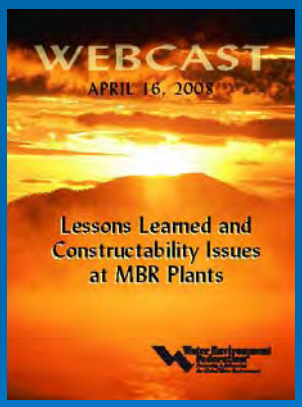
Lessons Learned and Constructability Issues at MBR Plants

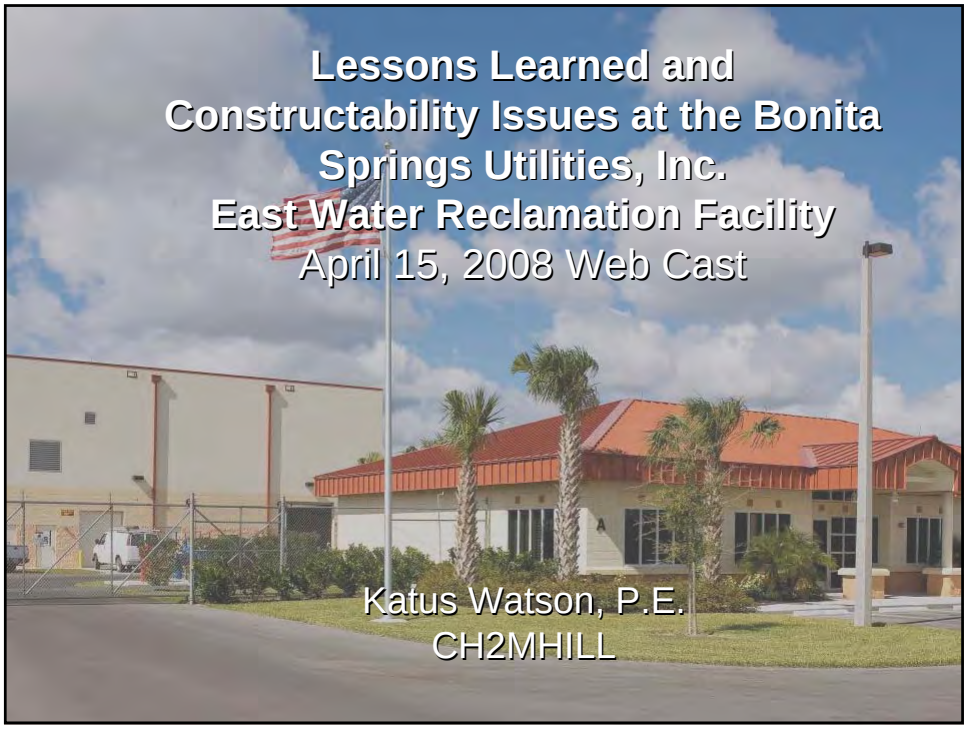


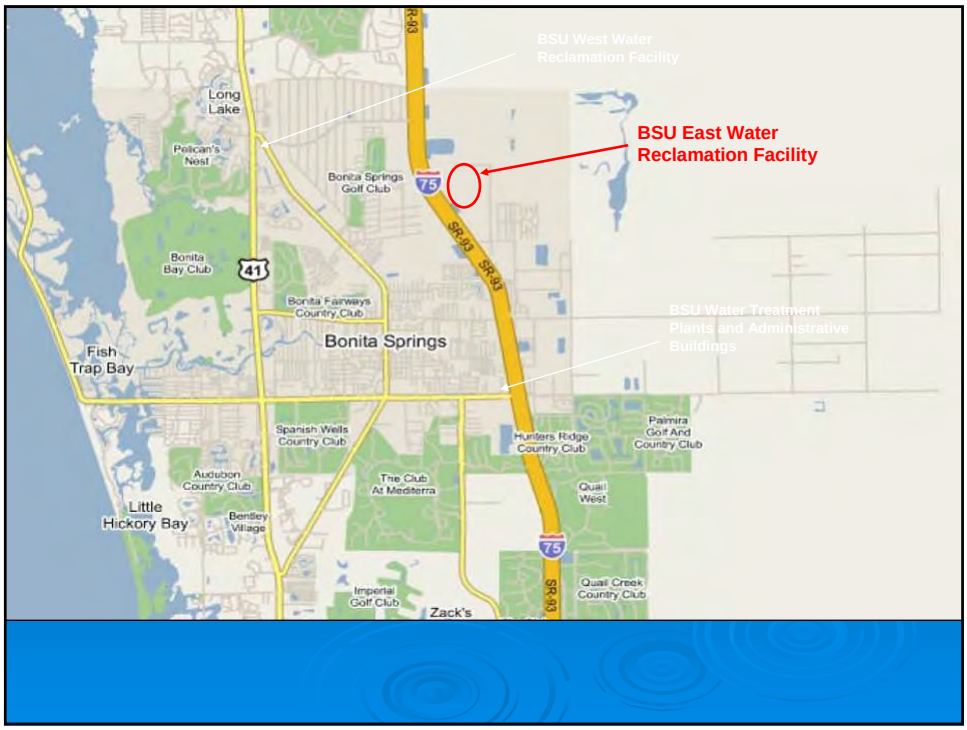
April 16, 2008 * 1:00-3:00pm EDT

Water Environment Federation®
Preserving & Enhancing the Global Water Environment

