Development of a Framework for an Integrated Water Quality Strategy for Chicago Area Waterways

David R. Zenz, Ph.D., P.E.

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Outline of Presentation

- Background
- Water Quality Standards
- Effluent Disinfection Studies
- Study of End-of-Pipe CSO Treatment
- Study of Supplemental Aeration of NBCR and SBCR
- Study of Flow Augmentation of the UNSC
- Study of Flow Augmentation and Supplemental Aeration of Bubbly Creek
- Development of an Integrated Water Quality Strategy for Chicago Area Waterways

Background

Reason For Initiating Studies

– 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
- IEPA Requested That District Conduct Certain Studies as Part of UAA Process

CTE Studies

Water Quality Management Options		Technical Memorandum
1.	Effluent Disinfection at MWRDGC Major Plants	TM-1WQ
2.	End-of-Pipe CSO Treatment	TM-3WQ
3.	Supplemental Aeration of the NBCR and SBCR	TM-4WQ
4.	Flow Augmentation of the UNSC	TM-5WQ
5.	Flow Augmentation and Supplemenetal Aeration of Bubbly Creek	TM-6WQ

TM-7WQ

– CTE to determine framework for developing "integrated water quality strategy" for the CAWs

Water Quality Standards

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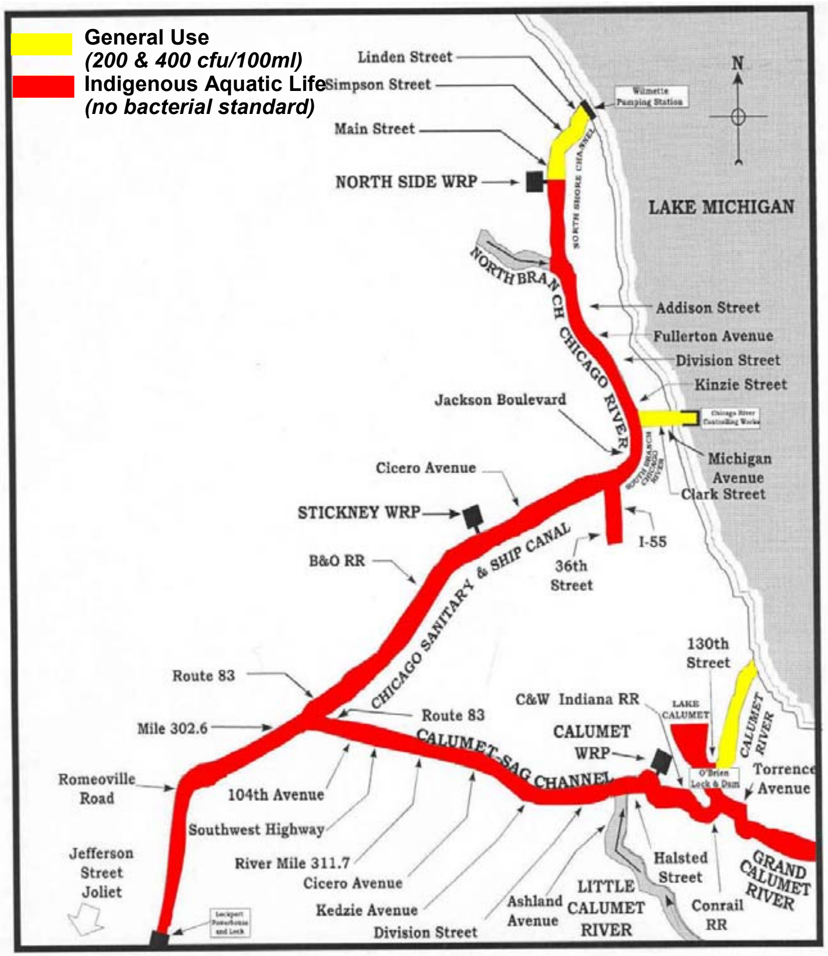
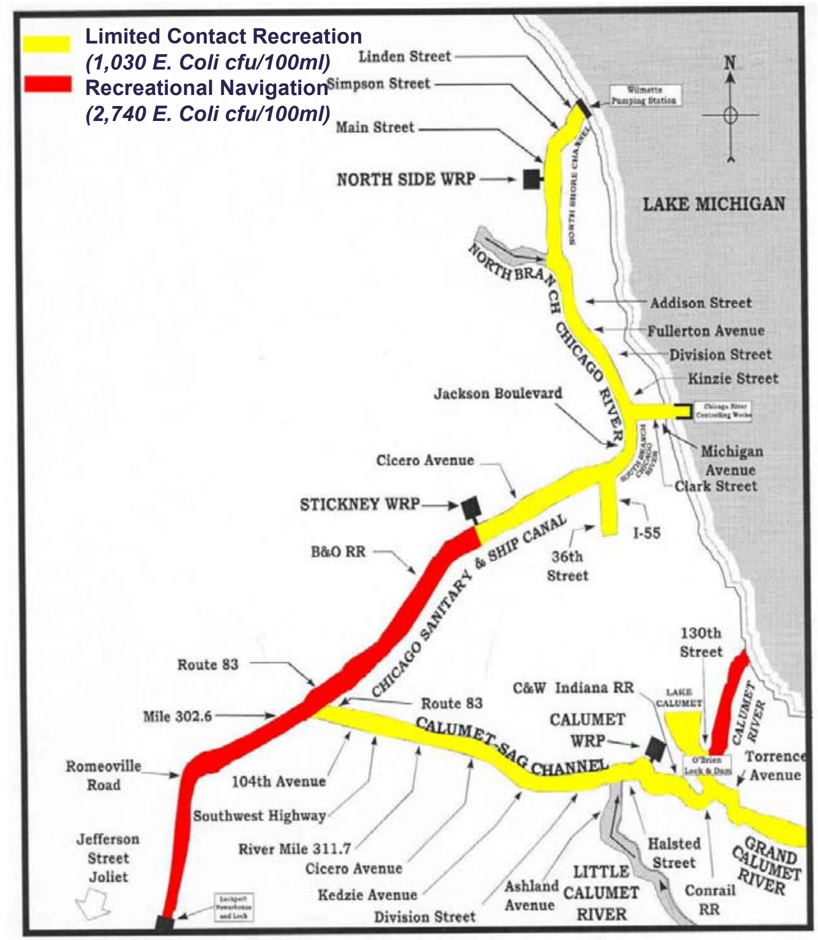
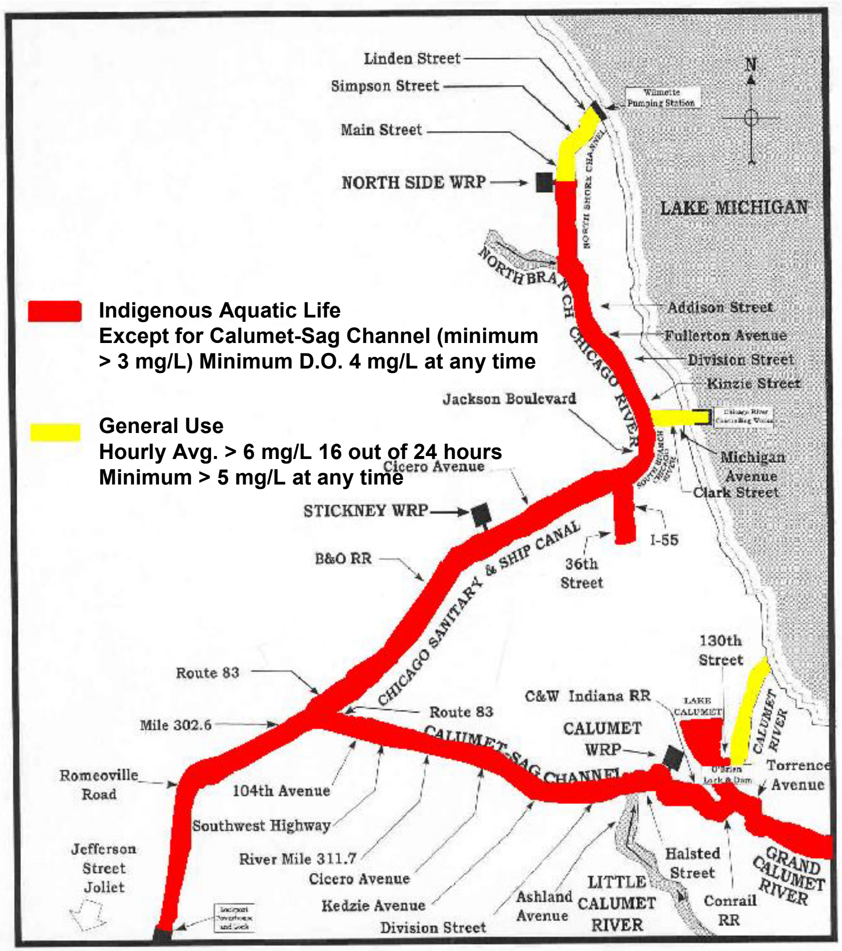


