CENTREVILLE WATER SYSTEM - DISCOLORED WATER ISSUES IN THE NORTH BROOK SERVICE AREA

SUMMARY AND PRIORITIZATION OF RECOMMENDED ACTIONS

May 21, 2020

After review of the North Brook Water Treatment Plant (WTP) –including the raw water, the WTP equipment, the backwash recycle system, the distribution and storage system, finished water quality, and archived McCrone communications during the initial startup of the facility – McCrone's opinion is the system is meeting the requirements for arsenic removal under normal operating conditions, but further investigation of the backwash recycle system is needed to determine if facility modifications are needed for when the facility is treating recycled backwash water.

Additionally, finished water quality should be monitored more frequently than the required once per quarter. The increased testing frequency can be slowly decreased as the results consistently show acceptable treatment like what the quarterly results have shown going back to 2017. If increased testing shows finished water quality is approaching drinking water limits, adjustments can be made to the backwash recycle system and the chemical feed system to optimize water treatment for iron/arsenic removal and to bring the facility in line with current recommended best practices.

As more data becomes available, the observations and recommendations in this document may change. McCrone will update this document when necessary and with the Town's permission to do so.

McCrone would like to highlight that most typical iron removal facilities do not remove 100% of the solids (i.e. iron and arsenic) from the raw water. The small fraction of solids that pass through the system will distribute themselves in the distribution system at the bottom of the pipes and in the bottom of storage tanks. When high flows occur in the distribution system for any reason (water main breaks, fire hydrants opened to fill pool trucks, fires in the distribution system, etc.) the deposited solids get temporarily stirred up and can then be observed by some users until the solids resettle.

Deposited solids are typically removed from a distribution system with a regular flushing program. However, if the solids leaving the treatment facility can be reduced by adjusting operations or optimizing the treatment process, then there will be less solids deposited in the storage and distribution system and less solids to stir up when a high flow situation happens. The temporary inconvenience to customers can be reduced in terms of frequency and severity via treatment optimization. Additionally, treatment optimization can reduce the needed frequency of flushing because less solids are being put into the system.

Based on McCrone's preliminary review of the existing North Brook WTP, the focus of the Town's efforts should be on the following:

1. Further investigating the quality of the recycled backwash water being sent to the filters from the backwash recycle system and the finished water quality from the WTP during treatment of recycled backwash water
2. Taking short-term steps to decrease solids in the recycled backwash water.

3. Closely monitoring finished water quality and adjusting the chemical feed systems if finished water quality approached drinking water standards.
4. Selecting and implementing a permanent solution to high solids in the recycled backwash water if those are found in item 1.
5. Removing existing deposited solids from the storage and distribution system.
6. Installing additional monitoring equipment at the WTP that will stop water production if the finished water quality degrades.

This document contains a synopsis of what McCrone has observed to date, recommended action items, and supplemental recommendation. The recommended action items within this document address the focus areas listed in the prior paragraph and are provided in a prioritized order. Supplemental recommendations are provided to help optimize the treatment process and monitor the distribution system.

Please note that Town representatives have been taking steps to investigate and resolve issues prior to the issuance of this document. The Town and McCrone have had regular communication since McCrone's involvement started on January 27, 2020. Some of the actions the Town has taken include: ordering new media for the pressure filters at the North Brook WTP; arranging for water quality tests to be performed on the raw water from both well #5 and #6; continuing to flush water mains; hiring a contractor to inspect the North Brook storage tank; and performing preliminary testing on the backwash recycle water. The Town has been able to accomplish these tasks despite several challenges including; workplace restrictions brought on by COVID-19, extended medical leave of critical staff, and a lightning strike at the WTP on Comet drive that has taken that facility offline for an extended period.

SYNOPSIS OF MCCRONE'S OBSERVATIONS TO DATE

In reviewing the North Brook WTP and Distribution system, McCrone took the standard approach of evaluating the water system from the raw groundwater, through the treatment process, and to the storage and distribution system. The provided synopsis follows that same path.

