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STORMWATER TREAMENT OPTIONS

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FUNDAMENTALS AND EVALUATION OF EMERGING STORMWATER TREATMENT TECHNOLOGIES

The California Regional Water Quality Control Board, San Diego Region has provided regulatory programs for storm water discharges since 1991. The programs include regulation of industrial and construction sites utilizing statewide general permits, and regulation of municipal separate storm sewer system (MS4) discharges using regional permits adopted for countywide copermittees. Three such permits are currently in place for portions of San Diego, Riverside and Orange Counties that are within the jurisdiction of the San Diego Regional Board. MS4 permits are adopted for a 5-year period and require the copermittees to implement a comprehensive management plan to monitor and control pollutants that enter or are discharged from their MS4. The goal of the storm water program is to protect beneficial uses of receiving waters by controlling pollutants that are discharged from MS4s. Each copermittee must carefully select, implement and evaluate the effectiveness of stormwater treatment technologies to comply with the MS4 permit.

Receiving water quality objectives are determined by the beneficial uses that are designated for the receiving waters. Pollutants that can adversely impact water quality must be identified and reduced using an iterative application of best management practices (BMP), which include treatment technologies. Each copermittee must develop and implement a strategy to attain compliance with their MS4 permit by addressing both ends of the MS4: Efforts to abate pollutants at the upper portion of the MS4 must be measured with the success of attaining water quality objectives in the receiving waters at the lower end of the MS4. The MS4 is the means by which the pollutants are collected, conveyed and discharged, however, compliance with the permit must ultimately be established by attainment of the water quality objectives and the sustained protection of all beneficial uses of the receiving waters.

The challenge for each copermittee is to find a cost effective way to reduce the pollutants before they can reach receiving waters. The assimilation of pollutants or the treatment of wastewater to remove pollutants is not a beneficial use of waters of the state. Therefore, all treatment for pollutant reduction must occur upstream of the point of discharge. In many situations, improvement of the assimilative capacity can be accomplished by restoration, rehabilitation or expansion of wetland functions in receiving waters, however, BMPs intended to meet permit requirements for pollutant removal or treatment within the receiving waters are not allowed. Therefore, the strategy to reduce pollutants must focus on the source, the collection, the conveyance or the diversion of pollutants in the MS4 waste stream.

Pollutant Source Reduction

It may be possible to eliminate pollutants that are discharged to an area subject to runoff conditions entirely by taking an action that stops the discharge. The best possible outcome for pollutant reduction is to abate the pollutants at the source. This will prevent the need for treatment of the runoff to remove the pollutant. Pollutant reduction BMP technology must be coordinated with education and monitoring to ensure that all persons that live, work and recreate within the area impacting each MS4 know how to abate their pollutant sources. This strategy requires much emphasis on human behavior to motivate people to modify their actions that would

otherwise cause or contribute to pollutant discharges. Activities such as car washing, landscaping maintenance, automobile usage, pet waste removal, swimming pool maintenance, using power washing equipment, trash and solid waste management, hazardous chemical and waste handling and even smoking cigarettes can all have significant impacts as sources of pollutants. Enforcing a BMP that prohibits such activities is difficult and many elected officials are reluctant to take such steps. The decision to implement a pollutant source reduction BMP must be weighed with the alternative of allowing the pollutant discharge to continue and possibly remove or treat it downstream. This may be acceptable for bacteria sources but not acceptable for toxic pesticide sources. If a pollutant is known to cause or contribute to impairment of the receiving waters and it is difficult to remove downstream, it may be the best option to prevent its discharge at the source. Many pollutant discharges are so ubiquitous and difficult to prevent that they cannot be effectively reduced at the source, however they can be kept from entering the MS4.

Pollutant Treatment or Removal Upstream of the MS4

For pollutants that cannot be eliminated prior to their discharge to an area subject to runoff conditions, the next option is to remove them from the surface of the runoff area using BMPs such as sweeping, vacuuming, washing or otherwise cleaning up the pollutants. Well-disciplined house keeping or aggressive cleaning prior to rain events can be a very effective means of removing pollutants that would otherwise enter the MS4 system. Significant improvements in vacuum type street sweeping equipment in recent years can facilitate very effective removal of particulate pollutants from paved areas. Many municipalities target specific areas such as parks, schools, beaches and creeks for regular cleanup by civic and volunteer groups. Cities can provide services for pet waste collection and removal, non-discharging pavement cleaning and improved litter control. One of the most effective strategies to prevent pollutants from entering a MS4 inlet structure is to eliminate all non-storm water flows that can transport the pollutants. This may be a viable option in the San Diego Region due to infrequent rains and the need to conserve water.

Pollutants that are destined to enter the MS4 can be intercepted at the point of entry by filtration or other means. Many pollutants migrate into the MS4 without a rain event by the urban dynamics of traffic, urban runoff, wind and intentional discharges of waste into the storm drain inlet. These discharges can be prevented by filter sacks or by use of filtration technology that separates pollutants from the flow of water. The pollutants can then be removed by cleaning the filter sack or by cleaning out the capture portion of the filtration device. One Orange County city installed filter sacks in most of their MS4 inlets in 2001 and discovered a great deal about the sources, characteristics and solutions to reduce many pollutants entering their MS4. They have since made significant progress in improving their receiving waters. A common technique today for most new development is to install a grassy swale, detention basin or pollution filtration device such as a filter cartridge in a vault, circulating separator device or a filter medium just upstream of the point of entry into the MS4. This approach is very effective to keep pollutants from entering the MS4 if they are well maintained and do not become overwhelmed during rainstorms. The San Diego Regional Board has great concern for the long-term effectiveness of these numerous new treatment devices and facilities and prefers that each be maintained by the copermittee rather than by a neighborhood organization. There is a distinct advantage to low impact development or the use of natural filtration features such as grassy swales because these methods may not require intensive maintenance.

