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Memo

Water & Pollution Control Department
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TO: Mayor and City Council Members

FROM: John Dunn, Director, Water and Pollution Control Department

DATE: November 13, 2009

SUBJECT: Nov. 17 Workshop – Wastewater Disinfection Technologies Study

It is my pleasure to provide you with the attached Executive Summary of the recently completed Wastewater Disinfection Technologies Study. The study is the initial phase of the WPC Plant Disinfection Project included in the current-year Capital Improvements Plan and was authorized by Council on July 14, 2009 when a professional services agreement was executed with Stanley Consultants of Muscatine, Iowa.

The end goal of the WPC Plant Disinfection Project is to design and construct a wastewater disinfection system capable of consistently achieving compliance with the State of Iowa's bacterial standards. In 2007, the Iowa Department of Natural Resources completed a Use Attainability Analysis (UAA) of the South Skunk River to determine the level of recreational uses that the stream could support. The conclusion of the UAA was that the South Skunk River segment where the Ames Water Pollution Control Facility (WPCF) discharges is capable of supporting full-body contact recreation and was reclassified as a Class A(1) stream.

The addition of the A(1) designation means that when the NPDES permit for the WPCF is renewed, a new numeric bacterial standard will be imposed. Even though there has been no action yet by the IDNR to require disinfection, staff believes that providing disinfection is an important obligation that is consistent with the department's mission to protect public health and the environment and is proposing to proceed with the installation of disinfection before a permit is issued. The *Iowa Administrative Code* has recently been amended to make the numeric limits clear, and staff feels there is minimal risk of a different standard being imposed when a permit is ultimately issued.

The first phase of the project, which culminates in our workshop on November 17, is a study to determine the most appropriate technology for the Ames facility. The attached Executive Summary provides an overview of the process used to select the recommended technology. The evaluation process included multiple workshops with the staff and consulting team, as well as tours by staff of the disinfection systems in use at other facilities. **The end result of the study is a recommendation to Council that disinfection at the Ames WPCF be achieved through the installation of an ultraviolet light system.** This recommendation is based on an evaluation of life-cycle costs (which includes both up-front capital costs and long-term operation and maintenance costs) as well as a qualitative evaluation of non-monetary factors, such as effectiveness, safety, and several other considerations.

At Council's direction, an evaluation of wetlands as a disinfection technology was included in the study. The consulting team selected for the study included a nationally recognized expert in wetland design. The study revealed that, while wetland systems do provide some degree of disinfection, they are not capable of consistently achieving compliance with Iowa's bacterial standard. Since they cannot achieve the ultimate purpose of the project, the use of wetlands as a stand-alone disinfection system was not pursued. The study did identify possible uses for wetlands beyond disinfection, such as nutrient removal and wet-weather flow treatment; and some preliminary cost estimates were prepared.

To gather additional input, a public open house was held on November 9. Although attendance was light, attendees expressed overall support for an ultraviolet light system as the preferred choice. Several attendees shared a desire to see wetlands incorporated as well, either as part of the disinfection system or for other purposes. Based on this feedback, staff and their consultant have had some additional discussions; and additional information on the possible uses for wetlands will be shared at the workshop.

The workshop format will consist of a presentation by the consulting team of the evaluation process used, a brief explanation of the alternatives evaluated, the results of the monetary and non-monetary evaluations, and the recommendation to install ultraviolet disinfection as the preferred technology. Staff anticipates that there may be those present at the workshop who desire to share comments with Council at the conclusion of the presentation.

No formal action is necessary from Council at this time. If Council agrees with the recommendation, staff will convert the recommendation into a Capital Improvements Plan project that will be formally approved by Council at a later date. Staff anticipates negotiating an engineering contract early in 2010 and bringing it to Council for approval. Staff expects engineering design will take six to nine months, and the project will be ready for bidding in the fall of 2010. Staff is awaiting the outcome of an application for a grant through the state's IJOBS stimulus program. The decision will be made in December. Funding through the Clean Water State Revolving Loan Fund (CWSRF) will be pursued for any costs not funded through the IJOBS program. The CWSRF offers community low-interest loans for water quality improvements.

If Council desires a different recommendation, guidance would be appropriate in advance of the CIP presentations in January.

