

Memorandum

To Brian Dudley, MassDEP SERO
George Meservey, Town of Orleans, Director of Planning & Community Development;
Michael Domenica, PE, Town of Orleans, Program Manager

CC Steve Hallem, MassDEP Boston
Kermit Studley, MassDEP SERO
Betsy Shreve, AICP, AECOM Project Director
Mark Owen, AECOM

Subject **Town of Orleans, MA**
Water Quality and Wastewater Planning
Proposed Hydrogeologic Site Evaluation
223 Beach Road Proposed Discharge Area

Project Number 60476644

From Thomas Parece, P.E., AECOM Project Manager

Date November 30, 2015

1. Project Description

The Town of Orleans is in the process of addressing wastewater management and water quality issues caused by excessive nitrate loading surrounding estuaries. The Town is considering both traditional and non-traditional technologies to manage nitrate. Non-traditional technologies proposed include aquaculture, floating constructed wetlands and permeable reactive barriers (PRBs). The traditional technologies being considered at this time include collecting and treating wastewater and discharging the effluent to groundwater. Two areas have been identified for the collection and treatment of wastewater: the Downtown and Meetinghouse Pond areas. The proposal includes an overview of the Orleans Water Quality and Wastewater Management Planning. The project overview is followed by a description of the proposed WWTF and groundwater discharge sites. Also included is a proposal to perform a hydrogeologic investigation and evaluation of the proposed groundwater discharge site for the Downtown area. The proposal details field investigations, data collection and analysis, groundwater mounding evaluation, and a summary of what will be included in the final report.

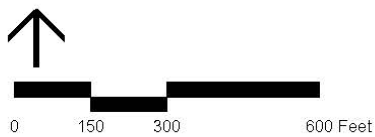
a. Overview

The proposed hydrogeologic site evaluation is being conducted as part of the evaluation of proposed treatment and disposal of sanitary sewage generated in the Meetinghouse Pond Area of Orleans, MA. Proposed treatment will take place at a new facility to be built at 223 Beach Road located in Orleans, Massachusetts or as an alternative at 178 Beach Road both located in Orleans, MA. Proposed discharge will take place at a new facility to be built at 223 Beach Road located in Orleans, Massachusetts (Figure 1). As part of the required Ground Water Discharge Permit (GWDP) (314 CMR 5.00), a hydrogeologic site evaluation is required to evaluate the feasibility of the proposed treated effluent discharge. The findings of this proposed hydrogeologic evaluation will be submitted to the Massachusetts Department of Environmental Protection (MassDEP) prior to and eventually as part of the GWDP for the facility



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Figure 1
Locus Map
Water Quality and Wastewater Planning
223 Beach Road
WWTF and Groundwater Discharge



The design flow of the proposed Wastewater Treatment Facility (WWTF) is to be determined, but is expected to treat and discharge approximately up to 200,000 gallons per day. The WWTF will serve businesses, residents, and other facilities in the Meetinghouse Pond Area and potentially the Downtown Area of Orleans. As the design flow has not been determined, the proposed hydrogeologic evaluation will estimate the groundwater discharge capacity for the site.

b. History and Background

The Town of Orleans developed a Comprehensive Wastewater Management Plan (CWMP) in 2010 to protect surface and groundwater from the nutrient loads associated with on-site wastewater systems, increased development and seasonal flux population. In 2012 the recommendations in the CWMP did not receive the required votes at Town Meeting to be implemented. The plan was brought before the town in 2013, but again there were insufficient votes to implement.

In 2014, the Town convened the Orleans Water Quality Advisory Panel (WQAP) to guide studies and assessments, and define preferred approaches for a customized, affordable water quality management plan for the Town of Orleans. In March 2015 the WQAP agreed on an Amended Water Quality Management Plan and Adaptive Management Plan (Consensus Plan) for improving water quality in Orleans' natural water systems to meet nitrogen reduction targets and other key requirements of local, regional, State and Federal regulations.

