City of Elk River Wastewater Treatment Facility Improvements

Achieving Wastewater Treatment Goals

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The City of Elk River received a new NPDES permit and the existing Wastewater Treatment Facility (WWTF) in Elk River would not be sufficient to meet the new effluent phosphorus limits. Elk River's original WWTF was constructed in the late 1950s and has gone through multiple expansions and rehabilitations. The existing facility was a trickling filter facility with various treatment processes running either at capacity or nearing the end of their useful life. The City of Elk River and Bolton & Menk, Inc. worked together to develop a comprehensive approach during the planning stages to evaluate the entire facility and its impacts on the environment. The City needed to make improvements to meet the new phosphorous limits and flows and loadings were developed for the City's urban service area for the design year 2035. This approach was reinforced by the City's tagline, "Powered by Nature." Various treatment options were explored and evaluated, and the extended aeration process was selected to allow the use of existing infrastructure and operational flexibility. The robust process provides consistent high quality effluent. Additionally, extended aeration is a first step into more complex activated sludge processes that may be necessary to meet additional and more stringent effluent requirements in the future.

The design year 2035 flows and loadings are:

Design Flows and Loadings **Wastewater Treatment Facility** **Elk River, Minnesota**	
Flows	**Loadings**
ADW Flow = 3.98 MGD	CBOD = 7,720 lbs/day
AWW Flow = 4.54 MGD	TSS = 9,990 lbs/day
PHWW Flow = 7.27 MGD	TKN = 1,362 lbs/day

PIWW Flow = 9.1 MGD	P = 273 lbs/day

The City started the planning process for the wastewater improvements project in April 2012 and submitted a Facility Plan to the MPCA in February 2013. The design started in the summer of 2013. The City bid the project in June 2014 and the project was awarded to Rice Lake Construction Group for approximately $16.5 million. Since the new discharge permit included a new limit for phosphorous the City and Bolton & Menk worked to apply for and obtain a Point Source Implementation Grant through the Minnesota Public Facilities Authority for approximately $2.6 million.

Liquid Stream Improvements

Improvements were made to the liquid stream treatment of the WWTF as follows:

Pretreatment: Integration of the existing pretreatment processes into an overall Supervisory Control and Data Acquisition (SCADA) system was done. The existing pretreatment equipment consists of fine screen, screening compacter, vortex grit removal, grit pump, and grit classifier. The existing pretreatment process had gone through major upgrades in 2005 and has remaining useful life and will continue to serve the community. Bolton & Menk confirmed the existing equipment's capacity to meet design year flows. No major upgrades or equipment changes were done to the pretreatment system at this time.

Biological Treatment: A complete demolition and removal of the existing trickling filters and ancillary equipment was done during the current project. The biological treatment processes now includes Anaerobic, Anoxic, and Extended Aeration Basins.

> Anaerobic Basins: Existing primary clarifiers were converted to anaerobic basins. The clarifier's scraper mechanisms and bridges were removed. A new submersible mixer was installed in each basin for mixing of microorganisms and influent wastewater. Microorganisms from the anoxic basin are returned to the anaerobic basins as anoxic recycle. The anaerobic tanks promote biological phosphorus removal. Phosphorus accumulation organisms (PAOs) are conditioned in anaerobic basins for luxury uptake of phosphorus in the aeration basin.

Anoxic Basin: The anoxic basin is used for denitrification of wastewater. In the anoxic basin facultative microorganisms convert nitrite and nitrate to nitrogen gas. Aeration Basin No. 1 is designed as a swing basin (anoxic or aeration) to provide flexible treatment as the community grows. Aeration equipment, two submersible mixers, and mixed liquor returns pumps are provided in the anoxic basin.

Aeration Basin: The aeration basin is used to mix wastewater with oxygen and allow bacteria to grow and multiply. These bacteria consume organic matter and ammonia, which are detrimental to fish and other aquatic life in receiving bodies of water. The aeration basin is divided into six tanks with a total volume of 3.94 million gallons (MG). Each basin has fine bubble diffusers and air is supplied by four blowers. The blower system consists of one high efficiency hybrid blower and three high efficiency turbo blowers. A combination of these blowers is used to meet the dissolved oxygen (DO) demand created by the bacteria interacting with the wastewater. Each blower has a capacity of 3667 SCFM. The effluent channel of the aeration basin also has mixed liquor return pumps to send microorganisms and nitrate back to the anoxic basin for further treatment.

Chemical Phosphorus Removal: A rapid mix basin is provided downstream of the aeration basin to remove any excess phosphorus that has not been captured biologically. Existing ferric chloride storage tanks and pumps are used to feed ferric chloride into the new rapid mix basin. Ferric chloride feed is controlled by an online Hach phosphorus analyzer. The phosphorus analyzer continuously measures the effluent phosphorus and directly controls the ferric chloride feed pumps to ensure the effluent phosphorus limit is being met without overfeeding the ferric chloride.

