St. Joseph River Watershed Initiative

2005 Water Quality Sampling Report

Prepared by Aaron Wartenberg
Water Resource Specialist

March 31, 2006

St. Joseph River Watershed Initiative Partnership, Inc.
3718 New Vision Drive
Fort Wayne, IN 46845
(260) 484-5848 x3
fax (260-484-5080
www.sjrwi.org

Executive Summary

The St. Joseph River Watershed Initiative has completed analysis of the water quality sampling data for the 2005 sampling season. The following report summarizes the findings and general trends throughout the watershed and at sites of historical concern.

The 2004 Water Quality Report offered a mixed assessment of St. Joseph River trends, and 2005 continues the same trend. The Initiative focuses on three parameters for in-depth analysis: atrazine, *E. coli*, and total suspended solids (TSS). Other parameters are analyzed as indicator contaminants and where higher concentrations require further examination. The 2004 bacteria numbers indicated overall improvements while continuing to demonstrate severely high concentrations on single sampling events. This pattern continued in 2005, particularly at the traditional sites of concern for the parameter. It was noted in 2004 that persistently contaminated sites were allowing the Initiative to further focus on problem locations and clarify the areas of greatest concern. This trend held true for bacteria in 2005, at sites noted further in the text of this report.

Atrazine results also followed the trend established in the previous seasons. Concentrations of the herbicide continued to remain low as a yearly average for all sampling locations. No site averaged more than 3.00 µg/L, and only one site averaged more than 1.50 µg/L atrazine. The number of exceedences of the 3.00 µg/L Environmental Protection Agency maximum contaminant level decreased dramatically as well. The 2005 sampling season did, however, produce consistently elevated metolachlor levels. The concentrations of this previously seldom used herbicide are presented following the atrazine results.

Sediment data is presented in great depth in this report, and highlights several sites of concern for high turbidity and total suspended solids (TSS) levels. While this report finds encouraging improvements in most parameters, sediment loading is an increasing concern in several sub-watersheds of the St. Joseph River. A sediment reduction grant from the Great Lakes Commission (GLC) will play a large role in identifying the sources of sediment loading throughout the larger watershed. The initial phase of the GLC grant produced a set of GIS map layers of ongoing conservation practices for each county in the St. Joseph Watershed. These layers were completed following the 2005 season and will function as data analysis and modeling tools in assessing the sediment loads and targeted areas for load reductions. The grant will also provide some funding for on-the-ground sediment reduction practices through June, 2006.

Copies of this report and previous water quality reports are available from the St. Joseph River Watershed Initiative Partnership, 3718 New Vision Drive, Fort Wayne, Indiana 46845, and on the organization's website, www.sjrwi.org.

Sampling Summary

The 2005 sampling season began on April 5 and was concluded on October 1, 2005. Sampling was conducted every Tuesday at the following sites in the St. Joseph River Watershed:

Table 1: 2005 sampling sites and parameters.

Site Name	Site Number	Location	Parameters
Cedar Creek	100	Tonkel Rd, Allen Co.	Full + nutrients
Willow Creek	101	Coldwater Rd, Allen Co.	Full
Black Creek	102	CR 7A, Dekalb Co.	Full
Little Cedar Creek	103	CR 64, Dekalb Co.	Full
Diehl/Peckhart Ditch	104	SR 427, Dekalb Co.	Full + nutrients
Matson Ditch	106	CR 39, Dekalb Co.	Full + nutrients
Garrett City Ditch	117	CR 15, Dekalb Co.	Full
Shank Ditch	123	CR 75A, Dekalb Co.	Full
Fish Creek	124	SR 49, Williams Co., Ohio	Full
St. Joe - West	125	US 20, Williams Co., Ohio	Full + nutrients
St. Joe - East	126	SR 15, Williams Co., Ohio	Full
Big Run	127	CR 79, Dekalb Co.	Full
Bear Creek – IN	128	SR 1, Dekalb Co.	Full
Nettle Creek	129	SR 576, Williams Co., Ohio	Full
Eagle Creek	130	CR J, Williams Co., Ohio	Full
Bear Creek – OH	131	SR 34, Williams Co., Ohio	Full + nutrients
Matthews Ditch	132	CR 4, Williams Co., Ohio	Full
East Fork – West	134	Sampson Rd, Hillsdale Co., MI	Full
West Fork – West	135	Sampson Rd, Hillsdale Co., MI	Full
Walter Smith Ditch	141	CR 39, Dekalb Co.	Full + nutrients
David Link Ditch	142	CR 37, Dekalb Co.	Full
Dibbling Ditch	143	CR 18, Dekalb Co.	Full
East Branch	145	Reading Rd., Hillsdale Co., MI	Full + nutrients
Witmer Ditch	146	Springfield Center Rd., Allen Co.	Full
Tiernan Ditch	147	St. Joe Rd., Allen Co	Full

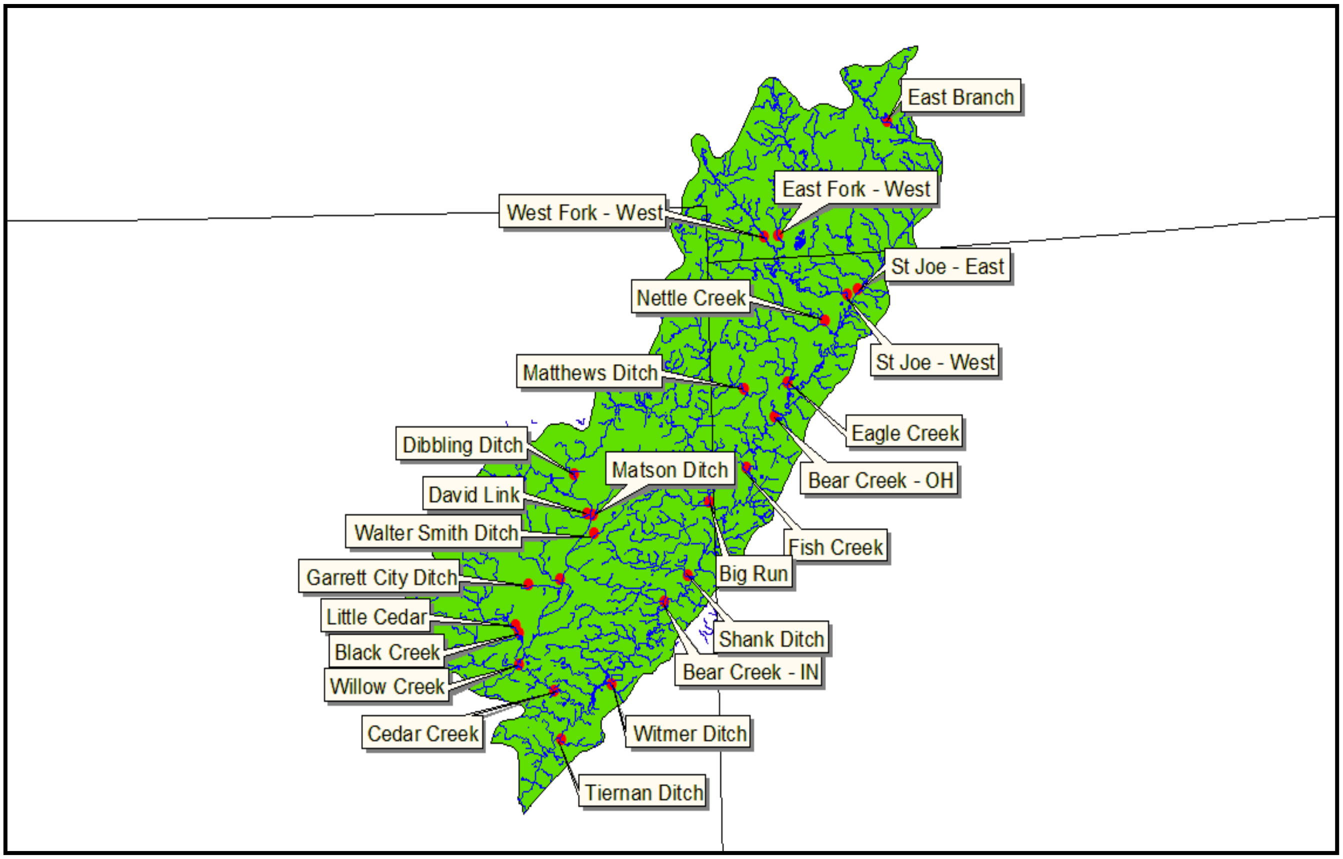

Figure 1: 2005 sampling locations.

Sites shaded in green in Table 1 on the previous page were added to the 2005 sampling roster. These sites have not been previously sampled by the Initiative. The East Branch site is the farthest upstream the Initiative has yet sampled in the watershed, about 1.3 miles southwest of the Town of Pittsford. The site samples a waterway technically known as the St. Joseph of Maumee River, which is a primary tributary of the East Branch system. The upper reaches of the St. Joseph River watershed in Hillsdale County are divided into two primary watersheds, the West Branch and the East Branch. The West Branch has been sampled at its two primary outlets, sites 134 and 135. The East Branch site was added to gain some coverage in the East Branch watershed and to gain sampling data reflecting more pristine waters high upstream in the watershed. The Witmer and Tiernan Ditch sites were added two gain more coverage in the two watersheds that will be examined as part of a 205j Watershed Management Plan grant in the next two years. Due to limitations in the volume of sampling locations and fluctuating fuel costs, the three new 2005 sites were placed on a rotating schedule in which East Branch was sampled once per month and Witmer and Tiernan were both sampled the other three monthly sampling days. Due also to seasonal flow fluctuations, the sites were sampled whenever possible and when open slots and time permitted.

2005 Sampling Parameters

The full parameters include those acquired via the Hach Hydrolab unit, those measured by hand, and bacteria and pesticide data analyzed by the laboratory at the City of Fort Wayne water filtration plant. These parameters are:

Hand Measurements
Time
Air Temp
Cloud Cover
Wind
Bridge-to-Water distance (Flow Height)

Hydrolab Measurements
Time
Water Temp
pH
Specific Conductance
Total Dissolved Solids
Dissolved Oxygen
Turbidity

Lab Measurements
Atrazine
Metolachlor
Alachlor
Cyanazine
E. Coli
Total Coliform
Heterotrophic Plate Count

Nutrient samples were taken at the indicated six sites. These samples were analyzed by the laboratory at the Water Pollution Control Plant of the City of Fort Wayne. The parameters are:

Phosphorus (total)
Ammonia (NH_3)

In addition, the East Branch site is sampled monthly for the above parameters and total nitrates.

Sampling Notes: The following conditions were of note during the sampling season.

- April 19 – Vehicle breakdown caused the sampling day to be stopped after the Dibbling Ditch site.
- May 3 – Snow and freezing temperatures throughout the Michigan sites and the first two sites in Ohio.
- May 17 – Very strong manure odor around site and in water at the Dibbling Ditch site.
- June 14 – Did not sample Matthews Ditch due to heavy equipment work around the streambanks.
- July 5 – Water at the Eagle Creek site was stagnant, but sample was still taken.
- July 12 – A very heavy oily sheen was noted at the Dibbling Ditch.
- September 13 – A very heavy oily sheen was observed at Garrett City Ditch.
- In addition, the 2005 sampling season was marked by extremely dry conditions in the St. Joseph River watershed, causing many missed samples throughout the season.

2005 Atmospheric Conditions

The 2005 sampling season was drier than the previous two seasons, resulting in low water levels and missed samples throughout the watershed. Rain gage data from several locations in the watershed illustrates the precipitation levels for the season and the previous season. All precipitation units are inches.

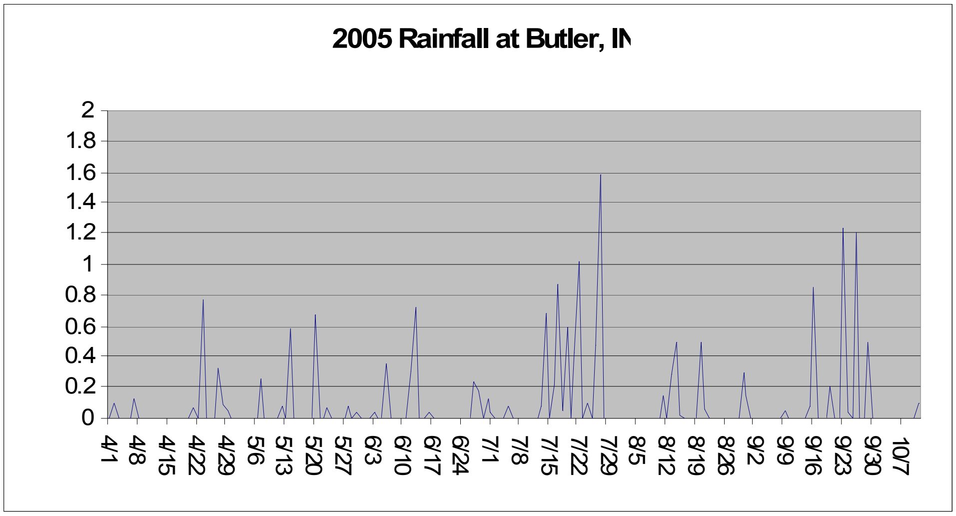

Figure 2: 2005 Precipitation at Butler, IN.

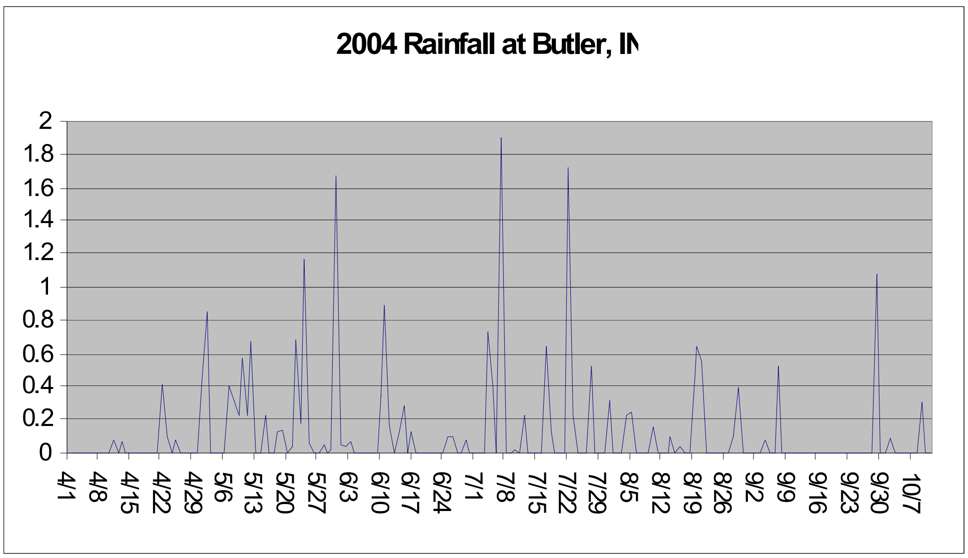

Figure 3: 2004 Precipitation at Butler, IN.

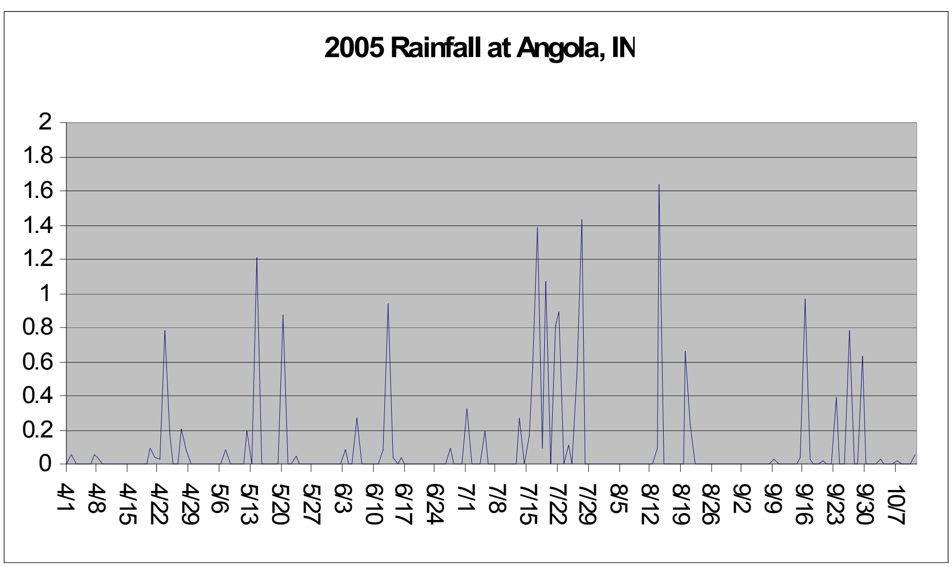

Figure 4: 2005 Precipitation at Angola, IN.

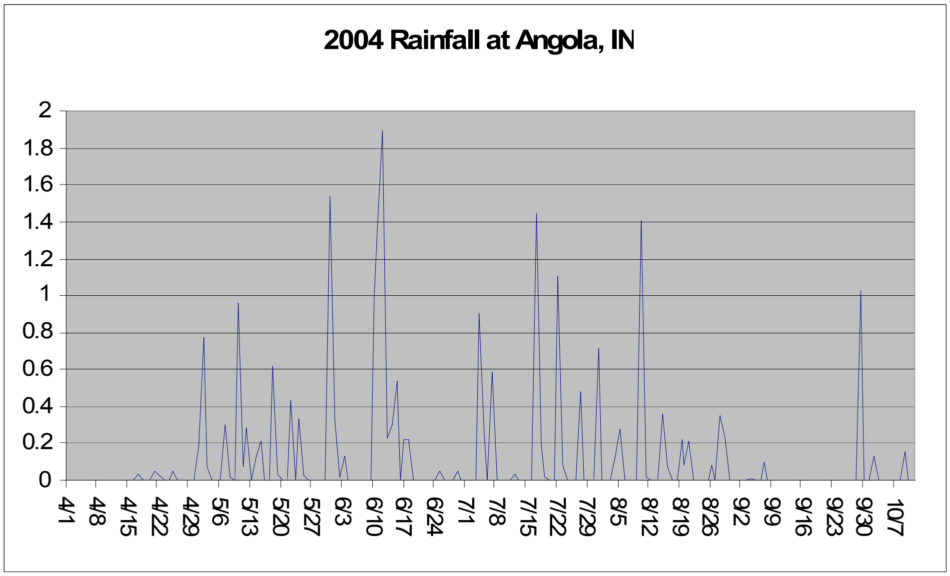

Figure 5: Precipitation at Angola, IN.

Some basic statistical analysis of the rainfall data reveals some of the differences in precipitation between 2004 and 2005 that led to the dry conditions in the waterways:

Butler, IN	**2005**	**2004**
Average Daily Precipitation	0.09	0.12
Days with No Precipitation	142	132
% of Days with No Precipitation	73	68
Average Rainfall on Days w/Precipitation	0.34	0.37
Total Inches Rainfall	17.65	22.95

Table 2: Precipitation statistics at Butler, IN.

