2ND ANNUAL
CAPE COASTAL
CONFERENCE

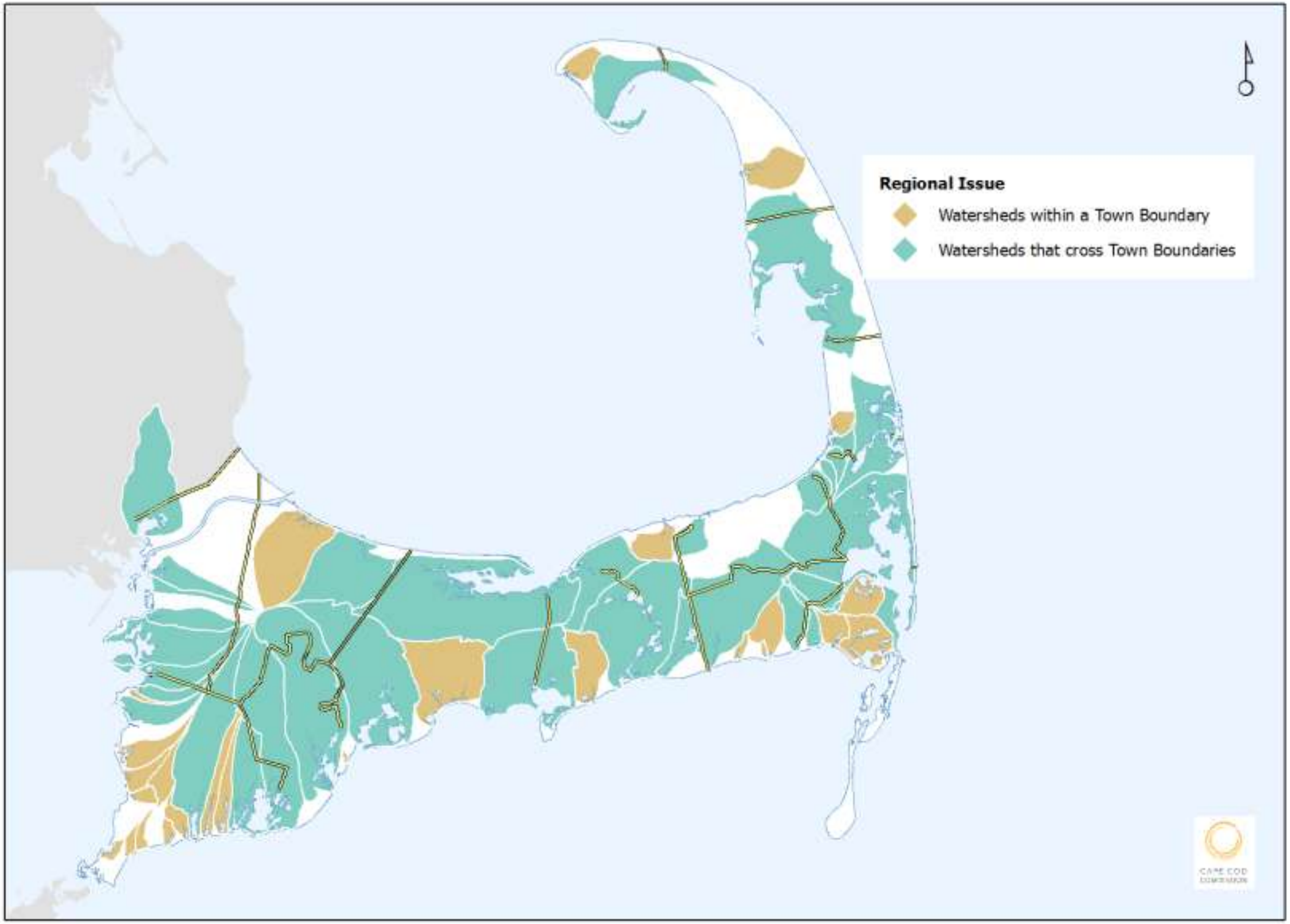
JUNE 5

AN INTEGRATED NUTRIENT MANAGEMENT APPROACH:

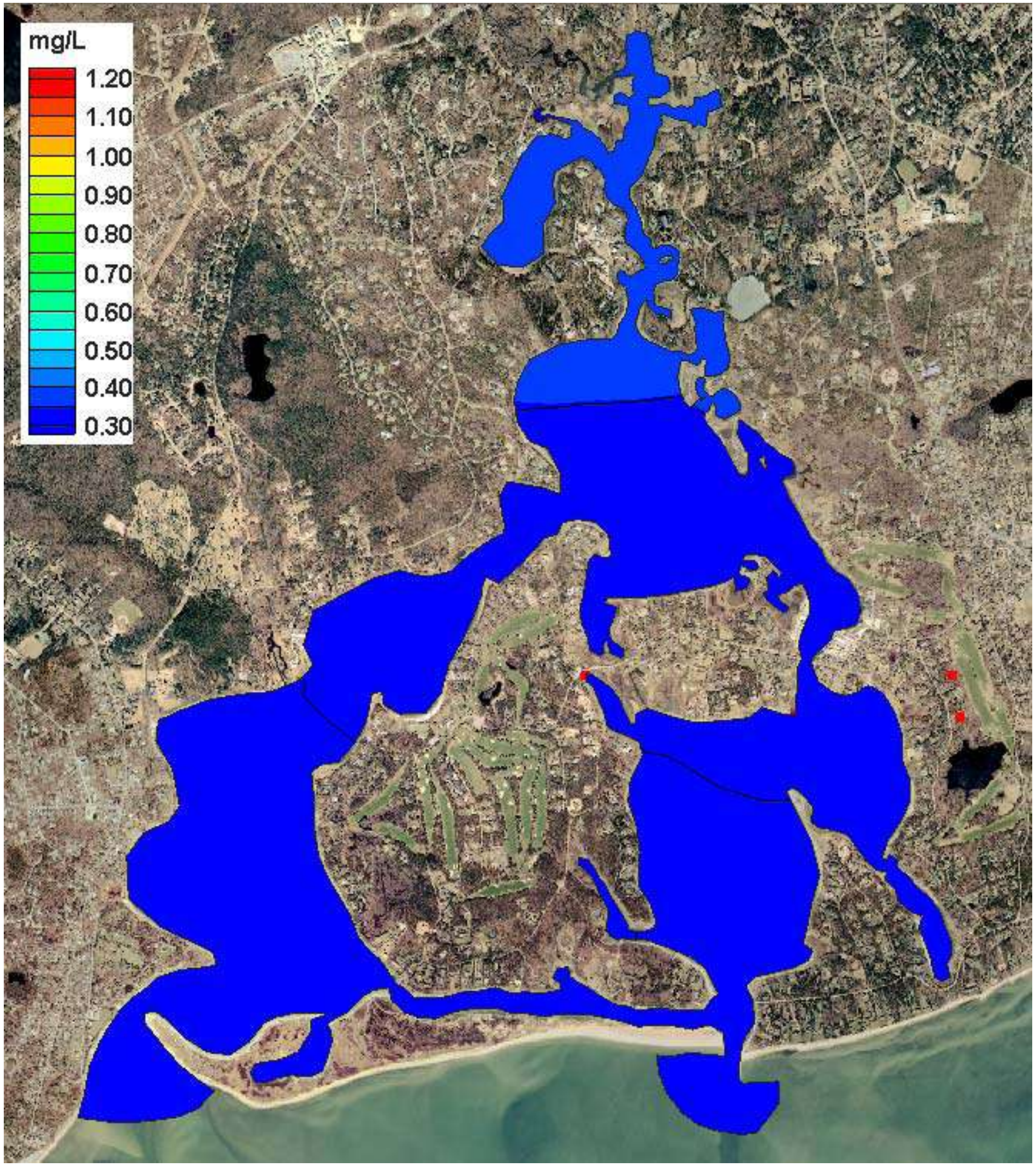
APPLYING NON-TRADITIONAL TECHNOLOGIES (GREEN INFRASTRUCTURE)

