4T Post-Construction Controls

Post-Construction Controls for New Development and Redevelopment

The focus of this guidance is post-construction controls for new development or redevelopment projects. Post-construction controls can be generally grouped into three types: **site planning measures** that avoid or reduce disturbance of the site and limit the addition of impervious surfaces; **pollution prevention/source control measures** that reduce or eliminate potential future sources of pollutants; and **treatment control measures** that treat polluted runoff from new development/redevelopment sites.

This guidance is focused strictly on specific controls that can be incorporated into individual development projects proposed by public and private entities to avoid or reduce the pollutants from the particular project. Where appropriate, pros and cons are described along with typical conditions under which these controls have been found to be effective.

As noted in Section 4.6 of the MURP, the best opportunities for post-construction controls are available in larger projects or when implemented on a regional basis, and most of this guidance emphasizes controls that can be introduced in larger new development/redevelopment projects through the discretionary approval process. The second section of this guidance presents a list of controls that can be employed for small infill-type projects (ministerial approval process) where the opportunities are limited.

Post-Construction Controls for Projects Requiring Discretionary Approvals

Site Planning Measures

This group of post-construction controls includes site planning to protect sensitive resources at or near the site and the use of alternate paving and cover materials to reduce the amount of impervious surfaces added by a new development.

Studies have shown that in single-family residential areas, streets are the primary producers of runoff, and sidewalks and lawns, if properly vegetated, are a minor source. In multi-family developments, streets, parking lots and roofs generate similar quantities of runoff. In commercial/industrial areas, parking lots and roofs are the main generators of runoff. It follows then that to reduce impervious surfaces, in single-family residential areas reduction of street width and driveway lengths should be the primary strategy, while in multi-family developments and industrial/commercial areas, strategies should focus on reducing parking lots and the footprint of buildings. *For more information on site planning, refer to Start at the Source Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection, available from BASMAA.*

Site planning measures that minimize impervious surface and maximize infiltration are described below:

- ✓ **Cluster development** - Concentrate the development on a limited portion of the site and leave the remaining portion undisturbed. This should be used where appropriate without creating other hazards such as those of access during emergencies.

- ✓ **Preserve natural drainages** - This measure includes not filling in the natural drainage features at the site, maintaining invert/streambeds to maximize capacity, and providing vegetated setbacks or buffer strips outside of the maximum water surface level. Main concerns are related to safety especially of children and future need for mosquito/pest control.

- ✓ **Reduce sidewalk widths, especially in low-traffic areas** - This control provides limited runoff reduction benefits, and reduction of width may not possible due to Americans with Disabilities Act (ADA) requirements.

- ✓ **Avoid curb and gutter along driveways and streets where appropriate** - This is recommended in areas where flooding and ponding of water creating mosquito habitat is not a problem. Replace with swales.

- ✓ **Use alternate paving materials/porous/permeable materials, where appropriate** - This measure includes use of alternate paving materials (e.g., porous asphalt, pervious concrete, pavers), landscaping, mulch, gravel and cobbles where appropriate to provide ground cover, and reduce the use of asphalt or other impervious pavement.

  Pavers are recommended for driveways, walkways, and patios in single-family residences where the site does not generate highly polluted runoff (that could contaminate groundwater if it were to infiltrate) and where ADA requirements do not have to be met. In non-residential areas, pavers are recommended for emergency access roads, overflow parking areas, and non-handicapped parking stalls. These are not recommended where heavy loads (e.g. truck movement) are anticipated. *For more information on alternate paving materials, see Post-Construction Controls for New Development Fact Sheets available from BASMAA.*

- ✓ **Reduce the length of driveways or infiltrate driveway runoff** - This control applies mainly to single-family residential units. Note that in most of the large metropolitan areas of California, driveways in new development are generally short due to the high cost of land. If long driveways in the Municipality are due to the fact that the structures have to be set back from the property line per the zoning ordinance, then the Municipality should consider changes in its zoning ordinance. If reduction of the driveway length is not possible, grade and construct driveway so that runoff from driveway is directed to the adjacent landscaped areas.

