UNDERGROUND INJECTION WELLS FOR STORMWATER

BEST MANAGEMENT PRACTICES MANUAL

oregon association of CLEAN WATER agencies

January 2003

Working with more than 70 community wastewater treatment agencies to protect Oregon's water.

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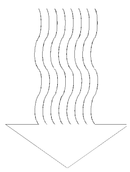
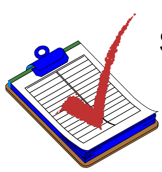
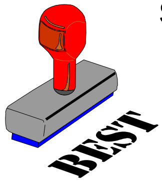
TABLE OF CONTENTS



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EMPLOYEES

APPENDICES

TABLES

FIGURES

EXHIBITS

SECTION 1.0

INTRODUCTION

Contents of Section 1.0

This section provides an introduction to the manual including background information regarding the UIC rules, purpose and applicability of the manual, and organization of the manual contents.

1.1 INTRODUCTION / BACKGROUND

Underground Injection Control (UIC) is a federal program under Part C of the Safe Drinking Water Act, with regulations first promulgated in 1983. Injection of fluids below ground is strictly regulated under the UIC program. The purpose of the program is to protect groundwater from contamination. According to the Oregon Administrative Rules (OAR) all groundwater in Oregon is considered suitable as a source of drinking water (OAR 340-044-0010(1)).

As with other Safe Drinking Water Act and Clean Water Act programs, implementation is delegated to state agencies. The UIC program was delegated to the Oregon Department of Environmental Quality (DEQ) in 1984, and delegation was reauthorized in 1991. In 1994, the U.S. Environmental Protection Agency (EPA) was sued regarding the adequacy of the UIC program. Based on the outcome of that lawsuit, in April of 2000, EPA gave the states 270 days to develop and submit new UIC rules for EPA approval. As a result, DEQ established a UIC working group in mid-1999 and a Task Force in October 1999 to assist the agency in updating and clarifying the state's UIC rules.

DEQ recognizes that stormwater disposal in underground systems may become more attractive as surface water disposal options are narrowed due to surface water quality concerns. One of the purposes of the UIC program is to see that all stormwater management entities (municipalities, other government entities, industries, and commercial enterprises) exercise the same care with respect to stormwater discharged to the ground that they do with stormwater that is discharged to surface water bodies (i.e., through the National Pollutant Discharge Elimination System (NPDES) program). The new Oregon UIC rules were adopted by the Environmental Quality Commission on June 22, 2001 and became effective September 20, 2001. The text of the Oregon UIC rules is contained in Appendix A.

Under the UIC rules, injection systems fall into five classes (Class I – V). Class V injection systems include five basic sub-categories of injection systems that inject fluids other than hazardous waste or radioactive waste into the subsurface. This manual is focused on one specific sub-category of Class V injection systems; stormwater injection systems that inject only stormwater runoff from residential, commercial or industrial facilities or roadways. In addition, the focus of this manual is on these Class V stormwater injection systems that are in municipal ownership.

Under the new State rules, Class V stormwater injection systems are prohibited unless they are "exempt", "authorized by rule", or "authorized by permit". These three classifications are defined as follows:

<u>Exemptions:</u> With respect to municipal Class V stormwater injection systems, an exemption from the UIC rules is provided for injection systems accepting stormwater runoff draining directly from a roof. The exemption applies only to roof drainage injection systems that do not accept, mix with or allow disposal of any other stormwater or fluid. Registration of these underground injection systems is still required, but requirements associated with authorization by rule or by permit do not apply. As of January 2003, DEQ requires registration of residential roof drain injection systems on a voluntary basis.

Rule Authorization: Municipal injection system owners are authorized by the UIC rules to continue operating existing Class V stormwater injection systems or construct new systems if the following conditions are met (OAR 340-044-0018):

- Existing stormwater injection systems were inventoried and registered with DEQ by December 2000 and new stormwater injection systems are registered with DEQ prior to operation.
- A system evaluation was conducted for existing systems, or will be conducted for new systems to show that the stormwater injection systems meet the following criteria:
  - No other waste (agricultural, industrial, sanitary) is mixed with stormwater.
  - Site design, development, construction, and management practices are implemented to minimize stormwater quantity.
  - No other method of stormwater disposal, including construction or use of surface discharging storm sewers or surface infiltration designs, is appropriate. An appropriate method shall protect groundwater quality and may consider management of surface water quality and watershed health issues.
  - No domestic drinking water wells are located within 500 feet (definition of a domestic water well can be found in Section 2.1).
  - No public water supply wells are located within 500 feet or the 2-year travel time, whichever is most protective (definition of a public water well can be found in Section 2.1).
  - The injection system does not exceed a depth of 100 feet.
  - No soil or groundwater contamination will be affected by injection (e.g., be mobilized).
  - Discharge does not occur directly into groundwater or below the highest seasonal groundwater table.
  - A confinement barrier or natural or engineered filtration medium is present between the base of the injection system and the highest seasonal groundwater table that prevents contaminants from reaching groundwater OR best management practices (BMPs) have been implemented to prevent or treat stormwater contamination before injection.
  - Spill control is present, including the ability to temporarily block a drainage facility in the event of a spill.
- A certification is prepared to certify that no hazardous substances or toxic materials are used, handled or stored in areas draining stormwater runoff to municipal stormwater injection systems. For municipal systems, this certification was due July 1, 2002.
- A stormwater management plan is prepared and implemented for municipal stormwater injection systems. For municipal systems, this was due July 1, 2002.

Jurisdictions are required to address both site and operational issues in the stormwater management plans for underground injection systems, focusing on:
1. the need for and effectiveness of pre-treatment before injection,
2. spill prevention and control measures designed to minimize immediate harm to underlying aquifers,
3. systematic monitoring and record keeping, and
4. system performance evaluation.

The stormwater management plans must be updated “routinely” as current conditions change. The municipal stormwater management plan requirements are different for municipalities 50 or more stormwater injection systems and municipalities with less than 50 registered underground injection systems as shown on the next page in Table 1-1 (OAR 340-44-0018 (3) (b) and (c)).

Table 1-1. Underground Injection System
Municipal Stormwater Management Plan Requirements
According to OAR 340-44-0018 (3) (b) and (c)

Plan Elements	Large Systems (=/> 50 Systems)	Small Systems (<50 Systems)
System Assessment	• Construction details of the underground injection systems and associated stormwater controls • Site conditions (i.e., land use and locations of use, handling or storage of hazardous substances and toxic materials)	Same
System Controls	• BMPs for source control and treatment • BMPs for segregation of stormwater from "areas where hazardous and toxic materials are used, handled, or stored" • Spill prevention and response plan • Maintenance plan and schedule, including frequency of visual inspection • Employee and public education plan • Named persons responsible for implementing these BMPs or plans	Same
System Monitoring	• Evaluates effectiveness of BMPs for treating stormwater prior to injection • Defines locations, times, analytes, and protocols • Uses information in system assessment to select representative sites and additional analytes • DEQ sets minimum sampling events as 2 in first year and 1 each subsequent year (at onset of wet weather) • DEQ sets minimum analytes as: ▪ BTEX (benzene, toluene, ethylbenzene, xylenes) ▪ benzo(a)pyrene ▪ lead, chromium, cadmium (unfiltered) ▪ total nitrogen ▪ fecal coliform	Routine evaluation of the effectiveness of the plan
Data Management	• As needed to track above items, particularly monitoring results. Monitoring and sampling results to be available for review upon request. On or before June 30, 2004, a summary report must be submitted to DEQ on the municipal stormwater management plan implementation, monitoring and sampling with supporting records and laboratory documentation. The report shall also include an assessment of the effectiveness of best management practices. With approval from DEQ, this assessment may be done as a regional or statewide study. • Annual monitoring is required on an on-going basis	Not necessary

This document is designed to provide individual jurisdictions with materials that can be used to craft the "System Controls" section of the plan. Individual jurisdictions are expected to use the guidance in this manual to develop customized stormwater management plans that meet the DEQ rules and are appropriate for the specific ordinances, infrastructure, and site conditions of the jurisdiction.

Authorization by Permit: If the information cannot be provided to show that an injection system qualifies as "rule authorized", then a Water Pollution Control Facilities (WPCF) permit will be required or the system must be decommissioned. An individual WPCF permit may be obtained for each injection system or for a larger group of injection systems (i.e., an area-wide permit). Information required to apply for a WPCF permit is similar to information required for obtaining rule authorization. Information is needed regarding the characteristics of the system, potential groundwater impacts that may occur, and steps that will be taken to prevent such impacts.

In certain cases underground injection is prohibited and a WPCF permit will not be issued. The prohibitions for Class V injection systems are outlined in OAR 340-044-0015(2). Underground injection is prohibited for Class V systems injecting:
Sewage into cesspools.

- Fluids from industrial/commercial processes using hazardous substances or petroleum products (exceptions with special permit conditions).
- Fluids from operation areas where hazardous substances or petroleum products are used or stored.
- Fluids directly from floor drains at industrial/commercial facilities.
- Motor vehicle waste from vehicle repair or maintenance.
- Industrial or municipal wastewater directly into groundwater.
- Agricultural drainage.

If a stormwater injection system cannot be exempted, rule authorized, or authorized by permit the system could potentially be updated or retrofitted to meet the criteria for those designations. However, if a decision is made to not update or seek a permit for a stormwater injection system that cannot be rule authorized or exempted, or a stormwater injection system is prohibited under OAR 340-044-0015(2), then the stormwater injection system must be decommissioned. Once an injection system has been decommissioned, stormwater must be managed using an alternative method such as routing stormwater to a surface discharging system or utilizing surface infiltration. Section 6.0 contains guidance for decommissioning underground injection systems and alternative stormwater management methods. For additional information, UIC rule-related guidance is available on DEQ's Web site at: *http://www.deq.state.or.us/wq/groundwa/uichome.htm*

The DEQ UIC Web site should be checked on a regular basis as guidance may change. It should be noted that all Web site addresses reported in this manual are as of August 1, 2002. Web site addresses and content may change over time.

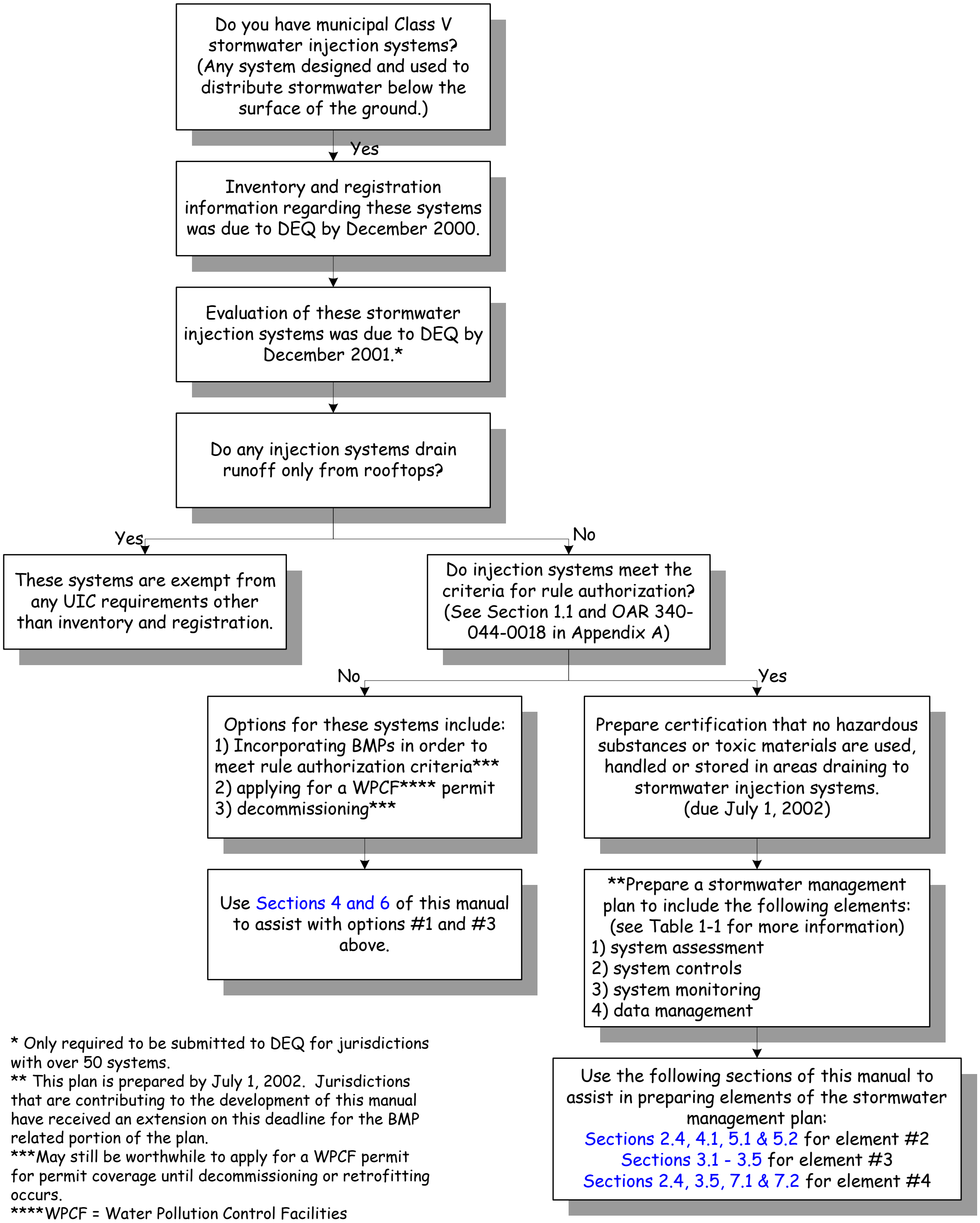
1.2 PURPOSE AND APPLICABILITY OF MANUAL

For municipal stormwater injection systems to be rule authorized or permitted, a stormwater management plan for injection systems must be developed. The purpose of this manual is to provide guidance for municipalities in the development of specific sections of stormwater management plans for injection systems. Specifically:

- The first purpose is to provide guidance for the continued operation of existing stormwater injection systems. This guidance includes a compilation of the best available existing information regarding the following management practices for municipal stormwater injection systems: BMPs for source and spill control, pre-treatment BMPs, maintenance practices, decommissioning, record keeping and reporting, and employee/public education. See Figure 1-1.
- The second purpose is to provide guidance related to the development of new stormwater injection systems including: siting criteria, design guidelines, construction details, and maintenance practices. The guidance in this manual regarding upstream BMPs for source/spill control, pre-treatment BMPs, record keeping and reporting, and employee/public education for existing stormwater injection systems also applies to new stormwater injection systems once they are operational. See Figure 1-2.

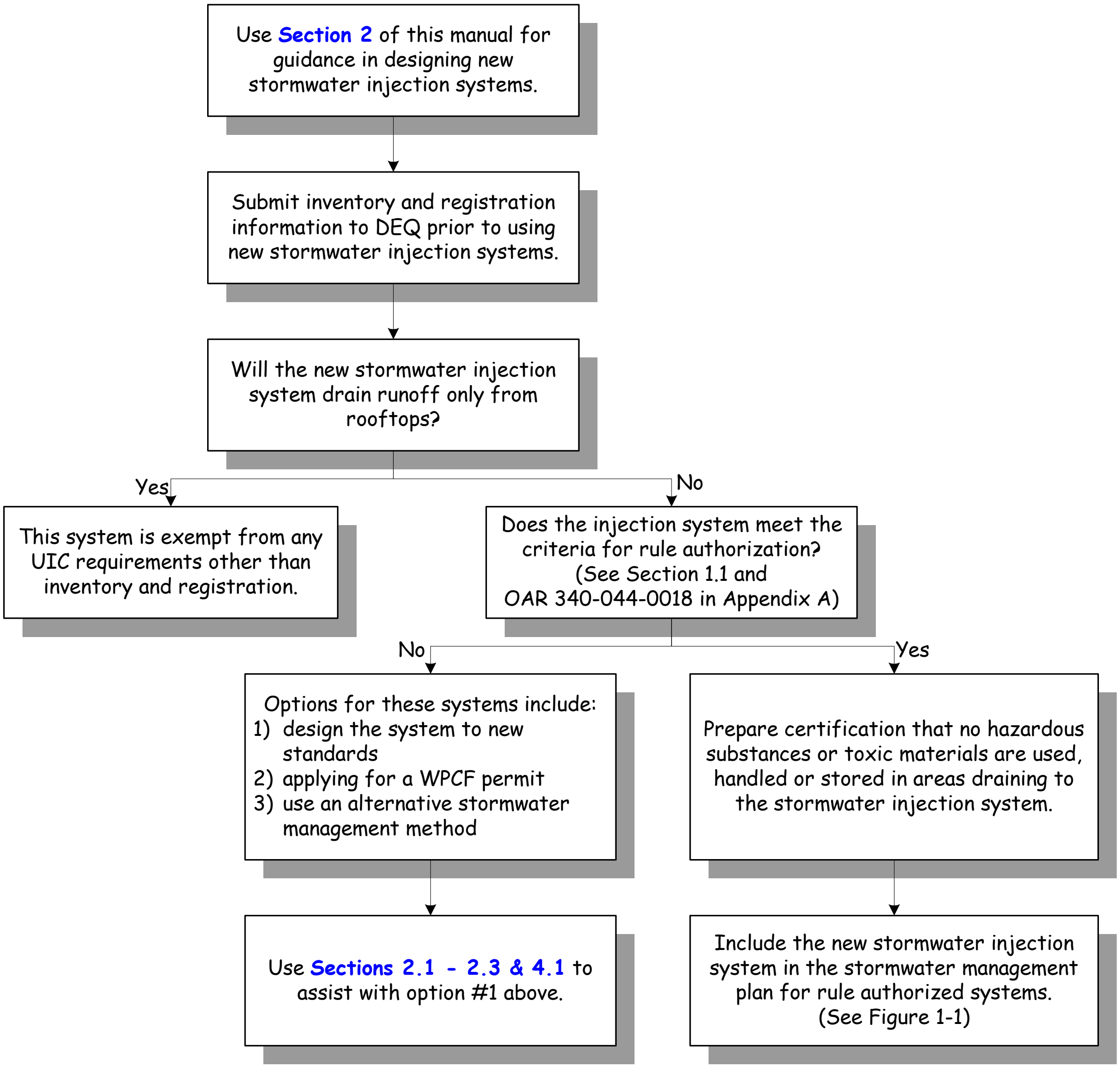
The manual will apply to municipal stormwater injection systems throughout the State of Oregon. As each municipality is unique in terms of the makeup and characteristics of their stormwater injection systems, each management plan will also need to be unique. The manual includes DEQ-approved elements of a management plan and provides options for municipalities to draw from in order to create their own individual programs. Individual jurisdictions are expected to use the guidance in this manual to develop customized stormwater management plans that meet the DEQ rules and are appropriate for the specific ordinances, infrastructure, and site conditions of the jurisdiction.

Figure 1-1
Guidance for the Development of Existing Stormwater Injection Systems



* Only required to be submitted to DEQ for jurisdictions with over 50 systems.
** This plan is prepared by July 1, 2002. Jurisdictions that are contributing to the development of this manual have received an extension on this deadline for the BMP related portion of the plan.
***May still be worthwhile to apply for a WPCF permit for permit coverage until decommissioning or retrofitting occurs.
****WPCF = Water Pollution Control Facilities

Figure 1-2
Guidance for the Development of New Stormwater Injection Systems



1.3 IMPORTANT DEFINITIONS

Some terms used when discussing stormwater management and underground injection control issues may have a variety of interpretations. Therefore, for the purposes of this document, the following terms have been clearly defined below: stormwater injection systems, best management practices (BMPs), source control BMPs, and pre-treatment BMPs.

Stormwater injection systems – Stormwater injection systems are Class V injection systems used for subsurface emplacement or discharge of stormwater runoff. Stormwater injection systems are designed to directly convey stormwater to the subsurface, and do not include stormwater discharge methods utilizing surface infiltration. Surface infiltration occurs when fluid moves from the ground surface into the underlying soil material without the subsurface fluid emplacement. The stormwater injection systems addressed in this manual are grouped into two categories: vertical injection systems and horizontal injection systems. Vertical injection systems are stormwater injection systems, such as dry wells and sumps, which have a vertical dimension (i.e., depth) greater than their horizontal dimension (i.e., diameter, or width and length). Horizontal injection systems are stormwater injection systems with greater horizontal dimensions than their depths. Examples of horizontal injection systems include french drains and infiltration trenches.

Best management practices – Best Management Practices (BMPs) for stormwater are schedules of activities, prohibitions of practices, maintenance procedures or other management practices to prevent or reduce the discharge of pollutants in stormwater. BMPs for stormwater may include operational and structural source controls that minimize and prevent contaminants from entering stormwater as well as treatment BMPs that remove contaminants contained in stormwater runoff before disposal or discharge (OAR 340-044-0005 (5)). In order to rule authorize a stormwater injection system, the owner or operator of the system must implement best management practices that prevent or treat stormwater contamination before injection, or a confinement barrier or a natural or engineered filtration medium must be present between the base of the injection system and the highest seasonal groundwater level that prevents contaminants from reaching groundwater (OAR 340-044-0018 (3)(a)(H)).

Source control BMPs – Source control BMPs include structural and non-structural BMPs designed to reduce runoff and/or prevent pollutants from affecting stormwater runoff. They include site design BMPs such as porous pavement and eco-roofs, source separation and containment practices, street and parking lot operational and maintenance BMPs such as street sweeping, catch basin cleaning and litter pick-up, operational and structural BMPs for specific activities such as vehicle cleaning, and spill control and response practices. Source control BMPs can be an element of rule authorized stormwater injection systems that do not have a confinement barrier or a natural or engineered filtration medium present between the base of the injection system and the highest seasonal groundwater table that prevents contaminants from reaching groundwater.

Site design BMPs – Site design BMPs are a type of source control BMP. Site design BMPs are practices and/or facilities that can be implemented to reduce the amount of impervious area at a site and the negative impacts from impervious areas that occur when sites are developed. Site design BMPs focus on minimization of impervious surface areas and the use of infiltration and dispersion through on-site vegetation to provide flow control and treatment of runoff. Site design BMPs can be used to provide runoff reduction and some water quality treatment of runoff from low pollutant-generating surfaces, such as driveways, small parking lots and rooftops[1]. Site design BMPs may include BMPs that reduce runoff volumes through site planning (e.g. reducing impervious surface areas), BMPs that reduce runoff volumes through infiltration or dispersion of runoff (e.g. porous pavement), and BMPs that provide retention and filtration of runoff on site (e.g. flow-through stormwater planters).

Pre-treatment BMPs – Pre-treatment BMPs remove pollutants from stormwater prior to stormwater discharge. They include vegetated swales, filtration systems, catch basins, sedimentation manholes, and other systems designed to remove pollutants through sedimentation, filtration and flotation. Although some pre-treatment BMPs (e.g. swales, ponds) may have incidental infiltration, they are designed for stormwater conveyance, detention, and treatment before ultimate discharge of stormwater to surface waters or the subsurface. Pre-treatment BMPs that may generate incidental infiltration are not considered to be stormwater injection systems by DEQ. Pre-treatment BMPs can be an element of rule authorized stormwater injection systems that do not have a confinement barrier or a natural or engineered filtration medium present between the base of the injection system and the highest seasonal groundwater table that prevents contaminants from reaching groundwater.

Additional definitions of words related to underground injection systems according to the DEQ UIC rules are provided in Appendix A, which contains the text of the DEQ UIC rules as recorded in OAR 340-044-0005 through 340-044-0055.

1 Porous pavement may not be appropriate for heavily-traveled roadways. See Fact Sheet #1 in Appendix B.

1.4 ORGANIZATION AND SUMMARY OF MANUAL CONTENTS

Section 1.0 (Introduction) provides information on the Oregon UIC program and its requirements and an overview of the manual.

Section 2.0 (Stormwater Injection System Siting, Design, Construction and Maintenance Guidance) provides design guidance for stormwater injection systems. Design guidance include descriptions of siting criteria, design guidelines (including the use of pre-treatment devices), construction details and maintenance practices.

Section 3.0 (Source Control Practices) provides descriptions of source control practices to reduce or eliminate the contact between stormwater runoff and contaminants to minimize the threat to groundwater. These source control practices include source separation, operational BMPs and spill control.

Section 4.0 (Pre-Treatment Practices) provides information regarding BMPs that are suitable for pre-treatment upstream of stormwater injection systems. These BMPs include site design BMPs, swales, stormwater ponds, filtration facilities, catch basins/sedimentation manholes, oil and water separators, and proprietary devices such as catch basin inserts. Fact sheets are provided for each type of BMP listed above that include information such as general description and application, advantages/disadvantages, maintenance practices and reference links to the most suitable design information.

Section 5.0 (Employee Education Guidance and References) provides guidance with respect to employee education. Education program examples are provided for reference. Section 6.0 (Guidance for Decommissioning Stormwater Injection Systems) outlines the Oregon DEQ requirements with respect to decommissioning of stormwater injection systems as an alternative to complying with UIC requirements. This section provides recommended procedures for decommissioning for local jurisdictions if they choose to, or if they are required to decommission a stormwater injection system.

Section 7.0 (Record Keeping and Reporting Recommendations) provides guidance on record keeping and reporting activities for stormwater injection systems to meet DEQ UIC rule requirements.

SECTION 2.0

STORMWATER INJECTION SYSTEM

SITING, DESIGN, CONSTRUCTION AND MAINTENANCE GUIDANCE

Contents of Section 2.0

This section provides design guidance for stormwater injection systems. The purpose of this guidance is to assist municipalities in minimizing the pollution from stormwater injection systems to underground sources of drinking water.

The design guidelines include:
- Siting Considerations (Section 2.1)
- Design Guidelines (Section 2.2)
- Construction Details (Section 2.3)
- Maintenance Practices (Section 2.4)

2.1 SITING CRITERIA

To be effective and protective of the environment, a new stormwater injection system must be appropriately located in an area with suitable subsurface conditions and at an appropriate distance from sensitive areas, or potential sources of drinking water. It must be properly designed, built and maintained. This section describes the factors that influence siting and provides design, construction and maintenance guidance. Figure 2-1 summarizes the guidance for development of new stormwater injection systems.

In siting new stormwater injection systems, municipalities will need to make sure that the injection systems do not become conduits for migration of contaminants into groundwater and hence into potential sources of drinking water. The goal of proper siting is to provide separation horizontally and vertically between the stormwater injection system and potential receptors of pollutants such as aquifers and drinking water wells. In general, the greater the separation between a stormwater injection system and groundwater, the lower the potential for pollutants to impact groundwater.

In addition, it is also important that municipalities consider how the system will be designed, operated and maintained when siting new systems. New systems should be sited to allow easy access for maintenance and monitoring. If the municipality wishes to implement source control or pre-treatment BMPs with the new injection system, consideration should be given to how those BMPs will be incorporated into the design at various sites. Source control BMPs and pre-treatment BMPs may be easier and less expensive to implement if they are incorporated into the siting and design decisions early in the injection system planning process.

Designers and installers of stormwater injection systems should consult the Oregon DEQ UIC program Web page (*http://www.deq.state.or.us/wq/groundwa/uichome.htm*) before siting a stormwater injection system. Siting criteria are summarized in Table 2-1. Siting criteria in the table are divided into two columns based on whether the criteria must be met in order to rule authorize new stormwater injection systems or the criteria is recommended by DEQ to protect groundwater and other sensitive areas.

Figure 2-1
Guidance for the Development of New Stormwater Injection Systems

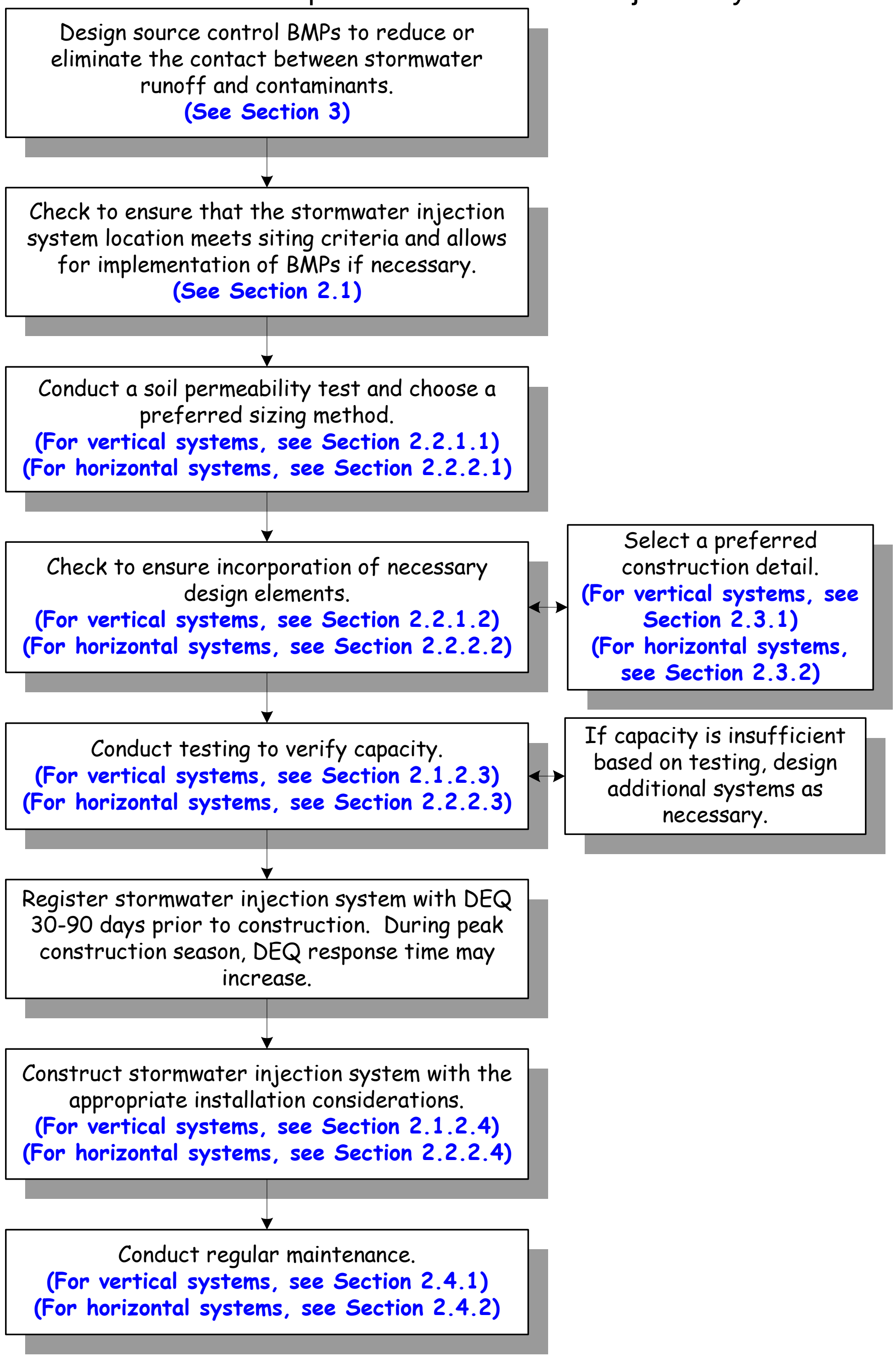


Table 2-1
Siting Criteria for New Stormwater Injection System

Considerations	Siting Criteria Required for Rule Authorization	Siting Criteria Recommended by DEQ[2]
Setback distance from drinking water wells	• No domestic drinking water supply wells are present within 500 feet • No public drinking water supply wells are present within 500 feet or 2-year time-of travel, whichever is more protective	
Vertical separation from the high groundwater table	• Injection system does not exceed a depth of 100 feet and does not discharge directly into groundwater or below highest seasonal groundwater level	• A minimum separation of between 4 to 10 feet exists between the bottom of the stormwater injection system and the seasonal high groundwater table, depending on site subsurface soil conditions and volume of injection
Subsurface soil requirements	• A confinement barrier exists in subsurface soil or a natural or engineered filtration medium is placed between base of injection system and highest seasonal groundwater level (required for rule authorization if no BMPs are used)	• Sufficient permeability to drain the entire volume of the design storm within 48 to 72 hours
Sensitive area considerations		Consider proximity to the following areas when siting a stormwater injection system: • Wellhead Protection Areas or groundwater withdrawal areas • Wetlands and riparian areas • Groundwater management areas. • Designated sole source aquifers • Areas in close proximity to water quality-limited streams (except for streams listed for temperature only) • Designated Federal Emergency Management Agency (FEMA) floodplain and floodways • Areas prone to landslides or slope instability • Properties with existing or past practice contamination issues

[2] Note: DEQ siting criteria recommendations as of October 2002. DEQ recommendations are subject to change over time.

