CHAPTER 3: PERMANENT BMP PLANNING AND SELECTION

3.1 PURPOSE AND ORGANIZATION OF THIS CHAPTER

Permanent Best Management Practices (BMPs) are required on all developed properties for the control and management of stormwater runoff and pollution. BMPs are planned and installed for all project scales from small single-family residential parcels to large municipal and highway projects. Large impervious areas, multiple land uses, and high pollutant loads may warrant the services of a licensed professional civil engineer or water quality specialist to design BMPs. Projects subject to a permit have BMPs evaluated and selected during the project planning phase in coordination with the input and approval of the permitting authority.

The purpose of this chapter is to provide BMP planning and selection guidance to project proponents including landowners, consultants, engineers, and agency permitting and planning staff.

This chapter is organized into the following sections:

- **Section 3.2** describes the relationship of BMP plan development to the Preferred Design Approach (PDP).
- **Section 3.3** describes the process for selecting BMPs while considering inspection and maintenance needs. Details on specific inspection and maintenance actions are provided in Chapter 6, Inspection, Maintenance, and Monitoring.
- **Section 3.4** discusses the three typical project scales based on parcel size and land use that are used in this BMP Handbook to guide a project proponent in developing and implementing a BMP plan.
- **Section 3.5** provides BMP selection guidance for all single-family residential projects and projects less than 1 acre except commercial uses.
- **Section 3.6** provides BMP selection guidance for all other land uses (except single-family) between 1 and 5 acres and any commercial land use.
- **Section 3.7** provides an overview of BMP planning and selection for all projects that are over 5 acres and all Water Quality Improvement Projects (WQIP) where a local jurisdiction, typically a county or the city, is the lead agency or implementer.
- **Section 3.8** recommends general approaches to address physical site limitations and other constraints such as high groundwater and bedrock, utility conflicts, run-on from upstream properties, and others.
- **Section 3.9** has considerations for planning BMP projects in special land uses including the shorezone, scenic corridors, and others.
- **Section 3.10** briefly summarizes the importance of temporary BMPs. More details on this subject are provided in Section 4.5, Temporary BMPs for Construction.
Section 3.11 briefly describes agency project inspection processes
Section 3.12 lists the references cited.

### 3.2 RELATIONSHIP OF BMP PLAN DEVELOPMENT TO PREFERRED DESIGN APPROACH (PDA)

Planning and selecting BMPs can result in very different choices depending on the site analysis, project scale, and applicable permit requirements of a given project. However, regardless of scale and land-use the overall process will generally follow a standard approach based on the California Tahoe Conservancy’s Preferred Design Approach (PDA) and the objectives of the project. The PDA emphasizes BMP design that prevents the mobilization of fine sediments and nutrients, and reduces the volume of runoff reaching surface waters primarily through infiltration. These two elements should be considered together when first exploring BMP opportunities. Stormwater treatment BMPs are employed as pretreatment to remove pollutants of concern prior to infiltration and to promote maintenance and BMP longevity. Stormwater treatment may be used as a “treat and release” stormwater BMP alternative based on project objectives and site constraints that limit on-site infiltration opportunities.

The first three categories below are representative of the PDA. The last two categories are included in this BMP Handbook for easy reference and to assist the reader in selecting techniques that are commonly integrated into BMP systems. The reader should be aware that some BMPs contained in this BMP Handbook may provide benefits for more than one category, but are placed in a single category that most accurately describes the intended function of the BMP. All five categories are represented both in this chapter and in the Chapter 4, BMP Toolkit where individual BMPs are described for consistent reference:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>POLLUTANT SOURCE CONTROL</strong></td>
<td>BMPs that prevent or minimize the initial mobilization of sediment, nutrients, and other pollutants associated with roadways, households, animals, and commercial/industrial uses.</td>
</tr>
<tr>
<td><strong>HYDROLOGIC SOURCE CONTROL</strong></td>
<td>Practices and BMPs that promote infiltration and reduce the volume and rate of stormwater runoff, thereby reducing the pollutant loading entrained in stormwater.</td>
</tr>
<tr>
<td><strong>STORMWATER TREATMENT</strong></td>
<td>Represents BMPs that treat stormwater through detention, settling, filtration, and nutrient cycling and less so through infiltration.</td>
</tr>
<tr>
<td><strong>STORMWATER COLLECTION AND CONVEYANCE</strong></td>
<td>While these practices typically have no water quality benefit by themselves, they are often a component of a BMP plan to capture and direct stormwater to an appropriate treatment and/or infiltration BMP.</td>
</tr>
<tr>
<td><strong>TEMPORARY BMPS FOR CONSTRUCTION</strong></td>
<td>Site preparation and erosion and sediment control BMPs that are used to minimize pollutant impacts during project construction.</td>
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BMP maintenance is the responsibility of the property owner on a parcel or the entity in charge of BMP installation for a project. All BMPs require some level of inspection and maintenance to function properly after installation and BMP selection should include consideration of how these needs will vary depending on specific drainage characteristics. Storage and infiltration of stormwater causes clogging due to fine sediment accumulation and in certain cases may require frequent maintenance to sustain an acceptable level of performance. These types of BMPs are referred to as hydrologic source controls or simply “infiltration BMPs” in this handbook. This section recommends an approach to select and site infiltration BMPs with the intent to identify: 1) infiltration BMP systems that are most practical to inspect and maintain; and 2) situations and specific types of infiltration BMP systems where additional inspection and maintenance efforts may be required to ensure continued performance.

Infiltration BMPs may require frequent maintenance if they receive stormwater runoff with significant amounts of fine sediment, which is most commonly washed-off from impervious surfaces such as driveways, parking lots, and roads where pulverized road abrasives accumulate. In these cases, an infiltration BMP may rapidly clog and its infiltration capacity may decline to unacceptable levels requiring a need for frequent maintenance to restore the BMP. For cases with relatively clean runoff having minimal amounts of fine sediment, such as roof runoff, clogging problems are usually not a significant issue and an acceptable level of infiltration capacity may be sustained for many years with minimal maintenance needs.

