Bowman Creek Supplemental Environmental Project

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For: City of South Bend
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January 2013

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AUGUST 2012

1. Introduction

This project was undertaken in connection with the settlement of an enforcement action, *United States and the State of Indiana v. City of South Bend, Indiana*, taken on behalf of the United States Environmental Protection Agency and the Indiana Department of Environmental Management pursuant to the Clean Water Act.

As part of this Supplemental Environmental Project (SEP), the following were performed:

1.1. Review of Existing Water Quality Studies

Review and evaluate existing water quality studies and water quality data for Bowman Creek from available sources, including without limitation, studies and data possessed by South Bend, EPA, IDEM, USGS, STORET, and the St. Joseph River WISE Sampling Program.

1.2. Field Investigation

A field investigation of Bowman Creek and its tributary ditches, Eberly, Auten, and Philips was performed and analytical results of water samples collected during the field investigation are presented herein. Starting at the Bowman Creek discharge point at the St. Joseph River, a two-person crew walked upstream the entire length of Bowman Creek and its tributary ditches Eberly, Auten, and Philips during dry weather both inside and outside the city limits of South Bend. Standard water quality sampling for the project are defined as including laboratory testing of field samples for phosphorus, ammonia, nitrates, *E. coli*, and surfactants, as well as field probe measurement of dissolved oxygen and water temperature at the sampling location.

a. Initial Sampling Phase

Collected and identified the location of standard water quality samples at a total of ten locations along Bowman Creek and its tributaries, including the points of discharge of the tributary ditches into Bowman Creek.

b. Primary Sampling

Collected and identified the location of standard water quality samples at an interval of approximately 500 feet along the areas of concern in Bowman Creek identified in the preceding Subparagraph to further isolate and identify problem areas.

c. Outfall Identification and Sampling

Located visible outfall pipes into Bowman Creek and its three tributary ditches using GPS equipment; documented physical measurements of each outfall pipe.

Collected standard water quality samples of outfalls observed to be discharging during the field investigation. Outfalls without observed discharge were located and measured as noted in the preceding Subparagraph, but not sampled.

d. Channel Condition Observation

Observed and documented the channel condition, noting evidence of erosion or scour and areas that require maintenance.

1.3. Evaluation of Improvement Alternatives

1. Evaluation of Alternatives

Based on the review of existing water quality data, and the data and information obtained from the field investigation, this task included the evaluation of appropriateness and effectiveness of methods to reduce the levels of bacterial contamination entering, and to restore Bowman Creek. Minimum assessment included the following methods: stream bank restoration, erosion control, sediment control and re-aeration, removal of point sources of wastewater, flow improvements, UV Disinfection, and maintenance and clean-up activities.

2. Report and Recommendation Regarding Alternatives

This report includes:

1. A summary of information obtained from the field investigation, including a presentation of physical and analytical data, and GPS data regarding outlet pipe locations
2. A summary that provides recommendations related to the most environmentally beneficial pollution reduction and restoration project(s) that the City of South Bend could perform to improve water quality in Bowman Creek and its tributary ditches.

2. Review of Existing Water Quality Studies

Existing water quality studies and water quality data for Bowman Creek was reviewed from a variety of available sources. These included: master plan recommendations (The Troyer Group, undated), flood insurance rate maps (Federal Emergency Management Agency, 2011), by South Bend, EPA, IDEM, USGS, and the St. Joseph River WISE Sampling Program.

2.1. Previous Studies by the City of South Bend

A Master Plan was prepared by the Troyer Group (The Troyer Group, undated). This brief plan identified several potential improvements, including day lighting opportunities and resizing of crossings.

Several aquatic monitoring studies have been performed (Deegan, 2010). Although the current study focuses on chemical testing, the aquatic monitoring study of major fish sampling sites in Elkhart and St. Joseph Counties did include a site along Bowman Creek (Site 30 at Ravina Park) and Auten Ditch (Site 29 at Kern Road). The results at the Ravina Park site indicated that the fish community is in poor condition (Index of Biotic Integrity, IBI, score of 13). The study further noted poor habitat quality (Qualitative Habitat Evaluation Index, QHEI, score of 41) at the site at Ravina Park on Bowman Creek and Kern Road on Auten Ditch. Ravina Park fell into the fair/impaired category for macroinvertebrates (Invertebrate Community Index, ICI). The study notes that temperatures along Bowman Creek were warmer than its cool water counterpart, Juday Creek.

Support data from the staff performing the aquatic study (Deegan, 2010) was also obtained to review historic Dissolved Oxygen (DO) levels measurements between the years 2001 and 2011. At the Ravina Park site, measured levels ranged from 5.50 to 8.74. At the Studebaker Golf Course site, the range was 3.56 to 10.81. At Chippewa Avenue, the DO ranged from 6.20 to 9.16.

2.2. EPA Studies

The "my WATERS Mapper" program (EPA) provides interactive access to the STORET water quality monitoring data. The WATERS Mapper program shows a STORET station in Mishawaka near the mouth of Willow Creek at the St. Joseph River, but does not indicate the presence of any STORET water monitoring stations within the Bowman Creek watershed.

Note that the WATERS Mapper program denotes the Bowman Creek watershed as the Auten Ditch watershed. At a local level, Auten Ditch is the name given to Bowman Creek mainline upstream of the St. Joseph Valley Parkway, therefore the two names might be used interchangeably at a Federal level.

The "my WATERS Mapper" does indicate three sites with Individual NPDES Permits: Buckeye Terminals - South Bend (expired 2011), Sunset Trailer Village and Clear Water Mobile Home Village. These are simply noted as locations of interest for consideration during the water quality sampling.

A website with links to additional EPA data regarding the watershed is https://wiki.epa.gov/watershed2/index.php/St._Joseph_Watershed

2.3. IDEM Studies

A Total Maximum Daily Load (TMDL) study for *Escherichia coli (E. coli)* was performed for the St. Joseph River (IDEM Office of

Water Quality - TMDL Program, 2004). As Bowman Creek and its tributaries are within the greater watershed of the St. Joseph River, this study would appear relevant with regards to potential contribution impacts of *E. Coli* levels from Bowman Creek to the St. Joseph River.

Waterbody Name: St. Joseph River

303(d) List ID: 36

County: Elkhart and St. Joseph Counties
Length: 27 miles

Basin: Great Lakes
Hydrologic Unit Code: 04050001

Impairments: *E. coli*, Fish Consumption Advisory for PCB and mercury

Schedule: 2010-2015, *E. coli*,

2020-2020, Fish Consumption Advisory for PCB and mercury

Bowman Creek was not one of the tributaries sampled as part of the IDEM TMDL study. However, with the exception of the Little Elkhart River and Juday Creek, the remainder of the tributaries sampled were determined to contribute to *E. coli* impairment in the St. Joseph River.

The TMDL study also notes following dischargers with *E. coli* limits:

Bowman CSO (Permit No. INM024520)

Auten Ditch Plume De Veau Plant (Permit No. IN0000884)

IDEM also funds a 319(h) grant

2.4. INDOT US 31 EIS

INDOT notes potential stream impacts along Auten Ditch and Philips Ditch, tributaries to Bowman Creek, in the EIS for the US 31 renovation project (INDOT, 2009). The EIS noted that there were no fish observed along Auten Ditch and an unnamed tributary of Auten Ditch upon repeated sampling at the fish sampling stations.

