Appendix M

Effluent Discharge Technologies

APPENDIX M

TREATED WATER RECHARGE TECHNOLOGIES

SECTION 1 - INTRODUCTION

The purpose of this Appendix is to summarize the various treated water recharge technologies.

SECTION 2 – IDENTIFICATION OF TREATED WATER RECHARGE TECHNOLOGIES

All wastewater treatment facilities require a means of dREcharging and/or reusing treated water. The technology selected for recharge needs to be specific to the site to minimize the impacts of recharge on nearby surface waters and groundwater, while utilizing any potential site's unique features. This section describes available technologies.

1. **Sand Infiltration Beds.** Sand infiltration beds are open basins designed to allow treated water to flow across the bottom of the basin and percolate through the sand bed, through the unsaturated zone, and then to the groundwater (see Figure M-1). Bed maintenance is relatively easy because the bed is exposed at the surface and the sand surface can be raked or replaced if the sand becomes plugged with effluent solids. Hydraulic loading rates of 5 gallons per day per square foot (gpd/sf) of bed area (as called out by MassDEP per their guidance documents) are typical for sites on Cape Cod but higher rates may be allowed with appropriate hydraulic testing. The Town currently uses open sand beds at the existing WWTF.

Treated water recharge in sand infiltration beds has the following advantages:

- Bed construction is relatively simple.
- Operation and maintenance (O&M) is relatively easy and O&M costs are lowest.

- Hydraulic loading rates are typically higher than other recharge methods, which allow the beds to take up less area.

Treated water recharge in sand infiltration beds has the following disadvantages:

- Construction of new beds requires the clearing of large areas of land, which may have a visual impact.
- Infiltration beds do not have secondary uses, such as parking lots and recreational areas (as subsurface leaching or spray irrigation facilities might have).
- Extensive site work may be required for construction of new beds at new sites.
- Disinfection is typically required.

Several site specific studies have been prepared and are included in Appendices of this document regarding recharging treated water using this technology in Chatham.

2. **Subsurface Infiltration.** Large–scale subsurface infiltration facilities typically utilize pump and piping systems to pressure dose infiltration areas (trenches, beds, or galleries) where the treated water percolates to the groundwater (see Figure M-2). Maintenance and cleaning of these systems is more difficult because the infiltration area is not exposed to the surface and effluent solids cannot be easily cleaned. Subsurface infiltration beds can have the potential for secondary uses, such as parking lots, lawns, playing fields, and recreational areas. Hydraulic loading rates of 2.5 gpd/sf (to the trench or gallery base and side walls) are typical for sandy soils like those found in Chatham, but higher rates are allowed by MassDEP after appropriate hydraulic loading tests.

Subsurface infiltration facilities have the following advantages:

- Disinfection is typically not required prior to recharge unless it is in a water supply recharge area.
- Facilities are contained underground and can have a secondary use, such as parking lots and recreational areas.

They have the following disadvantages:

- Large land areas are required (larger than sand infiltration beds) due to lower hydraulic application rates.
- Pressure dosing is typically required for large systems, which adds capital and O&M costs.
- Extensive site work may be required for construction, particularly if the site is forested.
- There is limited access for cleaning and maintenance.

3. **Spray Irrigation**. Spray irrigation facilities are typically comprised of pumps, distribution piping, and a spraying system consisting of risers and spray nozzles (see Figure M-3). Treated water is pumped through various distribution lines and discharged via spray nozzles to the surrounding area. Spray irrigation systems have often been used at golf courses and in large remote fields. Application rates for non-golf course areas are typically 2 inches per acre per week. Application rates for golf courses are typically based on the turf management needs.

Treated water recharge using spray irrigation has the following advantages.

- Allows for secondary use of land (i.e., golf courses) as regulated by MassDEP.
- Provides inexpensive means of irrigation, reducing clean water demands.
- Provides nitrogen uptake by plant life and also reduced nitrogen application at golf courses.

Treated water recharge using spray irrigation has the following disadvantages:

- Difficult to find locations suitable or willing to use spray irrigation.
- Limited cold weather use due to potential freezing problems.
- Spray nozzles may be subject to clogging.
- Requires secondary means of treated water recharge or storage during winter months.
- Must meet more stringent MassDEP requirements for reclaimed water use.
- Large areas are needed.