Considerations	Siting Criteria Required for Rule Authorization	Siting Criteria Recommended by DEQ[2]
Soil or groundwater contamination	No soil or groundwater contamination exists that will be impacted by the construction or use of a stormwater injection system	Potential areas where contamination may exist include: • Industrial areas and commercial developments where activities involve petroleum products, herbicides, pesticides, or solvents. • Areas where "reportable quantities" of hazardous materials are expected to be present • Areas with a high risk for spills of toxic materials, such as gas stations and vehicle maintenance facilities • Locations where deicing using salts or other chemicals occurs in winter • Designated truck routes and high vehicle traffic roads
Other siting considerations		Other siting considerations include: • Stormwater injection systems should be placed within public right-of-ways or drainage easements to assure access for maintenance • Setback distances from building foundations and natural water bodies should be considered • If the municipality wishes to implement source control or pre-treatment BMPs with the new injection system, consideration should be given to how those BMPs will be incorporated into the design

The following text provides detailed discussion of these siting criteria and provides references for obtaining additional information where necessary. These siting criteria are compiled based on DEQ's requirements for rule authorization of Class V stormwater injection systems and DEQ's recommendations for protecting groundwater and sensitive areas, as noted above in Table 2-1.

1. Setback Distance From Drinking Water Wells

The distance that pollutants may travel from their source toward a drinking water well will vary greatly depending on local factors such as the depth of injection, volume and rate of rainfall, type and extent of contamination, subsurface soil characteristics, groundwater flow conditions, water supply well use patterns, etc. Because a site investigation to determine the optimum distance of separation for each injection system is not practical, DEQ has developed the following general setback requirements for rule authorized Class V stormwater injection systems:

- Stormwater injection systems shall not be located within 500 feet of a domestic drinking water well.
- Stormwater injection systems shall not be located within the 2-year time-of-travel zone as delineated by the Oregon Health Services (OHS) or closer than 500 feet to a public water supply well, whichever is more protective (i.e., whichever distance is larger).

A domestic well is a well that produces water for human consumption. Information on domestic water wells can be found in the Oregon Water Resources Department (WRD) water well database (Groundwater Resource Information Distribution – GRID). WRD tracks the installation and abandonment of wells, including wells used for monitoring, industrial water use, and domestic drinking water. The WRD GRID database has been compiled from many historical well reports and is updated daily as well constructors submit new well logs to the department. Over 250,000 well reports for water wells, geotechnical holes, and monitoring wells are available in the GRID database. However, there are likely some wells in Oregon that have not been tracked accurately in the GRID database because of lack of data. For instance, abandoned wells that are no longer used for drinking water purposes may be listed as active wells in the GRID database if no formal well abandonment procedure was performed. The WRD database can be found at the following Web site: *http://deschutes.wrd.state.or.us/apps/gw/well_log/*.

To evaluate setback distances from domestic water wells, injection systems and all domestic water wells identified in the vicinity can be plotted on a map. A circle with a 500-foot radius can be drawn around the stormwater injection system to check whether any domestic water wells fall within the 500-foot vicinity.

Note that the information provided in the WRD database may sometimes be inadequate or inaccurate. Under some circumstances, field investigations may be necessary to verify the location and status of domestic water wells. Owners and operators of stormwater injection systems may want to check the WRD database annually to make sure that no new drinking water wells are installed within 500 feet of any existing stormwater injection system, as this may remove rule authorization eligibility for the injection system.

Information on the public water suppliers may be obtained from OHS or local public water supply agencies. A public water well is defined as a water well that has four or more service connections or serves at least ten people for more than sixty days in a year.

If there is a public water supply well in the study area, OHS' Groundwater Coordinator can be contacted at 503/731-4010 or 541/726-2587 for a copy of the delineated 2-year time-of-travel zone for the public water well. The distance between the public water well and the stormwater injection system, and the relative locations of the 2-year time-of-travel boundary and the stormwater injection system, if known, can then be evaluated to determine if the setback criterion is met.

2. Vertical Separation From the High Groundwater Table

Pollutants that are readily removed by adsorption to soil particles are less likely to contaminate the groundwater when injection systems do not directly discharge into groundwater. In order to rule authorize an injection system, the system may not exceed a depth of 100 feet and may not discharge directly into groundwater or below highest seasonal groundwater level. In addition, it is recommended that siting considerations include a minimum distance between the bottom of a stormwater injection system and the seasonal high groundwater table so that pollutants may be filtered out prior to stormwater entering groundwater. DEQ recommends a minimum separation distance of between four to 10 feet between the bottom of the stormwater injection system and the seasonal high groundwater level (see Figure 2-2 in Section 2.2 for a diagram of a typical dry well). Generally, a greater minimum separation distance (seven to 10 feet) is recommended for injection systems underlain by coarse-grained soils (sand and gravel) which have a lower capacity for removing pollutants through soil adsorption. A minimum separation distance of four to seven feet is recommended for injection systems underlain by fine-grained soils (clay and silt) that have a higher capacity for removing pollutants through adsorption onto soil particles. The type of surrounding land uses and associated expected pollutant loading to an injection system may affect best professional judgement regarding necessary vertical separation between an injections system and groundwater.

The seasonal high groundwater level may be discernable based on relevant United States Geological Survey (USGS) reports and local well logs. A bibliography of the reports that were published by the USGS or were authored by USGS personnel and published in State of Oregon reports, in journals, or in proceedings can be found at the following Web site: *http://oregon.usgs.gov/pubs_dir/orrpts.html.* The local well logs can be found from the WRD well log database at: *http://deschutes.wrd.state.or.us/apps/gw/well_log/.*

The seasonal high groundwater level for a proposed injection system location may also be reported in other documents. For example, the seasonal high groundwater level may also have been determined for a site close to the proposed injection system location for a septic system application. Septic system applications are submitted to DEQ in 14 counties and to county health or permitting departments in 22 counties. Contact DEQ or the county in which the proposed injection system site is located to ask for copies of any septic system applications that have been submitted for sites close to the proposed injection system, and review the applications for determinations of the seasonal high groundwater level. The distance of the septic system site from the proposed injection system site and varying soil and geological conditions between the sites may reduce the comparability of the groundwater levels between the sites.

If USGS reports, local well logs, or other documents reporting the seasonal high groundwater level are not available, a field investigation may be needed to determine the seasonal high groundwater level. The following provides general guidance for a field investigation to estimate groundwater levels.

When should a field investigation be conducted?
The best time would be the time of the highest groundwater level, which is typically late winter or spring in Oregon. The time of the highest groundwater level varies with the site's hydrogeologic setting, drainage characteristics of the subsurface materials, precipitation, and many other factors. It is recommended that jurisdictions consult with a licensed engineer, geologist, or hydrogeologist familiar with the local hydrogeologic conditions regarding the best time for conducting a field investigation.

What method can be used for a field investigation and what is the estimated relative cost?
There are several potential methods that are available. They vary in terms of accuracy, feasibility and relative cost.

- Direct Measurement
  The best method (in terms of accuracy) is direct measurement of groundwater levels using properly-constructed monitoring wells. Wells provide a means for periodic water level measurements throughout the winter and spring seasons, which helps ensure that the highest groundwater period is accurately identified. It is important to note, however, that the high water level time may vary somewhat from year to year based on the precipitation pattern during the year data are obtained. Direct measurement may be more expensive than other methods, because of equipment, monitoring, and data evaluation costs.

- Soil Borings
  If a groundwater monitoring well is not available, the depth to groundwater can usually be determined to a reasonable level of accuracy by drilling a soil boring and examining the degree of saturation of the soil column penetrated. Drilling methods vary greatly in complexity and cost. In areas where the depth to groundwater is reasonably shallow (30 to 60 feet), and the soil and water-bearing unit is comprised of unconsolidated fine-grained (silts and sands), a direct-push type drilling rig may be used. In areas underlain by gravel or consolidated bedrock, traditional drilling methods may be required (e.g., air rotary, cable tool, etc.). Direct-push drilling is typically much less expensive than other drilling methods.

- Indirect Geophysical Tools
  Indirect geophysical methods to estimate the depth to groundwater, such as seismic refraction or electromagnetic techniques, may also be practical in some situations. The drawback of using indirect geophysical methods is that it requires interpretation on groundwater depth based on indirect data. The advantage of using indirect geophysical tools is that it also provides some information regarding subsurface soils.

The cost of implementing a field investigation to estimate the depth to groundwater depends on a number of factors including the availability of existing wells, subsurface conditions, period of monitoring, level of precision required, etc. Field investigation costs may increase if traffic control or formal access agreements are necessary to conduct the investigation.

3. Subsurface Soil Requirements

Besides the vertical separation from the high groundwater table, the extent to which potential pollutants are removed by subsurface soils depends in part on the geologic components of the subsurface soils. Clay content in the soil is usually desirable for removing pollutants, particularly metals, from the stormwater. Sand or gravel has a much lower capacity for removing certain types of pollutants. For rule authorization of injection systems, there must be a confinement barrier or a natural filtration medium between the base of the injection system and the highest seasonal groundwater level or BMPs must be implemented to prevent contaminants from reaching groundwater. In general, fine-grained materials such as clay or silts are considered to provide a better filtration medium when compared to sand and gravel. However, for installation of a stormwater injection system to be practical, the surrounding soil permeability must be sufficient to drain the entire volume of the design storm within a certain period of time. Consequently, stormwater injection systems have typically been constructed in areas underlain by coarse-grained soils.

As stormwater injection systems may not be suitable in soils with low infiltration rates due to capacity issues, design engineers will need to balance infiltration capacities against the filtering abilities of the soil when siting stormwater injection systems. In places where a confinement barrier between the base of the injection system and the highest seasonal groundwater level does not exist, a natural or engineered filtration medium should exist or be placed between the base of the injection system and the highest seasonal groundwater level, or BMPs must be implemented to prevent exposure to pollutants or treat stormwater before injection for rule authorization of injection systems. Source control and pre-treatment BMPs are discussed in Sections 3.0 and 4.0.

It is recommended that stormwater injection systems be sited above soils with sufficient permeability to drain the entire volume of the design storm from the area tributary to the injection system within 48 to 72 hours, depending on typical storm intervals in the area. In western Oregon, where rain storms are more frequent, injection systems should drain within approximately 48 hours and in eastern Oregon, where rain storms are less frequent, they should drain within approximately 72 hours. Complete drainage is necessary to maintain aerobic conditions in the underlying soil and to allow the dry well drain before the next storm event. Locations where long periods of standing water in a stormwater injection system exist can cause vector problems (e.g. mosquitoes). Some design manuals (e.g., 2000 Maryland Stormwater Design Manual, Volume I, and 2001 New York State Stormwater Management Design Manual) recommend a minimum soil infiltration rate of 0.5 inches per hour and that the entire volume of the design storm should drain in less than 48 hours.

4. Sensitive Area Considerations

It is recommended that municipalities consider the proximity of a site to the following areas when siting stormwater injection systems in order to protect groundwater quality and sensitive areas:

- Wellhead Protection Areas or Groundwater Withdrawal Areas
  The Wellhead Protection Area Web site for Oregon Health Services can be used to locate Wellhead Protection Areas that have been delineated and groundwater withdrawal areas where source water assessments have been completed under the voluntary Drinking Water Protection Program. The Web site is located at: *http://www.ohd.hr.state.or.us/dwp/swp.htm*

  If the proposed stormwater injection system may be near a delineated or assessed groundwater source listed on the Wellhead Protection Area Web site, water well owners (communities, businesses, and organizations) can be contacted directly to obtain access to reports showing groundwater withdrawal areas. If direct contact with well owners is not feasible, the Springfield, Oregon office of Oregon Health Services (541/726-2587) can be contacted to obtain access to reports showing groundwater withdrawal areas in the vicinity of the proposed stormwater injection system.

- Wetlands and Riparian Areas
  The National Wetlands Inventory (NWI) Web site for the U.S. Fish and Wildlife Service Web site can be accessed to obtain digitized NWI maps. The Web site is located at: *http://www.nwi.fws.gov/*

  Note that not all NWI maps have been digitized. NWI maps may be viewed at the Division of State Lands office in Salem, Oregon or ordered from the Division of State Lands at their Web site: *http://statelands.dsl.state.or.us/wetland_nwi.htm.*

  As a part of Goal 5 of Oregon's statewide planning goals and guidance, local governments are to inventory riparian corridors and wetlands. Local wetlands inventories contain comprehensive maps and information about wetlands throughout a city or region that supplement NWI maps in urban areas. The Division of State Lands website can be reviewed to see a list of cities and areas with approved or pending local wetlands inventories. Local wetlands inventory maps may be viewed at city planning departments or at the Division of State Lands office in Salem, Oregon. The list of cities and areas with approved or pending local wetlands inventories is available at the following Web site: *http://statelands.dsl.state.or.us/lwi.htm*

- Groundwater Management Areas
  If investigations show an aquifer to be contaminated with nitrate, pesticides, or other hazardous compounds, the Oregon DEQ can officially designate it as a Groundwater Management Area. In early 2001, Oregon had two Groundwater Management Areas (GMAs):
  - Lower Umatilla Basin GMA in Morrow and Umatilla counties
  - North Malheur County GMA encompassing the cities of Ontario, Nyssa, and Vale

  Other areas of the state may be designated as Groundwater Management Areas in the future. In a Groundwater Management Area, there are specific guidelines for communities to form working groups to develop a plan to reduce groundwater contamination. The Oregon DEQ coordinates the program. More information can be obtained by calling the DEQ central number at 800-452-4011 and asking to be connected to regional DEQ office. The regional offices can be found on the following Web site*: http://www.deq.state.or.us/about/locations.htm*

- Sole Source Aquifers
  The Safe Drinking Water Act authorizes the EPA to designate aquifers that are the sole or principal source of drinking water for an area. To meet the criteria for designation, a sole source aquifer must supply at least 50 percent of the drinking water to persons living over the aquifer and there can be no feasible alternate source of drinking water. Once designated, EPA can review proposed projects that are to receive federal funds and which have the potential to contaminate the aquifer.

  A map showing sole source aquifers and their source areas in Washington, Oregon, and Idaho can be found at the EPA Region 10 Web site at *http://www.epa.gov/r10earth/maps/ssarx.html.* Aquifers that have been designated are shown along with those that have been petitioned for designation. County outlines and the Columbia River system are also shown.

  In Oregon, the only sole source aquifer shown on this map (produced on May 2, 1995) is the North Florence Dunal Aquifer. Jurisdictions are encouraged to contact their regional DEQ office to discuss if additional sole source aquifer designations are being considered in their geographic area. Updated sole source aquifer designation information can also be obtained by contacting EPA Region 10 at the following numbers:
  - 206-553-0344 (Primary Contact)
  - 206-553-1563 (Manager, Ground Water Protection Unit)
  - 1-800-424-4EPA

- Areas in close proximity to Water Quality-Limited Streams (except for streams listed for temperature only)
  The Oregon DEQ is required by the federal Clean Water Act to maintain a list of steam segments that do not meet ambient water quality standards. This list is called the 303(d) List after the relevant section of the Clean Water Act. The EPA has approved DEQ's 1998 list. An updated list for 2003 is being prepared. The 1998 Water Quality Limited Streams 303(d) list can be viewed at the DEQ Web site: *http://www.deq.state.or.us/wq/303dlist/303dpage.htm*

DEQ can be contacted for questions about the year 2002 303(d) List update process at 503/229-6804.

- Designated Federal Emergency Management Agency (FEMA) Floodplain and Floodways
  FEMA designates floodplains and floodways for cities and counties participating in the National Flood Insurance Program. The FEMA Map Service Center provides participating jurisdictions with FEMA Flood Insurance Rate Maps (FIRMs) that show floodplains and floodways in the jurisdictional boundaries. FIRMs can be viewed at the local jurisdiction planning department or a local U.S. Army Corps of Engineers office. FEMA also has digital and hard copies of FIRMs available for sale on their Web site located at:
  http://web1.msc.fema.gov/webapp/commerce/command/ExecMacro/MSC/macros/welcome.d2w/report

- Areas Prone to Landslides or Slope Instability
  Information on areas prone to landslides or slope instability can be obtained from local planning departments or the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI published a report titled "Slope Failures in Oregon - GIS Inventory for Three 1996/97 Storm Events" that includes a digital Geographic Information System (GIS) inventory of 9,582 Oregon landslide locations, a spreadsheet version of the inventory for those not using GIS, and explanatory text.

  "Slope Failures in Oregon - GIS Inventory for Three 1996/97 Storm Events", Special Paper 34 by R. Jon Hofmeister, Oregon Department of Geology and Mineral Industries is available for $6.00 from the Nature of the Northwest Information Center, 800 NE Oregon Street #5, Portland, Oregon 97232. To order a copy, call 503/872-2750 or order online at the following Web site: *http://www.naturenw.org*

  These items as well as all department maps can be purchased at DOGAMI field offices including 5375 Monument Drive, Grants Pass, 541/476-2496 and 1510 Campbell Street, Baker City, 541/523-3133. In addition, local planning departments may have information on areas prone to landslides or slope instability and should be consulted to determine site proximity to these areas.

- Properties with Existing or Past Practice Contamination
  DEQ's Environmental Cleanup Site Information (ECSI) database and Leaking Underground Storage Tank (LUST) database can be queried and searched to examine whether any contaminated sites exist that have potential to be impacted by the proposed stormwater injection system. DEQ's ECSI and LUST databases can be found on the following Web sites:
  http://www.deq.state.or.us/wmc/ecsi/ecsintro.asp
  http://www.deq.state.or.us/wmc/

  Pre-treatment BMPs may be recommended by DEQ for rule authorization if a new stormwater injection system is sited in any of the above sensitive areas. For existing stormwater injection systems located in sensitive areas, local jurisdictions may want to consider applying source control BMPs, retrofitting the existing stormwater injection system with pre-treatment BMPs, applying for a WPCF permit, or decommissioning the well.

5. Soil or Groundwater Contamination

In order to rule authorize an injection system, no soil or groundwater contamination may be present that will be impacted by the construction or use of the stormwater injection system (340-044-0018 (3)(a)(F)). Therefore, in addition to the sensitive areas listed above, consider the proximity of proposed stormwater injection system sites to the following areas where contamination might exist:

- Industrial areas and commercial developments where petroleum products, herbicides, pesticides, or solvents may be loaded/unloaded, stored, or applied within the drainage area.
- Areas where hazardous materials are expected to be present in greater than “reportable quantities” as defined by the US Environmental Protection Agency (EPA) in the Code of Federal Regulations 40 CFR 302.4. The regulation can be found on the following Web site: *http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr302_01.html*
- Areas with a high risk for spills of toxic materials, such as gas stations and vehicle maintenance facilities.
- Locations where deicing using salts or other chemicals occurs in winter.
- Designated truck routes and high vehicle traffic roads.

6. Other Siting Considerations

It is important that municipalities consider how the system will be designed, operated and maintained when siting new systems. New systems should be sited to allow easy access for maintenance and monitoring. It is recommended that stormwater injection systems be placed completely inside of the public right-of-way or within a drainage easement that provides maintenance personnel and equipment access and does not conflict with other public utility easements. When siting injection systems municipalities should also consider potential traffic control requirements during maintenance activities. In addition, setback distances need to be considered with respect to building foundations and natural water bodies such as streams, rivers, lakes, or coastal estuaries. If the municipality wishes to implement source control or pre-treatment BMPs with the new injection system, consideration should be given to how those BMPs will be incorporated into the design at various sites. Source control BMPs and pre-treatment BMPs may be easier and less expensive to implement if they are incorporated into the siting and design decisions early in the injection system planning process.

2.2 DESIGN GUIDELINES

The stormwater injection systems addressed in this section are grouped into two classes: vertical injection systems and horizontal injection systems. Vertical injection systems are stormwater injection systems, such as dry wells and sumps, which have a greater vertical dimension (i.e., depth) than horizontal dimension (i.e., diameter, or width and length). Horizontal injection systems, on the other hand, are stormwater injection systems with greater horizontal dimensions than vertical dimensions. Design guidance for vertical and horizontal injection systems are presented in separate subsections. For vertical injection systems, information covered in Section 2.2.1 includes dry well sizing, design factors, and installation considerations. Most of the information provided in Section 2.2.1 for vertical injection systems also applies to horizontal injection systems, which are discussed specifically in Section 2.2.2.

2.2.1 Vertical Injection Systems

Vertical injection systems are also known as dry wells or sumps. Vertical injection systems (herein referred to as dry wells) have a greater vertical dimension (i.e., depth) than horizontal dimension (i.e., diameter, or width and length) and are constructed in permeable strata within the unsaturated zone to capture, store, and dispose of stormwater runoff. These systems are installed above the water table so that the bottom and sides are dry except when receiving stormwater runoff. There are variations in vertical injection system designs. Some dry wells consist of a slotted or perforated vertical pipe that is backfilled with materials that allow water to penetrate and soak into the ground. Some dry wells simply consist of a hole that has been dug into the ground and backfilled with gravel. Sumps usually refer to perforated concrete cylindrical structures that are installed underground.

Although dry wells and sumps are terms that are used interchangeably, sumps typically refer to relatively shallower vertical injection systems when compared to dry wells. The use of a particular well/sump design is often selected based on local geology, hydrology, the desired degree of stormwater treatment, and most importantly, the design requirements set by local jurisdictions. The following subsections provide general information with regards to dry well sizing, design elements, and installation considerations. To evaluate whether stormwater injection systems are feasible for a specific site, the siting considerations provided in Section 2.1 should be consulted. A diagram of a typical dry well is shown in Figure 2-2.

DIAGRAM OF A TYPICAL DRY WELL

N.T.S.

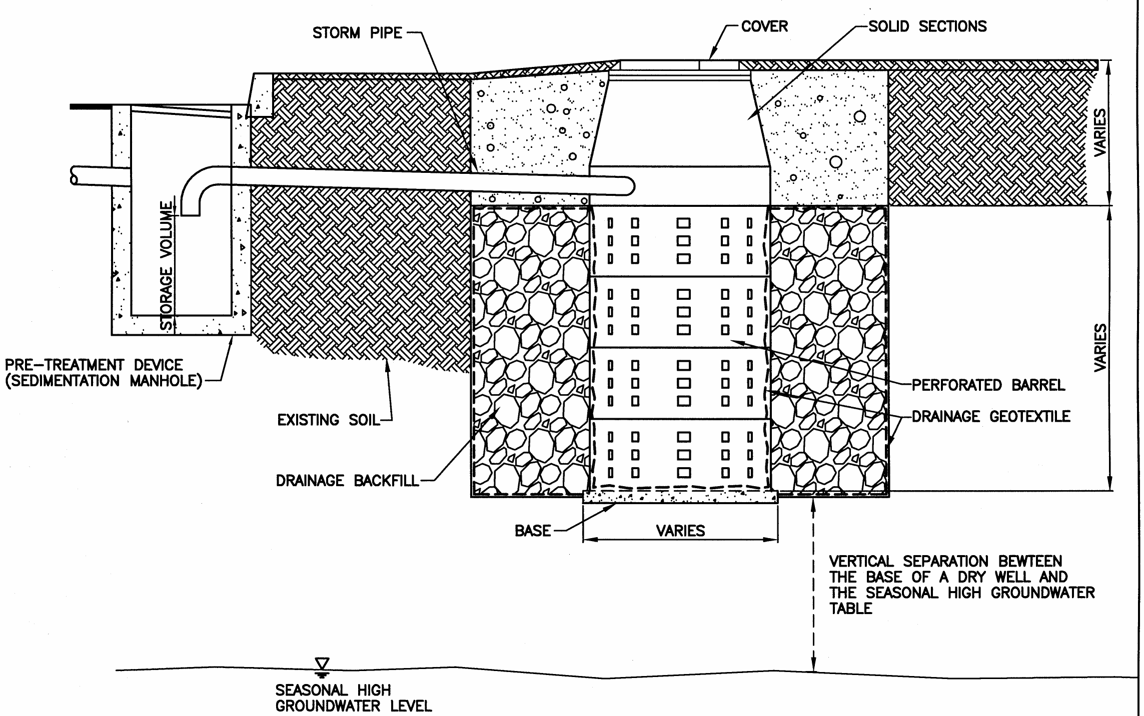


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FIGURE 2-2

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If the site conditions indicate that the use of a dry well for stormwater disposal is feasible, a soil permeability test should be performed by a licensed geologist, professional engineer or other qualified individual at the location of the proposed dry well or sump. Existing soil surveys or reports may provide a rough estimate of percolation rates, but site specific field tests are recommended as the capabilities of a site to accept surface water and distribute it into groundwater system depend on many site-specific factors. Among the most important are: natural ground slope, type and properties of surface and subsurface soils, and subsurface hydrology. There are different methods that may be used for field testing soil infiltration rates. The 2001 City of Gresham Public Work Standards contains a detailed description of how to perform a soil infiltration rate test (to obtain the standards contact the City of Gresham Department of Environmental Services at 503/618-2639). The individual who performs the test should check if the local jurisdiction requires a particular soil infiltration testing method to be used.

Once the soil infiltration rate is obtained through field testing, the required volume and surface area of dry wells can be estimated based on the design volume of runoff from the contributing area, the void space in the dry well, and the infiltration rate. In general, three methods can be used for sizing dry wells. These three methods are summarized as follows:

1. Method 1 - Dry Well Sizing Using Design Peak Flow Information

Using this method, the dry well is sized so that the flow rate out of the dry well through infiltration always exceeds the flow rate entering the dry well. The following steps are used for sizing:

- Step 1 - The design peak flow entering a dry well from the contributing area is estimated. DEQ recommends using a 2-year/24-hour storm event to estimate the peak flow. Several commonly used methods are available for estimating runoff rates: the Natural Resources Conservation Service (formerly the Soil Conservation Service) Curve Number Method, the Santa Barbara Urban Hydrograph (SBUH) method, and the Rational Method. For more information on these methods, review Chapter 2 of Volume III of the Western Washington Stormwater Management Manual (2001), Appendix C of the City of Portland Stormwater Management Manual (2002), and the Web site *http://www.utdallas.edu/~brikowi/Teaching/Applied_Modeling/SurfaceWater/LectureNotes/Rational_Method/Contents.html*. Design storm information (i.e., rainfall intensity) can usually be obtained from the intensity-duration-frequency (IDF) curves contained in a local jurisdiction's stormwater design manual.
- Step 2 - The maximum peak flow that will leave the dry well through infiltration is set to be equal to the design peak flow rate.
- Step 3 - The required surface area (in square feet) needed for infiltration in the dry well is calculated as the maximum flow (in cubic feet per second) coming out of the dry well divided by the average infiltration rate of the soil (in feet per second converted from inches per hour) obtained from the site specific soil test. The surface area needed for infiltration in the dry well refers to the area of the dry well that will be wetted and that will allow for infiltration when the dry well is filled to its maximum allowable design elevation. The surface area for infiltration may be horizontally oriented, vertically oriented, or both depending on the design of the dry well.

- Step 4 - The dimensions of the dry well can be estimated based on the required surface area needed for infiltration. For example, if the diameter of a dry well is given, the required wetted depth of the dry well is calculated as:

  $D_{wet} = (A_{wet} - A_{bottom})/P_{well}$

  Where, D_{wet} is the required depth of a dry well that allows infiltration;
  A_{wet} is the required infiltration area obtained from step 3;
  A_{bottom} is the bottom area of the dry well that allows infiltration;
  P_{well} is the perimeter of the dry well.

  A multiplier greater than 1.0 may be used in estimating the peak flow entering the dry well to provide for a factor of safety. For example, the City of Portland's Stormwater Management Manual requires a public sump be designed to handle twice the flow from a 10-year design storm.

The following jurisdiction currently requires dry well sizing based on peak flow information:

- Washington State Department of Transportation (WSDOT) – Dry well sizing is performed by calculating the amount of flow that enters the dry well and comparing it with the peak rate of flow that will infiltrate from the dry well. The designer must limit the amount of area draining to each dry well such that the flow out of the dry well through infiltration always exceeds the amount of flow entering the dry well. For more information, refer to Chapter 6 of the WSDOT's Hydraulic Manual (January 1997).

2. Method 2 - Dry Well Sizing Using Total Runoff Volume Information

Using the runoff volume method, the size of a dry well can be determined by subtracting the volume of water that will infiltrate from the facility from the volume runoff that will drain to the facility from the contributing drainage area during the design storm event.

