Course Monomedia for Wastewater Treatment Plants

Final Report 07-02
August 2006

New York State
Energy Research and
Development Authority

The New York State Energy Research and Development Authority (NYSERDA) is a public benefit corporation created in 1975 by the New York State Legislature. NYSERDA's responsibilities include:

- Conducting a multifaceted energy and environmental research and development program to meet New York State's diverse economic needs.
- Administering the **New York Energy $mart**SM program, a Statewide public benefit R&D, energy efficiency, and environmental protection program.
- Making energy more affordable for residential and low-income households.
- Helping industries, schools, hospitals, municipalities, not-for-profits, and the residential sector, including low-income residents, implement energy-efficiency measures.
- Providing objective, credible, and useful energy analysis and planning to guide decisions made by major energy stakeholders in the private and public sectors.
- Managing the Western New York Nuclear Service Center at West Valley, including: (1) overseeing the State's interests and share of costs at the West Valley Demonstration Project, a federal/State radioactive waste clean-up effort, and (2) managing wastes and maintaining facilities at the shut-down State-Licensed Disposal Area.
- Coordinating the State's activities on energy emergencies and nuclear regulatory matters, and monitoring low-level radioactive waste generation and management in the State.
- Financing energy-related projects, reducing costs for ratepayers.

NYSERDA administers the **New York Energy $mart**SM program, which is designed to support certain public benefit programs during the transition to a more competitive electricity market. Some 2,700 projects in 40 programs are funded by a charge on the electricity transmitted and distributed by the State's investor-owned utilities. The **New York Energy $mart**SM program provides energy efficiency services, including those directed at the low-income sector, research and development, and environmental protection activities.

NYSERDA derives its basic research revenues from an assessment on the intrastate sales of New York State's investor-owned electric and gas utilities, and voluntary annual contributions by the New York Power Authority and the Long Island Power Authority. Additional research dollars come from limited corporate funds. Some 400 NYSERDA research projects help the State's businesses and municipalities with their energy and environmental problems. Since 1990, NYSERDA has successfully developed and brought into use more than 170 innovative, energy-efficient, and environmentally beneficial products, processes, and services. These contributions to the State's economic growth and environmental protection are made at a cost of about $.70 per New York resident per year.

Federally funded, the Energy Efficiency Services program is working with more than 540 businesses, schools, and municipalities to identify existing technologies and equipment to reduce their energy costs.

For more information, contact the Communications unit, NYSERDA, 17 Columbia Circle, Albany, New York 12203-6399; toll-free 1-866-NYSERDA, locally (518) 862-1090, ext. 3250; or on the web at www.nyserda.org

COURSE MONOMEDIA FOR WASTEWATER TREATMENT PLANTS
FINAL REPORT

Prepared for the

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

Albany, NY
www.nyserda.org

Greg Lampman
Project Manager

Prepared by:

CRA INFRASTRUCTURE & ENGINEERING, INC.
Buffalo, New York

Vincent Rizzo, P.E.
Project Manager

NYSERDA Report 07-02 | NYSERDA 6988 | August 2006

NOTICE

TABLE OF CONTENTS

Figure Page

TABLES

Table Page

EXECUTIVE SUMMARY

The New York State Energy Research and Development Authority (NYSERDA), in cooperation with CRA Infrastructure & Engineering, Inc. (CRA), conducted an outreach program for New York State's wastewater treatment facilities aimed at promoting and implementing coarse monomedia filtration (CMF) technology. CMF is a method of filtration that was developed specifically for wastewater and uses a deep bed of large, round uniform size sand particles to remove solids from a liquid. Replacing conventional fine media with coarse monomedia in existing tertiary filters has reduced operational and maintenance costs in some installations. Coarse Monomedia (CM) may also have potential for treating primary effluent at the treatment plant (SSO) and at remote CSO sites. Therefore, the study was expanded to include the promotion and implementation of CMF as a wet weather treatment technology.

This outreach program was conceived based on the success of tertiary replacement installations in the Western New York area. Prior to this program, CMF had been installed and was successfully operating in the Town of Tonawanda and the Niagara County Sewer District WWTPs. It was also in the process of being installed at the Erie County Southtowns Sewage Treatment Plant (SSTP).

The CMF Outreach Program was divided into seven (7) tasks to facilitate the identification of candidate facilities, distribute information on the technology and study its benefits as an alternate to existing technology. A summary of the project tasks is as follows:

Task 1 – Treatment Plant Profiling and Selection

A list of all WWTPs in New York State employing tertiary treatment was compiled from data obtained from the New York State Department of Environmental Conservation (NYSDEC). One hundred thirty-seven WWTPs were identified. The plants were divided into NYSDEC Regions and sorted by size. Twenty-six WWTPs were selected as the most likely candidates for CMF based on location, size, and potential impact of the technology.

Task 2 – Technology Transfer and Promotional Materials

CRA, in conjunction with NYSERDA, developed an informational brochure to summarize the environmental benefits and potential energy savings associated with CMF. The brochure was mailed to the treatment plants identified in the previous task. The 26 plants identified as the best candidates for conversion also received a more detailed brochure and a letter offering an in-plant presentation. This letter was followed up two weeks later by a phone call.

Task 3 – Public Interest Organization Outreach

Various environmental, regulatory, and public interest organizations were contacted to make them aware of the benefits of CMF; five presentations were given to interest organizations. The SUNY at Buffalo, NYSDEC, Friends of the Buffalo Niagara River, Great Lakes United, and the Coast Guard participated. All organizations expressed an interest in the technology and the outcome of the program.

Task 4 – Coarse Monomedia Filtration Presentations at Priority WWTPs

Of the 26 WWTPs that were offered presentations, only five plants accepted the offer, Amherst SD #16, Lewiston WPCC, Rotterdam STP, Chautauqua WWTP, and Westfield WWTP. An additional, non-tertiary plant, the City of Geneva WWTP, was also given a presentation because of the potential benefit of CMF for wet weather remediation.

Task 5 – Preliminary Feasibility Studies

Of the six WWTPs that were given CMF presentations, five accepted the offer for a feasibility study.

The Town of Amherst operates the largest water pollution control facility equipped with tertiary treatment in New York State. The facility is a pure oxygen-activated sludge treatment plant that provides preliminary, primary, and secondary treatment, as well as tertiary filtration. Plant effluent is disinfected with sodium hypochlorite, and dechlorinated prior to discharge into Tonawanda Creek. In 1996, the plant's capacity was increased to an average daily flow of 36 MGD, maximum monthly flow of 48-MGD and 60-MGD peak capacity. Wet weather Stage 1 treatment is required to treat a sustained flow of 72 MGD, while Stage 2 must treat 60 MGD.

Amherst's tertiary process consists of six (6) traveling bridge filters (TBFs) manufactured by Infilco Degremont, Inc. (IDI), that were constructed as part of the original plant. TBFs differ from typical fine sand media filters in that TBFs contain shallow compartmentalized filter cells that are backwashed individually. The existing TBFs were rebuilt in 1983 due to their inability to meet design peak treatment capacity of 10 MGD per filter. Over the past 20 years the filters have never been able to sustain treatment for much more than 40 MGD, requiring process bypass during significant wet weather events.

For the purpose of this study, the installation of a new CMF system in the solids contact basin was compared with rehabilitating the existing TBFs. The evaluation was based on the current permitted capacity and wet weather flow (36 MGD and 60 MGD, respectively), as well as the peak plant capacity of 72 MGD. Consideration was also given to compatibility with future peripheral process modifications (e.g., change from chemical to ultraviolet disinfection). Both the TBF and CMF alternatives carry multi-million-dollar capital construction costs of similar magnitude $5,900,000 and $7,100,000, respectively.

The TBF system represents a lower initial capital investment than the CMF process. However, a Net Present Worth evaluation indicates the 30-year cost of CMF ($8,255,517) is about 9% lower than TBF ($9,056,231). The energy costs associated with operation are virtually offset by the energy savings associated with the new energy efficient building and heating equipment. Likewise, the higher capital cost can quickly be recovered with the higher maintenance costs associated with the TBF system.

The ability of the filter to perform effectively under all conditions has a significant impact on future modifications downstream. The plant's ability to convert the current chlorine disinfection system to UV in the future is heavily dependent on the ability of the filtration system to provide acceptable influent. The CMF process removes TSS more effectively and is also able to deal with upsets in flow and peak flow better than the TBF system. Therefore, the slightly higher capital investment of CMF will quickly outpace the maintenance and operations issues of TBF.

The Village of Westfield Water Pollution Control Facility has a rated average day capacity of 2.6-MGD, and a peak capacity of 6.5-MGD. The Facility was built in the early 1970s. The Facility was designed to provide primary and secondary treatment through a two-stage extended aeration system, followed by tertiary filtration. The disinfection system was upgraded to UV in the 1980s. The tertiary treatment process consisted of six (6) fine media sand filters that were constructed as part of the original facility. Filter clogging, due to the nature of the wastewater, caused the Village to take them offline for repair. Although the intention was to return them to service once they were functional, it was determined that permitted effluent goals could be achieved without tertiary treatment, therefore, the filters were kept offline.

For the purpose of the study, two options were identified as feasible for reinstating filtration, repair of the existing filters, and constructing new CMF upstream of the existing units. Currently, the Facility routinely experiences effluent levels of suspended solids that are greater than the permitted level. This condition will only be exacerbated by the Village's plan to route water plant filter backwash to the Water Pollution Control Facility. Evaluation of the efficiency of both processes found the CMF process outperformed the fine media filters by better than 100% (approximately 5 mg/L versus 10 mg/L) under both normal and peak conditions. When the processes were reviewed under peak loading, it is found that the fine media filter can sustain acceptable effluent quality for a short period of time. The ramifications of extended peak loading on the fine media process is possible permit violations, both on suspended solids and/or disinfection. Less obvious implications are filters that become blinded (will not effectively backwash and must be rebuilt); the maintenance and operations manpower required to enable the filters to successfully emerge from extended loading without the need for rebuild, and finally; the cost to the Village in capital as well as manpower in the event of a permit violation. Therefore, it is believed that although the order of magnitude capital cost of CMF ($3,300,000) is higher than rebuilding the existing filters ($1,000,000), long term the operational and maintenance issues will outweigh this disadvantage.

The Town of Lewiston's (Town) Water Pollution Control Center (WPCC) was put into operation in 1978 and was designed to provide primary, secondary, and tertiary treatment for up to 2.75 million gallons per day (MGD) average day. Any flow in excess of the 6-MGD peak day treatment capacity is sent to the Overflow Retention Facility (ORF), where it is held until it can be fed back to the head of the plant for treatment. Once the capacity of the ORF is exceeded, however, the excess is chlorinated and discharged directly to the Niagara River. The original filters proved to be very problematic and expensive to operate and during a filter repair outage, the Town discovered that they could meet their permit requirements without the filters, and as a result, they were removed from service and never brought back online.

For the purpose of this study the following Alternatives were developed as options for the Town to mitigate excursions in effluent quality through tertiary treatment; (1) install CMF in the existing filter building, (2) install CMF in the existing chlorine contact tanks to treat all flow up to 6 MGD, (2A) install CMF in the existing chlorine contact tanks to treat a portion of the flow. An important factor in the evaluation of Alternatives is the annual cost of operation and maintenance of the equipment. Alternatives 1, 2, and 2A all have similar O&M costs, ranging from $31,000 to $36,000 per year, with most of this cost due to the labor required to operate the equipment.

Maintaining the current operational ideology with no filters is clearly the most cost advantageous Alternative. However, should conditions change even slightly, the Town may face increased violations and fines, as well as a negative impact on the environment and other Facility operations. Of the remaining Alternatives, Alternatives 1 and 2A require comparable investments ($1,863,000 and $2,015,000 respectively). Though the energy use for Alternative 1 is higher than 2A, the capital cost is less. When annualized over 30 years, the results are similar. Alternative 2A only treats partial flow and some of the same arguments against maintaining the status quò apply here as well. It was, therefore, recommended to the Town that Alternative 1 be implemented.

The Town of Rotterdam (Town), New York Wastewater Treatment Plant (Plant) provides primary, secondary, and tertiary treatment and is rated for 1.25 million gallons per day (MGD). The filter is a Traveling Bridge Filter manufactured by Infilco Degremont, Inc (IDI), similar to the filters in

Amherst . Throughout the past four years, the Town has been encountering problems with their filter underdrain and the filter is frequently removed from service for extended periods of time for repair.

Two options for the restoration of filtration at the Plant were evaluated for this report; replace the existing traveling bridge filter with CMF, and rehabilitate the existing traveling bridge filter. CMF technology is generally considered an energy efficient means of providing tertiary treatment. However, for this project, implementing CMF at the Rotterdam Plant is not the most feasible option, under the current Plant configuration, effluent consistently complies with the discharge permit, with or without tertiary treatment. Therefore, regulatory compliance is not a driving force for switching to a new form of tertiary treatment. Based on this and the cost of rehabilitating the existing system versus installing CMF ($40,400 and $1,469,000 respectively). Not to mention the annual energy cost of implementing CMF ($8,500) is more than 16 times greater than the annual energy cost associated with the existing filters ($540). It was recommended the Village rehabilitate the existing TBF system.

The City of Geneva WWTP consists of two separate sites, Gulvin Park and Marsh Creek. The Gulvin Park plant was built in 1934. In 1974, the treatment process was expanded with the construction of the Marsh Creek plant (rated at 4 MGD), that provides biological treatment consisting of primary clarification, fine bubble aeration, and secondary clarification. At that time the Gulivin site was modified to provide influent pumping and screening as well as disinfection prior to discharge. In times of wet weather, the plant can experience flows as high as 14.5 MGD. The City is interested in exploring options to mitigate or eliminate the strain on the biological processes that is created by wet weather events.

The proposed arrangement would locate the CMF process in parallel with the biological process to minimize the impact of the intermittent spikes in flow associated with wet weather. With this approach, flow entering the Gulvin Park site would pass through the screen and be pumped as usual. Flow in excess of the biological treatment capacities would be diverted to CMF. Upon completion of the filtration process, the flow would be routed to the existing chlorine contact basins where it would recombine with the biologically treated flow.

Based on the data obtained in the study, it appears that the CMF process can offer a cost effective (estimated capital cost of $3,600,000) means of treating excess wet weather flow. Based on past performance, as well as the findings of this report, it is clear the filters should be capable of removing TSS to levels within the permit requirements of the plant. However, in order to properly evaluate the effectiveness of CMF for removing BOD, it must be pilot tested. Pilot testing will provide information on the ability of the process to remove BOD, as well as provide actual data on the characterization of the influent to the filter.

