Wellington Ditch Outfall Report
Cecilia Lapp Stoltzfus, December 20, 2016
Goshen College CHEM-450-3

Introduction

Wellington Ditch, as named by City of Goshen staff, is an unregulated vegetated drainage ditch that is approximately 3,900 feet in length, located in Section 16, Township 36 North, Range 6 East within the City of Goshen's corporate limits. The ditch runs north along the Millrace Canal from College Avenue to Murray Street (just south of Rieth Interpretive Center) where it turns west and flows into the Elkhart River. The ditch receives stormwater and industrial process water from the College Avenue and 10th Street corridors. Over the past decade, the City of Goshen has received frequent calls about sightings of water discoloration along the ditch. The water has been described as bright green/blue, fluorescent, and cloudy, and the Goshen City Department of Stormwater Management has expressed a commitment to determining the source of this discoloration in order to evaluate any biological or chemical concerns associated. Fish kills have also been reported in 1992 and 2004; in 1992, Elkhart County Health Department reported a significant fish kill in the ditch correlated with a reportedly continuous Zinc Stearate discharge from Goshen Rubber Co.[1] On March 11, 2004, the Elkhart Truth reported a significant fish kill involving thousands of small, dead fish found along the banks of "cloudy blue and green water" at the confluence of Wellington Ditch and the Elkhart River.[2] According to the Elkhart Truth, Indiana Department of Environmental Management (IDEM) representatives at the scene reported that this coloration usually occurs after storms, however no storm preceded the 2004 event.

Research Questions

What chemical input(s) are causing the periodic discoloration of Wellington Ditch? What potential upstream sources may be linked to these events?

Background

Influent Sources

All dry-weather flow in the College Ave storm sewer can be traced to inputs from the 10th Street corridor, specifically releases from Dairy Farmers of America (DFA), T&M Rubber, Parker Hannifin, and Flair Interiors. During wet-weather rain events the storm sewer and Wellington Ditch outfall also receive influents from a variety of residential areas as well as from portions of Goshen College, Goshen Hospital, and the Greencroft Goshen campus.

Discharge Permitting

The point-source discharge of pollutants to waters of the U.S is prohibited without disclosure and regulation under a permit through the EPA's National Pollution Discharge

[1] Appendix II. Hulewicz, John. *Elkhart County Complaint Form CO-92-734*. August 11, 1992. Goshen, IN.
[2] Appendix III. Serna, Javier. "Fish kill found: Sewer discharge may be cause." *The Elkhart Truth*, March 12, 2004.

Elimination System (NPDES).[3] The NPDES program monitors and caps discharge levels and these permits are put in place to ensure that human and environmental health is not negatively impacted by the release of pollutants. National Pollutant Discharge Elimination System permits are held by Parker Hannifin for temperature from non-contact cooling water[4] and by DFA for BOD5, TSS, oils and greases, total residual chlorine, temperature, ammonia, pH, and dissolved oxygen on “cow water” (condensate from the powdered milk process).[5]

Discharge Events

The City of Goshen Department of Stormwater Management filed an Illicit Discharge Incident Report on September 15, 2014, for manual dumping of Calford R-220 (a product containing Calcium Stearate) into an external storm drain at T&M Rubber.[6] Follow-up to the incident included an October 1, 2014, letter to James “Buck” Barton, T&M Corporate Officer/Maintenance Manager, outlining the necessity for the business to offer a “remedial training program to educate employees about stormwater and nonpoint source pollution,” determine an “alternative disposal method” for Calford R-220, and provide a site plan of internal discharge points to the City of Goshen. The City also took the additional action of marking the storm drains around the property with “No Dumping” tags attached to the storm drain grates. On November 15, 2016, Buck Barton notified Jason Kauffman, the City’s Stormwater Coordinator, and Cecilia Lapp Stoltzfus that all issues regarding the 2014 report had been resolved and the only effluent currently being released into the storm sewer is a boiler blowdown.[7] Regarding why T&M Rubber’s boiler blowdown water has not been regulated under an NPDES permit. Barton explained that T&M had received a letter from the EPA exempting the facility from the NPDES permitting process. A copy of this letter has not yet been made available to the City Stormwater Department, but Jason Kauffman has been in contact with Barton about access to this document.

