Tampa Bay Water Section 21 Wellfield Restoration

Project:

Evaluating Potential Health Risks Associated with Wetland Restoration Using Storm Water and Reclaimed Water

Deborah Daigle, P.G
HDR Engineering, Inc.
Tampa Bay Water

- Florida’s Largest Wholesale Water Supplier
- Created by Interlocal Agreement
- Six Member Govt’s
Groundwater Facilities

- 11 Wellfields
- Regulated by SWFWMD
- City of St. Petersburg owns the Section 21 Wellfield
- Property leased to Hillsborough County for use as a public park
- Tampa Bay Water owns 1 acre parcels surrounding the well heads
Consequences of Groundwater Pumping

- Impacts to Wetlands and Lakes
- Permit Requirements
  - Pumpage Reductions
  - Lake and Wetland Restoration Program for all Wellfields
- CSES, Phase I and II Mitigation Plans
Potential Restoration Source Options

- Groundwater Augmentation
- Reclaimed Water Augmentation
- Drainage Modifications
- Surface/Stormwater Diversion
Section 21 Wellfield Restoration Project

- Divert Storm Water and/or Reclaimed Water to Wetlands on Wellfield.
- Investigate the Potential Public Health Risks
- Develop and Utilize a Scientific Process for Evaluating Potential Impact to Public Health
- Co-Funded by SWFWMD and EPA
Site Map

Active Production Well

Restoration Site

Interceptor Canal
Section 21 Risk Assessment Process

- Hydrogeologic Site Characterization
- Hydrologic Modeling
- Run Flow and Transport
- Predicted Concentrations
- Risk Characterization
- Water Quality Sampling (Source and BG)

Proceed with Project?
Hydrogeologic Site Characterization

- Required for Model Input
- Ground Penetrating Radar
- 29 Soil Borings
- Laboratory Testing-Soils
- 24 Monitoring Wells
- Aquifer Performance Tests
- Tracer Tests
Site Hydrogeology

- Shallow Water Table Aquifer
- Confining Layer of Variable Thickness
- Floridan Aquifer Source of Drinking Water
- High Occurrence of GPR Anomalies
Section 21 Risk Assessment Process

1. Hydrogeologic Site Characterization
2. Hydrologic Modeling
3. Run Flow and Transport
4. Water Quality Sampling (Identify COPCs)
5. Predicted Exposure Point Concentrations
6. Risk Characterization

Proceed with Project?
Background and Source
Water Characterization

- Sampling for Chemical and Microbial Constituents
  - Production Wells
  - Lakes
  - Wetland
  - Interceptor Canal
  - Reclaimed Water
    - (DMAWWTP)
Chemical and Indicator Parameters

- Field Parameters
- Primary and Secondary Drinking Water Parameters (62-550 FAC)
- Disinfection By-Products
- Nutrients
Water Quality Sampling

- Microbiological Parameters
  - Human Enteroviruses
  - Protozoan Parasites
    - Cryptosporidium
    - Giardia
Risk Assessment Process

- Chemical Parameters – US EPA Risk Assessment Guidance for Superfund
  - Screening Process to Identify Constituents of Potential Concern (COPCs) to Human Health

- Microbiological Parameters – Quantitative Microbial Risk Assessment (QMRA)
Identify Chemical Constituents of Potential Concern (COPCs): Screening Process

Highest Concentration in Source and BG Waters (Level I)

YES
Select for Further Evaluation

Apply Transport Model Results to COPC Concentrations

Perform Level II Screening of Model Derived COPC Concentrations at Exposure Points

NO
Eliminate as COPC

Level II Exceeds Criteria?

YES
Perform Risk Evaluation

NO
Identify Constituents of Potential Concern (COPCs): Level I Screening Process

- Parameters that do not comply with the following Florida Administrative Codes:
  - 62-550 – Drinking Water MCLs, and
  - 62-777 Groundwater Cleanup Target Levels.
  - 62-302 – Class III Fresh Surface Water Quality Criteria
  - Federal (if no State guidance)
Level I Screening Process

- Parameters that are significantly different (statistically) for the restoration source waters when compared to the background waters
Level I Screening to Identify COPCs

