FINAL 10/16/06

TECHNICAL MEMORANDUM 3 WQ

STUDY OF END-OF-PIPE COMBINED SEWER OVERFLOW (CSO) TREATMENT

MASTER PLAN

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

NORTH SIDE WATER RECLAMATION PLANT

Submitted by:

CTE | AECOM

October 16, 2006

MWRDGC Project No. 04-014-2P
CTE Project No. 40779

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INTRODUCTION

The Illinois Environmental Protection Agency (IEPA) is conducting a Use Attainability Analysis (UAA) study of the Chicago Area Waterways (CAWs) to evaluate existing conditions, including waterway use practices and anticipated future uses to determine if use classification revisions are warranted. As part of this UAA study, the IEPA requested that the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) evaluate the technologies and costs for end-of-pipe treatment of Combined Sewer Overflows (CSOs) for a portion of the CAWs. Consoer Townsend Envirodyne Engineers Inc. (CTE) was commissioned by the MWRDGC to conduct this study of end-of-pipe CSO treatment in order to satisfy the IEPA request.

Background

Study Area

The Chicago Area Waterways is shown in Figure 3.1. The study area for this Technical Memorandum includes all CSO outfalls that discharge to the following waterway segments of the CAWs: Upper North Shore Channel (UNSC), Lower North Shore Channel (LNSC), North Branch Chicago River (NBCR) downstream of its confluence with the North Shore Channel, Chicago River (CR), and the South Branch Chicago River (SBCR). The South Fork of the SBCR was not included in this study.

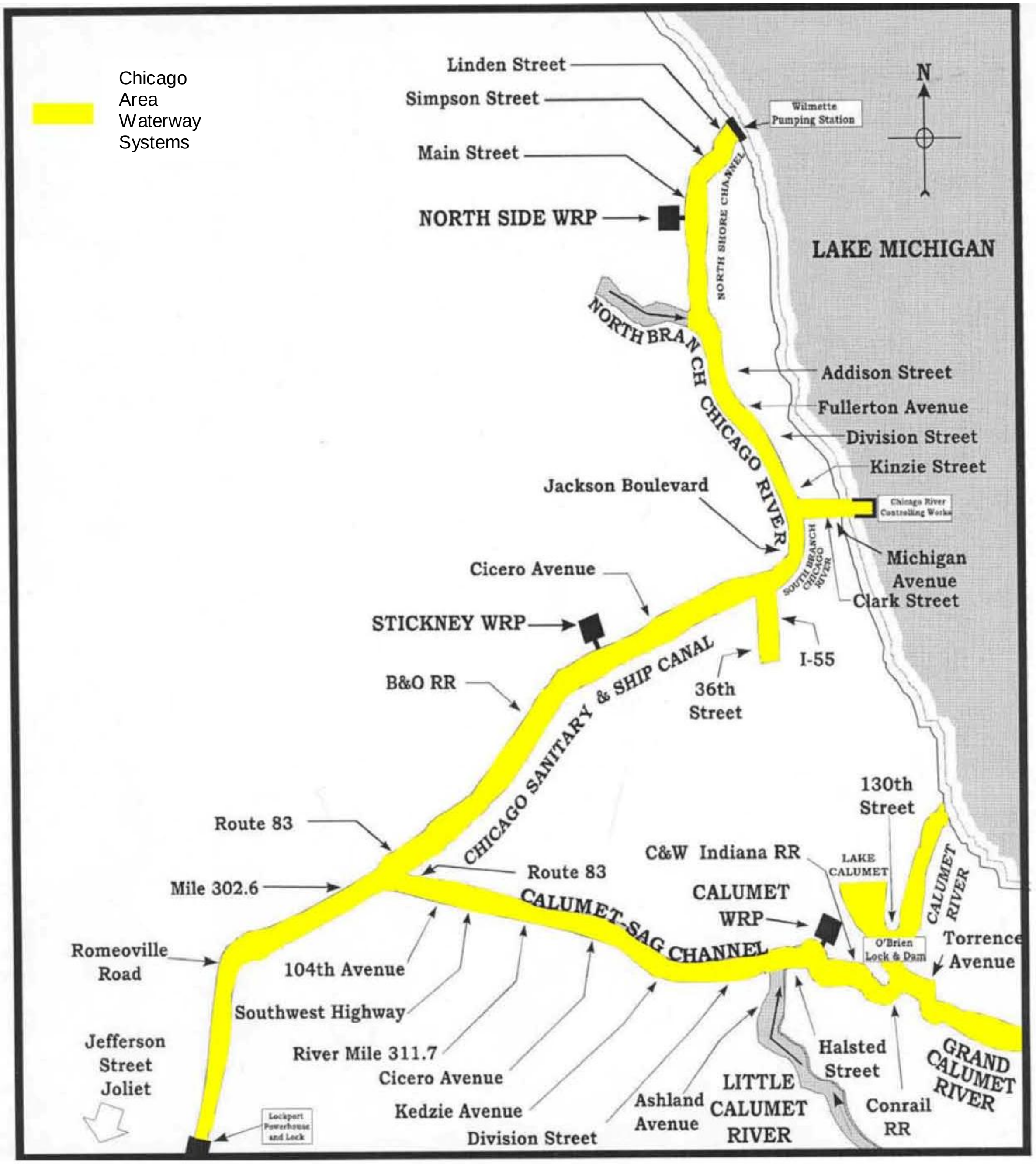

Figure 3.1 – Map of CAWs

There are a total of 170 CSOs in the study area. The locations and receiving waters of all CSO outfalls included in the study area are listed in Appendix A. A summary of this information is shown in Table 3.1.

TABLE 3.1
SUMMARY OF CSO INFORMATION

Waterway	**Total No. Of CSOs**	**CSOs Owned by MWRDGC**	**CSOs Owned by Chicago**	**CSOs Owned by Wilmette**	**CSOs Owned by Evanston**	**CSOs Owned by Lincolnwood**	**CSOs Owned by Skokie**
UNSC	25	5	0	1	16	0	3
LNSC	20	2	16	0	0	2	0
NBCR (after confluence w/NSC)	59	0	59	0	0	0	0
CR	18	0	18	0	0	0	0
SBCR	48	0	48	0	0	0	0
TOTAL	**170**	**7**	**141**	**1**	**16**	**2**	**3**

Current Water Quality Standards for CAWs

The Upper North Shore Channel and the Chicago River are presently classified by the State of Illinois as General Use Waters. The goals of these standards are to help protect aquatic life, wildlife, agricultural use, secondary contact, most industrial uses and the safeguarding of the aesthetic quality of the aquatic environment (35 IL Adm. Code 302.202). Significant portions of the General Use Standards are shown below.

- Offensive Conditions: Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin. (35 IL Adm. Code 302.203)

- Dissolved Oxygen: ≥6.0 milligrams per liter (mg/l) 16 Hr. out of 24 Hr. and ≥5.0 mg/l at any time (35 IL Adm. Code 302.206)

- Total Residual Chlorine: ≤0.019 mg/l (35 IL Adm. Code 302.208.d)

- Fecal Coliform: ≤200 counts per 100 milliliters (ctns/100 mL) geometric mean of 5 samples per 30-day period, May-October, and ≤400 ctns/100 ml in 10% of samples in any 30-day period (35 IL Adm. Code 302.209.a)

The Lower North Shore Channel, and the North and South Branches of the Chicago River are presently classified by the State of Illinois as Secondary Contact and Indigenous Aquatic Life Waters (35 IL Adm. Code 303.204). These standards are intended for those waters not suited for general use activities but which will be appropriate for all secondary contact uses and which will be capable of supporting an indigenous aquatic life limited only by the physical configuration of the body of water, characteristics and origin of the water, and the presence of contaminants in amounts that do not exceed the water quality standards listed in Subpart D (35 IL Adm. Code 302.401). "Secondary Contact" means any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating and any limited contact incident to shoreline activity (35 IL Adm. Code 301.380).

- Secondary contact waters subject to these standards shall be free from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, color or unnatural turbidity of other than natural origin (35 IL Adm. Code 302.403).

- Dissolved Oxygen: ≥4.0 mg/l at any time. Exception: Cal-Sag Channel, ≥3.0 mg/l at any time (35 IL Adm. Code 302.405).

- Total Residual Chlorine: No Limit

- Fecal Coliform: No Limit

Figures 3.2 and 3.3 illustrate the current Dissolved Oxygen (DO) and current Bacteria standards, respectively, for the CAWs.

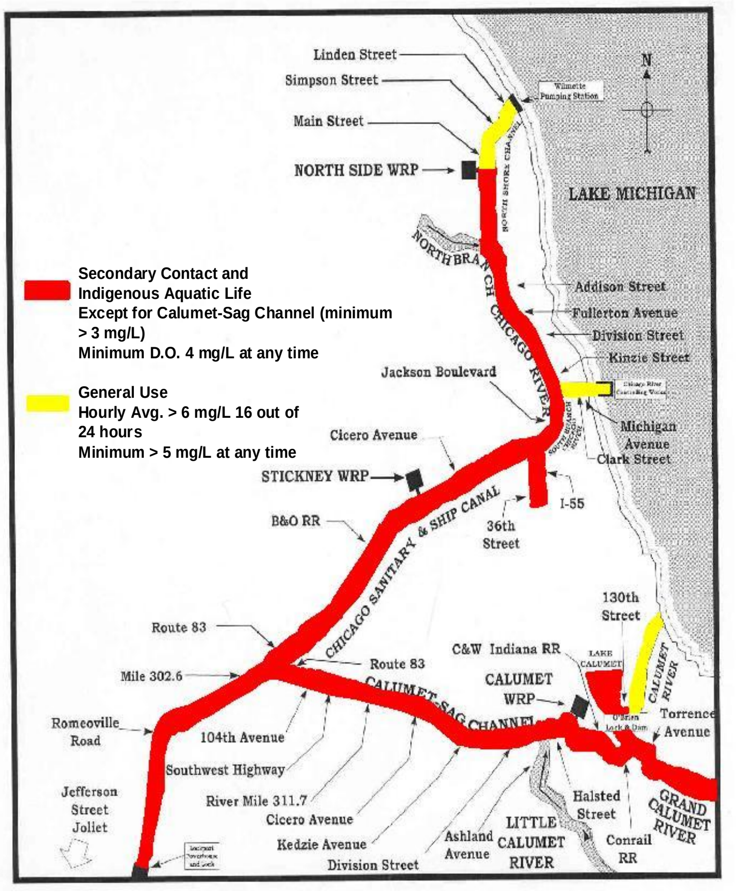

Figure 3.2 – Current Chicago Area Waterways Dissolved Oxygen Standards

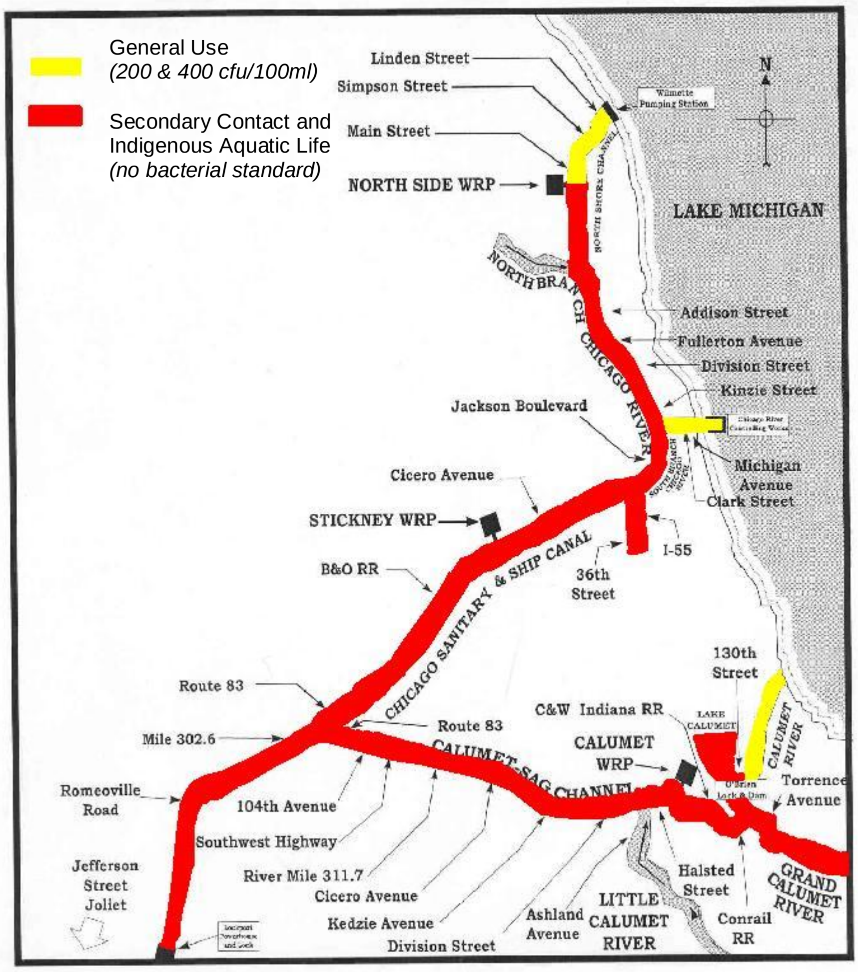

Figure 3.3 – Current Bacteria Standards for Chicago Area Waterways

<u>Proposed UAA for the CAWs</u>

The IEPA is conducting the Use Attainability Analysis (UAA) to create two new designated use categories and associated water quality criteria for the CAWs. In general, the UAA (Second Draft Report "Use Attainability Analysis of the Chicago Area Waterways", May 2004) proposes more stringent bacteria criteria for the following:

- North Shore Channel (NSC) downstream of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) North Side Water Reclamation Plant (WRP)

- North Branch Chicago River (NBCR) from its confluence with the North Shore Channel to its confluence with the South Branch

- Chicago Sanitary and Ship Canal (CSSC)

- South Branch of the Chicago River (SBCR) and South Fork (Bubbly Creek)

- Calumet-Sag Channel
- The Little Calumet River from its junction with the Grand Calumet River to the Calumet-Sag Channel
- The Grand Calumet River (GCR)
- The Calumet River, except the 6.8 mile segment extending from the O'Brien Locks and Dam to Lake Michigan
- Lake Calumet

Specifically, the following criteria are proposed in the draft UAA report:

E. Coli

- Limited Contact Recreation: A geometric mean of 1,030 colony forming units per 100 milliliters (cfu/100 mL) *E. coli*. This criterion will apply to all water bodies except the Chicago Sanitary and Ship Canal and the Calumet River (O'Brien Lock and Dam to Lake Michigan).
- Recreational Navigation: A geometric mean of 2,740 cfu/100 mL *E. coli*. This criterion will apply to the Chicago Sanitary and Ship Canal and the Calumet River (O'Brien Lock and Dam to Lake Michigan).

The criteria are to be compared to the geometric mean of measured values in the receiving water calculated over a 30-day period from March 1 to November 30.

For the purposes of this Technical Memorandum, the Limited Contact Recreation criteria will apply since the NSC, NBCR, Chicago River and SBCR are proposed to be designated as Limited Contact Recreation Waters.

The draft UAA report also recommends the following dissolved oxygen standards.

Dissolved Oxygen

- Modified Warm Water Aquatic Life (MWAL): Current general use standards or minimum > 4, 5, or 6 mg/l. These criteria would apply to the UNSC, NSC, and Upper North Branch Chicago River (UNBCR). (The UNBCR includes the length of the North Branch Chicago River from the confluence with North Shore Channel to the North Avenue Turning Basin). These waters are presently not capable of supporting and maintaining a balanced, integrated, adaptive community of a warm-water fish and macroinvertebrate community due to significant modifications of the channel morphology, hydrology and physical habitat that may be recoverable. These waters are capable of supporting and maintaining communities of native fish and macroinvertebrates that are moderately tolerant and may include desired sport fish species such as channel catfish, largemouth bass, bluegill, and black crappie. Water quality standards are identified in existing Illinois Pollution Control Board Regulations (35 Ill. Adm. Code Part 302, Subpart B.)

