North Side WRP Master Plan
Research and Development Department
2006 Seminar Series – October 27, 2006
Metropolitan Water Reclamation District of Greater Chicago
Today’s Goals

– Discuss project background
– Provide an overview of evaluation results
– Outline recommended plan
Content of Presentation

– Objectives and Guiding Principles
– Current and Future Conditions
– Liquid Handling
– Solids Handling
– Site Planning
– Recommended Plan
Objectives and Guiding Principles
Objectives and Guiding Principles

– Assess future flow and loads
– Study major needs to year 2040
– Consider escalating energy costs and stricter effluent limits
Objectives and Guiding Principles (cont.)

- Establish prioritized capital projects for next 20 years (year 2026)
- Comment on needs beyond year 2026
- Standardize equipment among all WRP’s where practical
Current and Future Conditions
NORTH SIDE Service Area

Service Area: 142.4 Sq. mi.


Design Average Flow: 333 MGD
## Population and Flow Projection

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Annual Average Flow, MGD</th>
<th>Gallons Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,349,392</td>
<td>259</td>
<td>192</td>
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<tr>
<td>2040</td>
<td>1,468,000</td>
<td>282</td>
<td>192</td>
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</table>
Land Use Evaluation

- Obtained land use map from NIPC
- Extracted acreage for year 2000
- Estimated flow based on gallons / acre
- Estimated land use for year 2040 assuming build-out of developable land
Land Use Projections

- Green area are open space or agricultural
- Limited undeveloped property
Year 2040 Flow Projections

- Population method: 282 MGD
- Land Use method: 287 MGD
- Current permitted rating: 333 MGD
- Conclusion: Use 333 MGD annual average for master planning evaluations
- Assume no net change in I/I over planning period
- Assume no change in raw sewage characteristics over planning period
## Summary of 1996 – 2003 Data (10% outliers excluded)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
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<th>Annual Avg</th>
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<th>Max-week</th>
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## Year 2040 Projected Influent Flow and Loads

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<tr>
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<td>mg/L</td>
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<td>3.1</td>
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### Current and Projected Monthly Average Permit Limits

<table>
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<th>Parameter</th>
<th>Current</th>
<th>Possible 2010 - 2020</th>
<th>Future Year 2040</th>
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<tr>
<td>Total Phosphorus (mg/l)</td>
<td>No standard</td>
<td>1.0</td>
<td>0.5</td>
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<tr>
<td>Total Nitrogen (mg/l)</td>
<td>No standard</td>
<td>6.0 to 8.0</td>
<td>5.0</td>
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<tr>
<td>Carbonaceous BOD₅ (mg/l)</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Total Suspended Solids (mg/l)²</td>
<td>12.0</td>
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<td>12.0</td>
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<tr>
<td>Ammonia-Nitrogen (mg/l)</td>
<td>2.5 (summer); 4.0 (winter)</td>
<td>2.5 (summer); 4.0 (winter)</td>
<td>1.5 (summer); 3.0 (winter)</td>
</tr>
<tr>
<td>E. coli (cfu/100 ml)</td>
<td>No standard</td>
<td>400 cfu/100 ml⁵</td>
<td>400 cfu/100 ml⁵</td>
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</table>

Potential permit limits were considered for space planning only and are not to be interpreted as acceptance by the District.
# Existing Treatment Capacity Evaluation Results – Based on Design Criteria

<table>
<thead>
<tr>
<th>Item</th>
<th>Design Guideline</th>
<th>Plant Influent Flows at which design guidelines exceeded, MGD</th>
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<tbody>
<tr>
<td><strong>Primary Settling</strong></td>
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<td></td>
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<tr>
<td>SOR (annual avg.)</td>
<td>1,000 gpd/sf</td>
<td>102</td>
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<tr>
<td>SOR (peak hourly)</td>
<td>2,000 gpd/sf</td>
<td>205</td>
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<tr>
<td><strong>Aeration Tank</strong></td>
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<tr>
<td>HRT (annual avg.)</td>
<td>8 hours</td>
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<tr>
<td>Organic Loading, BOD(_5)/1,000 ft(^3)/day</td>
<td>15 annual average</td>
<td>187</td>
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<tr>
<td><strong>Final Settling</strong></td>
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<td></td>
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<tr>
<td>SOR (peak hourly)</td>
<td>1,000 gpd/sf</td>
<td>335</td>
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<tr>
<td>SLR (peak hourly)</td>
<td>50 ppd/sf</td>
<td>488</td>
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</table>
### Existing Treatment Capacity Evaluation Results - Based on NSWRP Baseline Model

(10% Capacity Out of Service)

<table>
<thead>
<tr>
<th>Item</th>
<th>Current Permit Limit, mg/l</th>
<th>Plant Influent Flows at which model predicted permit violations, mgd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monthly Average</strong></td>
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<tr>
<td>CBOD$_5$</td>
<td>10</td>
<td>375</td>
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<tr>
<td>TSS</td>
<td>12</td>
<td>300</td>
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<tr>
<td>NH$_3$-N, winter</td>
<td>4</td>
<td>370</td>
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<tr>
<td><strong>Weekly Average</strong></td>
<td></td>
<td></td>
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<tr>
<td>CBOD$_5$</td>
<td>12</td>
<td>360</td>
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<td>TSS</td>
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<td>300</td>
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<td><strong>Daily Maximum</strong></td>
<td></td>
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<tr>
<td>NH$_3$-N, winter</td>
<td>8</td>
<td>360</td>
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</table>
Liquid Handling
Unit Processes Considered

