Stantec Consulting Services Inc.
725 East Fireweed Lane Suite 200, Anchorage AK 99503-2245

October 21, 2019
File: 204700415

Attention: Archie Giddings
290 E. Herning Avenue
Wasilla, AK 99654

Dear Mr. Giddings,

**Reference: Wasilla WWTP Effluent Discharge Pilot Study**

The City of Wasilla (COW) Wastewater Treatment Plant (WWTP) Effluent Discharge Pilot Study has been underway for approximately 4 months. To date, approximately 12 million gallons of effluent has been discharged into the wetland adjacent the WWTP. This letter provides a progress report on the Pilot Study and summarizes preliminary results to date.

**Background**

Effluent discharge commenced on June 24, 2019. For the initial target flow of 100,000 gallons per day (gpd), effluent diffusers #1 and #3 (see Appendix A) were opened, while the remaining three diffusers were left closed. Using the plug valve and flow meter constructed last fall, the discharge flow was set to approximately 80 gallons per minute (gpm), equaling roughly 115,000 gpd. Stantec employees observed flow and systematically sampled surface water daily for the first week and then weekly for the following 4 weeks, and monthly thereafter. Water was sampled using a combination of field testing for nitrates and laboratory testing for all other parameters, including fecal coliform cultures. Nitrate levels in surface water were used as the primary indicator to observe and track the movement of the spreading effluent "plume" into the wetland.

Nitrate levels in pre-discharge background surface water are very low to absent, while nitrate levels in the effluent are frequently 30mg/L or greater. In addition to nitrate levels being one of the primary water quality parameters targeted for treatment by the wetlands Pilot Study, nitrate levels can easily be measured in the field, allowing "real-time" tracking of the effluent migration.

Patterns of surface inundation were also observed to track effluent flow. The highest monitoring priority during initial weeks was to confirm effluent discharge remained on COW property and did not flow west towards neighboring properties. After several days of monitoring effluent flow, due to tendency for effluent to flow westerly towards the containment berm, diffuser #3 was closed on July 1. Closing diffuser #3 has mitigated the flow of effluent to the west. To date, only discharge diffuser #1 remains open and is flowing steadily at approximately 80gpm (115,000 gpd). Flow appears to be predominately south, without nitrate detections along the containment berm.

**Preliminary Results**

The two water quality parameters of particular importance to the Pilot Study are nitrate and fecal coliform levels. Nitrate levels in the effluent and surface waters were determined on-site (*in-situ*) using a Hach

DR890 portable colorimeter. Surface water was collected systematically down gradient of the effluent discharge on a fixed 50-foot sampling grid established and recorded with a differential GPS. It is not practical to sample every gird point every day; rather, selection of specific sampling locations on a given day were informed by real-time results from previous samples, with the intent of tracking the leading edge of the effluent plume as the effluent began to flow through the wetland. Over 250 *in-situ* nitrate tests have been conducted to date. The nitrate plume maps (Appendix B) shows the plume progression over the first week of discharge. Initially effluent pooled around diffusers #1, #2, and #3, and then slowly progressed south southwest at approximately 150ft/day (24hours). Prior to effluent diffuser #3 being closed, nitrate was detected in the surface water along the east side of the gravel berm. Nitrate levels west of the gravel berm never exceeded 1.0mg/L, with the majority of samples not containing any nitrate. The distribution of nitrate after the closure of discharge diffuser #3 clearly demonstrate that the effluent ceased flowing towards the gravel berm and progressed south and east, through surface water collection site SW-3 and towards SW-6 and SW-7. By the second week of discharging, nitrate levels along the gravel berm were reduced to background levels, and it appears effluent is no longer flowing towards the containment berm. To date the level of nitrate in surface water is reduced to well below 0.5mg/L by the time the effluent reaches surface water collection site SW-7 (Appendix C), about 700 feet from the discharge.

Fecal coliform (FC) and *E. coli* (fecal bacteria) levels were determined at surface water collection sites through laboratory culture (SGS). Fecal bacteria have been commonly detected throughout the wetland over the last three years, with peak concentrations during the warmest months (July and August) (Appendix C, Graph A). While FC are associated with the effluent discharge, they are also naturally occurring as a result of mammalian activity in the project area, mostly likely birds, small animals and moose. Prior to application to the wetlands, the effluent discharge is on the order of 1000 FC per 100 ml. None of the sample locations (Appendix C) downstream of the discharge show FC levels above normal background levels, suggesting that the effluent FC are removed within about 450 feet from the discharge.

It does appear that levels of fecal bacteria have increased over time, during the peak months of July and August in each of the last three summers. The fecal coliform increases are not attributed to the effluent discharge, as the trend began prior to discharge Rather, surface water temperatures have increased approximately 2 degrees C each summer for the past three years. As shown in Appendix C, Graph A, there is a clear correlation between the increase in surface water temperature and the increase in peak bacteria levels in the warmest months.

