

Appendix B

Description of IDEM Water Quality Data Sets Muncie, Yorktown, Ivy Tech - Muncie & Delaware County, Indiana

October 2010

General Information

This report has been compiled by GRW Engineers as an explanation of the water quality report assembled for the NPDES (National Pollutant Discharge Elimination System) Phase II as it pertains to storm water quality for the Buck Creek-Macedonia Creek watershed, the Jakes Creek-Eagle Branch watershed, the White River-Truitt Ditch watershed, the White River-Buck Creek (lower) watershed, the White River-Muncie Creek watershed and the White River-York Prairie Creek watershed in the Muncie area. The following will describe each characteristic of the sampling data. It will also provide a comparison of the data versus the standard limits. It should be noted that if 90% of the data within one parameter are below the detectable value, that parameter is considered insignificant. The most commonly used parameters for storm water quality related to recreational waters are turbidity, bacterial quality, and toxic compounds. For fish and wildlife, the most concerning parameters are the dissolved oxygen level and chlorinated organic compounds. IDEM collects data in the following categories: field data, general chemistry, metal, organics, and pesticides. These topics will be discussed in the following pages

Field Data

Dissolved Oxygen (DO)

This is one of the most important measures of water quality. For recreational purposes, it has significant effects on odor and color of the body of water. DO helps to reduce certain contaminants in the water. Bacteria uses oxygen to decompose organic material in addition to converting some more toxic chemicals to more stable less toxic forms. IDEM has set a minimum five-day level of 5 mg/L and no less than 4 mg/L at any one time in a freshwater stream for healthy organism life.

The data provided for the Partnership displayed acceptable values for DO over the 11-year period. However, three sampling points were below the minimum acceptable limit in that period. In the White River-Truitt Ditch watershed the level declined to 2.0 mg/L. The level also declined twice in the White River-Buck Creek (lower) watershed. These levels were 0.7 and 3.8 mg/L. While all three points are significantly low levels of DO they did not remain low. The reading of 0.7 mg/L may be a monitor malfunction.

There is not reason to be concerned with these results.

pH

The pH is a measure on a logarithmic scale ranging from 0 to 14 where the lower range numbers are associated with acidic solutions and the higher range numbers with basic solutions. Consequently the closer to the number 7 the results are, the more neutral the solution. For natural waters the pH value should be between 6 and 9, according to IDEM, however, daily fluctuations can occur. Daily fluctuations in pH are acceptable and can result in a daily reading exceeding 9.

These increases in pH readings rarely remain high and are likely to be associated with photosynthetic activity.

The values for the Partnership watersheds were well within the acceptable range.

Saturation Percent

The saturation percent is the calculation of the DO concentration relative to the capacity in a body of water. The main factors affecting it are the water temperature, salinity, and partial pressure. There are no set standards for this parameter, but it should stay as close to 100% as possible. If the percent saturation falls to a detrimental level, the result would show up in the DO available.

Muncie's data showed reasonable values for this parameter. The saturation percent ranged from 57 % to 117 % with the majority of the data points falling in the 90th percentile.

Specific Conductance

Specific conductance is the ability of water to conduct electricity. The IDEM standard for specific conductance for water to be used for agricultural, domestic and industrial uses is 1200 micromhos per centimeter. However, when used as a water quality parameter for surface water for recreational purposes, it is most often used in estimating TDS.

The majority of the Partnership watersheds were within the threshold for this parameter. However, both the White River-Buck Creek (lower) watershed and the White River-York Prairie Creek watershed had some falling values. 13% of the data retrieved from the Buck Creek (lower) watershed was higher than the standard. This is a relatively small percentage and is not large enough to cause concern. The York Prairie Creek watershed however, was significantly failing. 42% of the data was above the threshold. The value for TDS is within range for this watershed, so weather or not this parameter needs further attention depends on whether or not there is an intake near the failing area.

