Lake Geode Watershed Management Plan

Approved March 2010

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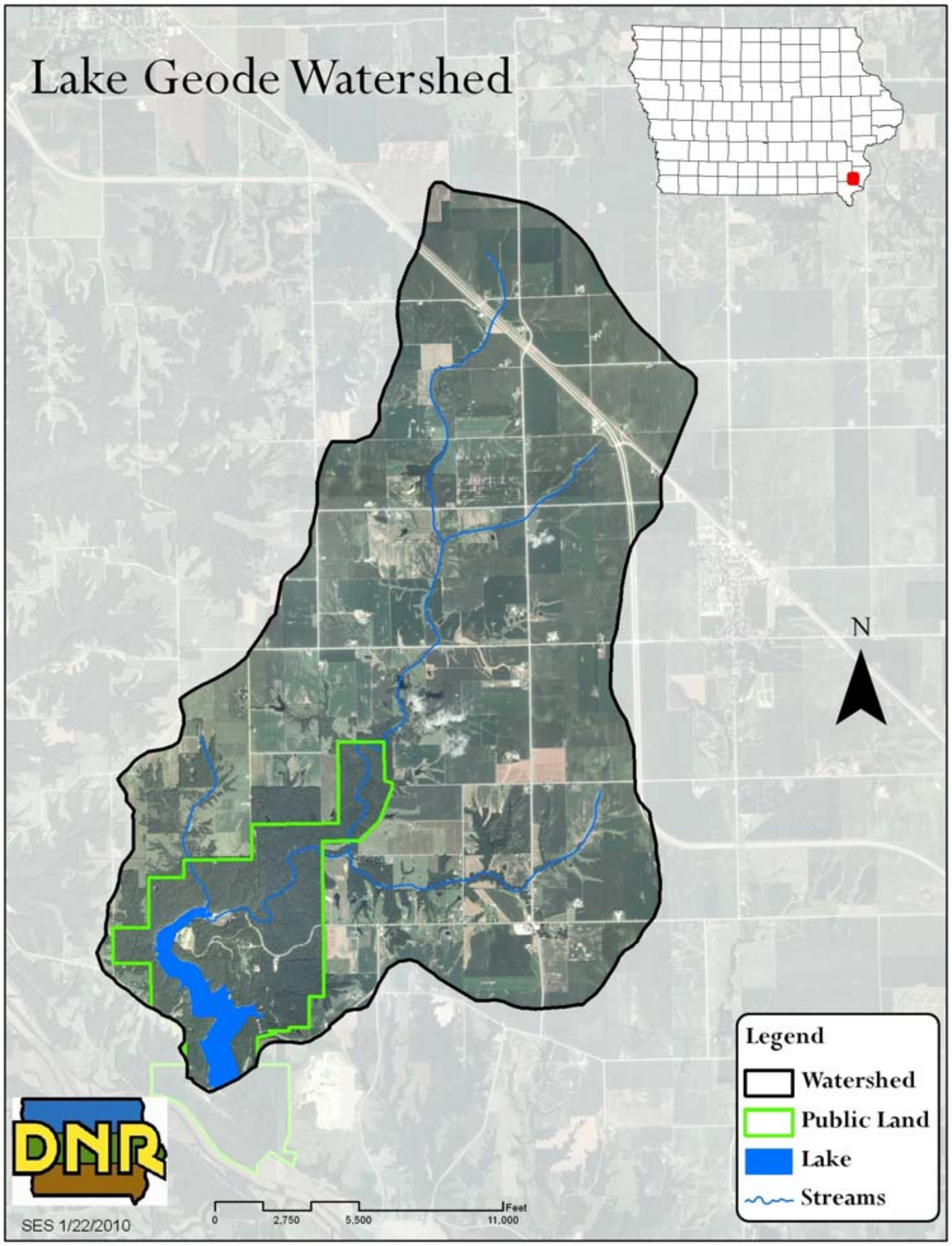


Background

Lake Geode, located in Henry and Des Moines Counties, is a 174 acre lake encompassed by a 1,640-acre state park. The entire Lake Geode Watershed consists of approximately 10,327 acres. The watershed is located in Hydrologic Unit Code (HUC) 12, 070801071004, Cedar Creek-Skunk River. The lake was constructed in 1950 and is known for excellent fishing and scenic views. Geode State Park is owned and operated by the Iowa Department of Natural Resources. Park amenities include 168 campsites, 2 modern shower buildings, 4 picnic shelters and 8 miles of trails. It is estimated that Lake Geode State Park attracts approximately 180,000 annual visitors who camp, hike, fish, and boat within the park. The Iowa DNR identifies Lake Geode as a major recreational area in Southeast Iowa ranking 8th out of 100 water bodies in social-economic value. This ranking compares the visitation rates, camping usage, willingness to pay for restoration and population within a 50-mile radius. Lake Geode is on the 303(d) impaired waters list due to high levels of bacteria and high levels of pH. The high pH was determined to be linked to excess phosphorous.

The primary goal of this watershed project is to reduce bacteria, TP and sediment loading into the lake to remove it from the 303(d) impaired waters list. The following agencies are working in partnership to achieve this goal, Iowa Department of Natural Resources (DNR), Iowa Department of Agriculture and Land Stewardship – Division of Soil Conservation (IDALS-DSC), Natural Resources Conservation Service (NRCS) , Henry Soil and Water Conservation District and Des Moines Soil and Water Conservation District. It is estimated that the waterbody will attain its fully designated uses after 15 years of management and conservation work.

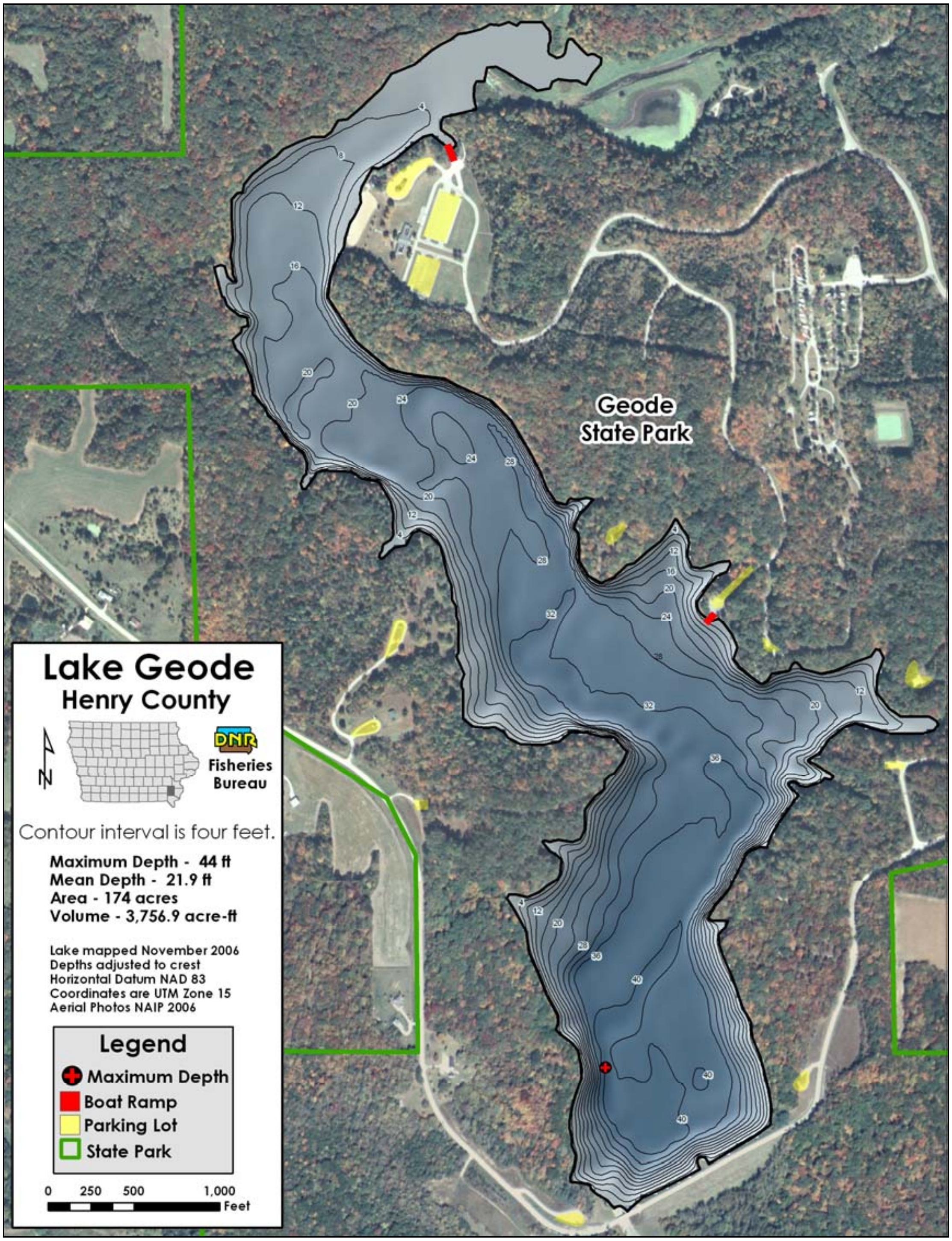
Hydrology

Lake Geode is a man-made reservoir created by an earthen embankment that impounds its primary tributary, Cedar Creek. The lake's hydrology is driven primarily by surface water inflows from Cedar Creek and several smaller tributaries that either drain to Cedar Creek or directly to the lake. Precipitation events, runoff and interflow have the most influence on water quality and water level fluctuations in Lake Geode. However, the deep reservoir does have a groundwater connection, which can influence both water quality and reservoir hydrology. The average residence time in Lake Geode is 98 days.

Morphometry, Substrate & Bathymetry

The surface area of Lake Geode is 174 acres, according to the bathymetry map prepared by IDNR in 2006. The primary substrate at the bottom of Lake Geode is sand, silt, and clay deposited over a period of years. When floodwater enters the lake, the velocity of the water decreases as the water spreads out and is no longer able to carry sand and silt. This has created large deposits of sand and silt at the north end of the lake. Clay also drops from the water column to the lake bottom after a longer settling time. The deposition of these materials has resulted in Lake Geode losing surface area in areas where tributaries enter the lake, and losing depth. In 1980, the maximum depth was reported as 52.0 feet, with a mean depth of 24.0 feet (Bachmann, et al., 1980). By 2006, the maximum depth had decreased to 44.0 feet, and the mean depth to 21.9 feet. Surface area of the lake had decreased from 189 to 174 acres (IDNR, 2006). Although some of the discrepancy in surface area may be due in part to new data collection methods and Geographical Information Systems (GIS) technology, it is well-documented that the lake has lost depth and that large sediment deposits are present at the north end of the reservoir.

Figure 2: Aerial photo and bathymetry of Lake Geode



Soils

The predominant soil association is the Weller-Pershing-Grundy association. It is a loess-derived soil mostly found on ridge tops and side slopes. Slopes range from 1-9% and the soils are moderately suited to growing row crops. NRCS has deemed this soil as a 3T soil, meaning only 3 tons/acre/year is allowed to erode to still retain productivity.

Secondary soil associations include the Nira-Otley-Mahaska association. A loess-derived soil found on wide ridge tops and short side slopes, these soils are well suited for growing row crops. Also found in the Lake Geode watershed is the Givin-Hedrick-Ladoga soil association. This is a loess derived soil found on ridge tops and is characterized by well-developed drainage ways. The slopes range from 1-9% and the soil is well suited to growing row crops.

Geology

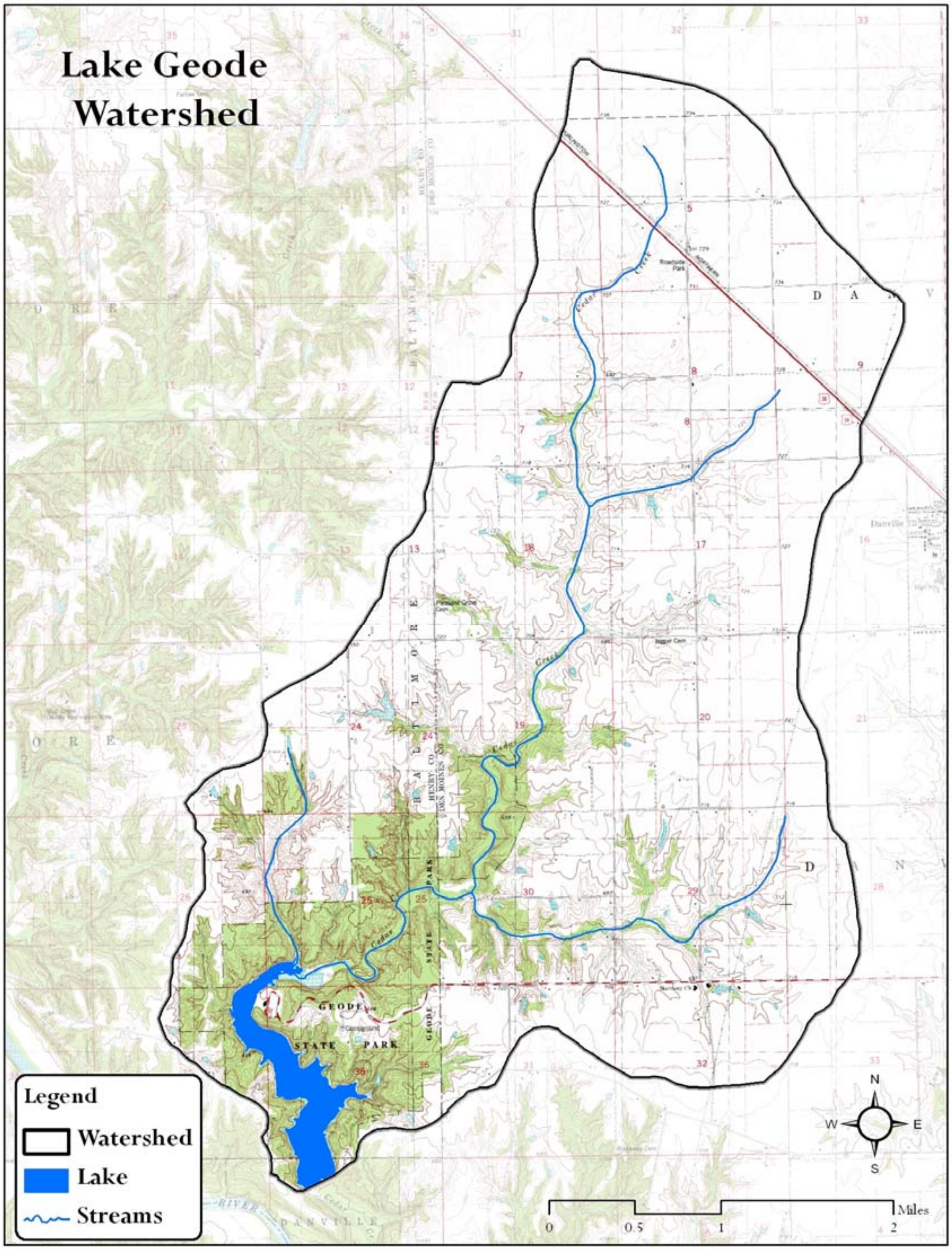
As indicated by its name, Geode State Park and Lake Geode have a unique geologic feature: the presence of rare rock formations called geodes. Geodes can be described as rocks with internal holes or cavities filled with crystal formations. Geodes are formed when dissolved silica carried by groundwater through cavities in sedimentary rock precipitates or crystallizes. The presence of geodes in the area indicates that limestone or related sedimentary rocks are prevalent. Limestone is not unique to Lake Geode, but the presence of geodes is relatively rare. There is no clear indication that the presence of geodes has a significant impact on water quality in Lake Geode.

