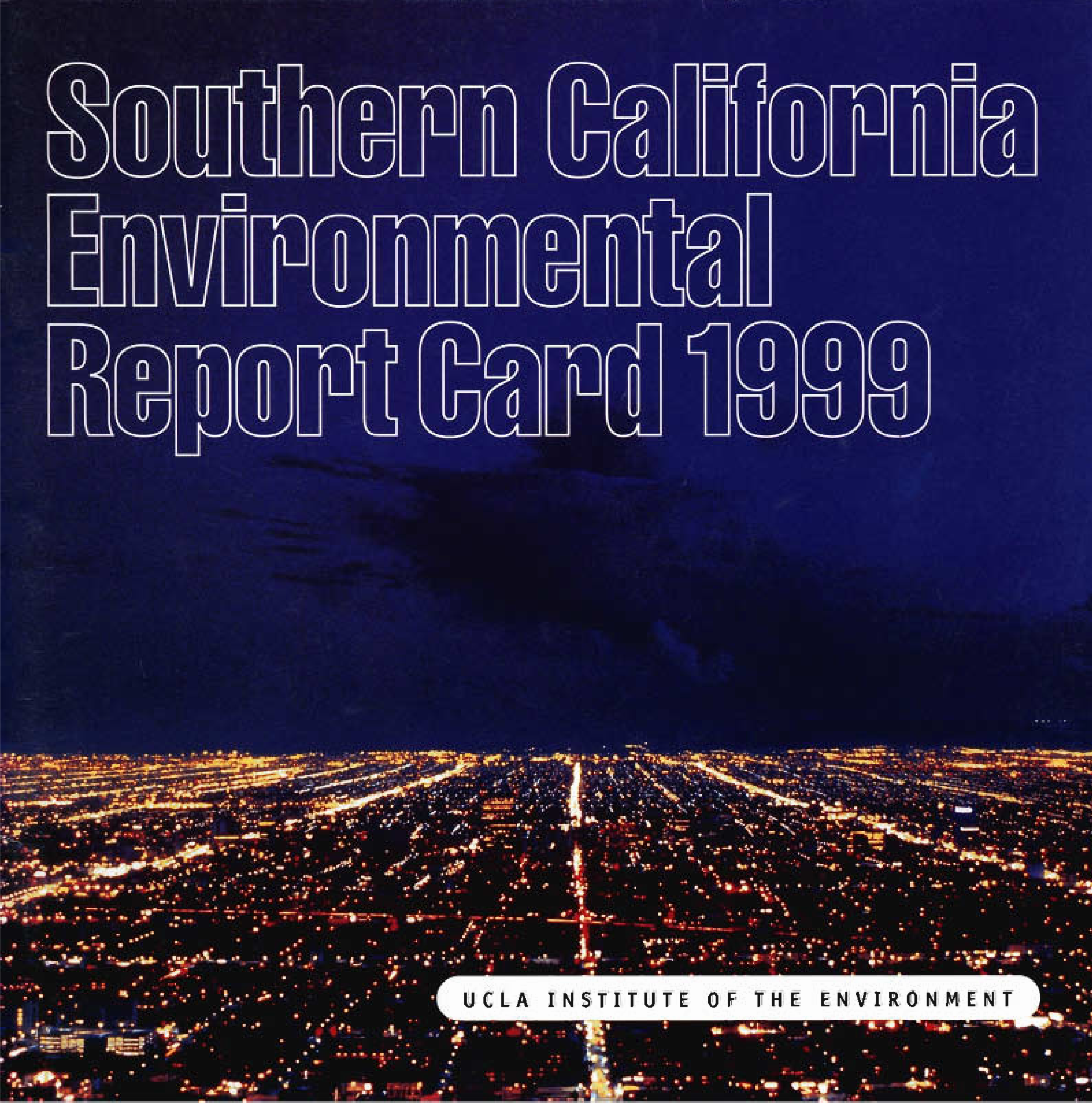
Southern California Environmental Report Card 1999



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GRADE B

Stormwater Impact

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Coastal waters are one of our most important natural resources. Coastal water quality is the natural resource that gives Southern California one of its greatest reputations—beaches. California's development has affected our coastal environment in many ways. Partially treated wastewater discharges have impacted coastal waters by releasing tons of pollutants, such as DDT (a well known, now banned pesticide), suspended solids and many others. The previous Report Card (RC 1998) described wastewater treatment, our successes and failures, and the plans to reach full secondary treatment, which the City of Los Angeles achieved in December, 1998.

