Appropriate Application of Water Quality Standards to Regulating Urban Stormwater Runoff

G. Fred Lee*, PhD, PE, DEE and Anne Jones-Lee, PhD
G. Fred Lee & Associates, 27298 E. El Macero Dr.
El Macero, CA 95618

ABSTRACT

The US EPA has determined that NPDES-permitted urban area and highway stormwater runoff must ultimately be treated to control chemical and other constituents in the runoff waters so they do not cause or significantly contribute to the exceedance of a water quality standard in receiving waters. This approach is being implemented in a stormwater runoff best management practice (BMP) ratcheting-down process where when an NPDES-permitted stormwater runoff water quality manager finds that a chemical constituent or pathogenic organism indicator, such as total or fecal coliform, causes or contributes to a violation of a water quality standard in receiving waters for the runoff, the stormwater manager must modify its stormwater management plan to implement additional BMPs designed to eliminate the exceedance of the water quality standard in the receiving waters associated with urban area and highway stormwater runoff. It has been found that this BMP ratcheting down process will ultimately cost communities tens of millions to a hundred billion or more dollars in retrofitting urban area and highway stormwater runoff conveyance structures with advanced wastewater treatment systems to treat stormwater runoff to comply with ultimately having to control the concentrations of chemical and other constituents in the runoff that cause water quality standards violations in the receiving waters for the runoff. This paper addresses the appropriateness of using US EPA water quality criteria as goals for urban area and highway stormwater runoff water quality management and presents an alternative, more cost-effective approach for regulating urban area and highway stormwater runoff that focuses on controlling real water quality use impairments in the receiving waters for the runoff.

KEYWORDS

water quality standards, stormwater, beneficial uses, cost-effective control

INTRODUCTION

The federal Clean Water Act prohibits NPDES-permitted wastewater discharges from causing ambient water quality standard violations in the receiving waters for the discharge. This approach is being used to regulate point source discharges of domestic and industrial wastewaters. The US EPA (1990) implemented a national urban area and highway stormwater runoff (UAHSR) water quality management program which requires that pollution of the receiving waters by stormwater runoff from permitted areas be controlled to the maximum extent practicable (MEP) using best management practices (BMPs). Urban areas above a certain population (Phase I-100,000) and highway stormwater runoff management entities are issued NPDES permits for these discharges.

The US EPA (1998) has recently promulgated proposed Phase II regulations which will regulate urban area stormwater runoff from smaller communities. Under current regulatory requirements, urban area and highway Phase I NPDES-permitted stormwater discharges must ultimately meet traditional point source discharge Clean Water Act requirements of not causing exceedances of water quality standards in the receiving waters for the discharge. NPDES-permitted stormwater dischargers must ultimately, through a BMP ratcheting down process, achieve sufficient treatment of the runoff so that there is no more than one exceedance of a water quality standard every three years.

California NPDES-permitted Phase I dischargers are about five years ahead of most of the U.S. in implementing their stormwater runoff water quality management programs. Many of these dischargers are into their second five-year NPDES permits. As part of the State Water Resources Control Board's review of the "receiving water language" in recently developed permits, there has been considerable discussion about the appropriateness of requiring that Phase I and ultimately Phase II permitted dischargers treat the runoff waters to meet water quality standards in the runoff with no more than one exceedance of any magnitude of a water quality standard every three years. As discussed by Jones-Lee and Lee (1998), several California communities have conducted studies or have made evaluations of the potential for the US EPA's Phase II six Minimum Control Measures as well as traditional structural BMPs such as detention basins and filters to treat urban area stormwater runoff so that it will not cause violations of water quality standards in the receiving waters for the runoff. They have concluded that advanced wastewater treatment technology will have to be used to treat the stormwater runoff to meet water quality standards in the discharge waters. The estimated cost of such treatment or retrofitting existing stormwater runoff conveyance structures range from hundreds of millions of dollars for smaller communities with populations in the order of one to two million, to approximately a hundred billion dollars for the Los Angeles area. In some communities, such as Sacramento, California, this would cause urban dwellers regulated under the NPDES stormwater permit to have to spend about $1 per person per day in perpetuity to achieve the required degree of constituent control in UAHSR.