The Consensus Plan includes implementing a combination of traditional and non-traditional technologies. Non-traditional technologies proposed include aquaculture, floating constructed wetlands and permeable reactive barriers (PRBs). The Consensus Plan includes the construction of demonstration projects of each of these non-traditional technologies. These demonstration projects would be designed and built in order to test hypotheses of nitrogen reduction through the use of these alternative technologies, which can then be used to estimate full implementation size and costs. As such, the Consensus Plan minimizes the number of properties within Orleans to be sewered by maximizing the use of non-traditional technologies. A copy of the Consensus Plan showing the location of the proposed sewer and demonstration areas is provided in Appendix A.

The traditional approach proposed within the Consensus Plan delineates two areas within Orleans for sewer implementation:

- Downtown Area - The Downtown Area, encompassing approximately 280 parcels, is estimated to generate approximately 100,000 gpd of domestic wastewater. The proposed facility will treat approximately 145,000 gpd, including 100,000 gpd of domestic wastewater from the Downtown Area and up to 45,000 gpd of septage. The new treatment facility will include tertiary treatment processes and is expected to have effluent concentrations of 10 mg/L of nitrate (N), 30 mg/L total suspended solids (TSS), and 30 mg/L biological oxygen demand (BOD).
- Meetinghouse Pond Area - The Meetinghouse Pond watershed area, encompassing approximately 360 parcels, is estimated to generate approximately 50,000 GPD of domestic wastewater to be treated at a satellite treatment facility and disposed at locations yet to be identified.

The proposed Hydrogeologic Site Evaluation will focus only on the discharge for the Meetinghouse Pond Area. A proposal for the Downtown Area will be submitted separately.

c. Site Description – 223 Beach Road

The 223 Beach Road site consists of five contiguous parcels owned by the Town of Orleans (Figure 2). The parcels total approximately 8.65 acres. The design of the proposed wastewater treatment facility (WWTF) is yet to be determined.

The elevation of the proposed discharge is approximately 40 to 47 feet above mean sea level (msl). The depth to groundwater is expected to be in excess of 35 feet. Groundwater below the site flows in an easterly direction towards the Atlantic Ocean. Therefore the nitrogen load in the effluent does not recharge the Meetinghouse Pond watershed and thereby reducing the watershed nitrogen load. The Atlantic is over 1,000 feet east of the site. Soils underlying the site are mapped as outwash sands and gravel.

The new WWTF will be constructed to treat wastewater flow from the Meetinghouse Pond Area and potentially the Downtown Area. A disposal facility on this site would consist of subsurface leaching trenches or sand beds (Figure 2). The discharge method selected will be based on the results of the hydrogeologic evaluation. If wicks are considered for discharge, MassDEP will be notified should additional hydrogeologic evaluation measures be necessary.

2. Proposed Hydrogeologic Evaluation

a. Test Pit Investigation

It is anticipated that a minimum of six test pits will be excavated in the proposed discharge area shown on Figure 2. Percolation tests will be conducted by a Certified Soils Evaluator at each location. The MassDEP and the Town of Orleans Health Department will be contacted to schedule their availability for witnessing the excavation of the proposed test pits.

b. Soils Testing and Data Analysis

To date, there have been no soil borings or monitoring wells installed at the proposed discharge site. Approximately four soil borings are proposed to be drilled using direct push drilling methods. The soil borings will be advanced to a depth of approximately 10 to 15 feet below the water table with split spoon samples collected every five feet. At one or two locations, the soil boring will be extended to depths of 25 to 40 below the ground surface to further evaluate the subsurface soils. If refusal occurs prior to reaching the water table, the borehole will be abandoned and a new location 10 to 15 feet from the proposed location will be drilled. The soil borings will be drilled in accordance with MassDEP's "Standard References for Monitoring Wells".

Three of the soil borings will be converted to monitoring wells by installing 2-inch diameter PVC well casing with ten feet of 10-slot well screen at the base. The bottom of the well screen will be installed a maximum of 15 feet below the water table. The wells will serve to collect water level data, collect water samples, conduct slug tests and eventually as up and downgradient monitoring wells. Each monitoring well will be surveyed for location and elevation (NGVD). Water levels will be measured and recorded at each location to determine the groundwater elevation, flow direction and horizontal gradient across the discharge area.

c. Slug Testing and Data Analysis

Slug tests will be performed on each monitoring well where there is a sufficient thickness of saturated soils. Slug tests consist of measuring the recovery of water levels in a well after a near-instantaneous change in head. The slug tests will be performed using a cylinder to displace the water in the well with a submersible pressure transducer connected to a data logger used to

record the water level response over time. Analysis of the slug test data will provide an additional estimate of horizontal hydraulic conductivity at each monitoring well location.



