Water Resources

This guidance is intended to clarify how the Water Resources Goal and Objectives of the Regional Policy Plan (RPP) are to be applied and interpreted in Cape Cod Commission Development of Regional Impact (DRI) project review. This technical bulletin presents specific methods by which a project can meet the goal and objectives.

Water Resources Goal: To maintain a sustainable supply of high quality drinking water and protect, preserve or restore the ecological integrity of Cape Cod's fresh and marine surface water resources.

- ***Objective WR1*** *– Protect and preserve groundwater quality*
- ***Objective WR2*** *– Protect, preserve and restore fresh water resources*
- ***Objective WR3*** *– Protect, preserve and restore marine water resources*
- ***Objective WR4*** *– Manage and treat stormwater to protect and preserve water quality*
- ***Objective WR5*** *– Manage groundwater withdrawals and discharges to maintain hydrologic balance and protect surface and groundwater resources*

The applicability and materiality of these goals and objectives to a project will be determined on a case-by-case basis considering a number of factors including the location relative to Water Resource Areas, context (as defined by the Placetype of the project's location), scale, use, and other characteristics of a project.

THE ROLE OF CAPE COD PLACETYPES

The RPP incorporates a framework for regional land use policies and regulations based on local form and context as identified through categories of Placetypes found and desired on Cape Cod.

The Placetypes are determined in two ways: some are depicted on a map contained within the RPP Data Viewer located at www.capecodcommission.org/RPPDataViewer adopted by the Commission as part of the Technical Guidance for review of DRIs, which may be amended from time to time as land use patterns and regional land use priorities change. The remainder are determined using the character descriptions set forth in Section 8 of the RPP.

The project context, as defined by the Placetype of the project's location, provides the lens through which the Commission will review the project under the RPP.

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INTRODUCTION

Cape Cod's water resources include fresh and marine waters as well as natural and built systems. The Cape Cod Aquifer, which serves as the primary link between all of the water resources on Cape, is relied upon to provide drinking water and wastewater disposal capacity for the human population, plays an integral role in maintaining plant and animal habitat in marine and freshwater settings, and ultimately underlies many of the scenic and recreational opportunities that serve as the primary economic driver for the region. Consistent with the Cape Cod Area Wide Water Quality Management Plan (the "208 Plan"), maintaining the integrity and health of the aquifer and the various systems connected to it while encouraging provision of water resource infrastructure and growth that is appropriate in form and location is the primary purpose of the Water Resources goal and objectives.

This Technical Guidance provides examples of various methods and strategies that DRI projects may use to satisfy the Water Resources Goal and Objectives of the RPP. Through implementation of these methods and strategies, DRI projects can support the protection of critical water resources through development that is consistent with the vision for the region. Although the majority of methods discussed in this Technical Guidance are intended to be flexible, certain methods will be required of all DRIs where a particular Water Resources objective is applicable.

DEFINITIONS

Best Management Practice (BMP): Structural or procedural control measures implemented to reduce the quantity and velocity of stormwater runoff, and improve water quality.

Contributing Area to Ponds (CAPs): This designation combines two areas, the Freshwater Recharge Area and the upgradient 300 foot buffer to ponds. It is an area in which land use and land-based activities are presumed to have a deleterious impact on pond water quality and ecology.

Environmentally Sensitive Site Design (ESSD): A design that incorporates Low Impact Development techniques or practices to prevent the generation of stormwater and non-point source pollution by reducing impervious surfaces, disconnecting stormwater sheet flow paths and treating stormwater at its source, maximizing open space, minimizing disturbance, protecting natural features and processes, and / or enhancing wildlife habitat.

Fresh Water Recharge Area (FWRA): Watershed area that contributes to a fresh water pond as defined by the topography of the water table.

Hazardous Material: Hazardous Materials as defined and regulated under the Massachusetts State Sanitary Code (105 CMR 480.00). Examples include petroleum products, petroleum distillates, organic and inorganic solvents, oil-based paints, oil-based stains, insecticides, herbicides, rodenticides, and pesticides.

Hazardous Substance: Any chemical or substance that when released into the environment will pose a significant contaminant threat to groundwater and drinking water supplies. Hazardous substances include Hazardous Materials and Hazardous Wastes.

Hazardous Substances, Household Quantity of: Quantities less than the following limits are considered Household Quantities:

- 275 gallons of oil on site at any time to be used for heating of a structure, or to supply an emergency generator
- 25 gallons or equivalent dry weight, total, of Hazardous Material(s) on site at any time (excluding oil as classified in part (a))

- 55 gallons of Hazardous Waste generated at the Very Small Quantity Generator level as defined in Massachusetts Hazardous Waste Regulations (310 CMR 30.000) and accumulated or stored on-site at any time.

Hazardous Waste: Any Hazardous Waste, Universal Waste, or Waste as defined in the Massachusetts Hazardous Waste Regulations (310 CMR 30.010), not including Hazardous Materials or biomedical wastes regulated under the Massachusetts State Sanitary Code (105 CMR 480.00).

Impaired Area: Impaired Areas are where groundwater may have been degraded by point and non-point sources of pollution, including but not limited to areas with unsewered residential developments with an average lot size of less than 20,000 square feet; landfills, septage, and wastewater treatment plant discharge sites; and areas of high-density commercial and industrial development and those downgradient areas where groundwater may have been degraded by those sources.

Impervious Area: Land area that is covered by surfaces which do not permit precipitation to naturally recharge. Typically includes paved surfaces, roadways, parking areas, hard-packed gravel, and rooftops.

Infill: Development of new housing, commercial, or other amenities on scattered or discontinuous sites within existing substantially built-up areas.

Low Impact Development (LID): Innovative stormwater management systems that are modeled after natural hydrologic features. LID manages rainfall at the source using uniformly distributed, decentralized, micro-scale controls. LID uses small, cost-effective landscape features located at the lot level. LID takes the form of techniques (e.g., porous pavement) or practices (e.g., reduced front yard setback).

Marine Water Recharge Area (MWRA): Watershed area that contributes to a marine embayment as defined by the topography of the water table, and determined by United States Geological Survey (USGS) modeling as part of the Massachusetts Estuaries Project (MEP)

Potential Public Water Supply Area (PPWSA): Land identified as suitable for the development of public water supplies.

Scientific Evaluation: Defined by MassDEP and set forth in the regulations at 310 CMR 15.002 and 15.214.

Stormwater Control Measure (SCM): Structural or non-structural action taken to control the rate, volume, and/or pollution of stormwater.

Wetland Area: For the purposes of the nitrogen loading calculation worksheet, an area that does not infiltrate stormwater runoff because it is "wet." Including areas such as wet meadows, marshes, swamps, bogs, and areas of flowing or standing water, such as rivers, streams, ponds, and lakes, or a coastal area including beaches, intertidal areas, salt marshes, and land under the ocean.

Wastewater Treatment Facility (WWTF): Wastewater treatment and collection systems that are designed to treat flows greater than 10,000 gallons per day.

Wellhead Protection Area (WHPA): Lands receiving precipitation that contribute to the recharge of public drinking water supply wells are considered Wellhead Protection Areas (WHPA). These include MADEP approved Zone IIs, interim wellhead protection areas, and certain town delineated water protection districts that extend beyond the Zone II limits.

SUMMARY OF METHODS

GOAL | WATER RESOURCES

To maintain a sustainable supply of high quality drinking water and protect, preserve or restore the ecological integrity of Cape Cod's fresh and marine surface water resources.

Objective WR1 – Protect and preserve groundwater quality

METHODS

All DRIs must:

- Limit site-wide nitrogen loading to a maximum concentration of 5 parts per million (ppm) except as provided below for Impaired Areas and Potential Public Water Supply Areas (PPWSAs)
- Not adversely impact downgradient existing or proposed drinking water wells
- Site septic systems and other sources of contamination to avoid adversely impacting downgradient existing or proposed drinking water wells
- Review existing Environmental Site Assessment(s) as available for previously developed properties and incorporate findings into project design

All DRIs should, to the greatest extent feasible:

- Utilize site design and operational best practices to preserve groundwater quality

For projects in an Impaired Area (see RPP Data viewer):

- If proposed site-wide nitrogen loading concentration exceeds 5 ppm, demonstrate no adverse impact on public or private drinking water supply wells, and potential water supply wells

All projects proposing private wastewater systems designed for flows greater than 2,000 gallons per day (gpd) and requiring greater treatment efficiency than specified by Massachusetts Department of Environmental Protection (MassDEP) permit or approval letter must:

- Enter into an Operation, Monitoring, and Compliance agreement with the Cape Cod Commission and local Board of Health

All Wastewater Treatment Facility DRIs must:

- Consistently achieve 5 ppm or lower total nitrogen in wastewater effluent or in groundwater at downgradient property boundary
- Utilize wastewater treatment facilities to protect and/or restore ground water quality provided that such facilities will not adversely impact water or other natural resources

For projects in areas where mapped Potential Public Water Supply Areas are present:

- Site-wide nitrogen loading concentration must be less than 1 ppm
- Site development should be minimized and designed to avoid the mapped PPWSA
- An analysis of the impacts of the proposed site plan on potential future well siting is required

All DRIs within Wellhead Protection Areas (WHPAs) or Potential Public Water Supply Areas (PPWSAs) (see WHPA and PPWSA layers in the RPP Data Viewer) must employ the following methods as applicable to meet Objective WR1:

