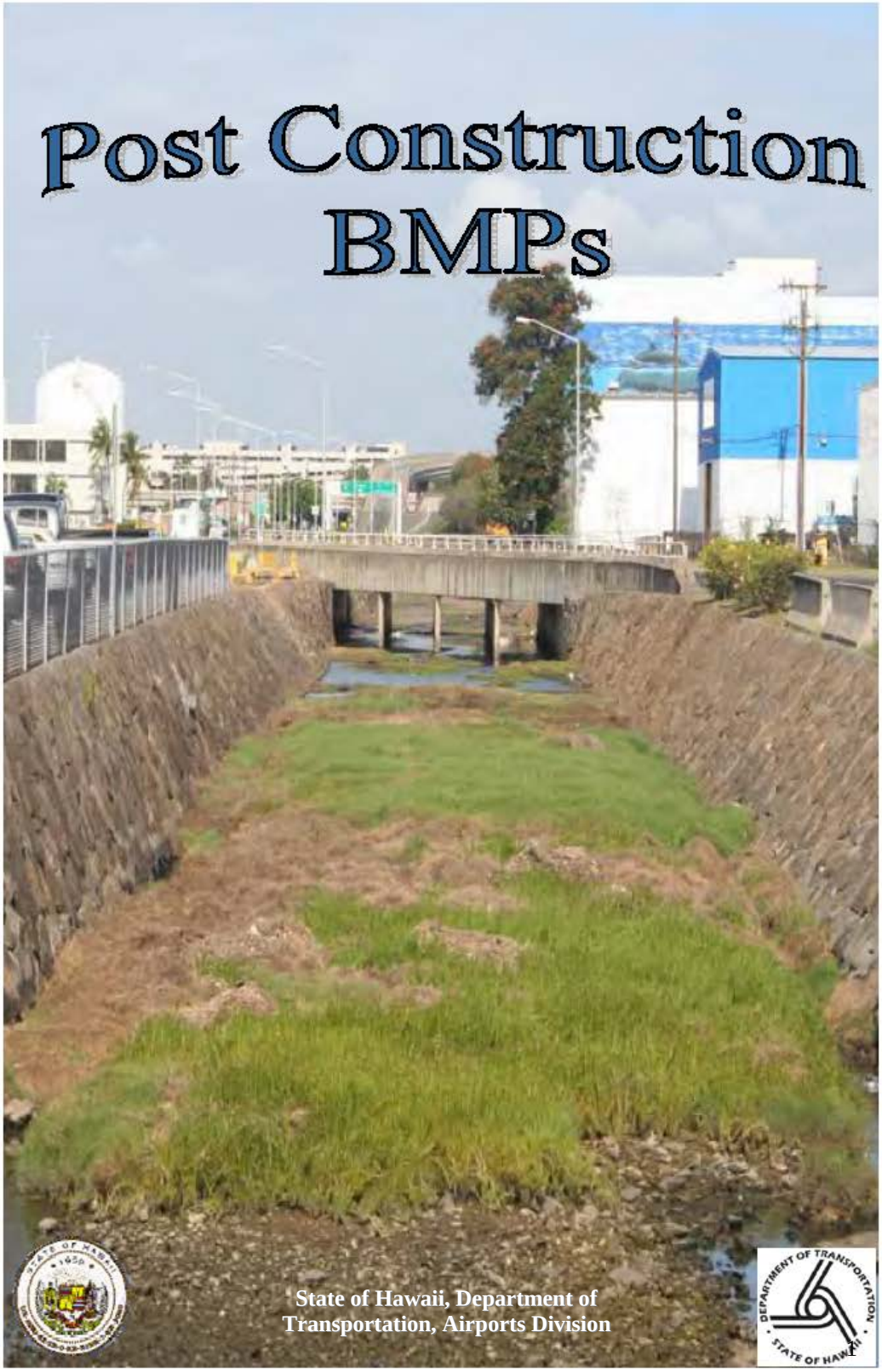
Post Construction BMPs



State of Hawaii, Department of Transportation, Airports Division

Table of Contents

Introduction

Design Process

Best Management Practices

- Pollutant Controls
- Reduce Runoff
- Treat Polluted Runoff

Permit Requirements

KEY TERMS

303(d) List - The Clean Water Act, Section 303(d) states that each State needs to compile a list of their impaired waters, taking into account the severity of the pollution and the uses to be made of such waters. The list is then submitted to Congress every two years. The State must also determine which pollutants are causing the impairment and set Total Maximum Daily Loads (TMDL) for that contaminant.

Best Management Practice (BMP) - 40 CFR 122.2 states that BMP means "schedules of activities, prohibitions or designations of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of 'waters of the United States.'"

Detention Volume - The volume of runoff that is held and treated in a BMP strucutre.

Discharge Rate - The rate at which water is discharged out of the BMP after being stored and treated.

Drainage Area - The drainage area (aka drainage basin or watershed) consists of an extent of land where the majority of the storm water runoff flows to an outlet point.

Erosion - The wearing away of the land surface by wind or water. Erosion occurs naturally for weather or runoff but can be intensified by land-clearing practices related to development.

Freeboard - The vertical distance between the water surface of the design discharge and a point of interest such as the top of a containment structure.

Hydrologic Cycle - The cycle of water movement from the atmosphere to the earth and returning to the atmosphere through various stages or processes such as precipitation, interceptions, runoff, infiltration, percolation, storage, evaporation, and transportation.

Impervious Surface - A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops and pavements.

Land Disturbing Activity - Any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography. Common land disturbing activities include, but are not limited to, demolition, construction, clearing, grading, filling, and excavation.

Municipal Separate Storm Sewer System (MS4) - A system of storm drains, channels, streams, and other water conveyance structures, owned by the State, that are used for collecting and conveying storm water to the receiving water.

KEY TERMS

Pervious Surface - Surface area which allow infiltration of water.

Pollutants - Pollutants in the storm water refer to anything that is not water. These items include nutrients such as phosphorus and nitrogen; suspended solids such as sediment; organic carbons and hydrocarbons such as oil and fuel; bacteria; trace metals such as lead; pesticides; and trash and debris.Trash and debris.

Receiving Water - A body of water such as an ocean or lake that ultimately receives all the storm water runoff from a drainage area.

Redevelopment Project - A project that consists of reconstruction or new construction on an existing impervious area exceeding one (1) acre.

Runoff Volume - The volume of water that flows off of a surface during a storm event.

Sheet Flow - Flow that occurs overland in places without defined channels. The flood water spreads out over a large area at a uniform depth.

Special Management Use Area (SMA) - The Revised Ordinances of Honolulu, Chapter 25 states that SMA is, "the land extending inland from the shoreline that was established by the State of Hawaii as requiring a SMA permit. The SMA permit includes development action which either exceeds the valuation of $125,000 or which may have substantial adverse environment or ecological effect, taking into account potential cumulative effects."

Storm Water Runoff - Precipitation which flows over the ground.

Swale - An elongated depression in the land surface that is at least seasonally wet, usually heavily vegetated, and normally without flowing water. Swales discharge storm water into primary drainage channels and may provide some groundwater recharge.

Topographic Map - A type of map depicting a limited set of features but including at the minimum information about elevations or landforms.

Waters of the United States - All waters which are currently used, or where used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide, all interstate waters and wetland, tributaries of these waters, and the territorial seas.

Wetlands—Lands where water saturation is the dominant factor determining the nature of soil development and the types of plants and animal communities living in the surrounding environment. Wetlands are also referred to as bogs, ponds, estuaries, or marches.

INTRODUCTION

Improvement and development at Honolulu International Airport (HNL) directly influences the water quality of the surrounding waters, including Keehi Lagoon and Mamala Bay. Buildings, pavement, and other impervious surfaces reduce the ability of the ground to absorb rainfall. Additionally, any pollutants left on the impervious areas, such as vehicle oil leaks, are washed away during storm events. These pollutants ultimately end up in Keehi Lagoon or Mamala Bay either through sheet flow or HNL's Small Municipal Separate Storm Sewer System (MS4).

