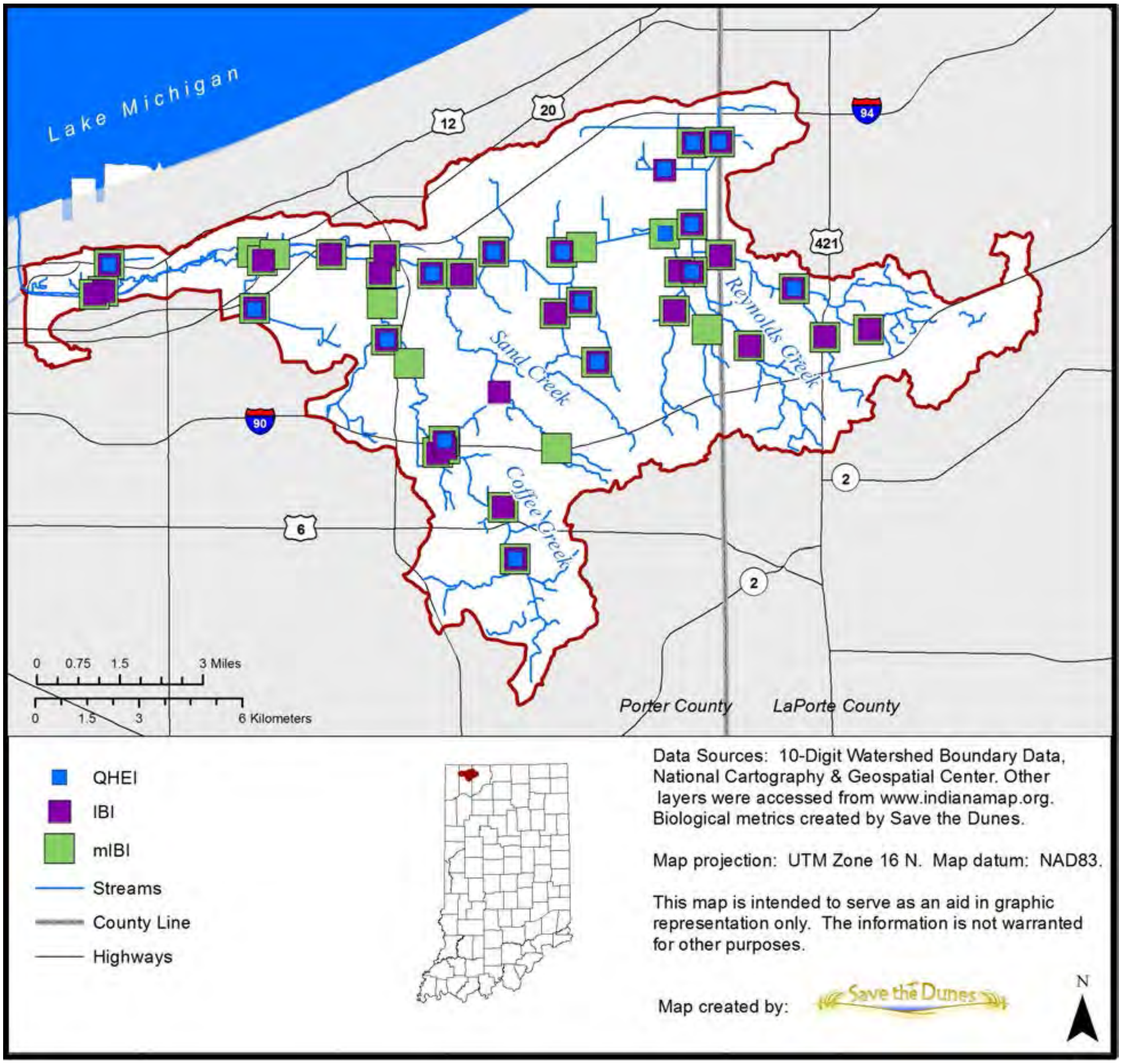

Figure 61.LCEB sampling sites that did not meet targets for 2012 Baseline Study

5.0 Review of Watershed Problems and Causes

5.1 Stakeholder Concerns

The following stakeholder concerns were developed from stakeholder input and the watershed inventory analysis. The LCEB steering committee evaluated the concerns and available data to determine the group's focus.

Table 14. Stakeholder concerns, evidence, and analysis

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Elevated Pathogens					
Pathogen loading from combined sewer and sanitary sewer overflows	Over the past 5 years, there have been 10 CSOs totaling over 9 million gallons and 26 SSOs totaling over 2 million gallons. Long-term control plans are in currently being implemented; consequently, significantly reduced CSOs and SSOs are expected for the future.	No	Yes	Yes	Yes, to support municipal efforts
Public health effects from high *E. coli* concentrations	During a drought (2012 baseline), over 80% of sampling sites exceeded the target and 20 sites exceeded the target in over 50% of samples collected.	Yes	Yes	Yes	Yes
High *E. coli* concentrations due to failing septic systems	During a drought (2012 baseline), over 80% of sampling sites exceeded the IAC target and 20 sites exceeded the target in over 50% of samples collected. 94% of the soils are classified as limited or very limited for on-site septic systems and 80% of the watershed is unsewered.	Yes	No	No	Yes
Pathogen loading polluting groundwater	Suggested by unsewered areas with low soil septic suitability, but there is no groundwater data to quantify this concern.	No	No	No	No
Not meeting water quality standards	2014 draft 303(d) assessment shows over 32 miles of LCEB streams are impaired for *E. coli*. 2012 baseline data shows many target exceedances for *E. coli*.	Yes	Yes	Yes	Yes
Integrate 2004 *E. coli* TMDL	The 2004 TMDL for *E. coli* has been incorporated in to this plan.	Yes	Yes	Yes	Yes
Excessive Sediment and Nutrient Loading					
Streambank erosion and sedimentation	Streambank erosion occurs along approximately 1.6 miles of watershed streams according to the windshield survey and the QHEI.	Yes	Yes	Yes	Yes

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Degraded riparian corridors allow sediment and nutrient loading from runoff	Insufficient or limited buffers are present along approximately 13 miles of streambank.	Yes	Yes	Yes	Yes
Highly erodible soils on cropland may contribute sediment	There are 27,721 acres of highly and potentially highly erodible soils in this watershed.	Yes	No	No	Yes
Nutrient loading from combined sewer and sanitary sewer overflows	Over the past 5 years, there have been 10 CSOs totaling over 9 million gallons and 26 SSOs totaling over 2 million gallons. Long-term control plans are in currently being implemented; consequently, significantly reduced CSOs and SSOs are expected for the future.	No	Yes	Yes	Yes, to support municipal efforts
Increased volume and flow causing stream bank and channel erosion	Changes in land use can increase the flashiness of streams. However, data is not available to support this claim.	Yes	No	No	Yes
Erosion caused by woody debris	NPS is currently studying the effects of woody debris in this watershed; however, no data is currently available.	Yes	No	No	No
Habitat, Biotic Communities and Hydrology					
Need to protect fisheries and habitat	35 sites (or 1.7 miles of stream) scored un-supporting (<36) for IBI, 41 sites (or 2.2 miles of stream) scored un-supporting (<36) for mIBI, and 17 sites (or 0.6 miles of stream) scored poor for habitat (51 or less) for the QHEI.	Yes	Yes	Yes	Yes
Fish habitat and passage for native non jumping fish	17 sites (or 0.6 miles of stream) scored (51 or less) poor habitat with the QHEI and 10 dams restrict fish passage.	Yes	Yes	Yes	Yes
Sedimentation in streams has a negative impact on fish habitat	The QHEI reported approximately 1.8 miles of streambed to have moderate to heavy silt.	Yes	Yes	Yes	Yes

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Failing to meet water standards	35 sites (or 1.7 miles of stream) scored un-supporting (<36) for IBI and 41 sites or 2.2 miles of stream) scored un-supporting (<36) for mIB and 17 sites (or 0.6 miles of stream) scored poor for habitat (51 or less) for QHEI. Nearly all stream segments are listed as impaired on the 2014 draft 303(d) reassessment.	Yes	Yes	Yes	Yes
Methods of dredging ditches are having multiple negative impacts on the LCEB	There is no data showing the environmental impacts of dredging on this watershed.	Yes	No	No	Yes
Emerald ash borer (EAB) killing trees, source of debris	EAB was studied for Coffee Creek Watershed Conservancy report. All ash in the region is expected to die within 5 years.	Yes	Yes	Yes	Yes
Invasive plants impact biodiversity and have impact on water quality/wetlands	There is currently no data quantifying the impact of invasive plants on water quality and wetlands in the LCEB.	Yes	No	No	Yes
Increased volume and flow due to altered hydrology (regulated drains, ditches)	Altered hydrology tends to increase stream flows and velocity; however, there is no data to confirm this claim. Stream gages are only located at the base of the watershed.	Yes	No	No	Yes
LaPorte County Waste Management landfill, is closed but may have impact	There is no data to support environmental impacts from the landfill.	No	No	No	No
Fish Consumption	The Fish Consumption Advisory listing provides data for fish consumption. Three fish species are listed under Advisory Group 4 and 2 fish species are listed under Advisory Group 3.	No	Yes	No	No, this is outside the scope of the project
Need to understand geology and hydrology. Several habitat types in watershed	Geology and hydrology have been described in this project. Habitats have also been described.	Yes	Yes	Yes	Yes
Need permits for woody debris management and fisheries and habitat protections	Permit acquisition is not within the scope of this plan. Fisheries and habitat protections will be explored for this plan.	No	No	No	No

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Promote conservation easements	Conservation easements can help improve water quality, but no data exists to support this claim in the LCEB.	Yes	No	No	Yes
Need more environmentally friendly methods for ditch maintenance	Environmentally friendly methods for ditch maintenance are encouraged by this project.	No	No	No	No
Need to protect bottomland, slopes, and highland	The protection of natural ecosystems is encouraged by this project.	Yes	No	No	Yes
Need to fix tributary ditches environmentally or remove them	The maintenance of regulated drains is not within the scope of this plan.	No	No	No	No
Stormwater management, flood prevention efforts need improvement	Stormwater best management practices are encouraged by this plan. Education on this topic is also encouraged.	Yes	No	No	Yes
Public Education, Involvement, and Access					
Public does not have enough access to information about LCEB or water quality	The social indicators study and this plan will help to improve public information available on the LCEB. Improved education on water quality and this watershed is a goal for this plan.	Yes	No	No	Yes
Lack of press coverage for LCEB management efforts and water quality	Four articles were published in 2012 and 5 in 2013.	Yes	Yes	Yes	Yes
Not enough private property owners are directly involved in WMP process	Public attendance of meetings is low.	Yes	Yes	Yes	Yes
Environmental assessment should have public component	A public meeting was held for the EA, but this is not within the scope of this plan.	No	No	No	No
Dumping of trash	Dumping was reported in the windshield survey.	Yes	Yes	Yes	Yes

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Lack of safe passage for paddlers due to log jams/woody debris, culverts, bridges, beaver dams, and physical features	Concerns have been documented by paddlers with pictures and GPS.	Yes	Yes	Yes	Yes
No continuous walking trail along LCEB	While many trails exist, there is no continuous trail along the LCEB.	Yes	Yes	Yes	Yes
Need to respect private property rights, locate access points in easements	Improved access is being explored by this plan.	Yes	No	No	No
Lack of river access sites – river and tributaries are out of public sight	Improved access is being explored by this plan.	Yes	No	No	Yes
Advocating for full body contact despite *E. coli* and contaminants	22% of samples collected for the baseline study exceeded IAC target for *E. coli*.	Yes	No	No	No
Need environmental assessment to evaluate paddling assess in INDU	The EA is currently in progress.	Yes	No	No	Yes
Two major branches flow under Highway 421	This statement is true.	No	No	No	No
Culverts, bridges, beaver dams, and physical features to be addressed	Culverts, bridges, and beaver dams are outside the scope of this plan.	No	No	No	No
ADA compliance at existing and future access sites	ADA access is being examined for this plan.	Yes	Yes	Yes	Yes
Create incentives and diminish disincentives for private property owners	Several state and federal programs currently exist to incentivize landowners to implement BMPs. This plan seeks to improve incentives for landowners.	Yes	No	No	Yes
Need data and information on positive impact of trails for property owners	There is currently no local data available on the impact of trails for landowners.	No	No	No	No
Inventory and identify land owners	This is outside the scope of this project	No	No	No	No

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Engage land owners in WMP process and increase communication	Press releases, public educational events, and the social indicators study helped to engage land owners.	Yes	No	No	Yes
Acquisition of land from farmers	Land conservation is a goal for this plan.	Yes	Yes	Yes	Yes
Fisherman may be eating fish, despite 303(d) impairment for PCBs in fish tissue	The Fish Consumption Advisory Listing provides data for fish consumption. Three fish species are listed under Advisory Group 4 and two species are listed under Advisory Group 3. However, there is no data on personal consumption.	Yes	No	No	No
Lack of Multijurisdictional Coordination					
Lack of funding to achieve all watershed goals	Stakeholder observation or perception	Yes	No	Yes	Yes
Lack of septic system inspection and operation and maintenance programs	Stakeholder observation or perception	Yes	No	No	Yes
Lack of cooperation between agencies to achieve watershed goals	Stakeholder observation or perception	Yes	No	No	Yes
Conflicting missions between agencies and organizations	Stakeholder observation or perception	Yes	No	No	No
Local government adoption of the plan once complete	Stakeholder observation or perception	Yes	No	No	Yes
Aging culverts and infrastructure	Stakeholder observation or perception	Yes	No	No	No
Varied waterway use for owners and municipalities creates lack of mutual respect	Stakeholder observation or perception	Yes	No	No	Yes

Stakeholder Concern	Evidence	Within Project Scope?	Data-Supported?	Able to Quantify?	Group Wants to Focus On?
Need industry and land owners at the table	Stakeholder observation or perception	Yes	No	No	Yes
Respect for each perspective. Find mutual benefit through process.	Stakeholder observation or perception	Yes	No	No	Yes
Need robust, long-term, sustained, meaningful monitoring	Stakeholder observation or perception	Yes	No	No	Yes