Loss of infiltration capacity is caused by an accumulation of fine sediment at the infiltration surfaces of the BMP (which is typically the base and to a lesser extent the sides of the BMP) where stormwater passes into the surrounding soil. When the infiltration surfaces of a BMP become clogged, restoring the lost infiltration capacity requires removal of the accumulated fine sediment to rehabilitate the infiltration surfaces. Depending on the ease of access to the clogged infiltration surfaces within the BMP, rehabilitation may be a simple or laborious process. For example, rehabilitation of the infiltration surface for an infiltration basin may simply require raking or tilling. Whereas rehabilitation of an infiltration trench may require removal of a dense layer of drain rock to access the clogged infiltration surfaces, removal of accumulated fine sediment, and reinstallation of cleaned drain rock.

The guidelines below are provided to select and site infiltration BMPs that receive runoff from driveways, parking lots, and roads with relatively high amounts of fine sediment and debris. Specific details regarding the guidelines summarized below have been integrated into relevant sections of this handbook for infiltration BMP selection and maintenance. Simpler procedures and a broader menu of BMPs, relative to what is summarized below, may be used to select and site infiltrating BMPs that receive runoff from surfaces with minimal fine sediment loads, such as roofs.

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- **Assess sediment loading to the BMP.** The frequency and extent to which accumulated sediment is observed on drainage surface will provide evidence of whether excessive sediment loading may be anticipated. Generally, parking lots, roads, and driveways may have excessive loading of fine sediment.

- **Can the fine sediment loads generated from the drainage surfaces be minimized?** Implement BMPs that control erosion and reduce sediment sources as described in Section 4.2 – Pollutant Source Controls. Additionally, periodically remove accumulated fine sediment and debris from impervious surfaces before it is discharged to a BMP system. For a driveway, this could be accomplished by periodically sweeping the driveway with a broom and dust pan to collect and dispose of accumulated material. Avoid spraying and washing off sediment from impervious surfaces.

- **Is pretreatment of the stormwater generated from the drainage surface feasible?** Stormwater treatment devices, such as sediment traps, provide an accessible clean-out location to facilitate periodic removal of debris and some fraction of accumulated fine sediment in stormwater runoff before it is discharged into an infiltration BMP. Stormwater treatment devices will require routine maintenance and will clog if maintenance is neglected. However, these devices when sited and designed properly can notably extend the performance life of infiltration BMPs and reduce more burdensome maintenance needs by reducing the load of fine sediment and debris discharged to the infiltration BMP.

- **Where feasible, avoid the use of subsurface infiltration BMPs or BMP designs where the infiltration surfaces are difficult to access.** Infiltration BMPs that are constructed in the subsurface, or for cases where a design covers an infiltration surface within a BMP with material such as drain rock, can make inspection, maintenance, and rehabilitation of the BMP more difficult. Surface treatments should be employed first wherever feasible.

### 3.4 PROJECT SCALE AND COMPLEXITY

Guidelines for determining the scale and complexity of a project are provided below using three project categories: 1) Projects Less Than 1 Acre and all Single Family Residential (SFR); 2) Projects 1 to 5 Acres and all Commercial, Industrial, Communications and Utilities (CICU); and 3) Projects Greater Than 5 Acres and all Water Quality Improvement Projects (WQIPs). The project categories were chosen to illustrate typical breakpoints in project scale and BMP regulatory requirements. However, the characteristics, objectives, and conditions of individual projects will vary and no categorization system can apply to all cases.

Each of the three project scales covered below includes a discussion of the standards and regulations applied to that scale, typical stormwater problems and pollutant sources, and a table of associated BMPs that can be applied to remedy or address the water quality problem or pollutant. Each BMP listed in the tables has an associated fact sheet in Chapter 4, BMP Toolkit that provides more details for applicability, planning criteria, and maintenance.
3.5 PROJECTS LESS THAN 1 ACRE AND ALL SINGLE FAMILY RESIDENTIAL PROJECTS

Single family and small multi-family residential parcels with no BMPs in place have stormwater and pollution issues typical of the following:

- Sediment tracking into roads from vehicles parking on unpaved driveways.
- Compacted soils from vehicle and equipment storage on unpaved surfaces.
- Over-use of fertilizers, pesticides, and irrigation in intensive landscaping and turf areas.
- Stormwater runoff from driveways, rooftops, and other structures.
- Leaking pollutants from improper household hazardous waste storage.

3.5.1 STANDARDS AND REGULATIONS

In order to fulfill BMP regulatory requirements and receive a BMP Certificate of Completion, all small residential parcels must either install parcel level BMPs AND/OR participate in an area-wide treatment that is part of a TMDL registered catchment or a conforming Area Plan. Parcel level BMPs must, at a minimum, 1) control sediment sources, erosion, and other pollutants on-site AND 2) infiltrate stormwater generated from all impervious surfaces to the capacity of a 20-yr/1-hr storm, approximately 1 inch of water in 1 hour (1"/hr). If infiltration is not feasible due to site constraints, as defined and determined by TRPA, then special considerations may apply. These are discussed in this chapter in Section 3.8 Site Constraints and Limitations. Inability to infiltrate the design storm from all impervious surfaces may result in TRPA issuing a Source Control Certificate when all other required on-site BMPs that control sediment sources, erosion, and other pollutants are in place. A Source Control Certificate provides proof that a property owner has done as much as possible to comply with regulatory requirements. However, in the future they may be required to update their BMPs in order to receive a full BMP Certificate. If agreements are established with a local jurisdiction to accept and treat stormwater runoff from the project as part of an area-wide treatment, and all sediment, erosion, and other pollutant control measures are in place on-site, a BMP Certificate of Completion may be issued by TRPA.

3.5.2 POLLUTANT SOURCE CONTROL

Pollutant controls may include legally paving dirt parking and driveways, protecting natural areas from damage caused by vehicles, removing turf and replacing with native and adapted plants, restoring compacted and disturbed areas, removing and disposing of fine sediment and pollutants on impervious surfaces, and properly storing and managing household hazardous waste.

A valuable resource for small residential properties is the Home Landscaping Guide to Lake Tahoe and Vicinity, a publication of the University of Nevada Cooperative Extension.
### Table 3-1: Waste Management and Materials Pollution Prevention

<table>
<thead>
<tr>
<th>HANDBOOK SECTION</th>
<th>APPLICABLE BMPS</th>
<th>COMMON WATER QUALITY PROBLEMS TO ADDRESS</th>
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<td>Filter Strip (Section 4.1-g)</td>
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<td>Pool and Hot Tub Management (Section 4.2-r)</td>
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<td>Vehicle Washing (Section 4.2-s)</td>
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<tr>
<td><strong>Soil and Vegetation Management (Chapter 5)</strong></td>
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#### 3.5.2.1 WASTE MANAGEMENT AND MATERIALS POLLUTION PREVENTION

While small sites may not individually generate high amounts of nutrients, oil, and waste from household hazardous materials, neighborhoods may cumulatively generate significant pollutant loads. The practices referenced in Table 3-1 are the most common BMPs that can prevent pollutants from leaving a site and contaminating soil, groundwater, and surface waters.