Common pollutants from the airport development include suspended solids and nutrients such as phosphorus and nitrogen from excess sediment washed into the water. Additionally, petroleum products such as oil and jet fuel can enter the storm water from aircraft or vehicle leaks and spills. Other pollutants include trace metals from batteries or exposed scrap metals and debris from uncovered trash bins or littering. All of these pollutants effect the health of the coral reefs in the area as well as the health of recreational users of those waters. Both Keehi Lagoon and Mamala Bay are listed on the Clean Water Act (CWA) 303 (d) list of impaired waters.

Another common issue associated with airport development is the increased storm water runoff velocity since the water cannot infiltrate into the ground. The increase in velocity can potentially cause flooding and soil erosion both at the airport as well as the surrounding areas.

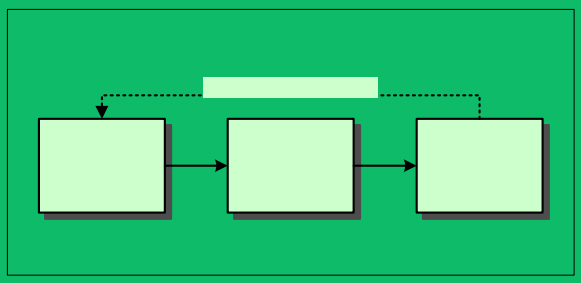
Therefore, post-construction BMPs should be implemented in current and future construction projects, retrofitted for existing structures, and impermeable areas to limit the environmental impact from airport development. The goals of these specific BMPs are to reduce the amount of storm water runoff leaving the airport, control pollutants, and treat the storm water runoff at the site.

Post-construction BMPs are a requirement of both the State of Hawaii Department of Health (DOH) Notice of General Permit Coverage (NGPC) for construction projects and HNL's National Pollutant Discharge Elimination System (NPDES) Permit No HI S00005. The program is described in further detail within HNL's Storm Water Management Program Plan (SWMPP).

POST-CONSTRUCTION BMP DESIGN CRITERIA

New development and redevelopment construction projects that result in a land disturbance of one (1) acre or more and construction projects that have potential to discharge pollutants to HNL's Small MS4 should be reviewed for implementation of post-construction BMPs. Projects that return area to pre-development runoff conditions and projects that do not have any impacts on storm water are exempt from post-construction BMP implementation.

It is important to consider post-construction BMPs throughout every phase of a construction project, including planning, conceptual engineering, and final design. Early consideration of post-construction BMPs will help identify sufficient rights-of-way needs and costs, potential community impacts, and design conflict. Therefore, post-construction BMPs should be considered throughout the life cycle of a project.



The basic steps in the storm water management plan process are:

- Assess site and watershed conditions;
- Understand hydrologic conditions of concern;
- Evaluate pollutants of concern;
- Identify candidate BMPs;
- Determine BMP size and capacity; and
- Develop a plan for BMP maintenance.

Post-construction BMPs can be viewed through three different objectives to improve water quality:

1. **Control the Source of Pollutants.** This method prevents contaminants from entering the storm water system initially.
2. **Reduce Runoff.** This method detains the storm water on-site so that it can infiltrate into the ground or evaporate; thereby reducing the contaminants that leave the site.
3. **Treat Polluted Runoff.** This methods take into consideration that certain contaminants must be generated during construction, redevelopment, or facility activities. Therefore, the storm water runoff is treated to remove as much of the contaminant as possible before it enters the receiving water.

Post-Construction BMPs should be designed by a licensed engineer with support from project planners and landscape architects. In order to design the BMPs, the storm water flow must be identified, specifically its exit points at the site. Once the study points are identified, the volumetric storage requirements should be estimated. A post-construction BMP design concept report should be generated that includes the following:

- Description of the project area;
- Description of the environmental resources;
- Description of the outfalls with condition report;
- Regulatory requirements;
- Proposed BMP location;
- Proposed BMP concept descriptions including assumptions, type, and treatment;
- Surface area and volume calculations;
- Topographic map showing BMP footprints;
- Preliminary construction cost for the proposed BMPs; and
- Appendices which consist of exiting and proposed drainage area maps, photos, and computations.

Source Control Best Management Practices

These BMPs work to stabilize the soil both during and following construction activities; thereby preventing sediment from impacting the storm water system or receiving water.

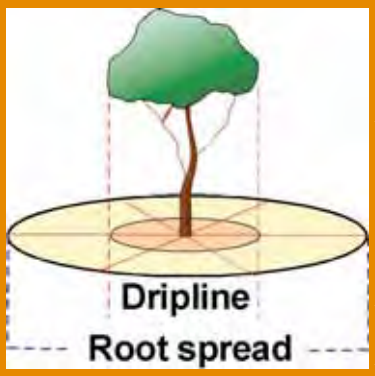
PRESERVATION OF EXISTING VEGETATION BMP

Description

Preservation of existing vegetation involves protecting desirable plants and trees in any area subject to land-disturbing activities. The primary function of existing vegetation preservation is to provide an effective form of soil stabilization control, as well as watershed protection, landscape beautification, dust control, pollution control, noise reduction, and shade.

Planning

Select sensitive areas, such as steep slopes, to preserve vegetation before the site is disturbed. Select vegetation based on health of the plant, aesthetics, wildlife benefits, adaptability, and life expectancy. All the vegetation that is to be kept on-site should be marked and protected in the construction site.



If trees are to be retained, mark off a 5 foot area around the drip line to ensure that the roots are not damaged by equipment.

Plans should also include details about the maintenance required for the plants. Any compacted soil around the plants should be aerated. Any damage to the tree or plant should be repaired by consulting with an arborist. Trees should be fertilized in late fall or early spring.

PERMANENT SEEDING AND PLANTING BMP

Description

Permanent seeding and planting is the process of establishing a perennial vegetative cover on areas that have been disturbed by construction or maintenance activities or are otherwise subject to erosion. Permanent vegetation shall be self-sustaining, need low maintenance, and be compatible with the surrounding environment.

The goal of the seeding is to reduce erosion by slowing runoff velocities, protect soil from raindrop impact, enhance infiltration and transpiration, trap sediment and other particulates, improve long-term aesthetics, and provide wildlife habitat.

Planning

Select the planting site by identifying the soil type and condition, site topography, climate and season, types of vegetation suited to the site, maintenance concerns, and aesthetic considerations.

Practice

- Roughen the slope or area to be seeded by plowing, disking, or raking to a depth of 6 inches.
- Plant the seed using broadcast seeding, seed drilling, or hydraulic application of seed.
- Mulch, fertilize, and irrigate the seed as necessary.
- Cutting or mowing grasses will encourage the establishment and spread of the grass.
- All seeded areas should be inspected to ensure that the vegetation is growing.

Note that Hawaii Department of Agriculture requires that all seed bags be sealed and marked with species, purity, percent germination, dealer's guarantee, dates of test, and the words "Pure Live Seed (PLS)."

MULCHING BMP

Description

Mulching is the process of applying loose bulk materials to the soil surface as a permanent or temporary cover. Common types of mulch are: green material, hydraulic matrices, hydraulic mulches made from recycled paper or wood fiber, stone and aggregate, vegetable fibers (hay or straw), and wood/bark chips. The primary function of mulching is to reduce erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff. Mulches have varying limitations so please review the full BMP in the HNL SWMPP before application. Mulches are also generally used to compliment seeding and vegetation establishment techniques.

Practice for Hay Mulching

- Apply seed and fertilizer to bare soil.
- Apply loose hay or straw over the top of seed/fertilizer at a rate of 2 tons per acre either by machine or by hand distribution.
- The mulch must be evenly distributed on the soil surface so that 80 to 90 percent of the ground is covered.
- Maximum fiber length shall be maintained and average fiber length shall be greater than 6 inches.
- Anchor the mulch in place by using a tackifier, netting, or "punch" it into the soil mechanically.
- "Punching" straw of hay into the soil can be accomplished with spade or shovel on small areas. On steep slopes, use plastic netting or jute held in place with wire staples, geotextile pins, or wooden stakes.