2.5. USGS

The United States Geological Survey (USGS) serves as a repository for a variety of types of data.

One such station is Site 413747086163501, along Bowman Creek 1422 ft upstream of Linden Road near Gilmer Park (USGS).

2.6. Watershed Initiative for a Safer Environment (WISE)

WISE was a joint initiative between three cities: Elkhart, Mishawaka and South Bend. Water quality sampling was performed on the St. Joseph River and its tributaries on a weekly basis from July 2002 to May 2003 (Nemura, Turner, Salee, & Umble, 2004). This sampling was aimed at tracking sources of *E. Coli* along the St. Joseph River in St. Joseph and Elkhart Counties and associated impacts during dry and wet weather conditions.

The WISE report defined "wet" or "dry" weather samples as to whether precipitation amounts greater than 0.1 inches were recorded at monitoring stations in two of the three cities within the past 24 hours (or one inch of estimated snowmelt).

The results of the historic sampling along Bowman Creek are shown in Figure 1. While the majority of samples along the St. Joseph and Elkhart Rivers were below the State water quality standard of 235 counts per 100 ml for a single sample, average results for Bowman Creek samples exceeded the water quality standard. These results were based on weekly sampling taken from July 19, 2002 to May 9, 2003. The concentrations ranged from 30 to 63,200 counts per 100 ml for dry weather samples (average 2,540). Wet weather sample concentrations ranged from 1,829 to 21,000 (geometric mean of 1,929).

The WISE report underscores the anticipated *E. Coli* contamination along Bowman Creek and the need to assess the sources of said contamination.

2.7. Indiana State Water Quality Standards

State Water Quality Standards have been established by Indiana Administrative Code (Water Quality Standards, 1990). The IAC temperature requirements for Bowman Creek call for the instream maximum temperatures listed in Table 1:

TABLE 1 - MAXIMUM INSTREAM TEMPERATURES

Month	Max Temp °F (°C)
January	50 (10)
February	50 (10)
March	60 (15.6)
April	70 (21.1)
May	80 (26.7)
June	90 (32.2)
July	90 (32.2)
August	90 (32.2)
September	90 (32.2)
October	78 (25.5)
November	70 (21.1)
December	57 (14.0)

In addition to temperature measurements, field measurements of dissolve oxygen were also performed. The IAC calls for "concentrations of dissolved oxygen shall average at least five (5.0) milligrams per liter per calendar day and shall not be less than four (4.0) milligrams per liter at any time".

Nitrate and Nitrite standards are 10 and 1.0 mg/l (max) for 30-day average point of consumption.

327 IAC 201.5-8(e)(2) establishes full body contact recreational use *E. Coli* WQS for all waters in the Great Lakes system (April 1 through October 31) as follows:

E. coli bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period.

An excerpt from the Hoosier Riverwatch manual (Hoosier Riverwatch, Spring 2012) presenting typical range and average results of chemical monitoring and IDEM Indiana Water Quality targets are provided in **Appendix E**.

3. Chemical Testing Parameters

The standard water quality sampling for the project are defined as including laboratory testing of field samples for phosphorus, ammonia, nitrates, *E. coli*, and surfactants, as well as field probe measurement of dissolved oxygen and water temperature at the sampling location

3.1. Thermal Pollution

The potential level of dissolved oxygen is related to the temperature of the water. Cold water can hold more DO than warmer water. Thermal pollution can be caused by loss of shade trees in the riparian zone, runoff from roads and parking lots or discharges from municipal wastewater or industrial sources (Hoosier Riverwatch, Spring 2012). Temperature decreases may be caused by a cold water source, such as a spring, entering the stream.

3.2. Dissolved Oxygen (DO)

As previously stated, potential DO levels are dependent upon the temperature of the water. Percent saturation is the level of DO in the water compared to the capacity level DO for the temperature and pressure conditions.

Poor DO levels increase the toxicity of other chemicals. Some causes of lower DO levels include:

- Decomposition of organic materials (algae, vegetation, manure, wastewater)
- High ammonia levels (in process of ammonia (NH_4^+) oxidation to nitrate (NO_3^-)
- Higher water temperatures (thermal pollution)
- Lack of mixing/turbulence

3.3. Phosphorous

Phosphorous enters surface waters in organic matter (dead plants/animals and animal waste), adsorbed to soil particles (bank erosion), or from man-made products (storm drains, detergents, lawn fertilizer, construction sites, industrial waste). A certain amount of phosphorus (P) is needed for healthy plant and animal life. In natural conditions, available phosphorous is often a limiting factor in algal growth, for example. Upon the addition of outside phosphorous to the ecosystem, algal blooms or excessive weed growth may result. Decomposition of excessive algae or vegetation depletes oxygen - a condition called hypoxia (Hoosier Riverwatch, Spring 2012), which can lead to eutrophication and fish kills.

Phosphorous naturally occurs in the form of phosphates (PO4). Orthophosphates are a form of phosphates that are dissolved in water and are readily available for plant uptake.

Phosphorous in an aquatic system remain until transformed into a form usable to plants (ex. orthophosphates) or removed (ex. by dredging). Therefore, total phosphates are a useful test for long term availability of phosphorous to a system.

3.4. Ammonia and Nitrates

Nitrogen occurs in water as nitrate (NO3), nitrite (NO2) and ammonia (NH3). Sources of nitrogen in the water column include human and animal waste, lawn or crop fertilizer and decomposing organic matter.

Similar to phosphorous, while a certain amount of nitrates are an essential nutrient for plant growth, excess nitrates can lead to algal blooms and eutrophication.

3.5. *E. coli*

Fecal coliform bacteria are found in waste from animals and humans. They typically enter a water body from Combined Sewer Overflows (CSO), poor septic systems, and runoff from agricultural livestock.

E. coli are a specific species of fecal coliform bacteria used in Indiana's state water quality standards. The presence of *E coli* is used as an indicator of fecal contamination and potential pathogens.

E coli can enter the body through the mouth, nose, ears or cuts in the skin. Risk factors from interaction with *E. Coli* include duration of contact, presence of cuts or wounds, and general health/age of the individual.

EPA recommends using *E. Coli* as the best indicator of health risk in water (IDEM, 2010).

3.6. Surfactants

Surfactants include a wide range of materials that lower the surface tension of a liquid. Examples of surfactants include detergents, fabric softeners, wetting agents, emulsifiers, shampoo, paints, adhesives, foaming agents and dispersants.

In addition to some surfactants having the potential for toxicity to animal, plant and human life, they may increase the diffusion of other contaminants.

4. Sampling Procedure

The following are the procedures utilized for the collection of a water quality sample based on USDA (Mengal, 1990):

Steps required for taking a water sample vary for different tests. Timeliness and cleanliness are important when collecting any water sample. All samples to be tested in the laboratory (phosphorous, ammonia, nitrates, *E. coli* and surfactants) shall be collected using the sterile collection bottles provided by the lab, as labs often will only accept samples taken in their collection bottles. Chain of command forms provided by the lab shall also be completed for each sample in order for the lab to process the sample.

4.1. Sample Naming Convention

The ten initial samples in question were labeled with the following specific designations:

04-11-2012-WB-XX, where

04-11-2012 is the day, month, year of collection.

WB is the water body in question (BM is Bowman Creek mainline, EB is Eberly Ditch, AD is Auten Ditch, and PD is Philips Ditch)

XX is the sample location of the day (ex: 05 would represent the fifth sampling location site observed on a given day)

After the initial ten samples were taken, systematic samples and samples of outfalls were provided with a unique identifier.