Turbidity

Turbidity is the measure of the clarity of water. An increase in turbidity is due to suspended impurities such as clay, silts, and soil particles. An increase can hinder the microorganisms from acting as disinfectants in surface waters. The acceptable range for turbidity varies between a "clear" lake at 25 units to a muddy unaesthetic body of water at 100 units. The Muncie watersheds only had 5% of its data point in the 100 units or above range. All the fixed monitoring stations reported relatively low numbers throughout the data with a few spikes. If these spikes were associated with a large rain event, then the waterways in the **Muncie** watershed would be considered "flashing water". "Flashing water" is a waterway that, due to a rain event and the terrain, has more soil particles released from the streambed.

There are no significant problems with this situation. It should be noted that one of Muncie's meters in each watershed had significant malfunctions throughout the data retrieval period.

Temperature

An increase in temperature of a body of water can increase the oxygen required for life while at the same time decrease the DO available. If changed at a rapid rate this could have detrimental effects on the aquatic life, however, since the levels of DO are within the required limits it is safe to extrapolate that the temperature is within a safe zone. The main factor related to temperature is the rate of change. For every 10 degrees Celsius increase the metabolic rate increases by a factor of two. The IDEM standard states that the water temperature should not exceed 32.2 degrees Celsius at any given time, and that the maximum rate of temperature increase should be no more

rapid than 2.8 degrees Celsius at any given time. This statement is from the IDEM standards and is incomplete. There is not a reference as to the unit of time.

This parameter should not be a concern.

General Chemistry

Alkalinity

Alkalinity is the ability of water to absorb hydrogen ions without having a change in pH. It is what helps to keep the pH stable when water conditions change. In surface water, the alkalinity is mainly affected by the presence of bicarbonates. There is not a standard alkalinity value. The value is a result of the geological formations of the area. This value can vary drastically from city to city. Areas of Indiana and Kentucky are prone to having high values of alkalinity; this is due to the large quantity of limestone in the area. Even taking this into consideration, the average values for the area studied are relatively average for the nation. The data for this parameter revealed relatively low levels of alkalinity.

This parameter should not be a concern.

Biochemical Oxygen Demand (BOD₅)

The BOD₅ is the measure of the amount of oxygen consumed in five days by microorganisms during biodegradation. According to NPDES, the standard for effluent from a sanitary sewer treatment facility is 20-50 mg/L with the average below 30 mg/L. The data from Muncie's water quality study is not at an effluent point, but instead at some point downstream of the mixing station. Therefore, the measured values should be considerably lower than expected values near the effluent. For the two watersheds monitored, White River-Truitt Ditch and White River-Buck Creek (lower), values were between 1.0-6.7 mg/L.

The measured values were below the effluent standard, however, there is no standard for the values downstream of the mixing zone. Therefore, the results are inconclusive.

Chlorides

Chlorides in large quantities contribute highly to the hardness of water. They also reduce the quality of taste in drinking water supply. The IDEM standard for chlorides is less than 250 mg/L. Muncie's watershed data for this parameter was significantly under the standard. The highest reading was 134 mg/L in the White River-Buck-Creek (lower) watershed.

This parameter should not be a concern.

Chemical Oxygen Demand (COD)

COD is the measure of the oxygen needed to oxidize chemical waste. There is not a standard set for this parameter; however, the values should be higher than the biochemical oxygen demand (BOD₅). The measured values for COD are higher than those identified for BOD₅, and they are also in a reasonable range.

This parameter should not be a concern.

Coliforms

The number of coliform bacteria found in a sample of water can be significant. This number indicates the potential for disease causing species being in the sample. The lower the number of coliform bacteria, the lower the potential for pathogenic organisms. The IDEM standard limit for

the coliform bacteria group is 5,000 MPN or MF per 100 mL on a monthly average and no more than 20% of the data samples can be above 5,000, and there has to be less than 20,000 MPN or MF per 100mL in 5% of the data collected.

The data reading for the Muncie watershed read greater than 2,419 per 100 mL. These data are inconclusive.

Cyanide

The IDEM standard for cyanide is 0.0052 mg/L for human health and 0.022 mg/L for aquatic life. Muncie's fixed monitoring stations reported more than 90% to be below the detectable value of 0.005 mg/L. And Yorktown reported more than 85% of their fixed monitoring stations to be below this value also. The White River-Truitt Ditch watershed had 4% of its measured values above the human health standard, but no points above the aquatic life standard. The only other watershed that had a significant data was the White River-Buck Creek (lower) watershed. This watershed had 12% of the measured values above the IDEM standard for human health and one value above the standard for aquatic life. However, none of the failing values were significantly above the standard and they did not remain elevated either.