GEOTEXTILES, MATS, AND EROSION CONTROL BLANKETS BMP

Description

Matting made of natural or synthetic material is used to temporarily or permanently stabilize soil. These products are to be considered at any sites where disturbed soils must be stabilized.

Site Preparation

- Grade and shape the area of installation
- Remove all rocks, clods, or other obstruction
- Prepare seedbed by loosening 2 to 3 inches of topsoil.
- Fertilize and seed the area
- Anchor the mat into the ground with U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes.

Installation

- Begin at the top of the slope and anchor the mat.
- Unroll the blanket or mat down the slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 2 to 3 inches and staple every 3 feet.
- When blankets must be spliced create a 6-inch overlap.
- Lay blanket loosely and maintain direct contact with the soil.
- There are additional instructions for installing in a channel.

Inspection

- All blankets must be inspected after installation and significant rainstorms.
- Replace if failures or washouts occur.

VEGETATED BUFFER STRIPS AND CHANNELS BMP

Description

Vegetative buffer strips and channels can be used to reduce the discharge of pollutants to the storm drain system or to watercourses from a new development or redevelopment. The vegetated surfaces are used to protect soils from erosion and to slow the velocity of runoff to allow the removal of sediment through filtering and settling. A vegetated buffer strip is a strip of land parallel to and adjacent to the edge of the contributing surface. It can be created with either new vegetation as part of a development project or a strip of existing vegetation that is left undisturbed during adjacent development.

Practice

- Remove all weeds and debris from the area;
- Plant as soon as possible after the area has been graded;
- Select a seed mixture appropriate to the site conditions (dense grass are most effective in slowing storm water velocity and removing pollutants);
- Water and fertilize the vegetation as needed;
- Avoid using the vegetated buffer strip for vehicular traffic;
- Inspect the plantings weekly and after significant storm events until they are established;
- Maintenance consists of mowing, weeding, and ensure the plants are adequately watered; and
- Repair any eroded or damaged areas.

Runoff Reduction Best Management Practices

These BMPs work to reduce the amount of runoff exiting the property; thereby reducing the discharge of potential pollutants that may be present in the storm water at the site.

EARTH DIKES, DRAINAGE SWALES, AND LINED DITCHES

Description

Earth dikes, drainage swales, and lined ditches are structures that intercept, divert, and convey surface runoff. The primary functions of such structures are to prevent erosion and to reduce pollutant loading conveyed to receiving waters.

Practice

- Select the design flow and safety factor based on evaluation of the risks associated with erosion and over topping, flow backups, or wash out of the structure.
- Examine the site for run-on from off-site sources.
- Select a flow velocity limit based on site-specific soil types and drainage flow patterns.
- Establish a maximum flow velocity for using earth dikes and swales, above which a lined ditch must be used.
- Design an emergency overflow section or bypass area for larger storms that exceed the design storm.
- Install and utilize permanent dikes, swales, and ditches early in the construction process.
- Conveyances must be lined when velocities exceed allowable limits for the soil type. Consider use of riprap, engineering fabric, vegetation, or concrete.
- If sediment-laden water is expected in those conveyances, discharge flows from the conveyance into a sediment-trapping device.

- Temporary conveyances are to be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.
- Inspect conveyances at least once every two years.

SLOPE DRAINS AND SUBSURFACE DRAINS

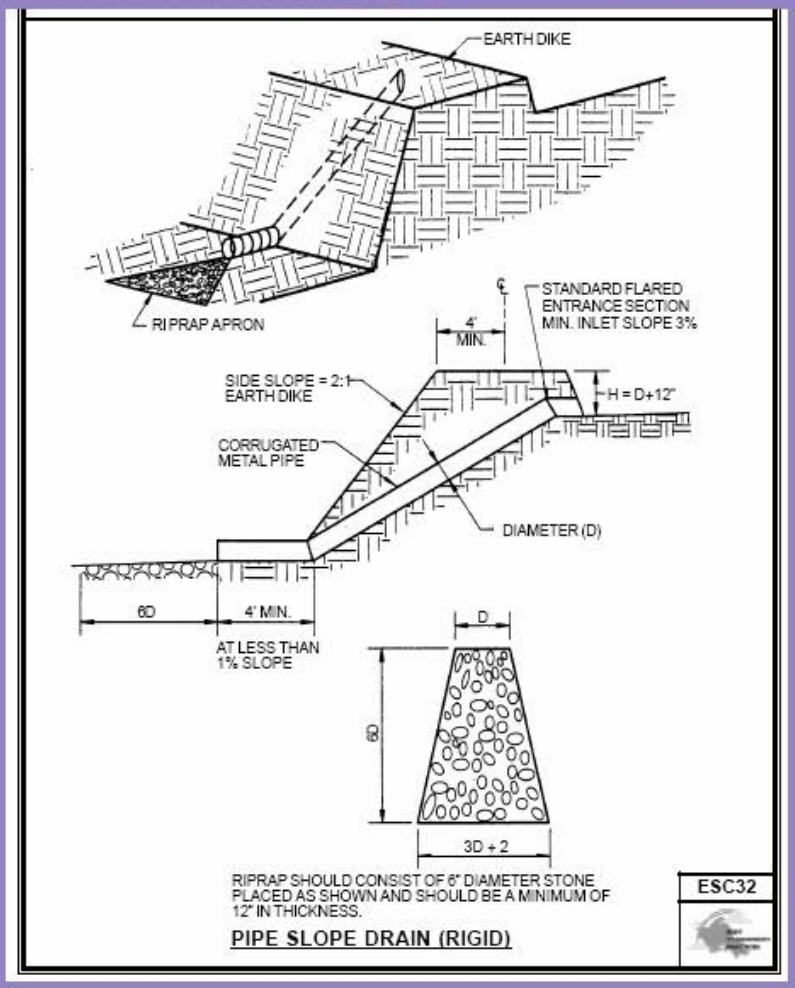
Description

A slope or subsurface drain is a pipe used to intercept and direct surface runoff or ground water into a stabilized watercourse, trapping device or other stabilized area. The primary function of a slope drain is to convey runoff down cut or fill slopes. A typical slope drain schematic is attached. The primary function of subsurface drains is to drain excessive soil saturation in sloping areas.

Practice

- Drainage area maximum is 10 acres.
- Maximum slope is 2:1 (H:V).
- Use interceptor dikes to direct surface runoff into a slope drain.
- Use a standard flared end section or headwall at the entrance to pipe slope drains larger than 12 inches to improve inlet hydraulics.
- Protect area around inlet with lining such as vegetation, filter cloth, etc.
- Place drainpipes on or bury them underneath the sloped surface.
- Securely anchor and stabilize pipe and appurtenances into soil.
- Direct flows to a detention basin if the slope drain has the potential to convey sediment-laden water.
- Protect outlets with riprap or other energy dissipation method.
- Inspect slope and subsurface drains annually during the rainy season. Follow routine inspection procedures for inlet thereafter.

SLOPE DRAINS AND SUBSURFACE DRAINS



TOP AND TOE OF SLOPE DIVERSION DITCHES/BERMS

Description

Top and toe of slope diversion ditches/berms are devices used to intercept and direct surface runoff to a slope drain, stabilized watercourse, or stabilized area. The primary function of top and toe of slope diversion ditches/berms is to minimize sheet flow over slope surfaces and reduce sedimentation by conveying collected runoff to a protected drainage system.

Practice

- Select design flow and safety factors based on evaluation of risks associated with erosion and overtopping, flow backups, or washout of the structure.

- Line or stabilize ditches where high flow velocities will occur.
- At top of slope, direct flow to slope drains.
- When installing diversion ditches and berms protect outlets from erosion.
- Use planned permanent ditches/berms early in the construction phase when practicable.
- Inspect permanent measures prior to the rainy season, after rainfall events exceeding their designed storm intensity during the rainy season.
- Inspect ditches/berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect structures and their inlets and outlets for accumulation of debris and sediment. Remove debris and sediment as needed.

OUTLET PROTECTION / VELOCITY DISSIPATION DEVICES

Description

Outlet protection/velocity dissipation devices are physical mechanisms placed at the outlets of pipes and channels. The primary function of such devices is to reduce the velocity and/or energy of existing water, preventing scour and minimizing the potential for downstream erosion.