The runoff volume can be estimated using the SCS Curve Number Method or the Santa Barbara Urban Hydrograph method. The volume of the water that will infiltrate from the dry well can be estimated simply by multiplying the average soil infiltration rate (feet per hour), the average infiltration area in the dry well (square feet) and the duration of the design storm (hours). Note that since the dry well is usually filled with stone or rocks, only the space between the rocks is available for storage. Therefore, the volume of the dry well should be calculated as the required storage capacity divided by the estimated porosity of the fill in the dry well.

The following jurisdictions require dry well sizing based on runoff volumes:

- City of Eugene, Public Works Department – The required storage capacity of the dry well shall be determined by subtracting the volume of water that can exfiltrate out of the facility within a 24-hour period from the volume of runoff from the contributing basin during a 24-hour, 5-year storm event. For more information, refer to Section 2 of the City of Eugene's Public Improvement Design Standards, 2001 Draft.
- City of Bend, Public Works Department – Dry wells shall be designed to contain the entire rainfall volume from a design storm consisting of 1.5-inches of rain. The capacity of the dry well is defined as the summation of the volume of the dry well barrel (i.e., perforated pipe), the volume of the pore spaces of the drain rock in place and infiltration capacity of the surrounding soil. The capacity of the surrounding soil shall be determined by the design engineer based on insitu conditions and shall be

considered negligible for impervious soil (i.e., rock). For more information, refer to City of Bend's Design Standards.

3. Method 3 - Dry Well Sizing Using A Design Storm Hydrograph

To size a dry well more precisely, a design storm hydrograph can be routed through the facility to optimize its dimensions. The reservoir routing method can be used to select a dry well dimension such that the water in the dry well is not allowed to exceed its depth. Reservoir routing calculations can be found in many hydrology/hydraulics textbooks. The storm hydrograph can be obtained by using the Santa Barbara Urban Hydrograph (SBUH) method based on the drainage characteristics and design storm information. The design storm volume, duration and distribution are required to perform this analysis. Outflow from the dry well due to infiltration for a given time step during the storm event can be estimated by multiplying the average soil infiltration rate, the wetted infiltration area in the dry well and the duration of the time step.

Some jurisdictions currently prescribe specific dry well sizes. Standard dry well systems are identified and recommendations are made as to how many of these systems may be required for a certain size drainage area. This method is only recommended when the prescribed sizes are based on varying soil types. The following jurisdictions require sizing using the hydrograph method:

- The Arizona Department of Environmental Quality recommends using the MaxWell Type IV system. For drainage systems draining paved areas, a minimum of one standard dry well is recommended for each 6,000 cubic feet of drainage volume. The drainage volume is calculated based on the use of the Rational Method for a 10-year design storm with a 2-hour duration. More information can be found on the following Web site:
  http://www.adeq.state.az.us/environ/water/permits/download/dwdesig.pdf
- The King County, Washington's Surface Water Design Manual specifies that a dry well must be 48 inches in diameter and have a depth of 5 feet. Each dry well may serve up to 1000 square feet of impervious surface for either medium sands or coarse sands. For more information, refer to the King County, Washington's Surface Water Design Manual.
- The City of Portland's Stormwater Management Manual requires the use of sizing charts to design private dry wells. To use the charts, the impervious area flowing to the proposed dry well is estimated, and this information is then used to select combinations of dry well diameters and depths that are applicable to the site.

2.2.1.2 Design Elements

The following design elements should be incorporated into the development of new vertical injection systems:

1. Depth

The dry well should be designed to have a separation distance between the seasonal high water table and bottom of the dry well. DEQ recommends a 4 to 10 feet distance. Generally, a greater separation distance (7 to 10 feet) is recommended for injection systems underlain by coarse-grained soils (sand and gravel) which have a lower capacity for removing pollutants through soil adsorption. A separation distance of 4 to 7 meet is recommended for injection systems underlain by fine-grained soils (clay and silt) that have a higher capacity for removing pollutants through soil adsorption. Also, where possible, the dry well should be designed so that bedrock is located below the bottom of the dry well to allow for some treatment of runoff before it reaches the groundwater and to allow adequate drainage from the system. Some design manuals (i.e., 2001 New York State Stormwater Management Design Manual, and the Best Management Practices for Control of Non-point Source Pollution from Stormwater, New Jersey, 2000 draft) recommend a distance of at least 3 feet above bedrock.

2. Recovery Time

The vertical injection system should drain within 48 to 72 hours following the runoff event for which system was designed, depending on typical storm intervals in the area (i.e., within 48 hours in western Oregon where rain storms are more frequent, and within 72 hours in eastern Oregon where rain storms are less frequent). Complete drainage is necessary to maintain aerobic conditions in the underlying soil, allow the dry well to recover its storage capacity before the next storm event, and prevent mosquito breeding. In slow infiltration soils, the recovery time may determine the well's design depth.

3. Pre-treatment BMP

Depending on the subsurface conditions and implementation of source control BMPs, pre-treatment BMPs may not be required by DEQ for new stormwater injection systems. However, pre-treatment BMPs that are intended to trap sediments prior to subsurface injection, such as catch basins and sedimentation manholes, are recommended by this manual for inclusion in the design of new stormwater injection systems (even those that are not required to implement pre-treatment BMPs) because of their maintenance benefits.

Catch basins and sedimentation manholes can reduce the amount of sediment and debris that enter a dry well, protecting groundwater quality and reducing the maintenance burden of injection systems by preventing pollutants from premature clogging of the dry well and improving the ease with which maintenance can be performed. If the outlet structure of a catch basin or sedimentation manhole is properly designed (see Figure 2-2), small spills of floating oil or petroleum products can also be retained. It is important to note that the effectiveness of catch basins and sedimentation manholes in trapping various pollutants is highly dependent on the frequency of inspection and cleaning. Maintenance practices recommended for dry well system components, including catch basins and sedimentation manholes, are discussed in Section 2.4. Use of catch basins or sedimentation manholes upstream of dry wells has become standard practice in many jurisdictions. For example, the City of Portland and the City of Eugene both require sedimentation manholes or catch basins to be included in their public dry well or sump designs. In sensitive areas additional BMPs may be necessary.

In areas with higher risks for spills, shut-off valves and/or oil/water separators may be required or recommended by DEQ to be included in new stormwater injection system designs. Shut-off valves and other mechanisms that allow flow into injection systems to be stopped can protect groundwater when accidentally or illicitly disposed wastes or contaminants are discovered in stormwater entering a dry well. Shut-off valves can partially fulfill the requirement for rule authorization that spill control measures are implemented for an injection system.

4. Top of the Dry Well

The top of the dry well should be designed to meet the corresponding local roadway design standards for loading, fill and pavement, if located within the road section or in a maintenance access way.

5. Observation Well

An observation well is recommended for injection systems that do not have an access manhole. The observation well can be used to monitor the decline in water level in the injection system over time. A simple observation well may consist of perforated PVC pipe, 4 to 6 inches in diameter. It is typically located in the center of the dry well and constructed flush with the finished grade. The top of the well should be capped to discourage tampering and prevent accidental entry of silt and debris while still allowing access for water level monitoring. Observation wells should be in a location that provides access for maintenance personnel and equipment, and should not conflict with public utility easements.

6. Perforated Pipes (Barrels)

The number and distribution of the holes in the perforated pipe (i.e., the pipe used for the dry well itself) should adequately allow stormwater runoff to exit the pipe. Designers using pre-fabricated perforated pipe should follow the manufacturer's recommendations and provide sufficient length of pipe to disperse the water from the design storm adequately.

7. Backfill Material

Coarse gravel or other clean aggregate such as drain rock, stones, etc. should be placed around the perforated pipe to act as a conveyor of water and as a filler between the pipe and the native soils. These backfill materials serve to reduce exit velocities through pipe perforations and provide sufficient void spaces for storage and movement of water. The selection of backfill materials should be based on cost, availability and durability.

8. Fabric Liner

Filter fabrics and cloth, also referred to as geotextiles, are used to prevent mixing of fine soils with high porosity backfill aggregates in dry wells. Filter fabrics with sufficiently small pore spaces can be placed at the bottom, sides and top of the dry well surface to effectively prohibit the passage of the smallest soil particles found in the native soil profile. Geotextiles may also be placed at the inside of the perforated barrel. The choice of filter cloth or fabric is dependent on the size and nature of the fines in the soils. However, the filter cloth must also have sufficient permeability to pass the design flow and have sufficient tensile strength to be installed without undue sagging and to resist tearing.

9. Manhole Cover

A solid manhole cover should be installed on the dry well to provide maintenance or monitoring access and insure flow is through the inlet pipe only. It is recommended that the cover be marked "STORMWATER" in raised cast letters. For dry wells that are not equipped with shut-off valves on the drainage pipe discharging to the dry well, it is important to ensure that maintenance staff or other responders to a spill would have the capability of quickly removing the manhole cover and plugging flow into the dry well from the drainage pipe.

2.2.1.3 In-Place Capacity Testing and Other Considerations for Dry Well Sizing

As soil permeability is critical to the success of dry wells, no matter what method is used for sizing, testing is recommended after dry well construction is complete in order to verify in-place capacity. Examples of dry well tests can be found in the 2002 City of Portland Stormwater Management Manual, the 2001 City of Gresham Public Works Standards, and the City of Bend Design Standards. If a dry well or a sump test fails to verify adequate capacity, an additional dry well or sump should be constructed.

It should also be noted that although the maximum depth of a dry well or a sump can be estimated based on the runoff data, soil infiltration rates, allowable storage times, and the void space of backfill materials, this estimated depth is also affected by other considerations. The UIC rules do not allow rule authorized injection systems to exceed a depth of 100-feet (OAR 340-044-0005). This requirement may preclude the rule authorization of dry wells in certain areas of the state, where geologic conditions (a thin soil layer covering a thick layer of basalt flows or crystalline rock with low permeability) may result in the design of dry wells greater than 100-feet in depth. As discussed in Section 2.1, DEQ also recommends that dry wells be designed with a minimum separation from the bottom of a dry well to the seasonal high groundwater level of four to 10 feet to minimize the potential for groundwater contamination and to provide complete infiltration of the design storm.

2.2.1.4 Installation Considerations

Proper construction is important for successful infiltration practices. The following installation considerations are recommended.

1. Maintenance and Monitoring

Provide adequate access space for maintenance and monitoring activities. An observation well should be installed in a dry well if it is not an accessible manhole-type structure. The observation well or accessible manhole-type structure will provide an indication of hydraulic performance and a method for observing silt buildup requiring maintenance.

2. Construction

A new dry well should not be placed in service until all major construction activities in the drainage area have been completed. The inclusion of a pre-treatment BMP in the dry well design is recommended to minimize the risk of groundwater contamination during dry well construction.

3. Excavation

Excavated material should be placed away from the excavated sides to prevent wall instability during excavation and backfilling. As a construction best management practice, the excavated materials should be covered with plastic to prevent sediment transport off-site due to exposure to wind and rain. Care should also be taken to keep excavated material away from slopes, neighboring properties, sensitive natural areas, sidewalks and streets. Large tree roots should be trimmed flush with the excavated sides to prevent puncturing or tearing of filter fabric during installation. The side walls should be roughened where sheared and sealed by heavy equipment.

4. Filter Fabric

Filter fabric should be installed with sufficient length to cover the bottom, sides and top of the aggregate. Filter fabric should be placed such that the fill is completely enclosed. The filter fabric should be wrapped and tied with wire or nylon twine or otherwise tightly secured around the horizontal inflow pipe if the pipe protrudes through the fabric.

5. Fill

Care should be exercised to prevent natural or fill soils from mixing with drainage aggregate. All contaminated aggregate must be removed and replaced with clean materials. Drainage aggregate should be placed in lifts and lightly compacted using plate compactors. The compaction process ensures filter fabric conformity to the excavated sides, reducing the potential for soil movement and filter fabric clogging. Voids between the filter fabric and excavated sides due to boulders or other obstacles should be avoided. Native soils should be placed in these voids during construction to ensure filter fabric conformity to excavated sides.

6. Capacity

A maximum of two dry wells should be used in series if one dry well does not provide enough capacity to adequately drain the design storm. If a second dry well is needed, a minimum distance between the dry wells should be determined to ensure that the operation of each dry well does not interfere with the other. The 2002 City of Portland Stormwater Management Manual requires a minimum separation distance of 25 feet between dry wells. The City of Bend Design Standards requires a minimum separation distance of 40 feet between dry wells.

2.2.2 Horizontal Injection Systems

Horizontal injection systems are also known as infiltration trenches, soakage trenches, and french drains. Horizontal injection systems (herein referred to as infiltration trenches) have a greater horizontal dimension (i.e., width and length) than vertical dimension (i.e., depth) and are constructed in permeable strata within the unsaturated zone to capture, store, and dispose of stormwater runoff. These systems are installed above the water table so that the bottom and sides are dry except when receiving stormwater runoff. Although there are variations in horizontal injection system designs, they are generally more than 24 inches wide and are backfilled with a coarse stone aggregate allowing for temporary storage of stormwater runoff in the voids of the aggregate material. Stored runoff then gradually infiltrates into the surrounding soils. The surface of the trench can be covered with grating or consist of stone, gabion, sand, or a grassed covered area. Perforated rigid pipe can be used to distribute the stormwater in a stone trench. Infiltration trenches can be used for sites where the groundwater table is relatively high and limited space is available for stormwater management. There is design information available on horizontal injection systems in the 2002 City of Portland Stormwater Management Manual, the 2002 Washington Department of Ecology Stormwater Management Manual for Eastern Washington (Public Draft), and the 2001 Washington Department of Ecology Stormwater Management Manual for Western Washington.

2.2.2.1 Trench Sizing

If the site conditions indicate that the use of an infiltration trench for stormwater disposal is feasible, a soil permeability test should be performed by a licensed geologist, professional engineer or other qualified individual at the location of the proposed system. Existing soil surveys or reports may provide a rough estimate of percolation rates, but site specific field tests are recommended as the capabilities of a site to accept surface water and distribute it into groundwater system depend on many site-specific factors. Among the most important are: natural ground slope, type and properties of surface and subsurface soils, and subsurface hydrology. There are different methods that may be used for field testing soil infiltration rates. The 2001 City of Gresham Public Work Standards contain detailed descriptions on how to perform one method of a soil infiltration rate test. The individual who performs the test should check if the local jurisdiction requires a specific method of soil infiltration test to be performed.

Once the soil infiltration rate is obtained through field testing, infiltration trenches are usually designed to exfiltrate the entire design storm through the floor of each system. The sides are not considered in sizing. The horizontal surface area of infiltration trenches can be estimated as follows:

$$Ap = Vw/(ndt)$$

Where, Ap is the horizontal surface area (ft^2)
Vw is the design storm volume (ft^3)
n is the porosity of the aggregates in the infiltration trench (no unit);
dt is the trench depth (ft)

2.2.2.2 Design Elements

Most design elements outlined for vertical injection systems also apply for horizontal injection systems. Specifically, design elements 1, 2 and 3 listed in Section 2.2.1.2 for vertical injection systems would apply to horizontal injection systems as well. Additionally, the following design elements apply for infiltration trenches:

1. Slope

The slope of the trench bottom is recommended not to exceed 3% in any direction.

2. Access Port

An access port or open or grated top should be included for accessibility to conduct inspections and maintenance.

3. Backfill Material

Coarse gravel or other clean aggregate such as drain rock or stones should be placed in the infiltration trench.

4. Filter Fabric

Protective permeable geotextile filter fabric should line the top and sides of the trench from one foot below the aggregate surface. The bottom sand or removable permeable fabric layer is optional.

5. Observation Well

An observation well should be installed at the lower end of the infiltration trench to check for water levels, drawdown time, and sediment accumulation. A typical observation well consists of a perforated PVC pipe, 4 to 6 inches in diameter, constructed flush with the ground elevation. For larger trenches a 12 to 36 inch diameter well can be installed to facilitate maintenance operations, such as pumping out sediment. The top of the well should be capped, or covered with an ordinary drainage grate.

6. Surface Cover

A stone-filled trench can be placed under a porous or impervious cover to conserve space as long as an access port is provided.

2.2.2.3 On-site Testing for Capacity

On-site testing for capacity of horizontal injection systems is generally not necessary beyond conducting the soil permeability tests recommended in section 2.2.2.1 above. Capacity testing may not be as essential for horizontal systems as it is for vertical systems due to the fact that there are more unknowns in terms of subsurface geology for deeper wells.

2.2.2.4 Installation Considerations

Most installation consideration outlined for vertical injection systems also apply for horizontal injection systems. Specifically, installation considerations 1, 2, and 3 listed in

Section 2.2.1.4 for vertical injection systems would apply to horizontal injection systems as well. Additionally, the following installation considerations apply for infiltration trenches:

1. Excavation

Use trapezoidal cross-sections rather than rectangular cross-sections at unstable excavation sites. Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate.

2. Filter Fabric

Ensure there are no voids between the geotextile filter fabric and excavated sides. Removing boulders or other obstacles from the trench walls can eliminate one source of such voids. Natural soils should be placed in voids during construction to ensure geotextile conformity to the excavated sides. This practice can prevent soil movement, geotextile clogging and possible surface subsidence.

The geotextile should be folded over the stone aggregate to form a 12-inch minimum longitudinal overlap following the stone aggregate placement. When overlaps are required between rolls, the upstream roll should overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect.

3. Fill

The stone aggregate should be placed in lifts and compacted using plate compactors. As a rule of thumb, a maximum loose lift thickness of 12 inches is recommended. The compaction process should ensure geotextile conformity to the excavated sides, thereby reducing the potential for settlement problems and pipe and geotextile clogging.

2.3 STORMWATER INJECTION SYSTEM CONSTRUCTION DETAILS

This section presents a compilation of construction details for vertical and horizontal injection systems, including commonly used pre-treatment devices. These design drawings are compiled from regional and local stormwater design manuals and are listed as follows:

- Vertical Injection Systems:
  1. Sump System from City of Portland, Oregon (Exhibit 2-1)
  2. Bored Well from EPA (Exhibit 2-2)
  3. Dry Well from City of Troutdale (Exhibit 2-3)
  4. Dry Well from City of Vancouver, Washington (Exhibit 2-4)
  5. Dry Well from Washington State Department of Transportation (Exhibit 2-5)
  6. Dry Well from City of Bend, Oregon (Exhibit 2-6)
  7. Sedimentation Manhole and Sump from Multnomah County, Oregon (Exhibit 2-7)

- Horizontal Injection Systems:
  1. Parking Lot Perimeter Trench – Department of Ecology, West Washington (Exhibit 2-8)
  2. Infiltration Trench from City of Portland, Oregon (Exhibit 2-9)

2.3.1 Vertical Injection Systems

1. Sumps - The City of Portland, Oregon

Where soil conditions favor percolation, the City of Portland allows the construction of sump systems to facilitate the infiltration of stormwater runoff primarily from residential areas. Public sumps are to be designed to handle twice the flow from a 10-year design storm using the Rational Method. Public sump design follows a standard sump design, outlined in the 2002 City of Portland Stormwater Management Manual. The sump system includes a sedimentation manhole and a sump connected in series. The sump (see Exhibit 2-1) is a perforated concrete cylindrical structure (48 inches in diameter), and is typically excavated 30 feet depending on local groundwater elevations.

2. Bored Wells – Environmental Protection Agency (EPA)

A typical bored well is usually at least 40 feet deep and constructed in consolidated bedrock where fractures or basalt interflow zones may dissipate the stormwater. Stormwater is typically injected through a filter screen directly into the subsurface. A basic design is shown in Exhibit 2-2.

3. Dry Well – City of Troutdale, Oregon

Exhibit 2-3 depicts a typical drywell detail for the City of Troutdale. The facility consists of a 48-inch diameter perforated manhole lined with Mirafi 140 filter fabric on this inside, bottom and outside of the perforated manhole section. The mahnole is filled with clean drain rock to the bottom of the lowest perforated section. Steps must be installed from 18 inches below the rim of the drywell elevation to no more than 12 inches from the bottom of the drywell. The steps must be coated with polypropaline and set in concrete rings.

4. Dry Well – City of Vancouver, Washington

The City of Vancouver standard dry well (Exhibit 2-4) is designed to effectively infiltrate the 100-year design storm event. All precast sections conform to the requirements of ASTM C478. The minimum dry well depth is 13 feet. All dry wells are required to have a minimum 6-inch thick base. Dry wells are backfilled with 2-inch minus clean round drain rock. Dry well installations incorporate an underground drainage geotextile adjacent to the limit of the excavation.

5. Dry Well – Washington State Department of Transportation

Exhibit 2-5 depicts a typical WSDOT dry well. The dry well has a precast perforated concrete pipe that sits in an underground structure with a bottom width of 72 inches and 2:1 side slopes. The space between the perforated pipe and well sides is backfilled with gravel. Geotextile filter fabric is placed at the bottom and sides of the well and on the outside of the perforated pipe.

6. Dry Well – City of Bend, Oregon

The standard precast dry well for the City of Bend is shown in Exhibit 2-6. A fabric liner is required for the inside of the perforated pipe. Geotextile filter fabric must be placed at the limits of all earth or gravel excavations to 24 inches into the rock to prevent fines from migrating into the drain rock.

7. Sedimentation Manhole and Sump – Multnomah County, Oregon

The standard sedimentation manhole and sump for Multnomah County is shown in Exhibit 2-7. Stormwater enters the system at a catch basin with 2 feet of storage, drains to a sedimentation manhole that is a minimum of 12 feet deep, and drains from the sedimentation manhole to the precast sump through a 10-inch pipe with an elbow at the inlet. The precast sump is 4 feet in diameter and a minimum of 22 feet deep. The sedimentation manhole must be a minimum of 25 feet from the sump.

2.3.2 Horizontal Injection Systems

1. Parking Lot Perimeter Trench – Department of Ecology, Washington

Infiltration trenches are generally at least 24 inches wide, and are backfilled with a coarse stone aggregate, allowing for temporary storage of stormwater runoff in the voids of the aggregate material. Stored runoff then gradually infiltrates into the surrounding soils. The surface of the trench can be covered with grating and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet. Perforated rigid pipe of at least 8-inch diameter can also be used to distribute the stormwater in a stone trench. Exhibit 2-8 presents several trench configurations.

2. Infiltration Trench – City of Portland, Oregon

Where soil conditions allow for percolation, the City of Portland allows for the construction of soakage trenches to facilitate the infiltration of stormwater into the ground. Soakage trenches are horizontal trenches backfilled with layers of sand and gravel that are a minimum of 12 to 15 feet in length. The minimum design length of soakage trenches depends on the geographic location of the system in the City of Portland. The City of Portland requires 20 to 25 feet of linear feet of soakage trench for every 1,000 square feet of impervious surface contributing stormwater to the trench. Soakage trenches on the east side of Portland (where soils are generally more permeable) must meet the lower minimum length requirements while trenches on the west side of Portland (where soils are generally less permeable) must meet the higher minimum length requirements. Exhibit 2-9 presents the east and west side soakage trench configurations. For more information, refer to the 2002 City of Portland Stormwater Management Manual.

2.4 STORMWATER INJECTION SYSTEM MAINTENANCE PRACTICES

Regular inspections and maintenance of stormwater injection systems are important to ensure the proper functioning of these systems. This section presents the maintenance practices for stormwater injection systems based on best available information. The maintenance practices covered in this section include inspection programs, condition assessments, sediment removal and waste disposal. The maintenance practices for vertical injection systems are also provided in a checklist format (Table 2-2).

It should be noted that some older vertical dry wells were installed without provision for maintenance access. If the wells are formed with concrete pipe, it may be possible to excavate down to the top of the structure, extend it to the surface, and install a manhole cover. Primitive dry wells that consist of gravel within a pit cannot be retrofitted to provide access and should be replaced.

2.4.1 Vertical Injection Systems

Specific maintenance requirements may vary from one dry well system to another, but in general they include the following:

- Systematically inspect the entire system on a routine basis.
- Immediately repair or replace any damaged or defective structural components.

- Remove accumulated sediment and debris when necessary.
- Properly dispose of stormwater sediments.

Table 2-2 outlines a vertical injection system maintenance checklist. Maintenance components are discussed in detail below the table.

Table 2-2
Vertical Injection System Maintenance Checklist

Maintenance Components	When Needed	Actions Required
Inspection and Condition Assessments	• Catch basins or sedimentation manholes should be inspected routinely • Dry wells should be inspected routinely, preferably more frequently during initial operation	• Monitor standing water in dry wells or sumps • Measure sediment and debris build up in catch basins or dry wells • Check trash and debris obstruction at the inlet or outlet devices • Examine cracks and deterioration of inlets, outlets, and other structural components of the system • Look for other signs of problems such as oil sheen on the water surface, discolored water, or an unpleasant order
Structural Repair	• Whenever structural damage is observed	• Promptly repair or replace any damaged structural components
Sediment Removal	• Sediments in catch basins or sedimentation manholes should be removed when the catch basin storage is one third full or the system is clogged	• Manually clean out or use specially designed equipment such as vacuum trucks to remove sediments/debris in catch basins or sedimentation manholes • Clean and remove sediment or debris in a dry well or sump using a compressed air jet
Sediment Disposal	• When sediments are removed from catch basins and/or dry wells	• Categorize its pollutant levels and determine its environmental and health risks • Select a cost-effective management or disposal option
Decant Water Disposal	• When sediments are removed from catch basins and/or dry wells	• Properly contain the decant water. • Discharge decant water to sanitary sewer system after approval

1. Inspection and Condition Assessments

The frequency with which dry well systems should be inspected and cleaned will vary with site conditions and the amount of sediment carried in the site stormwater. Stormwater sources and concentrations vary from site to site. Accordingly, stormwater pollutant loading from particular types of land use can vary greatly. Runoff from residential land has lower concentrations and loadings of most pollutants when compared to runoff from commercial land and transportation land use areas such as highways. Runoff from streets and parking lots generally will have higher concentrations of heavy metals and other petroleum associated pollutants than runoff from residential land. Consequently, the frequency of inspection and maintenance of stormwater injection systems should be based on an evaluation of factors such as the following:

- Local climate and precipitation.
- Land use of drainage area.
- Pollutant types and loads expected from land use.
- Construction or other soil disturbance in drainage area.
- Percent of impervious surface of drainage area.
- Type of stormwater conveyance system.
- Soil type surrounding injection system.

Ideally, dry wells systems should be inspected frequently in the first year of operation and maintained systematically on a routine basis to ensure optimal hydraulic and water treatment performance. Inspections should be completed early enough so that repairs can be made during dry weather.

During a dry well system inspection, the inspector(s) should look for the following:

- Standing water in dry wells or sumps. Dry wells and sumps are designed to go dry between storm events to provide maximum stormwater management benefits. Long-term standing water in a dry well may become a mosquito breeding area. Standing water most likely results from injection system clogging that obstructs the flow of water into the ground. Standing water can also result from seasonal high water tables or ground water mounding in the vicinity of the facility. Standing water can be observed by removing the dry well manhole cover or by checking water levels in the observation wells.
- Sediment and debris buildup in catch basins or dry wells. Inspection of sediment buildup may involve placing a long, thin probe through the storm grate and into the debris to estimate how much has collected. Thurston County (Washington) Water and Waste Management's Web site contains detailed steps on how to measure sediment levels in a catch basin or a dry well. The Web site address is listed below: *http://www.co.thurston.wa.us/wwm/stormwater%20pages/measuresediment.htm*
- Obstruction of the inlet or outlet devices by trash and debris.
- Cracks and deterioration of inlets, outlets, and other structured components of the system.
- Other signs of problems such as a sheen on the water surface, discolored water, or an unpleasant odor.
- Vandalism.

When a problem is noted, the inspector(s) should take steps to correct the problem, or route this information immediately to the appropriate individual(s) in the organization who can respond.

2. Structural Repair

Repairs to any structural component of the injection system should be made promptly. Equipment, materials, and personnel should be readily available to perform repairs on short notice. The immediate nature of the repair depends on the type of damage and its effects on the safety and operation of the system. Where structural damage has occurred, the design and execution of repairs should be undertaken only by qualified personnel.

3. Sediment Removal

Sediment and debris will gradually accumulate in catch basins and dry wells, to varying degrees. Clogged catch basins and dry wells are less effective at discharging stormwater and may act as a source of sediment and pollutants. Sediment removal prevents the buildup of a floating oil layer and a bottom sediment layer. If these layers build up too much, the oil and sediment can be drawn out of the well into the subsurface. Sediment removal and disposal usually generate the highest cost associated with maintaining a stormwater injection system.

Due to the variability of dry well systems and site conditions, no specific rules exist for sediment removal procedures and timetables. The following factors should be considered when determining the frequency:

- Local climate and precipitation.
- Land use and condition of drainage area.
- Presence of sediment-trapping BMPs upstream.
- Plans for future land disturbance upstream.
- Access to sediment accumulation areas in the system.
- Sediment disposal plans.

As a rule of thumb, catch basins or sedimentation manholes should be cleaned out when the catch basin storage is one-third full. The frequency with which dry wells should be cleaned will vary greatly depending on the site conditions and the depth of the dry well. Studies have shown that when 50 percent or more of a catch basin's storage volume is filled, its efficiency drops significantly. Sediment removal from a catch basin or a sedimentation manhole can be done either manually or by specially designed equipment, such as a vactor truck. The amount of sediment collected and removed should be recorded. GIS systems can be incorporated in maintenance recording keeping processes to track sediment collection, and to optimize future catch basin cleaning efforts. Maintenance workers should be properly trained in catch basin cleaning.

If a dry well or sump is clogged, a compressed air jet can be used to clean and remove sediment or debris. A compressed air jet typically consists of a holding tank for the water and sediment removed, a source of water supply, an air compressor, two air lines, a diffusion chamber, and a pipe to carry the washwater and other debris to the ground surface. During cleaning, a dry well is partially filled with water and the compressed air is injected through a nozzle near the bottom of the well. The sediment is forced out the top of the dry well.

4. Sediment Disposal

Sediment and debris cleaned from dry wells and catch basins is defined as an industrial process waste and there are waste rules that apply to how it must be managed. DEQ rules require that this waste must be disposed at permitted waste management facilities. Typically this means the solid waste portion of catch basin or sump cleanings goes to a permitted landfill while liquids go to a permitted sewerage facility. A slurry of catch basin cleanings must be separated into liquid and solid components before it can be disposed, or allowed to dry so that it meets solid waste standards for disposal. To reuse or treat any waste will likely require approval from DEQ.

