Town of Orleans Massachusetts

Nauset Regional School District

Eldredge Park Permeable Reactive Barrier

February 8, 2018

Agenda

- **Aquifer Recharge**
- **Eldredge Park Permeable Reactive Barrier**
  - Overview – Nitrogen Problem
  - Subsurface PRB Operations
  - Site Selection
  - Amendment – Emulsified Vegetable Oil (EVO)
  - Implementation - Fall 2016
  - Monitoring
  - AECOM and SMAST Findings
  - Next Steps
- **Science Classroom Educational Series**

Aquifer Recharge

Aquifer Recharge
Background – Site Selection

- **Tri-Town Septage Treatment Facility - 1987 thru 2016**
  - Permitted to Discharge 45,000 gpd
  - Discharge Nitrogen Concentration = 50 mg/L
  - Discharge Based on 1985 MEPA Finding of “No Significant Impact”
- **2010 CWMP Approved by MassDEP, MEPA, and Cape Cod Commission**
  - 740,000 gpd from New WWTF
  - Discharge Nitrogen Concentration = 10 mg/L
  - Proposed Discharge Based on USGS and SMAST Finding of “No Significant Impact”
- **Begin Work to Find Alternative Discharge Locations**
  - Fourth Detailed Site Identification Study in Last 12 years
  - Two Areas to be Sewered: Downtown Area and Meetinghouse Pond Area

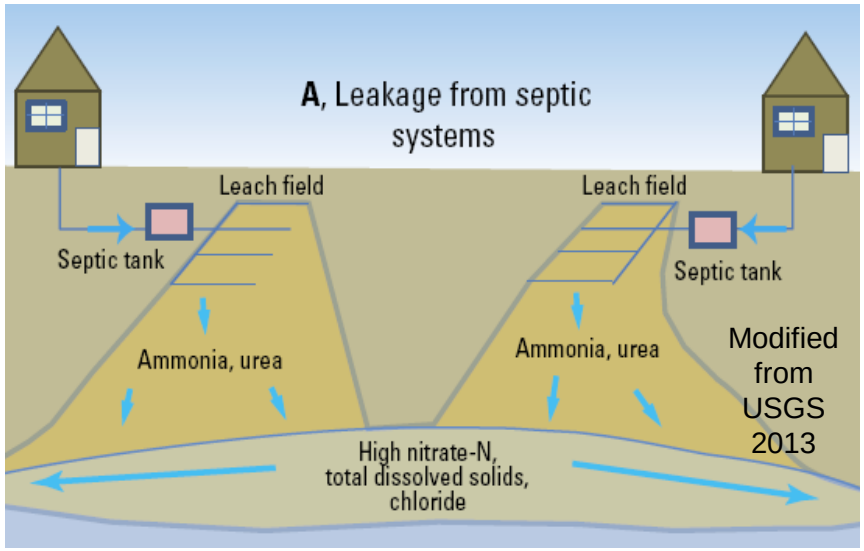
Aquifer Recharge
Current Status

- **Sites Eliminated**
  - Site 1/1A
  - Nauset Regional Middle School (70 Eldredge Parkway)
  - Thayer Property (Orleans Market Place)
- **Route 6 Interchange (Exit 12 Cloverleaf)**
  - Sufficient Land Area
  - Depth to Groundwater is Favorable
  - Allows for Several Discharge Options
  - Approval Obtained From MassDEP
  - Obtaining Approval from MassDOT
- **32 Lots Hollow Road and 43 Lots Hollow Road**
  - Sufficient Land Area
  - Depth to Groundwater is Favorable
  - Field Investigations Ongoing