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Approximate Discharge Area

- ◆ Proposed Monitoring Well
- ⊗ Proposed Soil Boring
- ⊠ Proposed Test Pit

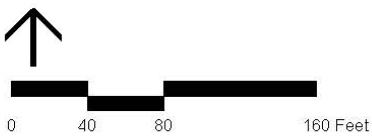


Figure 2
Site Map
Water Quality and Wastewater Planning
223 Beach Road
WWTF and Groundwater Discharge

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d. Baseline Water Quality Analysis

A round of groundwater samples will be collected from each of the proposed monitoring wells to provide baseline water quality data. Groundwater samples will be sent to a MassDEP approved laboratory and will be analyzed for pH, specific conductance, temperature, total nitrate, nitrate, nitrite, ammonia, phosphorus, orthophosphate, chloride, sodium and volatile organic compounds (VOCs).

e. Estimate of High Water Table

Once installed, a water level will be measured at the wells at the site and USGS monitoring wells BMW-22. The USGS wells are installed in similar aquifer material and located in Orleans and Brewster, respectively. The water table elevations measured at the site will then be adjusted to reflect the historic high water table conditions at the USGS well. Once the high water table elevations have been estimated, the values obtained from the groundwater mounding calculations will be added, resulting in groundwater mound elevations across the site during high water table conditions.

f. Estimated Groundwater Mounding

Data obtained from the site investigations will be analyzed and used to design a numerical groundwater flow model to simulate groundwater flow in the vicinity of the proposed discharge. The groundwater flow model will use MODFLOW, developed in 1988 by McDonald and Harbaugh of the US Geological Survey (USGS), to compute groundwater flow in an aquifer under different stressors. Once calibrated, groundwater mounding resulting from the discharge of wastewater will be simulated. The model will also be used to estimate the groundwater flow direction, design the base elevation of the proposed wastewater discharge, assess potential impacts to sensitive receptors, and evaluate the discharge capacity of the site and watershed(s) being discharged to.

g. Final Report

A Hydrogeological Evaluation Report will be prepared which will summarize the results of the field investigations, data analysis, laboratory results, groundwater mounding analysis, numerical model documentation, and potential impacts to sensitive receptors. Included will be USGS topographic and surficial geology maps, pertinent USGS geologic and hydrogeologic data, estimated depth to bedrock, the location of existing and potential water supply areas within a half-mile of the site, water supply protection areas, and pertinent subsurface investigations conducted at nearby sites.

The report will also identify watershed recharge areas and boundaries, assess potential impacts of nitrogen and/or phosphorus to receiving waterbodies, and estimate the additional nutrient load to the receiving watershed(s). The groundwater model results will include the lateral extent of the groundwater discharge, separation between the base of the discharge and the mounded water table under high water table conditions, groundwater travel times, and potential impacts on watershed(s), infrastructure, and potential sensitive receptors.

The final report will include a groundwater monitoring plan and will be submitted with permit application BRP WP 83 "Hydrogeologic Evaluation Report Guidance" at the conclusion of the evaluation in support of a Groundwater Discharge Permit.

APPENDIX A

Town of Orleans, MA - Consensus Plan

**Orleans Water Quality Advisory Panel
 Consensus Agreement of the OWQAP
 March 11, 2015***

The Orleans Water Quality Advisory Panel, or OWQAP, was convened to guide studies and assessments, define preferred approaches, seek consensus and build widespread community support for a customized, affordable water quality management plan for the Town of Orleans. The panel consists of **stakeholder representatives** (Orleans Selectmen and representatives of engaged citizen constituencies), and **liaisons** from key town boards and commissions, organizations, neighboring towns, and regional, state, and federal partners. It is staffed and assisted by Water Resources Associates, Stantec and its consultants, and the Consensus Building Institute (CBI).

