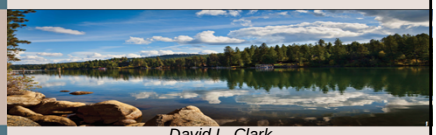
2012 Water Reuse Conference

Nutrient Removal Treatment and Effluent Reuse

Boise
April 17, 2012



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Nutrient Removal Treatment and Effluent Reuse

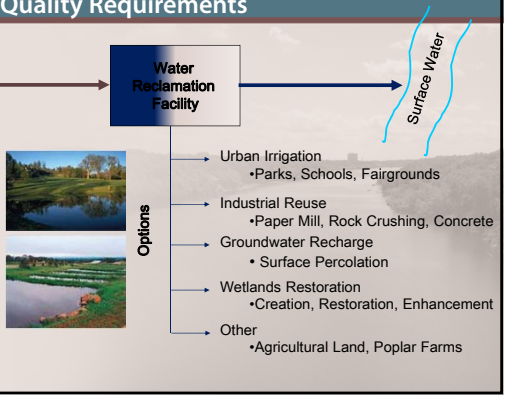
- Water Quality
- Treatment Technology
- Challenges

WATER QUALITY

Restrictive Surface Water Conditions Drive Alternative Effluent Management Options

- **Surface Water Challenges**
  - Expense and Technical Difficulty of Compliance
  - Low In-stream Nutrient Targets
    - Potentially Applied End-of-Pipe
    - Potentially Lower Than Limits of Treatment Technology
- **Potential Reuse Synergy**
  - Convergence of Treatment Technology Requirements
  - New Opportunities for Reclamation and Reuse
    - High Quality
    - Draught Proof
  - Recycling Water and Nutrients
  - Off-set Potable Demand
  - Supports In-stream Flows
    - Substitute for Irrigation Supplies

Reclamation Options to Meet Restrictive Surface Water Quality Requirements



Multiple Effluent Options Strengthen Wastewater Programs

- **Clean Water Services (CWS) Durham Plant**
  - –Tualatin River - Ammonia and Phosphorus Limits
  - –River Discharge and Effluent Reuse
- **Silverton Treatment Plant**
  - –Silver Creek - Ammonia Limits
  - –Wetlands, Creek Discharge and Effluent Reuse
  - –Oregon Nurseryman's Gardens
- **Spokane County**
  - –Spokane River DO TMDL
  - –River Discharge, Effluent Reuse, Groundwater Recharge, Wetlands
- **Bozeman**
  - –East Gallatin River Pending TMDL
  - –River Discharge, Effluent Reuse, Groundwater Recharge, Wetlands, Hyporheic Discharge

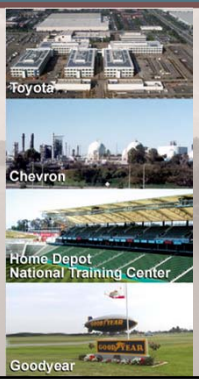
Urban Irrigation

Washington State Capitol Grounds
(Olympia, Washington)

Sunken Garden
(Olympia, Washington)

Industrial Reuse

Recycled water from the West Basin Recycling Facility in El Segundo; CA is provided to industrial customers for non-potable uses.



Groundwater Recharge

Riparian Preserve
(Gilbert Arizona)

LOTT Hawks Prairie
(Lacey, Washington)

Wetlands Restoration

Oregon Nurseryman's Garden
(Silverton, Oregon)

Other Reclaimed Water Uses

Cochrane Park
(Yelm, Washington)
Source: Department of Ecology

Reclaimed Water Fire Hydrants
Top: (Portland, Oregon)
Bottom: (Maui, Hawaii)

Nutrient Removal Treatment and Effluent Reuse

Benefits of Reuse

- Aid in Meeting Surface Water Discharge Limits
  - Diversion of Loadings from Surface Water
- Recycling Water and Nutrients
- Convergent Treatment Technology

Potential Challenges

- Securing Reuse Customers
- Distribution of Reclaimed Water
- Seasonal Demand for Reclaimed Water
- Effluent Discharge Permit Structures

TREATMENT TECHNOLOGY

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Water Quality, Nutrient Management, and Treatment Technology

Surface Water Quality (Emphasis on Phosphorus[1])

- Beneficial Use Protection
  - WQ Standards
    - D.O. and pH
  - Narrative Nutrient Standards
  - Future
    - Potential Numeric Nutrient Standards
    - Treatment Technology Standards
    - Trace Organics, EDCs, PPCPs
- TMDLs to NPDES Permits
  - N and P

