REINHOLD ENVIRONMENTAL Ltd.

2015 Wastewater-Ash Round Table Presentation

September 22, 2015, in Charlotte, NC / Hosted by Duke Energy

Zero Liquid Discharge System at Stanton Energy Center

Challenges and Solutions

Presented By

Eric Costello, PE – Orlando Utilities Commission

Dean Ritts, PE, CEM – Ritts Sustainable Engineering, LLC

OUC SEC ZLD Background

- History of OUC and SEC
  - Formed at the turn of the 20th Century
  - Purchased by citizens of Orlando in 1922
  - Authority as electric & water utility in 1923 by State
  - OUC operates as Commission
- Stanton Energy Center 1 and 2 Coal Units
  - Each has a gross rating 460 MW
  - Cycled at night

OUC SEC ZLD Background

- What does it mean to have a ZLD system?
  - No process water leaves the site
  - Managing water is essential to operations
  - Recent trends in unit loads and rainfall
  - ZLD site – integrated water management
  - Complimentary alternatives for CCR

Challenge - What changed?

Over Time from 2003:

- Addition of Combined Cycle Units;
- Change in Fossil fuel mix;
- Significant storm events;

Resulting in:

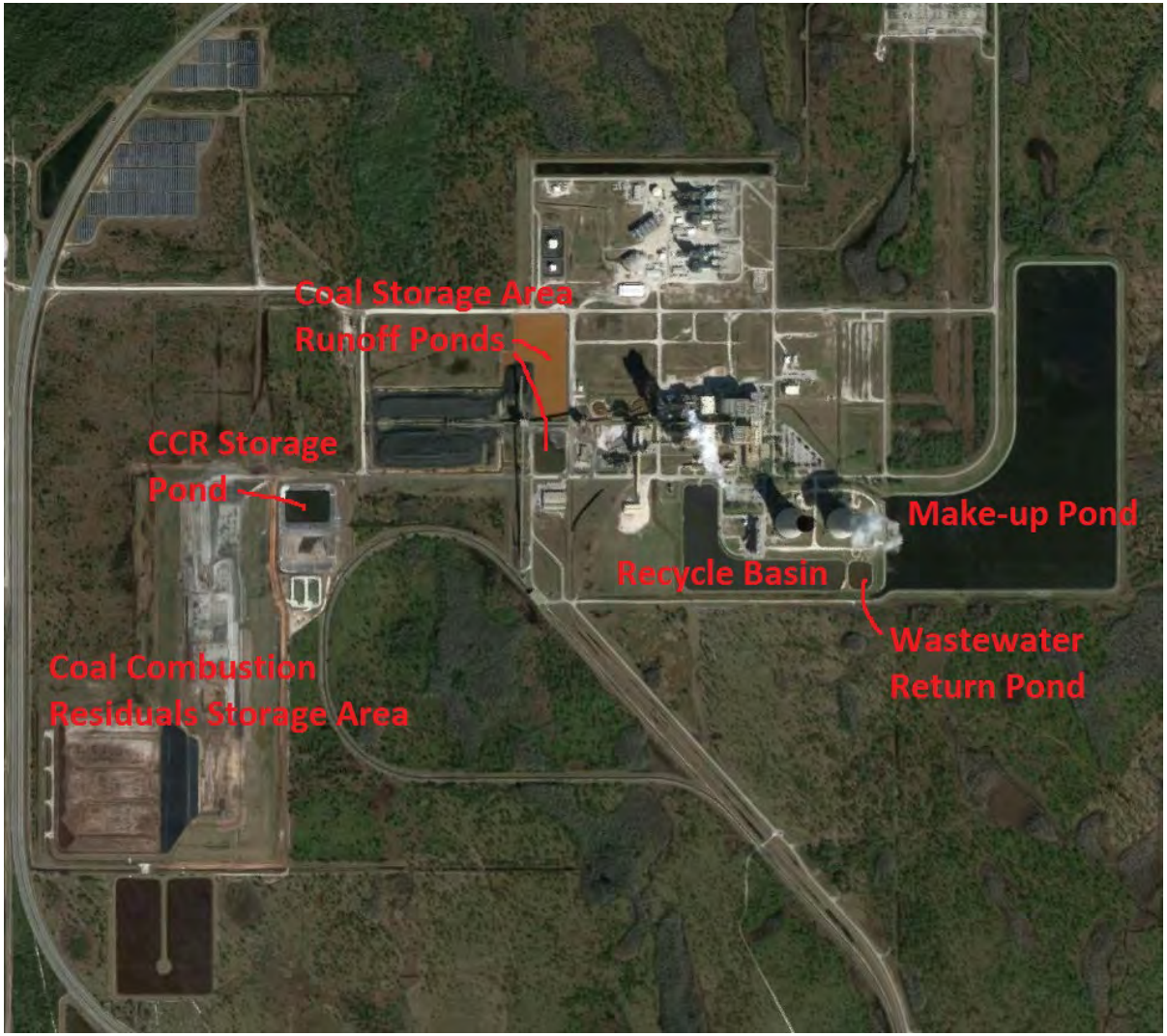
Decreased capacity to cost effectively maintain a zero liquid discharge system when operating cycling coal-fired units