#### 3.5.2.2 SOIL STABILIZATION

The following are the most common actions property owners can take to implement soil stabilization BMPs. Also see Table 3-2 for common soil stabilization problems and associated BMP solutions.

**A. RESTORE DISTURBED AND COMPACTED SOILS**
Restore soil infiltration function by aerating soils, increasing soil organic matter, planting native and adapted plants, and mulching bare soils. Refer to Chapter 5 Soil and Vegetation Management or consult the Home Landscaping Guide for Lake Tahoe and Vicinity.

**B. LEGALLY PAVE DIRT DRIVEWAYS, ROADS, AND PARKING**
Driveways, roads, and parking areas designated for year round use shall be paved with a hard surface that can withstand snow plowing during the winter months. Snow plowing must be done without disturbing soils.

**C. PROTECT NATURAL AREAS**
Install permanent barriers such as large shrub and tree landscaping, bollards, fencing, or boulders to prevent vehicle damage to natural areas, particularly those adjacent to driveways and parking areas.
Split rail fencing is a simple and aesthetic alternative to protect natural areas and landscaping from vehicle disturbance.

D. STABILIZE STEEP DISTURBED SLOPES

A naturally steep slope that is already stable and not slated for permitted construction shall be left undisturbed. Always maintain the overall natural topography of a site to the greatest extent possible. Slopes created from cut and fill during permitted construction may need structural solutions such as riprap, terracing, or retaining walls. Use native and adapted plants to increase soil stability and visually break up structural elements with soft pockets of vegetation. Where vegetation is unlikely to establish, riprap without additional vegetation may be appropriate.

<table>
<thead>
<tr>
<th>Table 3-2: Soil Stabilization</th>
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<td><strong>HANDBOOK SECTION</strong></td>
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<tr>
<td><strong>Sediment Source Control BMPS</strong> (Sections 4.2-d to 4.2-h, Slope Stabilization and Sections 4.2-i to 4.2-l, Soil Stabilization)</td>
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When using vehicle barriers, be aware of, and adjust for, any emergency response access requirements.
3.5.2.3 SOURCE CONTROL ON IMPERVIOUS SURFACES

Roads in the Lake Tahoe Region have the greatest potential to generate fine sediment among all urban land uses. The application of road abrasives and their subsequent pulverization by vehicles generates fine sediment. Fine sediment generated on road surfaces is transported with vehicles and can accumulate on surfaces where abrasives are not actually applied in substantial amounts, such as driveways and parking lots. Removal of accumulated fine sediment and debris from driveways should be regularly performed to improve the quality of runoff and reduce the loading of debris and fine sediment introduced to downstream BMPs. For a driveway, this could be accomplished by periodically sweeping with a broom and dust pan to collect and dispose of accumulated material. Avoid spraying and washing off driveways with a garden hose or other water source that will direct sediment laden runoff to a BMP system or a drainage system.

3.5.3 HYDROLOGIC SOURCE CONTROL

The Design Storm used for infiltration BMPs on small residential sites is the 20-yr/1-hr storm, approximately 1”/hr. Using the Natural Resource Conservation Service (NRCS) calculation spreadsheet is usually adequate for designing this storage capacity. Chapter 1, Urban Hydrology further discusses the BMP Calculation Spreadsheet, and the most recent version of the spreadsheet with supporting materials can be downloaded at: http://www.tahoebmp.org/. See Table 3-3 for appropriate infiltration techniques that provide hydrologic source control for stormwater runoff from driveways, parking lots, and rooftops. Table 3-3 illustrates that fine sediment and debris loads draining to an infiltration BMP will vary based on the type of impervious surface they have been design to treat. For driveways and parking lots, pollutant loads may be high enough that infiltration BMPs will require frequent inspection and maintenance activities to sustain performance.

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<table>
<thead>
<tr>
<th>Handbook Section</th>
<th>Applicable BMPs</th>
<th>Common Water Quality Problems to Address</th>
<th>Notes and Uses</th>
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<td>Runoff from Structures and Homes</td>
<td>Runoff from Paved Driveways and Parking</td>
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<td></td>
<td>Rock Lined and Vegetated Swale (Section 4.3-j)</td>
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<td>Subsurface Infiltration System (Section 4.1-d)</td>
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<td>Pervious Pavement (Section 4.1-a)</td>
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<td>Infiltration Basin (Section 4.1-b)</td>
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</table>
This rain garden collects driveway stormwater via a rock swale constructed through a grass area. An above ground low-flow irrigation system supports aesthetically pleasing native and adapted plants.

This infiltration trench collects sheet flowing stormwater off the edge of a driveway and is bordered with larger stones.

3.5.4 STORMWATER COLLECTION AND CONVEYANCE

Collection and conveyance techniques may be necessary to capture runoff from impervious areas and direct it to infiltration and/or treatment BMPs. Sediment Traps (Refer to Chapter 4 BMP Toolkit, Section 4.4-i) are needed at the end of all conveyance systems prior to infiltration BMPs to promote longevity and ease of
Table 3-4: Stormwater Collection and Conveyance

<table>
<thead>
<tr>
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<th>APPLICABLE BMPS</th>
<th>COMMON RUNOFF CONVEYANCE SYSTEMS</th>
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<td>A/C Swale (Section 4.3-h)</td>
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<td></td>
<td>Rock Lined Swale (Section 4.3-j)</td>
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<td>Vegetated Swale (Section 4.3-j)</td>
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Slotted channel drain collecting driveway runoff. Note the sediment trap at the discharge point of the slotted channel drain prior to a subsurface infiltration system.

3.5.5 STORMWATER TREATMENT

In the case of small residential sites, stormwater treatment usually takes the form of a sediment trap at the end of a conveyance system such as an asphalt swale or slotted channel drain prior to stormwater entering an infiltration system. It may also include sediment traps at the end of downspouts prior to rooftop runoff entering a subsurface gravel infiltration system. In some cases where there are site constraints such as high groundwater that prevent or limit infiltration, Filter Strips (Refer to...
Chapter 4 BMP Toolkit, Section 4.1-g) and dripline gravel armor (Refer to Chapter 4 BMP Toolkit, Section 4.1-c, Infiltration Trench) may be used as stormwater treatment for driveway and rooftop runoff.

