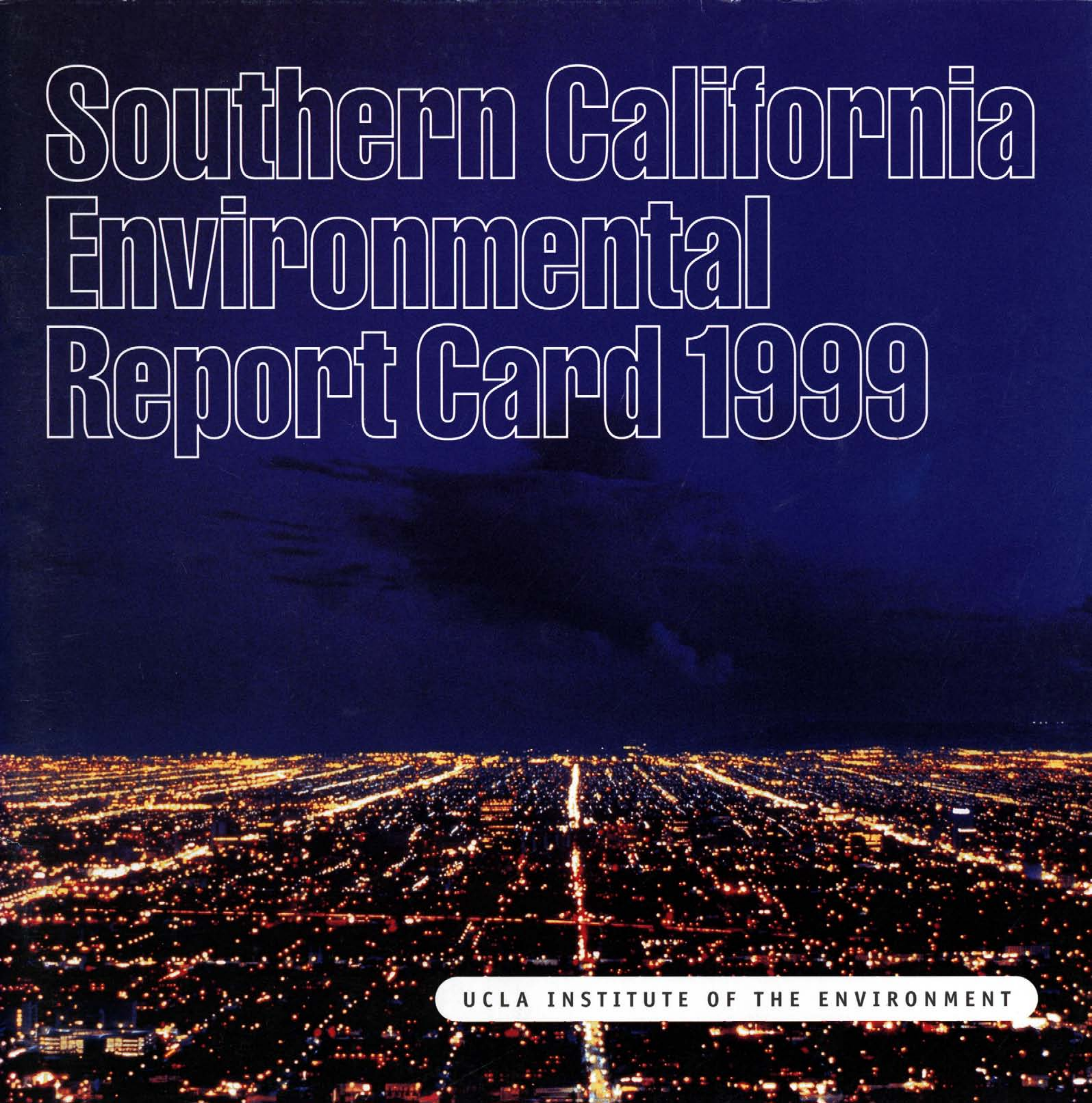
Southern California Environmental Report Card 1999



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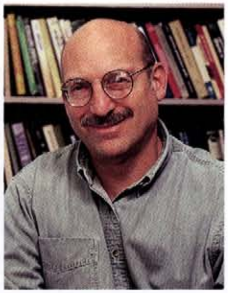
From the Editors

The Southern California Environmental Report Card is produced once a year by UCLA faculty under the sponsorship of the UCLA Institute of the Environment. Each issue contains several articles addressing critical environmental concerns facing the fourteen million people in the Southern California region. The goal of every article is to provide an introduction and background to the science and policy, describe the current situation, and then evaluate in a balanced manner relevant performance of the public and private sectors, and the general public, in meeting the challenges of that particular environmental concern.

The environmental issues addressed in each Report Card will rotate over time. While the dominant environmental problems of the region dictate that various aspects of air and water quality will be ongoing themes, other important environmental topics will also be addressed. For example, in the first Report Card published last year (RC 1998), one of the articles discussed the state of wetlands in Southern California. In this year's Report Card (RC 1999), one article considers the impact and control of wildfires. Another assesses the state of environmental education in primary and secondary schools.

While faculty who write for the Report Card are all experts in their fields, they represent a wide range of academic disciplines, including social science, natural science, law, public health, engineering, urban planning, public policy, and others. Since environmental issues do not come neatly packaged by the usual academic disciplines, it is appropriate that the Report Card present a multidisciplinary perspective. But all of the authors share a common desire to draw on the best scholarship possible in order to help inform local and regional policy discussions.

The environmental problems facing Southern California are complex, and rarely are there simple solutions on which all stakeholders can agree. Therefore, each Report Card in the future as well as the present one will include reactions from knowledgeable commentators on the content of the articles from previous years. Our aim is to foster informed dialog from different points of view. In that spirit, we welcome constructive responses, whether in agreement or contradictory, from any readers who wish to share their views. All of us in Southern California have a stake in working together to find cost-effective and socially acceptable solutions to our major environmental problems.



Richard Berk, Ph.D.
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Editors, IoE Report Card

Letter from the Director

This is our second annual Southern California Environmental Report Card (RC 1999). It follows last year's Report Card (RC 1998) which was a great success, judging from the many positive responses we received from decision-makers, faculty, students and the public. Some of the responses we received from agencies are given in a final section (see RC 1998 Revisited) including an account of an important success story concerning wastewater treatment. In this year's Report Card we discuss Wildland Fire, Stormwater Impact, Groundwater Quality, and Environmental Education. All of these affect our local environment and have national implications as well. The grades range from "B" to "F."

Our objective in this and future Report Cards is to focus attention on environmental issues that affect the quality of our lives. We hope to issue a "call to action" when there are problems, as well as recognize decision-makers and the public when credit is due. In this edition of the Report Card, we have a mixed record of successes and failures. We also suggest actions that can be taken to further improve the environment.

As discussed in more detail by our Editors, we hope each Report Card is an accurate, unbiased and understandable account of environmental issues. We believe individuals, agencies and advocacy groups will find the report useful. Each section of the Report Card represents the assessment of an expert in the respective field, and has also been reviewed by senior faculty and others who have broad and penetrating knowledge. Still, we do not expect everyone will agree with all points of these articles. We welcome your responses and comments.

It has been a busy year for the UCLA Institute of the Environment (IoE). Within the Institute, we are practicing an increasingly more popular method of performing research. The complex problems we face are institutional as well as technical. Their solution requires more than a single discipline. Our approach is to integrate research among many disciplines. The Institute represents more than 50 professionals with knowledge spanning environmental fields from 20 different disciplines.

An example of this way of performing research is the Santa Monica Bay Watershed Project "Integrated Urban Watershed Analysis: The Los Angeles Basin and Coastal Environment," an NSF/EPA-sponsored grant. In this project, we are developing a more comprehensive understanding of Santa Monica Bay. Our scientific teams are studying pollutant inputs from all sources, including atmospheric, stormwater, point sources and the ocean itself. We are also studying the transformation and fate of the contaminants within the Bay. Meteorology, both short and long term, is important for this understanding. We recently held a one-day symposium at UCLA with invited guests from agencies responsible for managing activities that affect the Bay. Next year, we will have a second symposium to present our final findings. These results will lead to a greater understanding and new management tools to better protect Santa Monica Bay.

We look forward to your comments and hope you find this year's Report Card useful.

Michael K. Stenstrom, Ph.D., P.E.
Director 1998-1999
Institute of the Environment

GRADE Previous Efforts: D Recent Efforts: B

Wildland Fire

by Philip W. Rundel, Ph.D.

Professor, Department of Organismic Biology, Ecology and Evolution

Fire is an inevitable and periodic disturbance in the southern California landscape. The seasonally dry Mediterranean climate, coupled with the presence of flammable chaparral communities in the urbanized wildlands of the mountain areas of Southern California, make wildfire one of the most serious economic and life-threatening natural disasters faced by the region. The long summer drought in our Mediterranean climate results in a pronounced fire season that extends from summer into fall and even into January in unusually dry years. Why does chaparral burn so intensively? These woody shrubs dry considerably during the summer months, and small twigs and dead grasses provide flammable kindling to help a fire ignite. Volatile oils produced by several common species increase the ease of igniting a fire.

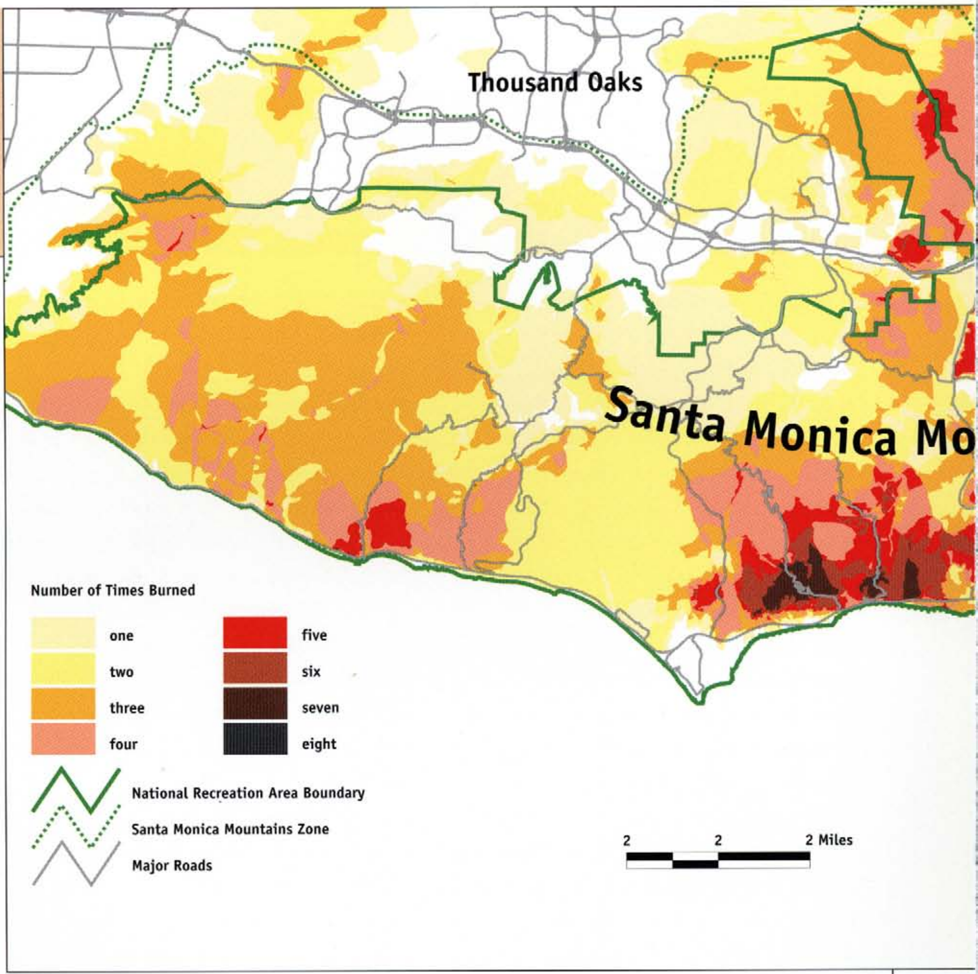
While the cause of chaparral fires was once rare lighting strikes in late summer, most fires today have a human origin through ignitions or regrettable deliberate actions. Human ignitions of fire are far from a random event, and instead occur with predictable high frequencies along specific road corridors. In the Santa Monica Mountains, for example, this means that fires commonly begin along either the Ventura Freeway or the urbanized corridor of Mulholland Drive at the northern margin of the range.

