delineation techniques to determine the exact boundaries of the wetlands within the project site. As part of the construction process for Option 2, material to re-construct the berm will be excavated from the pond basin. This will result potentially result in an increase in the open water habitat of the wetland once the berm is reconstructed. Excluding the berm re-construction and a minimal amount of stone used to stabilize the eroding stream channel, there will be no additional fill placed in a waters of the U.S.

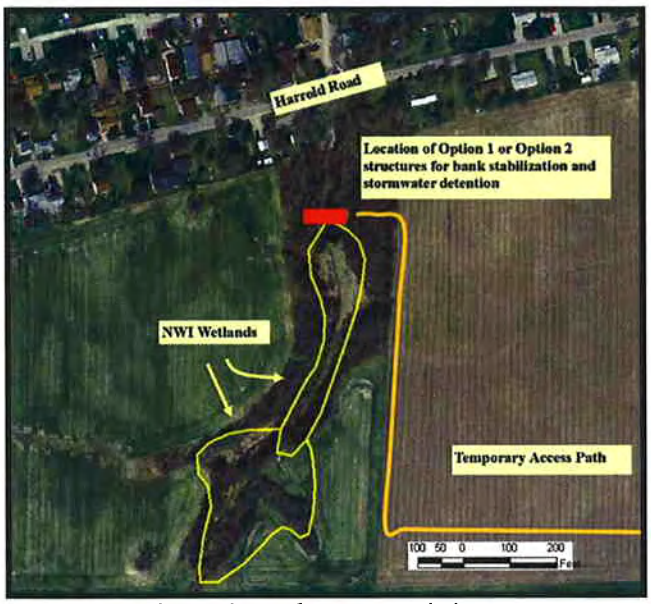


Figure 12. Location of proposed dam reconstruction or grade control at former pond basin site, Blue Lake, Whitley County, Indiana.

THIS IS NOT A PERMIT

State of Indiana
DEPARTMENT OF NATURAL RESOURCES
Division of Water

Early Coordination/Environmental Assessment

DNR #: ER-13243 **Request Received:** March 13, 2008

Requestor: JFNew and Associates
Mark Pranckus
708 Roosevelt Road
Walkerton, IN 46574

Project: Blue Lake feasibility study to improve water quality (4 projects)

County/Site info: Marshall

The Indiana Department of Natural Resources has reviewed the above referenced project per your request. Our agency offers the following comments for your information and in accordance with the National Environmental Policy Act of 1969.

Regulatory Assessment: This proposal will require the formal approval of our agency pursuant to the Lake Preservation Act (IC 14-26-2). Please include a copy of this letter with the permit application.

Natural Heritage Database: The Natural Heritage Program's data have been checked.
Purple lilliput (Toxolasma lividus), which is a state species of special concern mussel, has been recorded in Blue Lake. Also, the state endangered Blanding's turtle (Emydoidea blandingii) was recorded in 1903 to be located in the vicinity of the project.

Fish & Wildlife Comments: Site 1 - Shoreline Stabilization: The proposed shoreline stabilization projects are appropriate for this area of Blue Lake. These methods have demonstrated a high level of success on other lakes in Indiana and the Midwest. We recommend that upon completion, the area should be posted with appropriate "Do not mow" signage.

Site 2 - Rock Grade Controls: This activity will reduce down cutting of the stream, slow velocities, and allow for some sediment accumulation behind each structure. It does not appear that much clearing activity will be needed to install these practices.

Site 3 - Cross Valley Control Dam: Installation of this practice will compliment the practices installed at site 2. There will need to be some clearing of trees to install the berm and the majority of the site is out of the stream channel. Installation of this practice will increase the hydrology of this and adjacent loamy soil areas.

Site 4 - Former Pond Basin Berm Repair: Proposed construction activities at this site will occur where land disturbing activities have already taken place.
Option 1: The construction of a rock chute will prevent further down cutting through the existing dam.
Option 2: This option will restore hydrology and enhance the hydric soils located at this site.

The proposed practices for sites 2-4 have commonly been used at other stream locations throughout Northern Indiana that are experiencing the same erosion and increased stream flow conditions as these sites are.

Impacts to riparian forest habitat under one (1) acre should be mitigated at a 1:1 replacement ratio. Impacts to non-wetland forest habitat over one (1) acre should be mitigated at a minimum 2:1 ratio, and impacts to wetland habitat should also be mitigated at the appropriate ratio. Please reference Information Bulletin #17 (http://www.in.gov/legislative/register/20061213-IR-312060562NRA.xml.pdf) for guidelines on appropriate ratios.

In addition to the above recommendations, fish, wildlife, and botanical resource losses

THIS IS NOT A PERMIT

State of Indiana
DEPARTMENT OF NATURAL RESOURCES
Division of Water

Early Coordination/Environmental Assessment

as a result of this project can be further minimized through implementation of the following measures.
Revegetate all bare and disturbed areas landward of the shoreline with a mixture of grasses (excluding all varieties of tall fescue) and legumes as soon as possible upon completion.
Minimize and contain within the project limits all tree and brush clearing and provide the opportunity to utilize cleared trees of firewood and timber size.
Do not cut any trees suitable for Indiana bat roosting (greater than 3 inches dbh, living or dead, with loose hanging bark) from April 1 through September 30.
Appropriately designed measures for controlling erosion and sediment must be implemented to prevent sediment from entering the lake or leaving the construction site; maintain these measures until construction is complete and all disturbed areas are stabilized.
Do not excavate or place fill in any riparian wetland.

Contact Staff: Christie L. Stanifer, Environ. Coordinator, Environmental Unit
Our agency appreciates this opportunity to be of service. Please do not hesitate to contact the above staff member at (317) 232-4160 or 1-877-928-3755 (toll free) if we can be of further assistance.

Date: April 16, 2008

J. Matthew Buffington
Environmental Supervisor
Division of Fish and Wildlife

Mark Pranckus

From: Baldwin, Brad [bbaldwin@idem.IN.gov]
Sent: Wednesday, April 16, 2008 4:11 PM
To: Mark Pranckus
Subject: Blue Lake LARE Comments

Mark,

I am writing in response to your letter dated March 10, 2008, and received March 13, 2008, requesting review and comments regarding preliminary plans to improve the water quality of Blue Lake in Whitley County to be funded by the IDNR LARE Program.

I have the following comments for each project as currently proposed:

Site 1, Shoreline Stabilization along Blue Lake: As proposed, it seems as if there is a purpose and need for the stabilization. The legal lake level (OHWM) for Blue Lake is 850.28' msl. Per the Programmatic General Permit, IDNR will determine if the application for this aspect of the project should be forwarded to the USACE, and therefore IDEM do to the length of the impacts. In this case, the impacts exceed 300 linear feet, so I anticipate an Individual Permit (IP)Application will be required.

Site 2, Grade Control Structures: Per your example rock grade control for the Unnamed Tributary to Blue Lake, the plans indicate check dam. Please refer to this structure as a grade control in the submittal. Since these impacts will be associated with the stabilization at Site 1, these impacts should be included in the same IP submittal. There may be some concerns on the maximum allowable height of each structure, but if you demonstrate sufficient purpose and need, which it looks as if you will be able to, then grade control structures are approvable impacts.

I apologize, but I will have to comment on Sites 3 and 4 on Friday.

Please feel free to contact me on Friday if you have questions or concerns.

Thank you,

Brad C. Baldwin
Project Manager
Wetlands & Storm Water Section
IDEM - Office of Water Quality
Phone: (317) 234-5647

Mark Pranckus

From: Baldwin, Brad [bbaldwin@idem.IN.gov]
Sent: Thursday, May 01, 2008 9:41 AM
To: Mark Pranckus
Subject: FW: Blue Lake LARE Comments

Mark,

I sent them on April 18, please see email below. If you did not receive them I apologize, I don't know why that would have happened. Feel free to contact me if you have questions.

Thanks,

Brad C. Baldwin
Project Manager
Wetlands & Storm Water Section
IDEM - Office of Water Quality
Phone: (317) 234-5647

From: Baldwin, Brad
Sent: Friday, April 18, 2008 3:02 PM
To: 'Mark Pranckus'
Subject: RE: Blue Lake LARE Comments

Mark,

I am writing to continue my response to your letter dated March 10, 2008, and received March 13, 2008, requesting review and comments regarding preliminary plans to improve the water quality of Blue Lake in Whitley County to be funded by the IDNR LARE Program.

I have the following comments forsites 3 and 4 as currently proposed:

Site 3: Constructing in-channel control structure for in-line detention will most likely not be authorized. Additionally, as proposed, you may have impacts to a wetland upstream, which would require mitigation for this secondary impact. At the likely risk of being denied, you may submit your proposal, but LARE funds can probably be spent with less risk and more wisely.

Site 4: I would need more details regarding this project, to include pictures of the existing breached berm. When was the berm constructed? When was the berm breached by the property owner? Option 1 as written, to stabilize the breached area with a rock grade control structure, seems to be the option with the least impacts, both temporary and permanent. The project at this may be possible since it is an existing structure, though again I would need more information to determine if this impact would violate state water quality standards.

Please feel free to contact me if you have further questions or concerns.

Thank you for you inquiry.

Brad C. Baldwin
Project Manager

APPENDIX E:

DESIGN DATA

BLUE LAKE
ENGINEERING FEASIBILITY STUDY
WHITLEY COUNTY, INDIANA

Blue Lake Engineering Feasibility Projects

Review and Summary

Site 3.1 – The ditch downstream from the concrete box culvert to the beginning of the channel was surveyed, including the low area just upstream of the channel. A constructed wetland/sediment basin would be approximately 30 X 50 ft. with less than one foot of storage depth to permanent water level. Based on the limited size, need for continuous maintance and the difficulty to access with heavy equipment the site would not be cost effective.

Site 3.2 – Typical cross-sections of the ditch down stream of the potential cross valley structure indicates there is a capacity to flow approximately 10 year storm event. However, the channel grade of 1 to 1.5% creates a flow velocity significantly exceeding that required of a non-vegetated channel. The result being severe stream bank erosion.

The grade and velocity can be reduce to acceptable levels by installing three check dams as located on the aerial map. However, the channel capacity will be reduce to less than a 2 year storm event. This means much more out-of-bank flow and a higher risk of bank and gully erosion at the point runoff re-enters the channel downstream.

Site 3.3 – Four potential sites were identified. The four were narrowed down to two based on size and potential effectiveness. Very early in the preliminary design phase it was obvious the large watershed would require a rather costly structure to past the runoff through or over the embankment. One of the two sites was also going to be difficult to access. Thus, the two sites were combined into one basin area requiring one larger embankment and only one structure. The combining of the two sites also result in greater runoff storage volume.

The potential site has its limitations. Clay soil will have to be brought in from off site unless and agreement is reached with the landowner to use a portion of the crop field as a barrow area. This would increase cost of the embankment by five times what would be realized from fill material on-site. The 10 year – 24 hour storm event would deliver 17.8 acre feet of runoff into a basin which can store 3.92 acre feet. The storage of only 22% of the watershed runoff in the basin greatly reduces the effectiveness to settle out sediments and attached pollutants. The basin will likely fill up during the first part of the storm event when the sediment and pollutant load is low and when of greatest concern will past on downstream through the overflow structure as the basin will be full. To construct this basin may be economically unfeasible considering the cost and effectiveness.

A 6 inch pipe with an 18 inch riser is proposed to drain the storage portion of the runoff. The remaining runoff will be passed over the embankment through a rock chute spillway. This spillway is rather large to allow the flow of a 25 year storm. With homes below the

embankment it will be necessary to check DNR regulations and dam classifications. It may be necessary to go with a 50 year storm spillway.

Site 4 – Preliminary design of a WASCOB along the edge of the crop field indicated the watershed was to large construct an embankment, store the runoff and slowly release it. With this knowledge it was obvious a dry dam at the top of the hill above the homes would not be considered.