- ✓ **Reduce street width by eliminating on-street parking (where such actions do not pose a safety hazard)** - This measure can be generally used in new residential areas. In addition to reducing the impervious area, this control has the added benefit of removing cars from streets and making street sweeping easier and more effective. If on-street parking in residential areas is eliminated, the developer must provide adequate off-street visitor parking.

- ✓ **Reduce alley width or use alternate materials for paving alleys** - Alleys are generally not built in residential areas in California due to the high cost of land and concerns regarding safety and maintenance (alleys are often used for illegal dumping). However if alleys are included in a proposed development, width should be minimized or alternate paving materials should be used.

- ✓ **Mandate that all developments set aside open space** - This control is recommended for all developments (residential and non-residential). The main concern with open space relates to maintenance, weed control, and fire prevention.

Source Controls

This group includes controls that can be incorporated into new development/redevelopment projects to avoid pollution in the long run by eliminating sources.

- ✓ **Provide green areas where pets can be exercised** - Pet excrement is a major source of bacteria in urban runoff. In addition to instituting ordinances requiring owners to collect their pet's excrement, provide green areas in new residential developments where people can walk their pets and keep pet excrement away from sidewalks and streets.

- ✓ **Install landscaping or other cover** - Clearing and grading of surfaces in new development can increase potential for erosion. Install landscaping or other cover materials to minimize erosion from graded surfaces. Use of native plant materials is recommended because native plants require less maintenance and irrigation, and are typically more resistant to fires than non-native grasses. Native plants do take longer to cover slopes therefore during the first few years, supplemental protection (erosion blanket, mulch, etc.) will be necessary.

- ✓ **Incorporate low-maintenance landscaping** - At some sites where erosion may not be a concern but landscaping is proposed as part of the development, require or recommend use of low-maintenance landscaping that does not require frequent fertilizer, pesticide and herbicide application. In this regard, the Municipality should identify the types of trees, shrubs, and ground cover that would work in the community based on local climatic and soil conditions, and should make such lists available to municipal staff responsible for reviewing projects.

- ✓ **Require labeling of storm drains (to discourage dumping)** - Developer should be required to label all storm drains with the appropriate legend used in the city, cautioning against dumping.

- ✓ **Where possible, eliminate gutters/roofdrains or direct runoff to landscaped areas** - Roofdrains can be eliminated only in one to two-story buildings. Where these cannot be eliminated, direct the downspout of the gutter to a landscaped area or into an infiltration trench. Install several gutters to distribute the flow.

- ✓ **Construct designated vehicle wash area** - In new residential developments involving more than 50 units, require applicant to construct a designated vehicle wash area that is plumbed to discharge to the sanitary sewer (the Municipality should check with the local wastewater treatment plant before instituting this control).

- ✓ **Encourage underground parking and the construction of multi-storied parking structures** - For commercial projects, encourage developers to build underground or multi-story parking structures so that not only is impervious surface minimized but the parking surfaces are under a roof and not exposed to storm water.

- ✓ **Encourage cooperative or shared parking** - This control is recommended for commercial areas, and can be a cooperative effort between commercial entities or between commercial entities and the Municipality.

- ✓ **Encourage use of alternate paving materials for parking lots** - This control is recommended for overflow parking areas and for less frequently used parking spaces (typically these are spaces along the periphery of the parking lot that will not have to meet ADA requirements and due to low usage there will be less concern regarding pollution of groundwater through infiltration of stall runoff).

- ✓ **Encourage measures to reduce building footprint and increase use of taller structures (where appropriate)** - This control is recommended for commercial and municipal structures.

- ✓ **Require that waste storage areas be bermed** - Require all developments to grade and pave outdoor waste receptacle area to prevent run-on of storm water, and install a low containment berm around it. Alternately, construct a covered enclosure with wash-down capabilities outletting into the sanitary sewer.

- ✓ **Require installation of valves on storm drain inlets in loading dock areas** - At commercial/industrial facilities where loading docks are proposed, require the applicant to install a valve to control runoff in the event of spills.

Treatment Controls

This group includes controls that can be built at new development/redevelopment sites to capture and treat the polluted runoff before it enters the city's storm drain system or other receiving waters.