- All development, construction, clearing, and staging occurs at least 400 feet from identified future well sites
- Locate site development within the project area to preserve the 400 foot radius around areas suitable for future public supply wells
- Provide secondary containment for 110% of potentially hazardous fluid volume plus an additional volume to include the 100-year storm event over a 24-hour period
- Projects with elements that carry a high risk of contaminating groundwater, such as fleet storage, vehicle maintenance areas and loading docks, must locate those elements outside of WHPA / PPWSA when possible. When site constraints prevent locating these elements outside WHPA/PPWSA, projects must include a mechanical shut-off valve or other flow-arresting device in stormwater systems between the stormwater capture structures and the leaching structures. Additional requirements for stormwater management are detailed in Objective WR4.
- Do not use, treat, generate, handle, store or dispose of Hazardous Substances, in excess of Household Quantities, except under the following circumstances:

    - Reduce the quantity of Hazardous Substances on the site of redevelopment projects from the prior use and adequately document that reduction
    - Permanently eliminate the same or greater quantity of Hazardous Substances at another facility, project, or site within the same WHPA or PPWSA and adequately document that reduction
- Do not discharge effluent from private wastewater treatment facilities, unless private wastewater treatment facilities remediate existing water quality problems in the water supply area
- Employ integrated pest management and/or biorational landscape management practices (per the detailed methods) protective of water quality for non-residential development and redevelopment
- Minimize impervious surfaces of roadway and parking area designs and materials

METHODS TO MEET OBJECTIVE WR1

METHOD:	DRIS IN IMPAIRED AREAS	DRIS IN PPWSA	DRIS IN WHPA	ALL WWTF DRIS	ALL PRIVATE WW SYSTEMS W/ FLOWS > 2,000 GPD
All DRIs Must (as indicated):					
Limit site-wide nitrogen loading to ≤ 5 ppm	x		x	x	x
Not impact downgradient drinking water wells	x	x	x	x	x
Site septic systems to avoid adversely impacting downgradient drinking water wells	x	x	x	x	x
Review existing Environmental Site Assessment(s)	x	x	x	x	x
If site-wide nitrogen loading concentration exceeds 5 ppm demonstrate no adverse impact on drinking water wells	x				
Site-wide nitrogen loading concentration must be less than 1 ppm		x			
Site development should be minimized and designed to avoid the mapped PPWSA		x			
An analysis of impacts of proposed site plan on drinking water well siting		x			
All development, construction, clearing and staging occurs > 400 ft from well sites		x	x		
Locate site development w/in project site to preserve the 400-ft radius around wells		x	x		
Provide secondary containment for 110% of hazardous fluid volume plus additional volume to include the 100-yr, 24-hr storm event		x	x		
Projects with high risk of contaminating GW must locate those elements outside of WHPA/PPWSA		x	x		
Do not use, treat, generate, store, or dispose of hazardous substances in excess of household quantities*		x	x		
Do not discharge effluent from private WWTF*		x	x		
Employ integrated pest management and / or biorational landscape management practices protective of water quality		x	x		
Minimize impervious surfaces of roadway and parking		x	x		
Consistently achieve ≤ 5 ppm nitrogen in wastewater effluent				x	
Utilize WWTF to protect and/or restore groundwater quality				x	
Enter into Operations, Monitoring, and Compliance agreement w/ Cape Cod Commission and Board of Health					x
All DRIs Should:					
Utilize site design and operational best practices to preserve groundwater quality	x	x	x	x	x
** see exceptions in WR TB pg 9-10*					

Objective WR2 – Protect, preserve and restore fresh water resources

METHODS

All DRIs within a Contributing Area to Ponds (CAPs), which includes the recharge area to ponds (Freshwater Recharge Area, where they are delineated) and the 300 foot buffer area upgradient of a pond, as defined by groundwater contours, must employ the following methods as applicable to meet Objective WR2:

- Prevent loading of nutrients and other contaminants to fresh water resources from new development
- Maintain or reduce loading from nutrients and other contaminants to fresh water resources from redevelopment
- Maintain, increase, or enhance vegetated buffer zones along shorelines to ponds and lakes. See Cape Cod Freshwater Pond Buffer Guidance for reference.

All projects within a CAP where wastewater disposal is proposed must maintain a 300 foot buffer to the high water level of a freshwater pond unless they demonstrate that phosphorus transported by groundwater does not discharge into the pond or its tributaries.

Discharges of wastewater effluent over 2,000 gallons per day proposed anywhere in the recharge area to a freshwater pond must evaluate the impacts of wastewater discharge on pond water levels, and potential phosphorus transport by groundwater to the pond.

Objective WR3 – Protect, preserve and restore marine water resources

METHODS

All DRIs in a Marine Water Recharge Area (MWRA) where a critical nitrogen load has been determined through either a Total Maximum Daily Load, Massachusetts Estuaries Project (MEP) Technical Report, or other Scientific Evaluation (accepted by MassDEP) showing nitrogen impacts or impairment, or as defined by MassDEP's Natural Resource Nitrogen Sensitive Areas (NRNSA) must:

- Not add nitrogen mass (on a kg-N per year basis) to a MWRA unless:

    - There is a MassDEP Watershed Permit or locally adopted nutrient management plan, deemed consistent with the 208 Plan by the Cape Cod Commission, in the sub-watershed in which the project is proposed, and the approved nutrient management plan calls for initiation of nutrient reduction actions or strategies sufficient to offset nutrient contribution(s) from the project within five years of project approval; or
    - The project is in an area with available sewer connections, or is in a Placetype where nitrogen additions may be offset through a monetary contribution to address water quality problems in the affected surface waters.
- Improve on existing conditions by reducing project nitrogen mass loading for a redevelopment project

Projects in areas subject to a MassDEP-approved wastewater or watershed permit must:

- Further the goals of applicable local nitrogen management plan(s)

DRIs in a MWRA not meeting the above conditions must employ one or more of the following methods to meet Objective WR3:

- Not contribute additional nitrogen mass
- Connect project to sewer
- Remove an equivalent amount of nitrogen from the same subwatershed to offset the new nitrogen generated by the project
- Provide a monetary offset if allowed in the applicable Placetype (see list below)

To meet Objective WR3 all DRIs in a MWRA where there are water quality problems that have been documented in a MassDEP-accepted scientific study and a critical load has not been determined must:

- Maintain or reduce nitrogen mass amount relative to existing levels using the best available nitrogen reducing technology, including I/A systems approved by MassDEP for general use, provisional and pilot use, provided they perform as well as or better than the best performing general use systems

OBJECTIVE WR3 AREAS OF EMPHASIS BY PLACETYPE

Natural Areas | Development is discouraged in Natural Areas and monetary N-offsets are not permitted.

Rural Development Areas | Nutrient reduction actions are generally not anticipated in rural areas due to low development density, therefore monetary N-offsets are not permitted.

Suburban Development Areas | Monetary N-offsets may be permitted in Suburban Development Areas at Commission's discretion.

Historic Areas | Monetary N-offsets may be permitted in Historic Areas at Commission's discretion.

Maritime Areas | Monetary N-offset are permitted in Maritime Areas where sewer is not yet available.

Community Activity Centers | Monetary N-offsets are permitted in Community Activity Centers where sewer is not yet available.

Industrial Activity Centers | Monetary N-offset are permitted in Industrial Activity Centers where sewer is not yet available.

Military and Transportation Areas | Monetary N-offset are permitted in Military / Transportation Areas where sewer is not yet available.

* The nitrogen offset rate is based on cost efficiencies associated with wastewater collection and municipal treatment as described in Appendix C.

Objective WR4 – Manage and treat stormwater to protect and preserve water quality

METHODS

All DRIs must employ the following methods to meet Objective WR4:

- Provide a stormwater management system that prevents adverse impacts to water resources and other natural resources.
- Prevent discharge of untreated stormwater to marine and fresh surface water and natural wetlands by treating runoff from development, including areas located outside the jurisdiction of the Massachusetts Wetlands Protection Act.
- Locate new infiltration to maintain a minimum two foot separation between points of infiltration and the maximum high water table.

All DRIs, with the exception of redevelopment projects as discussed below, must employ the following methods to meet Objective WR4:

- Design stormwater systems according to the Massachusetts Stormwater Handbook to at a minimum: 1) accommodate the 100 year 24-hour storm, 2) remove at least 90% total suspended solids (TSS), 3) remove at least 60% of total phosphorus (TP), and 4) remove at least 44% total suspended solids prior to discharge into subsurface leaching facilities
- Provide storage and water quality treatment capacity for at least the first inch of stormwater runoff from impervious area using biofiltration, bioretention, or other Environmentally Sensitive Site Design (ESSD) and Low Impact Development (LID) techniques as detailed in the most recent version of the Massachusetts Stormwater Handbook, unless impracticable
- Site stormwater systems as far as possible from surface water bodies to avoid issues of shallow depth to groundwater and direct discharge to nearby water bodies

Redevelopment projects must:

- Improve site conditions to enhance stormwater retention, water quality treatment, and recharge over existing conditions
- Remove at least 80% TSS
- Remove at least 50% TP
- Include natural areas in stormwater system design, and utilize LID stormwater controls that add greenspace to project site

For Projects within WHPA or PPWSA

- Stormwater systems must include a mechanical shut-off valve or other flow-arresting device between the stormwater capture structures and the leaching structures

OBJECTIVE WR4 AREAS OF EMPHASIS BY PLACETYPE

Natural Areas and Rural Development Areas | Prioritize protection of mature trees and wooded areas and utilize natural drainage features to manage stormwater. Minimize construction footprint, land disturbance during and after construction, and impervious area creation to maintain natural filtration and recharge processes. Use

LID features that provide water quality treatment during storm events and provide environmental or recreational function at other times, and optimize SCMs to remove nutrients of interest to applicable water resources For example, target removal of nitrogen if near a saltwater resource, or phosphorus if near a freshwater resource.

