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23 March 2017

Mr. Joe Maez, P.E.
Bureau of Water Pollution Control
Nevada Division of Environmental Protection
901 S. Stewart St, Suite 400
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RE: Potential Impacts of Fluoride on the Truckee Meadows Water Reclamation Facility

Mr. Maez

As we discussed during our meeting on Monday, March 20th, I am concerned about the potential requirement for the Truckee Meadows Water Authority to add fluoride to the drinking water in the Truckee Meadows. Notably, there is little data available regarding the background fluoride levels in the Truckee River and its tributaries. This lack of data creates uncertainty which may impose requirements on the wastewater treatment facilities.

The current Bill Draft defines the maximum acceptable fluoride dosage at 1.2 mg/l and the minimum dose as 0.7 mg/l. The maximum dose is above the current water quality standard for the receiving water. Because the Truckee Meadows Water Reclamation Facility (TMWRF) does not currently have any process to remove fluoride from the influent, we would have no immediately available alternative to do so if the water quality in the Truckee River required it.

Fluoride Water Quality Standard

The water quality of the Truckee River is governed in part by NAC 445A.1236, Standards for toxic materials applicable to designated waters. This section of the administrative code establishes a maximum fluoride concentration of 1 mg/l, to be protective of the designated beneficial use as irrigation water.

Relatively little data exists regarding the natural concentration of fluoride in the Truckee River and its tributaries. With the data that is available, the background level of fluoride in the Truckee River is approximately 0.3 mg/l (NDEP – Bureau of Water Pollution Control data). However, the fluoride level in Steamboat Creek has varied from 0.7 mg/l to 1.4 mg/l (NDEP Bureau of Water Quality Planning data). These data were collected between 2014 and 2016.

While the source of the fluoride in Steamboat Creek has not been definitively determined, it is possible that the mineral is being introduced from the various hot springs in the southern portion of the Truckee Meadows. According to USGS Open-File Report 80-887 *Geochemistry of Steamboat Springs, Nevada* (Nehring 1980), several thermal waters in the area were sampled with fluoride levels ranging from 1.9 to 2.5 mg/l. If this is the case, the amount of flow, and consequently the mass of fluoride discharged to Steamboat Creek from these sources, would be independent of surface climate conditions. However, the geothermal water would represent a larger fraction of the total Steamboat Creek flow during drought years, resulting in a higher concentration of fluoride.

A condition is foreseeable where the concentration of fluoride in the discharge from TMWRF to the Truckee River could cause a violation of the water quality standard. In low flow periods, the majority of the flow in the Truckee River below the Vista Gauge is effluent from TMWRF. With increased loading from Steamboat Creek, the fluoride loading from TMWRF could result in a total fluoride concentration above the 1.0 mg/l water quality standard. This would be possible because currently the effluent from TMWRF has approximately 0.2 mg/l fluoride and thus serves to dilute the fluoride in Steamboat Creek. However, if the effluent from TMWRF contained as much as 1.2 mg/l fluoride, the maximum concentration allowable under the proposed regulation, the dilution capacity would be reduced or eliminated, and the best case would be a fluoride concentration equal to that in the TMWRF effluent. This water, when combined with the low flow in the Truckee River, could result in a final concentration above the water quality standard.

The Nevada Administrative Code section 445A.121 provides in part:

> *8. The specified standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of extreme high or low flow. Where effluents are discharged to such waters, the discharges are not considered a contributor to substandard conditions provided maximum treatment in compliance with permit requirements is maintained*

While this language would provide relief in the Nevada section of the Truckee River, it would not relieve any party from compliance with the downstream water quality standards established for the Pyramid Lake Paiute Reservation portion of the river. Thus, in a low flow period such as a drought, TMWRF could be a contributor to substandard conditions on that portion of the river.

At the recommended minimum dose of 0.7 mg/l in the potable water, the concentration of fluoride in TMWRF effluent would rise to approximately this level. While this would not cause a violation of the water quality standard directly, it would reduce the dilution capacity of TMWRF effluent in Steamboat creek by more than half. Given the extremely limited amount of data available on the natural fluoride concentrations in Steamboat Creek, it is not possible to say with specificity the conditions where this concentration would contribute to a water quality standard violation. However, it is exactly this lack of understanding of the system that is cause for concern.

Fluoride Treatment

While there are several methods available to remove fluoride from aqueous streams, only reverse osmosis membranes are marginally suitable for TMWRF.

Chemical precipitation can lower fluoride concentrations to approximately 1.0 mg/l but require high doses of Alum (≈350 mg/l) to achieve this level. Precipitation would need to occur near the end of the treatment process to avoid other pollutants scouring the flocculant dose. This level of chemical flocculant addition would cause a violation of the Total Dissolved Solids discharge standard.

Ion exchange can achieve similar levels of fluoride in the effluent but require a significant reduction in pH (to ≈ 5.5 SU) to do so. This increases the TDS concentration not only by the ions introduced in to the water in exchange for fluoride, but also by the conjugate base from the pH

adjustment. Additionally, the concentrated fluoride waste can be hazardous, requiring specialized disposal.