Angola, IN	**2005**	**2004**
Average Daily Precipitation	0.099	0.120
Days with No Precipitation	144	133
% of Days with No Precipitation	74	68
Average Rainfall on Days w/Precipitation	0.38	0.37
Total Inches Rainfall	19.06	23.22

Table 3: Precipitation statistics at Angola, IN.

The above differences reflect threshold values at which major flow differences can be observed in the waterways themselves during the sampling season. Additionally, further analysis reveals that longer periods of low or no precipitation was largely responsible for ground conditions in 2005. These can be seen in the above rainfall charts for both sites. These longer periods cause conditions more favorable to low waterway flow than do long periods of steady precipitation at any amount. This is less reflected in the average daily precipitation and days with no precipitation than in the total rainfall or rainfall intensity.

2005 Flow Conditions

The following chart was generated on the United States Geological Survey real-time water data website at the URL: http://waterdata.usgs.gov/nwis. As a result of the lower precipitation during the sampling season, the St. Joseph River itself in Fort Wayne was below normal flow for the majority of the April to November sampling season.

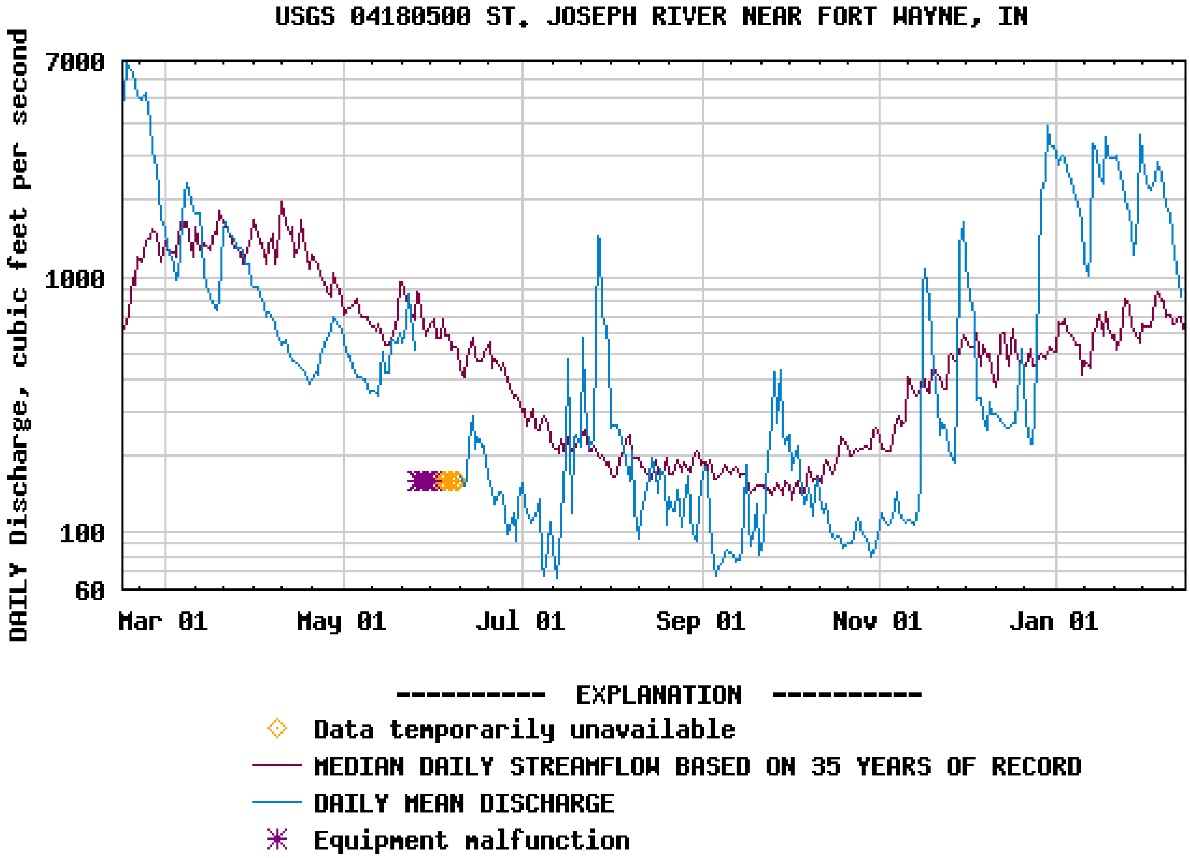

Figure 6: Streamflow in the St. Joseph River.

2005 Sampling Results

Atrazine

Average atrazine levels for each site are graphed below. No site had a season average exceeding the EPA MCL of 3.00 µg/L atrazine. 2004 results indicated a possible downward trend for atrazine levels at all sites. This pattern continued for 2005, as did the relative concentrations at the different sites. The shape of the bar graphs below remain essentially similar to previous sampling seasons. Even as levels decrease, the sites with historically elevated levels continue to be elevated over with respect to other sampling locations. Cedar Creek, Matson Ditch, Bear Creek- OH, and Walter Smith Ditch are among the sites retaining proportional similarity to previous years. While concentrations are decreasing overall, these three sites remain at the highest concentrations in the watershed.

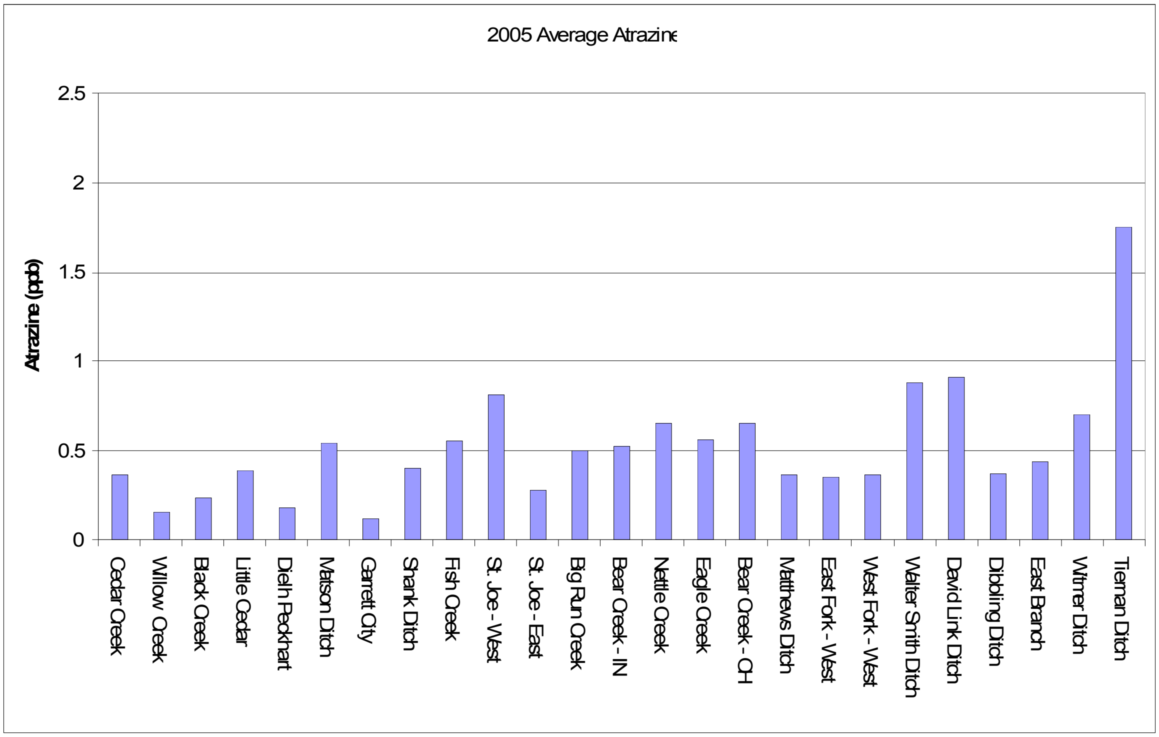

Figure 7: Average atrazine values at all sites in 2005.

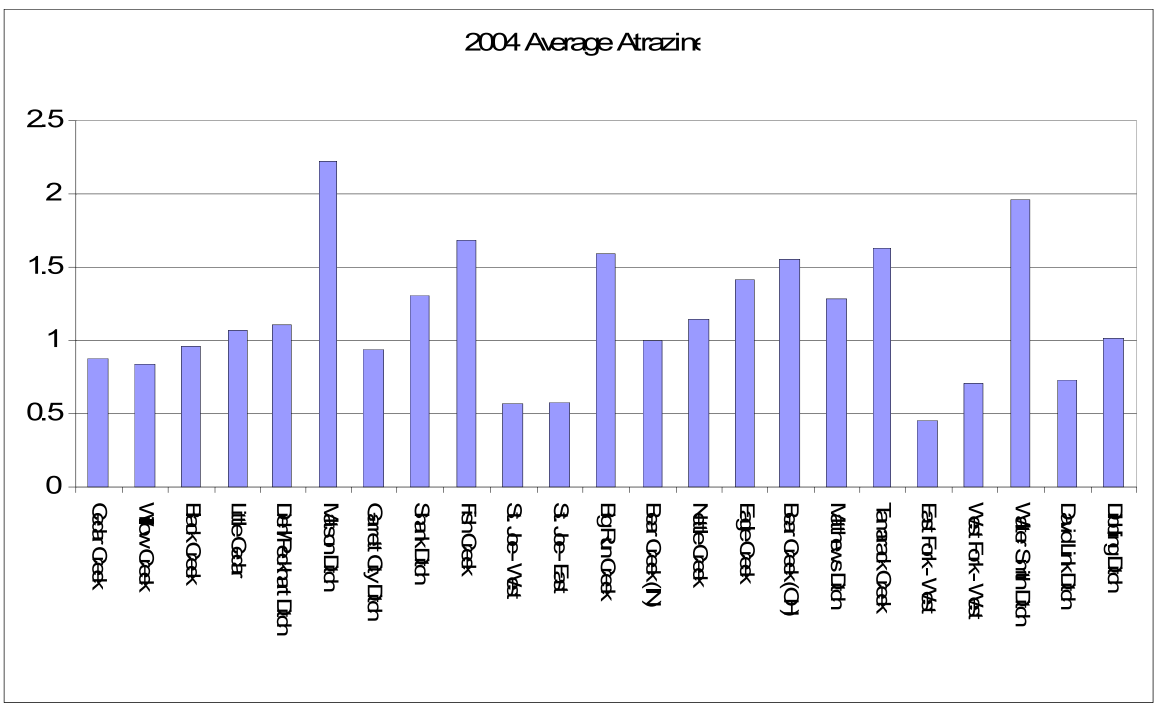

Figure 8: Average atrazine values at all sites in 2004.

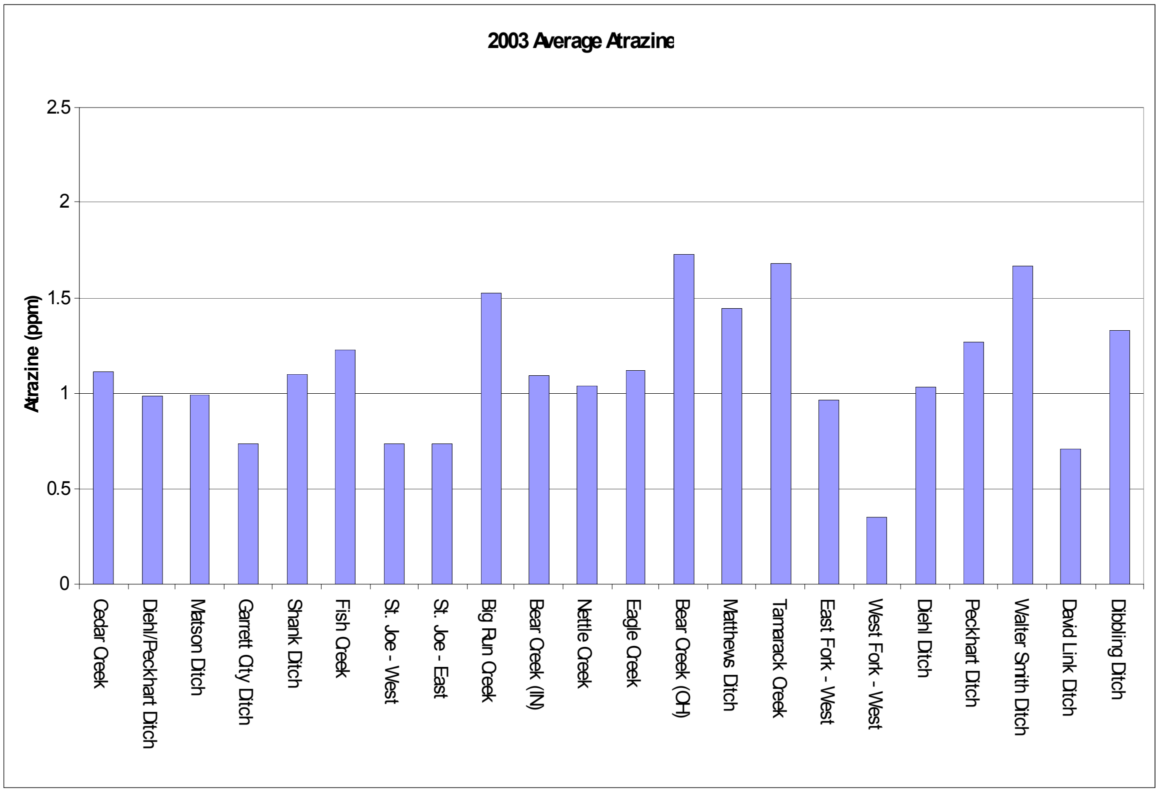

Figure 9: Average atrazine values at all sites in 2003.

A more in-depth look at the overall 2005 numbers is obtained by examining the averages along with the maximum values and the percent of times the site exceeded the 3.0 µg/L MCL.

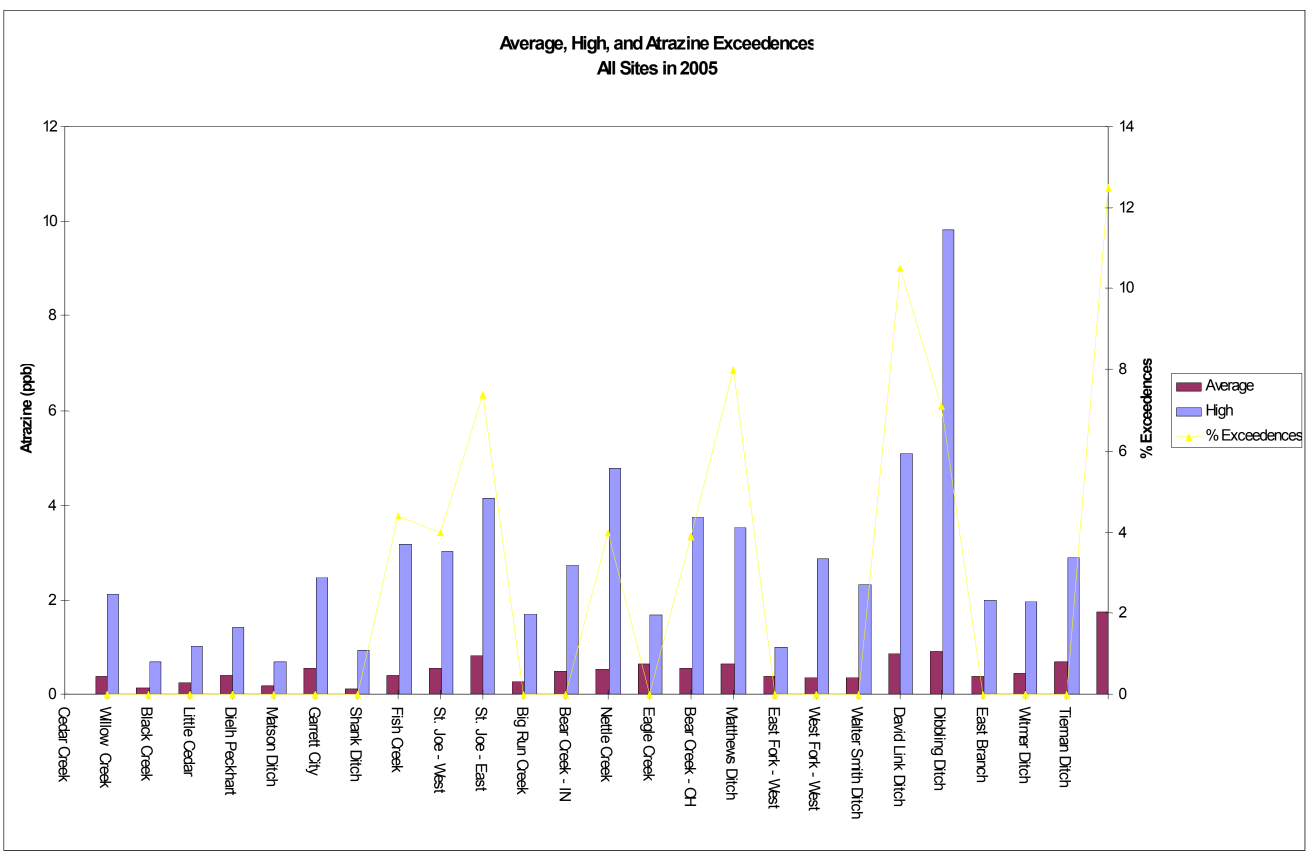

Figure 10: Average, maximum, and % exceedences at all sites in 2005.

There were 13 individual exceedences of the 3.0 µg/L MCL during the 2005 sampling season. Of these 13 exceedences, ten occurred during the traditional April/May/June peak herbicide application months. In 2004, there were 69 separate exceedences, 66 of which occurred during the peak months. In the 2004 water quality report, a chart of average exceedence values was included to provide a measure of the amounts by which the site exceeds the MCL. This chart cannot be generated for the 2005 season. Only nine sites experienced MCL exceedences in 2005 compared with 20 in 2004, and only four of these sites exceeded the MCL more than once. No site exceeded 3.0 µg/L more than twice in 2005. As a result of these numbers an exceedence average graph would be misleading and not useful for the 2005 sampling results. Instead, the following chart shows the recent decline in the numbers of sites averages more than 1.0 and 0.5 µg/L.

Year	# of Sites Below 1 µg/L	# of Sites Below 0.5 µg/L
2003	8	1
2004	10	1
2005	24	14

Table 4: Site average atrazine trends.

Individual Site Analysis

Three sites have been selected for a more in-depth historical examination in this report. These sites were selected for geographical distribution and for reasons of historical atrazine trends. The sites are: Bear Creek (Ohio), Walter Smith Ditch, and Matson Ditch. Each of these sites has demonstrated a trend toward high atrazine levels in previous sampling seasons. These sites have also demonstrated a downward trend of atrazine averages and total loads. Two sites, St. Joseph – West and West Fork West are briefly highlighted to illustrate trends at sites historically demonstrating low or varying atrazine values. The overall trends seen in 2005 are not seen at every site, but can be observed at sites historically recording high atrazine concentrations. The standard deviations show the magnitude of variance from the mean atrazine values for each year.