Lessons Learned and Constructability Issues at MBR Plants Webcast Speakers

- Paul Schuler, P.E., GE Water & Process Technologies
- Katus Watson, P.E., CH2M HILL
- Craig Olson, P.E., HDR Engineering
- Mark Prein, P.E., Prein&Newhof

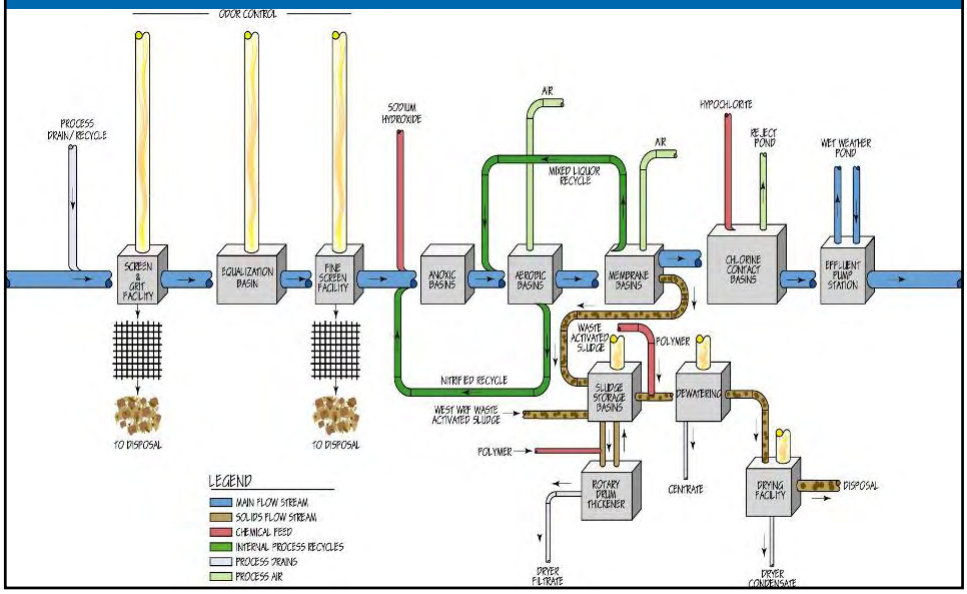

Lessons Learned and
Constructability Issues at the Bonita
Springs Utilities, Inc.
East Water Reclamation Facility
April 15, 2008 Web Cast
Katus Watson, P.E.
CH2MHILL


BSU West Water
Reclamation Facility
BSU East Water
Reclamation Facility
BSU Water Treatment
Plants and Administrative
Buildings
Long
Lake
Pelican's
Nest
Bonita Springs
Golf Club
Bonita
Bay Club
Bonita Fairways
Country Club
Bonita Springs
Fish
Trap Bay
Spanish Wells
Country Club
Audubon
Country Club
Little
Hickory Bay
Bentley
Village
The Club
At Mediterra
Imperial
Golf Club
Zack's
Hunters Ridge
Country Club
Palmira
Golf And
Country Club
Quail
West
Quail Creek
Country Club
SR-93
75
41

Project Scope

- Design & Construction of a 4 mgd water reclamation facility
- Includes state of the art MBR and Sludge Drying Facilities (AA Bio-solids)
- Expandable in 4 mgd increments to 16 mgd (160,000 people)
- Contract Type – Cost Plus GMP
- Project Delivery Method – Design/Build

Plant Process Flow Diagram



Recipe for Success on this project

- Application of ethical and professional behaviors
- Aggressively maintain a "**Can Do**" attitude, and **Drive** to move forward
- Single point of responsibility for schedule, budget, & quality from each organization
- Recall and discuss lessons learned from previous projects
- Proactive planning during all project phase
- Project constraints were planned and clearly presented to all team members
- Client Involvement

Key Lessons Learned Components

- Planning – what & when
- Coordination – how, who, where
- Communication – letting everyone know how they fit in, receive input to the plan & coordinate

Planning

- Chartering meeting with client, design team, and construction team
- Select MBR manufacturer early
- Factory assemble and test controls (where practical); verify controls function as designed prior to shipment to site

Planning

- Schedule equipment delivery and coordinate delivery dates to facilitate construction schedule and manpower resources
- Schedule and plan for delivery of membranes & provide suitable local storage
- Proactive planning based on what went wrong on other projects resulted in avoidance of issues

Coordination

- Document, Document, Document (Not News)
  - Document key decisions and circulate to others
  - Inventory shipped equipment, parts, and materials.
  - Inspect major components upon receipt to confirm dimensions, completeness, free of damage, take photographs and sign off on receiving inspection

Coordination

- Timely resolution to RFIs was a top priority
- Continuity in the project teams is important to the project overall success, People make it happen.
- Get it right the first time!

Coordination

- Operators were actively involved with ORTs & PATs
- Process instrumentation & control system coordination to occur early

Coordination

- Bring everyone onto the same page with a Startup Workshop and Pre-Event briefing
- Advance visits to jobsite during installation to review progress and to facilitate that startup goes smoothly.