Task 6 – Final Report

This final report summarizes the results of the program.

Task 7 – Metrics

Follow-up with the WWTPs that accepted studies are to be conducted to determine if CMF was implemented and, if so, gauge its success.

The findings of this study confirm that the CMF process is a cost effective, efficient alternative to the fine media process that has historically been used in the wastewater treatment process. In a new installation or a facility with existing deep bed filters, these benefits, combined with energy efficiency and reduced backwash flow, make CMF the alternative of choice. This study revealed, however, that facilities that currently operate shallow bed fine filters may not reap the intrinsic benefits of CMF, due primarily to the significant costs associated with modification of facilities in the implementation of the process.

Section 1

PROJECT DESCRIPTION

The New York State Energy Research and Development Authority (NYSERDA), in cooperation with CRA Infrastructure & Engineering, Inc. (CRA), conducted an outreach program aimed at promoting and implementing coarse monomedia filtration (CMF) technology to New York State's wastewater treatment facilities. CMF is a method of filtration that uses a deep bed of large, round uniform size sand particles to remove solids from a liquid. Because of its media characteristics, CMF can potentially capture more solids, run longer between backwashes, and use less backwash water than conventional fine media filtration. As a result, replacing conventional fine media with coarse monomedia in existing tertiary filters may reduce operational and maintenance costs including electrical usage.

This Project was conceived based on the success of tertiary replacement installations in the Western New York area. Prior to this program, CMF had been installed and was successfully operating in the Town of Tonawanda and the Niagara County Sewer District WWTPs. It was also in the process of being installed at the Erie County Southtowns Sewage Treatment Plant (SSTP). Both the Tonawanda and Southtowns projects were done in cooperation with NYSERDA.

The objective of the Tonawanda Demonstration Project was to evaluate the technical, environmental and economic impacts of the conversion to CMF. The Tonawanda WWTP had 16 existing filter cells with a combined original wet weather design capacity of 40 MGD. Filter clogging during wet weather events caused frequent backwashing and restricted capacity to less than 26 MGD.

The use of CMF has resulted in a more than four-fold increase in time between required backwashing making the filters more available during wet weather events. In addition, the Tonawanda WWTP can now process more than 60 MGD to full treatment.

Quantified CMF benefits include a reduction in required backwash water flow rates, resulting in the downsizing of backwash pumps from 125 HP to 50 HP. This, combined with a reduced frequency of backwashing, has decreased process electrical consumption by 79% (444,600 kWh/yr). The reduction in backwash water volumes has also drastically reduced the amount of applied disinfectant by 80%, collectively saving over $49,000 per year at the Tonawanda facility.

Shortly after the Tonawanda Demonstration Project proved successful, the Niagara County Sewer District converted their filters to CMF. They achieved similar results.

The Erie County SSTP recently completed the conversion of their 16 existing fine media filters to CMF. It was found that the facility would have excess filter capacity due to the nature of CMF after the conversion. CRA, in conjunction with NYSERDA, developed a demonstration project to install a pipe from the discharge of the Overflow Retention Facility (ORF) to the head of the filters so that any excess wastewater may receive as much treatment as possible prior to discharge. The effectiveness of CMF at processing primary treated wastewater is currently under evaluation.

Although this program was originally intended to promote CMF as an energy-efficient alternative to conventional fine media tertiary filtration, recent successes in other parts of the country with the use of CMF in the treatment of excess wet weather flow stimulated interest in exploring this potential.

One of the challenges facing publicly and privately operated wastewater treatment systems is compliance with regulations governing combined sewer overflow (CSO) and sanitary sewer overflow (SSO) treatment. Both the United States Environmental Protection Agency and the New York State Department of Environmental Conservation policy initiatives have pushed these compliance issues to the forefront. Most systems in New York State have begun identifying and quantifying CSOs/SSOs. Decisions on cost effective treatment technologies will have major impacts on most sewered communities in the State.

Coarse Monomedia (CM) may have potential for treating primary effluent both as excess wet weather flow at the treatment plant and at remote CSO/SSO sites. Coarse Monomedia has the potential to aid in compliance with NYSDEC's best management practices for CSO/SSOs in a cost-effective manner. Therefore, the study was expanded to include the promotion and implementation of CMF as a wet weather treatment technology.

The CMF Outreach Program was divided into seven (7) tasks to facilitate the identification of candidate facilities, distribute information on the technology and study the benefits of the technology as an alternate to existing technology. Each task had specific goals associated with it. The following is a description of each task.

Task 1 – Treatment Plant Profiling and Selection

A list of all treatment plants in New York State who could benefit from this technology was developed. The list was prioritized according to which plants would make the best candidates and had the largest potential benefits.

Task 2 – Technology Transfer and Promotional Materials

CRA, in conjunction with NYSERDA, created various types of promotional material targeted at informing the industry about the CMF technology. These materials included slide show presentations for both wastewater treatment plant personnel and public service organizations, as well as an informational flyer. The informational flyer was mailed to the priority treatment plants identified in the previous task.

Task 3 – Public Interest Organization Outreach

In addition to WWTPs, various environmental, regulatory, and public interest organizations were contacted and offered presentations. Presentations were to be given to a minimum of 7 of these organizations to inform them of the energy and environmental benefits of CMF.

Task 4 – Coarse Monomedia Filtration Presentations at Priority WWTPs

Based on the response to the mailings, presentations were given at interested WWTPs across the State. These presentations were based on the materials developed during Task 2, and were meant to inform the WWTP personnel about the benefits of CMF and the potential savings.

Task 5 – Preliminary Feasibility Studies

Preliminary feasibility studies were to be offered to the WWTPs that showed interest after the presentation. These studies examined issues such as plant hydraulics, wastewater quality, location, and existing energy and O&M costs to establish both an estimated cost to convert to CMF and the potential savings by doing so.

Task 6 – Final Report

After the completion of the preceding outreach tasks, this final report was to be written, summarizing the results of the program. It will review the interest shown in the technology as well as the findings of the preliminary feasibility studies.

Task 7 – Metrics

This final task is intended as a future follow up to determine if CMF was implemented and if so gauge its success. CRA is to conduct follow up surveys with each of the facilities and attempt to obtain plant process, energy, and O&M data as well as the cost to make the conversion. These surveys are to be done at both 2-year and 5-year intervals following the completion of the project.

Section 2

BACKGROUND

OVERVIEW OF TECHNOLOGY

CMF deviates from conventional fine media filtration in a number of ways. Conventional filtration uses a single type or combination of fine media, such as sand or anthracite, with particle sizes 0.8 mm and smaller. The filters generally have 24 to 48 inches of media, as well as an additional 12 inches to 24 inches of support gravel and an underdrain system. Water flows into the top of the filter at rates of 5 gpm/ft^2 or less, and down through the media where solids become trapped. The clean water passes out the bottom of the filter and is collected. With fine media filtration of wastewater, the majority of solids captured occurs on the surface and in the top few inches of the media because the size of the solids is often greater than the size of the voids between the particles.

CMF, however, features a single, deep layer (generally 60 inches or more) of large, rounded sand particles (2.3 mm to 3.0 mm diameter) with 14 inches of support gravel and an underdrain system. Because of the larger particle size and larger void spaces, filtration occurs at higher rates, typically 7.0 gpm/ft^2 to 9.0 gpm/ft^2. During a filtration cycle, solids attach to sand particles in the upper portion of the filter where void spaces exist and media surfaces are exposed. As solids continue to build up, pore spaces become restricted and local velocities increase to drive solids deeper into the filter bed. The large size and round shape of the sand maximizes void space between particles. One of the distinct advantages of CMF is that filters can accommodate the capture of large volumes of solids within the media voids, as compared to conventional fine-media processes.

Periodically, all filters must be backwashed to remove the collected solids and allow for further filtration. With conventional fine media filtration, this is done by introducing a flow of clean water in the reverse direction. To release the trapped solids, the filter bed must be fluidized, requiring a backwash rate of around 20 gpm/ft^2. The solids are picked up by the backwash water and carried over the top of the filter. Because the bed is fluidized, some media will be carried over with the backwash water as well.

CM filters are backwashed with a combination of air and water, followed by a water rinse. The round shape of the sand promotes rolling of the particles during backwashing, which aids in the release of solids. Due to the increased void space in the filter and the rolling action of the media particles, filter bed expansion is not required for the CMF backwash cycle. The required rate for backwash water is therefore much less, typically around 7.0 gpm/ft^2. This also means that there is no potential for media loss, nor need for periodic replenishment of media.

Backwash air is introduced via a distribution system installed under the rows of air/water distribution blocks in the bottom of the filter. The blocks are equipped with large ports formed into the sides at the highest point. As the air passes upward through the supporting layers of gravel, it is dispersed uniformly over the entire filter bottom in a pattern of coarse bubbles. Since nozzles are not used, potential maintenance problems associated with plugging are eliminated. Air and water are introduced simultaneously. The turbulence created by the air bubbles provides the needed scouring action, and the upward water flow carries the loosened solids to the surface where they are removed in overflow troughs. Upon completion of air/water backwash, the filter is rinsed with water only to transport remaining solids out, and to dislodge entrapped air.

In addition, the round shape allows particles to rub against each other without breaking down. The large sand size, which results in high bed porosity and permeability, minimizes the potential for surface plugging or blinding, as well as providing for an increase in the volume of solids captured. This leads to significantly longer filter run times between backwashes.

Section 3

OUTREACH

TREATMENT PLANT PROFILING AND SELECTION

A list of all WWTPs in New York State employing tertiary treatment was compiled from data obtained from the New York State Department of Environmental Conservation (NYSDEC). WWTPs on Long Island and in the five boroughs of New York City (NYSDEC Regions 1 and 2) were not considered for this program. Plants on Long Island and in New York City receive their power from the Long Island Power Authority and the New York Power authority, respectively. Neither of these are eligible for NYSERDA funding. 137 WWTPs were identified. The plants were divided into NYSDEC Regions and sorted by size. This list can be found in Appendix A.

Twenty-six of these WWTPs were selected as potential candidates for CMF based on location, size, and potential impact of the technology. At least one plant from each NYSDEC region was selected. This list can be found in Appendix B.

TECHNOLOGY TRANSFER AND PROMOTIONAL MATERIALS

An informational brochure was developed to summarize the environmental benefits and potential energy savings associated with CMF. This brochure was developed by NYSERDA and CRA and mailed to each of the plants recognized as tertiary treatment plants. A copy of the brochure can be found in Appendix C.

Each of the 26 targeted plants also received a more detailed brochure (again developed by NYSERDA and CRA) and a letter offering an in-plant presentation. This letter was followed up two weeks later by phone call.

OUTREACH

Of the 26 WWTPs that were originally offered presentations, only five plants accepted the offer, Amherst SD #16, Lewiston WPCC, Rotterdam STP, Chautauqua WWTP, and Westfield WWTP. An additional, non-tertiary plant, the City of Geneva WWTP, was also given a presentation because of the lack of interest by tertiary plants and the potential benefit of CMF on Geneva's wet weather problems.

Generally, the chief operator and other plant personnel attended these presentations.

During the presentations, the CMF technology and the past successes outlined in the mailings were presented in greater detail.

In addition to the presentations at WWTPs, five presentations were given to public interest organizations to make them aware of the benefits of CMF. The SUNY at Buffalo, NYSDEC, Friends of the Buffalo Niagara River, Great Lakes United, and the Coast Guard participated. All organizations expressed an interest in the technology and the outcome of the program.

Section 4

PRELIMINARY FEASIBILITY STUDIES

Of the six WWTPs that were given CMF presentations, five accepted the offer for a feasibility study. A summary of each of those studies is presented here. The full reports may be obtained from NYSERDA (Ref 1-5).

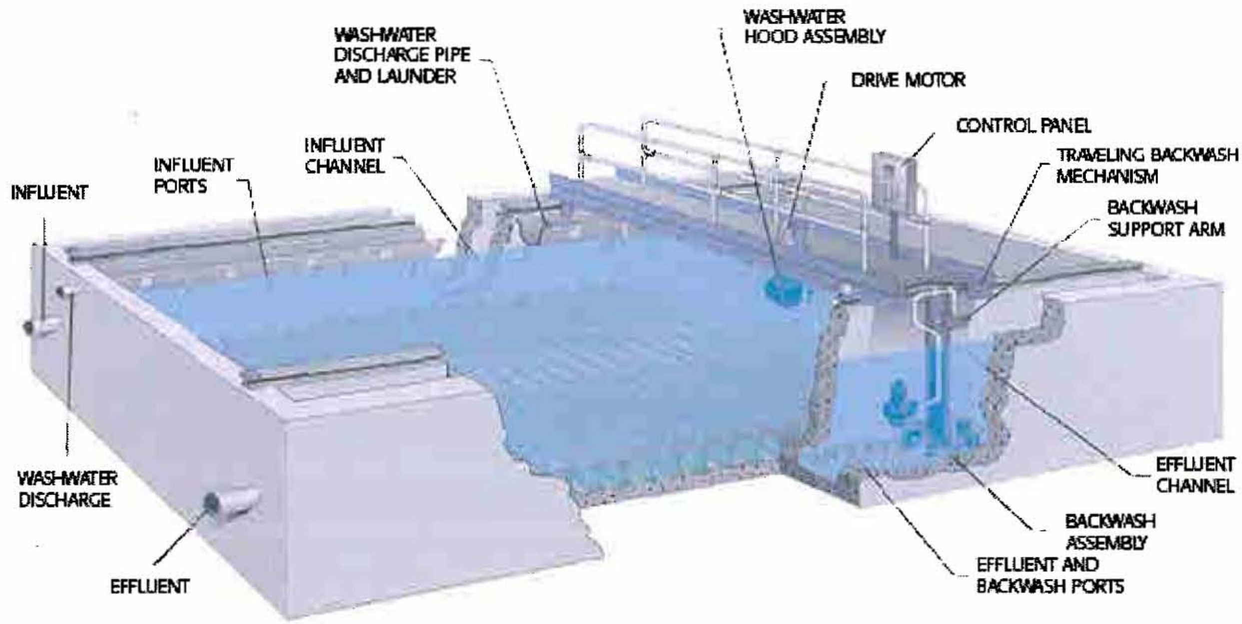
THE TOWN OF AMHERST

The Town of Amherst owns and operates Water Pollution Control Facility (Plant No.16), located at 455 Tonawanda Creek Road, Amherst, New York. The facility is the largest water pollution control facility equipped with tertiary treatment in New York State. The plant processes wastewater from the Towns of Amherst and Clarence and the Village of Williamsville. The facility is a pure oxygen-activated sludge treatment plant built in the late 1970s and early 1980s. It provides preliminary, primary, and secondary treatment, as well as tertiary filtration. Plant effluent is disinfected with sodium hypochlorite, and dechlorinated prior to discharge into Tonawanda Creek.