SCOTT HORSLEY, CONSULTANT
CAPE COD COMMISSION

Shared Watersheds



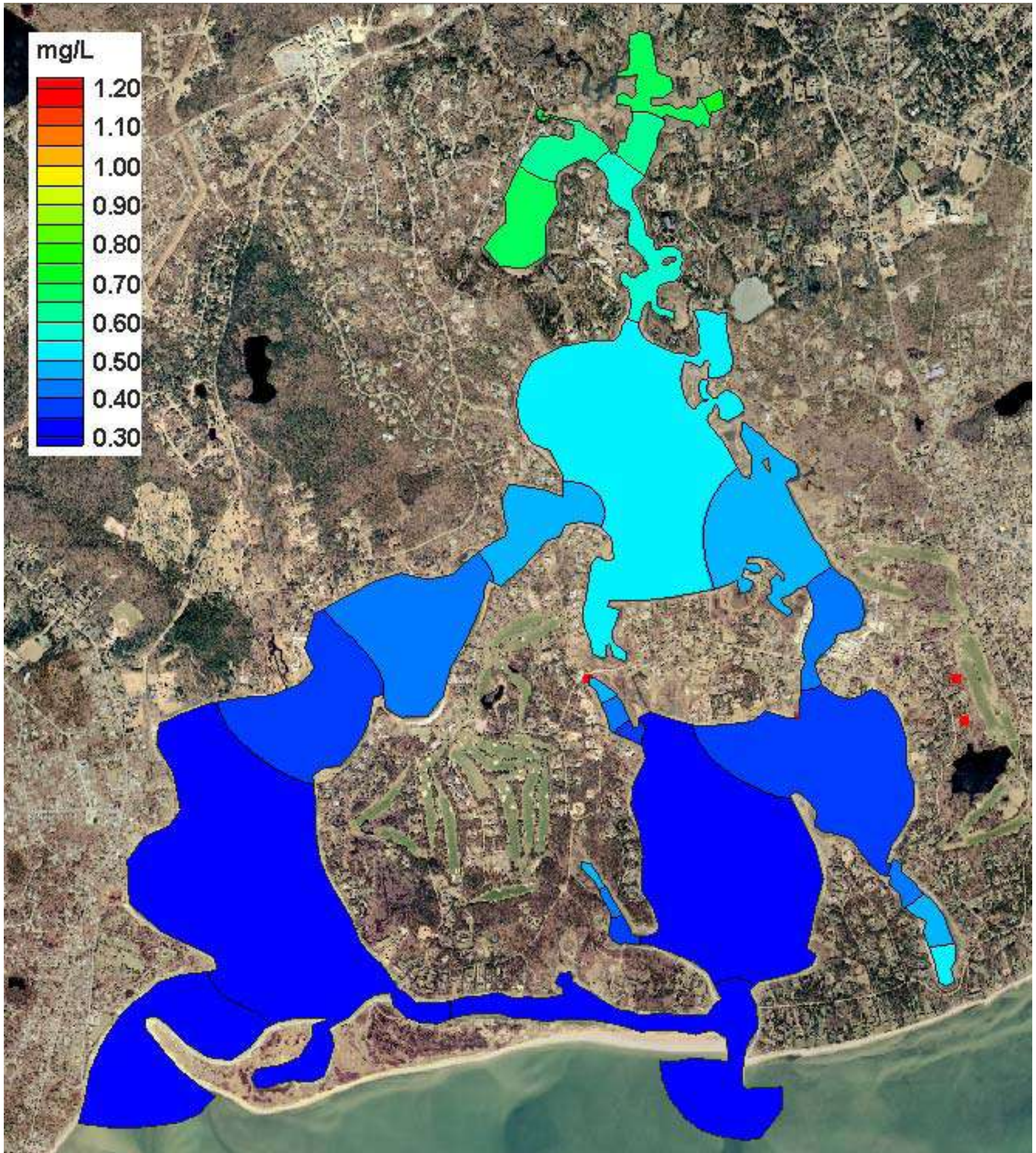
Pre-Colonial Conditions: Three Bays



Contour plot of **modeled total nitrogen concentrations (mg/L)** in Three Bays, for no anthropogenic loading conditions.

(Source: MEP 2006)

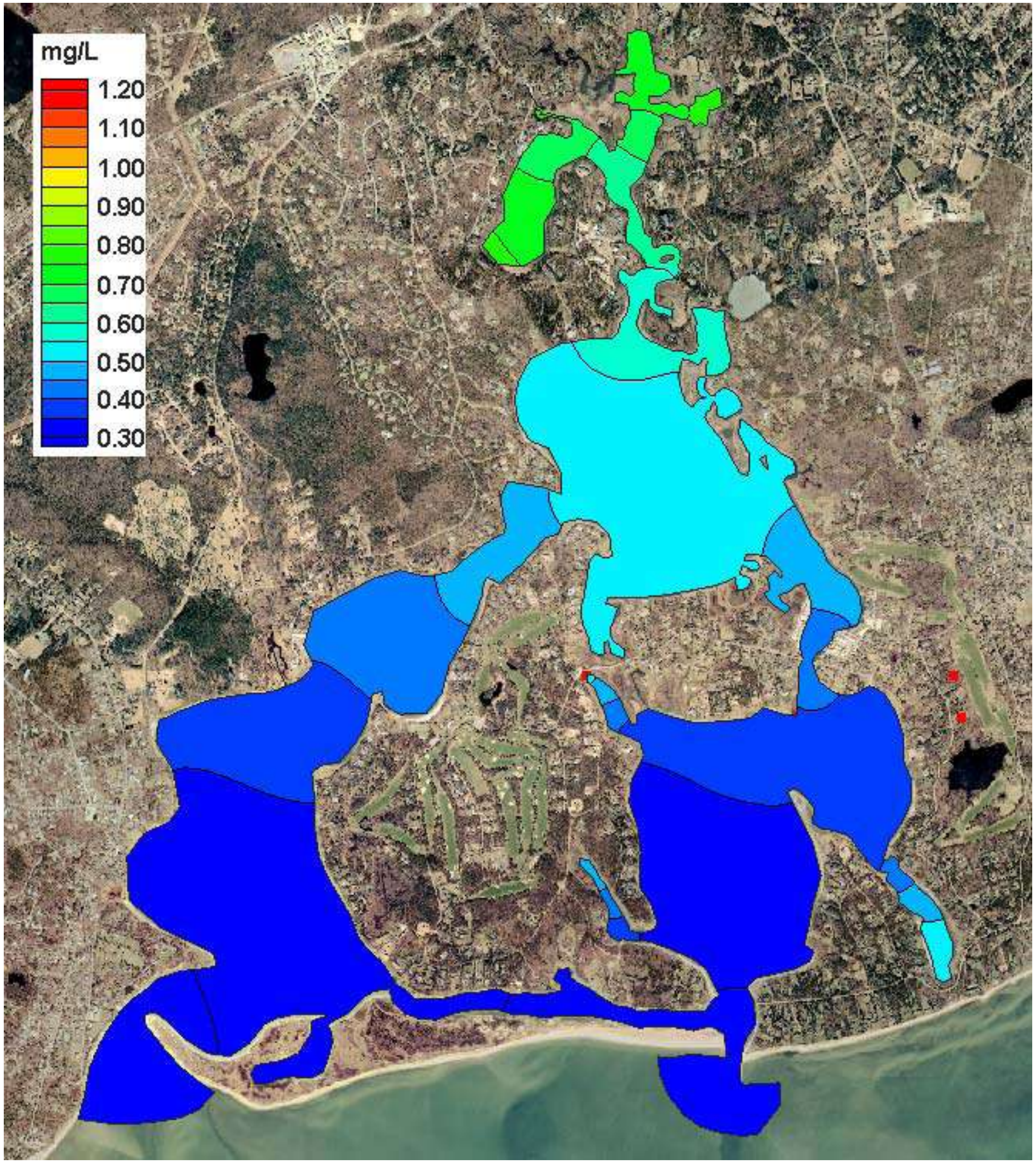
Present Conditions: Three Bays



Contour plot of **average total nitrogen concentrations** from results of the present conditions loading scenario, for the Three Bays system.

(Source: MEP 2006)

Build- Conditions: Three Bays



Contour plot of modeled **total nitrogen concentrations (mg/L)** in the Three Bays system, for projected build-out loading conditions.