- Limited Warm Water Aquatic Life (LWAL): Current general use standards or minimum > 4, 5, or 6 mg/l. These criteria would apply to the LNBCR, CR and SBCR. These waters are incapable of sustaining a balanced and diverse warm-water fish and macroinvertebrate community due to irreversible modifications that result in poor physical habitat and stream hydrology. Such physical modifications are of long-duration (i.e. twenty years or longer) and may include artificially constructed channels consisting of vertical sheet-pile, concrete and rip-rap walls designed to support commercial navigation and the conveyance of stormwater and wastewater. Hydrological modifications include locks and dams that artificially control water discharges and levels. The fish community is comprised of tolerant species including central mudminnow, golden shiner, white sucker, bluntnose minnow, yellow bullhead and green sunfish. These waters shall allow for fish passage.

Figure 3.4 shows the proposed Bacterial standards for the Chicago Area Waterways. Table 3.2 lists the proposed Dissolved Oxygen standards for the CAWs and Figure 5 illustrates these standards as they relate to the CAWs.

The MWRDGC has used the services of Marquette University in Milwaukee Wisconsin to develop a model of the CAWs. This model was developed by Marquette University's Institute for Urban Environmental Risk Management under the supervision of Dr. Charles Melching of the Department of Civil and Environmental Engineering.

The Marquette University water quality model will be used to determine the water quality impacts of end-of-pipe CSO treatment for the study area. The water quality impacts of CSO treatment as described in this Technical Memorandum will be reported in Technical Memorandum TM-7WQ. Since the Marquette Model will be used to determine water quality impacts of CSOs both treated and untreated, this model was also used to determine the CSO flows produced by various rainfall events. In fact the Marquette model was the best source for determining CSO flows since there is no collection system model available for estimating CSO flows for the MWRDGC.

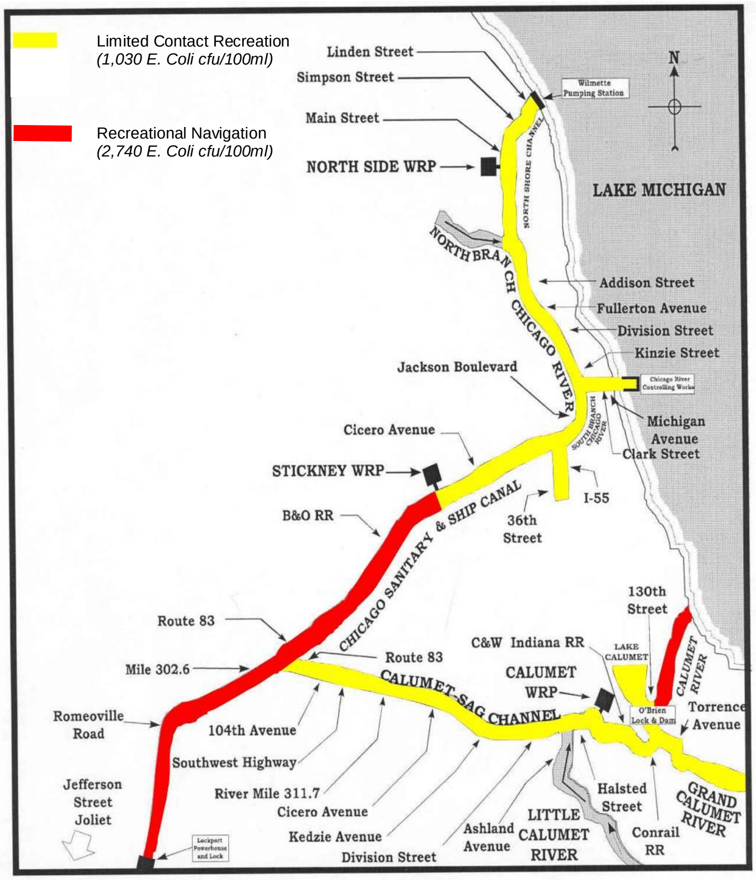

Figure 3.4 – Proposed Bacteria Standards for Chicago Area Waterways

TABLE 3.2
PROPOSED DISSOLVED OXYGEN STANDARDS FOR THE CAWs

Parameter	Aquatic Life Use Designation proposed in draft UAA	Proposed UAA Standard	UNSC	LNSC	UNBCR	LNBCR	CR	SBCR	Bubbly Creek	Chicago Sanitary Ship Canal	Calumet River	Grand Calumet	Little Calumet River	Calumet Sag Channel
Dissolved oxygen	Modified warmwater aquatic life (MWAL)	Current general use standards or Minimum > 4, 5, or 6 mg/l	♦	♦	♦							♦	♦	♦
Dissolved oxygen	Limited warmwater aquatic life (LWAL)	Current general use standards or Minimum > 4, 5, or 6 mg/l				♦	♦	♦	♦	♦	♦			

Review of United States Environmental Protection Agency (U.S. EPA) 1994 CSO Control Policy

The U.S. EPA 1994 CSO Control Policy (Policy) was established to elaborate on the 1989 National CSO Control Strategy due to concerns about (1) what CSO controls were appropriate, (2) when CSO controls should be implemented, and (3) how CSO controls should be funded (Lape and Dwyer 1996). The Policy is the result of extensive negotiations among stakeholders and has four key principles that drive decisions about the adequacy of CSO control:

1. *Provide clear levels of control that would be presumed to meet appropriate health and environmental objectives.*
2. *Provide sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting Clean Water Act objectives and requirements.*
3. *Allow a phased approach to implementation of CSO controls considering a community's financial capability.*
4. *Review and revise, as appropriate, water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.*

The Policy allows Permittees to pursue one of two approaches in developing a long-term control plan (LTCP) to determine if CSO control will meet the requirements of the Clean Water Act. These are the *presumption approach* and the *demonstration approach.* One element of the Policy, common to both approaches, is that CSO communities must implement the Nine Minimum Controls for combined sewer overflows. For example, Control No. 6 is stated as follows: "Control of solid and floatable materials in CSOs". The term "solid and floatable materials" generally includes materials that impair the aesthetics of the receiving water body, create navigational hazards, attract nuisance vectors, and retain bacteria and other pollutants.

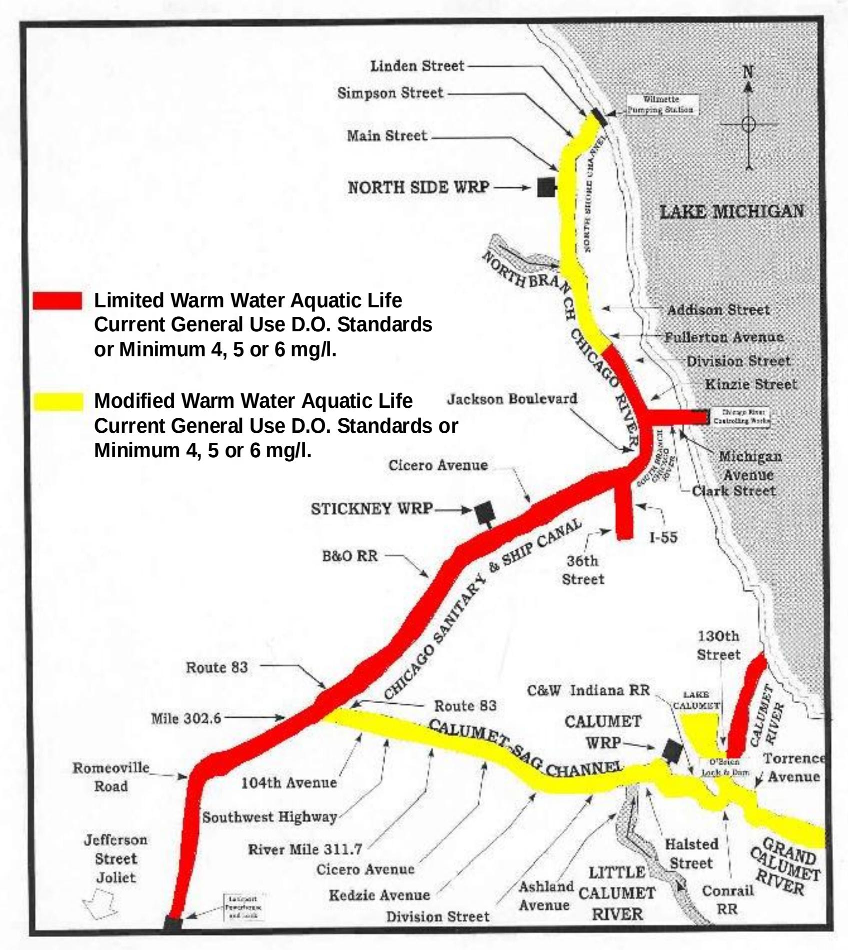

Figure 3.5 – Proposed Chicago Area Waterways Aquatic Life Use Designations and Proposed Dissolved Oxygen Standards

The Nine Minimum Controls are as follows:

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls;
2. Maximum use of the collection system for storage;
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized;
4. Maximization of flow to the POTW for treatment;
5. Elimination of CSOs during dry weather;
6. Control of solid and floatable materials in CSOs;
7. Pollution prevention programs to reduce contaminants in CSOs;
8. Public notification to ensure that the public receives adequate notification of CSO occurrences and effects; and
9. Monitoring to effectively characterize CSO effects and the efficacy of CSO controls.

Under *the presumption approach*, CSO controls must meet any one of the following criteria which are presumed to meet the water quality based requirements of the Clean Water Act:

1. Limit number of untreated overflow events to an average of four (or six) per year. (The states are permitted to allow six overflow events per year under certain circumstances). Provide the following minimum level of treatment for the other combined sewer overflows remaining after implementation of the Nine Minimum Controls:
    - Primary clarification; removal of floatable and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification;
    - Solids and floatables disposal; and
    - Disinfection of effluent to meet water quality standards (WQS), including removal of harmful disinfection chemical residuals, where necessary; OR

2. Eliminate or capture for treatment at least 85% of the wet weather combined sewage volume per year; OR

3. Eliminate or reduce the mass of pollutants equivalent to the 85% capture requirement.

Under the *demonstration approach*, the CSO control plan must demonstrate that it is adequate to meet the water quality-based requirements of the Clean Water Act. Each of the following requirements must be demonstrated:

1. The CSO control plan is adequate to meet water quality standards and protect designated uses, *unless* the water quality standards or uses cannot be met as a result of natural background conditions or pollution sources other than CSO; AND

2. CSOs remaining after implementation of the control program will not preclude attainment of water quality standards or designated uses or contribute to their impairment. If background impairment is present, total maximum daily load (TMDL) should apportion pollution loads; AND

3. The CSO control program will provide the maximum pollution reduction benefits reasonably attainable; AND

4. The CSO control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to meet water quality standards or designated uses.

The Wet Weather Water Quality Standards Act of 2000 amended the Clean Water Act by adding the requirement that permits, orders, and decrees issued after its date of enactment, shall conform to EPA's 1994 CSO Control Policy. The CSO Control Policy is to be implemented through NPDES Permits, consent decrees, or other orders.

CSO Treatment Requirements in Illinois Water Quality Standards and NPDES Permits

Illinois' program for CSO control includes an approach that pre-dates U.S. EPA's CSO Control Policy. However, it is unclear how this State Standard would apply given that it predates the Federal Standards. The State of Illinois has established treatment standards for CSOs under IL Adm. Code 306.305. The treatment standards presume that CSO communities are meeting water quality standards if the following requirements are met:

- All combined sewer overflow and treatment plant bypasses shall be given sufficient treatment to prevent pollution and the violation of applicable water quality standards. Sufficient treatment shall consist of the following: All dry weather flows and the first flush shall be transported to the main sewage treatment plant (STP) and shall meet all applicable effluent standards and the effluent limitations required for the main STP. Additional flows, but not less than ten times the average dry weather flow for the design year, shall receive the equivalent of primary treatment and disinfection with adequate retention time (Special Condition 10.1 and 35 IL Adm. Code 306.305(b)).

- All CSO discharges shall be treated in whole or in part, to the extent necessary to prevent accumulations of sludge deposits, floating debris and solids in accordance with 35 IL Adm. Code 302.203 and to prevent depression of oxygen levels below the applicable water quality standard (Special Condition 10.2 and 35 IL Adm. Code 306.305(c)).

These requirements have also been added to North Side WRP NPDES Permit No. IL0028088 and Stickney WRP NPDES Permit No. IL0028053. The Permits are effective from March 1, 2002 through February 28, 2007.

Tunnel and Reservoir Plan (TARP)

The following paragraphs are taken from Special Condition 20 of North Side WRP NPDES Permit No. IL0028088, and Special Condition 19 of Stickney WRP NPDES Permit No. IL0028053. They contain additional CSO requirements along with a brief description and history of the TARP system.

"This Permit contains provisions implementing the federal Combined Sewer Overflow (CSO) Control Policy (published in the *Federal Register* on April 19, 1994) and recognizes that the TARP, now under construction, as the long-term control plan for the

Chicago metropolitan area. Over the term of this Permit, construction of the McCook Reservoir shall be constructed according to the following schedule: March 31, 2002… through…December 31, 2015."

"Following extensive studies by the State of Illinois, Cook County, the City of Chicago, and the Permittee, TARP was found to be the most cost-effective means of achieving the control of CSOs in compliance with the Clean Water Act. The Permittee adopted TARP in October 1972, and later the same year the other three agencies mentioned above also approved TARP. Approval of TARP by the USEPA for funding purposes was obtained in 1975. In 1995, IEPA confirmed that TARP met the "presumption" approach requirements of the 1994 CSO Policy. IEPA and USEPA have determined, consistent with Section 1.C.2 of the CSO Policy, that the completion of TARP without further planning would fulfill the obligations of the CSO Policy, since it is believed that upon completion of the reservoirs, CSOs will no longer cause or contribute to violations of water quality standards or use impairment. The permit does require identification of sensitive areas that may trigger the need for additional planning for CSO control and further requires water quality monitoring during and after construction of TARP, to assure that CSOs controlled by TARP meet applicable water quality standards."

"Funding began in 1975 under the USEPA Construction Grants Program for construction of tunnels, drop shaft, connecting structures and a pumping station. The first portion of the TARP Mainstream System became operational in 1985. Construction of the TARP Des Plaines River System tunnel and the North Branch tunnel was completed in 1998. Both of these extensions were funded under the State Revolving Fund loan program. Upon completion, these tunnel extensions became operational, marking the completion of the TARP tunnels for these two systems. Approximately $1.6 billion has been expended on the construction of the TARP Mainstream and Des Plaines River Systems."

"The TARP McCook Reservoir is being designed and will be constructed by the U.S. Corps of Engineers using federal public works funding. A Project Cooperation Agreement was executed with the Corps in 1999. The Permittee has secured the land rights for the McCook Reservoir and begun site preparation using its own funding. Construction of the McCook Reservoir is expected to cost $0.5 billion and be completed by 2015."

"During the last three decades of the 20th Century, the Permittee has expended $4.5 billion on capital improvement projects. Of this total, $2.3 billion has been spent on the TARP and $1.1 billion on treatment plant expansions and improvements. The balance has been spent on intercepting sewers, biosolids processing, flood control and facility replacement. The facilities constructed and operated by the Permittee have resulted in a dramatic improvement in water quality in the Calumet, Chicago and Des Plaines River systems and the return of over 50 species of fish to these river systems. The Permittee shall be a participant in and support the UAA that is being undertaken for the Chicago Area Waterways System."

GENERAL APPROACH

In accordance with the Scope of Work, due to the large number of CSO outfalls included in the study area, an in-depth analysis of end-of-pipe CSO treatment and costs was prepared for the CSOs located on the Lower North Shore Channel. The results of this analysis were then extrapolated to the other CAWs CSO outfalls.

