COMPARISON OF NATIONAL DE FACTO REUSE PROJECTED WATER QUALITY VERSUS DIRECT POTABLE REUSE WATER QUALITY GOALS

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Outline

• Purpose:
  – Conduct geospatial and temporal analysis of how much wastewater is in source drinking waters
• Modeling approach
• National findings of extent of de facto reuse
• Regional and seasonal factors impacting de facto reuse
• Implications of de facto reuse on water quality
Evolution of Urban Water Systems

DeFacto Reuse = The unplanned or incidental presence of treated wastewater in a water supply source

WW Contaminants:
- Pathogens
- Inorganics
- Trace Organics

Definition: Defacto Reuse (DFR)

\[ X\% = \text{Treated Wastewater} \]
\[ DFR = X\% \]

\[ 100\% - X\% = \text{River water} \]
Identified HOT SPOTS for De Facto Reuse Occurrence at the National Scale

Where else is de facto reuse high

Relying upon field observations is slow?

Model Building

De facto Reuse Incidence in our Nations Consumable Supply

Model Validation

**Base Map:** National Atlas of the United States and USGS

**Hydrography:** USGS National Hydrography Dataset Plus

**WWTPs:**
- 14,651 data points
- CWNS 2008
- Permit Compliance System used for data mining missing location points

**DWTPs:**
- 6,330 total active surface water intake points
- 2,056 with population served > 10,000
Methodology

- Spatial analysis at the regional level (HUC)
- Network routing for flowlines (NHDPlus)
- DWTPs and WWTPs spatially joined to river network
- Python script to automate flowline networking
- Apply water mass balances

\[
\frac{dM}{dt} = \sum Q_{\text{in}} C_{\text{in}} - \left( \sum Q_{\text{out}} + Q_{\text{loss}} \right) C_{\text{river}} - R_{\text{loss}}
\]
Low Magnitude of de facto reuse

Legend
DWTPs Impacted by AVGDFR
- Less than 1%
- 1 to 5%
- 5 to 10%
- 10 to 15%
- Greater than 15%
States (National)
Influence of Droughts & Floods

Strahler Stream Order

Historic Streamflow Percentile
WaterIT

De Facto Reuse under Varying Streamflow Conditions

Impact of Monthly Streamflow Variation on DFR

Strahler Stream Order = 3

Strahler Stream Order = 6

Average Monthly Streamflow

WaterIT

Key DFR Findings

• 756 of the 1,210 DWTPs are located downstream of WWTPs
• 15 municipalities across the US have at least one intake with >20% wastewater effluent under average flow
• Seasonality in %DFR exists
• 32 of 79 intakes effluently dominated (>50% de facto reuse) under low flow conditions (Q95)
Comparison of DRINCS Predicted “HITS” for Steroids versus Observed in UCMR3 Databases

Only WTPs predicted to have DFR (average streamflow) occurring actual had detectable levels of steroids in UCMR3

Legend:
- DRWTPs Sampled for Steroids
- Steroid Detected
  - 17-alpha-ethyltestosterone
  - 4-androstene-3,17-dione
  - Testosterone
- States (National)

UCMR3 Min Reporting Level (MRL)

Estimates for Steroids (ng/L) From DRINCS

Legend: top and bottom of box = 75th and 25th percentiles respectively; top and bottom of whisker = 90th and 10th percentiles respectively; line across inside of box = median (50th percentile)
65 of 80 sites with chloramine treatment and positive NDMA samples were modeled as impacted by DFR.

**Modeled vs UCMR2 Data**

"Hits" for NDMA in MONOchlorinated DWTPs

**DRINCS Modeling Suggest High Potential Occurrence of NDMA**

49% of WTPs impacted by DFR could exceed NMDA CA notification level.
Red line represents the CA Notification Level (10 ng/l)

2011 NRC Report
Suggested:
DWTPs with > 5% DFR received higher levels of CECs than planned reuse schemes

DFR Loading of CEC's to DWTPs Impacted by >5% DFR
Summary

• GIS-based DRINCS model provides estimate of national trends in defacto reuse – Addressing a Top10 need from 2011 NRC Report

• For Surface WTPs serving > 10,000:
  – Roughly 50% of DWTPs are located downstream of WWTPs & 50% of the impacted intakes < 1% de facto reuse (HIGH FREQUENCY / LOW MAGNITUDE) under average streamflow
  – Streamflow matters
  – Lower stream order increases risk of higher levels of de facto reuse

• DRINCS predicts “hits” for CECs and NDMA in UCMR monitoring at drinking water facilities

• A key limitation is lack of stream gauge data at DWTP intakes