The danger of wildland fire spread from many such sites is magnified greatly in the fall and early winter when strong and dry Santa Ana winds from the inland desert blow into Southern California. As these winds funnel through canyons in the transverse and coastal ranges of Southern California, wind speeds increase dramatically. Such winds, coupled with relative humidities that may be as low as 2%, can push firestorms through our foothill regions with alarming speeds and intensities.

Fire, however, is a natural process in our mountains and existed long before human populations arrived. Furthermore, fires perform important ecosystem functions necessary for the healthy maintenance of chaparral and woodland communities. This concept of fire as a natural component of our region is clearly indicated by the remarkable adaptations that exist in our chaparral communities to thrive under fire conditions. Fire, for example, is necessary for the reproduction of many chaparral plant species, and these species exhibit a variety of adaptations for re-establishment after fire, through resprouting from their woody root crowns and germinating new individuals from seeds stored for many years in the soil.

Annuals and short-lived woody species, whose seeds may have lain dormant in the soil for 50-100 years or more, become established in the first spring after a fire and help to stabilize soils against erosion and hold nutrients that might otherwise be lost. The diversity of chaparral species is highest in the first year after fire, and declines as the dominant chaparral shrubs become re-established.

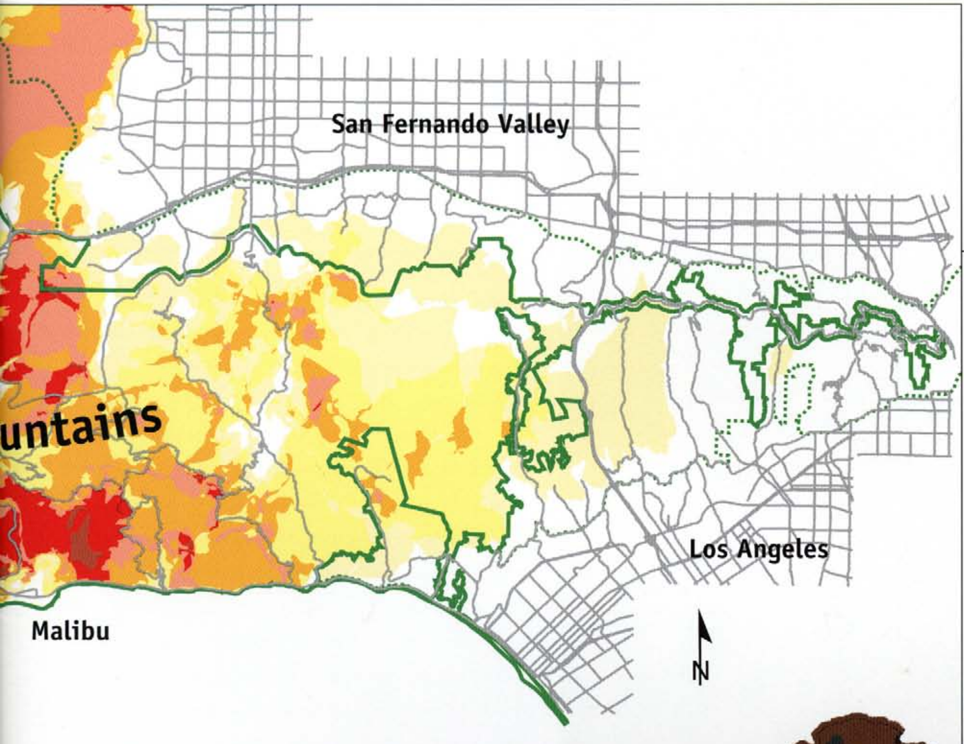
Fire history of the Santa Monica Mountains, showing the number of wildfires that occurred for the range between 1925 and 1997. Note that the Central Malibu coast has received 6-8 fires over this period compared to much lower frequencies to the west and east.



Surprisingly, most animals in chaparral habitats also survive fire very well. Small animals such as snakes, pocket gophers and mice can survive nicely in underground burrows, while larger animals such as deer, coyotes, and bobcats will flee in front of an advancing fire. It is only the intermediate size animals such as small rabbits and woodrats with their stick nests that suffer from fires because they are too large to go underground but not sufficiently agile to flee.

The question of what is a "normal" fire frequency in chaparral and coastal sage scrub has been the subject of considerable debate. Typical estimates range from 30 to 50 years between fires, but in reality we have little knowledge of what such frequencies were prior to this century. Human activities have obviously affected natural fire frequencies. Fire was widely used by Native Americans in Southern California as a tool for maintaining wildlife habitat and for encouraging certain utilitarian plant species. From colonial Spanish times to the current century, fire was frequently used by European and Mexican settlers to clear shrublands for farming and cattle ranching.

In recent decades, heightened human activity and arson have increased the fire frequency in some areas, particularly regions close to development and roads. Conversely, current policies of fire suppression that date back 75 years or more have reduced fire frequency in other areas. The irony of fire suppression is that it may have increased the likelihood of catastrophic fires by allowing large masses of flammable plant materials to accumulate with time. This process is reinforced when chaparral canopies suffer an extensive dieback of living tissues, as occurred, for example, during the long drought period from 1987-1993. Fire suppression has occurred at the same time there has been an increased penetration of urban development into chaparral vegetation, and thus increased danger to structures and human lives from wildfires.



FIRE HISTORY 1925 – 1997
Number of Fires Since 1925
Santa Monica Mountains National Recreation Area

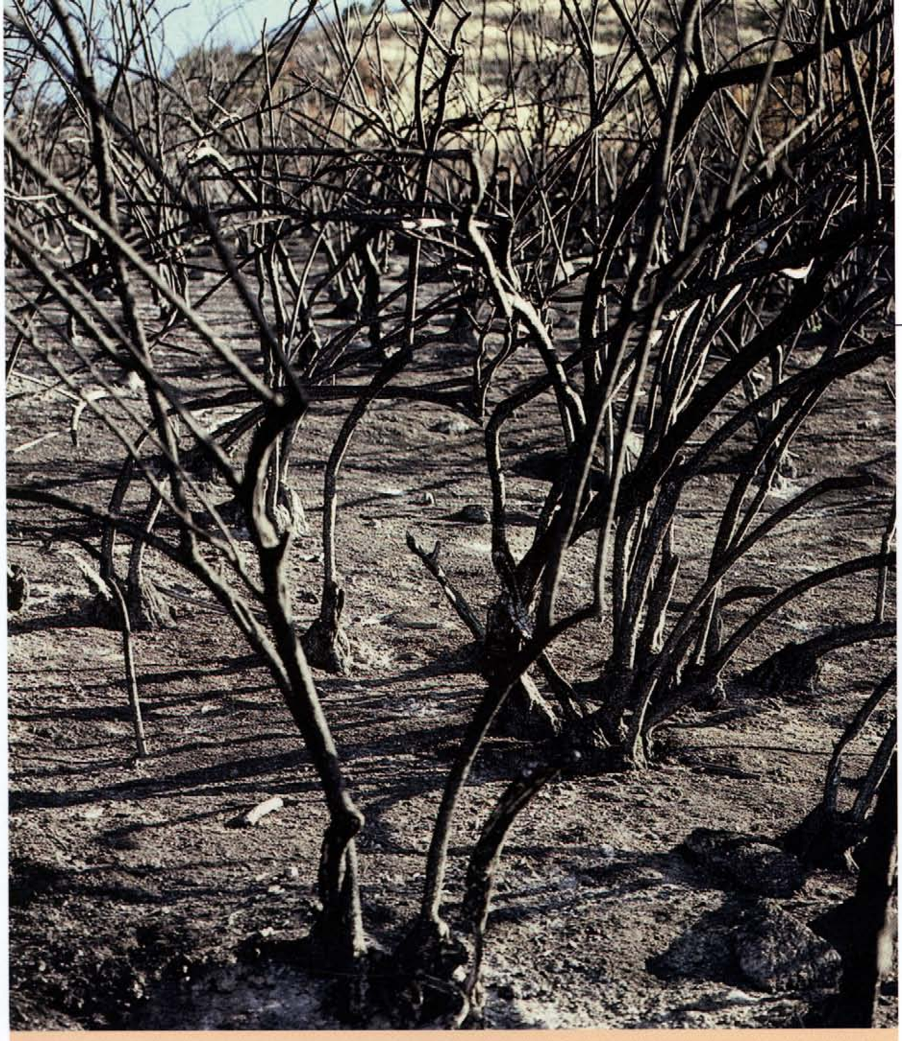
The question of what is a "normal" fire frequency in chaparral and coastal sage scrub has been the subject of considerable debate.

FIRE AT THE URBAN/WILDLAND BORDER

The Southern California wildfires of 1993 and 1996 illustrate the dimensions of this problem from a human and urban perspective. Within a two-week period during the Fall of 1993, large parts of the foothill areas of Southern California erupted into flames. Within the Santa Monica Mountains, the Green Meadows and the Old Topanga fires of 1993 raced a linear distance of 25 km within a few hours, consuming a combined area of more than 50,000 acres before stopping at the Pacific Ocean. More than 21 major fires over these two weeks burned through 200,000 acres of chaparral and oak woodland, destroying more than 1,000 homes. Financial losses in the greater Los Angeles area during this period were estimated to be over $1 billion dollars, exceeding the property damage associated with the 1992 Los Angeles civil unrest. Four people died and 162 individuals suffered significant injuries. Added to this cost is subsequent damage from mudslides when heavy rains eroded bare hillsides.

Overall, more than 15,000 fire fighters from every county of California, and all of the western states joined to fight these fires, arguably making this the greatest mobilization of fire fighters in the history of the world. These events were repeated in the fall of 1996, when another fire erupted in the city of Calabasas and followed a similar pattern, burning uncontrollably across the Santa Monica Mountains until it reached the Pacific Ocean. This time, however, a rapid mobilization of fire fighters, a lower population density of homes, and improved levels of clearance around homes built with less flammable materials all combined to greatly reduce the level of property damage.

Throughout much of the Southern California region, the buildup of fuels in remaining unburned areas make it inevitable that large areas will burn in the future. Large fires, driven by Santa Ana winds, will burn through vegetation of any age and are



Following chaparral fires, the living vegetation cover is totally burned, leaving only dead shrub skeletons and an ash layer. Most of these shrubs will quickly resprout, however, from underground buds.

Ongoing studies of fire behavior and ecology are providing important insights into the environmental role fire plays in chaparral and woodland ecosystems of Southern California.

exceedingly difficult to control. Without effective management policies and appropriate control on the nature of development, the loss of structures and human life will be an unavoidable consequence of intensive urban and suburban development in zones of flammable vegetation. The continued pressure to expand the urban fringe, and the continued difficulty of managing remaining chaparral fragments within the complex mosaic of land ownership in this area, ensure that fire will continue to be an important policy concern for the human and natural environments of our region.

The combined influence of increasing building regulations (e.g. less flammable building materials, shielding of overhanging decks, wider driveway access, water availability) and the encouragement of brush clearance and low flammability landscaping have done much to reduce danger to individual homes in the foothill areas. Newer homes built under such requirements are significantly less likely to burn than are older homes with flammable roofs and narrow driveways that restrict fire department access.

FIRE BEHAVIOR

Ongoing studies of fire behavior and ecology are providing important insights into the environmental role fire plays in chaparral and woodland ecosystems of Southern California. We know, for example, from 75 years of records that the central coastal areas of Malibu in the Santa Monica Mountains are subjected to far higher frequencies of fire than areas to the west and east. Such knowledge of past fire behaviors and extent are of great value in helping to develop mobiliza-

Fire management in the Santa Monica Mountains and the Los Angeles Basin has developed as a cooperative effort involving many government agencies.

The interfingering of urban development and wildlands in Southern California puts homes at potential risk from chaparral fires.

tion plans to fight future fires in the most effective manner. At the same time, these studies are raising many new questions.

If natural fires were largely ignited in the past from late-summer lightning strikes in August and September, these fires would typically have occurred before the onset of Santa Ana winds. The majority of such fires would be expected to have been low in intensity and relatively small in size. Such fires would produce natural mosaics of chaparral stands of differing ages. Central and northern California are shielded from Santa Ana winds by the Sierra Nevada and as a result have fewer large fires. However, if the seasons of natural fires in Southern California extended into the fall and were influenced by Santa Ana winds, then large catastrophic firestorms may be more typical of our landscapes. We lack the knowledge of fire histories before this century to adequately resolve this question.