Practice

- Apron length shall be based on outlet flow rate and tail-water level.
- Align apron with receiving stream and keep the apron straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
- If the size of apron riprap is 12 inches or longer, protect the underlying filter fabric with 4 inches minimum of gravel blanket.
- Provide additional protection where flow re-concentration and high flow velocities leaving the apron can occur, such as at the top of cut slopes or on slopes steeper than 10 percent.
- Establish a routine inspection schedule for permanent measures so that all structures are inspected at least once every three years.

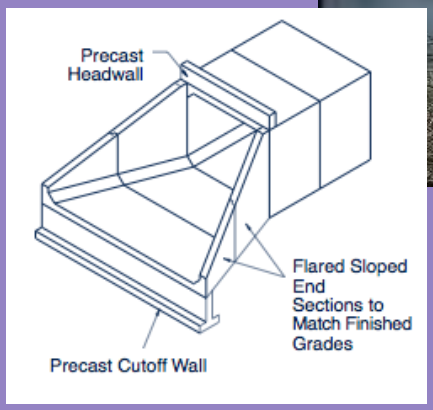
FLARED CULVERT END SECTIONS

Description

Flared culvert end sections are physical devices at the inlets and outlets of pipes and channels. The primary function of flared culvert end sections is to help prevent scour and minimize erosion at inlets and outlets. Such end sections can also improve the hydraulic operation and retain the embankment near pipe conveyances. A general design concept for a flared end section is detailed below.

Practice

- Construct at zero grade when possible.
- Use in conjunction with other outlet protection.
- At inlets, protect the transition into a flared end section to prevent scouring.
- Inspected flared end sections before the rainy season.



SLOPE ROUGHENING / TERRACING / ROUNDING

Description

Roughening, terracing and rounding are techniques used for creating down slope unevenness on bare soil. This is done by constructing furrows or intermediate benches running across a slope or by the use of construction equipment to track the soil surface. The primary function of surface roughening or terracing is to reduce erosion potential by decreasing runoff velocities, reducing the length of sheet flow, trapping sediment, and increasing infiltration of water into the soil.

Terracing Practices

- Terraces or benches are to be considered in design of slopes 4:1 (H:V) when slope heights exceed 30 feet. For highly erosive soils, and steeper slopes, slope heights as low as 15 feet are considered.
- Runoff from terraces and benches are to be directed to lined diversion ditches, installed where the terrace meets the slope.
- All slopes shall be rounded and then seeded and mulched to obtain seed germination and growth.
- Routinely inspect the terraces to ensure that they have not been eroded.

See BMP in the HNL SWMPP Section D for addition methods for slope roughening and rounding.

LEVEL SPREADER

Description

A level spreader is an outlet for dikes and diversions that disperses the runoff discharged from the slope. Its primary function is to help reduce erosion by dispersing small volumes of concentrated runoff as sheet flow. A level spreader can be the top of a channel, an earthen berm, or a rigid weir-like structure that distributes flow fairly evenly across its length at non-erosive velocities onto stabilized areas.

Practice

- Runoff containing high sediment loads must be treated device before being released to a level spreader.
- Use a rigid outlet lip design for high flow volume.
- The outlet area below the level spreader must be uniform and well vegetated having a slope of 10% or less.
- Do not allow discharge flow to re-concentrate below the level spreader outlet.
- Vehicles and heavy equipment are not to be operated in the level spreader, because they can create surface indentations that concentrate flow.

ALTERNATIVE PAVERS

Description

Alternative pavers are permeable surfaces that can replace asphalt or concrete and can be used for driveways, parking lots, and walkways. Alternative pavers include gravel, cobbles, wood, mulch, brick, grass pavers, turf blocks, natural stone, pervious concrete, and porous asphalt. This reduces the amount of impervious surface and therefore reduces storm water runoff. Additionally, the pavers can act as a filter for the runoff to remove contaminants.

Practice

- The soil beneath the alternative pavers should have a permeability of at least 0.5 inch per hour.
- Storm water collected by the alternative pavers should be collected, diverted, and treated.
- Alternative pavers are effective when applied in combination with other BMPs such as bioretention and green parking.
- In industrial areas, the pavement should be at least 2 to 5 feet above the seasonally high ground water table and at least 100 feet away from drinking water wells.
- Inspect the pavers monthly to ensure water infiltration .
- Maintenance will involve at a minimum monthly sweeping of debris and sediments to prevent clogging.

Limitations

- Alternative pavers are not recommended for high-traffic volumes.
- A discharge pipe from the alternative pavement should be installed to the MS4 (with approval from DOTA) to allow for a bypass during large storm events.

GREEN PARKING

Description

Green parking refers to several techniques that applied in the right combination can reduce the total impervious groundcover; thereby reducing the quantity of storm water runoff. Green parking lot techniques include:

- Setting maximums for the number of parking lots created;
- Minimizing the dimensions of parking lot spaces;
- Utilizing alternative pavers in overflow parking areas;
- Using bioretention areas to treat storm water;
- Encouraging carpooling; and
- Providing economic incentives for structured parking.

Practice

- The parking lot should be designed by determining average parking demand instead of conventional parking requirements which uses the highest number of parking space requirements during peak season.
- Minimize the dimensions of parking spaces within the limitations of the local codes.
- Use alternative pavers such as gravel, cobbles, wood, mulch, brick, grass pavers, turf blocks, natural stone, pervious concrete, and porous asphalt.
- Consider the limitations to green parking such as applicability, cost, and maintenance.

Storm Water Treatment Best Management Practices

These BMPs are utilized after it has been determined that the storm water exiting a site has been contaminated. Therefore, the storm water must be treated before it reaches the receiving water.

STORM WATER TREATMENT BMP DESIGN

Components

- Flow Regulation - diversion of storm water to and from BMP
- Pretreatment - trapping of coarse sediments to extend design lift
- Filter Bed and Filter Media - primary component of facility
- Outflow / Overflow - Safe conveyance of all storms through facility

Unified Sizing Criteria

Calculate Water Quality Volume (WQ_v):

$$\mathbf{WQ_v = (P) \times (R_v) \times (A)/12} \quad \text{(acre-feet)}$$

OR $$\mathbf{WQ_v = (P) \times (R_v) \times (A) \times 3630} \quad \text{(cfs)}$$

where

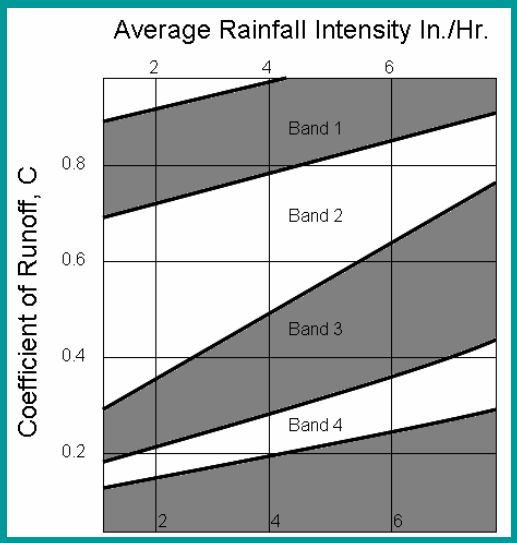
- P = rainfall depth (inches), usually 0.4 inches
- R_v = runoff coefficient
- A = drainage area (acres)

The runoff coefficient can be obtained from the following equation:

$$R_v = 0.05 + 0.009(I), \text{ where I = percent impervious}$$

OR

The runoff coefficient can be obtained from the figure below (likely from Band 1):



Band 1: Steep, barren, impervious surfaces
Band 2: Rolling barren in upper band values, flat barren in lower part of band, steep forested and steep grass meadows
Band 3: Timber lands of moderate to steep slopes, mountainous, farming
Band 4: Flat pervious surface, wooded areas

Required Filter Bed Area (Af):

Af = (WQv) x (df)/ [(k) x (hf+df) x (tf)]

where

- WQv = water quality volume (cu. ft)
- df = filter bed depth (ft)
- k = coefficient of permeability of the filter bed (ft/day)
- hf = height of water above the filter bed (ft)
- tf = design filter bed drain time (days)- 2 days recommended

Some common values of k are:

Sand 3.5 ft/day	Peat 2 ft/day
Leaf Compost 8.7 ft/day	Bioretention Soil 0.5 ft/day

Required Filter Bed Depth (d_{max}):

$$d_{max} = (f \times T_s) / n$$

where

- f is the infiltration rate (inches / hour)
- T_s is the maximum allowable storage time (hours), use 48 hours
- n is the porosity of the medium, use 0.4 for stone reservoirs

Porosity Calculation:

$$n = V_v / V_t$$

Where

- V_v is the voids volume
- V_t is the total volume

INFILTRATION TRENCH

Description

The infiltration trench provides recharge and water quality volume in one location. Infiltrated storm water shall be filtered through soils prior to entering groundwater to remove potential pollutants. Infiltration will only be used where soil conditions and slope stability are suitable.