Eldredge Park Permeable Reactive Barrier

Eldredge Park Permeable Reactive Barrier Overview – Nitrogen Problem

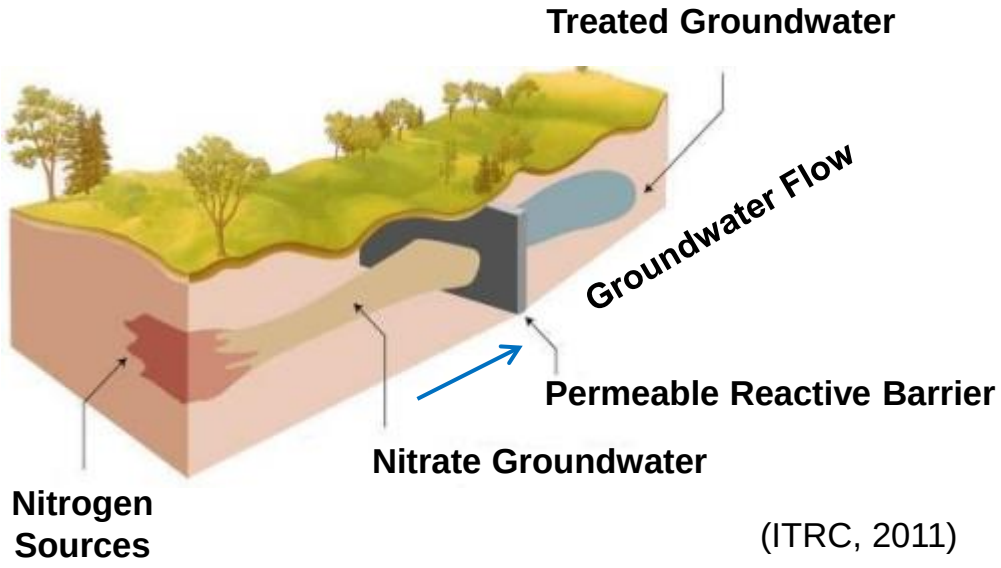
- **Septic Systems Used for About 85% of Wastewater Treatment on Cape Cod**



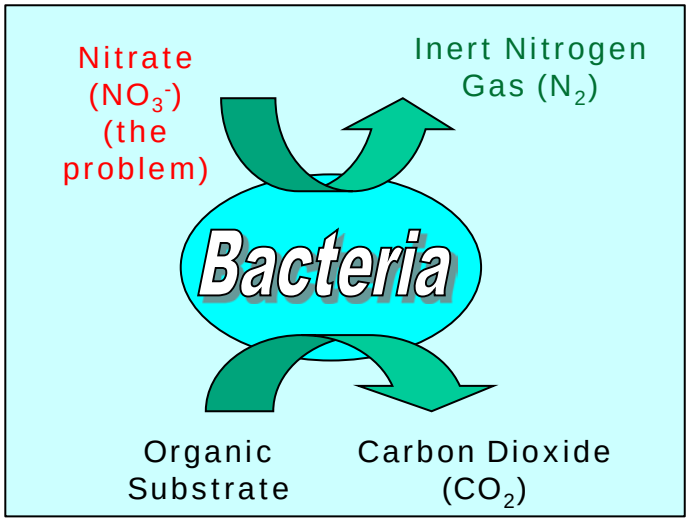
- **Naturally-occurring Bacterial Transform Organic Nitrogen to Nitrate**
- **Large Dilute Nitrate Plumes in Groundwater Flow into Coastal Waters**

Eldredge Park Permeable Reactive Barrier
Subsurface PRB Operations

- **Reactive Material Installed in the Path of a Plume (e.g. nitrate)**



(ITRC, 2011)



- **Naturally-occurring Bacteria to Convert Nitrate to Inert Nitrogen Gas (N_2)**
- **Requires Anoxic (Low Oxygen Conditions)**