FIRE MANAGEMENT POLICIES

Fire management in the Santa Monica Mountains and the Los Angeles Basin has developed as a cooperative effort involving many government agencies. These include the Los Angeles City and County Fire Departments, California Division of Forestry, Ventura County Fire Department, National Park Service, USDA Forest Service, and California Division of Parks and Recreation. The active fire management policies of these agencies have been focused on goals of reintroducing fire as a natural ecosystem process to the degree possible, consistent with the safety of human lives and property, and reducing the amounts of hazardous chaparral fuels present through the use of prescribed burns under controlled conditions. While the cost of active fire management activities is substantial, it is far less in the long-term perspective than the consequent costs of property damage resulting from extreme wildfires. Much of the effort on fire management through prescribed fires is being focused on key areas where historical data suggests such program can be of significant help in reducing fire intensities in areas where fires commonly begin or where moving fires can be controlled.

Fire management policies have led to a number of controversial issues that have now largely been resolved. Early fears of liability issues for property damage associated with prescribed fires have now been surmounted by a California State program of indemnification for fire management agencies, which carry out prescribed burns under what are termed *Best Management Practices*. Without indemnification, such prescribed burns would not be allowed.

Prescribed burning presents an effective means of reducing fire hazards in key areas. This technique reduces the build-up of flammable fuels through controlled fires carried out under conditions when fire intensities remain low and controllable.

Another example of long-standing controversy resulted from a policy of active post-fire reseeding with rye grass or other grasses, the prevailing management practice for many years. This practice continued up until this decade, despite a high cost and scientific studies indicating that such seeding offered little or no positive value in erosion control and impaired the ability of the native shrub and herb cover to become reestablished.

Brush clearance regulations remain another issue of contention as increased awareness of fire hazards in the foothill areas has led to more stringent city and county regulations on brush clearance around houses at the urban/wildland boundary. The potential for reduced homeowner's insurance rates through the California Fair Plan program has provided a strong financial incentive to comply with these regulations. Nevertheless, policies on recommended brush clearance practices and distances vary among agencies. There has long been an issue of the impact of new home construction along the boundaries of existing parkland where clearance setbacks extend into these public lands. New regulations now allow the Fire Department to review site plans for homes in the Santa Monica Mountains and many other foothill areas to encourage 200-ft setbacks of new homes from parkland boundaries.

Still other issues remain. In particular, the potential impact of prescribed burning on air quality has led to unresolved problems in evaluating the benefits of chaparral fuel reduction against the consequences of increased particulates in the atmosphere from smoke. Additionally, we still lack an understanding of the natural frequencies and intensities of chaparral fires before the arrival of human populations in Southern

Fire management policies have led to a number of controversial issues that have now largely been resolved.

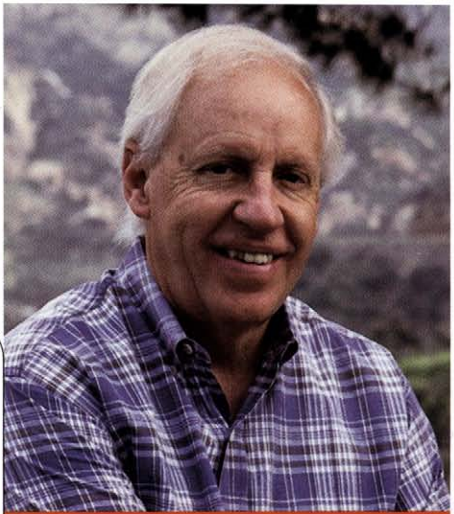
California. Scientific studies are now using the latest in electronic and remote-sensing technology to permit better predictions of the frequency, intensity and rate of spread of wildfires. However, more improvements are needed.

Prescribed chaparral burns create a management dilemma in that they reduce fire hazards but add smoke particulates which negatively impact air quality.

FIRE MANAGEMENT ASSESSMENT AND THE GRADE

The nature of fire management practices in the Los Angeles Basin and Santa Monica Mountains have shown significant improvement over the past decade. **Our previous efforts in wildland fire management deserve a "D".** A key to this progress has been the success of the Fire Alliance program that has brought together government agencies and private stakeholders (e.g. property owners and the insurance industry) to work cooperatively to develop the most appropriate policies for managing natural resources while protecting people and property from wildfires. This level of successful cooperation has been a model for other government/public programs.

In recent years, our overall program of wildland fire management has improved markedly, and now earns a rating of "B".



Philip Rundel is Professor of Biology in the Department of Organismic Biology, Ecology and Evolution at UCLA. He has been a faculty member in the University of California since completing his Ph.D. at Duke University in 1969. He has worked on a variety of studies of fire ecology and fire management in chaparral ecosystems and in mixed conifer forests in the Sierra Nevada. More broadly, his field of research investigates aspects of the adaptations of plants to environmental stress in Mediterranean-climate regions. He has actively worked with ecological studies of chaparral and related shrublands and woodlands in California, central Chile and the Cape Region of South Africa. Expanding beyond chaparral systems, he has also worked on a variety of programs related to the ecology and conservation biology of tropical regions around the world. This work has involved projects in Thailand and Indochina, Costa Rica, Brazil, Zimbabwe and the high Andean Altiplano region of Peru and northern Chile. In addition to his regular faculty duties, he is the manager of the UCLA Stunt Ranch Reserve, a field station for education and research in the Santa Monica Mountains.

GRADE B

Stormwater Impact

by Michael K. Stenstrom, Ph.D., P.E.

Professor and Chair, Department of Civil and Environmental Engineering

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.

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.

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.

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,

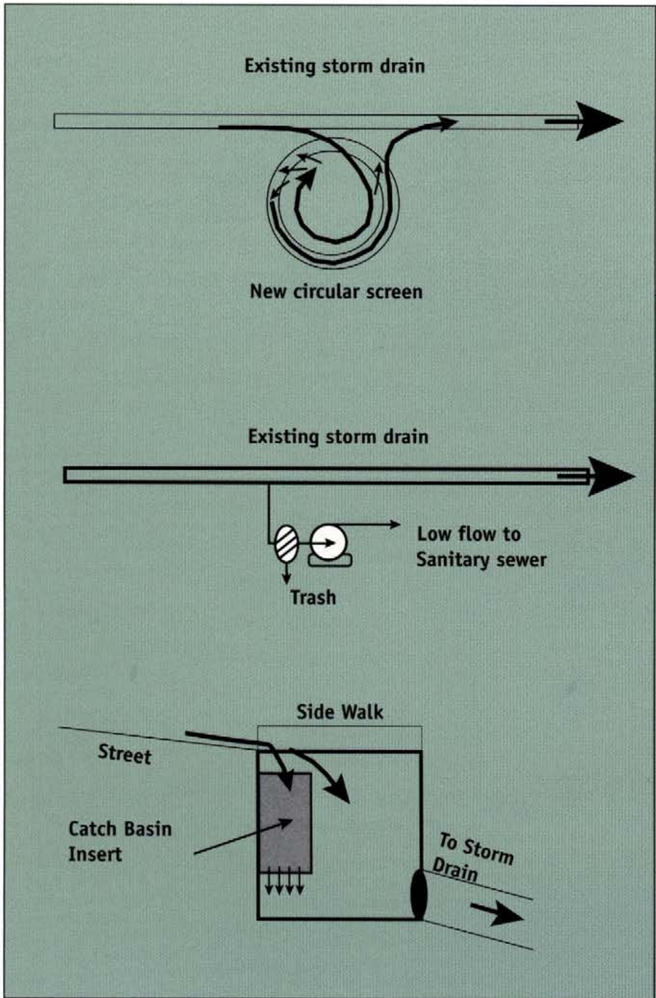


Figure 1

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.

GRADE Past History: F Recent History: C

Groundwater Quality

by Tom Harmon, Ph.D.

Professor, Department of Civil and Environmental Engineering

INTRODUCTION

Southern California depends on subterranean water, or groundwater, to supplement its water supply, yet this valuable resource is often overlooked by the general public as an environmental issue. In Southern California, groundwater problems tend to be overshadowed by the more readily observable problems of air or water pollution. This attitude toward groundwater is probably more a case of 'out of sight, out of mind' than one of outright neglect. Nonetheless, ignorance concerning this resource has garnered a woeful legacy of groundwater contamination that will require decades of effort and billions of dollars to mitigate. Thus, it is timely to consider the historical demise of our groundwater resources and what we want to do about these resources in the future.

As Southern California's population and economy grew during the latter half of this century, so did the scope of its groundwater quality problems. Many new and useful chemicals were produced, including 'chlorinated solvents', such as trichloroethene (TCE) and perchloroethene (PCE), degreasing agents used in vast quantities wherever mechanical or electronic components needed cleaning. With their use came leaking tanks, spilling buckets and hasty, poorly monitored disposal of spent solvents. Such behavior appears negligent in hindsight, but was, in most cases, simply the standard practice at the time. This is not surprising for it was a remarkable era of growth for Southern California, and there was little time for environmental foresight.

The purpose of this article is to promote an understanding of groundwater quality as a topic of environmental concern, and to define relevant technical and legislative issues associated with groundwater and its degradation as a resource. Perhaps the most important point to be made is that groundwater quality problems develop over a long time, and require an even longer time for clean up. We illustrate this point by way of a historical narrative about the San Fernando Valley groundwater basin. Finally, the discussion turns to the state of this resource in Southern California today, and its future outlook.

HYDROGEOLOGY 101

Hydrogeology is the study of water quantity and flows in the subsurface terrain (see Figure 1). Groundwater is a generic term for water that has accumulated in appreciable quantities in the pore space of unconsolidated or loose sediments, or in the fractures associated with bedrock. This subsurface reservoir serves as the dominant source of fresh water in the hydrologic cycle. Indeed, groundwater comprises about two-thirds of the fresh water supply on this planet. This water percolates into the ground, a process referred to as groundwater recharge, mainly during the rainy season. It can exit the subsurface through the roots of plants, the beds of rivers, lakes and streams, or water production wells.

Like water in rivers or in pipes, groundwater flows from zones of higher elevation or pressure to zones located downhill, or at lower pressure. Under special circumstances, groundwater pressure differences develop vertically, giving rise to the upwelling of natural springs. However, groundwater flow is typically horizontal and slow, its progress constantly impeded by the surrounding filter material (the soil). In fact, a groundwater velocity of 100 feet per year is considered normal. A slow flow rate means the residence time, or the average time spent by a parcel of water in a groundwater system, may be years, decades or even longer.

Contaminant hydrogeology is the study of the fate and transport of chemicals in groundwater. We have a reasonable understanding of how chemicals pollute groundwa-

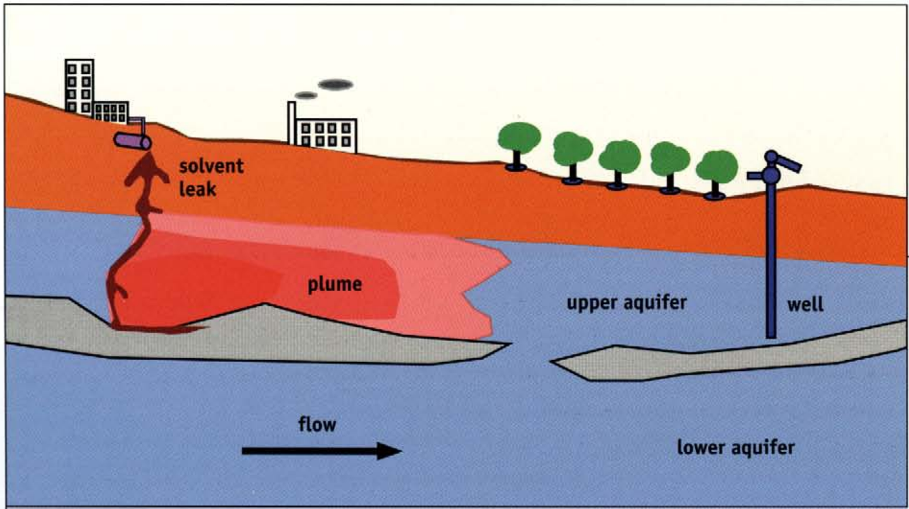


Figure 1: A schematic diagram of a subsurface environment where dissolving solvents are tainting the groundwater supply.

ter once they have been released into the subsurface. They first percolate through the soil until they reach the groundwater. There, they begin to dissolve very slowly into the passing flow, creating expansive plumes of tainted groundwater. The PCE plume shown in Figure 2 depicts this process in a carefully controlled laboratory setting. The slow bleeding characteristic of this chemical dissolution process is due mainly to the sparingly soluble nature of the chemical. PCE, for example, is soluble in the amount of about 150 milligrams per liter of water, or 150 parts PCE per billion parts water.