Combined Cycle Units – SEC A and SEC B

OUC SEC ZLD Background

- Main components of the ZLD at SEC?
  - Waste Water Ponds
  - FGD Make-up
  - Brine Plant – mechanical vapor compressor & crystallizer
- Successful ZLD Operation Requires
  - Storage Management
  - Re-use & Recycling

Site Plan – OUC SEC ZLD System



FGD System Evaporation – Full Load

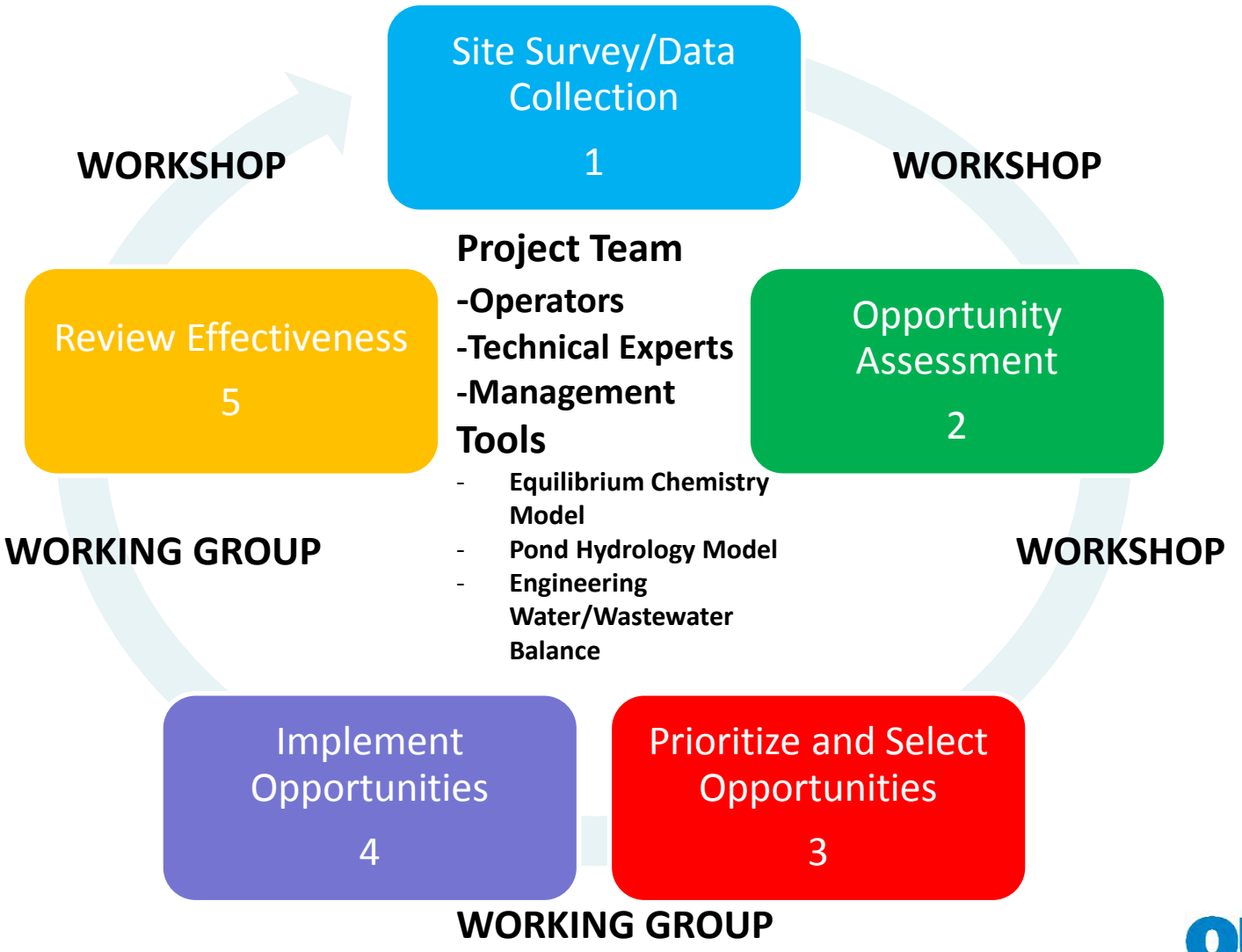
Brine Plant Blowdown SEC 1&2 & SEC A & SEC B

