# CITY OF JOHNSTON SURFACE WATER MONITORING

## JULY 2016 WATER QUALITY MONITORING SUMMARY

PREPARED BY:
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**2016 Data Collection**

This represents the fourth year of collection and analysis of water samples from surface waters at selected locations in Johnston. The attached report from James Luzier with the University of Iowa State Hygienic Laboratory provides an analysis of the samples collected on July 15, 2016. Below is a summary of the twelve collection locations and summary of historic collection data to supplement Mr. Luzier's report.

**Collection Sites**

In total, collections are pulled from ten sites throughout the community to allow for an analysis of changes to water quality over time. These locations have been identified as key locations for drainage in/through Johnston and many represent locations up or downstream from planned construction projects.

In 2016, one new collection site was added at the pond at the newly constructed Greenwood Hills Pond (Site #12) located west of NW 86th Street. This pond construction was completed in 2015 following a more than $3 million investment in constructing the pond and stabilizing the upstream channel which had been suffering from extreme erosion. Data from this site, and site C#2, which is downstream of the pond along Foxboro Road will allow a tracking of the water quality improvements in this basin as a result of the Greenwood Hills Pond project as well as a pending Green Meadows West Channel Stabilization project scheduled in 2017/2018.

All location sites are shown on the map included on Page 9, a summary of each site is also included on Page 10.

**Data Summary**

The data tables below include the results of all nine datasets collected to date: April 9, July 15, and October 9, 2013; April 8, 2014; July 2, 2014; October 7, 2014, April 16, July 8, and October 5, 2015; April 28, 2016 and July 15, 2016.

**Analytes**

***E.coli* Bacteria**

| Site | Site Description | Analyte | 4/09/13 | 7/15/13 | 10/09/13 | 4/08/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | E.coli | 330 | 380 | 570 | 41 | 1200 | 710 | 63 | 1600 | 450 | 1200 | 460 |
| #2 | Green Meadows West @ Foxboro Rd | E.coli | 3300 | 1400 | 480 | 31 | 930 | 370 | 110 | 680 | 160 | 1500 | 430 |
| #3 | "Waterford Creek" @ NW 86th St | E.coli | 210 | <10 | 180 | 20 | 1400 | 340 | 74 | 420 | 40 | 260 | 460 |
| #4 | Beaver Creek Elementary @ NW 86th St | E.coli | 460 | 1500 | 130 | 52 | 630 | 120 | 450 | 840 | 60 | 620 | 630 |
| #5 | NW 86th Street south of NW 70th Ave | E.coli | 530 | 570 | 31 | <10 | 390 | 600 | 200 | 700 | 280 | 530 | 490 |
| #6 | Little Beaver Creek @ NW 86th Street | E.coli | 420 | 250 | 400 | <10 | 4900 | 500 | 400 | 4600 | 300 | 1300 | 1600 |
| #7 | NW 59th St near Maurice's | E.coli | 1600 | 220 | NF | 470 | 630 | 86 | NF | 410 | 90 | 960 | 380 |
| #8 | Johnston Dr @ Prairie Point Crossing | E.coli | 2500 | 610 | 340 | 5500 | 620 | 190 | 10 | 280 | 100 | 660 | 86 |
| #11 | Crescent Chase @ NW 62nd Avenue | E.coli | -- | -- | -- | 210 | 1300 | 270 | 63 | 1900 | 770 | 710 | 1400 |
| TL | Terra Lake | E.coli | -- | -- | -- | -- | -- | -- | <10 | 110 | <10 | 150 | 10 |
| #12 | Greenwood Hills Pond | E.coli | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5500 | 170 |

***E. Coli* Results**

*E. Coli* are indicator bacteria monitored for water quality purposes to indicate the presence and level of animal or human waste. *E. Coli* are found in the gut of warm-blooded animals (birds and mammals). Bacteria levels can be highly variable and levels are often dependent on precipitation, with spikes in levels often occurring during and shortly after precipitation events as runoff transports the bacteria into drainage ways and streams. Other inputs in the absence of recent precipitation could include direct deposition by animals (wild or domestic) or faulty septic or sewer systems.