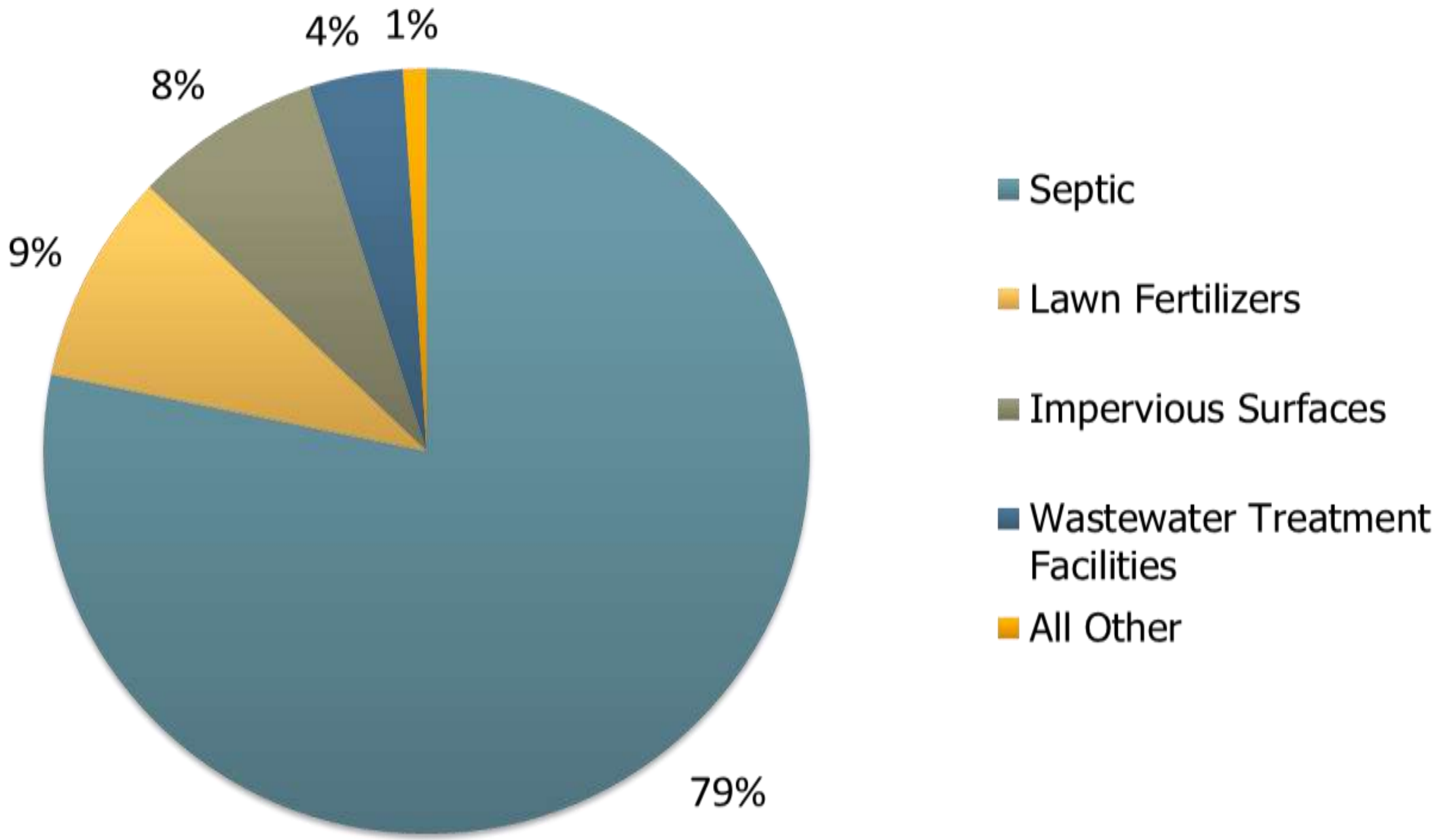
(Source: MEP 2006)

DENSITY:

Cape Cod Wide Estimate

30% growth will increase capital costs by 40%

Cape-Wide Controllable Nitrogen Loads



Note: Data averaged from existing Massachusetts Estuaries Project Reports

Non-Traditional Approach

1. **Identify Current N Removal Needs** (Targets/Reduction Goals)

   Present Load: X kg/day − **Target:** Y kg/day = **Reduction Required:** N kg/day

2. **Additional Removal Needs**
   - A. Title 5 Problem Areas
   - B. Pond Recharge Areas
   - C. Growth Management

3. **Low Barrier Technologies**
   - A. Fertilizer Management
   - B. Stormwater Mitigation

4. **Watershed Alternative Technologies**
   - A. Permeable Reactive Barriers
   - B. Inlet/Culvert Openings
   - C. Constructed Wetlands
   - D. Aquaculture

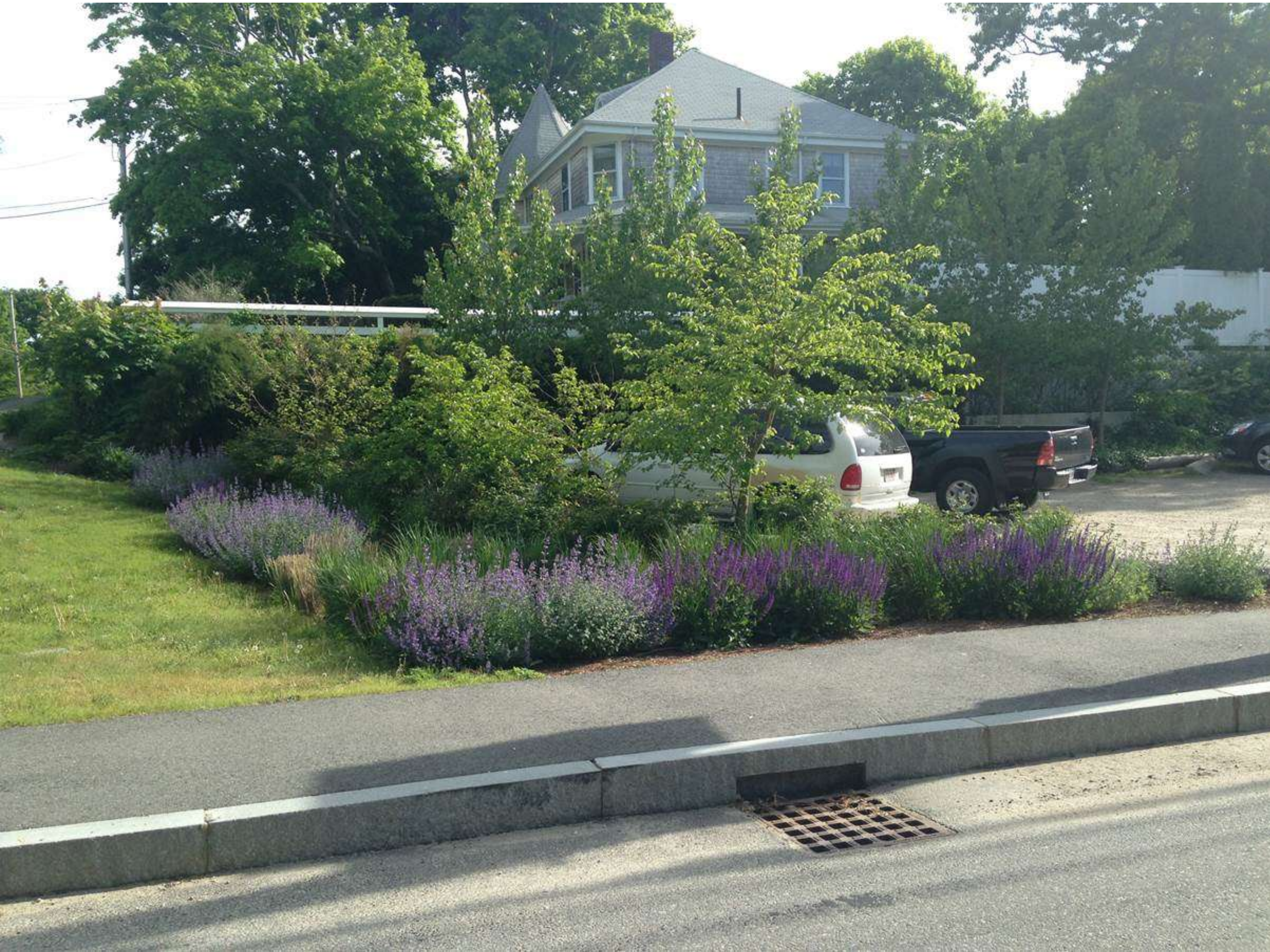
   PRB

5. **On-Site Alternative Technologies**
   - A. Eco-toilets (UD & Compost)
   - B. I/A Technologies
   - C. Enhanced I/A Technologies
   - D. Shared Systems