A rock lined channel over the hill was the selected solution. The rock lining would stop the bank erosion, but would have no affect on the runoff continuing on downstream where flooding occasionally occurs.

Site 5- It is recommended the former pond embankment not be utilized as is for a sediment basin. Large trees are present with roots exposed in the breach area. Removal of these trees will leave behind roots to decay creating tunnels and weakening the embankment. It is likely part of the old pond embankment can be used for fill. The remaining fill can come from the basin if constructed during dry conditions.

This site is very similar to site 3.3 in that only a small portion (19%) of the 10 year storm event can be stored in the basin. However, the construction cost is lower due to having fill material on site. Again, someone is going to have to make a decision as to whether the basin is cost effective. It is likely larger soil particles will settle into the basin. But the colloidal particles with attached pollutants will past through the basin on down stream.

As on site 3.3 the overflow structure is designed for a 25 year-24 hour storm event. I feel this is a minimum for an embankment above homes. Again, this is a site which needs to be checked with DNR to see if special regulations or dam classifications apply.

NOTE: Preliminary design and conceptual drawings are attached. When and if final designs are completed JFNew engineers will need to review and approve.

Site 3.2 and 3.3 – Cross Valley Control Dams and Check Dams

Hydrologic Data

* Watershed Area 108.6 acres

* Rainfall	Runoff	Peak Discharge
2yr -24 HR 2.7"	1.00	69 cfs
5yr - 24 HR 3.5"	1.58"	96 cfs
10yr - 24 HR 4.0"	1.97"	122 cfs
25yr - 24 HR 4.5"	2.38"	143 cfs
50yr - 24 HR 5.0"		

* Curve Number (CN) 79
* Ponding 4.9 Acres or 0.045 of watershed
  Adjustment for 25yr frequency 0.90
* Average W/S Slope 4% or moderate

Design – Basin Drain

Head 9'

Acft Storage Available 3.92 or 170,755 cu. ft.

Use 6" PVC x 80ft Length Capacity 1.85 cfs

18" Riser x 6' w/slots

Drawdown Time = $\frac{170,755}{1.85}$ = 92,300 seconds or 26 HRS

Two 3x3' Anti-Seep

Design – Rock Chute Spillway

25yr -24 Hr Storm Event Peak Discharge = 143 cfs

Rock size D_{50} 9" – 20' Bottom – 0.8 Depth Flow in Chute Area

26' Width – Entrance.

Design – Check Dams

* Existing channel capacity – Approximately 10yr storm event – 1.5% Grade
* Channel Capacity reduced 50% when reduced 3'-2' Depth on same grade

3' Depth 78cfs on 0.5% Grade

Example: 2' Depth, 4' Bottom, 0.5% Grade - Capacity 36cfs
Velocity 3.0 fps OK

Summary: Placing check dams to reduce grade to 0.5% which allows acceptable velocity within the ditch reduces the cfs capacity significantly resulting in frequent out of bank flow which may result in considerable over the bank erosion as runoff re-enters the channel.

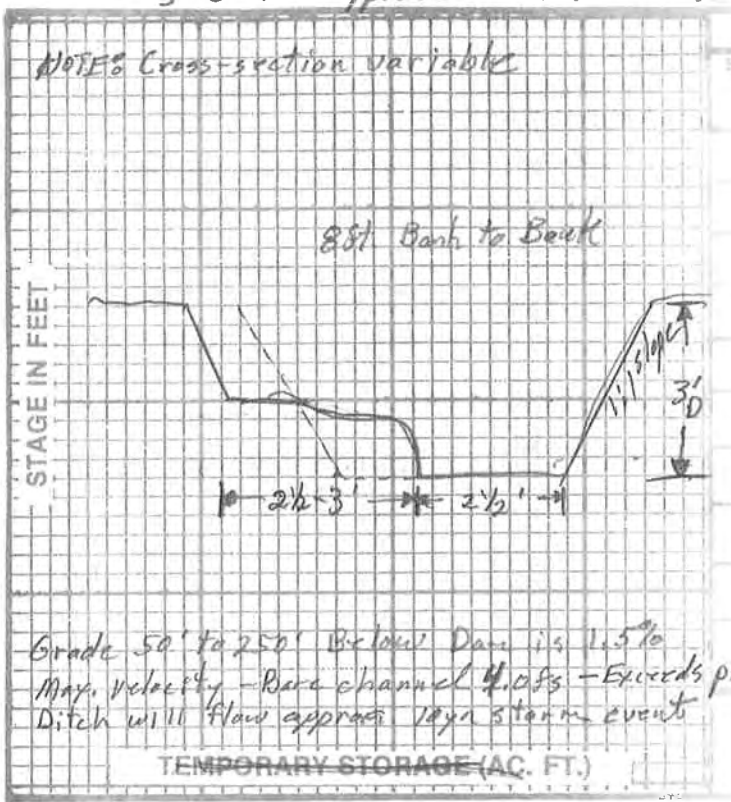
The ditch presently carries between 5-10 year storm. Check dam reduce the capacity to less than a 2ya. storm. Less than the 36cfs in example, due to friction passing over the stone.

If check dams are installed - construct 1.0' in heighth at locations shown on map. Landowners need to be made aware their will be more frequent out of bank flow and further erosion may occur at re-entry of runoff. Use D_{50} - 9" with 5:1 slope downstream and 5:1 slope upstream. 3' foot Top - Key into bank on each side. Place stone minium 18" Depth. Approx 20 Tons per check dam.

This is an excellent example why land treatment should be implemented in the upper reaches of the watershed.

Site 3.2 Typical Cross-section of Ditch

NOTE: Cross-section variable



Site 3.3

Station	Cu.yd.	Planned Acre	Average Acre	Spread Ft.	Acre Foot Storage Ft.	Acre Foot Storage Ac. Ft.
0	0	0				
2	1.7	0.39	.195	2	0.39	
4	3.65	0.84	0.615	2	1.23	
6	6.33	1.45	1.15	2	2.30	
						3.92 Ac Ft

1" = 10,000 sq ft
1" = 100 L.F.

Grade 50' to 250' Below Dam is 1.5%
Max. velocity - Bare channel 4.0 fps - Exceeds plus.
Ditch will flow approx. 10yr storm event

Site 3.3 **EARTHWORK COMPUTATIONS** Slopes 3:1 Front 5:1 Back Top 8

Station	Elevation	Fill Height Ft.	Cu.yd. per ft.	Average fill cu.yd.	Distance Ft.	Cu. yd.
0+00	8	0	0			
0+25	6	2	1.19	0.60	25	15
0+55	0	8	11.9	5.95	30	179
0+90	0	8	11.9	11.90	35	417
1+50	1	7	9.50	10.70	60	642
2+10	8	0	0	4.75	60	285
						1538
						307
				Settlement	20%	1845
						compacted Fill
Core Trench		150 cu yds				
	2' Depth	X 210 LF	X 8' Width			
Clearing	75' width	X	200 =	0.35 Ac		

Compaction Important for Emergency

Emergency 100 L.F. or 50 LF

Clearing adequate (yes) (no)_____

Stockwater system adequate (yes) (no)_____

Seeding adequate (yes) (no)_____

I certify that this job meets all the requirements of the Illinois Conservation Practice Standard (Grade 378) and the plans as designed.

Checked by:_____

U.S. Department of Agriculture
Soil Conservation Service

IN-ENG-10
Rev. 10/89
File Code 210-11

WORKSHEET IN-1: RUNOFF CURVE NUMBER (CN)

Client Blue Lake Practice and ID Site 3.2 and 3.3

_____ County Soil and Water Conservation District, Indiana

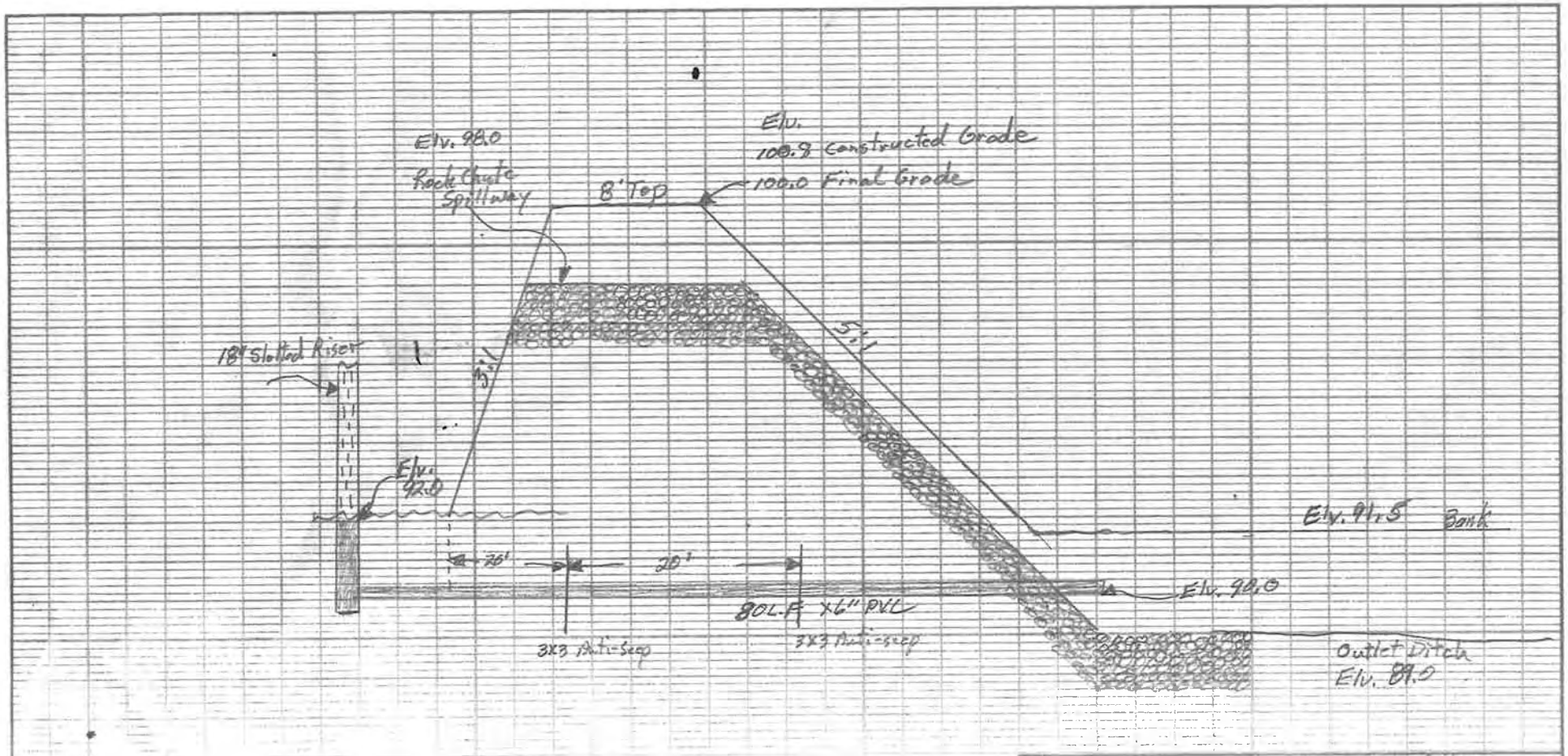
By _____ Date _____ Checked by _____ Date _____

COVER TYPE	TREATMENT 1/	HYDROLOGIC CONDITION 2/	CURVE NUMBER (CN) Hydrolocic Soil Group (EFM Table IN-2-2) A	B	C	D	AREA, ACRES	PRODUCT OF CN X ACRES
Row Crops	Straight Row	poor	72	81	88	91		
		good	67	78	85	89		
	Straight Row + CR	poor	71	80	87	90		
		good	64	75	82	85		
	Contoured + CR	poor	69	78	83	87		932.4
		good	64	74	81	85	12.6 75.9	6147.9
Small Grain	Straight Row	poor	65	76	84	88		
	Straight Row + CR	good	63	75	83	87		
Pasture or Grassland		poor	68	79	86	89		
		good	39	61	74	80		
Meadow	Not Grazed	--	30	58	71	78		
Woods		poor	45	66	77	83	7.6	77
		good	30	55	70	77	1.4 7.3	532 562.1
Farmsteads		--	59	74	82	86	1.3 1.1	96.2 90.2
Streets and Roads	Paved w/ Curb	--	98	98	98	98		
	Paved w/ Ditches	--	83	89	92	93	1.4	128.8
Residential 3/	1/4 acre lots	--	61	75	83	87		
	1/2 acre lots	--	54	70	80	85		
	1 acre lots	--	51	68	79	84		
Other (Specify)								
					TOTALS		108.6 ACRES	8566.6

1/ Crop residue cover (CR) applies if residue is on at least 5% of the surface throughout the year.
2/ See EFM Table 2-3 for definitions.
3/ Includes subdivision streets and driveways.