Of the sites monitored, only Beaver Creek has a stream classification established by the DNR. Beaver Creek is classified as an A3 Children's Recreational Use, which reflects the fact that the creek flows adjacent to residential lots and through public park areas where access is possible. The bacteria standard for A3 streams is a maximum of 235 MPN/100 ml (Most Probable Number per 100 milliliters) of *E.coli* bacteria.

***Nitrate + Nitrite Nitrogen as N***

| Site | Site Description | Analyte | 4/09/13 | 7/15/13 | 10/09/13 | 4/8/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | Nitrate + Nitrite nitrogen as N | 0.48 | 15.0 | 1.9 | 0.26 | 8.0 | 14.0 | 12.0 | 12.0 | 12.0 | 6.5 | 3.1 |
| #2 | Green Meadows West @ Foxboro Rd | Nitrate + Nitrite nitrogen as N | 0.86 | 1.8 | 1.1 | 0.46 | 3.2 | 1.8 | 1.4 | 1.4 | 1.0 | 0.62 | 0.56 |
| #3 | "Waterford Creek" @ NW 86th St | Nitrate + Nitrite nitrogen as N | 0.21 | 8.7 | 0.84 | 0.19 | 1.7 | 2.0 | 3.2 | 0.78 | 1.3 | 0.81 | 0.47 |
| #4 | Beaver Creek Elementary @ NW 86th | Nitrate + Nitrite nitrogen as N | 1.6 | 2.8 | 2.9 | 1.3 | 4.6 | 3.0 | 1.8 | 3.3 | 2.8 | 2.2 | 2.6 |
| #5 | NW 86th Street south of NW 70th Ave | Nitrate + Nitrite nitrogen as N | <0.10 | 5.6 | 1.9 | 0.48 | 4.5 | 2.7 | 1.8 | 2.2 | 1.6 | 0.67 | 2.8 |
| #6 | Little Beaver Creek @ NW 86th Street | Nitrate + Nitrite nitrogen as N | 3.4 | 9.6 | 12 | 7.2 | 10.0 | 11 | 6.0 | 8.7 | 8.1 | 5.1 | 5.6 |
| #7 | NW 59th St near Maurice's | Nitrate + Nitrite nitrogen as N | 0.62 | 0.26 | NF | 1.2 | 2.1 | 0.60 | NF | <0.10 | 0.30 | 0.16 | <0.10 |
| #8 | Johnston Dr @ Prairie Point Crossing | Nitrate + Nitrite nitrogen as N | 1.9 | 5.2 | 6.0 | 4.7 | 3.2 | 3.7 | 5.4 | 2.6 | 3.4 | 1.6 | 4.6 |
| #11 | Crescent Chase @ NW 62nd Avenue | Nitrate + Nitrite nitrogen as N | -- | -- | -- | <0.10 | 2.4 | 0.98 | 0.61 | 1.1 | 0.90 | 0.70 | 1.1 |
| TL | Terra Lake | Nitrate + Nitrite nitrogen as N | -- | -- | -- | -- | -- | -- | <0.10 | <0.10 | <0.10 | <0.1 | <0.10 |
| #12 | Greenwood Hills Pond | Nitrate + Nitrite nitrogen as N | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.71 | 0.48 |

This analyte is the total amount of nitrogen present as nitrate and nitrite in the sample. Since nitrite relatively quickly converts into nitrate, this is for practical purposes a measurement of the amount of nitrate in the sample. Nitrate is a nutrient commonly found in fertilizer and human and animal waste. Nitrate is regulated only for water bodies that are designated as drinking water sources, such as the Des Moines and Raccoon Rivers in the Des Moines area. For reference, the regulatory limit for drinking water sources is 10 mg/l and Des Moines Water Works activates its nitrate removal equipment when levels at their intakes exceed 9 mg/l.