Climate

The climate in southeast Iowa is classified as humid continental. The average temperature in January is 14 degrees Fahrenheit. The average August temperature is 85 degrees Fahrenheit. Total annual rainfall averages 38 inches while snowfall averages 25 inches. The length of the growing season for the area averages 183 days.

Topography

Figure 3: Lake Geode Topographical Map



Threatened & Endangered Species and Environments

Endangered Species means any species of fish, plant life, or wildlife which is in danger of extinction throughout all or a significant part of its range. Threatened Species means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, in the above mentioned categories, but are protected by law. If any threatened or endangered species are found in the area, extra precautions will be taken to ensure all state and federal laws are followed. Below is a list of all threatened and endangered species in Des Moines and Henry Counties.

Table 1: Threatened & Endangered Species in Des Moines and Henry Counties

County	Common Name	Scientific Name	Class	State Status
DES MOINES	Mudpuppy	Necturus maculosus	AMPHIBIANS	T
DES MOINES	Bald Eagle	Haliaeetus leucocephalus	BIRDS	E
DES MOINES	Red-shouldered Hawk	Buteo lineatus	BIRDS	E
DES MOINES	Grass Pickerel	Esox americanus	FISH	T
DES MOINES	Orangethroat Darter	Etheostoma spectabile	FISH	T
DES MOINES	Western Sand Darter	Ammocrypta clara	FISH	T
DES MOINES	Butterfly	Ellipsaria lineolata	FRESHWATER MUSSELS	T
DES MOINES	Creeper	Strophitus undulatus	FRESHWATER MUSSELS	T
DES MOINES	Fat Pocketbook	Potamilus capax	FRESHWATER MUSSELS	
DES MOINES	Higgin's-eye Pearly Mussel	Lampsilis higginsii	FRESHWATER MUSSELS	E
DES MOINES	Pistolgrip	Tritogonia verrucosa	FRESHWATER MUSSELS	E
DES MOINES	Spectaclecase	Cumberlandia monodonta	FRESHWATER MUSSELS	E
DES MOINES	Indiana Bat	Myotis sodalis	MAMMALS	E
DES MOINES	Bent Milk-vetch	Astragalus distortus	PLANTS (DICOTS)	S
DES MOINES	Blue Ash	Fraxinus quadrangulata	PLANTS (DICOTS)	T
DES MOINES	Downy Woodmint	Blephilia ciliata	PLANTS (DICOTS)	T
DES MOINES	Dwarf Dandelion	Krigia virginica	PLANTS (DICOTS)	E
DES MOINES	French-grass	Orbexilum onobrychis	PLANTS (DICOTS)	E
DES MOINES	Hill's Thistle	Cirsium hillii	PLANTS (DICOTS)	S
DES MOINES	Hortulan Plum	Prunus hortulana	PLANTS (DICOTS)	S
DES MOINES	Low Bindweed	Calystegia spithamaea	PLANTS (DICOTS)	S
DES MOINES	Paw Paw	Asimina triloba	PLANTS (DICOTS)	S
DES MOINES	Rose Turtlehead	Chelone obliqua	PLANTS (DICOTS)	S
DES MOINES	Rough Buttonweed	Diodia teres	PLANTS (DICOTS)	S
DES MOINES	Sessile-leaf Tick-trefoil	Desmodium sessilifolium	PLANTS (DICOTS)	S
DES MOINES	Slender Copperleaf	Acalypha gracilens	PLANTS (DICOTS)	S
DES MOINES	Small Morning Glory	Ipomoea lacunosa	PLANTS (DICOTS)	S
DES MOINES	Softleaf Arrow-wood	Viburnum molle	PLANTS (DICOTS)	S
DES MOINES	Spring Avens	Geum vernum	PLANTS (DICOTS)	S
DES MOINES	Stiff Yellow Flax	Linum medium	PLANTS (DICOTS)	S
DES MOINES	Sumpweed	Iva annua	PLANTS (DICOTS)	S

DES MOINES	Toothcup	Rotala ramosior	PLANTS (DICOTS)	S
DES MOINES	Virginia Snakeroot	Aristolochia serpentaria	PLANTS (DICOTS)	T
DES MOINES	Water Willow	Justicia americana	PLANTS (DICOTS)	E
DES MOINES	Waxleaf Meadowrue	Thalictrum revolutum	PLANTS (DICOTS)	E
DES MOINES	Waxyfruit Hawthorn	Crataegus pruinosa	PLANTS (DICOTS)	S
DES MOINES	Winged Monkey Flower	Mimulus alatus	PLANTS (DICOTS)	T
DES MOINES	Yellow Monkey Flower	Mimulus glabratus	PLANTS (DICOTS)	T
DES MOINES	Broom Sedge	Andropogon virginicus	PLANTS (MONOCOTS)	S
DES MOINES	Bush's Sedge	Carex bushii	PLANTS (MONOCOTS)	S
DES MOINES	False Hellebore	Veratrum woodii	PLANTS (MONOCOTS)	T
DES MOINES	Green Arrow Arum	Peltandra virginica	PLANTS (MONOCOTS)	E
DES MOINES	Green Fringed Orchid	Platanthera lacera	PLANTS (MONOCOTS)	S
DES MOINES	Oval Ladies'-tresses	Spiranthes ovalis	PLANTS (MONOCOTS)	T
DES MOINES	Ovate Spikerush	Eleocharis ovata	PLANTS (MONOCOTS)	S
DES MOINES	Sedge	Carex gracilescens	PLANTS (MONOCOTS)	S
DES MOINES	Shallow Sedge	Carex lurida	PLANTS (MONOCOTS)	S
DES MOINES	Slender Crabgrass	Digitaria filiformis	PLANTS (MONOCOTS)	S
DES MOINES	Slender Fimbry	Fimbristylis autumnalis	PLANTS (MONOCOTS)	S
DES MOINES	Slender Ladies'-tresses	Spiranthes lacera	PLANTS (MONOCOTS)	T
DES MOINES	Southern Adder's-tongue	Ophioglossum vulgatum	PLANTS (PTERIODOPHYTES)	S
DES MOINES	Blanding's Turtle	Emydoidea blandingii	REPTILES	T
DES MOINES	Western Worm Snake	Carphophis amoenus	REPTILES	T
DES MOINES	Yellow Mud Turtle	Kinosternon flavescens	REPTILES	E
HENRY	Mudpuppy	Necturus maculosus	AMPHIBIANS	T
HENRY	Bald Eagle	Haliaeetus leucocephalus	BIRDS	E
HENRY	Orangethroat Darter	Etheostoma spectabile	FISH	T
HENRY	Baltimore	Euphydryas phaeton	INSECTS	T
HENRY	Southern Bog Lemming	Synaptomys cooperi	MAMMALS	T
HENRY	Creeping Bush-clover	Lespedeza repens	PLANTS (DICOTS)	S
HENRY	Downy Woodmint	Blephilia ciliata	PLANTS (DICOTS)	T
HENRY	Earleaf Foxglove	Tomanthera auriculata	PLANTS (DICOTS)	S
HENRY	Pinesap	Monotropa hypopithys	PLANTS (DICOTS)	T
HENRY	Purple Coneflower	Echinacea purpurea	PLANTS (DICOTS)	S
HENRY	Roundstem Foxglove	Agalinis gattingeri	PLANTS (DICOTS)	T
HENRY	Softleaf Arrow-wood	Viburnum molle	PLANTS (DICOTS)	S
HENRY	Spring Avens	Geum vernum	PLANTS (DICOTS)	S
HENRY	Toothcup	Rotala ramosior	PLANTS (DICOTS)	S
HENRY	Virginia Snakeroot	Aristolochia serpentaria	PLANTS (DICOTS)	T
HENRY	Water Willow	Justicia americana	PLANTS (DICOTS)	E
HENRY	Winged Monkey Flower	Mimulus alatus	PLANTS (DICOTS)	T
HENRY	Clandestine Dropseed	Sporobolus clandestinus	PLANTS (MONOCOTS)	S
HENRY	False Hellebore	Veratrum woodii	PLANTS (MONOCOTS)	T
HENRY	Meadow Bluegrass	Poa wolfii	PLANTS (MONOCOTS)	S
HENRY	Oval Ladies'-tresses	Spiranthes ovalis	PLANTS (MONOCOTS)	T

HENRY	Slender Ladies'-tresses	Spiranthes lacera	PLANTS (MONOCOTS)	T
HENRY	Slender Sedge	Carex tenera	PLANTS (MONOCOTS)	S
HENRY	Soft Rush	Juncus effusus	PLANTS (MONOCOTS)	S

Historical Land Cover
Historic land cover in the Lake Geode was dominated by prairie, accounting for 63.7 percent of the watershed. Timber accounted for 34.9 percent.

Table 2: Historic Land Cover in the Lake Geode Watershed

	Timber	Prairie	Field
Percent of Watershed	34.9%	63.7%	1.4%
Acres	3,612	6,584	125

Current Land Cover
The Lake Geode watershed consists of approximately 10,327 acres. Row crop production is the primary land use in the watershed. Corn and soybeans are the most commonly grown crops. Timberland is concentrated in the state park and along the tributaries that feed Lake Geode. Roughly two percent of the watershed is used for grazing.

Table 3: Current Land Use in the Lake Geode Watershed

	Cropland	CRP/ Grassland	Grazed Timber	Pasture	Woodland/ Shrub	Wildlife Area	Artificial: Roads, Water, Residential	Confined Animal Feeding Operation (CAFO)
Percent of Watershed	62%	6%	.5%	1.5%	16.9%	3%	10%	.1%
Acres	6261	669	52	154	1815	322	1038	16

According to USDA-NRCS, of the cropland present in the watershed approximately 30% (2000 acres) is designated as highly erodible land. Within those acres 95% have an approved conservation plan under the Food Security Act. It is documented that 70% of the plans are fully implemented.

Identification of Causes and Sources of Impairment

Water Quality Standards and Designations
Lake Geode is a Significant Publicly Owned Lake, and is protected for the following designated uses:

- Primary contact recreation – Class A1
- Aquatic life – Class B(LW)
- Drinking water – Class C
- Fish Consumption – Class HH

The 2006 Section 305(b) Water Quality Assessment Report states that primary contact recreation in Lake Geode is "not supported" due to high levels of indicator bacteria, specifically *Escherichia coli (E. coli)*, that violate the state WQS. Primary contact recreation is also impaired due to violations of the WQS by high pH levels. In addition, high pH has resulted in the warm water aquatic life designated use to be assessed as impaired ("partially supporting"). The 2006 305(b) report can be accessed at http://wqm.igsb.uiowa.edu/wqa/305b.html.

The 305(b) assessment is based on: (1) the results of the IDNR-UHL beach monitoring program in summers of 2004, 2005, and 2006, (2) results of the statewide survey of Iowa lakes conducted from 2002 through 2006 by Iowa State University (ISU), (3) results of the statewide ambient lake monitoring program conducted from 2005 through 2006 by University Hygienic Laboratory (UHL), (4) information from the IDNR Fisheries Bureau, and (5) results of U.S. EPA/IDNR fish tissue monitoring in 1996 and 2006.

Water Quality Data
The Class A use has been significantly impacted since 2000, when excessive bacterial levels resulted in the posting of warnings at the beach area advising people of the potential hazards of coming into contact with the water containing high levels of E. coli bacteria. The trend of excessive bacteria has continued from 2000-2004 and has resulted in a dramatic decline of beach usage and as a consequence the loss of the concessionaire. From 2005-2007, test results have not indicated excessive bacteria, but according to Iowa DNR regional supervisor, Tom Basten, "use at the beach area has not rebounded." It is the opinion of the local working group and technical advisory committee that the public perception is a fear of contaminated water and associated risks.

Total Maximum Daily Load (Existing Loads, Pollutant Allocation, and Summary)
A Total Maximum Daily Load (TMDL) for pH and bacteria was written for Lake Geode in 2009. The findings are summarized below and the TMDL attached as Appendix A.

pH
High levels of pH in Lake Geode periodically exceed water quality standards (WQS) and impair two of the lake's designated uses. There are a number

processes occurring in Lake Geode that will have an impact on, and be affected by, pH. It is not possible to simply reduce the amount of pH that enters the lake to lower pH levels and meet water quality standards. The pH in Lake Geode is dynamic, and depends on other physical, chemical, and biological properties of the water column, surrounding soils, lake-bottom sediments, and the atmosphere and climate. High pH in the lake is associated with photosynthesis by algae, for which total phosphorus (TP) is the limiting nutrient.