When managing sediment removed from catch basins and dry wells it is important to characterize the sediment for treatment facility acceptance or other disposal options. The pollutant concentrations should be determined and the environmental and health risks associated with the pollutant concentrations should be evaluated. Once pollutants and risks are known, a cost effective management or disposal option can be chosen. The Federal Highway Administration, Oregon Department of Transportation (ODOT), and Multnomah County developed a research project to study the disposal and reuse of waste materials generated through highway maintenance activities. Their research indicated that sediments removed from roadway catch basins could potentially contain high levels of chemicals such as heavy metals, organic and petroleum products. The roadwaste research project has identified three major choices for roadwaste management. These options are disposal, reuse and treatment. The chosen management options must comply with environmental regulations. Management options for sediment that are contaminated with low pollutant loads include use as fill material in special highway projects, use in manufacturing compost, and stockpiling for passive remediation by natural microbial degradation. It is important to note that DEQ has not specifically approved or set guidance for these management options. Heavily polluted sediment management options include landfilling and high temperature thermal treatment. The research project is summarized in the following three reports:

- Roadwaste Issues and Options. Oregon Department of Transportation, Salem, Oregon. Report No. FHWA-OR-RD-98-21. December 1998.
- Roadwaste Management: Field Trials. Oregon Department of Transportation, Salem, Oregon. Report No. SPR 385. March 2001
- Roadwaste Management: A Tool for Developing District Plans. Oregon Department of Transportation, Salem, Oregon. Draft Report. October 2000.

Copies of the ODOT roadway waste research reports can be ordered from: 200 Hawthorne Avenue, SE, Suite B-20, Salem, Oregon 97301-5192, or by calling 503/986-2700. Reports 2 and 3 can also be downloaded from the Web site at:
http://www.odot.state.or.us/tddresearch/reports.htm

5. Decant Water Disposal

Disposal of decant water picked up by jet vacuum combination machines, often called Vactor trucks, is another important maintenance related issue. Vactor trucks must decant water two or three times per day to reduce the volume and weight of sediments to be recycled or landfilled. Options for management of decant water prior to disposal have been suggested in the Watershed Management Institute, Inc. and EPA's publication titled "Operation, Maintenance, and Management of Stormwater Management". The report can be found or ordered at the following Web site:
http://www.epa.gov/owow/nps/wmi/

Untreated decant water should not be conveyed to the storm sewer or nearby surface waters for disposal. Options for managing decant water include the following:

- Decant water can be contained (e.g., in a facility with a concrete pad, berms and roof) and conveyed to the sanitary sewer system after sanitary sewer pre-treatment requirements have been met. Depending on the sanitary sewer system, sanitary sewer pre-treatment requirements may be met by containing decant water for a minimum of 24 to 48 hours to allow settling of particulate matter. Clay particles may be difficult to settle prior to discharge to the sanitary sewer system.
- The volume of decant water that must be managed can be reduced by reducing the amount of liquids removed from storm facilities during maintenance. This can be accomplished by modifying vactor suction tubes and performing maintenance when systems have little or no standing water present.
- Decant water can be transported to decant stations for treatment, eliminating discharges in the field.
- Field settling sumps can be used to promote gravity settling and reduce decant water contamination.

2.4.2 Horizontal Injection Systems

The successful operation of horizontal injection systems (infiltration trenches) depends on maintaining the percolation rate of the sides and bottom of the system and preventing them from clogging. Preventive maintenance is vital for the long-term effectiveness of a horizontal injection system. Activities necessary to maintain system functionality include the following:

1. Inspection and Monitoring

The infiltration trench should be inspected routinely in the first year of operation and as needed on a systematic basis thereafter. The inspection should be conducted after large storms to check for surface ponding that might indicate local or wide spread clogging. Water levels in the trench's observation well should be recorded over several days after a large storm to ensure that the trench receives water and that it drains within the required time period after filling. The required drainage time for design storms usually varies from 12 hours to 72 hours, although 24 hours is recommended by some studies.

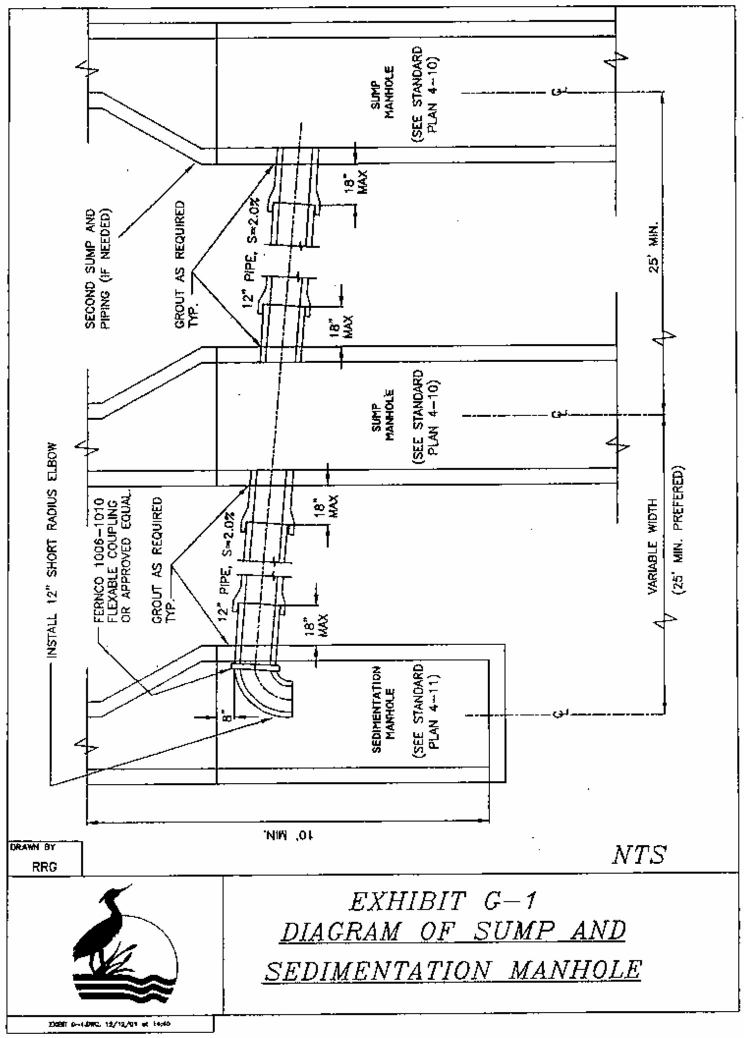
2. Inlet and Pipe Maintenance

The sediments and debris that accumulate in pretreatment devices such as catch basins or sedimentation manholes should be removed regularly to prevent them from moving into the trench. The inlets to an infiltration trench should be checked and cleaned as needed. The perforated pipe in a trench should be inspected routinely for the first year to determine how quickly materials accumulate in them. Accumulated materials can be vacuumed out with a jet vacuum combination machine (e.g., Vactor machine). High pressure cleaning of the holes or slots in the pipes can remove material from the holes or slots and help to reduce clogging.

3. Trench Rehabilitation

Clogging of underground infiltration trenches is likely to occur at the bottom of the trench at the fabric/soil interface. This clogging can be relieved by excavating away any pavement, turf, and soil over the trench, removing the existing stone, perforated pipe, and filter fabric, and rebuilding the trench. Prior to installing the new fabric, the soil at the bottom of the trench should be scarified and replaced with a layer of sand. The old stone or aggregate can be reused if it is washed prior to reinstalling it in the trench. The old filter fabric should be discarded and replaced with new fabric.

Exhibit 2-1 (1) Sumps – The City of Portland, Oregon



Stormwater Management Manual- Public Draft
Adopted July 1, 1999; revised September 1, 2002

Exhibit 2-1 (2) Sumps – The City of Portland, Oregon

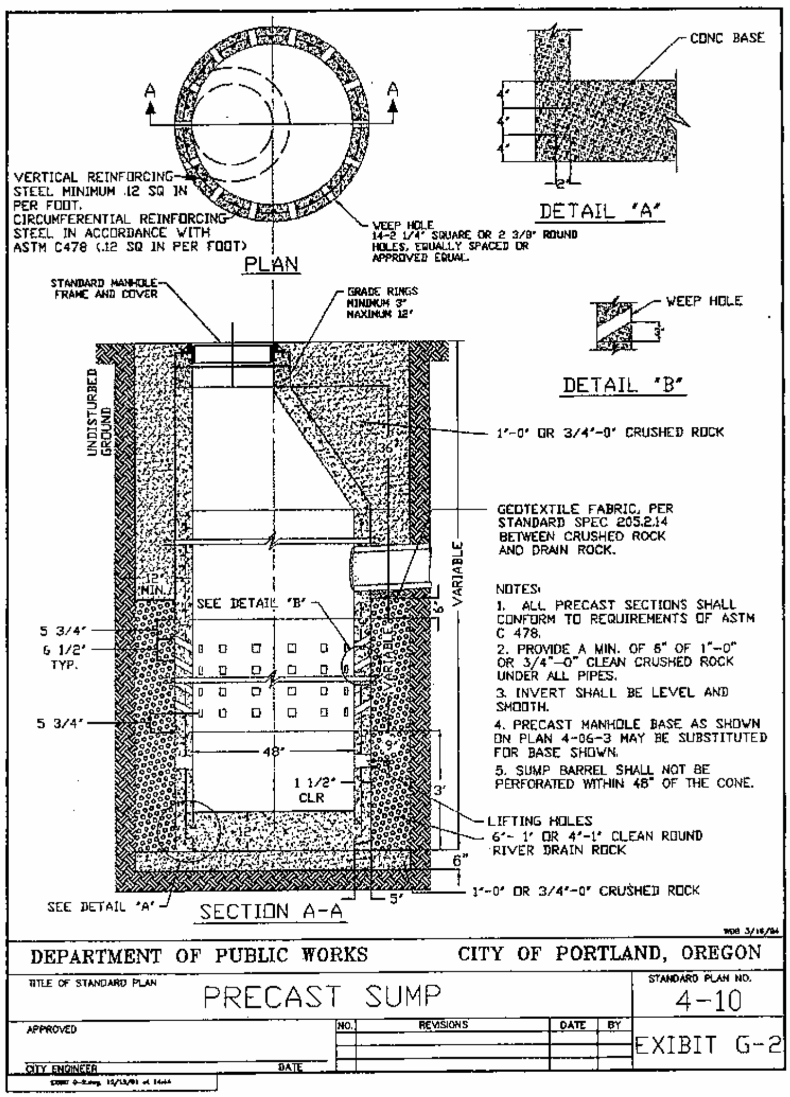
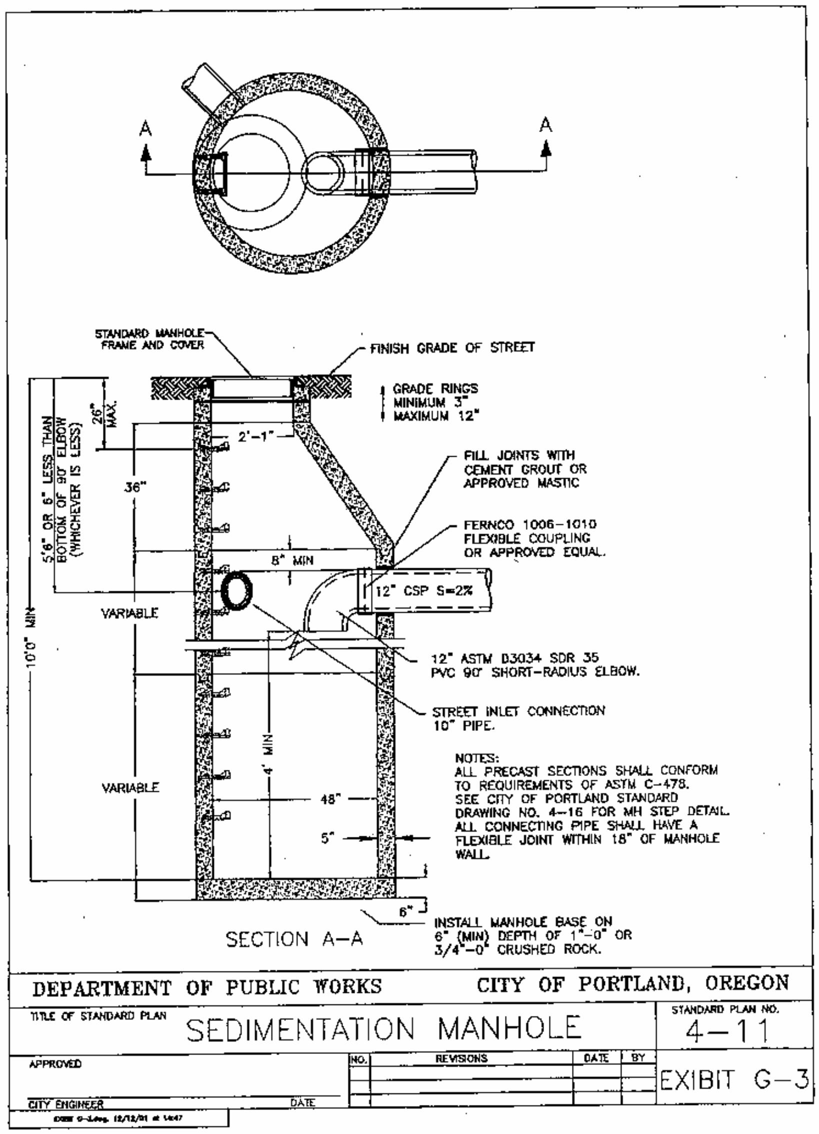
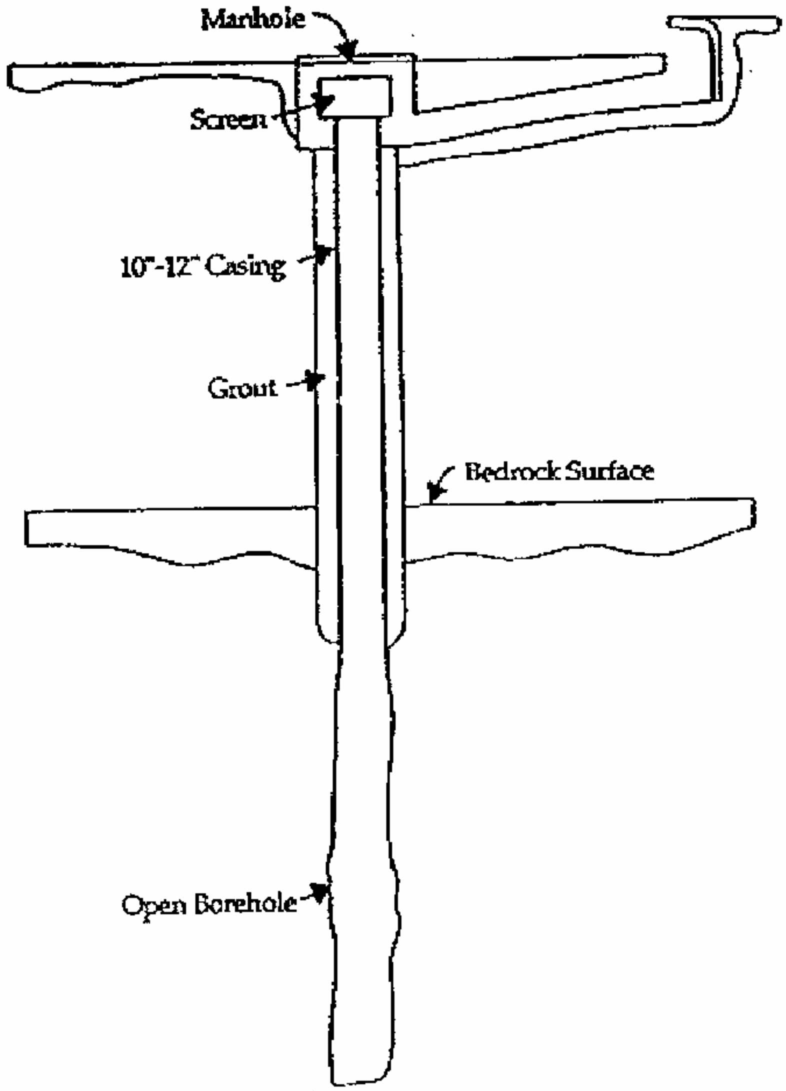


Exhibit 2-1 (3) Sumps – The City of Portland, Oregon



Stormwater Management Manual- Public Draft
Adopted July 1, 1999; revised September 1, 2002

Exhibit 2-2 Bored Wells -EPA



Source: Ohio EPA 1994

Last Updated 5/98
http://www.epa.gov/r5water/storm/ex4-5.htm

Exhibit 2-3 Dry Well - City of Troutdale, Oregon

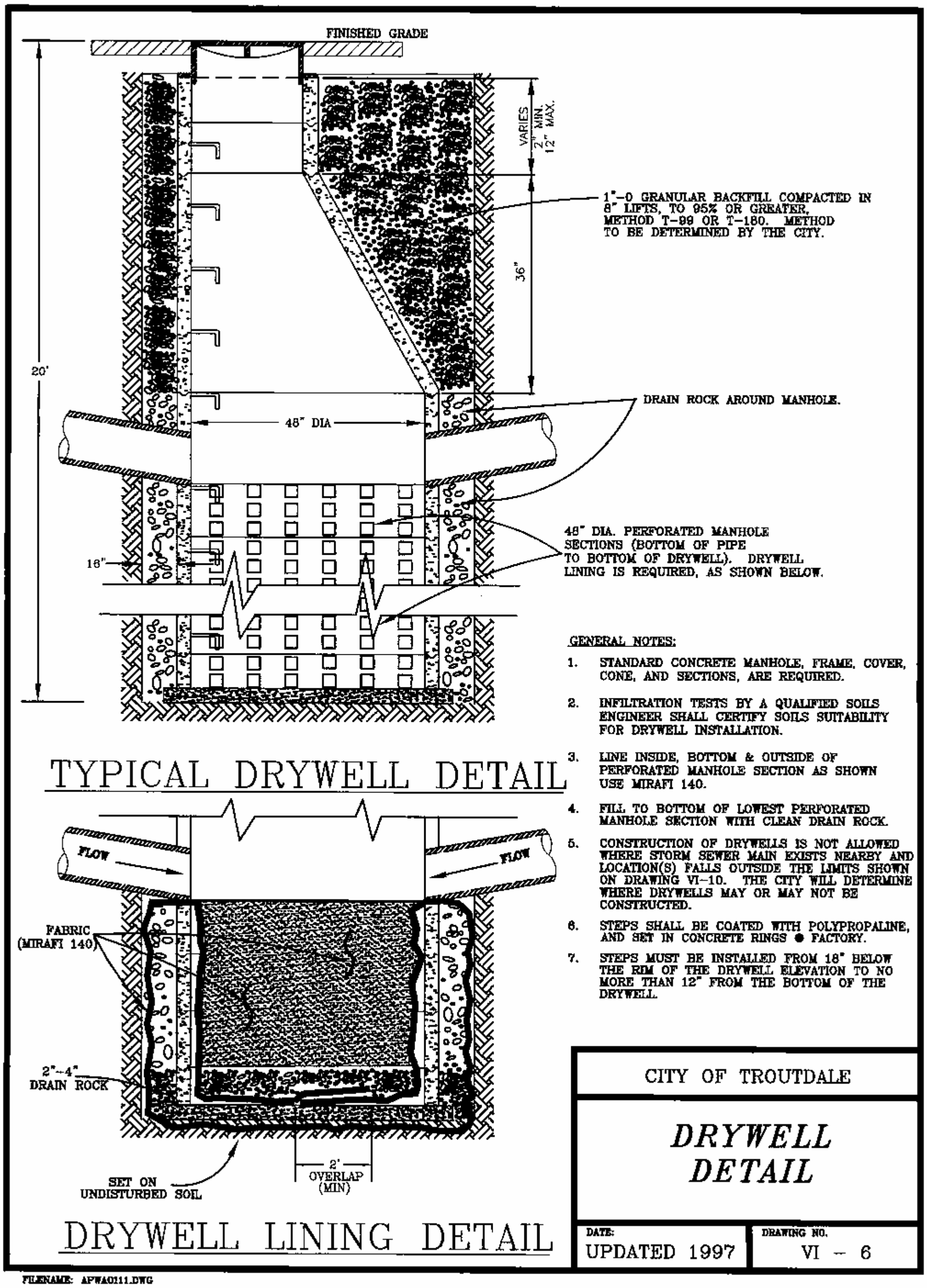
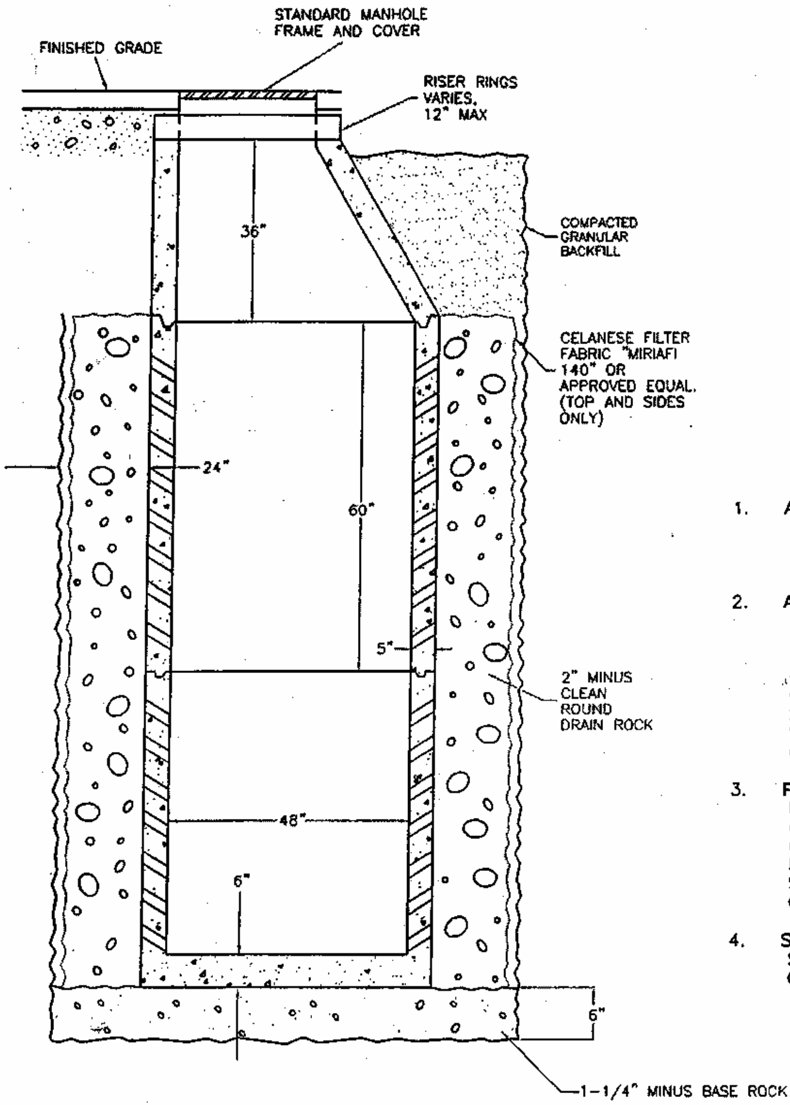


Exhibit 2-4 Dry Well – City of Vancouver, Washington



NOTES

1. ALL PRECAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF A.S.T.M. C478
2. ALL PIPING TO AND FROM PRECAST DRYWELLS SHALL HAVE AT LEAST 8" OF 1-1/2" MINUS CLEAN CRUSHED ROCK COVER CONTINUOUSLY AROUND PIPE WHERE DRAIN ROCK WOULD OTHERWISE BE IN CONTACT WITH PIPE.
3. PERFORATIONS SHALL BE HORIZONTAL ROWS OF (14) 2-1/4" SQUARE OR (14) 2-3/8" ROUND HOLES, EQUALLY SPACED. ROWS SHALL BE SPACED 6-1/2" CENTER TO CENTER.
4. STANDARD DRYWELL DEPTH SHALL BE 13' UNLESS NOTED OTHERWISE.

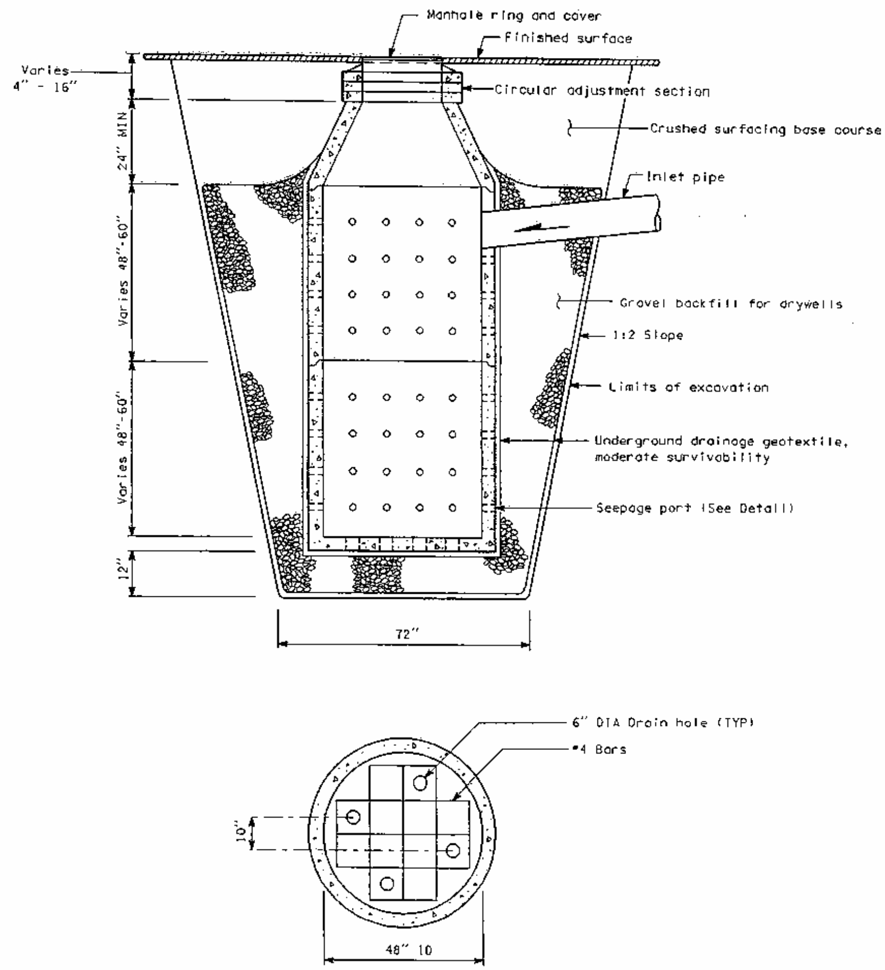
STANDARD PRE-CAST DRYWELL DETAIL

CITY OF VANCOUVER
DEPARTMENT OF PUBLIC WORKS

REV. NO.	DATE	BY	APPROVED
	8/22/95	GH	SA
1	12/12/95	GH	SA
2	11/20/98	GH	SA

STANDARD PLAN NO.
D-1.5

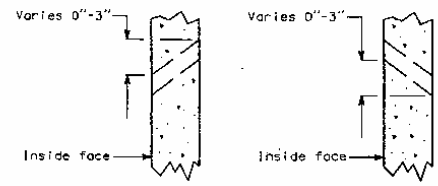
Exhibit 2-5 Washington State Department of Transportation



BASE DETAIL

NOTES:

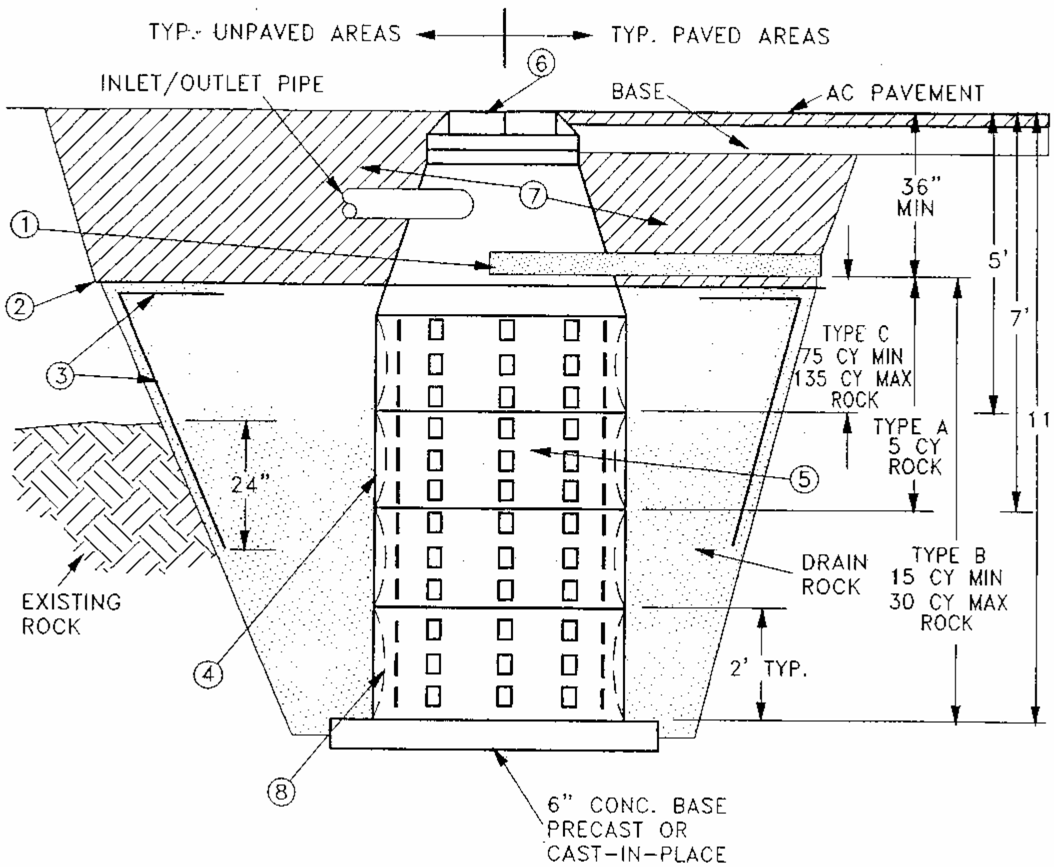
1. Precast cone sections may be eccentric or concentric.
2. Seepage port orientation varies among manufacturers.