Weighted CN = Product Total / Total Acres = 8566.6 / 108.6 ; Use CN = 78.9 Use 79

(Do not use less than CN 60 without approval of area engineer)



NOTE: Install Trash Rack around riser.

Rock Chute Spillway should be located in natural soils, if possible.

Do not outlet basin drain into stone spillway.

Design needs to be revicued and approved by "Registered Engineer" to ossure it is in compliance with DNR dam classification requirements.

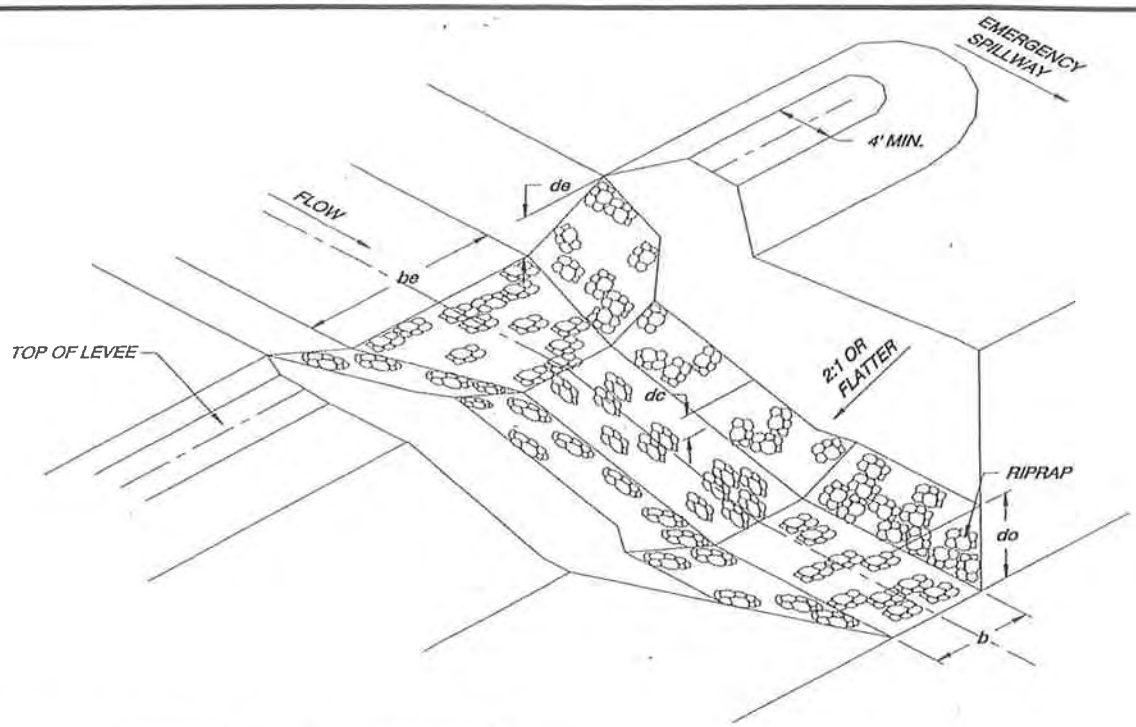
Site 3.3 Cross Valley Central Dam

NOTE TO SCALE

U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

Designed	Approved By
Drawn	Title
Traced	Title
Checked	Sheet No of — Drawing No.

U.S. GPO 1997 547-372



ROCK LINED CHUTE

CONSTRUCTION DATA		
OVERFALL (F) =	9.0	FEET
CHUTE SLOPE (S) =	5	:1
SIDE SLOPES (Z) =	3	:1
ENTRANCE LENGTH (Le) =	9-10	FEET
CHUTE LENGTH (Lc) =	45	FEET
OUTLET LENGTH (Lo) =	10	FEET
ENTRANCE ROCK HEIGHT (de) =	2.0	FEET
CHUTE ROCK HEIGHT (dc) =	1.8	FEET
OUTLET ROCK HEIGHT (do) = Top Bank	2.5	FEET
BOTTOM WIDTH (b) =	20	FEET
ENTRANCE B.W. (be) =	26	FEET
RIPRAP THICKNESS =	18	IN
BEDDING THICKNESS =		IN

CONSTRUCTION ELEVATIONS	
TOP OF LEVEE ELEV. =	
EMERGENCY SPILL. ELEV. =	
INLET ELEV. =	
OUTLET ELEV. =	

ESTIMATED QUANTITIES		
CLEARING:	0.40	AC.
EXCAVATION & BACKFILL:	1845 Dam 160 Core	CU. YD.
RIPRAP:	200	TONS
BEDDING:	—	TONS
OR GEOTEXTILE FABRIC:	230	SQ. YD.
REVEGETATION:	0.50	AC.
OTHER:	20 Tons – Gravel mix to fill voids	

NOTES:

1. THE CHUTE SLOPE (S) SHALL NOT BE STEEPER THAN 5:1.
2. THE SIDES SLOPES (Z) SHALL NOT BE STEEPER THAN 2:1.
3. THE ENTRANCE APRON WIDTH SHALL VARY UNIFORMLY FROM (be) TO (b).
4. PROVIDE AN EMERGENCY SPILLWAY, ONE ON EACH SIDE IF FEASIBLE, WITH THE CREST ELEVATION 0.3' TO 0.5' BELOW TOP OF ROCK ON ENTRANCE SIDE SLOPES.
5. GEOTEXTILE FABRIC MAY BE USED IN LIEU OF BEDDING.
6. AFTER PLACEMENT OF RIPRAP, SPREAD ENOUGH SMALL RIPRAP FRAGMENTS OR BEDDING MATERIAL OVER ENTIRE SURFACE OF THE CHUTE TO FILL THE VOIDS IN THE RIPRAP AND COMPACT RIPRAP WITH CONSTRUCTION EQUIPMENT. A MIXTURE OF SOIL AND SEED MAY BE SPREAD OVER THE RIPRAP.
7. TILE OUTLETS SHALL NOT BE ROUTED THROUGH THE STRUCTURE.

NOT TO SCALE

LANDUSER _____

_____ COUNTY SWCD, INDIANA

LOCATION _____

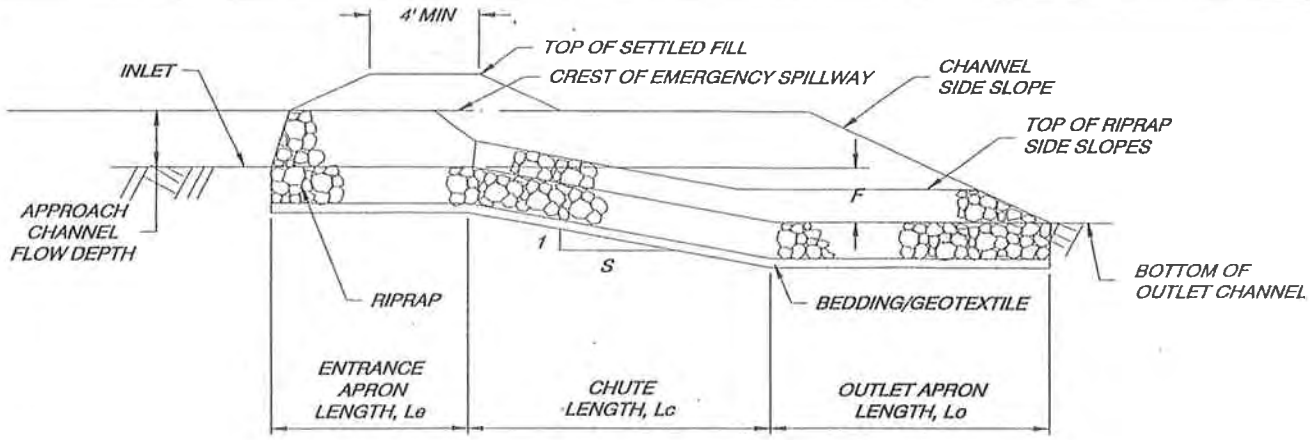
ROCK LINED CHUTE

GENERAL LAYOUT
INDIANA

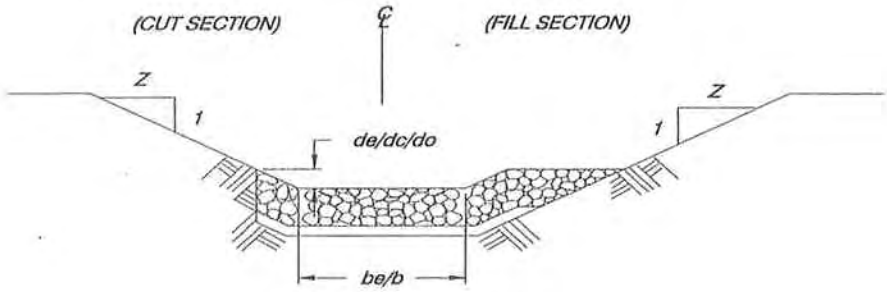
U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

	Date		Date
Designed		Approved by	
Drawn		Title	
Traced		Title	
Checked		Sheet No. of	Drawing No.

DRAWING NO. IN-ENG-36.XLS (REV. 1/00)



PROFILE ALONG CENTERLINE



TYPICAL CROSS SECTION

RIPRAP GRADATION

d50 = 9 INCHES

SIZE	% PASSING
	100%
	50%
	15%

BEDDING GRADATION

EQUIVALENT TO INDOT AGGREGATE # _____

GEOTEXTILE

TYPE:	NON-WOVEN, NEEDLE-PUNCHED
TENSILE STRENGTH:	180 LBS. MIN.
BURSTING STRENGTH:	320 PSI MIN.
ELONGATION @ FAILURE:	50% MIN.
U.V. LIGHT RESISTANCE:	70% MIN.
PUNCTURE:	80 LBS. MIN.
PERMITTIVITY:	0.70 SEC $^{-1}$ MIN.