However, fecal bacteria cultures are problematic, in that they are not human specific, such that fecal coliform concentration tests cannot determine the source of the bacteria. To differentiate human-source fecal bacteria from other mammalian sources, Stantec used DNA-based genetic screening of water samples that can detect human-specific fecal bacteria using EPA-approved methods. DNA screening demonstrated there were no human fecal bacteria present in the wetland prior to effluent discharge, nor have there been human fecal bacteria detected at any surface water sampling site after effluent discharge. This suggests that all human bacteria are removed from the effluent within 450 feet of the discharge, i.e, prior to the closest sample sites (SW3, SW4-SW7). There are two exceptions where human fecal bacteria have been detected, at SW-1 during background sampling and SW-14 after effluent discharge. Neither of these two locations have ever shown any impacts from effluent discharge (e.g. nitrate detections) and are generally characterized by more stagnant surface inundation covering less area and a lack of surface flow. Detections at these two sites might be from cross-contamination (this is a highly sensitive test), or with SW-14 potential direct impacts from effluent leakage associated with the percolation beds.

Nitrate and fecal coliform heat maps, graphical representation of test results, are included in Appendix C. At the present application rate of approximately 115,000 gpd, nitrate and fecal coliform levels appear to be indistinguishable from the surface water at roughly 700 feet from the discharge diffusers. This is about a quarter the length of the available wetlands, suggesting capacity to treat additional effluent volume.

**Berm Status**

An earthen containment berm was constructed in the northwest corner of the COW property as a protective measure in the event effluent tended to flow towards neighboring properties to the west. The berm is constructed from gravel fill placed on a geotextile mat that was laid on top of the natural wetland soils. While it was expected the berm would sink into the ground as the wetlands soil compressed and subsided, this occurred to a greater degree than anticipated, to the point the top of the berm became inundated with surface water prior to the start of discharge. The COW provided additional fill to raise the berm before discharge began. As discussed above, effluent did make its way to the berm, however the berm performed its duty well and prevented contaminants from flowing west. However, the berm has continued to settle throughout the summer prompting the COW to hire a contractor to further build up the berm. This activity proved to be harder than planned and the contractor was only able to build up about a third of the total length of berm. As the remainder of the berm settled, surface water did eventually overtop the berm in multiple locations. To date, there are multiple locations where water is sitting on top of the berm. In anticipation of this issue, the discharge was modified (turning off diffuser 3) to reduce effluent flow towards the berm. As a result, effluent is no longer flowing towards the berm. The water on and around the berm has been sampled extensively and the results indicate no nitrates.

The COW is planning on building up the remaining two thirds of the berm this winter. The berm will be raised above water level prior to any increase in discharge rate.

**Diffusers**

Based on observations to date, it appears that effluent diffusers 3, 4 and 5, and possibly 2 have a tendency to direct effluent to the western edge of the wetland, causing effluent flow towards the containment berm. This is not desirable, as it could potentially result in migration of effluent off property to the west. Conversely, the effluent plume shows no tendency to spread to the east (e.g., towards surface water sample site SW-5). As a result, about half of the “upper” wetlands is not involved in the effluent application and treatment. It was originally assumed that effluent would spread into this area, but that appears to not be the case, at least at current discharge rates.

It may be beneficial to add one or two more effluent discharge diffusers, several hundred feet east of diffuser #1. This would roughly double the area effectively treating effluent.

**Conclusion**

In general, the wetland appears to be doing a satisfactory job of the polishing treatment of the WWTP effluent. Nitrates are removed within approximately 600 feet and fecal coliform levels are not distinguishable from pre-discharge background levels.

Discharge will continue into winter months at the current rate. The wetland surface water sampling locations will continue to be sampled monthly and the subsurface locations quarterly. Conditions will be monitored to determine how long effluent should be discharged throughout the winter.

**Reference:** **Wasilla WWTP Effluent Discharge Pilot Study**

Based on results to date, it appears the wetland has capacity to accept and treat additional effluent. However, until the containment berm is reinforced, we do not recommend increasing the discharge rate. Current plans are to add fill to the berm this winter, so we suggest any increase in discharge rate wait until spring of 2020.

Consideration should be given to constructing two additional effluent diffusers to the east of the existing diffusers. This determination can be made in spring of 2020 once the limits of the increased discharge can be observed.