SEEPAGE PORT DETAIL
(See Note 2)

PRECAST
CONCRETE DRYWELL

Exhibit 2-6 (1) Dry Well – City of Bend, Oregon



NOTES:

SEE ALSO THE CITY OF BEND STANDARDS AND SPECIFICATIONS FOR DESIGN CRITERIA

1. 6" CONCRETE CAP, CL. 3000, REQ'D TO 24" BEYOND ALL PAVED AREAS
2. MOISTURE BARRIER-2 LAYERS OF 4 MIL POLY. ON ALL INSTALLATIONS
3. GEOTEXTILE FILTER FABRIC ON ALL EARTH OR GRAVEL EXCAVATIONS TO 24" INTO ROCK. LAP 24" WITH MOISTURE BARRIER.
4. LINE INSIDE OF PERF. BARREL WITH HEAVY WEIGHT VINYL SCREEN, SUCH AS FULLFLOW VINYL SCREEN (a 0706). ATTACH BY OVERLAPPING 12" MIN. BETWEEN JOINT OF MANHOLE CONE AND PERFORATED BARREL SECTION.
5. PRE-CAST SECTIONS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C-478. CONCRETE SHALL BE CL.3300, AIR ENTRAINED CONCRETE.
6. STANDARD RING AND COVER REQUIRED IN RIGHT-OF-WAY AREAS. SLOTTED COVER MAY BE USED IN PARKING LOTS IN LIEU OF A CATCH BASIN.
7. CLASS "A" BACKFILL COMPACTED TO 95% OPTIMUM (AASHTO T-99).
8. FABRIC LINER FOR DRYWELL BARREL. LINER SHALL BE FIXED TO BARREL AT BASE AND AT EACH END JOINT OT THE BARREL SECTIONS.

STANDARD PRE-CAST DRYWELL

DES.	DZ	CITY OF BEND ENGINEERING DIVISION		SCALE	NTS
DWN.	JSE			DATE	05/22/90
APR.	DZ	REV. 2	DATE 11/97	SHT.	3-8

Exhibit 2-6 (2) Dry Well – City of Bend, Oregon

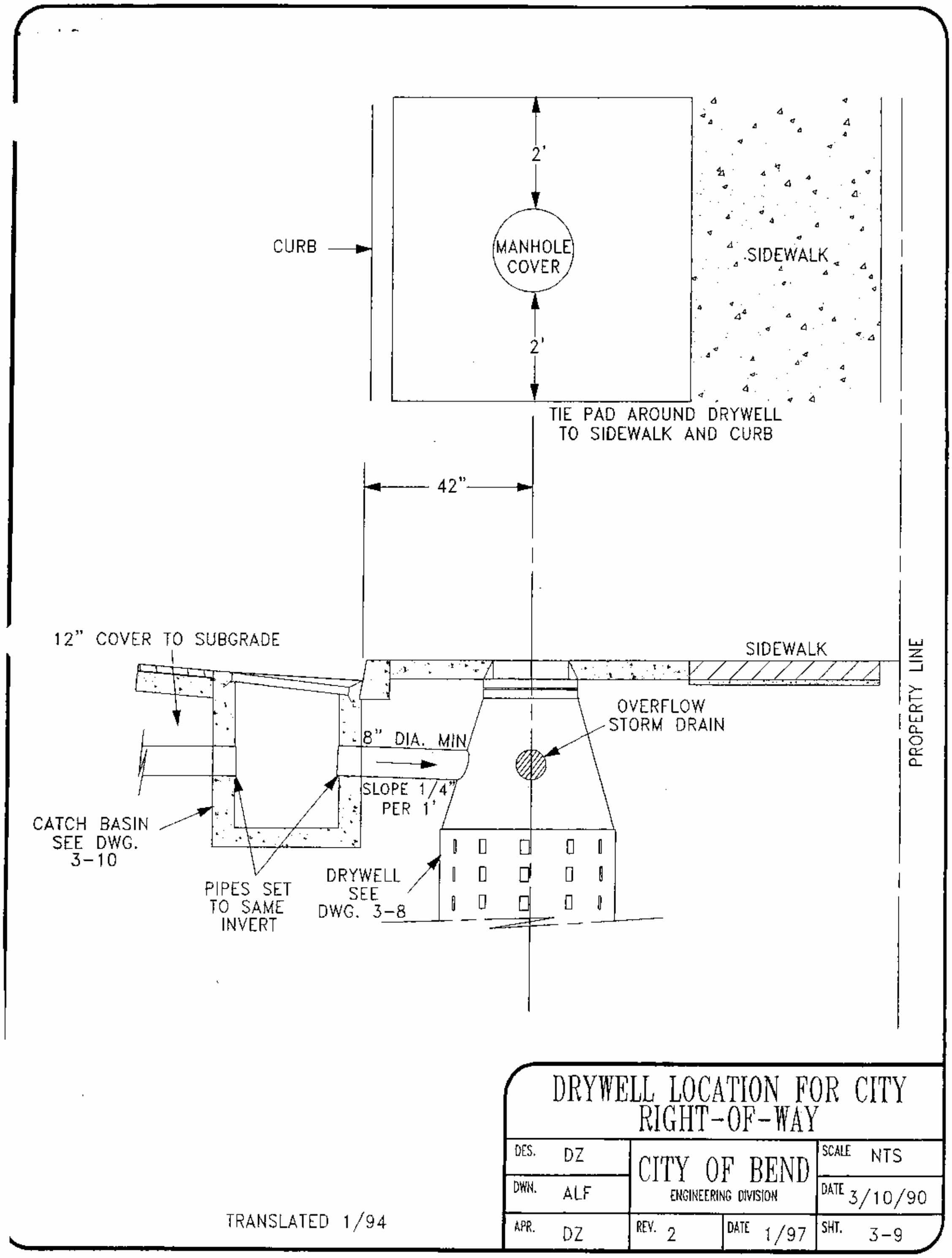


Exhibit 2-7 Sedimentation Manhole and Sump - Multnomah County, Oregon

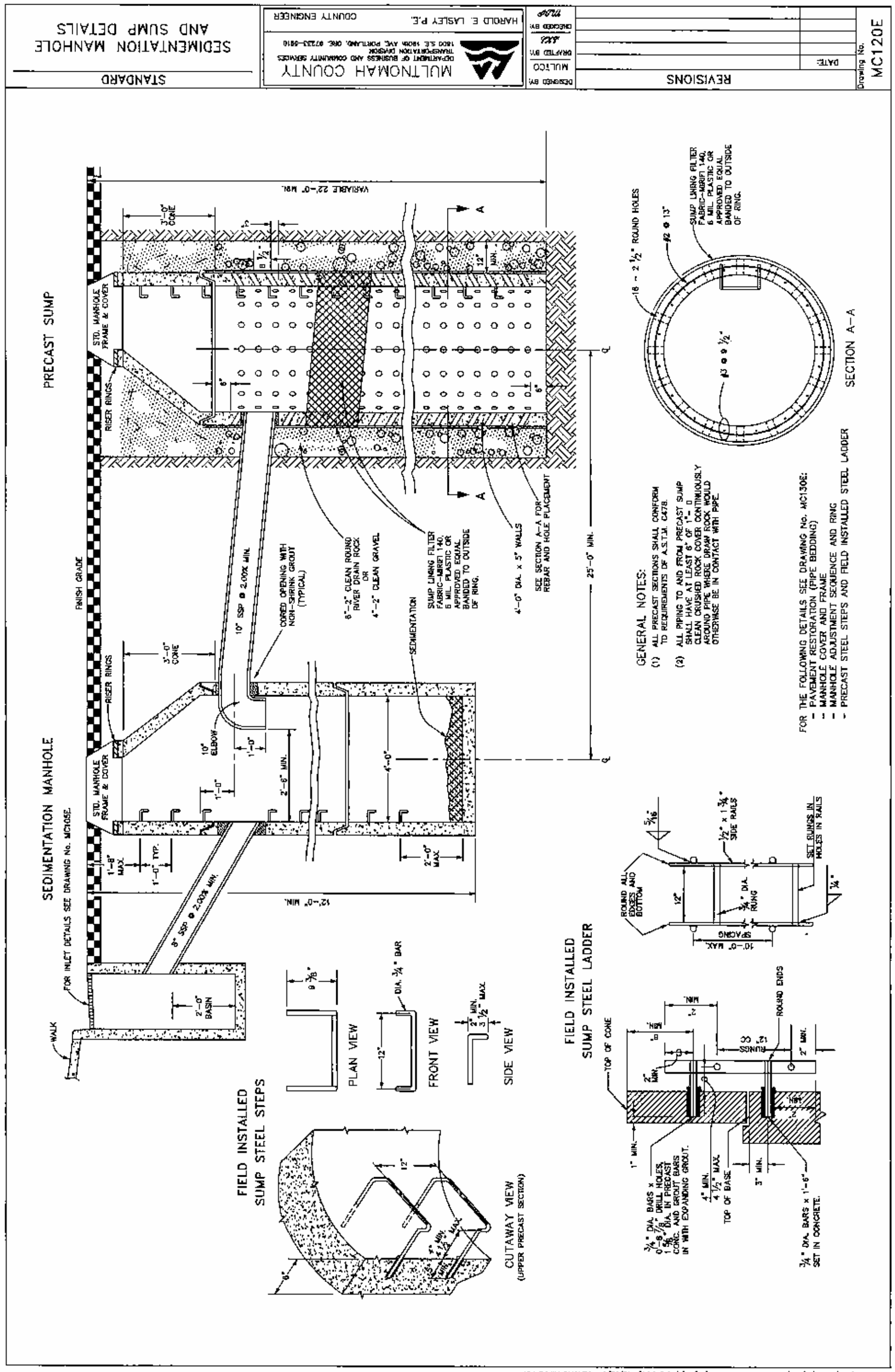


Exhibit 2-8 (1) Parking Lot Perimeter Trench – Department of Ecology, West Washington

BMP T7.20 Infiltration Trenches

Description:

Infiltration trenches are generally at least 24 inches wide, and are backfilled with a coarse stone aggregate, allowing for temporary storage of stormwater runoff in the voids of the aggregate material. Stored runoff then gradually infiltrates into the surrounding soil. The surface of the trench can be covered with grating and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet. Perforated rigid pipe of at least 8-inch diameter can also be used to distribute the stormwater in a stone trench. Trench configurations by Schueler (Figures 7.3 – 7.8) with inlet filter strips and/ or 6-12 inches bottom sand layers are shown.

Due to accessibility and maintenance limitations infiltration trenches must be carefully designed, constructed and maintained.

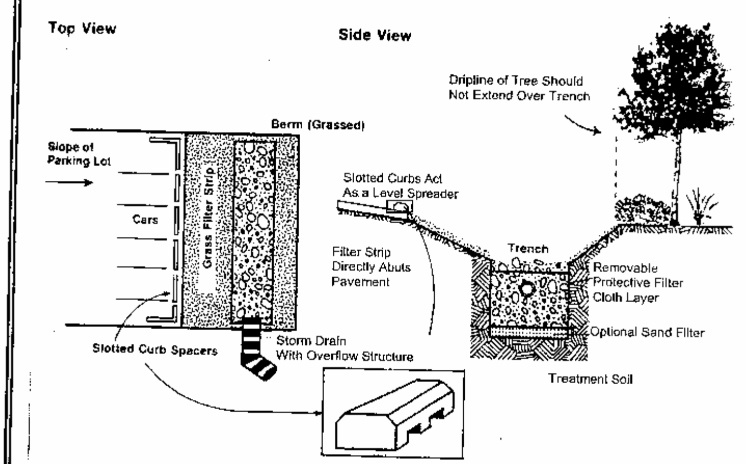


Figure 7.3 Parking Lot Perimeter Trench Design

Source: Schueler (reproduced with permission)

Volume V – Runoff Treatment BMPs *August 2001*

Exhibit 2-8 (2) Parking Lot Perimeter Trench – Department of Ecology, West Washington

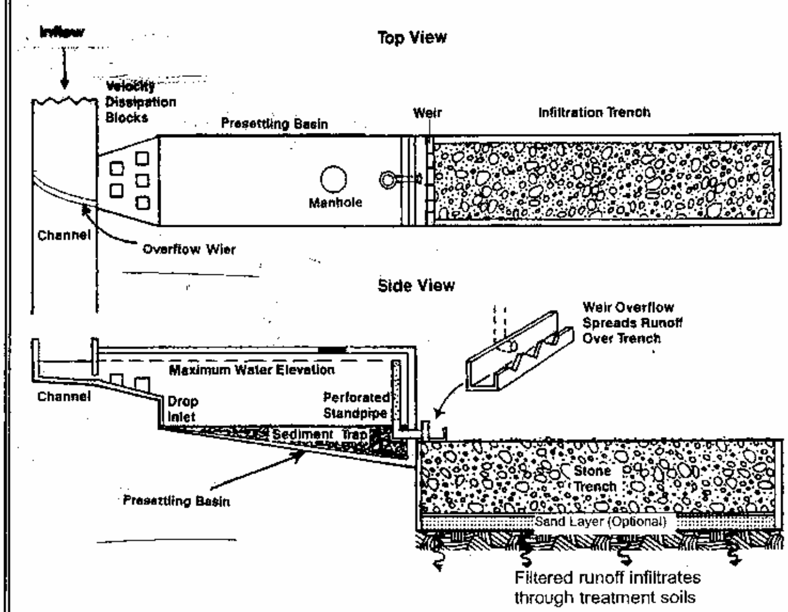


Figure 7.4 Infiltration Trench System

Source: Schueler (reproduced with permission)

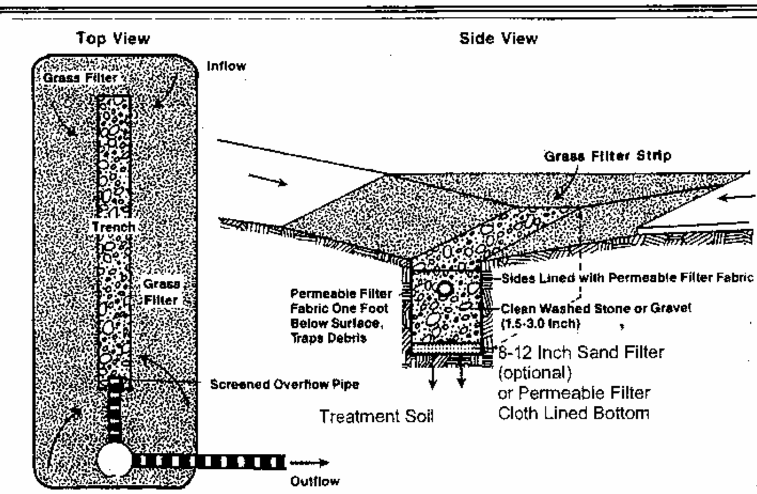
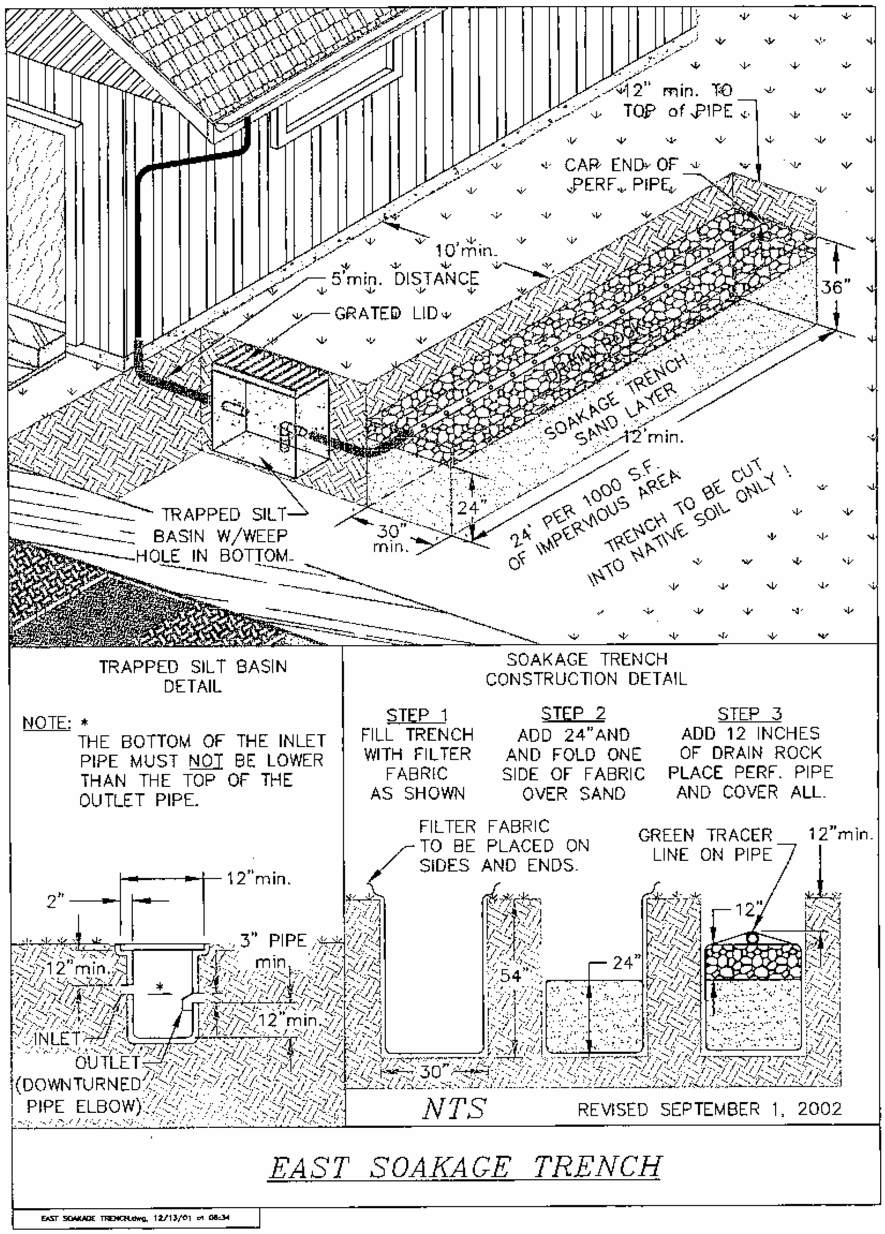


Figure 7.5 Median Strip Trench Design

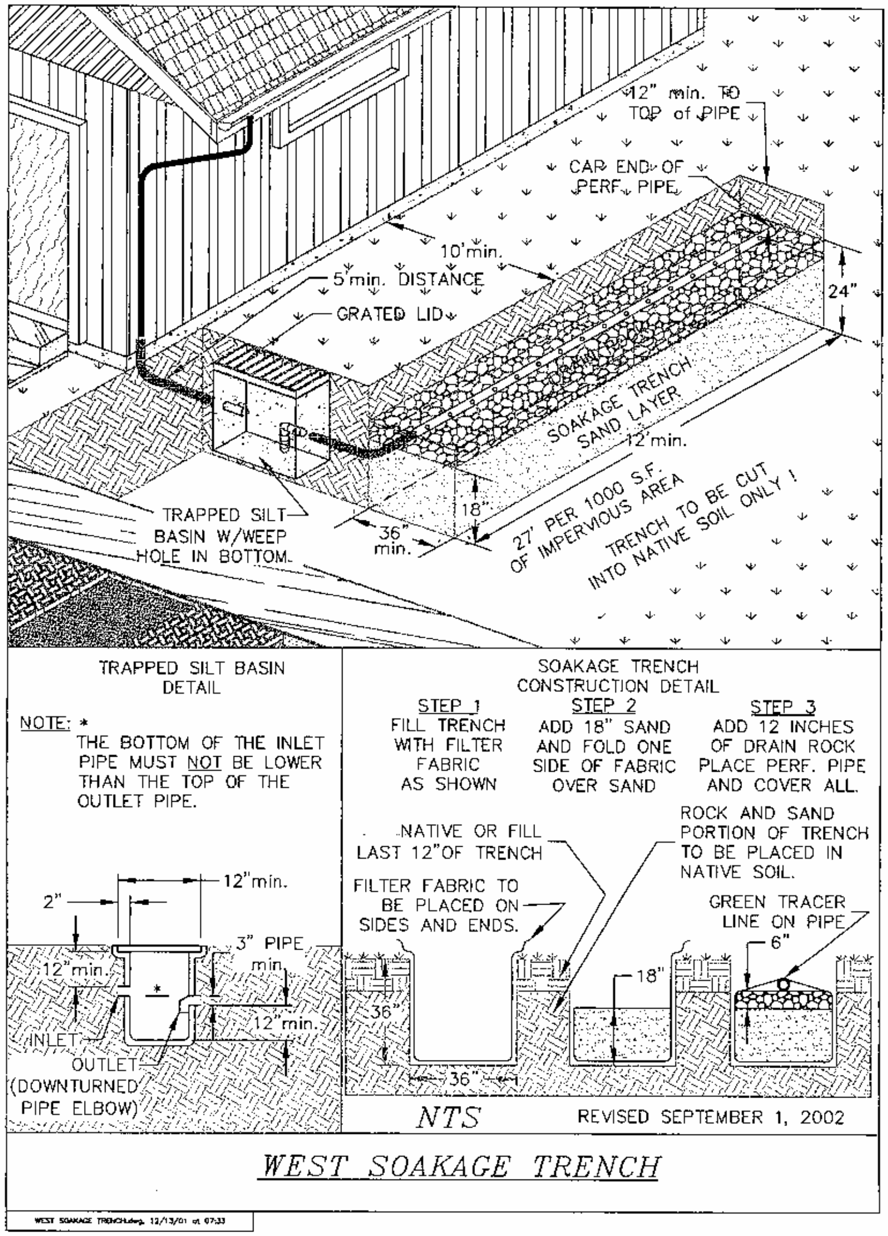
Source: Schueler (produced with permission)

Exhibit 2-9 (1) Soakage Trench - City of Portland



Stormwater Management Manual- Public Draft
Adopted July 1, 1999; revised September 1, 2002

Exhibit 2-9 (2) Soakage Trench – City of Portland



Stormwater Management Manual- Public Draft
Adopted July 1, 1999; revised September 1, 2002

SECTION 3.0

SOURCE CONTROL PRACTICES

Contents of Section 3.0

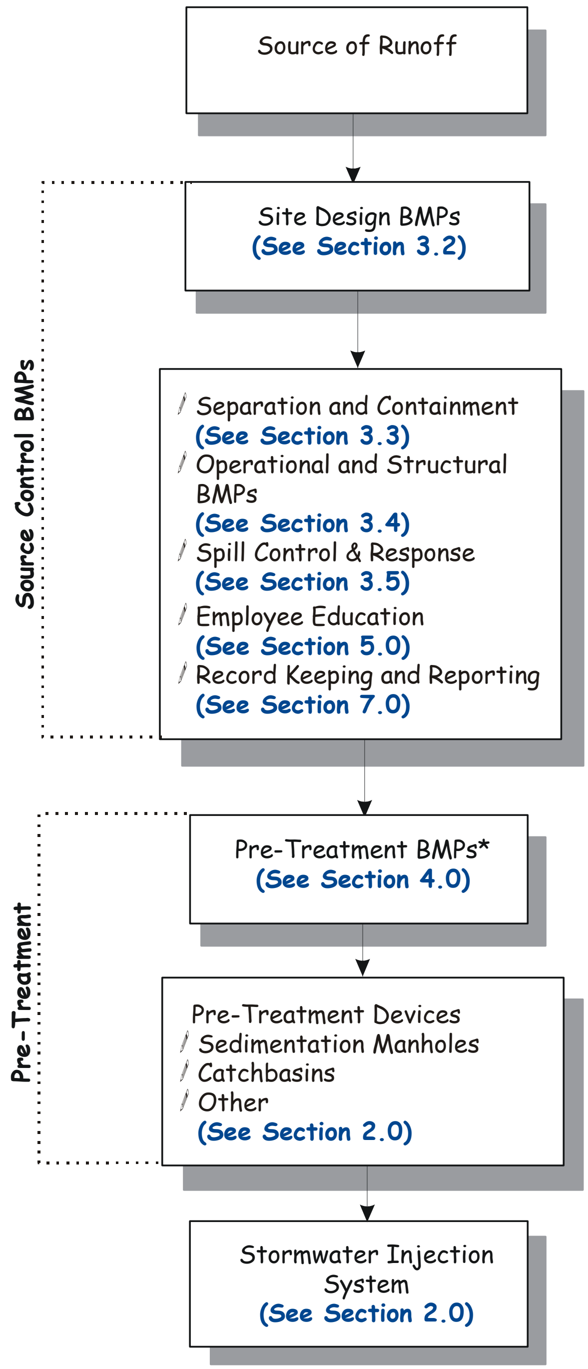
This section provides information on stormwater pollution source controls, including those that reduce runoff volumes and those that are necessary for specific site uses and operations that generate, or have the potential to generate, pollutants of concern. Types of source control practices covered in this section include:

- Site design BMPs
- Source separation and containment
- Operational BMPs for streets, highways and parking lots
- Operational and structural BMPs for common site activities including:
    - Vehicle and equipment fueling
    - Vehicle and equipment maintenance and storage
    - Vehicle and equipment washing
    - Loading and unloading
    - Storage, use and transportation of hazardous substances/toxic materials
- Spill control and response

3.1 INTRODUCTION

Source control practices include structural and non-structural BMPs designed to reduce runoff and/or prevent pollutants from contaminating stormwater runoff before it enters the municipal storm sewer system (see Figure 3-1). Stormwater can become contaminated when it comes into contact with substances stored on a site or when it comes into contact with any surface where pollutant residues are found. Typical urban activities that should incorporate source controls include manufacturing and commercial activities; high use vehicle parking; materials storage and handling; vehicle/equipment fueling, washing, maintenance, and storage. Stormwater may also become contaminated as a result of dumping, illicit discharges, or accidental spills. Illicit dumping or discharge can be reduced by source control practices, including public education.

Figure 3-1
Schematic of Source Control BMPs, Pre-Treatment BMPs, and Pre-Treatment Devices



* May not be necessary for rule authorized wells if sufficient natural filtration medium is present.

The objectives of source control BMPs are to:

- Reduce the volume of urban runoff entering the municipal storm drainage system.
- Prevent stormwater pollution by eliminating pathways that may introduce pollutants into stormwater.
- Protect soil and groundwater by capturing and properly disposing of accidental or illicit discharges or spills.
- Prevent illicit discharges to stormwater injection systems by draining areas with the potential for relatively consistent discharges (such as vehicle washing facilities) to the sanitary sewer system or other appropriate wastewater treatment or recycle system.
- Eliminate the potential for acute releases or accidental spills, (such as those from fuel islands or containment areas), from entering the municipal storm drainage system.

Reduction or elimination of stormwater pollutants can be achieved through the implementation of non-structural source control BMPs including site design, good housekeeping (i.e., operations), employee education, spill prevention and cleanup, preventive maintenance, regular inspections, and record keeping. These BMPs can be combined with structural source control BMPs such as impervious containment areas, curbing, and covering. Non-structural source control practices covered in this section include site design (section 3.2), operational BMPs (section 3.4), and spill control/response (section 3.5). Employee education, record keeping, inspection and maintenance are discussed in sections 5.0, 7.0 and 2.0, respectively. Structural source control practices are covered in sections 3.3 and 3.4.

When source control BMPs are not feasible or will not adequately reduce or prevent pollutants from entering stormwater injection systems, it may be necessary to implement pre-treatment BMPs. Pre-treatment BMPs are discussed in Section 4.0.

3.2 SITE DESIGN BMPS

Site design BMPs are practices and/or facilities that can be implemented to reduce the amount of impervious area at a site and the negative impacts from impervious areas that occur when sites are developed. Site design BMPs focus on minimization of impervious surface areas and the use of infiltration and dispersion through on-site vegetation to provide flow control and treatment of runoff. The site design BMPs contained in this manual can be used to provide runoff reduction and some water quality treatment of runoff from low pollutant-generating surfaces, such as driveways, small parking lots and rooftops. It should be noted that injection of stormwater runoff exclusively from rooftops is exempt from Oregon UIC rule authorization requirements. As of January 2003, registration of residential rooftop drain injection systems with DEQ is voluntary.

Depending on the subsurface conditions, contributing land use and underground injection system design, implementation of site design BMPs alone may not be sufficient to obtain rule authorization of an injection system. However, implementing site design BMPs is highly encouraged and should be considered in the early stages of development. Site design BMPs can reduce the amount of runoff for ultimate discharge and improve the quality of runoff. They are considered to be highly effective, low-cost and low maintenance stormwater reduction techniques. Site design BMPs are grouped into three categories and described below.

1. Site design BMPs that reduce runoff volumes through site planning.

BMPs that reduce runoff volumes through site planning include BMPs that retain vegetation and limit impervious surfaces. Implementation of this category of BMPs results in a reduction of the quantity of runoff that needs to be considered for water quality treatment. These BMPs may include the following:

- Preserve natural vegetation and/or plant additional native vegetation on site.
- Limit grading to preserve surface soils and natural topography.
- Implement alternative (low-impact) roadway layouts.
- Reduce roadway widths.
- Reduce driveway and sidewalk areas.
- Reduce parking lot areas.
- Reduce building footprints.

Design and implementation of this category of site design BMPs would not be affected by climate. However, design and implementation will depend heavily on local regulations. Each municipality has its own land use requirements and design codes that will affect implementation. The following references provide additional information:

- Green Streets Handbook (Environmental Designs for Transportation), Metro, Oregon (May 2002).
- Draft Zoning Ordinance, City of Boardman, Oregon (July 2001).
- Native planting and natural gardening information on the Metro Web site at: *http://www.metro-region.org/metro/rem/garden/natgar.html*.
- Low-Impact Development: An Integrated Design Approach, Department of Environmental Resources, Prince George's County, Maryland (January 2000).

2. Site design BMPs that reduce runoff volumes through infiltration or dispersion of runoff.

The second category of site design BMPs are those that result in the infiltration of concentrated or dispersed runoff. Generally these site design BMPs are intended to primarily reduce runoff volumes, and are not primarily intended to provide pollutant treatment. The BMPs that belong in this category and that are covered in this manual include:

- Porous Pavement (BMP Fact Sheet #1)
- Infiltration Stormwater Planter (BMP Fact Sheet #2)
- Downspout Infiltration System (BMP Fact Sheet #3)

3. Site design BMPs that provide retention and filtration of runoff on site.

The third category includes site design BMPs that provide storage but not infiltration. Vegetation in these BMPs provides some treatment through filtration and biological uptake. Examples of these BMPs include:

- Flow-through stormwater planters (BMP Fact Sheet #2)
- Eco-roofs and roof gardens (BMP Fact Sheet #4)
- Preserving or planting trees where the canopy covers impervious areas.

BMP fact sheets are provided for the second and third categories of site design BMPs in Appendix B. The fact sheets include the following information: general description, application and limitations, regional variations, advantages/disadvantages, maintenance practices, and references to the most suitable design information.

