

Section VI: Subwatershed Assessment

In an effort to characterize water quality throughout Eagle Creek Watershed using multiple data sets collected over several years, a comprehensive Subwatershed Assessment was conducted utilizing several layers of information ranging from water quality data to land cover analysis. Given the large suite of data with different spatial and temporal values, the assessment focused at a subwatershed scale with some subwatersheds being grouped based on location of the sampling stations.

Assessment Methodology

To identify Concerns and Critical Areas, several categories of data were analyzed. These include:

- IDEM's 303(d) Impaired Waterbodies List
- Water Quality Assessment (Benchmark Analysis)
- Atrazine Application Assessment
- Nutrient, Suspended Sediment, and *E. coli* Load Assessment
- Biological Assessment
- Land –Use Perturbation Assessment
- Watershed Visual Assessments
 - + Streambank Erosion Assessment
 - + Adequate Buffer Zone Assessment
 - + Livestock Access Assessment
 - + Trash Assessment
 - + Tile/Pipe Drain Assessment
- Adequate Woody Riparian Buffer Zone Assessment
- Impervious Surface Land Cover Assessment
- Point Source Assessment
- Unsewered Communities Assessment
- Headwater Stream Assessment

For each category, the subwatersheds were ranked against each other in the order of most impacted to least impacted.

IDEM's 303(d) Impaired Waterbodies List

All streams in Eagle Creek Watershed except School Branch were listed as impaired in the 2004 303(d) list. As, Kreager Ditch was listed as impaired for both *E. coli* and biotic community, this stream received the lowest rank of 1 with all other streams receiving a rank of 2 (Table VI-1).

Table VI-1: Subwatershed Ranking Based on IDEM 303(d) List

Subwatershed	Status	Parameter	Rank
Eagle Creek-Dixon Branch	Impaired	<i>E. coli</i>	2
Eagle Creek-Kreager Ditch	Impaired	<i>E. coli</i> : impaired biotic community	1
Eagle Creek-Finley Creek	Impaired	<i>E. coli</i>	2
Mounts Run-Neese Ditch	Impaired	<i>E. coli</i>	2
Eagle Creek-Jackson Run	Impaired	<i>E. coli</i>	2
Little Eagle Branch-Headwaters	Impaired	<i>E. coli</i>	2
Little Eagle Branch-Woodruff Branch	Impaired	<i>E. coli</i>	2
Fishback Creek (Eagle Creek Reservoir)	Impaired	<i>E. coli</i>	2
Eagle Creek-Long Branch/Irishman Run	Impaired	<i>E. coli</i>	2
Eagle Creek Reservoir – School Branch*		<i>E. coli</i>	2

* School Branch is not included in the list of impaired waterways for *E. coli*. However, data is now available showing that School Branch is also impaired and will be listed in the upcoming 303d listing (J. Arthur, IDEM, personal communication).

Water Quality Data

To allow for comparability between several data sets, water quality data was analyzed using a Benchmark Assessment. Three data sets were used for this assessment: Marion County Health Department (MCHD {1995 – 2004}), Eagle Creek Watershed Task Force (ECWTF {1997 – 2003}), and Central Indiana Water Resources Partnership (CIWRP {2003 and 2004}). Data sets are summarized in Table VI-2. Each sample site was apportioned to a specific Hydrologic Unit Code (HUC) 14-digit subwatershed of Eagle Creek Watershed (HUC 05120201120). Collected data was compared against known water quality thresholds (Table VI-3). These thresholds were categorized into tiers.

- Tier 1: standards mandated by Indiana Administrative Code (IAC);
- Tier 2: standards mandated by US EPA and other states' environmental protection agencies but not the IAC; and
- Tier 3: standards based on criteria for the protection of ecosystem health.

Table VI-2: Summary of ECW data sets used in Benchmark Assessment

MCHD Data Stream	Subwatershed	LOCATION†			SAMPLE PERIOD*	
		Street	Easting	Northing	From	To
Finley Creek	Finley Creek	SR32	n/a	n/a	09/02/99	10/15/03
Finley Creek	Finley Creek	SR421	n/a	n/a	04/09/98	06/30/04
Long Branch	Long Branch	116th	565628.57087	4423098.48995	04/09/98	06/30/04
Fishback Creek	Fishback Creek	Hunt Club	558202.25081	4421129.65161	04/09/98	06/30/04
Fishback Creek	Fishback Creek	Wilson	558248.30551	4415301.42958	06/16/95	06/30/04
School Branch	School Branch	Maloney Rd	555098.16417	4415264.58582	04/09/98	06/30/04
School Branch	School Branch	County Line Rd	557539.06316	4409682.75642	06/16/95	06/30/04
Little Eagle Creek	Little Eagle Creek - Woodruff Branch	SR421	563901.51969	4424917.65052	04/09/98	06/30/04
Little Eagle Creek	Little Eagle Creek	Vermont Rd.	n/a	n/a	06/05/96	04/01/02
Eagle Creek	Long Branch & Irishman Run	Ford Rd.	561679.38051	4419863.14742	06/16/95	06/30/04
Eagle Creek	Long Branch & Irishman Run	79th	560643.14981	4416397.53139	06/16/95	06/30/04
Eagle Creek	Reservoir	56th	559418.09484	4411570.99904	06/16/95	06/30/04

ECWTF Data Stream	Subwatershed	LOCATION†			SAMPLE PERIOD**	
		Street	Easting	Northing	From	To
School Branch	School Branch	Count Road 600 N	555749.04613	4411534.05146	05/13/97	10/22/03
Fishback Creek	Fishback Creek	82nd Street	558418.37444	4417103.76243	05/13/97	10/22/03
Irishman Run	Irishman Run	State Road 334	560359.40433	4422446.72932	05/13/97	10/22/03
Eagle Creek	Long Branch	Lions Club Park	563546.61288	4422361.63773	05/13/97	10/22/03
Eagle Creek	Jackson Run	Holiday Road	562081.62516	4426012.51540	05/13/97	10/22/03
Eagle Creek	Mounts Run & Finley Creek	Couny Road 200 S	560909.93950	4429444.01374	05/13/97	10/22/03
Little Eagle Creek	Little Eagle Creek - Woodruff Branch	156th Street	565842.86712	4429485.12365	05/13/97	10/22/03
Mounts Run	Mounts Run	State Road 32	557336.99427	4432413.19220	05/13/97	10/22/03
Finley Creek	Finley Creek	State Road 32	563093.64337	4432680.81784	05/13/97	10/22/03
Eagle Creek	Dixon Branch	Count Road 300 N	562022.40269	4437445.01387	05/13/97	10/22/03

