Stormwater Runoff Water Quality Science/Engineering Newsletter

Devoted to Stormwater-Runoff Water Quality Management Issues

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Preface to Volume 1, Number 5 Newsletter

This issue of the Newsletter is devoted to a review of potential urban area stormwater runoff water quality standards compliance issues. During the fall of 1998 the author, G. Fred Lee, was involved in a review of potential urban area stormwater runoff water quality standards compliance issues in California that was conducted by the Stormwater Science Work Group of the California Stormwater Quality Task Force. This review was prompted by the US EPA requiring that ultimately NPDES-permitted urban area and highway stormwater runoff must not cause violations of water quality standards.

This Newsletter is based on a report, "Assessment of Potential Urban Area and Highway Stormwater Runoff Water Quality Standards Compliance Problems," (Lee, 1998a) that Dr. Lee developed in connection with the Stormwater Science Work Group activities devoted to this topic. While the information provided is directed toward the California urban stormwater runoff water quality management situation, it is applicable to other parts of the US and, for that matter, other countries that utilize water quality standards similar to those developed by the US EPA in implementing water quality criteria into water quality standards and NPDES-permitted discharge limits to regulate urban area and highway stormwater runoff water quality.

In addition to discussing potential water quality standards compliance issues, this Newsletter also discusses why exceedance of worst-case-based water quality standards does not necessarily reflect a water quality use impairment of concern to the public. Further, guidance is provided in this and subsequent Newsletters on approaches that can be followed to develop appropriate water quality standards to regulate urban area stormwater runoff without significant unnecessary expenditures for the control of runoff-associated constituents. Questions or comments on this review should be directed to Dr. Lee at gfredlee@aol.com.

Past issues of the Newsletter are available from http://members.aol.com/gfredlee/gfl.htm. These issues contain additional backup material to the discussions presented in this newsletter. If you are not on the Newsletter email mailing list and wish to receive past or future issues, please contact Dr. Lee at gfredlee@aol.com

Regulatory Background to the BMP Ratcheting-Down Process

In January 1998, the US EPA reaffirmed its previously-announced position that ultimately NPDES-permitted urban area and highway stormwater runoff would have to meet water quality standards in the runoff waters as they enter a receiving water. As a result of disagreement between the US EPA Region 9 and the California Water Resources Control Board over "receiving water language" in NPDES permits, the US EPA Region 9 assumed authority to issue urban stormwater runoff NPDES permits in California. In December 1998 the US EPA Region IX issued a "pre-notice draft permit" to the Riverside County Flood Control and Water Conservation District, Riverside, California, covering the renewal of the District's NPDES stormwater runoff permit. The proposed permit conditions contain the following requirements.

A.. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

5. Compliance with Water Quality Standards

Discharges from the MS4 [municipalities with populations over 100,000] *that cause or contribute to the violation of water quality standards or water quality objectives (collectively WQSs) are prohibited.*

b. The permittees shall comply with Part I.A.5.a of this permit through timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the SWMP [Storm Water Management Program] *and other requirements of this permit including any modifications; the SWMP shall be designed to achieve compliance with Part I.A.5.a of this permit; if exceedance(s) of WQSs persist notwithstanding implementation of the SWMP and other requirements of this permit, the permittees shall assure compliance with Part I.A.5.a of this permit by complying with the following procedure:*

i. Upon a determination by either the permittees or USEPA Region IX that discharges are causing or contributing to an exceedance of an applicable WQS, the permittees shall promptly notify' and thereafter submit a report to USEPA Region IX that describes BMPs that are currently being implemented and additional BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedance of WQSs. The report may be incorporated in the annual update to the SWMP unless USEPA Region IX directs an earlier submittal. The report shall include an implementation schedule. USEPA Region IX may require modifications to the report;

ii. Submit any modifications to the report required by USEPA Region IX within 30 days of notification;

iii. Within 30 days following approval of the report described above by USEPA Region IX, the permittees shall revise the SWMP and monitoring program to incorporate the approved modified BMPs that have been and will be implemented, implementation schedule, and any additional monitoring required;

iv. Implement the revised SWMP and monitoring program in accordance with the approved schedule.

"So long as the permittees have complied with the procedures set forth above and are implementing the revised SWMP, the permittees do not have to repeat the same procedure

for continuing or recurring exceedances of the same receiving water limitations unless directed by USEPA Region IX to develop additional BMPs.." This is the approach that the US EPA Region IX has adopted to implement the requirements set forth in the Water Quality Act of 1987, Section 402(p). While the 1987 Water Quality Act (WQA) amended the Clean Water Act (CWA), the WQA did not specifically state that NPDES-permitted urban stormwater runoff must comply with water quality standards. The US EPA Region IX stated in the draft Riverside County, California NPDES permit, "*In January, 1991, EPA's Office of General Counsel reviewed this issue and concluded that the best reading of the CWA is that water quality standards apply to municipal as well as industrial storm water discharges.*"

The US EPA 1990 Federal Regulations governing urban area and highway stormwater runoff water quality management establish the requirement that "*...pollutants in storm water discharges be controlled to the maximum extent practicable (MEP)*" through the use of best management practices (BMPs). The regulatory requirements that the US EPA Region IX has formulated for renewal of the Riverside County NPDES stormwater permit establish a BMP ratcheting-down process where, as exceedances of water quality standards in the stormwater runoff are detected, increasingly more effective BMPs are to be implemented until compliance with water quality standards is achieved. This requirement does not at this time have a fixed timetable. Stormwater management agencies and regulatory agencies must, through a BMP ratcheting-down process, work toward achieving water quality standards in the runoff waters so that there is no more than one exceedance by any amount for any regulated parameter or condition every three years.