Suburban Development Areas | Cluster development to maximize contiguous natural areas. Minimize stormwater runoff by reducing road/driveway widths and using permeable materials or features to break up large impervious areas.

Historic Areas and Maritime Areas | Utilize permeable material choices when designing roadways, parking, and walkways where land area and subsurface access may be limited. Employ rainwater re-use techniques in ways that maintain local character. Explore opportunities for development of off-site shared district or community scale stormwater treatment.

Community Activity Centers | Prioritize inclusion of green space that can provide treatment and infiltration capacity for redevelopment / infill projects. Utilize subsurface storage and infiltration measures where site constraints limit above ground treatment capacity. Where applicable maintain or improve gray infrastructure to support development of shared off-site district or community scale stormwater treatment.

Industrial Activity Centers and Military and Transportation Areas | Prioritize inclusion of green space that can provide treatment and infiltration capacity for redevelopment / infill projects. Utilize permeable material choices when designing lower traffic roadways, parking, and walkways, and subsurface storage and infiltration measures where site constraints limit above ground treatment capacity. Where applicable maintain or improve gray infrastructure to support development of shared off-site district or community scale stormwater treatment. Design sites to minimize exposure of stormwater runoff to Hazardous Substances and other potential contaminants. Design stormwater systems to treat higher potential pollutant loads and contain runoff via flow arresting device or otherwise in the event of a spill / release.

Objective WR5 – Manage groundwater withdrawals and discharges to maintain hydrologic balance in a way that is protective of surface and groundwater resources

METHODS

- All DRIs must meet Objective WR5 by designing water withdrawals and wastewater discharges in a manner that protects surface water and wetland habitat from groundwater pumping and, in the case of effluent disposal, from water table mounding issues (e.g., breakout, flooding, water table separation).
- Projects proposing to discharge >10,000 or withdraw >20,000 gallons of water per day from the site must: provide a groundwater study that demonstrates the project will not have adverse impacts on groundwater levels or adjacent surface waters and wetlands.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR1

Objective WR1 *– Protect and preserve groundwater quality*

NITROGEN LOADING

Protection of Cape Cod's groundwater resources is critical for the protection of human health. The Cape Cod aquifer was designated as a Sole Source Aquifer (47 FR 30282) by the US Environmental Protection Agency (USEPA) in 1982, recognizing the complete dependence of the population on groundwater as its source for drinking water. The aquifer is primarily recharged by precipitation but also receives discharges of wastewater and stormwater, which can introduce contaminants into Cape Cod's primary source of drinking water. Nitrate-nitrogen (NO_3-N) is a primary contaminant of concern due to its potential human health effects, for which USEPA has established a maximum contaminant level (MCL) of 10 parts per million (ppm). In addition, high NO_3 concentrations in groundwater have also been correlated with higher concentrations of drinking water contaminants (e.g., volatile organic compounds and compounds of emerging concern). For these reasons the nitrogen loading requirements must be met by all DRIs, regardless of whether they are located within mapped water resource areas.

Detail on the methods for meeting Objective WR1 is provided below:

For all projects

Under the Safe Drinking Water Act, public supply wells which exceed 5 ppm NO_3-N are subject to additional monitoring requirements, and wells that exceed the MCL (10 ppm NO_3-N) cannot obtain variances or exemptions, thus requiring expensive treatment or being removed from operation. In aerobic subsurface environments like Cape Cod's unconfined aquifers, nitrate is highly persistent with natural chemical reactions providing minimal removal. Consequently, limiting the amount of nitrogen introduced to the aquifer is the most effective way to reduce NO_3-N concentrations in groundwater and protect Cape Cod's drinking water.

5 PPM NITROGEN LOADING STANDARD

The Cape Cod Commission has adopted a loading standard of 5 ppm NO_3-N which, based on a statistical analysis, is designed to keep violations of the USEPA MCL for NO_3-

N to less than 1 in 10 samples, while maintaining an additional margin of safety during times of simultaneous low recharge (i.e., drought conditions) and high loading (summer peak season). This standard is designed to protect human health, as well as current and potential future drinking water resources. A site-wide nitrogen loading concentration calculation takes into account all sources of nitrogen from the project site post-development and divides this cumulative nitrogen input by the water input (recharge) for the entire project site. Instructions on the information required and method for calculating site-wide nitrogen loading concentration are available in Appendix A – Nitrogen Loading Guidance for Water Resources. Applicants seeking to reduce site-wide nitrogen loading concentration may do so by providing advanced treatment of wastewater flows to remove additional nitrogen including new innovative / alternative technologies, reducing the volume of wastewater flows, increasing natural area on-site, decreasing fertilized lawn area, and incorporating Stormwater Control Measures (SCMs) optimized for nitrogen removal.

IMPACTS OF DEVELOPMENT ON LOCAL DRINKING WATER WELLS

The 5 ppm nitrogen loading concentration standard is designed to protect the Cape Cod aquifer as a whole, but localized impacts of a project on the groundwater resources also need to be considered. As nitrogen and other wastewater constituents follow the flow of groundwater, the direction of groundwater flow at the project site will determine where wastewater effluent travels. The location of septic and other wastewater disposal systems, direction of groundwater flow, and proximity of public or private drinking water wells at the site and on neighboring parcels must be examined, as applicable, to verify that a project even when complying with site-wide loading standards is not contaminating nearby drinking water resources. Applicants must identify existing or proposed drinking water wells within 400 feet of project boundaries, when this method is applicable. Groundwater flow direction should be determined using a water table map, which may be generated from groundwater elevation data (possible sources might include the United States Geological Survey, Massachusetts Department of Environmental Protection, or the town). The direction of groundwater flow should be used to locate wastewater treatment systems (including septic) appropriately so that effluent does not flow directly into downstream drinking water sources.

SITE ASSESSMENTS FOR PREVIOUSLY DEVELOPED PROPERTIES

Sites that have been previously developed, particularly those with uses that historically have used/generated hazardous substances (e.g., gas stations, auto repair facilities, dry cleaners, manufacturing facilities) may contain contaminated soil or groundwater even if site assessment and remediation activities have been conducted under the Massachusetts Contingency Plan (MCP). To prevent the unintentional mobilization of contaminants into groundwater, documentation of all Environmental Site Assessments and remedial actions must be provided for Commission review when this method is utilized to ensure the best available information regarding surface and subsurface site conditions is considered when evaluating the project design.

BEST DEVELOPMENT PRACTICES FOR SITE DESIGN

Low Impact Development is the practice of using innovative stormwater management systems that are modeled after natural hydrologic features. Low Impact Development techniques manage rainfall at the source using distributed decentralized micro-scale controls, and small cost-effective landscape features located at the lot level. They also facilitate compact, clustered development and minimize impervious surfaces.

Environmentally Sensitive Site Design incorporates Low Impact Development techniques to prevent the generation of stormwater and non-point source pollution by reducing impervious surfaces, disconnecting flow paths, treating stormwater at its source, maximizing open space, minimizing disturbance, protecting natural features and processes, and/or enhancing wildlife habitat.

Additional resources regarding site design best practices are available from the United States Environmental Protection Agency, the Metropolitan Area Planning Council, and other State and regional environmental and planning agencies..

USE OF SHARED INFRASTRUCTURE

Shared wastewater treatment utilizes a single system to treat wastewater from multiple units of development. This practice can facilitate higher density development, reduce environmental impacts and treatment costs, and enhance open space preservation as it only requires a single location for wastewater disposal and may require less total area for disposal. In cases where a parcel is subdivided or residential lots are to be sold individually, a covenant will need to be entered into by the homeowners for operation and maintenance of a shared system in order to meet Objective WR1 via this method.

Multi-unit development is also encouraged to include community or public water supplies as alternatives to multiple private wells, in order to avoid potential impacts from wastewater disposal and challenges of siting and associated setback requirements for multiple water supply wells.

For Projects Proposing Private Wastewater Systems

OPERATION, MONITORING, AND COMPLIANCE AGREEMENTS

When a wastewater system of sufficient capacity (greater than 2,000 gallons per day design flow) is proposed to operate with greater removal efficiency than currently certified by MassDEP permit or letter of approval in order to meet Water Resources objectives, an Operation Monitoring and Compliance (OMC) Agreement is required to ensure treatment goals are met. The OMC agreement should be entered into between the applicant, Cape Cod Commission, and the local Board of Health, and generally consists of:

- Treatment specifications
    - Wastewater flow limit
    - Effluent quality limits
- Monitoring requirements
    - Sampling locations
    - Analyses required
    - Sampling frequency
- Reporting requirements
    - Frequency of reporting
    - Enforcement actions
- Operations and maintenance plan and staffing

For Projects Proposing Wastewater Treatment Facilities

WASTEWATER TREATMENT FACILITIES

Wastewater collection and treatment systems that have a design flow of greater than 10,000 gallons per day are considered a Wastewater Treatment Facility (WWTF).