Plant No. 16 was commissioned in 1982 with a rated capacity of 24-MGD average daily flow, and 60-MGD peak capacity. The facility's SPDES permit was modified in 1996, and the plant's rated capacity was increased to an average daily flow of 36 MGD, and a maximum monthly flow of 48 MGD. The Town's current wet weather operation plan defines that Stage 1 treatment must be capable of a sustained peak flow of 72 MGD, while Stage 2 must be capable of a sustained peak flow of 60 MGD.

Plant No. 16's tertiary treatment filtration process consists of six (6) traveling bridge filters (TBFs) manufactured by Infilco Degremont, Inc. (IDI), that were constructed as part of the original plant. TBFs differs from typical fine sand media filters in that TBFs contain compartmentalized filter cells that are backwashed individually. As shown on Figure 4-1, the backwash mechanism is suspended from a motor driven carriage which seals off a compartment. It then draws clean water from the effluent channel and pushes it up through the underdrain and media, expanding the bed by approximately 10%. This releases the collected solids, which are captured by a hood in the backwash mechanism and pumped to the washwater channel.

Figure 4-1 – Typical Traveling Bridge Filter



IDI rebuilt the existing TBFs in 1983 because the original installation failed to meet their design peak treatment capacity of 10 MGD per filter, or 60 MGD total. The reconstructed filters also failed to treat 60 MGD. Over the past 20 years the filters have never been able to sustain treatment for much more than 40 MGD, requiring process bypass during significant wet weather events. All of the filters are backwashed continuously on a 24-hour per day basis throughout the year.

A review of plant operating records indicates that, during the 22-month period from February 2001 to November 2002, the facility logged 61 days with an average daily flow that exceeded 40 MGD. For 13 of these days, total flow exceeded 60 MGD. There were also 13 instances when the duration of the spike in flow lasted for two or more days. Peak instantaneous flows for the days with average flows over 40 MGD were in the range of 60 to 100 MGD.

Based on an analysis of historical flows at the facility, coupled with planned modifications to effluent disinfection processes at the Plant, the following significant considerations are relevant to the analysis of the tertiary filters. The design basis for this analysis of options for tertiary filtration should be a sustainable treatment capacity of 72 MGD to match the capacity of Stage 1 treatment and eliminate the possibility for a bypass. In addition, the Town is planning to convert the disinfection process to ultraviolet radiation (UV) in an effort to eliminate the need to store and handle the disinfection chemicals. It is important to achieve the highest quality of filter effluent possible for an increased effectiveness and decreased cost for UV disinfection.

Site Evaluation and Selection

The Plant No.16 facility was reviewed for locations suitable for a CMF process. Due to process flow considerations, site evaluation was confined to locations downstream of the Intermediate Pump Station. The existing Filter Building (Structure 9) and the recarbonation tanks, located upstream of the existing filters, were both evaluated as potential locations for installing CMF. Both were eliminated, however, because preliminary investigations showed that neither foundation could support the weight of the CMF process without substantial reinforcement. Further, hydraulic and capacity concerns made these choices not feasible.

The existing but unused Solids Contact Basins proved a more suitable location for CMF. Since these tanks currently lie within the original process flow path, flow re-routing would again be relatively easy and inexpensive. Preliminary analysis of the load-bearing capacity of the foundations of the Solids Contact Basins determined that their capacity has the capability of supporting the CMF process. A preliminary process layout revealed that if two (2) basins were used, each could accommodate 4 filters and the existing influent and effluent channels could be reused. A preliminary review of process hydraulics revealed that the Intermediate Pump Station would have to be upgraded to increase the pump discharge head by approximately 2 feet in order to achieve sufficient driving head for the CMF process. It is assumed that since the pumps will have to be rebuilt or replaced to meet the 72-MGD flow requirement, the additional discharge head will be addressed during their redesign.

Filtration Process Comparison and Evaluation

For this study, installing a new CMF system in the solids contact basin was compared with rehabilitating the existing TBFs. A manufacturer of CMF, Severn Trent Services (STS) assisted in developing the CMF preliminary engineering, including preliminary equipment sizing, estimated backwash frequency, process equipment costs, and other pertinent information. TBF data, including a report prepared by Parsons Engineering (Parsons), were provided by Amherst.

The quote received by Parsons from IDI was for equipment that is capable of treating an average daily flow of 25 MGD and a maximum daily flow of 60 MGD. For comparison purposes, this data was extrapolated to an average daily flow of 32 MGD and a maximum daily flow of 72 MGD. Table 4-1 below summarizes system information for each manufacturer:

Table 4-1 – TBF versus CMF - Physical System Comparison

System Information	Units	Traveling Bridge Extrapolation	Proposed CMF
System Capacity	MGD	32 Avg, 72 Max	36 Avg, 72 Max
Average Filter Flow	Gpm/ft^2	2	3
Max Filter Flow	Gpm/ft^2	4	6
Approx. Filter Size	Each	113' x 16'	88' x 12'
Approx. Filter Area	Each, ft^2	1,810	1,050
Number of Filters	Each	8	8
Filter System Area	ft^2	14,500	8,400

Backwash and Recycle Flows

Projected backwash flow data has been provided by both the TBF and CMF system manufacturers. The process design parameters for CMF, and the quotation and data provided by STS, are based on an applied influent quality of 20 mg/L TSS, and 5 mg/L TSS effluent quality, yielding 75% TSS removal. The quote provided by the TBF manufacturer is based on the same influent quality of 20 mg/L TSS, but 10 mg/L effluent quality, or 50% TSS removal.

Data provided by the TBF manufacturer indicates that their process, under peak flow conditions, uses approximately 24,000 gal/day/MG treated, based upon approximately 14 hours per day of backwash operation per filter. This compares to CMFs backwash volume requirement of approximately 27,000 gal/day/MG treated.

However, experience with the existing Amherst TBFs, indicates that the TBF filters have been unable to accommodate extended durations of operation at peak capacity. Currently, during periods of high flow, the filters must be continuously backwashed. Under this scenario, the TBF process would use approximately 39,000 gal/day/MG treated, or nearly 50% more flow than the CMF process. This equates to 2.8 MGD of plant capacity being utilized for TBF recycle flows during peak flow events when treatment capacity is critical. By comparison, the CMF process backwash volume is 1.9 MGD at full capacity. This translates to a 'gain' in available plant capacity during peak events of approximately 1 MGD when comparing CMFs to TBFs.

Operations and Maintenance Evaluation

The CMF system is simple to install, maintain, and operate. The installation is simply an underdrain system with support gravel and media laid over it. The potential for complications and deficiencies during construction is minimal due to the simplicity of design. The system has one set of backwash equipment with installed spares; therefore, the quantity of equipment to be maintained is minimized, and repairs can be conducted without concern for loss in capacity. Centralized control system and equipment expedite troubleshooting. An evaluation of maintenance tasks and their associated costs was conducted for each filter and the system. The analysis was done using the assumption that periodic maintenance (PM) is done, which will prolong the life of the equipment, as well as allow the use of standard vendor data on repair frequencies and costs. The CMF system PM generally consists of weekly/monthly lubrication and annual oil testing on the submersible pumps. The annual PM cost for the system was calculated to be approximately $3,500, not including lubricants. As mentioned in Section 2.0, CMF media is designed to prevent degradation due to abrasion during backwash; therefore, the need to top off the media is virtually eliminated. The media is expected to have a usable life of at least 20 years. Based on discussions with vendors, it was found that most of the equipment required rebuild (bearing and wear part replacement) every 5 years. The equipment can be rebuilt approximately 3 times (which translates to a 15-year usable life), at which time the equipment requires replacement. These numbers, however, are based on the equipment operating 24 hours a day, 7 days a week. Since the equipment utilization is approximately 12%, these durations can be extended. It was assumed a more realistic rebuild period is 7 years, and the life of the equipment will be 30 years. Based on this data, the cost of equipment rebuild will be $30,000 every 7 years, and the cost of equipment replacement will be $135,500 every 30 years (all prices in 2003 dollars). The replacement costs associated with the media is $900,000.

By comparison, TBFs require attention to detail and a good understanding of the workings of the system to perform installation, maintenance, and operations at an acceptable level. This is complicated by the need to dedicate the same attention to eight (8) filters in order to ensure reliable system operation. Due to the fact the filter is segmented to accommodate backwash, the installation process requires the installation of approximately 169 cells, which must be sealed to ensure proper operation. The installation of media is much the same as the CMF units; however, it is finer and there is less of it. The traveling bridge and associated equipment is an area where installation and maintenance are both extremely critical to operation. Since alignment of all moving parts and mating surfaces is critical to the operation of the filter, the rail system and bridge require significant attention to detail during installation and scheduled maintenance to ensure proper operation. As an example, if the rails, bridge, or backwash shoe are misaligned, backwash water will not be conveyed to the effluent port, and the filter will not backwash properly. The use of independent controls for each filter also multiplies the amount of equipment as well as complicates trouble shooting and system upgrades (i.e. changes in PLC logic). Similar to the CMF system, an evaluation of maintenance tasks and their associated costs was conducted for each filter and the system. The analysis was done using the assumption that periodic maintenance (PM) is done, which will prolong the life of the equipment as well as allow the use of standard vendor data on repair frequencies and costs. The TBF system PM generally consists of weekly/monthly lubrication, annual oil testing on the submersible pumps, and annual media top off. The annual PM cost for the system was calculated to be approximately $57,000, not including lubricants. Again, based on discussions with vendors, it was found that most of the equipment required rebuild (bearing and wear part replacement) every 5 years. The equipment can be rebuilt approximately 2-3 times, which translates to a 10-15 year usable life at which time the equipment requires replacement. These numbers, however, are based on the equipment operating 24 hours a day, 7 days a week. Since the equipment utilization is approximately 9%, these durations can be extended, and it was assumed a more realistic rebuild period is 7 years, and an equipment life of 30 years. The media is expected to have a usable life of at least 20 years. Based on this data, the cost of rebuild will be $182,400 every 7 years, and the cost of replacement will be $676,800 every 15-30 years (all prices in 2003 dollars). The PM and replacement costs associated with the media are $45,600 and $203,200, respectively.

Energy Evaluation

The primary consumption of energy associated with filtration is the operation of backwash equipment. The following is a summary of the mechanical/electrical components of each technology:

CMF Process Equipment
One (1) 50-HP backwash pump (plus 1 on-line standby)
Two (2) 125-HP backwash blowers (plus 1 on-line standby)
One (1) 10-HP mudwell pump (plus 1 on-line standby)
One (1) 5-HP air compressor (plus 1 on-line standby)

TBF Process Equipment
Sixteen (16) 3-HP backwash pumps (no on-line standby)
Eight (8) .75-HP bridge drives (no on-line standby)

The eight (8) proposed TBFs backwash 3 times each on an average day and 14 times each on a peak day. Backwash of the eight (8) filters consumes 42.3 kWh per occurrence (or 40.3kw x 1.05 hours). Since the backwash is initiated on level, the energy usage was calculated for the year 2002 and then averaged; therefore, the average monthly system usage was 85.4 KWh/day. However, if the eight (8) TBFs require constant backwashing (as is done currently), the consumption of electricity will be 967 kWh/day (or 40.3 kWh x 24 hrs.).

In comparison, each CMF will consume approximately114 kWh per backwash occurrence (or 235 kW x 0.483 hr./backwash). Since the CMF system runs on a cycle, the system can simply be analyzed on a daily basis. The filters will consume 687 kWh on an average day. Likewise, if the peak flow is analyzed, the CMF process will consume 1,089.6 kWh (or 113.5 kWh per occurrence x 1.2 /day/filter x 8 filters).

Placing the CMF process in the Solids Contact Basins requires the construction of a new building, which would be constructed to current energy efficiency standards. The building housing the existing filters was built nearly 25 years ago, before many of today's energy efficient technologies were required by code. The existing building lacks significant insulation, and is heated with hot water unit heaters. Considering the buildings are approximately the same square footage, preliminary building envelope analysis reveals heat loss would be approximately 325,000 BTU/hr less with the new building when compared to the existing

Filter Building. A degree-day analysis was performed using the preliminary envelope heat loss data, which resulted in an annual energy savings of approximately $12,000. Heat loss to filter surface should also be significantly reduced due to a reduction in surface area by approximately 40%. These numbers do not include the inherent inefficiencies of the existing heating system, and are very conservative considering a hot water system efficiency (i.e. pumping and piping loses) of 80% compared to an indirect fired natural gas furnace efficiency of +90%.

Capital Construction Cost Estimate

The Parsons report estimated the cost of rebuilding the existing TB filters at $3,303,000. This cost is to return the existing filters to their original capacity of 24 MGD average, and 60 MGD peak flow. Parsons has further estimated that the cost of constructing two (2) additional filters that would be necessary to achieve recommended flow capacity is $2,603,000, resulting in a total estimated cost of refurbishing and adding capacity to the existing TBF system of $5,906,000. The estimated cost associated with the installation of the CMF filtration, including a new building, is $7,100,000.

Conclusions and Recommendations

As discussed above, strong consideration must be given to the selection of a filtration process that can reliably treat the current permitted capacity and wet weather flow (36 MGD and 60 MGD respectively), as well as the peak plant capacity of 72 MGD. Consideration must also be given to compatibility with future peripheral process modifications (e.g., change from chemical to ultraviolet effluent disinfection). Both the TBF and CMF alternatives carry multi-million-dollar capital construction costs of similar magnitude. However, the processes are very different, therefore, they have different advantages and disadvantages. Table 4-2 summarizes these issues.