As part of developing guidance for implementing the BMP ratcheting-down process, it has been found that there is a lack of understanding among water quality regulatory agencies, stormwater runoff water quality management agencies, environmental groups, and others regarding the potential stormwater runoff water quality standards compliance issues facing NPDES-permitted stormwater management agencies. There is also a lack of understanding of the relationship between water quality standards which evolve from the US EPA water quality criteria and water quality use impairments of concern to the public. The US EPA Region IX (1998) in the draft Riverside County NPDES permit states under "Water Quality Concerns,"

"The 1987 decision by Congress to require NPDES permitting for the storm water discharges listed above was based on a growing awareness of the environmental significance of nonpoint sources of pollutants. For example, EPA's report entitled 'National Water Quality Inventory, 1996 Report to Congress' (EPA, 1998) shows that nonpoint sources, including storm water runoff, are the leading causes of existing water quality impairments."

"The Nationwide Urban Runoff Program (NURP), which was sponsored by EPA in the years 1978 through 1983, also showed that storm water runoff is a significant source

of pollutants (EPA, 1983). The study identified 77 priority toxic pollutants in storm water runoff discharged from residential, commercial and light industrial areas. Of these toxic pollutants, heavy metals such as copper, lead and zinc were detected most frequently and at levels of greatest concern. Nearly half the end-of-pipe storm water samples contained copper at a concentration exceeding EPA's acute toxicity criteria for fresh water."

The above-quoted statements go to the heart of the significant regulatory problems that exist today with cost-effectively regulating urban area and highway stormwater runoff to protect the designated beneficial uses of receiving waters for the runoff without significant unnecessary expenditures for chemical constituent control. As discussed in previous newsletters and by Lee and Jones-Lee (1996a, 1998a), the US EPA water quality criteria such as the "Gold Book" criteria (US EPA 1987) and their 1995 update (US EPA 1996) are based on worst-case-based assessments/ assumptions on how chemical constituents impact aquatic life. In general, they assume that the constituents are in toxic/available forms, and that th duration of exposure to these forms occurs for an extended period of time. However, when these criteria are mechanically used as state water quality standards that are applied to urban area and highway stormwater runoff, it is rare that they exceedance of a criterion value, sometimes by very large amounts, represents a significant adverse impact on aquatic life or other beneficial uses of a waterbody. This issue has been reviewed by Lee and Jones-Lee (1996a, 1998a).

The US EPA Region IX's citing of the US EPA's biennial reports to Congress (US EPA 1998a) on the role of urban area stormwater runoff-associated constituents as a cause of water pollution in the US is an example of unreliable reporting of issues. As discussed by Lee and Jones-Lee (1996b), the US EPA's biennial reports to Congress on the water quality of the nation's waters misinformed Congress on some aspects of the real causes of water quality use impairments of concern to the public. This is an outgrowth of the significant problems that developed when the US EPA Administration of the early 1980s adopted the chemical concentration approach as a basis for regulating chemical constituents in water that can potentially impact beneficial uses. While the chemical concentration approach is bureaucratically simple to administer, it is often technically invalid in reliably assessing the water quality impacts of concern to the public, who must ultimately pay for constituent control. Rather than focusing on chemical concentration control, as the Agency has been doing for 15 years, there is need to shift the emphasis to focusing on chemical impacts on the beneficial uses of waterbodies.

With respect to US EPA Region IX citing the NURP data as justification for the current BMP ratcheting-down process approach, a critical review of how the US EPA conducted the NURP shows that the Agency made no attempt to define pollutants, i.e., those constituents which impair beneficial uses. Instead the Agency focused on defining chemical concentrations in urban stormwater runoff without assessing whether the elevated concentrations of copper, lead, zinc, etc., were in toxic/available forms, i.e., would be real pollutants that are adverse to aquatic life. The problems with the way in which the

US EPA organized, implemented, and reported the NURP studies were recognized at the time that the studies were conducted. Lee and Jones (1981) in a paper, "Will EPA's Nationwide Urban Runoff Study Achieve Useful Results?", discussed the significant deficiencies of the US EPA's approach with the NURP, where they pointed out that the NURP was only providing additional data of the type that was already well-known, namely that urban area and highway stormwater runoff contained elevated concentrations of heavy metals and other constituents that were a potential threat to water quality. Further, Lee and Jones (1981) pointed out that the NURP should be directed to determining the water quality significance of the elevated concentrations of constituents in urban stormwater runoff.