3.3 SOURCE SEPARATION AND CONTAINMENT

Contaminants released by certain types of industrial and commercial activities, such as fueling, loading and unloading could be washed into stormwater injection systems by rainfall and stormwater runoff. Separating these activities from stormwater runoff minimizes contamination. Source separation and containment can be accomplished by moving activities indoors, installing spill containment devices, covering materials stored outdoors, or separating by grading and berming. These methods, which are discussed below, should be deployed when hazardous wastes and toxic materials are present.

1. Curbing

Curbing can be used as a type of containment barrier. It is usually made of concrete, metal, or other impenetrable substance, that can be used to separate potential spill areas from stormwater runoff discharge points. Curbing is usually used on a small-scale to prevent spills in areas where small amounts of liquids are stored or used. Grading within the curbing can be designed to facilitate cleanup by directing spilled liquids to one part of the curbed area. Curbing should be inspected routinely, especially after rainfall. Spills should be cleaned up promptly to avoid overflow to non-curbed areas and to minimize the contact between residual contaminants and rainfall. Materials spilled in curbed areas may be recycled or disposed of properly. While curbing is relatively inexpensive and easy to install, it is not effective in containing larger spills.

2. Containment Dikes

Containment dikes are earth or concrete retaining walls often constructed for loading and unloading areas and for aboveground liquid storage areas. Containment dikes are designed to hold larger spills. Dikes should be designed to hold at least a volume equal to the largest storage tank present plus expected rainfall. Some guidance recommends that at least 10 percent of the total “tank farm” volume (e.g. sum volume of a group of tanks) or 110 percent of the largest tank be retained. A pumping system or vacuum trucks can be used to remove spilled contaminants and prevent overflow from dikes. Diking is an effective method of preventing contamination of stormwater runoff, but may be expensive for small facilities because of construction and maintenance costs.

3. Containment Sumps

Containment sumps are holes or low areas structured so that liquid spills or leaks flow toward a particular part of a containment area. Pumps are often placed in the sump to transfer liquids away from the sump as it fills. Pump discharge should be connected to a holding area or sanitary sewer line (if approved by the treatment plant). Sumps should be constructed of impenetrable materials to avoid leaks into the surrounding subsoil and should be positioned at the lowest point in a containment area for maximum efficiency. Sumps are a practical means of collecting stormwater in a containment area, but pumps may require a high level of maintenance to avoid clogging.

4. Covering

Covering of outdoor materials is an effective way to prevent rainfall and stormwater runoff from coming into contact with potential contaminants. High-risk areas such as fueling areas, material storage areas and material handling areas can be covered by tarps, plastic sheeting, roofs, or awnings. Non-permanent coverings should be inspected routinely for any leakage.

3.4 OPERATIONAL BMPS FOR STREETS, HIGHWAYS AND PARKING LOTS

Regular maintenance of street surfaces and urban drainage systems can reduce the pollutant load in runoff that may drain to dry wells. Two operational BMPs that can reduce pollutant loads are street sweeping and catch basin cleaning.

3.4.1 Street Sweeping

Many communities sweep streets to remove dirt, litter and accumulated leaves. Public and private organizations do the same to keep parking lots clean. Sweeping removes material from urban surfaces that would otherwise migrate downstream through the storm drainage system to injection systems or surface waters. Pollutants may adsorb to soil particles that are removed during street sweeping. Past studies have indicated that street sweeping may not remove a substantial amount of the finer particles of street dirt that often carry a disproportionate share of the pollutant load, but street sweeping with modern vacuum sweepers may be more effective at removing finer particles than older mechanical sweepers. Even if only coarse-grained material is removed, street sweeping can reduce the pollutant and sediment load on injection systems, and thus reduce the need for injection system maintenance and media replacement.

3.4.2 Catch Basin Cleaning

Many catch basin and street inlet designs include storage areas (e.g. small sumps) that are intended to allow some sedimentation and litter trapping to occur prior to discharging stormwater runoff downstream in the drainage system. Sumped catch basins and inlets primarily remove coarse-grained materials (e.g. gravel and coarse-grained sediments), reducing the overall pollutant and sediment load that reaches a dry well or surface waters. The storage capacity of most catch basins and inlets is quite limited, however, and so without regular cleaning they become ineffective as a sediment and litter trap. Routine catch basin and inlet cleaning has the potential to reduce the pollutant and sediment load on dry wells and thus the need for dry well maintenance and media replacement.

3.5 OPERATIONAL AND STRUCTURAL BMPS FOR COMMON SITE ACTIVITIES

This section summarizes operational BMPs that can prevent or reduce pollutants entering stormwater due to common site activities. Site activities that can contaminate stormwater include vehicle and equipment fueling and/or maintenance, material storage and washing, material loading and unloading, and hazardous substances/toxic materials storage, use and transportation. Although operational BMPs may be effective in minimizing the impacts to stormwater from activities such as these, municipalities are discouraged from siting new stormwater injection systems in areas associated with these activities. In the case of washing activities, Condition 5 of the DEQ WPCF General Permit 1700B prohibits the construction and use of new drywells in areas receiving runoff from washing activities.

Implementing proper operational and structural BMPs can be an effective and inexpensive way of preventing stormwater contamination by common site activities. Appropriate operational and structural BMPs for common site activities are discussed below.

3.5.1 Vehicle and Equipment Fueling

DEQ recommends that no new injection systems should be installed in areas used specifically for fueling. There are several aspects of fueling activities that can lead to contamination of stormwater. These include:

- Spills or leaks during fueling or oil delivery.
- Spills caused by "topping off" fuel tanks.
- Allowing rainfall to run onto the fueling area.
- Washing or hosing the fueling area.

The following operational BMPs can be applied for fueling areas to prevent stormwater contamination:

- Prepare an emergency spill response and cleanup plan and have designated trained persons available either on site or on call at all times to promptly and properly implement the plan and immediately cleanup all spills.
- Keep suitable cleanup materials, such as dry adsorbent materials, on site to allow prompt cleanup of a spill.
- Post signs at the fueling dispensing area. Signs need to be water resistant and contain safety precaution information, immediate spill response procedure information, and emergency contact information.
- Transfer the fuel from the delivery tank trucks to the fuel storage tank in impervious contained areas and ensure that appropriate overflow protection is used.

Applicable structural source control BMPs for fueling areas include:

- Cover the fuel dispensing area with a permanent canopy, roof, or awning to prevent direct contact of precipitation with the fueling area.
- Pave the fueling area with Portland cement concrete instead of asphalt. Gasoline and other materials can react with asphalt pavement causing the release of toxic oils from the pavement.
- Grade the fueling area and install dikes or curbs to prevent stormwater from flowing across the area.
- Convey the stormwater collected on the fueling area to a sanitary sewer system (if approved by the treatment plant), or to an approved treatment system such as an oil/water separator.
- Install spill and overfill prevention equipment on storage tanks.

The following sources provide additional information on source control BMPs for fueling activities:

- Eco-logical Business Program web site: *http://www.ecobiz.org/automain.htm*
- City of Portland Stormwater Management Manual (2002), Section 4.2
- Stormwater Management Manual for Western Washington, Volume IV, by Washington State Department of Ecology (2001), Chapter 2.2

- Denver Urban Drainage Criteria Manual, Volume 3. Urban Drainage and Flood Control District, Denver (1999), Industrial and Commercial Best Management Practices Section 3.2.1.

3.5.2 Vehicle and Equipment Maintenance and Storage

Vehicle and equipment maintenance operations use materials and create wastes that can be harmful to humans and the environment if not properly handled. Stormwater runoff from these areas can become polluted with a variety of contaminants such as oil and grease, automotive fluids, and battery acids. Other potential problems associated with vehicle and equipment maintenance include leaks from vehicles and equipment in storage areas and improper disposal of maintenance materials such as greasy rags and used oil filters. The Oregon DEQ UIC program prohibits vehicle waste from repair or maintenance activities from being discharged to underground injection systems (OAR 340-044-0015 (2)(e)). More information can be found at:
http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

The following operational BMPs can be applied for vehicle and equipment maintenance and storage areas:

- Inspect the storage area regularly for leaks from incoming vehicles, parts, and equipment stored temporarily outside.
- Use drip pans or containers under parts or vehicles that drip or that are likely to drip liquids, such as during dismantling of liquid containing parts or removal or transfer of liquids.
- Remove batteries and liquids from vehicles and equipment in designated areas designed to prevent stormwater contamination. Store cracked batteries in a covered non-leaking secondary containment system.
- Empty oil and fuel filters before disposal. Provide for proper disposal of waste oil and fuel.
- Store and maintain appropriate spill cleanup materials in a location known to all employees and educate the employees on proper handling and disposal of engine fluids and proper spill clean up procedures.
- Do not pour/convey wash water, liquid waste, or other pollutants into storm drains.
- Do not connect maintenance and shop floor drains to an underground injection system.

Applicable structural source control BMPs for vehicle and equipment maintenance and storage operations include conducting routine maintenance and repair of vehicles and equipment in a building, or other covered impervious containment area that is sloped to prevent run-on of uncontaminated stormwater and runoff of contaminated stormwater.

The following references provide more information on source control BMPs for vehicle and equipment maintenance and storage:

- City of Portland Stormwater Management Manual (2002), Sections 4.9 and 4.11
- Stormwater Management Manual for Western Washington, Volume IV, by Washington State Department of Ecology (2001), Chapter 2.2

- Denver Urban Drainage Criteria Manual, Volume 3. Urban Drainage and Flood Control District, Denver (1999), Industrial and Commercial Best Management Practices Section 3.2.2.

3.5.3 Vehicle and Equipment Washing

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute stormwater. Wash water may contain high concentrations of oil and grease, solvents, heavy metals, detergents and suspended solids.

The following operational BMPs can be applied for vehicle and equipment washing activities:

- Use detergents that are biodegradable and contain no phosphates.
- Do not degrease or wash the underbody of a vehicle near a stormwater drain.
- Do not dispose of vehicle and equipment wash water in a drain connected to the storm drainage system. Convey wash water to the sanitary sewer if approved by the wastewater treatment plant. Wash water can also be conveyed to another appropriate wastewater treatment or recycling system if preferred or if sanitary sewer service is not available.

Applicable structural source control BMPs for washing operations include:

- Conduct outside washing operations in a paved area that is constructed as a spill containment pad to prevent the run-on of stormwater from adjacent areas.

It should be noted that Condition 5 of the DEQ WPCF General Permit 1700B prohibits the construction and use of new drywells in areas receiving runoff from washing activities. Use of existing drywells for disposal of water from washing activities is allowed provided written approval is obtained from DEQ and the discharge is authorized by a WPCF general permit 1700B or an individual WPCF permit[3]. Discharge to drywells from washing activities must meet the conditions and limitations specified in Schedule A of the permit for the drywell. DEQ's permit information can be found at the following Web site: *http://www.deq.state.or.us/wq/wqpermit/wqpermit.htm*

The following references provide more information on source control BMPs for vehicle and equipment washing activities:

- "Oregon DEQ Recommended Best Management Practices for Washing Activities" (March 1998), available at: *http://www.deq.state.or.us/wq/wqpermit/washwater.pdf*
- City of Portland Stormwater Management Manual (2002), Section 4.7
- Stormwater Management Manual for Western Washington, Volume IV, by Washington State Department of Ecology (2001), Chapter 2.2
- Denver Urban Drainage Criteria Manual, Volume 3. Urban Drainage and Flood Control District, Denver (1999), Industrial and Commercial Best Management Practices Section 3.2.4.

[3] As of January 2003, DEQ has given no site written approval for use of existing drywells for disposal of water from washing activities.

3.5.4 Loading and Unloading

Loading and unloading materials outside or at loading docks can be a source of stormwater contamination. Materials that are spilled or that leak from vehicles may enter stormwater drains. Specific loading and unloading activities that may cause stormwater contamination include transferring materials by truck, forklift, or conveyor belt, transferring liquids or gases between a truck or railroad car and a storage facility, and transferring dry chemicals between loading and unloading vehicles. Of particular concern are locations where materials such as liquids, gases, chemicals, petroleum products or other hazardous materials are loaded or unloaded. DEQ recommends that no new injection systems be installed at these locations and that existing injection systems at these locations be evaluated for removal.

The following operational BMPs can be applied for loading and unloading areas:

- Sweep the outside uncovered loading/unloading areas frequently to remove materials that could otherwise be washed off by stormwater.
- Place drip pans, or other appropriate temporary containment devices, at locations where leaks or spills may occur such as hose connections, hose reels and filler nozzles.
- Check loading/unloading equipment such as valves, pumps, flanges, and connections regularly for leaks and repair as needed.
- Prepare an "Operations Plan" that describes procedures for loading/unloading. Train employees, especially fork lift operators, in its execution and post it or otherwise have it readily available to employees.
- Prepare and implement an Emergency Spill Cleanup Plan for the site.
- Prepare and keep a Spill Response Kit nearby to where loading and unloading activities occur.

Applicable structural source control BMPs for loading and unloading operations include:

- Install and maintain covers, such as overhangs, or door skirts at loading/unloading docks to prevent contact with rainwater.
- Pave and slope loading/unloading areas to prevent the pooling of water.
- Berm or dike the loading/unloading area to prevent run-on of stormwater and to prevent runoff or loss of any spilled material from the area. Perform loading/unloading activities in these specially designed areas.
- Direct roof runoff away from loading/unloading areas.

The following references provide more information on source control BMPs for loading and unloading activities:

- City of Portland Stormwater Management Manual (2002), Section 4.6
- Stormwater Management Manual for Western Washington, Volume IV, by Washington State Department of Ecology (2001), Chapter 2.2
- Denver Urban Drainage Criteria Manual, Volume 3. Urban Drainage and Flood Control District, Denver (1999), Industrial and Commercial Best Management Practices Section 3.2.5.

3.5.5 Storage, Use and Transportation of Hazardous Substances/Toxic Materials

Areas where hazardous substances and toxic materials are stored, used and/or transported can result in stormwater pollution. Substances and/or materials spilled, leached, or lost from these areas may build up in soils or on other surfaces and be carried away by runoff. Possible stormwater contaminants from these activities include toxic compounds, oil and grease, organic compounds, heavy metals, bacteria, nutrients, and suspended solids. Potential pollutants can vary extensively in type and severity, depending on the characteristics of the material being stored, used or transported.

Design requirements for hazardous substances/toxic materials handling areas are typically dictated by City or County ordinances and zoning requirements. Handling of hazardous materials should follow relevant federal, state and local requirements. The structural and non-structural source control BMPs provided in this section are meant to provide management measures to minimize the potential for stormwater contamination from these areas.

The following operational BMPs can be applied for hazardous substances and toxic materials handling areas:

- Place tight-fitting lids on containers.
- Place drip pans beneath mounted containers or tank taps and at potential drip and spill locations during filling and loading/unloading containers or tanks.
- Inspect containers or tank storage areas regularly for corrosion, structural failure, spills, leaks, overfills, and failure of piping systems. Replace or repair containers and tanks that are leaking, corroded, or otherwise deteriorating.
- Prepare hazardous substances and toxic materials containment plan and provide signage in hazardous materials loading/unloading areas, work areas and transportation routes.
- Prepare and implement an Emergency Spill Cleanup Plan for the site.
- Prepare and keep a Spill Response Kit nearby to where hazardous substances and/or toxic materials are stored, used and transported.

Applicable structural source control BMPs for hazardous substances and toxic materials handling areas include:

- Keep containers or tanks with hazardous/toxic materials or other potential pollutant liquids inside a building unless it is impracticable due to site constraints or Uniform Fire Code requirements.
- Store containers or tanks in a designated area, which is covered, bermed or diked, paved and impervious in order to contain leaks and spills.
- Install a dike in liquid storage areas. The dike must be of sufficient height to provide a containment volume of either 10 percent of the total “tank farm” volume (e.g. sum volume of a group of tanks) or, if a single tank, 110 percent of the volume of the single tank.
- Provide secondary containment. Secondary containment can be achieved through curbs, gutters, berms, drains, pipes, valves, self contained sumps, vaults, double-walled tanks, or other commercially available secondary containment devices.

- Provide spill containment for transportation route. A transportation route is defined as any route used to transport hazardous/toxic materials onto, off of, or within a site. This includes driveways, parking areas, and all other passageways used to transport regulated materials onto, off of, or within a site.
- Use pavement, curbs, and gutter materials constructed of impervious materials for transportation routes.
- Seal all joints and cracks with a bonded epoxy or similar materials during material transportation.

The following links provide more information with regards to source control BMPs for hazardous substances/toxic materials storage, use and transportation:

- City of Portland Stormwater Management Manual (2002), Sections 4.4 and 4.10
- Stormwater Management Manual for Western Washington, Volume IV, by Washington State Department of Ecology (2001), Chapter 2.2
- Denver Urban Drainage Criteria Manual, Volume 3. Urban Drainage and Flood Control District, Denver (September 1999), Industrial and Commercial Best Management Practices Sections 3.2.6 and 3.2.9

3.6 SPILL CONTROL AND RESPONSE

Areas and activities that are most vulnerable to spills include fueling activities, loading and unloading activities, and vehicle maintenance and storage areas. Spills may also occur in areas such as access roads and parking lots. It is very important that municipalities have well-established spill response systems to handle accidental spills or leaks when such accidents occur in their jurisdictions. DEQ has developed a draft spill response plan appropriate for sites with a few injection systems as a part of its guidance on stormwater management plans for UICs. Jurisdictions are encouraged to contact their local regional DEQ office to obtain a copy of this document when they develop or update their spill response systems.

A spill response system typically consists of an emergency response team and emergency coordinator (i.e., leader) whose responsibilities are to clean up the spill quickly and prevent contamination from reaching drainage systems after a spill is reported. The emergency response team members should be trained and educated in proper spill response procedures. They should at least be familiar with the following:

- How to prevent a spill from reaching a drainage system;
- Who to call for additional help;
- How to use various spill clean up equipment;
- How to properly dispose of spilled materials.

The following paragraphs provide information on general measures used to prevent spills, measures to reduce the impact of spills, spill response and clean up, disposal of spilled materials and spill reporting.

1. General Measures to Prevent Spills

Section 3.4 contains useful information on spill prevention for areas and activities that are vulnerable to spills. These activities include fueling activities (section 3.4.2), loading and unloading activities (section 3.4.5), vehicle/equipment maintenance, storage and washing activities (sections 3.3.3 and 3.3.4), and hazardous material storage, use and transportation activities (section 3.3.6). The most commonly used preventive strategies are summarized below:

- Train employees that work in pollutant source areas in identifying pollutant sources and in understanding pollutant control measures and spill response procedures.
- Store chemicals inside a building or in areas not exposed to rainfall or stormwater runoff.
- Perform regular maintenance of vehicles and equipment on site to check for: proper operation, leaks, malfunctions, and evidence of leaks or discharge (stains).
- Repair or replace all leaking connections, pipes, hoses, valves, etc. which could contaminate stormwater.
- Collect spent automotive fluids and recycle or dispose of properly.
- Install berms or dikes in liquid chemical storage areas.
- Repair or replace all substantially cracked or otherwise damaged paved secondary containment, high-intensity parking and any other drainage areas, which are subject to pollutant material leaks or spills.

2. General Measures to Reduce the Impact of a Spill on Stormwater Injection Systems

The following measures will help reduce the impacts on a stormwater injection system from leaks or spills:

- Develop a spill plan for stormwater injection systems and educate employees and the public on the subject.
- Identify potential spill areas and their drainage points on maps to determine preventive measures and spill response actions.
- Consider color-coding or tagging of stormwater injection systems so that emergency crews know they are dealing with an injection system when responding to accidental spills.
- Consider storm drain stenciling to minimize illegal dumping.
- Place and maintain emergency spill containment and cleanup kit(s) at outside areas where there is a potential for spills. These kits should be appropriate for the material being handled and the size of the potential spill.
- Immediately upon discovery of a spill, take actions to stop, contain, and cleanup the spill that can be accomplished safely. Contain the spill or leaking substance. If the spill involves a liquid, consider blocking the flow by placing absorbent materials along the edge of the spill if this can be accomplished safely. If a spilled powder could blow away, contain it by covering it with plastic or, if it won't react with water, by dampening it with wet towels or a light water spray.
- If there is a chance the spill could enter the storm drain or a dry well, cover the drain inlet with rubber mats or have expandable well plugs to block conveyance lines in case of accidental spills.
- For new injection systems, consider including engineered structures such as a shut-off valves in the stormwater injection system in areas that are vulnerable to spills to temporally block and prevent the accidental spills from entering the injection system.

3. Spill Response and Cleanup

Municipalities should have emergency phone numbers accessible to the public for contact in case of a spill or leak. Once the municipality is notified of an accidental spill from citizens or employees, the emergency spill response team should be available to act immediately and to determine the most effective cleanup methods. Several factors affect the determination of the best method or combination of methods, for spill cleanups: the type and amount of material spilled, and the characteristics of the drainage path and the affected water body. The spill response team members should know what a "reportable spill" is, and what the appropriate response is for "reportable" and "below reportable" spills.

Municipalities should develop a list of necessary contacts to notify when a spill has occurred as a part of the spill response and clean-up process. Municipalities should consider including local water purveyors on this list, particularly if any spill occurs in the proximity of an injection system within the 2 to 5 year time-of-travel zone of a public water supply wellfield.

The measures most frequently employed to control spills and minimize their impact fall into four broad categories:

- Mechanical containments include booms, barriers, skimmers, and absorbent materials.
- Chemical and biological methods include dispersants, gelling agents, and biological agents (use of these methods generally requires detailed regulatory approval).
- Physical methods include wiping, sweeping and raking.
- Natural processes including evaporation, oxidation and biodegradation.

Different measures should be applied according to specific site and spill conditions since spills will vary in materials and volume. The following are recommended spill cleanup measures for common industrial facilities and automotive-related activities:

- For spill cleanup, use absorbent materials that can be swept or picked up such as kitty litter, rags, sawdust, or vermiculite. For solids such as powders, sweep or wipe the spill.
- Contain medium-sized spills with absorbents (kitty litter, sawdust, etc.) and use inflatable berms or absorbent pads as temporary booms for the spill. Store and dispose of absorbents properly. Wet/dry vacuums may also be used, but not for volatile fluids.
- For large spills, first contain the spill and plug storm drain inlets where the liquid may migrate off-site, then cleanup the spill.
- Have a list of available spill clean up services available as part of the spill control plan, as private cleanup firms may be needed for large spills.

4. Disposal of Spilled Material

Any material removed from the spill site should be disposed of properly, following local, state, and federal requirements. Washing spilled materials down a sanitary sewer or storm drain is generally prohibited. The contaminated absorbent material should be collected as a solid and placed in appropriate disposal containers. Rags used in small spills can be taken to professional cleaning service and reused. The cleaning service should be informed of the material on the rag. Absorbent and cleaning products used on a hazardous spill cleanup are likely to be hazardous waste. They must be bagged or placed in a drum, labeled, and transported to an authorized disposal site.

5. Spill Reporting

A spill or release may require reporting under several federal laws and Oregon law, including:

- Resource Conservation and Recovery Act (RCRA).
- Toxic Substances Control Act (TSCA).
- Hazardous Materials Transportation Act (HMTA).
- Clean Water Act (CWA).
- Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

The emergency coordinator should note that although the intent of Congress is to have the Reportable Quantity (RQ) of a hazardous material be the same under all the Acts, there may be a lag time before RQ levels are made uniform under all Acts. Also, chemicals appearing on one Act's list may not be found on another.

Oregon state rules regarding spills or releases of oil and/or hazardous substances can be found in OAR 340, Division 108 or in the following Web site:
http://www.deq.state.or.us/wmc/ hw/resliboar.html

If a serious emergency occurs and the local fire department has been called, or if there has been a spill that extends outside the facility/plant or could reach a storm sewer, groundwater, or surface water, the following numbers should be called immediately:

- The National Response Center (NRC) 1-800-424-8802
- The Oregon Emergency Response System (OERS) 1-800-452-0311 (in state), or 503/378-4124 (out of state)

Telephone reports to NRC and OERS are required when an accident involving a hazardous material results in:

- Death.
- Hospitalization.
- Property damage in excess of $50,000.
- Any situation a business thinks should be reported.
- A discharge of a hazardous material in excess of the reportable quantity in the current 40 CFR Table 302.4 and OAR 340-108.

A hazardous waste specialist at the Oregon DEQ regional office can be contacted to determine if a spill is a substance of a reportable quantity. Reportable quantity is defined in OAR 340-108-0010 as:

- Any quantity of radioactive material, or radioactive waste.
- Any quantity of oil released in the waters of the state that can produce a visible sheen.
- Oil spilled on the surface of the land, any quantity over 42-gallons (one barrel).
- Any amount equal to or greater than the quantity listed in 40 CFR Part 302 – Table 302.4 (list of hazardous substances and reportable quantities).
- One pound or more of nerve agents (released on-site).
- One pound of pesticide residues.

When reporting a spill, the following information shall be prepared:

- Name, address, and DEQ/EPA hazardous waste ID number of the facility.
- Date, time, and type of incident (e.g., spill or fire).

- Quantity and type of hazardous material, hazardous substance or hazardous waste involved in the incident.
- Extent of any injuries.
- Estimated quantity and disposition of any recovered materials.

More information with regard to spill reporting and clean up can be found in Chapter 13 of the Oregon DEQ's report titled *"Small Quantity Hazardous Waste Generator Handbook"*. This report can be downloaded or viewed at the following Web site: *http://www.deq.state.or.us/wmc/hw/SQGhdbook.html*

In addition to a spill report, the responsible party may be required by the Oregon DEQ to submit a written cleanup report within 15 days of a spill or other incident, describing all aspects of the incident and steps taken to prevent a recurrence.

As noted above, municipalities should consider including local water purveyors among those who are notified when a spill occurs, particularly if any spill occurs in the proximity of an injection system within the 2 to 5 year time-of-travel zone of a public water supply wellfield.

SECTION 4.0

PRE-TREATMENT PRACTICES

Contents of Section 4.0

This section provides information on pre-treatment BMPs that may be used upstream of stormwater injection systems. These BMPs include:

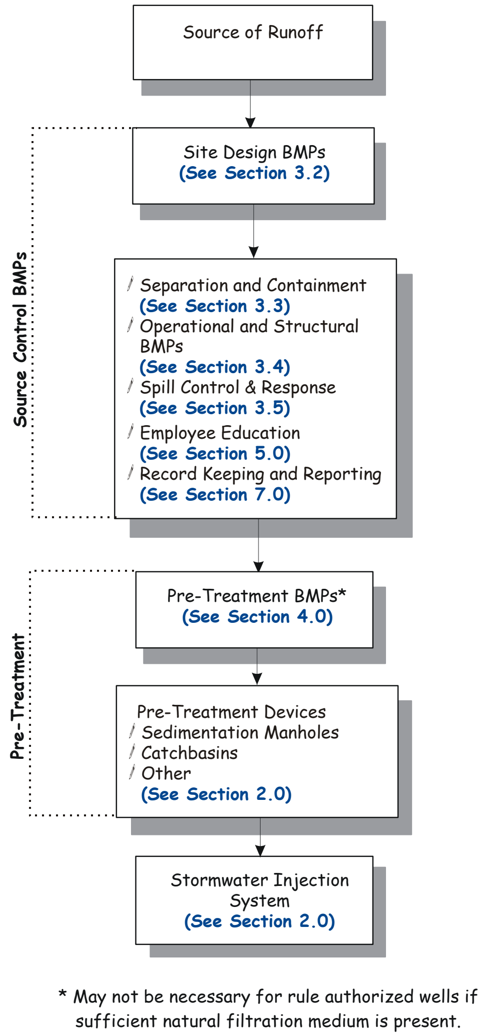
- Vegetated swales and flow-through planters
- Sand filters, catch basin inserts and stormwater filtration vaults
- Wet and dry ponds
- Constructed wetlands
- Catch basins and sedimentation manholes
- Stormwater sedimentation vaults
- Oil/water separators

4.1 PRE-TREATMENT BMPS

This section provides information on pre-treatment BMPs that may be used upstream of stormwater injection systems (see Figure 4-1). These BMPs are not needed for every injection system but local agencies may choose to use them to protect groundwater quality.

Pre-treatment BMPs include propriety devices. As of January 2003 DEQ will rule authorize injection systems that include proprietary devices that have been field tested and approved for on-going stormwater quality treatment (not temporary erosion control) by the Washington Department of Ecology, the Environmental Protection Agency, the American Society of Civil Engineers, or King County, Washington. Contact DEQ for additional information about approved proprietary devices for rule authorization.

Figure 4-1
Schematic of BMP Implementation



A BMP fact sheet for each pre-treatment BMP is included in Appendix B. Each fact sheet contains the following information:

- General description.
- Applications and limitations.
- Regional variations (if applicable).
- Advantages and disadvantages.
- Maintenance practices and cost information (if available).
- References to design information (i.e., BMP manual).

Pre-treatment BMPs employ several processes to remove pollutants from stormwater. They include sedimentation, flotation, filtration and adsorption. Some BMPs depend on a single process for their effectiveness but most depend on a combination of processes. Types of BMPs and the pollutant removal mechanisms they employ are described below.

4.1.1 BMPs that Depend Primarily on Filtration

1. Vegetated swales and flow-through planters

Vegetated swales slow the flow of stormwater and remove pollutants by filtration and straining through vegetation, and by sedimentation. Flow-through planters remove pollutants by filtration with soil acting as the filter medium. Nutrients deposited in swales or planters may be converted into plant material.

- Flow-through Stormwater Planters (BMP Fact Sheet #2)
- Vegetated Swales (BMP Fact Sheet #5)

2. Sand filters, catch basin inserts and stormwater filtration vaults

Sand filters remove pollutants by a combination of screening and sedimentation at the surface of the filter medium and adsorption on to sand particles. The filter is usually contained in an underground concrete structure.

Catch basin inserts are proprietary devices that fit into catch basins. Various types of filter media are used. A catch basin fitted with an insert typically depends on a combination of sedimentation, screening, and adsorption to remove pollutants. Catch basin inserts may capture a variety of pollutants such as dissolved metals and nutrients, depending on the filtration media and filtration processes used. Some filter media are designed to remove small quantities of oil and grease by adsorption.

Stormwater filtration vaults are proprietary devices that employ a variety of mechanisms for pollutant removal including filtration, sedimentation, and flotation. Stormwater filtration vaults are equipped with filtration devices that are used to screen and adsorb pollutants. Stormwater filtration vaults may capture a variety of pollutants such as dissolved metals and nutrients, depending on the filtration media and filtration processes used. Vaults are typically installed underground.