Eldredge Park Permeable Reactive Barrier
Site Selection

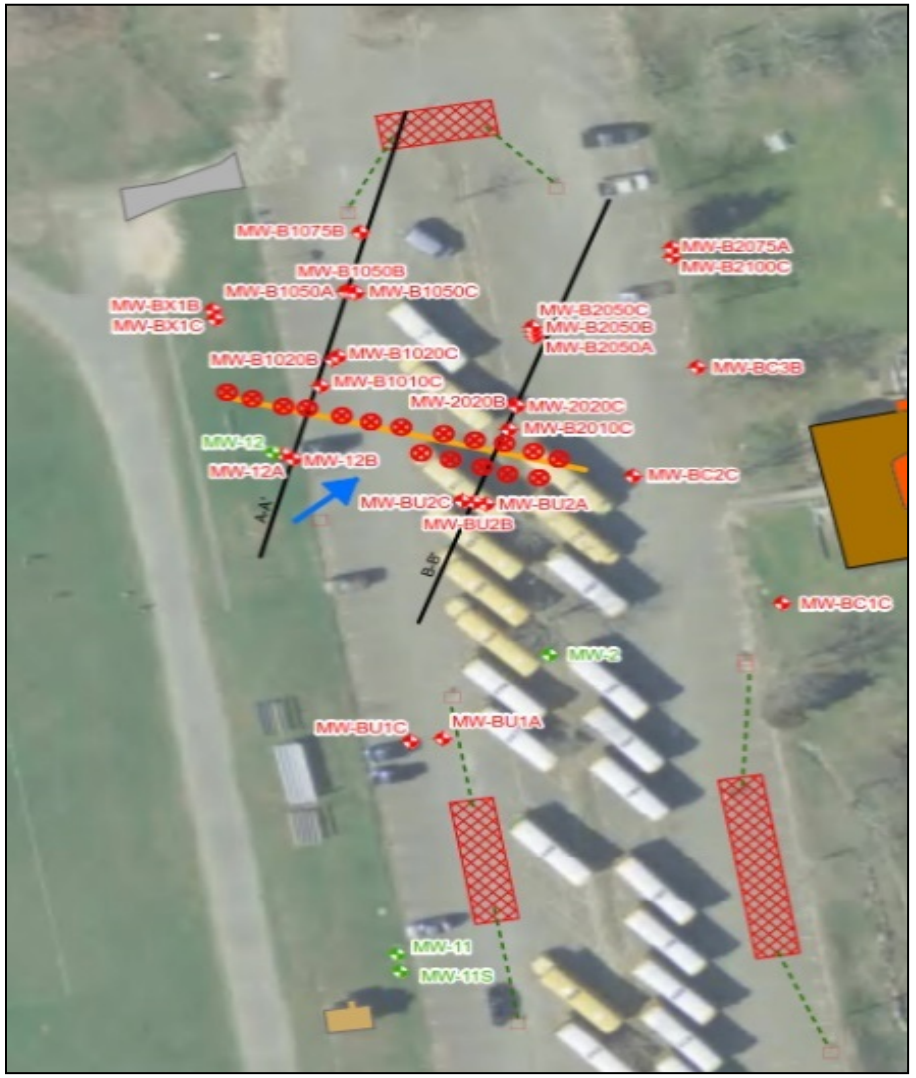
- **Completed an Evaluation of 8 Potential Sites for Based on Four Major Criteria**
  - Site Suitability: Depth to Groundwater, Groundwater Nitrogen Profile, and Groundwater Flow Direction and Velocity
  - Permitting: Potential Regulatory Concerns and Site Use
  - Project Evaluation: PRB Nitrogen Removal Efficiency and Accessible Well Locations
  - Other Considerations: Potential for Watershed Impacts and Potential for Full-scale Implementation
- **Collected Soil and Groundwater Samples from the Four Highest Ranked Locations**
- **Recommend PRB Demonstration Test sites**
  - Town Landfill
  - Eldredge Park

Eldredge Park Permeable Reactive Barrier Amendment – Emulsified Vegetable Oil (EVO)

- **Food-grade Substrate Made with Soybean Oil**
  - Consistency Similar to Soy Milk
- **Slowly Releases Dissolved Organic Carbon and Provides a Long Term Carbon Source for Denitrifying Bacteria**
- **Relatively Immobile Once Injected into Groundwater**
  - AECOM Experience at 10s of Sites
  - Never Travels More Than 100 Feet (Mostly Less Than 20 Feet)
- **Laboratory Studies with Cape Cod Sand Used to Develop an EVO Mixture that Does Not Migrate**
  - Less Than 3 Feet in a Column Study

Eldredge Park Permeable Reactive Barrier Implementation - Fall 2016

- **Installed Upgradient and Downgradient Monitoring Wells**
- **PRB Design**
  - About 110 Feet Long
  - Injected Emulsified Vegetable Oil at Points Spaced 10 Feet Apart
- **PRB Monitoring**
  - Baseline
  - Quarterly for 3 Years