But wastewater treatment is only part of the story. Much more contaminated water reaches our beaches and coastal waters through stormwater discharges, or nonpoint sources. This water, usually called stormwater, crosses a variety of land uses, such as yards, roof tops, parking lots and freeways, before it reaches the ocean. Stormwater was previously thought to be clean and not a pollutant. We now know that stormwater, especially from highly developed urban areas, such as parking lots and highways, contains many pollutants that create problems on the beaches and in our coastal waters.

In the Los Angeles area, we average about 15 inches per year of rainfall, which occurs primarily between November and April. Therefore, we have long periods when no rain falls, allowing trash and pollutants to accumulate on land surfaces and in the storm drain system. The first large storm of the season washes a disproportionate amount of trash to the ocean. You may have seen pictures of "trash plumes" extending from major storm drains, such as Ballona Creek, well into the ocean. The first rain of the season, and the first portion of any rainfall, is called a "seasonal first flush" or "first flush." The first flush is always the most contaminated stormwater. Recent work by UCLA investigators, which was also described in RC 1998, has shown that the bulk of the pollutants entering Santa Monica Bay are from stormwaters, as opposed to treated wastewaters. Future efforts to improve the water quality in Santa Monica Bay, and by implication, most other coastal waters in California, must focus on improving stormwater quality. Unfortunately, stormwaters are more difficult to control than wastewaters. They are more dispersed, with a greater number of public agencies responsible for their regulation. It is not yet clear who "owns" stormwater and is responsible for its cleanup.

WHERE STORMWATER COMES FROM

Stormwater flow and quality are a function of many different factors in addition to the amount of rainfall. Hydrologists use a procedure called the "rational method" to estimate the amount and rate of stormwater flow. Historically, the rational method was used to estimate flows in order to design drainage systems to prevent floods. Flood prevention is an important activity of our public agencies, which has generally been performed well. The rational method assumes that the amount of stormwater that flows from a specific area is the product of the rainfall, surface area and a runoff coefficient. The runoff coefficient is related to the imperviousness of the land. Open areas, such as undeveloped land, have low runoff coefficients, indicating that most of the water percolates into the soil, replenishing groundwater sources. Paved areas have the highest runoff coefficient; virtually all the rainfall becomes stormwater.

Highly impervious areas are associated with urban development and failed ecosystems. When imperviousness (percentage of impermeable surface area) exceeds 20 to 30%, the ecology is affected and sometimes destroyed. The increased stormwater volume

Picture 1: Ballona Creek during dry weather. This picture shows Ballona Creek at the Fairfax Street Crossing. The small flow visible at the bottom is dry weather flow.

and flow rate cause streams to undercut their banks, creating erosion problems and destroying habitat for wildlife. Flow rate in streams draining urbanized areas can change from a small trickle to raging torrents in only a few minutes. Erosion problems require flood control agencies to stabilize stream banks, which turns streams and creeks into the concrete channels we see in movies.

Two areas in the Santa Monica Bay Watershed, which UCLA researchers have been studying with U.S. EPA sponsorship are illustrative. The Ballona Creek watershed, draining the west portion of Los Angeles, is highly developed and more than 60% of rainfall becomes stormwater. It is not surprising that Ballona Creek is a concrete channel with water depth that changes from just a few inches before a storm to as much as 20 feet during a large storm (Picture 1). The concrete channel is needed for flood control, but has destroyed the ecology of the creek. Notice the water level in the second picture (Picture 2) of Ballona Creek. Furthermore, the flowing stormwater cuts through downstream wetlands and natural habitats, and deposits silt where there should be none. In contrast, the Malibu Creek watershed is much less developed and only 30% of the rainfall becomes stormwater. Much of this runoff results from the hilly topography, as opposed to its imperviousness, which is less than 30%. Malibu Creek, while affected from urban development, still retains much of its ecology.