Table VI-2: Summary of ECW data sets used in Benchmark Assessment (continued)

CIWRP 2003 Data Stream	Subwatershed	LOCATION†			SAMPLE PERIOD***	
		Street	Easting	Northing	From	To
School Branch	School Branch	Raceway Rd	557518.214	4409810.485	02/25/03	12/03/03
Fishback Creek	Fishback Creek	Wilson Rd	558258.702	4415347.485	02/25/03	12/03/03
Eagle Creek	Long Branch & Irishman Run	Lafayette Rd	559837.775	4415552.825	02/25/03	12/03/03
Eagle Creek	Long Branch & Irishman Run	Zionsville Rd	563219.929	4422038.412	02/25/03	12/03/03
Eagle Creek	Mounts Run	County Rd 200 S	560924.380	4429383.957	02/25/03	12/03/03
Little Eagle Creek	Little Eagle Creek - Woodruff Branch	County Rd 200 S	565844.616	4429497.815	02/25/03	12/03/03
Finley Creek	Finley Creek	County Rd 1100 E	563098.508	4432659.226	02/25/03	12/03/03
Eagle Creek	Eagle Creek Watershed – South of ECR Dam	Near 38 th St	n/a	n/a	02/25/03	12/03/03

† GPS coordinates are given in UTM: NGD 1983; Zone 16.

* Samples were taken regularly throughout this time period, usually beginning in late Winter/Early Spring and ending in Late Fall/Early Winter.

** Samples were taken regularly throughout this time period, usually April - October (2002: June - September; 1997 & 1998: May - November).

*** Samples were taken relative to event (3x 40 year stream discharge average) or base flow (40 year stream discharge average) as measured by the USGS Zionsville Gage (USGS 03353200).

Table VI-3: Tiers for Water Quality Benchmark Assessment

Tier 1			
<i>Parameter</i>	<i>Threshold</i>	<i>Units</i>	<i>Reference</i>
<i>E. coli</i>	Max: 235	CFU	IAC Title 327 – Full Body Contact
DO	Min: 4.0	mg/L	IAC Title 327 – Protect Aquatic Life
TDS	Max: 750	mg/L	IAC Title 327
pH	Range: 6 - 9		IAC Title 327 – Protect Aquatic Life
Tier 2			
<i>Parameter</i>	<i>Threshold</i>	<i>Units</i>	<i>Reference</i>
Atrazine	Max: 3.0	ppb	EPA Drinking Water Standard (Human Toxicity)
Nitrate	Max: 10	mg/L	EPA Drinking Water Standard (Human Toxicity) IAC Title 327
TSS	Max: 263	mg/L	Utah and South Dakota Standard for Warm Water Streams – Protect Aquatic Life
Total P	Max: 0.125	mg/L	National Average for US Watersheds 50-75% Agriculture (Omernik, 1977) & Ohio EPA
Total N	Max: 2.75	mg/L	National Average for US Watersheds 50-75% Agriculture (Omernik, 1977) & Ohio EPA
Tier 3			
<i>Parameter</i>	<i>Threshold</i>	<i>Units</i>	<i>Reference</i>
DIN / NO ₃ -N	Max: 1.0	mg/L	Levels leading to periphyton and macrophyte control (Dodds and Welch, 2000)
DO	>125%	DO _{sat}	Indication of excessive algal activity (indication of nutrient enrichment) (CB*, 2001)
pH	>8.3		Indication of excessive algal activity (indication of nutrient enrichment) (CB*, 2001)

* Commonwealth Biomonitoring

The thresholds were used to discern areas of poor water quality. If the measured parameter did not meet the threshold requirement, the sample was counted as exceeding the threshold. Each of the data sets was analyzed to determine how many times a subwatershed did not meet the threshold requirement and, subsequently, how many times a subwatershed indicated poor water quality based on each specific parameter. For instance, in all data sets and for all subwatersheds, the *E. coli* threshold (235 CFU/100mL) was exceeded more than 50% of the time sampled and the Atrazine threshold (3 ppb or 0.003 mg/L) was exceeded approximately 10% of the time sampled (Appendix D). This analysis allowed for a comparison of subwatersheds using multiple data sets taken over different spatial and temporal frequencies.

Based on the number of times each threshold was not met, each subwatershed was ranked against the others to determine a continuum of most impacted to least impacted according to each parameter. Based on this continuum, each subwatershed was assigned a rank with the lowest number rank representing the subwatershed that was the most impacted and a highest number representing the subwatershed that was the least impacted.

For each subwatershed, the ranks for each parameter within a Tier were averaged to obtain a Tier Score. A low tier score indicates a high percentage of times that the subwatershed did not meet the benchmark criteria. Because all parameters were not measured in all subwatersheds, three subwatersheds (Eagle Creek - Dixon Branch, Eagle Creek - Kreager Ditch, and Eagle Creek - Jackson Run) were not included in this analysis. According to Tier Scores, Mounts Run – Neese Ditch and Eagle Creek Reservoir - School Branch subwatersheds scored consistently the lowest in all Tiers (Table VI-4).

Table VI-4: Subwatershed Ranking by Tier Scores

Subwatershed	Tier 1		Tier 2		Tier 3	
	Score	Rank	Score	Rank	Score	Rank
Eagle Creek Dixon Branch	n/a	n/a	n/a	n/a	n/a	n/a
Eagle Creek-Finley Creek	4	4	5	5	2	1
Eagle Creek -Kreager Ditch	n/a	n/a	n/a	n/a	n/a	n/a
Little Eagle Branch-Headwaters	3	3	4	1	3	5
Mounts Run- Neese Ditch	2	1	4	1	2	1
Little Eagle Branch- Woodruff Branch	3	3	4	1	3	5
Eagle Creek- Jackson Run	n/a	n/a	n/a	n/a	n/a	n/a
Fishback Creek (Eagle Creek Reservoir)	4	4	5	5	2	1
Eagle Creek- Long Branch/Irishman Run	5	6	4	1	3	5
Eagle Creek Reservoir-School Branch	2	1	4	1	2	1

n/a – insufficient data to perform rank analysis.

