Outline of Presentation

CSO Treatment

- Purpose of Initiating Study
- Objective of Study
- CSO’s in Study Area
- Water Quality Standards
- End-of-Pipe Treatment Objectives
- Long List of Technologies
- Practicable Treatment Technologies
- Summary of Cost Estimation Procedure
- Layout of Typical CSO Treatment Facility
- Estimation of CSO Flows
- Study Area Land Availability
- Opinion of Probable Costs
Purpose For Initiating Study

– Use Attainability Analysis (UAA)
  • Through UAA, IEPA is Reviewing Existing Use Classifications for Chicago Area Waterways (CAWs)
  • Reclassifications Driven by Current and Potential Future Usage of CAWs
  • District is a Stakeholder in UAA Process
  • District Agreed to Perform Study of the Technologies and Cost of End-of-Pipe CSO Treatment on Designated Portions of CAWs
Objectives of Study

Determine the technologies, siting impacts and costs for end-of-pipe treatment of CSOs in the:

– Upper North Shore Channel
– Lower North Shore Channel
– North Branch of Chicago River (below confluence with North Shore Channel)
– Chicago River
– South Branch of Chicago River
Combined Sewer Overflows in Study Area
## Summary of CSO Locations in Study Area

<table>
<thead>
<tr>
<th>Water Way</th>
<th>Total Number of CSOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNSC</td>
<td>25</td>
</tr>
<tr>
<td>LNSC</td>
<td>20</td>
</tr>
<tr>
<td>NBCR</td>
<td>59</td>
</tr>
<tr>
<td>CR</td>
<td>18</td>
</tr>
<tr>
<td>SBCR</td>
<td>48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>170</strong></td>
</tr>
</tbody>
</table>
Water Quality Standards
Current Bacterial Standards for Chicago Waterway System

Proposed Bacterial Standards for Chicago Waterway System

General Use (200 & 400 cfu/100ml) vs. Indigenous Aquatic Life (no bacterial standard)

Limited Contact Recreation (1,030 E. Coli cfu/100ml) vs. Recreational Navigation (2,740 E. Coli cfu/100ml)
Current Chicago Waterway System Dissolved Oxygen Standards

Proposed Chicago Waterway System Dissolved Oxygen Standards
End of Pipe CSO Treatment Objectives
End-of-Pipe Treatment Objectives

– District Scope-of-Work
  • Primary treatment plus disinfection

– CSO Treatment Assumptions
  • Screening to remove floatables and large solids
  • CBOD$_5$ Removal of 30%
  • TSS removal of 50%
  • Disinfection effluent target of 1,030 E.coli/100ml (limited contact recreation)
Long List of CSO Treatment Technologies

– Fine Screens
  • Chain Driven Vertical Bars
  • Climber Type Vertical Bars
  • Catenary Screens
  • Horizontal Overflow Screens
  • Horizontal Brush Overflow Screens
  • Rotary Drum Screens
  • Net Bags
Long List of CSO Treatment Technologies

– Primary Treatment

• Rectangular Primary Tanks
• Circular Primary Tanks
• Swirl and Vortex Concentrators
• Ballasted Flocculation
• Microscreens
Long List of CSO Treatment Technologies

– Effluent Disinfection Study has Yielded the Following Short List:

• Ultraviolet Disinfection
  ✓ High Intensity

• Ozonation
  ✓ Oxygen
Disinfection Alternative Evaluation

– High Intensity UV Disinfection was Selected for Cost Estimation Purposes:
  • Over 100 End-of-Pipe CSO Treatment Plants in Study Area
  • Less Complex Mechanical Equipment
  • No On-site Storage of Oxygen
  • Ease of Start-up
CSO Treatment Process Train for Cost Estimation Purposes

INFLUENT

COARSE SCREENING → SUBMERSIBLE CENTRIFUGAL PUMP STATION → CATENARY BAR SCREENS → VORTEX SEPERATORS → HIGH INTENSITY UV DISINFECTION

OFF-SITE DISPOSAL OF SCREENING

SLUDGE DEGRITTING

OFF-SITE SLUDGE MANAGEMENT → OFF-SITE GRIT DISPOSAL

DISCHARGE TO WATERWAY
Cost Estimation Procedure
General Cost Estimation Issues

– Program Cost Estimate
  • Study Level
  • + 30%

– CSO Flow Information Needed to:
  • Size Treatment Units
  • Determine Treatment Process Footprint

– Use Attainability Analysis Requires:
  • CSO Treatment Program Cost Estimate
  • Water Quality Impacts

– Water Quality Impacts to be Determined by Marquette Model
General Cost Estimation Issues