Regardless of its low solubility, PCE is legally regulated at an even lower level of just five parts PCE per billion parts water. This extremely low limit is due to adverse health effects thought to be associated with long-term exposure to this chemical. The definition of 'long-term exposure' gets fuzzy, but can be interpreted to mean regular drinking and bathing by a community will result in an increase in certain types of cancer and birth defects. Thus, even small spills of these chlorinated solvents can inflict enormous damage upon groundwater basins.

AN HISTORICAL PERSPECTIVE: THE SAN FERNANDO VALLEY

There are Southern Californians alive today who remember when Los Angeles was little more than a bustling town surrounded by picturesque rural scenery. As late as the 1960s, vast portions of the San Fernando Valley remained as part of that scenery. However, the post-war industrial boom and associated influx of population have drastically altered that picture of the Valley, and with it the underlying groundwater resources of the Valley.

To better understand the history of the San Fernando Valley with respect to groundwater, a brief mention of the underlying hydrogeology is in order. Figure 3 depicts a map of the San Fernando Valley floor nestled within the confines of the surrounding mountains. Large zones beneath the Valley floor are known as alluvial aquifers, water-bearing layers of sand and gravel deposited over thousands of years of erosion and deposition of the surrounding mountains. Regional groundwater generally follows the path of the Los Angeles River, flowing from west to east across the valley, then funneling south through the LA River Narrows. In the wider, western expanses of the basin, groundwater flow rates are as slow as 5 feet per year. At the Narrows, flow velocities on the order of 1300 feet per year have been estimated.

There are three key water-bearing zones in the basin which we can refer to as the recent or upper alluvium, the older or lower alluvium, and the Saugas formation, or deep zone. The upper alluvium extends from the

Even small spills of these chlorinated solvents can inflict enormous damage upon groundwater basins.

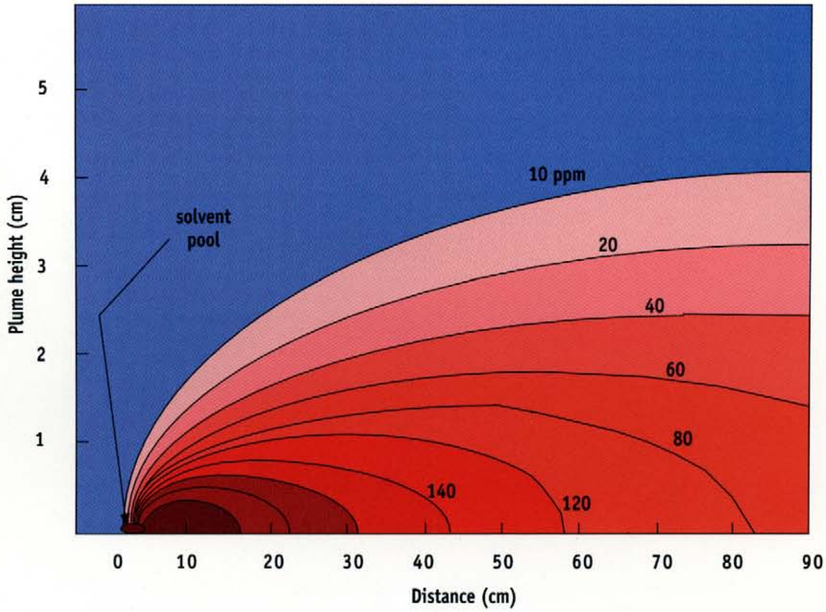


Figure 2: Contaminated groundwater pattern emanating from a dissolving solvent pool as observed by Dela Barre (1999)

ground surface to depths of roughly 200-250 feet. This zone is not fully saturated and the water levels there are quite sensitive to recharge and water usage. The lower alluvium extends to depths of 400-600 feet, and is separated from the upper zone by a layer of about 50 feet of finer sediments. This layer serves as barrier protecting the lower zone from water quality problems in the upper zone. However, the barrier is not failsafe because its thickness and the fineness of its sediments vary widely throughout the basin. Beneath the lower alluvium is the deep zone, which, due to its depths, has been the least-explored of the basin aquifers. It extends to at least 1,200 feet below the ground surface. Historically, groundwater extraction from the basin has been from the upper and lower alluvial zones.

The historical records for water levels in two San Fernando Valley production wells (Figure 4) provides an effective time-line for groundwater usage in that basin. Well 3700A is located in the southwest part of the basin, near Reseda, while Well 3914H is at the eastern end, near Glendale. For both wells, the record indicates consistently high water levels into the late 1940s followed by a steady decline. A severe drought during the late 1940s and early 1950s was responsible for the initial decline in water levels. However, drought alone cannot explain that the water levels for both wells continued to be depressed until the 1970s. Instead, these lower levels must be attributed to the increasing demands placed on groundwater in the basin over this period.

From the late 1970s forward, there was a rather rapid recovery in Well 3914H to pre-1940 levels, yet for the more westerly-situated Well 3700A, there was no such recovery. This difference is representative of the rapidly changing groundwater usage patterns in the San Fernando Basin during this period. Orchards had given way to the housing tracts needed for the growing army of factory workers of the post-war industrial boom. More significantly, this period of highly variable groundwater usage also serves to signal the beginning of historical groundwater quality problems in the San Fernando Basin.

In 1980, traces of industrial solvents, especially TCE and PCE, were detected in San Fernando Valley production wells. This discovery led to drastic reductions in

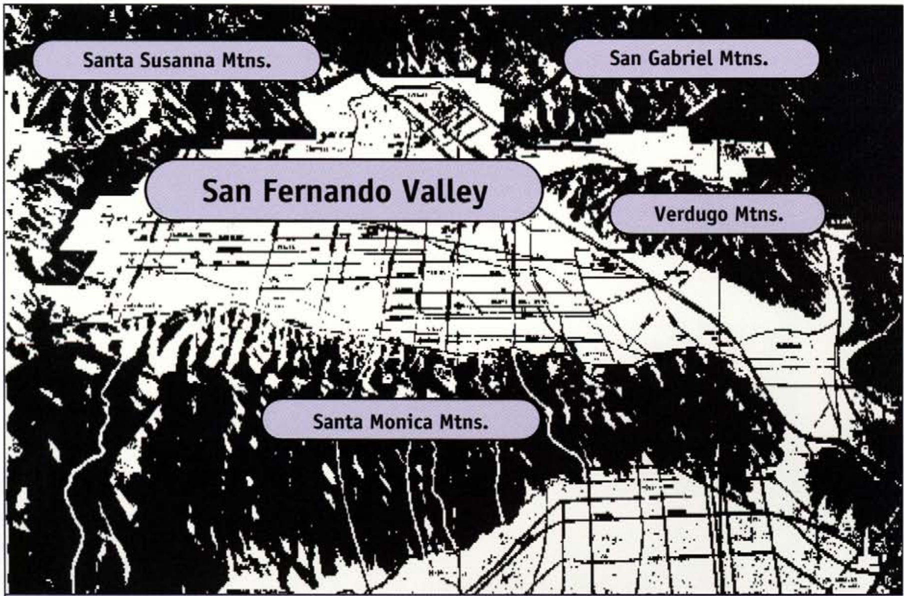


Figure 3: An overview of the San Fernando Valley and surrounding mountains.

groundwater extraction, particularly in the highly industrialized eastern end of the basin. As the 1980s progressed, it became apparent that the soils underlying many prominent factories of the Valley were affected by spills and leaks of these compounds and other toxic chemicals. Ironically, it may have been the reduced pumping of the late 1970s that first brought the groundwater in contact with many of these spills. In 1987, the U.S. Environmental Protection Agency (U.S. EPA) initiated a five-year remedial investigation of the groundwater contamination in the basin. The soils and groundwater underlying the streets and towns of the San Fernando Valley had become a gigantic Superfund site.

The plot in Figure 5 depicts the estimated extent of the upper aquifer TCE plume in the San Fernando Valley in the Spring of 1996. The creeping plume remains largely unchanged today. It is roughly 17 miles long and may contain more than 200 trillion gallons of contaminated groundwater. An interim strategy for extracting and cleaning groundwater at the front of the plume has been designed and will be implemented over the next 12 years while the responsibility and liability of various parties is assessed. However, the ultimate time-frame for cleanup is three decades or longer.

Unfortunately, the San Fernando Valley is not unique. The other major valleys, the San Bernardino and San Gabriel are also Superfund sites with problems very similar in size and scope to those associated with the San Fernando basin. Numerous landfills and military bases offer still other examples of Southern California's hazardous waste legacies in groundwater (see sidebar page 30).

OTHER CURRENT GROUNDWATER QUALITY ISSUES

Due to their ubiquitous usage and stability or staying power in the environment, chlorinated solvents such as those discussed above are the leading source of groundwater contamination in Southern California and the rest of the United States. However, there are many other groundwater contamination issues in our region, such as those associated with fuels, agricultural wastes, septic systems and sea water intrusion.

In the 1980s, it became clear most of the underground storage tanks at gas stations were leaking gasoline into groundwater. Of particular concern in gasoline leaks is benzene, a known carcinogen that is very mobile when released into the environment. As any Los Angeles motorist would suspect, repairing the tank systems and restoring the soil and groundwater around most corner gas sta-

The record for cleaning up contaminated groundwater in Southern California is not very strong.

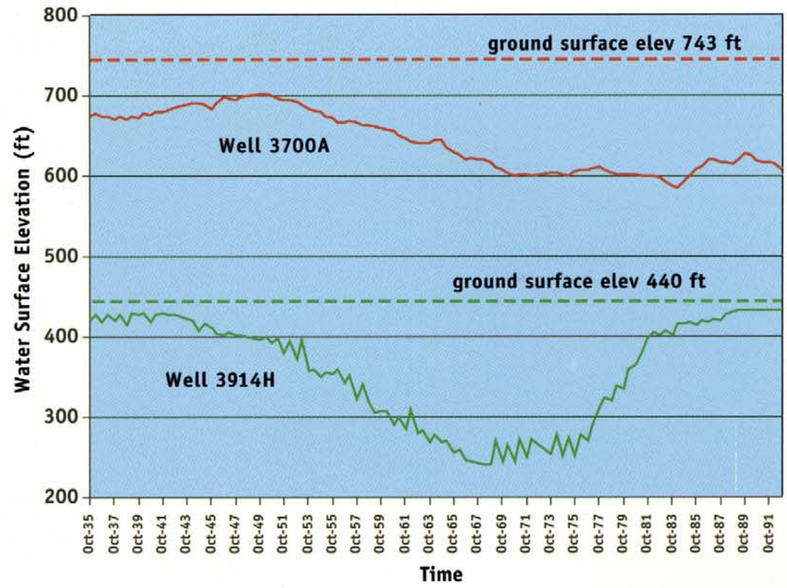


Figure 4: Historical depths to water for two San Fernando Valley drinking water wells (ULARA Watermaster Report, 1995)

tions in the region is an expensive proposition to say the least. Indeed, an estimated $2 billion dollars has been spent on this task in California throughout the early 1990s.