Reverse osmosis membranes are effective in removing particles down to approximately 0.1 nm, essentially removing all dissolved solids including fluoride. However, this process is energy intensive and creates a concentrated brine stream equal to approximately 10% of the stated capacity of the system. Consequently, a 10 MGD system could be expected to produce 1 MGD of concentrated brine that would require disposal. Currently there is no suitable disposal solution for an RO brine stream in the Truckee Meadows. Evaporation or direct ocean discharge are the most common methods of brine disposal. Evaporation in the Truckee Meadows could not depend strictly on solar ponds and would require supplemental energy. A 1,000,000-gallon brine stream at 18 C would require 1,290 MJ of supplemental energy to be evaporated.

Cost of Treatment

Given the widely variable flow conditions in the Truckee/Steamboat system, exact estimates for treatment requirements cannot be made. Preliminary calculations indicate a side-stream treatment of 10 MGD would be sufficient, when blended into the main discharge, to meet the water quality standard in the Truckee River. The cost of a reverse osmosis membrane system can vary widely based on variables in a particular system. A generally accepted planning level estimate for RO systems is $10 per gallon of treatment capacity to construct. Thus, a 10 MGD system is estimated $100 million. However, this cost will depend on many site-specific parameters, including:

- The need for any pre-treatment - The need for pre-treatment is determined by the quality of the feed water. Some RO systems require a micro-filtration membrane for pretreatment to protect the RO membranes and extend their service life.
- The need for redundancy – If a utility requires 10 MGD of treatment, the membrane system must be constructed with some redundancy to ensure adequate treatment capacity during routine and corrective maintenance. The amount of redundancy required would be determined by the regulating authority.
- Site improvements – The membrane system may require pumps, pipes and storage tanks to properly serve the membranes. These components are highly site specific and could only be estimated with a detailed preliminary engineering report.
- Energy requirements – RO membranes require energy to force the water across the barrier. While this is always delivered in the form of a pump, the type, size and number of pumps is site specific.

A preliminary examination of RO treatment for TMWRF was performed by Carollo Engineering in 2013. While the intent then was to remove dissolved organic nitrogen, the treatment system would be the same as that being considered here. At that time, it was determined that a 20 MGD system would be required, at an estimated capital cost of $269 million, or $13.50 per gallon of treatment capacity. This is more than the general estimate cost but given the preliminary level of investigation the difference is reasonable. This evaluation also estimated annual operation and maintenance costs at $4.5 million for the assumed 20 MGD system. Given the current estimate is for a system half that size, operations costs would be approximately half, or $2.25 million. However, please consider that this was

a planning level estimate and not a rigorous engineering analysis. This evaluation was provided to NDEP- Bureau of Water Pollution Control in 2013.

Total Dissolved Solids (TDS) Standard

The water quality standard for TDS on the Truckee River is 500 mg/l. This standard exists to maintain the high quality of the Truckee River and to ensure appropriate water quality for Lahontan Cut-throat Trout breeding. Consequently, the TDS standard for TMWRF is also 500 mg/l (NPDES Permit NV0020150). Through the last 9 years, the weekly effluent TDS from TMWRF has varied from 299 mg/l to 517 mg/l, with an average of 406 mg/l.

The addition of fluoride to the potable water system will raise the influent TDS to TMWRF approximately 3 mg/l, depending on the form of fluoride and dosage. While this is a small amount given the total loading, it does exacerbate an existing condition. There were two weeks in the data described above that were above 500 mg/l, and one other that would have been a violation with the additional loading. The TDS can vary widely over a given year due to the change in the relative amount of groundwater being pumped by the potable water utility.

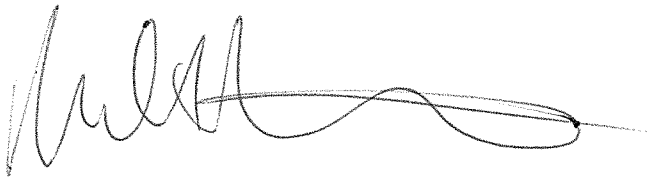
Currently neither Reno nor Sparks pre-treatment programs address TDS in industrial or commercial discharges. However, we are currently re-evaluating our local limits and there is a proposed Maximum Allowable Industrial Load (MAIL) for all Significant Industrial Users of 30,656 lbs per day of TDS. This is a preliminary limit and has not been formally adopted by either City. As with fluoride, reverse osmosis is the only viable treatment process available to remove TDS, with the same costs and challenges.

Conclusion

As I previously stated, the lack of data is a cause for concern. As the largest point source discharger on the Truckee River, it is reasonable to conclude that TMWRF would be considered a contributing factor for any water quality violation for constituents found in the facility's effluent. The current lack of a process to remove fluoride and the substantial capital and operational costs for such a treatment process compel me to bring these concerns forward.

If you have any questions regarding this letter I can be reached by electronic mail at mdrinkwater@cityofsparks.us or by telephone at (775) 861-4116.

Thank you



Michael A. Drinkwater
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