- ✓ **Rooftop Catchment Systems** - These are rooftops which are designed to pool stormwater, which following the storm, evaporates. This effectively eliminates rooftop runoff from the storm drain system, and thereby reduces the hydraulically-connected impervious area. Another function of these systems is to slow down the runoff to reduce peaks. Problems with rooftop catchment systems are mainly related to leakage. Such systems are usually recommended for large commercial and industrial sites, and in climatic zones where rainfall is intermittent and temperatures are above freezing.

- ✓ **Vegetated Filter Strips** - Vegetated filter strips, buffer strips, or riparian buffer zones are strips of vegetation placed between receiving waters (e.g., along streams) and pollutant sources. The effectiveness of the strips depend primarily on the width of the strip, and the vegetation type and condition. Strips of 100-300 feet in width are often considered. Such strips have been successfully applied to urban, agricultural, and forestry situations. Vegetation type selection in California must take into account the semi-arid climate and usually should be drought-resistant. Maintenance is primarily annual cutting. Such strips are recommended for new development located along receiving waters such as streams, rivers and lakes, but outside the flood control boundary.

- ✓ **Vegetated Swales** - Swales are shallow low gradient channels that are vegetated. They are commonly applied in rural residential areas in lieu of traditional curb/gutters and underground stormwater drainage pipes. Water quality improvement is achieved primarily through filtration, and performance is dependent on the swale hydraulic capacity and vegetation type and condition. Influent water should be relatively free of coarse sediment to avoid burying the vegetation. Where sediment loads are of concern, sediment settling basins can be provided upstream of the swales. Maintenance consists primarily of vegetation management and settling basin cleanouts. Swales are generally recommended for low-density residential developments located in relatively flat terrain.

- ✓ **Infiltration Basins** - Infiltration basins store and infiltrate stormwater into the surficial groundwater aquifer. Performance is critically dependent on soil porosity and adequate depth to groundwater. In California, such conditions are typical of inland valleys, in contrast to low lying coastal areas. In order to maintain recharge rates, influent water may require pretreatment to remove sediments. Infiltration basins are effective at reducing runoff rates and volumes and can provide water supply benefits through aquifer recharge. Maintenance primarily consists of periodic removal of accumulated trash, debris and sediments to maintain recharge rates. Infiltration basins are generally recom-

mended in semi-arid areas where the depth to groundwater is relatively high and the soils are highly pervious. Where such conditions exist, this technology is generally applicable to the entire range of urban development, although the potential for groundwater contamination is often of concern in industrial areas.

- ✓ **Infiltration Trenches** - Infiltration trenches are shallow drains filled with high porosity materials (e.g. gravel). Stormwater discharged to these trenches is stored during the runoff event and infiltrates into the groundwater during dry weather periods. As with infiltration basins, performance requires porous subsoils and adequate depth to the groundwater table. The acceptability and designs of infiltration trenches may be covered by building codes where there is concern that infiltrating water may adversely affect soil strength around foundations. Infiltration trenches are generally not recommended for roof runoff near buildings because of building code requirements; but can be effective as part of the overall open channel drainage system.

- ✓ **Dry Detention Ponds/Basins** - These are basins designed to temporarily store and treat storm water prior to gradually releasing it downstream. Such basins can provide flood control and storm water treatment benefits. Treatment performance depends on storage volume (12-24 hours of residence time is considered a good rule of thumb), and good circulation (avoidance of short circuiting). A major factor limiting good performance is that, during larger storm runoff events, water entering a dry basin may resuspend previously settled material in which case the ponds may act as a source of sediment and associated chemicals. In general dry basins are not as effective as wet basins(discussed below), however, in certain arid areas, wet basins are not feasible. Performance of dry basins can be improved by incorporating slow release outlet structures. Such basins are generally applicable to residential, commercial, and industrial development in arid areas where there is insufficient runoff to maintain wet basins. The cost of urban lands often preclude this type of treatment in the more dense portions of urban areas.