The US EPA has been seriously deficient in its water pollution control programs relative to regulating urban area and highway stormwater runoff, since it still has not conducted the studies that need to be conducted to determine the real, significant water quality problems associated with urban area and highway stormwater runoff. Further, and even more important, the Agency persists, as did the US EPA Region IX, with ignoring the well-known facts that applying US EPA worst-case-based water quality criteria/standards to urban area and highway stormwater runoff can readily lead to inappropriate regulatory approaches that can cost the public billions of dollars in the construction, operation, and maintenance of stormwater runoff treatment works that will do little in the way of improving the designated beneficial uses of the nation's waters. As it stands now, the BMP ratcheting-down process that is being implemented by the US EPA Region IX, where US EPA worst-case-based water quality criteria/standards are used as the goal of the BMP ratcheting-down process causes this process to be based on a technically unreliable foundation. This issue is discussed further below.

This discussion is based on the approximately 40 years of experience of the author (Dr. G. Fred Lee) in work on water quality criteria and standards development, evaluation and implementation and on water quality impact evaluation and management associated with urban area and highway stormwater runoff to a variety of waterbodies located throughout the US.

A review of existing stormwater runoff water quality characteristics shows that potential exceedances of worst-case-based water quality standards will likely occur in urban area and highway stormwater runoff at the point of discharge to receiving waters. Further, review (Jones-Lee and Lee, 1994, 1998) of the ability of conventional BMPs such as detention basins to treat stormwater runoff shows that conventional BMPs will not reduce the concentrations of stormwater runoff-associated constituents sufficiently to achieve compliance with worst-case-based water quality standards.

In November 1998, M. Walker of Larry Walker and Associates, Davis, California, presented a draft report to the SWQTF Executive Committee summarizing the results of a review of potential stormwater runoff water quality standards compliance problems for

Sacramento, Fresno, Los Angeles County, and Caltrans District 7 (LA area). His review focused on compliance with appropriate local Basin Plan requirements, Ocean Plan objectives, and proposed California Toxics Rule criteria. The attached table summarizes the initial results from Walker's review. This table also presents a summary of Dr. G. Fred Lee's experience in reviewing stormwater runoff water quality monitoring data in California and elsewhere relative to existing regulatory requirements. A summary of some of the key issues pertinent to achieving water quality standards compliance is presented below.

The discussion presented below applies to urban area residential and most commercial street and highway stormwater runoff. It does not necessarily apply to industrial stormwater runoff, or to some commercial stormwater runoff where substantial amounts of hazardous or otherwise deleterious chemicals are stored and/or used outdoors. Runoff from such areas into the municipal stormwater system can cause that system's stormwater characteristics to be different from the typical residential/commercial stormwater runoff.

In the discussion presented below, general comparisons are made between the results of reliably developed urban area and highway stormwater runoff water quality monitoring data and "worst-case based" water quality standards. These standards evolved from the mechanical application of US EPA 1986 (US EPA 1987) "Gold Book" water quality criteria, as well as the US EPA 1995 (US EPA 1996) update of these criteria. In August 1997 the US EPA (1997) released the draft proposed California Toxics Rule (CTR) water quality criteria for "priority toxic pollutants." The CTR criteria represent the US EPA's most recent publicly-released evaluation of worst-case-based critical concentrations of many regulated chemical constituents. While at this time the CTR criteria are only proposed for California, it is believed that they will be applied in the near future throughout the US.

Heavy Metals

A review of the attached table shows that total and dissolved copper, lead and zinc in urban area street and highway stormwater runoff will frequently exceed worst-case-based acute water quality criteria/standards in the runoff waters as they enter receiving waters, i.e., no-mixing zones. Cadmium in urban area and highway stormwater runoff is sometimes found to exceed the US EPA's worst-case-based water quality criteria/ standards in the runoff waters. As discussed in previous Newsletters, several studies have shown, that these heavy metals in urban area and highway stormwater runoff are in nontoxic, nonavailable forms, and therefore the water quality standards exceedance represents an "administrative" exceedance related to the nature of how the US EPA implements worst-case-based water quality criteria into state standards and NPDES-permitted discharges.

Lee and Jones-Lee (1995) have discussed the US EPA's Independent Application Policy as one of the most significant causes of the over-regulation of urban area and highway stormwater runoff. As they indicate, it is obviously technically invalid to require

Potential Urban-Area & Highway
Stormwater Runoff Water Quality Standards
Compliance Problems*

Frequency/Condition	**Constituents**
Frequently	Copper, Lead, Zinc Bis (2-ethyl) phthalate Fecal Coliforms Aquatic Life Toxicity
In Some Locations	Cadmium, Mercury, PAHs Individual & Total

If on 303(d) List of Impaired Waterbodies for

Toxicity - *Ceriodaphnia*	OP Pesticide, Unknown Causes
Nutrients	N & P Compounds
Contact Recreation/Shellfish	Total Coliforms
Sediment-Associated Constituents	Heavy Metals, PAHs, NH_3, H_2S
Bioaccumulation of Hazardous Chemicals	Hg, DDT, PCBs, Chlordane, Dioxins, etc.