5.2 Problems That Reflect LCEB Concerns

Table 15. Problems that reflect the concerns of the LCEB Watershed

Stakeholder Concerns	Problem
Elevated Pathogens	
Pathogen loading from combined sewer and sanitary sewer overflows	The LCEB and its tributaries have high pathogen loads, as indicated by high *E. coli*. This causes the river to fail to meet its designated use for recreational contact and poses a health risk for public access.
Public health effects from high *E. coli* concentrations	
High *E. coli* concentrations due to failing septic systems	
Not meeting water standards	
Pathogen loading from pasture and manure application	
Pathogen loading from pet waste and wildlife	
Excessive Sediment and Nutrient Loading	
Streambank erosion and sedimentation	Excessive sediment and nutrient loading to the LCEB and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation.
Degraded riparian corridors allow sediment and nutrient loading from runoff	
Highly erodible soils on cropland may contribute sediment	
Nutrient loading from combined sewer and sanitary sewer overflows	
Increased flow volume causing stream bank and channel erosion	
Fertilizer application to urban lands contributes nutrients	
Habitat, Biotic Communities, and Hydrology	
Need to protect fisheries and habitat	Biotic communities in the LCEB and its tributaries are impaired due to poor water quality, poor habitat, and altered hydrology. This causes the river to fail to meet its designated use for aquatic life use support.
Habitat and passage for native non-jumping fish threatened or lacking	
Sedimentation in streams has a negative impact on fish habitat	
Failing to meet water standards	
Methods of dredging ditches have negative impacts on the LCEB	
Emerald ash borer killing trees, source of debris	
Invasive plants impact biodiversity and have impact on water quality/wetlands	
Increased volume and flow due to altered hydrology (regulated drains, ditches)	
Poor water quality leads to impaired biotic communities	
Habitat, Biotic Communities, and Hydrology	
Public does not have enough access to information about LCEB or water quality	The public is not taking actions to protect and improve the LCEB and is not engaged in the LCEB watershed management effort.
Lack of press coverage for LCEB management efforts and water quality	
Not enough private property owners are directly	

Stakeholder Concerns	Problem
involved in WMP process	
Environmental assessment should have a public component	
Dumping of trash	
Lack of safe passage for paddlers due to log jams/woody debris, culverts, bridges, beaver dams, and physical features	Limited public access to the LCEB and its corridor limits recreational opportunities and public value of the LCEB.
No continuous walking trail along LCEB	
Need to respect private property rights, locate access points in easements	
Lack of river access sites and public visibility of streams	
Advocating for full body contact despite *E. coli* and contaminants	
Need environmental assessment to evaluate paddling in INDU	
Lack of Multijurisdictional Coordination	
Lack of funding to achieve all watershed goals	A lack of multijurisdictional coordination could limit the ability of the LCEB watershed group and partners to achieve watershed goals to protect and improve water quality
Lack of septic system inspection, operation, and maintenance programs	
Lack of cooperation between agencies to achieve watershed goals	
Local government adoption of the plan once complete	
Varied waterway use for owners and municipalities creates lack of mutual respect	
Need industry and land owners at the table	
Respect for each perspective. Find mutual benefit through process.	
Need robust, long-term, sustained, meaningful monitoring	

5.3 Potential Causes and Sources for LCEB Problems

Table 16 was generated using water quality data, windshield surveys, GIS, and local knowledge. This data can be useful for identifying water quality problems.

Table 16. Potential cause(s) and source(s) for each identified problem

Problem	Potential Cause(s)	Potential Source(s)
The LCEB and its tributaries have high pathogen concentrations, as indicated by high *E. coli*. This causes the river to fail to meet its designated use for recreational contact and poses a health risk for public access	High pathogen levels as indicated by *E. coli* concentrations that exceed state standards	Pathogen loading from combined sewer and sanitary sewer overflows and aging infrastructure in the Coffee Creek subwatershed. Over the past 5 years, there have been 10 CSOs totaling over 9 million gallons and 26 SSOs totaling over 2 million gallons. However, long-term control plans are in currently being implemented and significantly reduced CSOs and SSOs are expected for the future.
		Pathogen loading from malfunctioning septic systems in all three subwatersheds: Coffee Creek, Kemper Ditch, and Reynolds Creek. During a drought (2012 baseline), over 80% of sampling sites exceeded the IAC target for *E. coli* and 20 sites exceeded the target for over 50% of samples collected. 94% of the soils are classified as limited or very limited for on-site septic systems and 80% of the watershed is unsewered. Kemper Ditch and Reynolds Creek subwatersheds have no sewers and are entirely serviced by onsite septic systems.
		Pathogen loading from pasture runoff. There are 8 hobby farms in the Coffee Creek and Reynolds Creek subwatersheds with horses, cattle, and buffalo. Hobby farms comprise ~160 acres with approximately 91 horses, 10 cattle and 20 buffalo.
		Pathogen loading from pet waste originating from parks and residences primarily in the Coffee Creek subwatershed. Roughly 20% of the LCEB is developed and may generate elevated *E. coli* concentrations from pet waste.
		Pathogen loading from wildlife.
Excessive sediment and nutrient loading to the LCEB and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation	TSS levels exceed the target set by the LCEB watershed group	Sediment loading from in stream and stream bank erosion. Streambank erosion occurs along approximately 1.2 miles of LCEB streams according to the windshield survey and the QHEI. The QHEI reported approximately 1.8 miles of streambed to have moderate to heavy silt. The heaviest streambank erosion sites are located in the Kemper Ditch subwatershed on the mainstem

Problem	Potential Cause(s)	Potential Source(s)
		near Heron Rookery.
		Sediment loading from insufficient or limited buffers, which are present along approximately 13 miles of streambank. The Kemper Ditch subwatershed has ~8.0 miles of streambank needing improvements. The Coffee Creek and Reynolds Creek subwatersheds have 3.4 and 1.7 miles respectively of streambank needing improvements.
		Sediment loading from cropland, particularly on HEL soils. There are 27,721 acres of highly and potentially highly erodible soils in this watershed. HEL soils are fairly evenly divided among the subwatersheds but are most abundant throughout the southern portion of the LCEB.
		Sediment loading from roads and parking lots, including the strip mall parking lots along Indian Boundary Rd. in the Coffee Creek subwatershed.
		Sediment loading from construction sites located in all three subwatersheds.
	Nutrient (TP and nitrate) levels exceed the target set by the LCEB watershed group	Nutrient loading from combined sewer and sanitary sewer overflows in the Coffee Creek subwatershed. Over the past 5 years, there have been 10 CSOs totaling over 9 million gallons and 26 SSOs totaling over 2 million gallons. However, long-term control plans are in currently being implemented and significantly reduced CSOs and SSOs are expected for the future.
		Nutrient loading from insufficient or limited buffers, which are present along approximately 13 miles of streambank. The Kemper Ditch subwatershed has ~8.0 miles of streambank needing improvements. The Coffee Creek and Reynolds Creek subwatersheds have 3.4 and 1.7 miles respectively of streambank needing improvements.
		Nutrient loading from fertilizer application on urban lands and residential lawns (both urban and rural homes). Residential turfgrass lawns are prevalent throughout all three subwatersheds: Reynolds Creek, Kemper Ditch, and Coffee Creek.
		Nutrient loading from fertilizer application on cropland. Approximately 17% (8,600 acres) of the LCEB is conventional agriculture. The Kemper Ditch subwatershed is 44%

Problem	Potential Cause(s)	Potential Source(s)
		agriculture and the Reynolds Creek subwatershed is 31% agriculture.
		Nutrient loading from malfunctioning septic systems in all three subwatersheds: Coffee Creek, Kemper Ditch, and Reynolds Creek. During a drought (2012 baseline), over 80% of sampling sites exceeded the IAC *E. coli* target and 20 sites exceeded the target in over 50% of samples collected. For phosphorus, 91% of sampling sites exceeded the target with 30% of sites exceeding the target in more than 50% of samples collected. 94% of the soils are classified as limited or very limited for on-site septic systems and 80% of the watershed is unsewered. Kemper Ditch and Reynolds Creek subwatersheds are entirely serviced by onsite septic systems.
Biotic communities in the LCEB and its tributaries are impaired due to poor water quality, poor habitat, and altered hydrology. This causes the river to fail to meet its designated use for aquatic life use support	Macroinvertebrate and fish communities (as measured by mIBI and IBI) do not meet state standards	Nutrient and sediment loading from the sources described above in all three subwatersheds. CSOs & SSOs, malfunctioning septic systems, fertilizer application from cropland & urban lands are sources of nutrients. Instream & bank erosion, cropland, roads & parking lots, and construction sites are sources of sediment.
		High temperatures from lack of riparian cover and high levels of impervious surfaces in all three subwatersheds. Insufficient or limited buffers are present along 8 miles of the Kemper Ditch subwatershed and 3.4 miles in the Coffee Creek subwatershed. There are approximately 4,753 acres of impervious surfaces in the LCEB, primarily in the Coffee Creek subwatershed.
		Low DO due to high temperatures and high nutrient concentrations. 12 sites exceeded the low DO target at least once. 10 sites exceeded the low DO target in 25% of samples taken. Most DO exceedances are located in the Kemper Ditch subwatershed. 80% of sampling sites exceeded temperature targets at least once. 10 sampling sites exceeded the temperature target in 40% of samples collected. Most temperature exceedances are located in the Coffee Creek subwatershed. Limited tree canopy due to insufficient or limited buffers are present along 8 miles of Kemper Ditch and 3.4 miles of Coffee Creek subwatersheds can increase temperatures and reduce DO.
		Ammonia concentrations exceed state standards in localized tributaries. 17

Problem	Potential Cause(s)	Potential Source(s)
		sampling sites exceeded the IAC target at least once (10 of these sites are located in the Coffee Creek Subwatershed). 7 sampling sites exceeded the target in 25% of samples collected.
		Inadequate habitat exists to support biotic communities. 17 sampling sites (or 0.6 miles of stream) scored poor for habitat (51 or less) for the QHEI (9 sites in Kemper Ditch and 6 sites in Coffee Creek subwateresheds).
	Habitat as measured by QHEI does not meet state standards and limits biotic communities	Sedimentation in streams has a negative impact on fish habitat. The QHEI reported approximately 1.8 miles of streambed to have moderate to heavy silt.
		Direct alteration of in stream habitat occurs when streams are channelized and ditches are dredged. At least 45 stream miles are designated regulated drains and most of these miles are located in the Kemper Ditch and Coffee Creek subwatersheds.
		Indirect alteration of in stream habitat (low base flow, streambank and in stream erosion) due to altered hydrology (impervious cover, altered drainage, wetland loss, etc.) has occurred in all three subwatersheds: Coffee Creek, Kemper Ditch, and Reynolds Creek.
		Lack of riparian buffers. Insufficient or limited buffers are present along approximately 13 miles of streambank. The Kemper Ditch subwatershed has ~8.0 miles of streambank needing improvements. The Coffee Creek and Reynolds Creek subwatersheds have 3.4 and 1.7 miles respectively of streambank needing improvements.
		Death of ash trees due to EAB, resulting in altered hydrology, reduced riparian buffers, and decreased stream cover. All ash trees in the region (and all three subwatersheds) are expected to die within 5 years.
The public is not taking actions to protect and improve the LCEB and is not engaged in the LCEB watershed management effort	The public lacks adequate knowledge about the LCEB and water quality	Public does not have adequate access to information about LCEB or water quality.
		Lack of press coverage for LCEB management efforts and water quality.
	The public is uninvolved in LCEB watershed management efforts	Public does not have adequate access to information about LCEB or water quality.
		Lack of press coverage for LCEB management efforts and water quality.
		Not enough private property owners are directly involved in WMP process.
	Limited public	No continuous walking trail along LCEB.

Problem	Potential Cause(s)	Potential Source(s)
	access to the LCEB and its corridor limits recreational opportunities and public value of the LCEB	Lack of funds for environmental assessment to evaluate paddling in INDU, including public input.
		Private property owners may be distrustful of public access and watershed efforts.
		Lack of river access sites and public visibility of streams in all three subwatersheds.
		Lack of safe passage for paddlers due to log jams/woody debris, culverts, bridges, beaver dams, and physical features.
		LCEB does not meet recreational use standard.
A lack of multijurisdictional coordination could limit the ability of the LCEB watershed group and partners to achieve watershed goals to protect and improve water quality	Lack of funding to achieve all watershed goals	No funding for full time watershed coordinator to facilitate implementation of the LCEB WMP after June of 2014.
		Limited resources at county, municipal, state, and federal levels.
	Fear failure of local government and agencies to adopt WMP and achieve watershed goals	Lack of cooperation between agencies to achieve watershed goals
		Varied waterway use creates lack of mutual respect and cooperation.
		Lack of septic system inspection, operation, and maintenance programs in both Porter and LaPorte Counties.

6.0. Load Estimates

Nonpoint source pollution can be generated from varied sources including urban/suburban runoff, agricultural runoff, construction activities, stream bank erosion, and solid waste disposal, among others. Pollutant loading rates caused by these activities can be determined using many different methods, models and techniques. Two methods have been utilized to interpret nutrient, sediment and pathogen loading in the surface waters of the LCEB watershed: empirical data (measured results from the 2012 baseline sampling campaign) and modeled data using the Long-Term Hydrologic Impact Analysis (L-THIA), a nonpoint source pollutant loading model. Both methods provide advantages and disadvantages for understanding water quality in this watershed. The LCEB steering committee considered both modeled and empirical data when making decisions for water quality goals and critical areas.

6.1 Monitoring Results

Water quality data collected from sampling campaigns is typically used to estimate pollutant loads. Measured flow data combined with nutrient, sediment and pathogen concentrations is used to determine pollutant loads. This is often performed using Loadest, a commonly used modeling tool approved by IDEM for working with watershed management.

As discussed in section 3, 48 sampling sites located throughout the LCEB watershed were monitored once a month from November 2011 through November 2012. Unfortunately, this water sampling campaign occurred during a historic drought. This multi-year drought peaked during the growing season of 2012 and ended later in the same the year. Due to the extreme drought conditions, stream flow was low and some streams were dry at the time of sampling. Consequently, there was not enough data collected from many sampling sites to accurately calculate annual water quality loads using Loadest. There are obvious benefits for using empirical data to determine pollutant loads. However, drought-related problems with the 2012 dataset created limitations. Table 17 provides the loads for total phosphorus, nitrate-nitrite, and total suspended solids for the 2012 sampling sites. *E. coli* loads were not calculated due to limited amount of data.