The water quality from the two areas is also different. Stormwater from urban areas transports pollutants associated with land uses. Lawns and gardens release nutrients and pesticides, while streets release hydrocarbons, oil and grease and heavy metals associated with motor vehicles. Ballona Creek stormwater is elevated in many pollutants, such as heavy metals (zinc, lead, copper, and nickel). Malibu Creek stormwater, by comparison, is much cleaner. Recent work by the Southern California Coast Water Research Project (SCCWRP), in partial collaboration with UCLA and USC, suggests stormwater from Ballona Creek is toxic to certain aquatic life forms. Heavy metals are the most suspect pollutants. Stormwater from Malibu Creek does not appear to be toxic.

Another problem with storm drains is dry weather flow. Most observers find it strange that storm drains usually have a small flow, even in the driest portion of the year. These small flows result from natural drainage and "nuisance" flows. The flow from excessive irrigation of lawns, leakage, car washing, hosing down of streets and sidewalks, and other small sources, is nuisance flow. There are also permitted discharges into storm drains from cooling towers and, unfortunately, illegal discharges. These flows all add up and become the unsightly trickle across beaches in summer weather. These dry weather flows represent special problems and require innovative solutions.

Picture 2: Ballona Creek during a large storm. This picture shows Ballona Creek at the same location during a large storm. Reference the water level in this picture to the level in the previous picture using the white pipe that crosses the creek. The violence of this storm is evident, and the noise from the flow was so loud that conversation between two people standing at the bridge was not possible. Urban development causes these high flows, which requires the concrete channels to protect property.

WHERE STORMWATER GOES

Stormwater makes its way from the street in front of your house or your roof drains directly to the ocean through a series of pipes, channels, creeks and rivers, which increase in size until they reach the ocean. There are no treatment plants between the stormwater generation point and the ocean. The time of travel in a major storm may be short (generally around five hours from downtown Los Angeles to Santa Monica Bay, via Ballona Creek) or lengthy in dry weather (more than 25 hours during dry weather flow). During the summer, mounds of plants and algae may grow in the concrete channels. Pollutants are often deposited in the stormdrains during low flow. All of this material is flushed out all at once during a large storm. This makes the problems worse, because the beaches are "slugged," and the large slug of pollutants is generally worse than evenly distributed pollutant discharge.

In the Los Angeles area, stormwater flow to Santa Monica Bay is primarily through two large drains, Ballona Creek and Malibu Creek. There are approximately 30 other storm drains that can affect Bay beaches. The Los Angeles River is another major drain, and discharges south of Santa Monica Bay.

The stormwater that reaches the ocean requires time and distance to mix with the saltwater. This occurs because the temperature and density of the stormwater are different from sea water. Observe that the dry weather spill (Picture 3) does not quickly mix with the sea, but meanders in a plume. Eventually, the plume will become fully mixed, but until this occurs, anything in the plume will be exposed to stormwater pollutants, almost without dilution. During wet weather, the volume of stormwater flow at very large drains such as Ballona Creek, is such that the salinity of the ocean near shore can be temporarily reduced.