***pH***

| Site | Site Description | Analyte | 4/9/13 | 7/15/13 | 10/9/13 | 4/8/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | pH | 8.1 | 8.1 | 8.0 | 8.5 | 7.5 | 8.3 | 8.3 | 8.1 | 8.3 | 8.2 | 8.0 |
| #2 | Green Meadows West @ Foxboro Rd | pH | 7.8 | 7.7 | 7.8 | 8.0 | 7.9 | 7.9 | 8.1 | 7.9 | 7.9 | 7.8 | 7.6 |
| #3 | "Waterford Creek" @ NW 86th St | pH | 7.7 | 7.6 | 7.4 | 7.3 | 7.6 | 7.6 | 7.6 | 7.8 | 7.9 | 7.9 | 6.8 |
| #4 | Beaver Creek Elementary @ NW 86th St | pH | 8.0 | 8.0 | 8.1 | 8.2 | 8.1 | 8.2 | 8.4 | 8.1 | 8.2 | 8.2 | 8.1 |
| #5 | NW 86th Street south of NW 70th Ave | pH | 8.0 | 7.0 | 6.9 | 7.0 | 7.8 | 8.0 | 7.4 | 8.2 | 7.7 | 8.3 | 8.3 |
| #6 | Little Beaver Creek @ NW 86th Street | pH | 8.3 | 8.2 | 8.2 | 8.9 | 7.6 | 8.3 | 8.3 | 8.1 | 8.4 | 8.2 | 8.1 |
| #7 | NW 59th St near Maurice's | pH | 7.6 | 7.7 | NF | 7.7 | 7.6 | 8.2 | NF | 7.7 | 8.0 | 7.8 | 7.8 |
| #8 | Johnston Dr @ Prairie Point Crossing | pH | 7.6 | 7.6 | 7.8 | 7.5 | 7.8 | 7.7 | 8.1 | 7.7 | 7.6 | 7.6 | 7.5 |
| #11 | Crescent Chase @ NW 62nd Avenue | pH | -- | -- | -- | 8.1 | 8.1 | 8.2 | 8.1 | 8.1 | 8.2 | 8.0 | 8.0 |
| TL | Terra Lake | pH | -- | -- | -- | -- | -- | -- | 8.4 | 8.8 | 9.4 | 8.8 | 9.5 |
| #12 | Greenwood Hills Pond | pH | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.6 | 8.0 |

pH is a measure of how acidic or basic a substance is, with 7 being neutral and lower levels than that indicating increasing acidity and higher numbers indicating how alkaline something is. For reference, baking soda has a pH of 8, ammonia 11, bleach 13. Concrete washout has a pH of about 12. On the acidic side of the scale, orange or tomato juice is 4 and vinegar is 3. The pH of rainfall can be very variable but is typically acidic in the range of 5 to 6 on the pH scale. Most drinking water is adjusted during treatment to be approximately neutral (close to 7).

Most Iowa surface waters are slightly basic due to the effect of the local limestone geology and have a pH of in the range of 8.0 to 8.5; however several of the streams monitored in Johnston have shown averages between 7 and 8. None of the results thus far are far outside normal ranges but it is important to note trends so that any atypical results from future sampling will be more easily spotted.

***Total Phosphorus as P***

| Site | Site Description | Analyte | 4/9/13 | 7/15/13 | 10/9/13 | 4/8/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | Total Phosphorus as P | 0.18 | 0.12 | 0.25 | 0.17 | 0.49 | 0.19 | 0.09 | 0.45 | 0.18 | 0.29 | 0.12 |
| #2 | Green Meadows West @ Foxboro Rd | Total Phosphorus as P | 0.15 | 0.03 | 0.05 | 0.04 | 0.10 | 0.04 | 0.09 | 0.12 | 0.09 | 0.06 | 0.07 |
| #3 | "Waterford Creek" @ NW 86th St | Total Phosphorus as P | 0.07 | 0.10 | 0.07 | 0.04 | 0.14 | 0.08 | 0.14 | 0.15 | 0.11 | 0.08 | 0.09 |
| #4 | Beaver Creek Elementary @ NW 86th St | Total Phosphorus as P | 0.09 | 0.04 | 0.04 | 0.50 | 0.05 | 0.04 | 0.07 | 0.07 | 0.08 | 0.05 | 0.06 |
| #5 | NW 86th Street south of NW 70th Ave | Total Phosphorus as P | 0.06 | 0.02 | <0.02 | 0.02 | 0.07 | 0.06 | 0.04 | 0.09 | 0.08 | 0.08 | 0.07 |
| #6 | Little Beaver Creek @ NW 86th Street | Total Phosphorus as P | 0.54 | 0.37 | 1.0 | 0.72 | 0.30 | 0.28 | 1.0 | 0.30 | 0.46 | 0.26 | 0.73 |
| #7 | NW 59th St near Maurice's | Total Phosphorus as P | 0.13 | 0.11 | ND | 0.18 | 0.20 | 0.08 | NF | 0.18 | 0.09 | 0.16 | 0.14 |
| #8 | Johnston Dr @ Prairie Point Crossing | Total Phosphorus as P | 0.17 | 0.05 | 0.06 | 0.10 | 0.17 | 0.07 | 0.15 | 0.13 | 0.09 | 0.12 | 0.16 |
| #11 | Crescent Chase @ NW 62nd Avenue | Total Phosphorus as P | -- | -- | -- | 0.05 | 0.13 | 0.05 | 0.07 | 0.11 | 0.10 | 0.05 | 0.08 |
| TL | Terra Lake | Total Phosphorus as P | -- | -- | -- | -- | -- | -- | 0.04 | 0.08 | 0.07 | 0.07 | 0.03 |
| #12 | Greenwood Hills Pond | Total Phosphorus as P | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.13 | 0.05 |