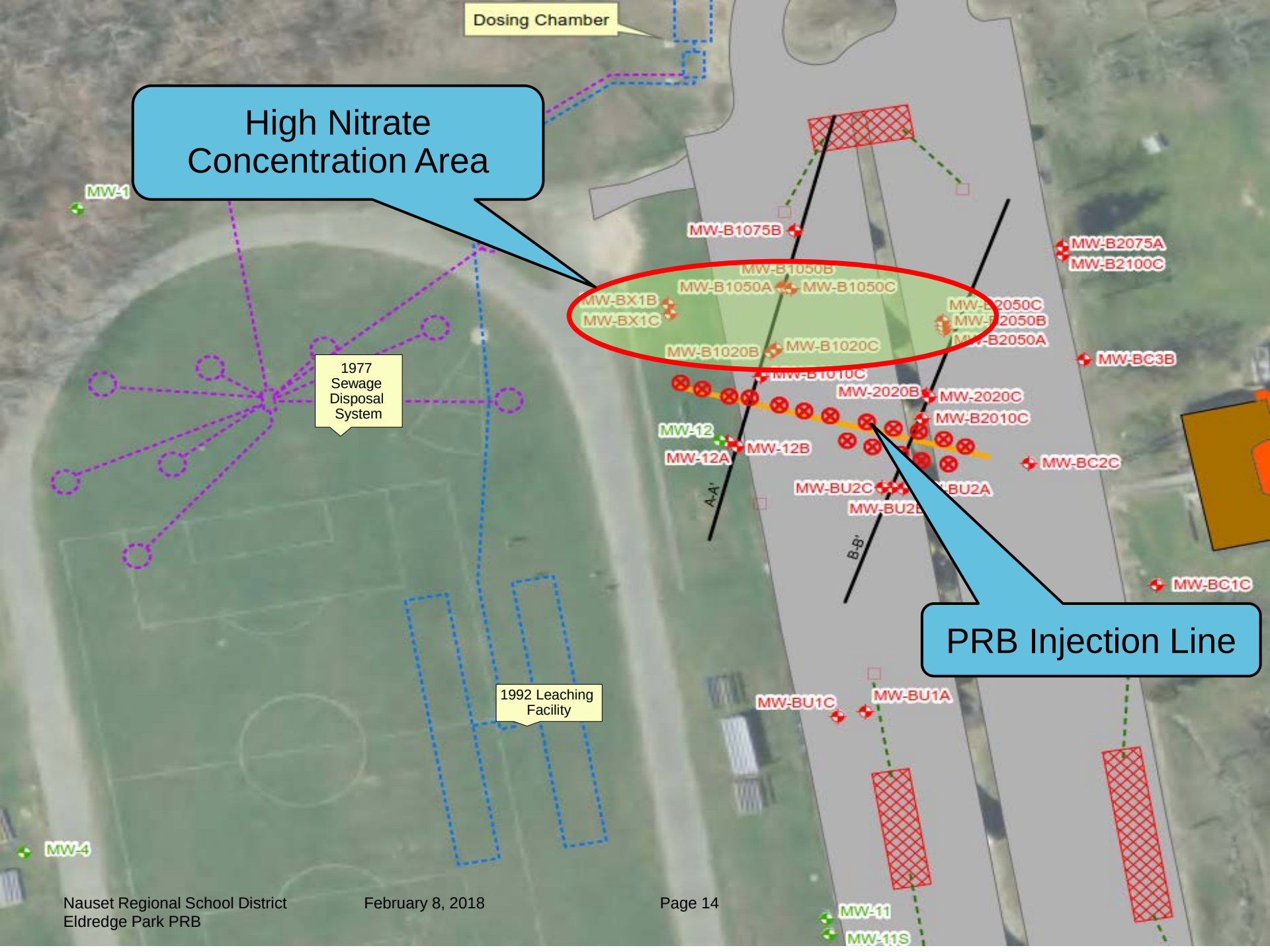


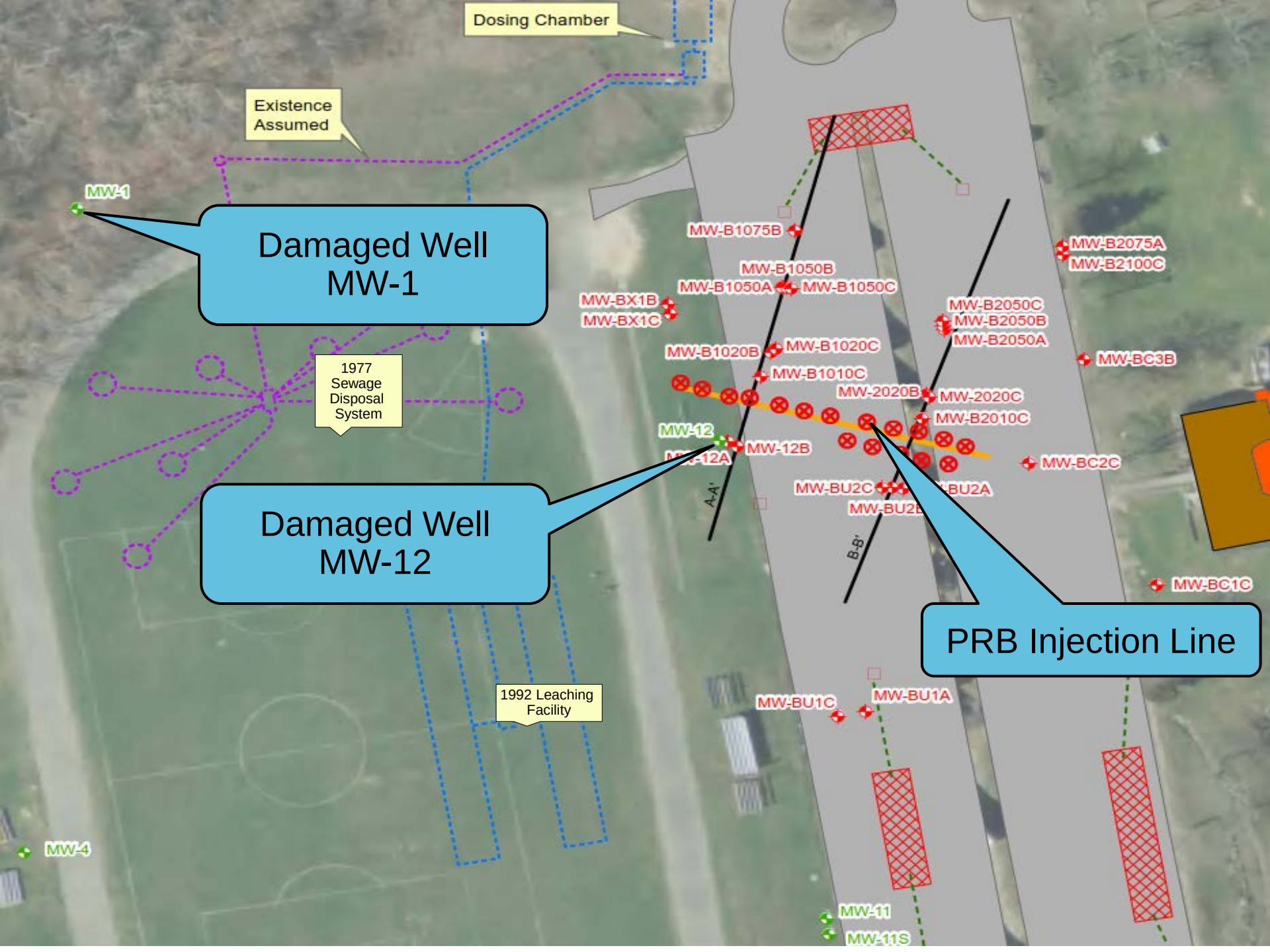
Eldredge Park Permeable Reactive Barrier Monitoring

- **Quarterly Monitoring**
  - 24 Wells Sampled and Analyzed for Nitrate and Other Key Parameters
  - Baseline Monitoring – October 2016
  - Quarterly Monitoring - February 2017, June 2017, September 2017 and January 2018
- **2nd Quarterly Report June 2017 (7 Months Post Injection)**
  - Reviewed by SMAST
  - Additional Information Regarding Nauset Regional Middle School's On-site Wastewater Disposal System Collected and Reviewed