Calcium Stearate

Calford R-220 is a white cream slurry, pH 5-7, 48-52% volatiles by weight, that comes as a 50% dispersion in water.[8] Calford R-220 is used as an anti-tacking agent in rubber manufacturing after dispersal with water (2-6% product by weight) and 60 minutes of continual stirring. The product disperses readily in water, demonstrates a low sedimentation rate, dull

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[3] "NPDES Permit Basics." EPA. https://www.epa.gov/npdes/npdes-permit-basics.

[4] Appendix II. United States. Indiana Department of Environmental Management. Permits Administration, Office of Water Quality. *Renewal-NPDES General Permit No. ING250096*. By Catherine Hess. July 25, 2007.

[5] Appendix II. United States. Indiana Department of Environmental Management. Permits Branch, Office of Water Quality. *NPDES Permit No. IN0055565*. By Paul Higginbotham. May 3, 2015.
The most recent NPDES permit accessible through IDEM’s Virtual File Cabinet was effective September 1, 2007, through August 31, 2012. In conversation on November 15, Greg Brown, DFA Quality Assurance Manager, stated that DFA renewed their permit in 2012. Further investigation through IDEM to locate the updated permit is advisable.

[6] Appendix II. United States. City of Goshen. *City of Goshen - Illicit Discharge Incident Report 2014-0025.* Full Report.

[7] James “Buck” Barton. Personal Communication, November 15, 2016.

[8] Blachford Product Data Sheet: Calford R-220, Rubber Release Agent. December, 2015.

matte color, and is “environmentally friendly; does not contain glycol ethers, is zinc free, heavy metal free, and Hazardous Air Pollutants (HAPs) compliant.”[9]

Calcium Stearate is the main component within Calford R-220. Calcium Stearate, $(C_{17}H_{35}COO)_2Ca$, is a molecule comprised of a Ca^{2+} ion ionically bound to two (2) stearate molecules ($C_{17}H_{35}COO$). Stearate, or stearic acid, is a saturated fatty acid chain, a waxy white solid that floats on water.[10] Throughout the course of the investigation insufficient information has been collected to determine the presence and/or impacts of Calcium Stearate in the outfall or within storm sewer structures. However observations and recommendations regarding future research for Calcium Stearate are included in the discussion section.

Methods and Results

Outfall Sampling

Weekly sampling was conducted at outfall #506-4990, the discharge of the College Avenue storm sewer to Wellington Ditch. Qualitative observations were recorded regarding the color of the water and presence of bubbles and/or fish. Photos of the outfall and surrounding area were taken weekly and the flow-rate was recorded. Each week a water sample was collected, analyzed in the lab using a LaMotte 2020 Turbidimeter, and the sample bottle was stored in the Goshen College lab. Site photos and an Excel file reporting weekly data can be found in
Appendix I.[11]

Turbidity levels in the outfall effluent are reliably higher than the turbidity of the upstream ditch water. While this turbidity trend is constant, other factors including flow rate of the outfall effluent vary significantly. Flow rate has been observed varying between zero (0) inches per second to three (3) inches per second in dry-weather conditions, with wet-weather flow observed at 14 inches per second. Bubbles are periodically observed along the surface during both blue-green/cloudy and non-coloration conditions. Additionally, on October 28 small white-solids were observed floating down the surface of the water, each enclosed within a section of bubbles. A solid sample that was collected and stored in a dry bag has retained form and begun to crumble, whereas the second solid sample was stored within the water sample and began to develop into a grayish color with black growth on the surface.Two weeks later on November 8, clumped accumulations of gelatinous, bright orange material gathered near the surface of the water. After collection, if the sample of gelatinous material was disturbed it would form a suspension in water, causing very high turbidity conditions (240 NTU), but then would settle to a film along the bottom of the jar. This orange material potentially indicates the presence of an iron-oxidizing bacteria within the ditch. Similarly colored accumulations were noted attached to the outfall structure walls on November 2, and a photo of this is accessible in Appendix I.[12]

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[9] Calford R-220 Product Data Sheet.
[10] "Calcium Stearate." PubChem. Accessed December 14, 2016. https://pubchem.ncbi.nlm.nih.gov/compound/calcium_stearate.
[11] Appendix I. Wellington Weekly Data.
[12] Appendix I. 11.02.16 orange growth photo.