1. **Wells** – McCrone recommended lab testing on the raw water early in our involvement and Town staff had the lab tests performed. The results were reviewed by McCrone and by the treatment equipment manufacturer, Hungerford and Terry (H&T). The results show some change in important water quality parameters when compared to the lab results the original design is based on. H&T indicated the lab results show the water could be a challenge to treat and some adjustment to chemical feed rates may be needed if water quality tests show inadequate treatment. Quarterly finished water arsenic tests going back to the beginning of 2017 show adequate arsenic removal.
2. **Treatment System**
   a. *Chemical Feed Systems* – Ferric chloride is not being overdosed to the point where the filters are being overloaded with solids. Under normal operating conditions, the current feed rates are helping to produce finished water that meets drinking water standards as documented by the quarterly lab tests submitted to MDE. pH adjustment may be needed and adjustments to the ferric chloride and chlorine feed rates may be needed if finished water quality degrades due to change in raw water chemistry. The chemical feed rates may need to be flow paced instead of constant feed to optimize treatment during backwash recycle. The testing in recommended action item #1 will help determine if adjustments are needed.
   b. *Greensand Filters* – The hydraulic loading rate (gallons per minute per square foot) under all flow conditions meets H&T recommendations. Solids loading rate from iron is in acceptable range. Backwash rate and equipment runtimes between backwashes are at acceptable values. Media was showing signs of wear likely due to frequent air scour. New media is onsite and being installed in the near term. Air scour adjustments are part of the supplemental recommendations.
   c. *Backwash Recycle System* – Backwash recycle rates are above the current best practice value of 10% of well flow rate. The high recycle rate can potentially stir up solids in the backwash tank which could overload the filters. McCrone's archived communications show the backwash recycle system was a source of problems during initial startup of the system in 2008/2009. Additional testing on the backwash water and finished water when recycle water is being treated are recommended action item #1. The results of the tests may necessitate changes to the backwash recycle system per recommended action items #2 and #4.
3. **Elevated Storage Tank –** The elevated storage tank is not a source of solids in the system, but they can accumulate there. The tank should be inspected and solids levels determined. Solids should be removed if they exceed criteria levels provided by McCrone.
4. **Distribution System** – The distribution system is not a source of solids, but they can accumulate at the bottom of pipes and be suspended under high flow conditions. McCrone provided flushing rates to the Town that will meet minimum flushing velocities. A regular uni-directional flushing program is recommended to remove accumulated solids from the distribution system so future high flows have less solids to disturb.

RECOMMENDED ACTION ITEMS

***Recommended Action #1* – Perform Additional Testing and Observations on the Backwash Recycle System**

The first recommended action is to perform additional testing on the backwash water recycle system to quantify the concentrations of iron and arsenic in the recycled backwash water; estimate the pumping rate of the recycle pumps; quantify the water quality in the WTP finished water during treatment of recycled backwash; and to observe the behavior of the solids in the backwash tank while the recycle pumps are operating. Some preliminary tests were performed on the combined raw well water and recycled backwash water by the Town, but the data is inconclusive because limited sampling locations did not allow a direct sample of the recycled backwash water.

The additional testing of the backwash recycle system would involve the following:

1. Install a sample tap on the 6-inch backwash recycle pipe as soon as it enters the WTP, before it connects to the 6" tee where raw water and recycle water meet. A sample tap at this location will allow sampling of recycled backwash water only.
2. When the solids level in the backwash tank nears the normal level that would cause the Town to remove the solids from the tank, take backwash water samples and finished water samples while one of the recycle pumps is on.
    a. Recycled backwash water samples should be taken 5 minutes after the recycle pumps turn on and then every 10 minutes thereafter.
    b. A recycled backwash water sample should be taken at the new sample tap **and** a grab sample taken from the backwash tank near the suction pipe of the recycle pump that is on.
    c. A finished water sample should be taken at the same location these are currently taken for the quarterly monitoring reports. Finished water samples should be taken at the same time the recycled water samples are taken and at the same frequency.
    d. All samples should be tested at a certified lab for arsenic, iron, pH, free chlorine, total suspended solids (TSS), and total chlorine.
3. The chemical feed systems should remain on during the testing to represent normal operation when recycled backwash water is being treated.
4. The water level in the backwash tank should be measured and recorded at the beginning of the test and every 5 minutes after the recycle pumps start. The recorded levels will be used to estimate the pumping rate.
5. During the entire test, observe the water in the backwash tank and look for indications that the solids are being agitated and/or resuspended. If possible, take 1-minute video clips of the backwash tank water at the same time backwash water samples are gathered.
6. Halfway through the test, approximately 30 minutes, switch to the other recycle pump. This is to see if one recycle pump agitates the water/solids in the backwash tank more than the other.

McCrone believes it is possible a high concentration of solids from the backwash recycle system may be seen due to past documentation of this issue via archived correspondence McCrone found from

2008/2009. Some of the temporary mitigation measures installed in 2009 are no longer installed and high solids to the filters may be occurring when backwash is being recycled.

***Recommended Action #2* –Short-Term Steps to Decrease Solids from the Recycled Backwash Water**

If the results of recommended action item #1 show a high level of solids or poor finished water quality, the second recommended action is to take short-term steps to decrease the possibility of high solids coming from the recycled backwash water. Please note that these short-term steps would not be permanent fixes but are steps the Town could take in the short-term while permanent solutions were being developed and implemented.

1. Throttle isolation valves on the discharge side of the recycle pumps to decrease output from the pumps. Current best practice is for the rate of recycled water not to exceed 10% of the raw water flow rate. The current well pumping rate is approximately 500 GPM and the recycle pump rate is approximately 200 GPM (40%). Lower pump output will lead to lower suction velocities being generated in the backwash tank. Lower velocities in the backwash tank will not agitate the settled solids as much.
    a. The flow target would be 50 GPM. A 50 GPM flow rate will require significant head be added by throttling the existing isolation gate valves. Start by throttling the two gate valves immediately downstream of the recycle pumps. If the target flow rate cannot be achieved with these two valves, the valve on the east side of the WTP can also be throttled. The valve on the east side of the WTP is shown on the site plan in the WTP design drawings and is on the pipe that brings all recycled backwash water to the WTP. Throttling that valve will impact both pumps.
    b. Perform a drawdown test to determine flow rate from the recycle pumps after the valves are throttled. There is not a flow meter on the backwash recycle line.
    c. Visually observe the water/solids in the backwash tank to see if solids are being stirred up while the recycle pumps are on.
    d. If solids are still being stirred up, further throttle the valves, and repeat the drawdown test and observations.
2. Have an operator onsite whenever the recycle pumps are running to ensure WTP effluent quality and observe the water in the backwash tank. The operator would observe conditions in the backwash tank (are solids getting stirred up?) and take frequent (i.e., every 15 minutes) onsite tests on the finished water for iron and arsenic. If either iron or arsenic concentrations in the finished water start to approach or exceeds their limits, the recycle pumps are manually shut down and the solids in the backwash tank can settle again. The recycle pump can be restarted after the solids have resettled.
3. Increase the frequency of solids removal from the backwash tank so there are less solids to potentially get stirred up and get sent to the filters via the recycle pumps. An initial recommendation would be to halve the normal time between emptying the tank (i.e. 2 months becomes 1 month).

Recommended Action #3 – ***Closely monitor finished water quality and adjust the chemical feed system if finished water quality approaches drinking water standards***

The treatment equipment vendor reviewed the newest raw water lab results and noted the water could be a challenge to treat due to several factors. At the same time, available quarterly lab results from certified labs show the arsenic is being treated to adequate levels going back to the beginning of 2017. Because this water has the potential to be difficult to treat, it is recommended the Town increase the frequency of finished water lab tests and measure for additional constituents.