Communication

- Confirm receipt and incorporation of drawing revisions to each sub and supplier
- Owner's staff involvement during all phases of the project
- Review start-up schedule early in the project to ensure that overall CPM schedule aligns with the project milestones

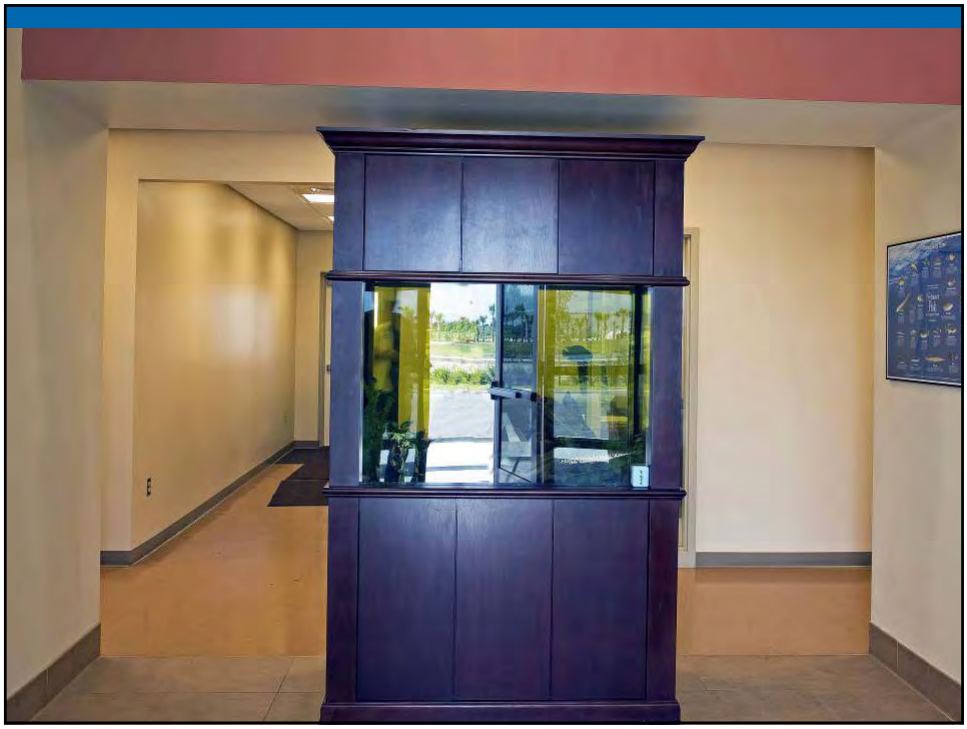
Communication

- Open lines of communication, straightforward answers, and strive to maintain a team atmosphere
- Demonstrate being "Mindful" of others costs and schedule needs
- Establish a single point of contact for each team during project construction.

Success

- On Time, On Budget, & Quality
- Seamless startup
- Straight into operation with no lost production time