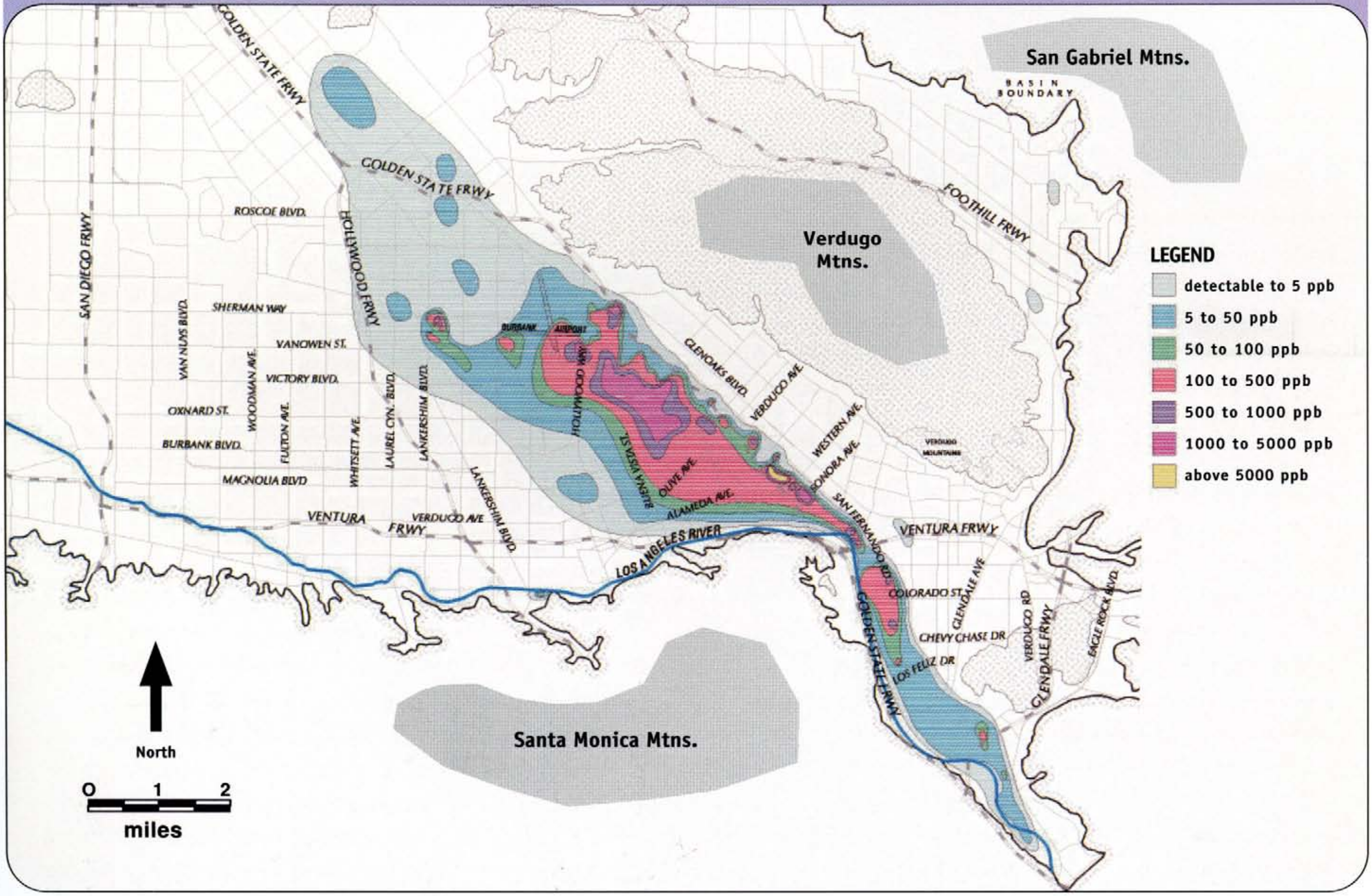
In the face of these costs, a movement toward more economically feasible strategies based on risk assessment was begun. A study regarding gasoline releases in the subsurface was commissioned by the state in 1995 and carried out by an advisory committee composed of scientists from several University of California campuses. The committee reported the human health risk associated with such gasoline releases was relatively small. They noted that plume reduction was generally already underway at such sites due to the biodegradability of gasoline components. Just as momentum was beginning to build behind the notion of worrying less about leaking underground gasoline tanks, a new problem arose in the form of cleaner burning gasoline mixtures.

Around the late 1980s, reformulated gasoline mixtures were introduced to help alleviate air quality problems associated with automobile emissions. A key ingredient in these mixtures was methyl tertiary-butyl ether (MTBE). Despite recent efforts to correct the problem of leaking underground storage tanks, MTBE has made its presence known in Southern California groundwater supplies, suggesting that even new tanks are leaking. In the city of Santa Monica, drinking water production wells in the Arcadia and Charnock well fields have been closed due to gross MTBE contamination. Based on its chemical properties and ubiquitous presence in California groundwater, MTBE is even more mobile than benzene, the previous gasoline component of interest. Based on a State-commissioned UC-wide study on MTBE in 1998, Governor Gray Davis proclaimed in March 1999, California will phase out MTBE over the next five years. Clearly, the full environmental impact of this chemical was not adequately assessed before it was introduced into our gasoline supplies.

HOW WELL ARE WE DOING?

Unfortunately, the record for cleaning up contaminated groundwater in Southern California is not very strong. There are many reasons for this poor progress. First, it can take years to gather sufficient information, through exploratory drilling and well sampling, to begin engineering proper cleanup strategies. Second, hazardous chemicals have had

Figure 5: Plume map showing the estimated extent of dissolved trichloroethylene (TCE) propagation in the San Fernando Valley's upper aquifer (adapted from U.S. EPA database)



Groundwater quality problems are often a case of out of sight, out of mind.

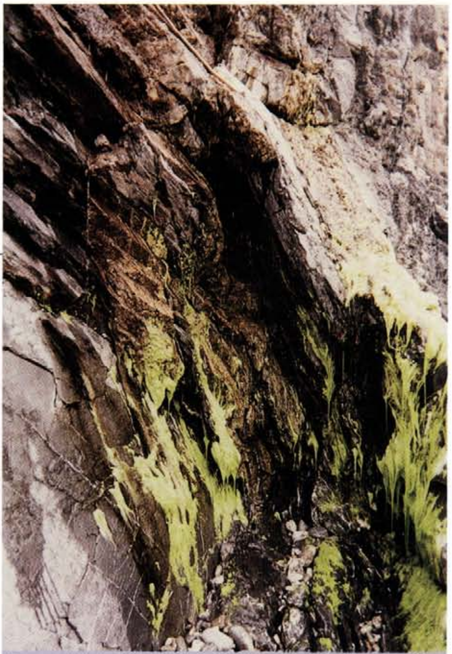
decades to spread out in the subsurface. Given that federally mandated cleanup goals for many of these chemicals (MCLs) are extremely low, cleanup of major groundwater quality problems, even under the best of circumstances, is a decades long proposition.

In addition to these technical reasons, cost issues are prominent in our failure to complete the cleanup of our groundwater resources. One unsavory problem is that many of the responsible parties view cleanup as a long-term and expensive penalty for what they consider to have been standard operating procedures of a bygone era. As a business they prefer to pay to contest their problems in court rather than expend resources on the cleanup. While litigation costs may be substantial, they are dwarfed by long-term cleanup measures. Furthermore, if a case is stalled long enough, there is always a chance a responsible party's problem will disappear, either by natural dilution processes or through changes in our laws.

On a more positive note, groundwater-related legislation appears to be doing a good job of at least controlling present waste disposal practices. Federal and state agencies, like the Environmental Protection Agency (U.S. EPA), Cal EPA and Regional Water Quality Control Boards are generally aware of most hazardous waste problems with groundwater repercussions. This is not to say there are no longer any active hazardous waste landfills; there are many. These agencies now operate a system of checkpoints to help minimize, supervise and track the waste. And, as the final defense before our taps, Southern California drinking water agencies are also aware of potential problems and regularly screen drinking water for hazardous contaminants. Most of these chemicals are easily removable once identified.

THE FUTURE

Despite this apparent progress, there is still substantial room for improvement in all of these areas. If the recently installed checkpoints discussed above prevent the occurrence of new hazardous waste sites, then they will have served a purpose. However, as we noted at the outset of this article, groundwater quality problems are often a case of 'out of sight, out of mind'. This is also true when it comes to budgets, where funding for local, state and federal agencies, as well as that for education and research, has a tendency to disappear in favor of more visible problems. As a society we need to lobby local, state and federal officials to keep groundwater restoration and preservation in mind when making decisions affecting land and water usage. Some difficult decisions about our groundwater resources will be made in the not-so-distant future. First and foremost, we will need to decide whether we want to pay to clean our aquifers to the levels currently dictated by the law. Those in favor of the cleanup might point out it is a dangerous precedent to begin relaxing environmental standards for any resources. The major impediment to this alternative is it will force us to share the cleanup costs, both as conscientious citizens and as consumers of the products causing the



A glimpse of groundwater seeping from exposed fractures in cliffs along the Southern California coast.

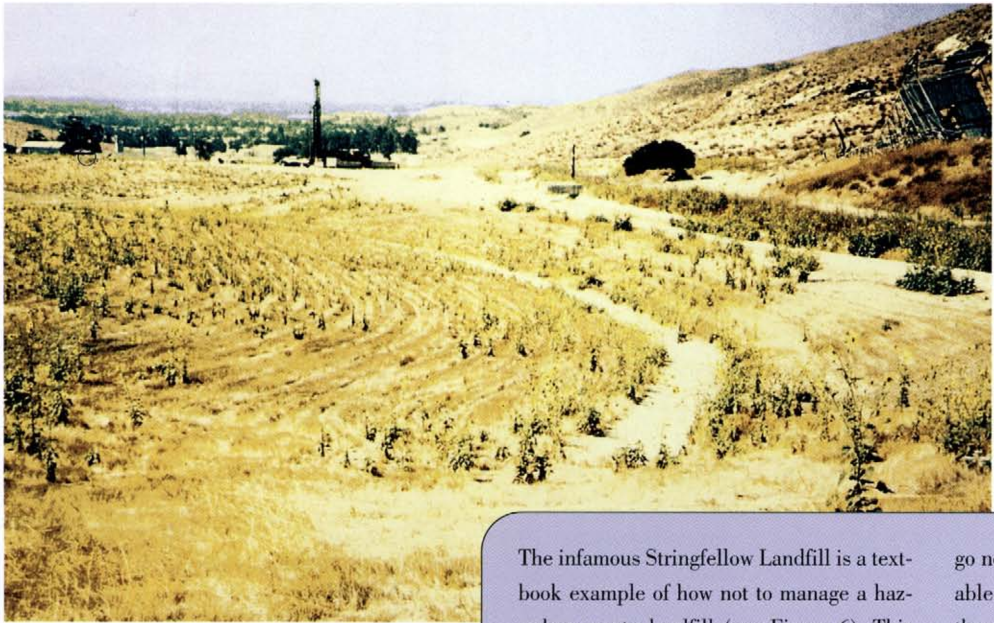
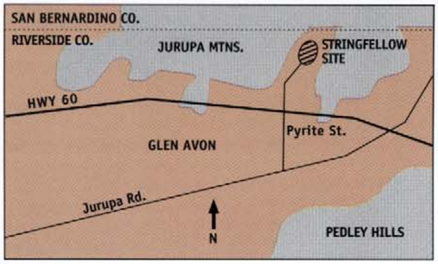
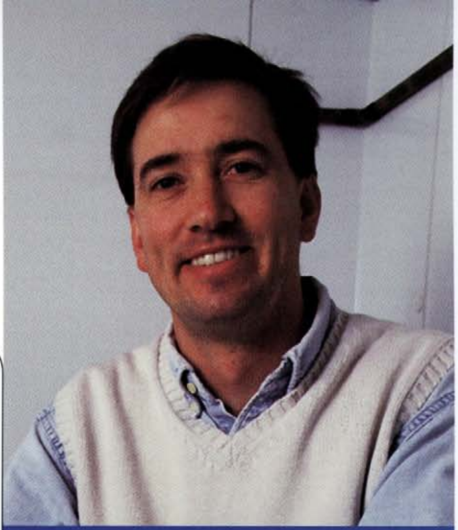


Figure 6: A recent view of the infamous Stringfellow Landfill site as it undergoes remediation.