This assessment was also used for the baseline or benchmark assessment of each subwatershed. The number of times a subwatershed does not meet the requirements of a water quality threshold can be used as a measurement of improvement. Given the implementation of better management practices, the number of times a subwatershed exceeds a water quality threshold should decrease.

Atrazine Application Assessment

Using Indiana statewide average application rates for Atrazine (1.32 lbs/acre-year) and estimated acreage of corn in each subwatershed, the amount of Atrazine applied in each watershed was estimated. This was compared to Tier 2 Benchmark Ranks of Atrazine exceedence whereby the subwatershed exceeding the Atrazine concentration of 3 ppb the most received the highest rank and the subwatershed with the least number of exceedences received the lowest rank. Then, each subwatershed was ranked against each other such that the subwatershed having the greatest estimated Atrazine load applied was assigned the lowest rank and the subwatershed with the lowest estimated Atrazine load applied was assigned the highest rank. The two ranks were then

combined to give an overall Atrazine Rank. This analysis showed that Eagle Creek – Dixon Branch, Eagle Creek – Finley Creek, Mounts Run – Neese Ditch, and Little Eagle Branch – Woodruff Branch were the most impacted by Atrazine (Table VI-5).

Table VI-5: Subwatershed Ranking by Atrazine

Subwatershed	Atrazine Applied*		Tier 2 Benchmark Analysis [†]				Overall Rank [‡]
	(lbs)	Rank	N	# Exceed 3 ppb	%	Rank	
Eagle Creek Dixon Branch	5,640	1	122	33	27%	1	1
Eagle Creek-Finley Creek	3,071	6	342	42	12%	5	4
Eagle Creek -Kreager Ditch	3,787	5					n/a
Little Eagle Branch-Headwaters	4,534	3					n/a
Mounts Run- Neese Ditch	5,514	2	122	9	7%	7	2
Little Eagle Branch- Woodruff	3,011	7	261	42	16%	2	2
Eagle Creek- Jackson Run	4,232	4					n/a
Fishback Creek (Eagle Creek Reservoir)	731	8	410	54	13%	4	5
Eagle Creek- Long Branch/Irishman Run	272	10	581	65	11%	6	7
Eagle Creek Reservoir-School Branch	478	9	418	61	15%	3	5

* Estimated using statewide average application rates.

[†] Benchmark Analysis is from combined MCHD and ECWTF data sets (Appendix D).

[‡] Overall Rank determined by Atrazine Applied Rate + Tier 2 Benchmark Rank.

n/a – insufficient data to perform rank analysis.

Nutrient, Suspended Sediment, and *E. coli* Loading Assessment

After loading for each subwatershed was calculated, each subwatershed was ranked against each other such that the subwatershed having the greatest estimated annual load was assigned the lowest rank and the subwatershed with the lowest estimated annual load was assigned the highest rank. Subwatersheds were accordingly ranked based on their loading per acre. Normalizing load to surface area allowed determination of which subwatersheds were loading disproportionately higher loads compared to their size. This with the land-use data and estimated fertilizer application can be used to determine possible sources of nutrient loads. This analysis showed that the subwatershed group of Little Eagle Branch - Woodruff Branch and Jackson Run, and Little Eagle Branch – Headwaters contributed the greatest per acre load of Total Organic Carbon (TOC) and Total P, and the upper subwatershed group of Eagle Creek – Dixon Branch, Eagle Creek - Kreager Ditch, and Mounts Run-Neese Ditch, and Little Eagle Branch – Headwaters contributed the greatest per acre load of Total N. Similarly, total suspended sediment (TSS) load was also normalized to surface area. These data show that the lower subwatersheds such as Little Eagle Branch - Woodruff Branch and Jackson Run, and Fishback Creek (Eagle Creek Reservoir) contribute the greatest amount of TSS load to the watershed (Table VI-6).

While *E. coli* themselves are not persistent – individual bacteria cells do not survive for more than a few days in a stream environment – the application of manure based

fertilizers or point sources of fecal contamination can cause *E. coli* numbers to follow similar transport dynamics as other water contaminants such as total suspended solids. Therefore, loads of *E. coli* were used to determine if any subwatershed contributed a disproportionate amount of *E. coli* to the watershed. This analysis shows that the subwatershed group of Eagle Creek – Little Eagle Branch – Woodruff Branch and Jackson Run contributed the most *E. coli* per acre, more than 100,000 cfu/acre (Table VI-7).

Table VI-6: Subwatershed Ranking by Load

Accountable Subwatersheds	TSS		Tot N		TOC		Tot P	
	tons/yr	Rank	tons/yr	Rank	tons/yr	Rank	tons/yr	Rank
Total Eagle Creek Watershed	26,000		1,500		60		890	
Eagle Creek – Dixon Branch and Eagle Creek - Kreager Ditch and Mounts Run-Neese Ditch	4,200	4	420	4	10	4	350	1
Eagle Creek - Finley Creek	670	5	60	5	3	4	40	6
Little Eagle Branch-Headwaters	2,300	3	230	2	10	2	120	2
Little Eagle Branch - Woodruff Branch and Jackson Run	12,900	1	480	1	20	1	150	4
Fishback Creek (Eagle Creek Reservoir)	6,600	2	210	3	8	3	140	3
Eagle Creek - Long Branch and Irishman Run		n/a		n/a		n/a		n/a
Eagle Creek Reservoir - School Branch	1,200	6	90	6	3	6	90	5

n/a – insufficient data to perform rank analysis.

Table VI-7: Subwatershed Rank by *E. coli* Load

Accountable Subwatersheds	<i>E. coli</i>	
	mCFU/yr	Rank
Eagle Creek Watershed	8,000	
Eagle Creek – Dixon Branch and Eagle Creek - Kreager Ditch and Mounts Run-Neese Ditch	1,900	4
Eagle Creek - Finley Creek	370	5
Little Eagle Branch - Headwaters	1000	2
Little Eagle Branch - Woodruff Branch and Jackson Run	2,800	1
Fishback Creek (Eagle Creek Reservoir)	930	3
Eagle Creek - Long Branch and Irishman Run		n/a
Eagle Creek Reservoir - School Branch	290	6

n/a – insufficient data to perform rank analysis.