This parameter should not be a concern.

E. Coli

Escherichia, E. coli is used as an indicator organism that suggests the presence of sewage and other pathogenic organisms. Most strains of E. coli are harmless, only one in hundred strains is harmful to humans. E. coli will not survive as long as coliforms will; therefore, if the coliform bacteria level is low it is probably not necessary to test for E. coli. The IDEM standard for full body contact with E. coli is no more than 235 MF per 100 mL in any one sample over a 30-day sampling period. Muncie's watersheds had consistent reading of E. coli that are significantly higher than the standard. The Buck Creek-Macedonia Creek watershed and the Jakes Creek-Eagle Branch watershed had 100% of their data points above the threshold. The White River-Muncie Creek watershed and the White River-Buck Creek (lower) watershed were both in the range of 65% failing readings. The remaining two watersheds, White River-Truitt Ditch and White River-York Prairie Creek had approximately 35% of the values above the threshold.

The E. coli reading in this area should be considered as a significant sign of contamination.

Fluoride

Fluoride is not to exceed 2.0 mg/L according to IDEM in any waterway in Indiana. Fluoride is added to many cities water supply for the benefit of protecting the consumer's teeth. This is only being done to an amount of 1.0 mg/L. In large quantities if ingested fluoride can cause brittleness of bones. The measured values in the watersheds in Muncie stayed within the standard.

This parameter should not be a concern.

Hardness

Hardness is a measure of the concentration of ions of calcium and magnesium, and is a major cause of staining plumbing fixtures. These properties should not be present in significant quantities in natural waters. Four additional elements contribute to the hardness of water. They are iron, manganese, strontium, and aluminum. It is considered to be excessive if the value is greater than 500 mg/L as CaCO₃ and is preferred to be around 150 mg/L as CaCO₃. In excessive amounts, hardness can cause skin irritation. These can vary and depend highly on the type of soil

that is in the area. The highest measured value for Muncie's watersheds was 470 mg/L as CaCO₃ in the White River-Buck Creek (lower).

This is not an issue for storm water discharge.

Nitrogen

Nitrate-N + Nitrite-N has an IDEM standard of 10 mg/L. Nitrate and nitrite are harmful if consumed in large quantities. They can function as a hemoglobin inhibitor. The measured values for the watershed do stay significantly low for all data points. In fact, there was not a single data point that crossed the maximum acceptable level.

Ammonia nitrogen has been known to have adverse affects on aquatic life at chronic levels as low as 0.1 mg/L, however the EPA standard is 3.5 mg/L. Again, all the data points were significantly lower than the standard.

This parameter should not be a concern.

Phosphorus

Nutrients are considered pollutants when the concentrations reach a level that is conducive for excessive algal growth. Excessive algae are undesirable for surface water for three main reasons. It adds to the turbidity of water, causes a foul smell, and reduces the DO levels in water.

Nitrogen, carbon, and phosphorus are the three most contributing nutrients for algae growth. In the Muncie watersheds, phosphorus is the limiting nutrient. Most state regulations require phosphorus-limiting streams to have a maximum of 1.0 mg/L of phosphorus. Common contributors of phosphorus are detergents, clay type soils, human waste and agricultural runoff.

8% of the data points from the White River-Buck Creek (lower) measured outside of the threshold and the highest value was 2.0 mg/L. Such a small percentage is insignificant, and the rest of the watershed in this area are within the threshold.

Sulfates

Sulfates in large quantities contribute highly to the hardness of water. They may have a laxative effect if found in high concentrations in a drinking water supply. The IDEM standard is 250 mg/L. Muncie's sulfate reading displayed several incidences where sulfates were considerably above the standard. 11% of the readings were above the threshold, and the highest reading was 723 mg/L. All of the points that were outside of the standard were in the White River-Buck Creek (lower) watershed.

Some of the readings were significantly elevated. The reason for this could need to be investigated.