Practice

- Obtain the runoff coefficient
- Calculate the WQ_v using the unified sizing criteria.
- Compute the maximum allowable depth (d_{max}) of an infiltration trench
- Select the trench depth (d_t) based on d_{max} and depth to water table
- Compute infiltration trench surface area (A_t) by

$$A_t = V_w / (n \times d_t + fT)$$

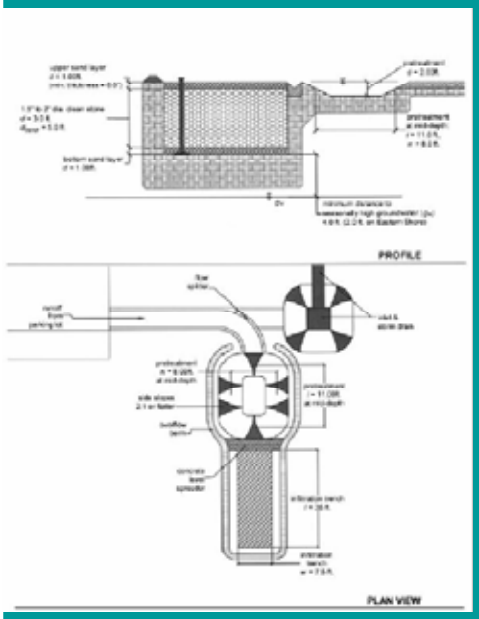
where

- V_w is the design volume
- n is the porosity, use 0.4
- d_t is the trench depth
- f is the infiltration rate
- T is the effective filling time for most infiltration trenches, use 2 hours.

- The trench will drain an area no larger than five acres.
- All trenches will be designed to fully de-water the entire WQ_v within 48 hours after the storm event.
- At a minimum, 25 percent of the WQ_v must be pretreated prior to entering into the infiltration trench using sump pit, stilling basin, etc.

INFILTRATION TRENCH

- The bottom of the trench should be separated by at least 4 inches vertically from the seasonally high water table.
- The trench should be located at least 100 feet away from any water well.
- Provide adequate storm water outfalls for the overflow associated with the ten-year design storm event.
- For concentrated flows, the trench will be located "off-line" from the main conveyance system. A flow splitter will be required to divert the water quality volume into the trench.
- After the completion of final grading, the trench should be well aerated and have a highly porous surface texture.
- Trenches may be lined with a 6 to 12 inch layer of filter material, such as coarse sand to help prevent the build-up of impervious deposits. Establish dense vegetation on trench side slopes and floor to prevent erosion and maintain high infiltration rates.
- An observation well shall be installed in every infiltration trench.



- Long-term techniques for infiltration protection are required (three per trench):

◊ Grass channel

◊ Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)

◊ Bottom sand layer

◊ Upper sand layer (6 inches minimum) with filter fabric at sand/gravel interface

◊ Washed bank run gravel used as aggregate

RETENTION BASIN

Description

A retention basin is a surface depression designed to capture the storm water runoff from the surrounding drainage area for disposal through evaporation and percolation. The primary functions of retention basins are to remove pollutants from storm water runoff where soil conditions are suitable, and to recharge or replenish groundwater. In addition, retention basins can significantly reduce total annual surface runoff volume, which can reduce stream bank erosion and other adverse impacts to stream habitats from storm water runoff.

Practice

- Determine the WQ_v using the unified sizing criteria.
- Obtain the runoff coefficient.
- Protect natural infiltration rate during construction through proper scheduling and techniques.
- Use lightweight equipment and construction procedures that minimize compaction.
- Inspect annually and following significant storm events.
- Debris and sediment accumulations are to be removed from the retention basin whenever these materials prevent proper functioning of the basin. Generally, this occurs when the sediment layer exceeds 12 inches.
- Retention basin floors shall be tilled as needed to restore the infiltration capacity and to control weed growth on the basin floor. Tilling shall be accomplished using rotary tillers or disc harrows.

BIORETENTION - RAIN GARDEN

Description

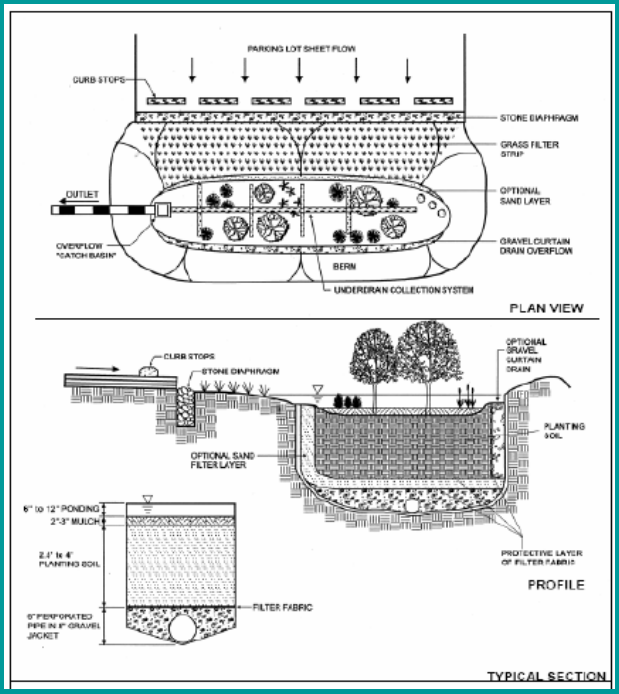
Bioretention combines open space with storm water treatment in vegetated areas where runoff is directed through vegetation and soils for filtration. It captures and temporarily stores the water quality volume and passes it through a filter bed of sand, organic matter, soil, or other media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil.

Practice

- Obtain the runoff coefficient.
- Determine the WQ_v and Af using the unified sizing criteria.
- A porosity value "n" (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Treatment components shall include
  - ◊ 2 ½ to 4 foot deep planting soil bed;
  - ◊ Surface mulch layer; and
  - ◊ 12 inches deep surface ponding area.

BIORETENTION - RAIN GARDEN

- The ponding depth should be less than 6 inches or less with a mulch layer of 2 to 3 inches.
- Overflow for the ten-year storm event shall be provided to a non-erosive outlet point and non-erosive velocities shall result.
- A flow regulator shall be provided to divert the storm water runoff to the filtering practice.
- The filters shall have a 6 inch perforated underground drain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.
- Landscaping is critical to the function and performance of the bioretention areas. A landscaping plan shall be provided for these areas including dense and vigorous vegetation.



SAND FILTERS

Description

Sand filters are usually designed as two-chambered storm water practices; the first is a settling chamber, and the second is a filter bed filled with sand or another filtering media. As storm water flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as the storm water flows through the filtering medium. There are several modifications of the basic sand filter design, including the surface sand filter, underground sand filter, perimeter sand filter, organic media filter, and Multi-Chamber Treatment Train. All of these filtering practices operate on the same basic principle. Modifications to the traditional surface sand filter were made primarily to fit sand filters into more challenging design sites (e.g., underground and perimeter filters) or to improve pollutant removal (e.g., organic media filter).