Biological Assessment

Biological assessment of ECW was summarized from the Commonwealth Biomonitoring report to the ECWTF in 2001. Normalized Index of Biological Integrity (IBI) scores for each subwatershed were ranked. A low number rank refers to the most impaired and a high rank refers to the least relatively impaired. Rank analysis showed that Mounts Run – Neese Ditch, Little Eagle Branch (Headwaters and Woodruff Branch), and Fishback Creek (Eagle Creek Reservoir) subwatersheds scored lowest for macroinvertebrate and fish biological integrity (Table VI-8).

Table VI-8: Subwatershed Ranking by Bioassessment

Subwatershed	Macroinvertebrates		Fish	
	Ave. Score*	Rank	Ave. Score	Rank
Eagle Creek - Dixon Branch	49	6	62	5
Eagle Creek - Finley Creek	55	8	70	7
Eagle Creek - Kreager Ditch	52	7	70	7
Little Eagle Branch (Headwaters and Woodruff Branch)	41	2	49	2
Mounts Run – Neese Ditch	39	1	47	1
Eagle Creek - Jackson Run	46	4	60	4
Fishback Creek (Eagle Creek Reservoir)	44	3	56	3
Eagle Creek - Long Branch/Irishman Run	46	4	62	5
Eagle Creek Reservoir - School Branch	67	9	80	9

* Macroinvertebrates were sampled twice in May and October for each station in each subwatershed. The average score is the average for all stations in the subwatershed for both sample dates.

Land-use Perturbation Assessment

Land-use perturbation potential was measured using the LUCI model and the number of single family home permits issued in 2003. Again, subwatersheds were ranked from most impacted to least impacted with the lowest number representing the subwatershed that was the most impacted and a highest number representing the subwatershed that was the least impacted. Using the LUCI model, degree of impact was determined by the predicted % change in urbanization.

Based on the LUCI model and on the number of single family home permits issued in 2003, subwatersheds were ranked according to their susceptibility to land-use perturbations and subsequent sediment loading to their streams. Eagle Creek - Long Branch/Irishman Run, Eagle Creek Reservoir - School Branch, Little Eagle Branch (Headwaters and Woodruff Branch), and Eagle Creek - Jackson Run subwatersheds are predicted to be the most susceptible to land-use perturbation based on land-use change by 2040 and single family home development in 2003. Mounts Run – Neese Ditch, Eagle Creek - Finley Creek, and Eagle Creek - Dixon Branch are expected to be the least impacted by land-use perturbation (Table VI-9, Figure IV-3, and Figure IV-4).

Table VI-9: Subwatershed Ranking by Land-use Perturbation

Subwatershed	Land-use Perturbation	
	LUCI 2040 Rank	2003* Rank
Eagle Creek - Dixon Branch	9	6
Eagle Creek - Finley Creek	6	6
Eagle Creek - Kreager Ditch	7	6
Little Eagle Creek (Headwaters and Woodruff Branch)	1	5
Mounts Run – Neese Ditch	7	9
Eagle Creek - Jackson Run	3	3
Fishback Creek (Eagle Creek Reservoir)	3	4 [†]
Eagle Creek - Long Branch/Irishman Run	2	2
Eagle Creek Reservoir - School Branch	5	1

* Based on the number of single family home permits issued in 2003 for townships within ECW.

[†] In July of 2004, a 3000+ home development was approved by Boone County (Figure V-6).

Watershed Visual Assessment

A windshield survey was conducted to provide a visual assessment of Eagle Creek Watershed. Observations were made to determine the condition of streambank erosion, the adequacy of stream buffers, the stream accessibility for livestock, the condition of trash in streams, and the presence of tile/pipes in the watershed. Each subwatershed was ranked based on the occurrence of parameters observed and the degree or severity of which they were observed. For example, each subwatershed visual assessment site was ranked individually for the degree of impact. The sites for each subwatershed were totaled, averaged and then ranked against the other subwatersheds to provide an overall ranking of the Eagle Creek subwatersheds. This was done for each parameter (erosion, buffer, livestock access, trash, tile/pipes) visually assessed. The lower ranked numbers represent the subwatersheds that are most impacted while the higher rankings represent subwatersheds that are less critically impacted by the particular parameter observed.

Stream Bank Erosion

Visual assessments of stream bank erosion showed that the upper subwatersheds such as Little Eagle Branch – Headwaters, Eagle Creek – Dixon Branch, and Mounts Run – Neese Ditch showed the least amount of stream bank erosion, while the lower subwatersheds such as Fishback Creek (Eagle Creek Reservoir), Eagle Creek Reservoir – School Branch, and Eagle Creek – Long Branch/Irishman Run showed the greatest amount of stream bank erosion (Figure V-7, Table VI-10). This corresponds well with the slope assessments (Figure IV-5): stream reaches closer to the reservoir showed higher slopes, which, if left bare, are more susceptible to stream bank erosion.

Table VI-10: Subwatershed Ranking by Degree of Stream Bank Erosion

Subwatershed	Average		# Sites Assessed	Rank
Eagle Creek – Dixon Branch	5.7	(Slight)	12	9
Eagle Creek – Finley Creek	5.6	(Slight)	9	7
Eagle Creek – Kreager Ditch	5.6	(Slight)	14	7
Little Eagle Branch – Headwaters	5.9	(Slight)	7	10
Mounts Run – Neese Ditch	5.7	(Slight)	14	9
Little Eagle Branch – Woodruff Branch	5.5	(Slight)	13	5
Eagle Creek – Jackson run	4.6	(Slight to Moderate)	15	4
Fishback Creek (Eagle Creek Reservoir)	3.1	(Moderate)	18	1
Eagle Creek – Long Branch/Irishman Run	3.4	(Moderate)	16	3
Eagle Creek Reservoir – School Branch	3.2	(Moderate)	10	2

Adequate Buffer Zone Assessment

Visual assessments of adequate buffer zone showed that upper subwatersheds where land use is predominantly agricultural rank the lowest for adequate stream buffer zone: Little Eagle Branch – Headwater and Eagle Creek – Dixon Branch have the least amount of adequate buffer (Figure V-7, Table VI-11). This visual assessments match well with ArcView GIS land cover assessments which showed that these two subwatersheds had the least amount of adequate buffer zone (page 109).