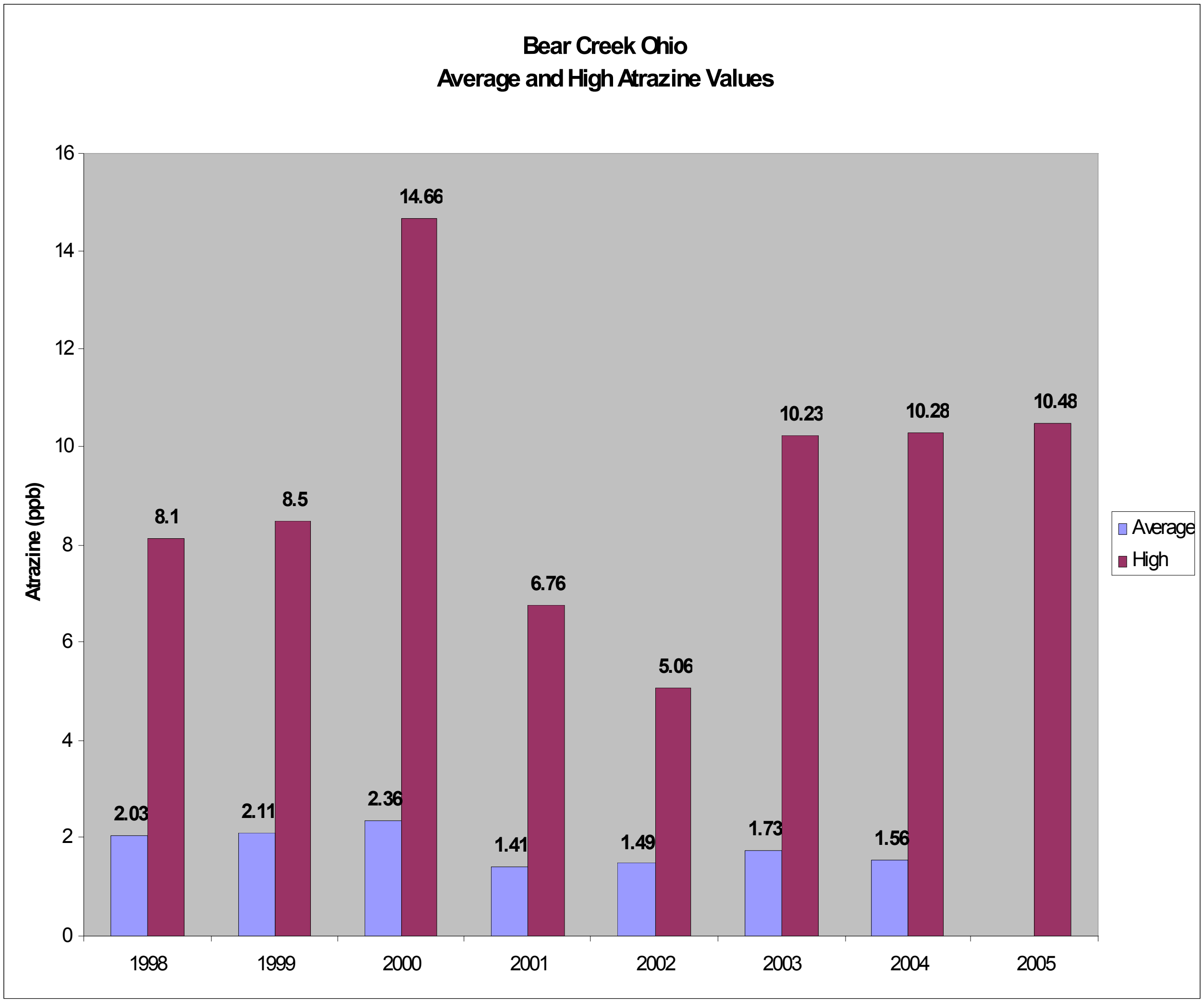

Figure 11: Bear Ohio historical average and high atrazine.

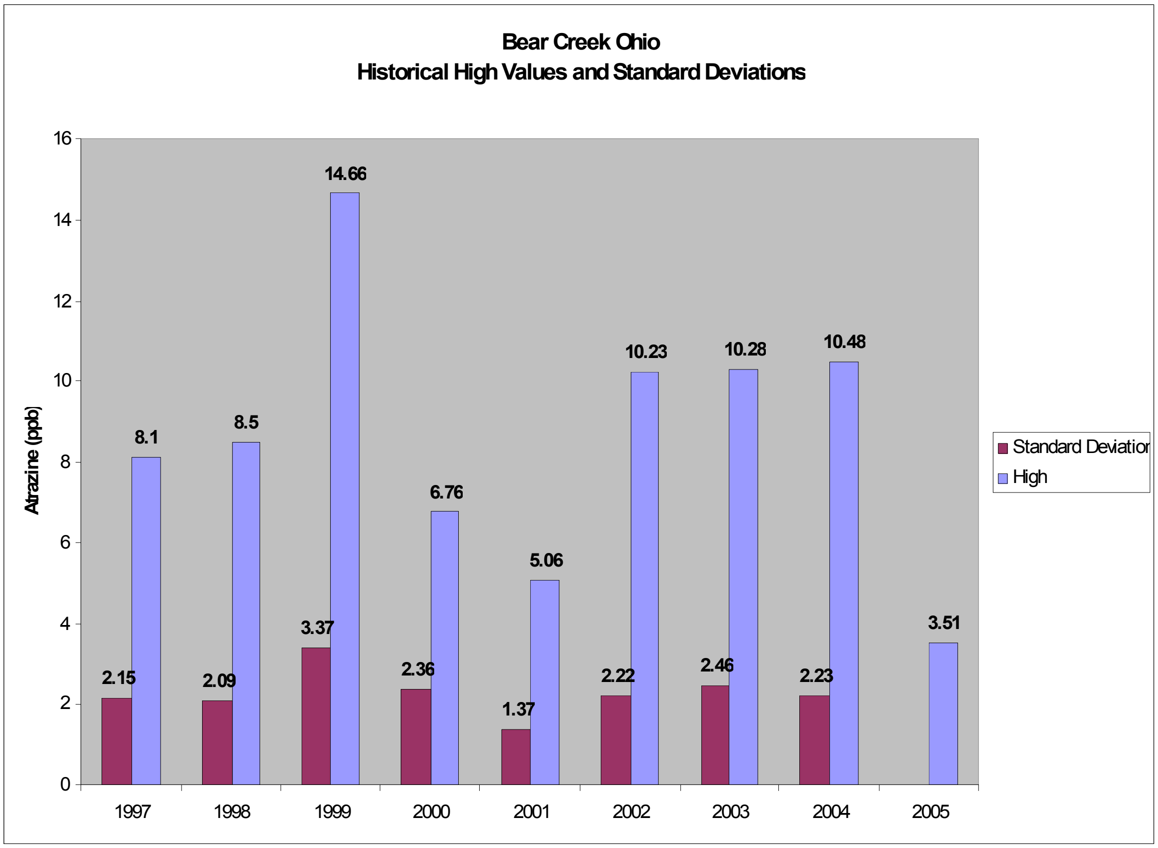

Figure 12: Bear Ohio historical atrazine highs and standard deviations.

Walter Smith Ditch

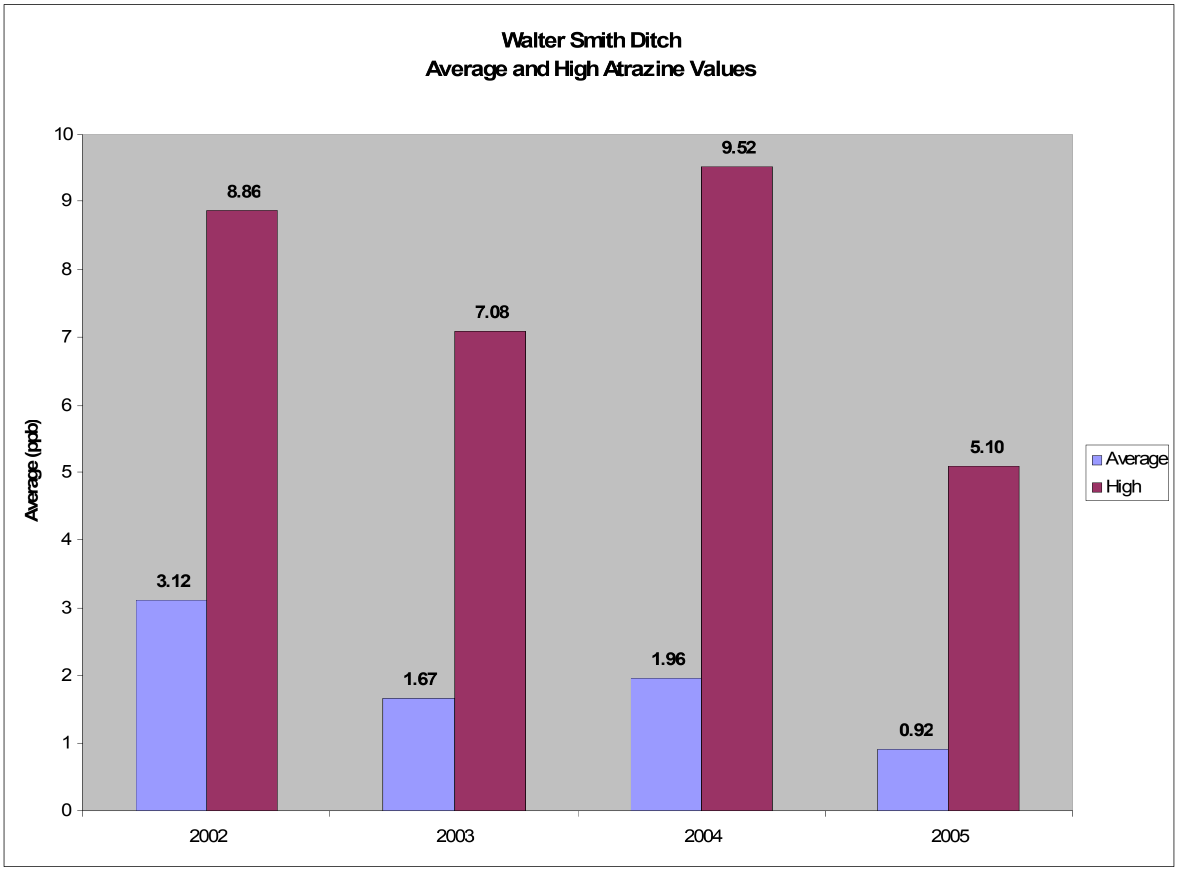

Figure 13: Walter Smith Ditch historical average and high atrazine.

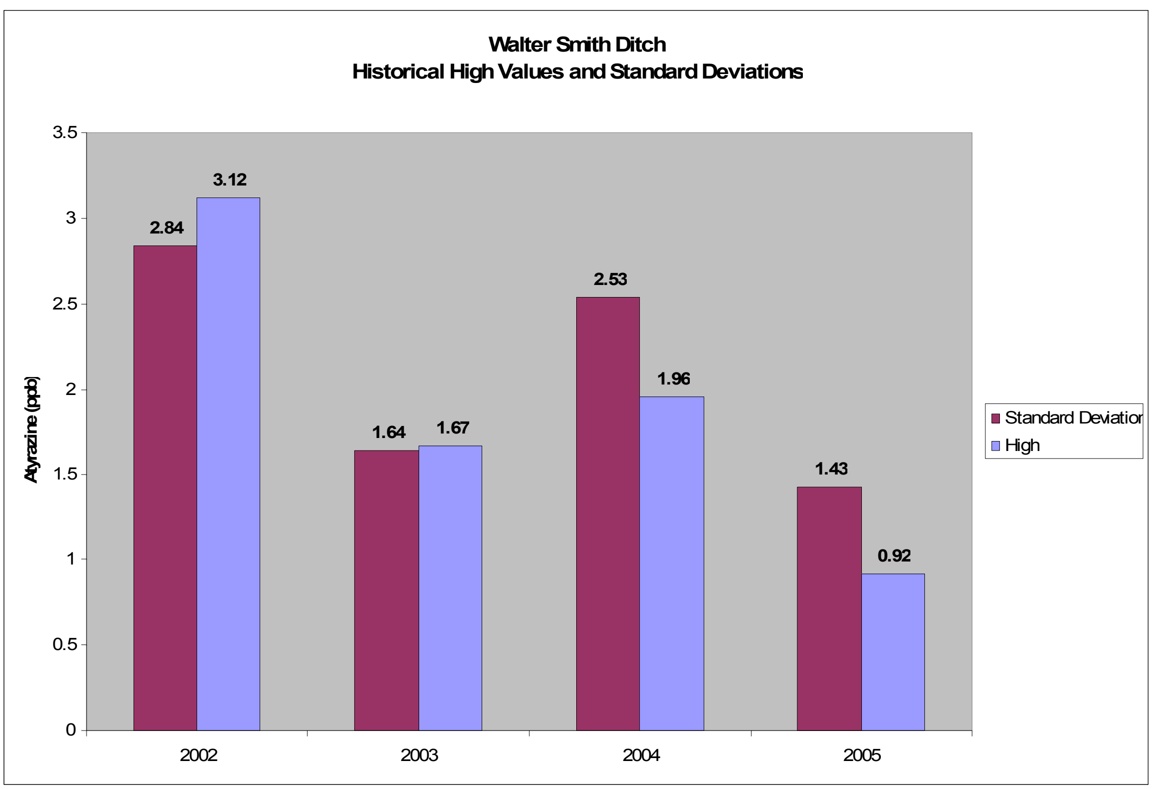

Figure 14: Walter Smith Ditch historical atrazine highs and standard deviations.

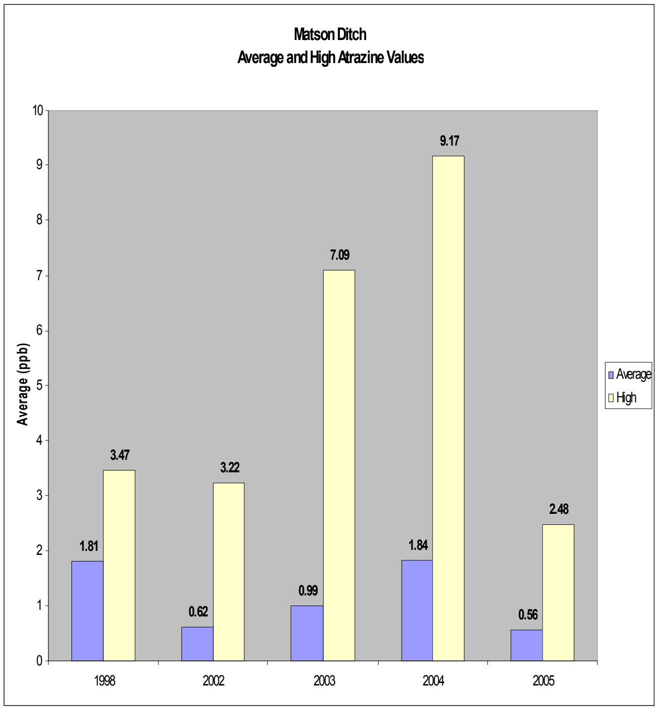

Figure 15: Matson Ditch historical average and high atrazine.

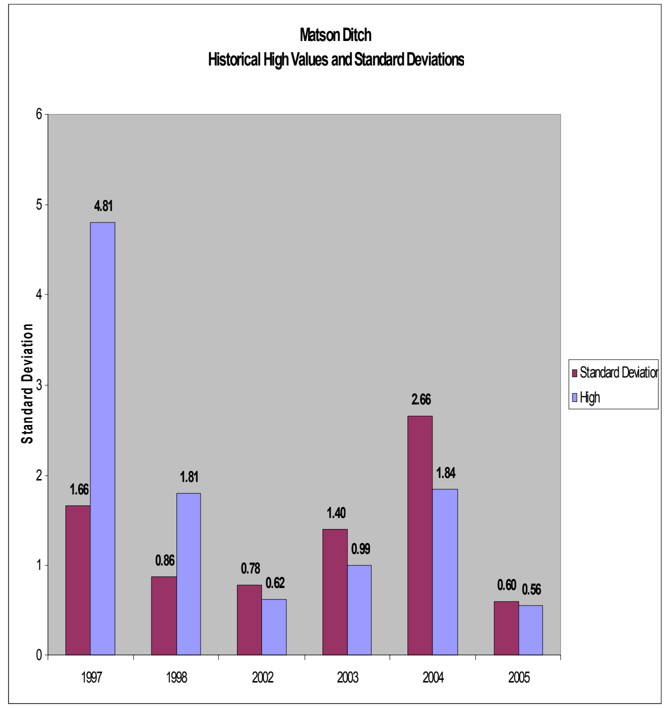

Figure 16: Matson Ditch historical atrazine highs and standard deviations.

The same general trend is noted at each of these sites. The use of standard deviations illustrates a noteworthy difference between sites demonstrating elevated atrazine levels. Standard deviations that trend lower than the high values and remain steady over time with the average values may indicate sites receiving steady contaminant input from several sources rather than period high volume input from one or only a few sources. The Bear Creek Ohio site is indicative of a stream undergoing steady and more generalized contamination, while David Link and Walter Smith appear more point-source originated.

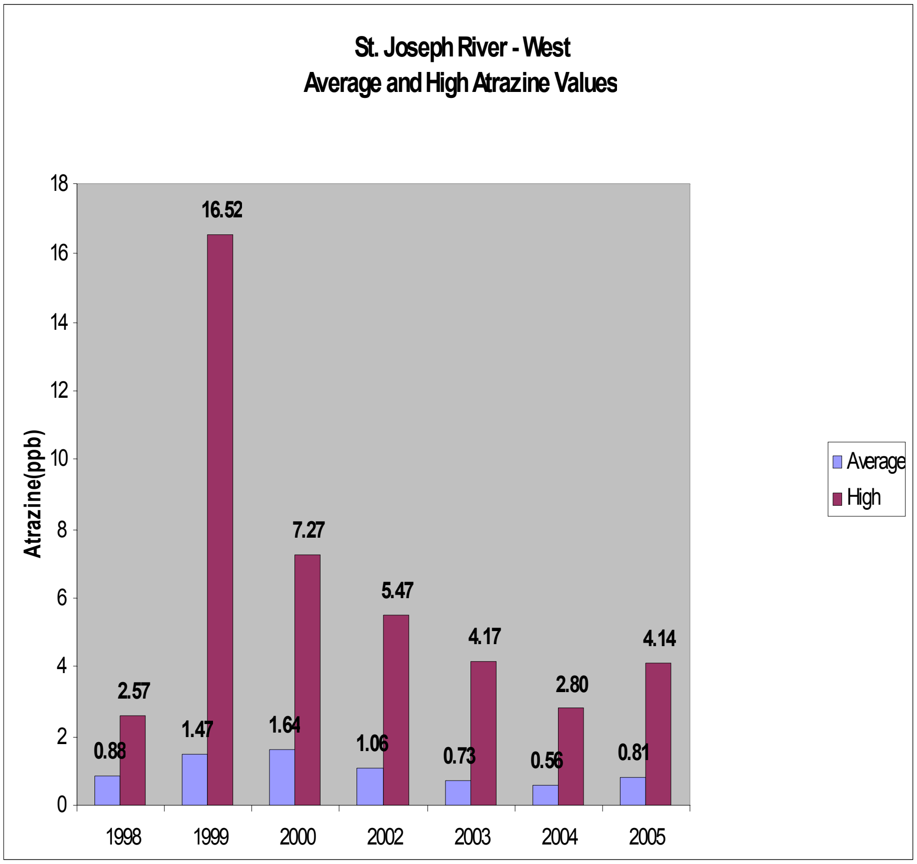

Figure 17: St. Joseph West historical atrazine highs and standard deviations .