At the direction of the MWRDGC the North Branch and Racine Avenue Pumping Stations, and the CSOs on the South Fork of the South Branch are excluded from the scope of this report. Based upon an understanding between the IEPA and MWRDGC, the study of end-of-pipe CSO treatment will not include the North Branch and Racine Avenue Pump Stations. The CSOs on the South Fork of the South Branch of the Chicago River (Bubbly Creek) were not included since flow information for these CSOs was not available from any source, including the Marquette University Waterway Model. Also, the MWRDGC indicated that these CSOs rarely discharge to the South Fork of the South Branch of the Chicago River and would be insignificant in comparison to the flows that enter this river segment from the Racine Avenue Pump Station.

Sizing of CSO treatment facilities was determined for each CAWs waterway segment based upon the Marquette Model flows for that segment for the design storm. CSO treatment facilities were sized for this flow and an aerial photo was reviewed to determine whether or not the treatment facility could be located at the CSO site along the waterway. The MWRDGC indicated that if vacant land was not available at certain CSO sites, 1 story buildings could be demolished to make room on the site. The MWRDGC directed that if sufficient land at a particular site was not available for primary treatment and disinfection, CSO treatment would not be considered for that site.

End-of-Pipe CSO Treatment Unit Processes

The following unit processes were included in the end-of-pipe CSO treatment plant:

1. **Removal and Disposal of Solid and Floatable Materials.** This is consistent with EPA's Nine Minimum Controls, the *presumption approach*, and State water quality standards. A common method used by other CSO communities to accomplish this treatment objective is to install CSO fine screens on the combined sewers with screen openings of either 1/4-inch (6 mm) or 1/6-inch (4 mm). Coarse screens (1-2 inch openings) sometimes precede the fine screens depending on the selected screening technology. Screenings are typically disposed of in a landfill.

2. **Pumping.** This is required in order to prevent having to build below grade CSO treatment facilities. It also offers some flexibility in siting the CSO treatment facilities as they will be constructed at the end of a force main. The least expensive option for intermittent pumping of large combined sewer flows is to use wet-pit submersible pumps with constant speed drives. The cost estimate will assume that each CSO treatment plant will require a submersible pump station.

3. **Primary Clarification.** The MWRDGC scope of work directs that end-of-pipe CSO treatment include primary treatment. This is consistent with the NPDES Permits, EPA's *presumption approach*, and State water quality standards. There is no exact definition of primary clarification in the state and federal CSO regulations; however, it typically results in a 30-35% removal of BOD_5 and a 50-60% removal of suspended or settleable solids. The intent of primary clarification is the removal of settleable solids which can make the receiving waters look cloudy or turbid, diminishing the aesthetic and recreational qualities of the water. Turbidity also limits light penetration which can reduce the growth of microscopic

algae and submerged aquatic vegetation. Collected solids are typically held on-site during the storm event and returned to the sanitary sewer system for processing at the sewage treatment plant after storm flows have receded. Grit is generally removed from primary sludge and disposed of separately.

4. **Disinfection.** The MWRDGC scope of work directs that end-of-pipe CSO treatment include disinfection. This is also consistent with the NPDES Permits, EPA's *presumption approach*, and State water quality standards.

Figure 3.6 shows a schematic of the above end-of-pipe treatment unit processes which were used for this Technical Memorandum.

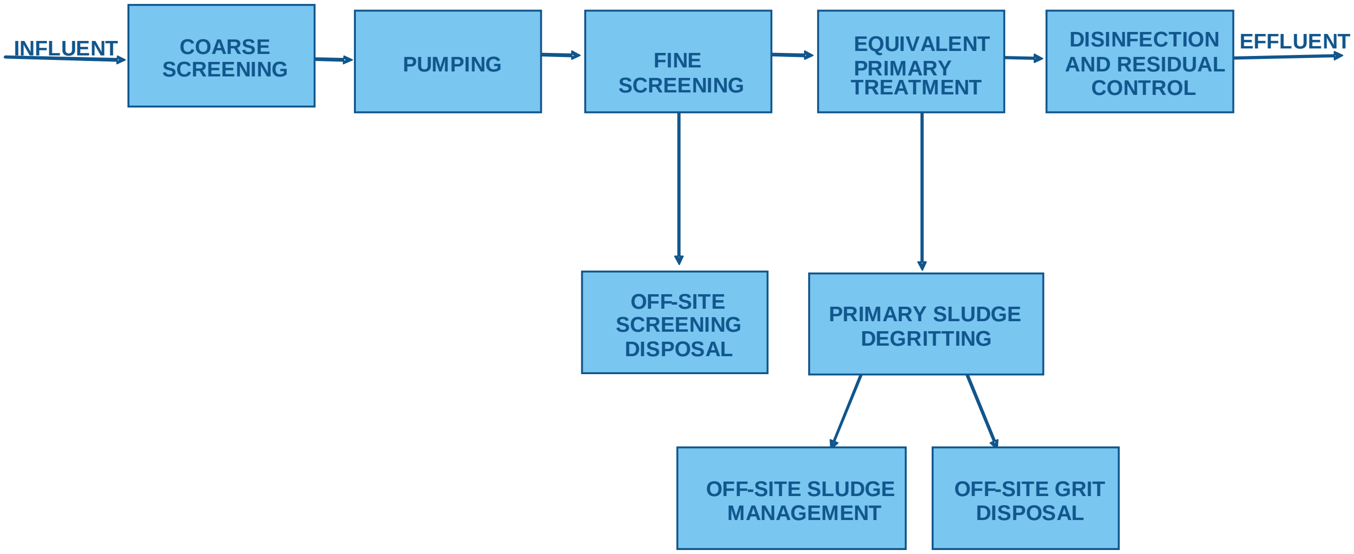

Figure 3.6 – Typical CSO Treatment Train

Financial and Non-Quantitative Criteria Analyses

A long list of treatment technologies was developed for evaluation. Using a matrix scoring system, the long list was narrowed down to recommended CSO treatment unit process alternatives. These recommended alternatives were used to estimate the cost of end-of-pipe CSO treatment.

This subsection describes a method of comparison of the alternative CSO screening technologies and CSO primary treatment technologies. Disinfection alternatives were not subjected to this evaluation since the short list of disinfection alternatives has been determined in TM-1WQ.

The evaluation of the alternative systems presented in this Technical Memorandum will be based on economic criteria as well as non-economic criteria. Matrices, evaluation criteria and weights assigned to each criterion were established previously in TM-3.

The economic and non-economic criteria will include a qualitative evaluation of the following items:

1. Life Cycle Cost - Based upon CTE experience for end-of-pipe CSO treatment plant life cycle costs in the U.S., CTE determined the relative score for each alternative. CTE did not determine the actual capital and operation and maintenance costs of each alternative for end-of-pipe treatment at the MWRDGC. CTE relied on its cost experience with the various alternatives for other systems in the U.S.
2. Maintainability - The relative ease of keeping systems, processes, and equipment in desired operating condition.
3. Operability - The relative ease of operations based on the main processes.
4. Reliability - The historical performance as an industry standard to reliably and consistently meet effluent requirements.
5. Energy Efficiency - The relative comparison of energy efficiency potential.
6. Impacts on Neighbors - Relative comparison of impacts on neighbors from odors, noise and light.
7. Expandability - Comparative ease to expand in the future and the ability to make changes or adaptations to the system for future needs.

REVIEW OF LONG LIST OF CSO TREATMENT TECHNOLOGIES

Based upon CTE's experience with CSO treatment facilities throughout the U.S., a long list of CSO treatment unit process alternatives was selected.

CSO Fine Screening Technologies

For CSO Fine Screening treatment, the following long list of screening alternatives was chosen for evaluation:

Alternative 1: Chain Driven-75° Vertical Bar Screens:

> This is similar to a typical bar screen in that it consists of evenly spaced bars inclined from the vertical position. It is cleaned by multiple rakes at all times.

Alternative 2: Climber Type-80° Vertical Bar Screens:

> This screen type is cleaned by a single rake. All sprockets and bearings are located above the water level.

Alternative 3: Chain Driven-60° Catenary Screens;

> This screen type is a front clean/front return chain-driven screen with no submerged sprockets.

Alternative 4: Horizontal Overflow Screens:

> This screen type is installed parallel to the combined sewer, and is cleaned by a hydraulically driven rake device.

Alternative 5: Horizontal Brush Overflow Screens

> This is similar to Alternative 4, with the addition of a brush cleaning mechanism mounted on a circular shaft.

Alternative 6: Rotary Drum Screens

> These screens consist of plastic mesh panels arranged on a rotating drum assembly. A horizontally mounted cylinder can be designed for very fine openings. Coarse screening is required upstream of these screens.

Alternative 7: Net Bags

> These are mesh bags with 1-2 cm openings which attach to the end of the pipe, where they capture debris before it is introduced into the receiving water. The bags are replaced when full.

Table 3.3 contains a summary of the advantages and disadvantages of the seven screening alternatives.

TABLE 3.3
CSO SCREENING TECHNOLOGIES--ADVANTAGES AND DISADVANTAGES

Alternative	Advantages	Disadvantages
1. Chain Driven-75° Vertical Bar Screens (Headworks Mahr™ Bar Screen)	1. Can be designed as either coarse screen (1-inch openings) or fine screen (1/4-inch openings). 2. Multiple rakes keeps screen clean at all times.	1. Requires disposal of retained screenings and floatables. 2. Lower sprockets and bearings submerged in flow, susceptible to grit wear.
2. Climber Type-80° Vertical Bar Screens (Infilco Degremont Climber Screen®, Link-Belt® Cog Rake Bar Screen, Vulcan Mensch Bar Screen)	1. Can be designed as either coarse screen (1-inch openings) or fine screen (1/4-inch openings). 2. All sprockets and bearings located above flow level.	1. Requires disposal of retained screenings and floatables. 2. Single rake mechanism may result in blinded screen under heavy debris loadings.
3. Chain Driven-60° Catenary Screens (E & I Corp. Catenary Bar Screen, Link-Belt® Catenary Bar Screen)	1. Multiple rakes keeps screen clean at all times. 2. All sprockets, bearings & shafts located above screen channel.	1. Requires disposal of retained screenings and floatables. 2. Normally used in coarse screen (1-2 inch openings) applications only.
4. Horizontal Overflow Screens (CDS Raked Bar Screen, Copa Raked Bar Screen, Hycor® ROMAG Screen, John Meunier StormGuard™, Waste-Tech Horizontal CSO Screen)	1. Screenings and floatables are retained in the combined sewer for transportation and disposal at the treatment plant. 2. Hydraulic drive cleaning mechanism.	1. Not applicable for pumped overflows. 2. Screens are installed parallel to the combined sewer; large structures may be required. 3. Rags may have to be manually cleaned following a rainfall event.
5. Horizontal Brush Overflow Screens (Copa Hydroclean Brush Screen)	1. Screenings and floatables are retained in the combined sewer for transportation and disposal at the treatment plant. 2. No outside source of energy required to rotate screen; uses a waterwheel.	1. Not applicable for pumped overflows. 2. Screens are installed parallel to the combined sewer; large structures may be required. 3. Rags may have to be manually cleaned following a rainfall event.
6. Rotary Drum Screens (Brackett Green Sewage Drum Screen, Hycor)	1. All sprockets, bearings & shafts located above screen channel. 2. Reliable operation under heavy debris loadings. 3. Can be designed for very fine openings, down to 1/16-inch (2 mm). 4. Screenings are dewatered and compacted thus reducing overall waste volume.	1. Requires preliminary coarse screening. 2. Requires disposal of retained screenings and floatables. 3. Requires high pressure water jets to clean screen panels. 4. Frequent replacements of screen panels. 5. Wide screen channels can result in heavy grit deposits.
7. Net Bags (Fresh Creek Technologies TrashTrap®)	1. No moving parts. 2. Simple. 3. Can be installed in-line or on floating pontoons in waterways.	1. Removal and disposal of net bags is labor intensive.

CSO Primary Treatment Technologies

For CSO Primary Treatment, the following seven alternatives were selected for evaluation:

Alternative 1: Rectangular Primary Settling Tanks

> This alternative includes the use of typical concrete settling tanks common to wastewater treatment plants, rectangular in shape.

Alternative 2: Circular Primary Settling Tanks

> This alternative includes the use of typical concrete settling tanks common to wastewater treatment plants, circular in shape.

Conventional primary settling tanks for CSO and bypass settling can be rectangular or circular and are typically sized at a maximum surface settling rate of 1,800 gpd/sf with a minimum liquid depth of 10 ft. and a minimum detention time of 1 hr. (35 IL Adm. Code 370.710).

Alternative 3: EPA Swirl Concentrators

> These units are constructed of High-Density Polyethylene and induce a circular flow pattern as CSOs enter by means of a tangential inlet pipe. A combination of gravitational and hydrodynamic drag forces encourage solids to drop out of the flow and migrate to the center of the chamber. Figure 3.7 shows a U.S. EPA Swirl Concentrator.

Alternative 4: Vortex Separators

> Solids separation in vortex separators is caused by the inertia differential, resulting from a circular path of travel. Waste is removed at the bottom of the unit and returned to the interceptor for treatment. Floatables are captured by baffles and removed when units are drained. Figure 3.8 shows a typical Vortex Separator.

Alternative 5: Enhanced Vortex Separators

> This is similar to Alternative 4, with chemical addition used for enhanced settleability. Figure 3.9 shows a typical Enhanced Vortex Separator.

Swirl and Vortex Separators are considered to be equivalent to primary settling tanks. They have an advantage of using less land and are typically sized at hydraulic loading rates of 20,000-23,000 gpd/sf (14-16 gpm/sf). These separators are circular in shape and have a practical limitation of 36 ft. diameter. Pilot testing is usually done to confirm manufacturer recommended loading rates.