Eldredge Park Permeable Reactive Barrier
AECOM and SMAST Findings

- **Groundwater Flow in the Vicinity of the PRB is Complex Due to the Low Gradient of the Water Table**
- **Local Conditions Such as Variable Discharge to the Middle School Leach Fields May be Periodically Altering Flow Around the PRB**
- **Based on Available Data, it is Difficult to Clearly Define Average Flow and Flow Paths for Water Through the PRB**
- **Localized High Nitrate Concentrations are Present in the PRB Monitoring Field that are Likely Not Passing Through the PRB**
- **High Nitrate Concentrations Potentially Associated with 1977 Middle School Leach Field or Other Local Source(s)**


Dosing Chamber
High Nitrate Concentration Area
MW-1
MW-B1075B
MW-B2075A
MW-B2100C
MW-B1050B
MW-B1050A
MW-B1050C
MW-BX1B
MW-BX1C
MW-B2050C
MW-B2050B
MW-B2050A
MW-B1020B
MW-B1020C
MW-BC3B
MW-B1010C
MW-2020B
MW-2020C
MW-B2010C
MW-12
MW-12A
MW-12B
MW-BC2C
MW-BU2C
MW-BU2A
MW-BU2B
A-A'
B-B'
MW-BC1C
PRB Injection Line
1977 Sewage Disposal System
1992 Leaching Facility
MW-BU1C
MW-BU1A
MW-4
MW-11
MW-11S


Dosing Chamber
Existence Assumed
MW-1
Damaged Well MW-1
1977 Sewage Disposal System
MW-B1075B
MW-B1050B
MW-B1050A
MW-B1050C
MW-BX1B
MW-BX1C
MW-B1020B
MW-B1020C
MW-B1010C
MW-12
MW-12B
MW-12A
Damaged Well MW-12
A-A'
B-B'
MW-2020B
MW-2020C
MW-B2010C
MW-BU2C
MW-BU2A
MW-BU2B
MW-B2075A
MW-B2100C
MW-B2050C
MW-B2050B
MW-B2050A
MW-BC3B
MW-BC2C
MW-BC1C
PRB Injection Line
1992 Leaching Facility
MW-BU1C
MW-BU1A
MW-4
MW-11
MW-11S

Eldredge Park Permeable Reactive Barrier
Next Steps

- **Repair Damaged MW-12**
- **Replace Damaged MW-1**
- **Install Additional Monitoring Wells to Resolve Uncertainties**
- **Update Status of Middle School Leach fields (Performance Reports and Operations)**
- **Extend PRB to the North to Intercept High Nitrate Concentrations**