Based on historical data as well as current urban stormwater runoff monitoring results from Phase I communities, it is becoming increasingly clear that exceedance of a water quality standard such as for a heavy metal (copper, zinc and lead) does not necessarily translate into a water quality use impairment of the receiving waters for the stormwater runoff. Copper, zinc and lead are of concern in urban area and highway stormwater runoff because of the potential toxicity to aquatic life within the receiving waters for the runoff. Several Phase I communities have found through their stormwater runoff water quality monitoring programs that the copper, zinc and lead which is present in the runoff waters at concentrations above US EPA water quality criteria and state standards based on these criteria, are in non-toxic, non-available forms. It is concluded that the exceedance of the water quality standards for these heavy metals is an administrative exceedance arising from the overly-protective, worst-case characteristics of US EPA water quality criteria and state standards based on these criteria. While not as well documented, similar results are being found for various types of regulated organics in urban area stormwater runoff.

Urban area stormwater runoff throughout California is being found to violate the State Water Quality Control Board's narrative requirements of no aquatic life toxicity in the discharge waters. Through Toxicity Investigation Evaluation (TIE) studies, it has been found that the toxicity in urban area stormwater runoff in numerous communities in California is due to unregulated organophosphate pesticides (diazinon and chlorpyrifos) used by homeowners for structural (termites and ants) and lawn and garden pest control.

It is apparent that there are significant problems with using US EPA water quality criteria and state standards based on these criteria as the BMP ratcheting down goals for urban area and highway stormwater runoff. This approach tends to over-regulate the regulated constituents, i.e. those for which there are water quality criteria/standards, and under-regulate chemical constituents in the stormwater runoff which are potentially causing significant water quality problems in the receiving waters for the runoff.

INAPPROPRIATENESS OF USING US EPA WATER QUALITY CRITERIA FOR URBAN STORMWATER RUNOFF WATER QUALITY MANAGEMENT GOALS

The nature of UAHSR at times having high flows for short periods of time and then extended periods with no flow would require the construction of large collection, storage and treatment works based on advanced wastewater treatment technology to treat UAHSR to the same degree as is being used for traditional point source discharges of domestic and industrial wastewaters. While it has been possible to require that traditional point source dischargers of wastewaters achieve this degree of treatment, i.e. no exceedance of a water quality standard in the receiving waters at the edge of a mixing zone, if allowed, more than once in three years, it is recognized that that approach often leads to unnecessary expenditures for wastewater effluent constituent control. The application of traditional point source discharge requirements to UAHSR would lead to an even more over-protective situation due to the short-term, episodic nature of stormwater runoff and the fact that many of the constituents of potential concern in stormwater runoff from urban areas and highways are in particulate, non-toxic, non-available forms.

The US EPA (Perciasepe, 1996), in an attempt to address this situation, has determined that while NPDES -permitted UAHSR must meet Clean Water Act requirements of not causing exceedances of water quality standards in the receiving waters for the runoff, such exceedances do not represent a violation of the NPDES permit that requires immediate compliance or the stormwater runoff water quality managers facing fines and/or imprisonment. The situation has therefore evolved to one of using US EPA water quality criteria and state standards based on these criteria as goals for implementing BMPs to control "pollution" to the MEP through a BMP ratcheting-down process that is expected to take from five to ten years.

One of the most significant fundamental problems with the current UAHSR water quality impact evaluation and management program is a proper assessment of the pollution caused by such runoff-associated constituents. Far too often a chemical constituent, such

as a heavy metal, that has been found at a location in a waterbody at some time to be adverse to aquatic life in that waterbody and therefore is appropriately labeled a pollutant that impairs use of that waterbody, is assumed to be adverse to aquatic life in another waterbody at all times where it causes an exceedance of a water quality standard at the point where stormwater runoff from an urban area or highway enters a waterbody. Under these conditions, chemical constituents, irrespective of their chemical forms and duration of exposure, are considered to be pollutants. Obviously, such an approach is technically invalid and can result in massive waste of public and private funds in developing treatment works for chemical constituents in UAHSR that are not adverse to the designated beneficial uses of the receiving waters for the runoff.

THE CHARACTERISTICS OF US EPA WATER QUALITY CRITERIA

The US Congress in 1972, as part of revising the federal Water Pollution Control Act, PL 92-500, established the requirement that the US EPA must develop water quality criteria that can be used by the states as the basis for formulating state water quality standards. These standards consist of a designated beneficial use of a waterbody and the associated criteria necessary to protect that use. These standards are used by the delegated states to develop NPDES permit discharge limits for regulated constituents, i.e. those for which there are water quality criteria. Congress, as part of formulating the revised federal Water Pollution Control Act, also required that the US EPA develop a list of chemical constituents that are known to cause water quality use impairments in the nation's waters. This requirement ultimately led to the Priority Pollutant list. The US EPA was required to develop water quality criteria for the Priority Pollutants.