LOCATION OF WASTEWATER TREATMENT FACILITIES

WWTFs are likely to play a role in many towns' nutrient reduction strategies, therefore it is important that public and private facilities are deployed in a coordinated and strategic manner. Nutrient reduction strategies may be laid out in a town's Comprehensive Waste Management Plan (CWMP), a Targeted Watershed Management Plan (TWMP) that may involve several towns, or in other planning documents. When a nutrient reduction strategy has been deemed consistent with the Cape Cod Area Wide Water Quality Management Plan Update (208 Plan Update) by the Cape Cod Commission, private WWTFs that are not owned or operated by a town, municipality or district may be located in areas where a) no public WWTF is proposed within five years of the proposed project construction date under the nutrient reduction strategy, or b) where the nutrient reduction strategy relies upon the proposed private WWTFs to achieve nutrient reduction goals. In areas where an approved nutrient management plan is not yet in place, private WWTFs are an encouraged strategy for maintaining or improving groundwater quality.

5 PPM NITROGEN CONCENTRATION LIMIT IN EFFLUENT OR AT DOWNGRADIENT BOUNDARY

Projects proposing WWTFs are required to maintain nitrogen at 5 ppm or lower when measured at the downgradient property boundary. As it can be assumed that nitrogen discharged to groundwater will flow advectively without natural attenuation to the property boundary, following discharge nitrogen concentrations generally remain constant or decrease slightly due to dilution from recharge. WWTF effluent nitrogen is monitored as part of a MassDEP groundwater discharge permit (GWDP), and projects with 5 ppm nitrogen or less in effluent are deemed to have met this requirement. Projects proposing to discharge nitrogen at concentrations greater than 5 ppm must use a groundwater model or an acceptable calculation using groundwater monitoring data to demonstrate that nitrogen concentration in groundwater at the downgradient property boundary will not exceed 5 ppm and the results must be submitted to the Commission for review and confirmation.

For Projects within Wellhead Protection Areas (WHPAs) and Potential Public Water Supply Areas (PPWSAs)

PROTECTION OF EXISTING AND FUTURE DRINKING WATER WELLS (WHPAS AND PPWSAS)

As additional development on land areas that contribute (or may contribute in the future) to drinking water wells will directly impact drinking water quality, certain additional protections are required to prevent excessive nutrient loading and minimize the risk of contamination.

Lands receiving precipitation that contribute to the recharge of public drinking water supply wells are considered Wellhead Protection Areas (WHPA). These include MADEP approved Zone IIs, interim wellhead protection areas, and certain town delineated water protection districts that extend beyond the Zone II limits.

Potential Public Water Supply Areas (PPWSAs) are locations that may be suitable for future development of drinking water supplies. The process to identify these areas started with creating a GIS layer of only pervious land on Cape Cod, from which surrounding land uses incompatible with wellhead placement were removed (e.g., landfills, hazardous waste sites or contaminant plumes, cemeteries, golf courses, airports). The remaining land was overlain with an 11.5 ac hexagon layer, the approximate size of a wellhead and its protective buffer. The resultant PPWSA layer is therefore hex based, not parcel based, and represents approximate locations where a well could be placed and have natural resource protection.

Discharging effluent from private wastewater treatment facilities in WHPAs or PPWSAs may negatively impact those resources by degrading water quality and/or modifying natural hydrological processes. Private wastewater treatment facilities may be proposed in a WHPA or PPWSA only when designed to specifically tie-in and treat existing sources of wastewater within that same water supply area.

HAZARDOUS SUBSTANCES LIMITATIONS

Any chemical or substance that when released into the environment will pose a significant contaminant threat to groundwater and drinking water supplies is considered a Hazardous Substance. Examples include petroleum products, petroleum distillates, organic and inorganic solvents, oil-based paints, oil-based stains, insecticides, herbicides, rodenticides, and pesticides. Any substances classified as Hazardous Waste,

Universal Waste, or Waste as defined in the Massachusetts Hazardous Waste Regulations (310 CMR 30.010) are considered Hazardous Wastes for the purposes of this technical bulletin. Hazardous Wastes do not include Hazardous Materials or biomedical wastes regulated under the Massachusetts State Sanitary Code (105 CMR 480.00). Hazardous Materials as defined in Massachusetts General Laws, Chapters 21E and 21K, do not include Hazardous Wastes, Articles, Consumer Products, or Cosmetics. This technical bulletin considers and regulates both Hazardous Wastes and Hazardous Materials as Hazardous Substances.

To minimize the potential risk of introducing contamination to existing or future water supplies, the following limits on Hazardous Substances apply in WHPAs and PPWSAs.

(a) 275 gallons of oil on site at any time to be used for heating a structure, or to supply an emergency generator
(b) 25 gallons or equivalent dry weight, total, of Hazardous Material(s) on site at any time (excluding oil as classified in part (a))
(c) 55 gallons of Hazardous Waste generated at the Very Small Quantity Generator level as defined in Massachusetts Hazardous Waste Regulations (310 CMR 30.000) and accumulated or stored on-site at any time.

Applicants should provide the Commission an inventory which includes the identities and quantities of expected and potential Hazardous Substances that will be generated, used, or stored on site for the proposed use. Similar inventories should be provided for the previous use (when applicants propose to reduce the quantity of Hazardous Substances present on site through redevelopment) or for the proposed offset site (when applicants propose to eliminate the same or greater quantity of Hazardous Substances from another project, site, or facility within the same WHPA or PPWSA).

Certain types of development even when remaining within the above limits on Hazardous Substances may present a greater potential for contaminating groundwater. Stormwater systems serving areas used for fleet storage, vehicle maintenance and repair, electrical transmission/generation, loading docks, waste handling, industrial machinery and equipment and railroad equipment maintenance, log storage and sorting yards, aircraft maintenance areas, railroad yards, fueling stations, construction businesses, paving, heavy equipment storage and / or maintenance, the storage of petroleum products, high-intensity-use parking lots, and any other use with greater potential for groundwater contamination must include a means to halt discharge from

the stormwater system (flow arresting device) in the event of a spill, accident, or release of any source of contamination.

1 PPM NITROGEN LIMIT

PPWSAs are a finite and increasingly limited resource that requires extra levels of protection to ensure they remain available to provide a stable drinking water system able to meet future water supply needs.

To maintain the suitability of PPWSAs to supply drinking water in the future, projects that disturb areas mapped as PPWSA are limited to a site-wide nitrogen loading concentration of 1 ppm (mg/L).

PRESERVATION OF POTENTIAL FUTURE WELL SITES

Public water supply wells require a 400-foot protective radius around the well, known as a Zone I, to be owned or fully controlled by the public water provider. Where project sites contain mapped PPWSA, development on the site should be minimized or avoided within the mapped PPWSA. If development cannot be located outside mapped PPWSA on a project site, any development should be sited to minimize fragmentation and preserve contiguous mapped PPWSAs. The application for Projects proposing to develop areas mapped as PPWSA should include an analysis of the impacts of proposed site plan on potential future well siting, including any remaining PPWSA on the project site and adjacent sites that still support the 400- foot Zone I radius. The goal of this analysis is to confirm that proposed projects are designed to preserve as many well sites as possible.

LANDSCAPE MANAGEMENT PRACTICES

Landscaping is an important part of development that may play a role in screening, stormwater management and treatment, and overall visual aesthetics. Proper maintenance of landscaping is necessary to maintain its continued function, and several approaches are encouraged to minimize the environmental impacts presented by chemical fertilizer and pesticide usage during these activities. Utilizing native species for landscape management practices is preferred as they require less water, fertilizer, and pesticides.

Additional detail regarding landscaping is provided in the Community Design Technical Bulletin. For additional plant guidance see Cape Cod Freshwater Pond Buffer Guidance,

Appendix B, the Cape Cod Commission Natural Resources webpage, and the Massachusetts Stormwater Handbook Volume 2, Chapter 2 for plants suitable for use in SCMs.

Where pesticide application cannot be avoided, integrated pest management and biorational landscape management should make use of an inspection and monitoring approach, along with a variety of pest control measures to maintain pest populations below levels that can cause significant damage or loss to installed landscaping. Soil nutrient and moisture testing should be employed with fertilization and irrigation methods tailored to the specific site conditions. Accurate identification of pests and monitoring of their populations should be used to determine rate and frequency for applying pest control (which may include chemical, cultural, and biological controls) to maintain pest population levels below identified thresholds. If no effective non-pesticide control measures are available, a key concept of integrated pest management is that selected pesticides should result in the lowest possible risk to health or the environment. The University of Massachusetts Extension provides a more detailed background and ongoing guidance regarding integrated pest management at (https://www.umass.edu/agriculture-food-environment/integrated-pest-management/about).

ROADWAY AND PARKING AREA DESIGN

In WHPAs and PPWSAs, roadways and parking areas should be designed to minimize impervious area, with pervious construction materials used whenever possible to minimize the impact of stormwater on drinking water supplies.