Table 4-2 – Filter System Summary

PARAMETER	TRAVELING BRIDGE FILTERS	COARSE MONOMEDIA FILTERS
Estimated Capital Cost	$5,900,000	$7,100,000
Number of Filter in System	8	8
System Capacity		
Average Day	32 MGD	36 MGD
Peak Day	72 MGD	72 MGD
Design TSS Removal Efficiency	50% (20 to 10 mg/L)	75% (20 to 5 mg/L)
Maximum Duration of Sustained Peak Flow	Not defined	Continuous
Backwash and Recycle Flows		
• Average Day		
Backwashes/Day/Filter	3	0.8
GPD / MG Treated	12,000	30,500
Daily Recycle Flow	0.37 MG	0.97 MG
• Peak Day[1]		
Backwashes/Day/Filter	22.9	1.64
GPD / MG Treated	39,000	27,000
Daily Recycle Flow	2.8 MG	1.9 MG

Maintenance Costs (30 year life) • Equipment o Periodic (NPW) o Repairs (NPW) o Replacement (NPW) • Media o Periodic (NPW) o Replacement (NPW)	 $1,083,286 $420,835 $244,234 $874,608 $112,512	 $67,130 $60,351 $55,826 N/A $498,330
Process Energy Consumption • Average Day • Peak Day • Annual[2] • Annual Cost[3] Building Heating Energy4 • Annual Cost	 85.4 kWh 967 kWh 61,603 kWh $4,620 207,248 BTU/hr $17,317	 687kWh 1,090 kWh 261,425 kWh $19,607 134,927 BTU/hr $5,100
System NPW[5]	$9,056,231	$8,255,517

[1] Peak day data for the TBF is based on the assumption that the filter will require continuous backwash to meet specified performance rather than the 14 backwashes a day at peak flow as quoted.
[2] Energy consumption is based on the assumption that the filters will experience 325 average days and 35 peak days.
[3] Energy costs are assumed to be 7.5 cents/kWh.
[4] Building Heating Energy loss's based on peak heating day, i.e. ASHRAE 97.5% and indoor temperature of 65°F.
[5] Total NPW includes annual Energy Operating Cost, but does not include annual Labor Operating Costs.

The TBF system represents a lower initial capital investment than the CMF process. However, a Net Present Worth evaluation indicates the 30-year cost of CMF is about 9% lower than TBF. The energy costs associated with the operation of electric motors are virtually offset by the energy savings associated with the new energy efficient building and heating equipment. Likewise, the higher capital cost can quickly be recovered with the higher maintenance costs associated with the TBF system.

The ability of the filter to perform effectively under all conditions has a significant impact on future modifications downstream. The plant's ability to convert the current chlorine disinfection system to UV in the future is heavily dependent on the ability of the filtration system to provide acceptable influent. The CMF process removes TSS more effectively as shown in Table 4-2. The CMF system is also able to deal with upsets in flow and peak flow better than the TBF system.

Additionally, the CMF process is capable of processing peak flow on a continuous basis, whereas the TBF system can only process the peak flow for short durations. This is apparent when the frequency of backwash is reviewed. The CMF filters can run approximately 3.5 times as long between backwashs, which indicates the ability to perform at a higher solids loading. This provides flexibility during peak loading because the backwash frequency can be increased to accommodate longer runtime. The TBFs, on the other hand, will go into a continuous backwash cycle if the loading exceeds its capability, and the filter will essentially never be cleaned (this is the current situation).

Operator attention can impact system operability and, therefore, overall cost. The quantity and complexity of equipment is vastly different for the two systems. The TBF system is very operator intensive in that there are many pieces of equipment and various alignment points that must be monitored for the system to operate effectively. It can be seen with the existing system that attention to detail is critical for the operation of the system. This issue manifested itself in construction and has been a problem ever since. Likewise, if the installation is done without deficiencies, the maintenance and operation then becomes susceptible to the same constraints of attention to detail. Therefore, if the system is not monitored and kept in good working order, the performance and capacity will suffer which will lead to excessive operator attention and maintenance involvement. The CMF system, on the other hand, minimizes the amount and complexity of the equipment which yields a more operator friendly system.

Biofouling is also eliminated with the CMF system, which eliminates the need to monitor for fouling and perform disinfection. This issue impacts both operator/maintenance involvement as well as chemical storage and handling systems.

Although the CMF represents a slightly higher capital investment, it is clear that that disadvantage is quickly overcome by maintenance and operations issues. It was, therefore, recommended that the most reliable, cost-effective filtration system for the long-term operation of the plant is Coarse Monomedia Filtration.

THE VILLAGE OF WESTFIELD

The Village of Westfield owns and operates a Water Pollution Control Facility located at Old Hawley Street, Westfield, New York. The Facility processes wastewater from municipal and industrial sources, and has a rated 2.6-MGD average day capacity, and 6.5-MGD peak capacity. Approximately 25% of the flow and 75-80% of the BOD loading is industrial wastewater (mostly from local grape processors). The balance is domestic wastewater from approximately 1,400 customers. The Facility was built in the early 1970s. The Facility was designed to provide primary and secondary treatment through a two-stage extended aeration system, followed by tertiary filtration.

The Facility does not currently utilize their tertiary treatment. Previously, the tertiary treatment process consisted of six sand filters that were constructed as part of the original facility. However, the Facility experienced significant problems with filter clogging, due to the nature of the wastewater. Fine plastics created during comminution were removed from the waste stream by the filters and later became trapped in the filters during backwash. The filters were taken offline for repair, with the intention of returning them to service once they were functional. To prevent a reoccurrence of this problem, a screen was installed at the influent to the filters. Meanwhile, it was determined that permitted effluent goals could be achieved without tertiary treatment. So, the filters were kept offline.

A review of monthly reports to the DEC indicates that, at times during the 12-month period from January 2003 to December 2003, the plant effluent did not meet permit requirements for suspended solids. In six of 12 months, the effluent suspended solids values were greater than the permitted 15% of the influent values. In five of those six months, the effluent suspended solids concentration exceeded the permitted maximum of 30 mg/L. In one of those six months, the effluent suspended solids exceeded the permitted maximum of 650 lbs./day.

There is concern that the current situation will be exacerbated by the Village's plan to discharge the Water Treatment Plant's filter backwash to the Water Pollution Control Facility. It is likely that the intermittent spikes of suspended solids generated from this new source, coupled with the already borderline treatment levels for suspended solids, will further reduce the effectiveness of treatment. This may also lead to a reduction in the ability of the ultraviolet system to disinfect the wastewater due to increased suspended solids in the effluent.

Tertiary Filtration at Westfield

The Westfield Water Pollution Control Facility was investigated for suitable filtration options and locations where the process may be sited. The four options identified included repairing the existing filters, retrofitting the existing filters with CMF, building new CMF filters in the location of the existing filters or constructing filters upstream of the existing units.

Retrofitting the existing filters with CMF and building new CMF filters in the location of the existing filters were both eliminated as feasible options. The existing filter beds did not appear to have the depth required for CMF. Demolishing the existing filter cells in place in order to install new CMF filters would have been cost prohibitive.

Installing coarse monomedia filters at a new location on the site was the preferable option for CMF. The filter size could be optimized, rather than being limited by the available space presented in the previous options. The design could also provide for future expansion if population growth occurs. The mudwell and chlorine contact tanks presently on site are of a size sufficient to be utilized as a clearwell and mudwell and would remain in place for the new CMF design. A building would be constructed to house the new filters. This building would require installation of electrical service and an HVAC system. New piping would have to be installed to connect the new filters to the treatment train.

Refurbishing the existing filters was looked at as a point of comparison and possibly a cost-effective solution. Although the original manufacturer no longer exists, this product is supported by US Filter, who purchased the technology. They were, therefore, consulted to determine what was required to return the units to service, and if this was done, what removal efficiency and capacity could be expected.

CMF Process Implementation

The proposed filters would receive flow that has undergone both primary and secondary treatment. Upon completion of the CMF treatment, the flow would be disinfected via ultra-violet radiation and then discharged into Chautauqua Creek. Currently, secondary treatment effluent enters the filter mix box and is diverted through the wall to the UV disinfection unit. Since the UV disinfection process works optimally with cleaner influent, the tertiary treatment would take place prior to UV disinfection.

A new concrete CMF system would be constructed in the area between the control building and the clarifiers. A pre-engineered building would be built to house the filters. The building would be provided with active lighting and energy-efficient heating and ventilating systems. The proposed filter building would abut the control building to facilitate direct access between the two. This positioning would also be the most conservative for piping and electrical connections. The existing steel filters could remain in place. The existing pumps and piping in the pump room associated with the old filter system would be demolished. The existing pump room would house the new pumps, blowers, and piping associated with the CMF system.

Effluent from the clarifiers would be diverted through the chamber to the coarse monomedia filters for tertiary treatment. Liquid effluent from the filters would then travel to the existing filter mix box and follow the existing path to the UV building for disinfection. Post disinfection, effluent from the UV building, would enter the control building for storage in the clearwell. Finally, the finished liquid is then released into Chautauqua Creek.

Periodically, the filters will require backwash. Filter effluent stored in the clearwell would be piped to the proposed filter building and tied into the effluent pipes for each filter. Filter backwash water would be piped back to the existing mudwell through the backwash lines. A precast box tunnel would connect the control building and the proposed filter building to provide space for a pipe.

The existing control building currently has a loading dock on the west side, proximal to the proposed filter building. To maintain accessibility, the dock may be extended through the proposed filter building, or the building may be positioned to end just north of the area, to avoid any spatial conflicts.

Filtration Process Evaluation

STS was contacted to assist in developing preliminary process concepts, and to supply information regarding the recommended size and number of filters required, etc. They were also consulted as part of this study to provide preliminary data on ancillary equipment sizing, estimated backwash frequency, process equipment costs, and other related process information.

STS proposal was based on design parameters projected from existing plant data (reported monthly for the year 2003), anticipated loadings to the plant, and future treatment goals. Table 4-3, below, indicates the basis for design. According to calculations done by the manufacturer, the CMF effluent will have a TSS of approximately 3-5 mg/L.

Table 4-3 – Wastewater Design Parameters

	Units	Typical	Peak
CMF Flow	MGD	2.6	6.5
Plant Influent TSS	mg/L	144	300
Filter Influent TSS	mg/L	33	80
Effluent TSS	mg/L	<5	<5

Table 4-4, below, summarizes system information for the preferred option.

Table 4-4 – CMF - Physical System Parameters

System Information	Units	New Filter
System Capacity	MGD	2.6 Average
Average Filter Flow	Gpm/ft^2	1.4
Max Filter Flow	Gpm/ft^2	3.5
Approx. Filter Size	Each	11'-4" x 19'-0"
Approx. Filter Area	Each, ft^2	215.3
Number of Filters	Each	6
Filter System Area	ft^2	1292

The backwash operation requires that each CMF filter is backwashed in its entirety. One filter will be backwashed at a time. The system uses one (1) backwash pump, one (1) backwash air blower, and one (1) mudwell pump (redundant standby pumps and blower are also provided). The filters are designed to backwash on a timed cycle; therefore, the equipment operation time is consistent. The backwash of each filter requires the equipment to operate for 30 minutes per cycle. Each backwash utilizes approximately 26,000 gallons of liquid. The existing chlorine contact tank, which will supply backwash liquid, has a capacity of over 90,000 gallons. The cycle is approximately 45 hours between backwashes under average flow conditions. Each filter is backwashed on average, 16 times a month (approximately 8 hours). Table 4-5 summarizes the backwash parameters for the CMF system. Upon completion of the backwash cycle, dirty backwash liquid would be stored in the facility's mudwell before eventual recycle to the head of the plant for re-treatment.

Table 4-5 – CMF Backwash Parameters

Parameter	Average Day	Peak Day
Backwash Flowrate (gpm/ft^2)	6.0	6.0
Percent of Plant Forward Flow Used for Backwash	3%	9%
Backwashes/Day/Filter	0.533	3.731
Backwash GPD (Filter System)	83,000	578,000

CMF Operations and Maintenance Evaluation

An evaluation of maintenance tasks and their associated costs was conducted using the same ideology as the previous study. The annual PM cost for the system was calculated to be approximately $2,400, not including lubricants. The media is estimated to have a usable life of at least 30 years. A replacement/ rebuild analysis was conducted using the same ideology as in the previous study. With all six (6) filters in service, the backwash equipment will operate approximately 48 hours per month. It was assumed a realistic rebuild period would be 10 years, and the life of the equipment would be 30 years. Based on this data, the cost of equipment rebuild will be $61,000, the cost of equipment replacement will be $171,000 and media replacement will be $220,000. Refer to Table 4-6 for the maintenance costs associated with the CMF system based on a 30-year estimated life (prices are in 2004 dollars).

Table 4-6 – Maintenance Costs Over a 30-Year Estimated Life

Item	Periodic Maintenance	Repair	Replacement
Equipment	$2,400	$61,000	$171,000
Media	N/A	N/A	$220,000

CMF Energy Evaluation

The primary consumption of energy associated with the preferred option is from operation of backwash equipment, building HVAC costs, and lighting. The following is a summary of the mechanical/electrical components of the preferred alternative:

CMF Process Equipment

One (1) 15-HP backwash pump (plus 1 on-line standby)

One (1) 75-HP backwash blower (plus 1 on-line standby)

One (1) 3-HP mudwell pump (plus 1 on-line standby)

Each filter will consume approximately 35 kWh per backwash occurrence (70 kW x 0.500 hr./backwash). Since the CMF system runs on a cycle, the system can simply be analyzed on a weekly basis. On an average day basis, six filters will consume 784 kWh per week (111 kWh per day). Likewise, if the peak flow is analyzed, the CMF process will consume 5485 kWh per week (784 kWh per day). Based on historical flows, it is unlikely that a sustained peak flow will occur. To be conservative, however, it was assumed that there would be 50 average-day weeks and 2 peak-day weeks per year. Based on this assumption, the projected equipment energy requirement is 50,170 kWh per year.

Constructing the new CMFs at an alternate location will require the construction of a new building, which would be constructed to current energy efficiency standards. There will be energy costs associated with the building's HVAC system and lighting. Due to the low cost of electricity in the Village, all appliances are operated with electricity. Based on an interior design temperature of 65°F and an exterior design temperature of 9°F, the projected heating requirement for the new building is 73,000 kWh per year. Based on an assumed 8 hours of lighting per day, with 150W high pressure sodium lamps, the projected lighting for the new building is 8,760 kWh per year.

The combined projected energy use is 132,370 kWh per year. Using the purchase rate of $0.035/kWh for electricity currently charged to the Water Pollution Control Facility, the plant would have an estimated yearly energy cost of $4,640.

Table 4-7 quantifies the projected energy use associated with the proposed CMF system.