Element Lab Tests

On October 5, 2016, water samples were collected at outfall #506-4990 and sent to the Element Materials Technology lab in South Bend for analysis. Samples were tested for Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), metals, and Total Petroleum Hydrocarbons (TPH). Results are summarized in an October 25 analytical report.[13] In a meeting in November, various representatives from the City of Goshen, IDEM, and Goshen College gathered to discuss results of this report and found no immediately problematic results.[14] All VOC and SVOC values were at or below the Practical Quantitation Limit (PQL), which signifies negligible levels within the water samples. Several metals displayed values higher than the PQL[15], however Jim Weingart from IDEM explained that none were above screening levels, and therefore were no cause for concern. As with the other results, THP tests (TPH Extended Range and TPH--Extended C8-C36) demonstrate not cause for concern.[16] Overall, the meeting concluded that based on this data, IDEM is not concerned and there is likely no public health risk. Suggestions for future tests stemming from this meeting included calcium testing in water and sediments, pH sampling up and down storm sewer pipes from influent sources, and sampling of organic growth on the outfall structure to determine species. Within the following month, calcium testing and pH sampling were conducted; the methodology and results of these investigations are discussed below.

On November 30, 2016, an additional three (3) samples were sent to Element for analysis to determine the presence of calcium in the samples from outfall #506-4990. Sample 1 was an aqueous sample collected November 23 during a rain event, while Samples 2 and 3 were collected November 30, and included one aqueous and one soil sample collected from the black, sandy substrate accumulated along the bottom of the outfall pipe. Results from the calcium analyses were received on December 6, 2016, in an Element report.[17] Each sample demonstrated the calcium readings significantly above the PQL: Sample 1 (32.5 mg/L, PQL 0.050), Sample 2 (80.7 mg/L, PQL 0.050), and Sample 3 (58,900 mg/Kg, PQL 2,480). Jim Weingart, director of IDEM's Northern Indiana Office of Program Support stated that recorded calcium levels in all three (3) samples are within a reasonably expected range, although Sample 2 is slightly on the high end for regional water hardness.[18] Groundwater hardness is measured

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[13] Appendix I. Final Element Lab Wellington Ditch Water Sample Report

[14] November 4, 2016, meeting attendees include Dustin Sailor, City of Goshen Director of Public Works; Jason Kauffman, City of Goshen Stormwater Coordinator; Larry Keil, Goshen Wastewater Pretreatment/Lab Coordinator; Ryan Sensenig, Goshen College professor of environmental science; Lew Naylor, GC professor emeritus of chemistry; Jim Weingart, director of IDEM Office of Program Support; and myself.

[15] Aluminum, Arsenic, Barium, Cobalt, Copper, Iron, Manganese, Molybdenum, Nickel, Selenium, and Zinc. Several of these are naturally occurring in regional groundwater (e.g. Arsenic and Iron), and Weingart explained that all metals in such low concentrations could be traced to vehicle exhaust and street runoff.

[16] Weingart explained that he doesn't find most TPH testing methods helpful because they measure all organic carbon chains, not solely those traced to petroleum hydrocarbons. However, of the possible TPH tests, the two used above are most effective.

[17] Appendix I. Final Element Lab Calcium Report.

[18] Weingart, Jim. "Re: City of Goshen water quality questions." E-mail message to author. December 19, 2016.

by Calcium Carbonate ($CaCO_3$), with national levels ranging from 0-250 mg/L according to the US Geological Survey.[19] Northern Indiana lies on the high end of the scale, however detailed information on expected levels of calcium in surface water regionally has not been located.[20]

Storm Sewer pH Monitoring

Monitoring of pH and temperature levels in storm sewer pipes took place twice, November 15 on a scheduled monitoring event and December 6 in immediate response to a ditch coloration event. On November 15, Jason Kauffman, the City's Stormwater Coordinator, and Cecilia Lapp Stoltzfus took pH and temperature readings at four (4) storm sewer structures in the New York and Burdick Street area. We began the December 6 sampling at the outfall at Wellington Ditch and worked our way successively through nine (9) additional upstream sampling points (excluding College Avenue for traffic considerations). Between these two dry-weather sampling days, water was observed entering the City's storm sewer system from the private storm sewer systems of Dairy Farmers of America, T&M Rubber, Parker Hannifin, and Flair Interiors. Results for both days are summarized in Excel files and sampling picture displays accessible in Appendix I.[21] Monitoring of stormwater structures demonstrated pH ranges between 7.50 and 8.65 and temperatures within normal range accounting for season and weather conditions (mostly between 11° and 17°C).[22] [23] Likewise, dissolved oxygen levels in each sample from December 6 were appropriate, ranging between 8.86 and 12.78 mg/L. Levels of all three (3) metrics do not display cause for concern.