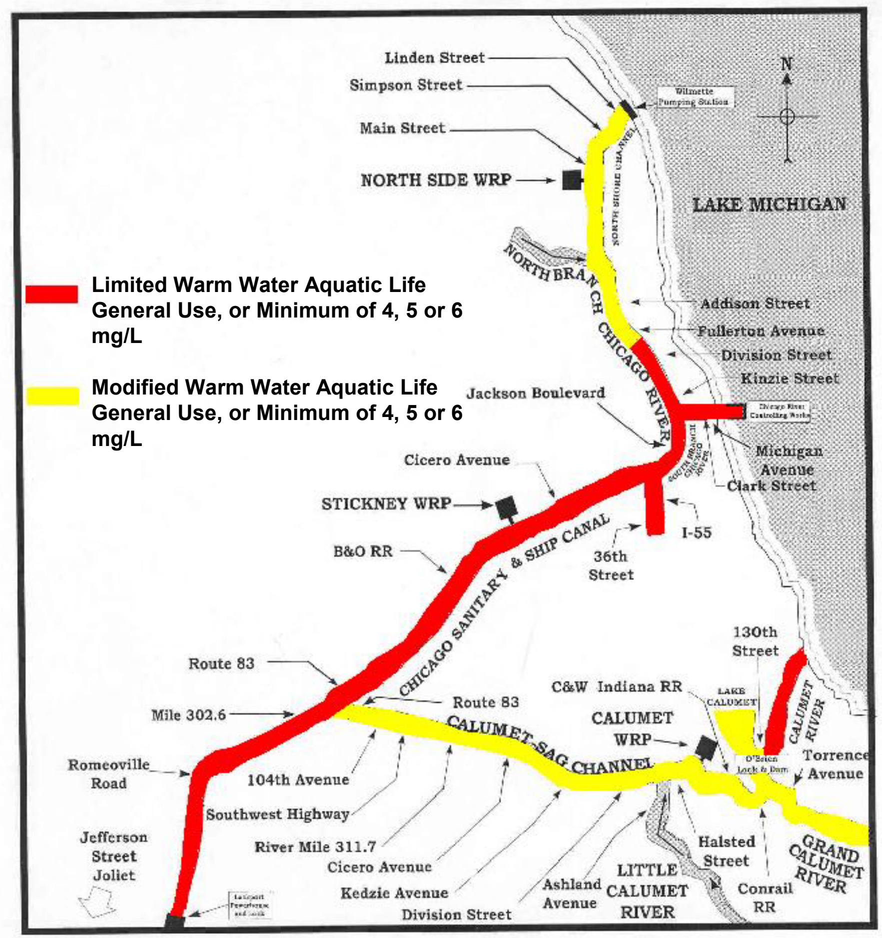
Current Bacterial Standards for Chicago Waterway System



Proposed Bacterial Standards for Chicago Waterway System



Current Chicago Waterway System Dissolved Oxygen Standards



Proposed Chicago Waterway System Dissolved Oxygen Standards

TM-IWQ
Effluent Disinfection Study

Effluent Disinfection Study for MWRDGC Three Major Plants – TM – 1WQ

– Review technologies for effluent disinfection

– Recommend technology(ies) most suitable for cost estimating purposes

– Prepare planning level cost estimate for MWRDGC major plants

Initial Short List of Technologies Requiring Further Consideration

- Chlorination (alone)
  - Liquid
  - Gas
- **Ozone**
- **Ultra-Violet Light**
- **Chlorination-Dechlorination**
  - **Liquid**
  - Gas
- Chlorine Dioxide
- Bromine (Br) Compounds
- Sequential Disinfection Processes
- Membrane Processes

Opinion of Probable Costs of UV and Ozone Disinfection for North Side WRP, Stickney WRP, and Calumet WRP (Without Filtration)

	NORTH SIDE WRP		STICKNEY WRP		CALUMET WRP	
Capital Cost Estimates, in millions	UV	OZONE	UV	OZONE	UV	OZONE
A. General Site Work	$ 4	$ 8	$93	$97	$14	$14
B. Low Lift Pump Station	$ 54	$ 54	$174	$174	$59	$59
C. Disinfection System	$ 25	$ 100	$91	$226	$31	$110
Total Capital Cost	$ 83	$ 162	$358	$497	$100	$180
Annual Operation and Maintenance Cost Estimates, in millions						
A. General Site Work	$ 0	$ 0	$0	$0	$0	$0
B. Low Lift Pump Station	$ 1.1	$ 1.1	$4.1	$4.1	$1.7	$1.7
C. Disinfection System	$ 3.2	$ 6.4	$8.5	$14.9	$3.1	$6.4
Total Annual O&M Cost	**$4.3**	**$ 7.5**	**$12.6**	**$19.0**	**$4.8**	**$8.1**

Opinion of Probable Costs of UV and Ozone Disinfection for North Side WRP, Stickney WRP, and Calumet WRP (With Filtration)