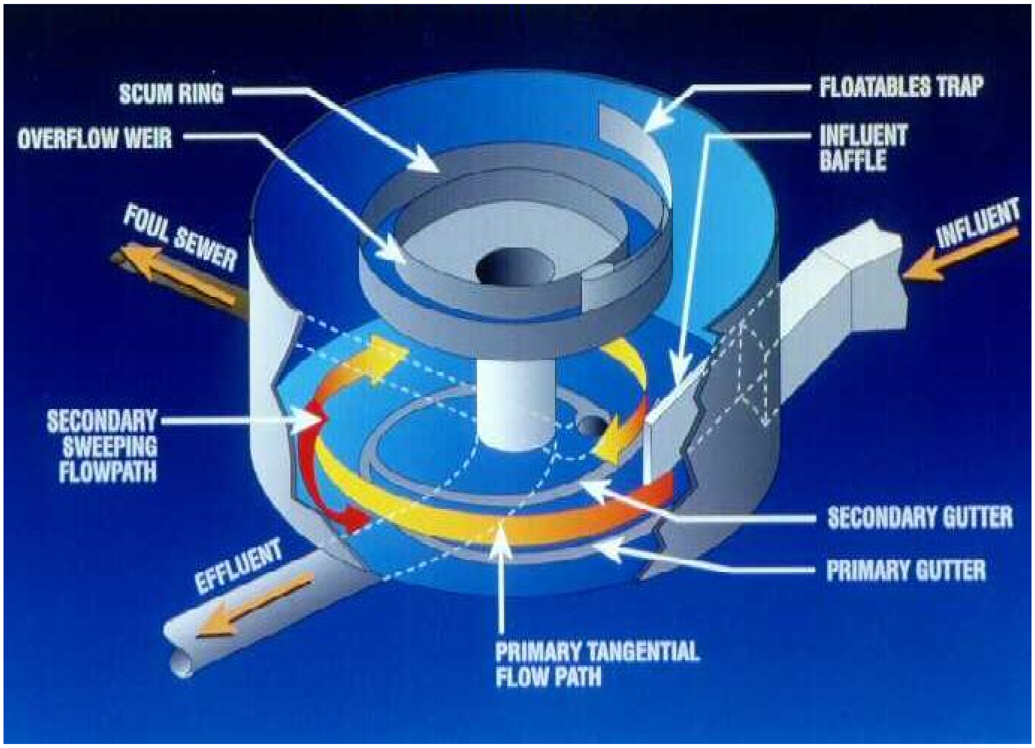

Figure 3.7 – USEPA Swirl Concentrator

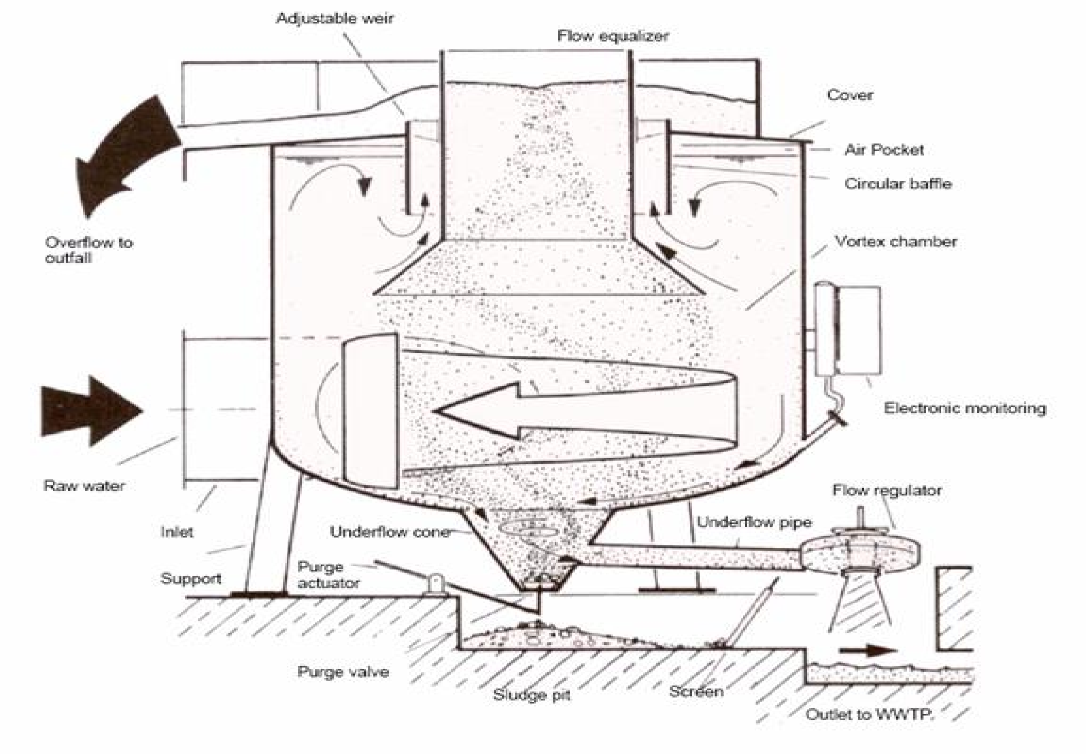

Figure 3.8 – Vortex Separator

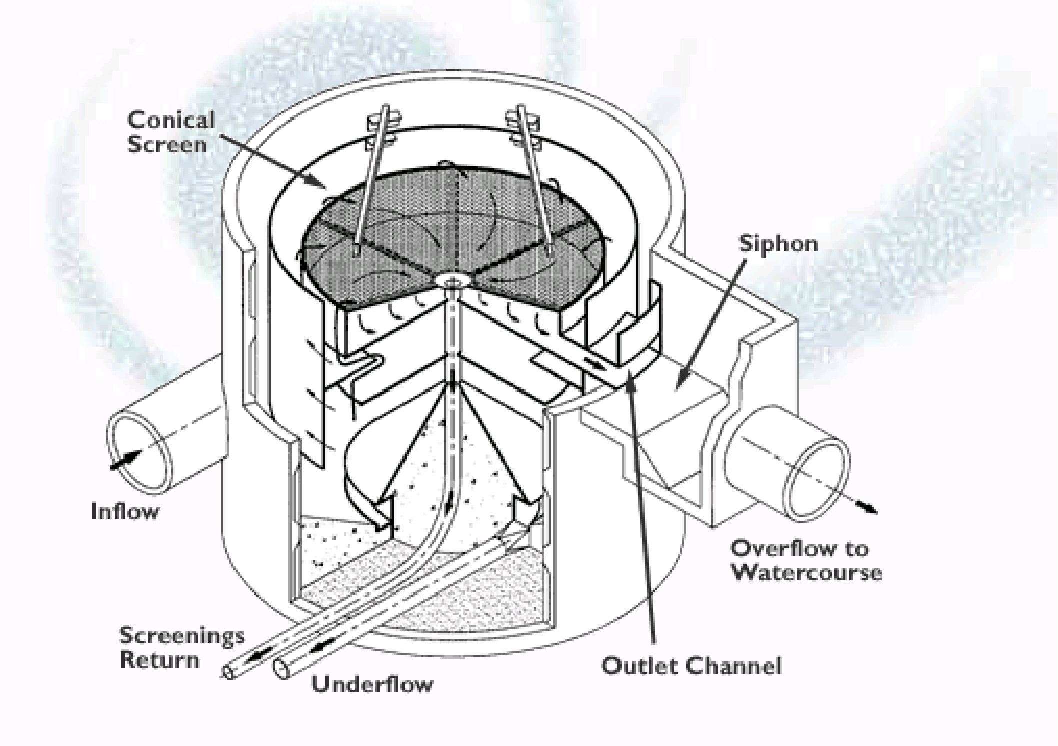

Figure 3.9 – Enhanced Vortex Separator

Alternative 6: Ballasted Flocculation

Ballasted Flocculation is a high rate sedimentation process that introduces coagulation and flocculation agents during high speed mixing to promote settlement and enhance solids removal. Ballasted flocculation involves the addition of a ballasting agent (high-density microsand, specific gravity = 2.65) to a chemically stabilized and coagulated suspension of particulate solids. Some of the benefits of ballasted flocculation are the large floc sizes that can be maintained, the greater roundness of the floc particles, and a lower shape factor for the ballasted floc, which all contribute to higher settling rates. Higher settling rates allow for smaller sedimentation units and decreased capital costs. Depending upon the application, removal rates can exceed primary treatment removal standards. Figure 3.10 shows a schematic of a Ballasted Flocculation System.

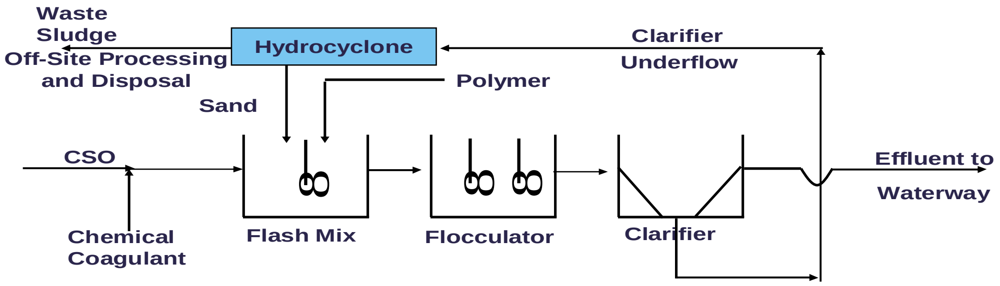

Figure 3.10 – Ballasted Flocculation (Primary Treatment)

Alternative 7: Microscreens

Screening can provide high-rate separation of solids from wastewater by preventing certain solids sizes from passing through the screen. Figure 3.11 shows a photograph of a typical microscreen.

– A Rotating Drum Supporting a Very Fine Screen
  - 23-35 micron Screen Openings
  - Screen Cleaned Using High Pressure Backwash System
  - 20-40% BOD Removal
  - 30-50% SS Removal

Figure 3.11 – Microscreens (Primary Treatment)

Table 3.4 contains a summary of the advantages and disadvantages of the seven primary treatment alternatives.

TABLE 3.4
CSO PRIMARY TREATMENT TECHNOLOGIES—ADVANTAGES AND DISADVANTAGES

Alternative	Advantages	Disadvantages
1. Rectangular Primary Settling Tanks	1. Compatible with existing sewage treatment plants. 2. Predictable solids removal rates. 3. Tank can also be used as chlorine contact volume.	1. Large space requirements. 2. Difficult to install in remote CSO locations. 3. Requires mechanical/electrical solids collection equipment.
2. Circular Primary Settling Tanks	1. Compatible with existing sewage treatment plants. 2. Predictable solids removal rates. 3. Tank can also be used as chlorine contact volume.	1. Large space requirements. 2. Difficult to install in remote CSO locations. 3. Requires mechanical/electrical solids collection equipment.
3. EPA Swirl Concentrators	1. Capable of high hydraulic loading rates, reduced space requirements. 2. No mechanical/electrical solids collection equipment. 3. Tank can also be used as chlorine contact volume.	1. Variable SS removal efficiencies, i.e. 30-50%. 2. Products are in the public domain; they are not represented by wastewater equipment manufacturers; they must be designed and fabricated. 3. Requires high pumping head.
4. Vortex Separators	1. Capable of high hydraulic loading rates, reduced space requirements. 2. No mechanical/electrical solids collection equipment. 3. Tank can also be used as chlorine contact volume.	1. Variable SS removal efficiencies, i.e. 40-60%. 2. Design hydraulic loading rates should be confirmed by pilot studies. 3. Requires high pumping head.
5. Enhanced Vortex Separators	1. Higher SS removal efficiencies than vortex separators, i.e. 55-65%. 2. No mechanical/electrical solids collection equipment. 3. Tank can also be used as chlorine contact volume.	1. Additional chemical storage and feed facilities required. 2. Design hydraulic loading rates should be confirmed by pilot studies. 3. Has a long start-up period. 4. Requires high pumping head.
6. Ballasted Flocculation	1. Higher BOD_5 and SS removal efficiencies than primary settling tanks and vortex separators.	1. Difficult to install in remote CSO locations. 2. Has a long start-up period, i.e. 10-30 minutes. 3. Requires an on-site operator.
7. Microscreens	1. Can be designed for very fine openings, down to 0.01-inch. 2. Higher SS removal efficiencies than primary settling tanks and vortex separators, i.e. ±80%.	1. Possible blinding of screens due to grease. 2. Requires high pressure water jets to clean screens.

CSO Disinfection Technologies

A number of disinfection technologies were evaluated in TM-1WQ, Disinfection Evaluation, August 26, 2005. Two disinfection alternatives were short-listed: 1) High Intensity UV Disinfection and 2) Oxygen Generated Ozone Disinfection.

Pending a detailed pilot study of both technologies by the MWRDGC, it was decided to proceed with UV disinfection for the end-of-pipe CSO treatment facilities. It should be noted that UV disinfection of CSOs is not commonly practiced due to the relatively high TSS. Potential problems with UV disinfection of CSO include excessive fouling of the UV lamps and inconsistent bacterial kills. Any future design of UV disinfection facilities for CSO treatment should include laboratory and/or pilot studies to study these potential problems.

Evaluation of Alternatives

Screening Technologies

Alternative 1 - Chain Driven-75° Vertical Bar Screens
Alternative 2 - Climber Type-80° Vertical Bar Screens
Alternative 3 - Chain Driven-60° Catenary Screens
Alternative 4 - Horizontal Overflow Screens
Alternative 5 - Horizontal Brush Overflow Screens
Alternative 6 - Rotary Drum Screens
Alternative 7 - Net Bags

These alternatives were evaluated using the matrix in Table 3.5. A discussion of this matrix evaluation follows.

TABLE 3.5
EVALUATION OF CSO SCREENING TECHNOLOGY ALTERNATIVES

	Criteria:	Life Cycle Cost	Maintainability	Operability	Reliability	Energy Efficiency	Impacts on Neighbors	Expandability	Total Score
Alternative 1. Chain Driven-75° Vertical Bar Screens	Rank x Weight Score	2 x 50 100	2 x 5 10	3 x 10 30	3 x 15 45	2 x 5 10	3 x 10 30	3 x 5 15	240
Alternative 2. Climber Type-80° Vertical Bar Screens	Rank x Weight Score	2 x 50 100	2 x 5 10	2 x 10 20	3 x 15 45	2 x 5 10	3 x 10 30	3 x 5 15	230
Alternative 3. Chain Driven-60° Catenary Bar Screens	Rank x Weight Score	3 x 50 150	3 x 5 15	3 x 10 30	1 x 15 15	2 x 5 10	3 x 10 30	3 x 5 15	265
Alternative 4. Horizontal Overflow Screens	Rank x Weight Score	1 x 50 50	2 x 5 10	3 x 10 30	3 x 15 45	2 x 5 10	2 X 10 20	1 x 5 5	170
Alternative 5. Horizontal Brush O'flow Screens	Rank x Weight Score	2 x 50 100	1 x 5 5	3 x 10 30	2 x 15 30	3 x 5 15	2 x 10 20	1 x 5 5	205
Alternative 6. Rotary Drum Screens	Rank x Weight Score	1 x 50 50	1 x 5 5	2 x 10 20	3 x 15 45	1 x 5 5	2 X 10 20	2 x 5 10	155
Alternative 7. Net Bags	Rank x Weight Score	2 x 50 100	1 x 5 5	3 x 10 30	2 x 15 30	3 x 5 15	3 X 10 30	3 x 5 15	225

CHAIN DRIVEN-60^{O} CATENARY BAR SCREENS HAVE HIGHEST SCORE

Life Cycle Cost

Alternative 3 had the lowest Life Cycle cost and therefore scored the highest (3) for this criterion. Catenary screens are fairly simple machines, with relatively low power requirements. Alternatives 4 and 6 scored lowest (1) for Life Cycle cost. Horizontal Overflow Screens require a separate, parallel concrete channel. Horizontal Drum screens require a very large footprint and use a high pressure spray wash for cleaning. Net Bags (Alternative 7) need to be replaced after every rain event, resulting in significant labor costs. This Alternative received a score of 2.

Maintainability

Alternatives 5, 6, and 7 scored low (1) for Maintainability. Trash removal from Horizontal Overflow screens is labor intensive. Rotary Drum Screens require operator attention due to the tendency of grit to collect in the bottom of the screen housing. Net Bag replacement is labor intensive, requiring access by boat. Alternative 1 was given an average rating (2) due to its submerged sprocket, which makes maintenance somewhat difficult. Chain Driven Catenary Screens, Alternative 3, scored high (3) for Maintainability, due to the absence of a lower sprocket.

Operability

Many of the alternatives scored high (3) for Operability, due to their simple ON/OFF switch operations. Alternative 2 scored a bit lower (2), because the single rake mechanism sometimes results in screen blinding under heavy debris loadings, such as during the autumn leaf drop. Rotary Drum screens also scored lower (2), due to the wide screen channels which can result in heavy grit deposits, and the requirement for preliminary coarse screening.

Reliability

The lowest score for Reliability was given to Alternative 3 (1). The smallest opening available for these screens is ½”, making their removal efficiency lower than finer screens under normal (unblinded screen) conditions. Alternative 5 scored average (2) because the screens tend to plug with rags, reducing their reliability. Alternative 7 scored average (2) because the Net Bags often blow off of the pipe end, leaving no screening mechanism.

Energy Efficiency

Alternatives 5 and 7, scored high (3) for this criterion since they use little or no power. Rotary Drum Screens scored the lowest (1). All other alternatives were relatively equal in their energy efficiency, and were given a score of 2.

Impacts on Neighbors

Alternatives 1, 2, and 3 scored high (3) for this criterion because debris is removed from the screens regularly, resulting in fewer odors. Net Bags also scored high (3), since screenings are consolidated in one spot, at the end of the pipe. Overflow Screens and Drum Screens scored lower (2) due to the tendency of rags to hang up on the screens, allowing odors to accumulate. Grit deposits and their associated odors resulted in a lower score for Rotary Drum Screens.

Expandability

Alternatives 4, 5, and 6 scored low (1) for Expandability. All three would require significant construction for expansion. Alternatives 1, 2, and 3 scored high given that their expansion would only require the construction of an additional channel.

Catenary Bar Screens earned the highest total score (265) and are the recommended alternative for screening.