The OWQAP has met for twelve half-day meetings since July 2014, all of which were open to public attendance and comment. After examining a broad range of options, the Panel has reached agreement on a set of principles and some key elements of an Amended Water Quality Management Plan (the Plan) and associated Adaptive Management Plan¹. This Agreement includes and requires successful completion of the steps described here to resolve uncertainties and confirm key elements, such as treatment and disposal site suitability and availability, development of demonstration sites for non-traditional (NT) technologies, and further work to find an equitable distribution of costs necessary to the development of an acceptable and executable engineering plan that adheres to the key elements.

Agreed Goals and Objectives:

- 1) The Plan seeks to **improve water quality in Orleans’ natural water systems, meet nitrogen reduction targets** and other key requirements of local, regional, State and Federal regulators, including finalized and preliminary TMDLs, while supporting updating of the analysis of current water quality conditions and MEP model runs. The Plan includes **flexibility** within an adaptive management framework to allow changes in the implementation plan to respond to any new findings from these updated analyses and resolution of other uncertainties.
- 2) In addition to needed nitrogen reduction, the Plan seeks to control phosphorous impacts on freshwater systems, address sanitary requirements, and respond to commercial and residential wastewater needs. The Plan also seeks to restore natural ecosystem services² using in-situ NT water quality solutions that offer rapid restoration, improve water and sediment quality, and restore habitat health.
- 3) The Plan also seeks affordability and fairness in its distribution of costs, by developing a detailed Financial Plan for allocations of costs, as well as a commitment to working together to identify and pursue all sources of grants and other financial support.

Agreed Plan Approach and Key Elements:

- 4) Given the potential benefits of NT technologies for **removing nitrogen and phosphorous** and providing valuable ecosystem services with more rapid results and at lower cost than traditional collection systems, the intent of the Plan is to maximize the use of **Coastal Habitat Restoration³(CHR), Aquaculture⁴, Floating Constructed Wetlands⁵(FCW), Permeable Reactive**

¹ This Plan will amend the approved CWMP approved by the Cape Cod Commission and MassDEP in 2011.
² Natural symbiotic processes conducted by one species and benefitting other(s).
³ Creating habitats including shellfish reefs (such as the oyster reefs created in Wellfleet) that restore natural ecosystem services in the water body. The shellfish remove nitrogen from the water, and a bio-diverse ecosystem of many other species also contribute to nitrogen reduction. The reefs support young fish, crabs and other bottom dwelling animals, and sustain or restore the submerged aquatic vegetation (SAV) and benthic conditions necessary for natural habitat functions.

OWQAP Consensus Agreement
 *This Agreement text was refined and finalized on March 16, 2015

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Barriers⁶ (PRBs) and other approaches (e.g., inlet management) as strategies for meeting water quality goals. While there are risks and much to learn about these technologies, the *Conceptual Approach to Meet Orleans Water Quality Goals Map* estimates technologies and sizes within each watershed that could reasonably be implemented to help meet TMDLs and water quality needs. If fully successful, this could include realizing up to two-thirds of the Town’s nitrogen reduction using NT technologies. A first phase of work to further evaluate the effectiveness, costs, risks, and opportunities for these NTs will be to select, design, and implement a series of demonstration projects. The findings from demonstration projects will be used to determine locations and areal extents of NT solutions, as well as their expected costs and contributions to nitrogen and phosphorous removal goals.