Table 17. Pollutant Loads for 2012 monitoring data using Loadest

Site	HUC 12	Nitrogen		Phosphorus		TSS	
		lbs/yr	lbs/yr/ac	lbs/yr	lbs/yr/ac	lbs/yr	lbs/yr/ac
3	Coffee	100,015	2.2	8,933	0.2	*	*
4	Coffee	*	*	*	*	*	*
5	Coffee	*	*	*	*	*	*
6	Coffee	*	*	*	*	*	*
7	Coffee	2,972	1.4	429	0.2	36,964	18.0
8	Coffee	*	*	*	*	*	*
9	Coffee	138,394	3.3	10,159	0.2	1,548,644	36.7
10	Coffee	*	*	*	*	*	*
11	Coffee	15,944	0.5	9,292	0.3	1,262,995	40.9
12	Coffee	8,560	0.9	1,627	0.2	292,918	29.6
13	Coffee	*	*	*	*	*	*
14	Coffee	*	*	*	*	*	*
15	Coffee	*	*	*	*	*	*
16	Coffee	*	*	*	*	*	*
17	Coffee	*	*	153	0.2	*	*
18	Coffee	*	*	871	0.2	*	*
19	Coffee	*	*	*	*	*	*
20	Coffee	2,619	0.6	740	0.2	89,278	21.0
21	Coffee	*	*	*	*	*	*
22	Coffee	4,189	1.2	995	0.3	175,493	50.0
23	Coffee	*	*	*	*	*	*
24	Coffee	*	*	*	*	*	*
25	Kemper	16,178	0.6	7,387	0.3	1,066,138	40.6
26	Kemper	*	*	*	*	*	*
27	Kemper	678	0.4	409	0.2	31,087	17.4
28	Kemper	834	0.7	185	0.2	*	*
29	Kemper	*	*	*	*	*	*
30	Kemper	*	*	*	*	*	*
31	Kemper	*	*	*	*	*	*
32	Kemper	11,609	0.6	5,922	0.3	894,995	47.4
33	Kemper	*	*	6,092	0.3	998,796	56.0
34	Kemper	*	*	2,723	0.6	*	*

Site	HUC 12	Nitrogen		Phosphorus		TSS	
35	Kemper	*	*	*	*	*	*
36	Kemper	*	*	*	*	*	*
37	Kemper	*	*	*	*	*	*
38	Reynolds	1,857	0.6	765	0.2	168,910	51.8
39	Reynolds	*	*	435	0.2	62,097	32.0
40	Reynolds	*	*	*	*	*	*
41	Reynolds	*	*	415	0.2	93,799	38.7
42	Reynolds	*	*	*	*	*	*
43	Reynolds	3,224	0.5	1,964	0.3	340,180	51.7
44	Reynolds	*	*	*	*	*	*
45	Reynolds	562	0.8	120	0.2	*	*
46	Reynolds	*	*	77	0.1	15,229	29.4
47	Reynolds	*	*	*	*	*	*
48	Coffee	*	*	*	*	*	*

* denotes inadequate data to calculate loads using Loadest

6.2 L-THIA Model Results

The Long-Term Hydrologic Impact Analysis (L-THIA) model is a tool to estimate runoff, recharge and nonpoint source pollution resulting from land use changes. It provides a long-term average pollutant load based on historical (30 year) precipitation data, land use, and soil type. This hydrological simulation model is an additional tool for the estimation of pollution loads, especially nonpoint source pollution. L-THIA is calibrated to the Great Lakes region of Indiana, including the LCEB watershed. Using current land use and historical precipitation data, L-THIA models pollutant transport as surface runoff to streams.

Like all models and methodologies, L-THIA has limitations. One noteworthy limitation is that L-THIA estimates only runoff volumes. Pollutant loadings from tile drainage, streambank erosion, livestock access, nutrient application, or point source pollution will not be represented by L-THIA. Another limitation is the inability of L-THIA to model *E. coli*, a common nonpoint source pollutant. Nonetheless, this model provides a useful estimation of watershed loadings for nonpoint source pollution.

6.3 Annual Load Estimates and Reductions

Due to the extreme and atypical hydrological conditions of 2012, the LCEB Technical Committee could not use the 2012 baseline study data to calculate watershed pollutant loadings (Table 17). Numerous sites did not have enough data to calculate a pollutant load. The technical committee concluded that the empirical data did not accurately represent typical loads resulting from nonpoint source pollution. Consequently, the committee opted to utilize modeled loads calculated with the L-THIA model. Water quality loads calculated from the 2012 baseline study were utilized for critical area designation.

To estimate subwatershed loads from the 2012 monitoring data, sampling sites near the base (or pour point) of each subwatershed were used. For the Reynolds Creek subwatershed, data from sites 38, 41, and 43 were combined to estimate pollutant loads. Site 25 represents the Kemper Ditch subwatershed and site 3 represents the Coffee Creek subwatershed.

Table 18. L-THIA modeled annual load estimates for subwatersheds

Subwatershed	Nitrogen		Phosphorus		TSS	
	(lb/yr)	(lb/ac/yr)	(lb/yr)	(lb/ac/yr)	(lb/yr)	(lb/ac/yr)
Reynolds Creek	18,229	1.6	4,694	0.4	404,314	35
Kemper Ditch	40,433	2.8	11,081	0.8	949,900	66
Coffee Creek	47,926	2.3	12,496	0.6	1,257,209	61
Total LCEB Watershed	**106,588**	**6.7**	**28,271**	**1.8**	**2,611,423**	**162**

Table 19. Comparison of measured vs. modeled loads

Subwatershed	Nitrogen (lb/yr)		Phosphorus (lb/yr)		TSS (lb/yr)	
	Measured	Modeled	Measured	Modeled	Measured	Modeled
Reynolds Creek	NA	18,229	3,144	4,694	602,889	404,314
Kemper Ditch	16,178	40,433	7,387	11,081	1,066,138	949,900
Coffee Creek	100,015	47,926	8,933	12,496	NA	1,257,209

Table 20. Comparison measured vs. modeled areal loads

Subwatershed	Nitrogen (lb/ac/yr)		Phosphorus (lb/ac/yr)		TSS (lb/ac/yr)	
	Measured	Modeled	Measured	Modeled	Measured	Modeled
Reynolds Creek	NA	1.6	0.7	0.4	142.2	35.2
Kemper Ditch	0.6	2.8	0.3	0.8	40.6	65.8
Coffee Creek	2.2	2.3	0.2	0.6	NA	60.9

Conclusions based on the comparison of measured and modeled data did not reveal consistent trends. The reader should note that the comparison is inherently unequal as the measured data was collected for one year during a historic drought compared to the L-THIA model, which incorporates 30 years of regional hydrological and land use data. Measured nitrogen loads were not available for Reynolds Creek due to the limited amount of data. L-THIA overestimated (~2x) nitrogen loads for Kemper Ditch, but underestimated (~2x) nitrogen loads for Coffee Creek. Measured phosphorus loads were available for all three subwatersheds. L-THIA underestimated phosphorus loads (~4x) the Reynolds Creek subwatershed, but overestimated phosphorus loads for both the Kemper Ditch and Coffee Creek subwatersheds. Measured data was not available for total suspended solids from the Coffee Creek subwatershed. TSS loads estimated by L-THIA were fairly similar to measured loads (within the same order of magnitude).

Target loads were calculated using the load duration curve (LDC) method. For this method, we utilized over 20 years of stream flow data from the USGS gage (#04095090 located on Burns Ditch) and adjusted flow rates based on watershed area to estimate flow for each subwatershed. Target pollutant loads were estimated by using the target pollutant concentrations At the 50% (average) flow and multiplying that by 365.

Table 21. Target annual loads for LCEB subwatersheds

Subwatershed	Nitrogen (lb/yr)	Phosphorus (lb/yr)	TSS (lb/yr)
Reynolds Creek	6,814	543	204,483
Kemper Ditch	14,738	1,178	442,179
Coffee Creek	24,739	1,978	742,158

Table 22. Load reductions for LCEB subwatersheds (lb/yr)

Subwatershed	Nitrogen (% Reduction)	Phosphorus (% Reduction)	TSS (% Reduction)
Reynolds Creek	11,415 (63%)	4,151 (88%)	199,831 (49%)
Kemper Ditch	25,695 (64%)	9,903 (89%)	507,721 (53%)
Coffee Creek	23,187 (48%)	10,518 (84%)	515,051 (41%)

The technical committee decided to use the *E. coli* loads and recommended reductions from the Little Calumet Portage Burns Waterway TMDL for *E. coli* Bacteria (2004). The TMDL sampling sites did not match up well with the subwatersheds but were close enough to estimate. The TMDL's sampling sites were called Junctions.

Junction 20 captures the entire Reynolds Creek subwatershed, as well as most of the eastern portion of the Kemper Ditch subwatershed. For this report, Junction 20 represents the Reynolds Creek subwatershed. AUIDs represented by this sampling site include: INC0141_01 (Little Calumet River, East Arm), INC0141_01A (unnamed), INC0141_T1001 (unnamed tributary near Walton Lake), INC0141_T1002 (unnamed tributary near Lake Lee), INC0141_T1003 (Reynolds Creek), INC142_T1001 (Carver and Kemper Ditch). Since Junction 20 includes more drainage area than only the Reynolds Creek subwatershed, the WASP6 model used in the TMDL was not able to determine loads specifically for this subwatershed. However, water quality data was collected in 2000 during wet and dry conditions and was used in the TMDL to determine that a 70% and 34% reduction, respectively, are needed in this subwatershed. These reductions seem to be consistent with our *E. coli* data that was collected in the Reynolds Creek subwatershed (80% of our mean values exceed the water quality standard during a drought year and we had a maximum value of 9,900 cfu/100 ml at Site 38. There was also one stream segment added to the 2014 303(d) list of impaired waters for *E. coli* in addition to two segments already listed in this subwatershed.).

Junction 15 captures the western portion of the Kemper Ditch subwatershed as well as the Sand Creek drainage area, which is part of the Coffee Creek subwatershed. For this report, Junction 15 represents the Kemper Ditch subwatershed. AUIDs represented by this sampling site include: INC0142_01 (Little Calumet River, East Arm), INC0142_T1002 (unnamed), INC0142_T1003 (unnamed tributary near Rice Lake), INC0142_T1004 (unnamed), INC0143_T1005 (Sand Creek), INC0143_04 (Little Calumet River, East Arm). The calculated load for this junction was 1.99 x 10^{10} cfu/yr. The target load was 2.02 x 10^{10} cfu/yr. The WASP6 model used in the TMDL calculated that the target load is higher than the actual load, indicating that no reduction is needed. However, water quality data was collected in 2000 during wet and dry conditions and was used in the TMDL to determine that an 81% and 59% reduction, respectively, are needed in this subwatershed. These reductions seem to be consistent with our *E. coli* data that was collected in the Kemper Ditch subwatershed (100% of our mean values exceed the water quality standard during a drought year and we had a maximum value of 17,000 cfu/100 ml at Site 34. There were also two stream segments added to the 2014 303(d) list of impaired waters for *E. coli* in addition to three segments previously listed in this subwatershed.).

Junctions 13 and 14 capture the remaining portion of the Coffee Creek subwatershed, just before the confluence with Salt Creek at site 3. For this report, Junctions 13 and 14 represent the Coffee Creek subwatershed. AUIDs represented by this sampling site include: INC0143_04 (Little Calumet River, East Arm), INC0143_T1006 (Coffee Creek), INC0143_T1006A (Coffee Creek), INC0143_T1007 (unnamed tributary near Mud Lake), INC0143_T1008 (Peterson Ditch). The calculated load for Junction 13 was 9.14 x 10^{10} CFU/yr. The target load was 5.24 x 10^{10} CFU/yr. The calculated load for Junction 14 was 9.14 x 10^{10} CFU/yr. The target load was 5.28 x 10^{10} CFU/yr. The WASP6 model used in the TMDL does indicate that load reductions are needed in this subwatershed, but the results are much lower than what the water quality data shows. The water quality data was collected in 2000 during wet and dry conditions and was used in the TMDL to determine that a 97% and 50% reduction, respectively, are needed in this subwatershed. These reductions seem to be consistent with our *E. coli* data that was collected in the Coffee Creek subwatershed (88% of our mean values exceed the water quality standard during a drought year and we had a maximum value of 11,000 cfu/100 ml at Site 7. There were also six stream segments added to the 2014 303(d) list of impaired waters for *E. coli* in addition to three segments previously listed in this subwatershed.).

Junction 12 captures the rest of the Little Calumet East Branch River just before the confluence with Burns Ditch and after the confluence with Salt Creek. AUIDs represented by this sampling site include: INC0143_04 (Little Calumet River, East Arm), INC0159_01 (Little Calumet River, West Branch), INC0159_02 (Burns Ditch). The calculated load for this junction was 1.45 x 10^{12} CFU/yr. The target load was 6.23 x 10^{10} CFU/yr. The WASP6 model used in the TMDL indicates that load reductions are needed in this subwatershed, but the results are much higher than what the water quality data shows. The water quality data was collected in 2000 during wet and dry conditions and was used in the TMDL to determine that a 46% reduction is needed at the outlet of the LCEB watershed. These reductions seem to be consistent with historical *E. coli* data that was collected at IDEM's fixed station, LMG060-0005 (Nearly 30% of the values exceed the water quality standard.

In 2012, the maximum value recorded was 2,400 cfu/100 ml. This stream segment has been impaired for *E. coli* since 1998.).

Table 23. *E. coli* loads, targets, and load reductions from the Little Calumet Portage Burns Waterway TMDL for *E. coli* Bacteria

Sub-Watershed	Junction	Total Average Loads From All Sources (CFU/day)	Estimated Average Loads From Nonpoint Sources (CFU/day)	Total Target Loads From All Sources (CFU/day)	Nonpoint Source Load Allocation (Wet)	Nonpoint Source Load Allocation (Dry)
Reynolds Creek	20	NA	NA	NA	70%	34%
Kemper Ditch	15	1.99×10^{10}	1.99×10^{10}	2.02×10^{10}	81%	59%
Coffee Creek	13	9.14×10^{10}	9.14×10^{10}	5.24×10^{10}	97%	50%
Coffee Creek	14	5.79×10^{10}	5.54×10^{10}	5.28×10^{10}		
LCEB + Salt Creek	12	1.45×10^{12}	7.60×10^{11}	6.23×10^{10}	46%	46%

7.0 Water Quality Goals and Indicators

Water quality impairments were shown throughout the LCEB watershed. The dominant impairments include nitrogen, phosphorus, sediment and *E. coli* bacteria. To address these impairments, goals were created to help focus implementation efforts. Goals for improving water quality in the LCEB watershed were based on baseline water quality sampling efforts, modeled pollutant loadings, the watershed inventory efforts (including the windshield survey), and stakeholder inputs (concerns, problems, sources).

The Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL) was used to model potential load reductions based on established BMPs and to develop scaled goals. This method is further described in Section 9.3 Load Reduction by Best Management Practice. The long-term goals of 25 years were chosen to provide a reasonable time period to meet the desired load reductions from Table 22. Two scaled (or short-term) goals for 5 and 15 years were selected to provide easier to reach benchmarks. Save the Dunes worked with the county Soil and Water Conservation Districts and LCEB Steering Committee members to determine appropriate best management practices and acreages for each subwatershed and critical area. The 5-year goals are focused entirely on the critical areas, per EPA requirements. The 15-year goals apply to the three HUC-12 subwatersheds. The STEPL modeling program utilized the selected BMPs and acreages to produce nutrient and sediment reductions.

7.1 Reduce Nutrient Loading

The overall goal for this project is for all waters in the LCEB watershed to meet the stated water quality standards of 1.0 mg/L for nitrogen and 0.08 mg/L for phosphorus. To achieve these goals, the following load reductions will be sought.

Reynolds Creek subwatershed
Long-term (25 year) goal: Reduce nitrogen loading by 11,415 lb/yr, which is a 63% reduction. Reduce phosphorus loading by 4,151 lb/yr, which is an 88% reduction.