Regards,

**Stantec Consulting Services Inc.**

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Principal
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Attachment: Appendices

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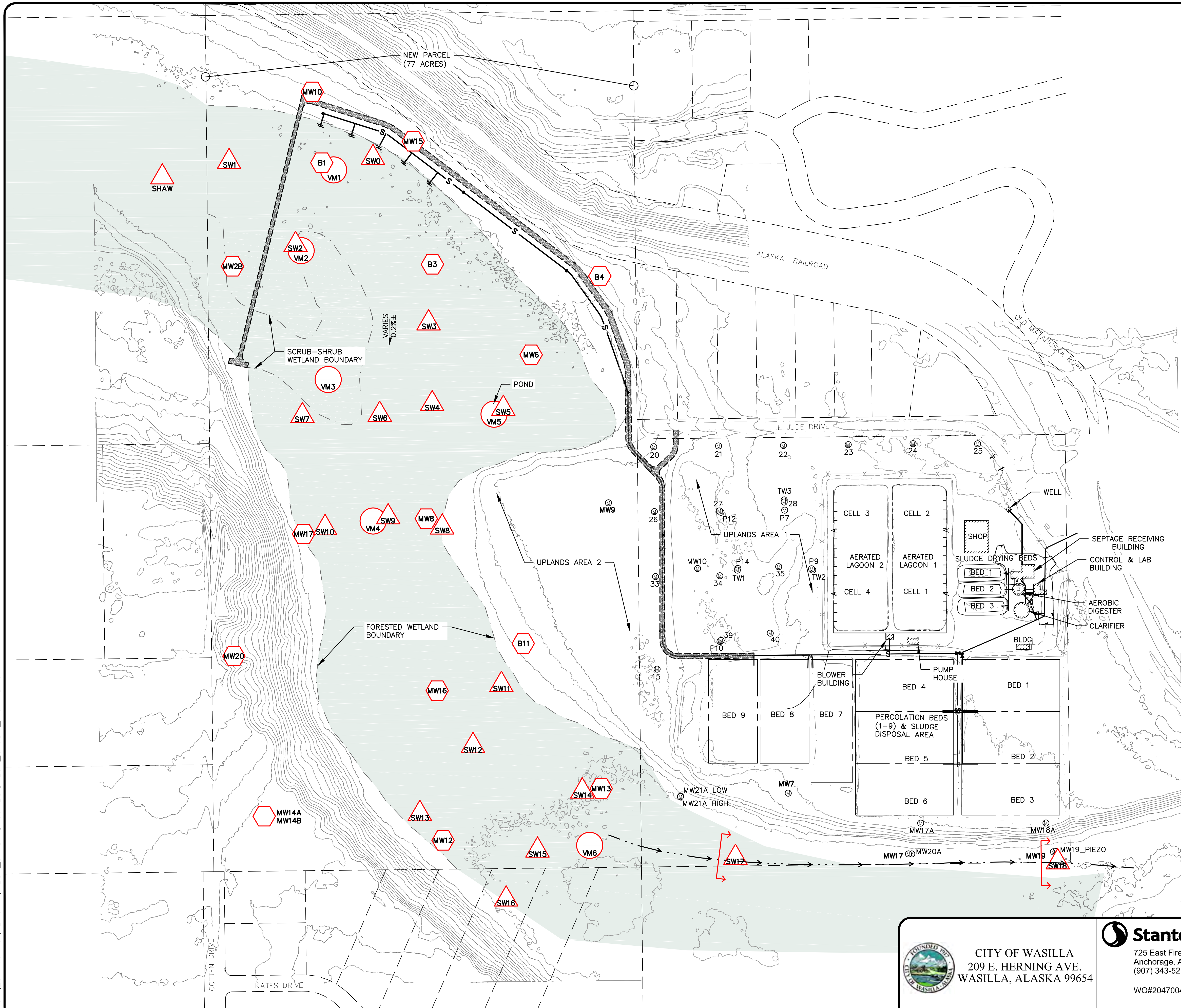
# APPENDIX A

## Site Plan




U:\204700415\REPORT\PILOT_STUDY\FIGURES\PILOT_STUDY_FIG-1.DWG

## LEGEND

- APPROXIMATE STREAM CHANNEL
- PARCEL BOUNDARY
- WETLANDS
- SW5 — SURFACE WATER SAMPLING SITE
- MW6 B5 — SUBSURFACE WATER SAMPLING SITE
- VM5 — VEGETATION MONITORING SITE
- STREAM GAGING STATION

## NOTES:

1. CONTOURS SHOWN ARE PRIMARILY BASED ON 2001 MSB LIDAR DATA WITH SUPPLEMENTAL SURVEY DATA. CONTOURS WITHIN WETLANDS HAVE BEEN ESTIMATED.
2. SURFACE WATER, SUBSURFACE WATER, AND VEGETATION SAMPLING LOCATIONS WERE COLLECTED WITH A HANDHELD GPS.
3. ALL EXISTING WWTP MONITORING WELLS ARE SHOWN ON THIS FIGURE. ONLY MONITORING WELLS BEING USED AS PART OF THIS PROJECT ARE SHOWN WITH HEXAGON LABEL.