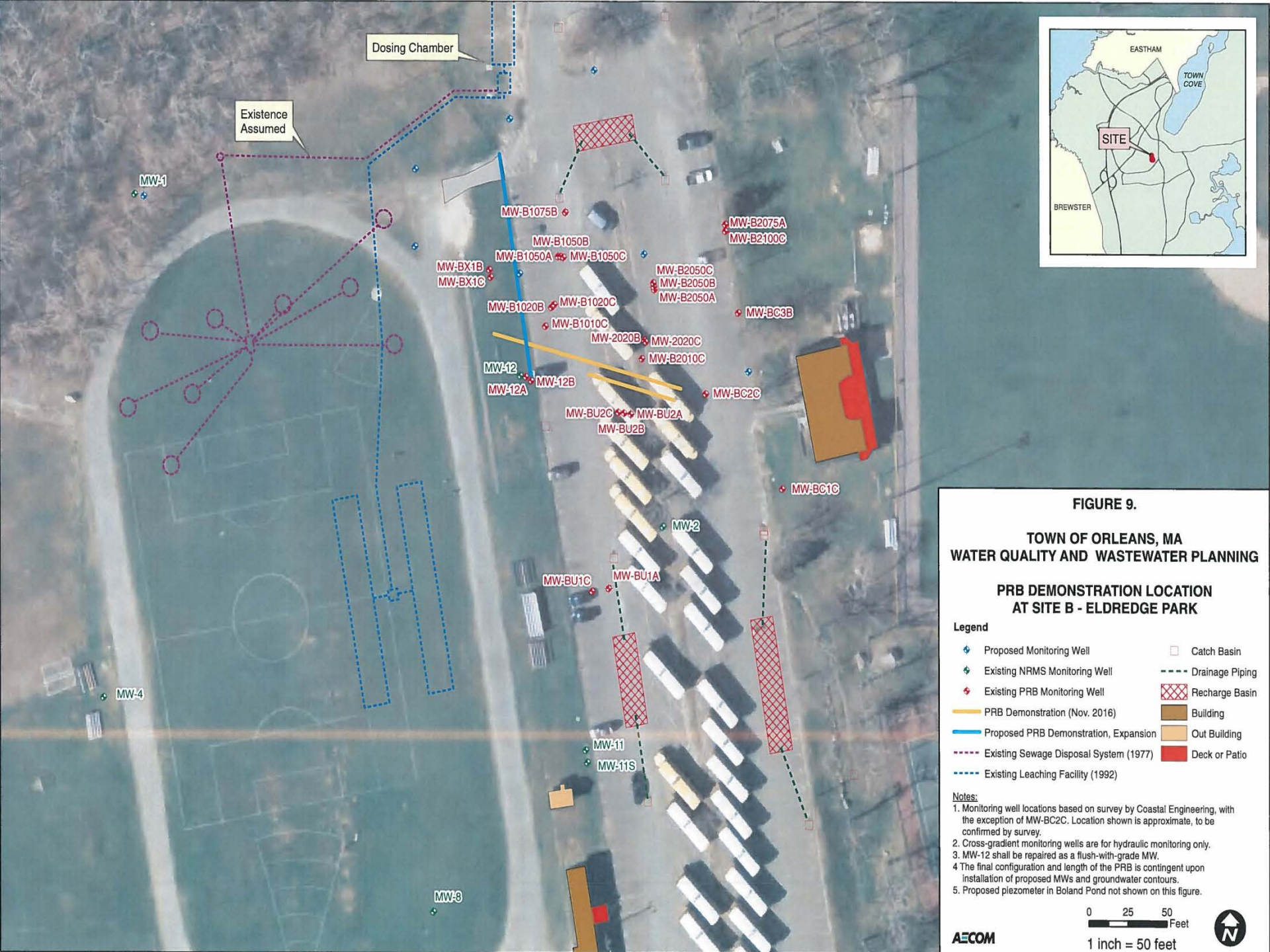


FIGURE 9.

TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING

PRB DEMONSTRATION LOCATION AT SITE B - ELDREDGE PARK

Legend

- Proposed Monitoring Well
- Existing NRMS Monitoring Well
- Existing PRB Monitoring Well
- PRB Demonstration (Nov. 2016)
- Proposed PRB Demonstration, Expansion
- Existing Sewage Disposal System (1977)
- Existing Leaching Facility (1992)
- Catch Basin
- Drainage Piping
- Recharge Basin
- Building
- Out Building
- Deck or Patio

Notes:
1. Monitoring well locations based on survey by Coastal Engineering, with the exception of MW-BC2C. Location shown is approximate, to be confirmed by survey.
2. Cross-gradient monitoring wells are for hydraulic monitoring only.
3. MW-12 shall be repaired as a flush-with-grade MW.
4 The final configuration and length of the PRB is contingent upon installation of proposed MWs and groundwater contours.
5. Proposed piezometer in Boland Pond not shown on this figure.

0 25 50 Feet

1 inch = 50 feet

AECOM

N

Town of Orleans Massachusetts

Science Classroom Educational Series

Science Classroom Educational Series
Draft Classroom Syllabus

- **Water Quality Background – Cape Cod Nitrogen Problem**
- **Massachusetts Estuaries Program and the Cape Cod Commission 208 Plan**
- **Potential Solutions**
  - Traditional Technologies
  - Non-Traditional Technologies
- **Orleans' Water Quality and Wastewater Planning Program**
  - Wastewater Collection and Treatment
  - Eldredge Park PRB Demonstration Project
  - Lonnies Pond Shellfish Demonstration Project

Town of Orleans Massachusetts

Thank You