A suggested testing frequency would be testing weekly for a month and then evaluating whether to continue weekly testing or decrease the frequency to every 2 weeks. The testing frequency can be dropped to once per month if the 2-week tests are consistent for a month. Testing frequency can be decreased to once per quarter (as currently done) if the monthly results show consistent results.

The suggested tests would be pH, iron, arsenic, free chlorine, and total chlorine.

If the more frequent tests show concentrations of iron and/or arsenic approaching their drinking water standard limit (0.3 mg/L for iron and 10 parts per billion for arsenic), then adjustments to the treatment process can be done. Initial recommended adjustments would focus on the chemical feed systems including reinstituting the acid chemical feed system for pH adjustment, adjustments to the chlorine feed rate, and adjustments to the ferric chlorine feed rate.

Putting the pH chemical feed system online would involve purchasing a new chemical feed pump, installing chemical feed tubing, and confirming the plant Programmable Logic Controller (PLC) still has the programming to operate the pH feed pump.

Recommended Action #4 – ***Evaluate and Select a Permanent Solution to the Solids in the Recycled Backwash Water***

As with recommended action #2, ***if recommended action #1 shows high solids in the backwash water or poor finished water quality***, then recommended action #4 would be to address the high solids from the backwash recycle tank and/or poor finished water quality. The Town can review the two main options described here and decide on one or develop additional alternatives. The two main options presented here are to send the backwash water to the sewer system or to make improvements to the existing backwash recycle system. The option to send backwash water to the sewer system currently has two alternatives. The option to make improvements to the backwash recycle system involves several upgrades. Each option is discussed further in this section.

Permanent Option 1A – Send backwash water to the existing Cypress Street Pump Station

General description: Pump all backwash water from the backwash tank to the Cypress Street Pump Station (CSPS) via a 2,800 ft 2-inch force main. Backwash water will no longer be recycled.

The design drawings for the CSPS show the design pumping rate was 35 gallons per minute (GPM). The station serves approximately 12 homes on Cypress Street, which would result in a peak flow of approximately 8.5 GPM to the CSPS. If a drawdown test confirms the CSPS has a 35 GPM pumping rate, then there is approximately 26.5 GPM of available pumping capacity at the CSPS. The CSPS would be able to accommodate approximately 25 GPM from the existing backwash tank.

Design work would be needed to investigate whether the existing recycle pumps can be reused to send backwash to the CSPS, select new pumps if necessary, select a mixer to keep the solids in suspension within the backwash tank while pumping out the backwash tank, integrate pump controls and alarms into the existing WTP PLC, modify the existing WTP piping to ensure backwash water cannot backup into the WTP, modify the SCADA system so a high level at the CSPS shuts off backwash tank pumps, prepare drawings and technical specifications for the work, perform a field survey, determine potential environmental impacts along the force main route, and obtain state and local permits. Right-of-ways would need to be acquired where the force main left the public right-of-way and crossed private land to get to the CSPS.

Preliminary review of online environmental maps shows there are wetlands, sensitive species, and floodplains in the wooded area that the force main would need to cross. These are issues that would need to be addressed and would require additional paperwork, field work, and approvals to get the force main through these areas.

McCrone put together a very preliminary budget number for construction and engineering costs for this option. The "ballpark" numbers are provided below.

Estimated Total Cost Range= $275,000 – $360,000

Construction Cost Range = $250,000 – $325,000

Engineering Cost Range = $25,000 – $35,000

Permanent Option 1B – Send backwash water to the existing low-pressure collection system

General description: Similar to Option 1A, but the backwash water would be discharged into the existing low-pressure collection system that serves the North Brook subdivision. There is a potential connection point immediately across Wexford Drive, east of the WTP approximately 200 feet from the existing backwash tank.

