

REINHOLD ENVIRONMENTAL Ltd.



**2014 Wastewater-Ash Round Table
& Expo Presentation**

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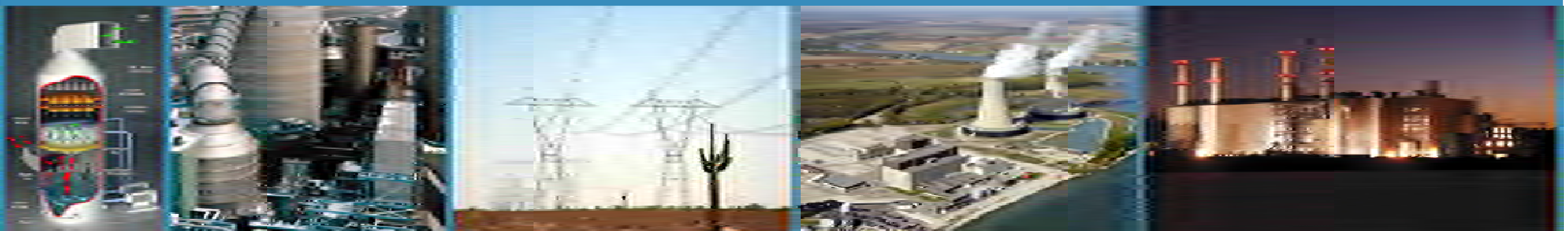


New Lower Cost and Simpler Technology for WWT and ZLD Treatment

Gordon Maller – URS Process Technologies, Austin, TX

2014 Wastewater-Ash Round Table
Renaissance Birmingham Ross Bridge Hotel
Birmingham, AL 35226

September 22, 2014



Topics To Be Covered

- FGD wastewater treatment overview
 - Physical-chemical treatment
 - Biological treatment
- ZLD technology overview
- Discussion of non-thermal ZLD process
- Evaluation of NT-ZLD process: Approach and results
- Conclusions

FGD Wastewater Treatment Overview

FGD Wastewater Background

- Wastewater a result of need to purge chlorides from scrubber
 - Corrosion of alloy materials
 - Ability of scrubber to obtain acceptable limestone utilization
- Ways that chlorides are purged from scrubber
 - Free moisture in FGD byproducts
 - Low solids purge stream (wastewater)
- Characteristics of FGD wastewater
 - Suspended solids
 - Major species: Ca, Mg, Na, SO₃, SO₄ and Cl
 - Trace species: As, B, Br, F, I, Hg, Se, Mn
 - Heavy metals
 - Nitrogen (nitrates and nitrites)
 - ORP: Can affect oxidation state of Se and Hg

FGD Wastewater Background (continued)