5-year goal for critical areas only (drainage area 43): Reduce nitrogen loading by 114.4 lb/yr, which is 0.3% of the long-term goal. Reduce phosphorus by 24 lb/yr, which is 0.2% of the long-term goal.

15-year goal: Reduce nitrogen loading by 5,411 lb/yr, which is 47% of the long-term goal. Reduce phosphorus loading by 1,320 lb/yr, which is 32% of the long-term goal.

Kemper Ditch subwatershed
Long-term (25 year) goal: Reduce nitrogen loading by 25,695 lb/yr, which is a 63% reduction. Reduce phosphorus loading by 9,903 lb/yr, which is an 89% reduction.

5-year goal for critical areas only (drainage areas 30, 31, 34, 35, and 36): Reduce nitrogen loading by 2,076 lb/yr, which is 8% of the long-term goal. Reduce phosphorus loading by 412 lb/yr, which is 4% of the long-term goal.

15-year goal: Reduce nitrogen loading by 8,338 lb/yr, which is 32% of the long-term goal. Reduce phosphorus loading by 1,961 lb/yr, which is 20% of the long-term goal.

Coffee Creek subwatershed
Long-term (25 year) goal: Reduce nitrogen loading by 23,187 lb/yr, which is a 48% reduction. Reduce phosphorus loading by 10,518 lb/yr, which is an 84% reduction.

5-year goal for critical areas only (drainage areas 12 and 22): Reduce nitrogen loading by 250 lb/yr, which is 1% of the long-term goal. Reduce phosphorus loading by 34 lb/yr, which is 0.3% of the long-term goal.

15-year goal: Reduce nitrogen loading by 4,104 lb/yr, which is 18% of the long-term goal. Reduce phosphorus loading by 844 lb/yr, which is 8% of the long-term goal.

Indicators for Success
Water quality and social data will be used to demonstrate progress toward these stated goals.

The Hoosier Riverwatch volunteer program will be utilized to monitor water quality improvements. Water quality sampling for nitrogen and phosphorus will occur (at minimum) at each of the three subwatershed's pour points. Samples will be collected monthly, except when surface waters are frozen. Pollutant loadings will be calculated from the water quality sampling to determine if goals are being met. Sampling will occur (at minimum) after 5, 15 and 25-years following implementation to assess progress made toward each interim goal. This post-implementation sampling will provide the necessary information needed to assess progress toward the stated goals and the effectiveness of BMPs implemented.

A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

7.2 Reduce Sediment Loading

The overall goal for this project is for all waters in the LCEB watershed to meet the stated water quality standard of 30 mg/L for suspended solids. To achieve this goal, the following load reductions will be sought.

Reynolds Creek subwatershed
Long-term (25 year) goal: Reduce sediment loading by 199,831 lb/yr, which is a 49% reduction.

5-year goal for critical areas only (drainage area 43): Reduce sediment loading by 19,758 lb/yr, which is 10% of the long-term goal.

15-year goal: Reduce sediment loading by 199,831 lb/yr, which is 100% of the long-term goal.

Kemper Ditch subwatershed
Long-term (25 year) goal: Reduce sediment loading by 507,721 lb/yr, which is a 53% reduction.

5-year goal for critical areas only (drainage areas 30, 31, 34, 35, and 36): Reduce sediment loading by 344,596 lb/yr, which is 68% of the long-term goal.

15-year goal: Reduce sediment loading by 507,721 lb/yr, which is 100% of the long-term goal.

Coffee Creek subwatershed
Long-term (25 year) goal: Reduce sediment loading by 515,051 lb/yr, which is a 41% reduction.

5-year goal for critical areas only (drainage areas 12 and 22): Reduce sediment loading by 11,158 lb/yr, which is 2% of the long-term goal.

15-year goal: Reduce sediment loading by 515,051 lb/yr, which is 100% of the long-term goal.

Indicators for Success
Water quality and social data will be used to demonstrate progress toward these stated goals.

The Hoosier Riverwatch volunteer program will be utilized to monitor water quality improvements. Water quality sampling for sediment will occur (at minimum) at each of the three subwatershed's pour points. Samples will be collected monthly, except when surface waters are frozen. Pollutant loadings will be calculated from the water quality sampling to determine if goals are being met. Sampling will occur (at minimum) after 5, 15 and 25-years following implementation to assess progress made toward each interim goal. This post-implementation sampling will provide the necessary information needed to assess progress toward the stated goals and the effectiveness of BMPs implemented.

A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

7.3 Reduce *E. coli* Loading

The overall goal for this project is for all waters in the LCEB watershed to meet the stated water quality standard of 235 CFU/100 mL for *E. coli*. To achieve this goal, the following load reductions will be sought.

Reynolds Creek subwatershed
Long-term (25 year) goal: Reduce *E. coli* loadings so that all streams meet the water quality standard, which is 70% reduction in wet conditions and 34% reduction in dry conditions.

5-year goal for critical areas only (drainage area 43): Reduce *E. coli* loadings 18% in wet conditions and 9% in dry conditions.

15-year goal: Reduce *E. coli* loadings 35% in wet conditions and 17% in dry conditions.

Kemper Ditch subwatershed
Long-term (25 year) goal: Reduce *E. coli* loadings so that all streams meet the water quality standard, which is 81% reduction in wet conditions and 59% reduction in dry conditions.

5-year goal for critical areas only (drainage areas 30, 31, 34, 35, and 36): Reduce *E. coli* loadings 20% in wet conditions and 15% in dry conditions.

15-year goal: Reduce *E. coli* loading 41% in wet conditions and 30% in dry conditions.

Coffee Creek subwatershed
Long-term (25 year) goal: Reduce *E. coli* loadings so that all streams meet the water quality standard, which is 97% reduction in wet conditions and 50% reduction in dry conditions.

5-year goal for critical areas only (drainage areas 12 and 22): Reduce E. coli loadings 24% in wet conditions and 13% in dry conditions.

15-year goal: Reduce E. coli loadings 49% in wet conditions and 25% in dry conditions.

Indicators for Success
Water quality and social data will be used to demonstrate progress toward these stated goals.

The Hoosier Riverwatch volunteer program will be utilized to monitor water quality improvements. Water quality sampling for *E. coli* will occur (at minimum) at each of the three subwatershed's pour points. Samples will be collected monthly, except when surface waters are frozen. *E. coli* concentrations will be calculated from the water quality sampling to determine if goals are being met. Sampling will occur (at minimum) after 5, 15 and 25-years following implementation to assess progress made toward each interim goal. This post-implementation sampling will provide the necessary information needed to assess progress toward the stated goals and the effectiveness of BMPs implemented.

A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

7.4 Improve Biological Communities

The overall goal for this project is for all waters in the LCEB watershed to meet the stated water quality standards for biological communities (IBI and mIBI scores $\geq$ 36). To achieve these goals, the following water quality improvements will be sought.

Reynolds Creek subwatershed
Long-term (25 year) goal: Restore the natural biological stream community (mainly fish and macroinvertebrates) so that all streams score higher than a 36 on the IBI and the mIBI. Restore stream habitats so that they fully support their aquatic biological communities (all streams score higher than 51 on the QHEI).

5-year goal for critical areas only (drainage area 43): Restore the natural biological stream community so that site 43 scores higher than a 36 on the IBI and mIBI.

15-year goal: Restore the natural biological stream community so that 60% of stream sampling sites score higher than a 36 on the IBI and mIBI.

Kemper Ditch subwatershed

Long-term (25 year) goal: Restore the natural biological stream community (mainly fish and macroinvertebrates) so that all streams score higher than a 36 on the IBI and the mIBI. Restore stream habitats so that they fully support their aquatic biological communities (all streams score higher than 51 on the QHEI).

5-year goal for critical areas only (drainage areas 30, 31, 34, 35, and 36): Restore the natural biological stream community so that these 5 sampling sites score higher than a 36 on the IBI and mIBI.

15-year goal: Restore the natural biological stream community so that 60% of stream sampling sites score higher than a 36 on the IBI and mIBI.

Coffee Creek subwatershed

Long-term (25 year) goal: Restore the natural biological stream community (mainly fish and macroinvertebrates) so that all streams score higher than a 36 on the IBI and the mIBI. Restore stream habitats so that they fully support their aquatic biological communities (all streams score higher than 51 on the QHEI).

5-year goal for critical areas only (drainage areas 12 and 22): Restore the natural biological stream community so that these two sampling sites score higher than a 36 on the IBI and mIBI.

15-year goal: Restore the natural biological stream community so that 60% of stream sampling sites score higher than a 36 on the IBI and mIBI.

Indicators for Success

Water quality and social data will be used to demonstrate progress toward these stated goals.

The Hoosier Riverwatch volunteer program will be utilized to monitor water quality improvements. Water quality sampling for biological communities will occur (at minimum) at each of the three subwatershed's pour points. Samples will be collected annually. Biological community metrics will be calculated from the water quality sampling to determine if goals are being met. Sampling will occur (at minimum) after 5, 15 and 25-years following implementation to assess progress made toward each interim goal. This post-implementation sampling will provide the necessary information needed to assess progress toward the stated goals and the effectiveness of BMPs implemented.

A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

7.5 Increase Public Awareness and Participation

The goals for Increased Public Awareness and Participation are the same for all subwatersheds.

Long-term (25 year) goal: Increase public awareness and knowledge of watershed processes, including sources of pollution and methods for reducing nonpoint source pollution. Using the social indicators study, increasing public understanding of the consequences of poor water quality by reducing the response 'I don't know' to zero percent for topics such as contaminated drinking water and excessive aquatic plants and algae. Increase public understanding of the existence and severity of common water pollutants by decreasing the response 'I don't know' to zero percent.

5-year goal: Improve community participation in watershed group meetings and educational events. Using the social indicators study, increasing public understanding of the consequences of poor water quality by reducing the response 'I don't know' to 10% for topics such as contaminated drinking water and excessive aquatic plants and algae. Increase public understanding of the existence and severity of common water pollutants by decreasing the response 'I don't know' to 10%.

15-year goal: Increase community involvement with BMP efforts, natural area protection, and participation in educational activities. Using the social indicators study, increasing public understanding of the consequences by reducing the response 'I don't know' to 5% for topics such as contaminated drinking water and excessive aquatic plants and algae. Increase public understanding of the existence and severity of common water pollutants by decreasing the response 'I don't know' to 5%.

Indicators for Success

A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

7.6 Lack of Jurisdictional Coordination

Long-term (25 year) goal: Increase cooperation among agencies to fund and achieve all long-term goals.

5-year goal: All applicable municipalities adopt the LCEB Watershed Management Plan.

15-year goal: Increase cooperation among agencies to fund and achieve all scaled goals.

8.0 Critical and Protection Areas

To prioritize future implementation efforts, critical areas and protection areas were established. Critical and priority areas were based on the 2012 baseline water quality sampling study. Several different parameters and datasets (such as the windshield survey, impervious surfaces map, 303(d) impairment listing, land use, potentially erodible soils map, and information from the Coffee Creek WMP) were considered for the selection of critical and protection areas. Ultimately, the Technical Committee decided that empirical data derived from the 2012 Baseline Study was the best indicator of water quality and water pollution. The sampling sites with the worst water quality have land use problems upstream and/or in the sampling site's drainage area. Further examination of land use within the drainage areas will lead to the source or cause of water pollution for the sampling site.

The Coffee Creek Watershed Management Plan (2003) designated two drainage areas as critical: Pope O'Connor Ditch (LCEB drainage areas 14 & 15) and Shooter Ditch (LCEB drainage area 19). The LCEB WMP did not select these areas as critical. Additionally, the upper Pope O'Connor Ditch (drainage area 15) has been selected as a protection area due to comparatively higher water quality. The areal watershed size for the 2003 Coffee Creek Watershed Management Plan is only approximately 21% of the LCEB watershed (10,048 acres compared to 47,293 acres). LCEB critical and protection areas were selected based on empirical data from the entire, much larger watershed. Consequently, the perceived severity of a degraded water body may vary when compared against water bodies with more significant water pollution. Pope O'Connor Ditch and Shooter Ditch were considered for inclusion in the LCEB critical areas but ultimately were not added.

Critical areas are locations with the most degraded water quality. These areas have been given highest priority for the implementation of restoration funds and activities. The designated critical areas are likely the largest contributors of pollutant loads in the watershed.

Conversely, protection areas have the highest water quality in the watershed. These areas are crucial for the long-term environmental health of the watershed and require protective measures to maintain or enhance existing water quality. The protection of these areas will prevent future degradation to promote higher water quality throughout the watershed.

Critical areas and protection areas were calculated using a numeric ranking system to score all 48 IDEM Baseline study sample sites. The 2012 water quality data was used as the basis for this ranking metric. Each site was individually ranked for *E. coli*, total suspended solids (TSS), nitrogen, phosphorus, ammonium, dissolved oxygen (DO), temperature, and the biotic community (IBI & mIBI) (See Appendix 6). The site with poorest (or worst) value for the water quality parameter was given a ranking score of 1. Increasing water quality scored incrementally higher values. Identical values were given the same rank; consequently, the highest rank possible varied among each water quality parameter. Unique metrics were developed for each parameter depending upon the available data.

For nitrogen, phosphorus, and TSS, the following parameters were individually ranked for each of the 48 sampling sites:

- mean
- percent of samples that exceeded the concentration target
- single highest sample
- 2012 annual load
- 2012 annual load per acre

For *E.coli*, temperature, and ammonia, the following parameters were individually ranked for each of the 48 sampling sites:

- mean
- percent of samples that exceeded the concentration target
- single highest sample

For dissolved oxygen, the following parameters were ranked for each of the 48 sampling sites:

- mean
- percent of samples that exceeded the concentration target
- single lowest sample

For the biotic communities (fish and macroinvertebrates), the values for the IBI and mIBI were ranked with the final scores combined.

For each parameter (e.g. nitrogen), the ranked scores (mean, % exceed, highest sample, load, and areal load) were summed across the row for each site and divided by the total possible score (the sum of the highest ranks). The result of this step was a Percent Score. This procedure was conducted separately for each water quality parameter: nitrogen, phosphorus, TSS, E. coli, temperature, ammonia, dissolved oxygen, and biological communities. Table 24 is the worksheet for the nitrogen metric, an example of how this metric works. All worksheets for this step are located in Appendix 6.

A water quality summary score was then created (see Table 25). The final percentage score for each parameter was averaged for each site, providing a final percentage score that can be interpreted as a grade for each particular site (see Table 25 and Figure 61)

The mean (across all sites) of these final water quality scores was 0.56 with a standard deviation of 0.12. Critical areas (as determined by the Technical Committee) were designated at one standard deviation below the mean (all sites scoring 44% and below). Protection areas were designated at one standard deviation above the mean (all sites scoring 67% and above).