3.6 PROJECTS 1 TO 5 ACRES AND ALL COMMERCIAL, INDUSTRIAL, COMMUNICATIONS AND UTILITIES (CICU) PROJECTS < 5 ACRES

These properties may be large and/or include multiple parcels that in combination create complex drainage and a high potential for on-site pollutants. These projects have stormwater and pollution issues typical of the following:

- High percentage of impervious surfaces (sometimes 80-100 percent), which generates high stormwater runoff volumes and leaves little room for open infiltration basins.
- Unpaved parking and vehicle tracking of fine sediment.
- Soil compaction and heavy equipment storage on bare soil.
- Over-use of fertilizer, pesticides, and irrigation.
- High pollutant loads in stormwater runoff.
- Improperly stored hazardous waste materials.
- Old and hidden illicit discharge connections leading directly to soil or municipal storm drains.

Figure 3-a shows a BMP selection flowchart providing general guidance at the conceptual level for a project BMP planner or designer. The flowchart also points the reader toward specific BMPs or a BMP category for further information and guidance.
Figure 3-a: BMP Selection Flowchart

1. Is stormwater runoff generated on-site from impervious surfaces such as asphalt and rooftops?
   - Yes: Proceed to the next step.
   - No: Go to the next question.

2. Are there existing "natural" undisturbed areas?
   - Yes: Protect natural areas to preserve infiltration capacity using parking barriers (Section 4.2.1 Parking and Vehicle Barriers) and use temporary BMPs during construction (Section 4.5 Temporary BMPs for Construction).
   - No: Ensure snow storage areas are outside of SEZs and SEZ setbacks. Use additional signage where necessary (Section 4.2.2 Snow Storage). Locate BMPs outside of SEZs and SEZ setbacks unless approved by the regulatory planner. Install parking barriers (Section 4.2.1 Parking and Vehicle Barriers).

3. Are any of these Stream Environment Zones (SEZ) and Riparian Areas on or along the site?
   - Yes: Legally pave (Section 4.2.1 Paving Parking Areas and Roads) the minimum amount allowed by the local jurisdiction (see Land Coverage Verification information in Chapter 2 Site Analysis and Chapter 7 Permitting), grade paved areas to obtain sheet flow into an infiltration area and/or use other collection and conveyance techniques (Section 4.3 Collection and Conveyance), restore denuded areas and permanently control erosion using appropriate soil and vegetation management techniques (Chapter 5 Soil and Vegetation Management). Structural slope stabilization is typically necessary for slopes over 50% (Section 4.2 Slope Stabilization). Once restored, protect from vehicle traffic with parking barriers.
   - No: Proceed to the next question.

4. Are there dirt roads, dirt parking, or other denuded and disturbed areas on the site?
   - Yes: Use pollution prevention and good housekeeping techniques (Section 4.2 Waste Management and Materials Pollution Prevention). Pre-treat stormwater for on-site pollutants prior to infiltration (Section 4.4 Stormwater Treatment).
   - No: Proceed to the next question.

5. Are pollutants present on-site such as oil, grease, or hazardous wastes?
   - No: Proceed to the next question.

6. Are there turf or other formal landscaped areas?
   - Yes: Create and follow a fertilizer management plan based on soil analysis (Chapter 5 Soil and Vegetation Management).
   - No: Proceed to the next question.
3.6.1 STANDARDS AND REGULATIONS

In order to fulfill BMP regulatory requirements and receive a BMP Certificate of Completion, all projects at this scale must either install parcel level BMPs AND/OR participate in an area-wide treatment that is part of a TMDL registered catchment or a conforming Area Plan. Parcel level BMPs must, at a minimum, 1) control sediment, erosion, and other pollutants on-site AND 2) infiltrate stormwater generated from all impervious surfaces to the capacity of a 20-yr/1-hr storm, approximately 1”/hr.

If infiltration is not feasible due to site constraints, as defined and determined by TRPA, then special considerations will apply. In these cases, the property may be required to “treat and release” their stormwater to meet TRPA discharge standards and monitor effluent concentrations to ensure these standards are met. Site constraints are discussed in further detail in Section 3.8 of this chapter. If legal agreements are established with a local jurisdiction to accept and treat stormwater runoff from the project as part of an area-wide treatment, and all sediment, erosion, and other pollutant control measures are in place on-site, a BMP Certificate of Completion may be issued by TRPA.

3.6.2 POLLUTANT SOURCE CONTROL

Identify all potential pollutants on the property. Ensure that all land-use activities on the property are appropriate and conducted in a manner that minimizes and prevents release of pollutants.

Moderately sized project site pollutant controls are likely to include or surpass those typical for small residential sites. These sites may have large areas of disturbed and compacted dirt areas that need to be legally paved or restored, including dirt and gravel parking, driveways, equipment and supply storage areas, and roads. Snow stored from impervious areas tends to be laden with oil, grease, and dirt from abrasives, requiring a detailed snow removal and storage plan. Multi-family condominium and homeowner association (HOA) facilities may have large common areas of turf that require proper fertilizer and irrigation management. Many commercial sites store, transport, and use hazardous waste material on-site. Implementing on-going pollution preventative measures minimize risk and reduce potential stormwater pollution delivery to surface water.

3.6.2.1 WASTE MANAGEMENT AND MATERIALS POLLUTION PREVENTION

A. MANAGE AND REDUCE TURF

Turf and other intensive landscaping can lead to over application of fertilizers and irrigation, increasing nutrient rich runoff to Stream Environment Zones (SEZs), public storm drains, and Lake Tahoe. Use proper fertilizer and irrigation management, and filter strips along turf perimeters. Remove unnecessary turf areas and replace with native and adapted plants. The practices referenced in Table 3-5 are common BMPs that can prevent pollutants from leaving a site and contaminating soil, groundwater, and surface waters.

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5 EPA http://www.epa.gov/ppic/pubs/ppicdist.html

Homeowners Associations (HOA’s) and Neighborhood BMPs

A group of landowners can choose to work together to design and implement a comprehensive BMP system to comply with regulations. Sharing project costs can reduce individual landowner costs through economies of scale. This takes commitment and time from each landowner, but can prove satisfactory in the long term.
The common areas in this large multi-family complex are undergoing turf removal and replacement with native and adapted plants.