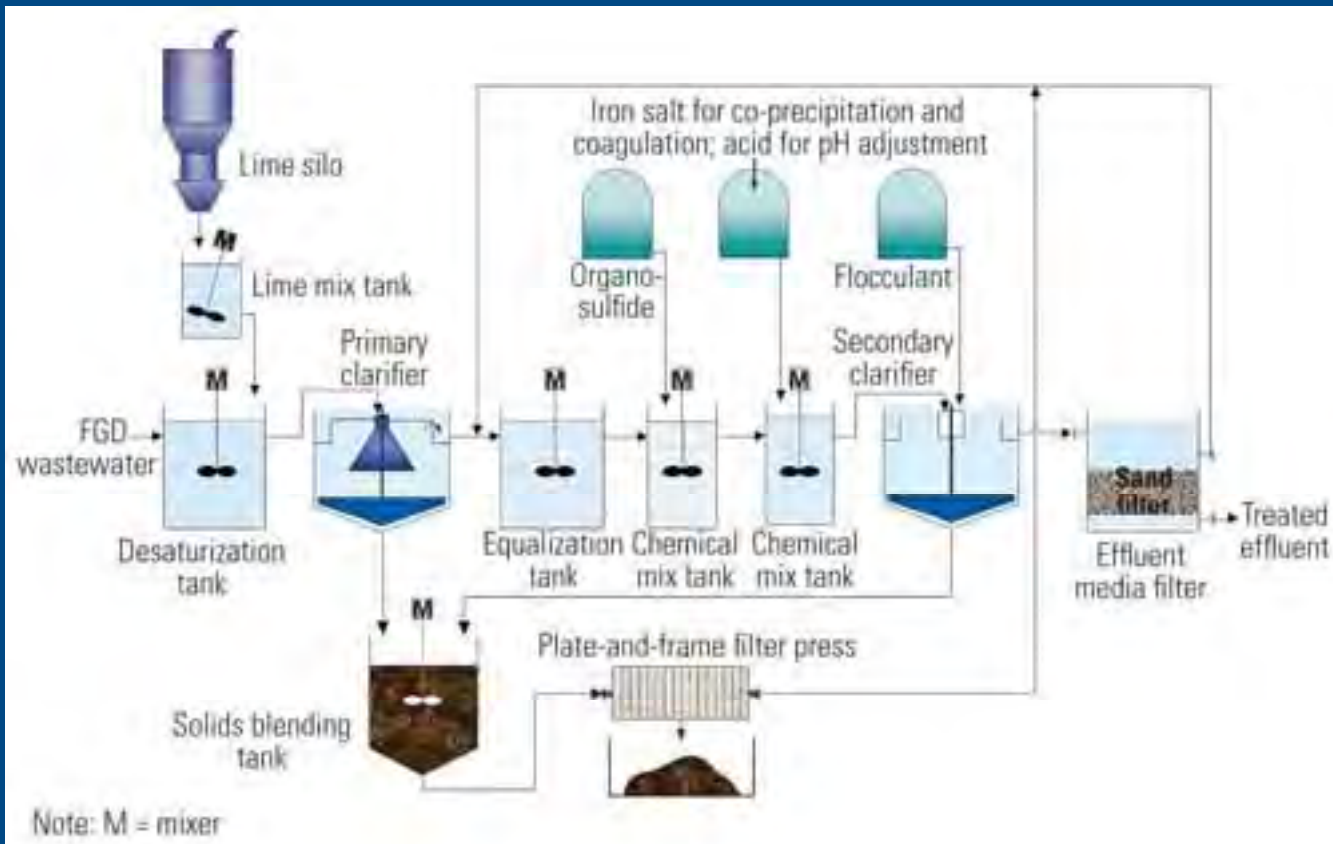
- Composition depends on:
 - Properties of fuel, reagent and makeup water
 - FGD process design and operation
- Wastewater from FGD can be saturated with gypsum. Can lead to scaling in WWT filtration and evaporation equipment