- Raw Sewage Pumping
- Screening
- Grit Removal
- Primary Tanks
- Aeration Tanks / Nutrient Removal
- Aeration Blowers
- Final Tanks
- Tertiary Treatment (for space planning only)
- Disinfection (for space planning only)
Raw Sewage Pumps
Existing Raw Sewage Pumps - Existing

6 Constant Speed

- Capacity:
  n+1  583 MGD
  n+1+1 400 MGD

- Objective:
  n+1+1 @ 450 MGD
  w/ flexibility
Raw Sewage Pumps Recommendation – Replace Impellers in Small Pumps w/ New Motors and VFD’s

Benefits:

• Improves Reliability

• Wide Range of Flow

• VFD enables automatic control

• Meets 450 mgd w/ one VFD pump and P-5 or P-6 out of service
Screening
Existing Screens – Climber Type

Coarse Screens
3.5” Clear Spacing

Fine Screens
0.5” Clear Spacing
Screening Recommendation – Replace Coarse Screens w/ 1.5” clear spacing; continue to maintain existing fine screens

Benefits:

- Improves reliability
- Minimizes solids build-up in grit tanks
Grit Removal
Grit System - Existing

Aerated Grit Tank

Dewatering w/concrete wash tank or cyclones & classifiers
Grit System Recommendation – Continue to maintain aerated grit system; provide redundant wash tank

Benefits:

- Improves reliability
- Minimizes need for cyclones and classifiers
- Provides redundancy
Primary Tanks
Primary Tanks at 1,000 gpd/sf – Conceptual Sketch

Considered a range of loading rates from 1,000 to 2,000 gpd/sf
Primary Tanks - Existing

- 8 Square Tanks @ 80’ x 80’ x 14’ center water depth
- 8 Circular @ 100’ dia w/ 17’-10” center water depth
- Total Surface Overflow Rate (SOR) 2,270 gpm/sf @ current average flow @ 259 MGD
Primary Tanks Recommendation – Provide 8 new Primary Tanks @ 100’ diameter; maintain existing circular tanks

Benefits:
- Eliminates inefficient square tanks
- Improves hydraulic flow splitting
- Provides SOR @ 2,000 gpd/sf
Aeration Tanks / Nutrient Removal
Aeration Tanks - Existing

- 4 Batteries w/ Total Volume @ 68 million gallons
- Hydraulic Retention Time, HRT @ 259 MGD current annual average flow, 6.3 hours
- Single stage nitrification, plug flow
- Silica / Alumina plate type diffusers
Aeration Tanks Recommendation – Increase HRT for minimum 7.2 hours; continue with alumina / silica plate diffusers; improve D.O. control

Benefits:

- Improves reliability
- Greater flexibility to meet maximum flow and loads
Aeration Blowers - Existing

Replace existing with new centrifugal units
Future Nutrient Removal

– Considered for planning future space requirements only
– Plan for lower TP and TN limits
– Evaluate impacts on existing system
Nutrient Removal Recommendations

- For effluent TP = 1.0 mg/l, use ferric chloride addition
- For effluent TP = 0.5 mg/l and TN in the range of 6 to 8 mg/l, use ferric chloride addition with 4-stage Bardenpho BNR process with tertiary filters
Four-stage Bardenpho w/ chemical addition and filtration

Nutrient removal was considered for planning purposes only and are not to be interpreted as acceptance by the District.
Final Tanks
Final Tanks - Existing

- 4 Batteries – difficult to control flow split proportionally
- Surface Overflow Rate, SOR @ 450 MGD peak flow
  ± 1,240 gpd/sf depending on flow split
- 40 square tanks @ 77’ x 77’ x 14.5’ side water depth (SWD)
- 12 circular @ 75’ diameter, 15’ SWD; 12 circular @ 70’ diameter, 15’SWD; 10 circular @ 110’ diameter, 14.5’ SWD (Battery D)
- Battery A, B, & C experience biological bulking on occasion
- Battery D functions more efficiently than Battery A, B, & C
Final Tanks - Recommendations

- Improve flow splitting to proportion flow equally
- Upgrade for SOR of 1,000 gpd/sf @ 450 MGD peak
- Use circular tanks @ 110’ diameter minimum
Solids Handling
Solids Handling Facilities

CONCENTRATION TANKS

SLUDGE PIPELINE TO STICKNEY WRP
Concentration Tanks - Existing

- 2 Rectangular tanks @ 46.75’ x 70’ x 14’ SWD
- 1 Circular Tank @ 70’ diameter w/ 15.92’ SWD
- Solids concentration varies between 1.1 to 1.4 %
- Tanks function as holding tanks w/ minimal thickening
Concentration Tanks Recommendation – Provide 2 new 70’ diameter concentration tanks