4. **Well Injection.** Well injection involves the recharge of treated water to groundwater below the land surface. The recharge is accomplished by pumping the treated water through wells that extend into permeable, saturated, and unsaturated geologic strata (see Figure M-4).

When recharged into saturated strata, this type of discharge can be compared to the reverse of extracting water from a well.

Wells can be designed to recharge a range of treated water flows depending on site conditions, such as depth to groundwater and geological conditions. A potential concern of well injection is the mounding of groundwater in low elevation areas. As a result, well injection requires extensive testing prior to design and construction. This would include hydraulic conductivity tests, hydrogeologic surveys, and pilot testing.

Well injection of treated water has been implemented on a limited basis throughout the United States, and there are limited regulatory standards on the siting, design, construction, and operation of the wells. A pilot test for this technology, performed at the Hyannis WPCF, indicated that injection wells can become plugged with biological growth if the effluent is not chlorinated. Discussions with the Massachusetts Department of Environmental Protection indicate minimal support for the development of this technology because it requires chlorination that may create secondary impacts to the groundwater, such as the formation of disinfection byproducts, which may provide health risks.

Treated water recharge with well injection has the following advantages:

- The land area required would be much less than the area required for infiltration beds, subsurface infiltration, and spray irrigation. The treated water recharge would occur below the surface, and the surface would have minimal disruption.
- Discharge points (wells) could be spread over a large area to minimize groundwater mounding.

It has the following disadvantages:

- Effluent filtration is needed to provide a high level of nutrient and solids removal to minimize plugging in the wells.
- Relatively unproven technology in Massachusetts, with recent testing at the Hyannis WPCF.
- Limited performance data is available.

- Chlorination is needed, which conflicts with guidance from the Massachusetts Department of Environmental Protection (MassDEP).

5. **Ocean Outfall.** This alternative would involve the siting, construction, and operation of an ocean outfall for treated water into the Atlantic Ocean, or Nantucket Sound. The Massachusetts Ocean Sanctuaries Act prohibits the discharge of any municipal wastewater into an ocean sanctuary. Waters off the coast of Chatham fall into the Cape Cod Ocean Sanctuary and the Cape and Islands Ocean Sanctuary. The legislation is strictly imposed and a variance is only available to communities that have an existing municipal wastewater discharge to an ocean sanctuary. Since Chatham has no outfall, they would not be eligible to apply for a variance.

The option of seeking special legislation is the only way the Town could gain regulatory approval of this technology.

Effluent disposal using an ocean outfall has the following advantages:

- No large land area requirements.
- Protects the groundwater and coastal embayments.

It has the following disadvantages:

- Special legislation, possibly at the Federal level, required to obtain regulatory approvals.
- Extensive design and permitting requirements depending on the location of the discharge.
- Possible high public opposition, especially from those outside Chatham.
- Potential reduction in aquifer recharge.

6. **Wick Well Technology.** Wick technology is a relatively new and innovative approach to treated water recharge. Wick technology entails the use of larger (3 to 6 foot) wells dug to the water table aquifer. The wells are filled with stone; treated water is recharged over the stone to infiltrate via gravity flow into the underlying aquifer (see Figure M-5). There are two wick well installations in southeastern Massachusetts.

Treated water recharge with wick wells has similar advantages and disadvantages to injection wells. Advantages include:

- The land area required would be much less than the area required for infiltration beds, subsurface infiltration, and spray irrigation. The treated water recharge would occur below the surface, and the surface would have minimal disruption.
- Discharge points (wells) could be spread over a large area to minimize groundwater mounding.
- High public acceptance.

Disadvantages include:

- Effluent filtration is needed to provide a high level of nutrient and solids removal to minimize plugging in the wells.
- Relatively unproven technology in Massachusetts. Limited performance data is available.

7. **Drip Irrigation.** Drip irrigation is a subsurface version of spray irrigation. Treated water is used to irrigate large sod areas. Subsurface piping is laid out approximately 6 to 12 inches below the surface in areas to be irrigated. Treated water recharge is through emitters that are spaced 12 to 24 inches apart; the laterals are spaced at 12 to 24 inch intervals. Water is pumped through the lines under pressure but is recharged slowly through the emitters. The intent of the system is to recharge the water into the root zones of the plants (see Figure M-6).