Consequently, eight sampling sites (or drainage areas) were selected as critical areas. The area of land that drains to each sampling site was calculated using the U.S. Geological Survey's StreamStats website (www.water. usgs. gov/osw/streamstats/).

Selected critical drainage areas originate from sampling sites:

- 12-Coffee Creek Mainstem (upstream from site 12 until site 13 and bounded approximately by I-94, SR 49, and Morgan Ave.)
- 22-Lower Sand Creek (upstream from site 22 until site 23 and bounded approximately by Indian Boundary Rd., N 350 E, and SR 49)
- 30-Unnamed Tributary (everything upstream from site 30 and bounded approximately by N 450 E, N 550 E, E 1050 N, and N 475 E)
- 31-Unnamed Tributary (everything upstream from site 31 and bounded approximately by I 94, N 500 E, E 1300 N, 375 E, and E 1400 N)
- 34-Carver Ditch Downstream (upstream from site 34 until sites 35, 36, & 37 and bounded approximately by 1500 N, W 300 N, County Line Rd., 1350 N, and 600 E)
- 35-Kelleys Ditch (everything upstream from site 35 and bounded approximately by I 94, County line Rd., 600 E, E 1400 N, and N 500 E)
- 36-Carver Ditch Upstream (everything upstream from site 36 and bounded approximately by 400 N, Old Chicago Rd., County Line Rd., E 1400 N, and E 1500 N)
- 43-LCEB Mainstem (upstream from site 43 until site 44 and bounded approximately by County Line Rd., Otis Rd., and Snyder Rd.)

These critical areas (or drainage areas) have the poorest water quality in the LCEB. While the final score was based on ranked water quality parameters, biological communities, and habitat, the most influential low scoring parameters varied for each site.

- Drainage Area 12 (Coffee Creek subwatershed) scored low based on sediment, temperature, dissolved oxygen, and *E. coli.* This drainage area is located in downtown Chesterton. The proximity of large roads and highways in addition to abundant stores and other businesses likely plays a large role in the degraded water quality of this area. Large strip malls drain directly to this stream and Chubb Lake, which affects water quality in this drainage area. `
- Site 22 (Coffee Creek subwatershed) scored low based on phosphorus, temperature, dissolved oxygen, ammonia, biotic communities, and *E. coli.* This drainage area is located near the base of Sand Creek and the LCEB mainstem, which is mainly within the City Limits of Chesterton and contains the Sand Creek Country Club. The golf course and large home developments are likely sources for water quality impairments.
- Site 30 (Kemper Ditch subwatershed) scored low based on phosphorus, sediment, biotic communities, and *E. coli.* This drainage area is located in a rural/low density residential setting. The combination of agricultural drainage with modern lawn care practices, and septic systems placed in poorly suited soils are the suspected sources of degraded water quality.
- Site 31 (Kemper Ditch subwatershed) scored low based on phosphorus, sediment, dissolved oxygen, and biotic communities. This drainage area is located in a rural

setting, checkered with low-density housing. The combination of agricultural management practices with septic systems placed in poorly suited soils is the suspected source of degraded water quality.
- Site 34 (Kemper Ditch subwatershed) scored low based on nitrogen, phosphorus, sediment, temperature, dissolved oxygen, and *E. coli.* This drainage area is located in a predominantly agricultural setting. The combination of agricultural management practices with septic systems placed in poorly suited soils is the suspected source of degraded water quality.
- Site 35 (Kemper Ditch subwatershed) scored low based on phosphorus, sediment, dissolved oxygen, ammonia, and biotic communities. This drainage area is located in a predominantly agricultural setting. The combination of agricultural management practices with septic systems placed in poorly suited soils is the suspected source of degraded water quality.
- Site 36 (Kemper Ditch subwatershed) scored low based on phosphorus, sediment, temperature, and dissolved oxygen. This drainage area is located in a predominantly agricultural setting. The combination of agricultural management practices with septic systems placed in poorly suited soils is the suspected source of degraded water quality.
- Site 43 (Reynolds Creek subwatershed) scored low based on phosphorus, sediment, biotic communities, and *E. coli.* This drainage area is located in a rural setting, checkered with low-density housing. The combination of agricultural management practices with septic systems placed in poorly suited soils is the suspected source of degraded water quality.

To determine which variables were driving the selection of critical areas, a principal component analysis (PCA) was run. The data for this analysis included all water quality data, QHEI data, and land use. First, a nonparametric t-test was run to determine which variables differed between the critical and priority sites (see Appendix 7). After deleting all non-significant variables, the principle components analysis (PCA) was run to see which variables contributed to explaining the cumulative variance. Step one was to run a scree plot to see how many factors to include (see Appendix 7). A two-factor solution was then run for the PCA (see Appendix 7). All loadings greater than 0.8 (+or-) were included for Factor 1 and those greater than 0.6 (+or-) for Factor 2. The two factor solution explains 80% of the cumulative variance.

Factor 1 explains 62% of the cumulative variance and has a strong habitat component with positive loadings on QHEI substrate, cover, and channel score as well as QHEI total score. On the chemical side there were strong positive loading on both DO (dissolved oxygen) and hardness with strong negative loadings on TP (total phosphorus), TOC (total organic carbon), and turbidity. Factor 2 explained an additional 18% of the cumulative variance negatively loading on ammonia, alkalinity, calcium, and agriculture.

The results from this statistical analysis will help to inform implementation decisions. The BMPs selected for each critical area will consider effects on stream habitat, dissolved oxygen, hardness, total phosphorus, total organic carbon, turbidity, and the other indicated drivers of critical area selection.

Eight sites (or drainage areas) were also selected as protection areas. Selected protection areas originated from sites: 13 (Coffee Creek Mainstem), 15 (Pope O'Connor Ditch Upstream), 16 (Coffee Creek Mainstem), 18 (Coffee Creek Mainstem), 23 (Middle Sand Creek), 40 (Massagua Creek Upstream), 42 (Reynolds Creek Upstream), and 45 (Lake Lee Outlet) (Figure 62). These sites have the highest water quality in the LCEB and will be monitored to maintain and improve conditions in these areas.

Table 24. Nitrogen critical/protection area metric

Nitrogen Critical/Protection Area Metric													
Site ID	Mean	Mean Rank	% Exceed	% Exceed Rank	Single Highest Sample	Highest Sample Rank	Load (lb/yr)	Load Rank	Load/Acre (lb/ac/yr)	Load/acre Rank	Rank Total	Total Possible	Percent Score (Grade)
3	0.74	6	0%	11	1.0	10	100015	2	2.2	2	31	93	33%
4	0.41	11	0%	11	0.5	15					37	67	55%
5	1.62	2	83%	1	2.6	4					7	67	10%
6	1.18	4	45%	4	2.9	3					11	67	16%
7	0.59	7	5%	9	1.3	8	2972	9	1.5	3	36	93	39%
8	0.79	5	36%	5	1.6	7					17	67	25%
9	1.22	3	75%	3	2.3	5	138394	1	3.3	1	13	93	14%
10	1.82	1	82%	2	3.1	2					5	67	7%
11	0.13	33	0%	11	0.3	17	15944	4	0.5	10	75	93	81%
12	0.18	22	0%	11	0.5	15	8560	6	0.9	5	59	93	63%
13	0.13	33	0%	11	0.4	16					60	67	90%
14	0.29	14	0%	11	0.8	12					37	67	55%
15	0.52	9	0%	11	0.9	11					31	67	46%
16	0.14	30	0%	11	0.3	17					58	67	87%
17	0.11	37	0%	11	0.2	18					66	67	99%
18	0.11	36	0%	11	0.2	18					65	67	97%
19	0.14	30	0%	11	0.3	17					58	67	87%
20	0.11	35	0%	11	0.5	15	2619	10	0.6	8	79	89	89%
21	0.16	27	0%	11	0.5	15					53	67	79%
22	0.50	10	0%	11	0.7	13	4189	7	1.2	4	45	93	48%
23	0.33	12	0%	11	0.5	15					38	67	57%
24	0.17	25	0%	11	0.2	18					54	67	81%
25	0.17	24	0%	11	0.4	16	16178	3	0.6	8	62	93	67%
26	0.26	17	10%	7	1.8	6					30	67	45%
27	0.26	16	5%	10	1.1	9	678	13	0.4	12	60	93	65%
28	0.18	23	0%	11	0.3	17	834	12	0.7	7	70	93	75%

Nitrogen Critical/Protection Area Metric													
Site ID	Mean	Mean Rank	% Exceed	% Exceed Rank	Single Highest Sample	Highest Sample Rank	Load (lb/yr)	Load Rank	Load/Acre (lb/ac/yr)	Load/acre Rank	Rank Total	Total Possible	Percent Score (Grade)
29	0.20	19	0%	11	0.4	16					46	67	69%
30	0.20	18	0%	11	0.6	14					43	67	64%
31	0.26	17	0%	11	0.7	13					41	67	61%
32	0.17	26	0%	11	0.5	15	11609	5	0.6	8	65	93	70%
33	0.15	29	0%	11	0.3	17					57	67	85%
34	0.59	8	15%	6	4.8	1					15	67	22%
35	0.19	21	0%	11	0.6	14					46	67	69%
36	0.15	29	9%	8	1.1	9					46	67	69%
37	0.12	34	0%	11	0.3	17					62	67	93%
38	0.15	28	0%	11	0.4	16	1857	11	0.6	9	75	93	81%
39													NA
40	0.14	31	0%	11	0.3	17					59	67	88%
41	0.07	38	0%	11	0.5	15					64	67	96%
42													NA
43	0.19	20	0%	11	0.3	17	3224	8	0.5	11	67	93	72%
44	0.13	32	0%	11	0.2	18					61	67	91%
45	0.28	15	0%	11	0.4	16	562	14	0.8	6	62	93	67%
46													NA
47													NA
48	0.32	13	0%	11	0.4	16					40	67	60%

Table 25. Critical areas and priority protection areas water quality summary

Site ID	Sub-Watershed	Nitrogen	Phosphorus	TSS	Temp	DO	Ammonia	Biotic Communities	*E. coli*	Average
3	Coffee	33%	69%	84%	8%	58%	28%	44%	93%	52%
4	Coffee	55%	98%	93%	8%	53%	19%	59%	100%	61%
5	Coffee	10%	87%	46%	66%	52%	NA	85%	49%	57%
6	Coffee	16%	40%	78%	58%	68%	NA	67%	79%	58%
7	Coffee	39%	63%	90%	23%	51%	65%	37%	9%	47%
8	Coffee	25%	35%	NA	88%	42%	63%	59%	53%	52%
9	Coffee	14%	45%	49%	15%	44%	76%	89%	28%	45%
10	Coffee	7%	38%	69%	64%	76%	NA	52%	75%	54%
11	Coffee	81%	34%	55%	71%	84%	NA	56%	85%	66%
12	Coffee	63%	61%	32%	25%	37%	61%	56%	17%	44%
13	Coffee	90%	53%	97%	53%	86%	NA	74%	65%	74%
14	Coffee	55%	24%	94%	38%	59%	26%	11%	70%	47%
15	Coffee	46%	58%	NA	73%	87%	NA	NA	93%	72%
16	Coffee	87%	82%	94%	26%	91%	NA	67%	81%	75%
17	Coffee	99%	56%	67%	51%	82%	NA	26%	25%	58%
18	Coffee	97%	81%	93%	49%	82%	NA	56%	83%	77%
19	Coffee	87%	31%	53%	61%	18%	26%	22%	77%	47%
20	Coffee	89%	81%	84%	14%	48%	91%	56%	58%	65%
21	Coffee	79%	55%	51%	28%	67%	NA	22%	48%	50%
22	Coffee	48%	31%	45%	41%	24%	44%	44%	10%	36%
23	Coffee	57%	70%	73%	83%	96%	NA	78%	34%	70%
24	Coffee	81%	56%	61%	100%	99%	NA	9%	43%	64%
25	Kemper	67%	49%	55%	73%	53%	NA	41%	58%	56%
26	Kemper	45%	21%	80%	89%	24%	31%	70%	52%	52%
27	Kemper	65%	41%	76%	16%	38%	56%	41%	73%	50%

Site ID	Sub-Watershed	Nitrogen	Phosphorus	TSS	Temp	DO	Ammonia	Biotic Communities	*E. coli*	Average
28	Kemper	75%	72%	99%	40%	21%	78%	52%	45%	60%
29	Kemper	69%	41%	26%	70%	66%	NA	22%	28%	46%
30	Kemper	64%	23%	13%	78%	66%	NA	33%	26%	43%
31	Kemper	61%	12%	19%	93%	37%	59%	11%	54%	43%
32	Kemper	70%	45%	31%	63%	43%	91%	78%	17%	55%
33	Kemper	85%	41%	38%	62%	81%	NA	67%	44%	60%
34	Kemper	22%	14%	18%	36%	16%	67%	63%	10%	31%
35	Kemper	69%	3%	4%	50%	36%	35%	19%	74%	36%
36	Kemper	69%	6%	10%	38%	12%	61%	56%	68%	40%
37	Kemper	93%	13%	34%	36%	59%	NA	48%	68%	50%
38	Reynolds	81%	54%	40%	67%	43%	96%	67%	12%	58%
39	Reynolds	NA	62%	72%	89%	73%	NA	48%	33%	63%
40	Reynolds	88%	75%	71%	98%	81%	NA	78%	73%	81%
41	Reynolds	96%	65%	39%	71%	60%	56%	67%	34%	61%
42	Reynolds	NA	90%	98%	95%	88%	NA	67%	91%	88%
43	Reynolds	72%	43%	26%	51%	52%	98%	26%	10%	47%
44	Reynolds	91%	73%	63%	60%	69%	NA	48%	36%	63%
45	Reynolds	67%	79%	69%	96%	83%	NA	70%	71%	76%
46	Reynolds	NA	68%	81%	65%	6%	NA	NA	86%	61%
47	Reynolds	NA	88%	96%	27%	28%	96%	15%	93%	63%
48	Coffee	60%	100%	48%	15%	91%	11%	48%	98%	59%