Final Clarifiers: Wastewater flows from the rapid mix basin through a control structure to the three existing final clarifiers. Final clarifiers separate microorganisms and solids from the wastewater. Settled microorganisms are either returned to ahead of the aeration basin or wasted to biosolids treatment processes. Each clarifier is 50 feet in diameter and has 16 feet side water depth. During the current upgrades, each clarifier was provided with new dome covers and drive motors were also upgraded to meet electrical code requirements. The domes reduce freezing issues during low flow winter months.

Sand Filters: Clarified wastewater flows to the existing gravity sand filters. The existing facility has six single media sand filters. Each filter cell is 12 feet by 20 feet. The filters were built during 2007 upgrades to the facility. A chlorine feed system to the filter influent was added to stop microorganism growth on the filter media.

While using the trickling filter process, the City had experienced microorganism growth causing mud balls on the filter media and reducing the filter performance. After the new aeration basins came online, the mud ball issue has been eliminated even without the use of the chlorine feed. The sand filter performance has improved and the number of backwashes has been reduced to one quarter of the previous frequency. The controls of the existing filters have been integrated into the new SCADA system.

Disinfection: The existing WWTF uses Ultraviolet (UV) disinfection before discharging treated wastewater to the Mississippi River. The original UV building and channels were built during the 1993 upgrade. During the 2007 upgrade, the UV disinfection system was completely replaced. With the current project the existing disinfection system was integrated into the central SCADA system.

Solids Stream Improvements

The biosolids generated at the existing facility were anaerobically digested, stored on site, and then land applied during the spring and fall land application periods. The existing anaerobic digesters and associated equipment were in need of a significant upgrade due to age and poor condition. Additional digester capacity was also required to meet biosolids needs for the design year. Additionally, anaerobic digestion of biosolids was not required due to change in the liquid stream processes by eliminating the primary clarifiers. Therefore, aerobic biosolids digestion was selected to process biosolids.

The existing primary digester, secondary digester, and the biosolids storage tanks were converted to aerobic digesters for biosolids processing. Coarse bubble air diffusers were added to all the tanks to aerate and mix the biosolids.

Dewatering: To facilitate handling of digested biosolids, various dewatering processes were evaluated including: belt presses, centrifuges, rotary presses, and screw presses. Screw presses were selected by the City due to ease of maintenance, lower RPM of moving parts, and less energy costs. The total capacity of the screw presses is 1,190 lbs/hr. The new screw presses consistently produce 18-20 % dewatered biosolids cake product. The cost of hauling and final disposal of the biosolids is significantly less due to reduced volume of biosolids.

Final Disposal: The dewatered biosolids are hauled by trucks and disposed of at the Waste Management landfill located a few miles north of the WWTF.

Cooperation with Private Entities

The City of Elk River has been a progressive and willing partner to work with private entities to find innovative solutions for wastewater treatment and biosolids disposal. One idea they had was to pump the biosolids to a nearby power plant and in return the plant would send cooling tower

wastewater to the City for treatment. The idea was considered, but ultimately was not incorporated.

During construction of the new facility, the City and Waste Management (WM) collaborated about the possibility of the City taking and treating the leachate from Waste Management's landfills. In conjunction, Waste Management investigated using the City's dewatered biosolids in their landfill. The City and Bolton & Menk performed a full scale pilot study to evaluate the treatability of the leachate at the WWTF. The key to running the full-scale pilot is to have the new aeration basins stay online and functioning for the full-scale pilot to work. The pilot was initiated in August 2016 and ran for approximately two months. The biggest concern with accepting leachate is the impact the color from the leachate may have on UV transmissivity and inhibiting the effectiveness of the UV disinfection system. The leachate received had a dark color and color is not easily removed. The leachate did impact the color of the water which in turn impacted the UV transmissivity. However, as noted above, the new biological treatment process did improve the overall quality of the water, so the introduction of the leachate did not negatively impact the UV disinfection process. The results from the pilot study were favorable for developing an agreement between the City of Elk River and Waste Management. The City is treating leachate (on a short term basis) from Waste Management and is meeting all of the effluent permit limits. The City and Waste Management are working towards a final long term agreement. A partnership like this is a testament to the City and their willingness to work with private entities for mutually beneficial solutions.

Overall, the new facility has provided better operational flexibility, a new control system, and has been producing better quality effluent than the previous treatment process. Additionally, the new extended aeration process has significantly improved the performance of the existing filters and UV system.