- Dale Mabry AWWTP

<table>
<thead>
<tr>
<th>Doesn’t meet FAC</th>
<th>Statistically Different from Background</th>
<th>Health Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>Conductivity</td>
<td>Chloroform</td>
</tr>
<tr>
<td>TDS</td>
<td>TDS</td>
<td>Bromodichloromethane</td>
</tr>
<tr>
<td>Odor</td>
<td>TTHM</td>
<td>Dibromochloromethane</td>
</tr>
<tr>
<td>TTHM</td>
<td>Chloroform</td>
<td>Don’t meet FAC</td>
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<td>Bromodichloromethane</td>
<td>Dibromochloromethane</td>
<td>Background</td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td></td>
<td></td>
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- Interceptor Canal

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<th>Doesn’t meet FAC</th>
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<th>Health Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO</td>
<td>Color</td>
<td>None</td>
</tr>
<tr>
<td>Odor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
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</tbody>
</table>
Risk Assessment Process

1. Hydrogeologic Site Characterization
2. Hydrologic Modeling
3. Run Flow and Transport
4. Water Quality Sampling (ID COPCs)
5. Predicted Concentrations/Level II COPC Screen
6. Risk Assessment

Proceed with Project?
Hydrologic Modeling

- **Steady-State and Transient Flow and Transport Models**
  - MODFLOW
  - MT3D

- **Simulate Restoration**
  - Source Water Migration Paths and Travel Time to Production Wells
  - COPC Concentration at Production Wells and Lakes/Wetlands
Hydrologic Modeling

- Starting Concentration of 1000 in Transport Model
- Transient Model Period of 20 Years
Model Results

- First Arrival to First Production Well: ~ 3 Months
- Transport Model
  - Peak Concentration at Production Wells: 0.3% to 5% of Source Water Concentration
  - Lakes: 26% to 98%
  - Wetlands: 5% to 56%
Identify Chemical Constituents of Potential Concern (COPCs): Screening Process

1. **Highest Concentration in Source and BG Waters (Level I)**
   - **YES**
     - Select for Further Evaluation
     - **Apply Transport Model Results to COPC Concentrations**
     - **Perform Level II Screening of Model Derived COPC Concentrations**
   - **NO**
     - **NO**
     - Eliminate as COPC
     - **YES**
     - **Level II Exceeds Criteria?**
     - **NO**
     - Perform Risk Evaluation
     - **YES**
     - Eliminate as COPC
Level II Identification of COPCs

- Calculated concentrations of constituents (identified in Level I) at the each Production well, Lake, and wetland as predicted from site-specific flow and transport modeling.

- Model derived concentrations are compared to State Maximum Contaminant Levels and/or EPA Region 9 Preliminary Remediation Goals (PRGs) – Tap water, EPA WQ Criteria for Human Health Clean Water Act or SDWA requirements
Level II Identification of COPCs

DMAWWTP
- Bromodichloromethane
- Dibromochloromethane
- Exceed Criteria for Wetlands and Lakes
Risk Assessment Tasks

Hydrogeologic Site Characterization → Hydrologic Modeling → Run Flow and Transport → Predicted Exposure Point Concentrations → Risk Characterization → Proceed with Project?
Identify Potentially Exposed Populations (Receptors)

- How will Humans be Exposed?
- Based on Land Use, Activities on the Park, Groundwater Use
  - Resident
  - Park Visitor
  - Worker
  - Trespasser
- Means to which Receptors Exposed
## Exposure Pathways and Receptors

<table>
<thead>
<tr>
<th>Exposure Medium</th>
<th>Exposure Point</th>
<th>Potential Receptor</th>
<th>Age</th>
<th>Exposure Route</th>
<th>On-Site/Off-Site</th>
<th>Selected for Further Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable Water</td>
<td>Well</td>
<td>Resident</td>
<td>Adult and Child</td>
<td>Ingestion Dermal Inhalation</td>
<td>Off</td>
<td>No</td>
</tr>
<tr>
<td>Incidental Contact</td>
<td>Well</td>
<td>Worker</td>
<td>Adult</td>
<td>Dermal Inhalation</td>
<td>On</td>
<td>Yes</td>
</tr>
<tr>
<td>Incidental Contact</td>
<td>Lakes/Wetlands</td>
<td>Worker</td>
<td>Adult</td>
<td>Dermal Inhalation</td>
<td>On</td>
<td>Yes</td>
</tr>
<tr>
<td>Swimming</td>
<td>Lakes</td>
<td>Trespasser or Visitor</td>
<td>Adult and Child</td>
<td>Ingestion Dermal Inhalation</td>
<td>On</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Chemical Risk Assessment Results