4.2. Holding Times

Maximum holding times (USDA-NRCS, 2003) for parameters related to nitrogen, phosphorous and surfactants are on the order of 24-48 hours. However, the holding times for samples taken during this study are limited by the need to test *E. Coli* within a relatively short period of time (6-8 hours). To meet this limitation, all samples taken on a given day were delivered to the laboratory within 6 hours of the first sample taken for the day.

4.3. Transport and Storage

Laboratory samples were stored on ice in an insulated container prior to testing, as prescribed by the lab. Care was taken to prevent anything but the water from contacting the inside of the bottle or the cap.

4.4. Sampling Procedure

The following General Procedures were followed when collecting a sample in accordance with the draft IDEM protocols (Indiana Department of Environmental Management Office of Water Quality, 2005):

Label sample bottles with a waterproof marker at the site. New, non-talc surgical latex gloves were used each time sample bottles were handled.

Collect water from a point upstream of where standing, being careful not to stir up any sediment. Samples were collected in a clean container to avoid contamination.

Water was directly collected from the stream with the container used for the chemical test.

Bottles were filled for nutrients (nitrogen, phosphorous) then general chemistry (surfactants, then *E. Coli*). A third bottle was filled for samples tested for surfactants (MBAS), for the initial samples and at flowing outfalls. Onsite field measurements of temperature and DO were taken by filling a glass Pyrex container with sample water after the other bottles were obtained as a general course of action (after rinsing the Pyrex container in sample water a minimum of three times to reduce the potential for contamination by other sample measurements taken in the container).

Samples were preserved either at the site or immediately upon arriving back at the transport vehicle.

Samples were submitted within 6 hours of collection (actual submittal times recorded for each sample). Because of the 6 hour holding time requirement, outfalls were first identified and physically located as a separate reconnaissance step from sampling. Those outfalls that were flowing were noted for sampling at a later date when holding time requirements could be met.

Samples were transported in a cooler on ice to the testing laboratory.

4.5. Rainfall Data

One parameter of the study was to try to obtain samples during a period of low flow conditions. In order to accommodate this constraint, an attempt was made to obtain water quality samples only at such times as there was negligible precipitation within the preceding 48 hours. Representative rainfall data records for the dates of testing are provided in **Appendix G**.

5. Quality Assurance and Quality Control

The Hoosier Riverwatch (Hoosier Riverwatch, Spring 2012) program provides some guidance on achieving reliability in both accuracy and precision. From a sample collection perspective, these include:

- Wear protective gloves and safety glasses
- Collecting the water sample as directed
- Rinsing bottles with sample water before collecting the sample and with distilled water after completing the test. (Note that the pre-rinsing procedure was not followed for samples requiring an acid preservative due to the potential for loss of preservative)
- Washing of hands upon completion
- Performing chemical tests immediately after collecting the water sample (in this case, storing the sample bottles on ice

until directing the samples to the laboratory within the prescribed holding time)

- Obtaining samples from the main stream flow, usually 3-5 inches below the surface. For this study, the majority of sites had total water depths less than 12 inches.
- Following the specific directions of a testing protocol as described. This included filling out the appropriate chain of command forms for sampling identification between McCormick Engineering and the sampling laboratory.

6. Data Analysis and Evaluation

6.1. Bowman Creek Watershed

The overall Bowman Creek watershed and its tributaries are shown in **Figure 1**. For clarification, Bowman Creek and Auten Ditch are the same stream. The difference in nomenclature appears to be the result of jurisdictional authority limits. Within the City, the stream is known as Bowman Creek. Within St. Joseph County, it is known as Auten Ditch. Some of the IDEM and EPA search engines refer to the entire stream as Auten Ditch. For the purposes of this study, reaches downstream of the St. Joseph Valley Parkway are identified as Bowman Creek. Areas of Bowman Creek upstream of this point are identified as Auten Ditch.

6.2. Preliminary Sampling

Ten representative sample sites were chosen along Bowman Creek and its tributaries to provide preliminary data for further investigation. The location of the initial sample sites, taken on April 11, 2012, along with the systematic sampling sites taken at a later date are shown in **Figure 2**. Results for the preliminary sampling data are provided in **Table 2**.

Based on the preliminary results, the lower reaches of Bowman Creek warranted further sampling and attention, as did the area near the interface of City/County jurisdictions at the St. Joseph Valley Parkway.

With regards to *E. Coli*, the result at the mouth of Eberly Ditch was relatively low (54 CFU/100 ml) indicating that further *E. Coli* testing along Eberly Ditch should not be the priority of additional testing in the study.

Results along Philips Ditch indicated receding E. Coli values as one progresses downstream, with no initial values exceeding the grad sample limit of 235 CFU/100 ml.

Along Auten Ditch preliminary results pointed to one or more potential sources of *E. Coli* contamination between Roosevelt Road and the St. Joseph Valley Parkway, warranting further investigation.

6.3. Outfall Identification

Outfalls observed over the course of the study are indicated in **Figure 3**.

Along Eberly Ditch, standing water was observed in several of the open channels. The open channel identified as 'Eberly UNT 6' had minor discharge but was not tested due to the reasonable water quality results obtained at the mouth of Eberly Ditch in the preliminary testing.

Two actively flowing outfalls were observed along Bowman Creek at a single residence with two large detention ponds ('BM Pond 1' and 'BM Pond 2' between Gertrude Street and the St. Joseph Valley Parkway). While the private homeowner did allow staff to observe and document the location of the 6-inch diameter outfalls from the ponds, the property owner did not grant access to take water quality samples. Because the ponds are limited to drainage from a single residence and an active fish community was observed from the shores of the ponds, the two ponds are not anticipated to be a source of major *E. Coli* contamination.

Two active outfalls were observed along Philips Ditch ('UNT Ritter' and 'PH Johnson). Both of the active outfalls along Philips Ditch were sampled for water quality.

Seven actively discharging outfalls and two ponds in the overbanks were sampled along Auten Ditch.

6.4. Photographic Documentation

Staff from McCormick Engineering created a reference of photographic documentation of the field conditions along Bowman Creek, Auten Ditch, Philips Ditch and Eberly Ditch. The location of support photographs are shown in **Figure 4**, while the actual images with reference coordinates and a reference map of each individual photograph are provided in **Appendix A**.

6.5. Systematic Samples

Based on the preliminary sampling performed, the surfactant portion of the standard water quality sampling was abandoned. As can be seen in Table 2, only two sample sites came back with quantifiable surfactant test results based on the MBAS method. One site was at the measuring threshold of 0.12 mg/L (verses a result of <0.12 mg/L for the other preliminary testing sites). The other measurable surfactant result was at an industrial outfall pond (AU IND 3) along Auten Ditch with a result of 25 mg/L. This pond was not directly discharging to Auten Ditch at the time of the study and will be discussed further in this report. Additional systematic surfactant testing did not appear justified in stream mainlines beyond the data collected in the preliminary testing sites. The surfactant tests were performed on active outfalls and were completed prior to getting all the lab results for the preliminary sites.

Eberly Ditch

As noted previously, the preliminary test taken at the mouth of Eberly Ditch (EB-05) resulted in acceptable results for all parameters. Additional work along Eberly Ditch beyond the initial sample was limited to the identification and location of all visible outfalls (Figure 3) and the photographic documentation of field conditions along the entire creek (**Figure 4** and **Appendix A**).