- Basic Sand Filters (BMP Fact Sheet #6A)
- Sand Filter Vaults (BMP Fact Sheet #6B)
- Linear Sand Filters (BMP Fact Sheet #6C)
- Catch Basin Inserts (BMP Fact Sheet #11A)
- Stormwater Filtration Vaults (BMP Fact Sheet #11B)

4.1.2 BMPs that Depend Primarily on Sedimentation

1. Wet and dry ponds

Wet and dry ponds retain stormwater for hours or days after a storm. Dry ponds drain out completely after a storm, whereas wet ponds are designed to have a permanent pool of water. Both types of ponds rely primarily on sedimentation to remove pollutants.

- Wet Ponds (BMP Fact Sheet #7A)
- Dry Ponds (BMP Fact Sheet #7B)

2. Constructed wetlands

Constructed wetlands are shallow wet ponds. The permanent pool is shallow enough to enable dense beds of emergent vegetation to grow in the pond. Constructed wetlands primarily rely on sedimentation to remove pollutants but some bacterial degradation of organic matter and incorporation of nutrients into plant material probably occurs in the growing season.

- Constructed stormwater wetlands (BMP Fact Sheet #8)

3. Catch basins and sedimentation manholes

Catch basins and sedimentation manholes are structures designed to remove particulate matter from stormwater. These structures remove pollutants by slowing flows and allowing for the settling of particulates. Catch basins and sedimentation manholes may provide some level of oil separation by flotation when the structures are designed to include baffle systems or controlled outlets below the water surface elevation.

- Catch Basins and Sedimentation Manholes (BMP Fact Sheet #9)

4. Stormwater sedimentation vaults

Stormwater sedimentation vaults are proprietary devices that employ a variety of mechanisms for pollutant removal, including sedimentation and flotation. Depending on the vault design, sedimentation may be enhanced by vortex forces, circular screening, and the design of internal components.

- Stormwater sedimentation vaults (BMP Fact Sheet #11C)

4.1.3 BMPs that Depend Primarily on Flotation

1. **Oil/water separators**

Oil/water separators are structures designed to remove oil, grease and floatable debris from stormwater. Under quiescent conditions, some hydrocarbons separate from stormwater and rise to the water surface in an oil/water separator. For stormwater applications, oil/water separators are almost always combined with a sediment removal device or designed to allow sedimentation as well as flotation to occur in the structure.

- Oil/Water Separators (BMP Fact Sheet #10)

4.2 SELECTING APPROPRIATE BMPS

Pre-treatment BMPs must be appropriately selected, designed, operated and maintained to provide effective treatment. Many factors need to be considered when selecting BMPs. They include:

- Stormwater characteristics
- Performance characteristics of BMPs
- Physical constraints
- Severity of risk of groundwater contamination
- Economics

Each of these factors is discussed below.

1. **Stormwater characteristics**

The quality of stormwater runoff depends on land use within a drainage basin. Typically, stormwater from industrial and commercial areas, heavily used parking lots and heavily traveled highways is more contaminated than runoff from residential areas. Potential contaminants in urban runoff from different land uses are shown in Table 4-1.

2. **Performance characteristics of BMPs**

Long-term performance data is generally not available for stormwater BMPs because they were not widely applied until the 1990s. However, it is apparent that some BMPs are likely to be more effective in removing certain contaminants than others. Table 4-2 provides a qualitative estimate of the effectiveness of several BMPs in removing different contaminants.

EPA and the Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE) have created a database of BMPs that is intended to evaluate the effectiveness of urban stormwater runoff BMPs nationwide. More information on the database can be obtained at *http://www.bmpdatabase.org*. Oregon ACWA is conducting a BMP monitoring and effectiveness evaluation in 2003. More information on the study and the results when they are available can be reviewed at *www.oracwa.org*.

Some pre-treatment BMPs may be installed either offline or online in the system. With offline facilities, the design treatment volume is diverted offline from the conveyance system to the treatment facility through a control structure. When the treatment facility reaches its full design capacity, the remaining runoff bypasses the facility and remains in the conveyance system. The offline configuration improves performance because it reduces the risk that particulates and other pollutants previously trapped by the facility will be re-suspended and transported downstream during high flows.

Pre-treatment BMPs can be installed in series to improve pollutant removal effectiveness. Combination or "treatment train" facilities (i.e., several facilities in series) can be designed so that upstream facilities pre-treat the runoff, enabling the main device to function optimally. Sites with high oil and grease pollutant loads may benefit from a flotation BMP in series with filtration BMP. Sites with high sediment pollutant loads may benefit from a sedimentation BMP in series with a filtration BMP. Table 4-3 provides examples of source control BMPs and pre-treatment BMP mechanisms suitable for use with underground injection systems.

The performance and pollutant removal rates of proprietary BMPs can be highly variable, depending upon system design, pollutant loads, maintenance frequencies and other factors. It is recommended that municipalities considering implementing proprietary BMPs request independent third party performance data from vendors. As discussed above, as of January 2003 DEQ will rule authorize injection systems that include proprietary devices that have been field tested and approved for on-going stormwater quality treatment (not temporary erosion control) by the Washington Department of Ecology, the Environmental Protection Agency, the American Society of Civil Engineers, or King County, Washington.

3. Physical constraints

Physical constraints may limit the choice of BMPs. The constraints are likely to be more severe for existing stormwater systems that drain to dry wells than for new systems. This is because retrofitting of existing drainage systems with pollutant removal devices is typically more difficult than building devices into new construction.

4. Severity of risk of groundwater contamination

The severity of risk of groundwater contamination from an underground injection system is primarily dependent upon the following factors:

- Land use
  As discussed above, the quality of stormwater runoff depends on land use within a drainage basin. Potential contaminants in urban runoff from different land uses are shown in Table 4-1.

- Implementation of source control BMPs
  Implementing source control BMPs that reduce runoff and/or prevent pollutants from contaminating runoff can reduce the risk of groundwater contamination from stormwater infiltration.

- Vertical distance from the bottom of the underground injection system to groundwater.
  As discussed in Section 2.1, in general, the greater the separation between a stormwater injection system and groundwater, the lower the potential for contamination. DEQ recommends a minimum separation distance of between four to 10 feet between the bottom of the stormwater injection system and the seasonal high groundwater level, depending on the soil characteristics.

- Soil characteristics in soils surrounding injection system.
  As discussed in Section 2.1, soil characteristics in soils surrounding an injection system affect the capacity of the soil to remove pollutants from infiltrated stormwater. Coarse-grained soils (sand and gravel) and fractured basalt have a lower capacity for removing pollutants through soil adsorption and fine-grained soils (clay and silt) have a higher capacity for removing pollutants through soil adsorption.

- Confinement barrier
  The presence of a confinement barrier (e.g. an impervious layer of bedrock) between an injection system and the groundwater table substantially reduces the risk of groundwater contamination from stormwater infiltration.

5. Economics

The initial implementation costs and long term maintenance costs of pre-treatment BMPs vary widely. A qualitative assessment of the costs of pre-treatment BMPs is contained in Table 4-2. Costs are also addressed in the BMP Fact Sheets in Appendix B.

Table 4-1
Common Stormwater Pollutants of Concern Associated with Various Land Use Types[1]

Land Use Types (Potential Pollutant Sources)	Potential Pollutants of Concern
PARKING LOT/DRIVEWAY	
High Use Sites (>1,000 trips/day)	High Oil and Grease, Total Suspended Solids, Copper, Zinc, Polycyclic Aromatic Hydrocarbons
Non High Use Sites (<1,000 trips/day)	Oil and Grease, Total Suspended Solids
STREETS/HIGHWAYS	
Arterials, Highways and High Use Intersections	High Oil and Grease, Total Suspended Solids, Copper, Zinc, Polycyclic Aromatic Hydrocarbons
Residential Collectors	Low Oil and Grease, Total Suspended Solids, Copper, Zinc
OTHER SOURCES	
Industrial/Commercial Development	Oil and Grease, Total Suspended Solids, Copper, Zinc
Residential Development	Total Suspended Solids, Pesticides/Herbicides, Nutrients, Bacteria
Landscaped areas	Total Suspended Solids, Pesticides/Herbicides, Nutrients
Fueling Stations	High Oil and Grease
Industrial Yards/Maintenance Areas	High Oil and Grease, Total Suspended Solids, Metals, Polycyclic Aromatic Hydrocarbons

[1] Table based on literature review and stormwater management manuals from Pacific Northwest jurisdictions, including Table 2.1 of Volume V of Stormater Management Manual for Western Washington (Washington Department of Ecology, August 2001).

Table 4-2
Overview of Pre-treatment BMPs

Pre-Treatment Stormwater BMP Type	Typical Land Use Applications	Pollutant Removal Effectiveness[2]					Physical Feasibility		Relative Cost[3]	
		Sediments	Nutrients	Metals	Bacteria	Oil and Grease	Drainage Area	Slope	Initial	Mainten-ance
Flow-Through Planters	Parking lots, commercial and residential land uses	◍	◍	◍	◌	◍	< 5 acres	< 4-6%	Low	Medium
Vegetated Swale[4]	Parking lots, buildings, highways or residential roads	◍	◍	◍	◌	◍	< 5 acres	< 4-6%	Low	Medium
Sand Filters	Small residential, commercial, or industrial sites	●	◍	◍	◍	◍	<10 acres - surface < 2 acres - underground	<6%	High	High
Catch Basin Inserts[5]	Various urban land uses	◍	◌	◍	◌	◍	< 1 acre	NA	Medium	High
Stormwater Filtration Vaults[5]	Various urban land uses	●	◍	◍	◍	◍	varies	NA	High	High
Dry Ponds	Roads, parking lots, residential neighborhoods, commercial, or industrial sites where space is available	◍	◌	◍	◌	◌	> 5 acres	NA	High	Medium
Wet Ponds		●	◍	◍	◍	◍	> 5 acres	NA	High	Medium
Constructed Wetlands	Residential, commerical, industrial, transportation land uses	●	◍	◍	◍	◍	> 5 acres	NA	High	High
Catch Basins	Various urban land uses	◍	○	◌	○	◌	< 1 acre	NA	Low	Medium
Sedimentation Manholes	Urban streets and parking lots		○	◌	○	◌	< 3 acres	NA	Medium	Medium
Stormwater Sedimentation Vaults[5]	Various urban land uses	●	◌	◍	◌	◍	varies	NA	Medium	Medium
Oil & Water Separators	High use sites that generate high concentrations of oil and grease	◌	○	◌	○	●	<1 acre	NA	Medium	High

[1] This table presents information on pre-treatment BMPs only. Source control BMPs, including site design and operational BMPs, are not included. For more information on these BMPs review Section 3.0.

[2] Pollutant removal effectiveness based on existing literature review. An ACWA-sponsored stormwater BMP effectiveness study will be conducted in 2003, and pollutant removal effectiveness data from that study may result in revisions to this table. See the

[3] See BMP fact sheets in Appendix B for more information on relative cost estimates.

[4] Vegetated swales that are located "offline" (e.g. stormwater can bypass swale during high flows to prevent scour) are generally more effective at pollutant removal, particularly sediment removal.

[5] Catch basin inserts and stormwater vaults are proprietary devices, and the cost and effectiveness of the products on the market varies widely.

Pollutant removal effectiveness key:
● more effective ◍ moderately effective ◌ less effective ○ generally not effective

Table 4-3
BMPs and BMP Pollutant Removal Mechanisms Suitable for Use With Underground Injection Systems

Land Use Types (Potential Pollutant Sources)	Source Control BMPs	Pre-treatment BMP Mechanisms[3]
PARKING LOT/DRIVEWAY		
High Use Sites (>1,000 trips/day)	Site design BMPs[2], street sweeping, catchbasin & sedimentation manhole cleaning, spill control and response	Flotation[4] and/or sedimentation[5]; or filtration[6]
Non High Use Sites (<1,000 trips/day)	Site design BMPs, street sweeping, catchbasin & sedimentation manhole cleaning, spill control and response	Flotation and/or sedimentation; or filtration
STREETS/HIGHWAYS		
Arterials, Highways and High Use Intersections	Site design BMPs, street sweeping, catchbasin & sedimentation manhole cleaning, spill control and response	Flotation and/or sedimentation; or filtration
Residential Collectors	Site design BMPs, street sweeping, catchbasin & sedimentation manhole cleaning, spill control and response	Sedimentation
OTHER SOURCES		
Industrial/Commercial Development	Site design BMPs, street sweeping, catchbasin & sedimentation manhole cleaning, source separation, spill control and response	Flotation and/or sedimentation; or filtration
Residential Development	Site design BMPs, street sweeping, catchbasin & sedimentation manhole cleaning, spill control and response	Sedimentation
Landscaped areas	Site design BMPs, catchbasin & sedimentation manhole cleaning	Sedimentation
Fueling Stations	Site design BMPs, sweeping, catchbasin & sedimentation manhole cleaning, source separation, spill control and response	Flotation and/or sedimentation; or filtration
Industrial Yards/Maintenance Areas	Site design BMPs, sweeping, catchbasin & sedimentation manhole cleaning, source separation, spill control and response	Flotation and/or sedimentation; or filtration

[1] Table developed by URS and the ACWA UIC BMP Manual Technical Advisory Committee using stormwater management guidelines from Oregon and Washington jurisdictions.

[2] Site design BMPs (e.g. porous pavement, planters and ecoroofs) may reduce stormwater volume as well as pollutant load.

[3] This column shows appropriate mechanisms for pollutant removal from stormwater runoff from different land use types. Particular BMPs that employ the named pollutant removal mechanism should be selected to fit individual circumstances. Additional pre-treatment may be necessary in sensitive areas. Guidance is provided in Table 4-2 and Appendix B.

[4] Flotation is used to remove oils, grease, and floatable debris. Flotation can be provided by oil/water separators and by baffle systems in catch basins and sedimentation manholes. Most filtration systems also provide some oil separation, as shown in Table 4-2. Sites with high oil and grease pollutant loads may benefit from a flotation BMP in series with a filtration BMP.

[5] Sedimentation can be provided by sedimentation manholes, catchbasins, vaults, ponds and wetlands. Filtration systems also remove sediments, as shown in Table 4-2. Sites with high sediment pollutant loads may benefit from a sedimentation BMP in series with a filtration BMP.

[6] Filtration of stormwater from existing drainage systems can best be provided by catch basin inserts because they are readily retrofitted into existing systems. Filtration of stormwater from new drainage systems can be provided by catch basin inserts, vegetated swales, sand filters, stormwater filtration vaults and flow-through planters.

SECTION 5.0

EMPLOYEE EDUCATION GUIDANCE AND REFERENCES

Contents of Section 5.0

This section presents recommendations for education and training to increase employees' awareness of issues associated with UIC requirements and stormwater discharges to the subsurface. Education program information from other states is provided for reference.

5.1 GENERAL RECOMMENDATIONS

Employee and public education can play an important role in maintaining and improving water quality. Accordingly, the UIC rules require that stormwater management plans contain public and employee education programs. This section of the manual contains recommendations for employee education and training. Public education outreach materials are being developed by ACWA and will be available on the ACWA website (*www.oracwa.org*). There are many options for employee education presented in this section, some of which may be more appropriate for certain jurisdictions than others. It is expected that jurisdictions will customize their employee education plans to fit jurisdictional needs. Not all elements outlined in this section will be appropriate for all jurisdictions.

Jurisdictions that are involved in development review and permitting should provide employees with appropriate education and outreach materials for the building and development community as a part of the employee education program, especially if injection systems are a recommended method of stormwater management within the jurisdiction.

The first step in the development of an employee education program is to identify employees who need to understand the issues and regulations associated with stormwater discharges to the subsurface. Employees that municipalities should provide training to include employees responsible for the planning, design, and maintenance of the stormwater drainage system, employees responsible for other activities that could affect the stormwater drainage system, and employees responsible for compliance with environmental regulations. Each municipality should compile a list of employees that should participate in the education program. These employees may be involved in the following areas:

- public works
- transportation
- engineering
- planning
- maintenance
- emergency/hazardous response
- regulatory compliance
- other fields related to stormwater management
- business licensing and permitting
- development review and permitting

It is recommended that employee education consist of two tiers. The first tier would provide a general overview of the UIC rules, how they affect an individual municipality, and how the municipality intends to respond to the rules. All employees identified above would be required to attend the first tier of the education program. The second tier of the education program would provide more specialized training for certain groups of employees.

A suggested strategy for the first tier of the education program is to provide a short (1 hour or less) training seminar and to distribute training packages with relevant education materials grouped by topic. For employees unable to attend the seminar, the training packages can be distributed along with a summary of the information presented in the seminar. The seminar should be led by someone in the jurisdiction that is familiar with the jurisdiction's existing underground injection system, the UIC rules, and the jurisdiction's plans to implement the rules. The training seminar could be combined with other routine staff or safety meetings.

Components of the training seminar could include discussion of the following topics:
1. Definitions related to the UIC program.
2. The purpose of the UIC program.
3. Regulatory summary of UIC program and particular requirements for individual jurisdiction.
4. The existing stormwater injection system owned by the municipality.
5. The plan for complying with UIC rules for existing and future underground injection systems.
6. Municipal Stormwater Management Plan Requirements.
7. Explanation of roles/responsibilities of state, municipalities, and others, including an organizational chart.
8. Resources available from DEQ, EPA, and other states.

Section 5.2 provides more detailed recommendations for each of these components of the employee education program, and provides references for obtaining more information where necessary. There are a number of resources available to aid municipalities in designing employee training programs. It is recommended that the training packages include information on each of the components discussed in the training seminar, as well as any additional information that may be useful for employees to read and understand.

The second tier of employee education would be a targeted educational program for employees that are involved with specialized aspects of stormwater management and the underground injection system. The second tier of employee education could be incorporated into routine employee training opportunities, such as safety training (also known as "tailgate training"). The targeted educational programs should focus on specific responsibilities and roles the employees will have as the jurisdiction complies with the UIC rules. For example, employees in public works and maintenance should be given targeted training and education in underground injection system inspection and maintenance, and operational BMPs. Employees in engineering and planning should be given targeted training and education in underground injection system siting and design, rule authorization, appropriate BMP design and implementation, and source control practices. Employees in emergency/hazardous response, maintenance, transportation, and public works should be given targeted training and education in spill control and response. The portions of this manual that cover these topics could be used as training materials, along with hands-on demonstrations as needed.

5.2 EMPLOYEE EDUCATION AND TRAINING EXAMPLES

This section provides more detailed recommendations for each of the components of the general employee education program, and provides references for obtaining more information where necessary.

1. Definitions related to the UIC program.

There are a number of terms associated with the UIC program that may be unfamiliar to some employees. These terms should be defined during the first tier of the education program and definitions should be included in the training packages provided to employees. Terms to define include Class V stormwater injection well (also known as dry wells and sumps), Underground Injection Control (UIC – note to audience that this term is sometimes used interchangeably with injection well), rule authorization, Best Management Practices (BMPs), and other acronyms or words with definitions that are important for employees to know.

The EPA Region 10 Web site includes a page that answers "Frequently Asked Questions about the UIC Program." This Web page includes definitions related to the UIC program and is located at:
http://yosemite.epa.gov/R10/WATER.NSF/476d8e2e8829cf19882565d400706530/51bbc02148429af1882568730082f6fa?OpenDocument

The Oregon DEQ overview of the UIC program for municipalities contains sections on the federal injection well classes in the "Federal Injection Classes" section. This document is available on the DEQ Web site at:
http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

The EPA Web site provides definitions that could be used for the first tier of the education program by answering questions such as "What is an injection well?" This Web site is located at:
http://www.epa.gov/safewater/uic/whatis.html

2. The purpose of the UIC program.

The overall purpose of the UIC program is to protect groundwater aquifers from contamination. Additional information on the purpose of the UIC program and background information on the problems associated with underground injection systems can be found in the overview of the UIC program that Oregon DEQ prepared for municipalities and the EPA Web site.

The Oregon DEQ overview of the UIC program for municipalities contains sections on "Background" and "Contaminants of Concern" that can be used to develop a brief summary of the purpose of the UIC program. This document is available on the DEQ Web site at:
http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

The EPA Web site provides an overview of the UIC program at the federal level. This Web site answers questions such as "Why do we need the UIC program?" This Web site is located at:
http://www.epa.gov/safewater/uic/whatis.html

3. Regulatory summary of UIC program and particular requirements for individual jurisdiction.

When underground injection systems are properly sited, constructed, and operated, they can be an effective and environmentally safe method to dispose of stormwater. The Safe Drinking Water Act established the Underground Injection Control Program to provide safeguards so that injection wells do not endanger current and future underground sources of drinking water. Oregon DEQ policy considers all aquifers in Oregon to be potential underground sources of drinking water and thus all groundwater in Oregon is protected by the UIC rules.

Oregon DEQ has prepared an overview of the UIC program for municipalities. The section of this overview entitled “Program Authorization and Intent” can be used to develop a brief regulatory summary of the UIC program. This document is available on the DEQ Web site at:
http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

Oregon DEQ has also prepared an overview of the UIC rules. This document could be provided to employees as a part of the training package. This document is available on the DEQ Web site at:
http://www.deq.state.or.us/wq/groundwa/uicrulesqa.pdf

The particular requirements for individual jurisdictions depend on the number and type of injection systems owned by the jurisdiction. These requirements and the options for meeting the requirements are described in Section 1.0 of this manual. The options (e.g. Exemption, Rule Authorization, Authorization by Permit, and Decommissioning) should be briefly explained to employees so that they are aware of possible methods for managing the systems and complying with the UIC rules. Additional information on these topics can be found at the following Web sites:

The Oregon DEQ overview of the UIC program for municipalities contains a section on “Regulations” that covers the options for underground injection systems. This document is available on the DEQ Web site at:
http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

Additional information is also available from Oregon DEQ regarding decommissioning and closing underground injection systems at the following Web sites:
http://www.deq.state.or.us/wq/groundwa/gwdecommplan.pdf

http://www.deq.state.or.us/wq/groundwa/closureguidelines.pdf

4. The existing stormwater injection system owned by the municipality.

A brief overview of the existing stormwater injection system owned by the municipality should be provided to the employees at the training seminar. Information such as the number and location of dry wells or other underground injection systems owned by the municipality should be provided either in list form or on a map.

5. Plan for complying with UIC rules for existing and future underground injection systems.

This portion of the employee training seminar should outline what existing underground injection systems will be exempted, rule authorized, permitted or decommissioned. It should also include a discussion of any new wells that are planned for the municipality.

6. Municipal Stormwater Management Plan Requirements.

This portion of the employee training seminar should outline the municipal stormwater management plan requirements discussed in this manual. A brief overview should be provided on site and operational issues such as pretreatment of stormwater before discharge to underground injection systems, spill prevention and control, monitoring, and performance evaluation.

7. Explanation of roles/responsibilities of state, municipalities, and others.

EPA has given Oregon DEQ primary enforcement responsibility (primacy) for implementing the UIC program in Oregon. DEQ has developed rules that owners of underground injection systems must comply with. The roles and responsibilities of the state, municipalities, and others should be explained to employees. DEQ is responsible for enforcing the UIC program rules, providing assistance to underground injection system owners working to comply with the rules, reviewing and approving UIC permit applications and inventory registrations, and approving underground injection system decommissioning plans.

Municipalities are responsible for complying with the UIC program rules issued by Oregon DEQ. Each municipality should determine what the roles and responsibilities will be for municipal departments and individual positions to ensure compliance with the UIC program. An organizational chart or sheet outlining these roles and responsibilities should be included in the training package provided to employees so that they understand who is performing what tasks and how each position or department fits into the overall UIC program compliance. For example, the employees or departments that are responsible for spill prevention and control should be outlined and the specific responsibilities these employees and departments have to prevent spills and control spills should be described. Some responsibilities, such as spill prevention, may be similar to those associated with stormwater that drains to surface waterbodies and may already be described in a municipality's NPDES MS4 Stormwater Permit application.

A brief description of the roles and responsibilities of non-municipal underground injection system owners, such as commercial or industrial facilities, should also be given so that employees are able to answer questions or direct inquiries from the public to DEQ in the proper manner. For instance, underground injection system owners that are excluded from the UIC Program should be described (e.g. single family residential septic systems).

As noted earlier, jurisdictions that are involved in development review and permitting should provide employees with appropriate education and outreach materials for the building and development community, especially if injection systems are a recommended method of stormwater management within the jurisdiction. The requirements of private owners of underground injection systems should be briefly described and a sheet indicating these requirements included in the training package. Information on the roles and responsibilities of other underground injection system owners can be found in the DEQ overview of the UIC program for municipalities. This document is available on the DEQ Web site at:

http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf

8. Resources available from DEQ, EPA, and other states.

EPA, Oregon DEQ, and other state environmental agencies offer many resources for municipalities working to comply with the UIC rules. The EPA UIC Program Web page contains research, news releases, state UIC contacts, video materials, and general program news. The EPA UIC Program Web page is located at: *http://www.epa.gov/safewater/uic.html*

The EPA Class V injection well information is located at: *http://www.epa.gov/safewater/uic/classv.html*

EPA has developed two videos that describe contamination problems that can result from Class V wells and how communities and businesses can prevent problems from occurring. The videos examine the real life challenges and successes experienced by communities in Montana, New Mexico, and Virginia when faced with contaminated drinking water supplies as a result of improper discharges to underground injection systems. The videos show that there are simple preventative steps a community can take to reduce threats to their water resource without disrupting the community's economy or going into financial debt. More information on these videos and contact information for requesting free copies can be found at the following location: *http://www.epa.gov/safewater/uic/videos.html*

The EPA Region 10 UIC Program Web site contains fact sheets, issue papers, research, news releases, and general program news. The Web site is located at: *http://yosemite.epa.gov/R10/WATER.NSF/476d8e2e8829cf19882565d400706530/51bbc02148429af1882568730082f6fa?OpenDocument*

The Oregon DEQ UIC Program Web site contains fact sheets, guidance, permit applications, and other resources to assist underground injection system owners in UIC rule compliance. The Web site is located at: *http://www.deq.state.or.us/wq/groundwa/UICHome.htm*

Other states are also developing UIC programs and may have resources available that will further assist municipalities in educating employees about underground injection systems and UIC compliance. Although each state's UIC programs must meet EPA guidelines for protecting groundwater, states have developed unique UIC rules and regulations. States may focus their UIC programs on particular areas of concern within the state based on the type of stormwater injection systems commonly used in the state and the type of associated groundwater contamination that is most frequently encountered or that could cause the greatest damage. Thus, the materials or guidance provided by other states may not directly apply in Oregon, but reviewing information provided by other states may be useful for municipalities developing their own UIC employee education programs. Two states that are implementing UIC programs and may have useful education materials to review are Washington and Massachusetts.

The Washington State Department of Ecology plans to include UIC Program information in the revised Eastern Washington Stormwater Management Manual due out in mid-2003. A public draft of this document is available through the Washington Department of Ecology

Web site:
http://www.ecy.wa.gov/programs/wq/stormwater/#e_wa_news

The state of Massachusetts has published UIC Program information to educate municipal employees. The purpose of the Massachusetts UIC Training Package is to provide local officials with the tools and guidance to develop and implement an effective local UIC pollution prevention program in compliance with Massachusetts regulations. Floor drains receiving industrial and commercial wastewater that discharge to underground injection systems are of concern in Massachusetts and the Massachusetts UIC Training Package focuses on education related to floor drains instead of stormwater injection systems. Thus, the Massachusetts UIC Training Package may include information that would not be appropriate for Oregon municipal employee training packages. However, review of the format, organization, and presentation of the Massachusetts UIC Training Package may assist municipalities in developing their own training packages. Massachusetts is currently revising the UIC Training Package and plans to release an updated version in November 2002. Updated information on the Massachusetts UIC Program and a revised Training Package for local officials may be available by contacting the Massachusetts Division of Water Supply at 617-348-4014.

EPA maintains a list of UIC Program state contacts that may be able to provide additional information regarding employee education on the UIC Program. The EPA list of state contacts is located at:
http://www.epa.gov/safewater/uic/states.html

Additional guidance in developing an education program for employees can be obtained from the ACWA publication "Oregon Municipal Stormwater Toolbox for Maintenance Practices". Chapter 8 of this publication, "Educating Maintenance Staff About Stormwater Quality", is provided in Appendix C and is also available on the ACWA Web site at:
http://www.oracwa.org/Pages/Chap8.pdf

SECTION 6.0

GUIDANCE FOR DECOMMISSIONING STORMWATER INJECTION SYSTEMS

Contents of Section 6.0

This section presents guidance with respect to the decommissioning of stormwater injection systems. As part of the DEQ UIC requirements, local jurisdictions will undertake a process to evaluate their dry wells and identify appropriate management practices. In some cases, decommissioning may be desired or required. This section outlines the decommissioning process to be used by local jurisdictions.

6.1 SUMMARY OF OREGON DEQ DECOMMISSIONING REQUIREMENTS

As discussed in Section 1.0, Class V stormwater injection systems are prohibited unless they are exempt, authorized by rule, or authorized by a WPCF permit. In certain cases underground injection is prohibited and a WPCF permit will not be issued. The prohibitions for Class V injection systems are outlined in OAR 340-044-0015(2). Underground injection is prohibited for Class V systems injecting:

- Sewage into cesspools[4]
- Fluids from industrial/commercial processes using hazardous substances or petroleum products (exceptions with special permit conditions)
- Fluids from operation areas where hazardous substances or petroleum products are used or stored
- Fluids directly from floor drains at industrial/commercial facilities
- Motor vehicle waste from vehicle repair or maintenance
- Industrial or municipal wastewater directly into groundwater
- Agricultural drainage

If a stormwater injection system cannot be exempted, rule authorized, or authorized by permit, the system could potentially be updated or retrofitted to meet the criteria for those designations. However, if a decision is made to not update or seek a permit for a stormwater injection system that cannot be rule authorized or exempted, or a stormwater injection system is prohibited under OAR 340-044-0015(2), then the stormwater injection system must be decommissioned and stormwater managed using an alternative method.

An alternative stormwater management method must be consistent with watershed health goals. Alternative stormwater runoff disposal methods include routing stormwater to a surface water discharging system or utilizing surface infiltration. Surface infiltration occurs when fluid moves from the ground surface into the underlying soil material without the use of wells, drain holes, pipes, drain tiles or other mechanisms that alter the natural infiltration process. Surface infiltration is not regulated as underground injection under the UIC program. Surface infiltration can be accomplished through infiltration basins, infiltration ponds, or other infiltration designs.