Table 4-7 – Projected Energy Consumption

	Average Day kWh	Peak Day kWh
Process Equipment	111	784
Building Heating Energy	200	200
Lighting[1]	24	24
Annual Consumption [2]	132,370	
Annual Energy Costs	$4,640	

[1]Assumption: twenty 150W high-pressure sodium luminaires, in use for 8 hrs/day.
[2]Assumption: 350 average days and 15 peak days per year.

__CMF Capital Construction Cost Estimate__

The estimated costs associated with the installation of a new CMF system include: site clearing and restoration, construction of a new building to house the filters and equipment, and the demolition of old piping and pumps. New piping must be installed to convey filter effluent to the UV disinfection tank, backwash supply liquid to the filters from the clearwell, and backwash waste liquid to the mudwell. Additional piping is required for air headers. Electrical and HVAC systems must be installed in the new building.

The estimate for the Coarse Monomedia Filters, pumps, and blowers was taken from the concept-level proposal received from the manufacturer. Not included in that estimate are costs for piping, concrete, electrical starters, spare parts, and other such ancillary equipment. As proposed, the filters will be housed in a 50x60 foot pre-engineered steel building. The associated blowers and pumps will be housed in the original filter building's pump room. As part of the support matrix for the filters, 30-foot piles at 7-foot spacing will be installed. The balance of the filter building will be a concrete slab, supported by foundation piers. Because the proposed filters are housed in a different location than the pumps, blowers, clearwell, and mudwell, a pipe tunnel or trench will have to be constructed between the buildings for routing piping and conduit. This would be constructed of prefabricated concrete box sections. The estimated capital cost for this project is $3,330,000 (in 2004 dollars).

Comparison With Existing Filters

The Facility's existing filters are shallow bed, fine sand, Hydro-Clear Filters, as manufactured by US Filter. As previously mentioned, the Facility no longer uses the filters because of problems with plastics. It is possible, however, that the filters be rehabilitated and placed back into service. A representative of US Filter was contacted to obtain information about the operation of these filters in order to compare them to CMF.

The Hydro-Clear filters were examined under the same influent design conditions as the CMF analysis. According to US Filter, with this quality influent, the Hydro-Clear Filters are only able to reduce the TSS to 10 mg/L. Table 4-8, below, summarizes the design parameters.

Table 4-8 - Wastewater Design Parameters for Hydro-Clear Filters

	Units	Typical Flow	Peak Flow
Filter Flow	MGD	2.6	6.5
Plant Influent TSS	mg/L	144	300
Filter Influent TSS	mg/L	33	80
Effluent TSS	mg/L	~10	~10*

*According to US Filter, the Hydro-Clear Filters are able to handle upset conditions for a number of hours. Should these conditions last longer, the effluent TSS would increase.

Table 4-9, below, summarizes the system information for the Hydro-Clear filters, as provided by US Filter.

Table 4-9 - Physical System Parameters

	Units	Hydro-Clear Filters
System Capacity	MGD	2.6 (Avg) 6.5 (Max)
Average Filter Flow	gpm/ ft^2	1.4
Maximum Filter Flow	gpm/ ft^2	3.6
Approximate Filter Size	Each	11' 9" x 18' 0"
Approximate Filter Area	Each, ft^2	211.5
Number of Filters	Each	6
Filter System Area	ft^2	1269

The Hydro-Clear Filters must be periodically "pulsed" to dislodge the particles trapped on the surface of the media. The pulse lasts for 20 seconds and uses backwash water to push trapped atmospheric air up, through the filters to regenerate the media. In addition, the filters utilize low pressure, diffused air bubbles to agitate the wastewater and lift floc particles off of the media surface to reduce filter blinding.

Once the pulses are no longer able to sufficiently clean the filters, a backwash is initiated. According to US Filter, under the conditions found at the Facility, a backwash will be required after every 6 pulses and each Hydro-Clear filter cell would be backwashed two times per day. Each backwash lasts for 3.5 minutes and uses 12 gpm/ft^2 of water. Table 4-10, below, summarizes the backwash requirements.

Table 4-10 Hydro-Clear Filter Backwash Parameters

Parameter	Average Day	Maximum Day
Pulses Per Day	12	72
Backwash Flowrate, gpm/ft^2	12.0	12.0
Percent of Plant Forward Flow used for Backwash	5%	12%
Backwashes/Day/Filter	2	12
Backwash GPD (Filter System)*	130,320	781,900

* Includes drain down at the completion of the backwash.

US Filter provided operations and maintenance data. Because the bed does expand during the backwash process, media loss is expected. US Filters expects approximately 55 cubic feet of media to be lost per year at a cost of $743 to replace it. Approximately 610 gallons of Grease Clean chemicals will be needed per year at a cost of $3,050. Additionally, it is expected that 610 gallons of a 12.5% sodium hypochlorite solution, or other disinfectant will be used to mitigate biofouling. US Filter anticipates approximately 375 man-hours per year to operate the filters and perform the maintenance.

Since the Hydro-Clear Filters are in an existing building, the energy usage for the building would be approximately the same as is currently used. It is recommended, however, new lighting be installed to replace the existing system. According to US Filter, the Hydro-Clear Filters have the energy requirements shown in Table 4-11. This results in approximately $4,299.6 for energy per year to operate the Hydro-Clear Filters.

Table 4-11 – Hydro-Clear Energy Usage

	Average (kWh/day)	Peak Day (kWh/day)
Chemical tank pumps		
Backwash water pumping	20.50	123
Spent backwash water pumping	30.00	180
Pulse-Mix	13.00	78
Air-Mix	29.50	177
Valve actuation	0.36	2.16
Total Estimated Process Energy Usage	93.39	560.16
Heat (est.)	200 kWh/day	
Lighting (est. assumes 8-hours/day)	24 kWh/day	
Annual Consumption	122,846 kWh	

Before these filters could be placed back into service, however, extensive repairs would be required. It is estimated the following work will need to be done to provide efficient, reliable operation into the future:

The steel tanks will need to be rehabilitated.

The existing pumps will need to be rebuilt or replaced.

The existing valves will need to be replaced.

The filters underdrain and media will need to be reinstalled.

The new blowers and air piping will need to be installed.

New chemical handling equipment will need to be installed

Conclusions and Recommendations

Currently, the Facility routinely experiences effluent levels of suspended solids that are greater than the permitted level. This condition will only be exacerbated by the Village's plan to route water plant filter backwash to the Water Pollution Control Facility. It is important that the Village take steps to reinstate tertiary treatment. A summary of the key parameters of the two filter systems is presented below in Table 4-12.

Table 4-12 – Parameter Summary Table

	CMF Average Day (Peak Day)	Fine Media Average Day (Peak Day)
Effluent quality	5 mg/L (5 mg/L)	10 mg/L (10 mg/L)*
Backwash Vol (GPD)	83,000 (578,000)	130,320 (781,900)
Backwash % of Plant Flow	3% (9%)	5% (12%)
Process Energy Consumption	111 kWh/day (784 kWh/day)	93.39 kWh/day (560.16 kWh/day)
Order of Magnitude Capital Cost	$3,300,000	$1,000,000

*Short duration run time

Given these parameters, the fine media filter appears to be the most economically feasible option to implement at the Village. However, the evaluation of the efficiency of both processes found the CMF process outperformed the fine media filters by better than 100% (approximately 5 mg/L versus 10 mg/L) under both normal and peak conditions. Under normal loading this would not likely be an issue as the effluent quality is still below the permit level of 30 mg/L. These levels will also provide the ability to effectively disinfect the effluent. Ten States Standards recommends suspended solids of no greater than 30 mg/L are required to achieve effective disinfection. Conservatively speaking, levels greater than 15 to 20 mg/L will impair UV disinfection and potentially result in inadequate effluent. When the processes were reviewed under peak loading, however, it is found that the fine media filter can sustain acceptable effluent quality for a short period of time. In fact, the manufacturer will not project the quality of the effluent if peak loading is sustained for more than a few hours. The ramifications of extended peak loading on the fine media process is therefore the possibility of permit violation both on suspended solids and/or disinfection. The less obvious implications are; filters that become blinded, (will not effectively backwash and must be rebuilt); the maintenance and operations manpower required to enable the filters to successfully emerge from extended loading without the need for rebuild, and finally; the cost to the Village in capital as well as manpower in the event of a permit violation. It was, therefore, recommended that the Village pursue the development of the CMF process for their facility.

THE TOWN OF LEWISTON

The Town of Lewiston (Town), New York owns and operates a Water Pollution Control Center (WPCC) that services approximately 19,000 customers. The WPCC was put into operation in 1978 and was designed to provide primary, secondary, and tertiary treatment for up to 2.75 million gallons per day (MGD) average day. However, the filters proved to be very problematic and expensive to operate. Much like in the Village of Westfield, during a filter repair outage, the Town discovered that they could meet their permit requirements without the filters, and as a result, they were removed from service and never brought back online.

Currently, flow enters the Facility and is pumped to two aerated grit chambers. It is then driven by gravity to the mix tanks, and proceeds into primary clarification, followed by aeration. The aerated wastewater is processed through secondary clarification and disinfection before discharging to the Lower Niagara River. Any flow in excess of the 6-MGD peak day treatment capacity is sent to the Overflow Retention Facility (ORF), where it is held until it is able to be fed back to the head of the plant for treatment. Once the capacity of the ORF is exceeded, however, the excess is chlorinated and discharged directly to the Niagara River.

Though the Facility's discharge is permitted on a number of parameters, only the total suspended solids (TSS) were considered for this study, since the filters are not likely to significantly affect other parameters.

The permit allows for a 30-day arithmetic mean of 30 mg/L or 688 lbs/day. In addition, the seven (7) day arithmetic mean may not exceed 45 mg/L or 1032 lbs/day. There has been only one instance in the three years examined that the Town exceeded the 7-day arithmetic mean levels. However, at times of elevated flow, the daily weight limit is approached, and the Town is interested in investigating CMF as a way to mitigate these events.

Based on the Plant's layout and hydraulics, the following Alternatives were developed as options for the Town to mitigate excursions in effluent quality.

1. Implement CMF in the existing filter building – CMF would be located in the same area as the original conventional sand filters, however, because of the lack of available head, pumping is required.

2. Implement CMF in the existing chlorine contact tanks to treat all flow up to 6 MGD. This places filtration in the existing chlorine contact tanks as a way to avoid pumping. However, additional filtration tanks and a clearwell/chlorine contact tank would have to be built in this Alternative in order to process the entire 6 MGD.

2A. Implement CMF in the existing chlorine contact tanks to treat a portion of the flow – This is a variation on Alternative 2. Again, filtration is placed in the existing chlorine contact tanks, however, it is sized to treat only a portion of the flow to reduce construction and maintenance costs. A new clearwell/chlorine contact tanks would still need to be built.

3. Rehabilitate the existing filters – This Alternative was investigated minimally as the Town is not interested in this Alternative because of the operations and maintenance troubles they had with the filters when they were in service.

4. Maintain Current Operations – The Town rarely exceeds their permit, therefore, action is not required. However, this leaves the Town with a process that operates close to its limits, which can be labor intensive and troublesome.

STS was again contacted to assist in the development of the preliminary process concepts and to supply the information about the Coarse Monomedia Filters used in the study. Their recommendations are included in the evaluation.

CMF in the Town of Lewiston

The existing filter building provides a logical fit for the potential CMF installation, both because it currently has ample available space and it is located in a convenient place within the treatment process.

The original filters were pressure filters, which required the influent to be pumped. Without filter influent pumps, there would only be approximately 2 feet of head for CMF, which is inadequate for filtration. As a result, to implement Alternative 1, pumping will be required.

In an effort to avoid the need to pump, the existing chlorine contact tanks were considered for filtration in Alternatives 2 and 2A. Preliminary hydraulic analysis indicated that with modifications to the secondary clarifier and the existing chlorine contact tank weirs, approximately five (5) feet of head would be available for CMF. The area available in the existing chlorine contact tank is not sufficient to filter the entire flow. For Alternative 2, additional filter space would be installed next to the tanks to allow for filtration of all flow. Alternative 2A limits the filter area to that available in the tanks. As much flow as possible would be filtered, and any additional flow bypassed around the filters to be blended at the effluent.

For Alternative 1, with optimal head available, STS recommends a nominal filter loading of 7 gpm/ft^2 and a peak loading of 10 gpm/ ft^2. With the limited head available in Alternatives 2 and 2A, a filter loading rate of no more than 3 gpm/ft^2 is required, even with one filter out of service. These loading rates dictate the system parameters. Table 4-13, below summarized the system information for these three Alternatives.

Table 4-13 – System Parameters

	Units	Alternative 1	Alternative 2	Alternative 2A
Design System Flow Rate	MGD	Average daily: 2.3 Peak hourly: 6.0	Average daily: 2.3 Peak hourly: 6.0	Average daily: 2.3 Peak hourly: 4.0
Filter Size	Each	9'0" x 14' 0"	12'8" x 14' 6"	12'8" x 14' 6"
Filter Area	Each, ft^2	126.0	183.7	183.7
Number of Filters	--	5	9	6
Filter System Area	ft^2	630.0	1,653	1,102
Filter Flow – all filters in service	Gpm/ft^2	Average: 2.5 Maximum: 6.6	Average: 1.0 Maximum: 2.5	Average: 1.4 Maximum: 2.5
Filter Flow – one filter out of service	Gpm/ft^2	Average: 3.2 Maximum: 8.3	Average: 1.1 Maximum: 2.8	Average: 1.7 Maximum: 3.0

The backwash operation requires that each CMF filter is backwashed in its entirety. One filter will be backwashed at a time. The system uses one (1) backwash pump, one (1) backwash air blower, and one (1) mudwell pump (redundant standby pumps and blower are also provided). The filters are designed to backwash on a timed cycle; therefore, the equipment operation time is consistent. The backwash of each filter requires the equipment to operate for approximately 23 minutes per cycle. (Two (2) minutes of air only and 21 minutes of air and water.) Table 4-14, below, outlines the backwash information for the Alternative.