	NORTH SIDE WRP		STICKNEY WRP		CALUMET WRP	
Capital Cost Estimates, in millions	UV	OZONE	UV	OZONE	UV	OZONE
A. General Site Work	$4.00	$8.00	$93.0	$97.0	$14.0	$14.0
B. Low Lift Pump Station	$54.0	$54.0	$174	$174	$59.0	$59.0
C. Tertiary Filtration	$168	$168	$642	$642	$208	$208
D. Disinfection System	$25.0	$100	$91.0	$226	$31.0	$110
Total Capital Cost	$251	$330	$1,000	$1,139	$310	$390
Annual Operation and Maintenance Cost Estimates, in millions						
A. General Site Work	$0	$0	$0	$0	$0	$0
B. Low Lift Pump Station	$1.10	$1.10	$4.10	$4.10	$1.70	$1.70
C. Tertiary Filtration	$2.30	$2.30	$4.20	$4.20	$2.30	$2.30
D. Disinfection System	$3.20	$6.40	$8.50	$14.9	$3.10	$6.40
Total Annual O&M Cost	$6.60	$9.80	$16.8	$23.2	$7.10	$10.4

TM-3WQ Study of End-of-Pipe CSO Treatment

Objectives of Study

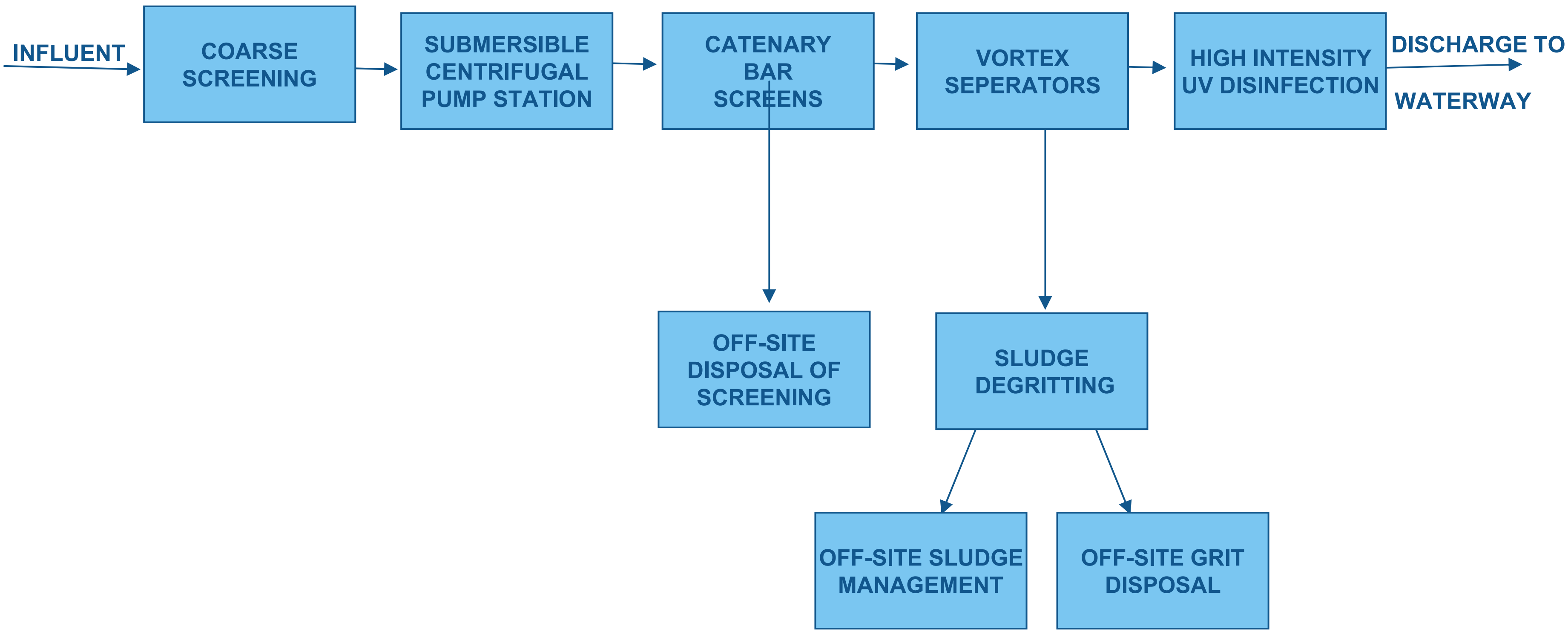
Determine the technologies, siting impacts and costs for end-of-pipe treatment of CSOs in the:

- 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

CSO's in Study Area

Location	Number of CSOs
Upper North Shore Channel	25
Lower North Shore Channel	20
North Branch Chicago River	59
Chicago River	18
South Branch Chicago River	48
Total	**170**

CSO Treatment Process Train for Cost Estimation Purposes



CSO Study Results

- Due to site limitations only 105 out of 170 potential sites can be used for CSO treatment
- Total treatment capacity of 105 sites = 2009 mgd
- Capital cost $900 million
- Annual cost $3.8 million