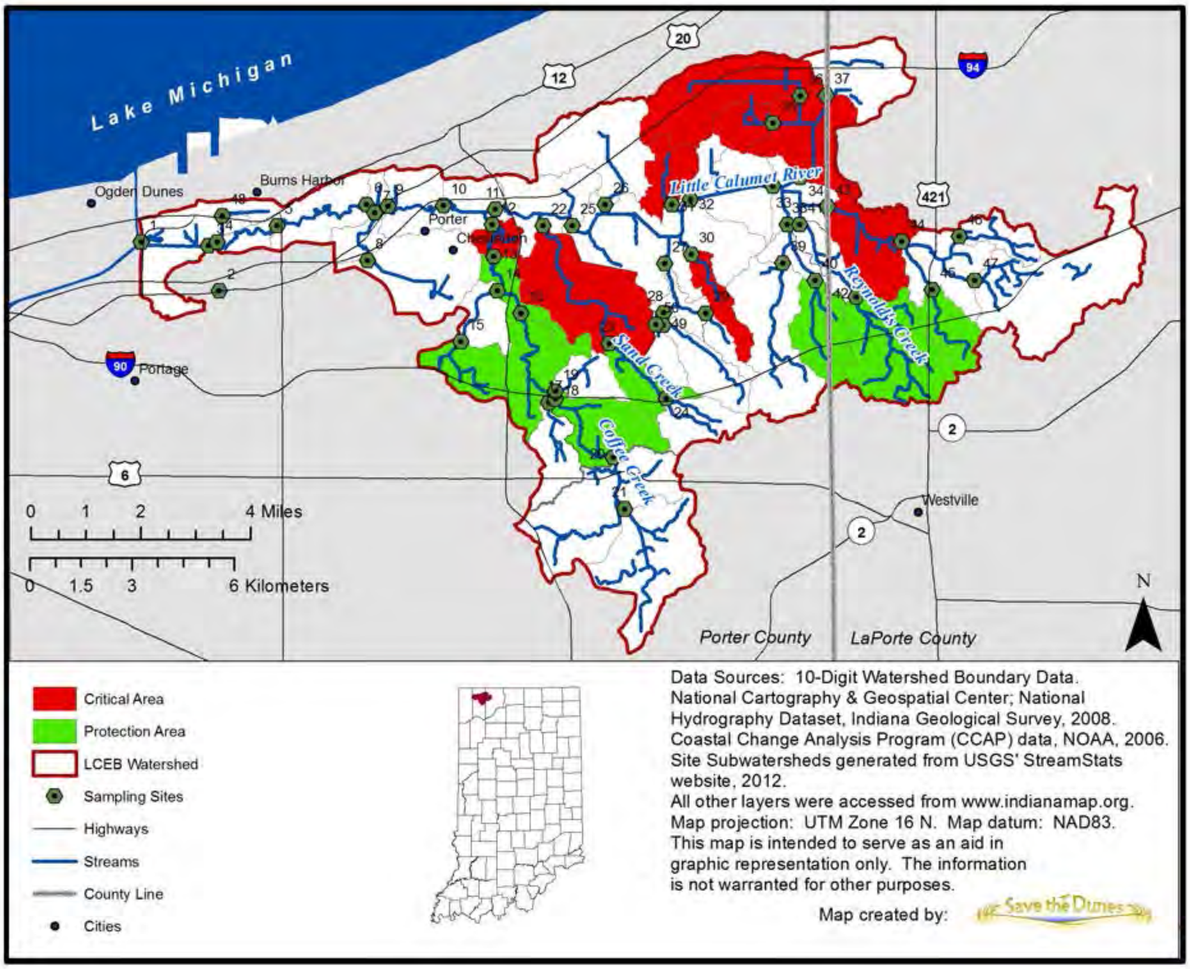

Figure 62. Critical and priority areas in the LCEB

8.4 Critical and Protection Areas Summary

Eight sites in the LCEB were selected as critical areas based on primarily on poor water quality, fish communities, macroinvertebrate communities, stream habitat quality, and land use issues. Due to the unusual conditions created by the historic drought of 2012, a unique metric was created to rank the LCEB sampling sites based on poorest quality to highest quality. Eight sites were also selected for protection using the same metric. The LCEB Technical Committee considered all available data and other sources of information including other planning initiatives, the windshield survey, 303(d) listings, habitat preserves, and personal knowledge of LCEB Steering Committee members.

9.0 Implementation Strategies

Best management practices (BMPs) have been developed to reduce nonpoint source pollution. The most common BMPs available are useful for reducing nutrients, sediment, and/or *E. coli*, which are the dominant pollutants in the LCEB. The following list of BMPs was compiled by the Technical Committee and is intended to identify the most common and most likely BMPs available in this region. Due to the diversity of land uses in the LCEB, this list includes agricultural BMPs as well as BMPs that are more effective in urban and suburban areas.

9.1 Best Management Practices

Nonpoint source best management practices (BMPs) are operational techniques implemented to reduce or prevent nonpoint source pollution. These practices control nonpoint source pollutants by reducing pollutant loads and often reducing stormwater flow volumes to nearby streams. BMPs that were considered by the LCEB Steering Committee for implementation include:

Cover Crops

Cover crops are the use of legumes (e.g. clover, hairy vetch, and alfalfa) or grasses, including cereals, (planted or volunteered vegetation) that are established following a harvested crop primarily for seasonal soil protection and the retention of nutrients. Cover crops protect soil from erosion and retain nitrogen and phosphorus in the root zone. They are grown for one year or less.

Biomass and Forage Crops

Biomass crops or forage crops are typically hay, pasture, or bioenergy grasses. They can be established and maintained for many years. These harvested perennial crops reduce the loss of nutrients and sediment from agricultural fields. These crops also typically reduce the quantity of stormwater runoff.

Extended Wet Detention Ponds

Extended wet detention ponds are large basins constructed with a permanent pool of water and additional storage room to hold stormwater flow. The pool is designed to release stormwater slowly. Pollutants are removed through settling, and biological and chemical processes.

Filter Strips: urban & agricultural

Filter strips are grassed strips of land that help to reduce sediment and nutrients in overland flow from reaching a receiving water body. Filter strips are placed perpendicular to flow thus reducing flow velocity and removing sediment and nutrients.

Grade Stabilization Structures

A grade stabilization structure is designed to control soil erosion in either natural or artificial waterways. Grade stabilization structures can prevent the formation or growth of gullies, enhance environmental quality, and improve or maintain habitat for fish and other wildlife.

Land Conversion: Cropland to Grassland
Land conversion to grassland is the practice of taking agricultural lands out of production to promote a grassland or prairie.

Land Conversion: Cropland to Wetland
Land conversion to wetland is the practice of taking agricultural lands out of production to allow or construct a wetland habitat.

Manure Management
Manure management involves the managing and/or considering the volume and type of manure produced, crop rotations, the quantity of nutrients needed for each crop, field slope, soil type, and manure collection, transportation, storage, and distribution methods. Manure management uses similar techniques to nutrient management with regard to nutrient budgets. Specific practices can include waste storage facilities and waste utilization programs.

Nutrient Management
Nutrient management involves the strategic application of fertilizer to crops. The goal is to apply no more fertilizer than the crop requires for optimal growth. Different parts of a field may require different rates of fertilizer. Nutrient management seeks to supply adequate nutrients for optimum crop yield, while helping to sustain the physical, biological, and chemical properties of the soil.

Pervious Pavement
Pervious pavement is any type of pavement that allows the infiltration of stormwater runoff. Pervious pavement reduces sediment and nutrient flow to receiving streams.

Prescribed Grazing or Livestock Restriction
Livestock that have unrestricted access to a stream or wetland have the potential to degrade water quality and aquatic habitats. Through defecation, livestock introduce nutrients and *E. coli* to stream ecosystems. Trampling removes riparian vegetation and weakens stream banks to increase bank erosion. Trampling also compacts soils in riparian areas, which reduces the infiltration of runoff. Specific practices include fencing and alternative watering sources.

Reduced Tillage
Reduced tillage involves one or more tillage trips, which disturbs the entire soil surface and is performed before or during planting. 15 to 30% residue cover is retained after planting.

Riparian Buffers: Urban & Agricultural
Riparian buffers are the vegetated area near a stream that is typically forested. Riparian buffers help to stabilize streambanks, reduce nutrients and sediment from overland flow and reduce water temperatures by providing shade.

Septic System Maintenance
Onsite septic systems are the dominant method for sewage treatment throughout most of the LCEB even though soils in this area range from somewhat limited to very limited for onsite septic systems. Poorly functioning and malfunctioning septic systems contribute raw sewage (includes *E. coli*, nitrogen, and phosphorus) to streams and ground water. Annual maintenance of these systems helps to address potential problems and reduce the loss of pollutants to local waterways.

Streambank Stabilization:
Streambank stabilization is the use of a structure or vegetation to stabilize a streambank and reduce erosion. A wide array of methodologies and products can be used for the implementation of this BMP.

Tree, Shrub, and Native Plant Establishment
Tree, shrub, and native plant establishment is the planting of perennial vegetation that will develop deep roots, stabilize soil and retain soil nutrients.

9.2 Best Management Practice Selection

The LCEB Steering Committee and Technical Committee selected best management practices. BMPs were selected based on their ability to address the parameter of concern, their appropriateness for this watershed.

Table 26. Best management practices suggested for critical areas

<table>
<tr><th>Reason for Being Critical</th><th>Critical Area</th><th>Suggested BMP</th></tr>
<tr><td rowspan="9">Sediment (TSS)</td><td rowspan="3">Drainage Area 12</td><td>Extended Wet Detention</td></tr>
<tr><td>Porous Pavement</td></tr>
<tr><td>Infiltration Swales</td></tr>
<tr><td rowspan="6">Drainage Areas 30, 31, 24, 35, 36, and 43</td><td>Cover Crops</td></tr>
<tr><td>Filter Strips</td></tr>
<tr><td>Reduced Tillage</td></tr>
<tr><td>Riparian Buffers</td></tr>
<tr><td>Septic System Maintenance</td></tr>
<tr><td>Tree & Shrub Planting</td></tr>
<tr><td rowspan="10">Nutrients
(nitrogen and phosphorus)</td><td rowspan="5">Drainage Area 22</td><td>Porous Pavement</td></tr>
<tr><td>Extended Wet Detention</td></tr>
<tr><td>Infiltration Swales</td></tr>
<tr><td>Rain Barrels & Rain Gardens</td></tr>
<tr><td>Forested Buffers</td></tr>
<tr><td rowspan="5">Drainage Areas 22, 30, 31, 34, 35, 36, and 43</td><td>Cover Crops</td></tr>
<tr><td>Filter strips</td></tr>
<tr><td>Reduced Tillage</td></tr>
<tr><td>Nutrient Management</td></tr>
<tr><td>Riparian Buffers</td></tr>
</table>

Reason for Being Critical	Critical Area	Suggested BMP
		Septic System Maintenance
		Tree & Shrub Planting
E. coli	Drainage Areas 12 and 22	Extended Wet Detention
		Infiltration Swales
	Drainage Areas 22, 30, 34, 43	Riparian Buffers
		Septic System Maintenance
Biological Communities	Drainage Areas 22	Porous Pavement
		Extended Wet Detention
		Forested Buffers
		Infiltration Swales
		Rain Barrels & Rain Gardens
	Drainage Areas 22, 30, 31, 35, and 43	Cover Crops
		Filter Strips
		Reduced Tillage
		Nutrient Management
		Riparian Buffers
		Septic System Maintenance
		Tree & Shrub Planting
Dissolved Oxygen	Drainage Areas 12 and 22	Porous Pavement
		Extended Wet Detention
		Infiltration Swales
	Drainage Area 22	Forested Buffers
		Rain Barrels & Rain Gardens
	Drainage Areas 22, 31, 34, 35, and 36	Cover Crops
		Filter Strips
		Reduced Tillage
		Nutrient Management
		Riparian Buffers
		Septic System Maintenance
		Tree & Shrub Planting

9.3 Load Reduction by Best Management Practice

Load reductions were calculated using the EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL). STEPL was designed to model the reduction efficiencies of nonpoint source pollution best management practices on a watershed scale. With assistance from the county Soil and Water Conservation Districts and the Steering Committee, a suite of nonpoint source best management practices and possible relevant acreages were carefully selected based on land use and personal knowledge of watershed conditions. The BMPs selected were considered most likely to be effective and could readily be implemented. Load reductions (for nitrogen, phosphorus, and sediment) were calculated (using the selected BMPs) for the critical areas and the three subwatersheds using STEPL. Load reductions were calculated for the stated goals of 5 years for the critical areas and the stated goals of 15 years and 25 years for the sub-watershed. Tables 27, 28, and 29 describe each selected BMP, its acreage, and the resulting pollutant reduction for the critical areas (grouped by subwatershed). Tables 30, 31, and 32 describe each selected BMP, its acreage, and the resulting pollutant reduction for the 15-year and 25-year goals.

For the 25-year goal, we were unable to reach the target load reductions for all the water quality parameters. This was likely due to the inability of STEPL to quantify all desired BMPs. For example, the widespread implementation of septic system maintenance is likely to have an important effect on water quality by reducing nutrients and *E. coli*. Unfortunately, STEPL does not model *E. coli* and does not have a reduction efficiency for septic system maintenance. Additionally, due to the complexity and expense of addressing tile drainage, the Steering Committee decided to focus attention on other BMPs. Nonetheless, tile drainage is likely a significant contributor of nutrients to the LCEB. The Steering Committee would like to address tile drainage in a future WMP revision.

Table 27. Reynolds Creek subwatershed critical area (5-year goal) load reductions from BMPs

Critical Drainage Area	**43**			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crops	57	26.2	1.8	400.0
Filter Strips	4	9.2	2.2	1867.4
Reduced Tillage	29	61.0	14.3	15622.8
Nutrient Management	29	10.6	3.9	0.0
Riparian Buffers	4	7.4	1.8	1867.4
Septic System Maintenance		NA	NA	NA
Tree & Shrub Planting	1	NA	NA	NA
Reduction Sum		**114.4**	**24.0**	**19757.5**

Calculated percent reductions for the Reynolds Creek subwatershed (5-year goal) are 1% for nitrogen, 0.6% for phosphorus, and 10% for sediment.

Table 28. Kemper Ditch subwatershed critical area (5-year goal) load reductions from BMPs

Critical Drainage Area	**30**				**Critical Drainage Area**	**31**			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**	**Suggested BMP**	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crop	53	24.3	1.7	400.0	Cover Crop	53	24.3	1.7	400.0
Filter Strips	5	13.2	3.1	2461.6	Filter Strips	5	13.2	3.1	2461.6
Reduced Tillage	53	122.1	28.6	15.6	Reduced Tillage	53	122.1	28.6	31245.5
Nutrient Management	53	19.7	7.0	0.0	Nutrient Management	53	19.7	7.0	0.0
Riparian Buffers	3	6.8	1.7	1692.5	Riparian Buffers	3	6.8	1.7	1692.5
Septic System Maintenance		NA	NA	NA	Septic System Maintenance		NA	NA	NA
Tree & Shrub Planting	2	NA	NA	NA	Tree & Shrub Planting	2	NA	NA	NA
Reduction Sum		**186.0**	**42.0**	**4569.7**	**Reduction Sum**		**186.0**	**42.0**	**35799.6**
Critical Drainage Area	**34**				**Critical Drainage Area**	**35**			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**	**Suggested BMP**	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crop	106	48.5	3.4	800.0	Cover Crop	53	24.3	1.7	400
Filter Strips	5	13.2	3.1	2461.6	Filter Strips	5	13.2	3.1	2461.6
Reduced Tillage	106	244.2	57.1	62491.0	Reduced Tillage	53	122.1	28.6	15.6
Nutrient Management	106	39.4	14.0	0.0	Nutrient Management	53	19.7	7.0	0.0
Riparian Buffers	13	27.2	6.8	6769.9	Riparian Buffers	3	6.8	1.7	1692.5
Septic System Maintenance		NA	NA	NA	Septic System Maintenance		NA	NA	NA
Tree & Shrub Planting	2	NA	NA	NA	Tree & Shrub Planting	2	NA	NA	NA
Reduction Sum		**372.4**	**84.4**	**72522.5**	**Reduction Sum**		**186.0**	**42.0**	**4569.7**

Critical Drainage Area	**36**			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crop	265	289	41	41661
Filter Strips	5	13.2	3.1	2461.6
Reduced Tillage	106	244.2	57.1	62491.0
Nutrient Management	106	39.4	14.0	0.0
Riparian Buffers	13	27.2	6.8	6769.9
Septic System Maintenance		NA	NA	NA
Tree & Shrub Planting		NA	NA	NA
Reduction Sum		**613.4**	**122.1**	**113383.2**

Calculated percent reductions for the Kemper Ditch subwatershed (5-year goal) are 6% for nitrogen, 3% for phosphorus, and 46% for sediment.