Conventional FGD Wastewater Treatment

- Physical-chemical treatment
- Biological treatment
- Constructed wetlands



Overview of Physical-Chemical Treatment



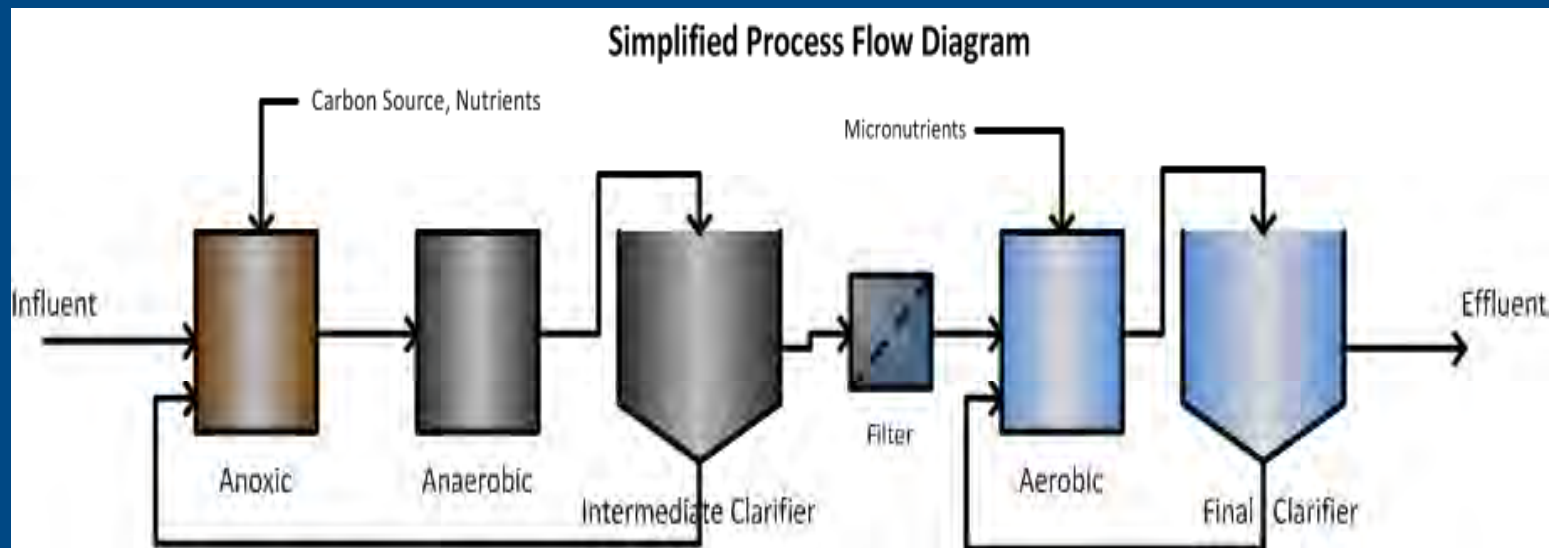
Source of flow diagram – CH2MHill

Overview of Biological Treatment

- Biological treatment located downstream of phys-chem treatment
- Needed to remove BOD/COD, NO₃, NO₂, ionic Hg, selenate
- Activated sludge process – need to maintain population of anaerobic bacteria to treat waste water
- Anaerobic bacteria reduce ionic Hg and selenate to elemental forms which are no longer soluble
- Process typically more challenging for O&M
 - Problems with high or low temperature, high salinity
 - Need to keep population of “bugs” alive
 - Works best with consistent influent flow and influent properties, does not work well as a batch operation

Overview of Biological Process

- Commercial package plants available from several vendors
- Constructed wetlands also an option



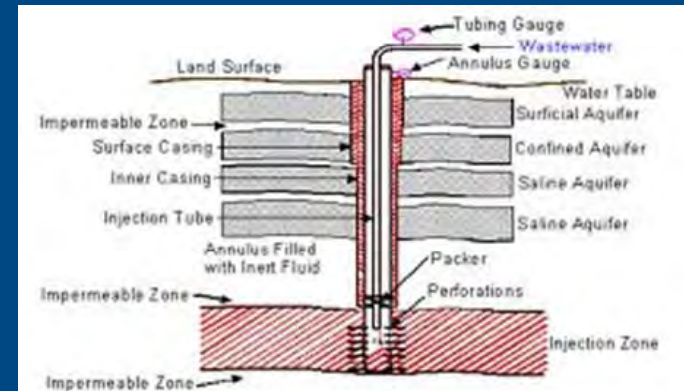
Discussion of ZLD Technology

ZLD Treatment Options

- Deep well injection
- Evaporative thermal process
- Wastewater spray dryer
- Non-thermal ZLD (blending)

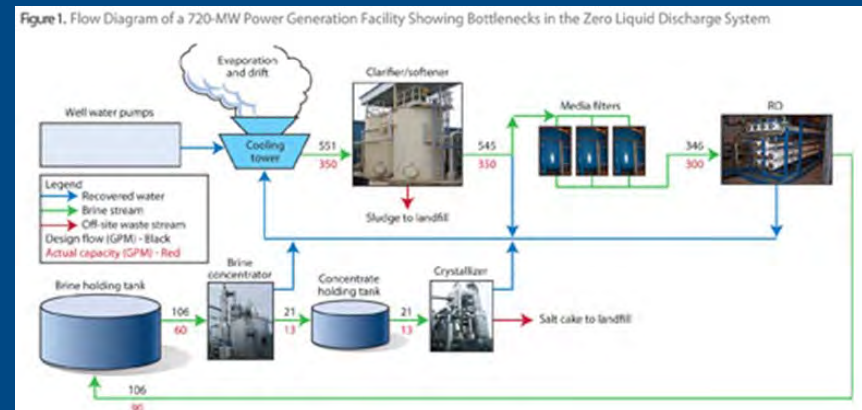
Deep Well Injection

- Deep well injection:
 - Waste must be treated before injection
 - Lower capital and O&M costs
 - Higher environmental risk
 - Not an option in some regions