Advantages include:

- Can be used in adverse terrain conditions.
- Is associated with water reuse because water is recharged into root zone of plants or crops.
- Ease of construction.
- Low human exposure to wastewater.
- Low delivery rate to minimize water table impacts.
- High public acceptance.

Disadvantages include:

- Effluent must be highly treated to minimize plugging.
- Difficult to monitor emitter performance.
- Periodic backflushing is required.
- May not operate in very cold conditions.
- There is limited long-term performance data.

8. **Wetland Restoration.** In recent years, an innovative technology/management concept has been considered. It is the conversion of abandoned cranberry bogs or previously modified wetlands to more diverse wetland settings that can accommodate and will benefit from increased hydrologic flow. It has the primary purpose of improving water quality of the groundwater flowing through the wetland and restoring hydrologic balance to areas that have been impacted by drinking water withdrawals. It can provide natural nitrogen attenuation and thereby protect downgradient marine waters. It can also provide improved wildlife habitat and improved open-space and recreational areas (see Figure M-7).

This concept has significant regulatory permitting challenges due to national, State, regional and local wetland protection regulations that have been written to stop any modifications in wetlands. However, many regulators, municipalities, and citizen groups are recognizing the water-quality and wildlife habitat benefits of converting previously disturbed, monoculture cranberry bogs to more diverse wetland settings.

The concept has been developed and promoted by the Massachusetts Estuaries Project (MEP) as a way to increase natural nitrogen attenuation in the watershed. It is also being considered as a way to reintroduce highly treated wastewater into watersheds that have been impacted by water withdrawals.

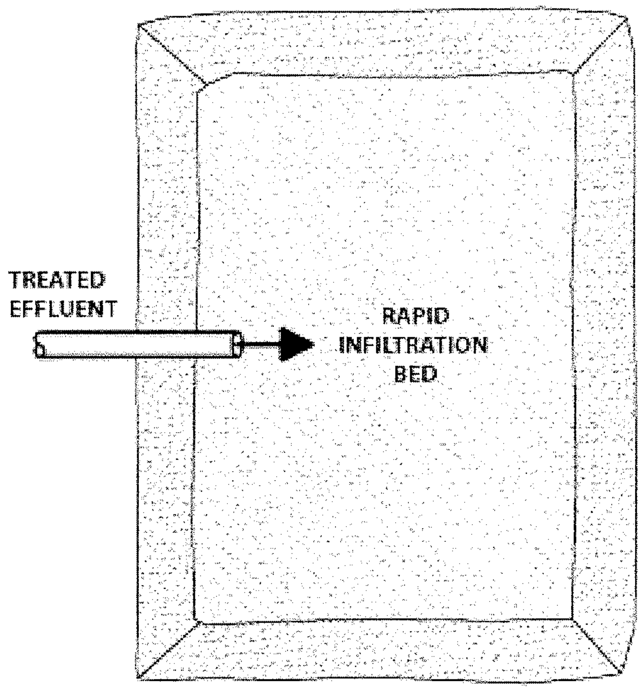
The benefits of wetland restoration include the following:

- Clearing of land is minimal; no change in land use would result.
- Significant nitrogen attenuation.
- High public acceptance.
- Potentially high ecosystem benefits.

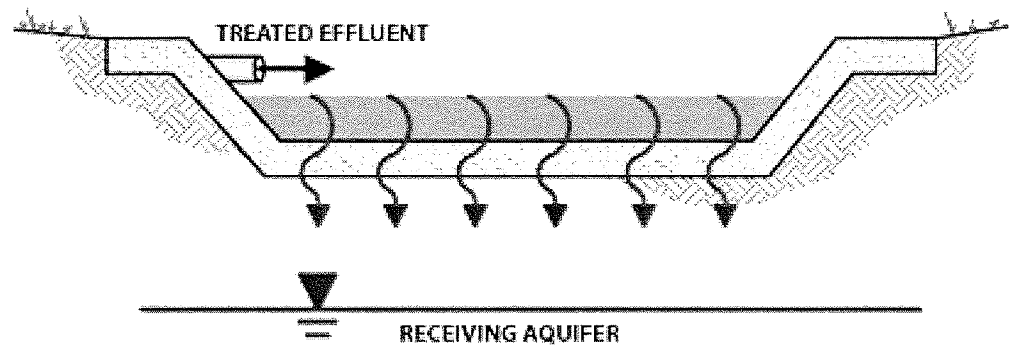
The disadvantages include:

- Regulatory hurdles are likely.
- Disinfection of effluent is likely required.
- Phosphorus removal is likely.

RAPID INFILTRATION BED (RIBs)



PLAN VIEW



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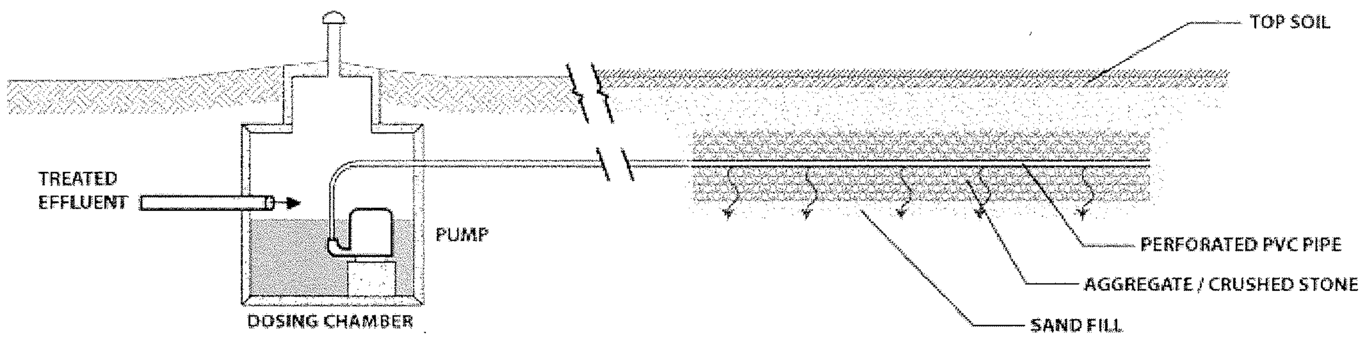
MANAGEMENT PLAN

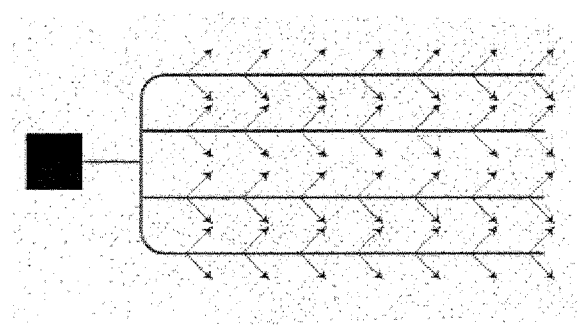
RAPID INFILTRATION BED

FIGURE M-1

SUBSURFACE INFILTRATION (PRESSURE DOSING)