Eberly Ditch is significantly different than Bowman Creek in channel bottom (6-9 inches average of muck verses sandy bottom in Bowman Creek). Eberly Ditch does not appear to be a significant source of *E. Coli*, but may provide small sediment particle source to act as a transport medium for *E. Coli* to downstream areas.

Bowman Creek

Along Bowman Creek and Auten Ditch, water quality samples (nutrients and E. Coli) were collected and located at an interval of approximately 500 feet for the entire watershed (see **Figure 2**).

Philips Ditch

Along Philips Ditch water quality samples (nutrients and E. Coli) were collected and located at the mouth (sample 'Philips 17'). The buried hydraulic connection from the mouth of Philips Ditch (a pipe outfall) and the basin between Ireland Road and Chippewa Ave was not found. The preliminary sample taken just upstream of the basin (PH-10) had a low value of 18 CFU/100 ml, indicating that Philips Ditch E. Coli problems are likely localized to specific areas along the ditch under low flow conditions and not a major contributor at the St. Joseph River. Between Johnson Road and Miami Road, Philips Ditch was not actively flowing, although the drainage area at Johnson Road is on par with the combined drainage areas of the Bowman Creek and Auten Ditch mainlines. Sampling of outfalls along Philips Ditch did indicate some localized E. Coli issues, as can be seen in **Table 2**.

6.6. Overview of Sampling E. Coli Results

The water quality results of the study must be viewed in the context of providing a snapshot of conditions at a given period of time. The testing period for outfalls and systematic samples extended from April 10, 2012 to April 24, 2012 for a variety of reasons, including: the number of samples the testing laboratory can handle at a given time (10-15 maximum capacity for *E. Coli* samples in given day); the prescribed holding time for *E. Coli* (6-8 hours); and the need to avoid sampling on days with recent precipitation.

The water quality sampling results for the study are presented in **Table 2**. The *E. Coli* sampling results for Bowman Creek and Auten Ditch are graphed as a function of stream length in **Figure 5**.

Bowman Creek

There are three relatively distinct areas of Bowman Creek. The first is from the corporate limit to a point on the AM General property where high *E. Coli* levels are rescinding to the legal grab sample limit of 235 CFU/ml. The second area is a reach where the values were consistently below the legal grab sample limit from the AM General site to downstream of Michigan Street. The third area is an area where the *E. Coli* levels increased above the grab sample limits from the Fox Street tunnel near St. Joseph Street to the mouth of Bowman Creek at the St. Joseph River.

There was a testing results anomaly at sample 'Bowman 18'. This particular site was taken roughly a week later than adjacent samples due to security concerns at the military proving grounds facility. It is assumed that adjacent contaminant levels would have reflected similar results if the time frame were adjusted to match this particular sample.

One sample in the third City reach was elevated off the charts in comparison to the remaining sample. Sample 'Bowman 08' returned an E. Coli result of >63,000 CFU/100 ml. The next highest result for the entire study was 2100 CFU/100 ml. This site is an obvious area of further discussion below.

The receding *E. Coli* levels within the City jurisdiction are reaches that flow through wooded and apparent wooded wetland areas. This is likely an indication of natural wastewater treatment processes having a positive effect on water quality. It is also possible that the sandy bed of Bowman Creek has a continuous connection with the groundwater table, making base flow source determination less direct.

Near the interface of City and County jurisdictions, an outfall along the south side of Ireland Road appears to transport *E. Coli* from the St. Joseph Valley Parkway right-of-way to Bowman Creek.

The reaches of concern within the jurisdiction of the City are presented in **Figure 6**. Although the majority of Bowman Creek has elevated levels of *E. Coli*, **Figure 6** underscores the need for the City to focus on alternatives that would affect the lower reach of Bowman Creek. In the upper affected reach of Bowman Creek, the City should collaborate with County, State, and Federal agencies to improve the water quality of discharges entering into the City jurisdiction.

Auten Ditch

As previously noted, Auten Ditch is the same watercourse as Bowman Creek outside the jurisdictional boundaries of the City. Jurisdiction of Auten Ditch does fall under the authority of County, State and Federal agencies, however.

From **Figure 5**, it can be seen that within the County jurisdiction, the mean *E. Coli* levels were generally below the grab sample legal limit upstream of Roosevelt Road. Between Roosevelt Road and the St. Joseph Valley Parkway, nearly all sites were above the grab sample limit.

There were several flowing outfalls within the County jurisdiction that appear to significantly contribute to overall *E. Coli* levels in downstream areas. One particular outfall near the boundary between County and City jurisdiction (AU IRELAND) was producing active discharges with *E. Coli* levels of 1000 CFU/100 ml.

The reaches of concern within the jurisdiction of the County are presented in **Figure 7**. Although the City has no direct jurisdiction over these areas, a meeting was held with stakeholders from County and State agencies to increase awareness of the water quality issues within the greater watershed. **Appendix F** includes meeting minutes of the discourse with these stakeholders. In addition to the noted meeting, the County Surveyor assisted in the project by providing Right-of-Entry to legal drains within the County jurisdiction, provided in **Appendix B**.

6.7. E. COLI LEVELS AT TUNNELS

There are several tunnels (stream enclosures) within the City jurisdiction. During the sampling along these particular portions of Bowman Creek, special attention was taken to take a sample at both the upstream and downstream ends of each tunnel to help determine possible contaminant sources within the enclosed areas.

The testing results from the perspective of tunnels are provided in **Table 3**. From **Table 3**, it can be seen that on April 15, 2012, the upstream of the tunnel enclosure identified as ‘Riley Track’ yielded sample results of 510 CFU/100 ml at the upstream and in excess of 63000 CFU/100 ml at the downstream end (same sample mentioned earlier as above the chart results). To a lesser extent, but similarly at the Fox Street tunnel, the results were 182 and 450 CFU/100 ml at the upstream and downstream ends of the tunnels.

These two tunnel sites were resampled on April 23, 2012 after the initial lab results were available to confirm the potential for contaminant sources. As can be seen in Table 3, the resampling at these two sites at a later date did not correspond to similar results as the systematic testing. In fact at both of these sites, resampling resulted in higher levels at the upstream than downstream ends of the tunnel.

While the difference tunnel results cannot be easily explained at the Fox Street tunnel, the original results at the Riley Track tunnel cannot be discounted due to the overall magnitude of the contamination at the downstream end. While sample contamination is always a possibility, great care was taken to provide representative samples. More likely is a difference in actual contributing conditions between the two sampling dates within the enclosure. The determination of potential sources of effluent contamination within the Riley Track tunnel enclosure remains a high priority.

6.8. OVERVIEW OF SAMPLING – OTHER PARAMETERS

Water Temperature

The ten (10) preliminary samples produced average water temperature results of 8.5°C, with a range of 5.9-10.5°C. At active outfalls, the range was 12.1-16.6°C. Systematic samples yielded and average temperature of 17.0°C, with a range of 12.4-23.0°C. Indiana Code (327 IAC 2-1-6) calls for maximum temperature of 21.1 Celsius in April and 26.7 Celsius in May. As all but three systematic samples met the requirement, there does not appear to be a significant outside source of thermal pollution in the creek. Creek temperatures appear to be highly effected by outside temperature due to shallow depths of flow (9”-12”) observed at the majority of sites.