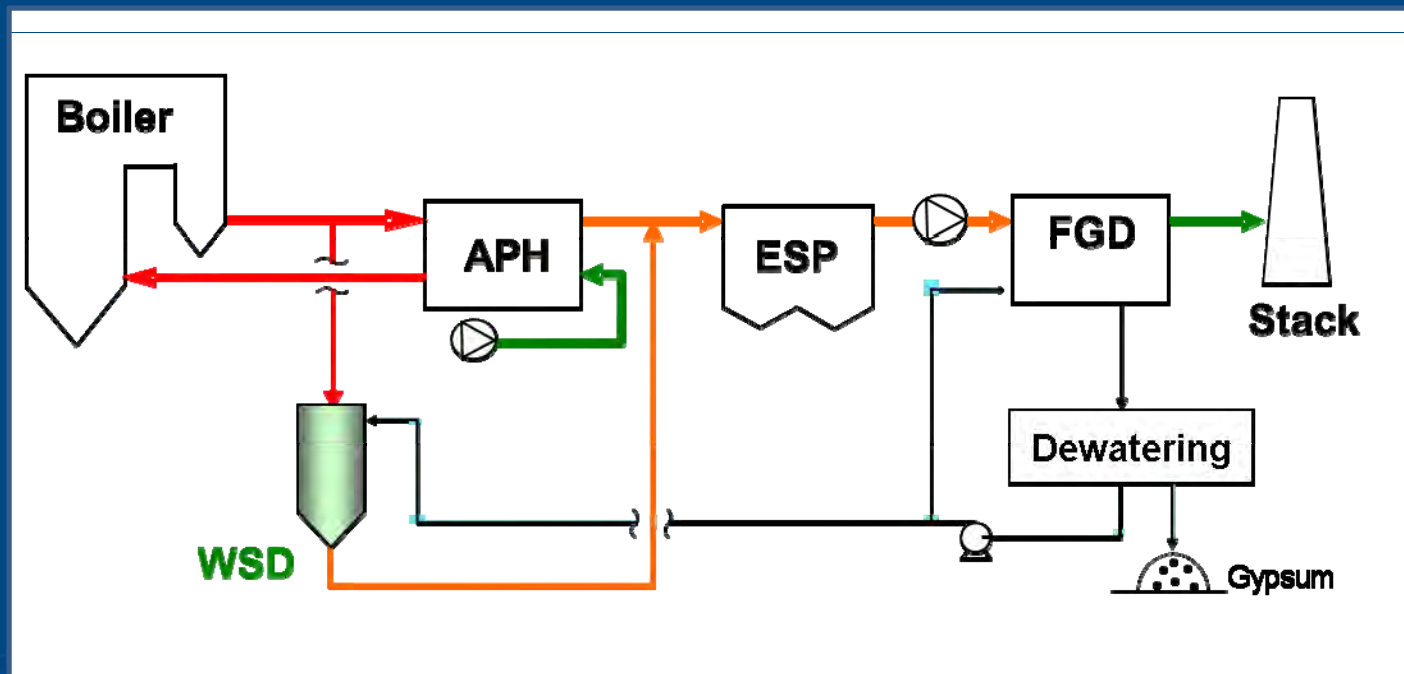
Evaporative Thermal ZLD

- Evaporative thermal process:
 - Brine concentrator for initial concentration of wastewater
 - Reverse osmosis treatment
 - Thermal evaporative (e.g., Vertical tube falling film)
 - Crystallizer
 - Removal of suspended solids and Ca^{++} required prior to treatment
 - High capital and energy requirements
 - Dissolved salts present in FGD wastewater, like CaCl_2 , hydrolyze at high temperature and become acidic and corrosive
 - Fairly complex operating and maintenance requirements



Wastewater Spray Dryer

- Addition of wastewater to small spray dryer installed in flue gas slipstream bypassing air heater
- Salts collected with fly ash in particulate control device



Overview of Non-Thermal ZLD Process

- Fixation and Blending for Disposal in Landfill:
 - Mixture of scrubber solids (e.g., gypsum), fly ash, lime (if required) and waste water to produce a cement-like product suitable for disposal in landfill
 - Non-thermal technology
 - No pretreatment of wastewater
 - Has potential to eliminate all discharges from plant (operate as ZLD plant)
 - Significantly lower in capital and operating costs than other technologies
 - Attractive option due to simple O&M

Application of Non-Thermal ZLD Process

Non-thermal ZLD

Mix FGD wastewater with scrubber solids (gypsum or sulfite), fly ash, and lime (if necessary) to produce a stable and fixated waste material.