NOT TO SCALE

LANDUSER _____

_____ COUNTY SWCD, INDIANA

LOCATION _____

ROCK LINED CHUTE

GENERAL LAYOUT
INDIANA

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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Cost-Estimate - Site 3.2 - Check Dams

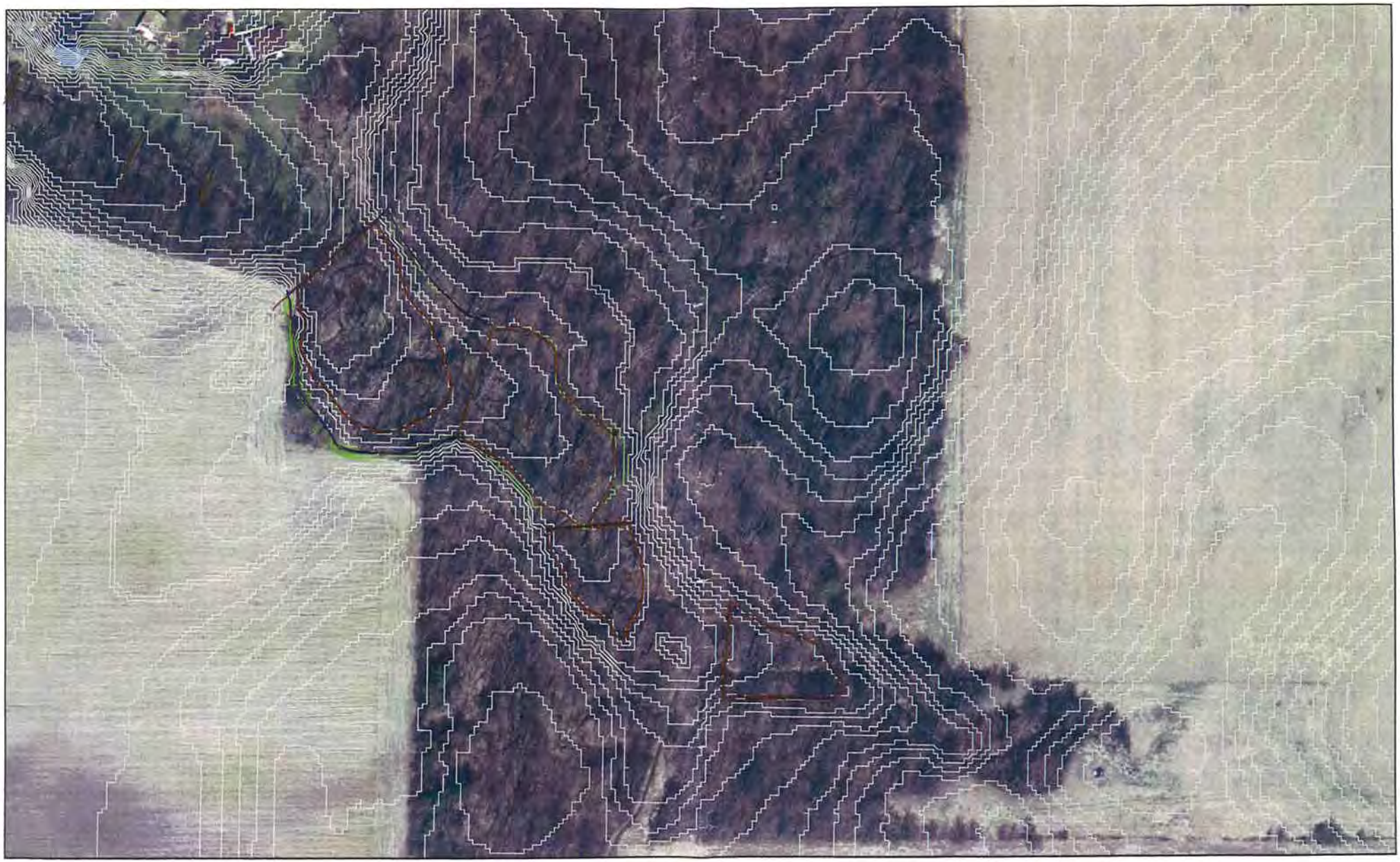
Per check dam

20 Ton D_{50}-9" Rip-rap installed @ $40/Ton	$800.00
Excavation/Grading	150.00
Seeding disturbed areas.	50.00
	$1000.00

Site 3.2 - Cross-valley control dam

Clearing 0.4 acre @ 5000.00/Ac (Cleared debris to remain on-site)	2000.00
Excavation - 1845 cuyds in dam @ $15.00/cuyd. hauled in within 2 miles	27675.00
150 cuyds - Core Trench @ $6.00	900.00
Structure - 200 Tons D_{50}-9" installed @ $40/Ton (Including geo textile fabric)	8000.00
20 Ton Gravel-mix in place @ $30	600.00
Basin Drain - Materials/Installation	1200.00
Trash Rack	300.00
Fertilizing, seeding, mulching 0.50 Acres	500.00
	$41,175.00
Use	$45,000.00
	($38,000.00)

Possibly - Temporary Erosion Control Measures



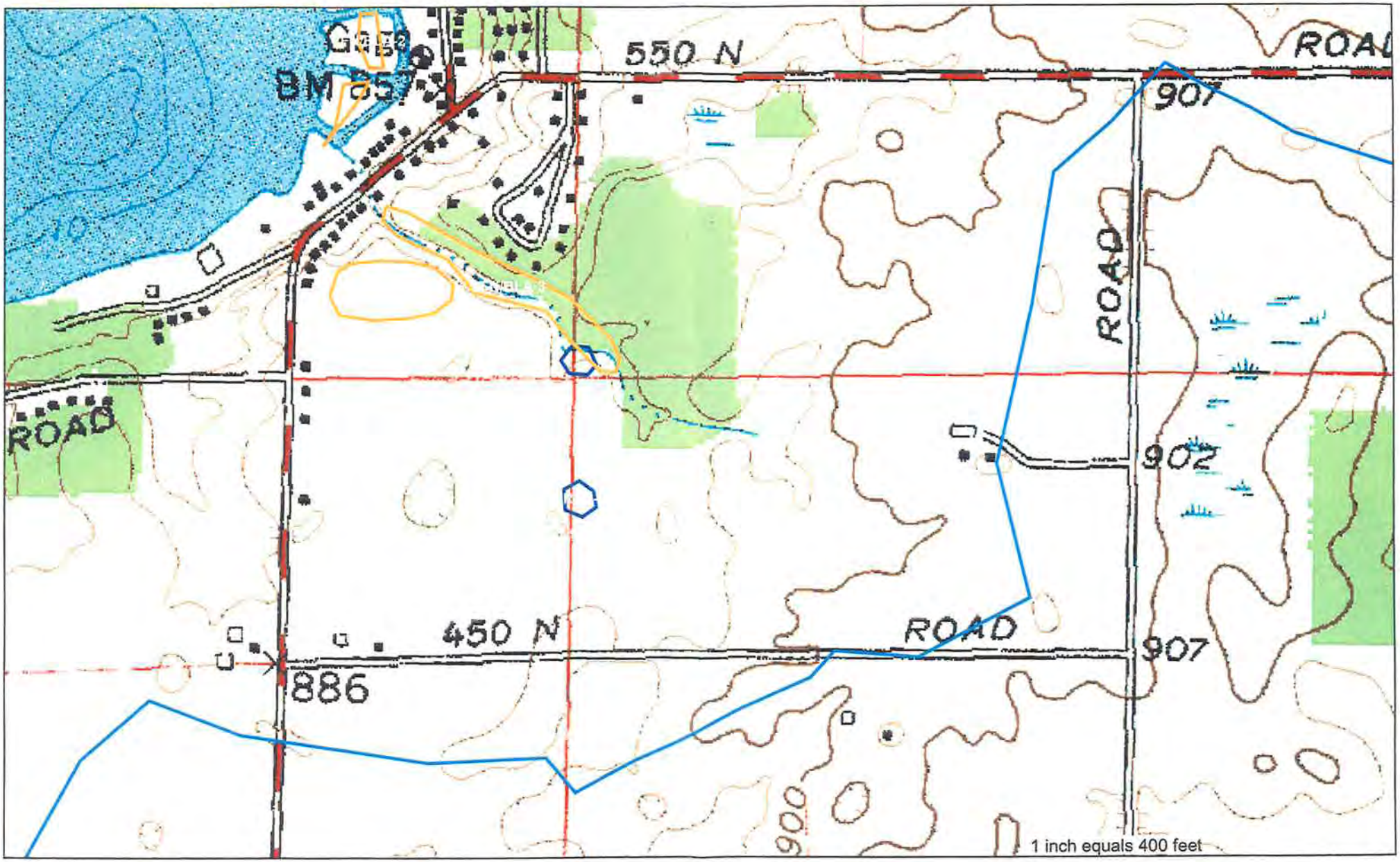
Blue Lake 1-Foot Contours

1 inch equals 100 feet

0 50 100 200 300 Feet

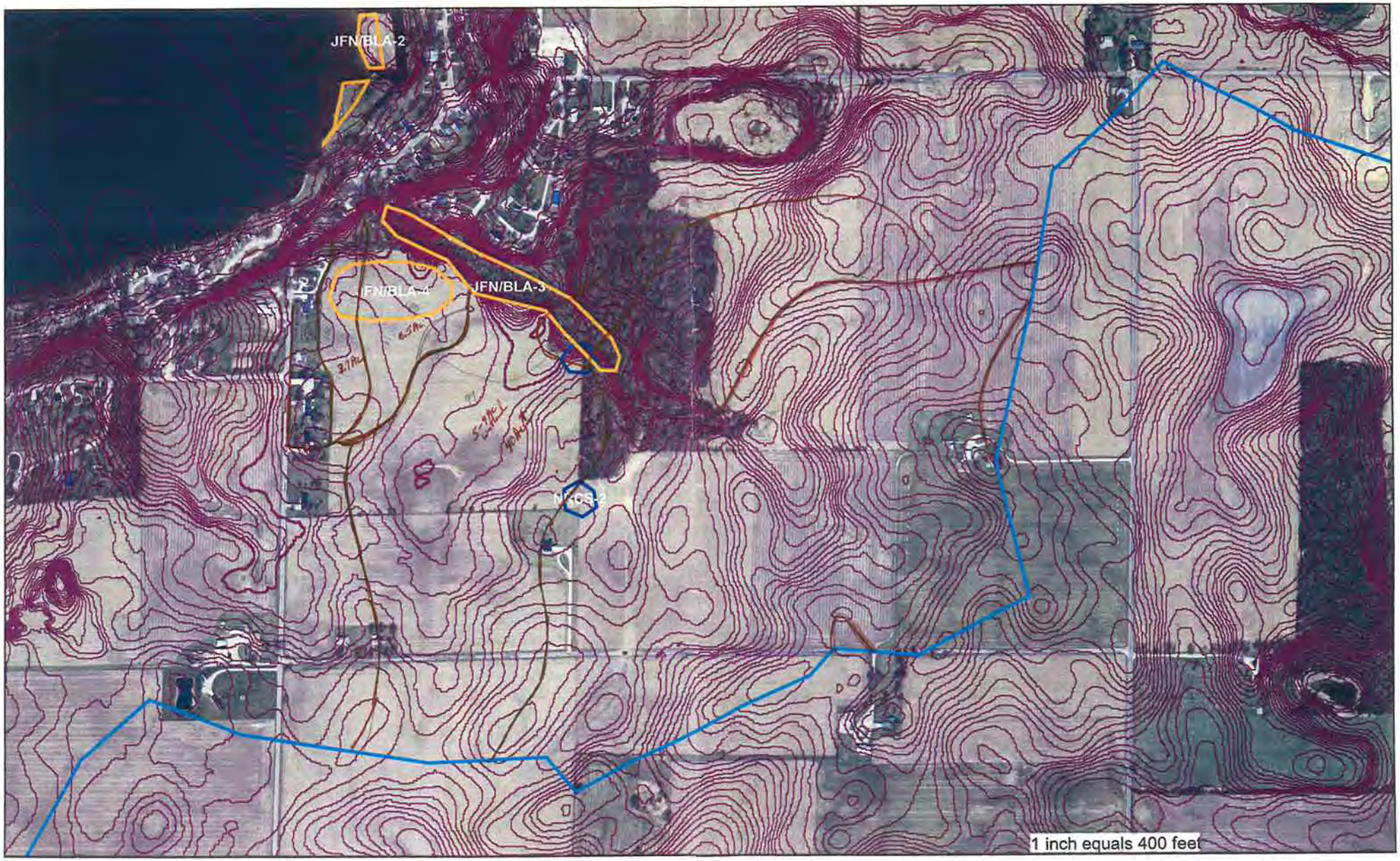
Blue Lake Soils

1 inch equals 300 feet



USGS Topo Map - Blue Lake

0 400 800 1,600 2,400 Feet



1-Foot Contours - Blue Lake

0 400 800 1,600 2,400 Feet

Rock Line Chute — site 4

10cfs — 10yr Storm

13cfs — 25yr Storm

Stone Size D^{50} 6" Max Velocity 6.9 fps

Chute Slope 4:1

Side Slopes 3:1

3' Bottom — 10yr Storm Approx 12cfs

4' Bottom — 25yr Storm Approx. 15cfs

0.5 Depth of Flow

Depth of Rock 12"