The TP load capacity for Lake Geode is 8,576 lbs/yr (average annual) and 111 lbs/day (maximum daily). To meet the target loads, a reduction of 45.8 percent of the TP load is required.

Additional in-field data was collected by NRCS and Des Moines County SWCD field staff for gullies in and around the Lake and watershed. The gullies were evaluated based on their severity and additional sediment and phosphorus loading to the Lake Geode. This data was not available when the TMDL was written. Inconsistencies in the data will be addressed later in this plan.

Pollutant Source Assessment from Lake Geode TMDL for pH
The TMDL theorized that the elevated pH was connected to an abundance of Total Phosphorus (TP) entering the system, therefore, the focus will be on reducing TP. Using the Generalized Watershed Loading Function (GWLF), the existing annual average TP load to Lake Geode from April 2005 through March 2008 was estimated to be 14,235 lbs/yr, or 39 lbs/day. The existing daily maximum load is 184 lbs/day.

The target TP load, also referred to as the load capacity, for Lake Geode is 8,576 lbs/yr (average annual) and 111 lbs/day (maximum daily). To meet the target loads, a reduction of 45.8 percent of the TP load is required. This percentage includes a 10 percent margin of safety as identified in the TMDL.

The existing TP load to Lake Geode stems from nonpoint sources of pollution. Table 4 reports existing TP loads from each source, as simulated using GWLF and 2005-07 climate data input. Figure 11 illustrates the percent of generalized land uses that make up the watershed, as well as the relative TP contributions from various sources.

The largest source of TP is runoff from row crop agriculture, which contains phosphorus bound to sediment, and phosphorus in manure or synthetic fertilizer applied to cropland. Other nonpoint sources include runoff that contains manure from pasture or grazed timber, discharge from failing or inadequate septic systems, and livestock with access to the streams that flow into Lake Geode.

Table 4: Existing TP source loads simulated using GWLF.

TP Source (land uses and other inputs)	Descriptions and Assumptions	Existing Load (lb/yr)	% of TP Load
Row Crops	corn, beans, oats, alfalfa, CRP	10,316	72.5

Grazed Lands	pasture, grazed timber	301	2.1
Farmsteads/Roads	homes, yards, roads, highways	641	4.5
Conservation Areas	forest, grassland, wildlife areas	1,067	7.5
Septic Systems	119 septic systems, 30% contributing to lake	171	1.2
Geese	150 geese (Oct-Apr); 70 geese (May-Sep)	44	0.3
Groundwater	TP inputs based on land use	1,695	11.9
Total		14,235	100.0

Figure 4. Percent of watershed in generalized land uses.

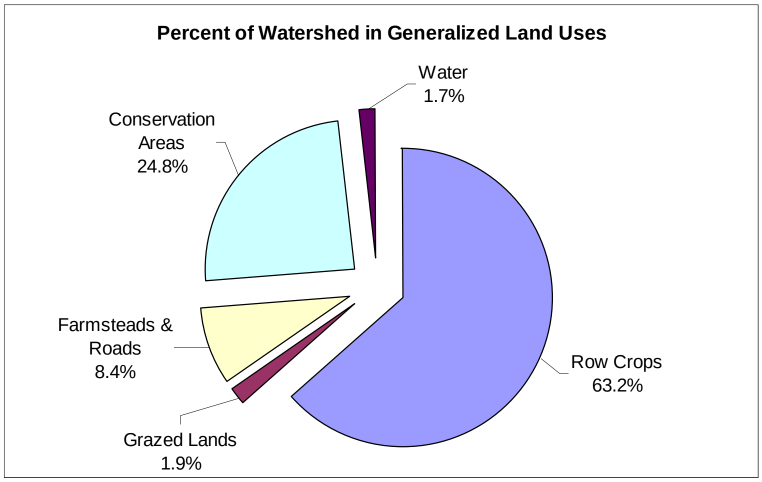
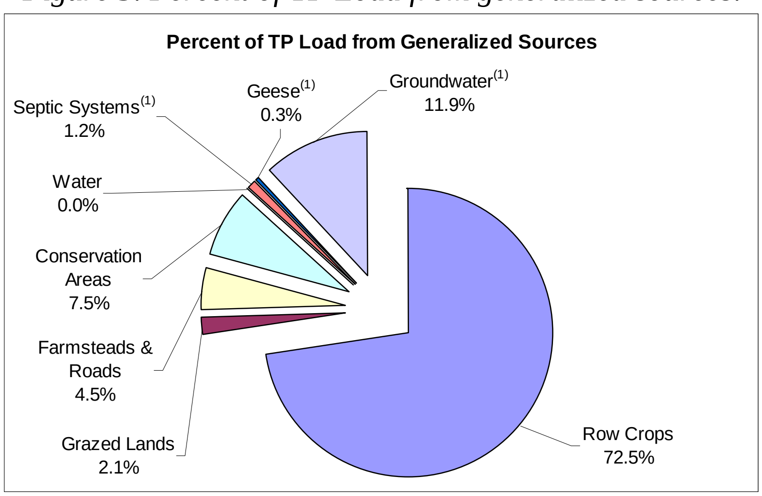


Figure 5. Percent of TP Load from generalized sources.



Bacteria

During periods of wet weather, excess rainfall runs off the land surface into ditches, lakes, and streams. This runoff has high potential for carrying fecal material that has built up on the land surface over time. Most of the WQS violations in Lake Geode occur during these runoff events, and are primarily due to runoff from manure application areas, pastures, feedlots, and areas containing wildlife. However, violations occur during dry periods (dry to normal conditions) as well. Violations under dry conditions are primarily due to E. coli sources that are independent of flow, such as direct deposition of fecal material into the lake or streams by livestock, wildlife, and septic systems. Water quality can be impaired by much smaller E. coli loads during dry periods, because there is less dilution of pollutants. Watershed and water quality modeling simulations estimated the existing median E. coli load to Lake Geode to be 2.72E+12 cfu/day, and the existing maximum (95th percentile) load is 4.54+E12. The load capacity for bacteria for Lake Geode as a median daily load to reflect dry to normal conditions is 1.68E+11 cfu/day. The load capacity for bacteria for Lake Geode, expressed as a maximum daily load to account for high-flow conditions is 2.95E+11 cfu/day.

Based on the existing loads and the loading capacity, the median daily E. coli load must be reduced by 93.8 percent, and the daily maximum load must be reduced by 93.5 percent.

Pollutant Source Assessment from Lake Geode TMDL for Bacteria
Most of the WQS violations in Lake Geode occur during runoff events, and are primarily due to runoff from manure application areas, pastures, feedlots, and areas containing wildlife. However, violations occur during dry periods (dry to normal conditions) as well. Violations under dry conditions are primarily due to E. coli sources that are independent of flow, such as direct deposition of fecal material into the lake or streams by livestock, wildlife, and septic systems. Water quality can be impaired by much smaller E. coli loads during dry periods, because there is less dilution of pollutants. Watershed and water quality modeling simulations estimated the existing median E. coli load to Lake Geode to be 2.72E+12 cfu/day, and the existing maximum (95th percentile) load is 4.54+E12.

Based on the existing loads and the loading capacity, the median daily E. coli load must be reduced by 93.8 percent, and the daily maximum load must be reduced by 93.5 percent. Table 5 reports the existing and target loads and the required reductions.

Contributing sources include manure application to row crops, manure runoff from grazed lands, cattle in streams, septic systems, geese at the Lake Geode swimming beach, and other wildlife in the watershed. Relative contributions of each source will vary seasonally and with flow. Sources deposited directly to the lake or stream, such as illegal septic drains, geese, and cattle in the stream, will have larger contributions during dry to normal conditions because there is no dilution from rainfall runoff. Conversely, sources such as runoff from pastures and manure application areas will be much larger during periods of runoff.

Table 5: Existing E. coli loads, loading capacity, and required reductions

Condition	Existing Load (cfu/100 mL)	Loading Capacity (cfu/100 mL)	Required Reduction (%)
Dry to Normal (Median Load)	2.72E+12	1.68E+11	93.8
Wet to High-Flow (95th Percentile)	4.54E+12	2.95E+11	93.5

Table 6: Potential load allocation scheme to meet target E. coli load

Bacteria Source	(1)Existing Load (cfu/day)	LA (cfu/day)	Load Reduction (%)
Manure Application	2.46E+12	1.23E+11	95
Grazing	1.31E+11	2.63E+10	80
Cattle in Streams	1.29E+12	1.29E+10	(3)99
Septic Systems	3.28E+11	3.28E+09	(3)99
Geese at Beach	2.57E+11	2.63E+10	(3)90
Wildlife	7.39E+10	7.39E+10	0
Total	4.54E+12	(2)2.66E+11	94.2

(1) 95th percentile loads, which represent wet conditions.
(2) The example LA is equal to the loading capacity of 2.95E+11 minus a 10% MOS
(3) These percent reductions result in an acceptable dry weather load allocation.

Figure 6: Percent of E. coli loads from watershed sources simulated for dry to normal conditions (median load).

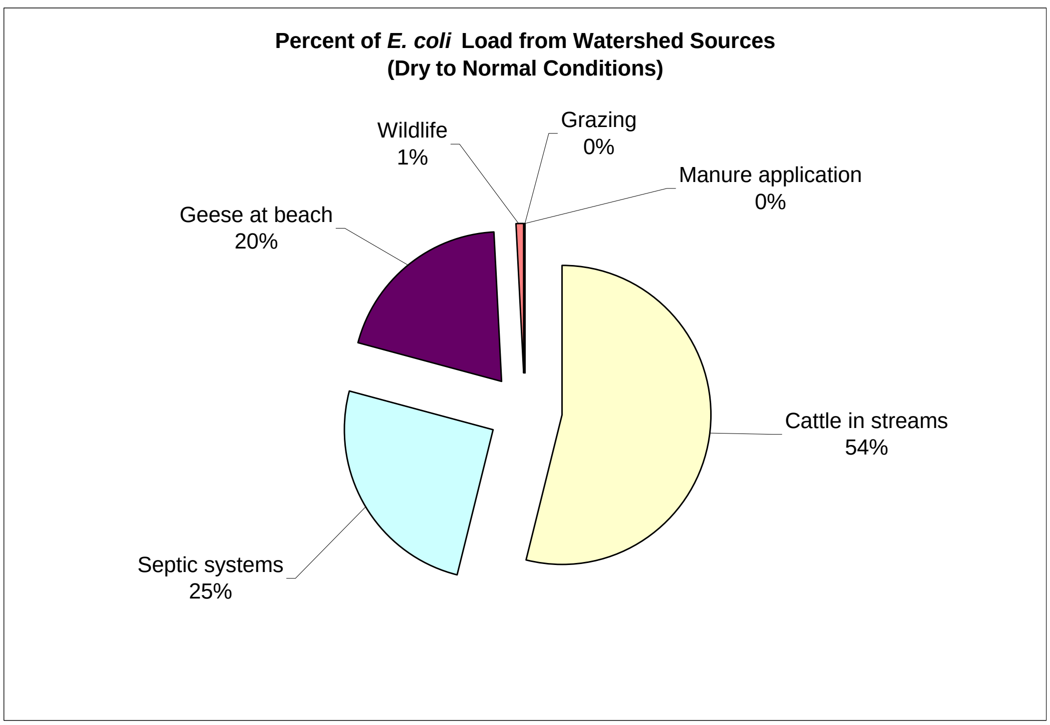
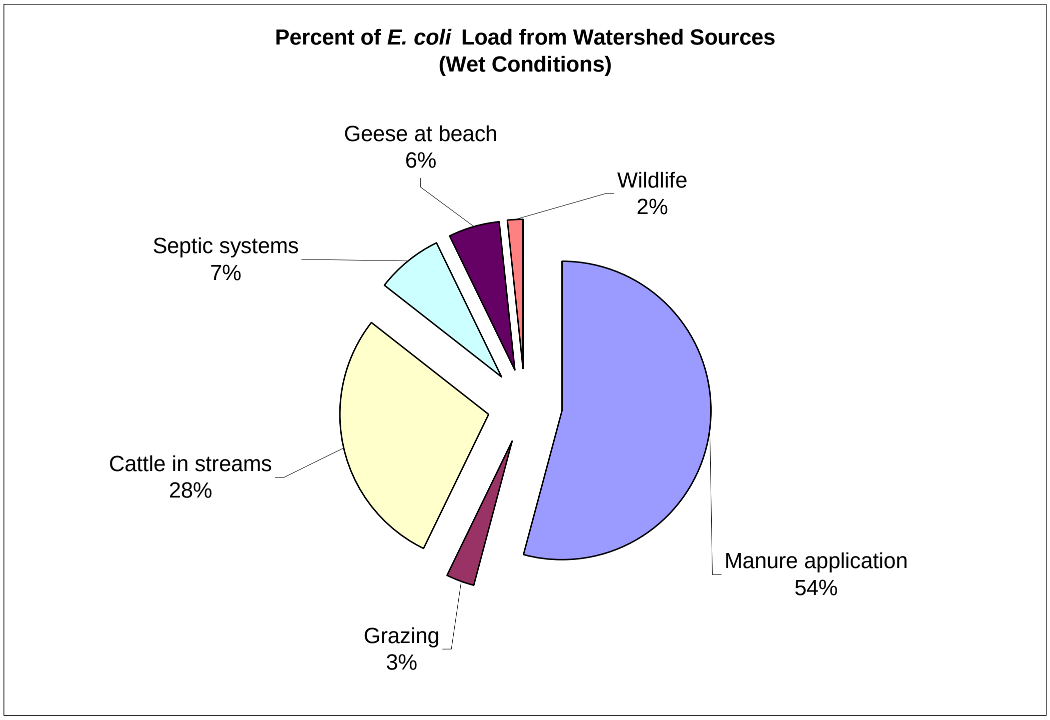


Figure 7: Percent of E. coli loads from watershed sources simulated for wet conditions (95th percentile load).



Land Use Assessments
Land use assessments were completed on Lake Geode in 2008. This combined information assists the watershed project in determining high priority areas and possible pollutant contributions from point sources and non-point sources.