BEACH CLOSURES

Beach closures are another symptom of stormwater problems. We are routinely told to avoid swimming near storm drains, and not to swim at all after storms (Picture 4). A recent study, partially sponsored and conducted by Heal-the-Bay, suggested that swimmers near storm drains were at greater risk than swimmers far from storm drains. The rapidly flowing stormwater scrubs bacteria and other pollutants from the land to create elevated concentrations on the beaches, and especially near stormdrains. Also, the greatest stress on sanitary sewers occurs during storms. The high water table causes infiltration, which is

Picture 3: Stormdrain showing a spill. This picture shows a spill from a small stormdrain that terminates at the surf. The brown color of the storm water reveals how it flows in a plume and is not immediately diluted. Our public health authorities have posted beaches, telling bathers not to swim close to stormdrains, for good reasons.

leakage of stormwater into sewers. The stormwater may overload the sanitary sewer and cause it to overflow at a downstream location. The overflow is a mixture of stormwater and sewage and contains bacteria and other pollutants, that can cause a serious health risk when it reaches the beach. Stormwater may in rare cases cause erosion problems, which may destroy a sewer or water line, creating a massive spill. The dry weather flow can also create high bacteria concentrations, especially if there is a sewer leak.

Our public agencies are required to monitor coastal water quality to detect leaks as well as assess the impact of stormwater. They use indicator organisms to determine water quality. Indicator organisms are non-harmful organisms that are associated with disease-producing or pathogenic organisms. Indicator organisms are more abundant and easier to measure than pathogens (pathogens are disease-producing organisms). We believe that monitoring indicator organisms is a more reliable way of assessing the safety of beaches than measuring the actual pathogens. Pathogens are more difficult to detect and less abundant, which means routine monitoring may not detect them.

Coliforms are the classic group of indicator organisms and are routinely measured by agencies that monitor beaches as well as those that operate water and wastewater treatment plants. When coliform concentration increases to a specific threshold, a beach is posted or closed. There are different types of coliform tests and new types of indicator organisms are being evaluated. Progress is also being made to more reliably and inexpensively detect pathogens. Rules for beach closures are evolving, and the limits and required responses by regulators vary across California.

A careful examination of beach closure data for the California's coastal counties reveals no significant upward or downward trend in beach closures. There is a definite trend that shows years with greater rainfall result in more closures, but this is expected. On average, less than 4% of "beach miles" are closed. A beach mile is a linear mile of shore line and is an attempt to standardize reporting. Obviously the closure of a single but very large beach is more significant than the closure of a small beach. At first, 4% of the beach miles being closed sounds like a large amount; however, one must realize that beaches adjacent to large stormdrains are always closed. San Diego County has the greatest number of closures but also has the greatest number of beaches. Does this suggest that beaches are getting better or worse?

In spite of the lack of quantitative data, beach water quality is improving. We are monitoring much more frequently than previously. We should expect to find more problems just because of more extensive monitoring. We also know that several long-term problems have been solved. The City of Los Angeles' efforts to upgrade the Hyperion Treatment Plant and replace aging sewers are resulting in far fewer sewage leaks. Other agencies are also making progress. It is now much more likely that a sewer leak will be quickly detected and fixed than 10 years ago.

Efforts are underway at the State Water Resources Control Board to create a statewide database of beach closures and postings. This is partially in response to a new law, AB 411, which requires greater monitoring and posting of beaches when indicator organisms exceed certain thresholds. Additional indicator organism types will also be monitored. The initial results of this law may be counterintuitive. Far more problems will be reported than before, and the stringent requirements will create more beach closures and postings. This will create a perception that beach water quality is worse, when it is actually the same or

Picture 4: Beaches are posted or closed when the indicator organism count exceeds a specific threshold. Beaches that are adjacent to a stormdrain are permanently posted. The public is also urged not to swim immediately after a storm.

improving. The additional monitoring over the next five to ten years will create a much better understanding of beach water quality.

WHAT WE CAN DO ABOUT IT

Stormwater is not as easy to control as wastewater. We cannot simply require an agency to provide treatment. The episodic nature of stormwater precludes the use of treatment plants. One large rainfall, lasting perhaps a few hours, creates more stormwater flow to Santa Monica Bay than our new Hyperion treatment plant can treat in a month. Conventional treatment systems are not appropriate. Instead, we are developing alternative approaches, called Best Management Practices or BMPs. BMPs can be structural, such as stormwater detention basins, or non-structural, such as encouraging the public to practice pollution prevention.