PROJECTS IN IMPAIRED AREAS

Areas where water quality has been degraded by land uses such as high-density residential, commercial, or industrial development; landfills, septage, and wastewater treatment discharges; and areas downgradient of these sources that are similarly impacted are considered Impaired Areas.

Projects located in Impaired Areas that are outside other mapped water resource areas including WHPAs, PPWSAs, MWRAs and CAPs may use existing groundwater quality data, distance from existing natural or built water resources, and position upstream or downstream of those resources relative to groundwater flow direction to demonstrate

that nitrogen loading concentration above 5 ppm will not adversely impact those resources.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR2

Objective WR2 *– Protect, preserve and restore freshwater resources*

Prevent loading of phosphorus to freshwater resources

Freshwater bodies of water are a valued natural resource across Cape Cod. They have nitrogen filtering capacity and connect to groundwater, the aquifer, and coastal embayments. Lakes and ponds are an important part of Cape Cod's ecosystems providing habitat for a diversity of aquatic flora and fauna, Ponds are also cherished as recreational resources, and for their cultural and aesthetic values. Freshwater Recharge Areas (FWRA) are defined watershed areas that contribute to a freshwater body as defined by the topography of the water table. For ponds that do not have a delineated recharge area, it is presumed that portions of the 300 foot pond buffer that are upgradient of the pond provide recharge to the freshwater body. These limited areas of the 300-ft buffer are delineated as significant based on groundwater contours and groundwater flow direction. To be more protective of ponds, these two areas, the Freshwater Recharge Area and the 300 foot buffer upgradient of a pond, were effectively combined on the RPP Data Viewer to yield Contributing Areas to Ponds (CAP). Applicants may provide evidence demonstrating that the 300-ft pond buffer areas (see data layer in the RPP Data Viewer) are not significant for pond recharge to overcome this presumption.

Maintaining or enhancing vegetative buffers with native plant species and additional canopies (groundcover, shrubs and/or trees) will be protective of pond and lake water quality. Increasing the width of vegetative buffers that are less than 100 feet will improve habitat and stormwater runoff infiltration thereby improving water quality. To incorporate additional ways to prevent phosphorus loading reference the Cape Cod Freshwater Pond Buffer Guidance (Cape Cod Freshwater Pond Buffer Guidance | Cape Cod Commission).

Phosphorus, unlike nitrogen, is attenuated in the subsurface through sorption to soil minerals or uptake during microbial or plant growth. Studies of phosphorus transport support regionally accepted use of a 300 foot buffer for purposes of protecting freshwater resources from wastewater discharges. Therefore, siting septic systems outside a 300 foot upgradient buffer to fresh surface waters will be protective of water quality.

For projects with sufficiently large flows in pond recharge areas, the phosphorus load may exceed the attenuation rate of the soils and ultimately result in additional phosphorus loading to the pond even when the discharge is located greater than 300 feet upgradient of the pond. In these situations, additional modeling which looks at groundwater flow, soil characteristics, and wastewater characteristics will be required to characterize the site and evaluate the expected extent of phosphorus transport, as appropriate.

Stormwater treatment systems located within Contributing Areas to Ponds are required to be designed to remove 60% of Total Phosphorus (TP) from runoff from all impervious surfaces on the site for new development, and 50% of TP for redevelopment projects.

Projects must prevent loading phosphorus to freshwater resources by not using fertilizer that contains phosphorus outside of the initial plant establishment period. Native plants are ideal and strongly encouraged for projects near lakes and ponds as they require less irrigation and fertilizer.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR3

Objective WR3 *– Protect, preserve and restore marine water resources*

Prevent and mitigate loading of nutrients and other contaminants to marine water resources

Cape Cod's marine waters provide a variety of complex habitats necessary to support shellfish populations, marine fisheries, migratory birds, and many other plant and wildlife populations. Less than 25% of the Cape Cod land surface drains to open marine waters (e.g., Cape Cod Canal, Cape Cod Bay, Nantucket Sound, Atlantic Ocean). Instead, the majority of land surfaces discharge to estuaries or coastal embayments through groundwater flow in the Cape Cod aquifer. Marine Water Recharge Areas (MWRA) are defined as watershed areas that contribute to a marine embayment as defined by the topography of the water table.

As of 2025, the Massachusetts Estuary Project (MEP) has studied 40 of Cape Cod's 53 coastal embayments. MEP continues to study coastal embayments on Cape Cod to determine the critical nitrogen load for each embayment, which is the maximum amount of nitrogen input that can be assimilated without negatively impacting ecosystem function and provision of habitat. A total maximum daily load (TMDL) is the maximum amount of a pollutant that a waterbody can assimilate on a daily basis and still support a healthy ecosystem, which for Cape Cod's coastal embayments is determined by MassDEP and the U.S. Environmental Protection Agency based on the results of the MEP studies. Six of the embayments studied to date have been found to have assimilative capacity for nitrogen; therefore, no TMDL is necessary at this time. The remaining watersheds that have been studied require nitrogen reduction to achieve healthy ecosystem function.

Additional information about the MEP, embayment reports, and applicable TMDLs is available at the MassDEP website (https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports).

The Cape Cod Section 208 Area Wide Water Quality Management Plan (208 Plan Update) was completed in 2015 in response to the need for a new approach to planning for and implementing nitrogen reduction plans and projects to achieve the critical nitrogen loads. The 208 Plan Update expands the available nutrient reduction

strategies beyond source reduction to include remediation and restoration approaches. This allows for a range of strategies to be employed, depending on the Placetype and context within the watershed of the area where nitrogen reduction is needed (ex. in-embayment strategies, such as the use of aquaculture, may be used in watersheds where low density development causes inefficient source reduction from a cost perspective). The 208 Plan Update provides a framework for applying watershed based solutions to reduce nitrogen in impaired embayments. CWMPs, TWMPs, and other municipal nutrient management plans and projects deemed consistent with the 208 Plan Update and those that are permitted by MassDEP through a watershed permit determine the approach and timing of solutions within an individual watershed or sub-watershed, and development that conforms with the approved nutrient management plan is considered to meet Objective WR3.

Development is generally prohibited from adding nitrogen to areas that contribute to nitrogen-overloaded coastal waters. Embayments which have nitrogen loading greater than or equal to their critical nitrogen loads are considered nitrogen-overloaded and may or may not have a TMDL associated with them. Documented water quality problems may also exist (e.g., shellfish or beach closures, failure to meet Massachusetts Surface Water Quality Standards) in areas where a critical nitrogen load or TMDL has not yet been established, in which case projects are required to mitigate or offset any proposed nitrogen load as described below. Nitrogen additions from the proposed project may be mitigated by connecting existing development to an existing sewer system, by tying-in and providing wastewater treatment to existing development currently served by septic systems, or by other means that result in the overall nitrogen mass amount within the (sub)watershed being maintained or reduced. Applicants proposing to use this form of mitigation should provide a calculation of the expected nitrogen mass amount generated by the project, the existing nitrogen sources (number, type, estimated load) proposed for mitigation, and a detailed description of the means by which treatment of those sources will be implemented (which could include financing of sewer tie-ins, a contract to provide wastewater treatment, installation and operation of I/A systems at existing properties, or other means of demonstrating how the proposed mitigation will ultimately be achieved).

Projects proposed in Placetype areas where development is encouraged and where infrastructure needed to meet nitrogen reduction requirements is lacking, may provide

a monetary offset of the project's nitrogen mass amount which can be used to support expansion of municipal wastewater treatment and nutrient management operations.

MONETARY NITROGEN OFFSET

Natural Areas | No monetary nitrogen offset available
Rural Development Areas | No monetary nitrogen offset available
Suburban Development Areas | Monetary nitrogen offset available where appropriate
Historic Areas | Monetary nitrogen offset available where appropriate
Maritime Areas | Monetary nitrogen offset available
Community Activity Center | Monetary nitrogen offset available
Industrial Activity Center | Monetary nitrogen offset available
Military and Transportation Areas | Monetary nitrogen offset available

Certain Placetypes may have existing sewer collection and treatment systems, or have sufficient density of development and other infrastructure to justify future connection to sewer systems. To promote the desired development density and facilitate future sewering, projects in Community Activity Centers, Maritime Areas, Industrial Activity Centers or Military and Transportation Areas Placetypes without available sewer connections may contribute a monetary offset calculated as up to $11,362 per kilogram per year nitrogen mass amount to be offset. The monetary offset is based on the cost of removing one kilogram of nitrogen per year for 20 years using a conventional sewer collection system and municipal wastewater treatment and applies to all project nitrogen sources (e.g. wastewater, stormwater, fertilizer). See Appendix C for further information on the methodology. An alternative analysis of per kilogram nitrogen costs may be submitted so long as it is consistent with a locally approved plan. The Commission may utilize a proposed alternative analysis to determine offset costs, as appropriate.

Patterns of development in Suburban Development Areas are generally too spread out to make centralized wastewater collection financially feasible, while Historic Areas may present special challenges to sewering in terms of access below grade and age of existing infrastructure. For these reasons monetary offsets are allowed in limited circumstances at the discretion of the Commission in those Placetype Areas. The extent, timing, and location of wastewater plans within the project's MWRA should be considered when determining whether to allow monetary offsets in Suburban Development Areas or Historic Areas. Factors that will be considered in determining

offset amounts in these Placetypes might include, but are not limited to, existing development, business and community activity, a community's vision for the area as described in their Local Comprehensive Plan or other planning documents, and any plans for construction of wastewater infrastructure or other nutrient management operations that will take place within five years.