CROSS SECTION VIEW





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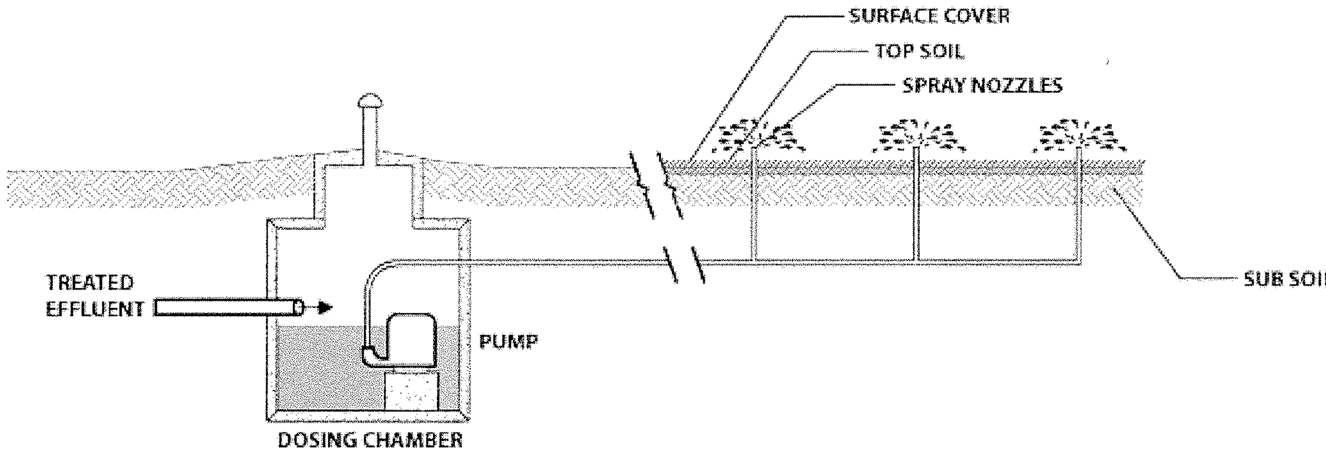
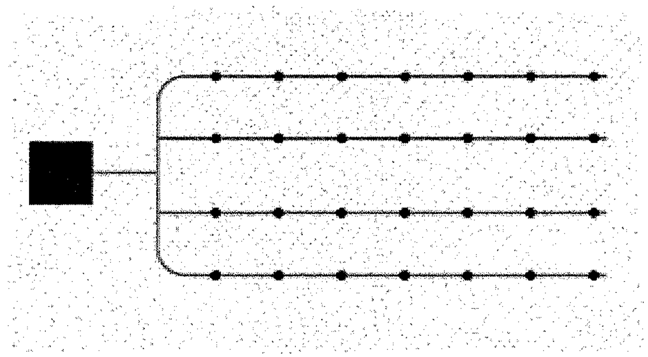
SUBSURFACE INFILTRATION

FIGURE M-2

SPRAY IRRIGATION

CROSS SECTION VIEW





PLAN VIEW

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SPRAY IRRIGATION

FIGURE M-3

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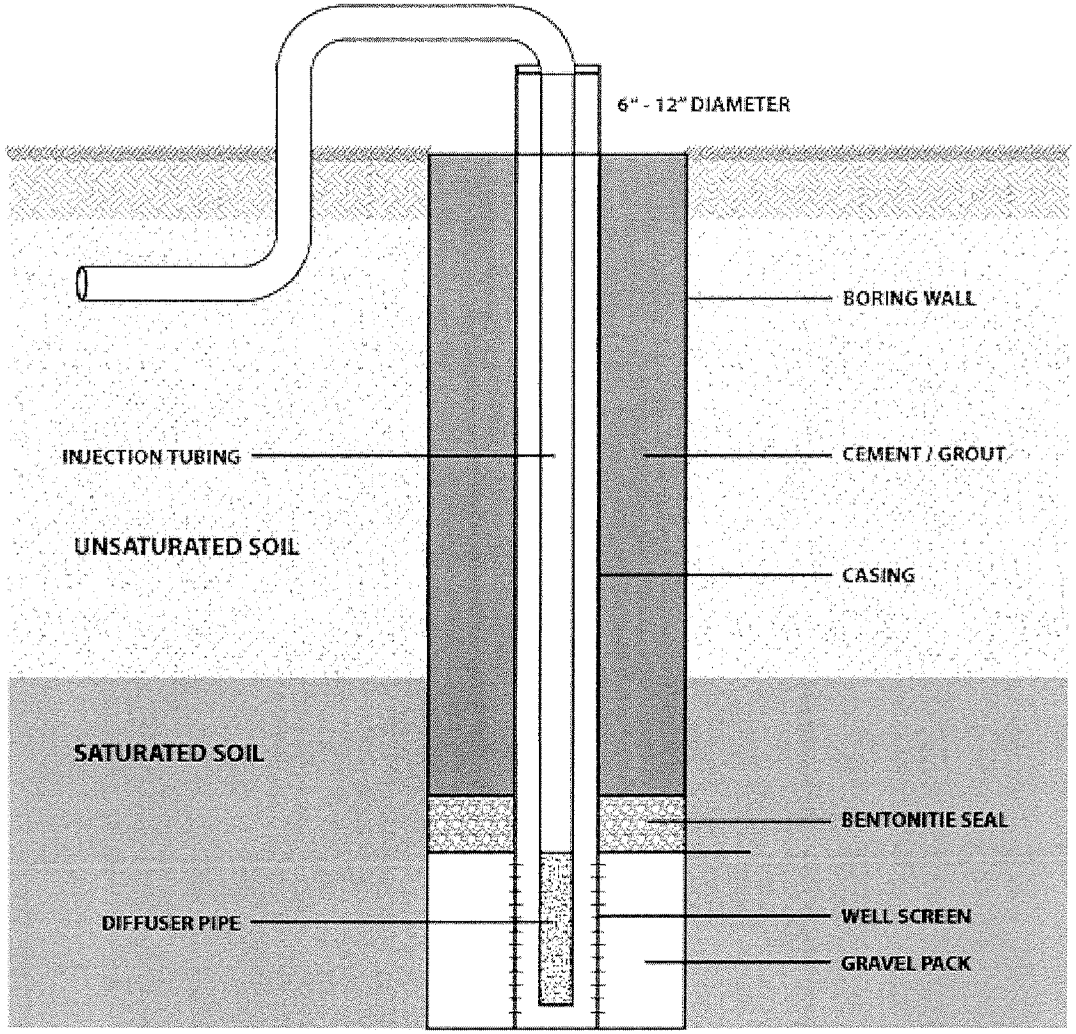
INJECTION WELL