Entrance 5' Long — Flow 3-6 or 4-8

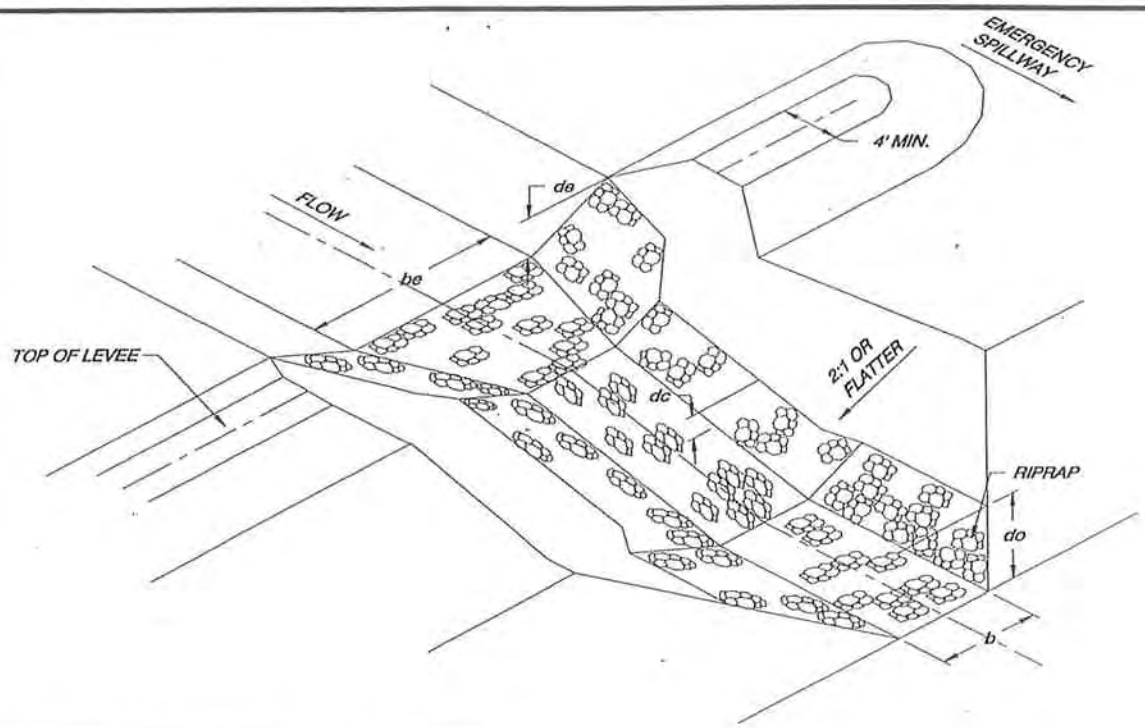
Exit Length 5'

Entrance Depth 1.5'

Grade to chute — top of fill 1½' above entrance flow

Fall 8' After lowering 1' at entrance

Chute Length 32-34' 4:1



ROCK LINED CHUTE

CONSTRUCTION DATA		
OVERFALL (F) =	8	FEET
CHUTE SLOPE (S) =	4	:1
SIDE SLOPES (Z) =	3	:1
ENTRANCE LENGTH (Le) =	5	FEET
CHUTE LENGTH (Lc) =	Approx 34	FEET
OUTLET LENGTH (Lo) =	5	FEET
ENTRANCE ROCK HEIGHT (de) =	2.0	FEET
CHUTE ROCK HEIGHT (dc) =	1.5	FEET
OUTLET ROCK HEIGHT (do) =	2.0	FEET
BOTTOM WIDTH (b) =	3	FEET
ENTRANCE B.W. (be) =	6	FEET
RIPRAP THICKNESS =	12	IN
BEDDING THICKNESS =	—	IN

CONSTRUCTION ELEVATIONS	
TOP OF LEVEE ELEV. =	
EMERGENCY SPILL. ELEV. =	
INLET ELEV. =	
OUTLET ELEV. =	

ESTIMATED QUANTITIES		
CLEARING:	—	AC.
EXCAVATION & BACKFILL:	35	CU. YD.
RIPRAP:	20	TONS
~~BEDDING:~~	—	TONS
OR GEOTEXTILE FABRIC:	45	SQ. YD.
REVEGETATION:		AC.
OTHER:		

NOTES:

1. THE CHUTE SLOPE (S) SHALL NOT BE STEEPER THAN 5:1.
2. THE SIDES SLOPES (Z) SHALL NOT BE STEEPER THAN 2:1.
3. THE ENTRANCE APRON WIDTH SHALL VARY UNIFORMLY FROM (be) TO (b).
4. PROVIDE AN EMERGENCY SPILLWAY, ONE ON EACH SIDE IF FEASIBLE, WITH THE CREST ELEVATION 0.3' TO 0.5' BELOW TOP OF ROCK ON ENTRANCE SIDE SLOPES.
5. GEOTEXTILE FABRIC MAY BE USED IN LIEU OF BEDDING.
6. AFTER PLACEMENT OF RIPRAP, SPREAD ENOUGH SMALL RIPRAP FRAGMENTS OR BEDDING MATERIAL OVER ENTIRE SURFACE OF THE CHUTE TO FILL THE VOIDS IN THE RIPRAP AND COMPACT RIPRAP WITH CONSTRUCTION EQUIPMENT. A MIXTURE OF SOIL AND SEED MAY BE SPREAD OVER THE RIPRAP.
7. TILE OUTLETS SHALL NOT BE ROUTED THROUGH THE STRUCTURE.

NOT TO SCALE

Site #4

LANDUSER _____

_____ COUNTY SWCD, INDIANA

LOCATION _____

ROCK LINED CHUTE

GENERAL LAYOUT
INDIANA

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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Designed		Approved by	
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Traced		Title	
Checked		Sheet No. of	Drawing No.

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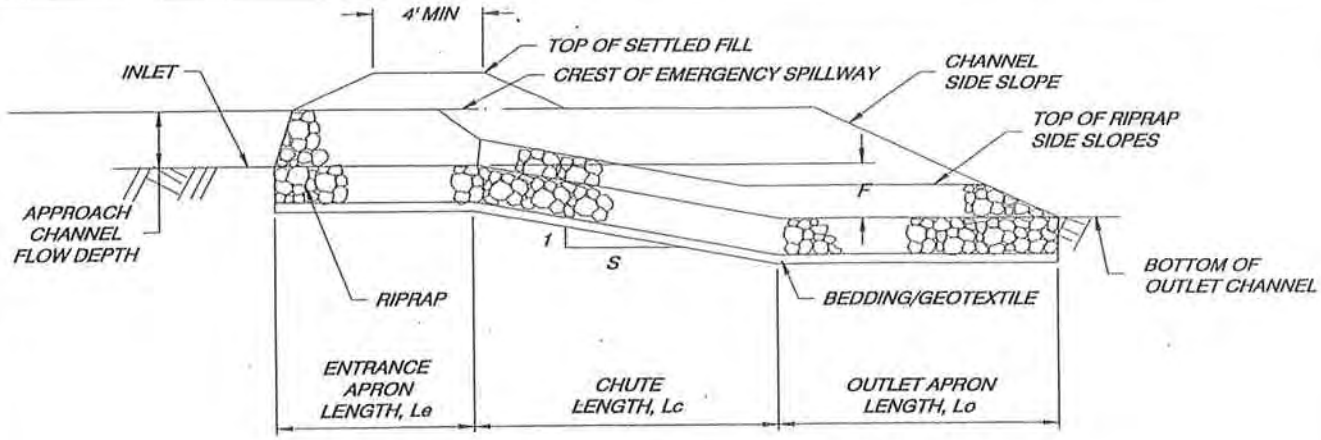
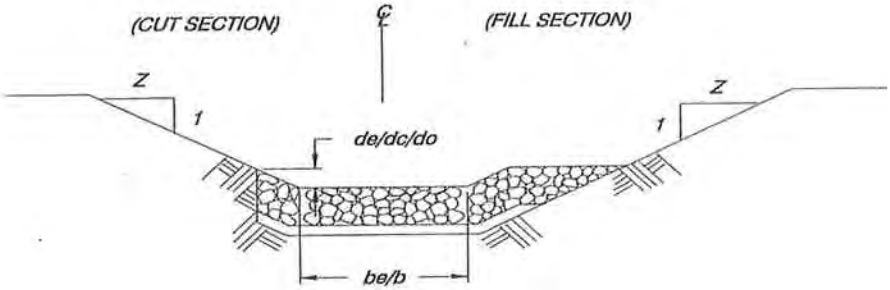
IN-ENG-36 (1 OF 3)



PROFILE ALONG CENTERLINE



TYPICAL CROSS SECTION

RIPRAP GRADATION

d50 = 6" INCHES

SIZE	% PASSING
	100%
	50%
	15%

BEDDING GRADATION

EQUIVALENT TO INDOT AGGREGATE # _____

GEOTEXTILE

TYPE:	NON-WOVEN, NEEDLE-PUNCHED
TENSILE STRENGTH:	180 LBS. MIN.
BURSTING STRENGTH:	320 PSI MIN.
ELONGATION @ FAILURE:	50% MIN.
U.V. LIGHT RESISTANCE:	70% MIN.
PUNCTURE:	80 LBS. MIN.
PERMITTIVITY:	0.70 SEC $^{-1}$ MIN.