Table 4-14 – Backwash Parameters

		Alternative 1		Alternative 2		Alternative 2A	
	Units	Average Day	Maximum Day	Average Day	Maximum Day	Average Day	Maximum Day
Filter Area	Ft^2	126.0	126.0	183.7	183.7	183.7	183.7
Backwash Rate	Gpm/ft^2	5.0	5.0	5.0	5.0	5.0	5.0
Volume/Filter Cell	Gal	13,230	13,230	19,290	19,290	19,290	19,290
Backwash Frequency	Days/filter	2.86	0.32	7.52	0.85	7.52	0.85
Backwashes/Day/ System	--	1.75	15.48	1.2	10.61	0.80	7.06
System Volume/Day	Gal	23,153	204,800	23,148	204,667	15,432	136,187
Percent of Plant Flow Used for Backwash	%	1.1	3.4	1.1	3.4	0.7	2.3

A reserve of filtered water is required for the backwashing process. In Alternative 1, the existing chlorine contact tanks provide ample water. The spent backwash water is returned to the head of the plant. A mudwell is generally employed to hold this water so that it can slowly be fed back to the head of the Facility. In this Alternative, a new mudwell would need to be constructed outside of the filter building with an approximate volume of 30,000 gallons. For Alternatives 2 and 2A, the existing filter tanks would be reused for the clearwell and the existing filter decant well would be converted for use as a mudwell.

Rehabilitate Existing Filters

The Facility was originally designed with a tertiary filtration system consisting of two Lyco 2F, mixed media pressure filters and three 25-HP influent pumps (one per filter plus one stand-by). Each filter is an above ground steel tank with three sections, and approximately 20 feet in diameter and 16.5 feet tall. The filters were designed to process the design average day flow of 2.75 MGD. However, due to hydraulic limitations, the actual capacity was limited to about 30-50% of the average daily flow. During wet weather, the filter influent quality decreased causing an increase in backwash frequency. In addition, the used backwash water could not be fed back to the head of the plant due to hydraulic limitations, and the filters were taken offline.

Not only did the filters prove to be able to handle less than anticipated hydraulically, but the mechanics proved problematic as well. The variable speed pump controllers on the filter feed pumps were unreliable and required an average of approximately $1,000 per month in parts for repair.

With two of the pumps operating 24 hours per day, the system consumed approximately 528 kWh/day. Due to all the problems encountered with the existing filters, the Town did not feel rebuilding them was economically feasible. The energy use of these filters can be compared with CMF, though, as a point of reference.

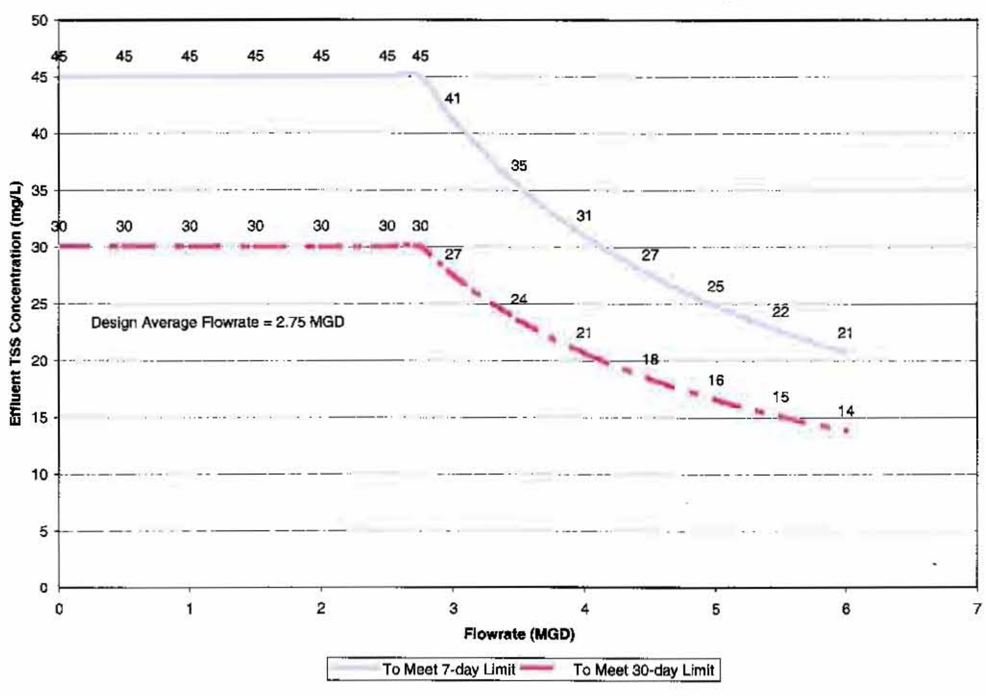
Maintain Existing Operations

Under Alternative 4, the Town would continue to operate the existing Facility without modification. Based on a review of the 2002 through 2004 discharge monitoring reports, only one TSS loadings excursion was reported. The non-compliance report indicated that even though the TSS concentration was within permitted levels, the loading exceeded permit limits due to a high flow rate. It is expected that if current operations continue without modifications, the Facility would exceed its permit at a frequency of about once every three (3) years.

As currently configured, the overall limiting factor in the Facility's ability to meet its permit limits is the concentration of contaminants in the effluent at elevated flow rates. Under these conditions, although process removal rates are on the order of 97-98%, the sheer volume of fluid processed leads to daily contaminants weights in excess of permit limits.

To minimize excursion potential, the Facility would need to carefully track effluent TSS concentrations when flows exceed the design average flow rate of 2.75 MGD. Figure 4-2 shows the maximum allowable TSS effluent concentration, such that the TSS loading is always compliant, assuming that the reported

FIGURE 4-2
MAXIMUM EFFLUENT TSS CONCENTRATION TO REMAIN COMPLIANT



loading is based on one sampling event.

For flows equal to or less than the design average flow of 2.75 MGD, the maximum allowable effluent TSS concentration that will enable the Facility to meet its weight limits is equal to the permitted effluent TSS concentration. For flows in excess of 2.75 MGD, the maximum allowable TSS concentration is reduced to the permitted loading divided by the flow rate. For example, when the treatment Facility is operating at its capacity of 6 MGD, the Facility risks exceeding its 7-day and 30-day loadings if TSS concentrations are equal to or greater than 21 mg/L and 14 mg/L, respectively. If the measured concentration exceeds the figure's values at the measured flow rate, additional sampling and analysis should be conducted.

Operations and Maintenance Evaluation

An evaluation of maintenance tasks and their associated costs was conducted for each CMF Alternative using the same ideology as the previous studies. The resulting annual PM costs for Alternative 1, Alternative 2, and Alternative 2A are $3,407, $2,483, and $2,404, respectively.

The rebuild/replacement cost of the systems were also analyzed with the same ideology used in the previous studies. Aside from the influent pumps required for Alternative 1, the equipment would operate between 12 and 26 hours per month. It was assumed the rebuild period would be 10 years, and the life of the equipment would be 30 years. Based on this data, the cost to rebuild the equipment over the expected lifetime for Alternative 1, Alternative 2, and Alternative 2A would be $66,000, $78,000 and $60,000, respectively.

Energy Evaluation

The primary consumption of energy associated with the various Alternatives is for operation of backwash equipment, building HVAC, and lighting. It is possible to eliminate the majority of the HVAC and lighting cost at the filters if the filters are left open. This is believed to be a feasible option, however, a detailed review of operations and maintenance must be conducted in order to minimize additional costs associated with added maintenance, due to exposure to inclement weather. The cost analysis has been conducted assuming a building has been built, however, the potential savings have been noted as well. The following is a summary of the mechanical/electrical components.

CMF process equipment varies slightly for the different Alternatives. Table 4-15, below summarized the process equipment and associated energy usage. The backwash equipment energy is based on average day usage and approximately 30 minutes of use per backwash cycle.

Table 4-15 – CMF Process Equipment

	Units	Alternative 1	Alternative 2	Alternative 2A
2 influent pumps (plus 1 on-line standby)	HP	10	N/A	N/A
1 backwash pump (plus 1 on-line standby)	HP	5	10	10
1 backwash blower (plus 1 on-line standby)	HP	25	40	40
1 mudwell pump (plus 1 on-line standby)	HP	1.5	2	2
Average System Backwashes/day	--	1.75	1.2	0.8
Energy for influent pumping/day	KWh	179.0	N/A	N/A
Energy for backwash equipment/day	KWh	20.5	23.3	15.5
Total process energy usage/day	KWh	199.5	23.3	15.5

Constructing the filters in the existing chlorine contact tanks has been estimated with the construction of a new building. These costs are noted so the potential savings of eliminating the building can be quantified. The building would be constructed to current energy efficiency standards. The energy costs associated with the building's HVAC system and lighting are shown below in Table 4-16. Heating requirements were determined based on an interior design temperature of 65°F and an exterior design temperature of 6°F. Lighting requirements were determined assuming 8 hours of lighting per day, with 150W high-pressure sodium lamps.

Table 4-16 – Building Energy Requirements

	Units	Alternative 2	Alternative 2A
Building Size	--	65' x 55'	55' x 40'
Natural Gas Requirements	ft^3/yr	78,500	58,500
Lighting Requirements	kWh/yr	8,500	4,250

Note: The heating and 75 % of the lighting costs can be eliminated if a building is not constructed.

Total energy usage and costs are summarized below in Table 4-17. The Town is currently paying approximately $0.12/kWh for electricity and $6.50/100 ft^3 for natural gas.

Table 4-17 – Energy Use and Cost Summary

	Units	Alternative 1	Alternative 2	Alternative 2A
Electricity Required	kWh/yr	72,820	17,000 (10,625)	9,900 (6,712.5)
Electricity Costs	$/yr	$8,738	$2,040 ($1,275)	$1,188 ($805.50)
Natural Gas Required*	ft3/yr	N/A	78,500 (0)	58,500 (0)
Natural Gas Costs*	$/yr	N/A	$5,103 ($0)	$3,803 ($0)
Total Energy Costs	$/yr	$8,738	$7,143 ($11,900)	$4,991 ($805.50)

Costs without building in ( ).

* Costs without building in ( ). It was assumed the energy usage in the existing building will be required whether the filters are installed or not.

CMF Capital Construction Cost Estimate

A preliminary order of magnitude cost estimate was developed for each of the different Alternatives. The estimated costs associated with the installation the CMF systems include: demolition and restoration, construction of a new building to house the filters and equipment for Alternative 2 and 2A, demolition of old piping and pumps where necessary, and installation of new piping. New influent pumps for Alternative 1, and electrical and HVAC systems for the new building in Alternatives 2 and 2A.

The cost estimates for the coarse monomedia filters, pumps, and blowers were taken from the concept-level proposal received from the manufacturer. Costs for piping, concrete, electrical starters, spare parts, and other such ancillary equipment were estimated. The estimated capital cost expenditure for the three Alternatives is shown below in Table 4-18.

Table 4-18 - CMF Capital Cost Estimate

	Alternative 1	Alternative 2	Alternative 2A
Estimated Capital Cost	$1,863,000	$2,886,000 ($2,685,000)	$1,994,000 ($1,853,000)

Cost without building in ( ).

Conclusions and Recommendations

An important factor in the evaluation of Alternatives is the annual cost of operation and maintenance of the equipment. Table 4-19, below summarizes the additional O&M cost for each of the Alternatives considered above and beyond the current O&M cost of the WPCC.

Table 4-19 - Annual O&M Comparison

	Alternative 1 CMF in Existing Filter Building	Alternative 2 CMF in Existing Chlorine Tank	Alternative 2A Partial CMF in Existing Chlorine Tank	Alternative 3 Rehabilitate Existing Filters	Alternative 4 Maintain Current Operation
Annual Preventative Maintenance	$3,407	$2,483	$2,404	$12,000	$0
Annualized Equipment Rebuild	$3,366	$3,978	$3,060	$4,000	$0
Annual Energy Costs	$8,738	$7,143	$4,991	$23,126	$0
Annual Operations Labor Costs	$20,800	$20,800	$20,800	$20,800	$0
Annual O&M Costs	$36,311	$34,404	$31,256	$59,926	$0

Alternatives 1, 2, and 2A all have similar O&M costs, ranging from $31,000 to $36,000 per year, with most of this cost due to the labor required to operate the equipment. Alternative 3 is about 85% more costly to operate and maintain than the CMF Alternatives, with most of this additional cost due to preventative maintenance and energy costs. Based on this, and considering the Town does not prefer this Alternative, it can be eliminated as a viable solution

A comparison of the total cost for each remaining Alternative and is presented in Table 4-20.

Table 4-20 - Total Annualized Cost

	Alternative 1 CMF in Existing Filter Building	Alternative 2 CMF in Existing Chlorine Tank	Alternative 2A Partial CMF in Existing Chlorine Tank	Alternative 4 Maintain Current Operation
Capital Cost	$1,863,000	$2,907,000	$2,015,000	$0
Peak Flow Receiving Tertiary Treatment	100%	100%	66%	0%
Annualized* Capital Cost	$95,013	$148,257	$102,756	$0
Annual O&M Costs	$36,311	$34,404	$31,256	$0
Total Annualized Costs	$127,448	$182,661	$134,012	$0
Cost per Customer	$7	$10	$7	$0

* Using a net present worth analysis over 30 years with three (3) % inflation per year.

Alternative 4 is clearly the most cost advantageous Alternative. However, should conditions change even slightly, the Town may face increased violations and fines, as well as a negative impact on the environment and other Facility operations. Of the remaining Alternatives, Alternatives 1 and 2A require comparable investments. Though the energy use for Alternative 1 is higher than 2A, the capital cost is less. When annualized over 30 years, the results are similar. Alternative 2A only treats partial flow and some of the same arguments against Alternative 4 apply here as well. It was, therefore, recommended to the Town that Alternative 1 be implemented.

THE TOWN OF ROTTERDAM

The Town of Rotterdam (Town), New York owns and operates a Wastewater Treatment Plant (Plant) located on West Campbell Road. The Plant provides primary, secondary, and tertiary treatment and is rated for 1.25 million gallons per day (MGD). Throughout the past four years, the Town has been encountering problems with their filter and frequently the filter has been removed for extended periods of time for repair. The Town, therefore, requested a feasibility study to examine replacing the TBF with coarse monomedia filters at the Plant to provide more reliable tertiary treatment.

The Rotterdam Plant accepts and treats wastewater from approximately 2,100 customers consisting of a mix of residential, commercial and industrial sources. Monthly discharge monitoring reports for the period from January 2004 through August 2005 were reviewed. In general, the wastewater can be characterized as weak to medium strength with total suspended solids (TSS) and biochemical oxygen demand (BOD) averaging 140 mg/L and 190 mg/L, respectively. Although the Plant is designed for 1.25 MGD, flow currently averages around 1 MGD. The wastewater quality and quantity are expected to remain relatively constant throughout the next few years as the general mix of residential, commercial and industrial customers are not projected to change significantly.