New Water Quality Criteria/Standards

Nutrients N & P
New Fecal Indicator Organisms
E. coli, Enterococci
Cryptosporidium, Enteroviruses
Organics - To Be Determined

Revised Water Quality Criteria/Standards

Hg, Se, As

* Does not necessarily mean a real significant beneficial use impairment

that urban area and highway stormwater runoff-associated copper be controlled to meet the copper water quality criterion/standard which is based on its potential toxicity to aquatic life, when adequately conducted studies show that the copper in the stormwater runoff and within the receiving waters for the runoff is in a nontoxic form. The Agency headquarters understands the over-regulation associated with this approach, especially under the Independent Application Policy, and is working to revise this policy and regulatory approach as part of the Announced Proposed Rule Making (ANPRM) for water quality standards that is currently under review. Lee (1999) has recently completed a review of the characteristics of the US EPA's water quality criteria implementation approach that will lead to over-regulation of urban area and highway stormwater runoff water quality.

The Agency provides for site-specific adjustment of worst-case-based standards/ discharge limits through its Water Quality Standards Handbook (1994). It is likely that a site-specific evaluation would show that the water quality standards can be adjusted significantly upward for the heavy metals that cause exceedance of worst-case-based water quality standards in stormwater runoff and still be protective of aquatic life-related beneficial uses of waterbodies for most urban area and highway stormwater runoff receiving water situations. Future issues of the Newsletter will discuss guidance on how stormwater management agencies, regulatory agencies and the public can/should work together to develop site-specific water quality standards for cost-effective management of the water quality impacts of urban area and highway stormwater runoff-associated constituents.

Bis(2-ethyl)phthalate

The water quality standards potential exceedances for bis(2-ethyl)phthalate in urban stormwater runoff that are being found by NPDES-permitted stormwater quality management agencies are likely due to contamination of the sampling equipment by this chemical. Phthalates are universal, frequent contaminants of environmental samples due to sampling and sample handling contamination problems. It is possible with great care to collect samples of stormwater which are not contaminated with phthalates. This needs to be done to determine whether there is a real phthalate-associated exceedance of the standard or whether the exceedance is simply an artifact of inadequate sampling approaches. If real exceedances are found, then the water quality significance of these exceedances as they relate to the beneficial uses of the urban area and highway stormwater runoff needs to be evaluated.

Fecal and Total Coliforms

Urban area and highway stormwater runoff will frequently cause exceedance of fecal coliform standards for contact recreation. It has been known for many years that fecal coliforms are an unreliable indicator of the sanitary quality of waters for contact recreation. It is likely, however, that for those situations in which there is no domestic wastewater present in the stormwater runoff through leaking sewers, spills, blockage of sewer lines, pump stations, etc., that the exceedance of the fecal coliform standard in

stormwater runoff does not represent a public health threat for bacterial-caused enteric (intestinal) diseases. There is the potential, however, that protozoan parasitic cyst-forming organisms of animal origin such as *Cryptosporidium* could be present in urban stormwater runoff, which would be a threat to cause disease to those who contact recreate in urban area and highway stormwater runoff-impacted waterbodies. This is an area that needs to be evaluated.

The US EPA (1998b), as part of its Beach Program and the National Water Quality Criteria and Standards Plan that is currently being adopted, plans to pursue causing the states to adopt new sanitary quality pathogen-indicator organisms instead of fecal coliforms. While the US EPA can likely add *E coli* and *Enterococci* to the sanitary quality fecal indicator organism standards, the Agency has no authority to require that departments of health abandon the use of fecal coliforms as a sanitary quality parameter. It will be difficult to get health agencies to abandon fecal coliforms as a sanitary quality parameter because of the long tradition that exists in the use of this parameter and its being embedded in department of health regulations. It is likely that urban stormwater runoff water quality managers will find that, in addition to having to meet the fecal coliform standard, they will also have to meet standards for *E coli* and *Enterococci*. It appears, however, that unless there are significant amounts of domestic wastewaters in the urban area stormwater runoff, the compliance problems associated with the new indicator organisms should be minimal.

At this time the sanitary quality of shellfish harvesting is based on total coliform content of the organisms. The urban stormwater dischargers to waterbodies where shellfish harvesting is restricted because of sanitary quality issues could readily find that they will have stormwater runoff water quality standards compliance problems meeting total coliform standards for the protection of shellfish harvesting.

Mercury

Mercury is of concern in urban area and highway stormwater runoff because of its potential to bioaccumulate in fish to excessive levels that cause the fish to be considered dangerous for use as human food. The urban area and highway stormwater runoff compliance problems for mercury are not well-established or understood because of the inadequate analytical methods that are typically used for mercury analyses. There are significant problems with measurement of low levels of mercury in environmental samples due to sample contamination. Further, the commonly used analytical methods for measuring mercury in stormwater runoff do not have sufficient sensitivity to determine if mercury concentrations are present in excess of worst-case-based water quality criteria/ standards, which are currently 12 ng/L and will soon become about 5 ng/L. It is possible that mercury in urban area street and highway stormwater runoff may become a water quality standards compliance issue, especially where the fish in the receiving waters for the stormwater runoff have excessive concentrations of mercury in their edible tissue.