– Marquette Model Can Determine Water Quality Impacts for:
  • Various CSO Flows
  • Various CSO BOD Removals
  • Various CSO Effluent Disinfection Targets

– Cost Estimate Flows Tied to Marquette Model CSO Flows

– Screenings Disposal
  • Assume Off-site Disposal Using Private Contractor for Landfill Disposal

– Grit Disposal
  • After Primary Sludge Degritting, Resulting Grit is Disposed in a Landfill by Private Contractor

– Sludge Management
  • Degritted Sludge Management by MWRDGC: Convey Sludge to North Side WRP After Storm Ends via Dry Weather Interceptor

– North Branch and Racine Avenue Pump Stations were not included
General Cost Estimation Procedure

– Use Marquette Model to Determine CSO Flows for Five Study Area Waterway Segments (for specific rainfall intensity and duration)
  – Upper NSC
  – Lower NSC
  – NBCR
  – Chicago River
  – SBCR

– Determine Flows for CSOs on Waterway Segment (total segment flow ÷ # of CSOs)

– Develop Space Requirements for Primary Treatment Plus Disinfection Treatment Train to Treat CSO Flows.

– Using Aerial Photos for CSOs on Waterway Segment Categorize all Sites:
  – Space Requirements < Site = Full Primary Treatment
  – Space Requirements > Site = No Treatment

– Determine Land Availability for CSO Treatment on Each Segment
  – Consider possibility of extrapolating land availability for waterway segments with similar land characteristics

– Determine Costs for CSO Treatment Facilities at Sites With Sufficient Land Space for Full Treatment
Summary of CSO Flow Estimation Procedure
### Treated Flow Using 2.80\(^\text{th}\) Storm for Design Flow Capacity

<table>
<thead>
<tr>
<th>Waterway Segment</th>
<th>Total Overflow Volume (MG)</th>
<th>Treated Overflow Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper NSC</td>
<td>1,178</td>
<td>1,113</td>
</tr>
<tr>
<td>Lower NSC</td>
<td>766</td>
<td>718</td>
</tr>
<tr>
<td>NBCR</td>
<td>1,904</td>
<td>1,784</td>
</tr>
<tr>
<td>Chicago River</td>
<td>112</td>
<td>105</td>
</tr>
<tr>
<td>SBCR</td>
<td>815</td>
<td>764</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,784</strong></td>
<td><strong>4,483</strong></td>
</tr>
</tbody>
</table>

94% of CSO Flow is treated if CSO treatment plant capacity is based upon design storm of 2.80\(^{th}\).
### Summary of CSO Treatment Capacities per Site & per CAWS

<table>
<thead>
<tr>
<th>CAWS</th>
<th>Recommended Design Flow for CSO Treatment</th>
<th>CSO Treatment Sites per CAWS</th>
<th>Recommended CSO Treatment Capacity Per Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper NSC</td>
<td>520 Mgd</td>
<td>25 Sites</td>
<td>520 / 25 + 5% = 22 Mgd</td>
</tr>
<tr>
<td>Lower NSC</td>
<td>340 Mgd</td>
<td>20 Sites</td>
<td>340 / 20 + 5% = 18 Mgd</td>
</tr>
<tr>
<td>NBCR</td>
<td>850 Mgd</td>
<td>59 Sites</td>
<td>850 / 59 + 5% = 15 Mgd</td>
</tr>
<tr>
<td>Chicago River</td>
<td>49 Mgd</td>
<td>18 Sites</td>
<td>49 / 18 + 5% = 3 Mgd</td>
</tr>
<tr>
<td>SBCR</td>
<td>359 Mgd</td>
<td>48 Sites</td>
<td>359 / 48 + 5% = 8 Mgd</td>
</tr>
</tbody>
</table>
Evaluation of Cost and Benefits of CSO Treatment and Supplemental Aeration, July 28, 2006

Layout of Typ. LNSC CSO Treatment Facility (18 mgd)

- **Primary Vortex Separators** (Storm King) 26' Dia. Each
  - 14 GPM/SF
  - Vol: 57,000 GAL. Each
  - Depth: 17'

- **Solids Retention Tank**
  - Vol: 137,000 GALS.
  - 36' Dia., Depth: 18'

- **Electrical Room**

- **Grit King**
  - 8' Dia.
  - Submersible Solids Pump
    - 3 H.P.

- **Fine Bar Screens** (Catenary)
  - ½” Openings
  - 8” Underflow
  - 6” F.M. (125 GPM)

- **UV Disinfection Channel**
  - Depth: 12'

- **Lower North Shore Channel**

- **Existing Drop Shaft** to Tarp

- **Existing Flap Gate**

- **Existing Chamber**

- **Existing Tide Gate**

- **Existing Dry Weather Sewer to Northside WRP**

- **Existing Combined Sewer**

- **Submersible CSO Pumps**
  - 100 H.P. Each

- **Required Footprint**: ~1/2 ACRE

- **Scale: Feet**

- **Required Footprint**: ~1/2 ACRE (18 mgd)

- **Submersible Solids Pump**
  - 3 H.P.