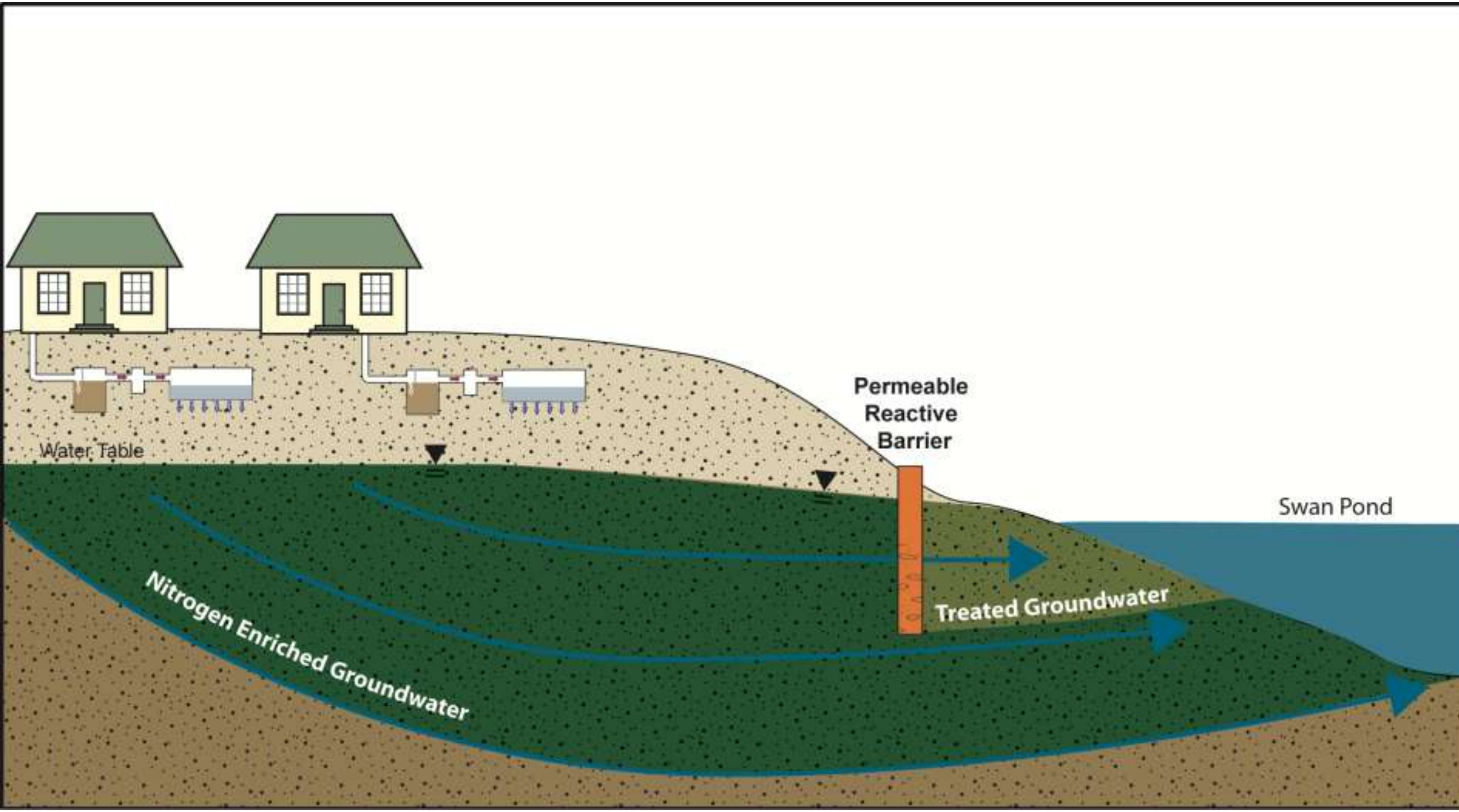
   IA Title 5 IA

6. **Supplemental Sewer Collection (Smallest Footprint)**

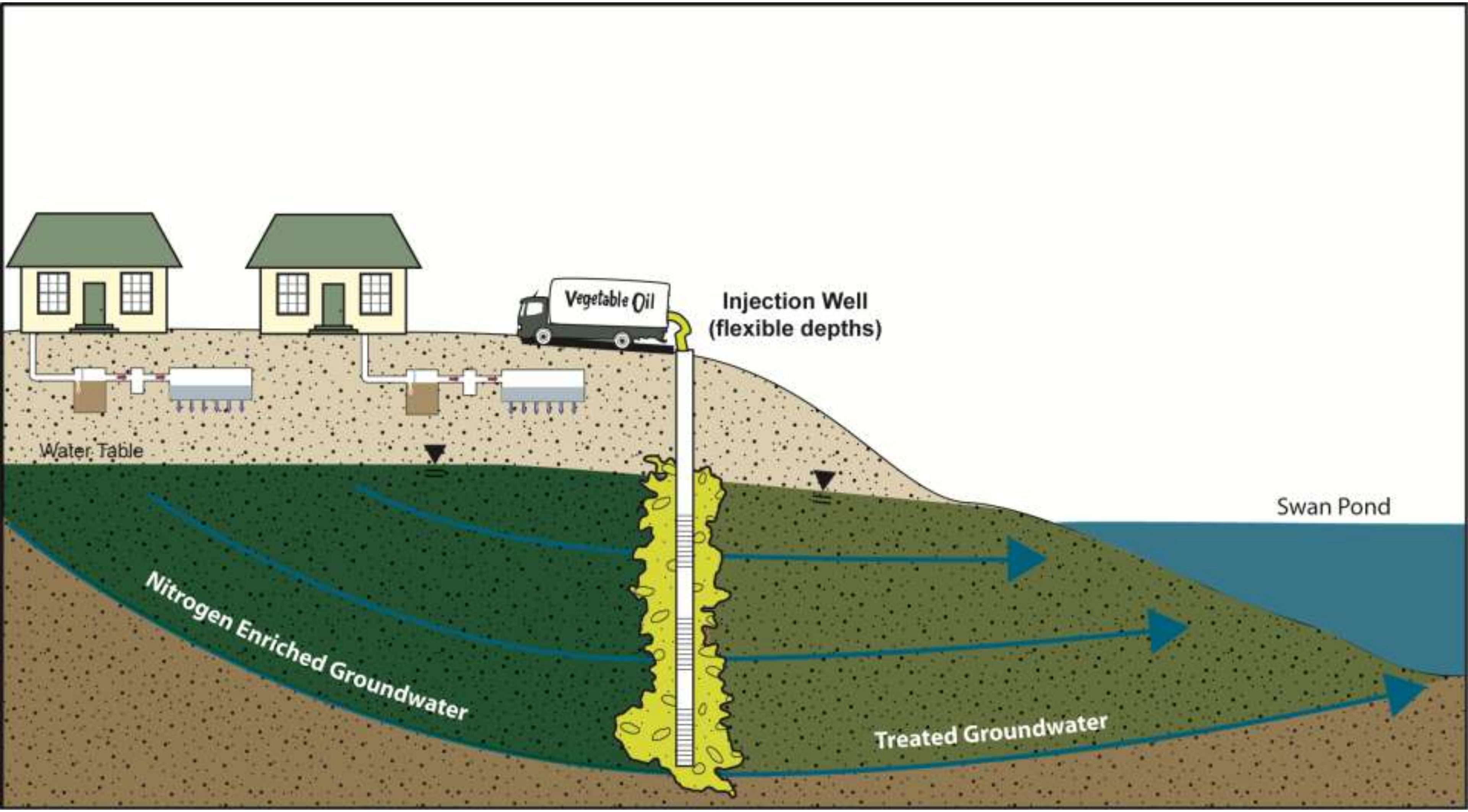
   Priority Areas May Include:
   - A. Greater Than 1 Dwelling Unit/acre
   - B. Village Centers
   - C. Economic Centers
   - D. Growth Incentive Zones