Primary Treatment Technologies

Alternative 1 - Rectangular Settling Tanks
Alternative 2 - Circular Settling Tanks
Alternative 3 - EPA Swirl Concentrators
Alternative 4 - Vortex Separators
Alternative 5 - Enhanced Vortex Separators
Alternative 6 - Ballasted Flocculation
Alternative 7 - Microscreens

Table 3.6 contains the matrix evaluation of the seven Primary Treatment alternatives. This evaluation is explained below.

TABLE 3.6
EVALUATION OF CSO PRIMARY TREATMENT TECHNOLOGY ALTERNATIVES

	Criteria:	Life Cycle Cost	Maintainability	Operability	Reliability	Energy Efficiency	Impacts on Neighbors	Expandability	Total Score
Alternative 1. Rectangular Settling Tanks	Rank x Weight Score	2 x 50 100	3 x 5 15	3 x 10 30	3 x 15 45	2 x 5 10	2 x 10 20	1 x 5 5	225
Alternative 2. Circular Settling Tanks	Rank x Weight Score	2 x 50 100	3 x 5 15	3 x 10 30	3 x 15 45	2 x 5 10	2 x 10 20	1 x 5 5	225
Alternative 3. EPA Swirl Concentrators	Rank x Weight Score	3 x 50 150	3 x 5 15	3 x 10 30	1 x 15 15	3 x 5 15	3 x 10 30	3 x 5 15	270
Alternative 4. Vortex Separators	Rank x Weight Score	3 x 50 150	3 x 5 15	3 x 10 30	2 x 15 30	3 x 5 15	3 X 10 30	3 x 5 15	285
Alternative 5. Enhanced Vortex Separators	Rank x Weight Score	2 x 50 100	3 x 5 15	2 x 10 20	3 x 15 45	2 x 5 10	3 x 10 30	3 x 5 15	235
Alternative 6. Ballasted Flocculation	Rank x Weight Score	2 x 50 100	2 x 5 10	2 x 10 20	3 x 15 45	2 x 5 10	3 X 10 30	2 x 5 10	225
Alternative 7. Microscreens	Rank x Weight Score	1 x 50 50	2 x 5 10	2 x 10 20	3 x 15 45	2 x 5 10	3 X 10 30	1 x 5 5	170

VORTEX SEPARATORS HAVE HIGHEST SCORE

Life Cycle Cost

Alternative 3-EPA Swirl Concentrators and Alternative 4-Vortex Separators received the highest score (3) for cost. Both systems have low power requirements and relatively small footprints. Alternative 7-Microscreens scored lowest (1) due to their complexity, large size, and high power requirements.

Maintainability

Alternatives 1-5 scored high (3) for this criterion. All of these systems are fairly simple and relatively easy to maintain. Alternative 6 scored lower (2) because of its moving parts, the tendency of the microsand to cause abrasion, and the need to maintain chemical systems. Alternative 7 (Microscreens) received a score of 2. These systems are prone to algae growth and plugging.

Operability

Alternatives 1-4 are simple to operate remotely by activating an ON/OFF switch. They received a score of 3 for this criterion. Alternatives 5 and 6 require adjustments to their chemical dosing systems, making them more difficult to operate remotely. Alternatives 5, 6, and 7 received a score of 2.

Reliability

Alternatives 1 and 2 (Settling Tanks) have proven to be reliable technologies over the years. They are capable of removing solids from municipal wastewater. Alternatives 5 and 6 use chemical addition to enhance their performance. Alternative 7, Microscreens, work very well when the screen is new. All of these technologies received the highest score (3) for Reliability. The lowest score (1) was given to EPA Swirl Concentrators (Alternative 3). Follow-up studies by the EPA have shown that these systems did not reliably remove solids from the wastewater.

Energy Efficiency

Alternatives 3 and 4 scored highest (3) for this criterion. Neither system has moving parts, nor do they use chemicals. Their operation is simple and requires little power. Alternatives 1, 2, and 7 scored lower (2) because their moving parts require power. Alternative 5 earned a score of 2 due to its power requirements for chemical dosing. Alternative 6, Ballasted Flocculation, earned a score of 2 because pumping of sand and chemicals is required.

Impacts on Neighbors

Alternatives 1 and 2 scored the lowest (2) for this criterion. Their large surface areas and longer detention times can cause odor problems. All other alternatives scored high (3) for this criterion.

Expandability

Alternatives 1, 2, and 7 scored low for Expandability. Alternatives 1 and 2 have large footprints, making expansion difficult. The complexity of the structure makes Alternative

7 difficult to expand. Alternatives 3, 4 and 5 scored high (3) due to their small footprints. Alternative 6 scored Average (2), even though its footprint is similar to vortex units, because it requires more concrete and equipment.

Since the vortex separator achieved the highest score (285), it was selected for the end-of-pipe CSO treatment plant.

Figure 3.12 contains the schematic of the end-of-pipe CSO treatment process train which is the final result of the alternative evaluation.

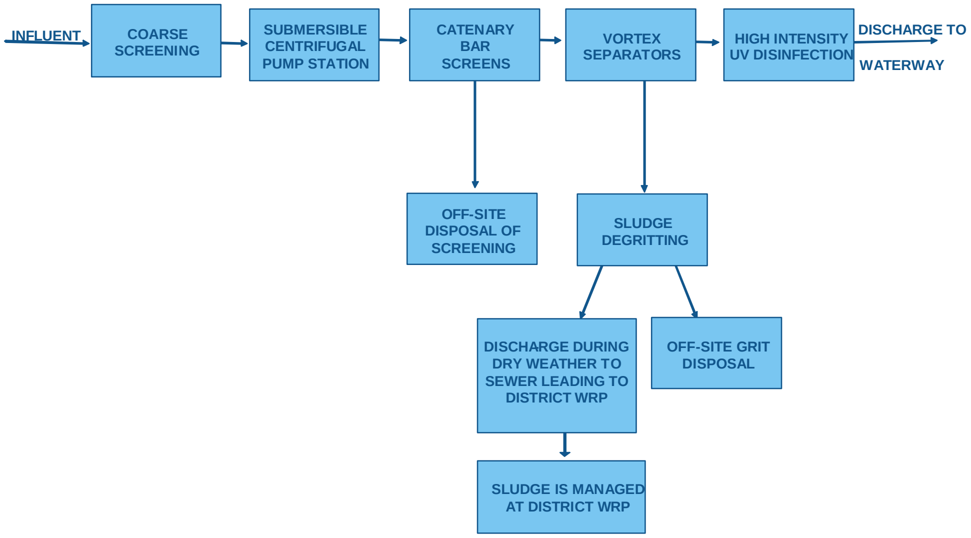

Figure 3.12 – CSO Treatment Process Train for Cost Estimation Purposes

DETERMINATION OF FLOWS

Using water-quality modeling, CSO flows for the CAWs have been determined by the Institute for Urban Environmental Risk Management at Marquette University, Milwaukee Wisconsin (See Report No. 04-14, Preliminary Calibration of a Model for Simulation of Water Quality During Unsteady Flow in the Chicago Area Waterways and Application to Proposed Changes to Navigation Make-Up Diversion Procedures, September 2004). These flows will be used to determine the water quality impacts of end-of-pipe CSO treatment.

For the sake of consistency and with agreement of the MWRDGC, the Marquette Model CSO flows were used in this report for sizing of the end-of-pipe treatment plants. The Marquette model was calibrated and verified to simulate the effects of the TARP system tunnels on CSO discharges. The TARP reservoirs have not been included in the Marquette Model.

The Marquette model determines CSO flows on entire CAWs segments and cannot determine CSO flow to particular CSOs on the waterway segment. Therefore, in this report, it is assumed CSO flow to a particular CSO on a waterway segment is represented by dividing the total CSO flow on that segment by the number of CSOs on the segment. Thus each CSO on a waterway segment is assumed to have the same flow and all end-of-pipe treatment plants for a particular waterway segment will have the same design capacity.

In order to determine the flow capacity for individual end-of-pipe CSO treatment plants, it was necessary to undertake a multi-step flow estimation approach for using the CSO flow from the Marquette model. This approach utilized the following steps:

1. Review of the rainfall event data contained in the Marquette model database.
2. Rank the rainfall events from Step1 according to intensity over a 24 hour period.
3. Rank the peak hourly flows produced by each rainfall event from Step 1.
4. Rank total overflow volume produced by each rainfall event from Step 1.
5. Review ranking from Steps 2, 3 and 4 above, and select the rainfall event to be used for the design capacity of the end-of-pipe treatment plant. Select a rainfall event (design storm) which meets USEPA CSO presumptive approach. Presumptive approach requires that 85% of CSO volume in a given year be captured for treatment.
6. For the design storm determined in Step 5, determine the CSO flow for the waterway segment using the Marquette model.
7. Determine the end-of-pipe treatment plant capacity by dividing the waterway segment flow from Step 6 by number of CSOs on the waterway segment.
8. Apply a 5% Safety Factor to capacity determined in Step 7, above.

Example of CSO Flow Estimating Procedures using the Lower NSC

The Marquette Model contains CSO flow data for rainfall events from 7/25/2001 to 10/23/2001. This database was used to select a representative design storm for use in determining flows for CSO treatment. The procedure for determining the representative design storm is discussed above. This procedure used flow data from the LNSC, as the MWRDGC directed that the results from this waterway segment could be extrapolated to other waterway segments.

Eleven storms occurred in the Chicago area from 7/25/2001 to 10/23/2001. These storms are shown in Table 3.7. Table 3.7 contains a ranking for each of these eleven storms based upon the recurrence interval determined by frequency distributions compiled by the Illinois Water Survey.

TABLE 3.7
REVIEW OF RAINFALL DATA (FROM MARQUETTE MODEL DATABASE)

Date (2001)	Rainfall Amount	Recurrence Interval**	Rainfall Intensity Rank
7 / 25	2.37 " / 3 Days	6 Month	3
8 / 2	3.58 " / 1 Day	2 Year	1
8 / 25	1.31 " / 1 Day	2 Month	6
8 / 31	0.80 " / 2 Days	1 Month	11
9 / 19	1.62 " / 3 Days	2 Month	5
9 / 21	1.03 " / 2 Days	1 Month	10
9 / 23	0.58 " / 1 Day	1 Month	8
10 / 5	1.62 " / 2 Days	3 Month	4
10 / 12	1.03 " / 2 Days	1 Month	9
10 / 14	2.80 " / 2 Days	1 Year	2
10 / 23	0.66 " / 1 Day	1 Month	7

**Frequency Distributions of Heavy Rainstorms in Illinois, Illinois State Water Survey, Champaign, 1989

Table 3.8 lists the three highest hourly CSO flows calculated by the Marquette model for the LNSC for the eleven storm events shown in Table 3.7. The hourly flows were then used to rank the eleven storm events from highest to lowest.

TABLE 3.8
LOWER NSC – PEAK HOURLY FLOWS (FROM MARQUETTE MODEL)

Date (2001)	Rainfall Amount	3 Highest Hourly Flows	Peak Hourly Flow Rank
7 / 25	2.37 " / 3 Days	152.0 / 152.0 / 128.4 Mgd	9
8 / 2	3.58 " / 1 Day	755.7 / 511.7 / 485.1 Mgd	1
8 / 25	1.31 " / 1 Day	771.3 / 410.3 / 353.8 Mgd	2
8 / 31	0.80 " / 2 Days	289.9 / 289.9 / 248.4 Mgd	5
9 / 19	1.62 " / 3 Days	339.2 / 316.2 / 293.0 Mgd	4
9 / 21	1.03 " / 2 Days	220.4 / 180.3 / 140.2 Mgd	8
9 / 23	0.58 " / 1 Day	242.4 / 215.7 / 188.5 Mgd	7
10 / 5	1.62 " / 2 Days	134.6 / 134.6 / 119.8 Mgd	10
10 / 12	1.03 " / 2 Days	232.8 / 232.8 / 187.8 Mgd	6
10 / 14	2.80 " / 2 Days	365.5 / 342.9 / 310.5 Mgd	3
10 / 23	0.66 " / 1 Day	132.6 / 132.6 / 94.7 Mgd	11

Table 3.9 contains a listing of the Marquette model calculated total overflow volumes for the LNSC for the eleven storm events shown in Table 3.7. These total overflow volumes were then used to develop a ranking for the eleven storm events.

TABLE 3.9
LOWER NSC CSO FLOWS TOTAL (FROM MARQUETTE MODEL)

Date (2001)	Rainfall Amount	Overflow Volume	Overflow Volume Rank
7 / 25	2.37" / 3 Days	31.9 M.G.	10
8 / 2	3.58 " / 1 Day	185.4 M.G.	1
8 / 25	1.31 " / 1 Day	97.6 M.G.	3
8 / 31	0.80 " / 2 Days	62.6 M.G.	4
9 / 19	1.62 " / 3 Days	55.1 M.G.	5
9 / 21	1.03 " / 2 Days	45.8 M.G.	6
9 / 23	0.58 " / 1 Day	43.7 M.G.	7
10 / 5	1.62 " / 2 Days	35.8 M.G.	9
10 / 12	1.03" / 2 Days	37.5 M.G.	8
10 / 14	2.80 " / 2 Days	153.2 M.G.	2
10 / 23	0.66 " / 1 Day	17.4 M.G.	11
Sum		766.0 M.G.	

Table 3.10 contains a summary of the rankings from Tables 3.7, 3.8, and 3.9 for three of the eleven storms events. Table 3.10 was constructed to demonstrate the procedure for selecting the design storm for determining end-of-pipe treatment plant capacity. As can be seen, the storm event on 10/14/01 was 2.80 inches over 2 days. This storm event was the second highest intensity of the eleven storms, produced the second highest total overflow and had the third highest hourly flow. This storm appeared to be a good candidate for selection as the design storm event. USEPA's CSOs regulations only require that 85% of the CSO produced in a given year be given treatment. Since this storm represents a substantial rainfall event, using it for determining the design flow for the CSO treatment plants should meet the 85% removal requirement.

Table 3.11 shows CSO overflow volumes calculated by the Marquette University Model for the eleven storm events from 7/28/01 to 10/23/01 to the study area waterway segments of the CAWs. It was determined that if CSO treatment plants were designed for the 10/14/20/2001 storm, 93.7% of the CSO volume produced by the eleven rainfall events in 2001 would be treated. Table 3.11 also shows the treated CSO volume based on treatment capacity using this Design Storm from Table 3.10. This exceeds the requirements for the U.S. EPA's Presumption Approach, which requires that 85% of the CSOs in a given year be captured for treatment. Therefore, the Design Storm of 10/14/2001 is a reasonable choice and was the basis for determining CSO flows on waterway segments using the Marquette University Model.

TABLE 3.10
DETERMINATION OF CSO TREATMENT PLANT DESIGN FLOW FOR LNSC

3 Largest Overflows (By Volume)	8/2/2001	8/25/2001	10/14/2001
Rainfall Amount	3.58" / 3 Days	1.31" / 1 Day	2.80" / 2 Days
Recurrence Interval	2 Year	2 Month	1 Year
Rainfall Rank	1	6	2
Highest Hourly Flows	756/512/485 Mgd	771/410/354 Mgd	366/343/311 Mgd
Flow Rank	1	2	3
Overflow Volume	185.4 Mgd	97.6 Mgd	153.2
Overflow Rank	1	3	2
Recommended Design Storm: 10/14/2001 LNSC Design Flow = Average of 3 Highest hourly flows = 340 Mgd			

TABLE 3.11
TREATED VOLUME FOR PERIOD OF 7/25/01 TO 10/23/01 USING 2.80" STORM FOR DESIGN FLOW CAPACITY

Waterway Segment	Total Overflow Volume (MG)	Treated Overflow Volume (MG)
UNSC	1,178	1,113
LNSC	766	718
NBCR	1,904	1,784
CR	112	105
SBCR	815	764
Total	4,784	4,483

DETERMINATION OF CSO DESIGN FLOW

Lower NSC Example Determination of CSO Treatment Design Flow Per Site

The LNSC will be used to illustrate how CSO treatment plant capacity is determined for the study area waterway segments. There are 20 CSO sites on the Lower North Shore Channel. The CSO Treatment Design Flow for the LNSC was determined as follows:

Average of three highest CSO Peak Flows for Design Storm (See Table 3.10): 340 MGD

Number of CSO Treatment Sites on LNSC: 20

Calculated Design Flow per Site = 340 MGD/20 Sites = 17 MGD/Site

Recommended CSO Treatment Capacity per Site = 17 MGD/Site x 5% Safety Factor

= 18 MGD/Site

Total LNSC CSO Treatment Capacity = 18 MGD/Site x 20 Sites = 360 MGD

The same procedure was then applied to other sites along the CAWs to determine a Recommended CSO Treatment Capacity Per Site. Table 3.12 summarizes these capacities.