Groundwater Quality (Emphasis on Nitrogen)

- Drinking Water Protection
  - Nitrate Nitrogen
  - Total Dissolved Solids
  - Future
    - Trace Organics, EDCs, PPCPs
- Special Resources
  - Groundwater Management Areas
    - Lower Boise/Canyon County Ground Water Quality Management Plan
    - Rathdrum Prairie Aquifer

[1] *Caveats: Ignores potential surface water co-limitation N and P , NRDC petition for N&P Treatment Technology Stds, Reactive N Greenhouse Gas emissions, etc*

Convergence in Treatment Technologies

Low Phosphorus

- Biological Options
- Chemical Options
  - Effluent Filtration
  - Single and Multiple Stage Media Filtration
  - Membranes
- Meets Reclaimed Water Standards
- Technology Selections
  - *Best Effluent Filter?*

Low Nitrogen

- Biological Options
- Chemical Addition
  - Supplemental Carbon Source for Denitrification
- Effluent Filters?
  - Separate Stage Denitrification

Reuse Classification

- Class A
  - Least restricted uses, most regulated. Requires filtration and disinfection.
- Class B
  - Similar to Class A, but more restricted uses.
- Class C
  - No filtration. Disinfection (23 orgs/100 mL).
- Class D
  - No filtration. Disinfection (230 orgs/100 mL).
- Class E
  - Primary treatment only.

Numeric Nutrient Criteria and Limits of Wastewater Treatment Technology[1]

Parameter	Typical Municipal Raw Wastewater, mg/l	Secondary Effluent (No Nutrient Removal), mg/l	Advanced Wastewater Treatment			Typical In-Stream Nutrient Criteria, mg/l
			Typical Biological Nutrient Removal (BNR), mg/l	Enhanced Nutrient Removal (ENR), mg/l	Limits of Treatment Technology, mg/l [1]	
Total Phosphorus	4 to 8	4 to 6	1	0.25 to 0.50	0.05 to 0.07	0.02 to 0.05
Total Nitrogen	25 to 35	20 to 30	10	4 to 6	3 to 4	0.300 to 0.600

[1] *Ignoring Considerations of Variability and Reliability of Wastewater Treatment Performance*

Water Environment Research Foundation (WERF) "*Nutrient Management: Regulatory Approaches to Protect Water Quality, Volume 1 – Review of Existing Practices*," Project #NUTR1R06i

Capabilities of Wastewater Treatment Technology – Nitrogen Speciation

Parameter	Typical Municipal Raw Wastewater, mg/l	Secondary Effluent (No Nutrient Removal), mg/l	Typical Advanced Treatment Nutrient Removal (BNR), mg/l	Enhanced Nutrient Removal (ENR), mg/l	Limits of Treatment Technology, mg/l
Total Phosphorus	4 to 8	4 to 6	1	0.25 to 0.50	0.05 to 0.07
Total Nitrogen	25 to 35	20 to 30	10	4 to 6	3 to 4
Effluent Nitrogen Speciation					
Ammonia NH_4-N			~0.3	~0.1	~0.1
Organic-N			~2.5	~2	~1.5
Nitrate + Nitrate NO_3-N			~8	~4	~1.5

Spokane River Dissolved Oxygen TMDL

- Original Phosphorus TMDL Limits Not Low Enough
  - 85% Removal/~ 1 mg/l (1,000 ug/l)
- Washington Department of Ecology TMDL (Total Maximum Daily Load) for Dissolved Oxygen
  - October 2004 Draft TMDL
  - Max TP Removal 0.050 mg/L (2009)
  - Final Goal to River TP 0.010 mg/L (2015)
- Negotiated Agreement to Pursue Facilitate Collaboration on TMDL
  - January 2005 to July 2006
  - "Foundational Concepts for the Spokane River TMDL Managed Implementation Plan" July 2006
- Sept 2007 Draft TMDL (TP 0.010 mg/L)
- May 2008 Draft TMDL (TP 0.050 mg/L)
- Sept 2009 Draft TMDL (TP 0.036 mg/L)
- *Final TMDL February 2010 (TP 0.036 mg/L)*