Flow currently enters the Plant and passes through the grit chamber and comminutor before entering the primary settling tank. After primary treatment, the flow is conveyed to one of two trickling filters. At this point, the flow is pumped from the intermediate pumping station into four rotating biological contactors (RBCs). The flow then undergoes secondary clarification, followed by tertiary treatment through a fine sand media filter, and finally UV disinfection. The treated flow is discharged to the Mohawk River.

The filter is a Traveling Bridge Filter manufactured by Infilco Degremont, Inc (IDI), much like the filters in Amherst (see Figure 4-1). The plant has been encountering problems with the filter, particularly the underdrain system. Leakage of media into the effluent channel began with the original porous plate underdrain. An attempt was made to rectify this issue by replacing the porous plate with a perforated PVC pipe. In 2002, the perforated pipe was replaced with a slotted PVC pipe based on the theory that the media was being carried through the holes in the PVC pipe. The problems continued, however, and the Plant personnel now believe the media leakage is due to problems with the seals around the pipe at the effluent ports.

The Plant's discharge is permitted on a number of parameters, however, only TSS were considered for this study, since the filters are not likely to significantly affect other parameters. The permit allows for a 30-day arithmetic mean discharge level of 30 mg/L or 313 lbs/day. The 7-day arithmetic mean discharge level may not exceed 45 mg/L or 470 lbs/day. In addition, the Plant must average 85% influent TSS removal over the 30-day period. The Plant has consistently complied with these permit requirements, even with the filters out of service. However, when the filters are out of service, the percentage removal is, at times, only slightly greater than 85%. Therefore, the Town is interested in investigating CMF as a way to enhance the Plant's performance to a more comfortable level. In addition, the Town's permit specifies filtration. Should the Town wish to abandon the process permanently, they would be required to obtain a permit modification. This is beyond the scope of this report and therefore, maintaining existing operations, i.e. operating without any filtration, was not considered an option for this report.

Two options for the restoration of filtration at the Plant were evaluated for this report. They are as follows:
Replace the existing traveling bridge filter with CMF,
Rehabilitate the existing traveling bridge filter.

<u>Replace with CMF</u>

STS was again contacted to assist in the development of the preliminary process concepts, and to supply the information about the coarse monomedia filters used in the study. Their recommendations are included in this report. The design parameters given to STS are shown below in Table 4-21.

Table 4-21 – Filtration Design Parameters

	Units	Average	Maximum
Plant Flow[1]	MGD	1.25[3]	3.1[4]
Plant Influent TSS[1]	mg/L	140	394
Filter Influent TSS[1]	mg/L	20	30
Target Filter Effluent TSS[2]	mg/L	<5	<5

[1] Based on existing conditions obtained from the Towns SPDES reports
[2] Based on level typically achieved by the existing TBF
[3] Average Plant Flow = Design Flow
[4] Maximum Plant Flow = Peak Hour = Average Day x 2.4

To implement CMF into an existing facility, a deep filter bed and sufficient head above that filter bed must be available. For Rotterdam, STS recommended a filter depth of 6 feet with a minimum of 5 feet of head above that. The existing system was designed to operate with a shallow media depth and 3 feet of head available. Therefore, to implement CMF in the existing filters, the filter walls would need to be raised to accommodate the greater media depth and influent pumps would need to be installed to provide the necessary head.

STS also recommended a maximum filter loading rate of 5.7 gpm/SF with one filter out of service. At the peak hourly flow of 3.1 MGD, this equates to a filter service area of approximately 380 SF with one filter out of service. The existing system has a filter area of only 400 SF, so additional filter surface area would be needed to accommodate CMF.

Since significant modifications to the existing filter would be required to implement CMF, it is more logical to construct a new CMF facility. STS recommended three new filter units each 9'-6" by 20'-0" with a total surface area of 570 SF. Flow to the filters would be pumped using three (two plus one standby) new 1,100 gpm pumps with variable frequency drives. Under average flow conditions with all filters in service, the filter loading of the proposed CMF system would be 1.5 gpm/SF. Under peak hourly flow conditions with one filter out of service, the filter loading rate would be 5.7 gpm/SF. The recommended system parameters are summarized in Table 4-22.

Table 4-22 – CMF System Preliminary Design Parameters

Parameter	Units	Value
Flow Rate	MGD	Average Daily: 1.25 Peak Hourly: 3.1
Filter Size	Each	9'6" x 20' 0"
Filter Area	Each, ft^2	190.0
Number of Filters	--	3
Filter System Area	ft2	570.0
Filter Flow – all filters in service	gpm/ft^2	Average: 1.5 Maximum: 3.8
Filter Flow – one filter out of service	gpm/ft^2	Average: 2.3 Maximum: 5.7

Filter backwash would be accomplished using a 1,140-gpm centrifugal submersible pump and a 950 cfm backwash air blower. The backwash sequence would operate for approximately 27.5 minutes per cycle (25 minutes of reverse water flow). Spent backwash would be contained in a 27,360-gallon working volume mudwell until it is pumped back to the head of the plant using a 240-gpm centrifugal submersible pump. Table 4-23 outlines the backwash design parameters for the CMF system.

Table 4-23 – CMF Backwash Preliminary Design Parameters

	Units	Average Day	Maximum Day
Backwash Rate	gpm/ft^2	6.0	6.0
Backwash Volume/Filter Cell	Gal	28,500	28,500
Backwash Frequency	Days/filter	3.65	0.88
Backwashes/Day/System	--	0.82	3.43
System Volume/Day	Gal	23,370	97,755
Percent of Plant Flow Used for Backwash	%	1.8	7.5

A reserve of filtered water, usually a clearwell, is required for the backwashing process. The Recommended Standards for Wastewater Facilities (Ten States Standards) recommends that the clearwell be sized to hold enough clean water for two complete backwashes, about 60,000 gallons, in this case. The existing filter cell does not provide enough storage for this, so a new clearwell structure would need to be built.

The new facility will need a new 35' by 45' filter building to house the filters, backwash and mudwell pumps, backwash air blowers, duplex instrument air compressor system with refrigerant dryer, and main control panel. The building would be constructed to current energy efficiency standards. Spent backwash would be contained in a new 20' by 20' by 10' mudwell. A new 60,000-gallon clearwell, connected to the existing chlorine contact tank, would also need to be constructed. The new facilities could be located between the secondary clarifier and the chlorine contact tank and northeast of the existing filters.

Rehabilitate Existing TBF

The Town believes that the majority of the problems with their existing TBF are a result of the underdrain replacement. The filter could be brought back into service with some modifications. The underdrain would need to be replaced, most likely with a porous plate system similar to the original. In addition, the media should be replaced and all other equipment cleaned, repaired or replaced as necessary.

The existing TBF is assumed to be adequately sized since the general characteristics of the wastewater have not changed significantly. The TBF parameters are shown below, in Table 4-24.

Table 4-24 – TBF System Parameters

Parameter	Units	Value
Flow Rate	MGD	Average Daily: 1.25 Peak Hourly: 3.1
Filter Size	each	12'6" x 32' 0"
Filter Area	each, ft^2	400
Number of Filters	--	1[1]
Filter System Area	ft^2	400
Filter Flow – all compartments in service	gpm/ft^2	Average: 2.2 Maximum: 5.4
Filter Flow – one compartment out of service	gpm/ft^2	Average: 2.3 Maximum: 5.8

Note: N/A = Not applicable
[1] One filter has 14 compartments.

The backwash process for the entire filter lasts for approximately 25 minutes. Each compartment backwashes for approximately one minute with an actual backwash flow of 150 gpm for approximately 30 seconds. The remaining 30 seconds is transitional time as the filter enters and exits the backwashing cycle. This transitional time is overlapped for the cells so that while one cell is being backwashed, the next is being prepared. The system uses approximately 3,750 gallons per backwash. At an average of 23.6 backwashes per day (based on historical data from January 2004 to August 2005), nearly 90,000 gallons of backwash are generated each day.

Operations and Maintenance Evaluation

The operations and maintenance evaluation includes a comparison of maintenance and energy costs required to keep the system operational over the next 30 years. The same ideology was used for this evaluation as was used for the previous studies. This evaluation does not include standard labor costs that would be similar for both systems such as routine filter inspections. The present worth of future costs such as rebuilding and replacement was estimated assuming 3% interest over the specified time frame. Annualized costs were calculated from present worth values based on 3% interest and a 30-year project life.

An evaluation of maintenance tasks and their associated costs was conducted for the CMF and TBF systems. The analysis was performed assuming the operators follow the manufacturer recommended periodic maintenance (PM) schedule, equipment is rebuilt after 5 years of continuous operation, and equipment is replaced after 20 years of continuous operation. For equipment that is used periodically, equipment utilization rates were estimated and equipment service life adjusted accordingly.

The backwash and mudwell pumps, backwash blower and media replacements are projected to occur after the 30-year project time frame and, therefore, are not included. The cost of performing these maintenance items on the CMF system, annualized over 30 years would be approximately $21,000 per year. The present worth is estimated at $403,000.

Since the TBF system is nearing the end of its useful life, it was assumed the backwash and washwater pumps, bridge, and bridge drives would be replaced in 10 years and thereafter rebuilt once every 10 years. The cost of performing the maintenance items annualized over 30 years would be approximately $17,000 per year. The present worth is estimated at $334,000. Most of this cost is attributable to replacing the mechanical equipment at some point during the next 30 years (for this project, estimated in 10 years).

Energy Evaluation

CMF system energy consumers include two influent pumps, a backwash pump and blower, and a mudwell pump with an average daily energy usage of 150 kWh. The TBF system has only two motorized pieces of equipment: the backwash pump and the travelling bridge drive, and uses approximately half of the energy (74 kWh/average day). Equipment horsepowers and projected usages are contained in Table 4-25.

Table 4-25 – Process Equipment Horsepower and Projected Usage

	Units	CMF	TBF
2 influent pumps (plus 1 on-line standby)	HP	5	N/A
1 backwash pump (plus 1 on-line standby)	HP	15	5[1]
1 backwash blower (plus 1 on-line standby)	HP	60	N/A
1 mudwell pump (plus 1 on-line standby)	HP	3	3[1]
1 traveling bridge drive	HP	N/A	0.25
System Backwashes/average day	--	0.82	23.26
Energy for influent pumping/average day	kWh	120	N/A
Energy for backwash equipment/average day[2]	kWh	30	72
Energy for traveling bridge drive/average day	kWh	N/A	2
Total process energy usage/average day	kWh	150	74

[1] TBF is not equipped with an on-line standby pump
[2] Assumes average day usage and approximately 30 minutes of use per backwash cycle.
Note: N/A = Not applicable

Facility (HVAC and lighting) energy usage associated with the CMF system is shown in Table 4-26. Heating requirements were determined based on an interior design temperature of 65°F and an exterior design temperature of 2°F. Lighting requirements were determined assuming 8 hours of lighting per day, with 150W high-pressure sodium lamps.

The filter building HVAC and lighting could be eliminated if the filters are left open. Additional maintenance costs would be accrued due to exposure to inclement weather. This alternative was not evaluated.

Table 4-26 – CMF Building Energy Requirements

	Units	CMF
Building Size	--	45' x 35'
Natural Gas Requirements	ft^3/yr	50,000
Lighting Requirements	KWh/yr	3,750

Total energy usage and costs are summarized below in Table 4-27. The energy costs have been estimated assuming a rate of $0.02/kWh for electricity and $14.5/100 ft^3 for natural gas.

Table 4-27 – Annual Energy Use and Cost Summary

	Units	Replace with CMF	Rehabilitate Existing TBF
Electricity Required	kWh/yr	58,500	27,000
Electricity Costs	$/yr	$1,200	$540
Natural Gas Required	ft^3/yr	50,000	N/A[1]
Natural Gas Costs	$/yr	$7,300	$0[1]
Total Energy Costs	$/yr	$8,500	$540

[1] It was assumed the energy usage in the existing building will be required whether the filters are installed or not.

Capital Construction Cost Estimate

A preliminary, order of magnitude cost estimate was developed for the installation of a new CMF system as well as the rehabilitation of the existing filters. The cost estimates for the coarse monomedia filters, pumps, and blowers were taken from the concept-level proposal received from the manufacturer. Costs for piping, concrete, electrical starters, spare parts, and other such ancillary equipment were estimated. The TBF cost estimate was provided by Gehring Pumps, Inc. and includes the porous plate underdrain and accessories and new media. The capital cost was annualized over 30 years assuming 3% interest. The estimated capital cost expenditures for CMF and TBF are shown below in Table 4-28.

Table 4-28 - Capital Cost Estimate

	Replace with CMF	Rehabilitate Existing TBF
Capital Cost	$1,469,000	$40,400
Annualized Capital Cost*	$75,000	$2,100

*Assumes 3% interest over the 30-year project time frame

Summary of Cost Comparison

Table 4-29 summarizes the costs of implementing each of the alternatives. Replacing the existing system with a new CMF system has higher capital, maintenance and energy costs than rehabilitating the existing system. On an annualized cost basis, the CMF alternative would cost approximately four times more than rehabilitating the existing system. Therefore, repairing the existing TBF system is the most economically feasible option.

Table 4-29 - Annualized Cost Comparison Summary

	Replacement with CMF	Rehabilitate Existing TBF
Annualized Capital Cost	$75,000	$2,100
Annualized Maintenance Cost	$21,000	$17,000
Annualized Energy Cost	$8,500	$540
Total Annualized Cost	$104,500	$19,600

Assumes 3% interest over the 30-year project time frame

Conclusions

CMF technology is generally considered an energy efficient means of providing tertiary treatment. However, for this project, implementing CMF at the Rotterdam Plant is not the most feasible option because:

Under the current Plant configuration, effluent consistently complies with the discharge permit, with or without tertiary treatment. Therefore, regulatory compliance is not a driving force for switching to a new form of tertiary treatment.

The existing filter system requires only relatively minor repairs to make the system fully functional. These repairs are estimated at $40,400.

The existing filter walls are not high enough and the footprint is not large enough to easily accommodate CMF (i.e. simply changing out the media). A new CMF system would be required at an estimated cost of $1,469,000.

Existing Plant hydraulics do not provide sufficient head to accommodate CMF. CMF influent pumps would be required.

The annual energy cost of implementing CMF ($8,500) is more than 16 times greater than the annual energy cost associated with the existing filters ($540). This cost difference is due primarily to the CMF influent pumps. Influent pump energy consumption accounts for about 80% of the CMF process energy used.

The CMF system ($21,000) has a higher annualized maintenance cost than the existing TBF system ($17,000).