Table VI-11: Subwatershed Ranking by Percent of Stream with Adequate Buffer

Subwatershed	Average		# Sites Assessed	Rank
Eagle Creek – Dixon Branch	1.5	(Moderate)	12	2
Eagle Creek – Finley Creek	1.8	(Moderate)	9	6
Eagle Creek – Kreager Ditch	1.7	(Moderate)	14	5
Little Eagle Branch – Headwaters	1.4	(Moderate)	7	1
Mounts Run – Neese Ditch	1.8	(Moderate)	14	6
Little Eagle Branch – Woodruff Branch	1.9	(Moderate)	13	8
Eagle Creek – Jackson Run	1.9	(Moderate)	15	8
Fishback Creek (Eagle Creek Reservoir)	1.6	(Moderate)	18	4
Eagle Creek – Long Branch/Irishman Run	2.0	(Moderate)	15	10
Eagle Creek Reservoir – School Branch	1.5	(Moderate)	10	2

Livestock Access

Visual assessments of livestock access showed that Eagle Creek – Kreager Ditch and Mounts Run – Neese Ditch have the greatest amount of places where livestock had free access to the streams (Figure V-8, Table VI-12).

Table VI-12: Subwatershed Ranking by Livestock Access to Stream

Subwatershed	# Sites w/ Livestock Access	# Sites Assessed	Rank
Eagle Creek - Dixon Branch	0	9	8
Eagle Creek - Finley Creek	0	9	8
Eagle Creek - Kreager Ditch	4	16	1
Little Eagle Branch - Headwaters	0	7	8
Mounts Run – Neese Ditch	4	13	1
Little Eagle Branch - Woodruff Branch	2	11	3
Eagle Creek - Jackson Run	2	17	3
Fishback Creek (Eagle Creek Reservoir)	2	18	3
Eagle Creek - Long Branch/Irishman Run	1	16	6
Eagle Creek Reservoir - School Branch	1	9	6

Trash

Visual assessments of trash in the streams showed that overall Eagle Creek Watershed is relatively clean, with some exceptions such a sofa in the lower reaches of Fishback Creek. Subwatersheds that had the greatest amount of trash were Fishback Creek (Eagle Creek Reservoir), Eagle Creek Reservoir – School Branch, and Eagle Creek – Dixon Branch (Figure V-9, Table VI-13).

Table VI-13: Subwatershed Ranking by Trash in Stream

Subwatershed	Average		# Sites Assessed	Rank
Eagle Creek - Dixon Branch	4.1	(slight)	12	6
Eagle Creek - Finley Creek	4.2	(slight)	9	4
Eagle Creek - Kreager Ditch	4.3	(slight)	15	5
Little Eagle Branch - Headwaters	4.6	(slight – none)	7	6
Mounts Run – Neese Ditch	4.8	(slight – none)	13	8
Little Eagle Branch - Woodruff Branch	4.6	(slight – none)	11	6
Eagle Creek - Jackson Run	4.9	(slight – none)	17	9
Fishback Creek (Eagle Creek Reservoir)	3.8	(mod. – slight)	18	1
Eagle Creek - Long Branch/Irishman Run	4.9	(slight – none)	16	10
Eagle Creek Reservoir - School Branch	4.0	(slight)	10	2

Tile/Pipe Drains

Visual assessment of the number of tile and/or pipe discharges into the streams showed that two subwatersheds with the greatest percent land-use for agriculture were also two of the lowest ranking subwatersheds for tile and/or pipe discharges into the streams: Eagle Creek – Dixon Branch and Mounts Run – Neese Ditch. School Branch also ranked as one of the lowest for tile and/or pipe discharges directly into the stream (Figure V-10, Table VI-14).

Table VI-14: Subwatershed Ranking by Number of Tile/Pipe Discharges

Subwatershed	# Sites with Tile/Pipe Observed	# Sites Assessed	%	Rank
Eagle Creek – Dixon Branch	9	12	75%	1
Eagle Creek – Finley Creek	1	9	11%	10
Eagle Creek – Kreager Ditch	6	14	43%	6
Little Eagle Branch – Headwaters	2	7	29%	8
Mounts Run – Neese Ditch	10	14	71%	3
Little Eagle Branch – Woodruff Branch	6	13	46%	5
Eagle Creek – Jackson run	3	15	20%	9
Fishback Creek (Eagle Creek Reservoir)	11	18	61%	4
Eagle Creek – Long branch/Irishman Run	6	16	38%	7
Eagle Creek Reservoir – School Branch	7	10	70%	2

Adequate Woody Riparian Zone Assessment (ArcView GIS)

After ArcView GIS assessment of each subwatershed using aerial photography, all subwatersheds were ranked against each other such that the subwatershed with the least adequate buffer received the lowest rank that the subwatershed with the most adequate buffer received the highest rank. Adequate buffer was measured as approximately 25' of woody riparian buffer on both sides of the stream. Eagle Creek - Dixon Branch, Little Eagle Branch - Headwaters, Mounts Run – Neese Ditch, and Eagle Creek Reservoir - School Branch Creek ranked the lowest amongst the subwatersheds, showing that these streams have the lowest percent adequate buffer of the Eagle Creek Subwatersheds (Table VI-15).

Table VI-15: Subwatershed Ranking by Adequate Woody Riparian Zone

Subwatershed	% of Stream With Adequate Buffer		Rank
Eagle Creek - Dixon Branch	20		1
Eagle Creek - Finley Creek	51		7
Eagle Creek - Kreager Ditch	45		6
Little Eagle Branch - Headwaters	26		2
Mounts Run – Neese Ditch	29		3
Little Eagle Branch - Woodruff Branch	43		5
Eagle Creek - Jackson Run	54		8
Fishback Creek (Eagle Creek Reservoir)	57		9
Eagle Creek - Long Branch/Irishman Run	57		9
Eagle Creek Reservoir - School Branch	34		4

Impervious Surface Assessment

After assessment of each subwatershed, all subwatersheds were ranked against each other such that the subwatershed with the most impervious surfaces by surface area (mi^2) received the lowest rank and the subwatershed with the least impervious surfaces by surface area received the highest rank (Table VI-16). In the case that two subwatersheds had the same amount of impervious surface area, percent surface area broke the tie, as in the case of Eagle Creek – Dixon Branch and Eagle Creek – Finley Creek which both had 0.6 mi^2 of impervious surfaces. As Eagle Creek – Finley Creek had a greater percent surface area of impervious surfaces, it received the lower rank (Table VI-16). Using this analysis, the subwatersheds closest to Eagle Creek Reservoir show the greatest amount of impervious surfaces in both surface area and percentage: Eagle Creek – Long Branch/Irishman Run and Eagle Creek Reservoir – School Branch rank the lowest while the subwatersheds such as Mounts Run – Neese Ditch, Eagle Creek – Kreager Ditch, and Eagle Creek- Dixon Branch ranked the highest. This suggests that the lower subwatersheds are the most susceptible to degradation from stormwater run-off.