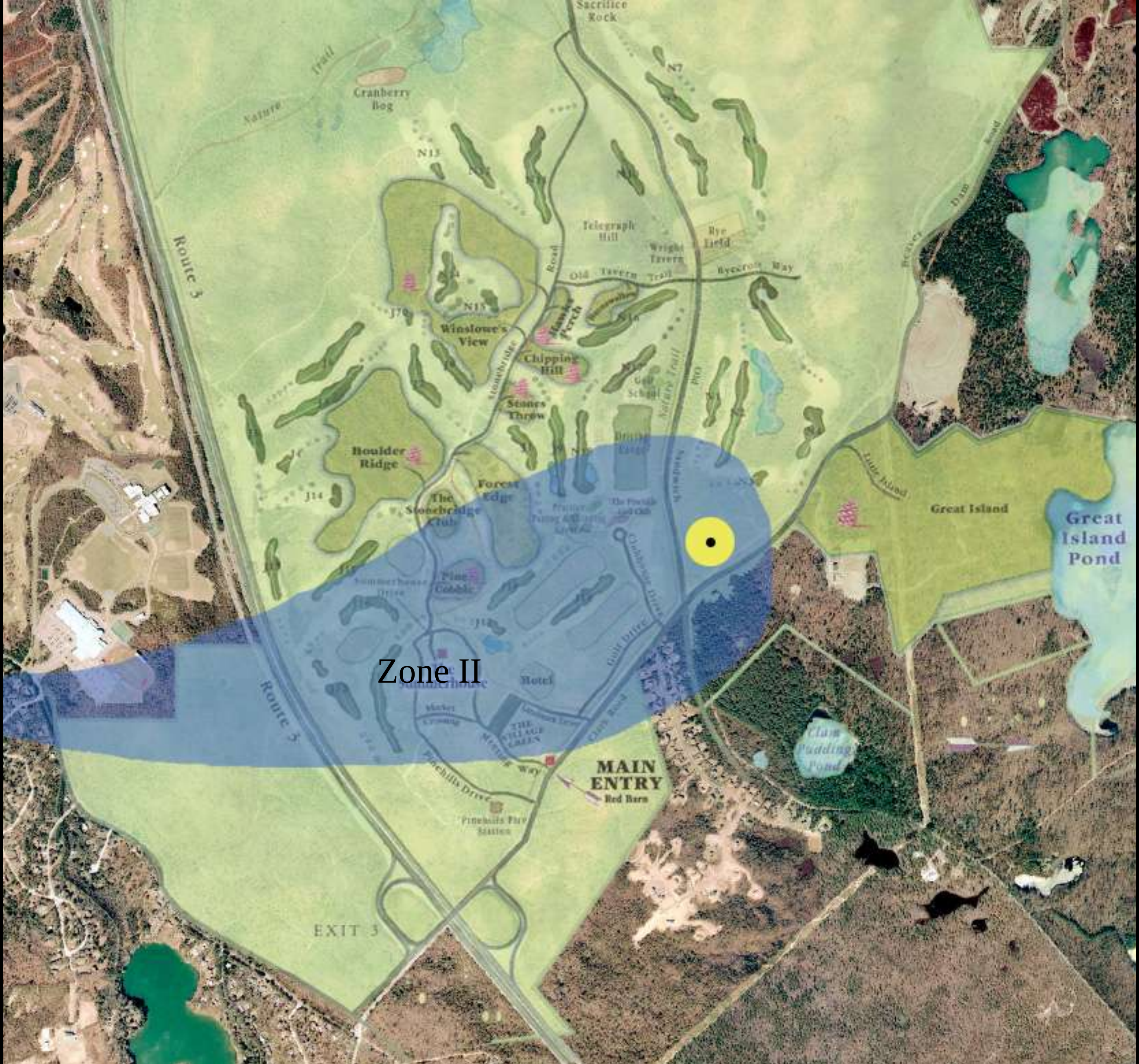


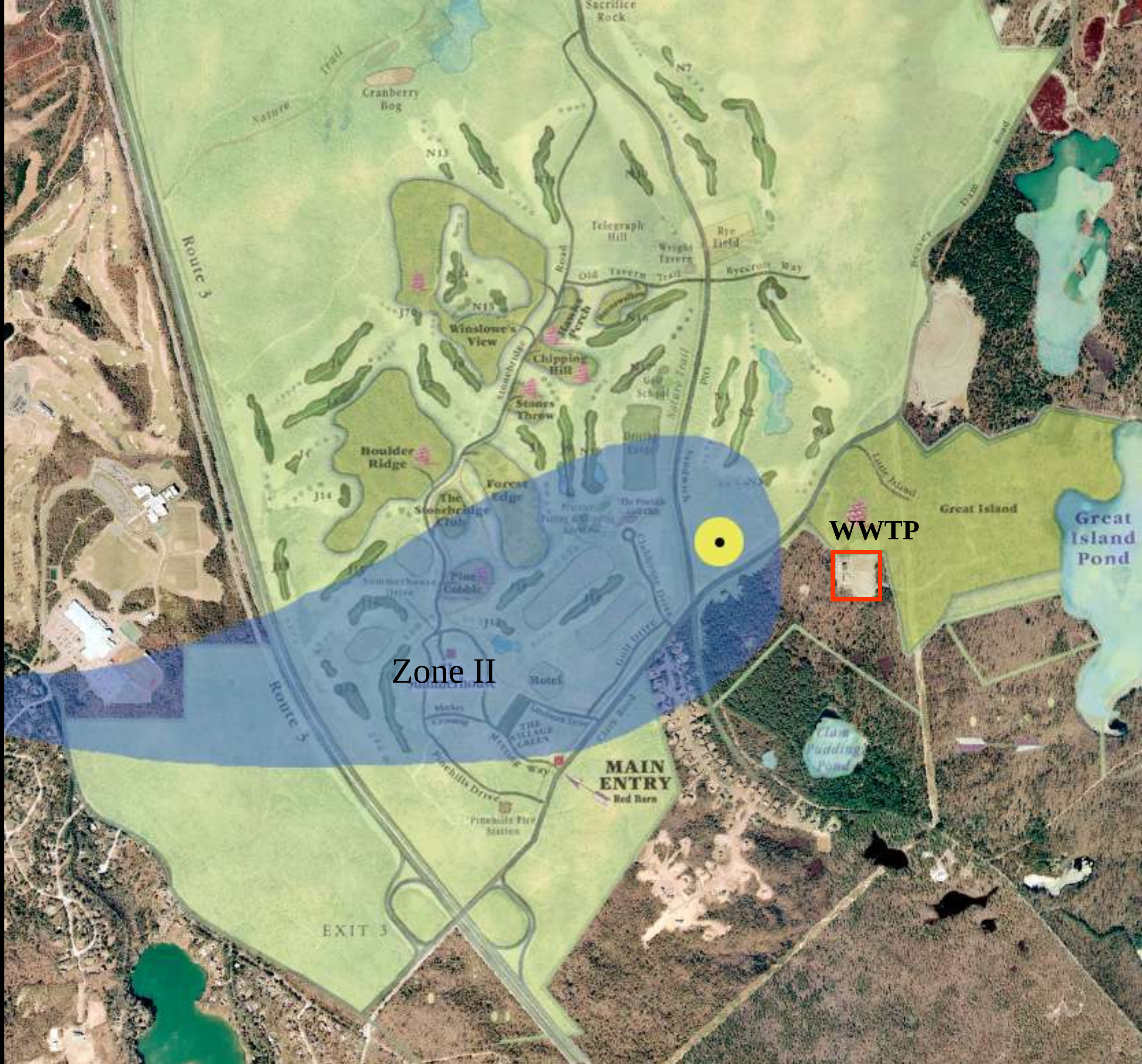
Permeable Reactive Barriers



Permeable Reactive Barriers




Zone II
Sacrifice Rock
Cranberry Bog
Nature Trail
Route 3
Telegraph Hill
Rye Field
Wright Tavern
Old Tavern Trail
Ryecroft Way
Beaver Dam Road
Winslowe's View
Chipping Hill
Stones Throw
Boulder Ridge
Forest Edge
The Stonebridge Club
Pine Cobble
Great Island
Great Island Pond
Little Island
Clam Pudding Pond
Hotel
MAIN ENTRY
Red Barn
Pinehills Drive
Pinehills Fire Station
EXIT 3