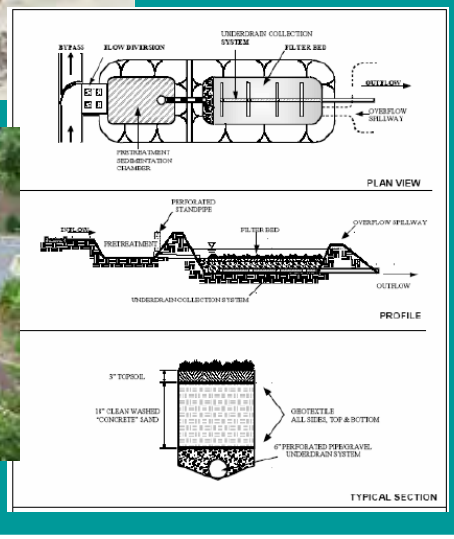
Practice

- Determine the WQ_v using the unified sizing criteria. Typical water quality volumes include the runoff from a 1-inch storm event or ½ inch of runoff over the entire drainage area.
- Obtain the runoff coefficient.
- Calculate the required filter bed area (Af).
- Sand filters are best applied on small sites up to 10 acres and up to 2 acres for perimeter or underground sand filters.
- They require an elevation drop, or head (about 5 to 8 feet), to allow flow through the system.
- Provide at least 2 feet of separation between the bottom of the filter and the seasonally high ground water table.
- The filter bed should have a minimum depth of 12 inches.

SAND FILTERS

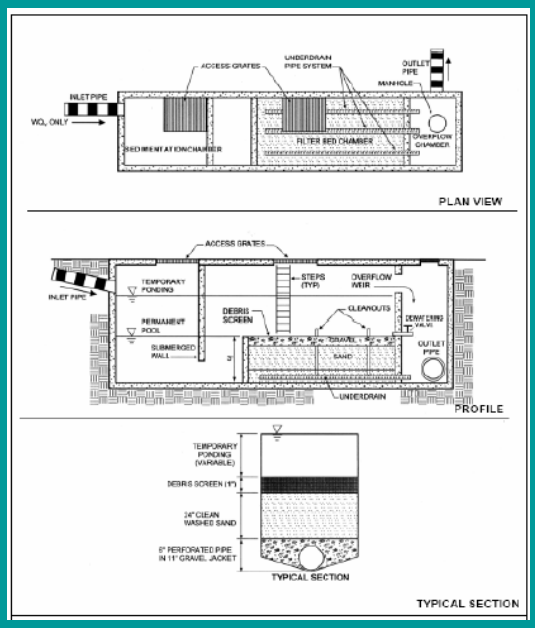
- Provide at least 25 percent of the WQ_v in a dry or wet sedimentation chamber as pretreatment to the filter system.
- Provide at least 75 percent of the water quality volume in the practice including both the sand chamber and the sediment chamber.
- The sand filters shall have a 6 inch perforated underground drain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.
- Use a flow splitter, which is a structure that bypasses larger flows to the storm drain system or to a stabilized channel during larger storms.

Surface Sand Filter

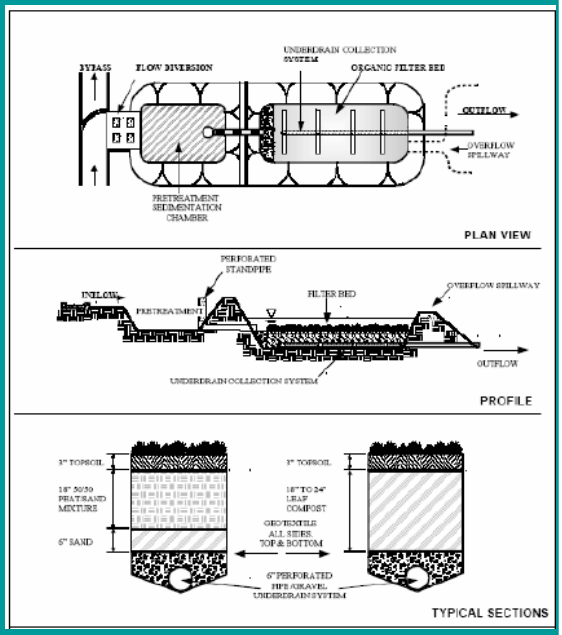


SAND FILTERS

Underground Sand Filter



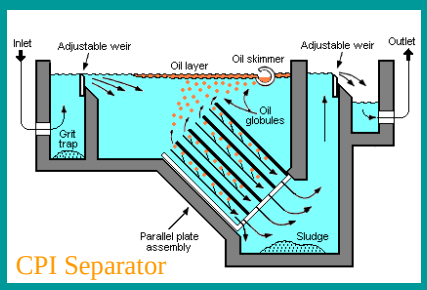
Organic Sand Filter



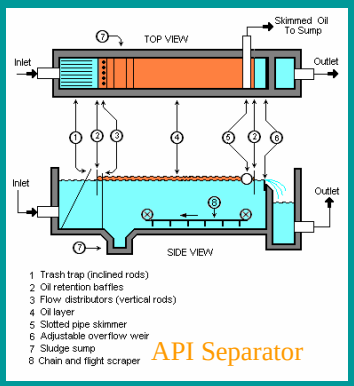
OIL/GRIT SEPARATOR

Description

Oil/grit separators are permanent treatment control devices designed to remove contaminants. The conventional separator, known as the American Petroleum Institute (API) separator, and the coalescing plate interceptor (CPI) are two commonly used oil/ grit separators. The primary function of oil/grit separators is to specifically remove petroleum compounds, other floatable debris, and settleable solids. Conventional separators are capable of removing oil droplets with diameters greater than 150 microns. CPI separators are used when droplets smaller than 150 microns must be removed.



CPI Separator

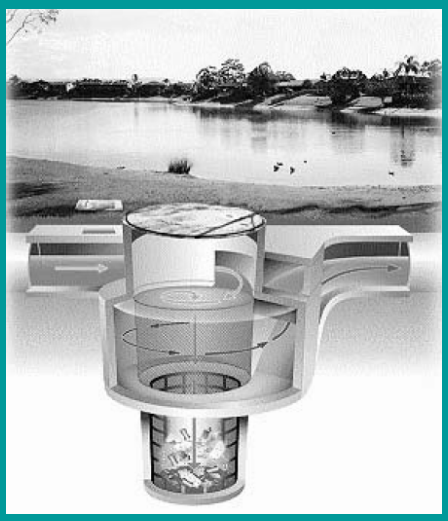


API Separator

Practice

- Determine the size of separators based on rate of runoff, rise-rate velocity of the oil droplets, and the settling rate of solids to be removed.
- Oil/grit separators shall be sized to treat the first flush of runoff; however, larger storms may be diverted around the separator.
- Determine type of separator, CPI or conventional. CPI separator contains closely spaced plates that enhance the removal efficiency.
- Oil/grit separators shall be inspected at least monthly and following significant storm events.

CONTINUOUS DEFLECTIVE SEPARATION (CDS)



Description

Continuous Deflective Separation (CDS) technologies direct solid pollutants into the lower catchment chamber and the floatables to the surface of the upper chamber using a non-mechanical, non-blocking screen technology. The system utilizes the natural motion of water to separate and trap sediments by direct infiltration. As storm water flows through the system, a very fine screen deflects the pollutants, which are captured in a litter sump in the center of the system.

Practice

- Determine the WQ_v using the sizing criteria.
- Processing capabilities vary from 3 to 300 cubic feet per second.
- Conduct detailed hydraulic analysis before installation to ensure optimum solids separation.
- Aggressive maintenance is required to reduce the risk of re-suspension of sediment during large storm events. Manholes should be included for each chamber for cleaning access.
- Document the amount of material removed from each chamber during the cleaning process.
- Disposal of waste should be done according to material contents and disposal requirements.