Phosphorus is an unregulated nutrient that is present in animal waste, decomposing organic matter and many commercial fertilizers. High levels can lead to algae blooms and undesirable levels of plant growth, especially in standing water such as ponds and lakes. Phosphorus attaches to soil particles, meaning that high levels of phosphorus can also be an indirect indicator of possible soil erosion. There are currently no regulatory levels for phosphorus in Iowa but for reference when considering the data, the EPA recommended maximum levels for total phosphorus is approximately 0.08 mg/l for flowing streams and 0.04 mg/l for standing waters and reservoirs in this ecoregion.

***Total Suspended Solids***

| Site | Site Description | Analyte | 4/9/13 | 7/15/13 | 10/9/13 | 4/8/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | Total Suspended Solids | 50 | 14 | 20 | 8 | 80 | 59 | 21 | 110 | 42 | 190 | 28 |
| #2 | Green Meadows West @ Foxboro Rd | Total Suspended Solids | 88 | 1 | 1 | 3 | 8 | 2 | 4 | 6 | 1 | 17 | 3 |
| #3 | "Waterford Creek" @ NW 86th St | Total Suspended Solids | 10 | <1 | 2 | 2 | 14 | 2 | 8 | 13 | <1 | 8 | 7 |
| #4 | Beaver Creek Elementary @ NW 86th St | Total Suspended Solids | 35 | <1 | <1 | 4 | 5 | <1 | 8 | 2 | <1 | 17 | <1 |
| #5 | NW 86th Street south of NW 70th Ave | Total Suspended Solids | 7 | 1 | 3 | 3 | 17 | 3 | 2 | 16 | 4 | 42 | 3 |
| #6 | Little Beaver Creek @ NW 86th Street | Total Suspended Solids | 18 | 3 | 5 | 4 | 40 | 3 | 5 | 44 | 3 | 73 | 11 |
| #7 | NW 59th St near Maurice's | Total Suspended Solids | 10 | 5 | NF | 6 | 7 | 2 | NF | 3 | <1 | 16 | 7 |
| #8 | Johnston Dr @ Prairie Point Crossing | Total Suspended Solids | 26 | <1 | <1 | 7 | 4 | <1 | 9 | 2 | <1 | 19 | <1 |
| #11 | Crescent Chase @ NW 62nd Avenue | Total Suspended Solids | -- | -- | -- | 22 | 42 | 5 | 16 | 50 | 4 | 11 | 18 |
| TL | Terra Lake | Total Suspended Solids | -- | -- | -- | -- | -- | -- | 2 | 16 | 6 | 3 | 3 |
| #12 | Greenwood Hills Pond | Total Suspended Solids | -- | -- | -- | -- | -- | -- | -- | -- | -- | 60 | 5 |