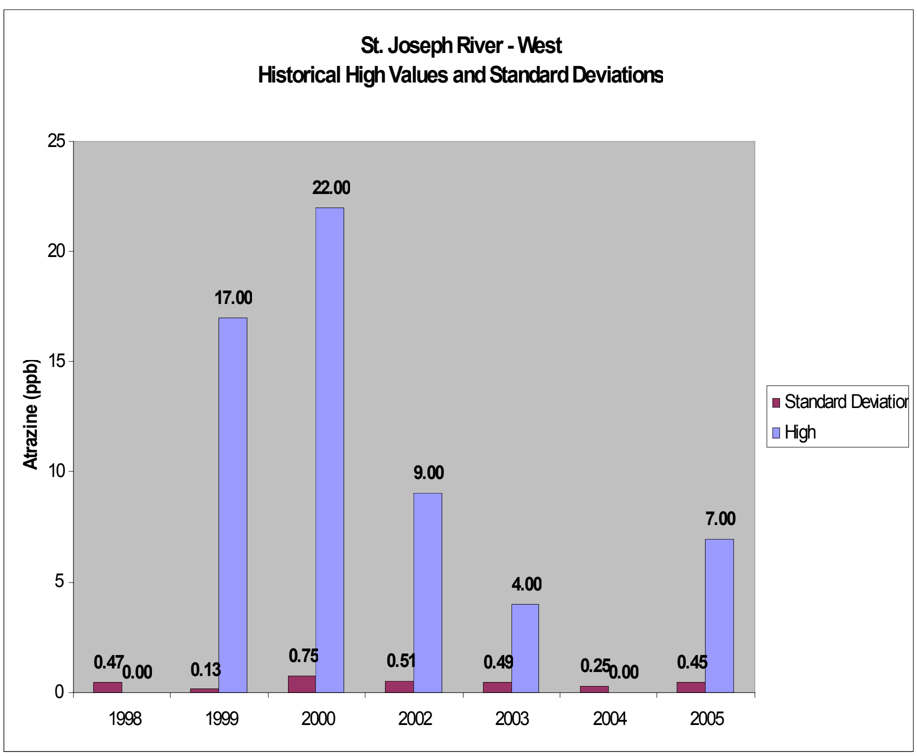

Figure 18: St. Joseph West historical atrazine highs and standard deviations.

The St. Joseph River West site is one of two sites in the watershed that experienced increases in yearly atrazine average. The other site is the David Link in Dekalb County Indiana, which increased from 0.735 µg/L to 0.937 µg/L. Atrazine and other herbicide results at David Link are of special note and will be examined later in the report.

West Fork – West

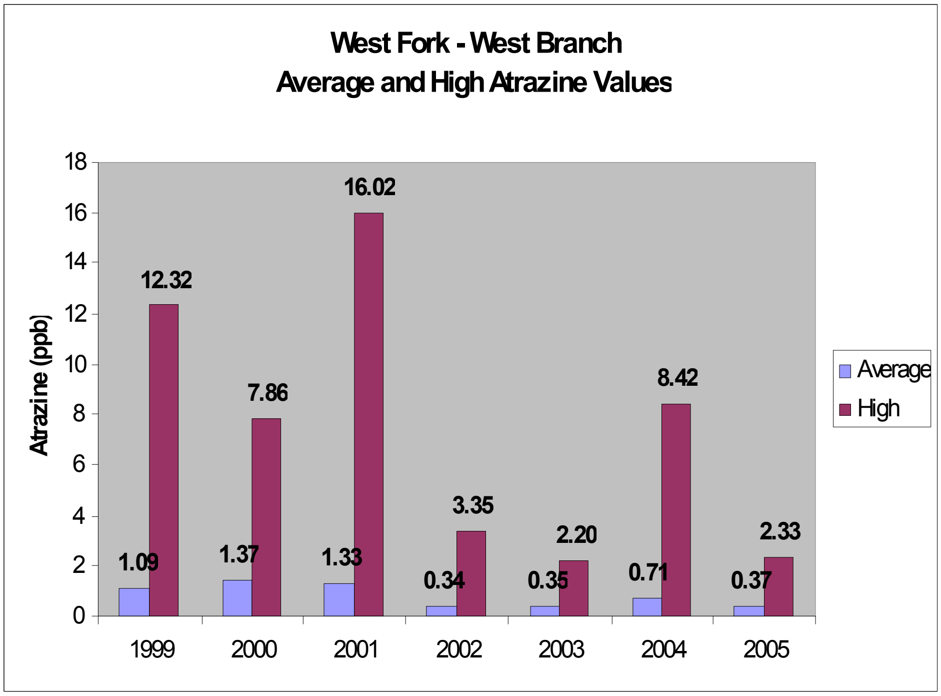

Figure 19: West Fork – West historical atrazine highs and standard deviations.

Historical Data

The following table shows the yearly atrazine averages at all sites for the past three seasons.

Site Number	Site Name	Atrazine (µg/L)		
		2003	**2004**	**2005**
100	Cedar Creek	1.114	0.871	0.347
101	Willow Creek		0.829	0.153
102	Black Creek		0.967	0.240
103	Little Cedar Creek		1.070	0.392
104	Diehl/Peckhart Ditch	0.984	1.106	0.180
106	Matson Ditch	0.993	2.219	0.543
117	Garrett City Ditch	0.732	0.939	0.116
123	Shank Ditch	1.103	1.309	0.403
124	Fish Creek	1.228	1.674	0.556
125	St. Joe - West	0.732	0.541	0.812
126	St. Joe - East	0.735	0.583	0.280
127	Big Run Creek	1.526	1.585	0.502
128	Bear Creek - IN	1.096	1.000	0.526
129	Nettle Creek	1.039	1.135	0.652
130	Eagle Creek	1.125	1.415	0.561
131	Bear Creek - OH	1.727	1.555	0.653
132	Matthews Ditch	1.441	1.279	0.363

134	East Fork - West	0.960	0.451	0.352
135	West Fork - West	0.353	0.706	0.360
141	Walter Smith Ditch	1.670	1.957	0.922
142	David Link Ditch	0.709	0.735	0.910
143	Dibbling Ditch	1.330	1.016	0.355

Table 5: Yearly atrazine averages at all sites 2003 to 2005.

Metolachlor

Although we have tested for metolachlor since 1996, it has not been a pesticide of concern in recent years for the Initiative. In 2005, however, metolachlor was detected in high concentrations at several locations across the watershed. The following chart illustrated metolachlor averages and maximum single values for each site in 2005:

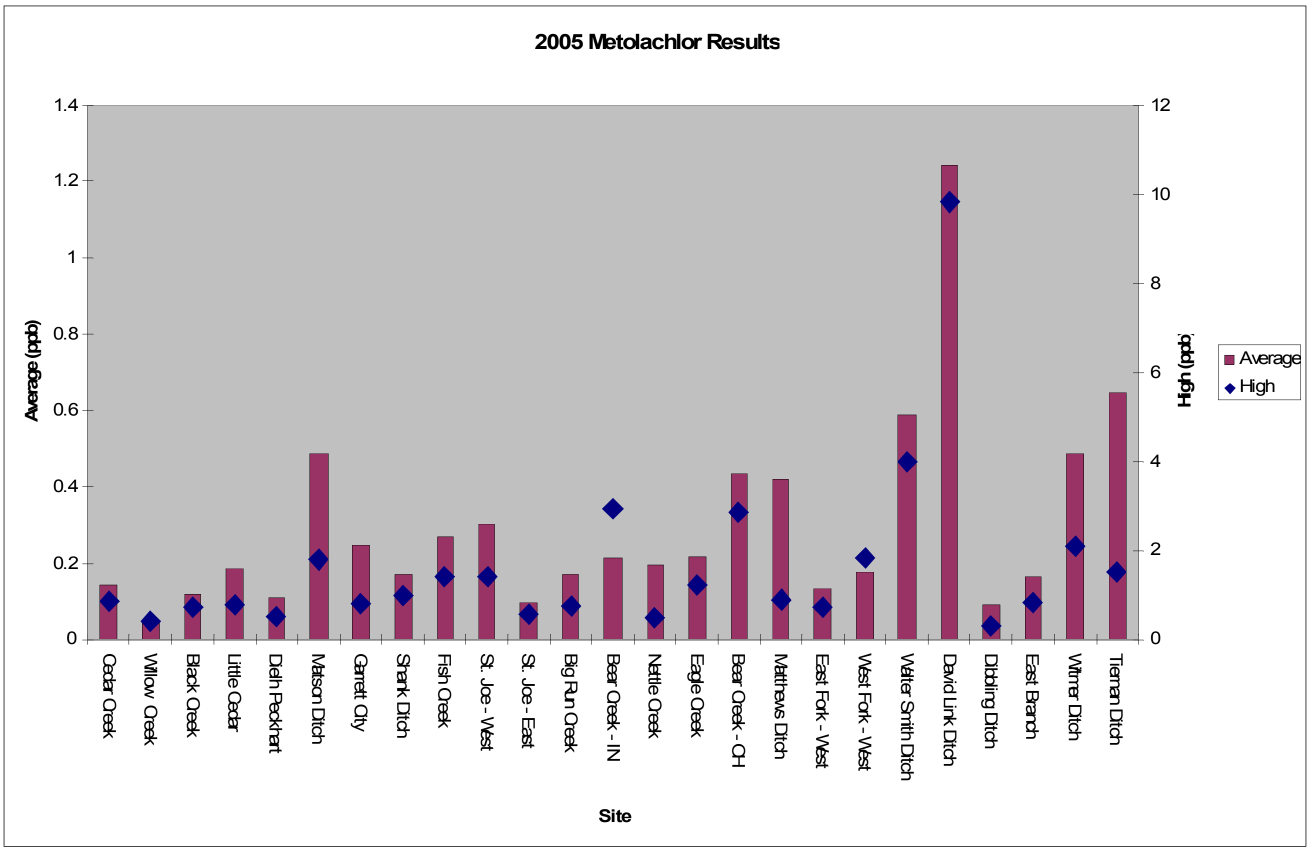

Figure 20: 2005 metolachlor averages and maximum values at all sites.

Metolachlor does not currently have an EPA Maximum Contaminant Level (MCL), but several guidelines do exist for the chemical for a variety of sources:

> Canadian Interim Maximum Acceptable Concentration: 50 µg/L
> Canadian Water Quality Guidelines Freshwater Guideline For Protection of Aquatic Life: 7.8 µg/L
> United States EPA Lifetime Exposure Health Advisory: 100 µg/kg/day

As with all the herbicides sampled for by the Initiative, metolachlor is slightly acutely toxic and a possible carcinogen to humans. In the environment, the chemical is a known groundwater contaminant and is slightly to moderately acutely toxic to aquatic animals. Metolachlor is also known to produce a chemical accumulation and mortality risk to fish, a genetic and mortality risk to amphibians, and a biochemistry, development, ecosystem process, growth, and population risk to aquatic plants.

David Link Ditch

The David Link Ditch in Dekalb County Indiana recorded very high metolachlor levels in 2005 in some unusual patterns in the distribution of the data. The yearly average in 2005 was 1.244 µg/L, an increase from 0.319 in 2004 and 0.528 in 2003, when the site was first sampled. The maximum recorded value in 2005 was 9.83 µg/L, 3.33 in 2004, and 6.40 in 2003. In the previous two seasons, the highest values were recorded during the peak application season, but in 2005 the peak season average was 0.192 µg/L and 2.22 µg/L in the off-season through October. In addition, the high standard deviation in 2005 (2.468 µg/L variation) causes concern relating to the method, timing, and purpose of the herbicide application.

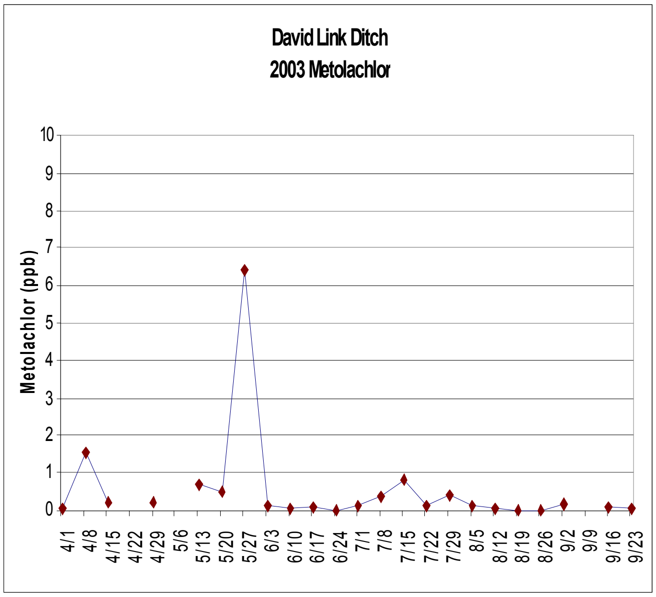

Figure 21: David Link 2003 metolachlor results.

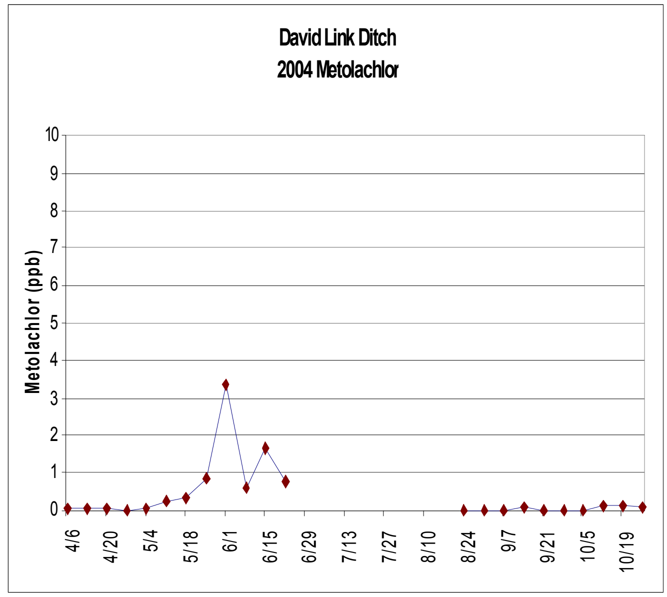

Figure 22: David Link 2004 metolachlor results.

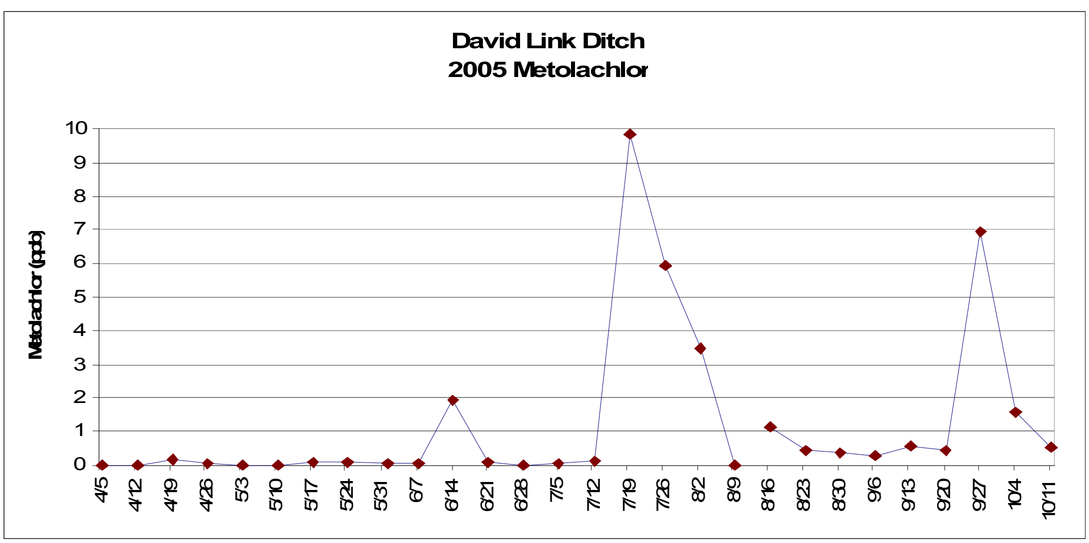

Figure 23: David Link 2005 metolachlor results.

Elevated metolachlor concentrations have been recorded at the David Link site in previous sampling seasons. In the past seasons, however, David Link was the only site in the watershed where the herbicide was detected. It was presumed then that the source was a single operator with access to a supply of the then seldom used chemical. While that may still be the case for the David Link, the 2005 metolachlor concentrations were clearly widespread across the entire St. Joseph watershed.

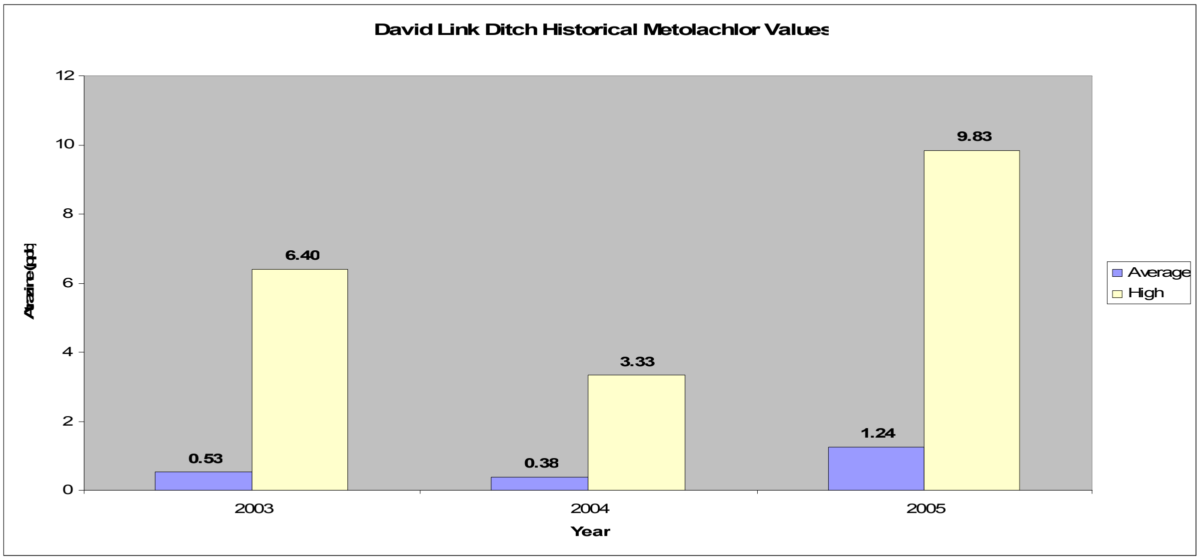

Figure 24: David Link historical metolachlor averages and maximum values.