B. MANAGE ANIMAL AND PET WASTE
Pet and livestock owners have a water quality and public health obligation to manage and properly dispose of animal feces and other wastes.

Use bags provided by local agencies at trail entrances to collect and properly dispose of pet waste when walking dogs. Be aware of any signs indicating seasonal prohibitions to dogs such as during wildlife nesting seasons.

C. DETECT AND REMOVE ILICIT DISCHARGE CONNECTIONS
An illicit connection from a land use such as an automobile maintenance garage or other commercial land use to the public storm drain or soil may exist for years
without employee or landowner knowledge or consideration. Local jurisdictions are the appropriate contact for illicit connection detection and removal. Any needed soil remediation activities will require a permit from the Lahontan Regional Water Quality Control Board in California (LRWQCB), or the Nevada Division of Environmental Protection in Nevada (NDEP).

D. **IMPLEMENT A HAZARDOUS MATERIALS AND SPILL MANAGEMENT PLAN**

Commercial properties that use, store, or transport hazardous materials on-site such as oils, grease, solvents, fuels, and other chemicals shall develop and implement a hazardous materials, spill, and cleanup management plan that includes employee education.

E. **COVER AND ENCLOSE DUMPSTERS**

Prevent trash exposure to rain and snow by ensuring dumpsters have adequate covering. Lock and enclose dumpsters to prevent animal entry.

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*Properly enclosing and securing dumpsters can prevent unwanted intrusions from wildlife and screening.*
### Table 3-5: Waste Management and Materials Pollution Prevention

<table>
<thead>
<tr>
<th>HANDBOOK SECTION</th>
<th>APPLICABLE BMPS</th>
<th>COMMON WATER QUALITY PROBLEMS TO ADDRESS</th>
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<tr>
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<td></td>
<td>Illicit Discharge Connections to Storm Drains or Soil</td>
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<tr>
<td>Pollutant Source Control BMPS (Sections 4.2-m to 4.2-s Waste Management and Materials Pollution Prevention)</td>
<td>Contact Local Jurisdiction (City or County)</td>
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</tr>
<tr>
<td></td>
<td>Soil and Vegetation Management (Chapter 5)</td>
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<td></td>
<td>Filter Strip (Section 4.1-g)</td>
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<td>Hazardous Materials Management (Section 4.2-n)</td>
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<td>Pet Waste Management (Section 4.2-p)</td>
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<td></td>
<td>Pool and Hot Tub Management (Section 4.2-r)</td>
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<td>Dumpster Management (Section 4.2-m)</td>
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<tr>
<td></td>
<td>Vehicle Washing (Section 4.2-s)</td>
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### 3.6.2.2 ROADWAY AND PARKING LOT POLLUTION PREVENTION

#### A. MANAGE ROADS AND ASSOCIATED ABRASIVES AND SNOW REMOVAL ACTIVITIES

A winter snow climate demands intensive management of roads, driveways, and parking areas to minimize pollutants. This may include properly removing and storing snow, using abrasives and deicers efficiently, and sweeping parking lots and roadways where abrasives are applied. Identify proper snow storage locations including flat or slightly depressed areas that are covered with vegetation and mulch, areas with good sun exposure, and areas upslope of BMP treatment systems. Careless snowplow techniques and lack of snow stakes can cause damage to landscaping, natural areas, and BMPs such as infiltration basins.

Locate snow storage areas separate from infiltration BMPs, and away from stormwater inlets and conveyances to minimize ice and snow blockage that can cause stormwater to bypass infiltration and treatment BMPs. If separation is not feasible, infiltration basins can be approved by the regulatory agency to double as snow storage if designed for a larger volume than the design storm based on anticipated snow loads, and access accommodations are made to prevent
snowplow damage. Table 3-6 lists several roadway and parking lot pollution prevention techniques for common water quality issues.

Table 3-6: Roadway and Parking Lot Pollution Prevention

<table>
<thead>
<tr>
<th>Handbook Section</th>
<th>Applicable BMPs</th>
<th>Common Water Quality Problems to Address</th>
</tr>
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<tbody>
<tr>
<td>Section 4.2-a to 4.2-c Roadway and Parking Lot Pollution Prevention</td>
<td>Abrasives and Deicer Management (Section 4.2-a)</td>
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<td>Street Sweeping (Section 4.2-b)</td>
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<td>Snow Storage (Section 4.2-c)</td>
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3.6.2.3 SOIL STABILIZATION

A. RESTORE DISTURBED AND COMPACTED SOILS

Restore soil infiltration function by aerating soils, increasing soil organic matter, planting native and adapted plants, and mulching bare soils. Refer Chapter 5 Soil and Vegetation Management for more details.
B. LEGALLY PAVE DIRT DRIVEWAYS, ROADS, AND PARKING
Driveways, roads, heavy equipment storage areas, and parking areas designated for year-round shall be paved with a hard surface that can withstand snow plowing during the winter months. Snow plowing must be done without disturbing soils.

C. PROTECT NATURAL AREAS
Install permanent barriers such as large shrub and tree landscaping, bollards, fencing, or boulders to prevent vehicle damage to natural areas, particularly those adjacent to driveways and parking areas.

D. STABILIZE STEEP DISTURBED SLOPES
A naturally steep slope that is already stable and not slated for permitted construction shall be left undisturbed. Always maintain the overall natural topography of a site to the greatest extent possible. Slopes created from cut and fill during permitted construction may need structural solutions such as riprap, terracing, or retaining walls. Use native and adapted plants to increase soil stability and visually break up structural elements with soft pockets of vegetation. Where vegetation is unlikely to establish, riprap without additional vegetation may be appropriate. Large, deep slope cuts for roads, driveways, and buildings may need larger, engineered structural solutions.

E. PROTECT STORMWATER DISCHARGE POINTS
Stabilized outlets are required at all stormwater discharge points to slow stormwater velocity and protect soil from erosion. Rock aprons are typically used, although in some cases, well vegetated areas are appropriate and can accept flows.
Rock armor at a stormwater discharge into an infiltration basin.