Pollutant Treatment or Removal Within the MS4

Some pollutants will enter the MS4 and present another opportunity for capture, removal or treatment. However, will likely be multiple pollutants in the waste stream at this point and the dynamics of the flow through a typical MS4 is not conducive to capture, removal or treatment of pollutants. Capture of pollutants can be accomplished with weir dams, basins, sumps, nets, booms or bar screens and these methods usually work best in low flow conditions. Removal can be effective within the MS4 if there are features designed to facilitate the periodic removal of trash, debris and sediment between major runoff events. Typically, in debris basins or other locations where flow velocities are minimized, it is also feasible to remove such waste on a periodic basis. Treatment for pollutant removal within the MS4 is very difficult under normal circumstances unless the MS4 is designed to for this purpose.

Wastewater treatment is best accomplished in rectilinear ponds vs. linear flowing channels. A pond configuration can better control the appropriate depth, retention time, temperature and flow-through rate to optimize treatment processes. Since the design of most MS4s are intended to move wastewater with high velocity though narrow conduits, the MS4 configuration will not typically offer suitable treatment locations unless such treatment "ponds" are added later for this purpose. Since MS4 design also utilizes subsurface flow conduits or surface channels lined with concrete, it is very difficult to stimulate or support natural aquatic processes within the MS4 that can effectively reduce pollutants. The choice of using treatment to remove pollutants from a typical San Diego Regional MS4 will likely require the design and construction of new treatment facilities since most existing storm drains in the San Diego Region were intend to flow rapidly to the ocean. The City of Santa Monica has built such a facility that can clean and recycle millions of gallons of runoff every day. If there is no option to remove or reduce pollutants with treatment within the MS4 the last option prior to discharge to the receiving waters is to divert the flow to a treatment facility.

Pollutant Treatment or Removal by Diversion From the MS4

Within the San Diego Region there are currently about 100 sites that are designed and constructed to divert MS4 waste waters with known high levels of bacteria pollution from the MS4 to the sanitary sewer system. In some locations the entire flow of a creek or stream is diverted into the sanitary sewer system or into the treated effluent flow from a sewage treatment pant to an ocean outfall. In at least 2 locations, the diverted creek is completely treated and returned to the creek bed free of pollution. During high flow events from rainfall, these diversion facilities are bypassed allowing the entire flow to enter receiving waters via the MS4 or creek.

The low-flow diversion strategy is utilized with great success in Southern California coastal MS4 locations that discharge to popular swimming beaches. The primary objective is to protect the beneficial use of body-contact water recreation at the beaches and in some inland streams. The diversion consists of either a complete diversion to the nearest sanitary sewer system or a diversion to an on-site treatment facility that can remove the pollutants in the flow and return the treated effluent to a streambed or MS4. In either case, there in not an additional permit requirement for the diversion or discharge to the streambed since the Regional Board has considered such a discharge to be a BMP required by the MS4 permit. There have been isolated occurrences of sewage spills due to overflows caused by excessive inflow from MS4 diversion structures, however most diversion sites have performed as expected with few problems.

There may be potential future use of area wide diversion for urban runoff to protect some receiving waters such as Areas of Special Biological Significance (ASBS) or drinking water sources such as inland reservoirs. Sweetwater Reservoir in the San Diego Region utilizes an "urban runoff diversion system" or URDS to prevent urban runoff pollutants from flowing into the reservoir. This system effectively diverts all the collected runoff to a point below the reservoir dam. The diversion of urban runoff may also be used to protect two ASBS sites in the San Diego Region. Failing iterative efforts to abate, remove, treat or divert the pollution in their MS4, the copermittee is destined to deal with the consequences of impacts to the receiving waters and possible enforcement actions, third party lawsuits or the imposition of a Total Maximum Daily Limit (TMDL) requirement.

Summary Comments

The ultimate successful treatment technology for pollutant reduction should be both affordable and effective to protect water quality and beneficial uses. It must be based on accurate information about the pollutants entering the MS4 and the water quality standards and beneficial uses. The ease in identifying and reducing a plentiful pollutant that has little impact in the receiving waters must be balanced with the urgency to reduce another that can cause far greater damage to the environment even in small quantities. In some locations pollutant reduction may be required by implementing a Total Maximum Daily Limit (TMDL). Reducing pollutants at their source by challenging human behavioral norms that cause them may be viewed as much more difficult than treating or removing the pollutants far downstream. The strategy that is used to abate a pollutant at the source can probably be phased out in time, but a strategy that treats the pollutants by removal from the wastewater flow is perpetual. Pollutant abatement is an iterative process that can be constantly adapted and improved through the use of well planned monitoring and analysis of the MS4 operations. Pollution treatment and removal infrastructure must be properly operated and maintained if it is to perform its function. Urban runoff bacteria pollutants can be diverted to the sanitary sewer system in some cases to protect swimming areas.