The infamous Stringfellow Landfill is a textbook example of how not to manage a hazardous waste landfill (see Figure 6). This remote, horseshoe-shaped canyon was designated as a potential hazardous waste receptacle by the State of California on little more than a 'drive-by' inspection in 1954. Under extreme pressure from the booming post-war chemical industry, the State lost no time in permitting landowner and quarryman, J.B. Stringfellow Sr., to operate the landfill. With little or no authoritative supervision, the site received an estimated 32 million gallons of hazardous waste between 1956 and its closure in 1972. At its peak operation, waste was dumped into the site's so-called evaporation ponds 24 hours a day. It was believed at the time that the hot, dry conditions would disperse the chemicals into the atmosphere at a rate greater than they were being delivered. It was also believed that any waste that did infiltrate into the subsurface would go no further than the underlying impermeable bedrock. To compound the problem, the waste was often dumped without regard to segregation of incompatible chemicals. The record is rife with horror stories of these ponds catching fire or erupting with toxic clouds. And beneath the surface more enduring problems developed as chemicals seeped through the pond bottoms and underlying sediments into the groundwater below. In hindsight, the reason for this seepage is clear: the bedrock contained a network of fractures which served as efficient conduits for conveying the toxic waste. The photograph in Figure 6 shows the site as it stood in 1992, after nearly 10 years of subsurface investigation and remediation design. Groundwater extraction and treatment, at an on-site treatment plant continues today. It is estimated that nearly half a billion dollars will have been spent on the site before work there is completed.



It is a dangerous precedent to start relaxing environmental standards for any resource.

pollution. Those against cleanup might just as rightfully argue that any water marked for consumption is easily treated on an 'as-needed' basis. One impediment to this alternative is the negative public perception regarding drinking water that was formerly referred to as wastewater. If and when this impediment is overcome, we will again need to be prepared to share the cost. In this case, the cost will be associated with the more advanced water testing and treatment processes that such a policy will require.

GRADES

The grades on our protection and restoration of groundwater resources are presented on a historical basis:

Past History: F. The extent of the damage that was done from the 1940s through the 1970s was enormous. There were no watchdog agencies to protect the public interest. The only positive note is that, in most cases, we really did not know what we were doing. We can liken this grade to the one you would expect to receive when you find that you have been going to the wrong classroom for three weeks. Then, when you finally arrive at the right classroom, it's the day for the midterm exam.

Recent History: C. Despite the fact we now have the agencies and technology to address many of our groundwater problems, we remain satisfied with keeping the problems from getting worse. In part, this attitude has been brought about by the nature of subsurface problems, which are difficult and expensive both to characterize and solve. However, a large portion of this attitude is part of a pervading mood of ambivalence regarding what really needs to be considered when it comes to cleaning up groundwater: responsibility, risk, cost, time, or some as yet unknown combination of these factors.

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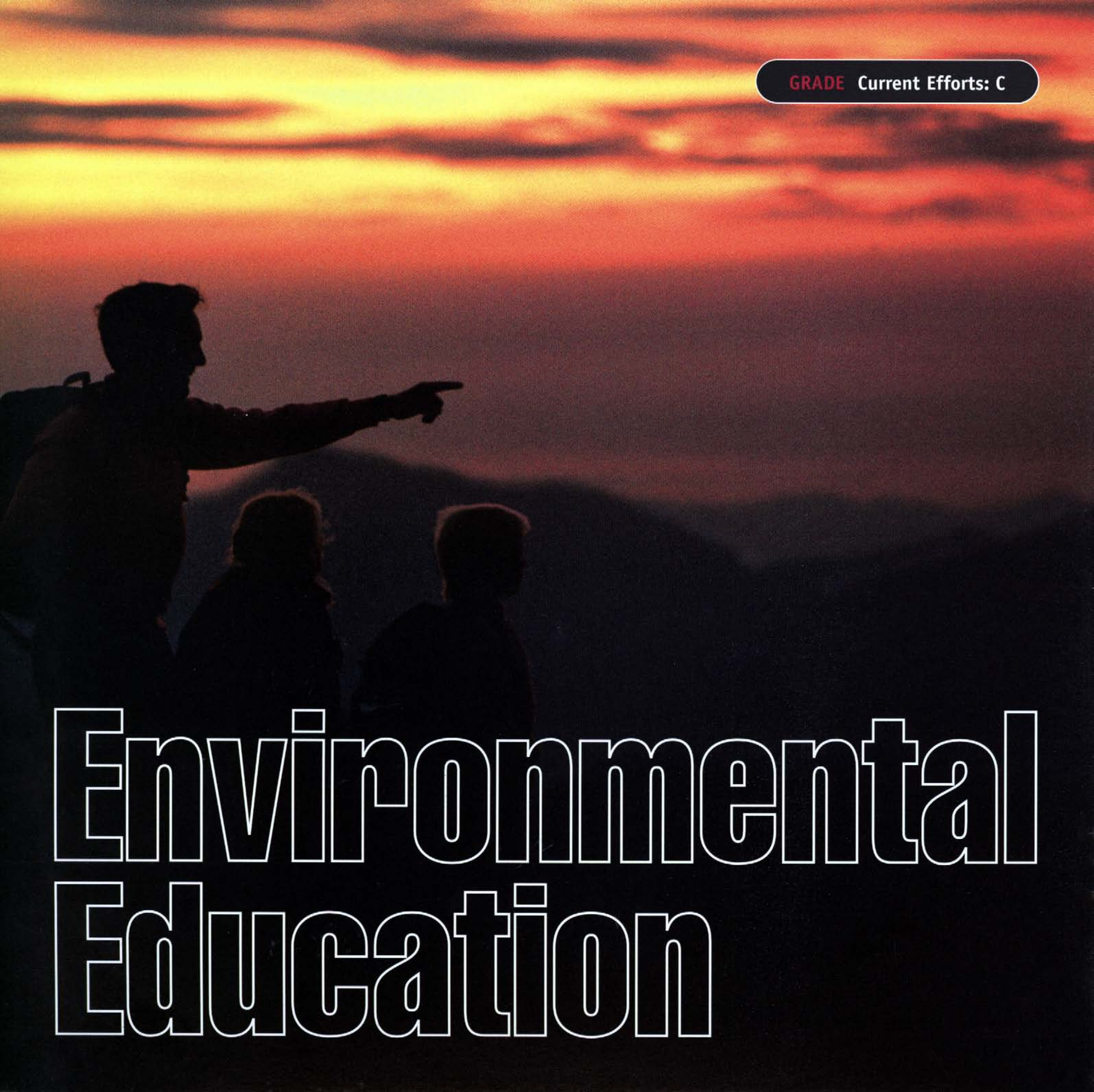
ULARA Watermaster (M.L. Blevins), Watermaster Service in the Upper Los Angeles River Area, Los Angeles County 1993-94 Water Year, May 1995.

U.S.EPA Database, http://www.epa.gov:80/region09/waste/sfund/npl/sanfernando/

Thomas C. Harmon is an associate professor in UCLA's Civil and Environmental Engineering Department. His research focuses on trying to understand the movement and fate of contaminants in soils and groundwater, and engineering effective physical, chemical and biological technologies for addressing this problem. His current work involves basic topics related to the behavior of chemicals in soils, and more applied topics related to tracking and mapping contaminant spills in subterranean space and restoring urban brownfields to productive use. As an instructor, he is committed to infusing the latest technology into the curriculum, and is currently developing virtual reality-base instructional software to help accelerate this process.

Professor Harmon received his B.S. in Civil Engineering from Johns Hopkins University in 1985. He received his Ph.D. from Stanford University in 1992, at which time he joined the faculty of UCLA. In 1995, he was awarded the National Science Foundation's Early Faculty Career Development Award.



GRADE **Current Efforts: C**

Environmental Education

by Janet M. Thornber, MSPH

Director of UCLA Programs for Science Teachers at Center X,
UCLA Graduate School of Education and Information Studies

WHAT IS ENVIRONMENTAL EDUCATION (EE)?

If we assume that education leads to literacy then the first question we should ask is "What is environmental literacy?" Earlier this decade, the Environmental Literacy (EL) Framework described environmental literacy as multi-faceted, including a cognitive dimension (knowledge and skill); affective dimension (attitude); and a behavioral dimension (individual or group involvement in environmental action). In 1992, C. Roth defined EL as "essentially the capacity to perceive and interpret the relative health of environmental systems and take the appropriate action to maintain, restore, or improve the health of those systems."

TOWARD ENVIRONMENTAL LITERACY FOR ALL

Should all our students become environmentally literate? A quick answer is "yes." Today's students, both from disadvantaged and non-disadvantaged groups, have listed many concerns, with their environment being high on the list. Students need opportunities to learn they are part of their environment—not observers of it, that it belongs to them as much as to anyone else; and that they, too, can understand it and have a role in its stewardship. In addition, many environmental advances have been made over the past two decades—Los Angeles' air is cleaner now than in the '70s (see RC 1998), and we must ensure that future generations maintain this progress. Students need not become ardent environmental activists nor research scientists, but literate voting citizens who can make decisions based on sound knowledge and evidence—even though some of these decisions may not be in tune with the local environmentalists' perspectives.

Environmental agencies and organizations (including the California Department of Education) that responded to a 1995 survey leading to the report *Pieces of a Puzzle: An Overview of the Status of Environmental Education in the United States* support EE for all:

- "Each individual should have a basic understanding of the environmental sciences"
- "Each individual should understand the relationships between human actions and the environment"
- "Environmental education should be integrated into all school curriculums"
- "Diverse environmental education opportunities should be available to the general public"
- "Environmental education in the state should be a cooperative venture, coordinated at all levels within the state and with national and international networks."

ENVIRONMENTAL RESOURCES

How can we, as educators, help students achieve environmental literacy? Over the past 10-15 years, diverse curricula projects have been developed from a variety of funding sources, each with their own agenda. For example, money from the California License Plate Fund has developed *Project WILD* and *Project Aquatic WILD*. These popular curricula provide classroom activities that model environmental concepts such as population fluctuations, impacts of toxins on food chains and webs, and the effect of the destruction of habitats on local species. Although designed for K-12 grades, they are most popular with elementary teachers. The California Department of Education (CDE) has supported the development of *A Child's Place in the Environment*, a K-6 curriculum that considers a specific environmental concept at each grade level. The Lawrence Hall of Science has

Teachers explore the ecology of Mono Lake.

As well as published environmental education curricula, developed environmental programs such as SEPUP (Science Education for Public Understanding Project) among their many programs for K-12 students. UC Santa Cruz has developed *Life Lab*, a program that uses school gardens as a vehicle for teaching science.

Local and state utility companies also provide a rich source of environmental education materials. The Los Angeles Department of Water and Power (LADWP) had a far-reaching education program until funding was reduced recently. Fortunately, many publications remain that promote understanding of water issues in the city, including transport to the city, purification, and delivery to customers. The Metropolitan Water District (MWD) had corresponding materials. Waste disposal concepts can be taught through *Closing the Loop*, a curriculum developed by the Los Angeles County Department of Integrated Waste Management, in which landfills provide the vehicle for teaching science concepts. Other programs include *Earth Resources*, a program developed by a consortium of oil companies in Texas. These latter two programs are geared toward teachers of secondary grades.

local school districts provide environmental instructional experiences for their teachers and students. For example, the Los Angeles Unified School District (LAUSD) works closely with the Los Angeles County Office of Education (LACOE) to take students to outdoor camps during the academic year. LACOE and LAUSD also offer the Yosemite Institute and Eastern Sierra program for teachers and students. In addition, there are marine science programs offered through Sea Education Afloat and the Roundhouse Marine Science Laboratory in Manhattan Beach. UCLA has developed a small aquarium, the Ocean Discovery Center in Santa Monica, and a marine science program at Fort McArthur that provide programs for students and teachers.

Care must be taken by teachers as they use environmental curricula, especially those published by strong activist groups that obviously further their own specific causes. It is easy to get caught up emotionally in these causes. Environmental issues are not black and white; there are many perspectives from which to study them. Teachers must remain even-handed whatever their own personal views. This does not mean that students should be shielded from activists. But they should be given opportunities to see issues from the perspectives of all stakeholders such as land developers, city councils, local water authorities, tax payers and others. One of the best teaching strategies is the classroom debate. Students must defend the perspectives of interested parties (such as those listed above), thus enabling them to see issues from all perspectives—an uncomfortable but illuminating exercise.

In addition, although it may not be the role of EE to develop activists, it is certainly the role of EE to help students learn actions they can take in their own personal lives that will support a healthier environment. They can learn how to conserve resources such as power and water, recycle, and dispose of toxic materials properly. Action must, of course, be linked to science and social science principles.

ENVIRONMENTAL EDUCATION IN SOUTHERN CALIFORNIA

Visits to local secondary school classes provide varying pictures. In some cases, you will see secondary and elementary students out on field trips to local areas such as the wetlands,

Children in elementary grades respond well to lessons on their environment. Such lessons provide concrete experiences upon which they can build more sophisticated understandings.