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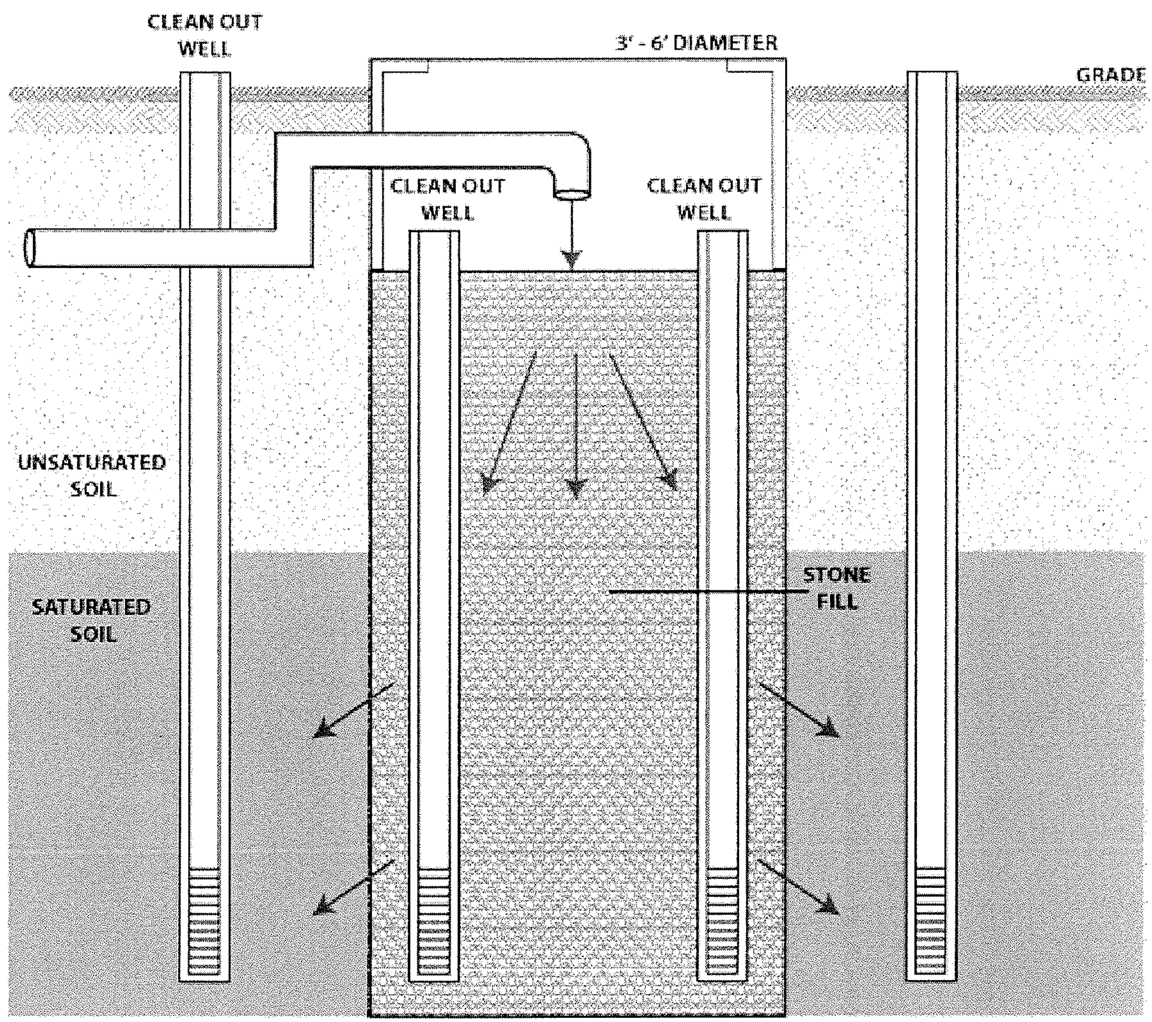
INJECTION WELL

