Human Health Criteria Treatment Technology Review and Cost Assessment

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Cities Affected in Idaho

- Wastewater discharges to designated public drinking surface water supplies (DWS) will likely be most affected if much lower As HHC are established (by DEQ or EPA)
- AIC research to date:
  - At least 54 cities have wastewater discharges to surface waters designated DWS
  - Located throughout the state

Technology Capability and Cost Cannot be Ignored

A coalition of NPDES Permittees sought answers on three questions:

- Are there wastewater treatment technologies that will ensure achievement of stringent numeric water quality standards?
- At what cost?
- Will there be associated adverse collateral environmental impacts?

Study Sponsorship

- Association of Washington Business
- Association of Washington Cities
- Washington State Association of Counties

Introducing the Study

- Washington was committed to updating human health-based water quality standards
- Dept. of Ecology began advisory committee process in 2012; a proposed regulation was expected in early spring 2014
- Many complex and challenging scientific, legal, regulatory policy issues; much stakeholder interest
- HDR study completed in December 2013
- Ultimately, EPA R10 promulgated HHC for WA,
  - 0.018 µg/L for arsenic

Study Design

- Create a conservative study scenario based on best information available in spring 2013
- Starting point: characterize wastewater quality from a well-operated secondary treatment system representing “all known available and reasonable methods of treatment” (AKART). 231 municipal and 187 industrial permittees.
- Limit the analysis to four troublesome pollutants: PCBs, mercury, arsenic, and a polyaromatic hydrocarbon (benzo(a)pyrene).
- Use WDOE and permittee wastewater data to define the range of pollutant concentrations in secondary-treated wastewater.
- Assume ambient water quality criteria need to be achieved at point of discharge; i.e., water quality-based effluent limit

Table 1: Summary of Effluent Discharge Toxics Limits

Constituent	Human Health Criteria based Limits to be met with no Mixing Zone (µg/L)	Basis for Criteria	Typical Concentration in Municipal Secondary Effluent (µg/L)	Typical Concentration in Industrial Secondary Effluent (µg/L)	Existing Washington HHC (water + org.), NTR (µg/L)
PCBs	0.0000064	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.0005 to 0.0025[b,c,d,e,f]	0.002 to 0.005[i]	0.0017
Mercury	0.005	DEQ IMD[a]	0.003 to 0.050[h]	0.010 to 0.050[h]	0.140
Arsenic	0.018	EPA National Toxics Rule (water + organisms)[k]	0.500 to 5.0[j]	10 to 40[j]	0.018
Benzo(a)Pyrene	0.0013	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.00028 to 0.006[b,g]	0.006 to1.9	0.0028

Study Design

- Conduct literature review of advanced treatment technologies targeting the four pollutants. Select the two or three most promising technologies. Assess capability to treat. Identify the practical design and operational constraints.

- For the candidate technologies:
  - estimate removal efficiencies for the four pollutants
  - estimate capital and O&M cost for a 5 million gallon per day (MGD) system
  - examine costs for a 0.5 MGD and then a 25 MGD treatment system

- Qualitatively identify any adverse collateral environmental impacts. Incremental electrical energy use, GHG emissions, residuals management and disposal, air emissions.

Table 5: Summary of Arsenic Removal Technologies[1]

Technology	Advantages	Disadvantages
Coagulation/filtration	• Simple, proven technology • Widely accepted • Moderate operator training	• pH sensitive • Potential disposal issues of backwash waste • As^{+3} and As^{+5} must be fully oxidized
Lime softening	• High level arsenic treatment • Simple operation change for existing lime softening facilities	• pH sensitive (requires post treatment adjustment) • Requires filtration • Significant sludge operation
Adsorptive media	• High As^{+5} selectivity • Effectively treats water with high TDS	• Highly pH sensitive • Hazardous chemical use in media regeneration • High concentration SeO_4^{-2}, F^-, Cl^-, and SO_4^{-2} may limit arsenic removal
Ion exchange	• Low contact times • Removal of multiple anions, including arsenic, chromium, and uranium	• Requires removal of iron, manganese, sulfides, etc. to prevent fouling • Brine waste disposal
Membrane filtration	• High arsenic removal efficiency • Removal of multiple contaminants	• Reject water disposal • Poor production efficiency • Requires pretreatment

[1]Adapted from WesTech

Evaluation of Toxics Treatment Effectiveness and Costs

Treatment Processes

- Desktop Analysis
  - HDR Experience
  - Technical Literature Review
- Treatment Process Effectiveness for Toxics Removal
  - Existing Secondary Treatment
  - Additional Removals in Advanced Treatment
    - Limited Information Available on Full Scale Performance for Toxics
- Two Advanced Treatment Process Trains Selected
  1. Micro Filtration Membrane followed by Reverse Osmosis (MF/RO)
  2. Micro Filtration Membrane followed by Granular Activated Carbon Adsorption (MF/GAC)

Cost Analysis

- Preliminary Cost Opinions
  - Association for the Advancement of Cost Engineering (AACE International)
    - Recommended Practice No. 17R-97 Cost Estimate Classification System
      - Class 4 Estimate
        - » 5% to 10% Project Definition
        - » Expected Accuracy: -30% to +50%

Microfiltration Membranes

Spokane County Regional Water Reclamation Facility MBR

LOTT Martin Way Reclamation Plant MBR

Microfiltration Followed by Either….