WWTP
Zone II
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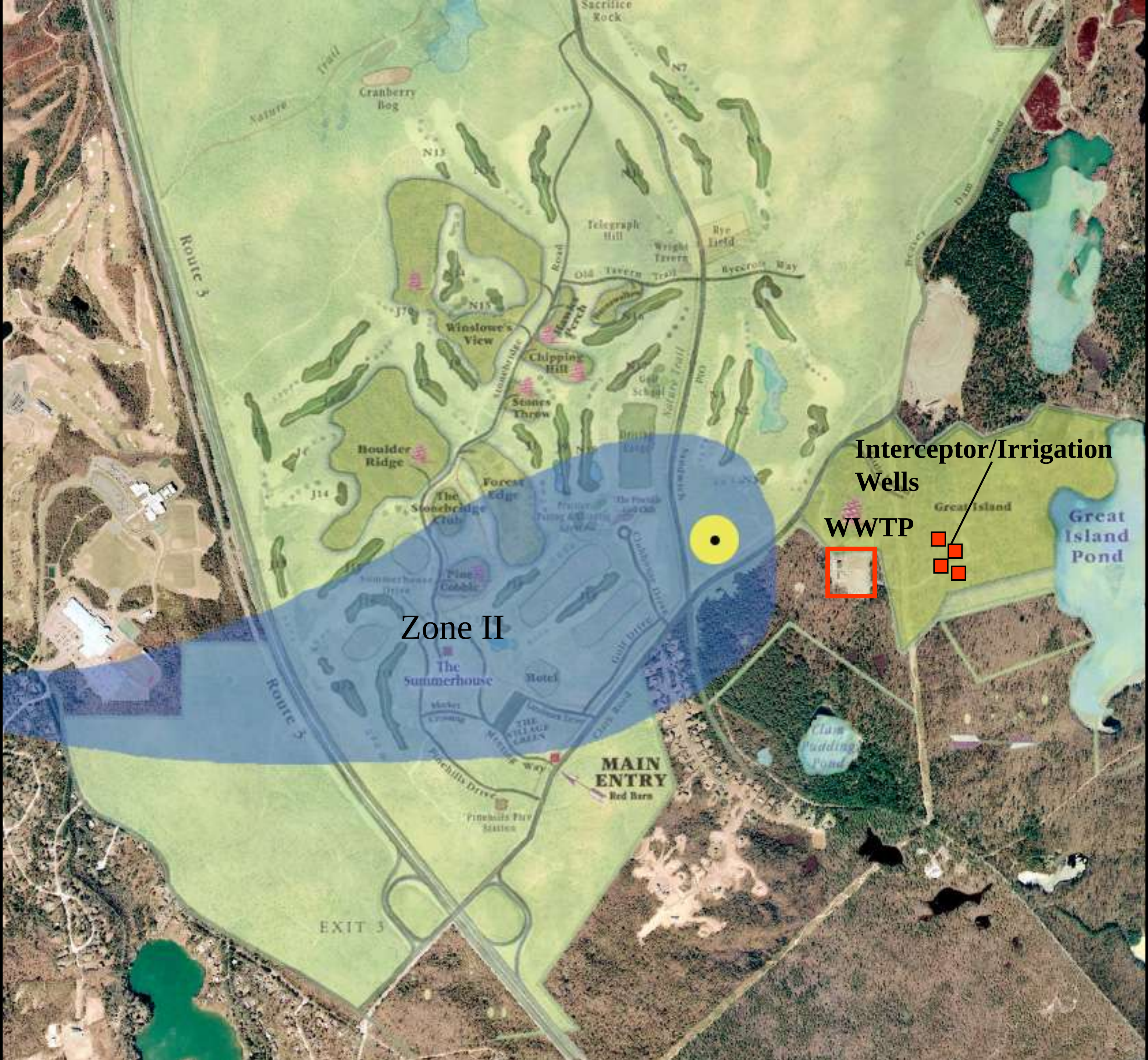
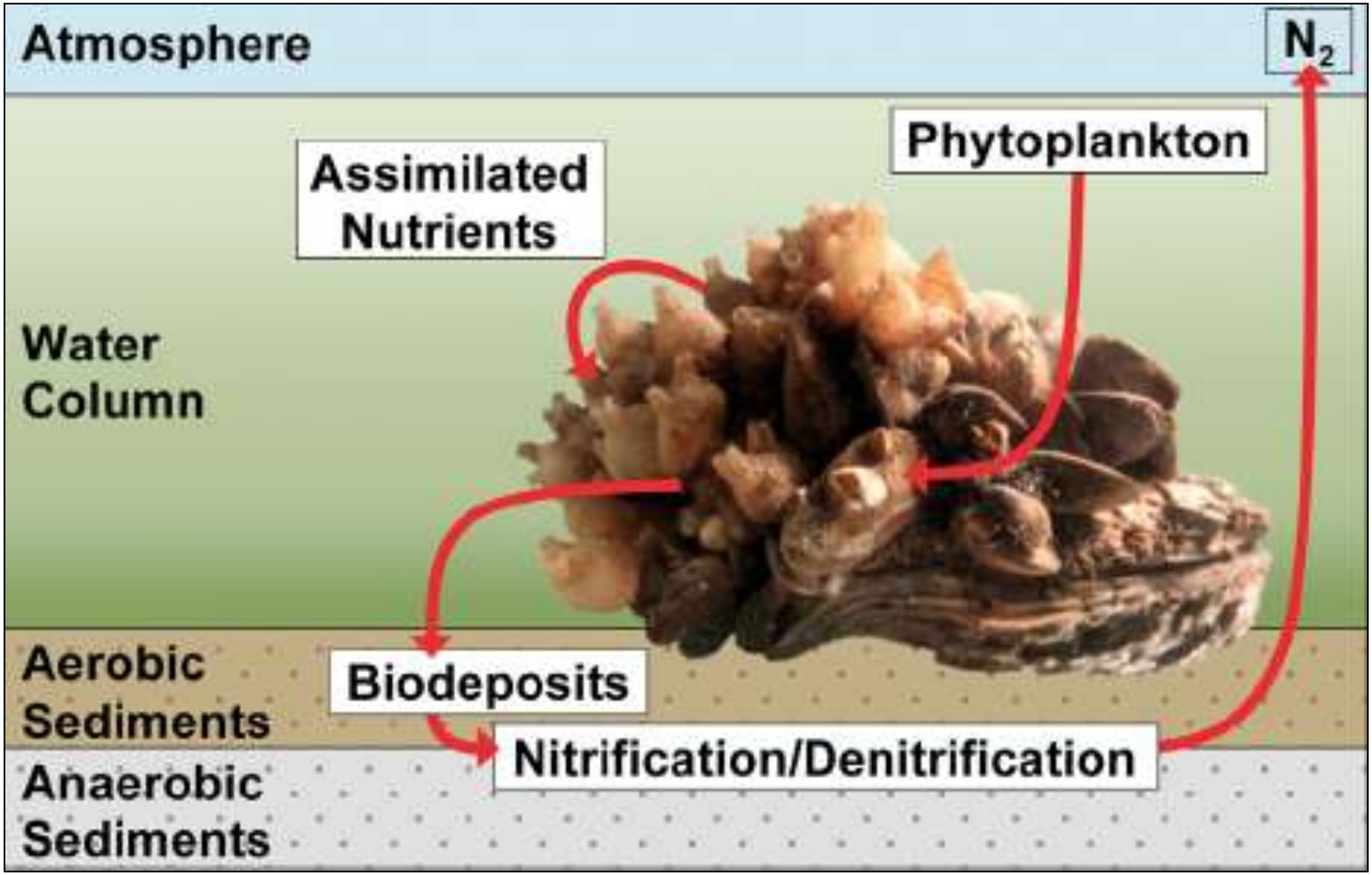


Interceptor/Irrigation Wells
WWTP
Zone II
Great Island Pond
Great Island
MAIN ENTRY
Red Barn
Route 3
Route 3
EXIT 3
Sacrifice Rock
Cranberry Bog
Nature Trail
Telegraph Hill
Old Tavern Trail
Boulder Ridge
Winslowe's View
Chipping Hill
Stones Throw
Forest Edge
The Stonebridge Club
Pine Cobble
The Summerhouse
Hotel
Pinehills Drive
Clam Pudding Pond