Benefits:

• Improves flexibility
• Arrange to thicken primary sludge & blend w/ WAS
Recommendation – Inspect / test existing pipeline prior to new pipeline

Benefits:

- Enable pressure up 100 psig
- Reduce pipeline maintenance
- Provides improved solids handling flexibility

Approx. 18 miles
Site Planning
Available MWRDGC Property

- Oakton St
- Skokie Golf Center (leased)
- Com Ed
- Metra
- North Shore Channel
- Skokie Park (leased)
- Howard St
Potential Conceptual Site Plan – utilize existing south site (including west ball park)

Legend:
- Infrastructure Improvements
- TP = 1.0 mg/l, E. Coli = 1,030 cfu/100 ml
- TP = 0.5 mg/l, TN = 6 mg/l, E. Coli = 400 cfu/100 ml
- TP = 0.5 mg/l, TN = 5 mg/l, E. Coli = 400 cfu/100 ml
- Demolition/Decommission

Considered for future space planning only
Potential Conceptual Site Plan – Two-plant operation (south and north)

Legend:
- Infrastructure Improvements
- TP = 1.0 mg/l, E. Coli = 1,030 cfu/100 ml
- TP = 0.5 mg/l, TN = 6 mg/l, E. Coli = 400 cfu/100 ml
- TP = 0.5 mg/l, TN = 5 mg/l, E. Coli = 400 cfu/100 ml
- Demolition/Decommission

New Headworks and Blowers
- Battery E
- Battery F
- Filters
- Disinfection
- Grit Chamber
- Pump and Blower House
- Sludge Concentration Tanks
- Sludge Pipeline
Proposed Site Plan – to Year 2026

- **Phase I**
  - New Battery E
  - New Final Settling Tanks @ 130’ Dia. Each (8 Typ.)

- **Phase II**
  - New Primary Settling Tanks @ 130’ Dia. Each (4 Typ.)

- **Phase III**
  - New Road
  - New Final Settling Tanks @ 110’ Dia. Each (24 Typ.)

- **Phase IV**
  - New Degritted Primary Effluent Pump Station
  - Grit Dewatering
  - New Primary Settling Tanks @ 100’ Dia. Each (8 Typ.)

- **Demolition/Decommission**
  - Sodium Hypochlorite Feed Point Modifications

- **Existing Facilities**
  - Existing Pump and Blower House
  - Coarse Screens
  - New Sludge Pipeline
  - North Site base loaded at 105 MGD

- **Additional**
  - Existing Primary Settling Tanks to Remain
  - New Final Settling Tanks @ 110’ Dia. Each (24 Typ.)
  - New Battery F
  - New Degritted Primary Effluent Pump Station
  - Sludge Concentration Tanks

- **Markets**
  - North Site base loaded at 105 MGD
# North Side Water Reclamation Plant
## Master Plan (Tentative)

### Near-Term Projects: 2007 – 2011

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Budget Costs</th>
<th>Start Year</th>
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<tbody>
<tr>
<td>Raw Sewage Pump Upgrades</td>
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<td>2008</td>
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<tr>
<td>Piping to Battery E and Degritted Primary Influent Pump Station</td>
<td>$64,000,000</td>
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<tr>
<td>Existing Sludge Pipeline Testing and Repair; and New Sludge Pipeline</td>
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<td>Aeration Blower Upgrades</td>
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<td>New North Battery E and North Site Primaries</td>
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<td>Sludge Concentration Tank Improvements</td>
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<td>Grit Dewatering Modification and Sodium Hypochlorite Feed System/Feed Point Modifications</td>
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## Mid-Term Projects: 2011 – 2015

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<td>Addition of New South PSTs; Primary Influent Distribution and Plant Drain Improvements</td>
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<td>New Battery F</td>
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<tr>
<td>---------------------</td>
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<tr>
<td>Demolition of Square PSTs; Addition of New North PSTs; and Plant Drain Improvements</td>
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<td>Battery C Improvements: FST Replacement; Diffuser Replacement; Air and Flow Distribution Improvements; Aeration Tank Repairs; Air Lift Pump Replacement; and Plant Drain Improvements</td>
<td>$87,000,000</td>
<td>2017</td>
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<td>Battery B Improvements: FST Replacement; Diffuser Replacement; Air and Flow Distribution Improvements; Aeration Tank Repairs; Air Lift Pump Replacement; and Plant Drain Improvements</td>
<td>$87,000,000</td>
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## North Side Water Reclamation Plant Master Plan (Tentative)

### Long-Term Projects: 2015 – 2026 (cont.)

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<tr>
<th>Project Description</th>
<th>Budget Costs</th>
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<tbody>
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<td>Battery A Improvements: FST Replacement; Diffuser Replacement; Air and Flow Distribution Improvements; Aeration Tank Repairs; Air Lift Pump Replacement; and Plant Drain Improvements</td>
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<td>Battery D Improvements: Diffuser Replacement; Air Distribution Improvements; and Air Lift Pump Replacement</td>
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<td>Coarse Screen Replacement</td>
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<tr>
<td>Submetering and Miscellaneous Electrical Upgrades</td>
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Questions ??