Table 29. Coffee Creek subwatershed critical areas (5-year goal) load reductions from BMPs

Critical Drainage Area	**12**				**Critical Drainage Area**	**22**			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lb/yr**	**Suggested BMP**	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lb/yr**
Extended Wet Detention	5	16.0	2.0	1000.00	Porous Pavement	5	24.7	1.9	979.6
Porous Pavement	10	49.3	3.8	1959.1	Extended Wet Detention	5	16	2	1000.00
Infiltration Swale	5	14.5	1.9	1000	Forested Buffers	5	7.3	1.5	600.0
Tree & Shrub Planting	1	NA	NA	NA	Infiltration Swale	5	14.5	1.9	1000
Reduction Sum		**79.8**	**7.7**	**3959.1**	Rain Barrels & Rain Gardens	10	58	5.8	2200
					Cover Crop	21	9.7	3.3	800.0
					Filter Strip	1	3.3	0.8	615.4
					Reduced Tillage	11	23.6	5.4	2.8
					Nutrient Management	21	8	3	0
					Riparian Buffer	3	5.3	1.3	0.6
					Septic System Maintenance		NA	NA	NA
					Tree & Shrub Planting	1	NA	NA	NA
					Reduction Sum		**170.2**	**26.7**	**7198.4**

Calculated percent reductions for the Coffee Creek subwatershed (5-year goal) are 1% for nitrogen, 0.3% for phosphorus, and 2% for sediment.

Table 30. Reynolds Creek subwatershed 15-year and 25-year load reductions from BMPs

Target Timeline:	15 Years				25 Years			
Suggested BMP	Acres	Nitrogen lb/yr	Phosphorus lb/yr	Sediment lbs/yr	Acres	Nitrogen lb/yr	Phosphorus lb/yr	Sediment lbs/yr
Cover Crop	714	784	113	114,916	1,427	1,568	225	229,831
Forage & Biomass Crops	285	NA	NA	NA	571	NA	NA	NA
Filter Strips, Ag	143	367	88	74,695	143	367	88	74,695
Reduced Tillage	571	1,328	313	344,747	856	1,993	469	0
Riparian Buffers, Ag	29	59	15	14,939	143	296	74	0
Land Conversion: crop to wetland	428	1557	372	337,852	571	2077	496	0
Land Conversion: crop to grassland	571	1054	338	367,730	856	1582	507	0
Nutrient Management	571	212	78	0	1,427	530	195	0
Porous Pavement	10	49	4	1,959	25	123	9	0
Tree & Shrub Planting	143	NA	NA	NA	285	NA	NA	NA
Septic System Maintenance		NA	NA	NA		NA	NA	NA
Education & Outreach		NA	NA	NA		NA	NA	NA
Sum		**5,411**	**1,320**	**1,256,838**		**8,535**	**2,064**	**304,526**
Needed Reductions		11,415	4,151	199,831		11,415	4,151	199,831
% Reduction		**47%**	**32%**	**629%**		**75%**	**50%**	**152%**

Table 31. Kemper Ditch subwatershed (15-year and 25 year) load reductions from BMPs

Target Timeline:	15 Years				25 Years			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crop	1324	1447	206	208,303	2,649	2,895	412	416,607
Forage & Biomass Crops	530	NA	NA	NA	1,059	NA	NA	NA
Filter Strips, Ag	265	675	161	135,397	265	675	161	135,397
Reduced Tillage	795	1831	428	468,000	1,059	2,442	571	624,910
Riparian Buffers, Ag	53	109	27	15,623	265	544	135	312,455
Land Conversion: cropland to wetland	795	2867	681	6,200	1,059	3823	909	124,982
Land Conversion: cropland to grassland	530	966	309	27,079	1,059	1,932	618	135,397
Nutrient Management	1,059	393	145	612,412	2,649	983	362	816,550
Porous Pavement	10	49	4	333,286	25	123	9	666,571
Tree & Shrub Planting	200	NA	NA	NA	300	NA	NA	NA
Septic System Maintenance		NA	NA	NA		NA	NA	NA
Education & Outreach		NA	NA	NA		NA	NA	NA
Sum		**8,338**	**1,961**	**1,806,301**		**13,417**	**3,177**	**3,232,870**
Needed Reductions		25,695	9,903	507,721		25,695	9,903	507,721
% Reduction		**32%**	**20%**	**356%**		**52%**	**32%**	**637%**

Table 32. Coffee Creek subwatershed (15-year and 25 year) load reductions from BMPs

Target Timeline:	15 Years				25 Years			
Suggested BMP	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**	**Acres**	**Nitrogen lb/yr**	**Phosphorus lb/yr**	**Sediment lbs/yr**
Cover Crop	532	569	78	75,742	1,065	1,138	156	151,484
Forage & Biomass Crops	213	NA	NA	NA	426	NA	NA	NA
Filter Strips, Ag	106	263	62	49,232	106	263	62	49,232
Reduced Tillage	213	472	107	113,613	426	943	215	227,225
Riparian Buffers, Ag	21	42	10	9,846	106	210	51	49,232
Land Conversion: cropland to wetland	319	1115	259	222,681	426	1487	346	296,908
Land Conversion: cropland to grassland	213	368	116	121,187	426	736	232	242,374
Nutrient Management	426	158	58	0	1,065	395	146	0
Porous Pavement	10	49	4	1,959	25	123	9	4,898
Tree & Shrub Planting	200	NA	NA	NA	300	NA	NA	NA
Septic System Maintenance		NA	NA	NA		NA	NA	NA
Extended Wet Detention	50	160	20	9,400	75	239	30	14,000
Filter Strips, Urban	200	618	71	28,298	300	927	107	42,447
Riparian Buffers, Urban	50	290	58	21,768	100	435	87	32,652
Education & Outreach		NA	NA	NA		NA	NA	NA
Sum		**4,104**	**844**	**653,726**		**6,898**	**1,440**	**1,110,452**
Needed Reductions		23,187	10,518	515,051		23,187	10,518	515,051
% Reduction		**18%**	**8%**	**127%**		**30%**	**14%**	**216%**

10.0 Strategies and Milestones for Reaching Goals

Goal statements and indicators were developed in Section 7. These goals were based on stakeholder concerns, water quality data, and potential sources of pollution. The goal statements represent the Steering Committee's desire to reach the target pollutant concentrations by 2030. The short-term targets of 5 years and 15 years were designed to provide realistic and achievable goals. Many of the selected strategies may apply to multiple goals and will be listed in several tables. Activities to be completed will be listed in each action register below. A water quality monitoring program and additional social indicator surveys will be used to measure the outcomes from implementation efforts.

10.1 Reduce Nutrient Loading

Table 33. Action register to reduce nutrient loading

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
Increase cover crop acreage	Reynolds Creek: Increase cover crops 57 acres by 2021 and 714 by 2031.	Agricultural landowners and operators	Annually identify cover crop funding options	$1,000	PP = Watershed Group (WG)
			Develop a cover crop demonstration area by 2017	$2,000*	PP = WG & SWCD TA = SWCD to provide guidance, location, and audience
	Kemper Ditch: Increase cover crops 530 acres by 2021 and 1,324 by 2031		Develop a cost-share program in 2016	$15,000*	PP = WG & SWCD TA = SWCD, NRCS, and Purdue Extension to provide guidance and promotion
			Host a biannual cover crop workshop (every other year from 2016 – 2031)	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience
	Coffee Creek: Increase cover crops 21 acres by 2021 and 532 by 2031		Create a contractors list for specific cover crop seeding in 2016	$500	PP = WG
			Implement 260 acres of cover crops annually (2021 – 2031)	$104,000	PP = WG & SWCD

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
			Implement 608 acres of cover crops in critical areas by 2021	$24,500	PP = Watershed Group (WG) & SWCD
Increase filter strip. Infiltration swale, forested buffer, and riparian buffer acreage	Reynolds Creek: increase buffers 8 acres by 2021 and 172 acres by 2031	Agricultural land owners and operators, urban and rural landowners	Annually identify funding opportunities for filter strips and riparian buffers	$1,000	PP = WG
	Kemper Ditch: increase buffers 60 acres by 2021 and 318 acres 2031		Develop and host a biannual BMP field day from 2016 - 2031	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience
	Coffee Creek: increase buffers 19 acres by 2021 and 377 by 2031		Develop a cost share program in 2016	*See Note	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance and promotion
			Implement 87 acres of buffers annually (2021-2031)	$87,000	PP = WG & SWCD
			Implement 87 acres of buffers in critical areas by 2021	$8,700	PP = WG & SWCD
Increase the acreage of fields using nutrient management	Reynolds Creek: increase use of nutrient mgmt. 29 acres by 2012 and 571 by 2031	Agricultural landowners and operators	Annually identify funding opportunities for nutrient management	$1,000	PP = WG
	Kemper Ditch: increase use of nutrient mgmt. 371 acres by 2021 and 1,059 by 2031		Develop and host a biannual BMP field day (2016 – 2031)	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience
	Coffee Creek: increase use of nutrient mgmt. 21 acres by 2021 and		Develop a cost share program	*See Note	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance and promotion

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
	426 by 2031		Implement 206 acres nutrient management annually (2021-2031)	$31,000	PP = Watershed Group (WG) & SWCD
			Implement 421 acres of nutrient management in critical areas by 2021	$6,400	PP = WG & SWCD
Increase the acreage of fields using reduced tillage	Reynolds Creek: increase use of reduced tillage by 29 acres by 2021 and 571 by 2031	Agricultural landowners and operators	Implement 158 acres of reduced tillage annually (2021-2031)	$5,000	PP = WG & SWCD
	Kemper Ditch: increase use of reduced tillage by 371 acres by 2021 and 795 by 2031				
	Coffee Creek: increase use of reduced tillage by 11 acres by 2021 and 106 by 2031		Implement 411 acres of reduced tillage in critical areas by 2021	$5,000	PP = WG & SWCD
Increase landowner awareness of septic system maintenance	Reynolds Creek: Reduce nutrient loading from septic systems	Rural and urban landowners	Develop and implement a workshop on septic system maintenance and education (2016-2031)	$40,000	PP = WG & Septics Coordination Group
	Kemper Ditch: reduce nutrient loading from septic systems		Annually identify funding for septic system maintenance and education	$1,000	PP = WG
	Coffee Creek: reduce nutrient loading from septic systems				

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
Increase acreage of extended wet detention	Coffee Creek: increase application of extended wet detention by 10 acres by 2021 and 50 by 2031	Urban landowners	Implement 10 acres of extended wet detention in the critical areas by 2021	$4,000,000	PP = WG & MS4
			Implement 5 acres of extended wet detention annually (2021-2031)	$20,000,000	PP = WG & MS4
Increase acreage of porous pavement	Coffee Creek: increase application of porous pavement by 15 acres by 2021 and 10 acres by 2031	Urban landowners	Implement 15 acres of porous pavement in the critical areas by 2021	$6,500,000	PP = WG
			Implement 1 acre of porous pavement annually (2021-2031)	$4,400,000	PP = WG
Increase acreage of tree and shrub planting	Reynolds Creek: increase tree & shrub planting by 1 acre 2021 and 143 by 2031	Rural and urban landowners	Implement 13 acres of tree & shrub planting in the critical areas by 2021	$400,000	PP = WG
	Kemper Ditch: increase tree & shrub planting by 10 acres by 2021 and 200 by 2031		Implement 54 acres of tree planting annually (2021-2031)	16,200,000	PP = WG
	Coffee Creek: increase tree & shrub planting by 2 acre in 2021 and 200 by 2031		Annually identify funding opportunities for tree and shrub planting	$1,000	PP = WG

*One cost share program and three education program plans will be developed covering the identified strategies. Educational program costs are for one-half the Watershed Coordinator's salary for 16 months plus meeting and program materials. The education plans include salary for the Watershed Coordinator to implement education and outreach for five years.