Place fixated waste material in dry landfill



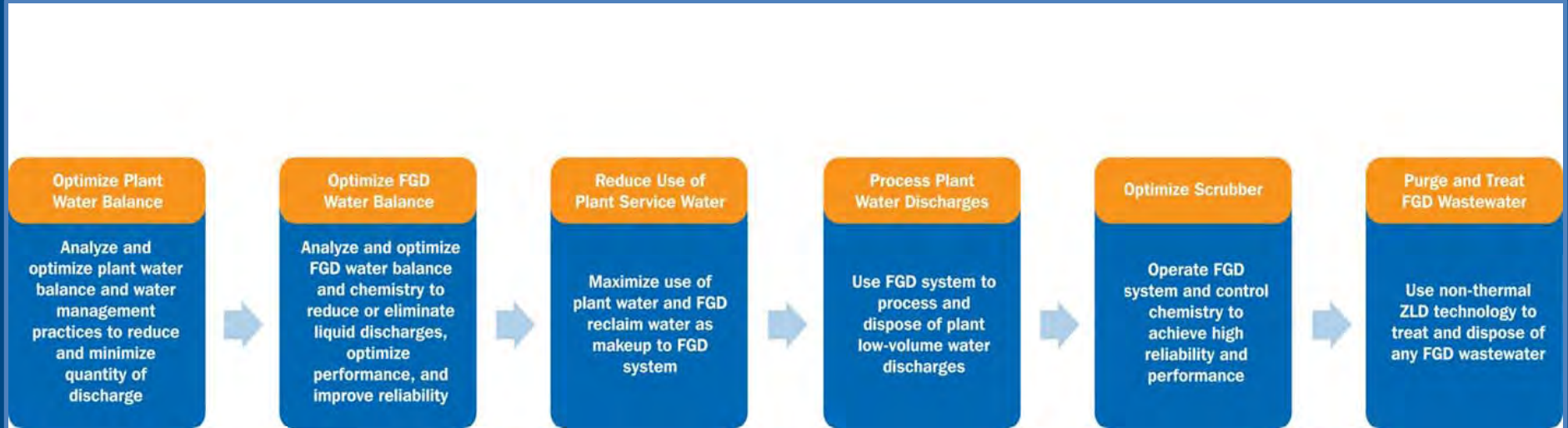
Return leachate and contact water to FGD

Typical Composition of Stabilized Byproduct

- 30-35% gypsum
- 30-35% fly ash
- 30-35% purge water
- 2-4% lime

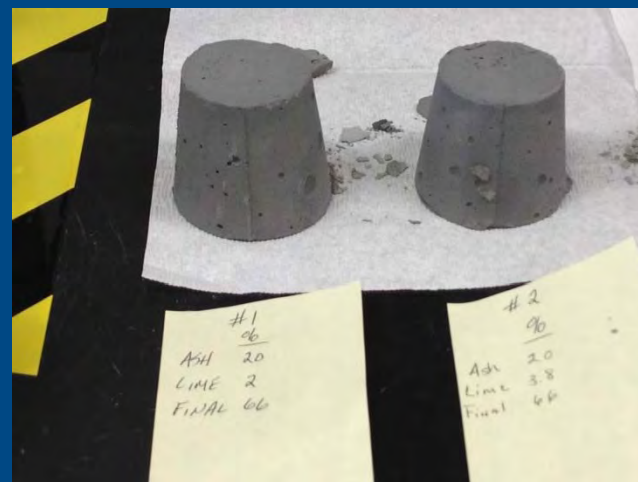
Project Approach for Plant ZLD Operation

Project Approach



Approach for Evaluation Testing

1. Evaluated 5 different test samples:
 - W-sub, E-bit fuel
 - Gypsum, sulfite scrubber solids
 - Class F and Class C ash
2. Samples blended and transferred to containers to cure
3. Strength testing during and following curing
4. TCLP extractions
5. Extraction liquid tested for RCRA metals, Hg and chloride
6. TCLP extractions and analyses performed on materials prior to blending to determine baseline concentration



TCLP Extraction Data – Preliminary Results

Conclusions for Testing

- Based on limited testing:
 - Generally good reduction for two ELG metals – As and Se
 - Somewhat mixed results for Hg although all concentrations below the ELG limit
 - Mixed results for other RCRA metals
 - Little if any reduction in chloride levels
- NT-ZLD process appears to be useful for reduction of toxic metals in ZLD application
- Additional testing is needed to evaluate and validate other parameters



THANK YOU

**Gordon Maller – URS Process Technologies
Austin, TX**

gordon.maller@urs.com

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