N

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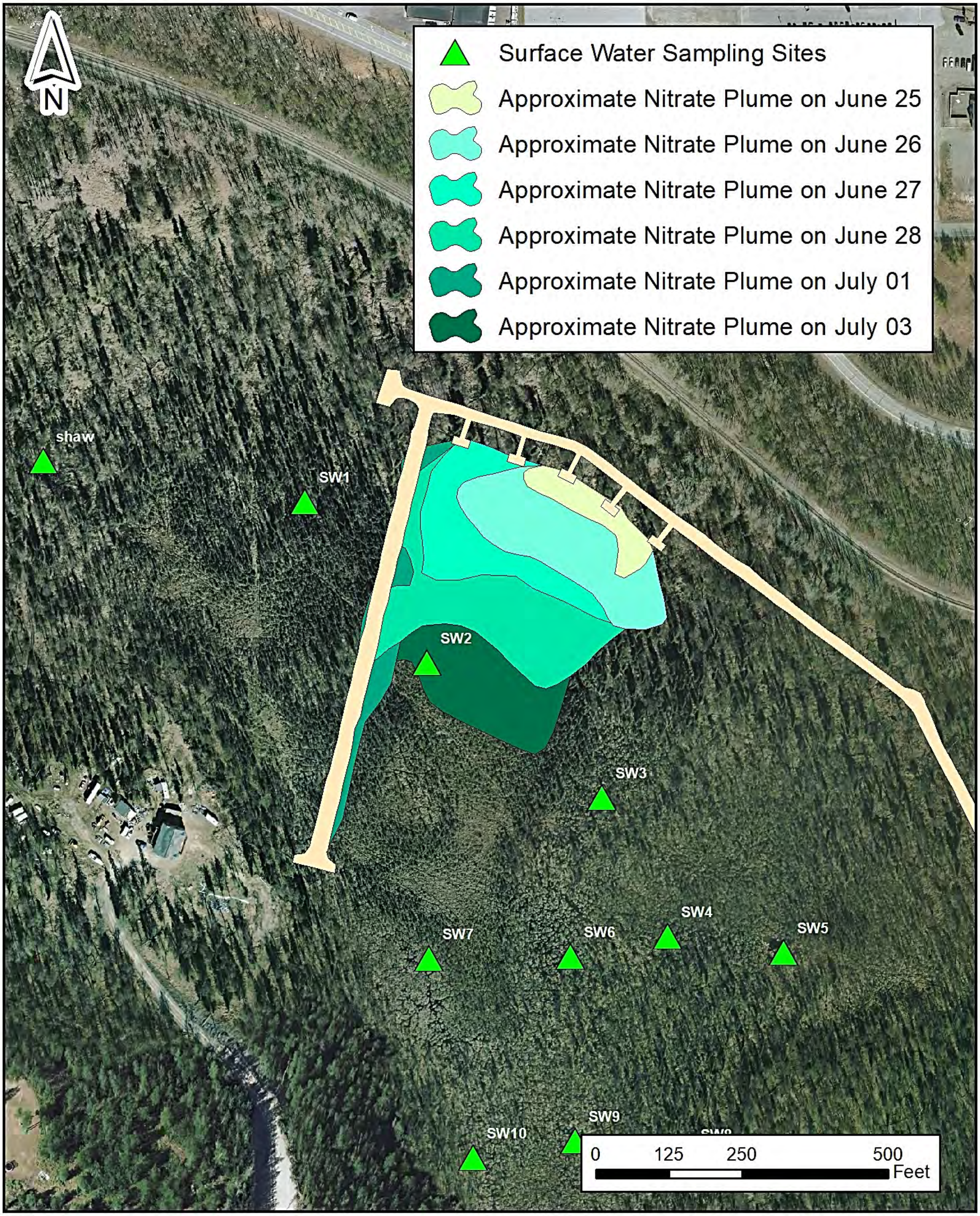
WASTEWATER OUTFALL PILOT STUDY