GREEN ROOFS

Description

A green roof, or rooftop garden, is a vegetative layer grown on top of an elevated impervious surface. Green roofs provide shade and reduce the heat within the structure through evapotranspiration, which reduces the temperatures of the roof surface and the surrounding air. In addition to mitigating urban heat islands, green roofs provide enhanced storm water management and water quality treatment. They can reduce and slow storm water runoff from impervious areas. The plants and growing medium of a green roof, in the same manner as other natural surfaces and vegetation, absorb water that would otherwise become runoff. The amount of rainfall retained by a green roof will depend primarily on the depth of the growing medium and may also be affected by the roof slope.

Green roofs can be installed on a wide range of buildings, from industrial facilities to private residences. They can be as simple as a 2-inch covering of hardy groundcover generally termed an "extensive" system, or as complex as a fully accessible park complete with trees, called an "intensive" system. Steeper roofs may retain less storm water than an equivalent, flatter roof.

Extensive Green Roofs

- Simpler and lighter weight.
- Plant selections typically include succulent, hardy varieties that do not require shade as well as other vegetation generally suitable for the environment in Hawaii.

GREEN ROOFS

- Plants adapted to extreme climates often make good choices and may not require permanent irrigation systems.
- The concept is to design a rugged green roof that needs little maintenance or human intervention once it is established.
- Green roofs are ideal for retrofitting an existing structure.
- Green roofs have been grown on roofs with slopes of 30° or more, which would equal a ratio of rise to run of 7:12 or greater.
- Overall, because of their light weight, extensive green roofs will require the least amount of added structural support.

Intensive Green Roofs

- An intensive green roof is similar to a conventional garden, or park, with almost no limit on the type of available plants, including large trees and shrubs.
- Buildings often install these roofs to save energy and provide a garden environment for the building occupants recreation.
- Compared to extensive green roofs, intensive green roofs are heavier and require a higher initial investment and more maintenance.
- They generally require more structural support to accommodate the weight of the additional growing medium and public use.
- Intensive systems also need to employ irrigation.

ALTERNATIVE WETLANDS

Description

The Federal Aviation Administration (FAA) requires that wildlife, specifically birds be limited within the airport due to the safety threat they pose to the aircraft. Therefore, it is not recommended that large wetland areas be developed within the airport limits, since they will likely draw local bird populations. However, alternative wetlands can be considered.

Floating Wetlands

The floating wetland is constructed of vegetation grown on a raft. The raft is placed in a polluted body of water such as a canal and the plants draw pollutants out of the water. Depending on the type of plant, the pollutant will either be stored in the plant or metabolized. When installing the BMP, the type of plant used must be considered as well as the plant disposal method.

Modular Wetlands

Smaller wetlands can be created adjacent to storm drains. These wetlands are usually accompanied by a 4-Stage Treatment Train. These can be used to treat the storm water in the MS4 as well as to reduce the flow rate. Hardy varieties of plants should be chosen that can survive during dry weather periods.

PERMIT REQUIREMENTS

Resource or Activity	Agency	Permit or Approval[1]
Construction site that disturbs more than one acre of land.	Hawaii Department of Health (HDOH), Clean Water Branch (CWB)	NPDES Form C
Dewatering	HDOH CWB	NPDES Form G
Construction activity which will generate a discharge of a pollutant from a point source into a navigable water[2].	HDOH CWB	401 Water Quality Certification
Construction within a navigable water (including dredging).	U.S. Army Corps of Engineers (ACOE)	Rivers and Harbors Section 10; Coastal Zone Management
Discharging dredged or fill material into a navigable water.	ACOE	CWA 404 permit
Construction within Special Management Area (SMA) (Lagoon Drive and the southern portion of HNL)	City and County of Honolulu Department of Planning and Permitting (DPP)	SMA permit
Grading	DPP[3]	Grading permit
Building a structure within airport airspace	Federal Aviation Administration	Federal Aviation Regulations, Part 77
Excavation	Hawaii One Call Center	Marks all underground utility lines

[1]This is not an exhaustive list of permits and additional permits may be necessary for an individual project.
[2]Navigable water is defined in Hawaii Administrative Rules 11-54-9.1.
[3]The DPP may require additional building permits based on the project.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NDPES) NOTICE OF GENERAL PERMIT COVERAGE (NGPC) FOR CONSTRUCTION ACTIVITIES

Applicability

Any construction project that disturbs one (1) acre or more of total land area, which includes activities that disturb less than one acre of total land area if they are a part of a larger common plan of development that will ultimately disturb one acre or more of total land area. Regulated under HAR §11-55 Appendix C.

Agency and Fees

The Notice of Intent (NOI) Form C will be filed with the Hawaii Department of Health (HDOH), Clean Water Branch (CWB) with the $500 filing fee.

NOI Requirements

The applicant must complete the form located at: http://hawaii.gov/health/environmental/water/cleanwater/forms/genl-index.html.

A construction best management practices (BMP) plan must be attached which includes the following: site characterization report; construction timetable and description; area of site and disturbed area; quantity of storm water runoff; soils to be used; site map; construction management techniques; county-approved erosion and sediment control plan; post-construction BMPs; and a description of non-storm water discharges.

Permit Conditions

- The activity must not contribute to a violation of water quality
- The applicant must inspect the state waters and implemented BMPs
- The applicant must report any pollutant source to the HDOH

Timeline

- The applicant must submit the NOI Form C 30 days prior to the start of construction activities.
- The permit is effective 10 days after filing with the lieutenant governor.
- The applicant must notify the HDOH one week prior to the start of construction.
- The permit will expire 5 years after the effective date.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NDPES) NOTICE OF GENERAL PERMIT COVERAGE (NGPC) FOR DEWATERING ACTIVITIES

Applicability
Due to the high water table within the Honolulu International Airport (HNL), dewatering activities may be required within a construction project. These activities are regulated under HAR §11-55 Appendix G.

Agency and Fees
The Notice of Intent (NOI) Form G will be filed with the Hawaii Department of Health (HDOH), Clean Water Branch (CWB) with the $500 filing fee.

NOI Requirements
The applicant must complete the form located at: http://hawaii.gov/health/environmental/water/cleanwater/forms/genl-index.html.

The NOI form requires a site characterization report; project description and timeline; analysis of source water quality; a dewatering plan; a dewatering maintenance plan; and construction pollution prevention. Additionally, if the site is over one acre of land, a county erosion and sediment control plan is required.

Permit Conditions
The applicant must monitor the discharge and submit a discharge monitoring report (DMR) to the HDOH. If the discharge is intermittent, it must be sampled once per discharge. If the discharge is continuous, the water must be sampled at least once per month. If the sampling reveals that constituent levels are not in compliance with the levels set forth in the dewatering plan, the HDOH must be notified. A written report will be sent within five days or an oral report will be made within 24 hours.

Timeline
- The applicant must submit the NOI Form G 30 days prior to the start of construction activities.
- The permit is effective 10 days after filing with the lieutenant governor.
- The applicant must notify the HDOH one week prior to the start of construction.
- The permit will expire 5 years after the effective date.

SECTION 401 WATER QUALITY CERTIFICATION

Applicability
Any activity, including construction, which may result in any discharge to navigable waters must be regulated by the Section 401 Water Quality Certification (WQC) under HAR §11-54-9.1.

Agency and Fees
The Section 401 WQC form will be filed with the Hawaii Department of Health (HDOH), Clean Water Branch (CWB) with the $1,000 filing fee.

Requirements
The applicant must complete the form located at: http://healthuser.hawaii.gov/health/environmental/water/cleanwater/forms/wqc-index.html.

The Section 401 WQC form will require information about the owner, contractor, site, and receiving water. The applicant must describe the project, the project schedule, and the existing environment condition. The applicant must attached a site characterization, monitoring and assessment plan, and mitigation/compensation plan. In addition, the applicant must describe the source and duration of the discharge as well as the description of any dredged materials.

Permit Conditions
The applicant must monitor the receiving water body before, during, and after construction activities. The HDOH has provided a matrix of the constituents that must be sampled along with frequency and duration at the above website.

Timeline
- After a completed Section 401 WQC has been filed, the HDOH director has one year from that date to act on the request.
- The director may provide the opportunity for a public hearing or for public comments (30 days).
- The permit will expire 2 years after the effective date.