TDR: The Concept

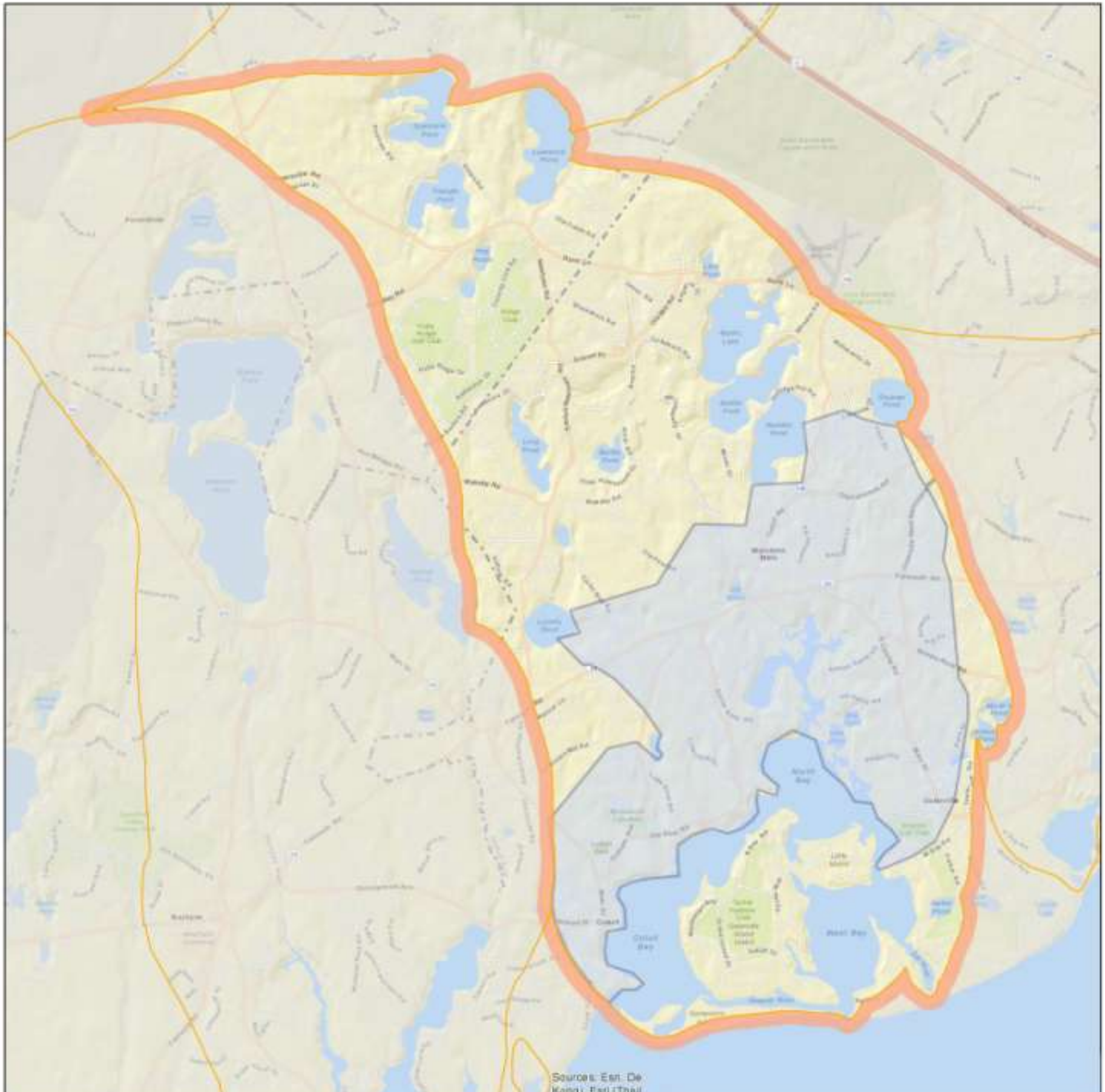
Owner of "sending" parcel sells development rights in exchange for permanent conservation easement.

Owner of "receiving" parcel buys development rights to build at densities higher than allowed under base zoning.



SOURCE: Kellogg et al., Denitrification and nutrient assimilarion on a restored oyster reef


Sources: Esri, De
Kong), Esri (Thail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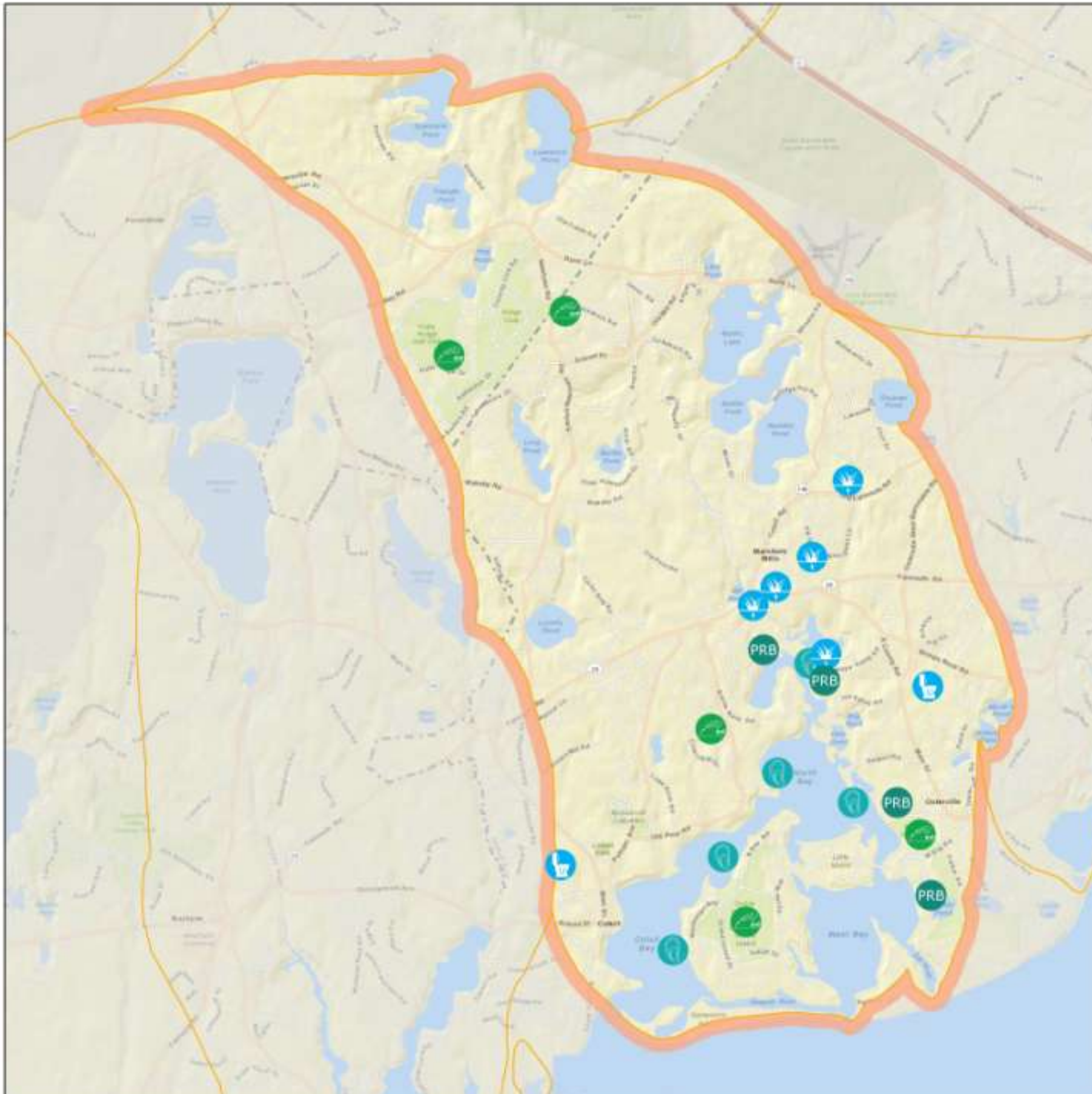

PRB
PRB
PRB
PRB

NITROGEN REDUCTION CALCULATOR

(MEP Watershed)	Name of Estuary:	Boat Meadow				
MEP Targets and Goals	**kg/year**	**kg/day**	**kg/day**	**Nitrogen (kg/yr)**	**Percentage of Total Load for Removal Required**	
Present Total Nitrogen Load			5.2	1,914		
Controllable Nitrogen Load						0
Wastewater	1,914	5.2				
Fertilizer	0	0.0				
Stormwater	0	0.0				
Target Nitrogen Load			3.9	1,436		
Nitrogen Removal Required			**1.3**	**479**	25%	
Total Number of Properties	390					

Low Barrier to Implementation	Percent of Total Removed	Reduction by Technology (Kg/yr)	Remaining to Meet Target (Kg/yr)	Average 20-Year Life Cycle Cost ($/kg N)	Amortized Annual Life Cycle Cost* ($/kg N)	Total 20-Year Cost (5% interest)
A) Fertilizer Management	50	0	479	$483	$39	$0
B) Stormwater Mitigation	50	0	479	$7,800	$626	$0