It is well-known, however, that the worst-case-based water quality criterion in most cases overestimates the actual bioaccumulation of mercury that will occur in edible fish tissue. The US EPA is proposing an alternative approach for regulating mercury based on establishing a site-specific bioaccumulation factor which involves back-calculating a standard for those waterbodies where excessive mercury edible aquatic life tissue residues exist. This back-calculation approach will likely meet with significant problems in relating mercury loads to a waterbody to fish tissue residues, especially where particulate mercury is added to the waterbody, and accumulates in the waterbody's sediments. Depending on the characteristics of this sediment, this particulate mercury may be slowly converted to methylmercury, which bioaccumulates in fish and other aquatic life tissue.

One of the issues that has not been addressed is whether the mercury in urban area street and highway stormwater runoff is in a bioavailable form that can be converted to methylmercury in receiving water sediments. This is an area that needs attention for any situation where there are water quality standards violations associated with mercury in urban area and highway stormwater runoff.

Polynuclear Aromatic Hydrocarbons

The polynuclear aromatic hydrocarbons (PAHs), such as chrysene, fluoroanthene, phenanthrene, and pyrene, are occasionally present in urban area and highway stormwater runoff at concentrations which will cause exceedance of worst-case-based water quality standards. These standards, however, are overly-protective in many situations and do not properly reflect the concentration of toxic/available forms of PAHs. It is also known that the toxicity of many of the PAHs is additive, where, even though no single PAH concentration exceeds a water quality standard, the sum of the PAHs can, under certain circumstances, be toxic. The US EPA is developing a water quality criterion for the sum of PAHs. This criterion could cause increased compliance problems for PAHs in urban area and highway stormwater runoff. It is possible that, through site-specific studies, at least part, and possibly all of the individual and summed PAH exceedances of water quality standards would be found to be administrative, where there is need to adjust the criterion to more properly reflect site-specific conditions affecting PAH toxicity to aquatic life.

Aquatic Life Toxicity

Essentially all urban stormwater runoff in California and in many other areas will cause exceedance of the aquatic life toxicity requirement of the US EPA and, in California, Regional Board Basin Plans prohibiting the presence of aquatic life toxicity in ambient waters. Urban area stormwater runoff aquatic life toxicity is typically due to residential and commercial use of two organophosphate pesticides, diazinon and chlorpyrifos, for structural (termite and ant) and lawn and garden pest control. Urban stormwater runoff contains sufficient concentrations of these two pesticides, that have toxicities which are additive, to cause toxicity to *Ceriodaphnia*, a freshwater zooplankton that is a US EPA

standard toxicity test organism. Chlorpyrifos is frequently present in urban area stormwater runoff in some parts of California at sufficient concentrations to be toxic to *Mysidopsis*, a marine zooplankton. Lee and Jones-Lee (1998b) and Lee, et al. (1999a, b) have recently presented comprehensive reviews of the organophosphate pesticide aquatic life toxicity issues associated with urban area stormwater runoff.

It is unclear whether urban highway stormwater runoff will contain sufficient OP pesticides to be toxic to *Ceriodaphnia* or mysids. Since these pesticides are not normally used for highway right of way pest control, their presence in highway stormwater runoff would have to come from airborne sources, most likely from agricultural use rather than urban use. V. Connor, of the California Central Valley Regional Water Quality Control Board (personal communication, 1998) has found that, at times, rainfall and fog fall in the Sacramento and parts of the Central Valley of California are highly toxic to *Ceriodaphnia* due to the use of diazinon as a dormant spray in orchards. During these times, highway stormwater runoff would be expected to be toxic to *Ceriodaphnia* due to the OP pesticide diazinon.

The regulation of pesticide toxicity to aquatic life is governed by both Clean Water Act and Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) pesticide registration requirements. The FIFRA requirements allow aquatic life toxicity, provided that it is not significantly adverse to the beneficial uses of a waterbody. At this time, there is considerable confusion and uncertainty as to how the toxicity in urban area stormwater runoff that is due to OP pesticides will be regulated. In February 1997, the California Water Resources Control Board and the California Department of Pesticide Regulation (DPR 1997) developed a Management Agency Agreement (MAA) where DPR has five years to establish an effective aquatic life toxicity control program for OP pesticides that are derived from their use on agricultural crops. It is unclear as to whether the MAA will also govern the urban stormwater runoff pesticide aquatic life toxicity problem. In about three years under the current MAA, the California Regional Water Quality Control Boards will have the responsibility of regulating OP pesticide toxicity if the current DPR voluntary approach fails to control toxicity in the state's waters.

Another aspect of the OP pesticide toxicity issue which will likely influence its regulation is that several California Regional Boards, as well as the US EPA for the San Francisco Region, have used aquatic life toxicity and/or the concentrations of diazinon/ chlorpyrifos as a basis for listing a waterbody on the 303(d) list of impaired waterbodies. This listing initiates the Total Maximum Daily Load (TMDL) process for the ultimate control of the OP pesticides to eliminate the toxicity. The Santa Ana Regional Water Quality Control Board has to develop a TMDL for OP pesticide-caused toxicity as it may impact the beneficial uses of San Diego Creek and Upper Newport Bay in Orange County by 2002.