Underground injection systems that are prohibited under OAR 340-044-0015(2) should be decommissioned. Underground injection systems that cannot be exempted or rule authorized, but are not prohibited under OAR 340-044-0015(2), may be decommissioned through a 10-year decommissioning plan developed by the municipal owner of the systems. In order to clarify requirements and reach agreement with DEQ on decommissioning scheduling, jurisdictions may elect to apply for WPCF permits for injection systems that are scheduled to be decommissioned.

[4] According to OAR 340-044-0013, the following injection activities are excluded from the UIC regulations: single family residential septic systems and cesspools; or non-residential septic systems and cesspools handling only human sanitary wastes and designed to serve less than 20 people per day or with a design flow of less than 2,500 gallons per day. Such systems are still subject to the requirements of OAR 340-071. This exclusion does not apply to sewage drain holes or drill holes. Construction of new cesspools of any capacity is prohibited by OAR 340-071.

The Oregon DEQ UIC Program Overview published in March 2002 (*http://www.deq.state.or.us/wq/groundwa/uicoverview.pdf*) outlines the procedure for closing underground injection systems in the section entitled "Closure". At least 30 days prior to closing an injection system the owner must notify DEQ of the proposed change in status and document the plans to close the injection system by submitting a Class V Pre-Closure Notification Form. This form is provided in Appendix D and on the DEQ Web site at: *http://www.deq.state.or.us/wq/groundwa/closure1000.pdf*

In Oregon, DEQ and the Water Resources Department (WRD) have joint authority to regulate the closure of subsurface wells. All underground injection systems must be closed in a manner that complies with the federal prohibition of fluid movement, as outlined in 40 CFR 144.12 and 144.82a. Oregon WRD well abandonment standards are designed to prevent contamination of the well or aquifer beneath the well by surface and subsurface leakage which may carry harmful chemicals or bacteria. The standards also seek to prevent physical injury, waste of water, and loss of artesian pressure. DEQ underground injection system closure requirements vary according to the type of injection system, but are consistent with WRD efforts to protect groundwater quality and public safety. Currently, DEQ recommends using the injection system closure guidelines in the EPA Region 10 closure manual ("Guidelines for Characterizing, Closing, and Abandoning Shallow Injection Wells") and WRD well closure guidance until a DEQ guideline document can be developed. The EPA Region 10 closure manual is located in Appendix D and is also available at the following Web site:
http://yosemite.epa.gov/R10/WATER.NSF/840a5de5d0a8d1418825650f00715a27/9a5fa158f8f78484882568c50052cb10/$FILE/ATTEM7TN/shallowwellclosureguidance2001R10.PDF

Oregon DEQ requires sampling for injection systems with high risk for groundwater contamination prior to closure and strongly recommends sampling for all types of injection systems prior to closure, including stormwater systems. DEQ considers stormwater injection systems that have drained stormwater from areas where chemicals and waste are or have been stored and areas of motor vehicle maintenance to be high-risk injection systems that require sampling prior to closure. Section 6 of the EPA Region 10 closure manual provides guidance on sampling of injection systems prior to closure. Fluids and/or sludge within constructed components of the injection system and soils receiving waste fluids from the injection system should be sampled for contaminants of concern.

Contaminants of concern may vary depending on the current and historic activities at a site draining to a high-risk injection system. EPA Region 10 guidelines recommend that samples associated with closure of high-risk injection systems be analyzed for the compounds listed below:

- Volatile Organics
- Semi-Volatile Organics
- Metals
- Total Petroleum Hydrocarbons
- Nitrates (if sanitary wastewater was commingled with stormwater)

Jurisdictions should consider the past and present land use and activities at a site and develop a closure plan based on potential contaminants of concern. The closure plan should include the following:

- Proposed soil and/or groundwater sampling locations and depths including rationale.
- Contaminants that will be analyzed.
- Name of the laboratory that will perform the analysis.
- Sampling and analytical methods.
- Field investigation quality assurance and quality check (QA/QC) plans.
- Equipment to be used for sample retrieval.
- Proposed disposal procedures for contaminated materials.

DEQ will review the closure plan proposed by the jurisdiction in the DEQ Class V Pre-Closure Notification Form, and will notify the jurisdiction of any requested modifications to the plan. After sampling is conducted, the analytical results of the samples should be evaluated by the jurisdiction and reported to DEQ as requested. Detection of soil or groundwater contamination from the injection system must be reported to DEQ within 14 days of observation or receipt of sampling results (OAR 340-044-0040 (4)).

WRD indicates that the appropriate permanent abandonment method for a subsurface well will depend on the information obtained from examination of the well log and an on-site investigation of the well. DEQ requires that the top portion of the injection system be plugged with a permanent seal to a depth of 18 feet below the surface, or that all portions of the underground injection system that are surrounded by a "solid wall" be plugged or filled. If plugging an injection system to a depth of 18 feet is not practical or feasible, the DEQ director may approve another method of injection system closure (OAR 340-044-0040 (3)(c)(C)). In general, the following materials are recommended for injection system plugging:

- Cement grout
- Concrete
- Bentonite (for drill holes)

An injection system closure report must be prepared regarding the closure activities. The closure report must include a certification by an Oregon registered professional geologist, engineering geologist, or engineer that the injection system has been properly closed. The closure report must be kept on file for record keeping purposes and potential DEQ inquiries regarding closure.

6.2 RECOMMENDED PROCEDURES FOR DECOMMISSIONING

Table 6-1 is a checklist that outlines recommended procedures for decommissioning underground injection systems. The Class V Pre-Closure Notification Form (provided in Appendix D) that must be submitted to DEQ 30 days prior to decommissioning and additional DEQ, WRD, and EPA requirements provide the basis for this checklist. An example of an injection system closure plan submitted to DEQ in July 2002 is shown in Appendix D. It is important to note that the example injection system closure plan provided in Appendix D is site specific, and should not be used as a template for other injection system closure plans. Injection system closure plans should be developed for individual sites, and may or may not include all of the components of the closure plan shown in Appendix D. Specific sampling plans and contaminated material management methods (if necessary) will vary from site to site.

The recommended procedures for decommissioning underground injection systems presented in this section apply to both vertical and horizontal injection systems. It is recommended, however, that owners of horizontal injection systems consult with Oregon DEQ during the development of the system closure plans to address any unique issues related to closure of horizontal injection systems. For example, DEQ may require the removal of perforated pipes in infiltration trenches prior to plugging.

It is important to note that the recommended procedures for decommissioning underground injection systems may change after DEQ develops a decommissioning guidance document. It is recommended that users of this decommissioning checklist frequently check the DEQ Web site to be aware of any changes DEQ makes to the recommended decommissioning procedures:
http://www.deq.state.or.us/wq/groundwa/uichome.htm

Below Table 6-1 is a narrative of the recommended closure procedure.

Table 6-1
Underground Injection System Closure Checklist[5]

Task #	Closure Task	Check here when task is complete
1	Describe injection system	
	Gather the following information on the injection system:	
	Location (latitude/longitude, facility name and physical address, vicinity map and site map)	
	Design (including type of system, depth, construction materials, year of construction, average flow received)	
2	Determine hydrogeologic conditions surrounding injection system	
	Gather the following information on the hydrogeologic conditions:	
	Depth to groundwater	
	Subsurface materials between surface and groundwater	
3	Conduct visual inspection of injection system	
	Note if any of the following exist:	
	A continuous oily stain or sheen over a large area of the surface that drains to the injection system, indicating a potential former release of a significant volume of petroleum product (oil, gas, etc).	
	A continuous oily stain over a large portion of the interior surface of the injection system, again indicating a potential former release of a significant volume of petroleum product, and accumulation of the product in the injection system.	
	Presence of petroleum product in the injection system, either on the bottom (if water is absent), or as floating product (if water is present).	
	Strong gasoline-like odors or other chemical odors within the injection system.	
	Presence of above ground tanks, product lines, or similar objects within the area draining to the injection system that are used for storage or handling of potentially hazardous materials and which could accidentally release hazardous materials to the injection system.	
	Other indicators of potential hazardous materials release.	
4	Determine if sampling is required or desired prior to closure	
	Check here if sampling is required due to high risk of groundwater contamination from land use in area draining to injection system (i.e. vehicle maintenance yards, locations where chemicals or waste are or have been stored).	
	Checklist is continued on following page	
	Check here if sampling is desired by municipality.	
	Check here if sampling is recommended due to results of visual inspection of injection system.	

[5] Table 6-1 is based on information compiled from the EPA Region 10 "Guidelines for Characterizing, Closing, and Abandoning Shallow Injection Wells", Oregon Water Resources Department well closure guidance, and Oregon Department of Environmental Quality underground injection system decommissioning and closure guidance.

5	Create sampling plan, as necessary	
	Consider the past and present land use and activities at a site and develop a sampling plan based on potential contaminants of concern. The sampling plan should include the following:	
	Proposed soil and/or groundwater sampling locations and depths, including rationale for proposed locations and depths.	
	Contaminants that will be analyzed, including rationale.	
	Name of the laboratory that will perform the analysis.	
	Sampling and analytical methods.	
	Field investigation quality assurance and quality check (QA/QC) plans.	
	Equipment to be used for sample retrieval.	
	Proposed disposal procedures for contaminated materials.	
6	Develop alternative stormwater management design	
	Based on site drainage surrounding the injection system and existing or planned stormwater treatment and/or conveyance facilities, develop a design for stormwater drainage after the injection system is closed.	
7	Complete and submit DEQ Class V Pre-Closure Notification form	
	Submit form at least 30 days prior to planned injection system closure.	
8	Sample and evaluate analytical data, as necessary	
	Evaluate analytical data as requested by DEQ.	
	Report sampling results to DEQ. Report within 14 days of receipt of sampling results if soil or groundwater contamination is detected.	
9	Develop plan for managing contaminated media, as necessary	
	Coordinate with DEQ to determine appropriate course of action for contaminated media.	
	Properly classify and dispose of excavated contaminated media.	
10	Close underground injection system	
	Remove liquid, debris, sediment, or sludge from injection system prior to closure, as required by DEQ.	
	Plug injection system with permanent seal to a depth of 18 feet.	
11	Prepare closure report	

	Prepare an injection system closure report and keep on file for record keeping purposes and potential DEQ inquiries regarding closure. The closure report should include the following information:	
	Checklist is continued on following page	
	A brief summary of injection system prior to closure.	
	A discussion of closure actions undertaken to ensure that injection system is no longer injecting fluids into subsurface.	
	Certification by a registered professional geologist, engineering geologist, or engineer that injection system has been properly closed.	
	A diagram and photograph of the closed injection system.	
	Pertinent documentation of injection system closure (photographs, waste and soil manifests, analytical data, etc.)	
	A description of how stormwater is managed following injection system closure.	

Narrative of underground injection system closure checklist:

1. Describe injection system.

Decommissioning requires gathering information on the location, design, year of construction, and average flow received of the underground injection system to be decommissioned. Review the DEQ Class V Pre-Closure Notification Form (located in Appendix D) to determine all information necessary to obtain for injection system description.

2. Determine hydrogeologic conditions surrounding injection system.

The WRD well log database and DEQ septic system site evaluation reports are resources that may be available to use in determining the hydrogeologic conditions surrounding the injection system. The WRD well log database maintains records for wells installed within the State of Oregon. The records typically include depth-to-groundwater information, as well as a description of the subsurface materials encountered during the drilling of the well.

3. Conduct visual inspection of injection system.

It is recommended that an inspection of an injection system be performed for visible evidence of contamination prior to closure. If the following indicators of contamination are visible, it is recommended that sampling be conducted prior to closure to determine the level of contamination:

- A continuous oily stain or sheen over a large area of the surface that drains to the injection system, indicating a potential former release of a significant volume of petroleum product (oil, gas, etc).
- A continuous oily stain over a large portion of the interior surface of the injection system, again indicating a potential former release of a significant volume of petroleum product, and accumulation of the product in the injection system.
- Presence of petroleum product in the injection system, either on the bottom (if water is absent), or as floating product (if water is present).
- Strong gasoline-like odors or other chemical odors within the injection system.
- Presence of above ground tanks, product lines, or similar objects within the area draining to the injection system that are used for storage or handling of potentially hazardous materials and which could accidentally release hazardous materials to the injection system.
- Other indicators of potential hazardous materials release.

4. Determine if sampling is required or desired prior to closure.

Oregon DEQ requires sampling for injection systems with high risk for groundwater contamination prior to closure and strongly suggests sampling for all types of injection systems prior to closure, including stormwater systems. DEQ considers stormwater injection systems that have drained stormwater from areas where chemicals and waste are or have been stored and areas of motor vehicle maintenance to be high-risk injection systems that require sampling prior to closure. If the indicators of contamination noted above in Closure Task 3 (Visual Inspection) are present, it is recommended that sampling be conducted prior to closure to determine the level of contamination.

5. Create sampling plan, as necessary.

If sampling is required or desired, jurisdictions should consider the past and present land use and activities at a site and develop a sampling plan based on potential contaminants of concern. The sampling plan should include the following:

- Proposed soil and/or groundwater sampling locations and depths, including rationale for proposed locations and depths.
- Contaminants that will be analyzed, including rationale.
- Name of the laboratory that will perform the analysis.
- Sampling and analytical methods.
- Field investigation quality assurance and quality check (QA/QC) plans.
- Equipment to be used for sample retrieval.
- Proposed disposal procedures for contaminated materials.

6. Develop alternative stormwater management design.

Based on site drainage surrounding the injection system and existing or planned stormwater treatment and/or conveyance facilities, develop a design for stormwater drainage after the injection system is closed.

7. Complete and submit DEQ Class V Pre-Closure Notification Form

At least 30 days prior to closing an injection system the owner must notify DEQ of the proposed change in status and document the plans to close the injection system by submitting a Class V Pre-Closure Notification Form. This form is provided in Appendix D and on the DEQ Web site at: *http://www.deq.state.or.us/wq/groundwa/closure1000.pdf*

8. Sample and evaluate analytical data, as necessary.

Section 6 of the EPA Region 10 closure manual provides guidance on sampling of injection systems prior to closure. Fluids and sludge within constructed components of the injection system and soils receiving waste fluids from the injection system should be sampled for contaminants of concern according to the sampling plan prepared in Task 5 of the closure process. The sample analytical data should be evaluated as requested by DEQ. Determine the nature and location of any contamination in the injection system based on sample analytical data. Determine the potential impact to groundwater quality from any contamination, and the need for managing any contaminated media. Report sampling results to DEQ as requested. Report sampling results to DEQ within 14 days of receipt of sampling results if soil or groundwater contamination is detected.

9. Develop plan for managing contaminated media, as necessary.

Depending on the nature of any contamination detected during injection system sampling, coordinate with DEQ to determine the appropriate course of action for contaminated media. Removal of contaminated soil and/or groundwater treatment may be required in cases of extensive contamination. If contaminated materials are to be removed, properly classify and dispose of excavated contaminated media (be aware that hazardous waste manifest regulations may apply). Address site Health and Safety considerations through removal procedures.

10. Close underground injection system.

An underground injection system may be closed 30 or more days after a Class V Pre-Closure Notification Form for the system has been submitted to DEQ. All underground injection systems must be closed in a manner that complies with the federal prohibition of fluid movement, as outlined in 40 CFR 144.12 and 144.82a. DEQ rules require that decommissioned underground injection systems be plugged with a permanent seal to a depth of 18 feet below the surface. If plugging an injection system to a depth of 18 feet is not practical or feasible, the DEQ directory may approve another method of injection system closure. Materials recommended for injection system plugging include cement grout, concrete, and bentonite. Liquid, debris, sediment, or sludge should be removed from the underground injection system prior to plugging as deemed appropriate by DEQ for the type of injection system. Documentation of the injection system closure is recommended through photographs and a diagram of the closed injection system.

11. Prepare closure report.

At the conclusion of closure, prepare an injection system closure report and keep on file for record keeping purposes and potential DEQ inquiries regarding closure. The closure report should include the following information:

- A brief summary of injection system prior to closure.
- A discussion of closure actions undertaken to ensure that injection system is no longer injecting fluids into subsurface.
- Certification by a registered professional geologist, engineering geologist, or engineer that the injection system has been properly closed.
- A diagram and photograph of the closed injection system.
- Pertinent documentation of injection system closure (photographs, waste and soil manifests, analytical data, etc.)
- A description of how stormwater is managed following injection system closure.

SECTION 7.0

RECORD KEEPING AND REPORTING RECOMMENDATIONS

Contents of Section 7.0

This section presents guidance with respect to record keeping and reporting for stormwater injection systems. A summary of record keeping and reporting requirements based on Oregon DEQ UIC rules and recommended underground injection system record keeping and reporting procedures are included.

7.1 SUMMARY OF RECORD KEEPING AND REPORTING REQUIREMENTS

Municipalities with 50 or more stormwater injection systems are required to include plans for record keeping and reporting of injection system monitoring in their municipal stormwater management plans to guide municipal activities in these areas (OAR 340-044-0018(3)(b)(C)). Monitoring and sampling results must be maintained by the municipality and be available for review by DEQ on request. On or before June 30, 2004, municipalities with 50 or more systems must submit a summary report to DEQ on the municipal stormwater management plan implementation, monitoring and sampling with supporting records and laboratory documentation. The report must also include an assessment of the effectiveness of best management practices. With approval from DEQ, this assessment may be done as a regional or statewide study. This section is intended to assist municipalities with 50 or more systems in developing the record keeping and reporting plan portions of their stormwater management plans.

Municipalities with less than 50 stormwater injection systems are required to routinely evaluate the effectiveness of their stormwater management plans. Municipalities with less than 50 stormwater injection systems are not required to include plans for record keeping and reporting of injection system monitoring in their municipal stormwater management plans, but may choose to develop record keeping and reporting plans to guide municipal activities in these areas. This section is intended to assist municipalities with less than 50 stormwater injection systems that choose to develop plans to guide record keeping and reporting practices.

7.2 RECOMMENDED RECORD KEEPING AND REPORTING PLAN COMPONENTS

As discussed above, municipal record keeping and reporting requirements are based on the number of injection systems owned by the municipality. There are a number of components of the stormwater management plan requirements that can be incorporated into the record keeping and reporting plans. These include:
1. Location and characteristics of injection systems (part of the system-wide assessment component of the management plan and the inventory/registration rule requirement).
2. Maintenance performed on injection systems (part of the systems controls/ maintenance plan component of the management plan).
3. Injection system monitoring and sampling activities (part of the monitoring and effectiveness evaluation components of the management plan).

These recommended record keeping and reporting plan components are discussed below.

1. Location and characteristics of injection systems.

Municipalities that own and operate new and existing injection systems are required to register and provide inventory data on the injection systems to DEQ. New injection systems must be registered prior to use. DEQ recommends that applicants register new injection systems at least 60 to 90 days in advance of the desired date to begin using the system to allow for potential design changes that may be requested in order to meet design and siting requirements. DEQ required registration and inventory information for existing injection systems to be submitted 90 days after the effective date of the Oregon UIC rules (December 2001).

The Underground Injection Control Registration form for jurisdictions and agencies with multiple stormwater systems lists the injection system inventory data that must be recorded and submitted to DEQ. The form is located in Appendix E and can also be found on the DEQ UIC Web page, located at:
http://www.deq.state.or.us/wq/groundwa/jur1005.pdf

The injection system inventory should include information such as location of injection system, type of injection system, distance to drinking water wells, waste type discharged to system, status of system, characteristics of system, installation year, and depth to winter high water table or average depth to groundwater for jurisdiction.

In addition to inventory and registration of injection systems, municipalities (both large and small) are required to perform a system-wide assessment as a part of the stormwater management plan. The system-wide assessment should include the location and construction details of all injection systems and other stormwater management controls, an evaluation of the land use and activities in all areas draining into the stormwater injection systems, and an identification (based on available information) of areas within the drainage catchment where hazardous substances and toxic materials are used, handled or stored (OAR 340-044-0018(3)(b)(C)(i)). The stormwater management plans, including the information provided in the system-wide stormwater assessment, must be updated routinely.

It is recommended that municipalities develop a system for recording and maintaining the injection system inventory, assessment, and registration information in an accessible and usable format as a part of the development of record keeping and reporting plans. The recommended methods for developing record keeping and reporting plans are discussed in Section 7.3.

2. Maintenance performed on injection systems.

It is recommended that municipalities keep accurate and comprehensive records of injection system inspections, maintenance, and repairs. Maintenance should be performed on injection systems and pre-treatment BMPs at regularly scheduled intervals to ensure proper system performance. Recommended maintenance activities and schedules for various types of injection systems are described in Section 2.4 of this manual. Recommended maintenance practices for pre-treatment BMPs are described in the BMP fact sheets in Appendix B.

The maintenance practices covered in Section 2.4 include inspection programs, condition assessments, sediment removal, and waste disposal. The maintenance practices for vertical injection systems are also provided in a checklist format in Table 2-2. Specific maintenance requirements may vary from one injection system to another, but in general, they include inspection, repair, removal of accumulated sediment and debris, and disposal of stormwater sediments.

It is recommended that municipalities develop a system for recording and maintaining injection system inspection, maintenance, and repair information in an accessible and usable format as a part of the development of record keeping and reporting plans. The recommended methods for developing record keeping and reporting plans are discussed in Section 7.3.

3. Injection system monitoring and sampling activities.

As discussed in Section 7.1, injection system monitoring and sampling requirements are determined by the size of the municipal injection system. Municipalities with 50 or more stormwater injection systems have more detailed system monitoring requirements than municipalities with less than 50 stormwater injection systems. Table 7-1 describes the system monitoring and data management requirements for large and small municipal injection systems as a part of the municipal stormwater management plan.

It is recommended that municipalities keep accurate and comprehensive records of injection system monitoring and sampling. Municipalities with 50 or more stormwater injection systems are required to maintain monitoring and sampling results in a format that would be available for review by DEQ on request. Municipalities with 50 or more stormwater injection systems are also required to submit a summary report to DEQ on their injection system stormwater management plant implementation, monitoring and sampling with supporting records and laboratory documentation on or before June 30, 2004. Municipalities with less than 50 stormwater injection systems are required to routinely evaluate the effectiveness of their injection system stormwater management plans.

It is recommended that municipalities develop a system for recording and maintaining injection system monitoring and sampling information in an accessible and usable format as a part of the development of record keeping and reporting plans. The recommended methods for developing record keeping and reporting plans are discussed in Section 7.3.

Table 7-1. System Monitoring and Data Management Requirements in Injection System Stormwater Management Plans

	Large Municipal Systems (≥ 50 systems)	Small Municipal Systems (< 50 systems)
System Monitoring	• Evaluates effectiveness of BMPs for treating stormwater prior to injection • Defines locations, times, analytes, and protocols • Uses information in system assessment to select representative sites and additional analytes. • DEQ sets minimum sampling events as 2 in first year and 1 each subsequent year (at onset of wet weather) • DEQ sets minimum analytes as: ▪ BTEX (benzene, toluene, ethylbenzene, xylenes) ▪ benzo(a)pyrene ▪ lead, total chromium, cadmium (unfiltered) ▪ total nitrogen ▪ fecal coliform bacteria	Routine evaluation of the effectiveness of the plan.
Data Management	As needed to track above items, particularly monitoring results. Monitoring and sampling results to be available for review upon request. On or before June 30, 2004, a summary report must be submitted to DEQ on the municipal stormwater management plan implementation, monitoring and sampling with supporting records and laboratory documentation. The report shall also include an assessment of the effectiveness of best management practices. With approval from DEQ, this assessment may be done as a regional or statewide study.	Not necessary.

7.3 RECOMMENDED METHODS FOR DEVELOPING RECORD KEEPING AND REPORTING PLANS

Municipalities should address the following topics when developing record keeping and reporting plans:

1. Information collection process.
2. Information display/access.
3. Information management/updating.
4. Information retrieval and submittal.

Recommended methods for addressing these topics when developing record keeping and reporting plans are discussed below.

1. Information collection process.

It is recommended that municipalities develop standard forms or checklists to be filled out by staff carrying out the following tasks:

- Gathering injection system inventory, assessment, and/or registration information
- Performing injection system inspection, maintenance, and/or repairs
- Performing injection system monitoring and/or sampling

The type of information that it is recommended municipalities record for each of the tasks listed above is described below. In some cases, municipalities may choose to use existing DEQ forms to record collected information. In other cases, municipalities may choose to modify existing municipal information collection forms or create new forms or checklists. Sample templates of forms that could be used for information collection are provided in Appendix F. Information collection forms and checklists should be developed that are consistent in format with other municipal environmental or stormwater-related program forms, when possible. Information collection forms or checklists may need to be modified over time to account for new information submittal requirements from DEQ.

The UIC Registration form for jurisdictions and agencies with multiple stormwater systems lists the injection system inventory data that must be recorded and submitted to DEQ. The form is located in Appendix E and can also be found on the DEQ UIC Web page (*http://www.deq.state.or.us/wq/groundwa/jur1005.pdf*). It is recommended that municipalities use this form to gather injection system inventory and registration information, or create a form that includes the same information.

The following injection system inventory information should be recorded and submitted to DEQ using the registration form:

- Location of injection system (latitude and longitude coordinates, site address).
- Type of injection system (i.e. dry well/sump, infiltration trench).
- Distance to nearest domestic/public water well, wetland, and surface water.
- Waste type discharged to system (i.e. roof drainage only, stormwater from parking lot and landscaped area, stormwater from maintenance yard).
- Status of system (i.e. under construction, active, not in use, decommissioned).
- Characteristics of system (i.e. depth, diameter, design drainage rate and volume, size of impervious area drained, type of pre-treatment BMPs used).
- Installation year.

The following injection system assessment information should be recorded and included in the municipal stormwater management plan:

- Location and construction details of all injection systems and other stormwater management controls.
- An evaluation of the land use and activities in all areas draining into the stormwater injection systems.
- An identification (based on available information) of areas within the drainage catchment where hazardous substances and toxic materials are used, handled or stored.

It is recommended that municipalities develop a form for recording the injection system assessment information listed above, or include this information in the form used to collect system inventory and registration information. A sample template of a form that could be used for collection of inventory and registration information is provided in Appendix F.

Municipalities may find the "Oregon Municipal Stormwater Toolbox for Maintenance Practices," an ACWA publication, a useful tool in developing a maintenance-related record keeping system (available at *http://www.oracwa.org/Pages/publicat.htm*). The "Oregon Municipal Stormwater Toolbox for Maintenance Practices" contains checklists and suggestions on water quality-friendly roadway, maintenance, and yard practices. Case studies and references are also included.

It is recommended that municipalities develop injection system and pre-treatment BMP maintenance checklists based on Table 2-2 and the BMP maintenance information provided in Appendix B of this manual. During each inspection, maintenance, or repair visit, staff should fill out a maintenance checklist (if applicable) in addition to a form that contains the following information:

- Injection system number or site name.
- Location of injection system and/or pre-treatment BMP.
- Type of injection system and/or pre-treatment BMP.
- Type of waste being discharged to system (i.e. roof drainage only, stormwater).
- The date and time of the maintenance activities.
- The weather conditions during and 24 hours prior to the maintenance activities.
- The type of work performed and the reason for the work (i.e. scheduled maintenance).
- A description of the maintenance activities completed. Checklists of all recommended activities for injection system (see Table 2-2) or pre-treatment BMP (see Appendix B) should be provided, including an explanation of why any recommended activities were not completed.

A sample template of a form that could be used for collection of inspection, maintenance, and/or repair information is provided in Appendix F.

Municipalities 50 or more stormwater injection systems are required to perform injection system monitoring and sampling and to evaluate the effectiveness of BMPs for treating stormwater prior to injection. Municipalities are to use system assessment information to select representative sites and additional analytes. DEQ sets minimum sampling events as two in the first year of the management plan implementation and one in each subsequent year. Sampling is to be performed at onset of wet weather. The following injection system monitoring and sampling information should be recorded and submitted to DEQ:

- Injection system number or site name.
- Location of injection system and/or pre-treatment BMP.
- Type of injection system and/or pre-treatment BMP.
- Type of waste being discharged to system (i.e. roof drainage only, stormwater).
- The date and time of the monitoring and/or sampling activities.
- The weather conditions during and 24 hours prior to the monitoring and/or sampling activities.
- Analytes - DEQ sets minimum analytes as:
  - BTEX (benzene, toluene, ethylbenzene, xylenes)
  - benzo(a)pyrene
  - lead, total chromium, cadmium (unfiltered)
  - total nitrogen
  - fecal coliform bacteria
- Protocols used.

It is recommended that municipalities develop a form for recording the injection system monitoring and sampling information listed above. A sample template of a form that could be used for collection of monitoring and sampling information is provided in Appendix F.

2. Information display/access.

Records can be maintained within a jurisdiction-wide environmental record keeping system (if available), electronic database, or paper files. DEQ maintains an Oregon UIC database that contains UIC registration information on facilities served by UICs, general discharges into UICs, and individual injection system characteristics. DEQ prefers that jurisdictions maintain injection system records that will be included in the Oregon UIC database in the Microsoft Excel or Access database programs. In some cases it may be necessary for some records related to underground injection systems to be maintained electronically and others to be maintained in paper files. It is preferable that both electronic and paper files are maintained in a manner that is easy to display and access by staff involved in municipal stormwater management and injection system maintenance or compliance. Underground injection system records should be maintained in a manner that is compatible with other stormwater maintenance records.

Multnomah County has developed an electronic maintenance database to monitor transportation feature maintenance and repair work that could affect water quality (such as underground injection sump cleaning, repair, and installation), to ensure compliance with its National Pollutant Discharge Elimination System (NPDES) permit requirements. The database is maintained in the Microsoft Access program and is linked to the Multnomah County Geographic Information System (GIS). Municipalities may find this database a helpful tool when developing their own record keeping systems. For more information on this database, contact Multnomah County at 503/988-5050.

3. Information management/updating.

As new injection systems are inventoried, old systems are decommissioned, and periodic inspection, maintenance, repair, monitoring and sampling is performed, information in injection systems records will need to be updated. Municipalities should establish which staff are responsible for submitting new record keeping information, and which staff are responsible for data entry or filing to update the record keeping system.

4. Information retrieval and submittal.

Municipalities with 50 or more stormwater injection systems are required to maintain and make available monitoring and sampling results for DEQ review, upon request. On or before June 30, 2004, a summary report must be submitted to DEQ on the municipal stormwater management plan implementation, monitoring and sampling with supporting records and laboratory documentation. The report must also include an assessment of the effectiveness of best management practices. With approval from DEQ, this assessment may be done as a regional or statewide study. Municipalities should establish which staff are responsible for retrieving record keeping information, and which staff are responsible for submitting records to DEQ.