Beginning in the early 1970s, the National Academies of Science and Engineering organized panels of experts to formulate water quality criteria designed to protect various beneficial uses of waterbodies. This effort ultimately led to the NAS/NAE "Blue Book of Water Quality Criteria" that was published in 1973.(NAS/NAE, 1973). The US EPA used the NAS/NAE "Blue Book" criteria as the basis for formulating the Agency's 1976 "Red Book of Water Quality Criteria." The "Red Book" criteria were designed to meet the congressional mandate of developing water quality criteria as part of implementing the revisions of the federal Water Pollution Control Act adopted in 1972. The National Academies and subsequently the US EPA adopted the approach of developing water quality criteria based on worst-case or near worst-case assumptions for how the chemical constituent could impact the beneficial uses of a waterbody. Of particular concern was the need to protect aquatic life from chronic exposure to toxic, available forms of potentially toxic constituents. For chemicals that are of concern because of their potential to bioaccumulate in edible fish tissue to sufficient concentrations to represent a health hazard to those who eat the fish, the criterion value was based on worst-case conditions of the constituent being 100% in an available form and that there was sufficient time for the aquatic organism to bioaccumulate the chemical to achieve steady-state tissue residues.

An important aspect of the "Red Book" criteria that has important implications for UAHSR water quality management is that the National Academies and the US EPA

determined that there was no way to reliably regulate potentially toxic heavy metals in wastewater discharges based on measurement of their chemical concentrations. NAS/NAE and the US EPA (1976) recommended that toxicity tests be used to determine whether heavy metals, such as copper, zinc, cadmium, and lead, present in a wastewater discharge were in toxic available forms and would therefore cause aquatic life toxicity in the receiving waters for the discharge that could impair the beneficial uses of these waters. In the early 1980s, the US EPA abandoned the regulation of heavy metals in wastewater discharges based on their toxicity and adopted chemical-specific, worst-case or near worst-case water quality criteria as the basis for regulating heavy metals in wastewater discharges where the criterion value for the heavy metal is not to be exceeded in the receiving waters for the discharge more than once every three years. The criteria developed from this approach were typically based on toxicity tests in which 100% available forms of the chemical constituent of concern were tested for chronic - extended exposure conditions. While this worst-case approach was appropriate for regulating wastewater discharges which contained concentrations of chemical constituents in 100% available forms over extended periods of time, it tended to significantly over-regulate short-term pulses of chemical constituents which were rapidly diluted in the receiving waters before the aquatic life exposed to the constituents could receive a chronic exposure. It also significantly over-regulated discharges of chemical constituents that are in non-toxic, non-available forms which remain in these forms in receiving waters for the discharge. This approach, while providing a technically valid basis for developing national water quality criteria for protecting aquatic life from potential toxicity and excessive bioaccumulation under worst-case conditions, did not provide a basis for adjusting these worst-case criteria to properly consider the fact that many sources of chemical constituents that are potential pollutants contain the chemical constituents in non-toxic, non-available forms.

The US EPA as part of developing implementation approaches for the worst-case criteria adopted a number of implementation approaches such as a one-hour average criterion and a four-day average criterion for acute and chronic criteria which may superficially cause someone not familiar with how chemical constituents impact aquatic life to believe that the criteria are appropriate for determining a water quality use impairment when the criterion value is exceeded. Those familiar with this topic area know that the translation of the acute toxicity test results which are typically based on four days of exposure to one hour and the translation of chronic exposure to four days significantly over-estimates the actual toxicity/bioaccumulation that will occur for most, if not all, chemicals for which criteria have been developed. The one-hour and four-day averages to represent acute and chronic toxicity were arbitrarily developed based on perceived worst-case conditions for one chemical (ammonia). Now, all other chemicals are being regulated based on this approach. Actually, ammonia is being grossly over-regulated by this approach as well. Concentrations of toxic available forms well above the criterion values can be present in a water without adverse impact to aquatic organisms. This highly significant, over-regulation is of particular importance to regulating UAHSR since this runoff typically contains chemical constituents such as heavy metals in non-toxic, non-available forms and the aquatic life present in the vicinity of the discharge for stormwater runoff are

typically only exposed to short-term pulses of toxic/available forms which are generally less than those that were used to develop the criterion values.

Another significant cause of over-regulation associated with the implementation of the US EPA worst-case water quality criteria is that no more than one exceedance of any magnitude of a criterion/standard value may occur once every three years. Short-term pulses of aquatic life toxicity can and do occur without being significantly adverse to the aquatic life-related beneficial use of the waterbody.