The OP pesticide aquatic life toxicity issue will be resolved through either regulatory channels, which will allow the use of OP pesticides and still have some stormwater runoff toxicity, or through source control at the place where the pesticides are used, possibly including reformulation and/or restrictions on their use that lead to their presence in stormwater runoff from areas where they are used. Because of the complexity of the regulatory issues, it is unlikely that the OP pesticide toxicity issue will be used to trip the BMP ratcheting-down process to achieve water quality standards in urban area and highway stormwater runoff in the near future.

Nutrients

One of the more common bases for listing a waterbody as impaired and thereby initiating the TMDL process is the presence of excessive nutrients, nitrogen and phosphorus compounds, which lead to excessive growth of algae and/or other aquatic plants. While most of the US focuses excessive fertility (eutrophication) control programs for fresh waters on phosphorus control, since it is the key limiting element governing maximum algal biomass development, in California, nitrogen, in the form of nitrate and ammonia, is the key limiting element for algal growth in fresh waters and marine waters. Therefore, eutrophication control programs in California will likely focus primarily on controlling nitrate input to fresh and marine waters. The excessive fertilization of near-shore marine waters in most of the US and other countries, will typically be focused on nitrate input to those waters.

As a result of environmental group litigation and a settlement agreement between the US EPA Region IX and an environmental group, the Santa Ana Regional Water Quality Control Board has already adopted a Phase I TMDL for controlling nitrogen and phosphorus inputs to Upper Newport Bay in Orange County, California. This TMDL was developed on a crash program without having adequate time to formulate a proper nitrate load-eutrophication response relationship for Upper Newport Bay. Within a few years, most areas of California, and, for that matter, many other parts of the US, will be developing and implementing TMDLs for nitrogen/phosphorus compounds. Many urban area stormwater runoff water quality management agencies will become involved in the TMDL process, where they will be expected - required to remove nitrogen from the stormwater runoff. This can be extremely expensive, since there is no readily-available, inexpensive technology for nitrate removal.

There are a number of aspects of developing appropriate TMDLs for nutrients (nitrogen and/or phosphorus) that need to be evaluated, the most important of which is the hydraulic residence time of the waterbody for which the nutrient TMDL is being developed. The hydraulic residence time is the volume of the waterbody divided by the inflow rate. It is a measure of how long the water and conservative - nonreactive chemicals spend in the waterbody water column before being flushed out. There will be a number of situations like Upper Newport Bay where nitrate added to the Bay in stormwater runoff was initially exempted from the TMDL limitations, since the runoff enters the Bay during the late fall,

winter, and early spring, when the excessive algal problem is not present in the Bay. The excessive algae growth problem is a summer problem. The nitrate added during the fall, winter, and early spring is flushed through the Bay by tidal action in about 10 days, and is therefore not available to impact the summer algal growth situation (Lee, et al., 1999a).

There will be other situations, however, where the hydraulic residence time of the waterbody will be such that the annual nitrate or phosphate load to the waterbody will be the load that determines the nutrient available to support algal growth during the late spring and summer. Under those conditions, urban stormwater runoff could have to be treated to control nitrate/phosphate input. The cost of significant nitrate control, however, is likely to be sufficiently great so that, through either US EPA or California Porter-Cologne economic considerations, it will be determined that it is not economically affordable for the urban public to implement a BMP nitrate-removal system that would control the nitrate input to a waterbody.

The excessive fertilization problems that could cause urban stormwater runoff water quality management agencies to initiate nitrate control through the BMP ratcheting-down process do not necessarily have to occur in the receiving waters for the stormwater runoff. The people in the Sacramento area, as well as other communities in the Sacramento and San Joaquin River systems could find that they have to remove nitrate from their stormwater runoff in order to reduce the frequency and severity of algal taste and odor problems that occur in water supply reservoirs in the Los Angeles and San Francisco areas. The algal problems in the Sacramento River system and Delta are minimal. The major problems are in domestic water supply reservoirs in the San Francisco Bay region and in southern California that use Delta water as a source of supply. Through the CALFED process, the water utilities are already calling for nutrient control programs, including urban stormwater runoff in the Sacramento and San Joaquin River systems, in order to reduce the cost of treatment to control tastes and odors caused by algae that develop in the water supply reservoirs.

Another of the key issues that should be evaluated in developing a eutrophication control program is whether the control of urban stormwater runoff-associated nitrate and/or phosphate represents a sufficient reduction of nitrate/phosphate load to the waterbody during the critical periods of the year to cause an impact on the excessive fertility-related water quality of the waterbody. In many situations, appreciable nitrate/ammonia will be added to the waterbody from agricultural runoff and domestic wastewater sources to be the dominant source of nitrate governing excessive fertilization of a waterbody. It is unlikely that regulatory programs are going to be put in place in the foreseeable future that will require agriculture other than feedlots and dairies to significantly control nitrate export from the land. However, efforts are beginning to be made along these lines in the Ohio River and Mississippi River watersheds. These efforts are directed to the low dissolved oxygen problem in the Gulf of Mexico, where a large area of anoxia (low dissolved oxygen)

has developed due to nitrate input from the Mississippi River system derived primarily from agricultural runoff that leads to excessive growths of algae in the Gulf of Mexico.