Naples Bird Club
Woodpeckers



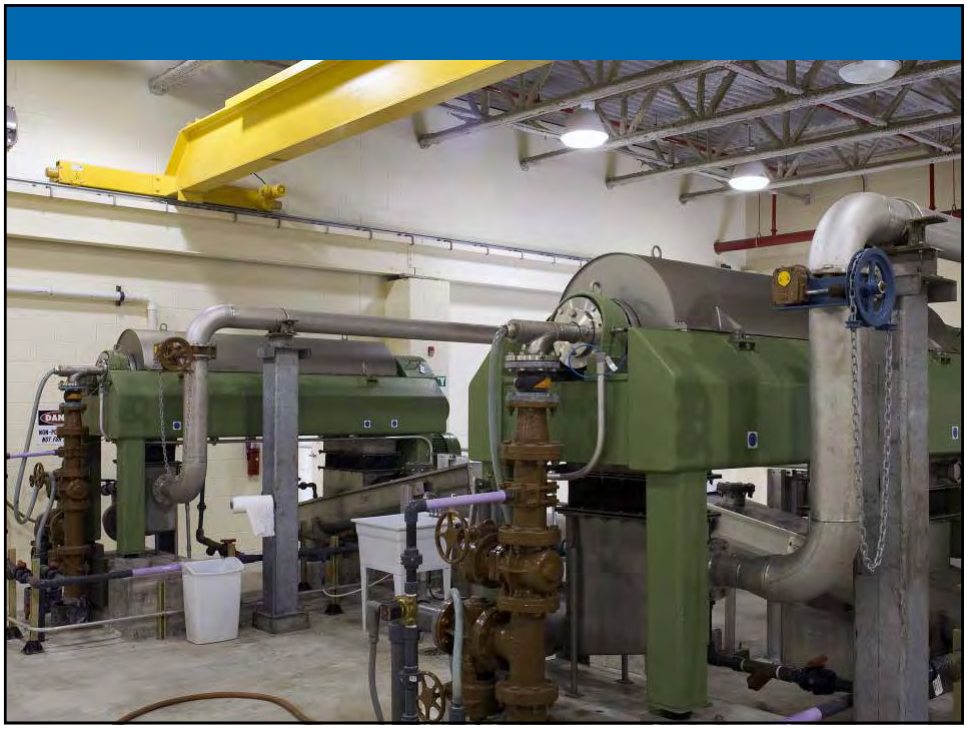
M

M

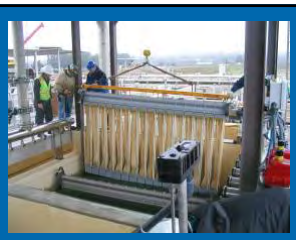
H

EMH 5 ton

2½ TON
AERZEN

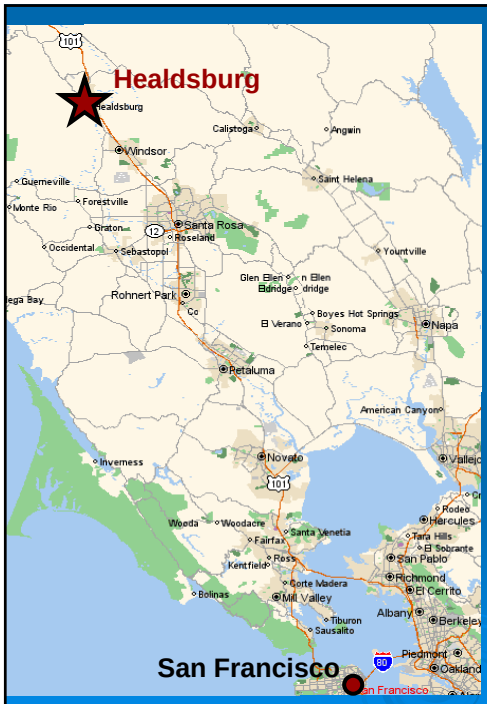


Questions?



Lessons Learned and Constructability Issues at MBR Facilities

Craig Olson, PE
HDR Engineering, Inc.



City of Healdsburg

- Located in Sonoma County on Highway 101, at the confluence of the Russian River and Dry Creek
- Incorporated in 1873
- Population 12,000

City of Healdsburg (cont.)

- Bustling wine tourism destination
- High proportion of commercial and industrial connections, providing approximately 50% of water and wastewater revenue
- Very low growth (<2.5%) due to voter-enacted Urban Growth Boundary (1996) and Growth Management Ordinance (2000)

Wastewater System

- Biological secondary treatment with four aerated ponds, followed by two oxidation/sedimentation ponds and chlorine disinfection
- Located one-mile southwest of the City, just east of the Russian River
- Effluent discharged to terrace mining pond adjacent to WWTP (Basalt Pond)
- Current dry weather flow: 0.95 mgd
- Permitted for a dry weather flow capacity of 1.4 mgd

Regulatory Background

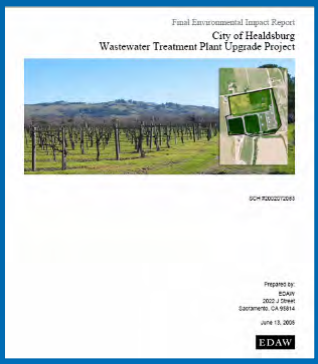
Until 2004	**City's discharge regulated as a discharge to land (vs. discharge to "Waters of the US")**
2002	**Citizen's lawsuit filed contending that the Basalt Pond was "Waters of the US," and that the City's discharge should be subject to NPDES Permit**
January 2004	**Decision by US District Court that Basalt Pond should is "waters of the United States" and subject to the requirements of the Clean Water Act, including NPDES permit**

New NPDES Permit Limits

Biological Oxygen Demand	**10 mg/L (monthly average)** **15 mg/L (weekly average)**
Suspended Solids	**10 mg/L (monthly average)** **15 mg/L (weekly average)**
Coliform Bacteria	**<2.2 MPN/100 mL (weekly average)** **<23 MPN/100 mL (daily average)**
Copper (interim)	**<30 µg/L (monthly average)**
Turbidity	**No Limit (yet)**
Nitrate, Nutrients	**No Limit (yet)**

Planning/Design for Advanced Wastewater Treatment Plant (AWT) Project

- Initiated in 2003
- Considered two treatment alternatives:
  - Conventional extended aeration with biological nitrogen removal (BNR) and tertiary filtration
  - Membrane bioreactor (MBR) with BNR
- City certified an Environmental Impact Report in July 2005 with MBR as the preferred project



Why MBR?

- Costs differential between conventional AWT and MBR likely to be small; membrane costs trending downwards
- Rapidly increasing number of operating MBR facilities and base of experience
- Completely new facility, City's desire to make the largest leap reasonably possible in level of treatment
- Ability to meet future regulations, anticipated or not