- 5) The Plan reduces the sewered footprint (area of town and number of properties to be sewered) to a minimum by maximizing the use of the non-traditional technologies referenced above. The Conceptual Approach delineates two footprints within Orleans for implementation of sewers. These areas include 1) ~280 parcels encompassing Downtown Orleans (~100,000 GPD), to be treated at a new treatment plant located at the Tri-Town site and disposed at one of several prospective sites nearby (potentially also using a reclaimed water system), and 2) ~360 parcels within the Meetinghouse Pond sub-watershed (~50,000 GPD), to be treated at a satellite treatment facility and disposal area to be identified. These areas were designated for wastewater collection and treatment because their nitrogen reduction requirements and wastewater needs could not be met using only NT technologies. The Downtown area includes numerous properties with aging and/or non-compliant systems and inadequate nitrogen reduction, which cannot be cost effectively retrofitted to meet current wastewater needs. Certain newer facilities may be “grandfathered” for some limited period of time. Options utilizing small cluster plants downtown were found not to have an economic advantage and the additional complexity involved in ownership, operation and maintenance of several small plants was a significant disincentive. Satellite or cluster treatment plants are valid wastewater treatment options in the appropriate circumstances and will be evaluated for other locations within Orleans.
- 6) In Meetinghouse Pond watershed, 100% nitrogen removal is required. Technology performance limitations and land use constraints in Meetinghouse Pond prevent deployment of sufficient NT solutions to meet those needs. The Plan includes siting a satellite treatment plant for the Meetinghouse Pond watershed.
- 7) The new treatment facility will be designed to treat septage from the towns currently served by the existing Tri-Town Septage Treatment Plant, as well as the wastewater from the downtown Orleans area only. Septage storage and treatment capacities will be evaluated for appropriate sizing, to avoid competition based on tipping fee / price. This will allow the town to continue to meet the septage treatment needs of the businesses and residents of Orleans and the Lower/Outer Cape, while generating net positive revenue that will lower customer rates in Orleans. Revenues from septage treatment will be allocated to those parties who contribute to the capital cost and Orleans will seek compensation for providing nitrogen treatment and disposal for flows from out-of-town customers.

⁴ Shellfish farming: the shellfish are filter feeders that remove nitrogen from the water system. The shellfish are harvested for market.

⁵ Floating structures filled with plants that use nitrogen and other nutrients from the water to grow.

⁶ PRBs intercept groundwater before it reaches the coastal water system and provide the necessary conditions for the conversion of nitrogen compounds to harmless nitrogen gas. The process is called denitrification.

**Orleans Water Quality Advisory Panel
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- 8) The Plan includes an Adaptive Management Plan (AMP), which will provide a detailed approach to monitoring the success and efficacy of each component of the Plan and a framework and methodology for evaluating and adjusting solutions over time, with back-up technologies (including possibly additional sewerage) to ensure compliance with regulatory requirements for water quality. The AMP will also provide for continued coordination with regulatory agencies to confirm compliance of the Plan with monitoring standards and water quality requirements, and continued monitoring of the financial and economic impacts of the plan on residents and businesses of Orleans. The AMP will also provide a framework for selecting, implementing and evaluating NT demonstration projects to refine initial assumptions about effectiveness, cost, and other implementation considerations. The *Conceptual Approach to Meet Orleans Water Quality Goals* will be updated and refined based on information developed through demonstration projects and other studies and analyses.
- 9) The Plan and AMP will seek to capitalize upon opportunities for potential management synergies and cost savings through cooperation with Orleans’ neighboring towns of Eastham and Brewster.