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

TM-4WQ
Supplemental Aeration of NBCR and SBCR

Supplemental Aeration of NBCR and SBCR – TM – 4WQ

– Locate and size supplemental aeration stations on NBCR nad SBCR

– Stream target

- 90% compliance with D.O. concentration of 5 mg/l

– Planning level costs for potential supplemental aeration technologies

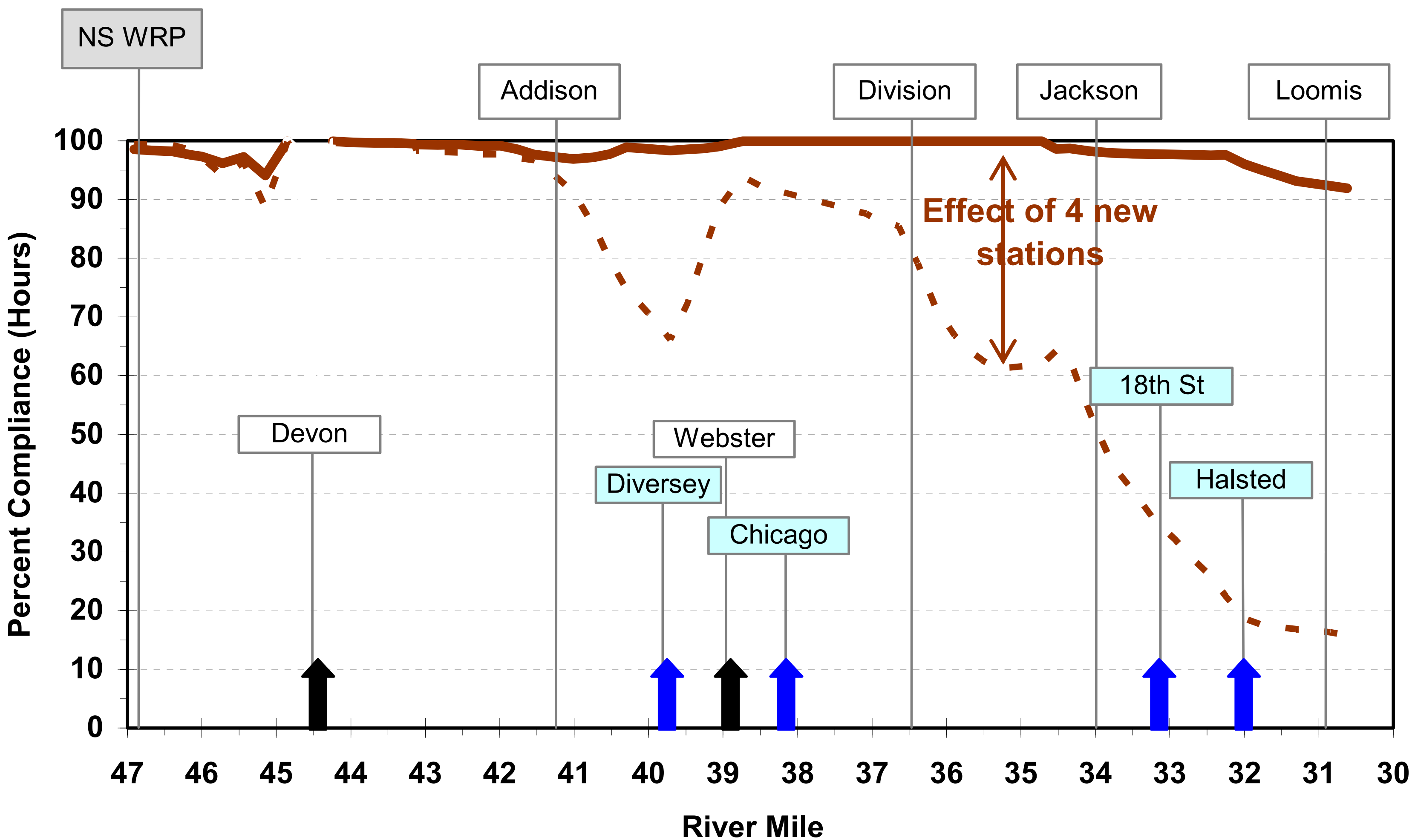
Supplemental Aeration Marquette Model Runs

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 Needed:

Waterway	Location	Aeration Capacity
NBCR	Diversey	30 g/s (5,700 lbs/day)
NBCR	Chicago	30 g/s (5,700 lbs/day)
SBCR	18th Street	30 g/s (5,700 lbs/day)
SBCR	Halsted	80 g/s (15,200 lbs/day)

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 Million - $2.42 Million

– Total Present Worth
  - $38.7 Million to $116 Million

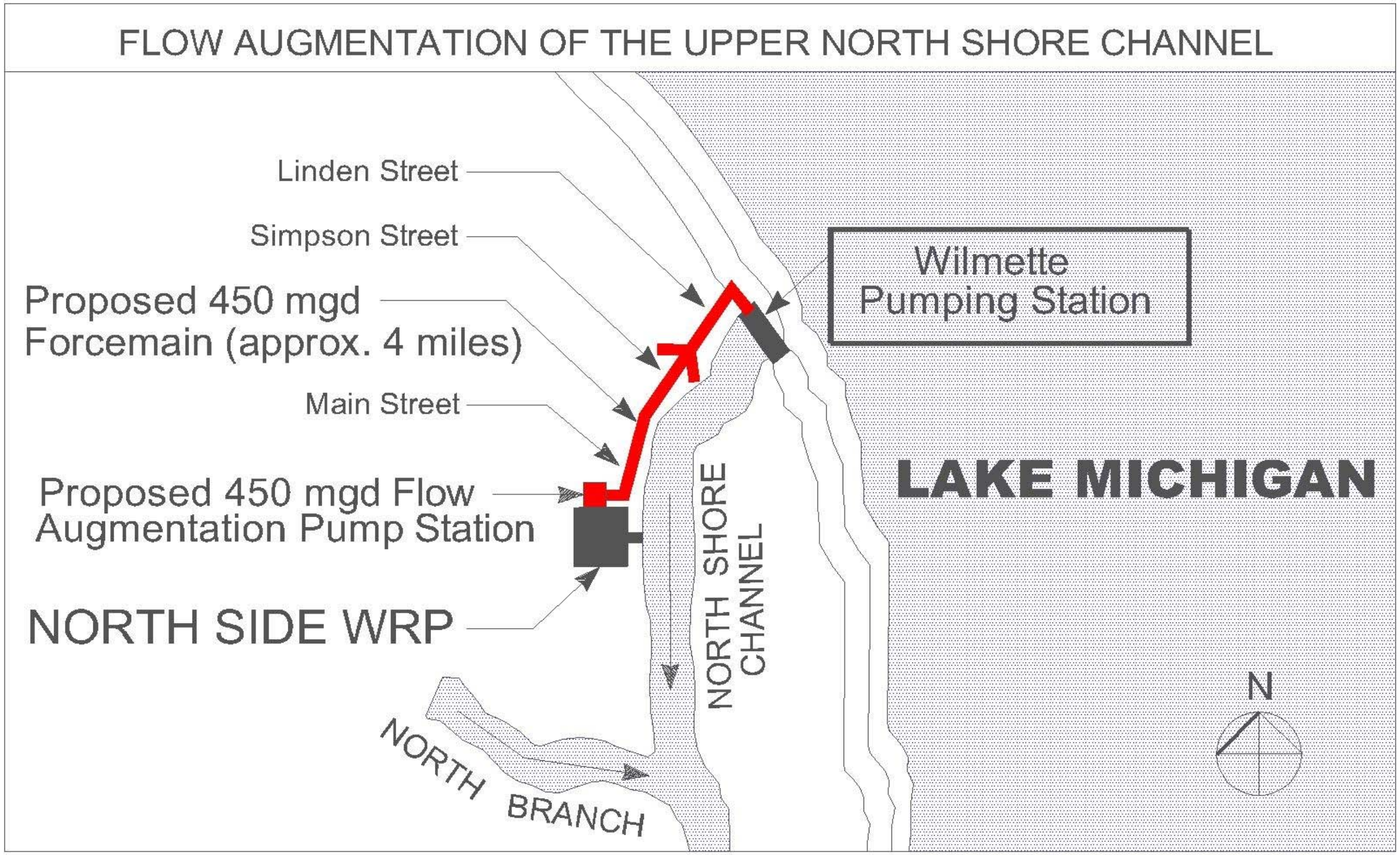
Cost of Four Supplemental Aeration Stations on NBCR and SBCR			
	Total Capital	Annual O&M	Total Present Worth
U-Tubes	$29.8	$.449	$38.7
SEPA	$59.1	$2.86	$116
Ceramic Diffusers	$28.9	$1.02	$49.3
Jet Aeration	$51.2	$2.42	$99.5