Brine Plant

Solutions needed

- Reduce short term impact of managing water – low cost solutions, maintain zero liquid discharge
- Long term strategy to manage water to maintain ZLD system cost effectively
- Integrate CCR management requirements if possible
- Process optimization for solids process management, Cl control in scrubbers, and storm water management
- Solution must reflect Engineering, Environment, and Economics

Approach – Five Steps to Success



Site Survey - Step 1

- Three day focused site-survey
  - Opening meeting and preliminary review of process and goals
  - “Walk-about” for data collection and interviews with operators
  - Close-out meeting to present survey findings to project team
- Review Data, create tools, develop findings

Site Survey Results - Step 1

- Tools Developed from Step 1
  - Engineering Water/Wastewater Balance
  - Equilibrium Chemistry Model for Identified Key Processes (Cooling towers, demineralizers, MVC, etc.)
  - Pond volume flow model – probability of overflow

Site Survey Results (continued)

- Major Findings
  - Developed “magic number” of wastewater volume that ideally should be diverted or removed from the Recycle Basin pond every day to allow ZLD to operate efficiently
  - Understanding of impact of storm events on recycle basin and ability of one FGD system to keep up: 1 yr. storm event can add 9.1 MG of water to recycle basin
  - Large dischargers and large users of water – including “one-offs” like outages (i.e., boiler flush)

Site Survey Results (continued)

- Major Findings
  - Better understanding of water/wastewater chemistry
  - Collection of operators concerns and observations and their solutions
  - Impact of CCR management and need to reduce solids overflow from scrubbers, coal pile runoff, and solids management pad

Solids Management Pad

Opportunities Assessment & Prioritization – Steps 2 and 3

Develop & Prioritize Alternatives to Reduce Water and Chemistry Load on Recycle Basin

Based on:

- Technical Feasibility
- Impact on problem
- Operational Feasibility
- Cost – CapEx/OpEx
- Impact on Pond Volumes and Probability of Overflow

- Workshops to discuss, select and prioritize
- Spreadsheet approach to catalogue opportunities

Opportunities Selected for Detailed Study

- Opportunities prioritized by project team in to three categories, high, medium, low
- Fall into four main technical categories:
  - Operational change
  - Mechanical change
    - forwarding systems
  - Chemical change
  - Civil change
  - combinations

Opportunities Selected for Detailed Study

- Re-route demineralizer wastewater to cooling towers
- Boiler blowdown to cooling towers
- Seal pump water
- RO Regen or replace demineralizer with RO
- Reduce Contact water & misc. drains
- Brine plant capacity available to treat cooling tower and recycle basin

Opportunities Around FGD Operation

- Importance of FGD Operation Efficiency
- FGD water balance becomes positive (more makeup than needed) at low load
  - Results in low density and high liquid level in absorbers
  - Increased flow to thickeners. Result in overflow of thickener return water tanks

Opportunities Around FGD Operation

- Revise mist eliminator wash logic to adjust wash frequency based on unit load
- Reduce amount of runoff in CCR stack-out areas
- Reduce seal water to recycle pumps
- Poor man’s chloride bleed system

ZLD & CCR Management Interface

- Solids Management is critical – keep solids out of recycle basin to:
  - Maintain storage volume
  - Reduce metals and salts in recycle basin increasing opportunities to re-use water around plant
- Considered
  - Conveyor CCR to landfill
  - Rain Cover Over Sludge Area – reduce contact water
  - Pump CCR to landfill

Implementing Opportunities –Step 4

- Implementing Opportunities is a Reiterative and Collaborative Process
- Key Lessons Learned:
  1) Importance of Working Groups to Process
  2) Continue to review data and question assumptions: it yields new opportunities
  3) Don’t throw away opportunities

Economics of Implementing Opportunities

- Risk/reward
- Economics
  - $/gal for treating with brine plant
  - $ to investigate sending small amount to cooling towers – became too risky to brine plant and condensate tubes cooling towers
  - $/gallon for treating with RO system on site

Temporary Measures – RO at Recycle Basin

Results Review and Status – Step 5

- Adjust the plan as needed – blend recycle basin water option for example – considered later
- Flow meters will be installed
- Training and follow-up

Next Steps

- New Recycle Pond Construction
- Boiler Blowdown Forwarding System
- Vacuum filter exhauster and vacuum filter filtrate pump re-use
- Neutralization Basin water re-use – pump back to Unit 1 or Unit 2 cooling tower basin

Neutralization Basin

Conclusions

- Five Step Approach to develop a long term strategy to manage water to maintain ZLD system cost effectively
  - Survey, Opportunities Assessment, Prioritize, Implement, Evaluate
- Integrate CCR management requirements if possible
- Solution must reflect Engineering, Environment, and Economics
- Process optimization for solids overflow management and Cl control in scrubbers

Discussion