Figure 8: Lake Geode Land Cover 2008

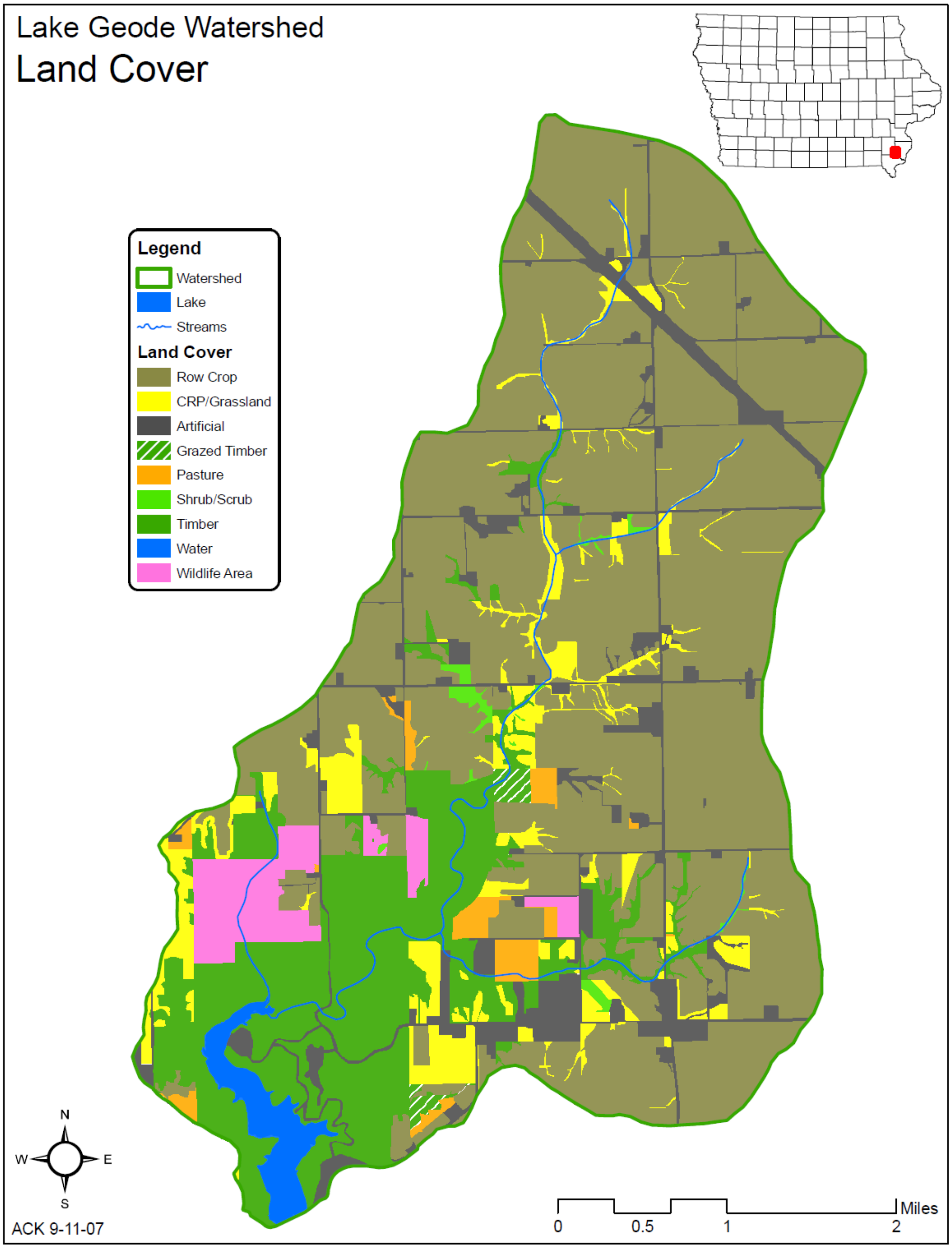


Figure 9: Lake Geode Sheet and Rill Erosion

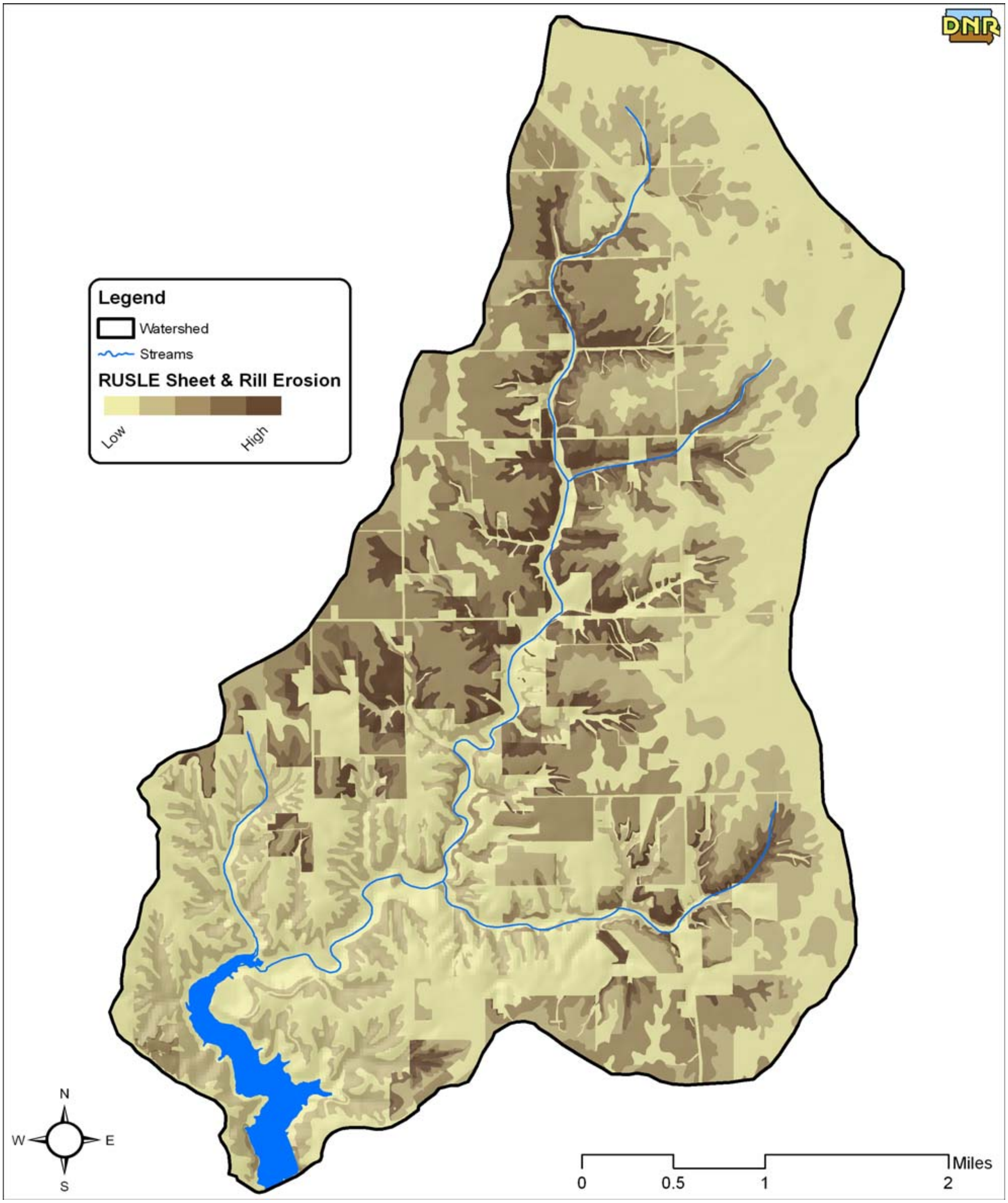


Figure 7 depicts sheet and rill erosion rates within the Lake Geode watershed. This data is based on current RKLS values using RUSLE soil loss methods, but does not take into account existing conservation practices.

Figure 10: Lake Geode Potential Sediment Delivery and Existing BMPs

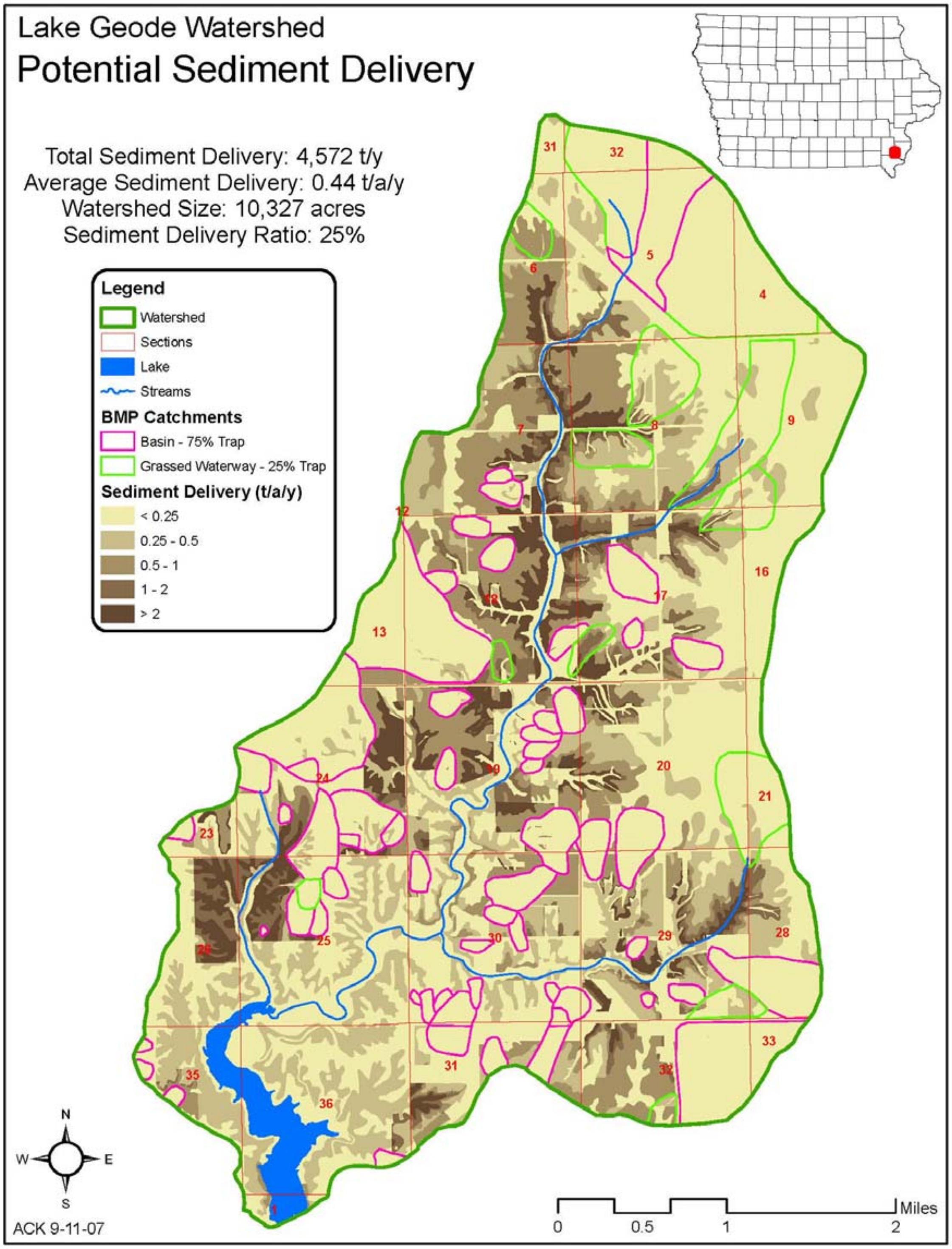


Figure 8 depicts the estimated sediment delivery to Lake Geode from sheet and rill erosion. This map is based on current RKLS values using the RUSLE soil loss method and takes into account existing conservation practices.

Figure 11: Lake Geode – Head Cut, Gully, and Stream Assessment Results

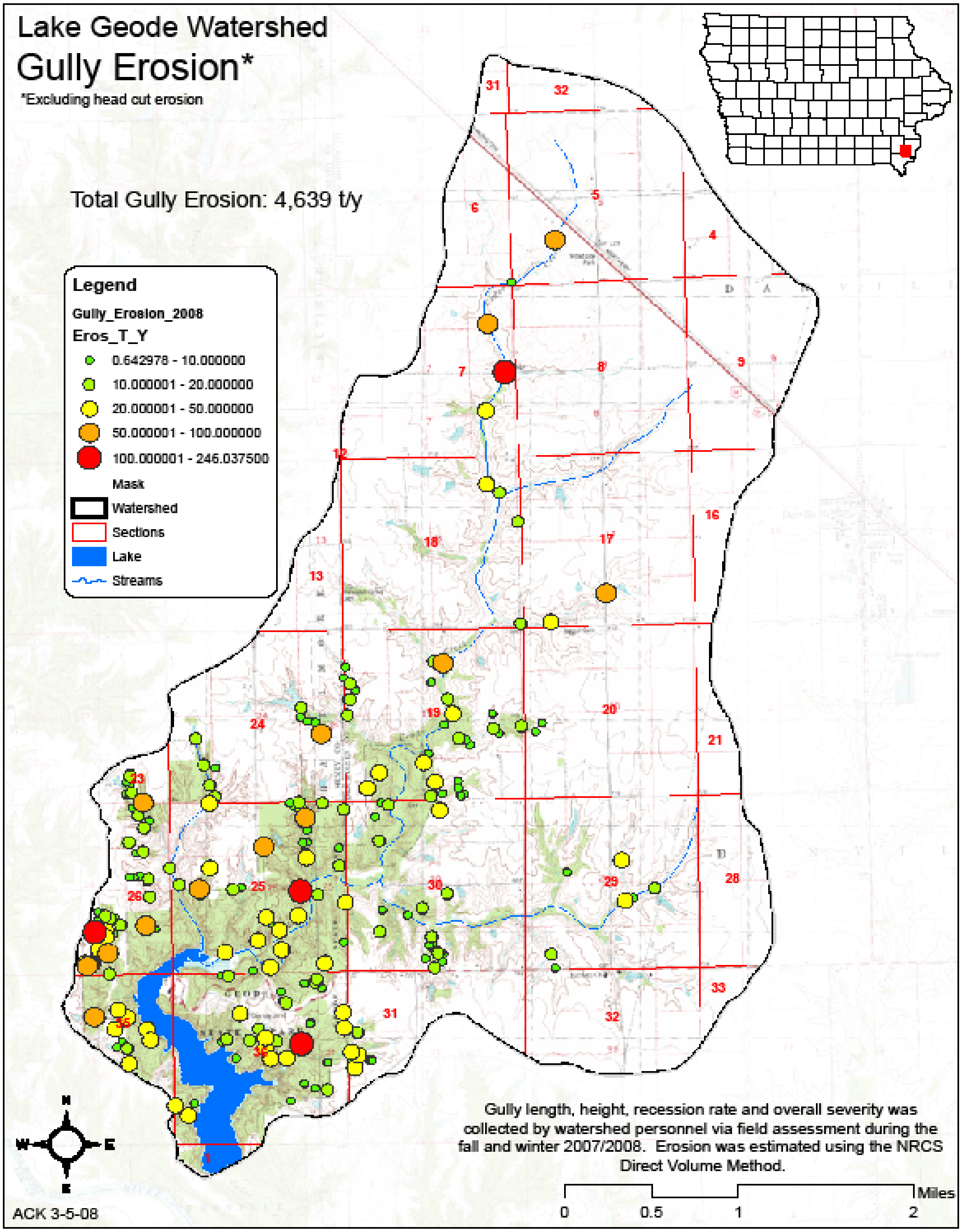


Figure 9 depicts the results of infield data collected on streambanks, gullies, and headcuts. The RASCAL protocol was used for the stream assessment and the NRCS Direct Volume Method was used to quantify erosion for gullies and headcuts.