Design work would be needed to prepare a hydraulic model of the existing low-pressure collection system to confirm the system can accommodate the additional flow and maintain adequate velocities to keep the iron sludge suspended; select pumps for the backwash tank that can pump backwash water with iron solids and have adequate pressure and flow to discharge into the existing low-pressure collection system; select a mixer to keep the solids in suspension while pumping out the backwash tank; design safety measures into the new discharge piping to make sure wastewater does not backflow into the backwash collection tank from the existing grinder pumps; integrate pump controls and alarms into the existing WTP PLC; make any necessary piping modifications to ensure backwash water cannot backup into the WTP; perform a small amount of field survey around the WTP and connection point to the existing low-pressure collection system; prepare drawings and technical specifications for the changes; and obtain state and local permits, if necessary.

McCrone put together a very preliminary budget number for construction and engineering costs for this option. The "ballpark" numbers are provided on the following page.

Estimated Total Cost Range= $170,000 - $215,000

Construction Cost Range = $150,000 – $190,000

Engineering Cost Range = $20,000 – $25,000

Permanent Option 2 – Make improvements to the backwash recycle system to reduce solids concentrations recycled to the filters and conform with current best practices

The following is a list of improvements that can be made or can be investigated to help permanently reduce high solids in the backwash recycle system.

1. Install a permanent floating decanter(s) with vortex inhibitor so that water is only drawn from the water surface no matter the water level in the tank.
2. Install Variable Frequency Drives (VFDs) on the backwash pumps in order to reduce the flow rate from the backwash recycle pumps to no more than 10% (50 GPM) of the filter inlet flow. Limiting to 10% of the raw water flow is a current best practice.
3. Change the dosing of chemicals to a flow paced approach so chemicals are added when recycled backwash water is added to the flow rate from the raw water well. This is a current best practice.
    a. A flow meter is needed downstream of where the recycled water and raw water combine, but prior to the first filter. McCrone believes there is adequate space available to do this in the piping prior to the inlet for filter #1.
    b. A 4-20mA signal proportional to the combined flow rate will need to be run to the existing PLC and chemical feed pumps.
    c. Programming changes will be needed at the PLC to change operation of the chemical feed pumps.
    d. The chemical feed pumps will need to be reviewed to determine if they need to be increased in size and whether they can accept a 4-20 mA signal.
4. Measure and totalize the flow rate of the recycled backwash water. This is a current best practice.
    a. The combined flow meter installed in item 3 and the existing flow meter on the raw water pipe can be used to calculate the flow rate from the recycle pumps. Combined flow less raw water flow will equal the flow from the recycle pumps. The existing PLC programming can be modified to perform this calculation and display an instantaneous flow rate from the recycle pumps as well as total accumulated flow from the recycle pumps.
5. Install a turbidity meter and chart recorder on the effluent side of the filters that will shut down the backwash recycle pumps, the well pump, and send out an alarm via SCADA if a high turbidity level is detected.
6. Install a second check valve on the discharge from each recycle pump to ensure discharge from one pump does not recirculate back into the backwash tank.
7. Install baffling in the tank to stop velocity currents created from pumping and currents created when the submerged backwash tank influent pipe drains during drawdown of the tank.

8. Investigate a better way to seat the pumps into the suction piping. Unseated pumps can stir up the solids on the bottom of the tank as well as cause the pump to draw from the bottom of the tank instead of the existing suction risers or the proposed floating decanters.

McCrone put together a very preliminary budget number for construction and engineering costs for this option. The "ballpark" numbers are provided below.

Estimated Total Cost Range= $300,000 - $390,000

Construction Cost Range = $270,000 – $350,000

Engineering Cost Range = $30,000 - $40,000

<u>Recommended Action #5</u> – Flush water mains, inspect elevated storage tank for solids, and clean the elevated tank, if necessary.

The Town has already taken steps to remove accumulated solids from the distribution system by increasing the frequency of water main flushing. These recommended actions are in addition to the steps the Town is already taking.