### Table 3-7: Soil Stabilization

<table>
<thead>
<tr>
<th>HANDBOOK SECTION</th>
<th>APPLICABLE BMPS</th>
<th>COMMON WATER QUALITY PROBLEMS TO ADDRESS</th>
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<td></td>
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<td>Disturbed and Compacted Soils</td>
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<td>Unpaved Driveways, Parking, and Equipment Storage Areas</td>
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<td>Soil Erosion on Slopes</td>
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<td>Runoff through Decks</td>
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<td>Sediment Source Control BMPs</td>
<td>Slope Stabilization (Sections 4.2-d to 4.2-h)</td>
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<td>Paving Parking Areas and Roads (Section 4.2-i)</td>
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<td></td>
<td>Parking and Vehicle Barriers (Section 4.2-l)</td>
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<tr>
<td></td>
<td>Deck Armor (Section 4.2-k)</td>
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</table>
3.6.3 HYDROLOGIC SOURCE CONTROL

In most cases, the baseline design storm used for calculating the size of infiltration BMPs on these scale sites is the 20-yr/1-hr storm, approximately 1”/hr. Using the BMP Calculation Spreadsheet may be adequate for dripline trenches and small impervious areas within the project to design this storage capacity. However, other calculation techniques for designing storage and conveyance may be more appropriate. Refer to Chapter 1, Urban Hydrology for further discussion of the BMP Calculation Spreadsheet and other useful stormwater tools.

Where project proponents are required to document an Environmental Impact Statement or similar, the environmental analysis and mitigation may necessitate an updated or unique design storm.

See Table 3-8 for appropriate infiltration techniques that provide hydrologic source control for stormwater runoff from driveways, parking lots, and rooftops. Table 3-8 includes consideration that fine sediment and debris loads draining to an infiltration BMP will vary based on the fine sediment accumulation on the impervious surface they have been designed to treat. For driveways, parking lots, and roads, pollutant loads may be high enough that infiltration BMPs will require frequent inspection and maintenance activities to ensure continued performance.
### Table 3-8: Hydrologic Source Control

<table>
<thead>
<tr>
<th>Handbook Section</th>
<th>Applicable BMPS</th>
<th>Common Water Quality Problems to Address</th>
<th>Notes</th>
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<td>Filter Strip (Section 4.1-g)</td>
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<td>Subsurface Infiltration System (Section 4.1-d)</td>
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<td>Rain Barrels and Cisterns (Section 4.1-e)</td>
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<tr>
<td></td>
<td>Rock Lined and Vegetated Swale (Section 4.3-j)</td>
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</table>
STORMWATER COLLECTION AND CONVEYANCE

Collection and conveyance techniques are commonly necessary to capture runoff from impervious areas and direct it to treatment and infiltration BMPs. Pretreatment BMPs (Refer to Chapter 4, Section 4.4 Stormwater Treatment) are needed at the end of all conveyance systems prior to infiltration BMPs to promote longevity, ease of maintenance, and to protect soil and groundwater resources from pollutant loads in stormwater.
Online BMP systems are designed to receive and safely convey an entire storm event, but only treat up to a specified design storm. Offline BMP systems are designed to receive only a specified flow rate or volume through a flow regulator (diversion structure, flow splitter, etc.). The advantage of an offline system is that there is less chance that previously captured sediment and other pollutants in the BMP will be re-suspended during higher flows.

*Figure 3-c: Offline System*

*A flow splitter for an offline system using a chamber weir that supplies a predetermined water quality flow rate.*
3.6.5 STORMWATER TREATMENT

3.6.5.1 MEET DISCHARGE STANDARDS

TRPA has a set of groundwater and surface water discharge standards. Refer to Chapter 60.1 in the TRPA Code of Ordinances for the most up-to-date standards. These standards apply to all discharges from developed properties to both surface waters and groundwater.

3.6.5.2 PRETREAT STORMWATER RUNOFF PRIOR TO INFILTRATION

Although infiltrating stormwater into the soil column provides adequate treatment of light pollutant loads, project areas with high vehicle traffic or land-uses that create high pollutant loads require pretreatment prior to infiltration. If there are few pollutants from a project area, a simple sediment trap will add longevity to an infiltration system. Incorporate cleanout ports, forebays, and other maintenance design elements into all BMPs.

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3.7 PROJECTS GREATER THAN 5 ACRES AND WQIPS

This scale typically involves a large redevelopment or publicly funded water quality improvement project that analyzes, designs, and implements improvements for an urban area on the order of 5 to 100 acres, including roadways and other public stormwater systems.

Project areas may be comprised of multiple land uses and land ownership. Significant conveyance facilities are required to serve multiple tributary areas and flow paths, often with differing hydrologic and water quality characteristics. Stormwater design flows depend on routing and storage in the drainage system and typically must be considered in the context of design storm events rather than a single peak flow. Compliance with municipal drainage design standards intended to protect public safety is typically a requirement for the project. Stormwater storage and treatment systems are potentially complex, and sizing may not be standardized due to variable opportunities and constraints in individual project areas. An alternatives analysis process is typically conducted to formulate and explore options for improvements to maximize water quality improvement within site or project constraints. A pollutant load reduction estimate is usually required to evaluate alternatives, obtain permits, evaluate environmental effects, and inform Total Maximum Daily Load (TMDL) compliance.

The following stormwater and pollution issues are typical of projects at this scale:

- A substantial amount of impervious linear project area including primary (highway) and secondary (county and city) roads creating stormwater runoff.
- Road abrasives are frequently applied and pulverized by vehicle traffic, creating a fine sediment source.
- Winter chained tires, plowing, and studded tires cause road degradation that creates sediment sources.
- Road shoulder compaction, sediment tracking, and erosion from off-pavement parking.
- Erosion on steep cut and fill slopes.
- High stormwater runoff volumes from large impervious square footage areas including multiple parking areas and large buildings with significant roof surfaces.

3.7.1 STANDARDS AND REGULATIONS

In order to fulfill BMP regulatory requirements and receive a BMP Certificate of Completion, all projects at this scale must either install parcel level BMPs AND/OR participate in an area-wide treatment that is part of a TMDL registered catchment or a conforming Area Plan.

3.7.1.1 JURISDICTION

These projects are complex to design and implement and use the Project Delivery Process developed by the Storm Water Quality Improvement Committee (SWQIC). A Technical Advisory Committee (TAC), usually comprised of the implementer,
Funder, permitting agencies, and local jurisdictions, determine a set of BMP alternatives and the final BMP design for the project.