Calcium Testing in Goshen College Chemistry Laboratory

On December 13, 2016, Cecilia Lapp Stoltzfus performed analysis of three (3) storm sewer samples collected December 6 from structures #506-4990, #507-3821, and #507-6181. Analysis was performed using Nitric Acid Digestion (3030D) and the EDTA Titrimetric Method

[19] Water Hardness and Alkalinity. USGS - U.S. Geological Survey Office of Water Quality - http://water.usgs.gov/owq/hardness-alkalinity.html.

[20] One potential source of local data on on calcium levels in groundwater and municipal water distribution would be the City of Goshen Water & Sewer Department who reports a water hardness of 20 grains per gallon, equivalent to 137 mg/L calcium. Additional information about hardness treatment methods and resulting reductions in calcium could be requested (574-534-5306).
Water & Sewer http://goshenindiana.org/water/sewer.

[21] Appendix I. Storm sewer pH 11.15.16 & 12.6.16, 2016.11.15 pH Sampling Picture Display, 2016.12.06 pH Sampling Picture Display.

[22] Discussion excludes data from structures #507-3140 and #507-33138 which are both not part of the storm sewer system.

[23] According to Dustin Sailor, City of Goshen Director of Public Works, industries are relying on ground temperature to help reduce effluent temperatures prior to reaching the outfall. However, according to temperature data from December 6, temperatures were actually higher in sites closer to the outfall. Whether this was due to differences in effluent temperature/sources throughout the several hour sampling period or the warming effect of the storm sewer system is not clear. Further data collection during summer months may help to clarify impacts of ground temperature on water. One potential source of this data would be the Flow Meter Data collected by the City of Goshen Department of Stormwater Management from September 2014 through September 2015.

(3500-Ca).[24] Through this methodology, the presence of calcium within the water samples was confirmed, however quantity or concentration of calcium was unable to be determined. Likewise, concerns regarding sample preservation were noted. According to Standard Methods for the Analysis of Water and Wastewater (20th Ed.), samples need to be preserved with acid in order to reduce interference with organic matter present and convert metals to a more easily detectable free state.[25] The addition of acid should result in the sample pH dropping to below 2, and the specific acid required depends on the target parameters for analysis. Generally speaking, Nitric Acid (HNO_3) is sufficient within the analysis of easily oxidized materials, whereas the addition of Nitric Acid combined with Sulfuric Acid (H_2SO_4) or Hydrochloric Acid (HCl) is required for readily oxidizable organic material. These guidelines provide support for the practices of Element Labs, as they required samples analyzed for metals to be collected in bottles containing Nitric Acid and VOC samples be immediately preserved with HCl prior to transportation to the lab. Without the immediate addition of HNO_3 or HCl, samples collected for metals or VOC analysis will degrade and provide inaccurate test results. Future water sample analysis for calcium or other metals will need to follow proper preservation methods by either using Element's sampling bottles already prepared with an acid preserving agent or through preservation with Nitric Acid in the Goshen College laboratory facilities as soon as possible after sampling.

Discussion

Several characteristics of Wellington Ditch merit research and investigation, namely the existence of several historic fish kills,[26] multiple permit violations (Zinc Stearate from Goshen Rubber Co. in 1992,[27] and Calford R-220 from T&M Rubber in 2014[28]), and periodic coloration of the ditch noticeable at the outfall structure #506-4990 and the zone between the culvert and Elkhart River confluence.[29] However, it seems that several stressors have been reduced over the past decades.

Since the 1992 incident, Zinc Stearate has been replaced with Calcium Stearate as an industrial product along the 10th Street corridor. Likewise, the lack of additional fish kills more recently coupled with additional efforts by several 10th Street industries to prevent the release of higher-temperature water into the storm sewer system has seemingly reduced concerns of thermal pollution and hypoxia throughout the ditch.

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[24] Parenthetical numbers indicate laboratory methodology as per Standard Methods for the Analysis of Water and Wastewater, 20th Ed. (1998).