Figure 12: Lake Geode Livestock Operations

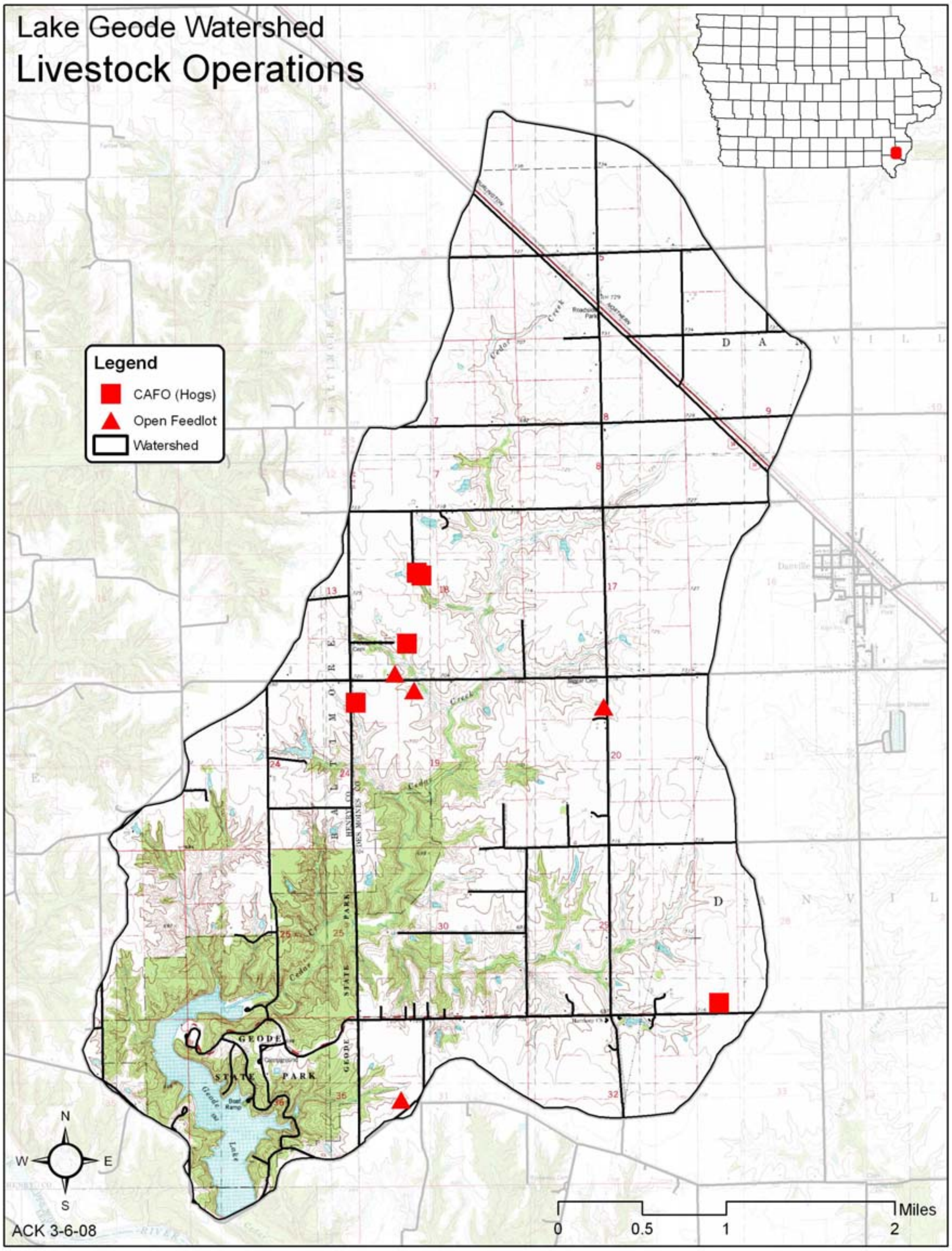


Figure 10 reflects the number and types of livestock operations within the Lake Geode Watershed. Data is based on a windshield survey of the watershed.

Figure 13: Lake Geode Potential Bacteria Sources

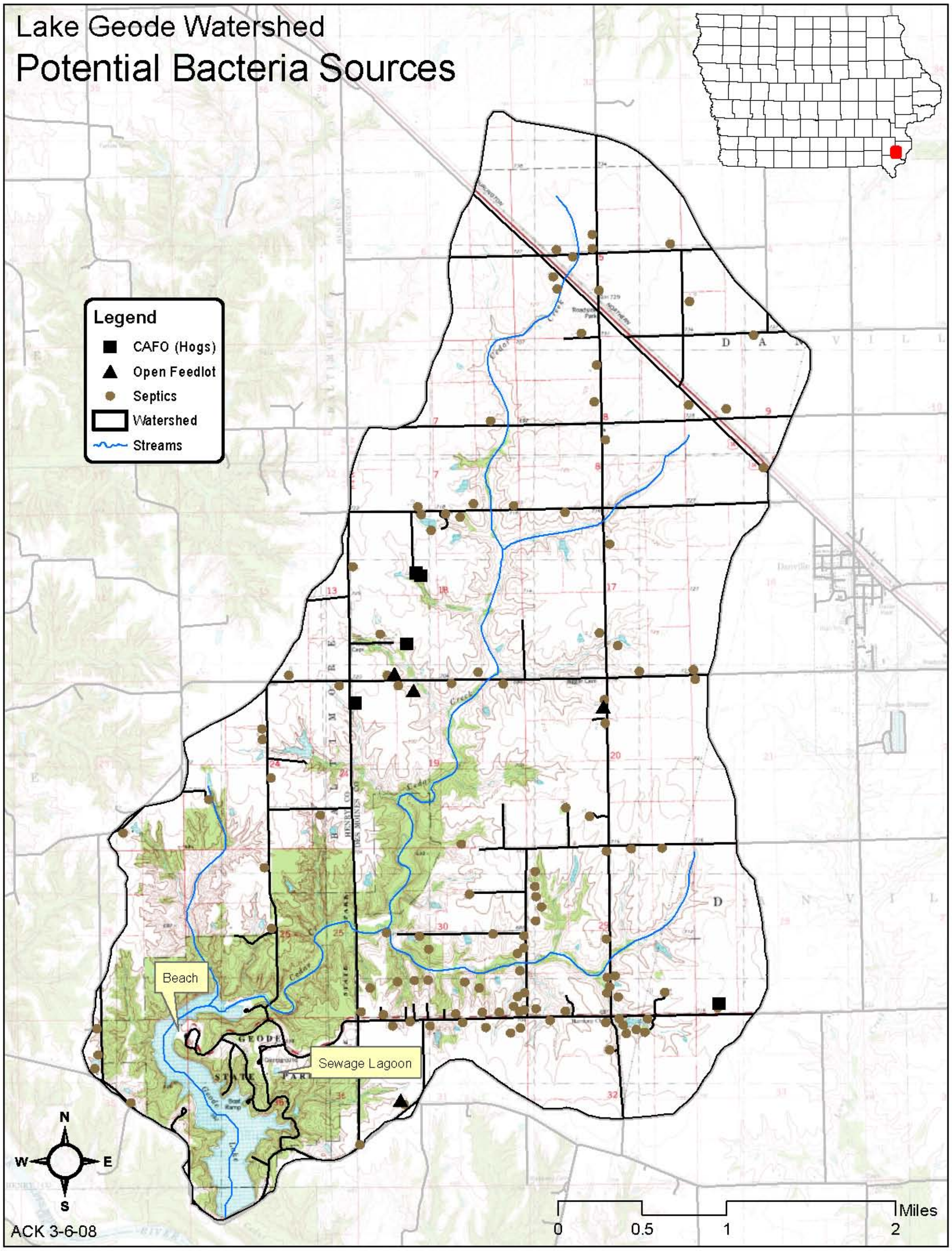


Figure 11 identifies all potential bacteria sources stemming from animal feeding operations and household septic systems. Data is based on windshield surveys and available GIS coverage's.

Expected Load Reductions

As stated previously excess TP and bacteria are impairing Lake Geode. Calculating bacteria and phosphorus load reductions can be challenging due to their nature and current methods utilized in field offices.

Goal 1: Address bacteria and pH impairments of Lake Geode & remove it from the 303(d) list

Bacteria Sources
Septic Systems (99% reduction)
Cattle in Streams (99% reduction)
Grazing (80% reduction)
Manure Application (95% reduction)
Geese at Beach (90% reduction)
Wildlife (0% reduction)

Bacteria source contributions will be addressed in the following manner:
Septics: Lake Geode Park currently uses an antiquated lagoon system for wastewater treatment within the park. It is a traditional discharge system that releases treated water into the lake after treatment. Since 2003 this lagoon has been pumped and the water has been hauled from the watershed. This system is in the process of being updated to a new mound wastewater treatment system for the park amenities. Although not completed, it should be functional within the next year. The new no discharge system should eliminate any potential threat of bacteria contributions to the lake.

Individual Household septic systems: Within the watershed there are an estimated 119 residences, of which 100% are served by individual on-site septic systems. According to the Des Moines County Sanitarian, all septic systems installed within the watershed after 1969 have been permitted. Approximately 42 residences built prior to 1969 are not permitted. Approximately 61 residences are permitted and another 16 are unknown. Even though over 50% of the households have permitted systems, it is likely that there are a number of systems, both old and newer, that are not functioning properly due to poor design, lack of maintenance, inappropriate soil conditions and old age. Based on the sensitive nature of this issue, it is unknown to what extent this could be impacting the watershed. Efforts to address this issue will include concentrated information and education program for rural residences in regards to operation, maintenance and replacement options for non-functioning septic tanks and water quality issues related to bacteria, resulting in the replacement of failing systems within the watershed. Addition water monitoring for optical brighteners will be used to target tributaries with wastewater issues.

Grazing and Cattle in streams: It is estimated that approximately 574 acres of grassland and pasture exist in the watershed. The watershed assessment identified six livestock grazing operations in the watershed with a limited number of head. Three of these operations allow unrestricted access to the approximately 3,600 feet of stream. The project goal is to establish 3, 600 feet of buffers and or fencing to eliminate livestock access. This will be accomplished through fencing, buffers, and providing alternative livestock water sources if needed.

Manure application: There are three confined animal feeding operations (hogs) within the watershed and two open feedlots (cattle). Of these operations, two of them meet the required threshold for permitting by the Iowa DNR. This requires that the producer have a nutrient management plan for manure application that meets the standards and protocols set forth by the permitting process. Based on operator contacts, approximately 85% of all manure is injected, with the remaining 15% being surface applied. The goal of this project is to complete nutrient management on all land that has manure applied to it (approximately 2,900 acres) and target an information and education program that focuses on proper application techniques and timing. Conservation practices such as grade stabilization structures, waterways, basins, and terraces will also be installed on manure application areas that restrict bacteria and phosphorus delivery to the lake.

Wildlife/Geese: Deer and geese have been identified as the primary wildlife species of concern. According to the Iowa DNR, there are an estimated 8 resident pair of geese and 700 deer residing within the 1,640-acre park. The resident geese and their offspring (up to 10 goslings per pair) have direct access to the lake and beach making them an identified contributor to bacterial water quality issues. Wildlife control activities that will address this concern include multiple alternatives such as, 1) purchasing a beach cleaner that will remove fecal matter from the beach area, sidewalks and other areas used by geese; 2) installation of fencing to serve as a deterrent; 3) beach landscaping practices designed to create insecurity among the geese deterring use and; 4) egg oiling (if necessary) to ensure zero population growth. Deer herd management will occur through the issuing of two hundred doe tags on a yearly basis. An annual harvest rate of fifty animals is projected.

Goal 2: Reduce total phosphorus and sediment delivery from agricultural and non-agricultural sources by 6,522 lbs/year and 4,221 tons/year, respectively.

Addressing TP by installing conservation practices in the watershed that will reduce sediment and TP delivery to Lake Geode. Currently, the method field staff has available to estimate TP reduction is to assume that each ton of sediment reduced has an associated phosphorus reduction. The following paragraphs and tables describe the issues and methodologies used to make the correlation between sediment and phosphorus.

Lake Geode is not impaired for sediment, therefore the TMDL did not specifically identify sediment loading to Lake Geode. Additionally, sediment delivery data related to gullies, headcuts, and streambanks was not available at the time the TMDL was written. This in-field data was later collected by NRCS and Des Moines and Henry County SWCD field staff for gullies, headcuts, and streambanks in and around the Lake and watershed. Table 8 identifies the inconsistencies in sediment delivery data from TMDL estimates and the in-field Assessment Data estimates.