Surfactants

Surfactants are man made synthetic organic chemicals often used in large quantities in detergents or result from the natural decay of organic substances found in a stream. These substances can cause a foamy layer on the surface of water. For the most part, this foam layer is not hazardous, but rather unattractive for recreational uses. There is no set standard for the concentration of surfactants for surface water.

Total Dissolved Solids and Suspended Solids

Total dissolved solids (TDS) are the amount of solids that pass through a 1.2-micrometer filter, while the term suspended solids refers to the amount of substance retained on said filter. In high

concentrations, dissolved solids can reduce the serviceable water for agriculture, domestic, and industrial uses. The TDS threshold for drinking water is 500 mg/L and the majority of data points fell around this range. However, the IDEM requirement for fresh water streams is 750 mg/L assuming that the water will be used for more than just recreation. For water used solely for recreational purposes, there is no existing standard. 11% of the TDS measured values were above the standard of 750 mg/L, with the highest value being 1450 mg/L. All of the failing data points were retrieved from the White River-Buck Creek (lower) watershed. Some of the suspended solids data were rather high as well, and there appeared to be a correlation between suspended solids and the TDS level. . 21% of the tests for suspended solids were above the allowable 30 mg/L as stated in the NPDES for effluents. These points were taken from the White River-Buck Creek watershed and the White River-Truitt Ditch watershed. The samples were taken from a location downstream from the mixing point. Therefore, they should have significantly lower values than the NPDES requirements for effluent discharge.

Total Kjeldahl Nitrogen (TKN)

TKN consists of ammonia plus organic nitrogen. According to NPDES, the standard for effluent from a sanitary sewer treatment facility is 20-50 mg/L with the average less than 30 mg/L. The data that is contained in Muncie's water quality study is not at an effluent point, but instead at some point downstream from the mixing station. Therefore, the measured values should be considerably lower than the actual values at the effluent. The measured values for the Muncie watersheds' were between 0.2-5.4 mg/L. Yorktown's watersheds measured between 0.3-5.4 mg/L.

The values were below the effluent standard, however, there is no standard for the values downstream of the mixing zone. Therefore, the results are inconclusive.

Total Organic Carbon (TOC)

TOC is the measure of the total organic material in a water supply source from natural and human activities. According to the EPA, in surface water the number should be no higher than 5 mg/L. All of the watersheds in this area had a few points that were slightly high, however, no one watershed had a significant amount of points above the threshold.

This parameter should not be a concern.

Metals

Antimony

The IDEM standard is 0.146 mg/L for surface waters. 50% of the measured values were below the detectable value. The highest reading from the fixed monitoring station was 0.011 mg/L in the White River-Buck Creek (lower) watershed. The highest measured value is still below the standard.

There is no reason to be concerned with the concentration of this metal.

Arsenic

Arsenic can cause a variety of problems for human health. It is a known carcinogen and a mutagen. In milder forms it can cause fatigue and dermatitis. The EPA standard is 0.05 mg/L for surface waters. The measured values for Muncie's watersheds are very low for this parameter. The highest value was 0.014 mg/L in Jakes Creek-Eagle Branch watershed.

There is no reason to be concerned with the concentration of this metal.

Beryllium

The EPA standard for domestic water supply is 0.004 mg/L. 93% of the measured values for Muncie's watersheds were less than the detectable value of 0.002mg/L. Therefore, this parameter is insignificant.

There is no reason to be concerned with the concentration of this metal.

Cadmium

Cadmium will concentrate long-term in the liver, kidneys, pancreas, and thyroid. It has also been suspected of causing hypertension. The IDEM standard is 0.01 mg/L for surface waters. 93% of the measured values for Muncie's watersheds were less than the detectable value.

There is no reason to be concerned with the concentration of this metal.

Calcium

Calcium can contribute to blue-green algae growth. Neither the EPA nor IDEM have set a standard for this.

Chromium

Long-term excessive exposure to chromium can cause skin irritation and kidney damage. The IDEM standard is 0.47 mg/L for surface waters. More than 93% of the measured values were below detectable values.

There is no reason to be concerned with the concentration of this metal.

