Orleans Water Quality Advisory Panel

Water Quality and Wastewater Planning Program

FCW and PRB Subcommittees Workshop

April 6, 2016

Agenda

- Introductions and Overview
- FCWs
  - Presentation and Discussion
  - Action Items
- Break
- PRBs
  - Presentation and Discussion
  - Action Items
- Closing and Action Items

Town of Orleans Massachusetts

Orleans Water Quality Advisory Panel

Floating Constructed Wetlands Subcommittee Workshop

Jennifer Doyle-Breen, AECOM
Terry Doss, Biohabitats, Inc.

FCW Overview

- Constructed Rafts That Float on the Water's Surface
- Planted with Native Plants
- Provide Habitat and Surface Area for a Wide Range of Naturally-Occurring Attached Growth Microorganisms and Invertebrates.
- As Water Passes Through the System, Pollutants Can be Reduced
  - Nitrogen
  - Phosphorus
  - Biological Oxygen Demand
  - Total Suspended Solids
  - Fecal Coliform
- Denitrification is Key Pathway for Nitrogen Reductions

Baltimore Harbor Floating Constructed Wetlands

OWQAP FCW Breakout Session January 20, 2016

- FCW Features and Benefits
- Demonstration Project Goals
- Site Selection
  - Screening Criteria
  - Rating Matrix

FCW Locations Evaluated

- **Lonnie's Pond**
- Namequoit River
- Paw Wah Pond
- Pochet Neck
- Quanset Pond

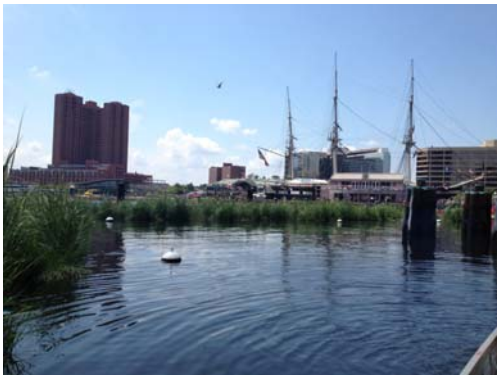
FCW 50% Engineering Work Plan

- Concept Design
  - Site Configuration – 2 Units 200 feet by 80 feet
  - Polymer Material Made From Plants
  - Anchoring – Helical Embedment Anchors
  - Mooring Lines – Elastic Lines with Steel Cables
  - Plants: *Spartina alterniflora*
  - Waterfowl Fencing
- Monitoring – Monthly Visits and Water Quality Sampling
  - Monthly Visits/Water Quality Sampling
  - Continuous Water Quality Dataloggers
  - Biomass Sampling/Lab Analysis
- Maintenance – Minimal Replanting & Repairs as Needed
- Cost

Representative Layout

FCW 2017 Demonstration Project Elements

- Research to Confirm Nitrogen Removal/Square Foot
- Concept Design Refinement



Town of Orleans Massachusetts

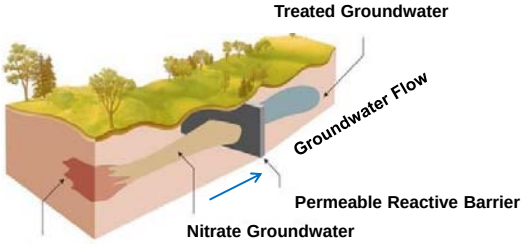
Orleans Water Quality Advisory Panel

Permeable Reactive Barrier (PRB) Subcommittee Workshop

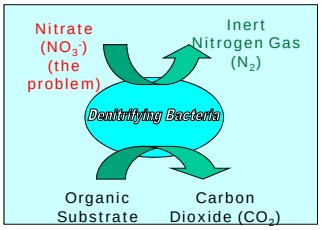
Paul Dombrowski, AECOM
James Begley, MT Environmental Restoration

PRB Overview

- A PRB Consists of a Zone of Reactive Material Installed in the Path of a Dissolved Contaminant (e.g. nitrate) Plume
- Denitrification - Biological Process by Bacteria Ubiquitous in the Environment
  - Nitrate converted to inert nitrogen gas (N_2)
  - Requires anoxic (low oxygen conditions)



(ITRC, 2011)



AECOM

PRB Application Methods

- Trenching
  - Solid Reactive Media (Mulch) Placed in Excavated Trench
  - Trenches 3 to 4 Feet Wide
- Soil Boring/Wells
  - Liquid Amendments (Food-Grade Carbon Substrate)
  - Solid Amendments Placed in Soil Borings
- Application methods discussed at January OWQAP PRB Breakout Session
  - **Recommendation to prepare Pro/Con tables for methods**