TM-5WQ
Study of Flow Augmentation of the UNSC

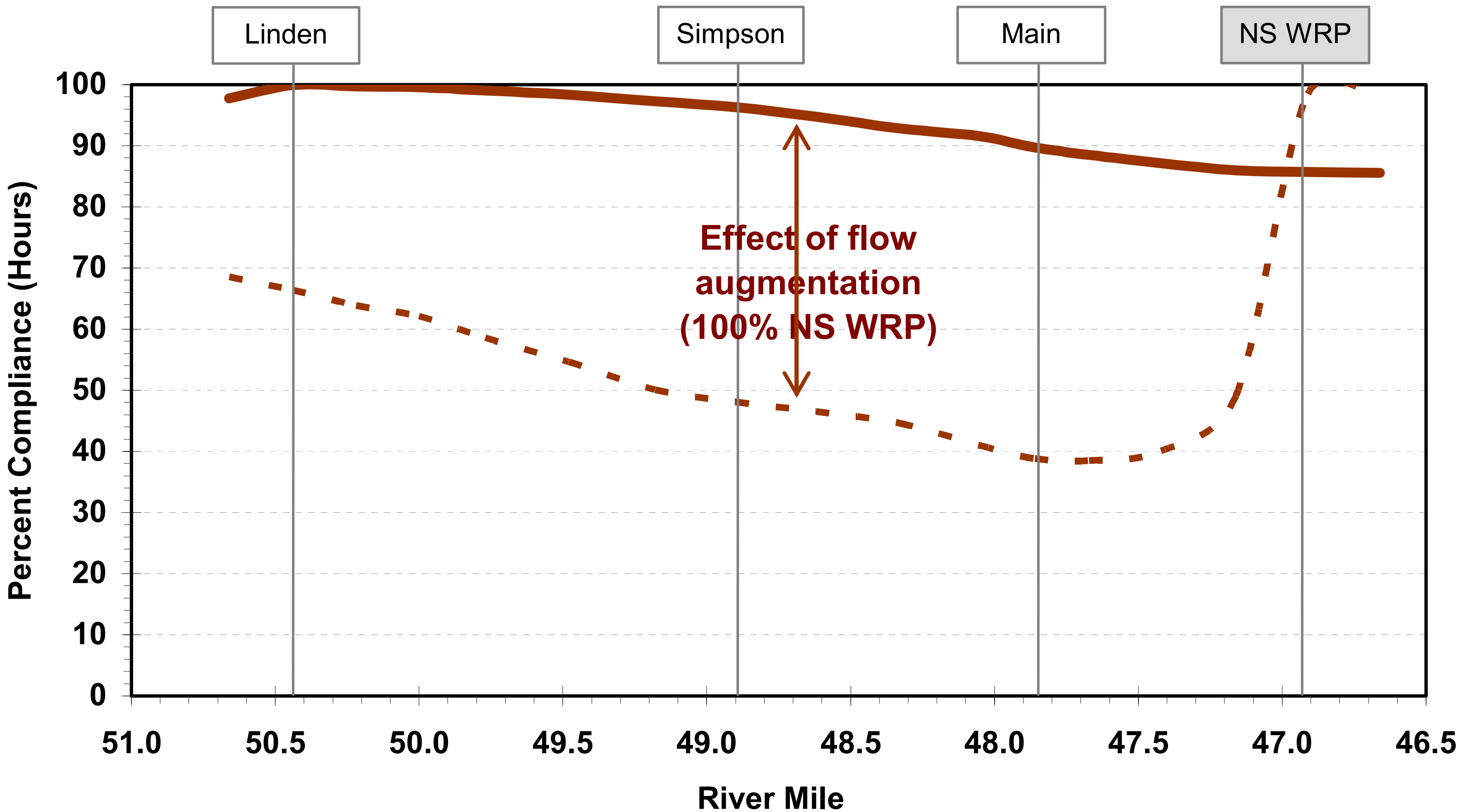
Flow Augmentation of the UNSC – TM – 5WQ

- Via force main bring North Side WRP effluent upstream to Wilmette lock
- Two options
  - No aeration of force main
  - Aeration of force main
    - Raise D.O. from approximately 6mg/l to saturation
- Stream D.O. Target: 90% compliance with D.O. of 5 mg/l

Flow Augmentation Without Aeration of Transferred Flow


FLOW AUGMENTATION OF THE UPPER NORTH SHORE CHANNEL
Linden Street
Simpson Street
Proposed 450 mgd Forcemain (approx. 4 miles)
Main Street
Proposed 450 mgd Flow Augmentation Pump Station
NORTH SIDE WRP
Wilmette Pumping Station
LAKE MICHIGAN
NORTH SHORE CHANNEL
NORTH BRANCH
N

% Compliance With Minimum 5 mg/l Waterway Dissolved Oxygen Concentration for 100% Flow Augmentation from North Side WRP, All Time Periods



Cost of Flow Augmentation of Upper NSC (Without Aeration of Transferred Flow)

Capital Cost($)	Annual Cost($)	Total Present Worth($)
$394,000,000	$2,700,000	$447,000,000