Watershed/Embayment Options	Quantity	Reduction by Technology (Kg/yr)	Remaining to Meet Target (Kg/yr)	Average 20-Year Life Cycle Cost ($/kg N)	Amortized Annual Life Cycle Cost* ($/kg N)	Total 20-Year Cost (5% interest)
A) Permeable Reactive Barrier (PRB)	0 linear feet	0	479	$0	$0	$0
B) Constructed Wetlands (No Collection System)	0 acres	0	479	$200	$16	$0
C) Constructed Wetlands (With Collection System)	0 acres	0	479	$0	$0	$0
D) Phytoirrigation	0 acres	0	479	$10,525	$845	$0
E) Phytobuffers	0 acres	0	479	$10,430	$837	$0
F) Fertigation - Turf	0 acres	0	479	$2,465	$198	$0
G) Fertigation - Cranberry Bogs	0 acres	0	479	$2,155	$173	$0
H) Surface Water Remediation Wetland	0 acres	0	479	$1,712	$137	$0
I) Dredging/Inlet Widening	0 cu. yard	0	479	$200	$16	$0
J) Phytoremediation	0 acres	0	479	$1,095	$88	$0
K) Aquaculture/Oyster Beds	0 acres	0	479	$491	$39	$0
L) Coastal Habitat Restoration	0 acres	0	479	$120	$10	$0
M) Floating Constructed Wetlands	750 sq feet	300	179	$60	$5	$18,000

Alternative On-Site Options	Quantity	Reduction by Technology (Kg/yr)	Remaining to Meet Target (Kg/yr)	Average 20-Year Life Cycle Cost ($/kg N)	Amortized Annual Life Cycle Cost* ($/kg N)	Total 20-Year Cost (5% interest)
A) Ecotoilets (UD & Compost)	15 homes	90	89	$1,045	$84	$94,050
B) UD School or Public Facility	0 people	0	89	$1,045	$84	$0
C) I& A Systems	16 homes	80	9	$4,030	$323	$322,400
D) Enhanced I & A Systems	2 homes	12	-4	$8,390	$673	$100,680

	Quantity	Reduction by Technology (Kg/yr)	Remaining to Meet Target (Kg/yr)	Average 20-Year Life Cycle Cost ($/kg N)	Amortized Annual Life Cycle Cost* ($/kg N)	Total 20-Year Cost (5% interest)
Unattenuated Load Remainder***	0 homes	0	-4	0	0	$0

Costs Using Non-Traditional Method	1,110	$89	$535,130

* Amortized at 5% annual interest over 20 years.

*** This represents that the alternative scenarios reflected meets water quality standards when natural attenuation is factored. If natural attenuation is included, this remainder is removed.

Existing Permitting for Non-Traditional Technologies

Technology/Approach	EPA	ACOE	DEP			BOH	ConComm	MEPA
	MS4	401/404	GWDP	WMA	I&A	Title 5	WPA	Thresholds
Fertilizer Management								
Stormwater BMPs	●						●	○
Constructed Wetlands		○	○				○	○
Pond Dredging		●					●	●
Salt Marsh Restoration		●					●	●
Shellfish Bed Restoration		●					●	●
Phytobuffer							○	○
Fertigation Wells			○	●				●
Shellfish Aquaculture		○					●	●
Perm. React. Barrier							○	○
Inlet Widening		●					●	●
Eco Toilet Systems					●	●		

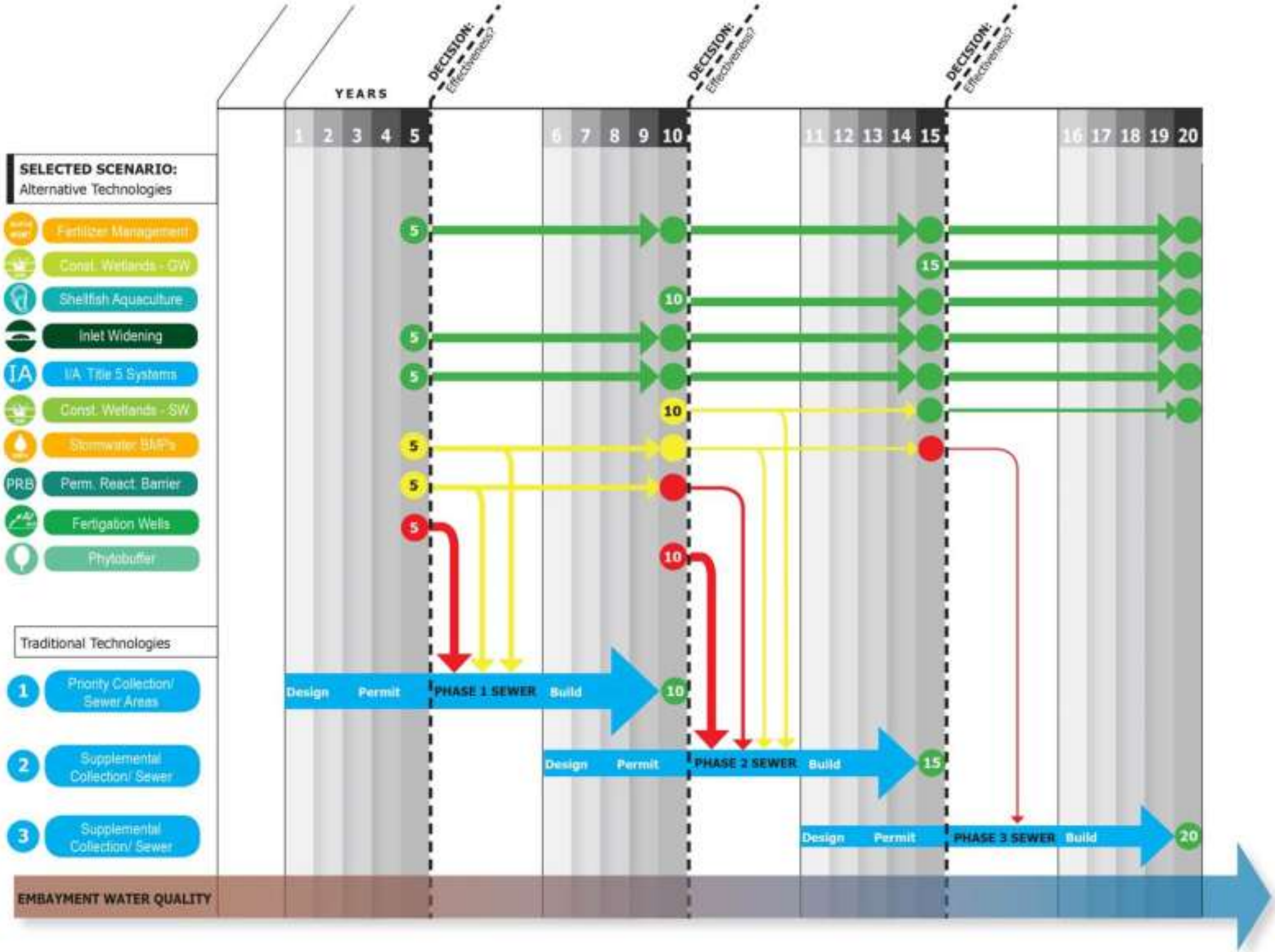
Additional permits may apply. Other agencies involved could include:

- MassDOT
- MA Historical Commission
- MA Natural Heritage and Endangered Species Program
- US Fish & Wildlife Service/MA Division of Marine Fisheries

● **Permit likely required**

○ **Permit may be required, depending on location**

How do you implement adaptive management?



NON-TRADITIONAL TECHNOLOGY MONITORING FRAMEWORK FOR PILOT PROJECTS (PRELIMINARY)

Technology	Monitoring	Frequency
Constructed Wetlands	WQ samples inlet/outlet (N)	Monthly during growing season
Pond Dredging	WQ samples inlet/outlet of pond (N/P)	Quarterly
Salt Marsh Restoration	Area of restoration, wetland types (GIS and field confirmation)	Annually
Shellfish Bed Restoration	Area of restoration/density of shellfish/landings N content of shellfish Denitrification in benthic (N,DO) WQ samples (N)	Annually Annually - composite 20 animals Annually - three locations Monthly during summer -three locations
Phytobuffer	WQ samples inlet/outlet (N)	Monthly during growing season
Fertigation Wells	Pumping volume/rate WQ samples (N)	Monthly Monthly during summer
Shellfish Aquaculture	Annual landings from each grant N content in shellfish	Annually Annually - composite 20 animals
Perm. React. Barrier	2 upgradient/2 downgradient wells – WQ samples (N, DO) Well in media - WQ samples (N, DO, N gas)	Quarterly Quarterly
Inlet Widening	Salinity measurements to confirm model WQ samples at sentinel station	Two tidal cycles Two tidal cycles
Eco Toilet Systems	Numbers/locations/types of installations WQ samples (N/P) - grey water	Running database Quarterly - three locations per watershed

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THANK YOU

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