- ✓ **Retention Ponds/Wet Basins** - These are basins that contain a permanent pool of water. Such ponds can provide flood control, ecological, and water quality benefits. The performance of wet basins depends on the size of the basin, watershed characteristics, and influent conditions. The primary treatment process in retention ponds is settling. Maintenance is required for removing debris, vegetation management, and maintaining the inlet and outlet structures. Accumulation rates in such basins typically require that accumulated sediment be removed about once every 10-20 years. Retention ponds are generally applicable to most urban situations, as long as there is adequate space for the facility and acceptable geological conditions. The cost of land often precludes this type of treatment in the more densely developed portions of urban areas.

- ✓ **Constructed/Restored Wetlands** - In addition to providing flood control and water supply benefits through artificial recharge of groundwater, constructed wetlands designed for stormwater management provide water quality benefits

through a number of processes including sedimentation, filtration, absorption, biological processes, and nutrient uptake. Pollutant removal performance depends on the size of the wetland relative to the watershed, the design of the wetland, and the type and composition of wetland vegetation. Wetlands also provide additional ecological and recreational benefits. If a significant amount of sedimentation is anticipated, a deep settling basin could be constructed (which the water would enter prior to reaching the wetland). The basin would require periodic maintenance to remove accumulated sediment. Constructed wetlands require maintenance, especially in the first 5-10 years during which vegetation is growing and natural seeding is occurring. Providing suitable hydrologic conditions for vegetation growth and water treatment is key to successful performance of constructed wetlands. Constructed wetlands are generally applicable to most urban situations, as long as there is adequate space for the facility, an adequate source of water, and appropriate soils. In California, such wetlands would likely be seasonal in nature. The cost of urban lands often preclude this type of treatment in the more densely developed portions of urban areas.

A variation of this control is the use of existing wetlands for urban runoff treatment. Existing wetlands at or downstream of a new development/redevelopment project can be enhanced to improve hydrology, and runoff from the development project can be directed to the wetlands.

Note that the dry detention ponds/basins, retention ponds/wet basins, and the constructed wetlands need to be periodically monitored for accumulation of toxic materials, and provisions made for cleanout and disposal pretreatment may be added (to remove heavy sediment trash and debris) to reduce maintenance. If a significant amount of sediment is anticipated, a deep settling basin could be constructed. This would also need to be periodically cleaned out to maintain capacity.

- ✓ **Filtration Systems -** Filtration systems convey stormwater through filter media (e.g., sand, compost, charcoal) to treat the storm water. The chemicals treated vary depending on the type of media and may include fine sediment, colloidal material, hydrocarbons, organics, nutrients and dissolved metals. Such systems come in many sizes and designs including: (1) inserts placed in individual storm drain inlets, (2) linear units that treat stormwater from small impervious areas such as parking lots, and (3) large 1-2 acre sand filters that treat runoff from urban catchments. Filters are effective as long as the capacity of the filter is not exceeded, and the filter is not allowed to clog. Filter inserts are particularly problematic in this regard, and recent testing and evaluation questions their applicability where material in runoff will clog or block the filter. In stormwater applications filter systems are required to remove blocking materials (leaves, trash, debris, sediments, oil and grease) and storage to better manage flowrates.

Experience to date with filter type inserts for drain inlets suggest that the units are easily clogged with sediment and debris, with resultant bypassing of most of the flows. Therefore, inserts are not recommended unless require frequent inspection and cleaning is performed. Filtration systems will have limited application in small well-maintained parking lots.

✓ **Oil/Grit Separators** - Oil/grit (gravity) separators are usually multi-chambered treatment units that are placed underground and treat stormwater from a drainage catchment. The individual chambers often are designed to trap grit and floatables, and adsorb hydrocarbons. Flows in excess of the design capacity should be diverted around the unit, otherwise there is the possibility that sediment previously trapped in the chambers will be resuspended and flushed downstream. Inspection and maintenance is required to ensure that the units are not filling up with sediment, as accumulation can affect performance. Traditional gravity oil/water separators that utilize skimming devices and coalescing plates (to increase droplet size and capture) are generally not applicable to stormwater conditions where total hydrocarbon concentrations are generally less than 10 mg/l. The performance of oil/grit separators varies depending on the chosen design and cannot be generally recommended at this time, pending more data from ongoing testing. In general, oil/grit separators are useful only at sites where there are chances that oil spills could occur and to a limited degree at development sites that have high oil and grease loadings such as petroleum storage yards and vehicle storage facilities.