Some Agency personnel and others understand the significant over-regulation problems associated with how the US EPA water quality criteria are being implemented into state standards and NPDES discharge limits. The Agency has been working toward correcting this over-regulation. However, thus far, except for adopting dissolved metals for regulating certain potentially toxic heavy metals, the Agency has not yet developed an implementation approach for regulated chemical constituents that will protect designated beneficial uses of waterbodies without significant unnecessary expenditures for chemical constituent control This problem is particularly significant for urban area and highway stormwater runoff.

APPROPRIATE USE OF POLLUTION CONTROL FUNDING

In situations where there is a large surplus of funds available for managing environmental problems and there are no other significant social problems which need funding, it may be acceptable to conclude that as part of "pollution" prevention it is appropriate to control heavy metals and other constituents in UAHSR, even though no real water quality use impairment problem has been found due to these constituents, so that the receiving waters for such runoff do not have exceedances of water quality standards for regulated chemicals more than once in three years at the point where the stormwater runoff enters the receiving waters. However, today where there are significant societal problems for which there is need for funds and there are limited funds available for water pollution control, it is important to focus the funds available on managing real, significant water quality use impairments of the receiving waters for UAHSR. This should require a prioritization of funding to control water quality problems in a waterbody in terms of their importance to impairment of the designated beneficial uses. It should also include funds to search for subtle problems that have not yet been recognized, as well as new problems that develop because of the use of new or expanded use chemicals that become part of the urban area and highway stormwater runoff.

WHY URBAN AREA AND HIGHWAY STORMWATER RUNOFF SHOULD BE REGULATED DIFFERENTLY

A critical review of how US EPA water quality criteria were developed relative to the characteristics of UAHSR -associated constituents shows that, in general, significant exceedances of water quality standards based on US EPA water quality criteria can occur in UAHSR without adversely impacting the designated beneficial uses of the receiving waters for the runoff. This situation arises from two characteristics of US EPA criteria.

The first of these is the aquatic chemistry of the constituents in the toxicity testing used to establish the criteria for potentially toxic chemicals. UAHSR-associated constituents are largely in particulate forms and have been, in general, demonstrated repeatedly since the 1960s to be non-toxic and non-available and be adverse to aquatic life through potential toxicity or to public health through bioaccumulation in aquatic organism tissue used as food.

The short-term, episodic nature of UAHSR relative to the duration of time used in the toxicity tests or the period of time necessary to achieve significant bioaccumulation of the constituents of concern is short compared to the time necessary to be adverse to aquatic life or to accumulate hazardous levels of chemicals in the aquatic organism tissue. While the US EPA water quality criteria and state standards based on these criteria have one-hour exposure criterion values, it is understood that these one-hour exposure concentrations, i.e. acute criterion, do not properly represent the real exposures that can occur for most constituents to aquatic life without adverse impact on the organism. Therefore, exceedance of a water quality criterion at the point where stormwater runoff from urban areas and highways occurs should not be interpreted to mean that this exceedance represents a potentially significant impairment of the designated beneficial uses of the receiving waters for the runoff.

For potentially toxic chemicals, in order for this exceedance to be of significance to the public who must ultimately pay for controlling constituents in UAHSR, it must significantly alter the numbers, types and characteristics of desirable forms of aquatic life. For potentially toxic chemicals, this means that the stormwater runoff should be toxic at the point of discharge and the toxicity should persist for a sufficient period of time and over a sufficient area to be significantly adverse to aquatic life within this area and that these adverse impacts are manifested in terms of reduced numbers of aquatic organisms of concern to the public.

For chemicals of concern because of potential bioaccumulation, such as mercury in UAHSR, the concentrations of mercury in such runoff, either alone or in combination with mercury in a bioaccumulatable form already in the receiving waters, should result in excessive bioaccumulation of mercury in edible organism tissue that causes or could cause a human health advisory to be issued for the use of the organisms as food. Eventually as wildlife-based critical tissue concentration criteria are established, consideration of the bioaccumulation impacts of constituents on wildlife should be included in evaluating whether whole organism tissue residues are potentially adverse to wildlife.

One of the most significant problems associated with the use of exceedances of water quality criteria/standards to judge potential water quality problems from UAHSR is that only a limited number of the chemical constituents present in UAHSR are regulated, i.e. for which there are water quality criteria. There is growing evidence that the primary constituents of concern in urban area stormwater runoff should be unregulated chemicals for which there are no criteria, such as some of the organophosphate pesticides (diazinon), as well as other pesticides and fungicides.