- Performed Risk Calculations for Selected Exposure Pathways and Receptors for COPCs
- No Human Health Risk Associated with a Chemical Exposure
Microbial Risk Assessment
**Quantitative Microbial Risk Assessment (QMRA) Approach**

<table>
<thead>
<tr>
<th>QMRA Step</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of pathogens</td>
<td><em>Cryptosporidium, Giardia, and enteric viruses</em></td>
</tr>
<tr>
<td>Determination of pathogen profile</td>
<td>Maximum and average values from monthly samples over 24 month period</td>
</tr>
<tr>
<td>Estimate of pathogen survival</td>
<td>First order die-off as function of time and temperature</td>
</tr>
<tr>
<td>Determination of exposure pathways</td>
<td>Ingestion, contact and non-contact recreation</td>
</tr>
<tr>
<td>Estimate of pathogen dose-response in humans</td>
<td>Exponential (protozoa), beta-Poisson (virus) models derived from human infectivity studies</td>
</tr>
<tr>
<td>Characterization of risk from pathogens</td>
<td>Independent action, based on single and multiple exposures</td>
</tr>
</tbody>
</table>

*Developed by Dr Joan Rose, others*
Assumptions Made to Calculate Microbial Risks

- 100% recovery of pathogens by the analytical methods
- 100% viability of the pathogens detected by the analytical methods
- No retardation of pathogens due to transport in aquifer
Assumptions Made to Calculate Microbial Risks

- Inactivation of pathogens by treatment was not considered in the risk calculation.

- Variations in water temperature were not considered. Risk calculations were based on a yearly average surface water and aquifer temperature of 26°C.
Microbiological Water Quality

Results

- **Wetland**
  - *Cryptosporidium* detected in 1 of 22 samples

- **Lake Jackson**
  - *Cryptosporidium* in 2 of 24 Samples
  - *Giardia* in 1 of 24 Samples

- **Interceptor Canal**
  - *Cryptosporidium* in 1 of 24 Samples
  - *Giardia* in 1 of 24 Samples

- **DMAWWTP**
  - *Giardia* in 22 of 24 Samples
  - *Cryptosporidium* in 20 of 24 Samples
  - Enteroviruses in 2 of 24 Samples
<table>
<thead>
<tr>
<th>Pathway</th>
<th>Exposure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingestion</td>
<td>2 liter/day</td>
<td>365 days/year</td>
</tr>
<tr>
<td>Contact Recreational</td>
<td>100 mL/visit</td>
<td>45 days/year</td>
</tr>
<tr>
<td>Non-Contact Recreational</td>
<td>1 mL/visit</td>
<td>45 days/year</td>
</tr>
</tbody>
</table>
QMRA

- Ingestion, Contact, and Non-Contact Recreation Risk Calculated for both Existing and Restored Condition

- Compared to Determine Increase or Decrease
QMRA Conclusions - Ingestion

- Interceptor Canal – Compared to Existing Condition
  - Similar yearly risk for *Giardia*
  - Reduced yearly risk for *Cryptosporidium*

- DMAWWTP effluent – Compared to Existing Condition
  - Increases yearly risk for *Giardia*
  - Similar yearly risk for *Cryptosporidium*

- The yearly viral risk is negligible for the existing and restored condition no matter which source water is used for restoration.
QMRA Conclusions – Contact and Non-contact Recreational Activities

Interceptor Canal – Compared to existing condition

- Similar recreational risk with respect to *Cryptosporidium* and enterovirus
- Increased recreational risk from *Giardia*-controlled through restricted access.

DMAWWTP effluent – Compared to existing condition

- Increased recreational risk for *Cryptosporidium*, *Giardia* and enterovirus—controlled through restricted access
Conclusions

- No significant risks with respect to chemical constituents.

- Use of reclaimed water/storm/surface water presents a comparable or decreasing risk profile for *ingestion* as compared to the background risk with respect to microbiological constituents.

- Use of reclaimed water/storm/surface water presents varying risk profiles for *recreational activities* as compared to the background risk with respect to microbiological constituents.