SAMPLING SITES

| DATE | FIGURE |
|---|---|
| 06/06/18 | 1 |

# APPENDIX B

## Nitrate Plume Map

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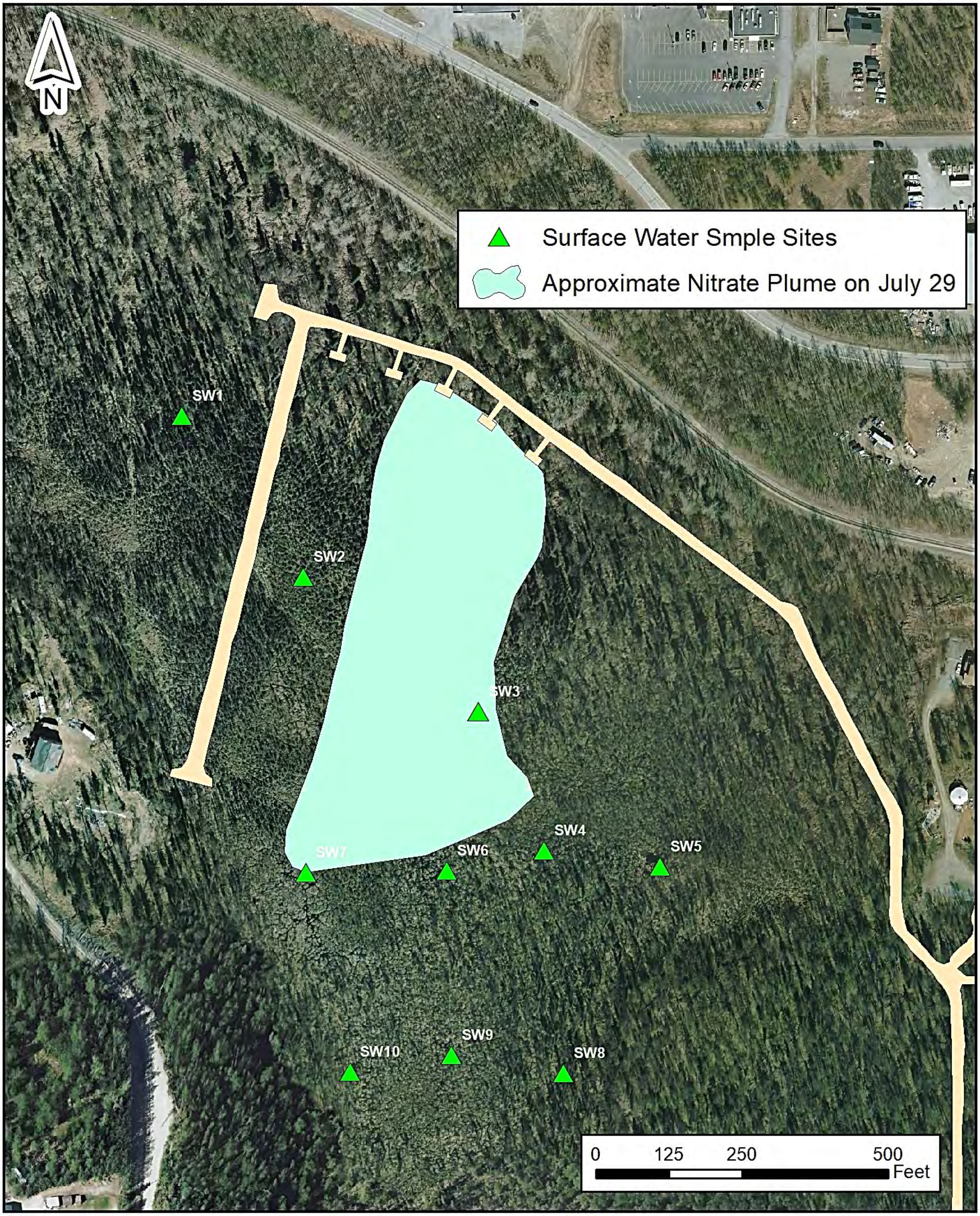
**Pilot Study - Nitrate Plume Mapping**

June 25 - July 03, 2019

FIGURE

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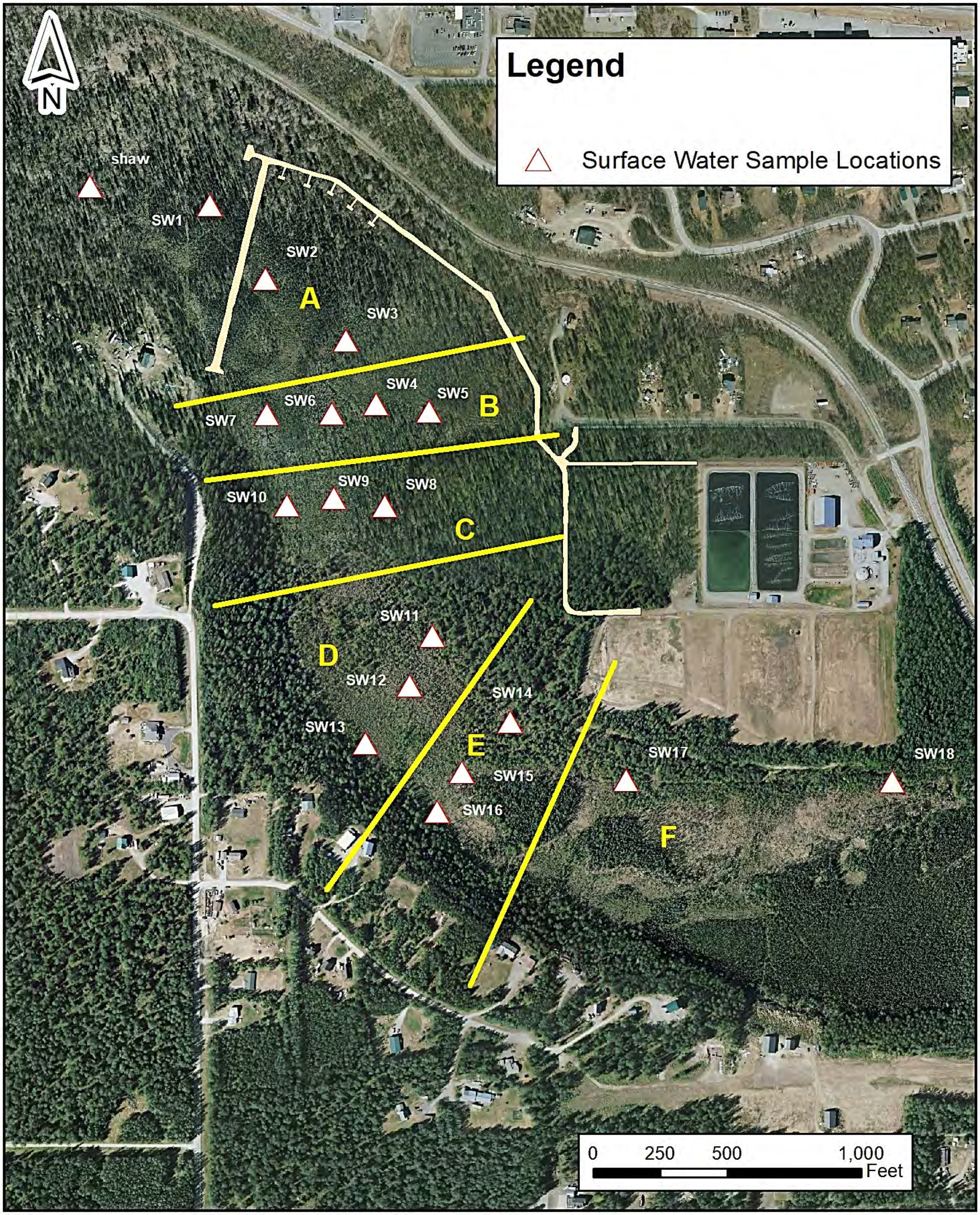
**Pilot Study - Nitrate Plume Mapping**