The specific primary sources of the increased metolachlor are unclear as of this time. Several new metolachlor-based products with a wide range of applications have become available to the agriculture industry in the past year. These new products, including Sipcam Agro USA's Stalwart line, have a wider range of applications than previous metolachlor products and can be applied to corn, sorghum, grain, and soybeans for control of annual grasses and broadleaf weeds. User data is unavailable, but it is likely the increased use of Stalwart and other similar products is responsible for the metolachlor loading in 2005.

Bacteria

Bacteria levels in the watershed have always been a primary concern to the Initiative. High *E. coli* levels have consistently been recorded throughout the watershed, and 2005 was no exception. The EPA's MCL for *E. coli* in freshwaters is 235 colonies/100 mL sample. In 2005 only two sites *did not* exceed the MCL for a yearly average. Those sites were Fish Creek (193 colonies/100 mL) and Bear Creek – Ohio (189 colonies/100 mL). The highest yearly averages were recorded at Tiernan Ditch (3116 colonies/100 mL), David Link (2001 colonies/100 mL), Big Run Creek (1636 colonies/100 mL), and Garrett City Ditch (1553 colonies/100 mL). Of these sites with high averages, the Garrett City Ditch reported the most consistently high concentrations, exceeding the MCL most often.

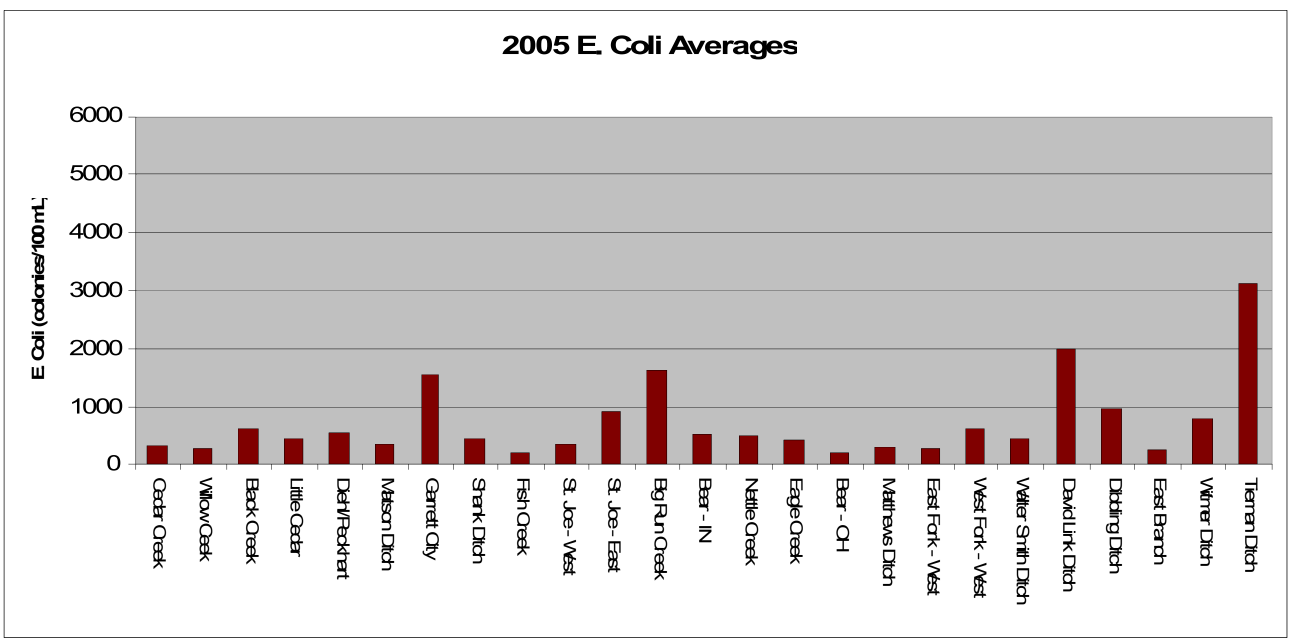

Figure 25: 2005 average *E. coli* levels at all sites.

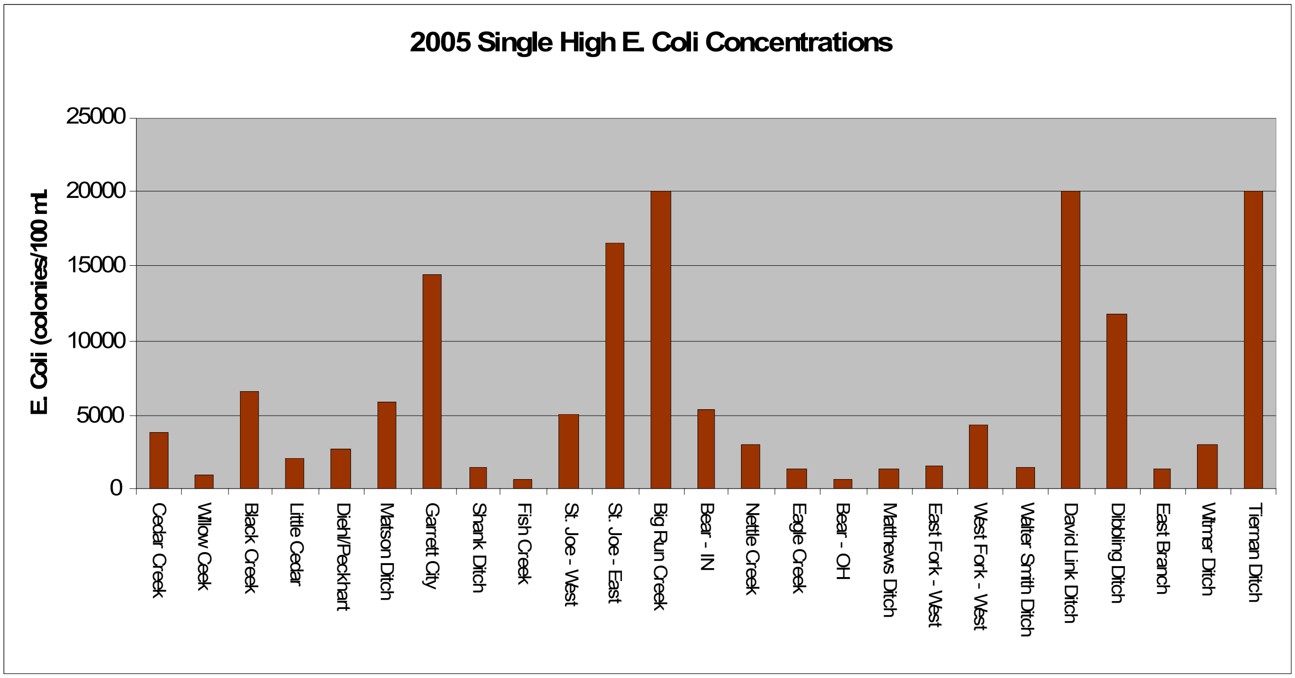

Figure 26: Maximum recorded *E. col*i levels in 2005.

The 2005 bacteria sampling results provide contaminant distribution trends when they are examined with relation to the variance of concentrations and consistency of high bacteria levels. For example, Garrett City Ditch was the most consistently highly contaminated site but did not record the highest single values. Site that exceed the MCL a high percentage of sampling days while also demonstrating lower standard deviations are appear indicative of a steady concentrated source of bacteria. The site exceeds the MCL frequently, but not by a wide variance. Indeed, the sampling site is downstream of a wastewater treatment plant, which could produce the consistently high but steady bacteria values seen in the following chart. Matthews Ditch is also located downstream of a municipal treatment plant.

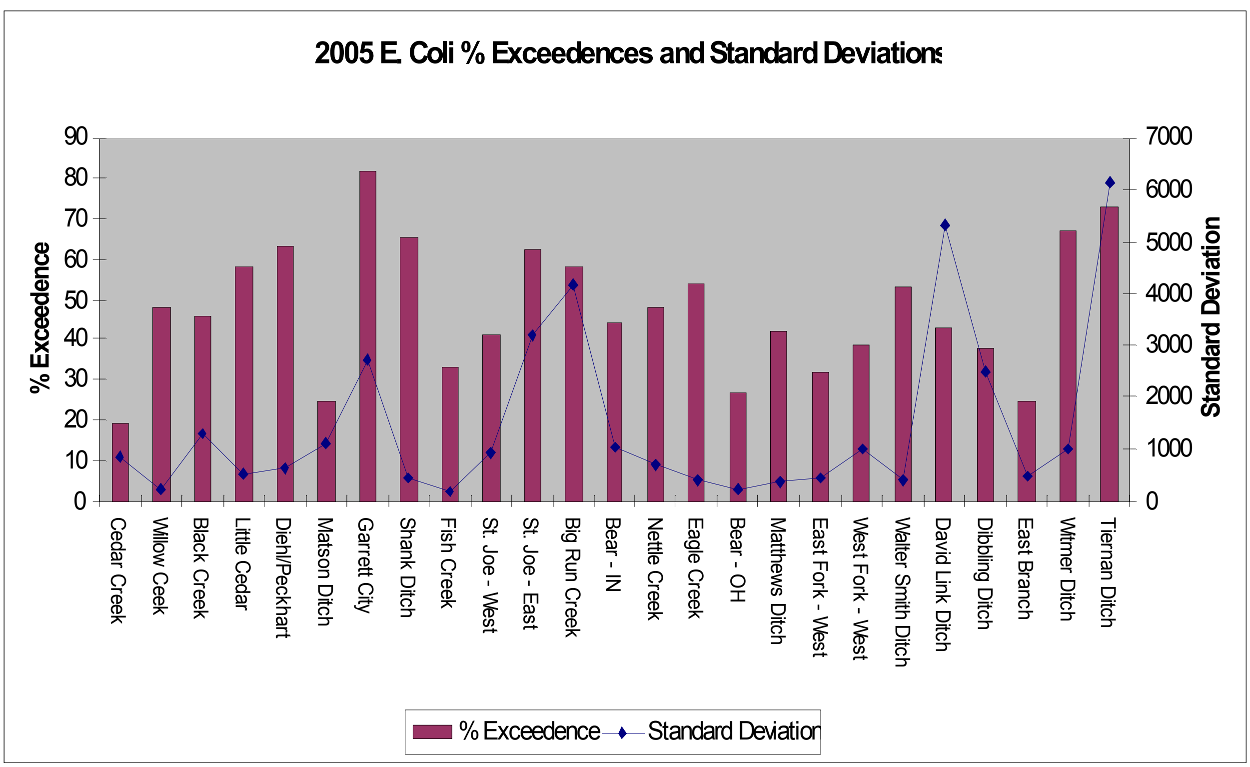

Figure 27: Percent exceedence and standard deviation at all sites in 2005.

Low level and/or widespread introduction of bacteria from a large number of point-sources may be indicated by elevated averages producing frequent MCL exceedences in combination with a low standard deviation. This condition has been observed at site located primarily agricultural areas, such as St. Joe – West and Bear – OH.

Bacteria Historical Trends

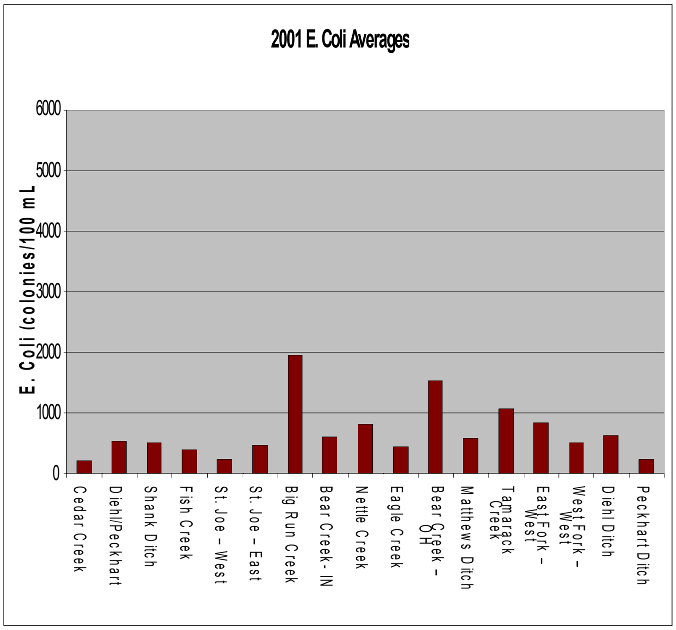

Figure 28: 2001 average *E. coli* concentrations.

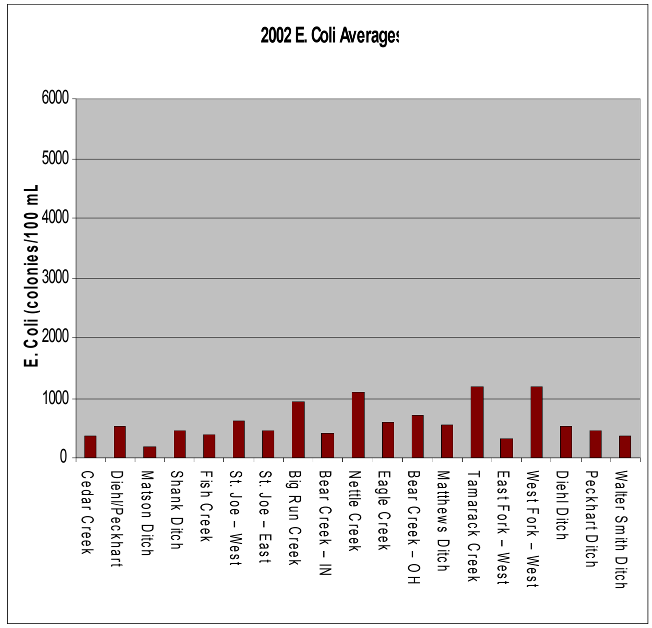

Figure 29: 2002 Average *E. coli* concentrations.

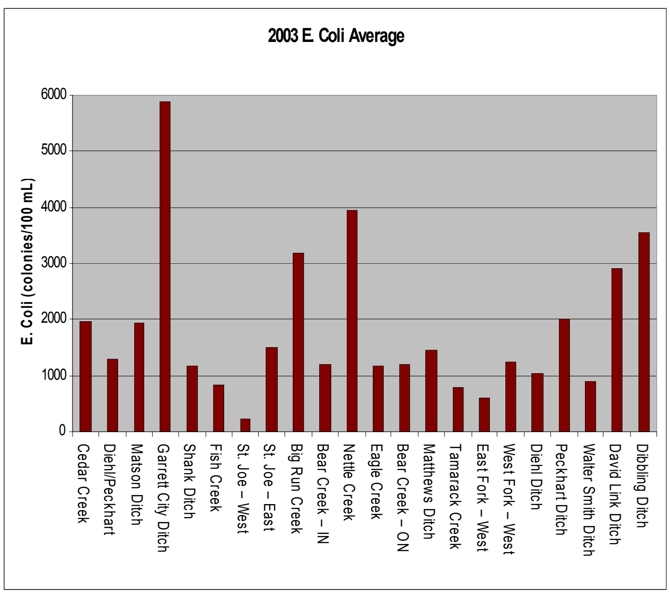

Figure 30: 2003 average *E. coli* concentrations.

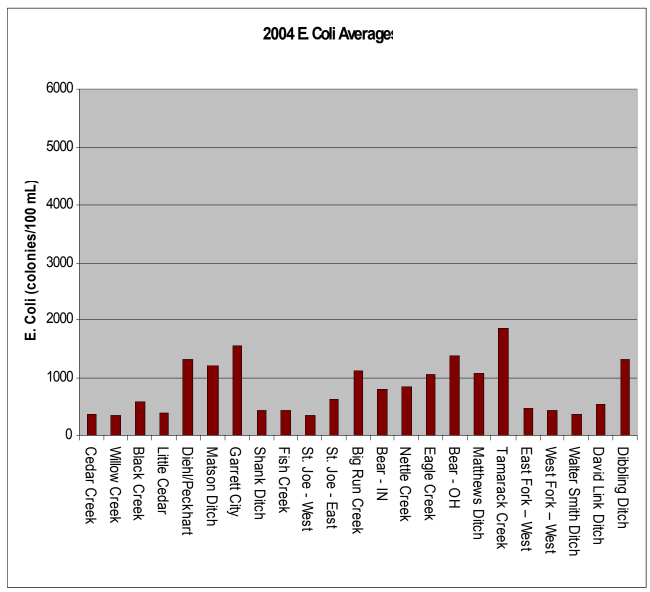

Figure 31: 2004 average *E. coli* concentrations.

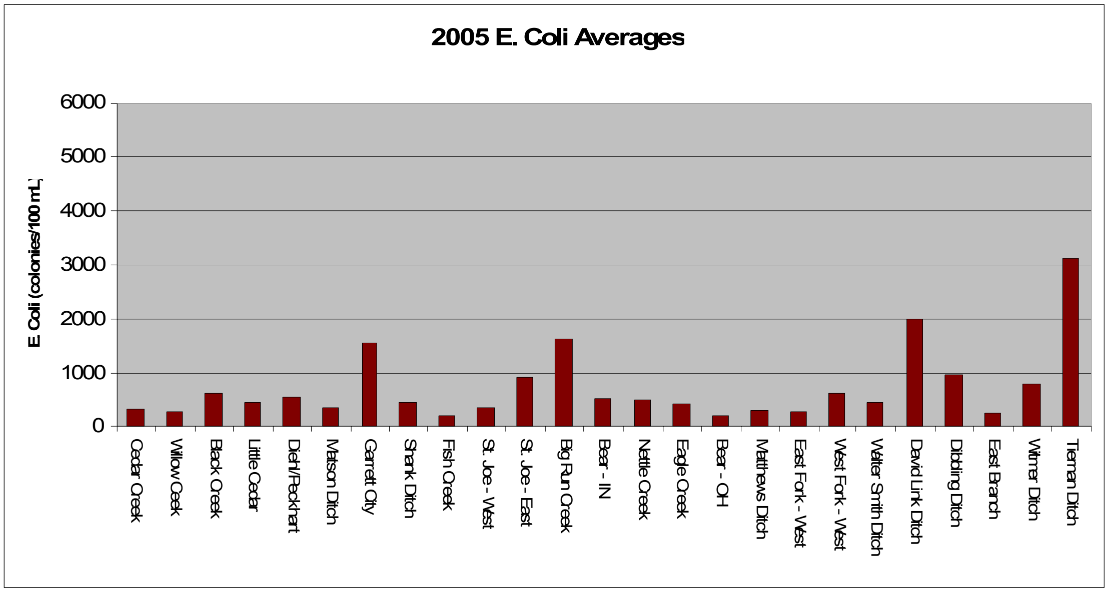

Figure 32: 2005 average *E. coli* concentrations.