General Design Considerations for Treatment Controls

Treatment control design standards, depending on the type of units, are based on either treating a given volume of runoff (e.g., first 0.5 inch of runoff) or a peak flowrate associated with a design storm. The volume approach is often utilized for small catchments where there tends to be a “first flush” condition (e.g., a parking lot). Design storms for storm water controls tend to be small (e.g. recurrence intervals of 3 months to 2 years) compared to flood control designs standards because of the need to minimize the size and cost of the unit, and because most runoff is associated with the more frequent smaller events. Treatment controls must be designed such that volumes and flows in excess of the design standard bypass the unit, otherwise there is the possibility of aggravating flooding and also causing resuspension of previously captured sediments or other constituents. Also, all of the treatment devices above require some inspection, maintenance, and disposal of solids to ensure optimum performance and often to avoid flooding.

Post-Construction Controls for Projects Requiring Administrative Permits

✓ **Incorporate low-maintenance landscaping** - The applicant should be instructed to use low-maintenance drought-tolerant landscaping that does not require frequent fertilizer, pesticide and herbicide application.

- ✓ **Require labeling of storm drains (to discourage dumping)** - The applicant should be instructed to label all storm drains with the appropriate legend used in the municipality, cautioning against dumping.

- ✓ **Where possible, direct gutters to landscaped areas** - Roof drains may be eliminated only in one to two-story buildings. Where these cannot be eliminated, instruct the applicant to direct the downspout of the gutter to landscaped area or into an infiltration trench. Install several gutters to distribute the flow. Note that roof drains may be eliminated in residential and some commercial areas only, and should not be eliminated in industrial areas.

- ✓ **Use alternate paving materials/porous/permeable materials, where appropriate** - Instruct applicant to use alternate paving materials (pavers), landscaping, mulch, gravel and cobbles where appropriate to provide ground cover, and reduce the use of asphalt or other impervious pavement. As noted earlier, pavers are recommended for driveways, walkways, and patios in single-family residences where the site does not generate highly polluted runoff (that could contaminate groundwater if it were to infiltrate) and where ADA requirements do not have to be met. In non-residential areas, pavers are recommended for emergency access roads, overflow parking areas, and non-handicapped parking stalls. These are not recommended where heavy loads (e.g. truck movement) are anticipated. *For more information on alternate paving materials, see Post-Construction Controls for New Development Fact Sheets available from BASMAA.*

Sources of Additional Information

For additional information on post-construction controls for new development and redevelopment projects, see the following:

Bay Area Stormwater Management Agencies Association. 1996. Start at the Source. Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection.

City of Olympia. 1994. Impervious Surface Reduction Study. Conducted by the Public Works Department. Water Resources Program. November. (for information on reducing impervious surfaces such as street widths, sidewalks, and parking facilities).

Wilson, A. 1994. "Stormwater Management, Environmentally Sound Approaches", published in the Environmental Building News, Vol. 3, No. 5, September/October. (for a general discussion of new development controls).

City of San Rafael. 1991. Hillside Residential Design Guidelines Manual. Prepared by Gast Hilmer Associates. (for more information on designing and building residential developments in hilly areas).

Bay Area Stormwater Management Agencies Association (BASMAA). 1997. Compilation of New Development Stormwater Treatment Controls in the San Francisco Bay Area. June. (For treatment controls)

California State Stormwater Quality Task Force. 1993. California Stormwater Best Management Practice Handbook - Municipal. March. (For treatment controls)

US Environmental Protection Agency. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Issued Under Authority of Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990. EPA 840-B-92-002. January.

Center for Watershed Protection, Watershed Protection Techniques, A Quarterly Bulletin on Urban Watershed Restoration and Protection Tools.

Center for Watershed Protection. 1996. Design of Stormwater Filtering Systems, prepared for Chesapeake Research Consortium, December.

Center for Watershed Protection. 1995. Site Planning for Urban Stream Protection, prepared by T. Schueler for Metropolitan Washington Council of Governments. (For information on cluster development, stream protection buffers, street reduction controls)