TABLE 3.12
SUMMARY OF CSO TREATMENT CAPACITIES PER SITE & PER CAWs SEGMENT USING SAME PROCEDURES AS LNSC

Waterway Segment	Recommended Design Flow for CSO Treatment	CSO Treatment Sites per CAWs	Recommended CSO Treatment Capacity Per Site
UNSC	520 MGD	25 Sites	520/25 x 5%=22 MGD
LNSC	340 MGD	20 Sites	340/20 x 5%=18 MGD
NBCR	850 MGD	59 Sites	850/59 x 5%=15 MGD
CR	49 MGD	18 Sites	49/18 x 5%=3 MGD
SBCR	359 MGD	48 Sites	359/48 x 5%=8 MGD

LAND AVAILABILITY FOR CSO TREATMENT

Figure 3.13 shows the layout that was developed for the 18 mgd facility on the LNSC. This layout requires a one-half acre footprint. Land required for treatment plants located along other waterway segments was determined proportionally, based on treatment plant capacities. These land requirements are shown in Table 3.13.

Aerial photographs and survey information were used on the LNSC and Chicago River to estimate the land area available for locating a treatment plant at each potential CSO site, within the study area, on the CAWs. This was done by superimposing a representative treatment plant area (drawn to scale) onto an aerial photograph of similar scale of the CSO. For the UNSC and SBCR, land availability was determined by assuming land availability was similar to other segments as explained below.

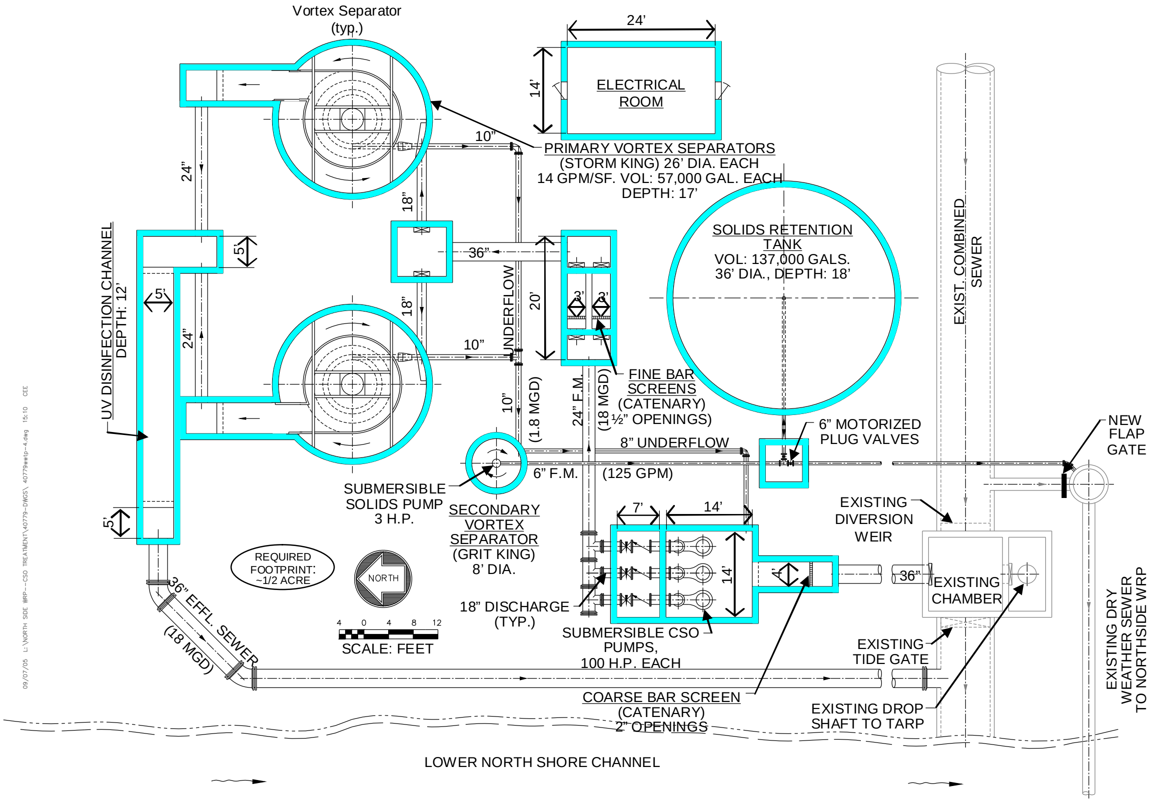

Figure 3.13 - Layout of Typical LNSC CSO Treatment Facility (18 mgd)

Using aerial photos and CADD, 0.50-acre parcels for the 18 mgd treatment plant (Figure 12) were placed at each CSO along the LNSC to determine whether or not a treatment plant would fit on the site. This detailed survey showed that 100% of the land in the Lower North Shore Channel is available since most of the sites are park land. Since the land along the Upper North Shore Channel is similarly occupied by park land, it was determined that there is 100% land availability in this area as well. A detailed survey was not performed on the UNSC.

A similar approach was used in the NBCR and SBCR. A 0.45-acre footprint was required for the 15 mgd treatment plants on the CSO sites along the North Branch of the Chicago River. Thirty-three of the fifty-nine sites have "reasonable" land availability for CSO treatment facilities. These sites contain a mixture of park land, parking lots, single family residences, and vacant land. Twenty-six sites have permanent structures such as high rise buildings and major roads. These sites are not available for treatment facilities. Therefore, land availability in the North Branch of the Chicago River is approximately 56%. The South Branch of the Chicago River is located in a similar mixed-use area. A detailed survey was not performed in this area. It is assumed that land availability is also 56% along the SBCR.

The Chicago River segment runs through the heart of downtown Chicago. Locating a treatment plant at any of these CSOs would require relocation of major roads and buildings, such as Wacker Drive and Marina Towers. This is not feasible, and for all practical purposes the land availability along this segment is 0%. A detailed survey using aerial photographs and CADD was performed along this waterway to verify the lack of land availability.

Of the 170 potential CSO treatment sites, land is available for 105 of them, for an overall availability of 62%. Table 3.13 shows the percent land availability for potential CSO treatment plants located in each segment.

TABLE 3.13
SUMMARY OF LAND AVAILABILITY STUDY

Waterway Segment	No. of CSO Treatment Plants/Total CSOs	Total Acreage Required	Total CSO Treatment Flow Capacity (MGD)
UNSC	25/25	15	546
LNSC	20/20	10	357
NBCR	33/59	15	890
CR	0/18	0	0
SBCR	27/48	8	216
Total	105/170	48	2009

DETERMINATION OF CSO TREATMENT COSTS

General Cost Estimation Issues

The following issues are taken into account when estimating costs for treatment facilities at CSOs along the CAWs:

- The Cost Estimate has been developed at a study level. The accuracy of this cost estimate is estimated to be plus or minus 30%.
- It is assumed that screenings disposal and grit disposal will be accomplished off-site using private contractors.
- After a storm ends, degritted sludge will be conveyed to the MWRDGC's Water Reclamation Plants via existing dry weather interceptors.
- Based on discussions with MWRDGC, and as previously mentioned in this report, the North Branch and Racine Avenue Pump Stations are not included in this cost estimate for end-of-pipe CSO treatment.
- CSOs in the Chicago River segment were also not included in this cost estimate. It was determined previously that these sites cannot support treatment facilities due to lack of land availability.
- There are a total of 105 sites that can support end-of-pipe CSO treatment facilities in the study area.

General Cost Estimating Procedure

The Marquette Model has been used to determine end-of-pipe CSO treatment plant capacity for the five waterway segments included in this study (See Table 3.12). A detailed planning level construction cost estimate was developed for one 18 mgd CSO treatment plant on the Lower NSC. From this detailed estimate, a unit cost in terms of $/mgd was calculated. This unit cost was applied to all 105 sites along the CAWs, using the treatment plant capacities from Table 3.12, to determine the cost of treatment for these CSO sites.

Appendix B contains a listing of the unit cost factors (Labor, Energy, etc.) used in determining the cost estimates for this Technical Memorandum. These unit costs are consistent with the cost factors found in TM-3.

Costs for Vortex Separators

The costs for the vortex separators was provided by Hydro International of Portland Maine. The sizing of the units assumed a design hydraulic loading rate of 11.8 gpm/ft^2. This design hydraulic loading rate was based upon Hydro's experience with their units treating CSOs throughout the country with a new improved vortex separator design. For typical CSOs, Hydro believes that a design peak hydraulic loading rate of 11.8 gpm/ft^2 will produce a BOD$_5$ removal of 30% and a total suspended solids (TSS) removal of 50%.

CTE is concerned that the MWRDGC's CSOs may not be typical of other CSOs throughout the country since the dry weather levels of BOD_5 and TSS in MWRDGC sewage are relatively dilute in comparison to other municipalities.

Based upon an examination of MWRDGC CSO sampling data, Marquette University assumed in the model the following levels in CSOs in the study area for the year 2002:

CSO Area	**BOD_5 (mg/l)**	**TSS (mg/l)**
North Side WRP Drainage Basin	35.44	101.85
Stickney WRP Drainage Basin	52.15	499.95

For the year 2001, Marquette University incorporated various BOD_5 and TSS levels for CSOs depending upon the storm event and the drainage basin for the CSO. For 2001, the CSO BOD_5 used in the Marquette Model ranged from 30.22 to 92.5 mg/l while the TSS ranged from 52.2 to 2,068 mg/l.

Water Environment Federation Manual of Practice (MOP) FD-17 (1999) gives typical pollutant concentrations for CSOs. MOP FD-17 shows the typical BOD_5 of CSO to be in the range of 25-100 mg/l and TSS to be 150-400 mg/l. Thus, MWRDGC CSO pollutant strength in terms of BOD_5 and TSS is within the range of concentrations found at other municipalities in the U. S. Thus, MWRDGC CSO pollutant strength appears typical of that found at other municipalities in the U.S.

CTE discussed the MWRDGC CSO BOD_5 and TSS data with Hydro International and asked whether the design hydraulic loading rate of 11.8 gpm/ft^2 at peak flow would produce 30% BOD_5 removal and 50% TSS removal for the MWRDGC CSOs. Hydro International stated that the determination of a design peak hydraulic loading rate for a particular CSO can only be determined through laboratory and/or pilot plant studies.

CTE believes that the design hydraulic loading rate of 11.8 gpm/ft^2 used to size the vortex separators may be higher than that which will produce the target BOD_5 and TSS removals of 30% and 50% respectively. In other words, a lower design hydraulic loading rate and thus larger vortex separators may be needed to achieve the target BOD_5 and TSS removals. As stated previously, CTE is concerned that the relatively low BOD_5 and TSS concentrations in MWRDGC CSOs may require a lower design hydraulic loading rate than 11.8 gpm/ft^2 in order to produce the target BOD_5 and TSS removals. Pilot and/or laboratory testing are needed to determine the design hydraulic loading rate for MWRDGC CSOs. CTE believes that such pilot and/or laboratory tests will probably result in a lower design hydraulic rate than 11.8 gpm/ft^2. Thus the costs for vortex separators would be higher than that presented in this technical memorandum.

Example of CSO Construction Cost Estimating Procedure using the Lower NSC

Detailed construction costs for the 18 mgd facility on the LNSC are shown in Appendix C. Items contained in this cost estimate include equipment, concrete, electrical and instrumentation costs. Equipment costs were obtained from vendors. Electrical and instrumentation costs were estimated to be 25% of the total construction cost. The contingency for this estimate is 40%. This value includes the 30% contingency recommended by the MWRDGC, as well as a 10% allowance for the demolition of existing structures on the sites.

The total costs for equipment, concrete, electrical, instrumentation, overhead (O) and profit (P) plus contingency for one 18 mgd CSO Treatment Facility is estimated to be $8.1 million. Dividing that cost by the facility size (18 mgd) gives a unit construction cost of $451,000/mgd. (See Table 3.14).

TABLE 3.14
UNIT CONSTRUCTION COSTS FOR 18 MGD CSO TREATMENT PLANT

Item	Costs
Coarse Screens, Pumping, Fine Screens, Vortex Separators, UV Disinfection	$4,190,800
Electrical & Instrumentation	$1,047,700
Subtotal	$5,238,500
40% contingency; 15% O&P	$2,881,175
Total Estimated Construction Cost	$8,119,675
Cost/MGD = $8,119,675/18 MGD = $451,093	

The MWRDGC owns most of the land along the UNSC and LNSC. For the NBCR and SBCR, the MWRDGC is not a significant land owner. Therefore, based upon discussions with the MWRDGC's Engineering Department, Table 3.15 lists the estimated number of CSO treatment plant sites which will need to be purchased on the study area waterway segments:

TABLE 3.15
CSO SITES TO BE PURCHASED

Waterway Segment	**Number of Sites to be Purchased**
UNSC	6
LNSC	5
NBCR	33
CR	0
SBCR	27
Total	71

Table 3.16 lists the condemnation costs, as supplied by the MWRDGC.

TABLE 3.16
CONDEMNATION COSTS FOR PROPOSED CSO TREATMENT SITES

Costs	**Cost per Site**
Administration	$3,500
Appraisal	$1,500
Survey	$8,000
Legal	$7,000
Environmental Assessment	$13,700
Total	$43,700

Table 3.17 lists the estimated construction costs, engineering costs, and land costs for the 105 CSOs on the CAWs.

Land costs were based upon information from the MWRDGC's Engineering Department which provided a range of land costs/acre for the CAWs study area. These land costs are found in Appendix D. A range of land costs was provided to CTE. Since land costs represent only a small portion of total costs, only the high end of the range of land costs are used for the cost estimate.

TABLE 3.17
TOTAL CAPITAL COSTS

Waterway Segment	Estimated Construction Costs	Estimated Engineering Costs and Construction Management	Estimated No. Of Sites to Purchase	Costs To Condemn $43.7K per Site*	Land Cost per Waterway Segment (High End Estimate)	Total Capital Cost (High End)
UNSC	$246,000,000	$49,200,000	6	$300,000	$2,200,000	$298,000,000
LNSC	$161,800,000	$32,200,000	5	$200,000	$1,300,000	$195,000,000
NBCR	$224,500,000	$44,900,000	33	$1,400,000	$10,000,000	$281,000,000
CR	$0	$0	0	$0	$0	$0
SBCR	$95,500,000	$19,100,000	27	$1,200,000	$3,600,000	$119,000,000
Total	$727,800,000	$145,400,000	71	$3,100,000	$17,100,000	$893,000,000

*Administration, Appraisal, Survey, Environmental Assessment and Legal Costs

The total capital cost for the twenty 18 mgd facilities located on the LNSC is estimated to be $195 million. The total capital costs for all 105 facilities is estimated to be $893 million.

Estimation of O&M Costs

Annual quantities of solids, screenings and grit were calculated for each CSO based on the treatment facility size in million gallons. Unit volumes of grit and screenings in terms of cubic feet per million gallons were taken from Water Environment Federation Manual of Practice No. 8 and were 8.5 ft^3/mgd and 5 ft^3/mgd, respectively.