NOT TO SCALE

LANDUSER _____

_____ COUNTY SWCD, INDIANA

LOCATION _____

ROCK LINED CHUTE

GENERAL LAYOUT
INDIANA

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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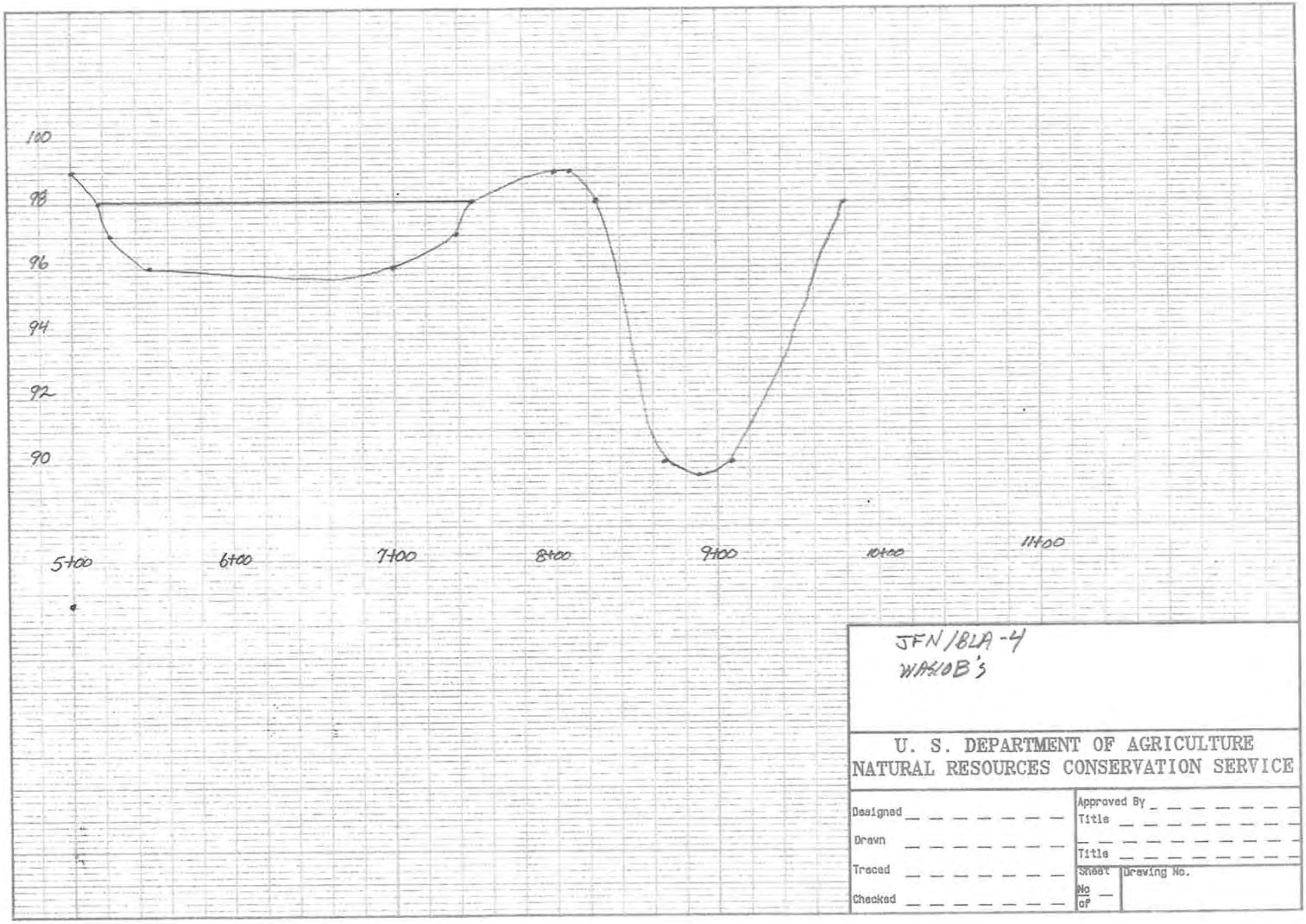
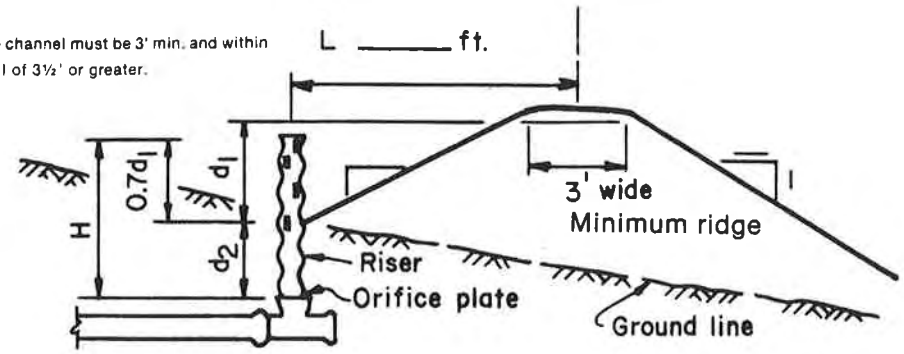


U.S. GPO 1997 547-372

Note: Riser height above channel must be 3' min. and within 6" of top of any fill of 3½' or greater.



DESIGN HEAD FOR ORIFICE PLATE

REQUIRED STORAGE

Ridge No.	D.A. Acres	Accum. D.A. Acres	Required d Storage		
			Runoff Cu.Ft.	Sed. Cu.Ft.	Total Cu.Ft.
1	3.7	3.7	28205	3256	31461
2	5.8	9.5	44213	5660	49873

ORIFICE DESIGN

Ridge Length	Ridge Elev.	Channel Elev.	d_1 Ft.	$0.7d_1$ Ft.	Orifice Elev.	d_2 Ft.	H Ft.

ORIFICE DESIGN AND SUBSURFACE DRAIN

Ridge No.	Required Capacity CFS	Orifice Size Inches	Discharge Provided CFS	Accum. Discharge CFS	Drain Grade %	Drain Size Inches	Max. Drain Cap. CFS	Draw-down Hours	Channel Above Level Ridge		
									Depth Ft.	Channel Grade %	Vel.1 FPS

1/SHOW VELOCITY ONLY IF GRADE EXCEEDS 0.6%

AVAILABLE STORAGE COMPUTATION

Ridge number	Field slope % each	Ridge elevation	Station	Design depth ft.	Cut depth ft.	Storage cu. ft./ft.	Average storage cu. ft./ft.	Dist. ft.	Storage cu. ft.
1	4	98.0	5+00	0	0	0			
			5+50	2	0	76.5	38.25	50	1912
	Front Slope	30'	7+00	2	0	76.5	76.5	150	11475
			7+50	0	0	0	38.25	50	1912
									15,299
2	8	98	8+25	0	0	0			
			8+65	8	0	464	232	40	9280
	Front Slope 2:1		9+10	8	0	464	464	45	20880
			9+80	0	0	0	232	70	16240
									46,400

WASLOB #1

D.A. 3.7 Acres

Soils = BmB2, PW, MyB2, BmA

Rainfall "10YR" = 4.0

25YR = 4.5

Hydrologic Soil Group = "C"

CN = 82

0.7?? Slope = 1.0% (Flat)

10cfs = (Flat Slope) = 10YR

12cfs = (Flat Slope) = 25YR

Runoff Inches 2.1 10YR

" " 2.45 25YR

Required Storage = 2.1 X 3.7 X 3630 = 28,205 cu.ft. 44213

Sediment Storage = 4(T) X 3.7 = 14.8 ton/yr 23

14.8 Ton/yr X 22cuft/Ton X 10yrs = 3256 cuft sediment 5060

Total Storage Required 31,461 cu.ft.

WASLOB #2

D.A. 6.5 Ac.

Soils = BmA, BmB2, PW

Cost-Estimate – Site 4 - Rock Line Chute

Excavation/Grading 35 cuyds @ $6.00	$ 210.00
D_{50} -6" Rip-rap installed - 20T @ $35/T (Includes geotextile fabric)	700.00
Seeding, fertilizing, mulching disturbed area (Possibly blankets)	175.00
	$1085.00
Use	$1500.00

(May need to pay minimum move in fees)

Blue Lake 1-Foot Contours

1 inch equals 100 feet

0 50 100 200 300 Feet

Site 5 - Former Pond - Sediment Basin

Hydrologic Data:

* Watershed Area 97.1 Acres
* Rainfall Per storm event

		Runoff	Peak Discharges
2yR - 24HR	2.7"	1.03" (12.36 AcFt)	49 cfs
5yR - 24HR	3.5"	1.64" (13.27 AcFt)	74 cfs
10yR - 24HR	4.0"	2.04" (16.35 AcFt)	95 cfs
25yR - 24HR	4.5"	2.46" (19.9 AcFt)	115 cfs
50yR - 24HR	5.0"		137 cfs

* Curve No (CN) 80
* Ponding - minimal - unknown - Further investigate during final design
* Average WS slope = 2% or Flat

Design - Basin Drain

Head = 8.0 ft.

AcFt Storage Available = 3.14 or 136,778 cuft

Use - 6" PVC X 80 ft Length Capacity 1.75 cfs

18" Riser X 6 ft w/slots

Drawdown Time = $\frac{136,778 \text{ cu.ft}}{1.7 \text{ cfs}}$ = 80458 seconds or 22 HRS

Two 3x3' Anti-seep

Outlet 6" PVC to side of rock chute spillway

Design - Rock Chute Spillway

25yR - 24 Hr Storm event = 115 cfs

d50 = 9" - 16' Bottom - 0.8 Depth Flow in chute Velocity = 7.8 fs Allowable = 8.4 cfs

20' Wide at entrance

U.S. Department of Agriculture
Soil Conservation Service

IN-ENG-10
Rev. 10/89
File Code 210-11

WORKSHEET IN-1: RUNOFF CURVE NUMBER (CN)

Client Sediment Basin Practice and ID Site 5

_____ County Soil and Water Conservation District, Indiana

By _____ Date _____ Checked by _____ Date _____

COVER TYPE	TREATMENT 1/	HYDROLOGIC CONDITION 2/	CURVE NUMBER (CN) Hydrolocic Soil Group (EFM Table IN-2-2) A	B	C	D	AREA, ACRES	PRODUCT OF CN X ACRES
Row Crops	Straight Row	poor	72	81	88	91		
		good	67	78	85	89		
	Straight Row + CR	poor	71	80	87	90		
		good	64	75	82	85		
	Contoured + CR	poor	69	78	83	87		
		good	64	74	81	85	91.0	7371
Small Grain	Straight Row	poor	65	76	84	88		
	Straight Row + CR	good	63	75	83	87		
Pasture or Grassland		poor	68	79	86	89		
		good	39	61	74	80		
Meadow	Not Grazed	--	30	58	71	78		
Woods		poor	45	66	77	83		
		good	30	55	70	77	6.1	427
Farmsteads		--	59	74	82	86		
Streets and Roads	Paved w/ Curb	--	98	98	98	98		
	Paved w/ Ditches	--	83	89	92	93		
Residential 3/	1/4 acre lots	--	61	75	83	87		
	1/2 acre lots	--	54	70	80	85		
	1 acre lots	--	51	68	79	84		
Other (Specify)								
						TOTALS	97.1 ACRES	7798

1/ Crop residue cover (CR) applies if residue is on at least 5% of the surface throughout the year.
2/ See EFM Table 2-3 for definitions.
3/ Includes subdivision streets and driveways.

Weighted CN = Product Total / Total Acres = 7798 / 97.1 ; Use CN = 80.3 Use 80

(Do not use less than CN 60 without approval of area engineer)

Site 5

STAGE IN FEET

TEMPORARY STORAGE (AC. FT.)

AVAILABLE STORAGE

Elevation	Area Sq In	Area Flooded Acres	Average Acres	Interval Ft.	Interval Storage Ac Ft	Accum Storage Ac Ft
0	0	0				
			.22	1	.22	
1	1.9	.44				
			.55	1	.55	
2	2.83	.65				
			.71	2	1.42	
4	3.40	.78				
			.95	1	.95	
5	4.9	1.12				

3.14 Ac Ft

1" Sq = 10,000 sq ft
1" = 100 LF

STAGE - STORAGE CURVE DATA

EARTHWORK COMPUTATIONS

3:1 Slopes and 5:1 Back & Top

Station	Elevation	Fill Height Ft.	Cu.yd. per ft.	Average fill cu.yd.	Distance ft.	Fill cu.yd.
0+00	0	0	0			
				4.75	45	214
0+45	7	7	9.5			
				9.50	70	665
1+15	7	7	9.5			
				4.75	40	190
1+55	0	0	0			