Planning and Design - AECOM PRB Team Activities

- Technical Memo on Site Characterization for PRBs
  - Groundwater and Soil Investigation to support PRB Planning
- Technical Memo for Preliminary Engineering Work Plan for PRBs

PRB Planning and Design – Site Characterization

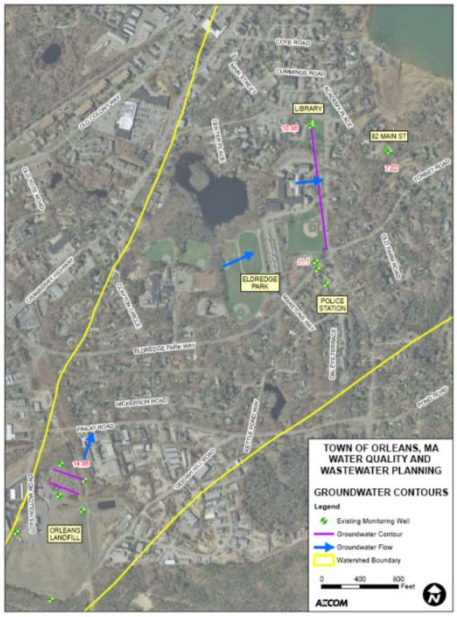
- **Technical Memorandum on Site Characterization for PRBs**
  - Draft submitted to Town in January 2016
  - Evaluated sites using 4 major criteria (20 sub-criteria)
    - Site Suitability
    - Permitting
    - Project Evaluation
    - Other Considerations
  - 8 sites in Orleans
    - A. Main Street/Tonset Road
    - B. Eldredge Parkway
    - C. Town Cove Gibson Road
    - D. Namequoit Road
    - E. Town Landfill
    - F. Paw Wah Pond
    - G. Rock Harbor Road Area
    - H. Lonnie's Pond
  - **Top rated sites in red**

PRB Planning and Design – Field Investigations

- Collect Soil and Groundwater Samples from Highest 4 Ranked Locations
- New multi-depth wells installed
  - Snow Library
  - 82 Main Street
  - Gibson Road at Asas Landing
  - Town Landfill
- Sample existing wells at Town Landfill and Eldredge Park
- Measure Parameters to Support PRB Site Selection and Design
  - Vertical Profile of Nitrate (and ammonia) Concentrations
  - Depth to Groundwater
  - Groundwater Flow Velocity
  - Soil Types
  - Other Groundwater Analytes of Interest

Results of Investigation

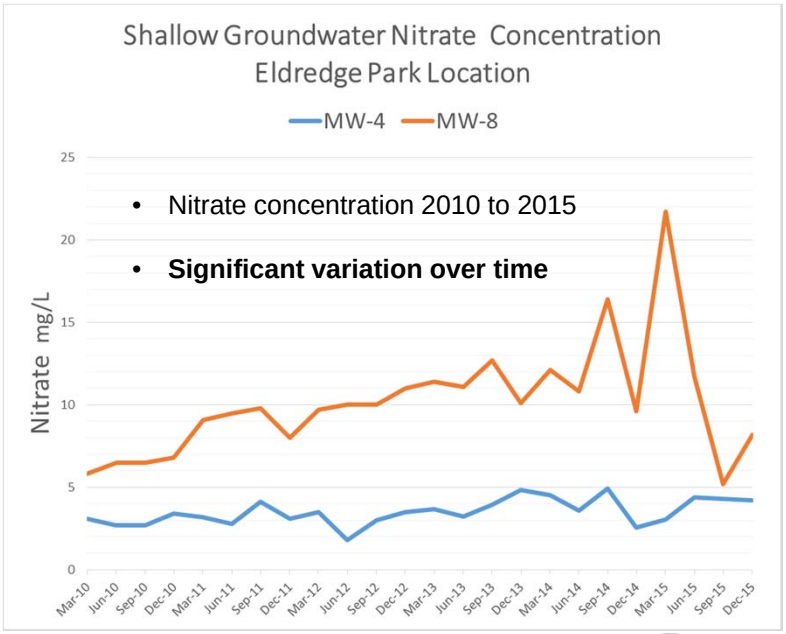
- Groundwater flow directions confirmed in areas of interest
- Initial view of nitrate/ammonia profile
- Better understanding of area hydrogeology
  - Aquifer material and groundwater flow velocity