Tujunga Wash, the Los Angeles River, and Castaic Dam, learning to understand environmental issues first hand. Others may be reading about them from newspaper or Sierra club articles and debating issues as a means to seeing all sides of specific concerns. Others may never get to environmental science because it's usually the last chapter in the text.

At the elementary level, the approach to EE is somewhat different. Most published programs referred to earlier offer workshops to teachers to help them become familiar with the curriculum, the environmental issues addressed, and, to a greater or lesser extent, the science behind them. However, the report *Pieces of a Puzzle* finds the average length of an EE teacher training program is 2-4 days. Hence the depth of content and quality of teacher training is severely limited. Although follow-up is usually provided in the form of newsletters, Internet sites and telephone hotlines, the preferred method— providing mentor teachers as support—is not common.

University faculty and teachers (usually those of secondary grades) question whether one should introduce students to basic science concepts first and then relate them to the environment, or introduce students to environmental issues and then help them understand the science behind them. There seems to be no hard data on what works best. But, from observations of instructional practice, it is easy to see that environmental curricula are popular with elementary students and teachers for several reasons. Children in elementary grades respond well to lessons on their environment. Such lessons provide concrete experiences upon which they can build more sophisticated understandings. Many teachers, including those less-well prepared to teach science, feel more comfortable teaching science through environmental topics. They often feel more comfortable taking their students outside to explore and ask questions than setting up explorative activities in their classrooms. In addition, elementary teachers relate environmental lessons to those in social studies, thus making them more likely to include environmental lessons in their instructional programs.

In the case of secondary students, those who do not have a natural tendency to gravitate toward science courses often become interested in science through an environmental approach—the increase in popularity of integrated science courses and corresponding low numbers of students enrolling in traditional chemistry and physics courses illustrates this. This brings more students into the study of science. Although it is perceived by some that such courses "water down" science, it may be more challenging to teach science through studying an integrated system such as the environment. To do so, one needs a broad background in all the sciences, and to be able to link concepts across science disciplines. It seems that few faculty and high school teachers feel comfortable in doing this, perhaps because they have strong content understanding in quite narrow fields and thus, only feel comfortable teaching their own specific discipline. This compares to the same discomfort that elementary teachers feel at teaching science, for which they feel unprepared.

CURRENT STATUS OF EE IN TODAY'S EDUCATION SYSTEM

Despite the large selection of EE curricula now available, despite access to a whole wealth of EE information on the World Wide Web, and despite efforts of individual agencies and organizations to bring EE into the education reform efforts of Goals 2000, the majority of school districts list no subject

Hands-on learning at the UCLA Ocean Discovery Center.

called "Environmental Education" in their school curricula. Since most EE curricula projects have been developed by agencies outside the formal education system, the discipline tends to be relegated to the sidelines. Little effort has been made to bring EE into the core curriculum. In addition, despite the recent flurry of activity to develop content standards in academic disciplines, EE has received no such attention. Perhaps this is not all bad. If EE is to be included in the main curriculum, it must be included in the main curriculum standards and not separated by standards of its own. However, in the new State Science Education Standards, there is no mention of environmental science (although there is a very strong strand of ecological standards across the grade levels). It will be left up to the teacher to weave in the environmental perspective.

On a more positive note, one goal of the large NSF-funded Los Angeles Systemic Initiative (LA-SI) is to establish an Integrated Science Program in all LAUSD secondary schools. Since environmental studies provide a rich integrated system, teachers have designed many of their integrated programs around a study of the environment, especially the urban environment. An example of such a program is the Venice HS program on Urban Science. Integrated Science is now accepted as a science course in the A-F requirements for UC entrance. Another positive move toward implementing more EE in secondary classrooms is the new Advanced Placement (AP) Environmental Science course being offered for the first time this year.

COMPONENTS OF AN EE CURRICULUM

Consider again the three components of EL listed at the beginning of this article. We see that although EE curricula usually address the content behind environmental issues, it is more often the attitude and the action components that teachers and students alike will appreciate, get involved with, and remember. It is difficult and challenging, especially at the elementary level, for teachers to focus on science concepts behind the issues. Even at the secondary level, where curricula explain science concepts clearly, it is too often the social and behavioral components that students find interesting. This contributes to the myth that an environmental focus "waters down" the scientific content in EE courses, and leads to lack of support by more traditional departments. However, an environmental issue often provides an excellent way to motivate students to learn more—acid rain triggers student interest in understanding acids and pH. This triggers questions such as what does pH mean? What acids are formed in the environment? Why? How? Why and when are hydrogen ions dangerous? Teachers must then teach the traditional concepts about acids and bases. Too often this last step is not taken. But why?

PREPARATION OF SCIENCE TEACHERS

It is challenging to teach science well both in elementary and secondary grades. Not only must teachers have a strong, broad background in science and be able to identify and clarify science concepts they want their students to learn, but they must also present the material in a way that enables all their students to learn—not simply those who have a flair for the discipline. And as more information is added to the body of science, the task

An increasing number of opportunities for teachers and students to conduct investigative science are available through electronic networks linked through the world wide web.

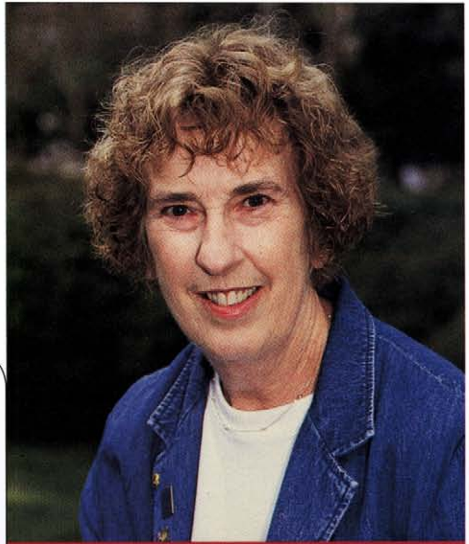
escalates. Too often, teachers will stop when they have gained their students' interest and not pursue the more difficult challenge of teaching complex content.

Local science education reform programs have addressed this concern by offering environmental programs that strengthen teachers' backgrounds, while helping them identify and use effective instructional methods. The CSP-UCLA Science Project and Project ISSUES from UCLA/Center X, provide content background in urban science, and the UCLA Department of Organismic Biology, Ecology, and Evolution (OBEE) new program SSWIMS (Science Standards With Integrated Marine Science) updates participants' backgrounds in marine science. These programs help teachers develop leadership expertise for disseminating effective strategies to their peers. UCLA's Stunt Ranch Santa Monica Mountains Reserve is also developing opportunities for EE and research for local teachers and students. In addition, an increasing number of opportunities for teachers and students to conduct investigative science are available through electronic networks linked through the World Wide Web. Programs such as those administered by Cornell University encourage students to gather data on specific birds (http://birdsource.cornell.edu); students can track butterflies through Monarch Watch (http://www.monarchwatch.com); and schools can become involved in recording weather data across the nation through Project GLOBE (Global Learning and Observations to Benefit the Environment), a program initiated by Vice President Al Gore.

But in-service programs such as these cannot produce the required quality of science education alone. Universities must also help prepare teachers. This is especially true for environmental science where we are rapidly increasing our understanding of the science content.

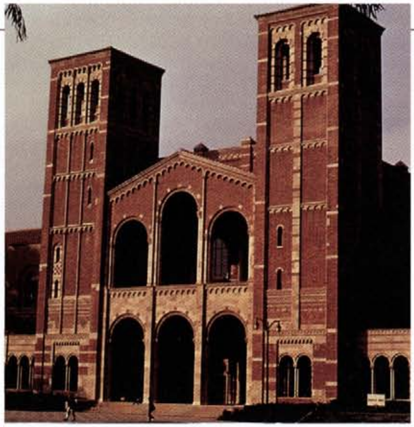
GRADING LOCAL EFFORTS

Not every local EE effort has been mentioned in this report—there are many of note. There are also many individual teachers who make extraordinary efforts to ensure their students have opportunities to understand the environment, and the role they play in it. **Their individual efforts deserve an A grade. But EE has not yet taken the major place in the curriculum it deserves; hence current efforts in Southern California rate only a C.**



Janet M. Thornber, Director of UCLA Programs for Science Teachers at Center X in UCLA's Graduate School of Education and Information Studies, also co-directs the UCLA Science Project, one of 12 sites of the California Science Project (CSP) administered through the UC Office of the President. Ms. Thornber's work is dedicated to teachers and students in those schools targeted by UCLA to increase the pool of UC eligible students, especially those from traditionally disadvantaged backgrounds. Over the past 15 years, Ms. Thornber has received science education grants from the National Science Foundation, the Eisenhower Program, and other agencies to develop programs for Los Angeles teachers of all grade levels. Many programs have used environmental science as a vehicle for helping teachers and students relate academic science to their own world experiences. Ms. Thornber received a BSc Honors degree in Biochemistry from the University of London, England and an MSPH in Nutritional Sciences from UCLA's School of Public Health.

About the UCLA Institute of the Environment



Formally established in 1997, UCLA's Institute of the Environment grew out of the need for a campus unit dedicated to facilitating connections among the many different and divergent fields relevant to environmental research and teaching. Understanding the environment requires inquiry that transcends discipline-specific approaches. Whereas most university-based environmental programs are affiliated primarily with a single department or school, the IoE is an autonomous unit that works campus-wide to add new dimensions to environment-related research, teaching, and community outreach. The IoE brings together UCLA's diverse environment-related programs, providing coordination and integration, and making such programs more visible and effective on campus, as well as in the broader community.

THE IOE'S OBJECTIVES ARE:

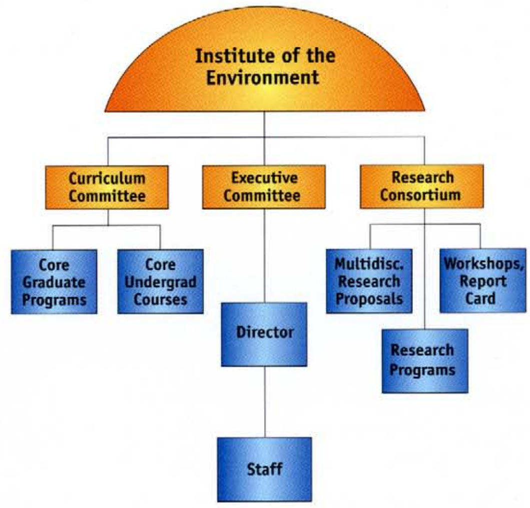
- To develop multidisciplinary academic programs that address the full breadth of environmental issues facing today's society;
- To stimulate innovative and integrative interdisciplinary research on local, regional, and global environmental processes; and
- To use collaborative problem-solving to strengthen UCLA's effectiveness in serving the community.

DISCOVERY-BASED LEARNING

To enhance the educational experience for UCLA students at all levels and in many fields, the IoE has the goal of incorporating environmental issues into every aspect of learning.

- The IoE played a major role in implementing a comprehensive overhaul of the general education curriculum in UCLA's College of Letters and Science. IoE faculty developed the first yearlong cluster course—Environment 1A, "The Global Environment: A Multidisciplinary Perspective"—which had its debut in the 1997-98 academic year.
- The IoE is developing environmental minors in six areas of concentration: engineering, life sciences, physical sciences, public health, public policy, and social sciences.
- In coming years, the IoE will initiate interdisciplinary graduate programs spanning a wide range of environmental topics.

Additionally, UCLA's Stunt Ranch Natural Reserve provides access to natural laboratory settings in the nearby Santa Monica Mountains, and the Marine Science Center's research vessel, "Sea World UCLA," enables students to collect data at sites in the Santa Monica Bay, Channel Islands, and Southern California Bight. The IoE encourages students to supplement classroom study by participating in field research throughout the Los Angeles area, gaining hands-on insights into air, land, and water issues affecting Southern California and beyond.



RESEARCH ACTIVITIES

The IoE fosters large-scale, multi-investigator, interdisciplinary environmental research by bringing together campus scholars as well as experts from local government and businesses. These broad-based investigations seek practical answers to complex questions about preserving natural resources, while still providing services for the community. They also present valuable opportunities for students to learn in the context of discovery.