Elements of the SWQIC Project Delivery Process:

**A. GOALS AND OBJECTIVES**

Development of project goals and objectives is the first step after project initiation and should receive formal support from the technical advisory committee. Project goals and objectives should directly relate to the problem the project is intended to address, and depict issues that will continue or result if the project is not implemented. Project goals and objectives should also define criteria by which project effectiveness can be evaluated to provide the means of tracking project success.

**B. EXISTING CONDITIONS ANALYSIS**

A general description of the project site, including physical description, use and condition, key issues, available technical data such as watershed location, soil type, land capability, pollutants of concern, hydrologic connectivity, as well as project opportunities and constraints should be documented as part of the existing conditions analysis.

**C. FORMULATE AND EVALUATE ALTERNATIVES**

Formulation of viable project alternatives should be based on the information collected as part of the existing conditions analysis and address the problem the project intends to solve. Each alternative should be evaluated based on its ability to meet the project goals and objectives.

**D. SELECT A RECOMMENDED ALTERNATIVE AND DEVELOP A PRELIMINARY DESIGN.**

From the Alternatives Evaluation, select a recommended alternative which may be an originally formulated alternative or a combination of alternatives. Once selected, design criteria, benefits, costs, and implementation constraints of the Recommended Alternative should be well defined in order to complete a Preliminary Design that is feasible to permit and construct.

The Lake Clarity Crediting Program establishes a comprehensive and consistent accounting system administered by the Lahontan Regional Water Quality Control Board and Nevada Division of Environmental Protection to track pollutant load reductions from urban stormwater using Lake Clarity Credits.

The Lake Clarity Crediting Program encourages the use of a standard set of tools and methods. The Pollutant Load Reduction Model (PLRM) is the standard load reduction estimation tool that models load reductions achieved through combinations of pollutant controls, including source control practices and treatment BMPs within catchments. The BMP Maintenance Rapid Assessment Methodology (BMP RAM) and Road Rapid Assessment Methodology (Road RAM) are the standard condition assessment methodologies used to inspect and report actual conditions. The Tahoe Integrated Stormwater Tool (TIST) is an online accounting system to support the Lake Tahoe TMDL and associated Crediting Program. 8

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8 LWQCB and NDEP, prepared by Environmental Incentives, LLC, 2009. Lake Clarity Crediting Program Handbook for Lake Tahoe TMDL Implementation v0.99
3.7.1.2 PRIVATE PROJECTS

These projects are also complex to design and implement compared to the other project categories, and typically use an equivalent of the Project Delivery Process developed by the SWQIC. This equivalent process typically takes the form of an Environmental Impact Statement document and project alternatives assessment with extensive public and regulatory scrutiny. These projects likely need TRPA Governing Board approval.

3.7 SITE CONSTRAINTS AND LIMITATIONS

Retrofitting or redeveloping existing properties can bring difficult design challenges. Obstacles may hinder design progress and, in some cases, potential solutions may be cost prohibitive.

3.7.1 SPECIAL CIRCUMSTANCES IF INFILTRATION IS NOT FEASIBLE

If infiltration is not feasible due to site constraints, as defined and determined by TRPA, then special circumstances may apply. A list of potential site constraints is discussed below. In the event that site conditions do not provide opportunities to infiltrate the runoff volume generated by a 20-yr/1-hr storm, project proponents must do either of the following:

- “Treat and Release” of Stormwater to Surface Waters
  Treat stormwater to meet TRPA discharge standards outlined in Section 60.1.3 of the TRPA Code of Ordinances using proprietary or publicly available technologies and establish a legal agreement with the local jurisdiction or another property owner to allow stormwater to discharge offsite. Proprietary “treat and release” media filtration technology may be an appropriate option in areas with infiltration site constraints. TRPA may require monitoring for “treat and release” projects to assess whether TRPA discharge standards are being met when infiltration is not feasible due to on-site constraints.

- Coordination with Local jurisdictions
  Coordinate with the local municipality or state highway department to document that shared stormwater treatment facilities treating private property discharges and public right-of-way stormwater sufficiently contribute to meeting the jurisdictions’ pollutant load reduction requirements.

3.7.2 COMMON SITE CONSTRAINTS AND ASSOCIATED BMP DESIGN CONCEPTS

Site constraints are defined as physical land attributes that prevent, or contribute to difficulties in, the implementation of BMPs required to meet regulatory water quality standards. The following are general suggestions for addressing commonly occurring site limitations and constraints. While these BMP design concepts may assist a project designer or planner in finding solutions to site constraints, each site has a unique set of issues and characteristics that need to be assessed individually to find the most appropriate solution.

3.7.2.1 HIGH GROUNDWATER AND BEDROCK

These constraints can limit the depth of infiltration systems. Where soil investigations show seasonal high groundwater levels or bedrock interfering or intersecting a designed infiltration system, alternative BMPs need to be considered.

TRPA requires at least 1 foot of separation from the bottom of infiltration systems to seasonal high groundwater soil indicators. This distance may increase or decrease dependent upon the project site and the discretion of the permitting authority.
BMP Concepts:

- Design shallower and wider BMP systems.
- Use shallow check dams to pool stormwater and to facilitate infiltration.
- Convey stormwater to a location with more appropriate soils.

### 3.7.2.2 UTILITIES AND INFRASTRUCTURE

Poor siting of BMPs can harm existing utilities and create further costs. In addition, many existing developments at Lake Tahoe have unmarked and unmapped infrastructure.

BMP Concepts:

- Verify all existing utilities during site analysis.
- Avoid installing BMPs over utilities.
- Convey water away from utilities.
- Relocating utilities typically have high costs, but may be an option for larger projects.
- Field fit the BMP to avoid any utilities during construction.

### 3.7.2.3 RUN-ON FROM OFF-SITE UPSTREAM LOCATIONS

Stormwater runoff from upstream (run-on), off-site locations can cause problems as it flows into and through a project.

BMP Concepts:

- Contact the property owner where the run-on originates and the local regulatory agency to ensure that water quality BMPs are installed on properties upstream.
- Size BMPs for larger flows to accommodate additional stormwater run-on volumes, however extra costs are associated.
- Convey water through the site in a stabilized channel following the existing historical flow lines and discharge to a stabilized location.

### 3.7.2.4 SHARED ACCESS AND EASEMENTS, AND IMPERVIOUS AREAS OVER MULTIPLE PARCEL OWNERSHIPS

Where ownership and access is shared over a small watershed area, confining stormwater runoff to within each respective parcel boundary may be costly and difficult.