Copper

Copper in surface water will act as a corrosive agent. The EPA standard is 0.028 mg/L for surface waters. In the Muncie area, 63% of the data points were below the detectable value, yet there were 3 out of the 296 results that were above the threshold. Two points were in the White River-Truitt Ditch watershed and one was in the White River-Buck Creek (lower) watershed. A few points above the threshold over an eleven-year period are not detrimental.

For Yorktown, 30% of the data points were below the detectable value, yet there was 1 out of the 144 results that was above the threshold. That point was in the White River-Buck Creek (lower) watershed. One point above the threshold over an eleven-year period is not detrimental.

There is no reason to be concerned with the concentration of this metal.

Iron

Iron in large quantities can cause staining of clothes, boats, etc. It may also contribute to the growth of Crenothrix, autotrophic bacteria. The EPA standard is 0.3 mg/L for surface waters. The data in this watershed were significantly higher than the threshold for the material. Only two watersheds had significant data on this parameter and some of the points were extremely high. The White River-Truitt Ditch watershed had 48% of the data above the threshold and the White River-Buck Creek (lower) watershed had 36% of the data above the threshold value.

This metal is found in too high of concentrations and should be investigated. The extreme levels found in this area could be due to a high clay or inorganic content in the soil.

Lead

Lead can cause long-term brain and kidney damage as well as birth defects if consumed in large quantities. The EPA standard is 0.011 mg/L for surface waters. 83% of Muncie's data was below a detectable value of 0.006 mg/L. However, there were still seven points above the threshold. Five of the points were in the White River-Buck Creek (lower) watershed and the remaining points were in the White River-Truitt Ditch watershed. Over an eleven-year period, seven measured values above the threshold is not detrimental, but should be watched

The concentration of this material is not a major concern, however, it should be closely monitored.

Magnesium

Neither the EPA nor IDEM have set a standard for this metal.

Thallium

The IDEM standard is 0.048 mg/L for surface waters. Muncie's watershed data was under detectable values.

There is no reason to be concerned with the concentration of this metal.

Organics

In the data tables for the types of organic material tested, very few had measured values above the detectable limits. The only chemicals addressed are those that had results above the detectable value.

Phenolics

The EPA standard limit for this material is 5 micrograms per liter. The majority of the results resulted in less than 5 micrograms per liter detected, however, three measurements were slightly above that. They ranged from 6-8 micrograms per liter. These points were located in the White River-Truitt Ditch and the White River-Buck Creek (lower) watersheds. If this chemical is found in excessive quantities, it can cause fish flesh tainting in the streams.

There is no reason to be concerned with the concentration of this chemical.

Pyrene

The EPA standard limit for this material is 0.21 mg/L. The majority of the results resulted in less than 0.00001 mg/L detected, however, one reading was above that. That result read 0.0002 mg/L in the White River-Buck Creek (lower) watershed. This is still significantly below the standard.

There is no reason to be concerned with the concentration of this chemical.

Pesticides

The only chemicals addressed are those that had results above the detectable value.

Acetochlor

There is not a standard for this material. The majority of the data were below the detectable value. Only 19% were above the detectable value, and those values ranged from 0.1-0.8 micrograms per liter.

There is no reason to be concerned with the concentration of this chemical.

Alachlor

The EPA standard limit for this material is 2 micrograms per liter. The majority of the results stated less than the detectable value, and all the reading were below the standard. If this chemical is found in excessive quantities, it can cause skin and eye irritation and some long-term kidney problems.

There is no reason to be concerned with the concentration of this chemical.

Atrazine

The EPA standard for this material is 3.0 micrograms per liter. The majority of the data were below the detectable value. Only 8% of the test results were above the standard, and those values ranged from 3.1-10.0 micrograms per liter. These points were taken from the data in the Buck Creek-Macedonia Creek watershed and the White River Buck Creek (lower) watershed.

There is no reason to be concerned with the concentration of this chemical.

Bromacil

The EPA standard limit for this material is 5 mg/L. The majority of the results were less than the detectable value, and all the readings were below the standard. If this chemical is found in excessive quantities, it can cause skin and eye irritation.

There is no reason to be concerned with the concentration of this chemical.

Metolachlor

There is not a standard for this material. The majority of the data were below the detectable value. Only a few were above that, and those values ranged from 0.1-2.7 micrograms per liter.