Dissolved Oxygen

The ten (10) preliminary samples produced average dissolved oxygen (DO) results of 12.6 mg/l with a range of 10.68-17.32 mg/l. Indiana Code (327 IAC 2-1-6) calls for calls for minimum DO of 4.0 mg/L and Max DO of 12.0 mg/L. However, cold water can hold more oxygen than warmer water and the preliminary samples were taken on a day with cooler temperatures. Therefore, the initial DO levels at three sites being above the normal acceptable range was less notable given the colder temperatures of the water samples on that day. At sampled outfalls, the range was 0.57 to 8.99 mg/L. Excluding the result at 'AU IND 3', an industrial pond mentioned earlier, all outfalls were within acceptable DO levels. Systematic samples yielded and average temperature of 9.3°C, with a range of 7.16-11.62mg/l. Given the propensity for water temperature fluctuation due to shallow flow depths (thus affecting DO levels), the DO levels observed during the study appeared to be within acceptable limits. Therefore, potential projects aimed at air entrainment to elevate oxygen levels would be less effective if long term conditions closely match those during the study period.

Ammonia and Total Nitrogen

Indiana code (327 IAC 2-1-6) calls for range of 0.0 to 0.21 mg/L total ammonia (NH3) depending on temperature. Ammonia sources in the water column include human and animal waste, lawn or crop fertilizer and decomposing organic matter. As can be seen in **Table 2**, there were several sites of concern with regards to ammonia. Notable problem areas were along Auten Ditch between Jackson and Ireland Roads (where a resident has been dumping lawn clippings) and along Auten Ditch immediately downstream of an industrial site at Roosevelt Road. The third area is along Auten Ditch in the effluent of Clear Water Mobile Home onsite wastewater treatment plant (sample 'AU WWTP 1').

Indiana Code (327 IAC 2-1-6) calls for max Nitrate-N + Nitrite-N of 10mg/L in waters designated as drinking water source. As can be seen in Table 2, none of the sample results approached this level of Nitrate-Nitrite, but the WWTP (AU WWTP 1) effluent was the highest at 4.6 mg/l.

Phosphorous

EPA target recommendation for total phosphorous is 0.076 mg/L (Hoosier Riverwatch, Spring 2012). The WWTP limit is 1 mg/L in Michiana areas that discharge to Lake Michigan. The WWTP along Auten Ditch (AU WWTP 1) yielded total phosphorous of 1.81 mg/l, which appears to be above the standard for WWTP's. Although there were elevated phosphorous levels at several locations that were on the order of 1 mg/l, the standing water in the industrial pond noted as 'AU IND 3' resulted in a reading of 85.3 mg/l. As such this site, although not discharging at the time of the study, would have the highest potential as a source of phosphorous contamination.

Surfactants

As previously noted, the sample of concern with regards to surfactants was taken at the standing water in the industrial pond noted as 'AU IND 3' resulted in a surfactant reading of 25 mg/l. As such this site, although not discharging at the time of the study, is of special concern due to the dispersive nature of surfactants.

7. Evaluation of Alternatives

The focus of the alternatives presented in this report is alternatives that fall under the jurisdiction of the City of South Bend. Within areas outside of the City jurisdiction, an initial stakeholder's meeting was held (minutes provided in **Appendix F**), with a follow up meeting scheduled in the future.

Minimum requirements of this study included assessment of the following alternative methods: stream bank restoration, erosion control, sediment control and re-aeration, removal of point sources of wastewater, flow improvements, UV Disinfection, and maintenance and clean-up activities.

7.1. Stream Bank Restoration - Tunnels

The greatest potential for stream bank restoration exists in the opening of existing stream enclosures/tunnels. In addition to the many bridge and culvert crossings, there are a total of six stream enclosures within the City jurisdiction:

- Nipsco tunnel
- tunnel under the Riley baseball facility
- Riley track tunnel
- Fox Street tunnel
- Michigan Street tunnel
- Greentech/AM General tunnel

Nipsco Tunnel

The Nipsco tunnel entrance is a large box culvert at the upstream end in Ravina Park (**Figure A-10**). At the downstream end of the Nipsco tunnel, the geometry has been reduced to a 48" diameter concrete pipe (**Figure A-8**). The reduction in flow area of the main creek could lead to pressurization at the downstream end (similar to a fire hose), which is not conducive to aquatic life, during higher discharge periods. In addition, the entrance being much larger than the downstream end without a trash rack makes this tunnel susceptible to clogging during flood events. Stream restoration of this approximate 1000' section of stream enclosure would require close coordination with the affected property owner, as the area above the tunnel is an active portion of the Nipsco operations (**Figure A-9**). The City would need to acquire the portion of the property used for the restoration of Bowman Creek to ensure proper maintenance of the restoration activities.

Riley Baseball Tunnel/Riley Track Tunnel

The approximate 1350 foot long tunnel under the Riley baseball facility begins approximately 200 feet upstream of Dubail Street and extends to the Studebaker Municipal Golf Course property. Bowman Creek is partially restrained by stone retaining walls for approximately 675 feet between this tunnel and the upstream tunnel under the Riley track facility (**Figures A-18 through A-20**). The Riley track tunnel extends approximately 730 feet to the entrance at Columbia Street.

Consideration to stream restoration was given to these two tunnels in the Bowman Creek Revitalization Master Plan (The Troyer Group, undated). Referring to **Figure 5**, it can be seen that the area between the Riley Track tunnel and the Nipsco tunnel is an area of increasing elevated *E. Coli* levels. This reach is also within the areas of concern noted in **Figure 6**. Native restoration of one or both of these stream enclosures, along with the restrained section of stream between these two tunnels is a positive alternative to long term improvements along Bowman Creek. Restoration activities, if pursued, would provide the benefit of exposure of outfalls within the tunnels, as well as habitat and potential aesthetic improvement.

Fox Street Tunnel/Michigan Street Tunnels

The restoration of Fox Street (approximately 350 feet long) and Michigan Street (approximately 600 feet) Tunnels have less potential to day light encapsulated stream due to the alignment of Fox Street and Michigan Street roadway sections relative to the creek. Opening the portion of the Fox Street tunnel not under the Fox Street roadway would require the demolition of several existing homes on the south side of Fox Street, yet provide very little additional stream exposure. A great portion of Bowman Creek outside of the Michigan Street roadway that could be exposed is currently used as part of a bank facility. Restoration of the Fox Street and Michigan Street tunnels is given consideration in the Bowman Creek Revitalization Master Plan (The Troyer Group, undated). In **Figure 5**, increasing *E. Coli* levels exceed the grab sample limit at the downstream limit of the Fox Street tunnel, but not at the upstream end. The Fox Street tunnel should be investigated through television monitoring to search for a point discharge of sewer effluent. The *E. Coli* levels were below the grab sample limit upstream and downstream of the Michigan Street tunnel, giving lower priority to this potential restoration project.

Greentech/AM General Tunnel

Bowman Creek is encapsulated for approximately 850 feet near the AM General test track facility. Water quality measurements near this tunnel site were below the grab sample limit upstream and downstream of the tunnel, giving lower priority to this potential restoration project.