Indicators for Success

Water quality and social data will be used to demonstrate progress toward these goals. The Hoosier Riverwatch volunteer program will be utilized to monitor water quality advances. Sampling for each subwatershed both before and after implementation will provide indications of progress. A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

10.2 Reduce Sediment Loading

Table 34. Action register to reduce sediment loading

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
Increase cover crop acreage	Reynolds Creek: Increase cover crops 57 acres by 2021 and 714 by 2031.	Agricultural landowners and operators	Annually identify cover crop funding options	$1,000	PP = Watershed Group (WG)
			Develop a cover crop demonstration area by 2017	$2,000*	PP = WG & SWCD TA = SWCD to provide guidance, location, and audience
	Kemper Ditch: Increase cover crops 530 acres by 2021 and 1,324 by 2031		Develop a cost-share program in 2016	$15,000*	PP = WG & SWCD TA = SWCD, NRCS, and Purdue Extension to provide guidance and promotion
			Host a biannual cover crop workshop (every other year from 2016 – 2031)	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience
	Coffee Creek: Increase cover crops 21 acres by 2021 and 532 by 2031		Create a contractors list for specific cover crop seeding in 2016	$500	PP = WG
			Implement 260 acres of cover crops annually (2021 – 2031)	$104,000	PP = Watershed Group (WG) & SWCD

<table>
<tr><th>Objective</th><th>Strategy</th><th>Target Audience</th><th>Milestone</th><th>Cost</th><th>Possible Partners (PP) and needed Technical Assistance (TA)</th></tr>
<tr><td></td><td></td><td></td><td>Implement 608 acres of cover crops in critical areas by 2021</td><td>$24,500</td><td>PP = WG & SWCD</td></tr>
<tr><td rowspan="6">Increase filter strip, forested buffer, infiltration swale, and riparian buffer acreage</td><td>Reynolds Creek: increase buffers 8 acres by 2021 and 172 acres by 2031</td><td rowspan="6">Agricultural land owners and operators, urban and rural landowners</td><td>Annually identify funding opportunities for filter strips and riparian buffers</td><td>$1,000</td><td>PP = WG</td></tr>
<tr><td>Kemper Ditch: increase buffers 60 acres by 2021 and 318 acres 2031</td><td>Develop and host a biannual BMP field day from 2016 - 2031</td><td>$20,000</td><td>PP = WG & SWCD
TA = SWCD, NRCS, and Purdue Extension to provide guidance, location and audience</td></tr>
<tr><td rowspan="4">Coffee Creek: increase buffers 19 acres by 2021 and 377 by 2031</td><td>Develop a cost share program</td><td>*See Note</td><td>PP = WG & SWCD
TA = SWCD to provide guidance and promotion</td></tr>
<tr><td>Implement 87 acres of buffers annually (2021-2031)</td><td>$87,000</td><td>PP = WG</td></tr>
<tr><td>Implement 87 acres of buffers in critical areas by 2021</td><td>$8,700</td><td>PP = WG</td></tr>
<tr></tr>
<tr><td rowspan="3">Increase the acreage of fields using reduced tillage</td><td>Reynolds Creek: increase use of reduced tillage by 29 acres by 2021 and 571 by 2031</td><td rowspan="3">Agricultural landowners and operators</td><td rowspan="2">Implement 158 acres of reduced tillage annually (2021-2031)</td><td rowspan="2">$5,000</td><td rowspan="2">PP = WG & SWCD</td></tr>
<tr><td>Kemper Ditch: increase use of reduced tillage by 371 acres by 2021 and 795 by 2031</td></tr>
<tr><td>Coffee Creek: increase use of reduced tillage by 11 acres by 2021 and 106 by 2031</td><td>Implement 411 acres of reduced tillage in critical areas by 2021</td><td>$5,000</td><td>PP = Watershed Group (WG)</td></tr>
</table>

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
Increase acreage of extended wet detention	Coffee Creek: increase application of extended wet detention by 10 acres by 2021 and 50 by 2031	Urban landowners	Implement 10 acres of extended wet detention in the critical areas by 2021	$4,000,000	PP = WG
			Implement 5 acres of extended wet detention annually (2021-2031)	$20,000,000	PP = WG
Increase acreage of porous pavement	Coffee Creek: increase application of porous pavement by 15 acres by 2021 and 10 acres by 2031	Urban landowners	Implement 15 acres of porous pavement in the critical areas by 2021	$6,500,000	PP = WG
			Implement 1 acre of porous pavement annually (2021-2031)	$4,400,000	PP = WG

*One cost share program will be developed.

Indicators for Success

Water quality and social data will be used to demonstrate progress toward these goals. The Hoosier Riverwatch volunteer program will be utilized to monitor water quality advances. Sampling for each subwatershed both before and after implementation will provide indications of progress. A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

10.3 Reduce *E. coli* Loading

Table 35. Action register to reduce *E. coli* loading

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
Increase landowner awareness of septic system maintenance	Reynolds Creek: Reduce *E. coli* loading from septic systems	Rural and urban landowners	Develop and implement workshop on septic system	$40,000	PP = WG & Septics Coordation Group

			maintenance and education (2016-2031)		
	Kemper Ditch: reduce *E. coli* loading from septic systems		Annually identify funding for septic system maintenance and education	$1,000	PP = WG
	Coffee Creek: reduce *E. coli* loading from septic systems				

Indicators for Success

Water quality and social data will be used to demonstrate progress toward these goals. The Hoosier Riverwatch volunteer program will be utilized to monitor water quality advances. Sampling for each subwatershed both before and after implementation will provide indications of progress. A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

10.4 Improve Biological Communities

Table 36. Action register to improve biological communities

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
Increase cover crop acreage	Reynolds Creek: Increase cover crops 57 acres by 2021 and 714 by 2031.	Agricultural landowners and operators	Annually identify cover crop funding options	$1,000	PP = Watershed Group (WG)
			Develop a cover crop demonstration area by 2017	$2,000*	PP = WG & SWCD TA = SWCD to provide guidance, location, and audience
	Kemper Ditch: Increase cover crops 530 acres by 2021 and 1,324 by 2031		Develop a cost-share program in 2016	$15,000*	PP = WG & SWCD TA = SWCD, NRCS, and Purdue Extension to provide guidance and promotion
			Host a biannual cover crop workshop (every other year from 2016 – 2031)	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
	Coffee Creek: Increase cover crops 21 acres by 2021 and 532 by 2031		Create a contractors list for specific cover crop seeding in 2016	$500	PP = WG
			Implement 260 acres of cover crops annually (2021 – 2031)	$104,000	PP = WG & SWCD
			Implement 608 acres of cover crops in critical areas by 2021	$24,500	PP = WG & SWCD
Increase filter strip, infiltration swale, forested buffer, and riparian buffer acreage	Reynolds Creek: increase buffers 8 acres by 2021 and 172 acres by 2031	Agricultural land owners and operators, urban and rural landowners	Annually identify funding opportunities for filter strips and riparian buffers	$1,000	PP = WG
	Kemper Ditch: increase buffers 60 acres by 2021 and 318 acres 2031		Develop and host a biannual BMP field day from 2016 - 2031	$20,000	PP = WG & SWCD TA = SWCD, NRCS, and Purdue Extension to provide guidance, location and audience
	Coffee Creek: increase buffers 19 acres by 2021 and 377 by 2031		Develop a cost share program	*See Note	PP = WG & SWCD TA = SWCD to provide guidance and promotion
			Implement 87 acres of buffers annually (2021-2031)	$87,000	PP = WG
			Implement 87 acres of buffers in critical areas by 2021	$8,700	PP = WG
Increase the acreage of fields using nutrient management	Reynolds Creek: increase use of nutrient mgmt. 29 acres by 2012 and 571 by 2031	Agricultural landowners and operators	Annually identify funding opportunities for nutrient management	$1,000	PP = WG
	Kemper Ditch: increase use of nutrient mgmt. 371 acres by 2021 and 1,059 by 2031		Develop and host a biannual BMP field day from 2016 - 2031	$20,000	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance, location, and audience

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
	Coffee Creek: increase use of nutrient mgmt. 21 acres by 2021 and 426 by 2031		Develop a cost share program	*See Note	PP = WG & SWCD TA = SWCD, NRCS and Purdue Extension to provide guidance and promotion
			Implement 206 acres nutrient management annually (2021-2031)	$31,000	PP = WG & SWCD
			Implement 421 acres of nutrient management in critical areas by 2021	$6,400	PP = WG & SWCD
Increase the acreage of fields using reduced tillage	Reynolds Creek: increase use of reduced tillage by 29 acres by 2021 and 571 by 2031	Agricultural landowners and operators	Implement 158 acres of reduced tillage annually (2021-2031)	$5,000	PP = WG & SWCD
	Kemper Ditch: increase use of reduced tillage by 371 acres by 2021 and 795 by 2031				
	Coffee Creek: increase use of reduced tillage by 11 acres by 2021 and 213 by 2031		Implement 411 acres of reduced tillage in critical areas by 2021	$5,000	PP = WG & SWCD
Increase landowner awareness of septic system maintenance	Reynolds Creek: Reduce nutrient & *E. coli* loading from septic systems	Rural and urban landowners	Develop and implement a workshop on septic system maintenance and education (2016-2031)	$40,000	PP = WG & Septics Coordination Group
	Kemper Ditch: reduce nutrient & *E. coli* loading from septic systems		Annually identify funding for septic system maintenance and education	$1,000	PP = WG

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
	Coffee Creek: reduce nutrient & *E. coli* loading from septic systems				
Increase acreage of extended wet detention	Coffee Creek: increase application of extended wet detention by 10 acres by 2021 and 50 by 2031	Urban landowners	Implement 10 acres of extended wet detention in the critical areas by 2021	$4,000,000	PP = WG & MS4
			Implement 5 acres of extended wet detention annually (2021-2031)	$20,000,000	PP = WG & MS4
Increase acreage of porous pavement	Coffee Creek: increase application of porous pavement by 15 acres by 2021 and 10 acres by 2031	Urban landowners	Implement 15 acres of porous pavement in the critical areas by 2021	$6,500,000	PP = WG
			Implement 1 acre of porous pavement annually (2021-2031)	$4,400,000	PP = WG
Increase acreage of tree and shrub planting	Reynolds Creek: increase tree & shrub planting by 1 acre 2021 and 143 by 2031	Rural and urban landowners	Implement 13 acres of tree & shrub planting in the critical areas by 2021	$400,000	PP = WG
	Kemper Ditch: increase tree & shrub planting by 10 acres by 2021 and 200 by 2031		Implement 54 acres of tree planting annually (2021-2031)	$16,200,000	PP = WG
	Coffee Creek: increase tree & shrub planting by 2 acre in 2021 and 200 by 2031		Annually identify funding opportunities for tree and shrub planting	$1,000	PP = WG

Indicators for Success

Water quality and social data will be used to demonstrate progress toward these goals. The Hoosier Riverwatch volunteer program will be utilized to monitor biological communities and their habitat. Annual sampling for each subwatershed will provide indications of progress. A social indicators survey will be conducted no less than five years after the start of implementation. The survey will be compared with the baseline survey to demonstrate progress.

10.5 Increase Public Awareness and Participation

Table 37. Action register to increase public awareness and participation

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
Increase community involvement and participation with watershed implementation activities	Develop a local volunteer water quality monitoring program using the Hoosier Riverwatch volunteer monitoring program	General public, businesses, schools	Facilitate training of key personnel and volunteers (2015-2021)	$3,500	PP = Watershed Group (WG)
			Annually recruit volunteers (2015-2031	$5,000	PP = WG
			Profile volunteers on partner websites and marketing efforts (2015-2031)	$3,500	PP = WG
			Monthly sampling at key sites throughout watershed	$50,000	PP = WG
Increase public awareness of watershed activities and participation in implementation activities	Share and communicate past, current, and future activities	General public, businesses, schools	Update watershed group activities to Save the Dunes website and provide information to partner organizations	$5,000	PP = WG
			Host semi-annual public meetings where stakeholders can receive updates and comment on watershed activities	$10,000	PP = WG
			Create pamphlets, brochures, and marketing materials as needed	$10,000	PP = Watershed Group (WG)

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners (PP) and needed Technical Assistance (TA)
			Create press releases quarterly or as needed	$1,000	PP = WG
Public understanding of water quality and watershed processes	Develop and conduct a social indicators survey	General public	Develop social indicator survey (2019 and 2029)	$20,000	PP = WG TA = Purdue University to do survey
			Disseminate survey to watershed home and landowners	$20,000	PP = WG
			Compile and analyze results	$20,000	PP = WG TA = Purdue University to do survey
Increase public knowledge of water quality and watershed processes	Host a field day or other educational event	General Public	Host field days with partner organizations to encourage the use of popular BMPs	$30,000	PP = WG
			Host educational workshops highlighting water quality, water pollution , and stream ecology	$10,000	PP = WG

10.6 Lack of Jurisdictional Coordination

Table 38. Action register for jurisdictional coordination

Objective	Strategy	Target Audience	Milestone	Cost	Possible Partners
Strengthen relationship with local governments to support watershed related policies	Encourage all municipalities to adopt watershed plan	Local politicians and other town officials	Present watershed plan and Implementation programs to NIRPC, drainage boards, and town councils (2015 – 2031)	$5,000	PP = WG

Increase cooperation among agencies to fund implementation	Develop and conduct educational workshops for municipalities and other agencies	Local politicians and other town officials	Host annual educational workshops for groups that typically do not attend watershed meetings to emphasize the benefits of implementation (2015-2031	$5,000	PP = WG

11.0 Project Tracking and Future Effectiveness

11.1 Indicator Tracking

The ultimate success of a watershed management plan relies on the ability of the stakeholders implement restoration activities. To track the progress of implementation action items, the Steering Committee will meet annually and as needed to evaluate progress and make changes.

Water quality indicators are measurements of water chemistry, biological communities, and aquatic habitats. Data will be collected as part of a volunteer water quality monitoring program developed using the Hoosier Riverwatch volunteer monitoring program. Data collected will include nitrate+nitrite, orthophosphorus, and turbidity, macroinvertebrate community composition, and stream habitat. Data will be collected at the subwatershed 'pour points' so that loading reductions can be calculated on a subwatershed level. This monitoring program will be conducted (at minimum) after 5, 15 and 25-years following implementation to assess progress made toward each interim goal. Water quality indicators will be compared to the 2012 Baseline study and will identify changes in water quality over time, changes in the biological community, and will quantify the effectiveness of BMP implementation. Data will be tracked using the Hoosier Riverwatch water quality database. Additional monitoring will supplement the volunteer monitoring, as funding allows.

A Water Quality Monitoring Committee will be convened annually to assess water quality reports and determine effectiveness of implemented best management practices. This committee will make recommendations for refining future implementation activities.

Social indicators provide information on stakeholder awareness, attitudes, and behaviors concerning water quality and watershed protection. Social indicators will track changes in stakeholder:

- knowledge of watershed processes
- attitudes toward BMPs and water quality improvement
- awareness of watershed activities, concerns, and accomplishments
- participation in watershed activities
- participation in cost-share and education activities

Social indicator data will be tracked using the social indicators survey. Funding will need to be acquired for this activity. The cost is estimated to be approximately $20,000. The LCEB Education Committee and Steering Committee will plan and implement the survey that will be conducted within 5 years, or as needed.

11.2 Future Plans and Considerations

To ensure the success of future watershed management plan updates, a long-term water quality dataset must be developed. An active volunteer driven water quality monitoring program will be developed using the Hoosier Riverwatch volunteer monitoring program. A committee will be created to evaluate monitoring efforts and collected data. The committee will meet annually to review data and provide recommendations to enhance and secure future water quality data collection.

The social indicators survey will be conducted no less than 5 years following the beginning of implementation. Additional social indicators surveys will be conducted as each phase of implementation progresses. The education committee will assist with the implementation and evaluation of each social indicators survey to determine changes in stakeholder knowledge, attitudes, and behavior.

Permission to implement BMPs on any piece of land must be obtained by the landowner prior to any installation. Many restoration activities require permits. All applicable permits must be acquired prior to any work on site.

A BMP Technical Committee will be established to evaluate the needs and effectiveness of any BMP implemented. This committee will meet annually and as needed during the different phases of implementation. The Steering Committee will meet annually at minimum to discuss the BMPs installed, plans for additional BMPs, plans for acquiring grant funds, and potential collaborations to increase implementation.

Each action item will be tracked on a quarterly basis and data will be maintained in a database. Progress will be tracked with measurable items such as BMPs installed, meetings and events held, and number of attendees at meetings and events.

Watershed management plans are intended to be living documents. Revisions and updates will be made as needed or desired by Save the Dunes and/or the Steering Committee. The LCEB Steering Committee suggests an update for this plan in five years.

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