- **Secondary Vortex Separator** (Grit King)
  - 8’ Dia.
  - 18” Discharge (Typ.)

- **Underflow 10”**

- **Fine Bar Screens** (Catenary)
  - ½” Openings
  - 8” Underflow
  - 6” F.M. (125 GPM)

- **Diversion Weir**

- **Coarse Bar Screen** (Catenary)
  - 2” Openings

- **Existing Tide Gate**

- **Existing Drop Shaft** to Tarp

- **Lower North Shore Channel**

- **New Flap Gate**

- **Existing Flap Gate**

- **Existing Dry Weather Sewer to Northside WRP**

- **Existing Combined Sewer**

- **Submersible CSO Pumps**
  - 100 H.P. Each

- **Coarse Bar Screen** (Catenary)
  - 2” Openings

- **Existing Tide Gate**

- **Existing Drop Shaft** to Tarp

- **Lower North Shore Channel**

- **New Flap Gate**

- **Existing Flap Gate**

- **Existing Dry Weather Sewer to Northside WRP**

- **Existing Combined Sewer**

- **Submersible CSO Pumps**
  - 100 H.P. Each
Study Area
Land Availability for CSO Treatment
## SUMMARY OF LAND AVAILABILITY STUDY

<table>
<thead>
<tr>
<th>Waterway Segment</th>
<th>No. of CSO Treatment Plants/Total CSO’s</th>
<th>Total Acreage Required</th>
<th>Total CSO Treatment Flow Capacity (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper NSC</td>
<td>25/25</td>
<td>15</td>
<td>546</td>
</tr>
<tr>
<td>Lower NSC</td>
<td>20/20</td>
<td>10</td>
<td>360</td>
</tr>
<tr>
<td>North Branch</td>
<td>33/59</td>
<td>15</td>
<td>495</td>
</tr>
<tr>
<td>Chicago River</td>
<td>0/18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>South Branch</td>
<td>27/48</td>
<td>8</td>
<td>216</td>
</tr>
<tr>
<td>Total</td>
<td>105/170</td>
<td>48</td>
<td>1607</td>
</tr>
</tbody>
</table>
Opinion of Probable Costs
# End-of-Pipe CSO Treatment (105 Sites) Cost Summary

<table>
<thead>
<tr>
<th>River Segment</th>
<th>Total Capital Costs, $ (million)</th>
<th>Total Annual O&amp;M Costs ($)</th>
<th>Total Present Worth-O&amp;M, $ (million)</th>
<th>Total Present Worth, $, Capital + O&amp;M (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper NSC</td>
<td>$297.7</td>
<td>$1,009,000</td>
<td>$19.6</td>
<td>$317.3</td>
</tr>
<tr>
<td>Lower NSC</td>
<td>$194.5</td>
<td>$746,000</td>
<td>$14.5</td>
<td>$209.0</td>
</tr>
<tr>
<td>NBCR</td>
<td>$280.9</td>
<td>$1,164,000</td>
<td>$22.6</td>
<td>$303.5</td>
</tr>
<tr>
<td>Chicago River</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>SBCR</td>
<td>$119.4</td>
<td>$813,000</td>
<td>$15.8</td>
<td>$135.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$892.5</strong></td>
<td><strong>$3,732,000</strong></td>
<td><strong>$72.5</strong></td>
<td><strong>$965.0</strong></td>
</tr>
</tbody>
</table>
Schedule Issues

– End-of-Pipe CSO Treatment is an “Interim” Measure

– Potential Implementation Schedule
  • Preliminary Design 2-3 years
    Detailed Hydraulic Analysis
    Detailed Site Surveys
  • Final Design 1-3 year
  • Construction 3-5 years

Total 6-11 years (2012-2017)
McCook Reservoirs scheduled to be Done by 2015

– Implementation Issues
  • Land Acquisition
  • Brownfield Problems
  • Public Acceptance
Outline of Presentation

Supplemental Aeration of the North and South Branches of the Chicago River

- Objective of Study
- Panel of Experts
- Purpose of Initiating Study
- Assumptions in Study
- Water Quality Standards
- Dissolved Oxygen Target for Study
- Short Listed Technologies
- Size and Location of Supplemental Aeration Stations
- % Compliance with Water Quality Target
- Costs for Supplemental Aeration of SBCR & NBCR
Objectives of Study

To Determine the Supplemental Aeration Technology(ies) and Costs to Achieve Future Regulatory Dissolved Oxygen Levels for:

– North Branch of Chicago River (Downstream of Confluence with the North Shore Channel)
– South Branch of Chicago River
Panel of Experts

– Dr. Marcello Garcia
  • Professor at University of Illinois
  • Intimate Knowledge of Chicago Area Waterway System
  • Leader in field of River Mechanics

– Dr. Mark Laquidara, P.E.
  • M&E Vice President
  • M&E Practice Leader
  • 25 Years Experience

– Dr. Dominique Brocard, P.E.
  • M&E Vice President
  • 30 Years Experience
  • Participated in Water Quality Assessment for the Charles River, Boston

– Dr. Tom Butts
  • 36 Years Experience With Illinois Waterway Survey
  • Participated in Planning for SEPA Stations
Purpose For Initiating Study

– Use Attainability Analysis (UAA)

• Through UAA, IEPA is Reviewing Existing Use Classifications for Chicago Area Waterways (CAWs)
• Reclassifications Driven by Current and Potential Future Usage of CAWs
• District is a Stakeholder in UAA Process
• District Agreed to Perform Study of the Technologies and Cost of Supplemental Aeration for NBCR and SBCR
General Assumptions of Study

– TARP Tunnels are Fully Operational
– TARP Reservoirs are not On-line
– Other Technologies (i.e. End-of-Pipe CSO Treatment) are not On-line
– Devon and Webster Avenue in-Stream Aeration Stations are Operational
Current Chicago Waterway System  Dissolved Oxygen Standards
Proposed Chicago Area Waterway System Aquatic Life Use Designations and Proposed Dissolved Oxygen Standards

- **Limited Warm Water Aquatic Life**: Current General Use D.O. Standards or Minimum 4, 5 or 6 mg/l.

- **Modified Warm Water Aquatic Life**: Current General Use D.O. Standards or Minimum 4, 5 or 6 mg/l.
**Dissolved Oxygen Target For Study**

- 90% Compliance With Minimum Waterway Dissolved Oxygen Concentration of 5mg/l

- % Compliance Determined By:
  - %Hourly D.O. Concentrations > 5mg/l
Supplemental Aeration of NBCR and SBCR
Short Listed Supplemental Aeration Technologies

- Compressed Air U-Tubes
- Free Fall Weirs (i.e., existing SEPA Stations)
- Ceramic Diffusers (i.e., existing Devon and Webster Avenue Stations)
- Jet Aeration
Schematic of Compressed Air U-Tube Contactor

LOW PRESSURE AIR

20' TO 200'
Schematic of Jet Aeration System
**Supplemental Aeration Marquette Model Runs**

Marquette Model Runs

- With Operation of existing Devon and Webster In-Stream Aeration Stations and Target of 90% Compliance with Minimum D.O. of 5 mg/l; 4 New Aeration Stations:

<table>
<thead>
<tr>
<th>Waterway</th>
<th>Location</th>
<th>Aeration Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NBCR</td>
<td>Diversey</td>
<td>30 g/s (5,700 lbs/day)</td>
</tr>
<tr>
<td>NBCR</td>
<td>Chicago</td>
<td>30 g/s (5,700 lbs/day)</td>
</tr>
<tr>
<td>SBCR</td>
<td>18th Street</td>
<td>30 g/s (5,700 lbs/day)</td>
</tr>
<tr>
<td>SBCR</td>
<td>Halsted</td>
<td>80 g/s (15,200 lbs/day)</td>
</tr>
</tbody>
</table>
Supplemental Aeration of North and South Branches of Chicago River, Percent of Hours Complying with 5 mg/l Criterion, All Time Periods
Opinion of Probable Costs

- Capital Cost
  • $28.9 Million - $59.1 Million

- Annual O&M Costs
  • $449,000 - $2,419,000

- Total Present Worth
  • $38.7 Million to $116.3 Million

<table>
<thead>
<tr>
<th>Cost of Four Supplemental Aeration Stations on NBCR and SBCR</th>
<th>Total Capital</th>
<th>Annual O&amp;M</th>
<th>Total Present Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-Tubes</td>
<td>$29,764,000</td>
<td>$449,000</td>
<td>$38,744,000</td>
</tr>
<tr>
<td>SEPA</td>
<td>$59,134,000</td>
<td>$2,859,000</td>
<td>$116,320,000</td>
</tr>
<tr>
<td>Ceramic Diffusers</td>
<td>$28,937,000</td>
<td>$1,020,000</td>
<td>$49,342,000</td>
</tr>
<tr>
<td>Jet Aeration</td>
<td>$51,145,000</td>
<td>$2,419,000</td>
<td>$99,527,000</td>
</tr>
</tbody>
</table>
Questions & Answers