7.2. Stream Bank Restoration - Other

Within the confines of the AM General property from the Greentech/AM General tunnel to a failing instream dam near water quality sample 'AM General 9' (**Figures A-43** through **A-70**), the creek has been channelized with concrete. Although concrete channels provide little to no direct benefit to aquatic habitat, the *E. Coli* levels in this area were generally low in comparison to other reaches of Bowman Creek. The presumable reason for reduced E. Coli levels in this reach is the upstream wetland near sample location 'Bowman 18'. Although concrete channels can lead to thermal pollution this particular channel is relatively shaded. In addition, a lack of maintenance along the concrete channel that can be seen in **Figures A-43** through **A-70** has led to trees growing into and through the concrete in some areas, as well as the beginnings of concrete failure. Natural restoration of the stream is therefore beginning in this lower priority area.

7.3. RE-AERATION ALTERNATIVES

Re-aeration is an alternative directed at increasing dissolved oxygen (DO) levels.

In the previous aquatic study (Deegan, 2010), there were two observed areas of low DO. However, these areas were limited to isolated pools. With the exception of an industrial pond site within the County jurisdiction, DO levels were above the minimum range. Initial sampling results had three locations above the maximum DO of 12.0 mg/l. These initial samples were taken on a cold morning which increases potential DO levels. As such there were no observed locations where the priority would be to increase the DO levels to bring them into the range of 4-12 mg/l. Aeration of discharges may be included as part of a project, but does not appear warranted as a standalone alternative. Low levels of DO in isolated pools may continue to be an issue, but it does not appear realistic or viable to aerate such potential areas.

7.4. EROSION AND SEDIMENT CONTROL

There were some noted with Erosion and Sediment Control issues.

- A site at the downstream end of the Riley baseball tunnel (**Figure A-16**) has erosion that is undermining a grouted riprap slope. The grouted slope could be repaired with more grouted rip-rap, standard riprap or by protecting the slope with a more flexible means of erosion control, such as a Turf Reinforcement Mat (TRM).
- The wooded reach of stream between Chippewa Avenue and Gertrude Street (**Figures A-90** through **A-98**) has some eroded banks at the meanders in the creek. Due to the natural wooded nature of the area, a bank protection project in this reach would need to involve a product that would have minimal adverse impacts, such as hand placement of vegetated straw wattles. However, this particular reach of Bowman Creek is under the County jurisdiction (**Figure 6**). Although there is notable bank erosion in this area, this erosion is part of the stream geomorphologic response to the hydrologic inputs. Therefore, high priority should not be placed on reduction of sediment transport in this area.
- A minor instream dam at the AM General site is being undermined (**Figure A-69**). Were this dam to fail altogether, there would be the potential for increased erosion due to release of sediment from the stream bottom as head cutting occurred. Repairs to or removal of

this dam, if warranted should be initiated by the property owner.

7.5. Removal of Point Discharges of Wastewater

Documentation of the active outfall locations shown in **Figure 3** did not yield observed point discharges of wastewater within the City jurisdiction. The City should continue to work closely with County, State and Federal agencies to resolve point discharges outside of its jurisdiction.

The results of the study did indicate increasing levels of E. Coli within the City jurisdiction between the Fox Street tunnel and the Nipsco tunnel, but did not find an associated point discharge source. Testing at the upstream and downstream ends of tunnels initially pointed to a potential issue at the Riley track tunnel and the Fox Street tunnel. Confirmation testing at these sites did not yield similar results at these sites. Additional testing is recommended at certain tunnels to reduce the likelihood of a point discharge of wastewater within these tunnels:

- The Riley track tunnel and Fox Street tunnel should have video monitoring to document point discharge locations, since the systematic sampling indicated higher *E. Coli* levels at the downstream end of the tunnel than the upstream end.
- The Riley track tunnel and potentially the Riley baseball tunnel should have additional systematic water quality testing performed at the upstream and downstream ends to examine *E. Coli* levels as a function of student presence at the Riley High School Facility. The following would appear to be a reasonable option:
  - Take *E. Coli* samples and DO/temperature readings on M-Th at 7am, 10am and 4pm for two continuous weeks.
  - Compare values upstream and downstream of the tunnel
  - Compare values as a function of the time of day

  The M-Th option is suggested due to the standard lab practice of not accepting samples on Fridays or weekends. The noted times ensure a reduced student population at certain times, while requiring only two lab drop offs per day to meet the 6-hour holding time requirement. Consideration should be given to taking the sample for the downstream end of the baseball tunnel at Indiana Avenue (upstream end of Ravina Park) for ease of access purposes.

7.6. Removal of Non-Point Discharges of Wastewater

The increasing E. Coli levels between the Fox Street tunnel and the upstream end of the Nipsco tunnel were not able to be directed to a point source as part of the study, but appear to be systematically increasing as a function of distance downstream. It is possible that this is the result of historic septic fields/tanks. A GIS search of residencies that did not connect to the City sewer system should be performed in the area from Michigan Street to Broadway Street. Any residences that did not connect should be investigated to ensure that all sanitary discharges with the City jurisdiction are directed to the WWTP.

7.7. UV Disinfection

Exposure to ultraviolet (UV) lights is a proven method to disinfect wastewater at treatment facilities. A short wavelength (UVC) light is typically used to provide germicidal disinfection, but is primarily blocked by the atmosphere of the Earth (EPA, 2010). Most exposure to UV light references the longer wavelength UVB light commonly associated with human sunburns and cancer exposure.

UV Disinfection is directly related to contact time and amount of UVC exposure. In wastewater systems, this means that very close proximity to a clean bulb is required. Bulbs are subject to common replacement as dust or films are produced on the bulb. Therefore, UV disinfection is usually placed as a tertiary treatment process, where the suspended particles have been removed from the water column (as they provide the equivalent of shade to portions of the water).

The application of UV disinfection as applied to stormwater is limited in North America to date. A limited number of sites in Canada are using UV disinfection for stormwater. One such facility was placed at a detention pond site (Soil & Water Conservation Society of Metro Halifax, 2006). The Moonlight Beach Urban Runoff Treatment Facility site in Encinitas, California uses UV disinfection to treat low flows along a stream for beach protection (Water World). While the treatment capacity of the Moonlight Beach facility is unknown, the 2002 project had an initial construction cost of $438,000 (American City and County, 2003).

A World Health Organization report indicates that “UV units to treat small batches (1 to several liters) or low flows (1 to several liters per minute) of water at the community level are estimated to have costs of 0.02 US$ per 1000 liters of water, including the cost of electricity and consumables and the annualized capital cost of the unit.” (World health Organization). While the treatment in question is for batch treatment, the article also notes that the turbidity should be low (<30 NTU) to provide effective UV treatment.

Unlike chlorination, UV Disinfection does have the benefit of providing no residual chemicals; however, the treatment rates at a centralized WWTP are typically lower than field conditions on a non-attenuated stream. The lower reach of Bowman Creek does not currently have any major detention facilities or natural ponds to act as clarification and rate attenuators. The area within an existing tunnel might prove to be a feasible location to treat flows with UV disinfection. However, if the City did desire to utilize this alternative, additional testing on representative field turbidity conditions would be required. While the turbidity observed in this study was relatively low based on visual assessment alone, it is unlikely that an influent requirement of 30 NTU would be achieved, if this held as a constrain, for the installation without the need for additional chemical precipitation or other clarification means.