Stormwater pollution prevention must be a joint effort between individuals and public agencies. We also need to rethink some of our building practices. The following section suggests some BMPs for Southern California.

Education: We need to educate the public so they understand that stormdrains are a "large slick pipe" to the ocean. A discarded cup or can will most likely end up on one of our beaches. At present there is no treatment system for stormdrains. Our public agencies have recently instituted stormdrain stenciling to inform the public not to discard trash or pollutants into stormdrains. Litter is infuriating. It is ironic that the same public that wants clean beaches also creates a large part of the problem. Caltrans reports that 20% of the material removed from freeway storm drain inlets is cigarette butts.

Porous Pavement: It is not always necessary to pave areas with 100% impervious material. In other locales, especially in Europe, porous pavements are used. Porous pavement results in more infiltration and less stormwater flow. A variety of forms exist. In some cases, porous pavement can be as simple as using loosely-arranged bricks or concrete blocks. Porous pavements are not applicable to all sites, such as well-traveled freeways. We need demonstration projects to show better the potential applications of this technology.

One large rainfall, perhaps a few hours, creates as much stormwater flow to Santa Monica Bay as our new Hyperion treatment plant treats in a month.

Biomass Injection: If you inspect a parking lot with green space (open space with vegetation), you will probably notice that stormwater is directed towards a drain and not to the green space. Infiltration can occur in the green space and, more importantly, the green space can actually provide treatment for some of the pollutants. Parking lot C at LAX is an example of a site where we should practice biomass injection. The stormwater can be directed to the green space where much of it can percolate into the soil. Excess can flow to a storm drain inlet that is in the middle of the green space. New construction techniques and building codes are required, but they should be no more expensive than existing approaches.

Wetlands, Ponds and Detention Basins: We have little opportunity in our inner city areas to construct wetlands and detention ponds. A wetland is a marsh or swamp (see RC 1998 for more information) in the drain system or coastal area. The natural processes in the wetland can treat many pollutants. Ponds and detention basins are used to capture a portion of the storm flow, especially the first flush. Pollutants can settle out and the stormwater can be gradually released, which avoids scouring pollutants and slugging of the beaches cited previously. These methods are land intensive; however, in developing areas, we can set aside a portion of each new development to provide for stormwater abatement. This is a more common practice on the East Coast.

Trash Screens and Racks: Recent approaches to screening stormwater to remove trash and debris are being evaluated in several places in Southern California. These new technologies may be able to remove trash and gross solids without excessive maintenance or flood control risks. The solutions are not cheap, but will probably provide a viable alternative for trash control. Figure 1 (p. 19, top) shows how these screens work.

Low Flow Diversion: It is possible to pump the dry weather flow from stormdrains to sanitary sewers. This BMP was suggested by the Pico-Kenter Stormdrain task force in the early 1980s. In dry weather, the small flow in the stormdrain is pumped to a sanitary sewer. It flows to the treatment plant and is eventually discharged through ocean outfalls. New treatment plants such as Hyperion have the capacity to handle these flows; furthermore,