Executive Summary
Wastewater Disinfection Technologies Study
November 2009

Introduction

The objective of the study is to evaluate wastewater disinfection technologies and select the most appropriate technology to disinfect the effluent from the City of Ames (City) Water Pollution Control Plant (Plant). Selection of the disinfection technology is based on the city's non-monetary selection criteria, capital cost, and life-cycle cost analysis. Disinfection of the plant's effluent is not currently a requirement of the plant's discharge permit. However, the receiving stream for the plant effluent, the South Skunk River, was re-classified an A(1) full-body contact recreational river in 2007. The A(1) full-body contact recreation designation sets seasonal (March 15-November 15) in-stream water quality standards for E. Coli, a bacteria used as an indicator of human waste contamination. New E. Coli limits are anticipated in the city's next National Pollutant Discharge Elimination System (NPDES) permit likely to be issued in 2010. The study used design flows consisting of an average daily flow of 7.1 million gallons per day (mgd), an average wet-weather flow of 12.1 mgd, and a peak flow of 20.4 mgd.

Methodology

The study methodology uses non-monetary criteria developed by city staff to perform initial ranking of technologies prior to concept development and cost analysis of the top three to four technologies. The technologies evaluated in the study include sodium hypochlorite (liquid chlorine), chlorine gas, chlorine dioxide, peracetic acid, ultraviolet (UV) light, ozone, and wetlands. Liquid and gas chlorine delivery versus on-site chlorine generation was also considered. The technologies were numerically ranked in collaboration with city staff based on weighted non-monetary criteria, such as safety, effectiveness, operation and maintenance requirements, reliability, green design, and public and regulatory acceptance. Other minor criteria were given positive, negative, or neutral ratings. The highest scored alternatives (sodium hypochlorite, UV light, and peracetic acid) were retained for further consideration and development. City staff also requested development and costing of UV combined with peracetic acid. Wetland technology, with input from recognized wetlands expert Scott Wallace, was determined to not be able to consistently meet the 30-day geometric mean E. Coli standard of 126 colony-forming units per 100 mL. However, city staff requested wetlands alternatives be developed for both a base-flow polishing system and as a wet-weather flow mitigation alternative. The results of the concept development and cost analysis are presented to city staff in the form of a draft report for consideration. A public meeting was held on November 9, 2009 to present the various technologies, non-monetary criteria evaluation, concepts and costs, and to receive feedback from the public.

Disinfection Study Alternatives

Sodium Hypochlorite

Sodium hypochlorite is a liquid chlorine solution commonly known as bleach. A basic liquid hypochlorite chlorination system includes solution tank(s), metering pumps, chemical tubing, a diffuser (to inject the solution into the water), and a contact tank to allow the chemical time to inactivate the bacteria. A building for housing the equipment is normally provided. Leftover chlorine remaining in the wastewater effluent is toxic to aquatic life and must be removed. Sodium bisulfate is typically used for removal of residual chlorine. Some key advantages are that it requires minimal operation and maintenance, can reliably meet the bacterial standard, and has low energy consumption. Some disadvantages are that it has higher chemical costs and requires staff to handle two chemicals.

Peracetic Acid

A system that uses peracetic acid (PAA) is very similar to a sodium hypochlorite system. A building and contact tank is provided just like the sodium hypochlorite system. PAA breaks down into water and carbon dioxide. However, PAA is a biocide prior to breakdown. Currently, there is no receiving stream standard for PAA, but it is anticipated that an additional chemical will need to be fed to inactivate the PAA prior to release to the receiving stream. Peracetic acid is not a common method of disinfection in the United States but is practiced in Europe. Only a couple facilities in the United States produce peracetic acid, and the nearest facility is in Joliet, Illinois. The advantages of this method of disinfection are similar to sodium hypochlorite. The disadvantages are chemical handling, higher chemical costs, and concerns over chemical availability.

UV Light

An ultraviolet light (UV) disinfection system is a physical process that transfers electromagnetic (light) energy from a mercury arc lamp to a microbe's genetic material inactivating the microbe. The main components of a UV disinfection system are mercury arc lamps, a reactor, and ballasts. The source of UV radiation is either the low-pressure or medium-pressure mercury arc lamp with low or high intensities. A UV system consists of a channel or channels where the banks of UV lamps are immersed in the wastewater effluent and a building for housing ancillary equipment and the lights during the non-disinfection season. An advantage is that UV is a reliable, proven technology with minimal chemical handling. The main disadvantage is that it has higher energy consumption than the other studied alternatives.