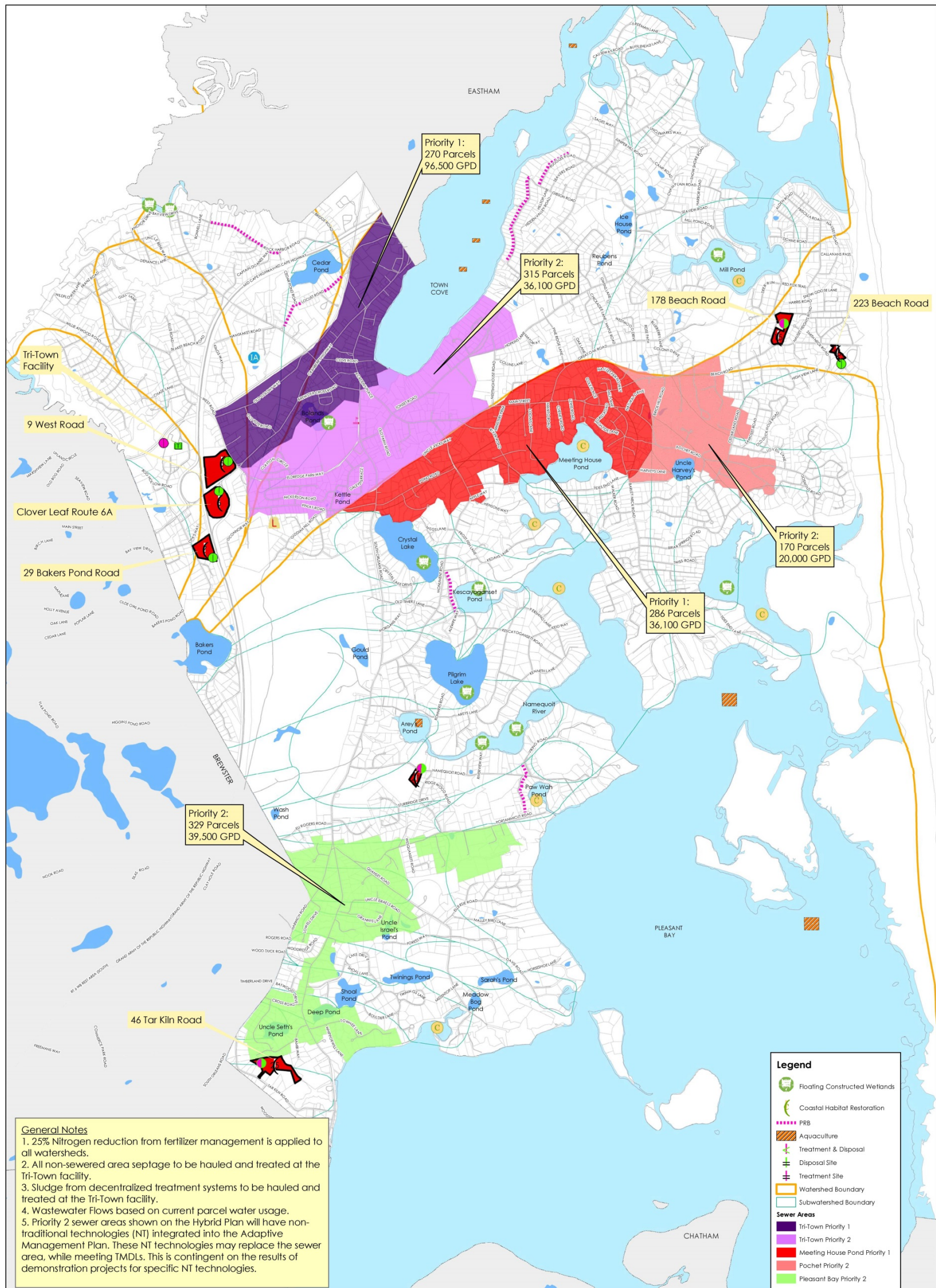
OWQAP Commitment:

- 10) By agreeing to these principles and key features of an Amended Water Quality Management Plan, OWQAP Stakeholder Representatives endorse the goals, objectives, approach, and key elements as described above, and commit to support Warrant Articles, By-laws, and other Town measures to pursue and implement the Plan and its underlying principles. Representatives also agree to inform and engage their full stakeholder groups and related constituencies about these components and principles.
- 11) OWQAP Stakeholders also agree to work to refine and implement Adaptive Management in a manner consistent with these principles and with the Plan, and to work collaboratively to address challenges encountered in the process of resolving uncertainties in the Plan and to work collaboratively to finalize an executable engineering plan that is consistent with the principles of the Plan.

CONSENSUS of the Orleans Water Quality Advisory Panel is defined in their approved Operating Protocols as unanimous concurrence of the Stakeholder Representatives, representing their constituencies. Members may also “abstain.” Abstaining means not offering consent or endorsement, but also not blocking an agreement. Abstaining members are not counted in determining if consensus has been reached.

- Sims McGrath, Orleans Selectman
- Alan McClennen, Orleans Selectman
- David Dunford, Orleans Selectman
- Jon Fuller, Orleans Selectman (in absentia)
- Judith Bruce, on behalf of the Former CWMP Committee
- Dale Fuller, on behalf of the Orleans Taxpayers Association
- Jim McCauley, on behalf of the Orleans Pond Coalition
- Sid Snow, on behalf of the Orleans Chamber of Commerce
- Jeff Eagles, on behalf of the Orleans Water Alliance
- Doug Fromm, on behalf of Orleans CAN
- Peter Haig, on behalf of the Orleans Community Partnership
- Abstention by Mark Fiegel, on behalf of the Citizens Peer Review Committee

OWQAP Consensus Agreement
 *This Agreement text was refined and finalized on March 16, 2015





Stantec

JANUARY, 2015

REVISED ORLEANS INITIAL HYBRID MAP

TOWN OF ORLEANS
MASSACHUSETTS