FIGURE M-4

WICK WELL



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TOWN OF CHATHAM, MASSACHUSETTS
COMPREHENSVE WASTEWATER
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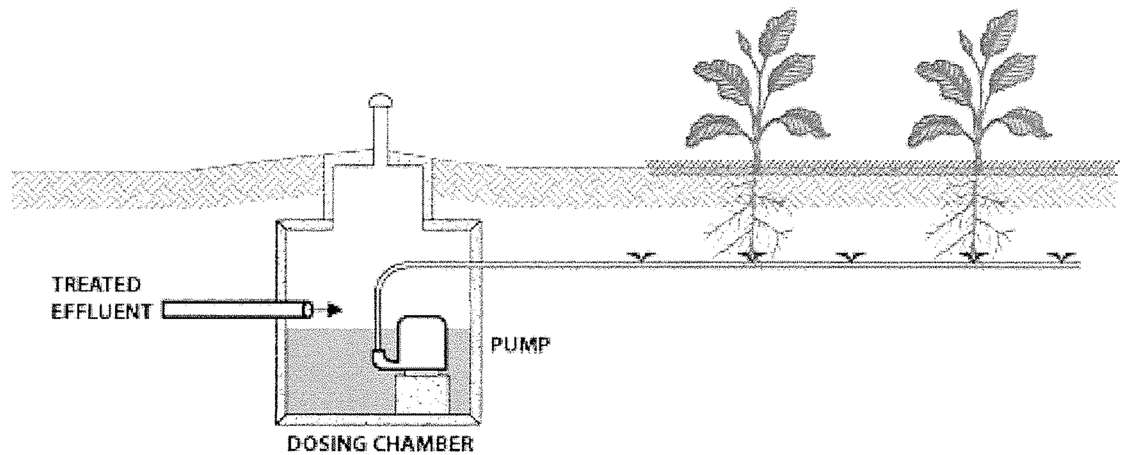
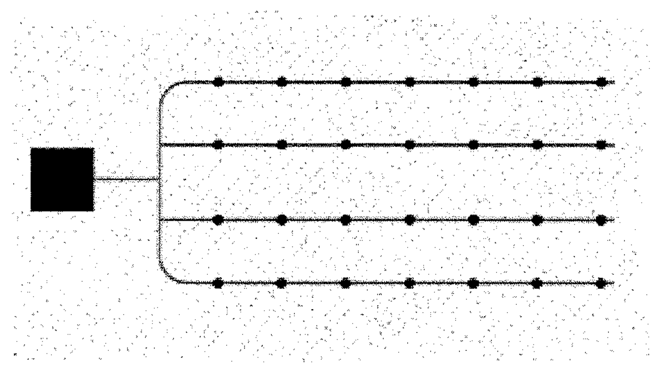
WICK WELL