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR4

Objective WR4 *– Manage and treat stormwater to protect and preserve water quality*

Undisturbed natural areas generally slow the velocity of runoff, allowing natural processes to remove nutrients and contaminants and facilitating recharge so that rain largely stays where it falls. When natural areas are covered by impervious surfaces, the resulting stormwater runoff from rainfall or snow melt travels at higher velocities and in more concentrated flows, making both infiltration and removal of nutrients or contaminants more challenging. As rainfall amounts and patterns continue to change, the increased frequency of high intensity storms present challenges and risks to many forms of infrastructure. Stormwater systems designed to handle increased runoff in a distributed and decentralized manner should be an integral part of community planning for water quality, flood protection, climate resilience, and capital infrastructure. Across the Commonwealth of Massachusetts, untreated stormwater runoff is the single largest source of water body impairment. To maintain and improve the health of Cape Cod's water resources and the communities that depend on them, it is critical to manage both the quantity and quality of stormwater runoff that is generated by development.

Stormwater system design

To protect existing water resources and maintain safety by preventing flooding/ponding of water on roadways, stormwater systems must be designed to capture, treat, and infiltrate rainfall from roadways, parking lots, and rooftops on the project site. Stormwater runoff collects sediment, bacteria, nutrients, and pollutants from the impervious surfaces it flows over, which negatively impact ground and surface water resources if not adequately treated. Properly designed and maintained treatment SCMs minimize the amount of these pollutants that are ultimately discharged to surface waters and groundwater. The Massachusetts Stormwater Handbook (https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards) provides guidance for minimizing site disturbance and impervious cover, disconnecting impervious surfaces, and designing stormwater structures to meet the water quality treatment and storage/infiltration aspects of Objective WR4.

To best account for changing patterns in precipitation, updated projections for extreme precipitation events should be used whenever designing new stormwater systems. The

Massachusetts Stormwater Handbook currently uses precipitation data from U.S. Weather Service Technical Paper 40, which was published in 1961. Projections from the National Oceanic and Atmospheric Administration (NOAA Atlas 14 Plus, published 2015) and Northeast Regional Climate Center (Extreme Precipitation Analysis, http://precip.eas.cornell.edu/) utilize much more recent data than Technical Paper 40 and are forward-looking. MassDEP currently recommends using the most conservative (largest) rainfall volume from among the three resources.

Applicants proposing projects near surface bodies of water must demonstrate through the stormwater report or other topography mapping that no pollutants will be added to the pond via overland sheet flow of stormwater. Surface watershed mapping will also aid in design and location of buffer area to ponds to reduce the impact of erosion caused by stormwater.

Applicants should provide a stormwater maintenance and operation plan certified by a licensed Professional Engineer that details a schedule for inspection, monitoring, and maintenance; and identifies the party responsible for implementation. The applicant should also agree to provide a Professional Engineer certified letter that details inspection of the stormwater facilities one year after completion and certifies that the system was installed and continues to function as designed and approved.

Requirement to manage stormwater through Environmentally Sensitive Site Design (ESSD) and Low Impact Development (LID) techniques and stormwater controls

Low Impact Development techniques or practices prevent the generation of stormwater and non-point source pollution by reducing Impervious Surfaces, disconnecting stormwater sheet flow paths, and treating stormwater at its source. LID techniques provide additional benefits including maximizing open space, minimizing disturbance, protecting natural features and processes, and/or enhancing wildlife habitat. LID when employed in conjunction with other site design choices for buildings, parking and roadways, and landscaping, can be considered ESSD. All projects are required to meet applicable stormwater standards through LID and ESSD, unless impracticable based solely on physical constraints, and demonstrated through a written alternatives analysis.

Separation from High Groundwater

A calculation of the high groundwater level is required to be performed when this method is applicable to ensure that stormwater facilities are designed to maintain the proper 2 foot separation from the water table under all conditions. Appendix B – Estimation of High Groundwater Levels describes a calculation that may be used to adjust water levels measured at discrete Cape Cod locations and estimate high groundwater levels at those same locations. Applicants may utilize the High Groundwater Levels Data Viewer to assist with calculating the proper groundwater adjustment. The high groundwater estimation approach was developed in cooperation with the US Geological Survey and is based on historic long-term groundwater-level measurements at index wells located across Cape Cod.

Total Suspended Solids Removal and Water Quality Treatment Volume

For new development, stormwater systems are required to be designed to remove 90% of Total Suspended Solids (TSS) and provide water quality treatment for the first inch of precipitation from all impervious surfaces on the site . For redevelopment, stormwater systems are required to be designed to remove 80% of TSS. An estimate of the TSS removal achieved in the stormwater treatment train(s) can be performed using MassDEP's TSS Removal Calculation Worksheet. (https://www.mass.gov/files/documents/2016/08/nn/tss.xls)

The required water quality treatment volume can be calculated using the following equation.

$$WQ\ treatment\ volume\ (ft^3) = impervious\ area\ (ft^2) * (1\ inch / 12\ inches\ per\ foot)$$

Storage/treatment volume provided by most stormwater SCMs can be calculated with a stage-storage table, where the incremental volume of each stage is given by

$$Incremental\ volume\ (ft^3) = (elevation_2 - elevation_1) * ((area_2+area_1)/2)$$

Example stage-storage volume calculation

ELEVATION (FT)	SURFACE AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
72.5	210	0	0
73	660	217.5	217.5
73.5	1,020	420	637.5
74	1,500	630	1267.5

The *Massachusetts Stormwater Handbook* contains detailed explanations, examples, and guidance for additional methods, including the simple dynamic method which may be used to calculate required volume(s) in Volume 3, Chapter 1 – Standard 4. Use of the static method will be conservative and result in larger sized stormwater controls since it does not consider exfiltration during the design storm event. The dynamic method can be used to correctly size smaller stormwater controls that still meet design requirements, reducing land disturbance associated with the stormwater management system.

For redevelopment projects the *New England Stormwater Retrofit Manual* contains guidance for retrofit scenarios.

Phosphorus removal

Stormwater systems located within CAPs (FWRA and 300-ft buffer upstream of freshwater bodies) are required to be designed to remove 60% of Total Phosphorus (TP) from all impervious surfaces on the site for new development, and 50% of TP for redevelopment.

Nitrogen removal

Projects within a nitrogen sensitive MWRA or MassDEP Natural Resource Nitrogen Sensitive Area should optimize Stormwater Control Measures for nitrogen removal. Credits for nitrogen removal from SCMs are applied to site-wide nitrogen loading under Objective WR1, and to the project's total nitrogen mass for purposes of Objective WR3.

Additional methods to meet Objective WR4:

- Where site constraints limit capacity for water quality treatment, rooftop runoff may be separately managed through direct infiltration unless there is an identified rooftop water quality concern requiring additional treatment or management.
- Refer to EPA's SCM Performance Curve to appropriately size Stormwater Control Measures to meet load reduction requirements (MS4 General Permit, Appendix F).

DETAILED DISCUSSION OF METHODS FOR MEETING OBJECTIVE WR5

Objective WR5 *– Manage groundwater withdrawals and discharges to maintain hydrologic balance in a way that is protective of surface and groundwater resources*

Projects that exceed 20,000 gpd withdrawals must provide adequate groundwater characterization to demonstrate that drawdown of the groundwater due to pumping will not negatively impact nearby surface waters and wetlands, which may be connected to and fed by groundwater. The study should include mapping of surface water morphology and comparison of existing and affected water-table fluctuations. In addition, projects utilizing wastewater treatment facilities should provide adequate groundwater characterization to determine the maximum expected height of groundwater mounds and the potential for groundwater with this additional mounding to breakout above the land surface or to impact water levels in surface water resources. Projects should provide a high groundwater estimate consistent with the methodology of Appendix B –Estimation of High Groundwater Levels to incorporate into modeling of potential mounding.

GENERAL APPLICATION REQUIREMENTS

Application materials should provide sufficient detail to demonstrate that the project meets the applicable goals and objectives, but typically include:

A. Project description including site location, applicable Water Resource Areas, and narrative of proposed wastewater, stormwater and drinking water systems
B. Site-wide nitrogen loading calculation
C. Site plan including applicable grading, drainage, and utilities
D. Stormwater treatment and capacity calculations
E. Operations and maintenance plan(s)

These items may not be required for all projects. See guidance below.