Flow Augmentation With Aeration of Transferred Flow

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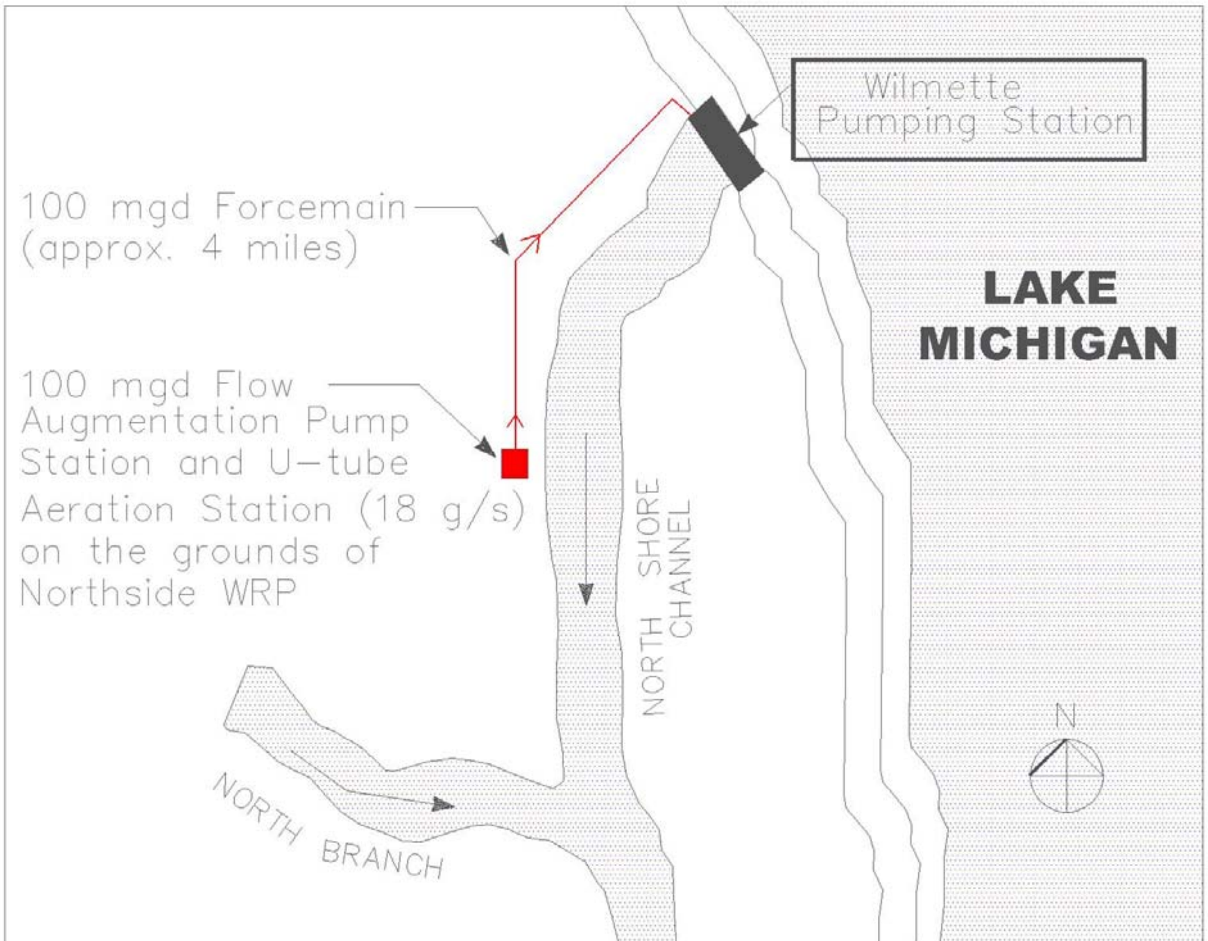
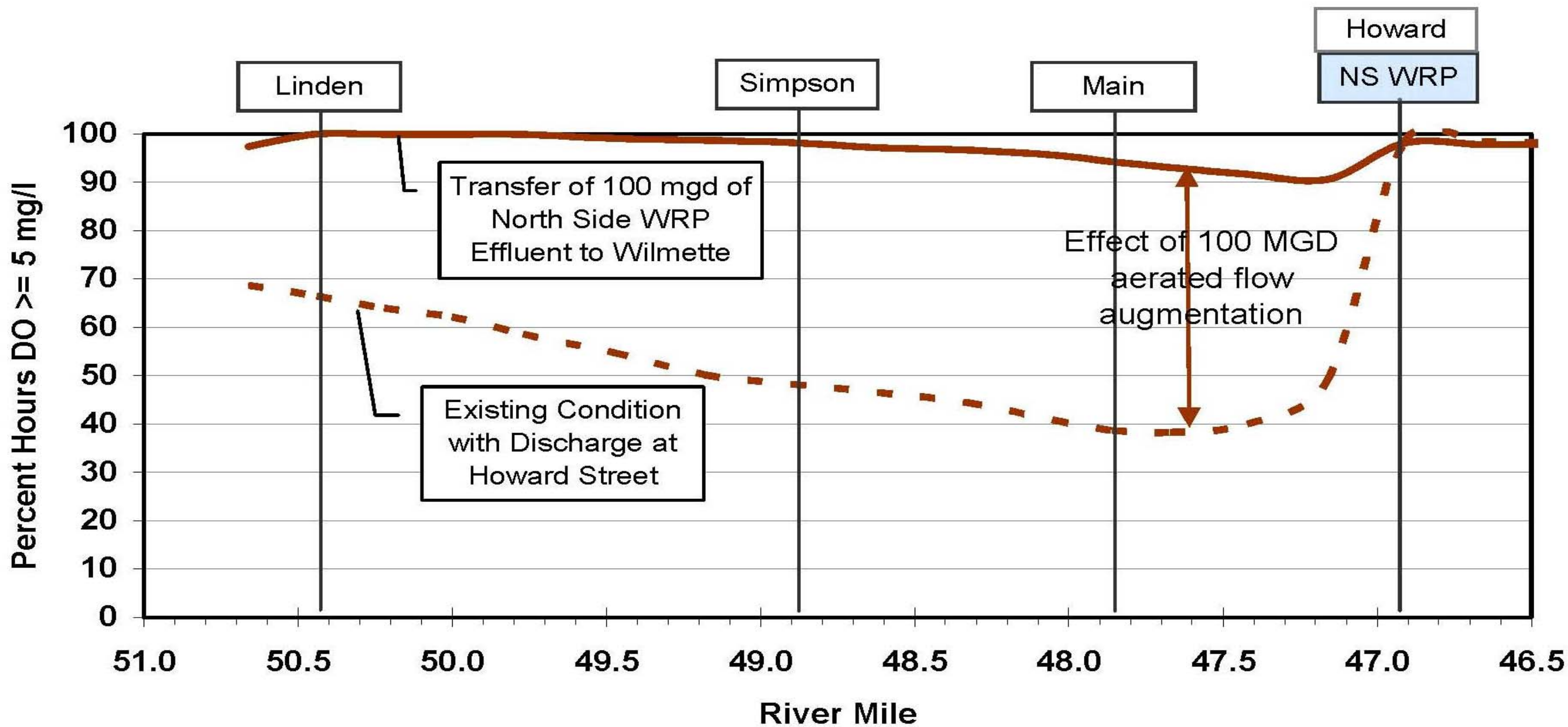
Flow augmentation of the Upper North Shore Channel with aeration of the transferred flow



% Compliance with Minimum 5 mg/l Dissolved Oxygen for 100 MGD of Aerated Flow Augmentation, All Time Periods