This data is inconclusive.

Metribuzin

There is not a standard for this material. The majority of the data were below the detectable value. Only a few were above that, and those values ranged from 0.1-0.5 micrograms per liter.

This data is inconclusive.

Simazine

The EPA standard limit for this material is 4 micrograms per liter. The majority of the results were less than the detectable value, and all the readings were below the standard. If this chemical is found in excessive quantities, it can harmful to the livestock that use the stream for nourishment.

There is no reason to be concerned with the concentration of this chemical.

Macroinvertebrates

Macroinvertebrates are important to the water quality of a stream. They consume bacteria and contaminants in the waterway and provide forage for fish. The most sensitive macroinvertebrates belong to one of three families the Ephemeroptera (mayflies), the Plecoptera (stoneflies), or the

Trichoptera (caddisflies). These three families together make up the term EPT. There are four basic methods to assessing the streams water quality based on the macroinvertebrates that exist in it. A score based on the characteristics of the streambed are used to evaluate suitability of the environment for macroinvertebrate life. Secondly, the HBI, a score that describes the pollution tolerance of the stream, is calculated. Next the overall MBI is considered, and finally the percentage of EPT.

The total metric score for the stream characteristics for each monitoring stations is considered first. The stream is scored from 1-100 with the 100 being a perfect environment for macroinvertebrate life. The area of the White River-Buck Creek (lower) monitor revealed that the environment was 66-70% positive. Jakes Creek-Eagle Branch also has a positive environment, with 62%. The White River-Truitt Ditch monitors returned positive results as well, 71%. All the Muncie watersheds that were monitored returned acceptable values for macroinvertebrate life.

The HBI is a measure of the pollution tolerance of macroinvertebrates in a waterway. Scores are based on a scale of 0-10, where 0 is the least tolerant community and 10 is the most tolerant. All the monitoring stations revealed less than desirable conditions. Buck Creek station did not cross the fourth marker and the remaining monitors topped out at 6. These readings are not unacceptable, they are just slightly lower than ideal.

The MBI score is based on a scoring system of 0-6, where 0 is least desirable and 6 is ideal. The Buck Creek-Macedonia Creek watershed and the Jakes Creek-Eagle Branch watershed both had values in the range of 4. The White River-Buck Creek watershed returned values in the range of 1.6-3.8. The White River-Truitt Ditch watershed readings were around 6. The lower readings seem to be associated with the West Fork portion of the White River. Again, these values are slightly less than desirable.

Probably the most telling measure is the percent of EPT. A high percentage of EPT macroinvertebrates is vital to aquatic life. The percentages for the White River-Truitt Ditch watershed, White River-Buck Creek (lower) watershed, and the Buck Creek-Macedonia Creek watershed were 54%, 39%, and 5% respectively. The only one that may be of some concern is the Buck Creek-Macedonia Creek watershed; these numbers are significantly low. The other two watersheds are definitely within an acceptable range. The EPT percentage is the most important factor and is sufficiently high that there need not be a concern for the aquatic life in the Muncie watersheds based on the macroinvertebrate life.

Resources

The previous information has been compiled by GRW Engineers for use by Muncie to analyze the IDEM water quality data for the area. In this effort, the following resources were used:

- Adding Alkalinity to Water by Limestone Leach Beds; West Virginia University.
- Hydrology and the Management of Watersheds; Brooks, Ffolliott, Gregerson, and Thames.
- Hydrology and Quality of Water Resources; Hammer and MacKichan.
- Introduction to Environmental Engineering and Science; Masters.
- McGraw Hill Series in Water Resources and Environmental Engineering; Linsley and Franzini.
- McGraw Hill Series in Water Resources and Environmental Engineering; McGhee.

- Surface Water-Quality Modeling; Chapra.
- Taxonomy and Stream Ecology; Lenat and Resh
- Water-Resources Engineering; Linsley, Franzini, Freyberg, Tchobanoglous.
- Water Supply and Pollution Control; Viessman Jr and Hammer.
- 401 KAR 5:031 Surface Water Standards
- www.cwp.org
- www.epa.gov
- www.scorecard.org/chemicals