TATA & HOWARD

MEMORANDUM

To: Town of Barnstable DPW **Date:** March 14, 2018

From: Tata & Howard, Inc. – Jon W. Gregory, P.E. **Copies:** File

Subject: Design Memorandum – Maher Filtration Plant Pilot Study

The following memorandum provides a summary of key conclusions and recommendations resulting from pilot testing conducted at the Maher Water Treatment Plant (Maher Facility) from July 17, 2017 through November 8, 2017. This document adds some additional considerations to the evaluation and provides a recommendation for implementation of Treatment Option No. 2. The full Pilot Test Report was submitted to the Massachusetts Department of Environmental Protection (MassDEP) on January 19, 2018 and approved by the MassDEP on February 28, 2018.

Pilot Test Report Summary

The purpose of the pilot test report was to present the results of the pilot testing program conducted at the Maher Facility and provide recommendations for treatment systems necessary to remove iron and manganese, 1,4-dioxane, Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) from the source water at the Maher Well Nos. 1, 2, and 3.

Four treatment processes were piloted for the new Maher Water Filtration Plant (WFP). Pressure Filtration with Adsorptive Media, Advanced Oxidation, and Granular Activated Carbon (GAC) were selected as the pilot treatment technologies. Pressure Filtration with Adsorptive Media included GreensandPlus and LayneOx™ filtration for iron and manganese removal. Advanced Oxidation utilized ultraviolet (UV) light treatment and hydrogen peroxide for 1,4-dioxane reduction. GAC filters provided treatment and contaminant removal, including PFOS/PFOA, and also act as a polishing filter process to maintain a stable, consistent finished water quality. The treatment technologies were tested in series followed by an extended pilot run utilizing only advanced oxidation and GAC filtration.

Although pilot testing results suggest that removal of 1,4-dioxane and PFOS and PFOA to below regulatory limits will occur without iron and manganese removal, we recommend implementation of all proposed treatment processes, including greensand filtration.

Technical Conclusions and Recommendations

1,4-Dioxane Removal

Based the results of the advanced oxidation pilot testing, which demonstrated high UVT, low hydroxyl radical scavenging, and removal of 1,4-dioxane levels to below laboratory detection limits, we recommend that the Town proceed with advanced oxidation with hydrogen peroxide for the removal of 1,4 dioxane from the source waters at the Maher Wells. The recommended UV reactor system includes two trains of TrojanUVPhox™

30AL50 (one duty reactor per 750 gpm train) and one identical redundant train. The initial operating dose of hydrogen peroxide shall be 4.5 mg/L.

PFOS/PFOA Removal

Based the results of the GAC filtration pilot testing, which reduced PFOS and PFOA levels to below laboratory detection limits in all samples collected during the pilot test, we recommend that the Town proceed with GAC filtration for the removal of PFOS and PFOA from the source waters at the Maher Wells.

Iron and Manganese Removal

The following summarizes technical conclusions resulting from the pilot testing program as they pertain to iron and manganese removal.

- Pressure filtration with both GreensandPlus and LayneOx™ medias meet all other drinking water standards including secondary contaminants, and disinfection byproducts.
- In the absence of pressure filtration, iron was oxidized by hydrogen peroxide and removed by the GAC contactors during the pilot test. Hydrogen peroxide from the advanced oxidation process acted as a strong oxidizer thereby, allowing the iron to easily convert from a soluble to insoluble state leading to removal of iron by the GAC contactors. Iron does not adsorb to the carbon media, which allows it to accumulate on the surface of the media enabling it to be removed by backwashing.
- In the absence of pressure filtration for iron and manganese removal, manganese passed through the GAC contactors in the soluble state. The hydrogen peroxide dosage required for the advanced oxidation process along with the required contact time was not sufficient to completely oxidize manganese and allow for removal of manganese by the GAC contactors. The addition of chlorine as a disinfectant after this treatment and before the baffled water storage tank could oxidize some of the manganese creating precipitation and water discoloring.
- The removal of iron and manganese would improve water quality within the water distribution system and, subsequently, reduce the amount of dirty water calls from water customers and reduce the amount of system flushing.
- Removal of iron and manganese ahead of advanced oxidation and GAC filtration would benefit the functionality, efficiency, and life span of the equipment and media.
- Intervals between backwashing of the GAC contactors would increase resulting in an increase in the life span of the carbon media and a decrease in disruption of water production.
- Although backwashing of the GAC contactors was not required during pilot testing, it is anticipated that the introduction of iron to the carbon media for an extended period of time at the full-scale facility would require periodic backwashing of the carbon media, which would not normally be needed if iron were not present in the water. This has been exhibited at the Town's Mary Dunn facility where extended runs through the GAC filters show that the introduction of iron and manganese from the wells causes problems with the carbon media thereby requiring abnormally frequent backwashing of the media.
- It is desired that the filtration plant will operate with minimal interruptions during the summer months to maximize water production. This may minimize the ability of the carbon filter bed to expand during shutdowns to compensate for the added iron removal and lead to an increase in differential pressure requiring more frequent backwashing of the carbon media if greensand filtration is not implemented.

- Fouling of the UV lamp sleeves associated with advanced oxidation would be reduced with the implementation of iron and manganese removal, thereby improving the efficiency of the equipment and lengthening the lamp replacement interval.
- Sequestering of iron and manganese would no longer be required resulting in reduced chemical costs and O&M on the chemical injection equipment.

Additional Considerations:

Benefits of Greensand Filtration to the Water Customer

Implementation of all proposed treatment processes at the Maher WFP at present, including greensand filtration for iron and manganese removal, will provide the optimum benefit and provide water customers with the best water quality based on the treatment options presented in the Pilot Study. Water customers would have the security of knowing that the drinking water they are being provided exceeds all State and Federal drinking water standards associated with iron, manganese, 1,4-dioxane, and PFOS/PFOA.