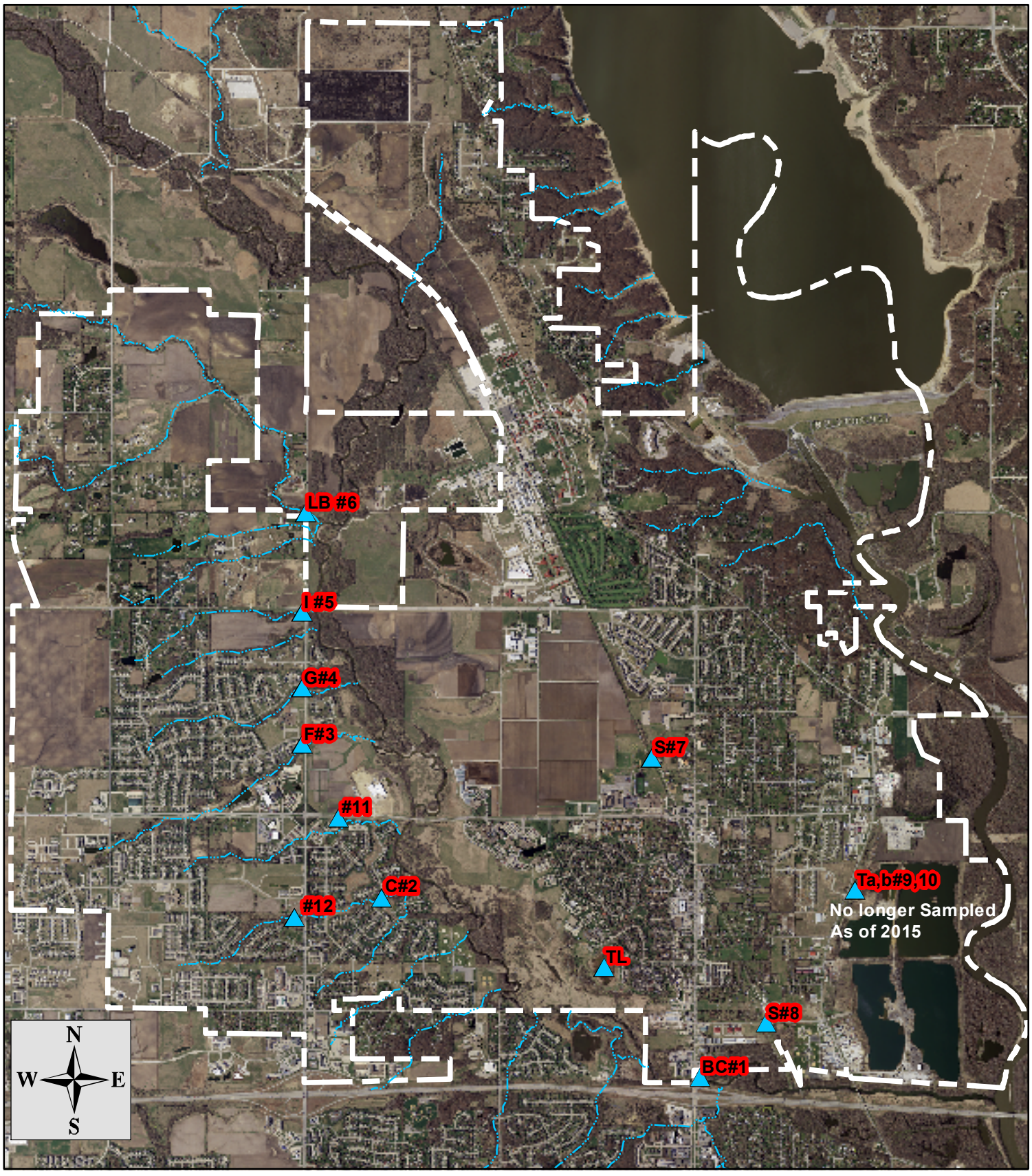
Total Suspended Solids (TSS) is a measure of the amount of solid (undissolved) particles present in water samples. High TSS levels are usually an indicator of active soil erosion upstream. There are no regulatory levels for surface waters in Iowa, but high TSS levels can silt in streams, ponds and lakes and increase the cost of drinking water treatment through the need for increased filtration and chlorination.