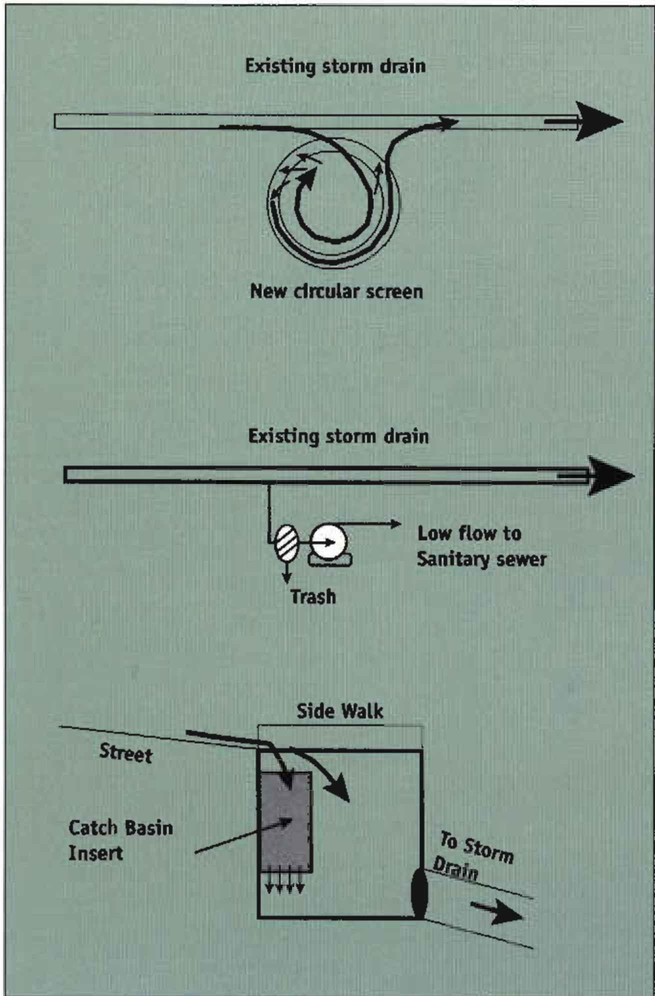

Figure 1

This figure shows three alternative Best Management Practices for stormwater. All have been investigated or proposed by researchers at UCLA.

The top of this figure shows a new type of screen being installed at several places with Proposition A funding. The screen is constructed next to an existing storm drain, represented by the two horizontal lines. A small diversion (weir) is placed in the storm drain to direct a fraction of the flow through the screen. The specially designed screen resists clogging and capture trash, debris and large solids. The captured material must be removed periodically and disposed to a landfill or other appropriate place. These devices are designed to treat the first flush and the smaller storms. Very large storms will bypass the screen.

The middle diagram shows a diversion for low flow. This low flow trickles across our beaches to reach the ocean. By installing a diversion, the low flow can be pumped to a sanitary sewer, then to a treatment plant, such as the Hyperion Plant, where it is treated and discharged several miles away from the cost.

The bottom figure shows a catch basin insert. Normally stormwater flows across the street to an opening in the curb, and from there into a small storm drain that eventually flows to a large drain such as Ballona Creek. Solids, trash and debris collect in the basin. One goal is to clean the basins before the wet season, which prevents the dry weather accumulation (trash, debris, road dust and particles) from reaching the ocean. During wet weather, small storms wash material into the catch basin which accumulates until it is flushed out in a large storm. The insert shown in the figure is a method of trapping the accumulated material so that it is retained in the basin. More advanced inserts have sorbents that will remove a large portion of the suspended solids and oil and grease. The inserts must also be periodically cleaned and replaced.

For over 90 years Civil Engineers have been separating stormwater from the sanitary sewer. Now we are telling them to put the low-flow stormwater back into the sewer.

dry weather flows occur when there is no infiltration (ground water that seeps into sanitary sewers), which reduces load on the treatment plant. The City and County of Los Angeles are planning several such diversions, and ten are in some state of planning or completion at present. Figure 1 (p. 19, middle) shows a diversion.

Street Sweeping and Catch Basin Cleaning: Street sweeping prevents trash and gross pollutants from entering stormdrains. Better sweeping methods to increase the recovery of small particles are being developed. Catch basins (the opening on the street where stormwater enters the stormdrain) can be more aggressively cleaned and maintained. Recent research conducted at UCLA and partially sponsored by a consortium of cities, lead by the City of Santa Monica, has demonstrated that catch basin inserts can retain pollutants and avoid flooding problems. Figure 1 (p. 19, bottom) shows an insert.

Product Replacement and Pollution Prevention: We now know that certain products are more polluting than others. Automobile brake pads are an example. Some brake pads have high metal content, which becomes a stormwater pollutant as the pads wear. Work is underway to provide brake pads with less metal content. There are numerous other examples. Many industries and businesses can practice pollution prevention. Simple measures, such as providing covered storage for product inventory, can significantly reduce stormwater pollution. The public needs to understand and practice pollution prevention techniques. Vehicle inspection programs to reduce smog also reduce stormwater pollution.