| DATE | FIGURE |
|---|---|
| July 29, 2019 | |

# APPENDIX C

## Data Summaries

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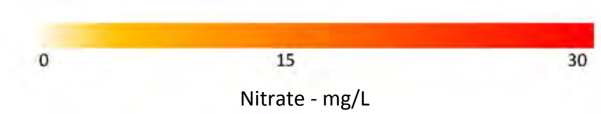
**Pilot Study - Surface Water Groups**

| DATE | FIGURE |
|---|---|
| 2019 | |

| Nitrate - mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Location | | Pre-discharge | | | | | | | | | | | | | | | | | | | | | | | | Post-discharge | | |
| Sample Month | | Jul-17 | Aug-17 | Sep-17 | Oct-17 | Nov-17 | Dec-17 | Jan-18 | Feb-18 | Mar-18 | Apr-18 | May-18 | Jun-18 | Jul-18 | Aug-18 | Sep-18 | Oct-18 | Nov-18 | Dec-18 | Jan-19 | Feb-19 | Mar-19 | Apr-19 | May-19 | Jun-19 | Jul-19 | Aug-19 | Sep-19 |
| A | SHAW | - | - | - | - | - | - | - | - | - | - | - | 0 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW1 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW2 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | - | 0 | 0 | 2.38 |
| | SW3 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 4.39 | 9.6 | 13.3 |
| B | SW4 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW5 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0.06 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW6 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW7 | - | 0 | 0 | 0 | - | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| C | SW8 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW9 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW10 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| D | SW11 | - | 0 | 0 | 0 | - | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW12 | - | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW13 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| E | SW14 | 0 | 0 | 0 | 0.34 | - | - | - | - | - | - | 0.63 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW15 | 0 | 0 | 0 | 0 | 0 | 0.07 | 0.06 | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| | SW16 | - | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| F | SW17 | - | 2.18 | 2.22 | 1.95 | 4.79 | 3.19 | 2.92 | 2.96 | 2.4 | 1.07 | 1.16 | 1.07 | 1.48 | 1.49 | 2.23 | 1.6 | 3.41 | 3.26 | 3.08 | 2.68 | 1.3 | 1.44 | 1.16 | 1.5 | 2.25 | 3.32 | 2.43 |
| | SW18 | - | 4.88 | 4.68 | 3.79 | 7.44 | 5.02 | 3.92 | 4 | 1.51 | 1.74 | 2.54 | 8.25 | 6.08 | 5.62 | 5.21 | 7.08 | 7.85 | 3.34 | 3.28 | 3.04 | 2.2 | 2.47 | 2.23 | 4.17 | 3.54 | 4.13 | 3.26 |

Note:

1. Blank (-) values indicate lack of liquid water for sampling.
2. Group E and F associated with WWTP seepage, not effluent discharge.