7.8. Maintenance and Clean-Up Activities

Certain portions of Bowman Creek contained more garbage and debris than others. Notable locations for clean-up activities include:

- Within Ravina Park (**Figure A-12**).
- Between the Riley track tunnel and the Fox Street tunnel (**Figure A-24**).
- Between the St. Joseph Valley Parkway and Gertrude Street (**Figure A-105**).

Cleanup operations along these three reaches would provide for increased aesthetics along the creek. Garbage and debris are a source of water quality degradation.

There were also notable maintenance activities:

- Undetermined utility of an assumed trash rack system at the upstream end of the Riley baseball tunnel (**Figure A-17**).
- Fallen trash rack at the upstream end of the Riley track tunnel (**Figure A-25**).
- Damage to the trash rack at the upstream end of the Fox Street tunnel (**Figure A-30**).
- Damage to the trash rack at the upstream end of the Michigan Street tunnel (**Figure A-33**). This trash rack potentially appears to have been damaged by metal scrappers.
- Damage to the trash rack at the Main Street Bridge (**Figure A-39**). The close spacing of the bars at this trash rack increase potential for clogging and associated flooding of Main Street.

7.9. Other Measures and Alternatives

E Coli Modeling

In 2005/2006 Limno-Tech, Inc developed a Bowman Creek watershed model using Hydrologic Simulation Program-Fortran (HSPF) model for the portion of the St. Joseph River watershed in Indiana. "The goals of this task were to simulate flows and *E. coli* loads on a watershed basis for tributaries to St. Joseph River (between the City of Elkhart and the Michigan-Indiana state line), to simulate best management practices (BMP) removal efficiencies for several sources, and to link each BMP to a cost associated with implementation" (Limno-Tech, Inc., 2006). Bowman Creek was one of 13 tributaries or sub-watersheds in the study area. Both point and non-point source pollutants were represented in the model based on land use and were not site specific. In a summary memo (Limno-Tech, Inc., 2006), Limno-Tech concluded that more intensive sampling of the individual tributaries was necessary in order to use the model for anything other than a general BMP planning tool. The City could develop a more refined model of Bowman Creek *E. Coli* levels based on the sampling results from this study coupled with site specific land use data for the watershed.

Regulatory Hydraulic Modeling

A regulatory Digital Flood Insurance Rate Map (DFIRM) exists for portions of regulated Bowman Creek to establish Special Flood Hazard Areas (SFHA) for insurance purposes. The Flood Insurance Study (FIS) has a large impact on the regulatory permitting of activities along the creek at both a State level (Indiana Department of Natural Resources Construction in a Floodway permit) and Federal level (Federal Emergency Management Agency). Based on initial investigations at a site along Bowman Creek near the AM General tunnel, the extents of the SFHA for portions or all mapped reaches of Bowman Creek appear to have been improperly mapped as a mirror image from the stream centerline. For example if the FIS modeling indicated that the SFHA extended 100 feet to the left and 1000 feet to the right of a given point from the center of the stream, the true area of flooding would have extended from 1000 feet to the left to 100 feet to the right, even if the model were fully representative of actual conditions.

The entire regulatory reach of Bowman Creek will likely require remodeling to accomplish regulatory permitting in in-stream projects. IDNR will likely require that the Federal SFHA mapping be updated to reflect the more current information. This may have the unintended effect of taking certain residences out of the SFHA, while placing other properties into the remapped SFHA (and subsequent flood insurance requirements).

As remapping of the SFHA, achieved through a process known as the Letter of Map Revision (LOMR), is a process that involves detailed survey of bridges, culverts, tunnels, topography; mapping of regulatory SFHA extents; Public Hearings and Agency review and coordination. This lengthy process can take from one to several years. As this mapping error presents a regulatory obstruction to potential construction projects recommended in this study, discussions with IDNR for the City to initiate the Bowman Creek restudy should be pursued.

CSOnet

In 2008, South Bend, IN implemented a dense real time monitoring system for its wastewater collection system. The system was designed using a concept named Combined Sewer Overflow Embedded Sensor Network or CSOnet. This system was aimed at aiding with operations and maintenance of the collection system and providing data to refine its hydraulic and hydrological model. More than 100 level and flow sensors distributed along critical locations throughout the sewer system makes South Bend the most densely monitored system in the United States. The CSOnet system transmits more than 30,000 data points per day to wastewater utility officials on current hydraulic conditions in the sewer lines and other regulating structures. In the past few years sensors have been added to ditches, creeks, ponds and water quality structures to monitor their functions.

Additional sensors and valves along Bowman Creek would be useful for monitoring flow conditions, especially during dry weather. Adding controls to an in-line pond at Franklin Street could be beneficial in retaining water in the existing in-line pond and releasing it during dry weather which would allow for added flow during low flow conditions. Note that this pond is near the upper end of the lower reach within City jurisdiction. Therefore, extending the duration of flow from the reach that met water quality standards during the study into the lower reaches would be a positive effect.

GIS Analysis

As noted above in **Section 7.6**, it is fully clear if each residence located along Bowman Creek has been connected to the City's Sanitary Sewer System. It is possible that there are old septic fields that are in use but that are in poor condition and are contributing to the *E. coli* presence in the creek.

It would be beneficial for the City to do a GIS analysis of the watershed from the mouth of Bowman Creek to the limits of jurisdiction at the St. Joseph Valley Parkway to identify any homes not currently connected to their wastewater collection system. A buffer distance of 300-500 feet from Bowman Creek stream centerline in both directions would appear to establish a reasonable starting point for this analysis. Any suspect residences should be confirmed and connected to sanitary sewer, if appropriate.

Public Involvement

As noted above in **Section 6.6**, although the majority of Bowman Creek has elevated levels of *E. Coli*, there is a need for the City to focus on alternatives that would affect the lower reach of Bowman Creek, since the upper affected reach of Bowman Creek, shown in **Figure 6**, shows contamination at the inflow to the City jurisdiction. That is not to say that the City should ignore the contaminated discharge in the upper reaches, but the City should collaborate with County, State, and Federal agencies to improve the water quality of discharges entering into the City jurisdiction. There are other Public entities whose participation might also be instrumental to improving the water quality along Bowman Creek. Beyond the County and State officials who have been appraised of the testing results during the course of the work (County Surveyor's Office, IDEM - Office of Compliance Support, St. Joseph County MS4 Coordinator, and St. Joseph County Health Department), the City should consider engaging and presenting the results of the study to the following non-exclusive list of agencies:

- University of Notre Dame
- Indiana University of South Bend
- Riley High School
- St. Joseph County Engineer
- AM General
- Republic Services
- Economic Development
- City of Elkhart (Daragh Deegan, Aquatic Biologist)
- Friends of the St. Joseph River

At a minimum, theses agencies may be able to provide volunteer workforce candidates to help with some of the physical cleanup operations along reaches of Bowman Creek.

8. Summary of Recommendations

8.1. Recommended Actions

Based on the Testing Results presented in **Section 6** and the Evaluation of Alternatives discussed in **Section 7** above, the following recommendations are provided. **Table 3** includes a reasonable estimate for each recommendation as well as proposed schedule for completion.

1. There are six (6) tunnels located between the AM General vehicular proving grounds and the mouth of Bowman Creek within the jurisdiction of the City. Field sampling was completed at the upstream and downstream end of each tunnel. These "tunnel" samples were found to be of high concern for water quality near the existing Riley High School campus. Some of the tunnels were also found to have maintenance issues such as displaced trash racks, and undercutting of footings at downstream slope walls.