Flow Augmentation of UNSC With Aeration of Force Main

– Capital costs approximately $60 million

– Annual costs approximately $0.8 million

– Total present worth approximately $75 million

TM-6WQ
Flow Augmentation and Supplemental Aeration of Bubbly Creek

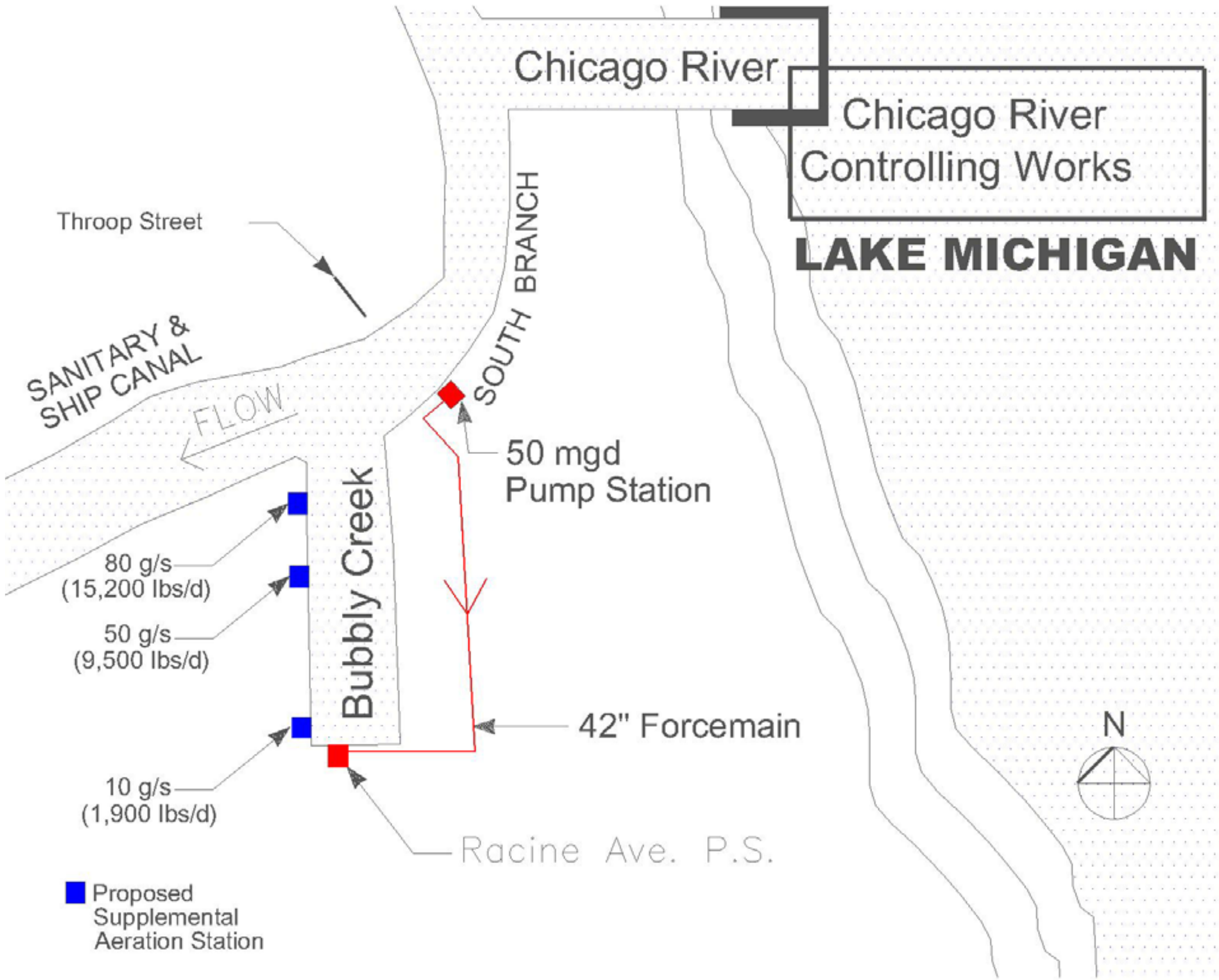
Flow Augmentation and/or Supplemental Aeration of Bubbly Creek – TM – 6WQ

- Flow augmentation
  - Withdraw water from SBCR at Throop Street
  - Bring water to headwaters of Bubbly Creek
  - Two options
    - ✓ Aeration of Force Main
    - ✓ No Aeration of Force main
- Supplemental aeration
  - If necessary, locate supplemental aeration stations on Bubbly Creek
- D.O. Target – 90% compliance with 5 mg/l of D.O.

"Best" Scenario for Bubbly Creek

- Three aeration stations on Bubbly Creek
  1) 15,000 lbs/day at mouth
  2) 9,500 lbs/day at midpoint
  3) 1,900 lbs/day at headwaters
- Flow Augmentation
  - 50 MGD pump station on SBCR
  - 2 mile force main to headwaters of Bubbly Creek
  - No aeration for Force Main

Flow Augmentation & Supplemental Aeration of Bubbly Creek



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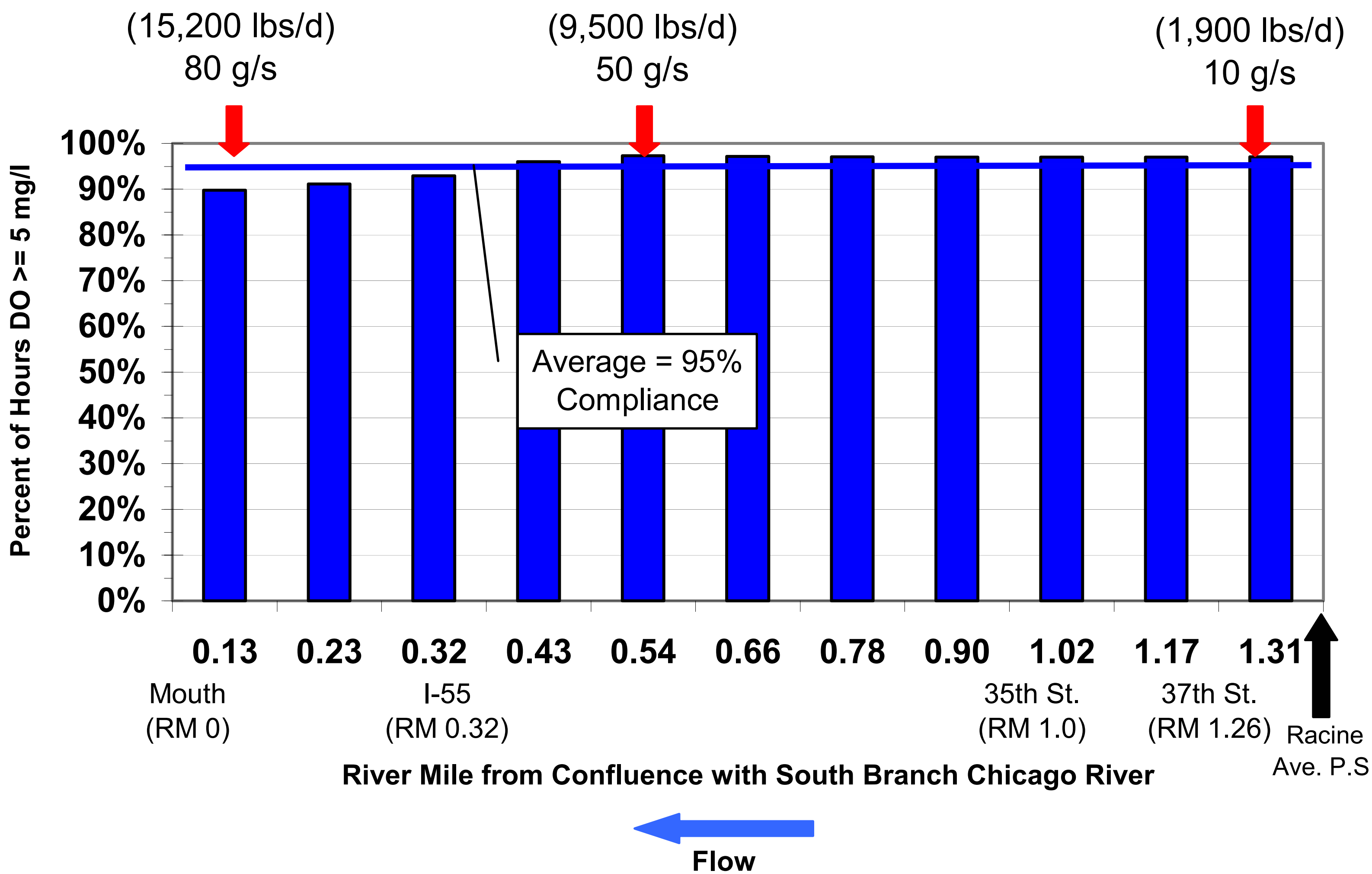
Flow Augmentation (50 mgd) snd Supplemental Aeration of Bubbly Creek at 3 locations, Percent of Hours Complying with 5 mg/l Dissolved Oxygen Criterion, For All Simulated Time Periods in the Marquette Model