~~1069~~ 214

settlement 20% 1283 cu yds compacted

Core Trench 140 cu yds 3'D X 155' X 8' Width

Clearing 75' X 200 LF = 0.35 Ac

Compaction Important for Emergency

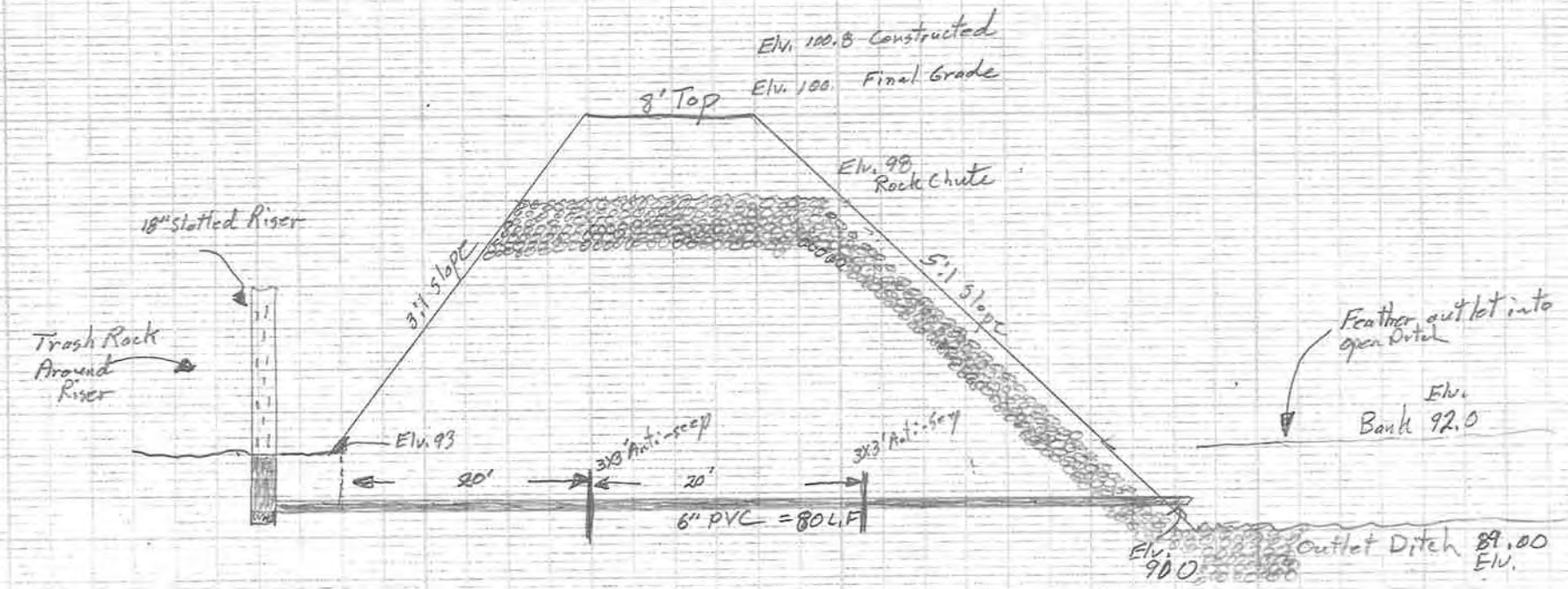
CONSTRUCTION CHECK

Length of fill _____ ft.
Top width _____ ft.
Side slopes _____
Pipe diameter _____ in.
Stage (emerg.-prin.) _____ ft.
Top fill — emerg. el. = _____ ft.
Veg. splwy. width _____ ft.
Top fill el. _____
Veg. splwy. el. _____
Prin. splwy. inlet crest el. _____
Prin. splwy. outlet invert el. _____

Clearing adequate (yes) (no) _____ Core trench adequate (yes) (no) _____
Stockwater system adequate (yes) (no) _____ Fencing adequate (yes) (no) _____
Seeding adequate (yes) (no) _____ Pipe installation adequate (yes) (no) _____

I certify that this job meets all the requirements of Indiana Standards and Specifications for Pond (Code 378) and the plans as designed.

Checked by: _____ Date: _____



NOTE: Rock Chute Spillway should be located in natural soils or settled fill.

Do not outlet basin drain into stone spillway.

Design needs to be reviewed and approved by "Registered Engineer" to assure it is in compliance with DNR dam classification requirements.

Site 5 – Former Pond Sediment Basin

NOT TO SCALE

U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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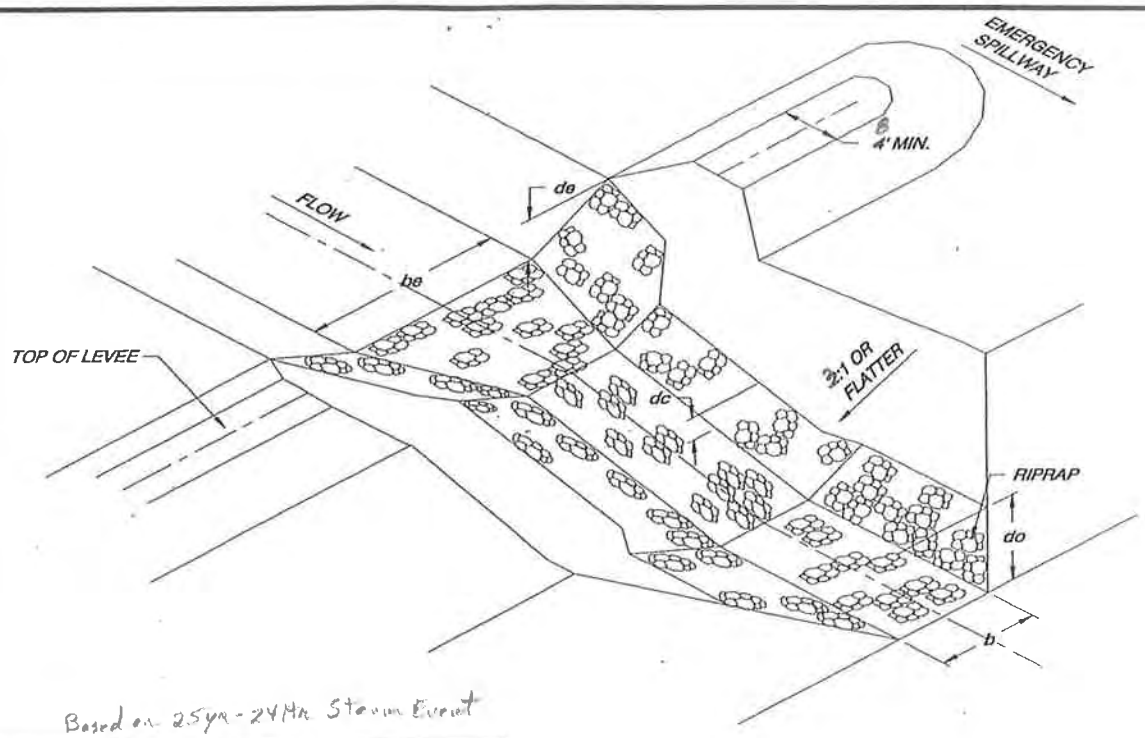
Traced	Title
Checked	Sheet No. of / Drawing No.

U.S. GPO 1997 547-372



Based on 25yr - 24Hr Storm Event

CONSTRUCTION DATA

OVERFALL (F) =	9.0	FEET
CHUTE SLOPE (S) =	5	:1
SIDE SLOPES (Z) =	3	:1
ENTRANCE LENGTH (Le) =	8	FEET
CHUTE LENGTH (Lc) =	45	FEET
OUTLET LENGTH (Lo) =	10	FEET
ENTRANCE ROCK HEIGHT (de) =	2.0	FEET
CHUTE ROCK HEIGHT (dc) =	1.8	FEET
OUTLET ROCK HEIGHT (do) =	3.0	FEET
BOTTOM WIDTH (b) =	16	FEET
ENTRANCE B.W. (be) =	20	FEET
RIPRAP THICKNESS =	18"	IN
BEDDING THICKNESS =	—	IN

CONSTRUCTION ELEVATIONS

TOP OF LEVEE ELEV. =	
EMERGENCY SPILL. ELEV. =	
INLET ELEV. =	
OUTLET ELEV. =	

ESTIMATED QUANTITIES

CLEARING:	0.35	AC.
EXCAVATION & BACKFILL:	1325 Dam 175 Lo	CU. YD.
RIPRAP:	160	TONS
~~BEDDING:~~	—	TONS
OR GEOTEXTILE FABRIC:	220	SQ. YD.
REVEGETATION:	0.35	AC.
OTHER:	15 Tons Gravel - To scatter over surface	

ROCK LINED CHUTE

Entrance Stone 21 Ton
Chute Section 112 Ton
Outlet Section 28 Ton
161 Tons

NOTES:

1. THE CHUTE SLOPE (S) SHALL NOT BE STEEPER THAN 5:1.
2. THE SIDES SLOPES (Z) SHALL NOT BE STEEPER THAN 2:1.
3. THE ENTRANCE APRON WIDTH SHALL VARY UNIFORMLY FROM (be) TO (b).
4. PROVIDE AN EMERGENCY SPILLWAY, ONE ON EACH SIDE IF FEASIBLE, WITH THE CREST ELEVATION 0.3' TO 0.5' BELOW TOP OF ROCK ON ENTRANCE SIDE SLOPES.
5. GEOTEXTILE FABRIC MAY BE USED IN LIEU OF BEDDING.
6. AFTER PLACEMENT OF RIPRAP, SPREAD ENOUGH SMALL RIPRAP FRAGMENTS OR BEDDING MATERIAL OVER ENTIRE SURFACE OF THE CHUTE TO FILL THE VOIDS IN THE RIPRAP AND COMPACT RIPRAP WITH CONSTRUCTION EQUIPMENT. A MIXTURE OF SOIL AND SEED MAY BE SPREAD OVER THE RIPRAP.
7. TILE OUTLETS SHALL NOT BE ROUTED THROUGH THE STRUCTURE.

NOT TO SCALE

LANDUSER _____
_____ COUNTY SWCD, INDIANA
LOCATION _____

ROCK LINED CHUTE

GENERAL LAYOUT
INDIANA

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

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Drawn		Title	
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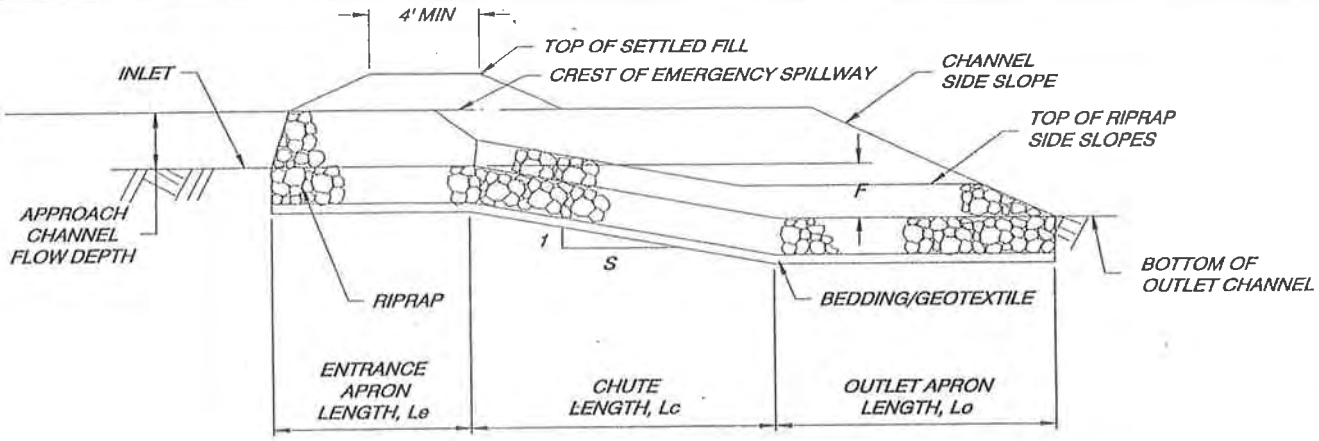
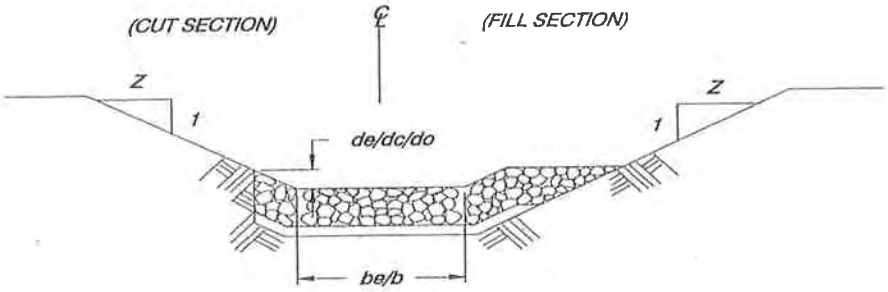
IN-ENG-36 (1 OF 3)



PROFILE ALONG CENTERLINE



TYPICAL CROSS SECTION

RIPRAP GRADATION

d50 = 9 INCHES Average

SIZE	% PASSING
	100%
	50%
	15%

BEDDING GRADATION

EQUIVALENT TO INDOT

AGGREGATE # _____

GEOTEXTILE

TYPE:	NON-WOVEN, NEEDLE-PUNCHED
TENSILE STRENGTH:	180 LBS. MIN.
BURSTING STRENGTH:	320 PSI MIN.
ELONGATION @ FAILURE:	50% MIN.
U.V. LIGHT RESISTANCE:	70% MIN.
PUNCTURE:	80 LBS. MIN.
PERMITTIVITY:	0.70 SEC $^{-1}$ MIN.