Predesign/Procurement

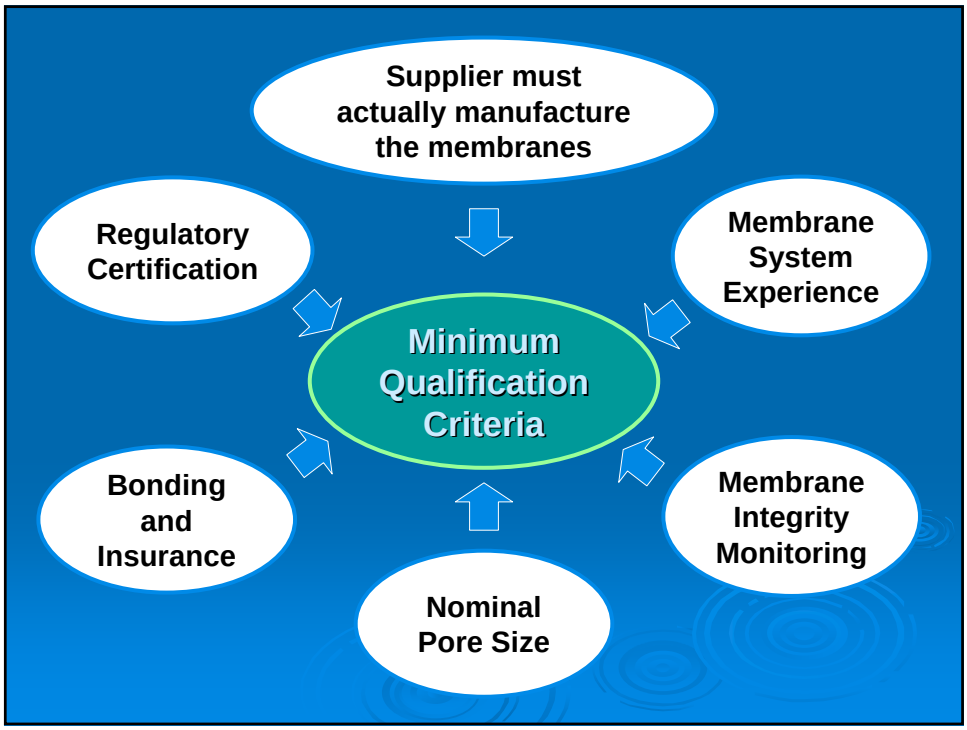
- City selected consultant and began preliminary design after the US District Court decision
- City/consultant immediately began preparing bid documents for membrane equipment procurement in July 2005

Lessons Learned #1

Many Proprietary Manufacturers

↓

Design Around One Manufacturer



Bid Evaluation

Life-Cycle Cost Analysis

- 20-Year Project Life
- 6% Interest

Cost Components

- Capital Costs
- Facility Costs
- O&M Costs

Healdsburg Project: Two Bids Submitted

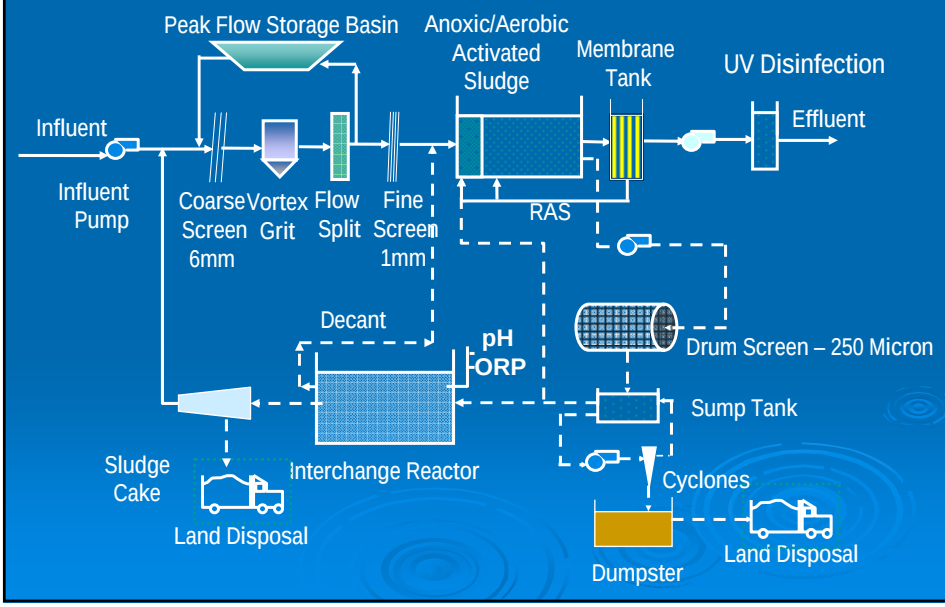
Lessons Learned #2

Develop Relationship with Manufacturer Throughout the Project

Healdsburg MBR Process Basics

- Design flows: 1.4 mgd ADWF, 4.0 mgd peak
- Equalization of partially screened influent for flows > 4.0 mgd
- 6mm coarse screening followed by 1mm fine screen
- Modified Ludzack-Ettinger (MLE) process with biological nitrogen removal (BNR)
- 2 parallel biological trains
- 5 membrane tanks with submerged membranes (n+1 design basis)
- UV disinfection
- Cannibal® solids reduction process