Assembling all sites into a yearly watershed *E. coli* average for all sites reveals the general trend across the entire watershed:

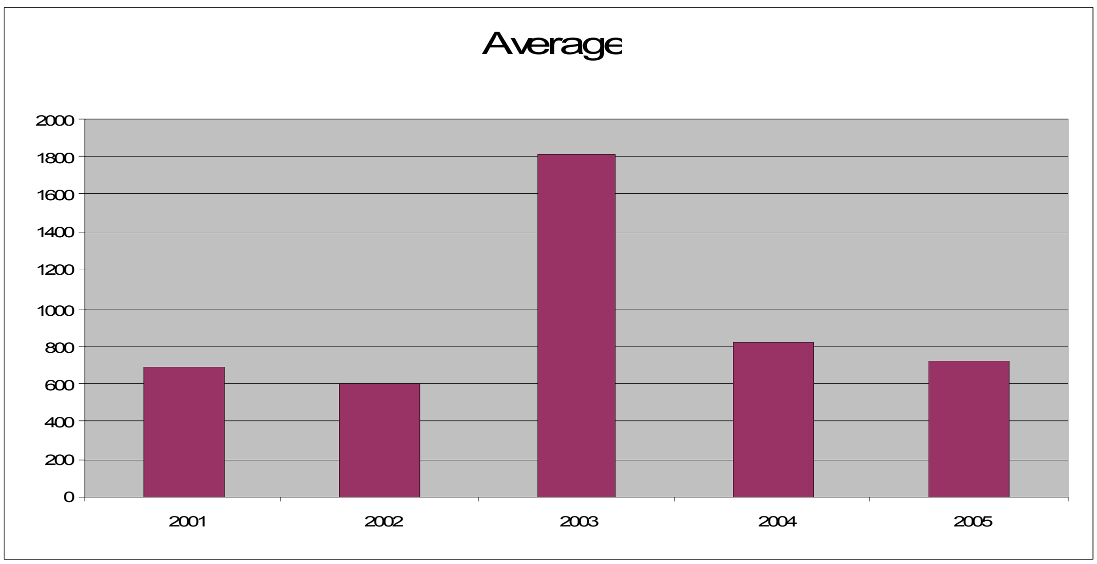

Figure 33: Overall *E. coli* average for all sites by year.

Levels of *E. coli* in the waterways and appear to be highly susceptible to influence from seasonal atmospheric conditions. A load duration curve analysis of Cedar Creek *E. coli* data indicated a variety of potential bacteria sources across the watershed, possibly influenced by patterns of urban and suburban development and conflict with agricultural areas. For example, the load duration curve (*Figure 32)* for the Cedar Creek site (100) plotted the highest volume of MCL violations during wet periods. This pattern is suggestive of *E. coli* loading produced by rainfall surface runoff. Other sites in the watershed, including Diehl/Peckhart Ditch (104) and Little Cedar Creek (103) exceeded the MCL more frequently during low to dry flow conditions. A dry weather pattern indicates point source loading of bacteria. Most sites,however, displayed exceedences spread across all flow conditions and may be influenced by a combination of point and non-point sources. In short, the averages and temporal analysis of the *E. coli* data is not sufficient data to accurately indicate problem areas and direct remediation efforts.

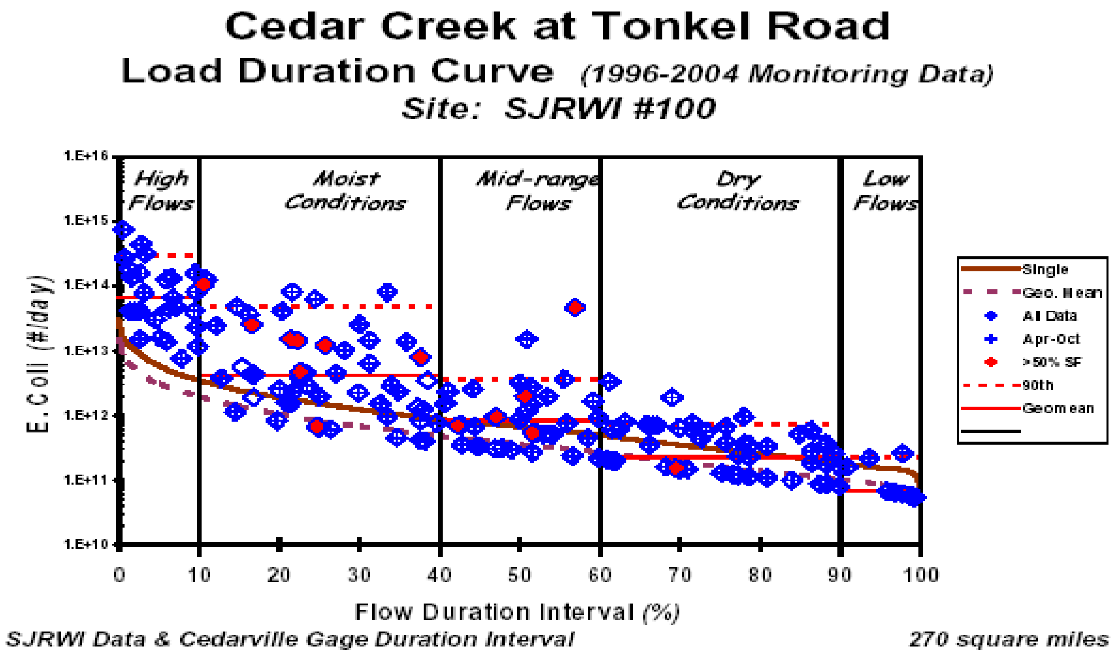

Figure 34: Load duration curve for Cedar Creek site. Chart produced by Indiana Department of Environmental Management.

The following duration curve demonstrating a dry weather pattern of *E. coli* exceedences. Point source contamination is indicated here. *E. coli* results presented in this report must be examined with seasonal atmospheric conditions in mind. The dry conditions outlined in the first data section of this report may have strongly affected the source, magnitude, and geographic distribution of the bacteria loading. Simple annual trends presented in this report are insufficient evidence of any true trends, increasing or decreasing, in the Initiative's bacteria sampling results.

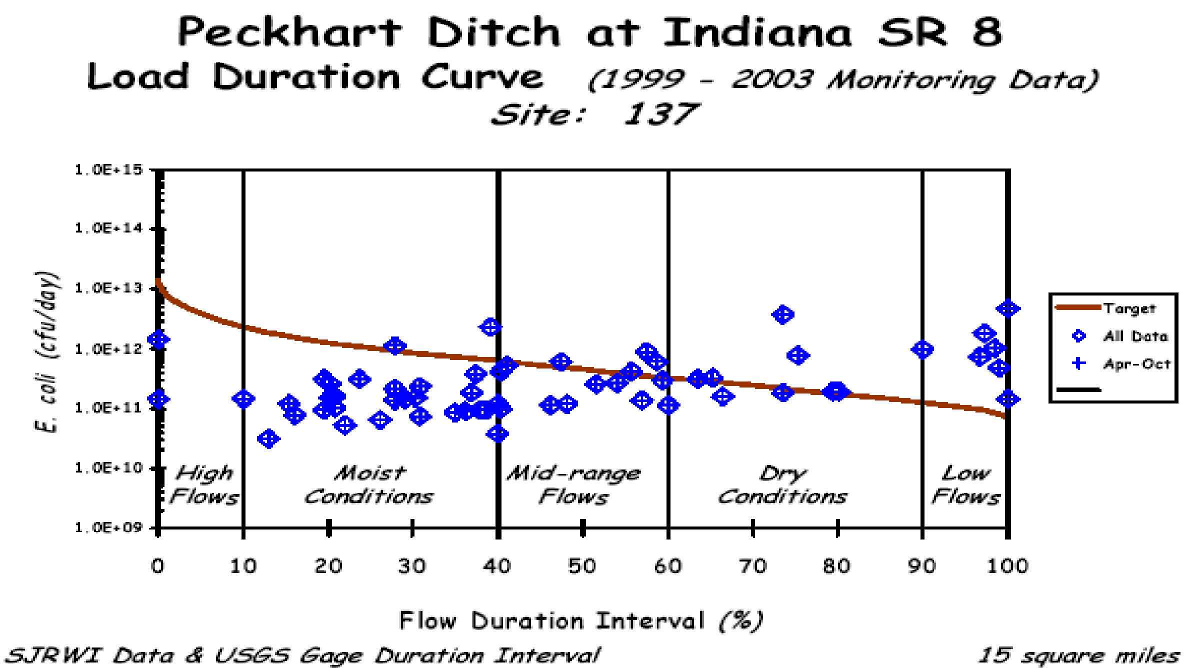

Figure 35: Load duration curve for Peckhart Ditch site. Chart created by Indiana Department of Environmental Management.

Historical Bacteria Averages

Site Number	Site Name	E. coli (colonies/100 mL)		
		2003	**2004**	**2005**
100	Cedar Creek	1954	363	324
101	Willow Creek		337	282
102	Black Creek		580	598
103	Little Cedar Creek		393	435
104	Diehl/Peckhart Ditch	1313	1332	543
106	Matson Ditch	1918	1230	369
117	Garrett City Ditch	5861	1571	1553
123	Shank Ditch	1164	449	448
124	Fish Creek	822	440	193
125	St. Joe - West	229	332	370
126	St. Joe - East	1508	639	904
127	Big Run Creek	3195	1127	1636
128	Bear Creek - IN	1193	805	560
129	Nettle Creek	3929	848	494
130	Eagle Creek	1170	1046	412
131	Bear Creek - OH	1206	1396	189
132	Matthews Ditch	1473	1076	299
134	East Fork - West	600	485	283
135	West Fork - West	1265	436	600
141	Walter Smith Ditch	915	376	452
142	David Link Ditch	2908	542	2001
143	Dibbling Ditch	3543	1318	971

Table 6: Yearly *E. coli* averages at all sites 2003 to 2005.

Historical Trends at Individual Sites

Diehl/Peckhart – The Diehl/Peckhart Ditch has historically recorded high bacteria levels. In 2005, the site had an average concentration of 543.3 colonies/100 m; a maximum recorded value of 2710 colonies/100 mL, a standard deviation of 641.2 colonies/100 mL, and exceeded that MCL 63% of the sampling days.

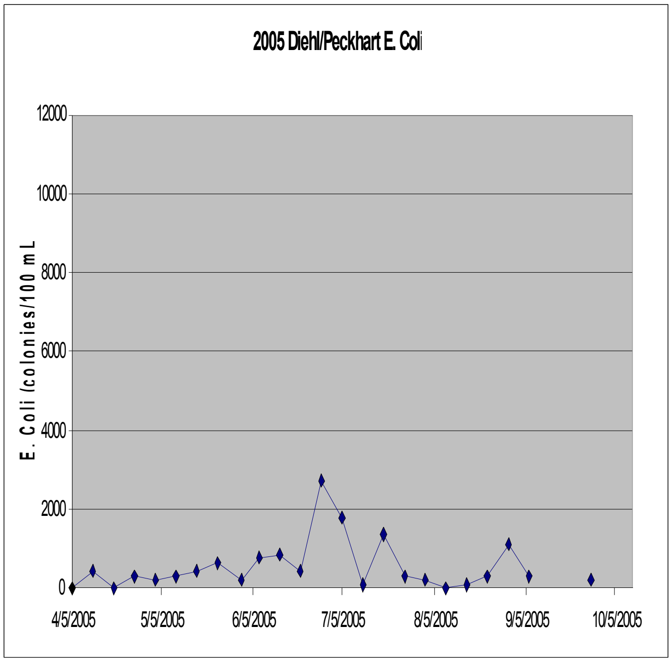

Figure 36: 2005 Diehl/Peckhart *E. coli* results.

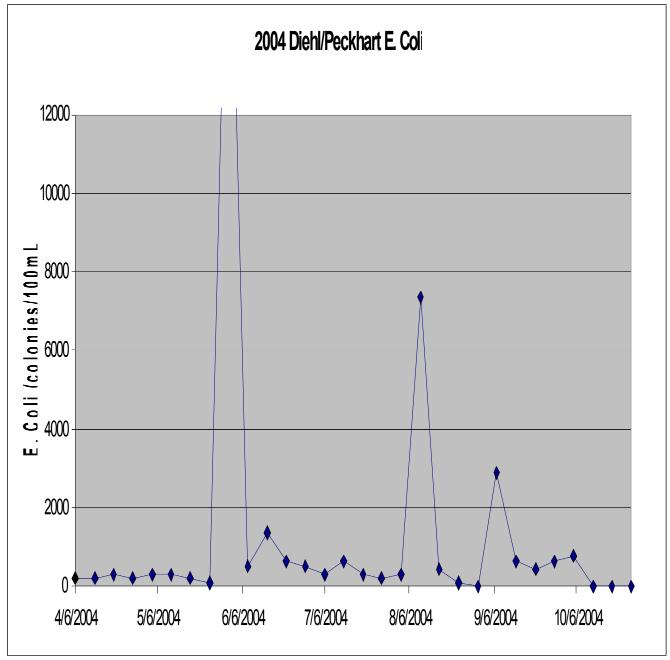

Figure 37: 2004 Diehl/Peckhart *E. coli* results.

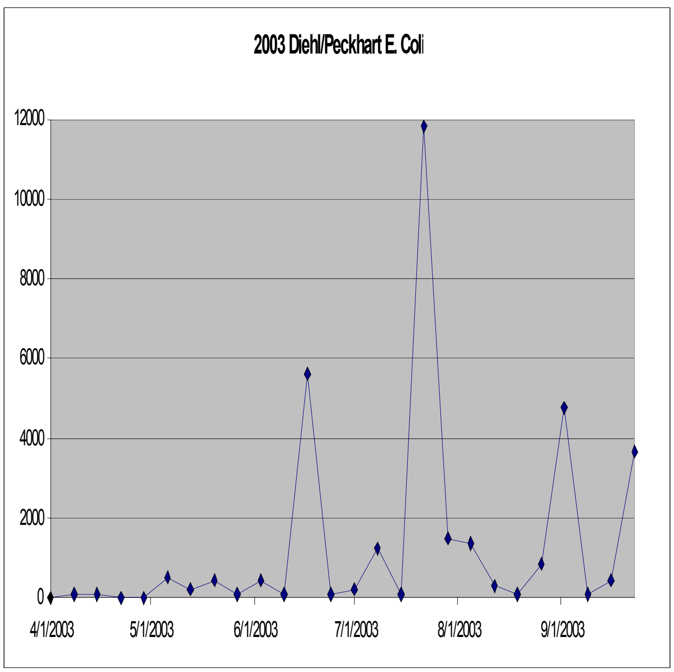

Figure 38: 2003 Diehl/Peckhart *E. coli* results.

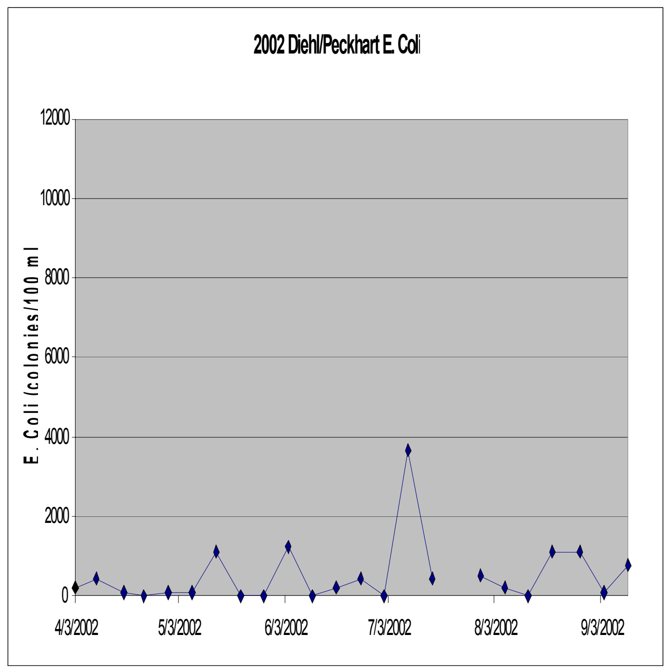

Figure 39: 2002 Diehl/Peckhart *E. coli* results.

Five sites with consistently high *E. coli* levels in 2005 are selected as sites of interest for further examination and future attention. These sites are David Link Ditch, Dibbling Ditch, Big Run Creek, and Garrett City Ditch. The following graphs show historical and current bacteria results for these sites:

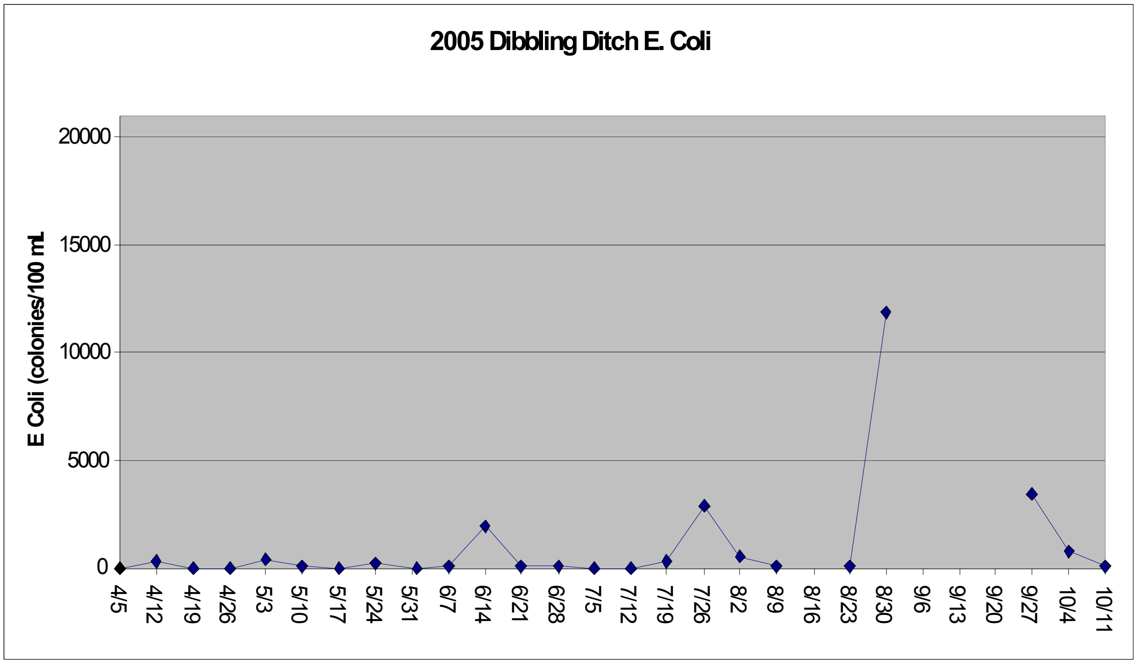

Figure 40: 2005 Dibbling Ditch *E. coli* results.