BMP Concepts:

- Re-grade the site to separate flows between parcels.
- Use stormwater collection and conveyance techniques to separate flows.
Cooperate with the adjacent property owner to design and construct BMPs for both properties. This would require deed restrictions on both parcels that outline long term maintenance responsibilities, however, could potentially provide design, construction, and maintenance cost savings.

### 3.7.2.5 RETAINING WALLS ALONG DRIVEWAYS AND ROADS

Cut and fill slopes are common given Lake Tahoe Region’s steep topography in order to construct roads, driveways, and other development. These areas may require retaining walls for stabilization. This BMP retrofit situation is fairly common in many areas around the lake, and cause problems when looking for infiltration areas.

**BMP Concepts:**
- Implement all sediment and erosion control and pollutant control BMPs.
- Collect and convey stormwater to a more appropriate location.
- Use pervious paving.

### 3.7.2.6 PROXIMITY TO DRINKING WATER WELLS

Drinking source water protection is critical for health and safety. Where feasible, infiltration BMPs in commercial areas shall be placed no closer than 600 feet of a drinking water source.

**BMP Concepts:**
- Stormwater treatment is required for all related land use pollutants prior to infiltration BMPs that are installed within a 600 foot radius buffer from any wells or springs and any lake intakes.
- Collect and convey stormwater to outside the 600 foot buffer zone.

### 3.7.2.7 100 PERCENT IMPERVIOUSNESS

The urban core can be challenging for infiltration system design when parking is at a premium and minimal open space is available.

**BMP Concepts:**
- Remove asphalt and install an infiltration basin.
- Consider pervious paving systems. However, redundant infiltration is required for areas accessed by vehicles.
- Install subsurface pre-fabricated BMP systems that are traffic rated.

### 3.7.2.8 STREAM ENVIRONMENT ZONES (SEZS)

SEZs are sensitive water-influenced environments that are mapped by TRPA and legally protected.
BMP Concepts:

- Where alternatives are identified, BMPs shall not be installed within an SEZ or SEZ setback.
- Convey water to higher capability land with higher soil Ksat rates.
- Use filter strips adjacent to SEZs and SEZ setbacks.
- Avoid storing snow in SEZ and SEZ setback areas.
- If a project plans to disturb SEZ or SEZ setback, contact TRPA for any applicable permits.

3.8 SPECIAL LAND USE CONSIDERATIONS

3.8.1 SCENIC HIGHWAY CORRIDORS

All projects visible from a scenic corridor, including BMP Retrofit projects, shall comply with TRPA scenic threshold standards. Incorporate screening and landscaping into BMP plans for these areas. Obtain applicable encroachment permits from Caltrans, NDOT, and/or the local jurisdiction.

3.8.2 LAKEFRONT AND SHOREZONE

Any land modifications in the backshore of Lake Tahoe require special permitting through a TRPA Shorezone application. Permits from other agencies with jurisdiction over the Shorezone (Nevada Division of State Lands, US Army Corps of Engineers, CA State Lands Commission, etc.) may also be necessary. BMP work above the delineated backshore boundary can be addressed with standard BMP’s. However, scenic requirements must be considered. For parcels with turf next to the lake, fertilizer management plans are necessary to prevent over watering and fertilizing. Refer to Chapter 5 Soils and Vegetation Management for more details regarding guidelines.

3.8.3 WILDLAND URBAN INTERFACE

Although fire defensible space measures are important for ALL development properties in the Lake Tahoe Region, this becomes especially important on the fringes of urban areas where development and forest lands meet. BMPs should also conform to local, state, and national fire defensible space requirements. Call your local fire protection district to request a fire defensible space inspection (Refer to http://www.livingwithfire.info/tahoe/).

3.8.4 FOREST SERVICE SUMMER SEASONAL USE ONLY DESIGNATION

Roads that lead into these areas are typically gated to prevent winter plowing access. If the existing structures are subject to a Forest Service Lease agreement, contact the Forest Service for a BMP inspection. If the roads are closed via a gate and lock by the Forest Service during the winter, paving with a hard plowable surface may not be required. However, parking areas need erosion and sediment control, and parking barriers and infiltration facilities are still required.
Example of a lakefront property that used native logs, plants, and rocks to stabilize the slope while integrating closely with local environmental conditions.

3.8.5 CONSERVATION AND RECREATION AREAS

These include parks, trails, campgrounds, and day-use areas. Bear-proof cans and BMPs that blend into the native landscape are required so that any stormwater and erosion control systems do not detract from a visitor’s experience. Parking barriers and designated parking areas also apply in these areas.

3.9 TEMPORARY CONSTRUCTION BMPS

All permanent BMP plans must also identify the temporary construction BMPs that provide sediment, erosion, and other pollutant controls during grading and other disturbance activities proposed on the project during construction. Refer to Section 4.5 Temporary BMPs for Construction for a description and list of BMPs required during construction.
**Sediment versus erosion:**
Suspended sediment is entrained in stormwater, and deposited sediment is settled out of stormwater. Erosion is the process of detaching soil from one location and transporting it to another location.

A silt fence installation for temporary sediment control on a construction project.

**The official grading season in the Lake Tahoe Region begins May 1 and ends on October 15. Fines may apply for grading outside of this season. Grading exceptions are granted only for water quality and public health and safety projects.**

Permanent erosion control using native and adapted grasses.

### 3.10 AGENCY BMP INSPECTIONS

For permitted projects, a pre-grade inspection by the permitting authority is necessary after the temporary BMPs are in place, but before construction begins. Stamped plans and signed permits must be available on-site at all times during construction. Any changes to the permitted plans require approval from the permitting authority prior to being implemented on-site.

A final inspection by the permitting authority is required to ensure all BMPs are in place per the permit conditions and plans prior to issuance of a BMP Certificate of Completion. Project proponents should be prepared to test the BMPs during the
final inspection to show that BMPs are functioning. This may include a “hose” test where water is sprayed into conveyances to ensure water is flowing to the correct places.

Photos of the BMP installation that include a scale such as measuring tape in the photo will come in handy when providing proof of correct sizing to an inspector for a subsurface infiltration system.

Excavation of an infiltration trench with a measuring tape to show depth.

Testing runoff sheet flowing to a BMP for a final BMP inspection.