***Turbidity***

| Site | Site Description | Analyte | 4/9/13 | 7/15/13 | 10/9/13 | 4/8/14 | 7/2/14 | 10/7/14 | 4/16/15 | 7/8/15 | 10/5/15 | 4/28/16 | 7/15/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | Beaver Creek @ Merle Hay Rd | Turbidity | 25 | 7.1 | 12 | 4.0 | 51 | 28 | 8.2 | 61 | 21 | 65 | 13 |
| #2 | Green Meadows West @ Foxboro Rd | Turbidity | 38 | 1.4 | 1.2 | 2.6 | 4.0 | 2.8 | 3.3 | 5.5 | 2.4 | 14 | 3.7 |
| #3 | "Waterford Creek" @ NW 86th St | Turbidity | 10 | <1.0 | 2.5 | 2.0 | 16 | 1.7 | 4.3 | 8.4 | 1.6 | 5.4 | 9.3 |
| #4 | Beaver Creek Elementary @ NW 86th St | Turbidity | 19 | <1.0 | <1.0 | 2.1 | 1.4 | <1.0 | 2.2 | 1.2 | <1.0 | 6.8 | 1.2 |
| #5 | NW 86th Street south of NW 70th Ave | Turbidity | 5.2 | <1.0 | <1.0 | <1.0 | 8.0 | 2.2 | <1.0 | 10 | 1.7 | 22 | 3.0 |
| #6 | Little Beaver Creek @ NW 86th Street | Turbidity | 7.8 | 1.5 | 3.5 | 1.9 | 27 | 2.8 | 1.8 | 25 | 2.0 | 45 | 8.2 |
| #7 | NW 59th St near Maurice's | Turbidity | 11 | 1.5 | NF | 8.1 | 9.2 | 4.2 | NF | 4.6 | 1.5 | 17 | 5.2 |
| #8 | Johnston Dr @ Prairie Point Crossing | Turbidity | 20 | <1.0 | <1.0 | 8.5 | 5.4 | <1.0 | 2.1 | 2.1 | <1.0 | 20 | <1.0 |
| #11 | Crescent Chase @ NW 62nd Avenue | Turbidity | -- | -- | -- | 14 | 17 | 2.7 | 3.2 | 22 | 2.4 | 7.6 | 10 |
| TL | Terra Lake | Turbidity | -- | -- | -- | -- | -- | -- | 2.9 | 8.2 | 4.0 | 3.6 | 2.0 |
| #12 | Greenwood Hills Pond | Turbidity | -- | -- | -- | -- | -- | -- | -- | -- | -- | 100 | 3.7 |

Turbidity is a measure of water clarity and is measured in NTU's (Nepholometric Turbidity Units). In this measurement of clarity, lower numbers indicate higher water clarity (as a reference, treated drinking water is Iowa is required to meet a turbidity standard of 0.3 NTU's in at least 95% of samples, and no single sample can exceed 1 NTU). Turbidity, like TSS, is often an indicator of active erosion but can indicate the presence of other pollutants as well.

# Watershed Sampling Sites




0 1,450 2,900 5,800 8,700 11,600
Feet

Created by City of Johnston Department of Community Development
6221 Merle Hay Road, P.O. Box 410, Johnston, IA, 50131-0410 (515)278-2344 Fax:(515)278-2033

**The following is a brief description of each testing site:**

**BC # 1 - Beaver Creek at Merle Hay Road** – this sub-watershed is the largest identified in Johnston. It gives us a sample location prior to contribution from the east side of Johnston.

**C # 2 - Green Meadows West at Foxboro** – this is the location of the sanitary sewer repair and the highest % of impervious of all the proposed sampling areas. Is also part of the downstream drainage area for proposed Greenwood Hills Greenbelt project, allowing for pre, during and post construction sampling.

**F # 3 - "Waterford Creek" at NW 86th Street** – the first of three sites along NW 86th Street, each of which is at a different stage of development. Developed sites that would be considered with this sample location: Waterford, Century Woods and west. Eastward of this location, the Pioneer fields have experienced erosion damage from increased flow.

**G # 4 - Beaver Creek Elementary School at NW 86th Street** – this site drains to the Augustine development which has also experienced erosion damage due to increased flow. This channel is scheduled for improvements in 2022.