Reverse Osmosis (RO)

Scottsdale, AZ Water Campus

Granular Activated Carbon (GAC)

Potable Water Treatment

Key Findings on Technologies

- Technology/Performance capability
  - PCBs: no demonstration of ability to achieve the Oregon criterion
  - Arsenic: no demonstration of ability to achieve a 0.018 µg/L criterion
  - Mercury: possibly able to achieve Oregon-like criterion
  - B(a)P: Insufficient information to make judgment

- Expect many site-specific challenges with retrofit of advanced treatment technology onto existing facilities
  - Disposal of Reverse Osmosis brine (1-10% of influent flow)
  - Land requirements for advanced treatment technologies

Treatment Technology Costs

- 5 Million Gallon per Day (mgd) Facility

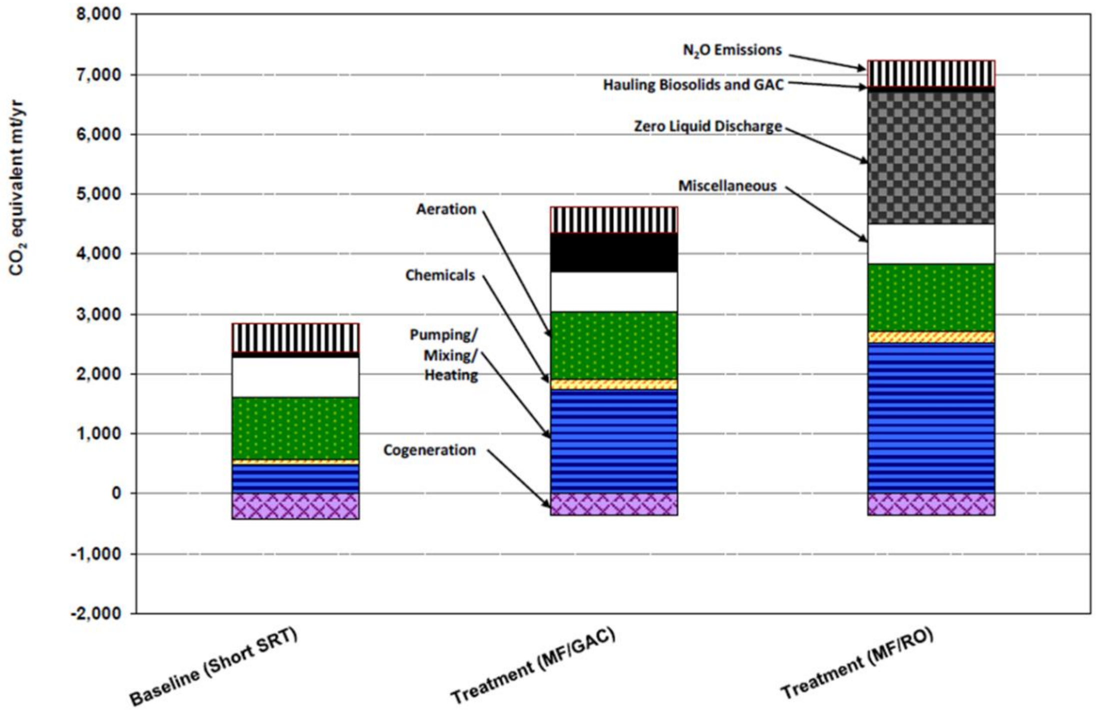
Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million) ***	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
Baseline (Conventional Secondary Treatment) *	59 - 127	5 - 11	65 - 138	13 - 28
Incremental Increase to Advanced Treatment - MF/RO	48 - 104	26 - 56	75 - 160	15 - 32
Advanced Treatment - MF/RO **	108 - 231	31 - 67	139 - 298	28 - 60
Incremental Increase to Advanced Treatment - MF/GAC	71 - 153	45 - 97	117 - 250	23 - 50
Advanced Treatment - MF/GAC	131 - 280	50 - 108	181 - 388	36 - 78

- Basis: Net Present Value, 25 year project life. "Baseline" costs do not include probable needed secondary treatment system upgrades for existing facilities.

Collateral Impacts of Advanced Treatment

- Larger Plant Site Physical Space Requirements for Additional Unit Processes
- High Energy Consumption
  - Additional Pumping, Mixing, etc
- Increased Chemical Use
- Increased Residual Solids Production
- Increased Truck Hauling
- RO Brine Disposal
- Carbon Regeneration

Increased Greenhouse Gas Emissions



Key Outcomes

- The traditional process to derive human health-based water quality standards yields very stringent numeric criteria (Oregon 2011). Certain pollutants are ubiquitous and seem to pose exceptional regulatory challenges (PCBs, mercury, arsenic and benzo(a)pyrene).
  - Assumed Washington would have arsenic criterion of 0.018 µg/L
- There are no "proven" advanced treatment technology options with demonstrated capability of achieving Oregon-like water quality criteria for PCBs and arsenic, and perhaps not for mercury.
- Advanced treatment technologies are very expensive to construct and operate. There would be formidable site-specific challenges in retrofitting existing secondary treatment systems.
- There are significant adverse collateral environmental impacts associated with these technologies.
- The full report can be accessed at: http://www.awb.org/hdrtechreport/

Questions

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