Lee and Jones-Lee (1995a) have discussed the appropriate use of numeric chemically-based water quality criteria. They have also discussed the problems with the US EPA's Independent Applicability Policy in regulating chemical constituents derived from UAHSR (Lee and Jones-Lee, 1995b). Based on a review of the characteristics of US EPA water quality criteria and UAHSR, it may be concluded that using US EPA water quality criteria as goals for regulating regulated chemical constituents in UAHSR can lead to technically invalid approaches. Further, their use can inappropriately focus control programs on inert constituents of limited water quality significance, while at the same time fail to identify important constituents in UAHSR that are adverse to the beneficial uses of a waterbody receiving such runoff, such as the organophosphate pesticides.

ALTERNATIVE GOALS FOR STORMWATER RUNOFF WATER QUALITY MANAGEMENT

An alternative approach for developing more technically valid, cost-effective management of real water quality problems associated with UAHSR involves examining the receiving waters for adverse impacts in what is called an "Evaluation Monitoring" program. As discussed by Lee and Jones-Lee (1996a; 1997a,b,c), rather than measuring a suite of heavy metals and other constituents that are of concern because of their potential toxicity to aquatic life at the edge of the pavement for UAHSR as it enters a particular waterbody, Evaluation Monitoring measures toxicity using sensitive species in standard toxicity tests. The toxicity assessment involves the use of the same kinds of tests that have been used to establish the water quality criteria, and therefore the organisms are responding to the same types of impacts as are protected by the criteria. Evaluation Monitoring focuses on toxicity and considers such issues as the fate, areal extent and persistence of toxicity within the receiving waters to determine whether toxicity in a stormwater discharge occurs in the receiving waters to a sufficient degree to be potentially adverse to aquatic life in the waterbody. Toxicity due to the unregulated chemicals, such as organophosphate pesticides, is also assessed in the Evaluation Monitoring program through the direct measurement of toxicity.

Evaluation Monitoring considers not only toxicity, but also addresses bioaccumulation through direct measurement of excessive tissue residues in organisms. If excessive concentrations of chlorinated hydrocarbons or mercury are found, then the source(s) of the constituents specifically responsible for the available forms that are bioaccumulating to excessive levels is determined through forensic studies within the waterbody and watershed.

Evaluation Monitoring is implemented as a watershed-based regulatory agency, stormwater discharger, environmental group and public stakeholder program that focuses on finding significant water quality use impairments in the receiving waters for the stormwater runoff that warrant the public's expenditure of funds for pollutant control using site-specific BMPs to the MEP. In addition to considering toxicity and bioaccumulation, all other use impairments such as excessive fertilization, sanitary quality problems associated with contact recreation, impairment of domestic water supply raw water quality, excessive siltation, turbidity, aesthetic quality, oil and grease

accumulation and litter, etc. are evaluated with respect to their significance in causing use impairments of a particular waterbody.

Basically, in accord with recommendations of Lee and Jones-Lee (1995a,b), US EPA water quality criteria and state standards based on these criteria are used in the Evaluation Monitoring approach as guides to potential water quality problems for the regulated chemicals and narrative standards. If an exceedance of a water quality criterion/standard is found, then the waterbody is examined to determine whether the potential problem associated with that exceedance is, in fact, occurring due to the constituent causing the exceedance. For example, the concentration of copper in UAHSR is typically above the US EPA water quality criterion for protection of aquatic life from toxic effects. However, the criterion value is based on essentially 100% available/toxic forms of copper where the organisms were exposed for extended periods of time. It is being found repeatedly that the copper in UAHSR is in a non-toxic, non-available form and that the duration of exposure to the concentration above the criterion value is normally short compared to the exposure necessary to be toxic to aquatic life if the copper in the stormwater runoff were in a toxic form. Therefore the copper in the UAHSR is a chemical constituent but not a pollutant since it does not cause toxicity in the receiving waters for the stormwater runoff. A violation of Clean Water Act water quality requirements by the exceedance of the copper criterion/standard in UAHSR does not cause pollution, and therefore there should be no need to develop a BMP to control the copper input to the waterbody until such time as a real, significant use impairment due to copper is found.

A similar situation exists with respect to lead in UAHSR. The concentrations of lead in such runoff frequently exceed the US EPA water quality criterion. However, repeated studies over the years have demonstrated that the lead in UAHSR is in a non-toxic, non-available form and therefore does not cause an impairment of the designated beneficial uses of the receiving waters for the runoff.