FIGURE M-5

DRIP SYSTEM

CROSS SECTION VIEW





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TOWN OF CHATHAM, MASSACHUSETTS
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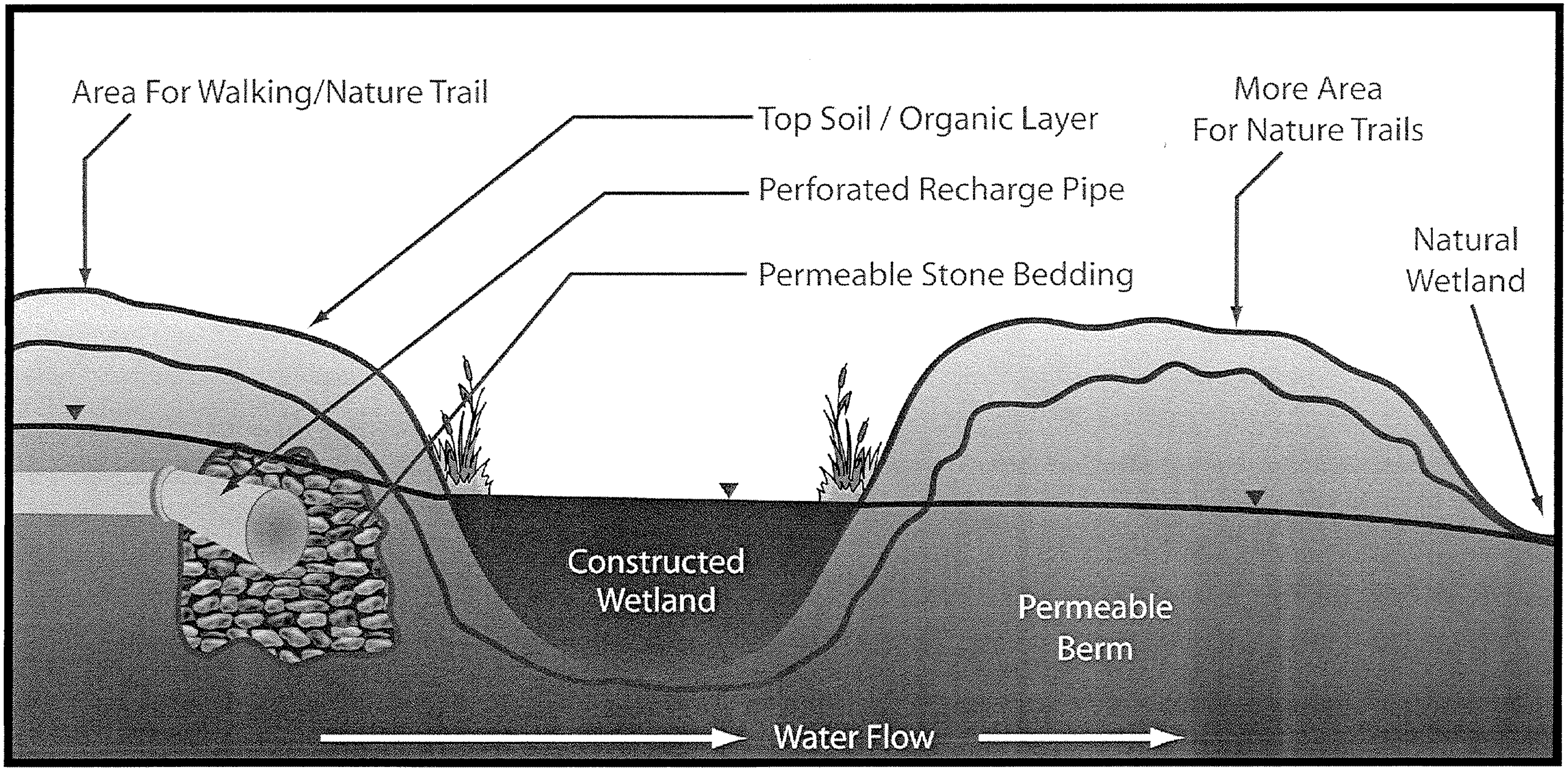
DRIP SYSTEM

FIGURE M-6



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WETLAND RESTORATION

FIGURE M-7