[25] Standard Methods for the Analysis of Water and Wastewater, 20th Ed. (1998), 3-6, 3030 D. Digestion for Metals and EDTA Titrimetric Method (3500-Ca).

[26] Appendix II. Hulewicz, John. *Elkhart County Complaint Form CO-92-734*. August 11, 1992. Goshen, IN. Appendix III. Appendix III. Serna, Javier. "Fish kill found: Sewer discharge may be cause." *The Elkhart Truth*, March 12, 2004.

[27] Appendix II. Hulewicz, John. *Elkhart County Complaint Form CO-92-734*.

[28] Appendix II. Appendix II. United States. City of Goshen. *City of Goshen - Illicit Discharge Incident Report 2014-0025.* Full Report.

[29] Map in Appendix I. The aforementioned culvert is located less than 100 yards East of the confluence with the river and is visible via walking trails through the forest.

The presence of Calcium Stearate in Wellington Ditch remains to be confirmed, although calcium was found in water samples collected on November 23, November 29, and December 6. Although IDEM has explained that levels are not concerning, further connection with the Goshen Water and Sewer Department and IDEM will be helpful.[30] [31] Follow-up testing for calcium and Stearate in the white solids floating on the water surface on October 28 is also recommended. Likewise testing for the presence of Stearate in aqueous samples might prove a more effective way to determine the presence of Calcium Stearate in the storm sewer effluent at outfall #506-4990. Both tests could be performed by Element labs, using samples collected during future coloration events.

Despite various areas of improvement, regular sightings of blue-green, cloudy water coloration have remained. Sampling over the past nine months has enabled compilation of data that can be used to observe trends in water quality. Regular water quality monitoring was mainly used to determine turbidity level, water coloration, and flow rate, baseline information that can supplement more specific laboratory testing. While overall variability of ditch conditions and flow rate varies daily and even by the minute, turbidity levels are invariably higher in storm sewer effluent than within upstream water in Wellington Ditch. The regular presence of fish in the outfall signifies a baseline level of water quality, especially since Cecilia Lapp Stoltzfus has never observed the presence of dead fish.[32]

Future outfall monitoring could expand from turbidity and flow rate measurements to include water temperature and dissolved oxygen readings as a way to assess conditions for aquatic life. Additionally, frequent monitoring at various times of the day would prove helpful for establishing qualitative observational information.

In addition to continued monitoring by the City and future Goshen College students, the City Stormwater Department could consider increased layperson involvement. As residents continue to call with reports of extreme water coloration in Wellington Ditch, Kauffman and Sailor could ask these callers if they would be interested in becoming more involved in ditch research by consciously assessing water color on their daily walks along the Millrace Trail. Such regular observations would not be practical for technical research purposes, but a willing resident trail-user could likely be found to note qualitative observations about coloration patterns.

Continued monitoring is definitely advisable, and future collaboration with a Goshen College chemistry or environmental science student could be mutually beneficial to the City Stormwater Department and Goshen College community.

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[30] Additional data from the City of Goshen Water & Sewer Department could be compared to calcium levels in effluent from outfall #506-4990.

[31] Jim Stahl and Rob Beck of IDEM have also been in contact with Kauffman about further investigation into Wellington Ditch coloration questions.

[32] Sometimes the water was too turbid to accurately determine whether fish were present, but frequently fish were visible when the water was less turbid.

Appendices

1. Appendix I: Raw Data
    a. Map of Wellington Ditch Water Discoloration Area of Study
    b. Wellington Weekly Data
    c. Storm Sewer pH 11.15.16 & 12.6.16
    d. pH Sampling Picture Display 11.15.2016
    e. pH Sampling Picture Display 12.06.2016
    f. Final Element Lab Wellington Ditch Water Sample Report
    g. Final Element Lab Calcium Report
    h. Photos at outfall structure #506-4990
2. Appendix II: Permits, Illicit Discharge reports, and City-industry correspondence
    a. Elkhart County Complaint Form CO-92-734. 08.11.1992
    b. City of Goshen - Illicit Discharge Incident Report 2014-0025. 09.15.2014
    c. Dairy Farmers of America NPDES correspondence 07.25.2007
    d. Parker Hannifin NPDES correspondence 05.03.2015
3. Appendix III: Newspaper articles and other sources
    a. *The Elkhart Truth*, "Fish kill found: Sewer discharge may be cause." 03.12.2014