**I # 5 - NW 70th Avenue at NW 86th Street** – this area north of the Green Meadows North neighborhood is poised for development with the former Simpson property and the Bright Trust allowing for sample prior, during and after development.

**LB # 6 - Little Beaver Creek at NW 86th Street** –sampling of Little Beaver Creek before the confluence with Beaver Creek providing an understanding of impairments that are occurring outside and "above" Johnston in the larger Beaver Creek watershed.

**S # 7 - NW 59th Street at Northglenn (drainage ditch near Maurices)** – area with known drainage challenges. Monitoring this location will also provide upstream data to compare to the Prairie Pointe Crossing site in the same subwatershed.

**S # 8 - Johnston Drive at Prairie Point Crossing** –Monitoring this site will also provide a downstream data to the NW 59th Street location in the same sub watershed as well as an analysis of stormwater quality for an area that currently doesn't have sanitary sewer service.

**T # 9 and 10 – Storm-ceptor at NW Beaver Drive (2 sampling locations)** –Sampling Discontinued in 2015 at this site due to regular lack of flow.

**TL – Terra Lake** – a newly renovated pond in a public park that is primarily groundwater fed via well but sampling could give a good baseline as to groundwater contaminants. Also this newer pond includes a forebay that is intended to capture some runoff from the great lawn and clean it before entering the pond. Fish were stocked in 2015 and sampling will help determine the health of the ecosystem here.

**#12 – Greenwood Hills Greenbelt** – Newly renovated drainage basin with new best management practices in place as of 2015. Sampling at this location could show how use of said practices influences runoff quality in an urban stream corridor. This drainage way is a typical scenario replicated in Johnston in several basins. If retrofits work well this could be a template for how to address urban stream quality in other areas in town.

THE UNIVERSITY OF IOWA

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David R. Wilwerding, AICP
Community Development Director
City of Johnston
6221 Merle Hay Road – P.O. Box 410
Johnston, IA 50131

August 22, 2016

Dear Mr. Wilwerding,

The State Hygienic Laboratory at the University of Iowa (SHL) collected water samples at eleven sites in the City of Johnston on July 15, 2016. Included with this report is a summary table of the results, pictures and notes from each site, and an appendix with reports generated from our Laboratory Information Management System (LIMS).

According to the National Weather Service station KDSM at the Des Moines International Airport, the low temperature for the day was 60° F and the high temperature was 77° F. Month-to-date precipitation was reported as 2.91 inches, which is above the average of 2.30 inches. There was no measureable precipitation on the day of sample collection and conditions were partly cloudy.

Samples were collected with an HDPE sampling bucket and split into the appropriate sample containers. Samples were preserved as required per method and placed into a cooler with ice immediately after collection. The pH and total residual chlorine (TRC) were measured in the field immediately after sample collection using portable pH and TRC meters. All other analyses were performed at the SHL. Photographs were taken of each site and any pertinent field observations were recorded.

Water samples were analyzed for pH, total phosphorus, *E. coli*, nitrate + nitrite nitrogen, total suspended solids, and turbidity. The pH ranged from 6.8 to 9.5, total phosphorus ranged from 0.03 mg/L to 0.73 mg/L, *E. coli* ranged from 10 MPN/100 ml to 1,600 MPN/100 ml, nitrate + nitrite nitrogen ranged from <0.01 mg/L to 5.6 mg/L, total suspended solids ranged from <1 mg/L to 28 mg/L, and turbidity ranged from <1.0 NTU to 13 NTU. TRC was less than the reporting limit (<0.1 mg/L) at all sites.

A field blank was collected using lab pure water and was analyzed for the same analyses as the water samples. All results for the field blank were less than the reporting limit for each analyte.

Please let me know if you have any questions.