The algae die, settle to the bottom, decompose, and thereby consume the oxygen in the bottom waters of a part of the Gulf, leading to the anoxic conditions. If significant control of nitrate and ammonia from agricultural lands is achieved in the Mississippi River drainage system, then similar programs will likely be initiated in other aareas, including California. At that time, which will likely be several decades in the future, urban stormwater water quality management agencies could be in the position of having to justifiably control nitrate concentrations in the stormwater runoff.

As part of the implementation of the Clean Water Action Plan that was adopted last winter by the US EPA (1998), the Agency announced in June 1998 that it is going to require that all states adopt nutrient-based numeric water quality standards. As announced last August, these criteria will be implemented like heavy metal criteria or toxics. If and when this occurs, urban area and highway stormwater runoff water quality management agencies will likely have compliance problems meeting the standards that are based on these criteria, since the concentrations of nitrogen and phosphorus typically present in urban area stormwater runoff will almost certainly be greater than the typical worst-case-based criterion/standard value that the US EPA is proposing to develop. Lee and Jones-Lee (1998c) have discussed the significant technical problems with the US EPA's proposed approach for regulating nutrients under the Clean Water Action Plan. For now, it is important that NPDES-permitted stormwater runoff water quality management agencies become involved in an effort to try to get the Agency to abandon its current "National Strategy for the Development of Regional Nutrient Criteria" and focus eutrophication management on site-specific evaluations of the key nutrient loads to a waterbody that lead to the excessive fertility.

Dioxins

Dioxins are part of a group of chlorinated hydrocarbons such as PCBs, DDT, and chlordane, that tend to bioaccumulate in fish tissue to a sufficient extent to cause the fish to be considered a health hazard to those who consume them as food. Some fish in San Francisco Bay have been found to contain excessive dioxins. Also, stormwater runoff from streets and highways has been found (CRWQCBSF, 1997) to contain readily measurable amounts of dioxins. Recently the US EPA has announced that it will require that certain dioxin sources begin to develop management programs to reduce the load to the Bay, either through wastewater discharges or atmospheric transport. It is possible that the US EPA Region IX will require the stormwater management agencies in the Bay Area to monitor dioxin input as part of a management program for the excessive dioxin in some Bay fish. It is possible that within a few years stormwater management agencies in some areas will be conducting expensive monitoring programs to define the load of dioxin in urban area street and highway stormwater runoff.

One of the key issues that needs to be addressed is whether urban area and highway stormwater runoff-associated dioxin is in a bioavailable form. Studies on the bioavailability of urban area and highway stormwater runoff dioxins should be initiated in order to determine if the dioxin in stormwater runoff is, in fact, significantly contributing to the excessive concentrations in Bay fish.

The other chlorinated hydrocarbons that tend to bioaccumulate to hazardous levels within edible fish tissue, such as PCBs and the chlorinated hydrocarbon pesticides, DDT, chlordane, etc., may cause urban stormwater runoff water quality standards compliance problems. The organochlorine pesticides have been widely used in urban areas and are present in urban soils. Whether there is sufficient flux of these chemicals today in stormwater runoff to contribute to the excessive bioaccumulation problem that is occurring in some areas, such as San Francisco Bay, is unknown. As with mercury, the analytical methods that are typically used for these chemicals are inadequate to determine their concentrations in stormwater runoff that could lead to excessive accumulation in fish tissue.

There is need to develop high-quality data on urban area stormwater runoff to those waterbodies where fish have excessive concentrations of the bioaccumulatable chlorinated hydrocarbons to determine whether urban area stormwater runoff today is potentially a significant contributor to these problems. If it is found that the total concentrations of any of the chlorinated hydrocarbons that are bioaccumulating to excessive levels in a waterbody's fish are present in urban area stormwater runoff above water quality standards, then studies need to be done to determine whether these constituents are present in bioavailable forms, and thereby contribute to an excessive bioaccumulation problem.

Sediment-Associated Constituents

Some California Regional Boards such as the LA Region have used increased concentrations of constituents in sediments as a basis for placing a waterbody on the 303(d) list of impaired waterbodies. The approach that has been used by the LA Region in selecting the critical concentrations of heavy metals and other constituents in sediments to cause this listing is well known to be technically invalid. It involves the use of co-occurrence-based values, which are known to be less reliable in predicting sediment toxicity than flipping a coin. However, unless the listing is changed, the LA Regional Board will be developing TMDLs which will cause urban area stormwater dischargers to be out of compliance with respect to discharge limitations, and to initiate control of the particulate heavy metals and possibly other constituents in the stormwater runoff.

O'Connor (1999) has recently summarized the unreliability of co-occurrence-based sediment quality guidelines of the type that the US EPA is developing, in predicting sediment toxicity. Lee and Jones-Lee (1993, 1996d) have provided extensive discussions of these issues, where they recommend that sediment quality evaluation should be based

on biological effects-based testing, such as toxicity tests, rather than on chemical measurements in which there is an attempt to try to estimate toxicity based on chemical concentrations found in sediments.