Recommendations

Repairing the TBF system has the least expensive annualized cost. Effluent from the system also complies with the Plant's SPDES permit. Therefore, CRA recommends rehabilitating the existing TBF system as the most feasible option.

THE CITY OF GENEVA

The City of Geneva owns and operates a WWTP that consists of two separate sites, Gulvin Park and Marsh Creek. The plant serves customers from the City of Geneva, the Town of Geneva, and a portion of the Town of Waterloo. In addition, the plant processes leachate from two landfills, and septic tank waste. The Gulvin Park plant was built in 1934. It was the sole treatment plant until 1974, when the treatment process was expanded with the construction of the Marsh Creek plant.

The majority of system wastewater flow enters the Gulvin Park site, receives preliminary treatment (screening), and is pumped to the Marsh Creek site. At the Marsh Creek plant the flow is joined by flow from other areas of the City and undergoes biological treatment consisting of primary clarification, fine bubble aeration, and secondary clarification. The entire process flow is returned by gravity to the Gulvin Park site for disinfection by chlorination before it is discharged into Seneca Lake.

The City of Geneva's Marsh Creek WWTP has a rated treatment capacity of 4 MGD. In times of wet weather, the plant can experience flows as high as 14.5 MGD. Currently, all flow received by the plant passes through all treatment units. But, since wet weather flows so greatly exceed rated plant capacity, the biological treatment processes are often disrupted. The biological process, which is the basis of secondary wastewater treatment, operates at its optimum when process parameters such as flow, temperature, quality, and quantity of wastewater and microorganisms remain constant. During wet weather, many of these parameters change significantly. At these times, the treatment plant experiences influent flows 3 to 4 times greater, and significantly weaker in strength, than the average daily flow. These spikes in flow can cause the biological process to be washed out, resulting in the loss of organisms that are the basis of the wastewater treatment process. In addition, following the wet weather event when flows return to normal, the biological organism population can be too small to permit adequate treatment of even the design flow. The plant must then re-establish equilibrium, which can take many days (two to three sludge ages).

The City was, therefore, interested in exploring options to mitigate or eliminate the strain on the biological processes that is created by wet weather events. A review of plant operating records indicated that during the 12-month period from October 2002 to September 2003, the facility logged 48 days with an average daily flow that exceeded 4 MGD. There were 8 occurrences where the duration of the spike in flow lasted for two or more days, with the longest occurrence lasting for 8 days.

The proposed arrangement for the City would locate the CMF process in parallel with the biological process to minimize the impact of the intermittent spikes in flow associated with wet weather. The Gulvin site currently receives 90% of the total flow treated in this plant. During wet weather the total flow received at Gulvin is 13 MGD.

With this approach, flow entering the Gulvin Park site would pass through the screen, and be pumped as is currently done. Prior to leaving Gulvin Park, flow above the capacity of biological treatment would be diverted. Flow metering and valving would be installed in the existing 24-inch diameter pump discharge, as well as the new filter influent line. When plant capacity is reached, the diversion valve to the filters would begin to open. A flow meter in that line would provide operators with the ability to track filter usage. Upon completion of the filtration process, the flow would be conveyed to the existing chlorine contact basins. The chlorine contact basin would also be used as the clearwell for filter backwash, thus saving the expense of constructing a new clearwell. The backwash effluent would be stored in a mudwell adjacent to the filters and fed by gravity at a controlled rate back into the plant influent at the head house.

With assistance from STS, the physical parameters of the proposed system were developed based on historical flows and influent TSS, as well as desired effluent quality. STS also provided input on preliminary equipment sizing, estimated backwash frequency, process equipment costs, and other relevant information. Table 4-30 below summarizes preliminary, concept-level physical system information for a potential CMF application:

Table 4-30 – CMF Physical System Parameters

System Information	Units	Proposed CMF
System Hydraulic Capacity	MGD	10.5
Number of Filters	Each	3
Average Filter Flow	gpm/ft^2	4.0
Max Filter Flow	gpm/ft^2	7.0
Approx. Filter Size	Each	9' 5" x 48' 0"
Approx. Filter Area	Each, ft^2	456
Total Filter System Area	ft^2	1,368

Table 4-31 below indicates wastewater design parameters extracted from available plant data. Due to the fact no data was available which characterized the Gulvin Park flow, the TSS values were projected from existing plant data, and based on estimated flow division per conversations with operators.

Table 4-31 – Wastewater Design Parameters

	Units	Typical	Peak
CMF Flow	MGD	1.5	10.5
Influent TSS	mg/L	6.5	25
Effluent TSS	mg/L	<5	<5

The manufacturer has provided projected backwash information. The entire backwash process lasts for approximately 30 minutes, and uses a combination of air and water. Each backwash is expected to use approximately 55,000 gallons of water at a rate of 6 gpm/sq. ft for 20 minutes. At an approximate volume of 180,000 gallons, the chlorine contact tanks will have sufficient volume for the backwash. Upon completion of the cycle, the backwash water would be fed at a controlled rate back to the head of the plant to be treated. Since CMF would be used to treat excess flow and may need to be backwashed during times of high flow, a mudwell would be built to store the backwash water. This would allow the backwash liquid to be introduced into the plant influent at a time and rate that would minimize the impact on the plant capacity.

An evaluation of maintenance tasks and their associated costs was conducted for the proposed CMF system. The same ideology was used as was used in previous studies. The resulting annual PM cost for the system was calculated to be approximately $1,500, plus the cost of lubricants.

As mentioned in Section 2.0, CMF media is designed to prevent degradation due to abrasion during backwash; therefore, the need to top off or replace the media is virtually eliminated. The original media is expected to have a life of at least 20 years if used continuously; in intermittent use it should attain significantly longer life. The replacement cost associated with the media is estimated at $230,000 (2004 dollars).

An analysis of the rebuild/replacement costs was conducted using the same ideology as was used in previous studies. The rebuild duration and life expectancy of the equipment would theoretically be hundreds of years if utilization alone is factored in; therefore, it was assumed a more realistic rebuild period is 7 years, and the life of the equipment will be 30 years. Based on this data, the cost of equipment rebuild is projected to be $33,000 every 7 years, and the cost of equipment replacement is projected to be $106,000 every 30 years (all prices in 2004 dollars).

Energy Evaluation

The primary consumption of energy associated with filtration is the operation of backwash equipment consisting of the following equipment:

One (1) 30-HP backwash pump (plus 1 on-line standby)
One (1) 100-HP backwash blowers (plus 1 on-line standby)
One (1) 5-HP air compressor (plus 1 on-line standby)

Backwash requirements were examined for the following four operating conditions:

Average bypassed flow with average suspended solids

Average bypassed flow with high suspended solids

High bypassed flow with average suspended solids

High bypassed flow with high suspended solids

The calculated required number of backwashes per day at each condition was 0.04, 0.55, 0.29, and 3.84, respectively. According to the data for the period from October 2002 to September 2003, there were 48 days when the flow exceeded 4 MGD. Of these, 4 days could be considered high flow with the need to backwash 4 times (3.84 rounded up) each day, and the remainder would be average flow with a backwash every two days. Under these conditions, the filters would need to be backwashed approximately 40 times each year. With each backwash using approximately 42 kWh, the yearly energy usage for the backwashing process would be approximately 1,700 kWh.

In addition, there would be energy usage associated with the building enclosure. Using a 60 by 75-foot filter building footprint with a 20 by 25-foot annex to house mechanical equipment, the total area to be heated would be 5,050 square feet. At an interior design temperature of 65 degrees F, the projected heating requirements for such a building equates to 180,000 cubic feet of natural gas per year. Electricity requirements for HVAC equipment and lighting are estimated to be an additional 9,000 kWh per year.

Using estimated purchase rates of $0.075/kWh for electricity and $10.75/mcf for natural gas, the facility would have an estimated yearly energy cost of $2,800. The following table summarizes projected process and ancillary facility energy usage for the proposed CMF process:

Table 4-32 – Process and Facility Energy Usage

Process	Yearly Usage	Cost	Cost/Yr.
Backwash Pumping	1,700 kWh	$0.075/kWh	$130
Building Heat	180 mcf	$10.75/mcf	$2,000
Building Services	9,000 kWh	$0.075/kWh	$675
		TOTAL	**$2,800**

Capital Cost Estimate

A preliminary capital construction cost estimate was performed based on the concept-level proposal received from STS as well as certain construction assumptions. The cost estimate included:

- Pipe, valves, and a new flow meter
- CMF filters, and related equipment from the STS proposal
- Concrete for the filter structure and mudwell
- A pre-engineered building enclosure
- Electrical facilities

- Process control system integration, including need to purchase software and design the interface.

The total estimated capital cost associated with CMF is approximately $3,600,000.

<u>Conclusions and Recommendations</u>

The operational considerations when applying CMF to primary treated and raw wastewater are the ability of the filter to maintain effective removal under high flow and loadings, as well as its ability to remove BOD. It is, therefore, obvious that the performance of the filters and the removal efficiency relative to these parameters directly affect the plant's ability to meet its permit requirements. Based on past performance, as well as the findings of this report, it is clear the filters should be capable of removing TSS to levels within the permit requirements of the plant. The process also can be integrated into the existing process without major modifications.

Wastewater characterization varies from plant to plant and area to area. This variation includes the amount of organic material that is in suspension versus that in solution. It is clear the CM filtration process can most effectively deal with the suspended solids material; however, limited testing has been done to determine the impact of CMF treatment on the overall reduction in BOD based upon TSS removal, or on the portion of BOD in solution.

In order to properly evaluate the effectiveness of CMF for removing BOD, it must be pilot tested. Pilot testing will provide information on the ability of the process to remove BOD, as well as provide actual data on the characterization of the influent to the filter. This testing will verify the assumptions made in this study on wastewater loadings, as well as actual removal rates. Furthermore, the filters can be tested under various modes of operation to determine what, if any, operational challenges will arise upon installation.

In addition, since the application of CMF to wastewater treatment in New York State is relatively recent (first installation was an R&D Engineering project in Tonawanda, NY in 1999), and since no installations of CMF in New York have been for treatment of raw wastewater, it is expected that regional and State representatives of the NYSDEC will require sufficient evidence of its effectiveness as a condition of granting approval for construction.

Therefore, the following course of action is recommended:

- Set up a CMF pilot filter at the Gulvin Park site, interconnected with the existing process so that it operates in parallel with the biological treatment train in a condition hydraulically similar to the proposed permanent installation

- Involve the local regional office of NYSDEC in the process of setting up and evaluating pilot process parameters, and with the intended direction of the investigations and procedures leading to the implementation of CMF at the Geneva facility.

- Conduct testing of the pilot process in accordance with a protocol to be established that evaluates influent and effluent parameters including TSS, BOD, and CBOD (soluble and suspended).

- Evaluate CMF pilot performance under wet weather events of varying duration and intensity.

- Conduct a thorough review of available and yet-to-be collected data from the Village Creek WWTP CMF installation, for comparison to projected design parameters and actual influent wastewater characteristic at Geneva.

- Seek additional funding from NYSERDA for the next phase of pilot testing of CMF at the Geneva facility, given the vast potential for application of CMF in WWTP's across the State in addressing wet weather flow issues.

- Refine project siting and configuration details, and update construction cost estimates based on the results of pilot testing.

- Identify potential sources of funding for construction of CMF at the Geneva plant (e.g., WERF, NYSERDA, NYCWSRF, etc.).

Section 5

CONCLUSIONS

It has been found that when existing fine media filters are deep bed design, the conversion to CMF is viable and cost effective since the filter depth is comparable to CMF. The equipment is similar in size, however, with CMF it runs less which results in an energy saving in conversion. Given the fact that the deep bed filtration is not the only type of fine media filtration currently in use, some of the other variations of this process can be a challenging conversion. This was the case of the four facilities examined in the study. Three of the existing filtration systems were designed to operate with minimal head. The other was a pressure system, designed to have flow pumped into the filter. In all of these cases, there was not enough available head with the existing infrastructure for CMF; therefore, the conversion would require either pump upgrades or the installation of new pumps. Additionally, the existing facilities were not of sufficient size to accommodate reuse, such as in the case of the traveling bridge filter which does not require redundancy because only part of a filter is backwashed at any one time.

Based on these results, the greatest advantage of CMF, "reduced energy consumption," is eliminated due to the need for upgraded or added pumping. The potential cost savings are also reduced since the additional and/or upgrade of equipment increases the operations and maintenance requirements for CMF over the existing systems. In most cases, significant structural and mechanical work would have to be performed to build new filter cells, reroute flow, and/or build new buildings. These costs all further reduce the potential cost savings for a CMF conversion.

One of the findings of this project was the potential ability of CMF to treat wastewater that has only undergone preliminary treatment. It had previously been proven to enhance wet weather treatment by eliminating the problems encountered by typical fine media filters. The preliminary feasibility study for the City of Geneva shows that CMF may go beyond the tertiary application to treating flows that would otherwise be bypassed around part or all of a treatment plant because of excessive wet weather flows. Though this would not save energy over existing operations with a bypass, its environmental benefit is great. The conclusion of that study was to pursue a pilot study of the equipment in that arrangement. For more detail on this NYSERDA study, the February 2006 Coarse Monomedia Filter Pilot Testing Final Report prepared by CRA Infrastructure & Engineering, Inc. can be referred to.

The CMF process can be a cost effective, efficient alternative to the fine media process that has historically been used in the wastewater treatment process. Additionally, it has been found that CMF may have applications in wet weather flow treatment as well. Given the process was developed specifically for wastewater treatment rather than adapted from water treatment, many of the operational limitations and maintenance problems associated with fine media have been addressed. For a facility that is either looking at the construction of a new plant or the upgrade of their current process, these benefits combined with energy efficiency and reduced backwash flow, make CMF the alternative of choice. Existing plants that operate shallow bed filters, however, may not realize any benefit in conversion due to the major modifications and associated costs caused by the lack of sufficient hydraulic grade and existing facility limitations.

For information on other
NYSERDA reports, contact:

New York State Energy Research
and Development Authority
17 Columbia Circle
Albany, New York 12203-6399

toll free: 1 (866) NYSERDA
local: (518) 862-1090
fax: (518) 862-1091

info@nyserda.org
www.nyserda.org

Course Monomedia for Wastewater Treatment Plants

Final Report 07-02

State of New York

Eliot Spitzer, Governor

New York State Energy Research and Development Authority

Vincent A. DeIorio, Esq., Chairman

Peter R. Smith, President, and Chief Executive Officer