Table VI-16: Subwatershed Ranking by Impervious Surface Assessment

Subwatershed	Impervious		Rank
	(mi^2)	%	
Eagle Creek Dixon Branch	0.6	3.4%	8
Eagle Creek-Finley Creek	0.6	5.4%	7
Eagle Creek -Kreager Ditch	0.3	2.7%	9
Little Eagle Branch-Headwaters	1.1	6.8%	6
Mounts Run- Neese Ditch	0.2	1.3%	10
Little Eagle Branch- Woodruff	1.7	12.5%	5
Eagle Creek- Jackson Run	2.4	12.7%	3
Fishback Creek (Eagle Creek Reservoir)	2.1	10.0%	4
Eagle Creek- Long Branch/Irishman Run	5.2	27.3%	1
Eagle Creek Reservoir-School Branch	3.0	14.9%	2

Location of Point Sources Assessment (NPDES)

Using the location of each NPDES permit (point source and combined animal feeding operation, CAFO) located within Eagle Creek Watershed, the number of point sources within each subwatershed was counted (Figure V-11, Figure V-12). Subwatersheds were then ranked against each other such that the subwatershed with the most NPDES permitted point sources received the lowest rank and the subwatershed with the least received the highest rank (Table VI-17).

Table VI-17: Subwatershed Rank by Number of NPDES and CAFO Sources that Discharge into the Stream

Subwatershed	# Point Sources* and CAFOs	Rank
Eagle Creek - Dixon Branch	1 NPDES 1 CAFOs	2
Eagle Creek - Finley Creek	0 NPDES 0 CAFOs	8
Eagle Creek - Kreager Ditch	0 NPDES 2 CAFOs	2
Little Eagle Branch - Headwaters	4 NPDES 0 CAFOs	1
Mounts Run - Neese Ditch	0 NPDES 0 CAFOs	8
Little Eagle Branch - Woodruff Branch	2 NPDES 0 CAFO	2
Eagle Creek - Jackson Run	2 NPDES 0 CAFO	2
Fishback Creek (Eagle Creek Reservoir)	0 NPDES 1 CAFO	7
Eagle Creek - Long Branch/Irishman Run	2 NPDES 0 CAFOs	2
Eagle Creek Reservoir - School Branch	0 NPDES 0 CAFOs	8

* Only NPDES permits classified as Process Water, Sanitary, or Stormwater Run-off were used in the ranking.

Unsewered Communities Assessment

Using the location of each unsewered community found within Eagle Creek Watershed, each unsewered community was assigned to a subwatershed. Subwatersheds were then ranked with the subwatershed with the greatest number of known unsewered homes receiving the lowest rank and the subwatershed with the lowest number of unsewered homes receiving the highest rank. Using data from the Indiana Community Action Association's "Unsewered Community Survey Report" (2003), this assessment showed that Little Eagle Branch – Woodruff Branch has the most unsewered homes in Eagle Creek Watershed.

Table VI-18: Subwatershed Rank by Number of Unsewered Homes

Subwatershed	# Unsewered	
	Homes	Rank
Eagle Creek - Dixon Branch	*	5
Eagle Creek - Finley Creek	*	5
Eagle Creek - Kreager Ditch	26	3
Little Eagle Branch - Headwaters	48	2
Mounts Run - Neese Ditch	*	5
Little Eagle Branch - Woodruff Branch	62	1
Eagle Creek - Jackson Run	*	5
Fishback Creek (Eagle Creek Reservoir)	22	4
Eagle Creek - Long Branch/Irishman Run	*	5
Eagle Creek Reservoir - School Branch	*	5

* According to the INCAA report, no unsewered communities were surveyed in these watersheds as of April 18, 2003.

Headwater Stream Assessment

Using the classifications discussed in Section V., subwatersheds were ranked according to the percentage of stream miles that could be designated as a headwater stream (1st and 2nd order). Subwatersheds with a larger percentage of stream reach classified as headwater streams received the lowest rank and subwatersheds with the lowest percentage of stream reach classified as headwater streams were ranked the highest. This analysis showed that Eagle Creek-Finley Creek, Little Eagle Branch –Headwaters, Fishback Creek (Eagle Creek Reservoir), and Eagle Creek Reservoir – School Branch had the greatest amount of headwater streams: all stream reaches (100%) in these subwatersheds were classified as headwater streams.

Table VI-19: Subwatershed Rank by Headwater Stream Classification

Subwatershed	Headwater Streams*		Rank
	mi	%	
Eagle Creek - Dixon Branch	24.1	84%	5
Eagle Creek - Finley Creek	15.2	100%	1
Eagle Creek - Kreager Ditch	13.1	68%	9
Little Eagle Branch - Headwaters	20.6	100%	1
Mounts Run - Neese Ditch	29.4	81%	6
Little Eagle Branch - Woodruff Branch	18.7	71%	8
Eagle Creek - Jackson Run	22.6	73%	7
Fishback Creek (Eagle Creek Reservoir)	31.2	100%	1
Eagle creek - Long Branch/Irisman Run	12.1	55%	10
Eagle Creek Reservoir - School Branch	12.1	100%	1

* A headwater stream was defined as a 1st and/or 2nd order stream.

Results of Assessment

Once all subwatersheds were ranked for all parameters, parameters were parsed into two major categories: (1) Level of Degradation based on water quality parameters and (2) Level of Vulnerability to on-going and future degradation based on land-use/land cover assessments and other pertinent aspects of the subwatersheds. Then, with all parameters equally weighted, the average for each category was calculated and the subwatersheds were ranked according to their Level of Degradation (Category 1) and Vulnerability (Category 2). The subwatershed ranks of these two categories were then averaged. This average was then used to determine the subwatersheds overall rank, or Rank Score. This provided insight into how subwatersheds compared in terms of Level of Degradation (Category 1), Level of Vulnerability (Category 2), and overall. As with the individual parameter rankings, the most impacted subwatershed received the lowest rank and the least impacted received the highest rank (Table VI-20 and Table VI-21).