Spokane River Dissolved Oxygen TMDL Scenarios

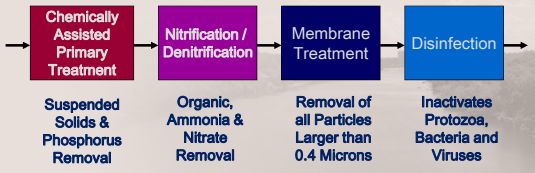
Scenario	$CBOD_5$, mg/l	Ammonia-N Permit, mg/l	Ammonia-N Average, mg/l	TP Permit, mg/l[1]	TP Average, mg/l
1	5.0	1.0	0.71	0.050	0.036
2	5.0	1.0	0.71	0.070	0.050
3[a]	5.0	1.0	0.71	0.050	0.036

[1]Maximum Month Limits for Phosphorus Based on Assumed Relationship Between Max Month and Long Term Average from BOD Data Set
[a] Scenario 3 Same as Scenario 1 Except for Hayden Summer Reuse (Mar-Jun TP = 0.150 mg/l and July-Sept 0.010 mg/l)

- Ecology Selected Scenario 1 for TMDL Wasteload Allocation (WLA) in Washington
  - Revised Idaho Permits to Ensure Compliance with Washington Standards

Spokane County Regional Water Reclamation Facility

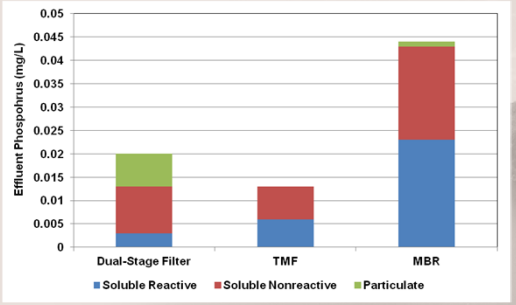
Spokane County Regional Water Reclamation Facility



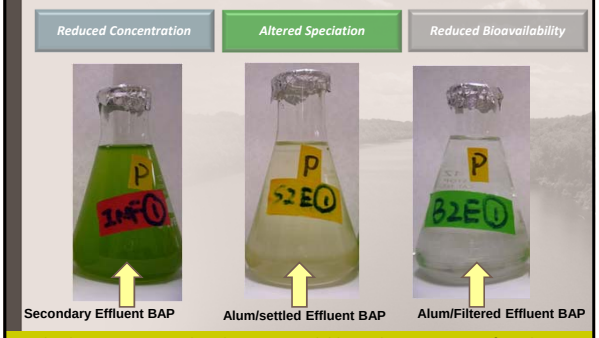
100% Meets Washington Class A Reclaimed Standards

Coeur d'Alene Low Phosphorus Demonstration Pilot Testing

Pilot Testing Effluent Phosphorus Speciation



Advanced Treatment and Effluent Nutrient Speciation and Bioavailability



Michael T. Brett & Bo Li Phosphorus Bioavailable Studies, University of Washington

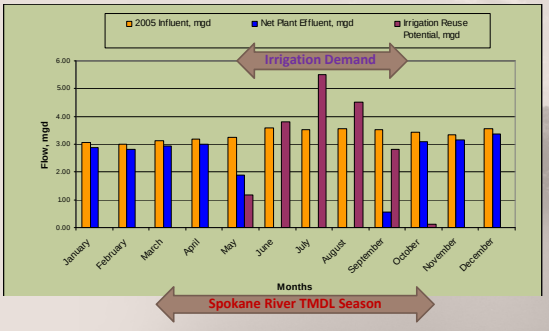
CHALLENGES

HDR

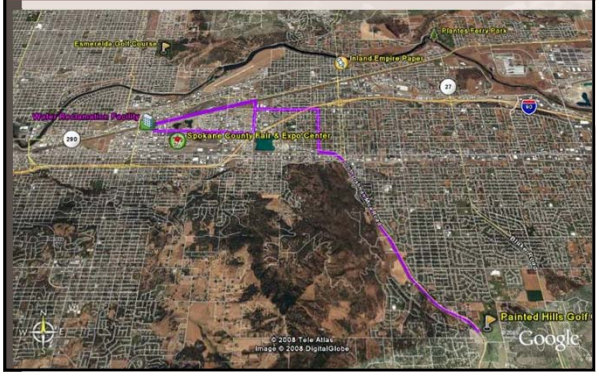
Potential Challenges in Nutrient Management and Effluent Reuse

- Seasonal Demand for Urban Irrigation Uses
- Expense of Reclaimed Water Distribution Systems
- Limited Potential for Substantial Diversion of Loadings From Surface Water
- Over-specified Effluent Discharge Permits
- Integrated Planning

Seasonal Reuse Demand for Irrigation in Coeur d'Alene v. Spokane River TMDL Season