- Our landmark Watershed project integrates the meteorology, hydrology, chemistry, biology, and coastal oceanography of the Los Angeles basin to address a host of issues related to water quality, availability, and management.
- The GLOBE (Global Observations to Benefit the Environment) project brings together faculty from the graduate School of Education and Information Studies and the Departments of Atmospheric Sciences, Biology and Geography to help local K-12 teachers lead students through scientific exercises, using actual instruments to record and interpret meteorological data.
- We have obtained funding from NASA to create an Environmental Remote Sensing Research Laboratory (ERRL) at UCLA. Offering state-of-the-art image-processing and computational services, the ERRL will support researchers involved in the growing field of environmental observation from space.
- The Lower Malibu Creek and Malibu Lagoon Resource Enhancement and Management Project is collecting data about the complex physical processes occurring in the largest watershed that drains into Santa Monica Bay. The aim is to identify strategies for preserving and restoring these vital and irreplaceable coastal resources.
- Over the past several years, researchers at the IoE in the natural and social sciences have been developing computer models that characterize various aspects of human-climate interactions in the Los Angeles Basin. One central theme has been the urban water cycle, which serves as an integrating metaphor linking five research sectors: human water use, coastal water quality, land use, regional meteorology, and regional air quality. With funding from the NSF, statistical tools are being developed to assess uncertainties in these computer models and provide statistical diagnostics to help improve how well they perform. The statistical procedures being developed also have wider applicability in part because they are embedded of a broad strategy for how to evaluate computer simulation models in a number of fields.
- Support from the California Sea Grant College System is enabling IoE researchers to design the first Model of the Southern California Coastal Ocean capable of resolving three-dimensional circulation patterns and integrating the most important features of biogeochemical and particulate dynamics.

UCLA Institute of the Environment

- Funded through the EPA, the Multi-level Statistical Models project extends existing methods to provide new techniques for working scientists. The goal is to assist in the process by which scientists try to generalize their findings from "case studies" or other special purpose investigations. Normally, generalizing from such research can sometimes be rather risky because it is difficult to know whether the findings apply to settings different from the ones actually studied. Since much of the research undertaken by the IoE is based in Southern California, the new statistical tools may help to indicate which finding only apply locally and which may have broader implications. The extension of statistical multilevel models include: 1) multiple response variables, 2) non-linear functional forms, 3) missing data, 4) disturbance covariance matrices allowing for temporal and spatial dependencies and 5) latent variables. At the end of the project, there will be software available for the techniques being developed that will run on a number of different platforms.
- With generous assistance from Intel Corporation, the IoE has built a Regional Environmental Assessment Laboratory and Geographical Information System (REAL/GIS) that will be accessible on campus as well as on the Internet. The REAL/GIS will provide scientists, planners, and the public with access to one of the largest and most diverse environmental databases for a major urban area.
- The IoE is collaborating with the Los Alamos National Laboratory to establish a Center for LIDAR environmental and atmospheric research. The center will develop a mobile, eye-safe system using lidar observations (a technique, similar to radar, that employs pulsed laser light instead of microwaves) to inform regional air quality forecasts.
- The IoE is a leader in earth system modeling, a holistic approach for studying global climate change by examining relationships among the atmosphere, land surfaces, oceans, and biogeochemical cycles.

"What is unique about the Institute of the Environment as an environmental program is its interdisciplinary breadth. It encompasses all of the major academic fields on a major university campus. Other university-based programs tend to focus on a single discipline, like engineering or agriculture. The IoE is broadly interdisciplinary to the same extent that our society is."

Richard P. Turco, Ph.D.
Founding Director, Institute of the Environment
Professor of Atmospheric Sciences

HOW TO REACH US:

The Institute has established a new web site. Our activities are routinely updated on the site, and we announce events and other activities of interest to those concerned about the environment. Contact us through our web site and sign our Guestbook. We welcome your feedback.

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RC 1998 Revisited

WASTEWATER TREATMENT

We received several comments on the Wastewater article. The Los Angeles County Sanitation Districts (LACSD) (James Stahl) felt they had good reasons for delaying the decision to provide secondary treatment at their Joint Water Pollution Control Plant in Carson. They noted the DDT contained in the sediments off White's Point may someday be reintroduced into the environment, where they will do additional damage. Presently the DDT sediments are covered by sediment from the release of primary effluent. Continued release of primary effluent might keep the sediments covered and prevent their release. The U.S. EPA recognized the need to prevent DDT from reentering the environment, but felt the damage from primary effluent was greater than the risk of DDT release. A comment from Professor Stenstrom, the author of this article, is that the scientific merits of both sides of the debate were never entirely understood. This resulted from a lack of a disinterested third party. Scientific arguments offered by LACSD were never credible to the environmental community because of a real or perceived conflict of interest. The savings of avoiding secondary treatment would accrue to LACSD and its users. A proposal for an ocean waiver by a neutral third party, without financial interests, might have been received differently. The issue of DDT contaminated sediments remain, and will haunt us for some time to come.

The Bureau of Sanitation, City of Los Angeles (Judy Wilson) wrote to say they appreciated the "A" they received for inland plants, but believed they now deserve an "A" for the Hyperion Wastewater Treatment Plant. They cited the difficulties associated with its expansion and improvements, including differences of opinion with regulatory agencies about the design and method for its expansion. The Report Card was a retrospective look at the wastewater treatment by the Hyperion Plant since the Clean Water Act Amendments in 1972. The grade was based on the performance during this entire period, as opposed to more recent events, and the author stands behind this grade.

However, there is a new story to tell with respect to the Hyperion Plant. The plant began full secondary treatment in December, 1998, two months ahead of its final construction schedule. The City and guests celebrated the plant's opening on May 15 in a ceremony attended by 1500 people. The City announced that the plant was constructed ahead of schedule and at a cost significantly under budget. The completion of the plant will end a 22-year lawsuit over its construction.

The construction of the plant is a tribute to the City. It is a "top 10" plant in terms of its size. There are few plants larger in the United States. The most outstanding aspect of the Hyperion construction is the very tight construction schedule, and the small area occupied by the plant. The plant provides not only for secondary treatment, but anaerobic sludge digestion and sludge dewatering. The digesters produce methane gas which is burned at the Scatter Good Power station to produce electricity for Hyperion at significant savings. Hyperion also provides approximately 20 million gallons per day of reclaimed water for the West Basin project, and additional reclamation will occur in the future. Hyperion now has the capacity to treat the City's wastewaters, including the high flows that occur in winter, as well as low-flow diversions, which will protect our beaches in the summer.

Hyperion may not be the largest plant, but it is probably the largest plant in the smallest land area of any plant in the world. This results in part because of the use of high purity oxygen for aeration, but mostly from clever design. Its construction required delicate timing because there simply was not room for normal construction practices. It was also necessary to keep the old secondary plant operating until it could be replaced by the first completed portion of the new secondary plant.

In the late 1970's and early 1980's, engineers reviewed the old Hyperion Plant, the requirements for the secondary treatment, including sludge disposal, and said that "it can not be done." Now the City has done it, and we have to thank the City's new team for accomplishing this great task.

Michael K. Stenstrom, Ph. D.
Professor, Civil and
Environmental Engineering,
School of Engineering
and Applied Sciences

WETLANDS

Ballona Wetlands. Although there has been little change to the wetland area at Ballona Wetlands, there continues to be a great deal of political activity surrounding the preservation and restoration of the wetlands. A coalition of environmental groups continues to protest the plans for Playa Vista, a $7 billion residential and commercial development, and especially the involvement of DreamWorks. In summer 1998, a federal judge issued an injunction that stopped work on a 16-acre freshwater marsh being constructed to regulate and treat freshwater runoff before it enters the salt marsh, but not other construction activities; the ruling is being appealed. The plans for the salt marsh restoration have not yet been released.

Malibu Lagoon. UCLA has just completed a study of the Malibu Creek Watershed, led by Professors Richard Ambrose and Tony Orme. The study has improved our understanding of the hydrology and barrier beach dynamics as well as refined our ideas about the evolution of the wetlands. The study also evaluated numerous alternatives for managing the resources of the watershed and provided preliminary wetland restoration plans and recommendations for several areas in the lagoon area. The recommendations will soon be considered by the community. The Southern California Wetlands Clearinghouse has given Malibu Lagoon a high priority for funding for restoration, so planning for additional restoration in the area should begin soon.

Richard F. Ambrose, Ph.D.
Professor, Environmental Health Sciences,
Director, Environmental Science and
Engineering Program,
School of Public Health

AIR QUALITY

Response received from the South Coast Air Quality Management District

According to its opening *Letter From the Director*, the Institute's first Report Card was intended to "document progress and regression" in four environmental areas. However, significant strategic accomplishments were omitted from both the grading analysis and the discussion of our region's air quality programs. Taken together, these new tools quietly paved the way for increased public health benefits, continued reductions in ambient emission levels, and improved cost-effectiveness for air pollution control measures.

For example, unmentioned in the air quality article were two benchmark accomplishments that occurred in the year under review, 1997:

- **Early rewards from the AQMD Governing Board's Environmental Justice Initiatives**, including initiation of an unprecedented, comprehensive mobile monitoring effort measuring air toxics exposure to more than 50 compounds; targeted Town Hall meetings to resolve chronic nuisance emissions in previously under-represented neighborhoods (such as low-income communities of color); and enhancement of New-Source Review for cancerous and hazardous air contaminants.

- **Adoption of far-reaching fugitive dust controls, to address some of the worst fine-particulate pollution in the nation**, including measures to significantly reduce suspended road dust, which comprises one-third of the ambient particles smaller than 10 microns in diameter, known as PM10—strongly linked to respiratory disease and increased deaths. The measures adopted required a comprehensive approach tying together technical research and implementation among the construction industry, scores of street maintenance operations by local governments, and Southland agriculture.

In addition, that year also saw progress on reducing emissions from solvents, petroleum coke handling, restaurant chain-charbroilers, boilers and water heaters, and refinery flaring operations. Beyond these formal regulatory actions, progress was made on other fronts:

- Enhancement of socioeconomic assessment tools to provide decision-makers with more complete understanding of the potential benefits and costs of alternative air quality solutions;

- Market acceleration for a host of low-emission technologies and fuel systems developed through public-private partnerships under the internationally recognized Technology Advancement program; and

- Improved dialog to clarify enforcement priorities, highlight compliance issues, and streamline working relationships among regional, state, and federal bodies.

Finally, critical seedwork was taking place to improve the body of scientific knowledge on air pollution. This key seedwork included expansion of the region's air monitoring network, practical demonstrations of waterborne cleaners and low-emission paints, and important research on diesel exhaust—later declared as a toxic air contaminant and a significant public health threat.

1999's air quality successes have included heightened focus on ways to mitigate disproportionate impacts of poor air quality on children and those with pre-existing health problems, and a landmark rule controlling emissions from architectural coatings, a significant source of ozone-precursor emissions in the South Coast. Today's action focus would not have been possible without the active public and small-business feedback solicited over the past two years.

Southern Californians can measure their progress in the war on smog by comparing 1977's 121 Stage 1 smog episodes to the single episode in 1997. And though El Nino showers helped our air that year; so did diligent efforts that may have escaped the attention of the Institute. The prospect for the future is blue sky by the time that federally mandated clean air standards are to be achieved.

Barry R. Wallerstein, D. Env.
Executive Officer, South Coast AQMD

Response to SCAQMD

We welcome the SCAQMD's response as part of an open dialogue concerning critical environmental issues confronting the region. However, far from reviewing only a single year, 1997, as stated by the District, the Air Quality article in the 1998 Report Card provided a much larger perspective on the 50 year effort to reduce air pollution in Southern California. Within that larger framework it was not possible to list every recent accomplishment of the local air pollution agency, although most of its major achievements were cited. Clearly, many of the recent projects listed in the District's response to our article are laudable and, in several cases, long overdue. Nevertheless, it remains unclear whether the present overall efforts by the District will in fact produce "blue skies" in the next decade, as promised in their letter. For example, while taking credit for there being only a single Stage I ozone alert in 1997, the District's letter fails to mention that in 1998 the number of Stage I alerts surged to 12. Whether this represents a short-term setback, or the beginning of a reversal in the long-term decline in ozone, will only be revealed over time. We intend to revisit the District's Air Quality Management Plans, and the status of air quality in Southern California, no later than the 2003 Report Card. At that time, the additional years of air monitoring data will tell us whether the District's rosy projections were justified.

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1999 Southern California Environmental Report Card

UCLA Institute of the Environment

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