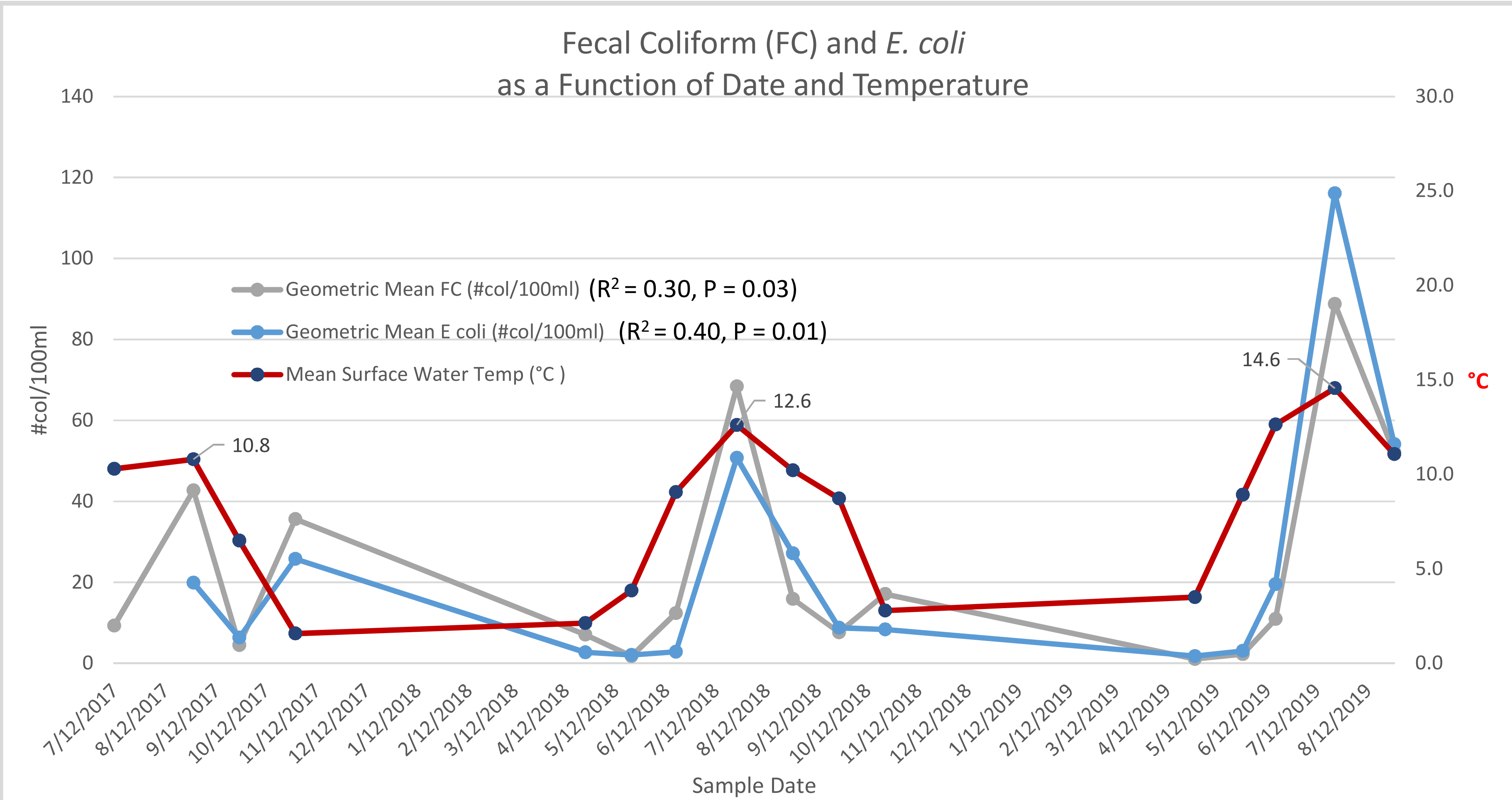


| Fecal Coliform (FC) - col/100mL | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Location | | Pre-discharge | | | | | | | | | | | | | | | | | | | | | | | Post-discharge | | |
| Sample Month | | Jul-17 | Aug-17 | Sep-17 | Oct-17 | Nov-17 | Dec-17 | Jan-18 | Feb-18 | Mar-18 | Apr-18 | May-18 | Jun-18 | Jul-18 | Aug-18 | Sep-18 | Oct-18 | Nov-18 | Dec-18 | Jan-19 | Feb-19 | Mar-19 | Apr-19 | May-19 | Jun-19 | Jul-19 | Aug-19 | Sep-19 |
| A | **SHAW** | - | - | - | - | - | - | - | - | - | - | - | 3.3 | 0 | 72 | 12 | 0 | - | - | - | - | - | 0 | 3 | 5 | 1030 | 36 | 4 |
| | **SW1** | 4 | 1110 | 0 | 0 | 0 | - | - | - | - | 0 | 7 | 0 | 36 | 39 | 2 | 1 | - | - | - | - | - | 0 | 1 | 2 | 0 | 17 | 8.3 |
| | **SW2** | 20 | 10 | 0 | 320 | 0 | - | - | - | - | 2 | 1 | 0 | 40 | 6 | 1 | 0 | - | - | - | - | - | 0 | 3 | - | 6.6 | 50 | 46 |
| | **SW3** | 3 | 30 | 0 | 90 | 0 | - | - | - | - | - | 0 | 0 | 24 | 13 | 9 | 37 | - | - | - | - | - | 0 | 1 | - | 16 | 0 | 2421 |
| B | **SW4** | 1 | 10 | 0 | 0 | 0 | - | - | - | - | 7 | 0 | 2 | 9 | 20 | 11 | - | - | - | - | - | - | 0 | 0 | 0 | 94 | 0 | 20 |
| | **SW5** | 720 | 18 | 0 | 164 | 0 | 0 | 1 | 0 | - | 5 | 0 | 17 | 83 | 38 | 26 | 36 | 1 | 0 | 0 | 0 | - | 1 | 0 | 0 | 21 | 66 | 20 |
| | **SW6** | - | 2 | 0 | 8 | - | - | - | - | - | 6 | 0 | 0 | 30 | 21 | 10 | - | - | - | - | - | - | 0 | 1 | 1 | 78 | 20 | 10 |
| | **SW7** | - | 5 | 3 | 280 | - | - | - | - | - | - | 0 | 0 | 6670 | 14 | 51 | 10 | - | - | - | - | - | 0 | 11 | 1 | 40 | 10 | 560 |
| C | **SW8** | - | 0 | 0 | 181 | - | - | - | - | - | 10 | 0 | 0 | 21 | 0 | 0 | 1 | - | - | - | - | - | 0 | 0 | 1 | 4.9 | 120 | 10 |
| | **SW9** | 3 | 5 | 1 | 12 | 0 | - | - | - | - | 92 | 0 | 0 | 85 | 2 | 1 | 0 | - | - | - | - | - | 1 | 1 | 5 | 64 | 12 | 2 |
| | **SW10** | - | 16 | 14 | 3 | - | - | - | - | - | 0 | 0 | 0 | 58 | 390 | 10 | 2 | - | - | - | - | - | 0 | 0 | 17 | 3.3 | 40 | 0 |