NOT TO SCALE

LANDUSER _____

_____ COUNTY SWCD, INDIANA

LOCATION _____

ROCK LINED CHUTE

GENERAL LAYOUT

INDIANA

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

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DRAWING NO. IN-ENG-36.XLS (REV. 1/00)

Emergency - Rock Chute Criteria

25yr Storm Required cfs 115 Less 58cfs (Principal) = 57cfs

50yr. Storm Required cfs 137 less 58cfs (Principal) = 79cfs

25yr-Storm d50 = 7" Key in at inlet - Slope to Bottom of ditch

Depth of Flow 0.6

Bottom 12'

Chute Slope 5:1

Capacity 56cfs

Velocity 5.5 fs

3:1 Side Slopes

50yr Storm

18 ft Bottom - The rest the same

Capacity 82 cfs

4' Bottom 3:1 Sides

0.7 Flow depth in chute

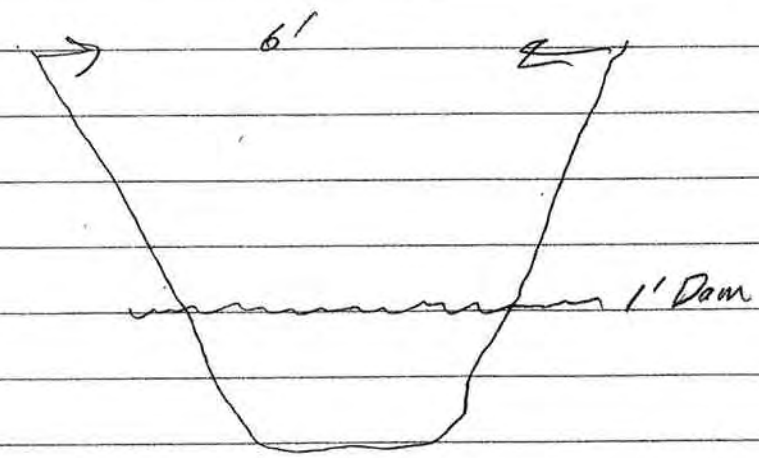
7.0 Velocity

capacity 42cfs

Approx. 2yr Storm Event

Check Dam - Downstream 40-50ft

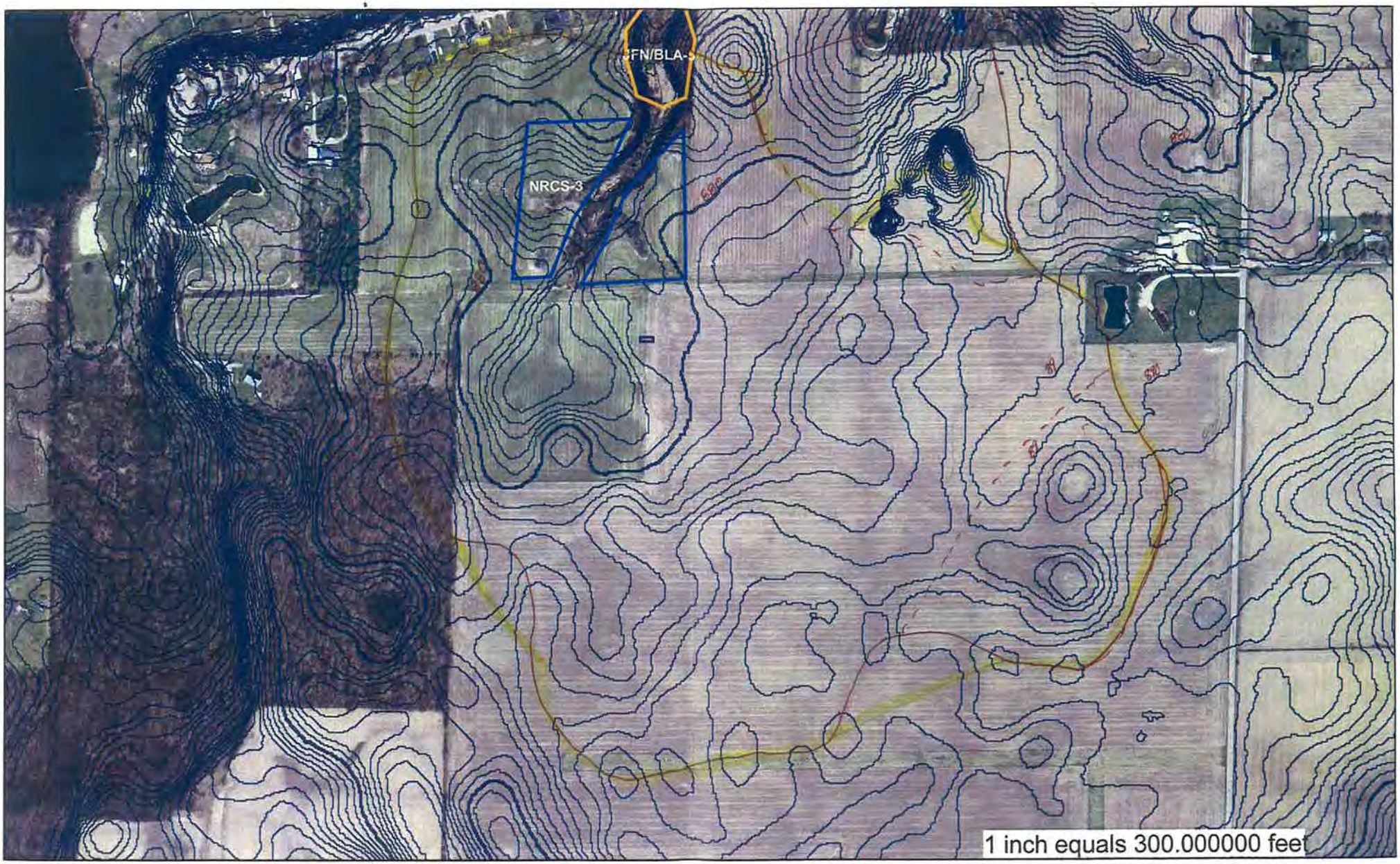
???



Cost-Estimate - Site 5 - Former Pond

Clearing	0.35 Acre @ $5000.00/Ac	$1750.00
(Debris remaining on-site)		
Excavation -	Dam 1325 cuyds @ $5.00/cuyd.	6625.00
	(Assumes using soil on-site)	
	Core Trench - 175 cuyds at $6.00	1050.00
Structure -	160 Tons D_{50}-9" installed @ $40/T	6400.00
	(Includes geotextile fabric)	
	15 Ton - Mixed Gravel in place @ $30/T	450.00
Basin Drain -	Material/Installation	1200.00
	Trash Rack	300.00
Fertilizing, seeding, mulching	0.40 Ac @ $1000/Ac	400.00
		$18,175.00

NOTE: Possibly cost related to temporary erosion control measures.



1-Foot Contours - Blue Lake

0 300 600 1,200 1,800 Feet

Blue Lake Soils

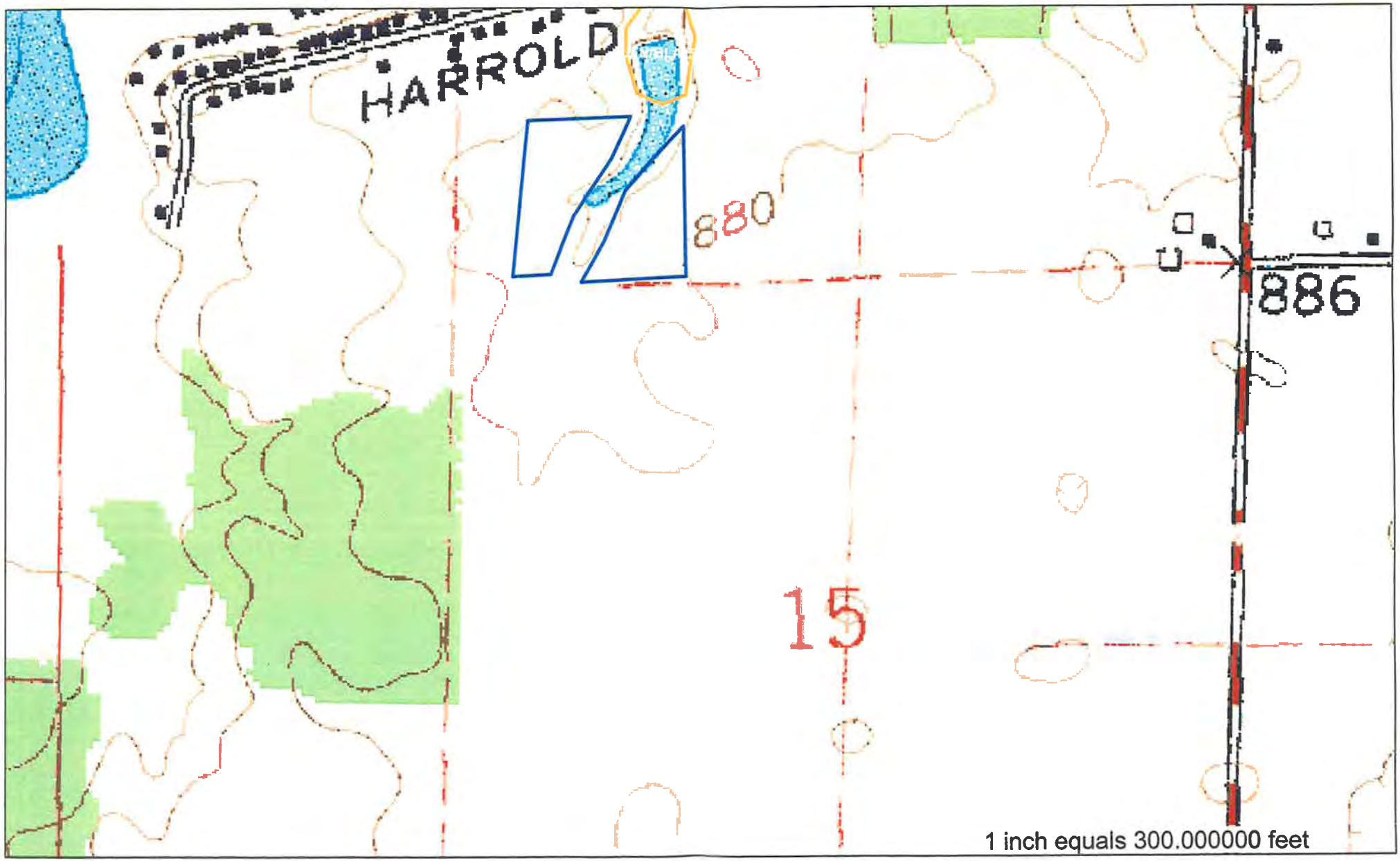
1 inch equals 300 feet

0 150 300 600 900 Feet

Blue Lake 1-Foot Contours

1 inch equals 100 feet

0 50 100 200 300 Feet



USGS Topo Map - Blue Lake

0 300 600 1,200 1,800 Feet