Dibbling Ditch has been a site of concern for the Initiative since it was initiated as a sampling site in 2003. The waterway has demonstrated both consistently elevated bacteria levels and the capacity to record high spikes of *E. coli* bacteria. In 2003, the site averaged 3543 colonies/100 mL and exceeded 10,000 colonies/100 mL on five occasions and over 1000 colonies 11 total times, scattered throughout the sampling season. A maximum recordable level 20,050 colonies/100 mL was observed once during the season. Bacteria levels at Dibbling Ditch were similarly elevated in 2004. The maximum level was again recorded once, and levels exceeding 1000 colonies/100 mL were seen on six sampling days. As illustrated in Figure 38, *E. coli* levels experienced significant decreases in 2005, but remain at levels of concern in Dekalb County. Flow levels at the Dibbling sampling location tended very low in 2005, and samples could not be retrieved on four occasions. The ditch still maintained an elevated average of 971 colonies and exceeded 10,000 colonies once and 1000 colonies fours times.

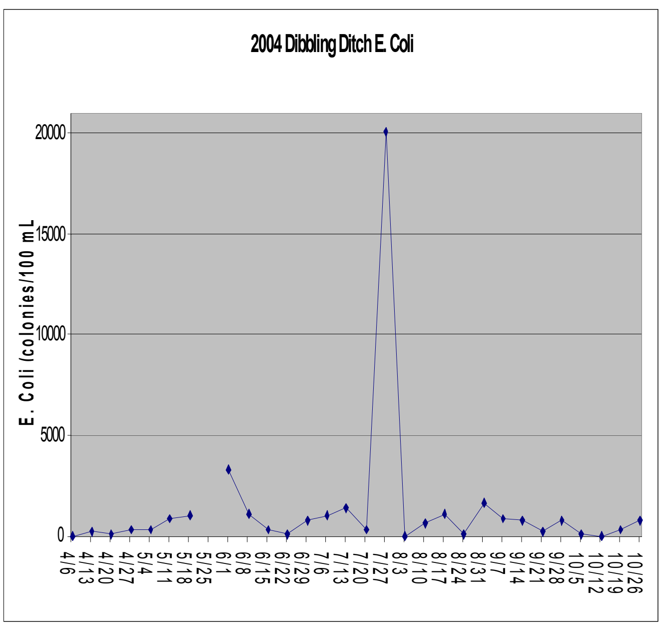

Figure 41: 2004 Dibbling Ditch *E. coli* results.

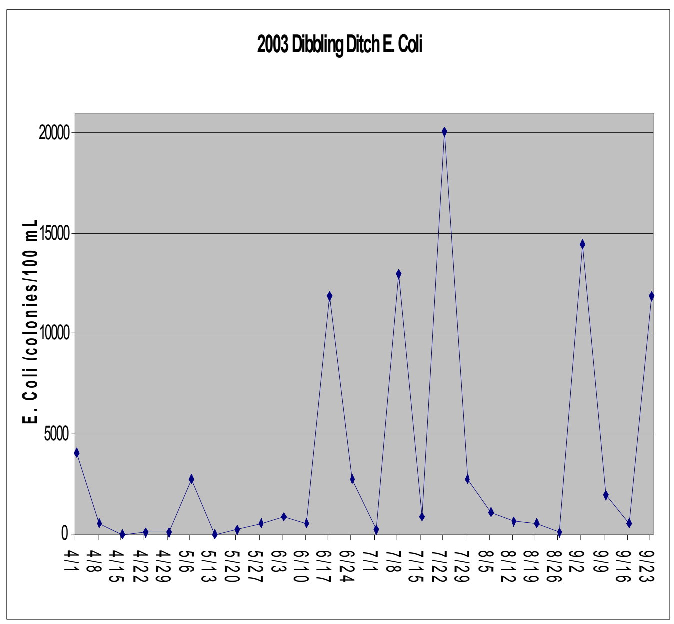

Figure 42: 2003 Dibbling Ditch *E. coli* results.

Garrett City Ditch

The Garrett City Ditch site is located directly downstream of the City of Garrett wastewater treatment facility and also receives input from the Garrett stormwater system. Ongoing and past efforts to inventory all sources of the Garrett City Ditch have to date been unsuccessful. As a percentage of total area, the Garret City Ditch watershed upstream of our sampling location is one of the most urbanized and developed in the entire St. Joseph watershed. The following map illustrates the location and land-use data for the watershed. The Initiative's sampling location is marked by the red circle.

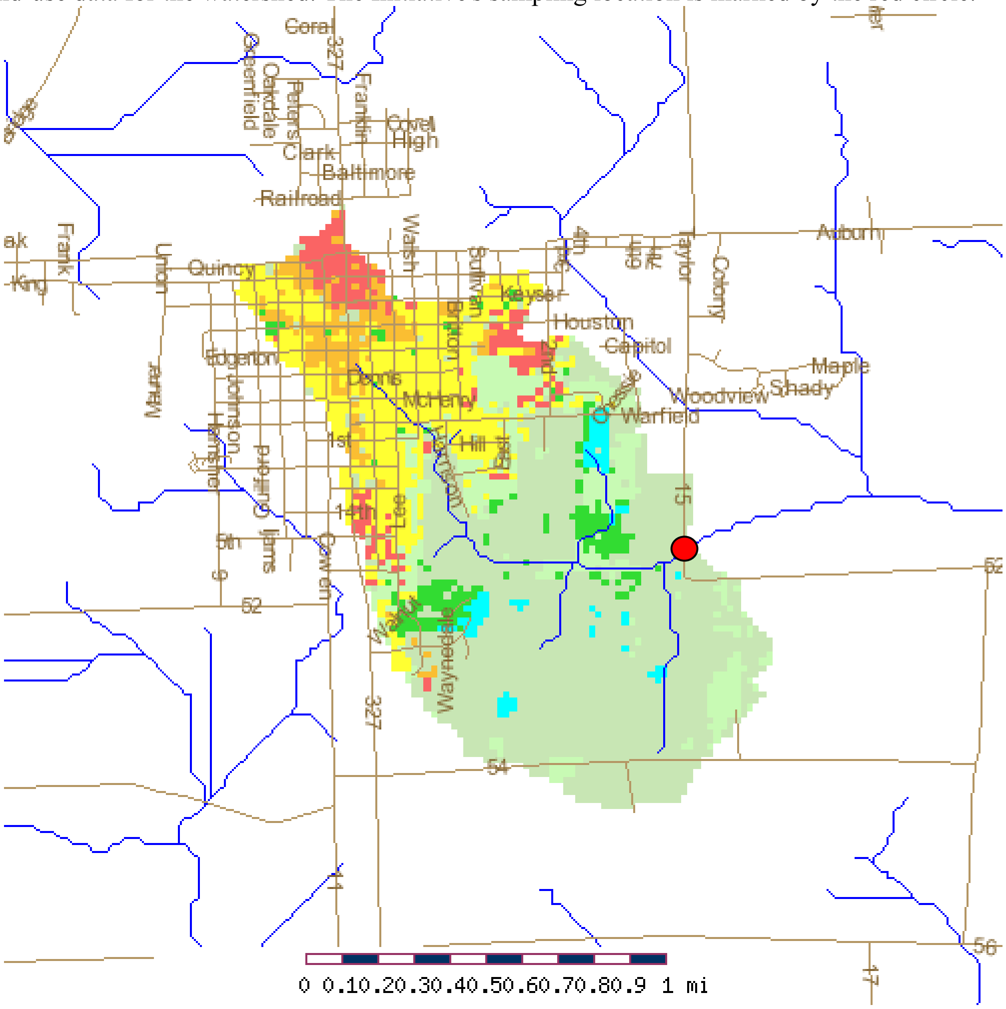

Figure 43: Garret City Ditch delineation and land-use. See land use key below.

The following bacteria sampling results were recorded at the Garrett City Ditch site. It is important to note that the Town of Garrett wastewater treatment plant was expanded and improved between the 2003 and 2004 sampling seasons. The effect of the plant improvements can be seen in the following charts:

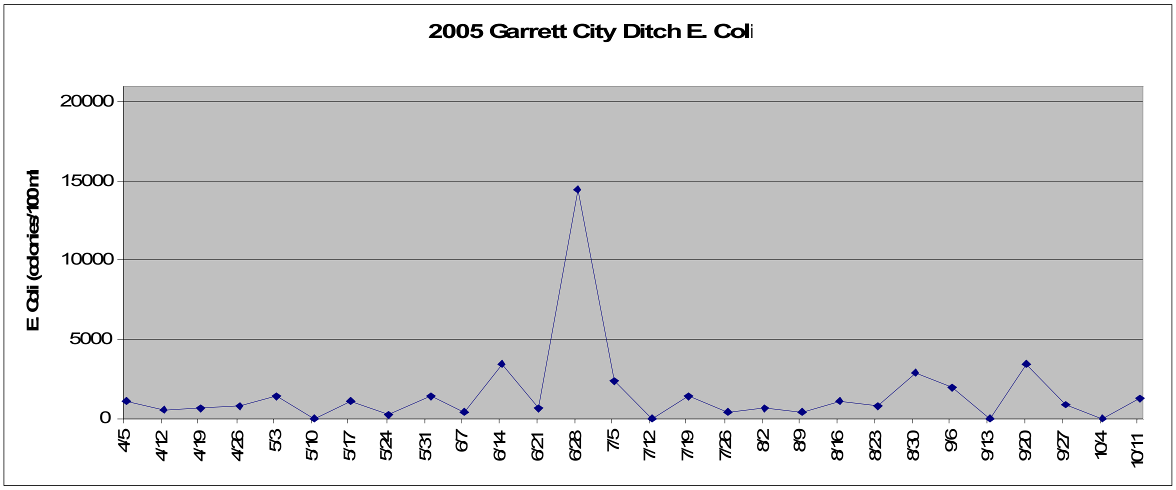

Figure 44: 2005 Garrett City Ditch *E. coli* results.

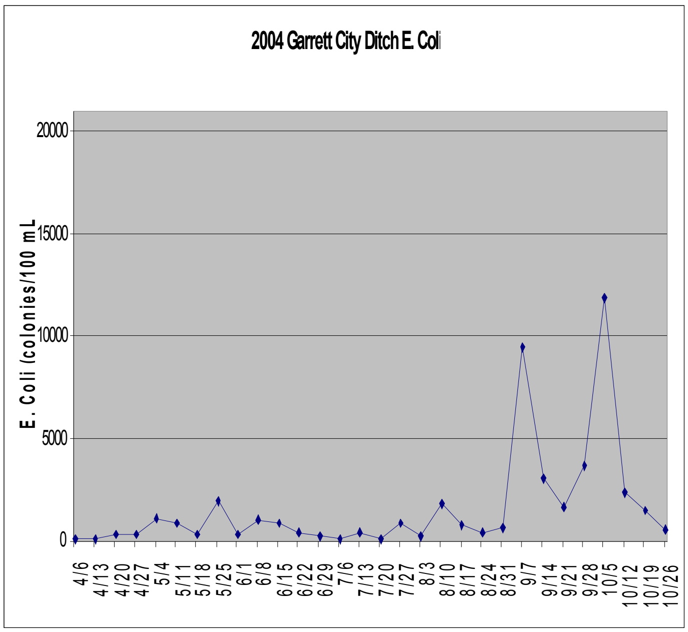

Figure 45: 2004 Garrett City Ditch *E. coli* results.

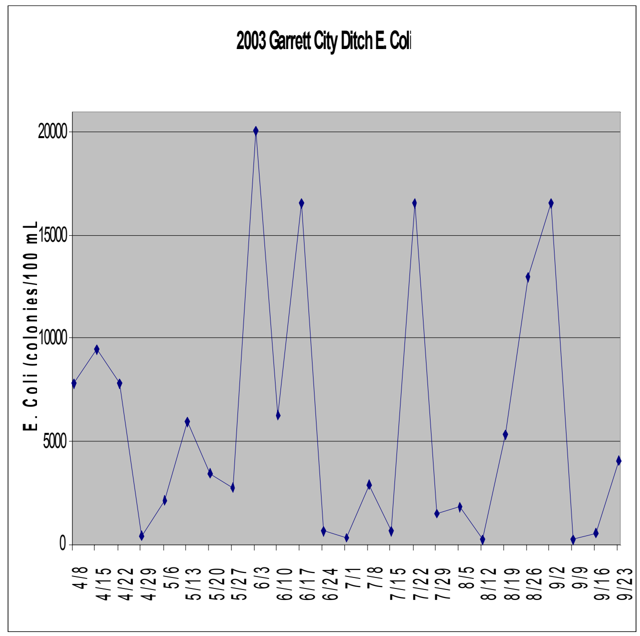

Figure 46: 2003 Garrett City Ditch *E. coli* results.

The primary effect of the wastewater improvements was clearly an overall reduction in the total load of bacteria in the waterway, but examination of the standard deviations and yearly averages reveals other changes to the contaminant concentrations:

Year	Average	SD
2003	5860.80	6121.24
2004	1571.33	2640.91
2005	1552.5	2704.27

Table 7: Yearly *E. coli* average and standard deviations at Garrett City Ditch 2003 to 2005.

The primary cause of the high average before the wastewater improvements was the high fluctuations of bacteria levels marked by the 2003 standard deviation exceeding the yearly average. Following the improvements the averages have remained steady, and lower than 2003 as the standard deviations have decreased dramatically. Averages still remain among the highest in the watershed. It is possible that in this case, wastewater system improvements have improved the overall averages by reducing the magnitude of the spikes released from the facility. At the same time, however, it appears that the underlying baseline bacteria release from the facility might not yet be properly addressed.

Other Parameters

Pesticides and bacteria are the primary parameters of concern to the Initiative. Many of our other sampling parameters are utilized for the purpose of indicating potential problems and should not be used alone for diagnosis of waterway contamination. These parameters include: dissolved oxygen, specific conduct, and pH. Turbidity, however, can be used to approximate the total suspended solids (TSS) levels using a relationship developed for the watershed using statewide IDEM water quality data. The relationship states the mg/L TSS is equal to 1.64 NTU units of turbidity. Highlights of the 2005 sediment data are presented below.

Sediment

Total suspended solids include all filterable particles suspended in water. Suspended solids can include inorganic materials (such as those from eroded sediment or industrial waste) and organic materials (such as dead plant and animal material), and living microorganisms. Elevated suspended solids levels can reduce available light to aquatic plants, raise water temperatures, clog fish gills, and fill in spawning and other habitat areas. High total suspended solids values can also be indicative of other contaminants in the waterway, including nutrients, metals, bacteria, and industrial chemicals.

As of this time there is neither an EPA or State of Indiana standard for total suspended solids in freshwaters. However, concentrations of 80 mg/L or greater are generally considered to be harmful to aquatic life.

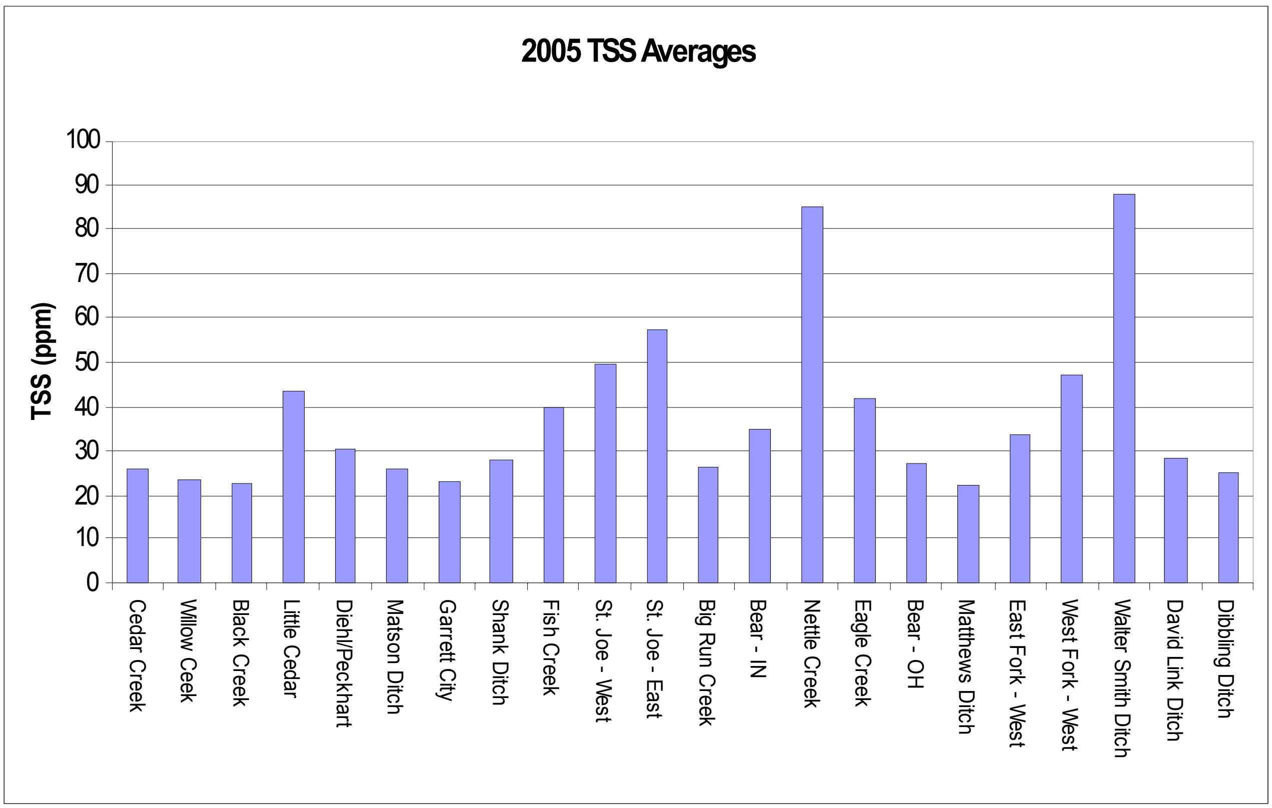

Figure 47: 2005 average total suspended solids at all sites.

There are three sites of concern for elevated sediment loading: Nettle Creek, Walter Smith Ditch, and St. Joe-East. The following graphs chart the 2005 sediment results for these three sites. These sites have historically demonstrated similar sediment results. The primary change in 2005 is seen in the magnitude of the peak values. At Nettle Creek, high peak values are recorded over the background of consistently high normal values. Steady bank erosion and widespread non-point sourcing are indicated at this site in particular. It is for this reason that Nettle Creek is the site of greatest concern for sediment loading and has been the subject of early efforts toward the production of a Watershed Management Plan to address sediment and other issues of local concern.