Table 7: Estimated Sediment Delivery to Lake Geode

	TMDL Estimates	In-Field Assessment Estimates
Sheet and Rill Erosion	4,829 t/y	4,572 t/y
Gully Erosion	NA	4,639 t/y
Total	4,829 t/y	9,211 t/y

As the table notes, sediment loading based on in-field data collection is significantly higher than what was used for the TMDL. However, since the impairment is based on phosphorus loads and the TMDL identifies the need for a 45.8 percent load reduction in phosphorus, we can assume that a 45.8 percent reduction in sediment delivery to the lake will equate to a 45.8 percent reduction of phosphorus as well. Table 9 identifies the sediment and phosphorus loading to the Lake and estimated reductions needed.

Table 8: Updated Pollutant Load Allocation for Lake Geode

	TMDL Estimated Load	In-field Assessment Estimated Load	Load Capacity	Reductions Needed (%)
Sediment	4,829 t/y	9,211 t/y	NA	4,219 t/yr (45.8)
Phosphorus	14,235 lbs/y	14,235 lbs/yr	7,715 lbs/yr	6,520 lbs/yr (45.8)

It is also important to note that additional reductions in dissolved phosphorus loading will be achieved by other practices proposed in this plan. These practices include nutrient management, livestock restriction, updating septic systems, and addressing wildlife populations within the park. Implementation of any of these practices will help to exceed phosphorus reductions identified in the TMDL.

<u>TP Sources</u>

Private Land – Install a variety of conservation practices on targeted land that will reduce sediment delivery by an estimated 1,625 tons and 2,511 pounds of phosphorus annually
Public Land – Install water and sediment control basins and grade control structures on targeted gullies that will reduce sediment delivery by an estimated 2,596 tons and 4,011 pounds of phosphorus annually.

Anticipated reduction of sediment and associated phosphorus through implementation of the Watershed Management Plan: 4,221 t/y resulting in 6,522 lbs/yr (48%) reduction in TP from public and private lands

Reduction of sediment and phosphorus needed to meet TMDL: 45.8% reduction or 4,219 t/yr of sediment and/or 6,520 lbs/yr of phosphorus.

Proposed Management Measures

The overall goals of the Lake Geode Watershed Project are to reduce bacteria, sediment and phosphorus from loading into Lake Geode. These goals will be achieved through a combination of best management practices that will target identified source contributors.

Watershed Goals

Goal 1: Address bacteria and pH impairments of Lake Geode & remove it from the 303(d) list
Goal 2: Reduce total phosphorus and sediment delivery from agricultural and non-agricultural sources by 6,522 lbs/year and 4,221 tons/year, respectively.

> Task 1: Install strategically located conservation practices on high priority sediment delivery areas.
> Task 2: Complete nutrient management plans on high priority cropland (2,900 acres) within the watershed.
> Task 3: Eliminate 100% of continuous livestock access to stream within the watershed.
> Task 4: Replace, fix or clean out 100% of failing septic systems in the watershed.
> Task 5: Eliminate geese population on beach through various methods, such as landscaping, fencing, scare tactics and egg oiling.

Best Management Practices (BMPs)
A variety of structures and management practices will be required to reduce both TP and bacteria contributions to the watershed. Many of the same BMPs will benefit pollutant issues; however, some BMPs are specific to each pollutant.

The following BMPs will be used:

- Sediment control basins and grade control structures
- Terraces
- Waterways
- Buffers
- Livestock fencing to eliminate continuous livestock access to streams
- Beach landscaping and grooming
- Goose and wildlife population controls
- Septic system inspection and repair or replacement
- Nutrient management plans
- Manure management (incorporation, timing, proper application rates)
- I/E campaign for septic systems.

Other possibilities

- Buffer strips
- Conservation Tillage
- Crop rotation schemes (to help minimize manure fertilizer requirements)

Figure 14: Lake Geode Watershed – High Priority Areas on Public Land Targeted for Sediment and Phosphorus Reduction

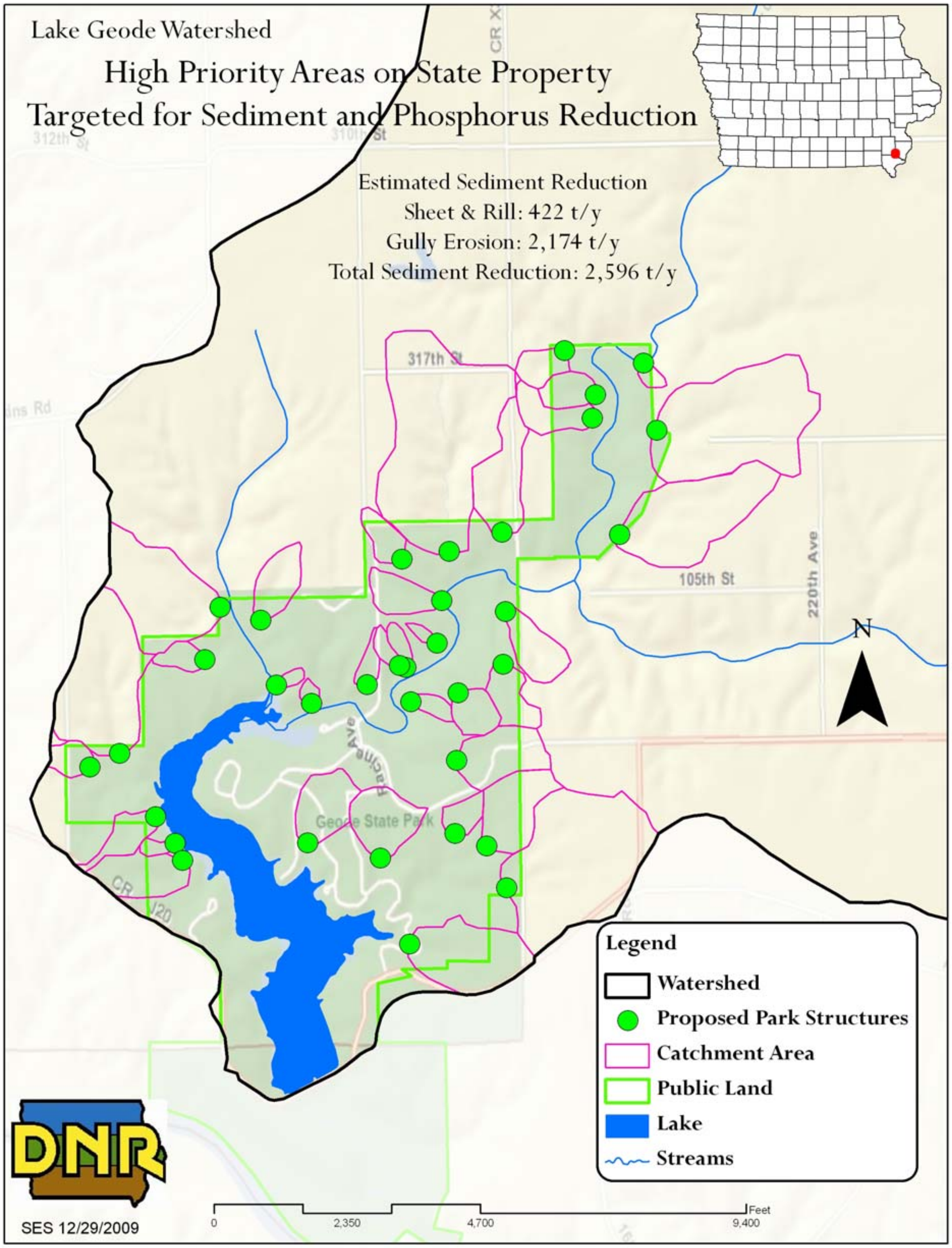


Figure 15: Lake Geode Watershed – High Priority Areas on Private Land Targeted for Sediment and Phosphorus Reduction

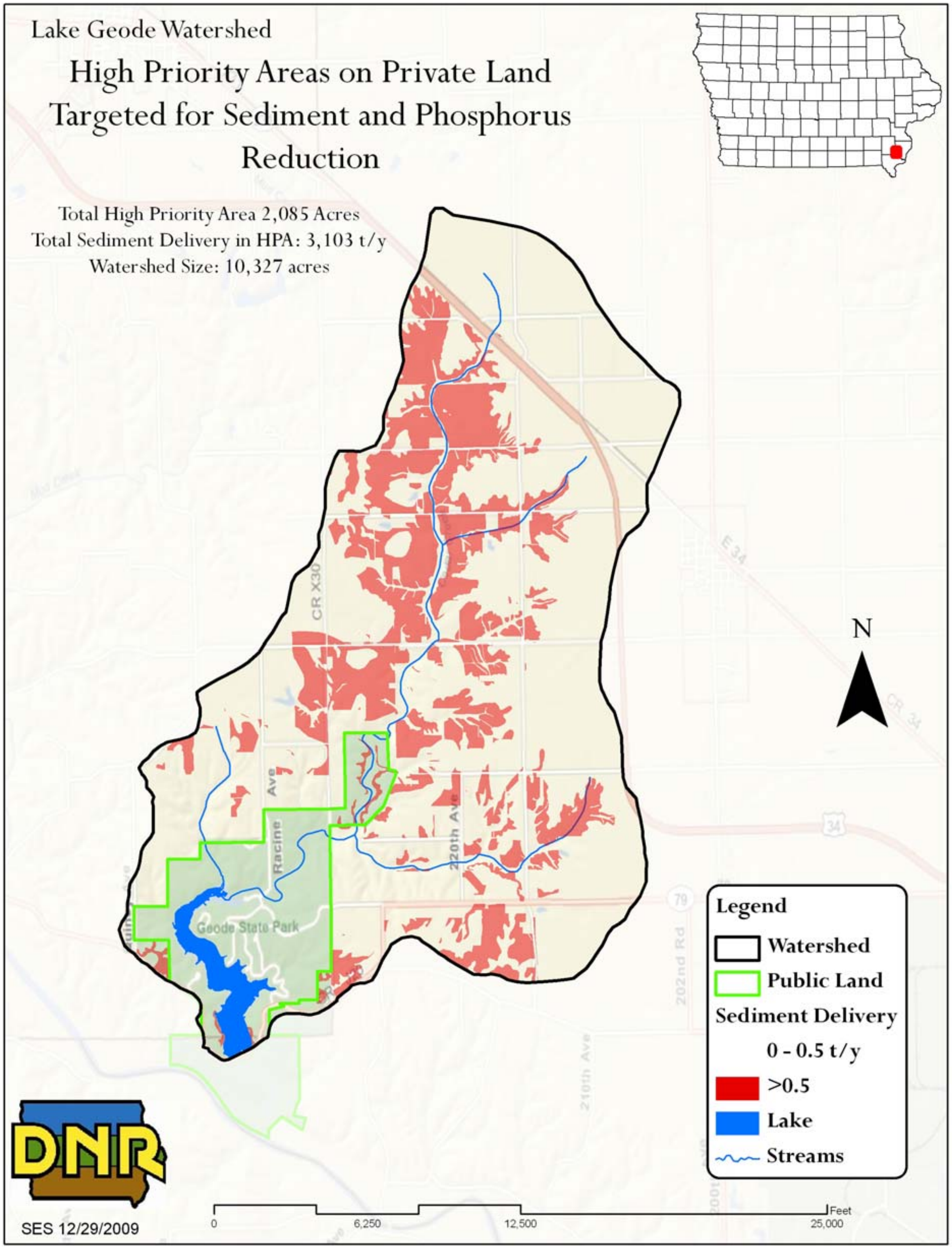
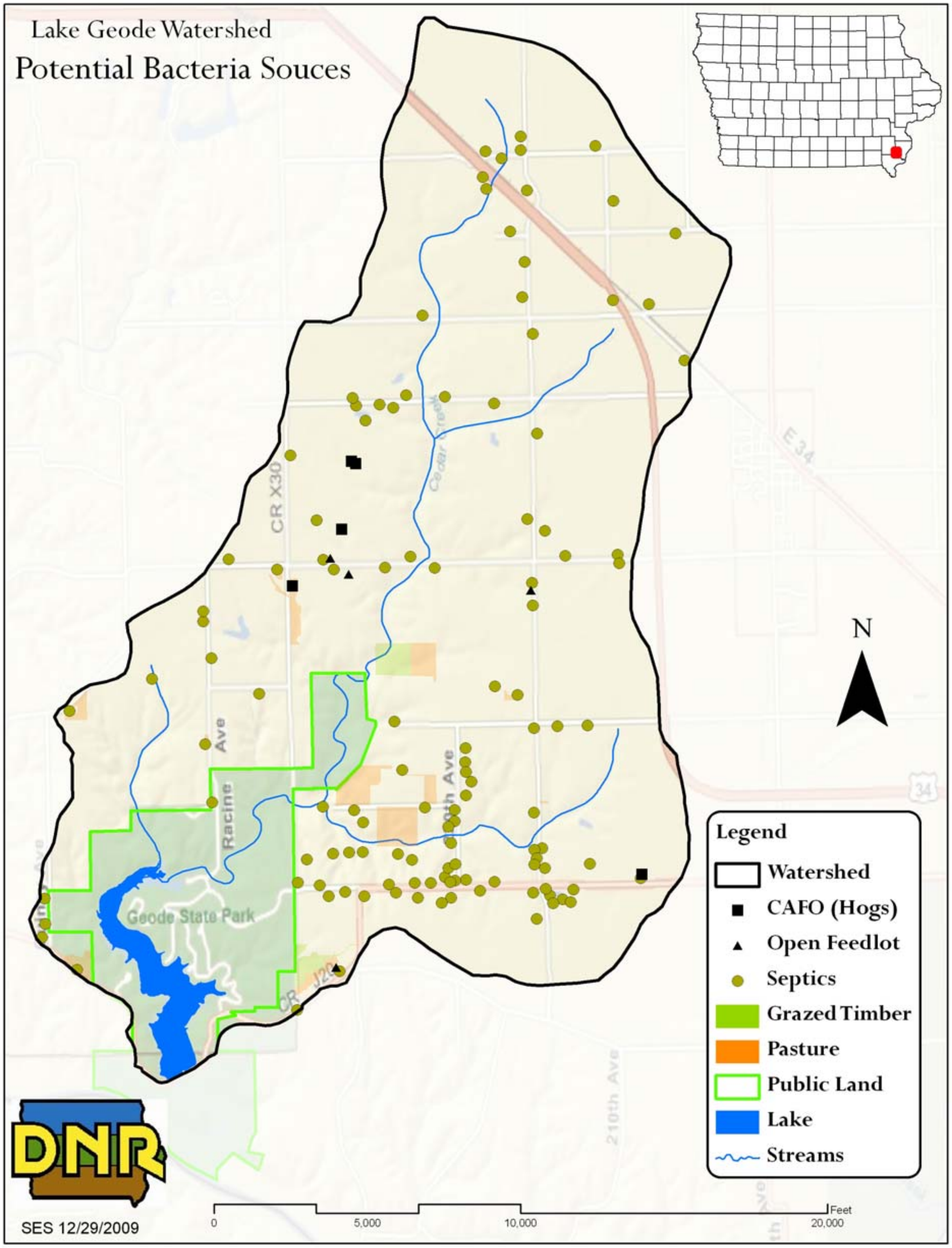