This assessment showed that Mounts Run – Neese Ditch, Little Eagle Branch – Woodruff Branch, and Little Eagle Branch – Headwaters showed the highest level of overall water quality degradation (Category 1 Evaluation Table VI-20), and that Eagle Creek Reservoir – School Branch, Fishback Creek (Eagle Creek Reservoir), and Little Eagle Branch – Woodruff Branch exhibits the greatest amount of overall subwatershed vulnerability to on-going and future degradation (Category 2 Evaluation Table VI-20). Overall Rank Scores showed that Little Eagle Branch – Woodruff Branch, Fishback Creek (Eagle Creek Reservoir), Little Eagle Branch – Headwaters, and Mounts Run – Neese Ditch ranked the lowest for all parameters in all categories.

This overall analysis demonstrates the importance of an integrated approach to improving water quality in Eagle Creek Watershed: All subwatersheds pose serious challenges for remediation as there are multiple contaminants of concern and multiple land-use/land cover stressors that may be contributing to the subwatersheds degraded water quality.

Summary of Findings:

- According to IDEM 303(d) listings and water quality data, most Eagle Creek Subwatersheds do not meet criteria to support the Watershed's designated uses. This is supported by the Benchmark Assessment which showed that most subwatersheds exceeded *E. coli* thresholds designated for water bodies to support full body contact recreation (235 cfu/100 mL) more than 50% of the time sampled (Tier 1:Appendix D). 2003 load data show that the subwatersheds with the greatest contribution of *E. coli* (cfu/acre-year) are Little Eagle Branch – Woodruff Branch and Eagle Creek - Jackson Run, and Little Eagle Branch Headwaters. As ECR has a designated use as a drinking water resource, subwatersheds were characterized for Atrazine and nitrate concerns based on the number times they exceeded IAC 327 and US EPA Primary Drinking Water Regulations of 3 ppb of Atrazine. Benchmark Analysis show that the Tier 2 threshold of 3 ppb of Atrazine is exceeded approximately 10% of the time, with some subwatersheds such as Eagle Creek – Long Branch/Irishman Run and Little Eagle Branch -

Woodruff Branch exceeding the threshold 35% and 24% of the time, respectively (Tier 2:Appendix). Recent storm flow data from an on-going 2005 study show that Atrazine concentrations can exceed 75 ppb in Eagle Creek Watershed.

- Tier 2 Benchmark Analysis of Total N and Total P show that nutrient concentrations often exceed the national averages for Total N and Total P in US watersheds with at least 50% agricultural land-use: both were exceeded at least 50% of the time sampled. Load analysis shows that over 880 tons of Total N and 58 tons of Total P are transported in Eagle Creek Watershed streams annually. This load divided by the total acreage of Eagle Creek Watershed results in an average watershed Total N flux of approximately 500 lb/acre-year and a Total P flux of approximately 1 lb/acre-year. These nutrients are most likely sourced from agricultural production, inadequate septic systems, animal waste and residential area runoff, NPDES point source discharges and uncontrolled stormwater in tributary streams and in ECR. Land cover and land-use perturbation assessments show that ECW is under pressures from agriculture, urban development, and increasing population demands. A watershed land-use analysis done utilizing the LUCI model for ECW projected that Eagle Creek Reservoir - School Branch, Fishback Creek (Eagle Creek Reservoir), Eagle Creek – Long Branch/Irishman Run, Eagle Creek - Jackson Run, and Little Eagle Branch – Woodruff Branch would be more than 50% urbanized by 2040 (Tedesco *et al.*, 2003). Using 2003 Single Family Home Permits issued per township, new home building is currently focused in Eagle Creek Reservoir - School Branch, Fishback Creek (Eagle Creek Reservoir), Eagle Creek – Long Branch/Irishman Run, Eagle Creek - Jackson Run, and Little Eagle Branch – Woodruff Branch, making these subwatersheds highly susceptible to land-use perturbations and sediment loading, which threaten the sustainability of the watershed's designated uses.
- Total suspended sediment data, Adequate Buffer Assessments, Streambank Slope Analysis, Streambank Erosion Assessments, Land-use Perturbation Assessments, and Impervious Surfaces Assessments show that the watershed is susceptible to suspended sediment contamination from streambanks, cropland, construction sites, and ditches.
 - For example, Fishback Creek (Eagle Creek Reservoir) which contributed 985 lbs/acre-year of suspended sediment has adequate woody riparian buffers on only 57% of its stream, relatively steeply sloped streambanks, moderate visually assessed streambank erosion, a high level of land-use perturbation due to the transformation of farmland to suburban land-use, and impervious surfaces covering 10% of the watershed. All of these can contribute to total suspended sediment loading. All other subwatersheds show similar multiple vulnerabilities to suspended sediment loading.
 - During Spring runoff events (CIWRP 2003 data), all subwatersheds except Eagle Creek Reservoir - School Branch exceeded TSS benchmark criteria of 263 mg/L (Utah and South Dakota standard for warm water streams) for protection of aquatic life.
 - Total suspended solids load analysis showed that the combined subwatersheds of Little Eagle Branch – Woodruff Branch and Eagle Creek - Jackson Run contributed the greatest TSS load: 1,250 lb/acre-year.

- All subwatersheds are lacking adequate buffer along many of the stream reaches: Eagle Creek - Dixon Branch (80%), Little Eagle Branch – Woodruff Branch (74%), Mounts Run – Neese Ditch (71%), and Eagle Creek Reservoir - School Branch (67%) have the highest percent of stream reach with inadequate buffers.
- Streambank Slope Analysis, Streambank Erosion, and Land-use Perturbation, and Impervious Surface Assessments show that the three lower subwatersheds closest to the Reservoir (i.e., Eagle Creek – Long Branch/Irishman Run, Eagle Creek Reservoir – School Branch, and Fishback Creek (Eagle Creek Reservoir)) have the highest streambank slope, the greatest amount of streambank erosion, are most susceptible to land-use perturbation, and the highest amounts of impervious surfaces.
- Commonwealth Biomonitoring’s 2001 report showed that Fishback Creek (Eagle Creek Reservoir), Mounts Run – Neese Ditch, and Little Eagle Branch – Woodruff Branch had low biotic index values for fish or benthos, indicating that habitat in these streams was not able to support diverse fish and macroinvertebrate communities. The lack of clean-water taxa and abundances of tolerant taxa indicate that the watershed may be undergoing degradation such that it will not be capable of supporting a well-balanced, warm water aquatic community.