Process Flow Schematic

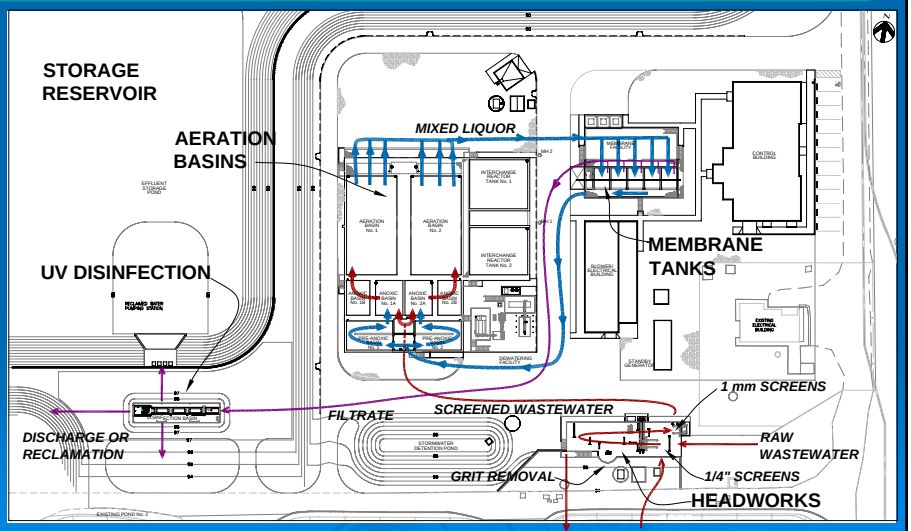


Membrane System Design

- Hollow fiber membranes
- 144 modules in 9 racks of 16 modules
- Each tank can accommodate up to 160 modules
- Design Flux Rates:
  - Average Flow : 3 tanks in service @ 11.2 GFD (19.1 lmh)
  - Peak Flow:4 tanks in service @ 21.6 GFD (36.7 lmh)
- Transmembrane pressure range: 0.8 – 9 psi
- Rotary Lobe pumps utilized for permeate pumps (reversible)
- Filtrate Pump control based on the level in the biological system

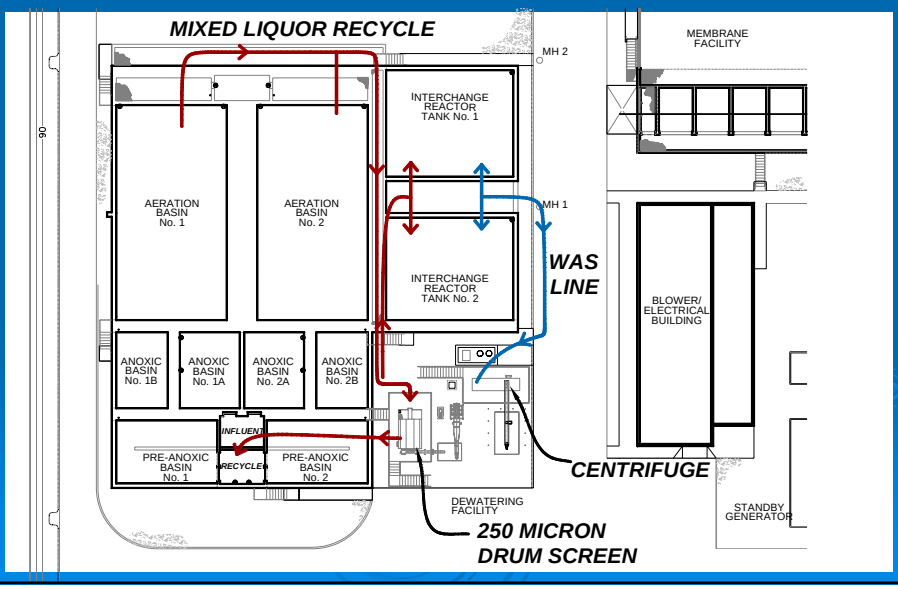
Lesson Learned #3

De-Couple Membrane Facility and Biological Process



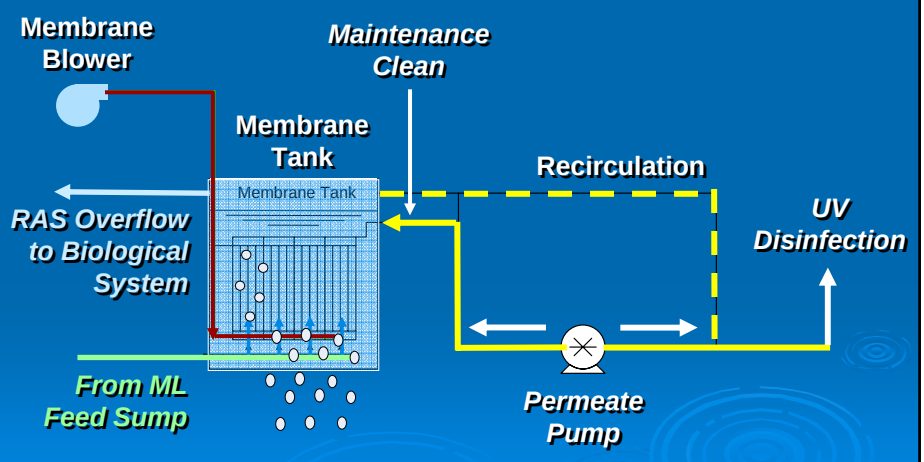
Plant Layout & Process Flow (Biological/MBR)

Plant Layout and Process Flow (Cannibal®/Solids Handling)



Dewatering Area

Membrane System Schematic



Membrane System As Constructed

Lessons Learned #4

Prequalification Process to Qualify Prospective Bidders for the WWTP Construction Contract

- Process included interviews with CM managers for contractors' prior projects
- Resulted in a pool of eight qualified contractors that were allowed to bid on the project; only one disqualification

Prequalification Factors

- **Experience**
- **Financial capabilities**
- **Project delivery**
- **Past history of substantial or unresolved construction claims**
- **Timely payments to subcontractors, etc.**

Construction Phase

- 730 calendar days total contract duration
- WWTP must be producing AWT-treated wastewater by May 1, 2008
- CM by City staff w/engineering support from consultant for submittal review, RFI response, and change orders

Lessons Learned #5

Assign Membrane Contract to General Contractor

Lessons Learned #6

Get Client Electrical/Instrumentation Personnel Involved Early

Heavy Client Electrical/Instrumentation Personnel Involvement During Startup

Lessons Learned #7

Do Partnering with Contractor

Does not Guarantee Success!!!