WHAT HAVE WE DONE?

How well are we doing? Unlike last year's report on wastewater treatment, the answer is not so clear. Stormwater management is a much more difficult problem than wastewater management. The reasons are both technical and institutional. Although stormwater management was required by the 1972 Amendments to the Clean Water Act, we are still struggling to create a regulatory framework. Successful stormwater management must be practiced by individuals as well as agencies.

The Santa Monica Bay Restoration Project has funded several significant studies to better understand stormwater and mitigate its impacts. This research is continuing, but there is still a long way to go. At least we can now estimate the mass of pollutants from stormwater and treated wastewater; five years ago we could not even do this.

Proposition A is funding a number of construction projects to demonstrate stormwater management approaches. These include screens and trash racks, catch basin inserts, low flow diversions and other management strategies. The successful projects will become models for long-term, full-scale projects and long term changes.

Monitoring programs are improving. The Los Angeles County Department of Public Works is creating a monitoring program, which should eventually be able to measure stormwater runoff from the entire County. Increased beach monitoring will also assist in isolating problems and encouraging solutions.

The rededication to wastewater treatment has resulted in new treatment plants and new sewers. We now have the capacity for low flow diversion in the City of Los Angeles' Hyperion Plant. Preventing sewage spills should have the highest priority. The technology exists to greatly reduce sewage spills.

The past record is not all good. In some instances our public agencies acted only after being sued by environmental advocacy

We previously thought stormwater was clean. Now we know that stormwater transports more pollutants to Santa Monica Bay than the treated wastewaters.

groups. Caltrans, which initially resisted efforts to clean freeway stormdrains, now has an aggressive program to develop solutions preventing freeway stormwater pollution. The U.S. EPA and the Regional Water Quality Control Board are now dedicated to developing a total management daily load (TMDL) for litter from stormwater. Other TMDLs will also be developed.

SUMMARY AND THE GRADE

Large challenges still exist. We lag behind many East Coast and Pacific Northwest communities in preventing stormwater pollution. We are better than many rapidly growing cities, particularly in Asia, where stormwater pollution is sometimes out of control. Unfortunately many of the challenges are not technical, but institutional, and therefore usually more difficult to address. We need to change building codes to improve stormwater management. In many cases, this will result in less development, and we must require developers to set aside land and resources for stormwater management. Agencies responsible for flood control must now understand that pollution control is an equal part of their mission. They must be proactive in developing alternatives that reduce stormwater pollution while providing flood protection. We must reconsider the assumption that the public is not willing to pay for environmental protection. There is ample evidence, especially in the Southern California region, that the public is willing to pay for protection, provided they understand the reasons and are assured the measures are economically and fairly applied. Our regulatory agencies do not have the staff to fully implement the required programs. Clearly, all individuals must practice stormwater pollution prevention in their everyday actions; the blunt truth is that one of our largest problems, litter, could be solved at no cost if people just behaved differently.

Our compromise grade is B. We have not protected the environment sufficiently to earn a B, but the problems are so challenging that we collectively deserve a B for our efforts.

Michael K. Stenstrom has been a professor in the Civil and Environmental Engineering Department for 22 years. During this time he has performed research and teaching in the areas of water and wastewater treatment. He is particularly interested in oxygen transfer, degradation of specific organic compounds and applications of control systems to biological processes. In the past several years he has worked on stormwater management. In this area he has developed a mass emissions model of stormwater-transported pollutants to Santa Monica Bay, and evaluated several best management practices for minimizing stormwater pollution.

Professor Stenstrom received his Ph.D. from Clemson University in 1976 and worked two years in industry before joining UCLA in 1977. He currently serves as chair of the Civil and Environmental Engineering Department. He has written more than 150 scientific publications and received more than $10 million in grants and contracts. He also serves as a consultant to municipalities and industries that wish to improve their treatment systems.