Figure 16: Lake Geode Watershed – Potential Bacteria Sources



Financial Assistance Needs:

Local Project Coordinator Salary for life of project: $682,000

Travel, Training, Supplies: $20,000

Engineering Assistance: $70,000

Grade Stabes, Terraces, WASCOBs, Waterways, Buffers, Fencing, Nutrient Management: $1,868,785

Beach Landscaping, Fencing, Maintenance: $20,000

I/E Campaign for Septic Systems (including cleaning vouchers): $20,000

I/E Campaign for Watershed Project: $15,000

Water Monitoring: $60,000

Technical Assistance Needs:

Engineering, Water Monitoring, GIS, Nutrient Management

Information and Education - Public Outreach Plan

1. **SET YOUR PLAN GOALS**
   - Address bacterial impairment of Lake Geode in an effort to remove it from the impaired waters list
   - Reduce total phosphorus and sediment from agricultural and non-agricultural sources by 6,522lbs/year of TP and 4,211 tons/year of sediment.
   - Increase support of project and perceived value of lake among Henry and Des Moines County residents

2. **DETERMINE YOUR TARGET AUDIENCES**

   Who do you depend on to make changes to the land and in the water?
   - DNR
   - Landowners
   - Recreational lake and park users

   Who do you depend on to keep your project afloat?
   - Lake Geode Advisory Committee
   - City governments of Burlington, New London
   - Other stakeholders to be identified by the project coordinator
   - State Senator Gene Fraise
   - State Representative David Heaton
   - U.S. Senators Chuck Grassley and Tom Harkin
   - U.S. Representative Dave Loebsack
   - DNR, IDALS-DSC, NRCS

   Who do you depend on to spread your message to these people?
   - Respected individuals in the community that can serve as project leaders and spokespeople (referred to in plan as “community leaders”)
     - SWCD Commissioners
     - Board of Supervisors
   - Project partners and stakeholders
     - DNR,IDALS-DSC ,NRCS, Henry and Des Moines SWCDs
     - New London and Mount Pleasant chambers of commerce
     - Burlington Parks and Recreation Department
     - Henry and Des Moines county boards of supervisors
     - Iowa Cattlemen’s Association
     - Iowa Pork Producers
     - Iowa Soybean Association
     - Iowa State University Extension
   - Local agriculture-based and outdoor recreation-based businesses and clubs
     - Pheasants Forever
     - Ducks Unlimited
     - 4-H

- Newspapers:
  - Burlington Hawk Eye
  - New London Journal
  - Mount Pleasant News
- Radio:
  - KCLJ-AM (Mount Pleasant)
  - KBUR/KGRS (Burlington)
  - KBKB AM/FM (Burlington)
  - KCPS (Burlington)
  - KKMI-FM/KDMG-FM (Burlington)
  - WQKQ-FM/KHDK-FM (Burlington)
- Television:
  - WQAD, Quad Cities
  - KWQC, Quad Cities
  - WHBF, Rock Island
  - KCRG, Cedar Rapids
  - KGAN, Cedar Rapids

3. RESEARCH YOUR TARGET AUDIENCES

The Lake Geode watershed effort would benefit from researching its audiences, especially to learn what barriers have kept landowners from using conservation practices in the past and what prevents them from making changes now. It would also be beneficial to help develop outreach strategies to address sensitive areas and issues that exist in the watershed, including how county residents perceive the lake and park. However, due to time constraints, the watershed project has chosen not to conduct research and will base its outreach strategies and efforts on these assumptions:

Landowners

Assumed barriers to participation:

- Reluctant to work with government officials and programs
- Increased costs to install practices during harsh economic times.
- Potential loss of productivity and crop area.
- Concerns about loss of control of land use by property owners.
- Lack of understanding about project goals and issues.
- Assumptions that problems are only responsibility of DNR and within public lands.
- Concerns about getting neighbors to also apply practices as well.
- Whether applying practices to some land will benefit the entire watershed.

Assumed motivators, incentives or benefits for participating in project:

- Funding assistance will defray costs to install conservation practices.
- Improving the watershed will reduce soil loss and keep the value of the land up.
- Allow better use of lands and increased acreage for crops.

- The project will keep our local community involved and our recreation area usable.
- Reduced need for fertilizers and repair work in fields after storms will help profits.
- Projects like this one will help make the land more sustainable and provide a positive image for our local area.

County residents

Assumed barriers to participating or supporting project:

- Little or no understanding of water quality problems
- Little or no understanding of how watershed improvement works and why it is necessary
- Feeling that there's nothing they can do to help lake; up to government or others
- Previous bad experiences with efforts to help park and lake

Motivators, incentives or benefits for participating or supporting project:

- Improving the water quality will make it more acceptable for recreational needs
- Improving the water quality will increase the demand for tourism
- The structural conservation practices will provide more recreational opportunities
- Financial benefits to the community

4. USE RESEARCH TO DEVELOP YOUR OUTREACH STRATEGY

Goal 1: Address bacterial impairment of Lake Geode in an effort to remove it from the impaired waters list

Audience:

- Landowners

Barriers to landowners adopting practices:

- Concerns over being held responsible for problems at Lake Geode.
- Costs and changes in practice that could affect profit margins.
- No certainty that the problems are agriculturally-related and may just be a DNR issue.

Possible solutions:

- Show landowners how conservation practices can benefit their land and farming operations
- Show landowners how practices will protect their land and land down the watershed
- Develop education programs and collect data to clarify source of bacterial problem.

- Make certain that public lands serve as an example and do not contribute to problems.

Message:
- Conservation practices can reduce bacteria levels

Message delivery:
- In-person meetings with landowners
- Have "community leaders," if one is a landowner, talk to his/her neighbors about practices, explain why they use them
- Newsletters
- Direct mailings as needed
- Field days and demonstrations
- Arrange small-scale or neighborhood meetings in an informal setting to allow more direct, localized involvement

Goal 2: Reduce total phosphorus and sediment from agricultural and non-agricultural sources by 6,522 lbs/year of TP and 4,211 tons/year of sediment.

Audience:
- Landowners

Barriers to landowners adopting practices:
- Adopting some practices may reduce profits and affect land uses.
- Costs of installing practices are prohibitive during these tough economic times.
- Lack of understanding regarding nutrient management planning and pollutant sources.

Possible solutions:
- Show landowners how conservation practices can benefit their land and farming operations
- Show landowners how practices will protect their land and land down the watershed

Message:
- Conservation practices can reduce erosion and increase soil quality.

Message delivery:
- In-person meetings with landowners
- Have "community leaders," if one is a landowner, talk to his/her neighbors about practices, explain why they use them
- News releases
- Newsletter

- Direct mail as needed
- Field days and demonstrations
- Arrange small-scale or neighborhood meetings in an informal setting to allow more direct, localized involvement

Goal 3: Increase support of project and perceived value of lake among Henry and Des Moines County residents

Audience:

- Local community (Henry and Des Moines counties)
- Stakeholders

Assumed barriers:

- Little or no interest
- Little or no understanding of water quality problems
- Little or no understanding of how watershed improvement works and why it is necessary
- Little or no understanding of role they play in protecting the lake, or assuming it is someone else's responsibility

Possible solutions:

- Better explain how water quality is tied to fishing, other recreation, tourism, etc.
- Explain water quality problems and how project will address them
- Explain what community can do on an individual level to help the lake (give them simple tasks that are easy to take ownership of – picking up trash, etc.)
- Meet with Pheasants Forever, Ducks Unlimited, other stakeholder group members to see how they can help spread message
- Periodically survey community (by mail or interview at park, meetings) to gauge changes in water quality knowledge, concern and support for the project and lake; evaluate and adjust outreach strategies as needed

Message:

- The increased water quality of the lake will benefit the entire community as well as the surrounding areas through improved recreation, tourism and economic development.

Message delivery:

- News releases highlighting how watershed work will benefit community
- Advisory Committee meetings
- Advisory Committee, stakeholders and "community leaders" spreading message among friends, family, neighbors
- PowerPoint presentations to community groups, at stakeholder meetings
- Arrange small-scale or neighborhood meetings in an informal setting to allow more direct, localized involvement

- Create informational kiosk at park to provide background on the project and updates
- Develop simple program giving lake users five or 10 things they can do in the park to help the lake; create incentive program to track participation and progress; use as a way to get "foot in the door" about talking about watershed project – need to balance responsible use of the lake with the larger water quality issues in the watershed.
- Hold large community celebration event at lake to draw community and explain project's purpose; arrange participation opportunities at Geode
- Place signs identifying conservation practices in watershed
- In last year of project, develop a promotional plan to encourage landowners and residents to keep up water quality improvement after project ends
- Offer educational opportunities for students

5. CARRY OUT THE PLAN

YEAR 1:

- The Lake Geode Project was developed
- Article in Burlington Hawk Eye
- Radio interview on KCLJ-AM in Mt. Pleasant, worked to get spots on Burlington stations.
- Sent introductory letter to watershed residents.
- Meetings with Iowa Wesleyan/Southeast Iowa Community Colleges.
- Attempted developing relationships with two county sanitarians regarding septic system education program
- Des Moines County Fair display.
- Working to arrange meetings with area Cattlemen/Pork Producers/Soybean Association.
- With Jessie Brown developed posters for display in area, project logo, signage for watershed designations.
- Attempted to re-activate "Friends of Lake Geode" group
- Began development of photo journal, local history data and other information.
- Ongoing process of meeting local residents.
- Met with Iowa State University Extension service about involving 4-H clubs.
- Working to develop IOWATER educational program for local schools to conduct samplings.
- Work with Rachel Erb to arrange introductory public meeting for January/February.
- Meetings with various public entities: IDNR, IDALS, County Conservationists, NRCS staff, IDOT, Federal agencies, others.
- Met with Danville Lions Club.
- Attendance at area contractors' meeting, CRP mid-contract mgt. meeting.

YEAR 2:

First quarter:

- Public meeting to update area residents on project.
- Provide news article on project goals and status.
- Provide newsletter to area residents to update on project.
- Conduct individual meetings with area producers.
- Develop project advisory board.

Second quarter:

- Install signage designating watershed.
- Conduct IOWATER sessions with local schools.
- Arrange field day to display conservation practices.
- Conduct individual meetings with area producers.

Third quarter:

- Provide news article on project updates and status.
- Work with area media and deliver broadcast information.
- Provide newsletter for area residents.
- Conduct septic system educational forum.
- Conduct individual landowner and small group meetings.

Fourth quarter:

- Hold public meeting to update area residents on project.
- Arrange meeting with area agricultural suppliers.
- Annual review of project with advisory board.
- Conduct individual landowner and small group meetings.
- Summarize and review monitoring data for year.

YEAR 3:

First quarter:

- Public meeting to update area residents on project.
- Provide news article on project goals and status.
- Provide newsletter to area residents to update on project.
- Conduct individual meetings with area producers.
- Conduct project advisory board meeting.

Second quarter:

- Install signage for conservation practices in watershed.
- Conduct IOWATER sessions with local schools.
- Arrange field day to display conservation practices.
- Conduct individual meetings with area producers.

Third quarter:

- Provide news article on project updates and status.
- Work with area media and deliver broadcast information.
- Provide newsletter for area residents.
- Conduct septic system educational forum.
- Conduct individual landowner and small group meetings.
- Install stream bank erosion monitoring instrumentation.

Fourth quarter:

- Hold public meeting to update area residents on project.
- Arrange meeting with area agricultural suppliers.
- Annual review of project with advisory board.
- Conduct individual landowner and small group meetings.
- Summarize and review monitoring data for year.
- Re-evaluate sediment delivery from project sites.

YEAR 4:

First quarter:

- Public meeting to update area residents on project.
- Provide news article on project goals and status.
- Provide newsletter to area residents to update on project.
- Conduct individual meetings with area producers.
- Conduct project advisory board meeting.

Second quarter:

- Install signage for conservation practices in watershed.
- Conduct IOWATER sessions with local schools.
- Arrange field day to display conservation practices.
- Conduct individual meetings with area producers.
- Conduct nutrient management planning sessions.

Third quarter:

- Provide news article on project updates and status.
- Work with area media and deliver broadcast information.
- Provide newsletter for area residents.
- Conduct septic system educational forum.
- Conduct individual landowner and small group meetings.
- Continue stream bank erosion monitoring.

Fourth quarter:

- Hold public meeting to update area residents on project.
- Conduct meeting with area agricultural suppliers.
- Annual review of project with advisory board.
- Conduct individual landowner and small group meetings.
- Summarize and review monitoring data for year.
- Re-evaluate sediment delivery from project sites.

YEAR 5:

First quarter:

- Public meeting to update area residents on project.
- Provide news article on project goals and status.
- Provide newsletter to area residents to update on project.
- Conduct individual meetings with area producers.
- Conduct project advisory board meeting.
- Set up long-term monitoring program with local groups.