The Water Resource Areas, which are defined in the Definitions section beginning on WR-5 can be viewed in the RPP Data Viewer, and include:

- Wellhead Protection Areas (WHPA)
- Contributing Areas to Ponds (CAPs)
- Marine Water Recharge Areas (MWRA)
- Potential Public Water Supply Area (PPWSA)
- Impaired Areas

DETAILED WATER RESOURCES APPLICATION REQUIREMENTS

1. The project narrative should include a description of the site location and any applicable resource areas, existing site conditions, and how the proposed project will change those conditions during and after construction. Areas that should be considered include:
    a. Presence of existing and proposed drinking water wells within 400 feet of project boundaries
    b. Expected wastewater design flow and proposed treatment including system type (manufacturer, model, etc.) and total nitrogen concentration in wastewater effluent for on-site wastewater treatment systems.
    c. Source of drinking water supply
    d. Changes in natural and impervious area cover (tabulated in square feet and/or acres as appropriate)
    e. Stormwater management and treatment

   f. for previously developed sites a description of historical site usage, and if a reportable release under the MCP has occurred at the project site or if a Site Release Tracking Number (RTN) has been assigned for the site by MassDEP, a Chapter 21E site assessment or other Environmental Site Assessment information is required to be submitted for Commission review when method is utilized.
2. A calculation of site-wide nitrogen loading should be performed using the method described in Appendix A.
3. The site design should specify the location of the proposed septic system or wastewater treatment facility and identify downgradient resources as described in WR1 – detailed methods.
4. Sites proposing development in PPWSAs must include an analysis of project impacts on future public well siting.
5. The stormwater report should include a description of the proposed system including the treatment train(s) (for small systems, a description in the project narrative may be sufficient) and the following information as necessary:
   a. Soil survey and / or boring logs
   b. Calculation of high groundwater level (in feet below land surface or elevation above sea level) to ensure that stormwater facilities are designed with proper separation from the water table as described in WR4 – detailed methods.
   c. Estimate of TSS removal achieved in stormwater treatment train(s) using MassDEP's TSS Removal Calculation Worksheet (https://www.mass.gov/files/documents/2016/08/nn/tss.xls)
   d. Calculation of required water quality treatment volume and treatment volume provided as described in WR4 – detailed methods.
   e. Engineering design drawings, standard details, or cut sheets for proposed stormwater system components
6. Operations and maintenance plans for all proposed water systems (drinking water supply, stormwater, and wastewater treatment) should be submitted for Commission review

REFERENCES

Cape Cod Commission, 1992. Estimation of High Groundwater Levels for Construction and Land Development, Technical Bulletin 92-001

Cape Cod Commission, 1999. Priority Land Acquisition Assessment Project – A guide to evaluating the suitability of land for future water supply sites

Cape Cod Commission, 2001. Priority Land Acquisition Assessment Project Phase II

Massachusetts Estuaries Project and Reports
https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports

The Massachusetts Stormwater Handbook and Stormwater Standards (https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards)

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National Oceanic and Atmospheric Administration, 2015. Atlas 14 Precipitation Frequency Data Server
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http://precip.eas.cornell.edu/

USGS, 1986. Ground-Water Resources of Cape Cod, Massachusetts Hydrologic Investigations Atlas-692

United States Environmental Protection Agency, 2009. Incorporating Environmentally Sensitive Development into Municipal Stormwater Programs
https://www.epa.gov/sites/production/files/2015-11/documents/region3_factsheet_lid_esd.pdf

Metropolitan Area Planning Council, 2014. Low Impact Development Toolkit
https://www.mapc.org/resource-library/low-impact-development-toolkit/

Grow Smart Maine, 2015. Building "Smart": Environmentally Sensitive Design
Resources for Your Community - GrowSmart Maine

University of Massachusetts Extension, 2018. Integrated Pest Management Program
http://ag.umass.edu/integrated-pest-management

APPENDIX A: NITROGEN LOADING GUIDANCE FOR WATER RESOURCES

The Water Resource Goal of the Cape Cod Commission's Regional Policy Plan is "to maintain a sustainable supply of high quality drinking water and protect, preserve or restore the ecological integrity of fresh and marine surface waters." The Water Resources Technical Bulletin contains five (5) Objectives that are distinguished by Water Resource Area and Placetype. The Water Resource Areas are: Wellhead Protection Areas, Contributing Area to Ponds, Marine Water Recharge Areas, and Potential Water Supply Areas. The Water Resources Technical Bulletin also recognizes Impaired Areas where water quality may have been impaired from existing development.

The applicant will need to know specific project information to complete a nitrogen loading calculation

A methodology has been adopted by the Commission for calculating groundwater nitrogen loading concentrations. The methodology is based on information and parameters describing wastewater flows; stormwater runoff volumes; lawn sizes, fertilization and leaching rates; respective nitrogen masses and concentrations attributable to these nitrogen sources, and precipitation dilution factors as described below and shown in the example calculations.

WORKSHEET INSTRUCTIONS

The applicant will need to know the information listed below to complete a Nitrogen Loading calculation:

Identify the Water Resource Area the project is located in, if any (RPP Data Viewer);

1. Upland area of site (square feet);
2. Wastewater flow rate (calculated pursuant to 310 CMR 15.203);
3. Actual Flow rate determined by occupancy rate;
4. Average residential flow rate, calculated from the Title 5 design + the Actual Flow rate;
5. Type of septic system proposed (e.g. alternative design pursuant to 310 CMR 15.280);
6. Paved and roof areas (assumed 2,500 square feet for residential projects);
7. Proposed lawn area (assumed 5,000 square feet for residential projects);

A summary of Nitrogen Loading conversion factors and sample calculations are shown on the following pages.

A Nitrogen Loading and Mitigation Worksheet is available at www.capecodcommission.org/NitrogenWorksheet.

SUMMARY OF NITROGEN LOADING VALUES

TARGET CONCENTRATION: 5 ppm (milligram/liter) NO3-N

WASTEWATER

Residential Concentration: 35 ppm NO3-N
Flow: Title 5 (310 CMR 15.02)
Non-residential Concentration: 35 ppm NO3-N
Flow: Title 5 Design or actual documented flows

OCCUPANCY: Range (Actual town rate of 2 people per bedroom)

LAWNS

Area: 5,000 ft2
Fertilizer: 3 lbs/1,000 ft2 of lawn
Leaching: 25%

RECHARGE

From impervious surfaces: 40 inches per year

Concentrations
Road runoff: 1.5 ppm NO3-N
Roof runoff: 0.75 ppm NO3-N

Natural areas

Barnstable:	18 inches per year
Bourne:	21 in/yr
Brewster:	17 in/yr
Chatham:	16 in/yr
Dennis:	18 in/yr
Eastham:	16 in/yr
Falmouth:	21 in/yr
Harwich:	17 in/yr
Mashpee:	19 in/yr
Orleans:	16 in/yr
Provincetown:	16 in/yr
Sandwich:	19 in/yr
Truro:	16 in/yr
Wellfleet:	16 in/yr
Yarmouth:	18 in/yr

EXAMPLE RESIDENTIAL LOADING CALCULATIONS

Home (3 bedrooms)
Lot Size: 1 acre (43,560 ft^2)
Impervious Surfaces: Roof Area: 2,000 ft^2; Paving Area: 500 ft^2
Natural Area: 41,060 ft^2; Lawn Area: 5,000 ft^2
Title V Flow: 110 gallons/day per bedroom

WASTEWATER

Title V (2 people per bedroom)

$$3 \text{ bedrooms} \left[\frac{110 \text{ gpd}}{\text{bedroom}}\right]\left[\frac{3.785 \text{ L}}{\text{gal}}\right] = 1{,}249.0 \text{ L/d} \quad \left[\frac{35 \text{ mg}}{\text{L}}\right] = 43{,}716.8 \text{ mg/d}$$

Actual (assume 2.5 people/unit average occupancy within the town)

$$3 \text{ bedrooms} \left[\frac{110 \text{ gpd}}{\text{bedroom}}\right]\left[\frac{3{,}785 \text{ L}}{\text{gal}}\right]\left[\frac{2.5}{6}\right] = 520.4 \text{ L/d} \quad \left[\frac{35 \text{ mg}}{\text{L}}\right] = 18{,}214.6 \text{ mg/d}$$

IMPERVIOUS SURFACES

$$2{,}000 \text{ ft}^2 \left[\frac{40 \text{ in}}{\text{yr}}\right]\left[\frac{\text{ft}}{12 \text{ in}}\right]\left[\frac{28.32 \text{ L}}{\text{ft}^3}\right]\left[\frac{1 \text{ yr}}{365 \text{ d}}\right] = 517.3 \text{ L/d} \quad \left[\frac{0.75 \text{ mg}}{\text{L}}\right] = 387.9 \text{ mg/d}$$

$$500 \text{ ft}^2 \left[\frac{40 \text{ in}}{\text{yr}}\right]\left[\frac{\text{ft}}{12 \text{ in}}\right]\left[\frac{28.32 \text{ L}}{\text{ft}^3}\right]\left[\frac{1 \text{ yr}}{365 \text{ d}}\right] = 129.3 \text{ L/d} \quad \left[\frac{1.5 \text{ mg}}{\text{L}}\right] = 194.0 \text{ mg/d}$$

LAWN

$$5{,}000 \text{ ft}^2 \left[\frac{3 \text{ lbs}}{1{,}000 \text{ ft}^2 * \text{yr}}\right]\left[\frac{1 \text{ yr}}{365 \text{ d}}\right]\left[\frac{454{,}000 \text{ mg}}{\text{lb}}\right]\left[0.25\right] = 4{,}664.4 \text{ mg/d}$$

NATURAL

$$43{,}560 \text{ ft}^2 - 2{,}500 \text{ ft}^2 = 41{,}060 \text{ ft}^2$$

$$41{,}060 \text{ ft}^2 \left[\frac{1.5 \text{ ft}}{\text{yr}}\right]\left[\frac{28.32 \text{ L}}{\text{ft}^3}\right]\left[\frac{1 \text{ yr}}{365 \text{ d}}\right] = 4{,}778.7 \text{ L/d}$$