Lessons Learned #8

Build the Equipment Consolidator (i.e., Warehousing) Concept into Procurement Documents

Avoids Scheduling Problems Associated with Equipment Delivery

Lessons Learned #9

Have Membrane Blowers Be in Membrane Equipment Supplier Scope

Lessons Learned #10

Have a Realistic Schedule for Membrane Equipment Startup and Testing

Lessons Learned #11

In a Pre-Procure/Design/Bid Situation

Insist that the Membrane Supplier Review, Comment and Approve the General Construction Contract and Specifications, Especially for Electrical & Mechanical Work

Headworks

Lessons Learned #12

In the Pre-Procurement Contract with an Evaluated Bid

Make the Parameters that Factor Most Significantly into the Life-Cycle Analysis (i.e., Air Flow Requirements) Enforceable with a Penalty Clause

Current Status

- All major mechanical equipment installed and started-up, and control system wiring and programming are approximately 99% complete
- Started biological process the week of March 17th - MLSS currently 3,500 mg/liter
- Membrane system operational in automatic mode

Questions?

PARCC Side Clean Water Plant

North Kent Sewer Authority
Kent County, Michigan

Introduction

Key Participants

- North Kent Sewer Authority, Owner
  - Alpine, Cannon, Courtland and Plainfield Townships, and the City of Rockford
- Prein&Newhof, Engineer
- Triangle Associates, General Contractor

Introduction

History

- Existing collection system flows treated by neighboring community.
- Proposed new contract with various changes impacting the user; not based on flow or quality.

Introduction

History

- NKSA investigated construction of own Clean Water Plant (CWP).
- Tried negotiating new contract for nearly 8 years, until the last possible moment.

Introduction

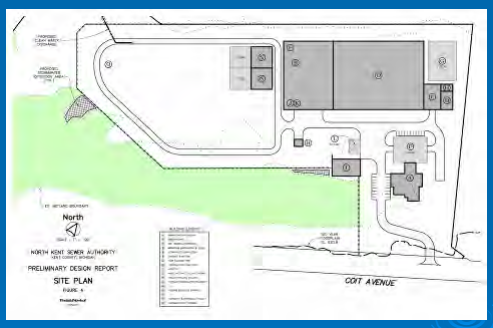
History

- Obtained NPDES permit; required stable effluent; MBR allowed cost effectively.
- NKSA concluded best solution for communities was to construct own Clean Water Plant (CWP).

Introduction

History

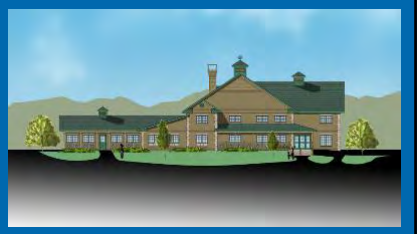
- Compressed design period.
- Construction began before design complete.
- MDEQ permitted design in pieces.



Introduction

Design Concept

- Be a good neighbor.
  - Incorporate farm theme.
  - Minimize noise.
  - Minimize outdoor lighting.
  - Minimize outdoor equipment.
  - Include odor control.



Introduction

Design Concept

- Exceed expectations on treatment.
- Be cost effective.

Introduction

Basis of Design

- Plant Flows
  - Separated Collection System
  - Current Average Day Flow of 4.2 MGD
  - Design Average Day Flow of 8 MGD
  - Design Maximum Day Flow of 12 MGD
  - Design Peak Hour of 16 MGD
  - Future Expansion to 12 MGD ADF
- Membrane System
  - Initially No Equalization

Introduction

Discharge Limits (mg/L)

Parameter	*Monthly*	*Daily*
Biochemical Oxygen Demand	4	10
Total Suspended Solids	20	—
Ammonia Nitrogen	0.5	2.0
Total Phosphorus	1.0	—

Pre-Select Membrane System

Pre-Select Membrane System

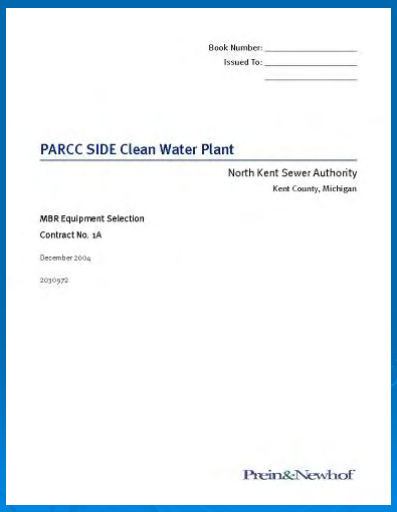
- Consider key differences between systems.
- Look at up/down stream requirements.
- Clearly define your break in responsibility.
  - Screening Requirements

Pre-Select Membrane System

- Restrict membrane type, if desired.
- Include any site constraint.
- Look at how to handle solids.
  - Lack “Structure”

Pre-Select Membrane System

- Understand that each membrane supplier has different support system needs.
- Generate specifications with your specific/ standard equipment.