Perform uni-directional flushing of all water mains in North Brook. A flushing plan should be created and followed to systematically flush the solids from the water mains. Flow rates from the flushed hydrants should be measured so the proper flushing velocity is achieved. Flow rates should be 400-475 GPM to achieve 2.5 to 3.0 feet per second velocities in the 8-inch pipes within the North Brook area.

The extent of the solids across the distribution system is unknown, so it is a conservative step to flush all water mains in the North Brook distribution system.

Visually inspect the North Brook elevated storage tank to determine solids levels and whether a sediment plate or silt stop is installed in the reservoir near the outlet pipe. These devices are used to keep built up solids from exiting the tank under high flows. If solids levels are halfway up these devices, cleaning solids from the tank would be recommended.

If a visual inspection is inconclusive, it is recommended the Town hire a tank inspection company, such as Suez or Corrosion Control, to use a diver or a remote-control robot to inspect the solids level in the elevated tank and look for the presence of a sediment plate or silt stop. If the solids level meets the criteria in the previous paragraph, solids removal would be recommended.

The Town has contracted Suez to perform inspections on Tower #1 (north of the fire house) and Tower #3 (North Brook). The inspections are scheduled to take place in June.

One method for flushing solids from the tank would be to isolate the tank and the WTP from the distribution system and flush the tank using the hydrant in the field to the north of the tank. If the solids are not adequately removed by flushing the hydrant, drain the tank to remove the sediment and cleanout any remaining sediment.

<u>Recommended Action #6</u> – Install a Turbidity Meter and Chart Recorder at the WTP

The installation of a turbidity meter and chart recorder are mentioned in Option 2 of Recommended Action #4. If Option 2 is not selected, it is still recommended to install a turbidity meter and a chart recorder on the filter effluent. The turbidity meter would shut down the well pump and send out an alarm if high turbidity is measured. This would act as a safety measure against discharging less than optimal finished water into the distribution system.

Supplemental Recommendations for Treatment Optimization and Distribution System Monitoring

The following supplemental recommendations are made to help with optimizing water treatment plant performance. By optimizing the treatment process, even more solids can be removed by the treatment process resulting in less solids build up over time in the distribution system that can be potentially agitated by high flows.

1. Confirm air scour is only used every two weeks or once per month. Hungerford and Terry have stated that the main reasons for excessive stripping of the manganese dioxide coating on the greensand plus media is low pH or excessive air scouring. The pH is not low at well #6 (North Brook), so air scouring is the leading reason why there is premature stripping of the greensand plus media. The H&T representative has recommended air scour once every two weeks to once per month.
2. Purchase a testing unit that can read arsenic results directly at the North Brook WTP.
    a. If a bench top unit that meets testing requirements is not available, an online analyzer may be needed. Hach makes the EZ6300 unit that uses reagents to test for total dissolved arsenic up to every 15 minutes. It has an accuracy of 0 – 20 ppb.
    b. Another option is to purchase the "Quick Arsenic Scan Unit" from the same vendor that manufactures the arsenic test kits used by the Town. The scanning unit is supposed to work with the test kits used by the Town and provides a "reading" of the test strip. The reading returns a numerical value that is then used in a table that converts the numerical value into an arsenic concentration. According to the manufacturer, it is supposed to be more accurate than visually comparing the color of the test strip to the color chart provided with the test kits. The part number is 481305.
3. Tests for arsenic and iron in the distribution system should be done with regular frequency. Monthly samples at strategic points in the distribution system (i.e. tanks) will help to monitor arsenic in the distribution system and help to detect areas of concern. The sample locations would consist of locations that were sampled each month along with two locations that change every month. The two sampling locations that change every month will help to monitor the entire system without having to test the entire distribution system every month.
4. Perform a laboratory analysis on the raw water once per year so changes in water quality can be monitored.
5. Have Hungerford and Terry perform an annual analysis on a core sample of the media at the North Brook WTP. The media is in the process of being replaced, but it is still good practice to monitor the status of the media on a regular basis.