SUMMARY

Title V Flow

$$\frac{43{,}716.8 + 387.9 + 194.0 + 4{,}664.4 \text{ mg}}{1{,}249.0 + 517.3 + 129.3 + 4{,}778.7 \text{ liters}} = \frac{48{,}963.1 \text{ mg}}{6{,}674.3 \text{ liters}} = 7.34 \text{ ppm}$$

Actual

$$\frac{18{,}214.6 + 387.9 + 194.0 + 4{,}664.4 \text{ mg}}{520.4 + 517.3 + 129.3 + 4{,}778.7 \text{ liters}} = \frac{23{,}460.9 \text{ mg}}{5{,}945.7 \text{ liters}} = 3.95 \text{ ppm}$$

Final Calculation $(7.34 + 3.95)/2 =$ **5.65 ppm**

EXAMPLE NONRESIDENTIAL LOADING CALCULATIONS

Office Building:

Lot Size: 5 acres (217,800 ft^2)
Impervious Surfaces: Roof Area: 15,000 ft^2; Paving Area: 30,000 ft^2
Natural Area: 172,800 ft^2; Lawn Area: 10,000 ft^2
Title V Flow: 75 gallons/day per 1,000 ft^2

WASTEWATER

$$15{,}000\ ft^2 \left[\frac{75\ gpd}{1{,}000\ ft^2}\right]\left[\frac{3.785\ L}{gal}\right] = 4{,}258.1\ L/d \qquad \left[\frac{35\ mg}{L}\right] = 149{,}034.4\ mg/d$$

IMPERVIOUS SURFACES

$$15{,}000\ ft^2 \left[\frac{40\ in}{yr}\right]\left[\frac{ft}{12\ in}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 3{,}879.5\ L/d \qquad \left[\frac{0.75\ mg}{L}\right] = 2{,}909.6\ mg/d$$

$$30{,}000\ ft^2 \left[\frac{40\ in}{yr}\right]\left[\frac{ft}{12\ in}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 7{,}758.9\ L/d \qquad \left[\frac{1.5\ mg}{L}\right] = 11{,}638.4\ mg/d$$

LAWN

$$10{,}000\ ft^2 \left[\frac{3\ lbs}{1{,}000\ ft^2 * yr}\right]\left[\frac{1\ yr}{365\ d}\right]\left[\frac{454{,}000\ mg}{lb}\right]\left[0.25\right] = 9{,}328.8\ mg/d$$

NATURAL

$$5\ acres \left[\frac{43{,}560\ ft^2}{acre}\right] = 217{,}800\ ft^2; \quad 217{,}800\ ft^2 - 45{,}000\ ft^2 = 172{,}800\ ft^2$$

$$172{,}800\ ft^2 \left[\frac{1.5\ ft}{yr}\right]\left[\frac{28.32\ L}{ft^3}\right]\left[\frac{1\ yr}{365\ d}\right] = 20{,}111.1\ L/d$$

SUMMARY

$$\frac{149{,}304.4 + 2{,}909.6 + 11{,}638.4 + 9{,}328.8\ mg}{4{,}258.1 + 3{,}879.5 + 7{,}758.9 + 20{,}111.1\ liters} = \frac{172{,}911.2\ mg}{36{,}007.6\ liters} = \boxed{4.80\ ppm}$$

Cape Cod Commission - Nitrogen Loading

User Inputs			Instructions
Wastewater System			
	Title 5 Design Flow (gpd)		Enter Value
	Actual Flow (residential) (gpd)		Enter Value
	System Type	GWDP	Choose from dropdown
	Effluent N (mg/L)		Enter value - See Wastewater System Instructions below
Project and Site Coverage			
	Town	Barnstable	Choose from dropdown
	Project Site Area (ac)		Enter Value
	Wetland Area (sqft)		Enter Value
	Paving (sqft)		Enter Value
	% of paving with LID treatment		Enter Percentage (whole # 0-100)
	Roof (sqft)		Enter Value
	% of roof directed to LID treatment		Enter Percentage (whole # 0-100)
	Managed Turf (sqft)		Enter Value

Wastewater System Instructions

Wastewater System Type	Effluent N value (mg/L) [Enter in Cell E9]
Title 5	35
I/A Septic	Enter MassDEP permit approval value in E9
Groundwater Discharge Permit	Enter MassDEP permit approval value in E9
Sewer System	0

Outputs				
Wastewater	Average Flow (gpd)		0	
Site Coverage	Upland Area (sqft)		0	
	Natural Area (includes managed turf) (sqft)		0	
Project Nitrogen Load (Objective WR1)	Wastewater nitrogen (kg/yr)		0.00	Eqn (1)
	Stormwater nitrogen (kg/yr)		0.00	Eqn (5)
		Pavement nitrogen (kg/yr)	0.00	Eqn (2)
		LID Credit	0.00	Eqn (4)
		Rooftop nitrogen (kg/yr)	0.00	Eqn (3)
		LID Credit	0.00	Eqn (4)
	Fertilizer nitrogen (kg/yr)		0.00	Eqn (6)
	Total Project Nitrogen (kg/yr)		0.00	
Project Recharge	Recharge from Wastewater (l / yr)		0	Eqn (7)
	Recharge from Natural (l / yr)		0	Eqn (9)
	Recharge from Impervious (l / yr)		0	Eqn (8)
	Total Recharge (l / yr)		0	
Project Nitrogen Loading	**Sitewide Nitrogen Loading (mg/L or ppm)**		**#DIV/0!**	
Project Nitrogen Mass (Objective WR3)	Wastewater nitrogen (kg/yr)		0.00	Eqn (1)
	Stormwater nitrogen (kg/yr)		0.00	Eqn (5)
	Fertilizer nitrogen (kg/yr)		0.00	Eqn (6)
	Total kg N to coastal waters		**0.00**	
	Monetary offset amount		**$ -**	

Note: For Objective WR3, Title 5 systems are considered to have an effective effluent N of 26.25 mg/L. For other types of systems effluent N is the same for WR1 and WR3

APPENDIX B: ESTIMATION OF HIGH GROUND-WATER LEVELS

The Water Resources Technical Bulletin Appendix B - Estimation of High GW is available at:

https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/regulatory/HighGroundH20TechBulletin.pdf

Current groundwater levels and adjustments are available from the High Groundwater Levels Data Viewer: https://cccommission.maps.arcgis.com/apps/webappviewer/index.html?id=f1d0ad5a1b5d44c7976ed6a9749d2d4a

Historical monthly groundwater levels, adjustment tables, and other resources are available at: https://capecodcommission.org/our-work/estimating-high-groundwater-levels/

APPENDIX C: MONETARY NITROGEN OFFSET

For projects that will not connect to sewer, monetary nitrogen offsets may be allowed in certain circumstances. The appropriate Placetypes and methods for providing a monetary nitrogen offset are generally set forth in the 2025 Water Resource Technical Bulletin.

Nitrogen Management Policy

The 2025 RPP encourages growth in certain areas, such as Community Activity Centers, and discourages growth in other areas, such as in Natural Areas. For that reason, the per kilogram nitrogen monetary offset may be applied up to the maximum amount of $11,362; however, a lesser dollar amount per kilogram of nitrogen ($0 to less than $11,362) may be applied in areas where growth is encouraged as evidenced by:

- The presence of existing development, business and community activity, or
- The Local Comprehensive Plan or other planning documents identify a vision of growth and infill for the area, or
- Plans have been approved for construction of wastewater infrastructure or nitrogen management actions to be implemented within five years of a Commission Decision.

The maximum dollar per kilogram amount of $8,290 for nitrogen offsets was based on Capital and 20-year O&M costs for nitrogen removal by conventional sewering as derived from the Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod, updated in 2014. To adjust this amount to present day costs, the cumulative inflation factor of 1.3706 (~ 37%) was applied to the infrastructure and operational costs in the 2014 report to 2025 costs: $8,290 x 1.3706 = $11,362 .

Calculation of Monetary Nitrogen Offset

The monetary nitrogen offset represents the calculated cost to remove a project's nitrogen with a typical municipal-scale Wastewater Treatment Facility:

The per kilogram nitrogen offset cost calculation combines the capital cost for a treatment plant with assumed design flow of 1.5 million gallons per day and a collection system requiring 100 linear feet of piping per parcel connected, with the present value of the cost to operate and maintain that system for 20 years, to get the total present worth. Dividing the total present worth by the nitrogen load removed in kg-N per year

(20-yr planning period) results in the cost per kilogram of nitrogen removed in ($/ kg N / yr).

A project's monetary nitrogen offset is calculated by multiplying the project's total Nitrogen mass (in kg/yr) by the per kilogram nitrogen offset cost ($11,362 / kg N / yr).

EXAMPLE OFFSET

- 30-unit residential sub-division (mix of 2- and 3-bedroom)
- Actual flow: 125 gpd per unit; 3,760 gpd total
- Wastewater load to be offset: 136 kg-N/yr
- Calculation of monetary offset

$1.5 million = $289 million x 136 kg-N/yr / 24,800 kg-N/yr

Likewise $11,362 / kg-N per year x 136 kg-N/yr = $1.5 million