Costs for Flow Augmentation and Supplemental Aeration of Bubbly Creek

– Capital Costs of 60.4 million to $102.9 million

– Annual costs of $1.0 million to $2.8 million

– Four potential supplemental aeration technologies
  - U tubes
  - Sidestream elevated pool aeration
  - Ceramic diffusers
  - Jet aeration

TM-7WQ
Development of a Integrated Water Quality Strategy for the Chicago Area Waterways

Need For Integrated Strategy

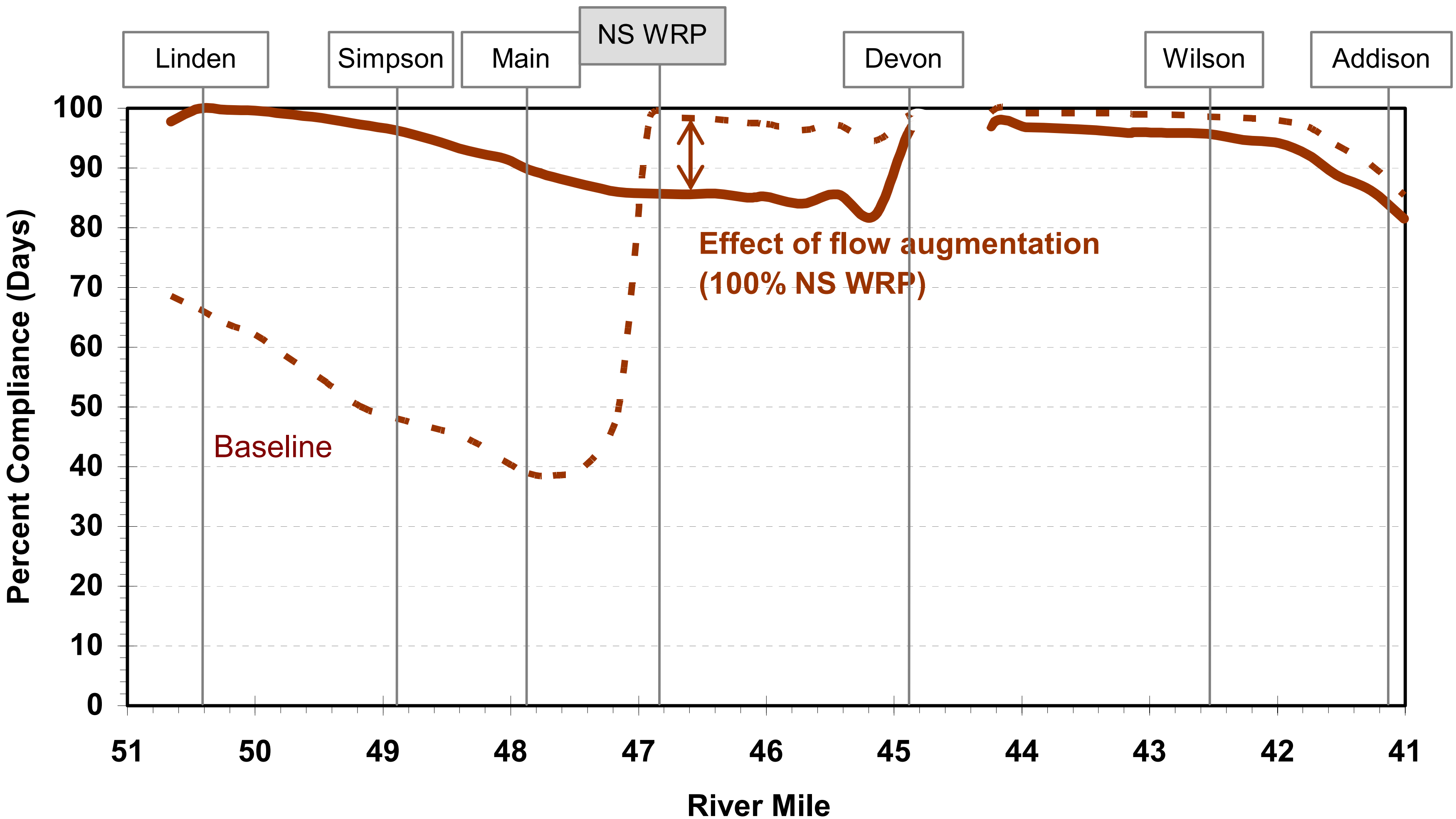
– Previous studies assumes only single option was operating on the CAWS

– Previous studies did not include all portions of CAWS

– Water quality management options can be combined to meet water quality objectives

Flow Augmentation (100%) for the Upper North Shore Channel Reduces Compliance below the North Side WRP

Percent of Hours Complying with 5 mg/l Criterion, All Time Periods



Suggested Integrated Water Quality Development

Task 1 - Develop long list of potential water quality management options

Task 2 - Prepare short list of water quality management options

Task 3 - Audit water quality model

Task 4 - Model modifications and/or improvements

Task 5 - Evaluate short list of water quality management options

Task 6 - Prepare final water quality strategy

Task 1 – Develop long list of potential water quality management options

– Work with stakeholders

– Workshop approach

– Use results of TM-1WQ to TM-6WQ

– Finalize water quality targets

– Look at variety of options

- Sediment Remediation
- Completion of TARP

Task 2 – Prepare short list of potential water quality management options

– Matrix Evaluation

- Economic Factors
- Non-Economic Factors

– Workshop Approach

Task 3 – Audit Models

– Review Available Models

- U of I Hydraulic Model of TARP Tunnels and Reservoirs
- U of I Water Quality Model
- Marquette University Water Quality Model

– Consider Need for Collection System Model

Task 4 – Model Modifications and Improvements

– If Necessary

- Revise calibration and verification
- Add additional data bases
- Additional sampling and analysis
- Sensitivity analysis

Task 5 – Evaluate Short Listed Water Quality Management Options

- Sizing of Options
  - Use of Model
- Simulate Water Quality Benefits
  - Use of Model
- Develop Study Level Costs
- Matrix Criteria and Weights
- Workshop

Task 6 – Prepare Final Water Quality Management Strategy

– Workshop Approach

Conclusion

Much more work needs to be done to determine what combinations of water quality management options offer the most cost-effective means to meet water quality objectives.

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Questions & Answers