Table VI-20: Determination of Subwatershed Rank Score**Category 1: Level of Water Quality Degradation**

Subwatershed	# Parameters	Average	Category 1 Rank
Eagle Creek - Dixon Branch	8	3.38	3
Eagle Creek - Finley Creek	11	4.64	9
Eagle Creek - Kreager Ditch	7	4.00	7
Little Eagle Branch - Headwaters	10	2.40	3
Mounts Run - Neese Ditch	11	2.00	1
Little Eagle Branch - Woodruff Branch	11	2.18	2
Eagle Creek - Jackson Run	7	2.43	4
Fishback Creek (Eagle Creek Reservoir)	11	3.09	5
Eagle Creek - Long Branch/Irishman Run	7	4.29	8
Eagle Creek Reservoir - School Branch	11	4.64	9

Category 2: Level of Vulnerability to On-going and Future Degradation

Subwatershed	# Parameters	Average	Category 2 Rank
Eagle Creek - Dixon Branch	11	5.45	5
Eagle Creek - Finley Creek	11	6.09	9
Eagle Creek - Kreager Ditch	11	5.82	7
Little Eagle Branch - Headwaters	11	4.55	3
Mounts Run - Neese Ditch	11	6.09	9
Little Eagle Branch - Woodruff Branch	11	4.73	4
Eagle Creek - Jackson Run	11	5.64	6
Fishback Creek (Eagle Creek Reservoir)	11	3.45	2
Eagle Creek - Long Branch/Irishman Run	11	5.91	8
Eagle Creek Reservoir - School Branch	11	2.91	1

Rank Score and Evaluation

Subwatershed	1 & 2 Sum	Rank Score	Evaluation*	
			Level of Degradation	Level of Vulnerability
Eagle Creek - Dixon Branch	8	4	3 - High	5 - Moderate
Eagle Creek - Finley Creek	18	10	9 - Low	9 - Low
Eagle Creek - Kreager Ditch	14	8	7 - Moderate	7 - Moderate
Little Eagle Branch - Headwaters	6	1	3 - High	3 - High
Mounts Run - Neese Ditch	10	5	1 - High	9 - Low
Little Eagle Branch - Woodruff Branch	6	1	2 - High	4 - Moderate
Eagle Creek - Jackson Run	10	5	4 - Moderate	6 - Moderate
Fishback Creek (Eagle Creek Reservoir)	7	3	5 - Moderate	2 - High
Eagle Creek - Long Branch/Irishman Run	16	9	8 - Low	8 - Low
Eagle Creek Reservoir - School Branch	10	5	9 - Low	1 - High

* 1 – 3 = High; 4 – 7 = Moderate; and 8 – 10 = Low

Table VI-21: ECW Subwatershed Rankings. Lowest ranking subwatersheds are shaded.

Category 1: Level of Water Quality Degradation												
Subwatershed	303(d)	Tier 1	Tier 2	Tier 3	Atraz.	TSS	TotN	TOC	TotP	Mac*	Fish	
Eagle Creek - Dixon Branch	2	n/a	n/a	n/a	1	4	1	4	4	6	5	
Eagle Creek - Finley Creek	2	4	5	1	4	5	6	5	4	8	7	
Eagle Creek - Kreager Ditch	1	n/a	n/a	n/a	n/a	4	1	4	4	7	7	
Little Eagle Branch - Headwaters	2	3	1	5	n/a	3	2	2	2	2	2	
Mounts Run - Neese Ditch	2	1	1	1	2	4	1	4	4	1	1	
Little Eagle Branch - Woodruff Branch	2	3	1	5	2	1	4	1	1	2	2	
Eagle Creek - Jackson Run	2	n/a	n/a	n/a	n/a	1	4	1	1	4	4	
Fishback Creek (Eagle Creek Reservoir)	2	4	5	1	5	2	3	3	3	3	3	
Eagle Creek - Long Branch/Irishman Run	2	6	1	5	7	n/a	n/a	n/a	n/a	4	5	
Eagle Creek Reservoir - School Branch	2	1	1	1	5	6	5	6	6	9	9	

Criteria 2: Level of Vulnerability to On-going and Future Degradation												
Subwatershed	LUCI 2040	2003 Permits	Erosion	Stream Buffer	Live-stock Access	Trash	Tile/ Drain Pipe	ARB [†]	Imp. Surf.	NPDES	USC ^o	HW [□]
Eagle Creek - Dixon Branch	9	6	9	2	8	6	1	1	8	2	5	5
Eagle Creek - Finley Creek	6	6	7	6	8	4	10	7	7	8	5	1
Eagle Creek - Kreager Ditch	7	6	7	5	1	5	6	6	9	2	3	9
Little Eagle Branch - Headwaters	1	5	10	1	8	6	8	2	6	1	2	1
Mounts Run - Neese Ditch	7	9	9	6	1	8	3	3	10	8	5	6
Little Eagle Branch - Woodruff Branch	1	5	5	8	3	6	5	5	5	2	1	8
Eagle Creek - Jackson Run	3	3	4	8	3	9	9	8	3	2	5	7
Fishback Creek (Eagle Creek Reservoir)	3	4	1	4	3	1	4	9	4	7	4	1
Eagle Creek - Long Branch/Irishman Run	2	2	3	10	6	10	7	9	1	2	5	10
Eagle Creek Reservoir - School Branch	5	1	2	2	6	2	2	4	2	8	5	1

Shaded cells represent subwatershed that were combined in that category to determine a rank. Thus, the rank is for all highlighted subwatersheds.

* Mac = Macroinvertebrate Ranking

† Adequate Riparian Buffer Analysis done using ArcView GIS.

‡ Headwater Stream Assessment

o Unsewered Communities

□ Headwater Stream