Similarly, the State Water Resources Control Board's recently-adopted BPTCP Policy (WRCB, 1998a, b) governing the identification and control of toxic hot spots in the state's waters has similar, significant technical deficiencies in designating and ranking toxic hot spots. Some environmental groups are calling for revisions of the toxic hot spot list to include areas that are directly impacted by particulates derived from urban stormwater runoff, based on the fact that they accumulate in sediments, causing the sediments to have elevated concentrations of heavy metals and other potential pollutants. As discussed by Lee (1998b, c), urban stormwater runoff water quality management agencies could readily find compliance problems associated with having to control particulates in stormwater runoff, since there is an "association" between a constituent that exceeds an arbitrarily-established concentration in sediments that is "associated" with sediment toxicity, and constituents present in the runoff.

The US EPA, as part of its national sediment quality management strategy, is developing guidelines for sediment quality that can ultimately lead to compliance problems for urban stormwater runoff water quality management agencies. The Agency, in implementing its sediment quality management strategy, is opting for administratively simple but unreliable sediment quality characterization based on chemical concentration-based methods to estimate toxicity, rather than on measuring toxicity directly. This will lead to inappropriate limitations on urban area stormwater runoff-associated constituents, since some of these constituents accumulate in receiving water sediments.

Revised Water Quality Criteria/Standards

The US EPA is in the process of revising a number of water quality criteria, such as for mercury, selenium, and arsenic, which could cause urban stormwater runoff water quality management agencies to experience additional stormwater standard compliance problems. Of particular concern is arsenic. It is likely that the current water quality standard for arsenic of 50 µg/L will be decreased to about 2 µg/L, based on the potential of arsenic to cause cancer through consumption of drinking water. If this occurs, there will be stormwater runoff compliance problems for some urban area stormwater management agencies, since arsenic occurs in some urban stormwater runoff at concentrations greater than 2 µg/L.

Overall

From the information available at this time, it can be concluded that some urban area and highway stormwater runoff-associated constituents have the potential to cause water quality standards exceedances. They also can cause exceedances of TMDLs for constituents causing 303(d) listings of impaired waterbodies. However, these exceedances do not necessarily reflect real significant water quality use impairments that

the public would perceive as impairments of the beneficial uses of the waterbody that should result in the significant expenditure of public funds for their control.

Several of the projected exceedances can be classified as "administrative" exceedances that are related to the overly-protective nature of the US EPA worst-case-based water quality criteria that serve as the basis for water quality standards and stormwater runoff discharge limits. A number of the exceedances will disappear when appropriately developed water quality standards are used to regulate urban area and highway stormwater runoff. It is likely that, through the use of US EPA procedures for adjusting water quality standards to site-specific conditions, many of the "administrative" exceedances will no longer occur. Further, through US EPA-proposed changes in implementation of water quality criteria into state standards and discharge limits such as the elimination of the Independent Application Policy for chemically-based water quality standards, urban area and highway stormwater runoff will be found to be in compliance with appropriate water quality standards that will be protective of the beneficial uses of the receiving waters for the runoff.

There may be some situations, such as those for the protection of contact recreation during the winter months from excessive fecal coliform concentrations in stormwater runoff, that will be found to be excessively expensive to control. Under these conditions, variances or other administrative procedures can be developed that will eliminate the exceedance of a water quality standard based on economic considerations.

There are, therefore, a variety of mechanisms that can and should be explored as part of the BMP ratcheting-down process for addressing the projected exceedances of water quality standards associated with urban area and highway stormwater runoff. Draft suggested guidance on how the BMP ratcheting-down process should proceed, which includes discussion of these mechanisms, is being prepared and will be available in a future issue.

Stormwater Runoff Water Quality Short Course

A two-day Stormwater Runoff Water Quality Management short course was presented Dr. G. Fred Lee and Mr. Scott Taylor of RBF in mid-November 1998 in Orange County, CA. Local arrangements were made by Chris Crompton, Manager Environmental Resources, Orange County Public Facilities and Resources Department. The course was attended by 36 individuals primarily representing the Orange County NPDES stormwater permit co-permittees. Based on the participants' course evaluations forms, the course was well-received. Plans are being made to offer this course in the Los Angeles area where the Los Angeles County Environmental Project Division - Water Quality Los Angeles Department of Public Works would be the local sponsor. Information on the course content is available from http://members.aol.com/gfredlee/gfl.htm. The course in devoted to providing an overview of the technical background to the BMP ratcheting-down process to achieve water quality standards in a technical valid, cost-effective manner. The course

can be offered to at a location where a local sponsor will make arrangements. Those interested in attending this course should contact Dr. Lee regarding future presentations.

Announcements

The International Association on Water Quality/International Association Hydraulic Research Specialist Group Urban Storm Drainage has developed a newsletter. This newsletter is available at http://www.iawq.org.uk/newsletter1/udnews12.pdf. Those interested in how urban stormwater runoff water quality issues are addressed in other countries may wish to review that newsletter.

Comments and Contributions

Comments and contributions to this Newsletter are welcome. Please send contributions or comments to G. Fred Lee at gfredlee@aol.com.

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Additional Information

Additional information on these topics is available from http://members.aol.com/gfredlee/gfl.htm.