Unit costs for handling of solids, screenings and grit were applied to these volumes to determine total cost for management of these materials. Table 3.18 lists the total disposal and management costs. The unit costs for biosolids management can be found in Appendix B. Unit costs for screenings and grit disposal can be found in Appendix E. Unit costs for grit and screenings were based upon information from North Side WRP Maintenance and Operations (M&O) personnel. Sludge treatment and management unit costs were based upon 1995 M&O department budget costs for sludge management for the Stickney Plant extrapolated to 2005 dollars using the Engineering News Record Index.

Total annual O&M costs per waterway segment were developed using grit, screening and sludge management costs from Table 3.18, plus costs for energy, fuel, and labor for the CSO treatment plant processes.

TABLE 3.18
ANNUAL SCREENINGS, GRIT, AND SOLIDS MANAGEMENT COSTS

Waterway Segment	CSO Treatment Plants Per Waterway Segment	Treated Annual CSO Volume (MG/Yr)	Screenings Volume @ 8.5 Cu. Ft./MG (CY/Yr)	Annual Screenings Disposal Cost @ $35/CY)	Annual Grit Volume @5 Cu. Ft./MG (CY)	Annual Grit Disposal Cost @ $35/CY	Dry Solids @ 50% SS Removal in Vortex Separator (Dry Ton/Yr)	Annual Sludge Treatment & Management Cost @ $260/Dry Ton
UNSC	25	2,967	934	$33,000	549	$19,000	619	$48,000
LNSC	20	1,914	602	$21,000	354	$12,000	399	$31,000
NBCR	33	2,660	838	$29,000	493	$17,000	555	$43,000
CR	0	0	0	$0	0	$0	0	$0
SBCR	27	1,146	361	$13,000	212	$7,000	239	$19,000
Total	105	8,687	2,735	$96,000	1,609	$55,000	1,811	$141,000

Table 3.19 lists the annual total O&M costs for CSO sites at each waterway segment of the CAWs as well as the total O&M costs. The total annual O&M cost for the LNSC is approximately $746,000. The total annual O&M cost for all 105 CSO Treatment Facilities is approximately $3.8 M.

TABLE 3.19
TOTAL ANNUAL OPERATIONS & MAINTENANCE COSTS

Waterway Segment	Screenings Disposal Cost	Grit Disposal Cost	Solids Treatment & Disposal Cost	Energy, Fuel & Lamp Replacement Cost	Labor Cost	Total O&M Cost
UNSC	$33,000	$19,000	$48,000	$299,000	$610,000	$1,000,000
LNSC	$21,000	$12,000	$31,000	$193,000	$488,000	$746,000
NBCR	$29,000	$17,000	$43,000	$268,000	$805,000	$1,200,000
CR	$0	$0	$0	$0	$0	$0
SBCR	$13,000	$7,000	$19,000	$116,000	$659,000	$813,000
Total	$96,000	$55,000	$141,000	$876,000	$2,562,000	$3,759,000

20 Year Present Worth Costs

Present Worth (PW) Costs were developed for each waterway segment of the CAWs. These PW costs were applied to the low end capital cost, high end capital cost and annual O&M costs calculated previously. The present worth factors used for this estimate are 3% annual interest rate, 3% annual inflation rate, and a mechanical facilities life of 20 years.

20 year present worth costs are presented in Table 3.20.

TABLE 3.20
20 YEAR PRESENT WORTH COSTS @ 3% INTEREST & 3% INFLATION

Waterway Segment	Capital Cost (High End Land Cost)	Annual O&M Cost	Present Worth Annual O&M Cost	Total Present Worth Cost (High End Land Cost)
UNSC	$298,000,000	$1,000,000	$20,000,000	$318,000,000
LNSC	$195,000,000	$746,000	$14,000,000	$209,000,000
NBCR	$281,000,000	$1,200,000	$23,000,000	$304,000,000
CR	$0	$0	$0	$0
SBCR	$119,000,000	$813,000	$16,000,000	$135,000,000
Total	$893,000,000	$3,759,000	$73,000,000	$966,000,000

The total present worth cost for treating CSO flows in the Chicago Area Waterways is approximately $966 million.

<u>Aesthetic Issues</u>

There exist numerous political and economic obstacles to obtaining land along the CAWs for the purpose of constructing end-of-pipe CSO treatment facilities. There are countless stakeholders involved in this area, all of whom would need to reach consensus on the proposed use of the land. Any decision to place treatment facilities along the busy, scenic CAWs needs to be made with a sensitivity to many socio-political considerations.

SUMMARY

The IEPA is conducting a UAA for the Chicago Area Waterways. As part of the UAA process, the IEPA requested that the MWRDGC determine the technologies and costs for end-of-pipe treatment of CSOs on the NSC, NBCR, SBCR and Chicago River.

CTE Engineers was commissioned by the MWRDGC to conduct the IEPA requested study of end-of-pipe treatment of CSOs.

Based upon a detailed evaluation of various CSO treatment alternatives and an analysis of state and federal CSO regulations, CTE determined that the end-of-pipe treatment plants should consist of:

Coarse Screening
Submersible Centrifugal Pumps
Catenary Bar Screens (Fine Screens)
Vortex Separators
High Intensity UV Disinfection

All of these technologies would need to be reviewed again if design work were to proceed since a more in-depth assessment involving pilot and/or laboratory testing would be necessary. Disposal of screenings and grit would be done off-site at local landfills while sludge management would be accomplished at the MWRDGC's North Side and Stickney WRPs.

There are a total of 170 CSOs in the study area. Based upon the needed space requirements for an end-of-pipe treatment plant at each site and the available land, it was determined that treatment plants could be located at 105 of the 170 sites. Placement of treatment plants at the other 65 sites would require demolition of large multi-story buildings or relocation of major roads. In particular, it was not possible to site CSO treatment plants at any of the 18 CSO sites on the Chicago River without the need to demolish large downtown buildings or move major roads such as lower Wacker Drive. Similar demolition/and or road relocation would be required for some sites on the NBCR and SBCR.

To provide end-of-pipe treatment for the 105 sites would require a total capital expenditure of approximately $893 million and have a continuing annual cost of nearly $3.8 million. The total present worth for CSO treatment (capital and annual) would be $966 million.

It should be noted that the construction of 105 end-of-pipe treatment plants on the NBCR and SBCR would involve overcoming numerous political, aesthetic and economic obstacles. There are countless stakeholders in the study area all of whom would need to reach consensus to overcome these obstacles. Even if all these obstacles can be overcome and the MWRDGC invests $966 million on a present worth basis, end-of-pipe CSO treatment will still not achieve the USEPA requirement that 85% of the CSOs in a given year be captured for treatment from the 170 CSO points in the study area.

APPENDIX A
CSO OUTFALL LOCATIONS IN THE STUDY AREA

CSO Outfalls in the Study Area

- **North Side WRP Service Area CSO Outfalls in the Study Area:**

Receiving Water	NPDES Outfall No.	Owner--Location
UNSC	S010	Wilmette--Sheridan Rd.
UNSC	M101	MWRDGC--Sheridan Rd., Wilmette PS
UNSC	M102	MWRDGC--Green Bay Rd. & McCormick Blvd., W of Channel
UNSC	M103	MWRDGC--Emerson St. & Leland Ave.
UNSC	S010	Evanston--Isabella St., E of Channel
UNSC	S020	Evanston--Central St., E of Channel
UNSC	S030	Evanston--Lincoln St., W of Channel
UNSC	S040	Evanston--Asbury Ave., E of Channel
UNSC	S050	Evanston--Bridge St., W of Channel
UNSC	S060	Evanston--Elgin Road, S of Emerson St., W of Channel, next to bridge
UNSC	S070	Evanston--Emerson St., W of Channel
UNSC	M104	MWRDGC--Lake St., E of Channel
UNSC		Evanston--Green Bay Rd. & McCormick Blvd.
UNSC	S090	Evanston--Greenleaf St., E of Channel
UNSC	S020	Skokie--Greenwood St., W of Channel
UNSC	S030	Skokie--Emerson St. & McCormick Blvd.
UNSC	S100	Evanston--Main St., E of Channel
UNSC	A10	Evanston--Main St., W of Channel
UNSC	S110	Evanston--Cleveland St., E of Channel
UNSC	S120	Evanston--Oakton St., E of Channel
UNSC	S130	Evanston--Mulford St., E of Channel
UNSC	A13	Evanston--Mulford St., E of Channel
UNSC	S140	Evanston--Simpson St.
UNSC	M110	MWRDGC--Oakton St. & McCormick Blvd.
UNSC	S010	Skokie--N of Howard St., W of Channel, in sluice gate chamber
LNSC	M105	MWRDGC--Howard St. & McCormick Blvd.
LNSC	M106	MWRDGC--Morse Ave. (Extension) & McCormick Blvd.
LNSC	C001	Chicago--Touhy Ave., E of Channel
LNSC	C002	Chicago--Pratt Ave., E of Channel
LNSC	C003	Chicago--North Shore Ave., 260' S of DS 97, E of Channel, S of Pratt
LNSC	S010	Lincolnwood--Morse Ave. (Extension), W of

		Channel
LNSC	S020	Lincolnwood--Pratt Ave.
LNSC	C004	Chicago--Devon Ave., W of Channel
LNSC	C005	Chicago--Devon Ave., E of Channel
LNSC	C006	Chicago--Peterson Ave., E of Channel
LNSC	C007	Chicago--Peterson Ave., W of Channel
LNSC	C008	Chicago--Thorndale Ave., W of Channel
LNSC	C009	Chicago--Ardmore Ave., W of Channel
LNSC	C010	Chicago--Ardmore Ave., E of Channel
LNSC	C011	Chicago--Bryn Mawr Ave., E of Channel
LNSC	C012	Chicago--Bryn Mawr Ave., W of Channel
LNSC	C013	Chicago--Balmoral Ave., E of Channel
LNSC	C014	Chicago--Foster Ave., W of Channel
LNSC	C015	Chicago--Foster Ave., E of Channel
LNSC	C038	Chicago--Berwyn Ave., W of Channel

NBCR	C035	Chicago--Kedzie Ave., W of NBCR
NBCR	C040	Chicago--Argyle St., W of NBCR
NBCR	C041	Chicago--Lawrence Ave., W of NBCR
NBCR	C042	Chicago--N of Lawrence, W of NBCR
NBCR	C043	Chicago--Giddings St., W of NBCR
NBCR	C044	Chicago--Leland Ave., W of NBCR
NBCR	C045	Chicago--Leland Ave., E of NBCR
NBCR	C046	Chicago--Wilson Ave., E of NBCR
NBCR	C047	Chicago--Wilson Ave., W of NBCR
NBCR	C048	Chicago--Sunnyside Ave., E of NBCR
NBCR	C049	Chicago--Sunnyside Ave., W of NBCR
NBCR	C050	Chicago--Agatite Ave., E of NBCR
NBCR	C051	Chicago--Montrose Ave., E of NBCR
NBCR	C052	Chicago--Montrose Ave., W of NBCR
NBCR	C057	Chicago--Berteau Ave.,W of NBCR
NBCR	C058	Chicago--Irving Park Rd., E of NBCR
NBCR	C059	Chicago--Irving Park Rd., W of NBCR
NBCR	C060	Chicago--Grace St., W of NBCR
NBCR	C061	Chicago--Addison, E of NBCR, inside Com Ed's property
NBCR	C062	Chicago--Addison St., W of NBCR
NBCR	C231	Chicago--Grace St., W of NBCR
NBCR	C063	Chicago--Roscoe, W of NBCR
NBCR	C064	Chicago--Belmont, W of NBCR

NBCR	C065	Chicago--Western, S of Nelson, E of NBCR
NBCR	C066	Chicago--Oakley Ave., E of NBCR
NBCR	C067	Chicago--Leavitt St., E of NBCR
NBCR	C068	Chicago--Diversey, W of NBCR
NBCR	C069	Chicago--Diversey Ave., E of NBCR
NBCR	C070	Chicago--Logan Blvd., S of Diversey, W of NBCR
NBCR	C072	Chicago--Damen Ave., W of NBCR
NBCR	C073	Chicago--Fullerton, W of NBCR

- **Stickney WRP Service Area CSO Outfalls in the Study Area:**

Receiving Water	NPDES Outfall No.	Owner--Location
NBCR	C075	Chicago--Fullerton Ave., E of NBCR
NBCR	C076	Chicago--Webster Ave., E of NBCR
NBCR	C077	Chicago--McLean Ave., W of NBCR
NBCR	C078	Chicago--McLean Ave., E of NBCR
NBCR	C079	Chicago--Cortland St., W of NBCR
NBCR	C080	Chicago--Cortland St., E of NBCR
NBCR	C081	Chicago--Clifton Ave., E of NBCR
NBCR	C082	Chicago--North Ave., W of NBCR
NBCR	C083	Chicago--North Ave., E of NBCR
NBCR	C084	Chicago--Blackhawk St., W of NBCR
NBCR	C085	Chicago--Blackhawk St., E of NBCR
NBCR	C086	Chicago--Eastman St., E of NBCR
NBCR	C087	Chicago--Division St., W of NBCR
NBCR	C088	Chicago--Division St., E of NBCR
NBCR	C089	Chicago--Division St., W of NBCR
NBCR	C090	Chicago--Halsted St., E of NBCR
NBCR	C230	Chicago--Hobbie St., E of NBCR
NBCR	C091	Chicago--Halsted St., W of NBCR
NBCR	C092	Chicago--Cortez St., W of NBCR
NBCR	C093	Chicago--Cortez St., E of NBCR
NBCR	C094	Chicago--Haines St., E of NBCR
NBCR	C095	Chicago--Halsted St., E of NBCR
NBCR	C096	Chicago--Chicago Ave., W of NBCR
NBCR	C097	Chicago--Chicago Ave., E of NBCR
NBCR	C098	Chicago--Erie St., W of NBCR
NBCR	C099	Chicago--Erie St., E of NBCR
NBCR	C100	Chicago--Grand Ave., W of NBCR
NBCR	C101	Chicago—Kinzie St., W of NBCR

CR	C104	Chicago--Lake Shore Dr., N of CR
CR	C105	Chicago--Fairbanks Ct., N of CR
CR	C106	Chicago—Beaubien Ct., S of CR
CR	C107	Chicago--Michigan Ave., N of CR
CR	C108	Chicago--St. Clair St., N of CR
CR	C109	Chicago--Michigan Ave., S of CR
CR	C110	Chicago--Rush St., N of CR
CR	C111	Chicago--Wabash Ave., S of CR
CR	C112	Chicago--State St., S of CR
CR	C113	Chicago--Dearborn St., N of CR
CR	C114	Chicago--Dearborn St., S of CR
CR	C115	Chicago--Clark St., N of CR
CR	C116	Chicago--Clark St., S of CR
CR	C117	Chicago--LaSalle St., N of CR
CR	C118	Chicago--LaSalle St., S of CR
CR	C119	Chicago--Wells St., N of CR
CR	C120	Chicago--Wells St., S of CR
CR	C121	Chicago--Franklin St., S of CR
SBCR	C123	Chicago--Randolph St., E of SBCR
SBCR	C124	Chicago--Washington St., E of SBCR
SBCR	C125	Chicago--Washington St., W of SBCR
SBCR	C126	Chicago--Madison St., E of SBCR
SBCR	C127	Chicago--Monroe St., E of SBCR
SBCR	C128	Chicago--Adams St., E of SBCR
SBCR	C129	Chicago--Quincy St, E of SBCR
SBCR	C130	Chicago--Jackson Blvd., E of SBCR
SBCR	C131	Chicago--Van Buren St., E of SBCR
SBCR	C132	Chicago--Harrison St., W of SBCR
SBCR	C133	Chicago--Harrison St., E of SBCR
SBCR	C134	Chicago--Polk St., W of SBCR
SBCR	C135	Chicago--Polk St., E of SBCR
SBCR	C136	Chicago--Taylor St., W of SBCR
SBCR	C137	Chicago--Taylor St., E of SBCR
SBCR	C138	Chicago--Roosevelt Rd., W of SBCR
SBCR	C139	Chicago--Roosevelt Rd., E of SBCR
SBCR	C140	Chicago--Maxwell St., W of SBCR
SBCR	C141	Chicago--14th St., W of SBCR
SBCR	C142	Chicago--14th St., W of SBCR
SBCR	C143	Chicago--14th St., E of SBCR
SBCR	C144	Chicago--15th St., E of SBCR

SBCR	C145	Chicago--16th St., W of SBCR
SBCR	C146	Chicago--16th St., E of SBCR
SBCR	C147	Chicago--18th St., W of SBCR
SBCR	C148	Chicago--18th St., E of SBCR
SBCR	C149	Chicago--19th St., E of SBCR
SBCR	C150	Chicago--Stewart Ave., S of SBCR
SBCR	C151	Chicago--Canal St., S of SBCR
SBCR	C152	Chicago--Cermak Rd., W of SBCR
SBCR	C153	Chicago--Cermak Rd., E of SBCR
SBCR	C154	Chicago--Normal Ave., S of SBCR
SBCR	C155	Chicago--Wallace St., S of SBCR
SBCR	C156	Chicago--Union Ave., N of SBCR
SBCR	C157	Chicago--Halsted St., N of SBCR
SBCR	C158	Chicago--Halsted St., S of SBCR
SBCR	C159	Chicago--Morgan St., N of SBCR
SBCR	C160	Chicago--Senour St., S of SBCR
SBCR	C161	Chicago--Racine Ave., N of SBCR
SBCR	C162	Chicago--Throop St., N of SBCR
SBCR	C163	Chicago--Throop St., S of SBCR
SBCR	C164	Chicago--Loomis St., N of SBCR
SBCR	C165	Chicago--Loomis St., S of SBCR
SBCR	C166	Chicago--Laflin St., N of SBCR
SBCR	C167	Chicago--Ashland Ave., N of SBCR
SBCR	C168	Chicago--Paulina St., N of SBCR
SBCR	C169	Chicago--Wood St., S of SBCR
SBCR	C170	Chicago--Damien St., N of SBCR

APPENDIX B
UNIT COST FACTORS FOR ANNUAL O&M COST ESTIMATE

Life cycle cost (LCC) analysis requires the development of certain constants that will be used throughout the evaluation of alternatives. Values used for constants are presented below. These values have been developed in consultation with District staff and represent actual values or agreed upon assumptions.