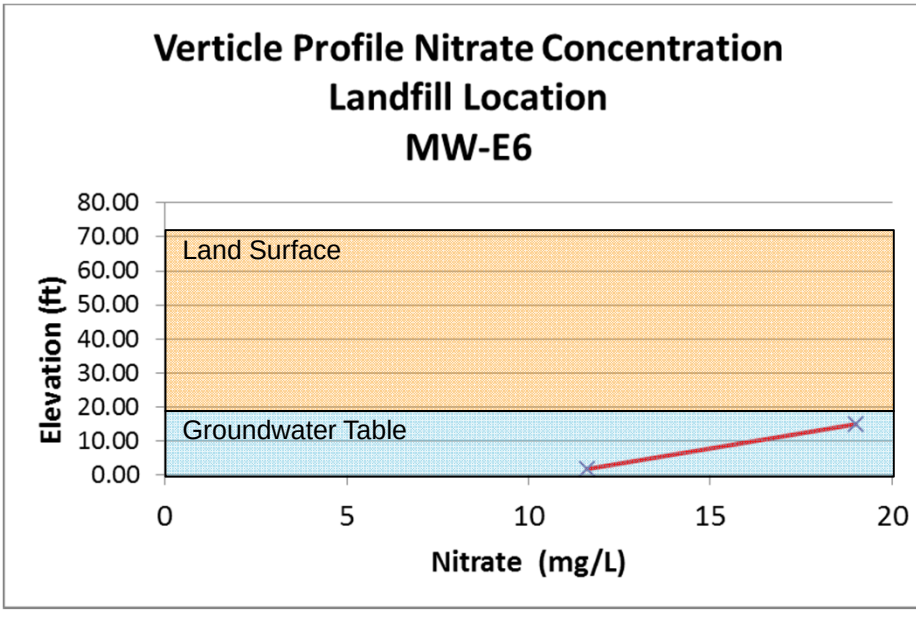
Nitrate Concentrations in Groundwater

- Eldredge Park – up to ~21 mg/L (5 years historical data)
- Landfill – up to ~40 mg/L (10 years historical data)
- Library – maximum ~ 2 mg/L (one round of samples)
- Main Street near Town Cove maximum ~ 5 mg/L (one round of samples)
- Asas Landing < 1mg/L (one round of samples)

Preliminary estimate: Groundwater flow velocity is in the range of 1 to 5 feet/day so nitrate flux is high



- Nitrate concentration 2010 to 2015
- **Significant variation over time**

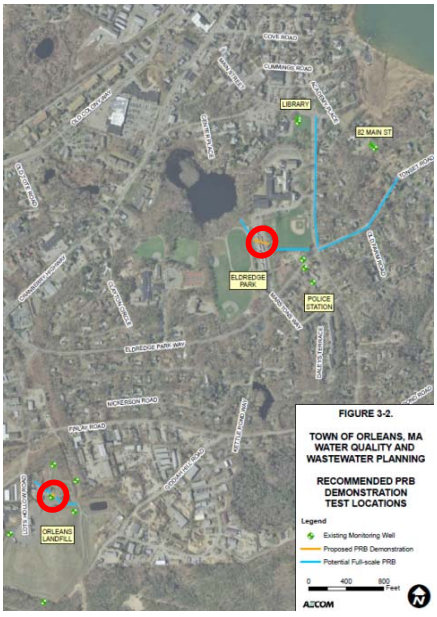


PRB Planning and Design
Preliminary Design

- Preliminary Engineering Work Plan for PRBs
  - Draft submitted to Town in February 2016
  - Preliminary Design for PRB Demonstration Tests
    - » Process Description
    - » Demonstration Test Objectives
    - » Demonstration Test Sizing
    - » Amendments and Application Methods
    - » Treatment Dosages
    - » Performance Monitoring
  - Key Design Considerations
    - » Town-owned land / PRB scale-up
    - » Depth to Water
    - » High groundwater velocity
    - » Vertical Treatment Interval
    - » Ability to effectively monitor groundwater

PRB Planning and Design
Preliminary Design (cont.)