Second quarter:
- Install signage for conservation practices in watershed.
- Conduct IOWATER sessions with local schools.
- Arrange field day to display conservation practices.
- Conduct individual meetings with area producers.
- Conduct nutrient management planning sessions.

Third quarter:
- Provide news article on project updates and status.
- Work with area media and deliver broadcast information.
- Provide newsletter for area residents.
- Conduct septic system educational forum.
- Conduct individual landowner and small group meetings.
- Evaluate stream bank erosion monitoring.

Fourth quarter:
- Hold public meeting to update area residents on project.
- Conduct meeting with area agricultural suppliers.
- Annual review of project with advisory board.
- Conduct individual landowner and small group meetings.
- Summarize and review monitoring data for year.
- Re-evaluate sediment delivery from project sites.

YEAR 6:

First quarter:
- Public meeting to update area residents on project.
- Provide news article on project goals and status.
- Provide newsletter to area residents to update on project.
- Conduct individual meetings with area producers.
- Conduct project advisory board meeting.

Second quarter:
- Install signage for conservation practices in watershed.
- Conduct IOWATER sessions with local schools.
- Arrange field day to display conservation practices.
- Conduct individual meetings with area producers.
- Conduct nutrient management planning sessions.

Third quarter:
- Provide news article on project updates and status.
- Work with area media and deliver broadcast information.
- Provide newsletter for area residents.
- Conduct follow-up septic system educational forum.
- Conduct individual landowner and small group meetings.
- Evaluate stream bank erosion monitoring.

Fourth quarter:
- Hold public meeting to update area residents on project.

- Conduct meeting with area agricultural suppliers.
- Annual review of project with advisory board.
- Conduct individual landowner and small group meetings.
- Summarize and review monitoring data for year.
- Re-evaluate sediment delivery from project sites.
- Possible awards dinner for participating producers.
- Project evaluations and progress summarizations.

6. MEASURE AND EVALUATE EFFECTIVENESS; PROMOTE SUCCESSES

Measures:
The Lake Geode project is highly encouraged to track the following measures to evaluate the success of the project in reaching its goals:

- Number of articles published in newspaper
- Attendance at presentations and public meetings
- Number of landowners involved in project
- Park usage
- Lake usage
- Number of conservation practices installed in priority areas
- Sediment delivery rates
- Nutrient delivery rates
- Bacteria levels

The following could be evaluated in follow-up research:
- Landowners' recognition and understanding of water quality issues affecting the lake, watershed approach, watershed project
- Community's value of lake
- Community's understanding and knowledge of water quality issues affecting the lake

Promote successes:

The Lake Geode project, as it progresses, should consider publicizing success stories to encourage others to become involved in the project and raise awareness and support among the community.

Implementation Schedule

Goal 1: Address bacteria and pH impairments of Lake Geode & remove it from the 303(d) list				**Phase 1**						
Goal 2: Reduce total phosphorus and sediment delivery from agricultural and non-agricultural sources by 6,520 lbs/year and 4,219 tons/year, respectively.										
		Milestone metric	Milestone totals	2010	2011	2012	2013	2014	Project Outcome	Estimated Load Reductions
Task 1:	Install strategically placed BMPs *	Ft terraces No. WASCOBS and GSS Acres WW Acres buffers	20,000 ft 110 no. 5 acres 10 acres	4,000 ft 10 no. 1 ac. 2 ac.	4,000 ft 15 no. 1 ac. 2 ac.	4,000 ft 25 no. 1 ac. 2 ac.	4,000 ft 35 no. 1 ac. 2 ac.	4,000 ft 25 no. 1 ac. 2 ac.	Reduction in bacteria, sediment & TP delivery to the lake.	Estimated bacteria reduction 10% Estimated TP reduction = 6,522 lbs/yr Estimated sediment reduction = 4,211 t/y
Task 2:	Complete nutrient management plans on high priority** cropland (2,900 acres) within the watershed	# of acres	2,900	200	200	200	200	200	Reduction in bacteria from runoff	Estimated 5% reduction of bacteria contributions from cropland
Task 3:	Eliminate 100% of livestock access to stream within the watershed	% of livestock with no stream access	100%	10	10	10	10	10	Reduction in bacteria from cattle in streams	Estimated 50% reduction of TP & bacteria sources from livestock in streams
Task 4:	Replace, fix or clean out 100% of failing septic systems in the watershed***	100% fully functional septic systems	100%	5	5	5	5	5	Reduction in TP & bacteria contribution from septic systems	Estimated 50% reduction of bacteria sources & TP from faulty septic systems
Task 5:	Eliminate geese population on beach through various methods, such as landscaping, fencing, scare tactics and egg oiling.	geese population and reduction of geese on beach during spring, summer and fall	100% Reduction	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	Reduction in beach sampling bacteria	Estimated 100% reduction of bacteria & TP contributions from geese

* See Targeted areas for BMP implementation Maps

**See High Priority Map

***There are an estimated 50 septic systems that are not functioning correctly that will be targeted. See Potential Bacteria Map.

EACH STATE FISCAL YEAR THIS IMPLEMENTATION SCHEDULE WILL BE UPDATED ACCORDINGLY TO ACCOUNT FOR ANY UNFORSEEN HOLD-UPS.

Goal 1: Address bacteria and pH impairments of Lake Geode & remove it from the 303(d) list				**Phase 2**						
Goal 2: Reduce total phosphorus and sediment delivery from agricultural and non-agricultural sources by 6,520 lbs/year and 4,219 tons/year, respectively.										
		Milestone metric	Milestone totals	2015	2016	2017	2018	2019	Project Outcome	Estimated Load Reductions
Task 1:	Install strategically placed BMPs *	Ft terraces No. WASCOBS and GSS Acres WW Acres buffers	20,000 ft 110 no. 5 acres 10 acres	This task should be complete if weather and landowners cooperate. Next step will be to monitor the practices to ensure they are functioning properly and reducing pollutants. See Water Monitoring Plan Section.						
Task 2:	Complete nutrient management plans on high priority** cropland (2,900 acres) within the watershed	# of acres	2,900	200	200	200	200	200	Reduction in bacteria from runoff	Estimated additional 5% reduction of bacteria & TP contributions from cropland
Task 3:	Eliminate 100% of livestock access to stream within the watershed	% of livestock with no stream access	100%	10	10	10	10	10	Reduction in bacteria from cattle in streams	100% of Livestock have no access to streams within the watershed
Task 4:	Replace, fix or clean out 100% of failing septic systems in the watershed***	100% fully functional septic systems	100%	5	5	5	5	5	Reduction in TP & bacteria contribution from septic systems	100% of Septic systems should be cleaned, fixed or replaced
Task 5:	Eliminate geese population on beach through various methods, such as landscaping, fencing, scare tactics and egg oiling.	geese population and reduction of geese on beach during spring, summer and fall	100% Reduction	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	observe population - reduce by 25%	Reduction in beach sampling bacteria	Estimated 100% reduction of bacteria contributions from geese

* See Targeted areas for BMP implementation Maps

**See High Priority Map

***There are an estimated 50 septic systems that are not functioning correctly that will be targeted. See Potential Bacteria Map.

EACH STATE FISCAL YEAR THIS IMPLEMENTATION SCHEDULE WILL BE UPDATED ACCORDINGLY TO ACCOUNT FOR ANY UNFORSEEN HOLD-UPS.

Goal 1: Address bacteria and pH impairments of Lake Geode & remove it from the 303(d) list				**Phase 3**						
Goal 2: Reduce total phosphorus and sediment delivery from agricultural and non-agricultural sources by 6,520 lbs/year and 4,219 tons/year, respectively.										
		Milestone metric	Milestone totals	2020	2021	2022	2023	2024	Project Outcome	Estimated Load Reductions
Task 1:	Install strategically placed BMPs *	Ft terraces No. WASCOBS and GSS Acres WW Acres buffers	20,000ft 110 no. 5 acres 10 acres 6	This task should be complete if weather and landowners cooperate. Next step will be to monitor the basins to ensure they are functioning properly and reducing pollutants. See Water Monitoring Plan Section.						
Task 2:	Complete nutrient management plans on high priority** cropland (2,900 acres) within the watershed	# of acres	2,900	180	180	180	180	180	Reduction in bacteria from runoff	Estimated additional 5% reduction of bacteria & TP contributions from cropland
Task 3:	Eliminate 100% of livestock access to stream within the watershed	% of livestock with no stream access	100%	This task should be complete if landowners cooperate.						
Task 4:	Replace, fix or clean out 100% of failing septic systems in the watershed***	100% fully functional septic systems	100%	This task should be complete if homeowners cooperate.						
Task 5:	Eliminate geese population on beach through various methods, such as landscaping, fencing, scare tactics and egg oiling.	geese population and reduction of geese on beach during spring, summer and fall	100% Reduction	observe population - reduce if needed	observe population - reduce if needed	observe population - reduce if needed	observe population - reduce if needed	observe population - reduce if needed	Reduction in bacteria from beach sampling	Estimated 100% reduction of bacteria contributions from geese

* See Targeted areas for BMP implementation Maps

**See High Priority Map

***There are an estimated 50 septic systems that are not functioning correctly that will be targeted. See Potential Bacteria Map.

EACH STATE FISCAL YEAR THIS IMPLEMENTATION SCHEDULE WILL BE UPDATED ACCORDINGLY TO ACCOUNT FOR ANY UNFORSEEN HOLD-UPS.

Acronyms:
WASCOS – Water & Sediment Control Structures
GSS – Grade Stabilization Structures
WW – Winter Wheat (cover crops)
BMPs – Best Management Practices

Water Monitoring Plan:

- Annual lake monitoring to determine if water quality "standards" are being met (progress toward secchi, TSI, P goals).
- Continued monitoring of beach to determine if the beach water quality standards are being met (progress toward E. coli goal).
- Monitor the performance of structures/basins implemented throughout the watershed to determine if load reduction goals are being met (therefore both concentration and flow needed).
- Align monitoring with ongoing Beach Monitoring Intensive monitoring efforts and Safe lakes Program efforts.
- Assess the impact of upgraded wastewater facilities at the park.
- Conduct and repeat RASCAL streambank and gully erosion assessment after BMP implementation to quantify reduction in sediment delivery from these sources.

Plan:

1. Monitor tributary inflow to Lake Geode.
    a. One site will be instrumented with an ISCO sampler to sample each event during the non-winter months (icing of equipment prevents sample collection when temperatures drop below freezing).
        i. Samples will be composited for laboratory analysis using the equal time method. Sample collection will be triggered when the stage of the stream increases by 0.5 ft. This stage may be adjusted as needed if the trigger does not result in enough volume in the sample bottles or if the 0.5 ft. increase does not represent a significant event.
        ii. Stream stage will be captured by the ISCO unit during the event and converted to a stream volume using a rating curve. The rating curve will be developed by measuring stream volume and channel dimensions during the season.
        iii. All ISCO sampling will be maintained through a contract with IDNR.
    b. Determine the number of sites to monitor and the locations.
    c. Determine the frequency of sampling at the various sites and length of sampling.
    d. Determine flow monitoring to assess load reductions.
    e. Determine personnel conducting sampling at each site and the roles and responsibilities for the various entities.
2. Conduct annual lake monitoring.
    a. Ambient program will continue to monitor the lake three times during the spring-fall season according to standard protocols.
    b. Beach monitoring program will continue to monitor the lake twice weekly through the recreation season.
    c. Determine if Lake Geode is on the Fisheries Restoration Priority List or is scheduled for any other in-lake work.

d. Work with the counties to support IOWATER monitors and organize volunteer monitoring to gather additional data (secchi readings at least).

3. Monitor stream sediment and phosphorus loads to the lake.

a. ISCO sampler with flow measurement at the inflow to the lake, downstream of where structures or basins have been implemented.

b. In-situ turbidimeter to measure sediment.

4. Work with Safe Lakes monitoring crew to continue source-tracking efforts at the lake. Perhaps use fluorometry to measure impacts of wastewater upgrades at the park.

5. Project staff to conduct pre and post-implementation RASCAL assessment including estimates of reduction of sediment delivery from bank and gully erosion.

The Lake Geode Watershed consists of one main feeder, Cedar Creek and by several smaller, unnamed streams which serve either as tributaries of Cedar Creek or drain directly into the lake from surrounding uplands. A series of 12 regular (twice monthly) and 7 alternate sampling sites have been established within the watershed during August, 2009. These sampling points (see attached watershed map) are located specifically to sub-divide feeder streams into discrete reaches and allow tracking of pollutants or changes along the main watercourse as well as materials entering the system from minor or intermittent drainages.

At each monitoring point, samples are being taken at two-week intervals throughout the year during open water periods in an effort to establish baselines and incident spikes for the following:

-Nitrate + Nitrite as N,

-Ammonia

-Total Kjeldahl Nitrogen

-Total Phosphate

-E coli bacteria

-Chloride

-pH

-Temperature and turbidity.

Samples are collected and sent to the University of Iowa Hygienic Laboratories for analysis. Twelve sites are currently being tested with the additional alternate sites to be sampled if need arises within a stream segment. In addition to this regime an IOWATER transect is being established for supplemental sampling of waters at a point just above the lake and at the mouth of Cedar Creek, the major feeder stream. This station will sample for the above parameters and do additional sampling for Dissolved Oxygen, water clarity, macroinvertebrate populations and physical stream conditions on a monthly basis. The regular sampling is being conducted by the Geode Watershed Coordinator and the IOWATER site will be utilized as an educational tool with the intention of using supervised school groups to conduct field studies and supplement findings.

In the case of coordinator sampling, the purpose is two-fold. In the first sense the sampling will allow determination of pollutant presence and quantities throughout the year as well as localization of non-point sources as much as possible. The second purpose is to detect changes in pollutant loading over time resulting from the installation of erosion-control practices or changes in land use. Thus, a decline in phosphates, nitrates and turbidity should reflect a decrease in nutrient or soil run-off within a stream reach as sources are treated. The IOWATER monitoring should reflect any improvements over time within the main feeder and serve as an overall indicator of water quality reaching the lake.

Figure 16: Lake Geode Water Monitoring Locations Map