   The City should continue to investigate possible contributing factors for *E. coli* at the tunnels by testing when school is in session for a limited but prescribed duration of time that encompasses periods of high and low student presence. This would establish or at least provide an indication of whether restroom facilities at the Riley High School campus are contributing to *E. Coli* levels through an illicit connection currently unknown to the City, including Riley High School administrators. The testing should be done in conjunction with dye testing. As the levels at the downstream end of the Riley Track tunnel were the highest observed in the study, **this recommended testing beyond the scope of the original project is the key to further identifying potential sources of *E. Coli* contamination and thus provides for the most potential beneficial impact to water quality along Bowman Creek**.

2. The tunnel located at Riley High School track should be re-televised after completion of dye testing.
3. The large main line sanitary sewer located within Studebaker Golf Course

should be televised. This would be helpful in determining if deterioration of the sewer such as loss of invert is contributing to the high *E. Coli* levels in Bowman Creek. Existing video of the connecting trunk lines should also be viewed to observe the number of connections in comparison to the number of homes in order to identify houses that are not connected to the system and may have failing septic systems. Trunk lines that do not have available video should be televised.

4. A GIS study to search for residences with sanitary sewers that are not connected to the public sewer system within the lower reach from Michigan Street to the mouth could prove helpful to reduce ongoing nonpoint contamination from potential septic fields.
5. Televise tunnel at Riley High School baseball field to look for evidence of unknown point discharges and maintenance issues.
6. Televise Fox Street tunnel to look for evidence of unknown point discharges and maintenance issues.
7. Televise Michigan Street tunnel to look for evidence of unknown point discharges and maintenance issues.
8. Televise Nipsco Street tunnel to look for evidence of unknown point discharges and maintenance issues.
9. Televise Greentech/AM General tunnel to look for evidence of unknown point discharges and maintenance issues.
10. Upon completion of video monitoring of all tunnels, a maintenance schedule should be created for each of them.
11. As part of the televising of tunnels, the City should attempt update maps of outfalls seen during the televising process to ensure that the GIS mapping of the outlfall locations is representative of current conditions.
12. Cleanup and maintenance operations should be implemented within Ravina Park.
13. Cleanup and maintenance operations should be implemented along Bowman Creek between Fox Street and the Riley track tunnel.
14. Reset the fallen trash rack at the upstream end of the Riley track tunnel.
15. Remove the trash rack at the Michigan Street Bridge. This trash rack would appear to present a significant risk of clogging and roadway overtopping.
16. The City should initiate work on a LOMR to redefine the limits of flood insurance mapping, as current errors in this mapping will provide an ongoing regulatory impediment to stream bank restoration and “day lighting” initiatives. As a first step to achieve this end goal of accurate flood mapping and base modeling for permit activities, the City needs to complete a scoping study to establish the available data, survey needs and limits and concurrence on regulatory discharges for the desired study reach limits.

17. Placing a monitored valve on a pond within the reach of Bowman Creek found to be below acceptable *E. Coli* levels might be able to elongate the duration of “clean water” discharges into the lower reaches of Bowman Creek when extreme low flow conditions are seen. Such a valve should be connected to the CSOnet network for maximum potential benefit.
18. During the field investigation portion of the project, samples were taken both within the jurisdictions of both City of South Bend city limits and of St. Joseph County. A number of the County samples had *E. coli* counts higher than acceptable for grab samples. It is recommended that the City continue its collaboration with the County as well as the Indiana Department of Environmental Management, initiated as a result of this study, to refine the source of pollution at sample locations and to implement measures that could be taken to improve the water quality of the greater watershed. **This recommendation provides for the greatest potential benefit to water quality in the upper reaches of City jurisdiction, where the water quality coming into the City is already impaired**.

    The City should also engage other Public stakeholders in the process that might provide additional insight or actual volunteer labor forces to implement noted recommendations.

8.2. INITIATED ACTIONS

Some of the work beneficial to improving water quality along Bowman Creek, yet not specifically mandated by the report requirements, has been started by the City and County as a direct result of the water quality sampling results of this study. These include:

1. Coordination with City, County and State Agencies related to testing results outside of the City jurisdiction.
2. As a result of the study, the County Surveyor, as a proactive water quality partner, has been in contact with a homeowner to cease and desist the dumping of grass clippings into Auten Ditch sown in **Figure A-127**.
3. To confirm abnormal elevated results at the Riley track tunnel and Fox Street tunnel during systematic sampling, the City authorized secondary resampling at these sites as part of this study. The resampling did not provide results similar to the previous round of testing, which indicates that there may be an intermittent source of contamination at these sites, or a contamination issue at this specific site despite adherence to accepted protocols by the

sampler and lab to minimize the risk of this possibility.

4. To investigate the potential for flowing outfalls within the Fox Street and Riley track tunnels, the City initiated video monitoring at these two sites. Video monitoring did provide for documentation of a limited number of outfalls, none of which were providing discharge at the time of monitoring.

TABLE 3 - SUMMARY AND SCHEDULE OF IMPLEMENTATION PROJECTS

Priority Action Item	Estimated Cost	Completion Time (months)
1. *E-coli* testing at Riley High School to determine if elevated levels are the normal condition through that section of creek. Testing should include dye testing from the building facility as well.	$9,000	6
2. Re-televise Riley Track tunnel (~730 ft after dye testing)	$1,600	6
3. Televise large Combined Sewer near Riley High School. This should also include watching videos of smaller trunk lines connecting to main line to complete lateral counts.	$6,000	12
4. GIS research into residences without lateral connections to the public sewer system within the lower reach from Michigan Street to the mouth could prove helpful to reduce potential nonpoint contamination from historic septic fields.	$1,800	8
5. Televise Tunnel under Riley HS baseball field (~1350 ft)	$4,800	12
6. Televise Fox Street tunnel (~350 ft)	$800	12
7. Televise Michigan Street tunnel (~600 ft)	$1,600	12
8. Televise Nipsco tunnel (~1,000 feet)	$6,400	12
9. Televise Greentech/AM General tunnel (~850 ft)	$1,200	12
10. Create a tunnel maintenance schedule	$1,000	18
11. Remap tunnels and sewer lines in City GIS to match new information gathered in televising videos	$2,000	18
12. Clean-up Creek at Ravina Park	$1,400	6
13. Clean-up Bowman Creek between Fox Street and Riley Track	$3,200	6
14. Reset fallen trash rack at Riley track	$400	3
15. Remove trash rack upstream end of Michigan Street	$1,600	12

TABLE 3 – SUMMARY AND SCHEDULE OF IMPLEMENTATION PROJECTS

Priority Action Item	Estimated Cost	Completion Time (months)
16. Complete scoping project regarding hydraulic modeling of Bowman Creek. This should include information gathering, hydrologic review, agency coordination and concurrence of discharges and future modeling approaches, preparation of survey RFP and summary report.	$10,000	36
17. Final Design of Franklin Street pond low flow valve improvements	$10,000	24
18. Stakeholder Participation Meeting(s)	$3,200	12
Total	**$66,000**	

Notes:

1. Televising and cleanup activities are based on an effective billing rate of $200/hour for three-man crew and equipment
2. Schedule of completion is assumed to have a start date coincident with final acceptance of this report by EPA
3. Nipsco tunnel and Riley HS baseball sites have higher relative hours per linear foot of tunnel televising due to observed geometric configuration changes between entrance and exit conditions

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