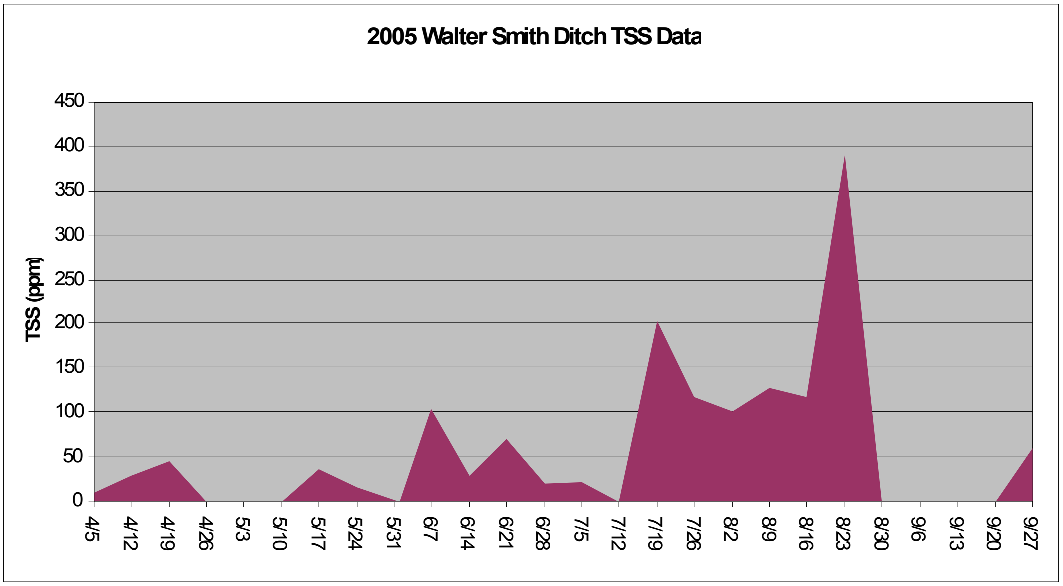

Figure 48: 2005 Walter Smith Ditch TSS results.

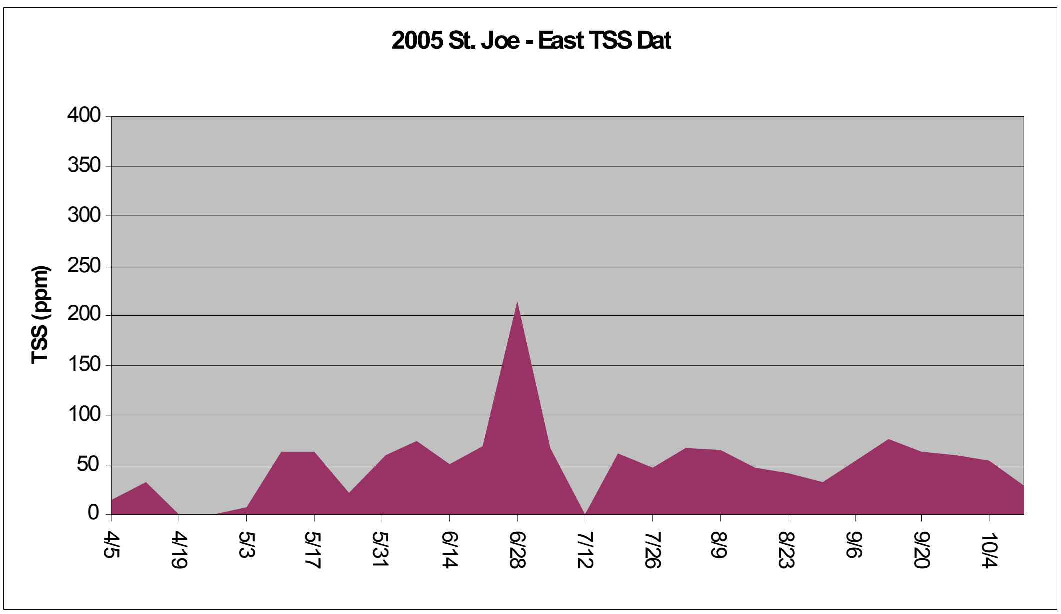

Figure 49: 2005 St. Joe – East TSS results.

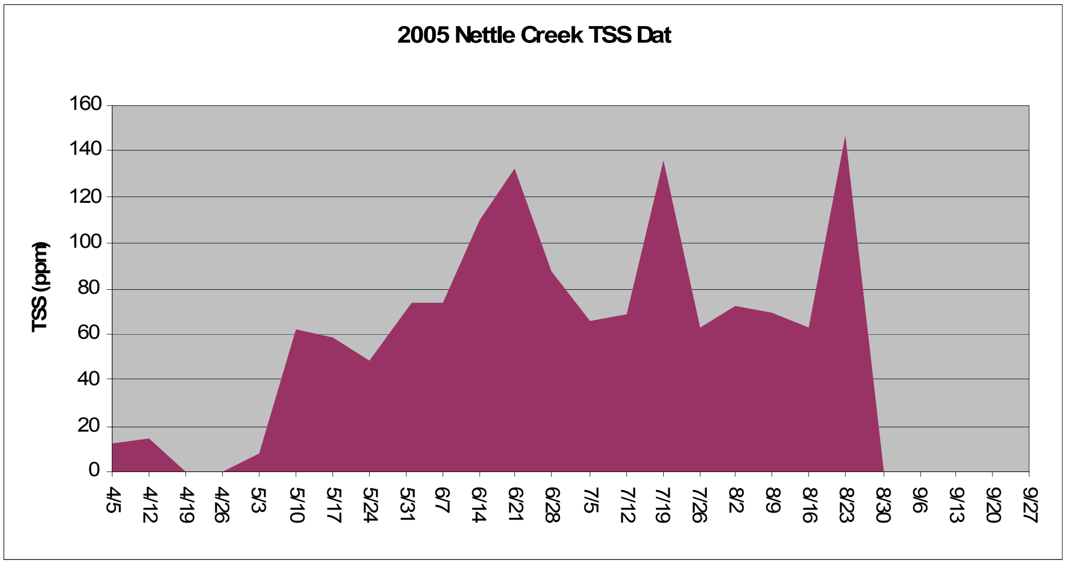

Figure 50: Nettle Creek TSS results.

Historical Total Suspended Solids Averages

Site Number	Site Name	TSS (mg/L)		
		2003	**2004**	**2005**
100	Cedar Creek	28.45	23.32	28.18
101	Willow Creek		20.52	23.56
102	Black Creek		35.25	22.82
103	Little Cedar Creek		27.66	44.25
104	Diehl/Peckhart Ditch	29.81	15.62	30.76
106	Matson Ditch	19.43	31.24	26.91
117	Garrett City Ditch	15.68	26.25	23.76
123	Shank Ditch	26.07	20.28	27.89
124	Fish Creek	27.64	26.20	41.22
125	St. Joe - West	30.56	20.11	50.71
126	St. Joe - East	26.70	23.89	58.86
127	Big Run Creek	31.22	27.23	27.74
128	Bear Creek - IN	22.75	34.27	35.44
129	Nettle Creek	30.72	37.66	87.70
130	Eagle Creek	22.33	42.16	43.39
131	Bear Creek - OH	20.29	32.36	28.46
132	Matthews Ditch	64.84	27.39	24.09
134	East Fork - West	8.60	12.33	48.67
135	West Fork - West	17.54	24.91	93.34
141	Walter Smith Ditch	24.16	173.80	30.64
142	David Link Ditch	17.10	13.38	66.64
143	Dibbling Ditch	27.45	27.72	26.40

Table 7: Yearly TSS averages at all sites 2003 to 2005.

Nutrients

Phosphorus

There are no federal, state, or local standards concerning phosphorus in rivers, streams, and lakes, but some general guidelines have been established across the country. The nutrient is considered an EPA Priority Pollutant, and has had several benchmark concentrations established for its presence is freshwaters. The EPA of the State of Illinois has established a level of 0.61 mg/L as capable of impairing aquatic life. This level has been adopted by the Initiative as a general guideline.

Phosphorus can enter waters through both natural and man-made means. Naturally, phosphorus occurs as an erosion product of local rocks and minerals, and as a primary constituent in the nucleic acids of all living cells. Urban runoff, livestock operations, and untreated wastewater, and secondarily treated wastewater are the major sources of phosphorus contamination. Minor sources include malfunctioning septic systems, illegal trash dumping, and residential fertilizers. All of these sources, major and minor, are increased substantially by heavy rainfall and runoff.

The 2004 Water Quality Report found that no site had an average exceeding the guideline. Two site, Bear – OH and Walter Smith did exceed the guideline twice each. Walter Smith Ditch was found to demonstrate a tendency towards persistently high phosphorus levels. In 2005 only Walter Smith Ditch exceeded that guideline, while all other sites remained well below the target value. The 2005 results confirmed this assessment, as the average for the year increased from 0.30 to 0.40 mg/L, and the highest recorded single value increased from 1.50 to 2.24 mg/L.

Ammonia

Ammonia is very simply the most reduced form of nitrogen, and is produced by the biological decay and animal and plant material. Ammonia is introduced into rivers and streams via urban and rural routes, and is equally represented in the sampling areas of the St. Joseph River watershed. Urban exposure to ammonia generally results from the discharge of sewer treatment plants and from such industrial processes such as fertilizer manufacture and oil refining. In rural and agricultural areas, the pollutant is often present due to fertilizer applications and failing septic systems.

The toxic effects of ammonia are controlled by the pH of the stream. At a higher pH (>8.0), ammonia is converted to a highly toxic (unionized) form that is fatal to aquatic life at very low levels. At a high pH, ammonia levels as low as 0.06 mg/L can begin to damage fish, and levels of 0.20 mg/L will begin to kill sensitive fish species. As a general rule, streams with an ammonia level of 0.10 mg/L or greater should be considered to be impaired by the pollutant. The Indiana Administrative Code recommends that ammonia concentrations is fresh waters should range between 0.00 and 0.21 mg/L, depending on water temperature and pH.

Ammonia results for 2005 were an overall improvement of the 2004 sampling season. The seasonal averages for all sites were lower than those recorded on 2004. Matson Ditch and Bear Creek – OH recorded the highest averages and exceeded 0.20 mg/L on several occasions. Both sites exceeded 0.20 mg/L on several occasions. These sites will require further examination and continued nutrient sampling.

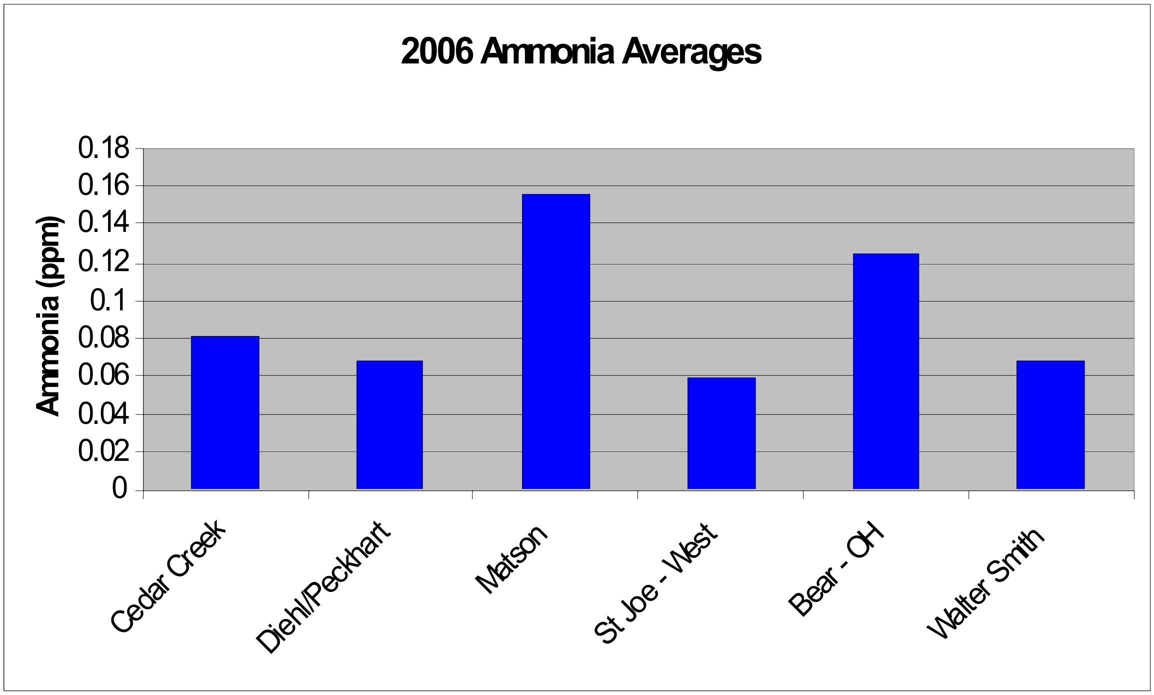

Figure 51: 2006 ammonia averages.

SUMMARY

The findings of this report are outlined herein. These observations do not reflect all conclusions drawn from the 2005 sampling results, but do list the areas and pollutants of greatest concern to the Initiative. Conditions are changing rapidly in the St. Joseph Watershed, presenting new challenges in both understanding and remediating potentially harmful runoff into the tributaries. Rapid urban and suburban growth and shifting land-use trends have also reduced the Initiative's ability to address water quality issues with its existing understanding of the dynamics of the watershed. The following conclusions reflect the most significant symptoms of changing conditions in the St. Joseph River Watershed, both good and bad.

1) Atrazine levels appear to be continuing to decline at all sites across the watershed.
2) Sites historically demonstrating elevated atrazine levels continue to contain concentrations elevated in the same proportions with respect to the other sites. Although the levels in 2005 are universally lower than previously recorded, the historical problem sites indicate a persistent source of atrazine contamination.
3) Despite declining levels, traditional sites of concern for the pollutant, David Link, Walter Smith, and Matson Ditch in Dekalb County continue to experience events of unacceptably high atrazine levels. These events are of lesser magnitude than previous events at the sites, but they remain at levels of concern. These sites are now responsible for the majority of the EPA MCL exceedences among all sites in the watershed.
4) St. Joseph River West in Williams County and David Link Ditch in Dekalb County are the only two sites demonstrating an increase in atrazine levels in 2005.
5) New herbicide products with broad applications containing metolachlor became widely available for the 2005 growing season. These products have proved popular with local producers in all areas of the watershed. As a result, the runoff of the metolachlor applications became evident in local waterways through the Initiative's sampling results. Metolachlor runoff was widespread in the watershed, but was particularly seen in the David Link Ditch, and in lesser degrees in Matson Ditch, Fish Creek, and St. Joe West.
6) Bacteria is the most significant contaminant in the watershed. Every sampling location exceeded the *E.coli* MC on at least 20% of sampling days. The entire watershed exceeded the MCL an average of 47.4% of the sampling days. The traditional sites of concern for the parameter remain elevated and exceed the MCL at least 60% of the time. These sites are: Walter Smith, Little Cedar, Diehl/Peckhart, Garrett City, Shank, St. Joe East, Tiernan, and Eagle. The sites are widely geographically distributed within the larger watershed.
7) Sites recording a high *E. coli* average and high number of MCL exceedences were not the sites presenting the highest single levels of the bacteria. Dibbling, Black, Big Run, and David Link are among sites charting extreme variances in *E. coli* levels and single event levels approaching and exceeding 20,000 colonies per 100 mL.
8) Sediment loading is not widespread in the watershed, but several waterways are undergoing chronic sedimentation and erosion. Nettle Creek, Walter Smith Ditch, and St. Joe East are the sites of greatest concern due to historical trends and continuing high baseline and maximum turbidity and TSS levels. Statistical analysis indicates that Nettle Creek experiences both elevated background levels and maximum sediment concentrations. The analysis may indicate significant and far-reaching degradation of streambank and land use conditions in the Nettle sub-watershed.
9) Sediment levels are acceptable over the majority of the St. Joseph River Watershed. The three sites of concern (Nettle, Walter Smith, and St. Joe East) do not reflect overall conditions in the watershed.
10) Nutrient levels remain low in the watershed. Previous water quality reports have indicated potential development of persistent contamination at Walter Smith Ditch. Phosphorus concentrations in the waterway increased slightly and the single maximum value increased significantly. Again, Walter Smith Ditch will require careful observation as levels trend toward the threshold of concern. Efforts to inventory potential phosphorus sources should be commenced in 2006 in preparation for any future remediation in the sub-watershed.
11) Ammonia levels have traditionally been low throughout the larger watershed. Concentrations continued to decrease in 2005. Matson and Bear Ohio were under observation for the parameter based on trends through the 2004 sampling results. These sites again carried slightly elevated ammonia levels, but did not increase form the 2004 results. Nutrient sampling should continue at these sites in future sampling seasons. Due to the highly toxic effects of ammonia to aquatic life these sites will again be examined closely for indications of rising concentrations. As of the 2005 report, however, the parameter is not a primary concern in the watershed.

References

Environmental Protection Agency Maximum Contaminant Levels for pesticides were obtained and/or confirmed at the *EPA Chemical Fact Sheet* site at: www.**epa**.gov/**pesticides**/factsheets/ .

E. coli regulatory information was retrieved at the *EPA Safe Water Website* at: www.**epa**.gov/safewater/**mcl**.html.

Canadian governmental guidelines for metolachlor were obtained at the *Pesticide Information Clearinghouse* site at: http://preview.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34759#Regulatory.

State of Illinois phosphorus guidelines were found at the *Illinois EPA Total Maximum Daily Load Website* at: http://www.epa.state.il.us/water/tmdl/.

Ammonia toxicity and guideline information was obtained from the *EPA Water Science Website* at: www.**epa**.gov/waterscience/criteria/**ammonia**/.

Toxicity information for metolachlor containing herbicides retrieved at the *Environmental Protection Agency Chemical Registry Site* at: http://www.epa.gov/oppsrrd1/reregistration/metolachlor/.

Precipitation data obtained from the online database of the Indiana State Climate Office at Purdue University at: http://shadow.agry.purdue.edu/sc.index.html. Data from the Angola and Butler sites was retrieved for this report.

The peak flow chart was produced at theU.S.G.S. *Water Data Retrieval Site* at: http://water.usgs.gov/in/nwis. The St. Joseph River is site #04182000.

Land use map of Garrett City Ditch Watershed was created on the *Spatial Decision Support System for Watershed Management* website programmed and hosted by the Purdue University Agricultural and Biological Engineering Department and the Center for Advanced Application of GIS. Copyright 2005.

St. Joseph River Watershed Initiative 2004 Water Quality Sampling Report prepared by Aaron Wartenberg, Jane Loomis Executive Director.

Fleming, A.H., 1994. *The Hydrogeology of Allen County, Indiana. A Geologic and Ground-Water Atlas.* Indiana Geological Survey Special Report 5, Bloomington, IN.

Brownlow, Arthur H.,1979. *Geochemistry.* Prentice-Hall, Englewood Cliffs, New Jersey.

St. Joseph River Watershed Initiative, 2003. *St. Joseph River Watershed Comprehensive Graphical Information System Atlas*, completed with funding from the Indiana Department of Environmental Management grant. Metadata available for review the The Initiative offices and on publicly distributed *Atlas* materials.

Rice, N., 2005. *Water Quality Modeling Analysis for the Cedar Creek Watershed.* Prepared for the St. Joseph River Watershed Initiative. Indiana Department of Environmental Management, Watershed Management Section, Indianapolis, IN.