Sincerely,

James M. Luzier

James M. Luzier
Limnologist

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Table 1. Water quality results for samples collected from 11 sites in the City of Johnston on July 15, 2016.

| Site Name | Site Description | Accession Number | pH (no units) | Total Phosphorus as P (mg/L) | *E. coli* (MPN/100ml) | Nitrate + Nitrite Nitrogen as N (mg/L) | Total Residual Chlorine (mg/L) | Total Suspended Solids (mg/L) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|
| S#11 | Crescent Chase at NW 62nd Ave | 401863 | 8.0 | 0.08 | 1400 | 1.1 | <0.1 | 18 | 10 |
| S#12 | Greenwood Hills Greenbelt | 401861 | 8.0 | 0.05 | 170 | 0.48 | <0.1 | 5 | 3.7 |
| BC#1 | Beaver Creek at Merle Hay Rd | 401867 | 8.0 | 0.12 | 460 | 3.1 | <0.1 | 28 | 13 |
| C#2 | Green Meadows West at Foxboro Rd | 401862 | 7.6 | 0.07 | 430 | 0.56 | <0.1 | 3 | 3.7 |
| F3# | Waterford Creek at NW 86th St | 401860 | 6.8 | 0.09 | 460 | 0.47 | <0.1 | 7 | 9.3 |
| G#4 | Beaver Creek Elementary at NW 86th St | 401871 | 8.1 | 0.06 | 630 | 2.6 | <0.1 | <1 | 1.2 |
| I#5 | NW 70th Ave at NW 86th St | 401870 | 8.3 | 0.07 | 490 | 2.8 | <0.1 | 3 | 3.0 |
| LB#6 | Little Beaver Creek at NW 86th St | 401869 | 8.1 | 0.73 | 1600 | 5.6 | <0.1 | 11 | 8.2 |
| S#7 | NW 59th St at Northglenn | 401864 | 7.8 | 0.14 | 380 | <0.10 | <0.1 | 7 | 5.2 |
| S#8 | Johnston Drive at Prairie Point Crossing | 401868 | 7.5 | 0.16 | 86 | 4.6 | <0.1 | <1 | <1.0 |
| Terra Lake | Terra Lake | 401865 | 9.5 | 0.03 | 10 | <0.10 | <0.1 | 3 | 2.0 |

**Site Pictures and Field Notes**


Figure 1. Looking downstream from Site 11 on July 15, 2016. Collector's comments: "Cattails abundant, appears to be a wetland. Water shallow, clear, and slightly flowing."

Figure 2. Looking upstream from Site 11 on July 15, 2016.

Figure 3. Looking downstream from Site 12 on July 15, 2016. Collector's comments: "Filamentous algae abundant."

Figure 4. Looking upstream from Site 12 on July 15, 2016.

Figure 5. Looking downstream from Site BC1 on July 15, 2016. Collector's comments: "Stream is brownish-green in color.  Normal flow."

Figure 6. Looking upstream from Site BC1 on July 15, 2016.

Figure 7. Looking downstream from Site C2 on July 15, 2016. Collector's comments: "Clear, flowing, shallow water. Filamentous algae common."

Figure 8. Looking upstream from Site C2 on July 15, 2016.

Figure 9. Looking upstream from Site F3 on July 15, 2016. Collector's comments: "Cloudy turbid water, normal flow."

Figure 10. Looking downstream from Site F3 on July 15, 2016.

Figure 11. Looking downstream from site G4 on July 15, 2016. Collector's comments: "Water clear and flowing."

Figure 12. Looking upstream from site G4 on July 15, 2016.

Figure 13. Looking downstream from site I5 on July 15, 2016. Collector's comments: "Water clear. Low flow."

Figure 14. Looking upstream from site I5 on July 15, 2016.

Figure 15. Looking downstream from site LB6 on July 15, 2016. Collector's comments: "Water clear. Low flow."

Figure 16. Looking upstream from site LB6 on July 15, 2016.

Figure 17. Looking downstream from site S7 on July 15, 2016. Collector's comments: "Very low flow. Filamentous algae abundant."

Figure 18. Looking upstream from site S7 on July 15, 2016.

Figure 19. Looking downstream from site S8 on July 15, 2016. Collector's comments: "Stream is clear. Filamentous algae abundant.  Steady flow."

Figure 20. Looking upstream from site S8 on July 15, 2016.

Figure 21. Looking south from the Terra Lake sampling location on July 15, 2016. Collector's comment: "Lake higher than previous sampling. Water being pumped into lake from nearby reservoir. Warm water temperatures. Fish present. Water clear with abundant vegetation."

Figure 22. Looking north from the Terra Lake sampling location on July 15, 2016.