Book Number: _____
Issued To: _____

PARCC SIDE Clean Water Plant

North Kent Sewer Authority
Kent County, Michigan

MBR Equipment Selection
Contract No. 1A

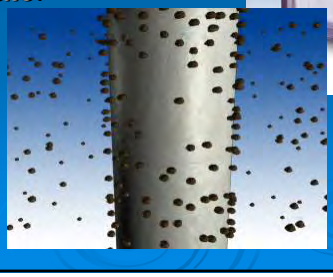
December 2004

2030972

Prein&Newhof

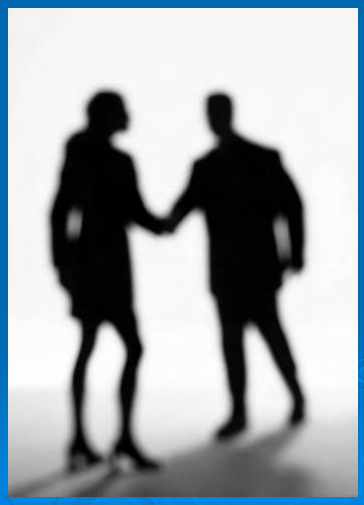
Pre-Select Membrane System

- Consider performance-based specification.
- Look at life cycle cost.
  - Capital, Replacement, Chemicals, Power, Land, Operator Interface



Team Approach

- Pick your team.
- Everyone must buy into the plan.
- The core team goes from three parties to four – include membrane supplier.

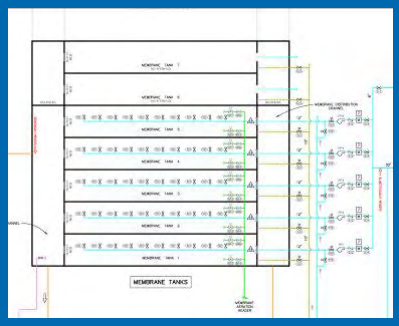


Team Approach

- General contractor included five prime subcontractors in all aspects.
- Contractors issued GMP.
- Team included the MDEQ and other regulatory agencies.

Membrane Expansion

- Take advantage of the expandability and flexibility of the membrane system.
  - Life Cycle Issue
  - Reduce Capital Costs
  - Reduce O&M Costs



Membrane Expansion

- Multiple trains to maximize reliability.
  - With Minimal Idle Membrane Trains
  - While Maximizing Capacity of Support Systems

- 8 MGD ADF of Membrane Tanks
- Populated Five of Seven Trains

Membrane Expansion

- Leave Spare Cassette Space in Train
  - Reliability
  - Future Membrane Revisions
  - Future Temporary/Permanent Expansion Space
- Evaluate Flow Equalization

Focus of Design

- Make the membrane system applicable to your situation.
- Be willing to push the issue; force the membrane supplier to defend the design.

Focus of Design

- You know your design needs.
- Look for improvements to the system.
- Make sure you listen to the membrane supplier's requirements and real needs.

Focus of Design

- Eliminated testing tank.
  - Set up trains so can test in place.
- Eliminated water storage tank.
  - Used overhead permeate pipe as tank.

Focus of Design

- Eliminated drain pumping system.
  - Set up tank hydraulics so can drain back to the site sanitary.
- Don't forget foam/ scum.

Construction Status

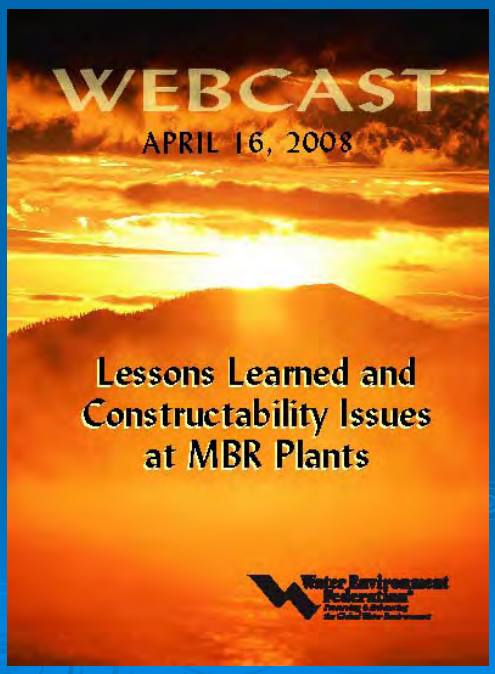
- Started in January 2007.
- Majority of structures nearing completion.
- Hydraulic testing to start in June 2008.
- Membranes installed; wastewater to be delivered in August 2008.

Key Lessons

- Pre-select the membrane supplier.
- Capitalize on membrane system flexibility.
- Expand the team approach.
- Focus the design.

Questions?

Q & A Session

- Paul Schuler, P.E., GE Water & Process Technologies
- Katus Watson, P.E., CH2M HILL
- Craig Olson, P.E., HDR Engineering
- Mark Prein, P.E., Prein&Newhof

Water Environment Federation®
Preserving & Enhancing the Global Water Environment