UV/Peracetic Acid

This alternative combines the UV and PAA processes. UV is used for the base flows up to 12 mgd. PAA is used for flows greater than 12 mgd when the effluent solids slightly rise, decreasing the efficiency of the UV. The combination allows a reduction in UV equipment sizing and the PAA contact tank. The facilities required include the UV system with building and the PAA system with building and contact tank. Advantages include the use of a proven technology for normal operating periods and low consumable costs. Disadvantages are chemical handling and the fact that PAA is not a demonstrated technology in the U.S.

Wetlands

Wetlands are a solar-powered ecosystem that acts as a significant sponge for carbon, nutrients, metals, and other constituents such as pharmaceuticals. These constituents are in a dynamic equilibrium and cycle through various forms in the wetlands. Wetlands can also be very effective in de-nitrification systems.

Wetlands reduce pathogens through various processes, including settling, filtration, predation, and solar disinfection. The combined effect of these processes often results in a two- to three-log removal rate. However, wetlands are also a source of pathogens due to the wildlife and waterfowl that use them, so the removal efficiency varies with wildlife use.

As a result, while wetlands can be thought of as a pathogen reduction technology, they cannot be regarded as an appropriate sole disinfection technology for the City of Ames in the sense that wetlands will not be able to consistently meet the required E. Coli standard. No option was evaluated using wetlands as a stand-alone disinfection technology.

However, wetlands may be appropriate for the City for wet-weather overflow mitigation and/or nutrient removal since they combine the benefits of detention and treatment in the same reactor volume.

Cost Analysis

Table 1. Cost Summary

Alternative	Description	Capital Costs, $	Annual O&M Costs, $	Total 20-Year Present Worth, $
1	UV Disinfection	1,930,000	18,000	2,200,000
2	Sodium Hypochlorite Disinfection	1,480,000	120,000	3,000,000
3	Peracetic Acid (PAA) Disinfection	1,010,000	743,000	10,300,000
4	UV Disinfection Plus PAA Disinfection	2,200,000	67,000	3,000,000

Source: Stanley Consultants, Inc.

The alternative that evaluated wetlands in combination with UV is estimated to cost a minimum of $4.5 million to construct and will have an estimated annual operation and maintenance cost of $100,000. This equates to a present-worth cost of $5,800,000.

A sensitivity analysis was conducted on operations and maintenance costs, and the outcome showed UV still remained the most cost-effective means for disinfection of the plant effluent.

Public Input

Staff from the Water and Pollution Control Department held a public open house on Monday, November 9, 2009. The purpose of the open house was to solicit feedback on the evaluation process used to select the final four alternatives that were evaluated in depth and to learn about public perception of those four alternatives. The open house was publicized on the city web site, and a press release was distributed to area media outlets. Staff also mailed invitations to previous open houses attendees for related topics and to every person who provided a comment to the Iowa Department of Natural Resources when the South Skunk River was re-designated with the Class A(1) recreation use.

A total of nine people attended the open house. Based on responses shared on feedback forms, the majority of attendees indicated support for ultraviolet disinfection as their preferred alternative. Reasons identified on the feedback forms for the choice included the reliability of the system, the safety of ultraviolet both for employees and surrounding neighbors, and the life-cycle costs. In addition, many of the attendees expressed an interest in including wetlands if an appropriate use could be determined. Reasons cited for this preference included the potential for nutrient removal, the potential for removal of compounds that are not currently regulated, and energy efficiency.

Following the public open house, staff and their consulting team again discussed the alternative that seemed most practical for incorporating wetlands into a disinfection system. Because it had been determined that wetlands alone could not achieve consistent compliance with the disinfection standard (which is the ultimate purpose of this project), a wetland system would need to be paired with one of the other disinfection systems. After giving wetlands this additional consideration based on the public input, staff again came to the conclusion that wetlands do not make practical sense as a disinfection technology. **It should be pointed out that implementation of any of the other disinfection technologies does not preclude the future use of wetlands as a nutrient removal technology or as a wet-weather flow technology.**

Recommended Alternative

The recommended disinfection alternative is UV disinfection. UV disinfection provides a safe, reliable method of disinfecting wastewater effluent. The technology is well demonstrated in wastewater disinfection applications. Operation and maintenance are fairly simple with costs relatively low. This process does not introduce any additional constituents into the effluent. The capital cost is somewhat higher than some of the technologies that were further developed, but the overall 20-year present-worth value is the lowest of the technologies.