Water supplied by the Maher Facility serves areas in Hyannis including Cape Cod Hospital, commercial businesses, hotels, the Youth & Community Center (Ice Rink), and other critical water customers in the downtown area. These are sensitive areas of town making it imperative that the best water quality possible be provided to these locations.

Removal of iron and manganese from the water supply would improve water quality within the water distribution system and, subsequently, reduce the amount of dirty water complaints from commercial and residential water customers and reduce the amount of system flushing thereby saving labor and production costs.

Benefits of Greensand Filtration Regarding Current and Future Regulations

Removal of iron and manganese using greensand filtration would reduce iron and manganese levels to below Secondary Maximum Contaminant Levels (SMCL) set forth by the United States Environmental Protection Agency (USEPA). SMCLs are not federally enforceable regulations, but iron and manganese levels in drinking water at or above the SMCL can result in taste, odor, and color complaints by water customers. Investing in and implementing greensand filtration, along with the other proposed treatment processes up front, will also better position the Town and the Maher Facility to treat anticipated new emerging contaminants in the future.

Average raw water total manganese concentrations observed during pilot testing exceeded the non-enforceable SMCL of 0.05 mg/L but were well below the current Massachusetts Office of Research and Standards Guideline (MA ORSGL) of 0.3 mg/L for manganese. Despite the MA ORSGL of 0.3 mg/L, the MassDEP has recently required public water suppliers with total manganese levels in water supplies of 0.20 mg/L and above to develop a plan to keep manganese levels in water supply sources reliably and consistently below 0.20 mg/L. The ORSGL was developed to address potential health concerns of manganese in drinking water. There is the potential for the MA ORSGL for manganese to be reduced in the future pending further research by State and Federal agencies

Benefits of Greensand Filtration for Operations and Water Production

The proposed GAC filters for the new Maher WFP are currently utilized for PFOS and PFOA removal from the drinking water at the Mary Dunn Wells. The raw water at the Mary Dunn Wells has elevated iron and manganese levels, similar to the Maher Wells. The Mary Dunn Wells do not utilize greensand filtration or other iron and manganese removal processes. As a result, the GAC filters at the Mary Dunn Wells require backwashing on a bi-weekly basis to remove the build-up of iron on the GAC media and optimize the treatment capabilities of the GAC media to remove PFOS and PFOA from the drinking water. In addition, taking the Mary Dunn Wells out of service on a regular basis to backwash the carbon media creates problems with system water supply during peak water demand periods and requires additional personnel time and effort to conduct backwashing operations.

Frequent backwashing of the GAC media will reduce the lifespan of the carbon media. The Maher Facility is a critical water treatment component of the Hyannis Water System. It is imperative that any impacts to the carbon media are minimized in an effort to optimize the treatment capabilities and life span of the carbon media both from the standpoint of operation and cost.

Air stripper media at the current Maher Facility has a history of clogging. Based on recent laboratory analyses of the media, clogging of the media is likely a result of sediment (iron and manganese) in the source water attaching to the media during the air stripping process. This requires periodic maintenance to clean the media and on occasion, full replacement of the air stripper media. Greensand filters would remove these constituents from the source water thereby extending the useful life of the air stripper media.

In addition, the precipitation of iron and manganese through the advanced oxidation and GAC treatment processes will promote sedimentation with the system's water storage tanks. This will result in more frequent cleaning and maintenance of the storage tanks and added risk for water quality problems in the system than if iron and manganese removal were implemented at present, which would mitigate the accumulation of these constituents in the tanks.

Conclusion

Although pilot testing results suggest that removal of 1,4-dioxane and PFOS and PFOA to below regulatory limits will occur without iron and manganese removal, we recommend implementation of all proposed treatment processes, including greensand filtration, advanced oxidation, and GAC filtration. Implementation of greensand filtration at present will improve the performance, functionality, and longevity of the advanced oxidation and GAC equipment and treatment processes and provide the optimum benefit and water quality to Hyannis Water System customers.

Financial Summary

The results from pilot testing led to the development of two treatment options, which were evaluated as part of the pilot test report. One option included iron and manganese removal and one did not. In the most recent update of the Hyannis Water System rate tool, the Treatment Option No. 2 was included and is part of the FY19 rate recommendation.

Treatment Option No. 1 includes a 66' x 95' metal building, advanced oxidation and GAC filtration equipment and all appurtenances, chemical feed equipment, backwash holding tank for residuals management, site work, concrete work, electrical, instrumentation, mechanical, plumbing, and fire protection. The total estimated capital cost of Option No. 1 is $7,615,000. The estimated first year operation and maintenance cost associated with Option No. 1 is $320,000. Option No. 1 limits new treatment at the facility to 1,4 dioxane removal and PFOS/PFOA removal. Removal of iron and manganese is not included in Option No. 1.

Treatment Option No. 2 includes all items in Option No. 1 for PFOS/PFOA removal and 1,4-Dioxane removal and also includes the installation of greensand filtration for iron and manganese removal, which will help optimize the treatment processes under Option No. 1. The total estimated capital cost of Option No. 2 is $9,970,000. The estimated first year operation and maintenance cost associated with Option No. 2 is $373,000.

Construction of all proposed treatment processes under one construction contract (Option No. 2) in lieu of Option No. 1 (implementing greensand in the future) would simplify design and optimize construction of the filtration plant and result in a substantially lower total project cost. Capital costs to implement greensand filtration at the new facility at a future date (assumed Year 2024) will increase by approximately $850,000 when compared to the cost to implement greensand filtration under Option No. 2 at present. This includes construction, additional design, permitting, MassDEP approval, and bidding requirements.

Signature: Jon K. Gregory