| D | **SW11** | - | 0 | 0 | 0 | - | - | - | - | - | - | 0 | 0 | 0 | 1 | 14 | 0 | - | - | - | - | - | 0 | 0 | 0 | 290 | 155 | 4 |
| | **SW12** | - | 330 | 3 | 23 | 217 | - | - | - | - | 13 | 3 | 0 | 270 | 27 | 86 | 2 | - | - | - | - | - | 0 | 1 | 1 | 27 | 100 | 10 |
| | **SW13** | - | 160 | 7 | 13 | - | - | - | - | - | 1 | 0 | 0 | 93 | 2 | 0 | 77 | - | - | - | - | - | 0 | 0 | 340 | 310 | 55 | 6 |
| E | **SW14** | 1 | 280 | 11 | 4 | - | - | - | - | - | - | 1 | 0 | 4 | 0 | 0 | 17 | - | - | - | - | - | 0 | 0 | 30 | 210 | 9.1 | 10 |
| | **SW15** | 112 | 160 | 4 | 40 | 9 | 24 | 3 | - | - | 6 | 0 | 8 | 36 | 42 | 2 | 360 | - | - | - | - | - | 1 | 0 | 13 | 727 | 0 | 2 |
| | **SW16** | - | 0 | 0 | 8 | - | - | - | - | - | 11 | 0 | 7 | 800 | 20 | 0 | 0 | - | - | - | - | - | 1 | 0 | 260 | 55 | 0 | 0 |
| F | **SW17** | - | 120 | 18 | 79 | 5 | 1420 | 0 | 3 | 0 | 11 | 0 | 109 | 55 | 12 | 17 | 69 | 10 | 0 | 1 | 1 | 31 | 0 | 0 | 110 | 1540 | 153 | 70 |
| | **SW18** | - | 55 | 2 | 23 | 7 | 430 | 1 | 2 | 0 | 4 | 2 | 460 | 29 | 10 | 8 | 30 | 0 | 2 | 0 | 1 | 8 | 2 | 6 | 120 | 1020 | 96 | 10 |

Note:
1. Blank (-) values indicate lack of liquid water for sampling.
2. Group E and F associated with WWTP seepage, not effluent discharge.

0 1000 2000

FC - col/100mL



Fecal Coliform (FC) and E. coli
as a Function of Date and Temperature
140
120
100
80
60
40
20
0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
°C
#col/100ml
Geometric Mean FC (#col/100ml) (R2 = 0.30, P = 0.03)
Geometric Mean E coli (#col/100ml) (R2 = 0.40, P = 0.01)
Mean Surface Water Temp (°C )
10.8
12.6
14.6
7/12/2017
8/12/2017
9/12/2017
10/12/2017
11/12/2017
12/12/2017
1/12/2018
2/12/2018
3/12/2018
4/12/2018
5/12/2018
6/12/2018
7/12/2018
8/12/2018
9/12/2018
10/12/2018
11/12/2018
12/12/2018
1/12/2019
2/12/2019
3/12/2019
4/12/2019
5/12/2019
6/12/2019
7/12/2019
8/12/2019
Sample Date


**Graph A**