Potential Sites for Reclaimed Water Use in Spokane County – Painted Hills Golf Course



Phased Coeur d'Alene Central Reuse Distribution System

Estimated P Load Diversion from Spokane River and Distribution System Cost

Phase	Average Daily Irrigation Demand, gpd	P Load Applied to Reuse, lbs/day*	Opinion of Project Cost**
SUBTOTAL PHASE 1	351,300	0.15	$684,000
SUBTOTAL PHASE 2	94,000	0.04	$1,000,000
SUBTOTAL PHASE 3	559,000	0.23	$3,600,000
SUBTOTAL PHASE 4	1,865,000	0.78	$2,400,000
TOTAL FOR CENTRAL DISTRIBUTION	2,870,000	1.20	$7,680,000

* P reduction is based upon 0.05 mg/L effluent P.

** Cost opinion does not include the cost of treatment, offsets from deferring new source development, and potential revenue from the sale of reclaimed water.

Avoid Over-specifying NPDES Effluent Limits and Discouraging Reuse

Mass and Concentration

- Long Averaging Periods Preferred
- Maximum monthly, weekly, and daily limits likely to be exceeded by even the best designed and operated low nutrient treatment facilities

Mass Only

- Mass Limits Provide Greater Flexibility
  - Supports Effluent Reuse
  - Supports Trading/Water Quality Off-sets

NPDES Permitting Regulations

- **40 CFR 122.45(d) requires that all permit limits be expressed as average monthly limits and average weekly limits for publicly owned treatment works (POTWs) and as both average monthly limits and maximum daily limits for all others, unless "impracticable."**

Mass Limits Required for NPDES Permitting

Effluent N and P concentration is highly variable for even the best designed and operated low nutrient treatment facilities

Individual permit writers in every nutrient limited watershed must interpret these NPDES regulations and the definition of "impracticable" with limited guidance

Spokane River Nutrient Reduction, NPDES Permit Limits and Reuse

Spokane River Dischargers

- Very Restrictive TMDL
  - Cumulative Anthropogenic D.O. Depression <0.2 mg/L
- TMDL Scenario
  - TP 0.042 mg/L
  - CBOD 4.2 mg/L
  - Ammonia-N 0.21 mg/L

NPDES Permits

- Seasonal Mass Loading Limits
  - TP, CBOD, NH_3N
- ***Compliance Based on Season End Mass Discharged***

S1.B.a Alternate effluent limits for oxygen consuming pollutants demonstrated to be equivalent to DO TMDL baseline effluent limits in S1.A (option 1).

Parameter	Seasonal Limit Applies March 1 to October 31 See notes f and g	
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$)	133.4 pounds/day (lbs/day) average	
Total Phosphorus (as P) March 1 to Oct. 31	3.34 lbs/day average	
Total Ammonia (as NH_3-N)	**Seasonal Limit**	**Maximum Daily Limit**
For "season" of March 1 to March 31	1067.5 lbs/day average	16 mg/L
For "season" of April 1 to May 31	66.7 lbs/day average	16 mg/L
For "season" of June 1 to Sept. 30	16.7 lbs/day average	8 mg/L
For "season" of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/L
Parameter	**Average Monthly** [4]	**Average Weekly** [5]
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$), November 1 through February 29	2.0 milligrams/liter (mg/L) 133 pounds/day (lbs/day)	---

Integrated Water Planning Goals and Objectives in Billings

Example Internal Go

- Economical Operation
- Efficiency
- New Technology
- Automation
- Health and Safety
- Energy Management

Drinking Water
- *Residuals*

Wastewater
- *Nutrient Removal*
- *Effluent Reuse*
- *Biosolids*
- *Energy Recovery*

Stormwater

Example External Goals

- Regulatory Compliance
- Available Capacity
- Service Area Policies
- Competitive User Rates
- Customer Satisfaction

Potential Priorities in Integrated Water Planning

- Identify Opportunities
  - Cost Savings, Environmental Benefits, Social Benefits
  - Efficiency and Innovation
- Identify Which Utility
  - Water, Wastewater, Stormwater
- Identify Benefits
- Identify Barriers
  - Regulatory, Physical, Policy
- Identify Policy Needs
- Special Interests
  - Internal Utility Staff
  - Public Interests
  - Council Interests
  - 3rd Parties

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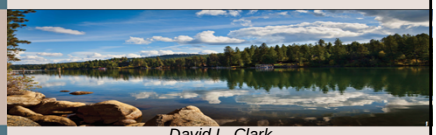

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