- Detailed Demonstration Tests
  - Eldridge Park
  - Town Landfill
- 50 to 200 feet long Demonstration Tests
  - Dimensions easily adjusted
- Assume treatment 40 feet below groundwater table

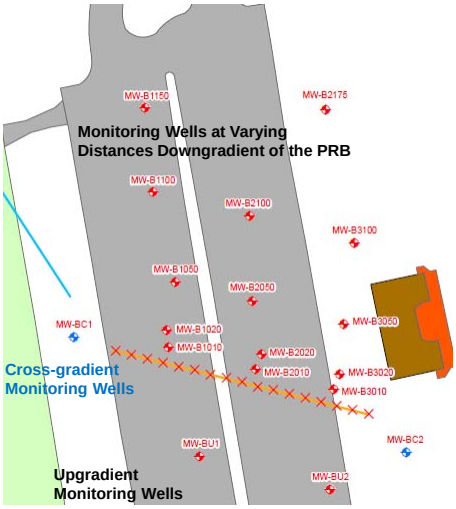


PRB Demonstration Test Monitoring Overview

- PRB Demonstration Testing will Include Extensive Groundwater Sampling and Analysis Program
- Performance Monitoring
  - Evaluate Changing Nitrogen Concentrations and Load Reduction
  - Assess Size of Reactive Zone (Distance Downgradient of PRB)
  - Evaluate Migration of Carbon Substrate
- Evaluate Secondary Water Quality Impacts
- Engineering Design Optimization
- Monitoring Wells Located Upgradient and Downgradient of the PRB

PRB Demonstration Test Monitoring Overview

- 50 to 200 feet long
  - Dimensions easily adjusted
- Monitoring Parameters
  - Total Nitrogen
  - Nitrate
  - Nitrite
  - Ammonia
  - Dissolved Metals
  - Sulfate
  - Dissolved Organic Carbon
  - Methane
  - Dissolved Oxygen
  - pH
  - Oxidation-Reduction Potential



PRB Application Methods – Trenching

Advantages

- Mulch PRBs widely accepted groundwater treatment method and construction equipment readily available
- Reactive media (mulch) has no potential to migrate
- Treatment longevity of trench typically longer than injection-based methods

PRB Application Methods – Trenching (Cont.)

Disadvantages

- Requires large construction equipment and not likely to reach target depths for treatment
- Reactive zone (residence time) limited to trench width (3 to 4 feet) and may not treat entire vertical zone required
- Requires soil handling and disposal plus area to stage soils
- Limited flexibility in alignment to accommodate above and below ground site features
- May lead to settling of ground surface over time and are not suitable in roadways
- Requires future rejuvenation (often by injection of emulsified vegetable oil), instead of by replacing the trench through excavation)
- Limited to depth of 20 to 30 feet which would require placing PRB in proximity to surface water.
- Locations very close to surface water resource would not provide sufficient downgradient travel time for stabilization of groundwater chemistry before groundwater discharge to the surface water (i.e., iron staining at surface water)
- Permitting Challenges

PRB Application Methods – Injection

Advantages

- Locations flexible and can be located upgradient away from environmental resource areas.
- Carbon substrate injections widely accepted groundwater treatment method and equipment readily available.

❖ Small equipment footprint (small drill rig, all pumps and mixing tanks contained to box truck/trailer.

❖ Injection can be performed under roadways.

❖ Limited impacts to traffic and abutters.

❖ Orientation can be adjusted in the field to accommodate above and below ground site features (utilities, curbs, trees, overhead power lines).

❖ Injection can generate a wider treatment zone (more residence time) than a trench filled with solid reactive media.

❖ Application not limited by depth (for anticipated depths in Orleans).

❖ Shorter field construction time than trenching.

❖ Injection method can be pilot-tested at small scale cost-effectively.

PRB Application Methods – Injection (cont.)

Disadvantages

- Liquid amendments can be transported short distances/diluted by groundwater flow (requires verification of stability).
- Injection PRBs likely would require replenishment sooner than trenches.

Site at end of an injection day

PRB Next Steps

- Gather input from the Committee
- Complete final Technical Memorandums
- Complete Design for Demonstration Tests – FY 2017
- Implement Demonstration Test #1 – FY 2017
- Implement Demonstration Test #2 – FY 2018
- Groundwater sampling for PRB Demonstration – FY 2017–FY 2019
- Design full-scale PRB(s)
- Implement full-scale PRB(s)

Program Schedule - Key Activities / Dates

- FCW / PRB Subcommittee Workshop – April 6, 2016
- Shellfish / Aquaculture – April 2016
- OWQAP – April 20, 2016
- Town Meeting – May 9, 2016

Town of Orleans Massachusetts

Thank You