1. Present Worth Factors for Life-Cycle Costs	
• Years	20
• Annual interest rate	3%
• Annual inflation rate	3%
• Annuity Present Worth Factor (with inflation)	19.42
2. Design Life	
• Structural Facilities	20
• Mechanical Facilities	20
3. Electrical Cost	
• NSWRP (current Com Ed Rate 6L)	$0.05/kW-hr
4. Labor Rates Per Hour Including Benefits (1)	
• Electrician	$159.50/hr
• Operations	$90.00/hr
• Maintenance	$90.00/hr
5. Parts and Supplies	5 percent
6. Biosolids Management Cost	$260/dry ton
7. Contractor Overhead and Profit (2)	15%
8. Planning Level Contingency (3)	30%
9. Engineering Fees including Construction Management (4)	20%

(1) A multiplier of 2.9 was used to reflect benefits as provided by the District.
(2) Percent of Total Construction Cost
(3) Percent of Total Construction Cost plus Contractor Overhead and Profit
(4) Percent of Total Construction Cost, Contractor Overhead and Profit plus Contingency

APPENDIX C
DETAILED CONSTRUCTION COSTS FOR 18 MGD END-OF-PIPE CSO TREATMENT FACILITY

FINAL 10/16/06

CONSTRUCTION COST OPINION FOR LNSC END-OF-PIPE CSO TREATMENT

				MATERIAL		LABOR		INSTALLED COST
DIVISION	**ITEM DESCRIPTION**	**UNITS**	**NO.**	**UNIT COST**	**TOTAL COST**	**UNIT COST**	**TOTAL COST**	**TOTAL**
2	**SITEWORK**							
	Excavation	CY	4,700	$20.00	$94,000.00		$0.00	$94,000.00
	Backfill	CY	700	$20.00	$14,000.00		$0.00	$14,000.00
	Wellpoint Dewatering	LF	500	$60.00	$30,000.00		$0.00	$30,000.00
	Sheeting	SF	7,000	$30.00	$210,000.00		$0.00	$210,000.00
	Asphalt Pavement	SY	1,000	$40.00	$40,000.00		$0.00	$40,000.00
	Sodding	SY	2,000	$8.00	$16,000.00		$0.00	$16,000.00
	Foundation Piles	LF	10,000	$25.00	$250,000.00		$0.00	$250,000.00
	Chain Link Fence	LF	650	$15.00	$9,750.00		$0.00	$9,750.00
3	**CONCRETE**							
	Slabs On Ground	CY	280	$350.00	$98,000.00		$0.00	$98,000.00
	Formed Concrete	CY	460	$500.00	$230,000.00		$0.00	$230,000.00
4	**MASONRY**							
	Masonry Screen Building	SF	530	$175.00	$92,750.00		$0.00	$92,750.00
	Masonry Electrical Building	SF	350	$175.00	$61,250.00		$0.00	$61,250.00
5	**METALS**							
	Aluminum Hatches	EA	10	$2,000.00	$20,000.00		$0.00	$20,000.00
	Handrail	LF	500	$40.00	$20,000.00		$0.00	$20,000.00
	Metal Grating (Aluminum)	SF	200	$25.00	$5,000.00		$0.00	$5,000.00
6	**WOOD & PLASTICS**							
7	**THERMAL & MOISTURE PROTECTION**							
8	**DOORS & WINDOWS**							
9	**FINISHES**							
	Painting	LS	1	$10,000.00	$10,000.00			$10,000.00
10	**SPECIALITIES**							
11	**EQUIPMENT**							
	Submersible Pump	EA	3	$55,000.00	$165,000.00		$0.00	$165,000.00
	Coarse Bar Screen	EA	1	$48,000.00	$48,000.00		$0.00	$48,000.00
	Fine Bar Screen	EA	2	$36,000.00	$72,000.00		$0.00	$72,000.00
	26 Ft. Dia Hydro Storm King	EA	2	$340,000.00	$680,000.00		$0.00	$680,000.00
	8 Ft. Dia Hydro Storm King	EA	1	$40,000.00	$40,000.00		$0.00	$40,000.00
	Grit Pump, Classifier, and C.P.	EA	1	$120,000.00	$120,000.00		$0.00	$120,000.00
	36 Ft. Dia Sludge Scraper Mechanism	EA	1	$200,000.00	$200,000.00		$0.00	$200,000.00
	UV Equipment	LS	1	$900,000.00	$900,000.00		$0.00	$900,000.00
13	**SPECIAL CONSTRUCTION**	see Div. 13/16 below						
	Process Instrumentation and Control Systems (see Div. 16 below)							

15	**MECHANICAL**							
	HVAC	LS	1	$20,000.00	$20,000.00		$0.00	$20,000.00
	36" x 36" Manual Sluice Gate	LS	4	$30,000.00	$120,000.00		$0.00	$120,000.00
	36" x 36" Motorized Sluice Gate	LS	1	$37,500.00	$37,500.00		$0.00	$37,500.00
	18" x 18" Motorized Sluice Gate	LS	2	$20,000.00	$40,000.00		$0.00	$40,000.00
	24" Flap Gate	LS	1	$20,000.00	$20,000.00		$0.00	$20,000.00
	36" DIP	LF	220	$200.00	$44,000.00		$0.00	$44,000.00
	24" DIP	LF	60	$130.00	$7,800.00		$0.00	$7,800.00
	18" DIP	LF	100	$90.00	$9,000.00		$0.00	$9,000.00
	10" DIP	LF	100	$40.00	$4,000.00		$0.00	$4,000.00
	8" DIP	LF	50	$30.00	$1,500.00		$0.00	$1,500.00
	6" DIP	LF	120	$25.00	$3,000.00		$0.00	$3,000.00
	24" Magnetic Flowmeter	EA	1	$30,000.00	$30,000.00		$0.00	$30,000.00
	Piping to Connecting Structures	EA	3	$8,000.00	$24,000.00		$0.00	$24,000.00
	City Water Piping	LF	250	$25.00	$6,250.00		$0.00	$6,250.00
	18" Check Valve	EA	3	$22,000.00	$66,000.00		$0.00	$66,000.00
	18" Plug Valve	EA	3	$22,000.00	$66,000.00		$0.00	$66,000.00
	6" Check Valve	EA	1	$1,000.00	$1,000.00		$0.00	$1,000.00
	6" Plug Valve Motorized	EA	3	$6,000.00	$18,000.00		$0.00	$18,000.00
	Tank Drain Pump Station	EA	1	$15,000.00	$15,000.00		$0.00	$15,000.00
16	**ELECTRICAL**							
	UV Wire, Conduit & Duct Bank	LF	150	$260.00	$39,000.00		$0.00	$39,000.00
	Standby Generator w/Tank	EA	1	$193,000.00	$193,000.00		$0.00	$193,000.00
	Subtotal							**$4,190,800.00**
13/16	Electrical and Instrumentation @ 25% of Subtotal							$1,047,700.00
	Subtotal				**$4,190,800.00**		**$0.00**	**$5,238,500.00**
	Contractor OH&P @ 15%							$785,775.00
	Subtotal							**$6,024,275.00**
	Contingency @ 40%							$2,095,400.00
	Subtotal							**$8,119,675.00**
	Total							**$8,119,675.00**

APPENDIX D
LAND COSTS FOR CAWs STUDY AREA

Range of Land Costs per acre (2005 $)

Waterway Segment	Cost, ($/Acre)
Upper North Shore Channel	$200,000 to $600,000
Lower North Shore Channel	$175,000 to $525,000
North Branch Chicago River	$225,000 to $675,000
South Branch Chicago River	$150,000 to $450,000

APPENDIX E
UNIT COSTS FOR SCREENINGS AND GRIT DISPOSAL

Item	**Unit**	**Value**	**Source**
Annual Screenings Volume	ft^3/MG	8.5	MOP* 8
Annual Screenings Disposal Cost	$/CY	$35	MWRDGC
Annual Grit Volume	ft^3/MG	5.0	MOP 8
Annual Grit Disposal Cost	$/CY	$35	MWRDGC

*Manual of Practice

October 31, 2006

Mr. Toby Frevert, Manager
Division of Water Pollution Control
Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Dear Mr. Frevert:

Subject: Evaluation of Management Alternatives for the Chicago Area Waterways: Investigation of Technologies for End-of-Pipe Combined Sewer Overflow Treatment

The Metropolitan Water Reclamation District of Greater Chicago, at the request of the Illinois Environmental Protection Agency, hereby submits the enclosed report entitled "Technical Memorandum 3WQ: Study of End-of-Pipe Combined Sewer Overflow (CSO) Treatment."

Using the services of Consoer Townsend Envirodyne Engineers, Inc., this report has been developed to evaluate technologies and costs for end-of-pipe treatment of CSOs for the designated portions of the Chicago Area Waterways.

It is noted that the present worth estimate for capital, operations and maintenance for treating CSOs at only 105 outfalls is $965 million. CSO treatment would be costly, require land rights at each outfall and be time consuming for design and construction. It would not provide any significant water quality benefit prior to the McCook and Thornton Reservoirs coming on line. This was discussed at the May 9, 2006 UAA Study Stakeholders Advisory Committee meeting, and it was determined that this alternative technology would not receive any further consideration.

If you have any questions, please contact Mr. Lou Kollias at (312) 751-5190.

Very truly yours,

Richard Lanyon
General Superintendent

JS:TK
Attachments
cc: R. Sulski, IEPA

Metropolitan Water Reclamation District of Greater Chicago

To: Stakeholder Advisory Committee May 9, 2006

From: R. Lanyon

Subject: USE ATTAINABILITY ANALYSIS STUDY
Alternative Water Quality Technologies
Combined Sewer Overflow Treatment
A Preliminary Assessment

Results of the work of CTE/AECOM were presented to District management on November 9, 2005. CSO treatment preliminary designs and cost estimates were prepared for CSO outfalls discharging to the Chicago River, North Branch, North Branch Canal, North Shore Channel and South Branch.

There are 170 CSO outfalls in the above reaches, not including the North Branch Pumping Station. Based on a review of land availability, it is possible to locate treatment plants at 105 outfalls. Land available was defined to include vacant property and commercial, industrial and residential properties with structures not exceeding one-story. No treatment plants were located for the 18 CSO outfalls along the Chicago River due to land availability restrictions.

Primary treatment plus disinfection was included to achieve screening for floatables and large solids and removal of 30 percent of CBOD5 and 50 percent of TSS. Disinfection was included to meet the proposed limited contact recreation standard. The treatment train included coarse screening, pumping, fine screening, primary settling and ultraviolet radiation. Screenings would be disposed off-site and accumulated primary sludge would be held and disposed via intercepting sewers to the District's North Side or Stickney Water Reclamation Plants.

Each treatment unit would occupy a half-acre parcel. Based on modeling, the total treatment capacity necessary is 1,617 mgd, or 15.4 mgd per location for the 105 sites. Costs were estimated based on a modular plant with a capacity of 18 mgd. The estimated costs in millions of dollars for 105 sites are:

- Total capital, 892.5
- Total annual O&M, 3.73
- Total present worth O&M, 72.5
- Total present worth capital plus O&M, 965

Based on the above estimates by CTE and using a linear proportionate extrapolation, the cost in millions of dollars for all 366 gravity TARP CSO outfalls are as follows:

- Total capital, 3,100
- Total annual O&M, 13
- Total present worth O&M, 250
- Total present worth capital plus O&M, 3,400

Rough approximations of the cost for treatment for the 125th Street, North Branch and Racine Avenue Pumping Stations can be extrapolated based on their CSO pumping capacity and the above estimated costs as follows:

Pumping Station	CSO Pumping Capacity mgd	Total Capital $ Millions	Total annual O&M $ Millions	Total present worth O&M $ Millions	Total present worth capital plus O&M $ Millions
125th Street	760	420	1.8	34	450
North Branch	1,000	550	2.3	45	600
Racine Avenue	4,000	2,200	9.2	200	2,400
Total	5,760	3,170	13.3	279	3,450

The availability of land for treatment at these three stations has not been investigated, but it is likely that the taking of a significant amount of private property will be necessary as the areas required are estimated as follows: 125th Street, 23 acres; North Branch, 30 acres; and Racine Avenue, 120 acres. It is noted that a typical city block occupies 5 acres.

The total cost of CSO treatment is over $6 billion dollars on a total capital cost or total present worth basis. It is noted that the total capital cost is approximately twice the capital cost already expended and expected to be expended to complete the TARP project, tunnels and reservoirs. The construction of TARP has been underway since 1975 and another 10 to 15 years will be required for completion of the reservoirs.

The water quality benefits to be achieved, based on modeling of CSO treatment for the 105 outfalls, are in the range of a 2 or 3 percent improvement in the percent of time that DO concentrations are in compliance with the current standards of 4.0 mg/L. This degree of improvement is insignificant and would not be apparent to the public. Modeling based on CSO treatment of all CSO flows can be performed, but it is unlikely that significant improvement would be achieved.

CSO treatment would mostly be needed until the McCook and Thornton Reservoirs are online and reduce the duration, frequency and volume of CSOs. Currently, the reservoirs are scheduled to go online in 2012, a period of 7 years from now. If we were to go ahead with this work, it is unlikely that there will be a significant amount of CSO treatment facilities completed and in operation before the TARP reservoirs are online.

It is likely that even with the reservoirs online, there will be occasional CSOs. The degree to which this occurs cannot be estimated until the District completes the development of TARP modeling currently underway by the University of Illinois at Urbana Champaign.

Affordability is another issue. The District is committed to complete TARP and to proceed with major projects to replace aging facilities at the three major treatment plants. Given the current statutory constraints on District taxing authority, the District cannot afford to construct CSO treatment for its several outfalls and three pumping stations. However, the majority of expenditures will fall upon the City of Chicago and the 39 suburban municipalities that have permitted CSO outfalls.

It can be concluded that an expenditure of $6 billion for CSO treatment is not justified.