UNITED STATES ARMY CORPS OF ENGINEER PERMITS

Rivers and Harbors Act 1899 §10
Section 10 of the Rivers and Harbors Act of 1899 requires approval prior to the accomplishment of any work in or over navigable waters of the United States, or which affects the course, location, condition or capacity of such waters. Typical activities requiring Section 10 permits include, dredging and excavation, artificial reefs, and construction of piers, ramps, floats, or pipeline.

Clean Water Act §404
Section 404 of the Clean Water Act requires approval prior to discharging dredged or fill material into the waters of the United States.

Coastal Zone Management Act §307
Section 307 of the Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1458(c)), requires the applicant to certify that the project is in compliance with an approved State Coastal Zone Management Program (CZM) and that the State concurs with the applicants certification prior to the issuance of a Corps permit. Information on the State CZM program can be found at http://hawaii.gov/dbedt/czm/index.php.

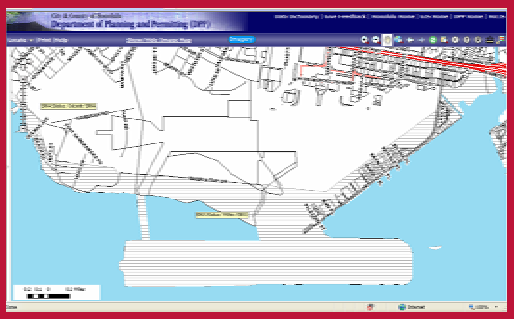
All Permit Requirements
All of the above permits are filed for using the standard form located at http://www.poh.usace.army.mil/ec-r/EC-R.htm. In addition, the applicant must provide construction drawings, location maps, and a description of the activity. For dredging projects, a description of the type, composition, quantity, and disposal methods for the material must be provided.

Fees
The U.S. Army Corps of Engineer (USACE) charges $100 for projects with industrial/commercial use and $10 for projects that involve non-commercial work. If multiple permits are required, additional fees are not charged.

Timeline
Prior to applying for the permit, the applicant can schedule a pre-application meeting with the USACE to determine which permits are required. After the application is submitted, the engineer will have 15 days to evaluate the application. Then the public will be allowed to comment for a 30 day period. Following the public comment period, the engineer will have 30 days to make a final decision on the application. Once the permit is issued, it will not expire for 10 years or until the project is completed.

SPECIAL MANAGEMENT AREA USE PERMIT

Applicability



There are two permits which apply to the special management use area (SMA); the SMA - minor permit covers developments that have a value less than $125,000 with no adverse environmental effects and the SMA-major permit covers any development, structure, or activity within the SMA as defined by Chapter 25 of the Revised Ordinances of Honolulu. At the Honolulu International Airport, the SMA includes the south ramp and reef runway areas (shaded areas of figure 1).

Agency and Fees

The City and County of Honolulu Department of Planning and Permitting (DPP) issues both the SMA - major permit as well as the SMA - minor permit. The SMA - major permit has varying fees; for agriculture, aquaculture, or outdoor recreation the fee is $300 and for all other developments the fee is $600 plus an additional $300 per acre up to a maximum of $10,000. The SMA - minor permit has a fee of $100.

Requirements

The SMA - major permit is a two phase process. The first phase involves preparing an Environmental Assessment (EA) or Environmental Impact Statement (EIS) for the project. The second phase involves the processing of the permit application and includes a public hearing.

The SMA - minor permit involves completing the application form and attaching a project description as well as plans and drawings. The application form for both permits can be found at: http://www.honoluludpp.org/download/permits/permitlistings.asp?p_TypeID=2.

SMA - Major Permit Timeline

- A pre-application meeting with DPP is recommended to determine SMA requirements.
- The DPP will hold a public hearing 60 days after acceptance of application.
- 10 days after the public hearing, the findings are transmitted to the City Council.
- The City Council must take action within 60 days after the close of the public hearing.

City and County of Honolulu Department of Planning and Permitting (DPP) Building Permits

Applicability

The DPP requires permits for a variety of construction activities. A complete list with the associated application form can be found at http://www.honoluludpp.org/download/permits/. For example, projects with the Honolulu International Airport may require grading operations and therefore a grading permit. A grading permit is required for any project that changes the drainage pattern, exceeds 50 cubic yards (cy) of cut or fill, or exceeds 3 feet in vertical height at its deepest point.

Agency and Fees

The applicant should contact the DPP to determine specific fees for individual projects. As an example, grading permit fees depend upon the amount of cut or fill material. If there is less than 1,000 cy, the fee is $45 for each 100 cy; from 1,001 to 10,000 cy of cut or fill, the fee is $450 for the first 1,000 cy plus $45 for each additional 1,000 cy; and if the cut or fill is more than 10,001 cy, the fee will be $855 for the first 10,000 cy plus $27 for each additional 1,000 cy.

Grading Permit Requirements

The DPP issues the grading permit as required by Chapter 14 of the Revised Ordinances of Honolulu. The application requires a grading plan that includes project information, slope calculations, existing and new drainage patterns, quantity and description of cut or fill material, disposal plans, and best management practices (BMPs). The grading permit application has additional requirements based on the nature of the project.

Drainage Plan and Erosion Control Plan and Procedures may be required if the project covers more than 7,500 square feet or the cut or fill exceeds 7.5 feet in height.

Engineering Slope Hazard Report may be required if the cut or fill is greater than 15 feet in height and has a grade steeper than 40 percent.

Engineer's Soils Report:

- The cut or fill exceeds 7.5 feet in height;
- The proposed grading is on land with existing slopes exceeding 15%;
- Any fill is to be placed over a swamp, pond, lake, wetland, or waterway;
- The fill material will be highly plastic clay; or
- The fill is to be used to support foundations for buildings.

FEDERAL AVIATION ADMINISTRATION REGULATIONS

Applicability
Federal regulations Title 14 Part 77 requires establishes standards and notification for objects affecting navigable airspace. This includes any construction on Honolulu International Airport regardless of the height or location.

Agency
The notice must be submitted to the Federal Aviation Administration (FAA) (808) 541-1232. There are no fees associated with the notice and the notice form can be found at https://oeaaa.faa.gov/oeaaa/external/portal.jsp.

Requirements
Applicants must complete the "Notice of Proposed Construction or Alteration" form. In addition, the FAA may request the following:

- Scaled drawing showing location of alteration in relation to nearest runways. This may be marked up-Airport Layout Plan or Terminal Area sheet.
- Perpendicular distance of the proposed alteration to the nearest runway centerlines.
- Distance along centerline (actual or extended) from runway end to the perpendicular intercept point
- Ground elevation at the site of the proposed alteration
- Height of the proposed alteration including antennas or other appurtenances
- Accurate geodetic coordinates conforming to NAD 83
- Sketches, drawings, etc. showing the type of construction or alteration being proposed

Timeline
The notification must be submitted 30 days prior to construction. However, the FAA recommends that the notification be submitted 60 days prior to construction to allow time for conduct the aeronautical study.

FAA Determination
Once the FAA has completed the aeronautical study, they will make a determination about the project. "No Objection" means that the construction did not exceed the obstruction standards. "Conditional Determination" means that the proposed construction would be acceptable upon implementing measures such as marking and lighting. "Objectionable" means that the proposed construction is an air hazard.

HAWAII ONE CALL CENTER

Applicability
Hawaii Revised Statutes, Chapter 269E, state that require that utility owners provide advanced warning to excavators before they begin digging. Therefore the Hawaii One Call Center was created to allow excavators to dial 1-866-423-7287 and reach the main utility companies.

Agency
Each individual utility company will be notified to deploy to the construction site to mark the location of their underground lines.

Requirements
The excavator must provide the Hawaii One Call Center with the following information:

- Contact information including name, phone number, and address
- What type of work is being done
- Who the work is being done for
- The location of the construction site including address and distance from nearest intersection

Once the Hawaii One Call Center has recorded the information, they will provide the excavator with a ticket number.

Timeline
Within two hours of receiving the ticket number, the Hawaii One Call Center will have notified all the utility owners of the proposed excavation. The utility owners will mobilize to the site within 2 to 5 days and mark the location of the underground lines with the appropriate color codes.