There are some who argue that the US EPA's current recommended approach of regulating heavy metals such as copper and lead based on ambient water dissolved forms is not protective of benthic or epibenthic organisms since the unregulated, particulate forms can accumulate in the receiving water sediments and be toxic to organisms therein. There is widespread agreement, however, that it is inappropriate to try to use US EPA water quality criteria which are designed to regulate impacts of chemicals to aquatic life within a watercolumn to try to regulate chemicals in sediments as they may impact aquatic life. Lee and Jones-Lee (1996b) have discussed approaches that should be used to investigate whether chemical constituents in sediments are causing significant aquatic life toxicity that would require sediment remediation and/or control of the input of particulate contaminants that tend to accumulate in receiving water sediments. Through direct toxicity and bioaccumulation measurements, it is possible to reliably determine whether sediments are toxic to aquatic life and/or serve as a significant source of bioaccumulatable chemicals.

THE DEVELOPMENT AND IMPLEMENTATION OF A STORMWATER RUNOFF WATER QUALITY MANAGEMENT PROGRAM

The typical approach being used by many stormwater runoff water quality managers is to assume that the exceedance of a water quality criterion in the runoff waters represents a significant adverse impact on the receiving waters that requires control of the constituent responsible for the exceedance. Some communities are spending substantial funds identifying the sources of constituents that cause an exceedance of a US EPA criterion/state standard without first determining whether the exceedance is an administrative exceedance which reflects the overly-protective nature of US EPA criteria and state standards based on these criteria or represents a real water quality use impairment. As discussed by Lee and Jones (1991), Jones-Lee and Lee (1994)and Lee and Jones-Lee (1998), the first step in any technically valid stormwater runoff water quality impact evaluation and management program should be the determination of whether the exceedance of the standard represents a potentially significant water quality problem. For example, for lead and copper, since both of these are of concern because of their potential toxicity to aquatic life, the toxicity in runoff waters should be assessed. If toxicity is found, then through the use of TIEs, it is possible to determine if the toxicity found is due to copper and/or lead or some other constituents in the runoff waters. It was through this approach that diazinon was found to be a common cause of urban area stormwater runoff toxicity. It was also through this approach that both lead and copper were found to not cause aquatic life toxicity in UAHSR.

While an exceedance of the water quality criterion for copper, lead or other constituents represents a violation of NPDES permit conditions, if it is found through proper studies that this exceedance does not cause a real water quality use impairment, i.e. is administrative, then rather than trying to control the sources of copper and/or lead that are causing administrative exceedances of the water quality criterion/standard, the stormwater manager should focus the resources available on working to obtain a more appropriate regulatory approach than the one being used by the US EPA today to regulate potentially toxic constituents. The Agency's current Independent Applicability Policy requires that NPDES-permitted dischargers control chemical constituents in discharges/runoff that are of concern because of potential toxicity, even though appropriately conducted studies have shown that the constituents are in non-toxic, non-available forms. Administrative exceedances can only be effectively addressed through administrative approaches rather than through very expensive chemical constituent source control and/or treatment.

Evaluation Monitoring shifts the emphasis from chemical constituents that could, in some situations cause water quality problems, to defining real water quality problems - use impairments associated with UAHSR, determining their cause and through forensic studies, the source of the constituents responsible for the problem - use impairment. Rather than using inappropriate water quality criteria/standards as goals for BMP development, which often diverts attention away from real water quality issues of concern to the pubic, Evaluation Monitoring uses the control of significant water quality use impairments as the goal for BMP development. While this approach is different than the traditional chemical constituent approach that the US EPA adopted in the early 1980s, it recognizes what was well known then and is well known today-that aquatic chemistry, aquatic toxicology/biology and hydrodynamics/mixing all play important roles in

determining whether a chemical constituent in a particular discharge/runoff impairs the beneficial uses of a waterbody.

Evaluation Monitoring also points out the inappropriateness of "traditional BMPs" that have been used for UAHSR "water quality" management such as detention basins, filters, etc. to remove particulate forms of constituents such as inert heavy metals and focuses BMP development on source control for those forms of the constituent that are, in fact, causing real use impairments in the receiving waters for the stormwater runoff (Lee and Jones-Lee, 1998). The traditional BMPs were not developed based on finding that they control real water quality problems in the receiving waters for the stormwater runoff; they were developed based primarily on hydraulic considerations which ignored what has been known since the 1970s in the fields of aquatic chemistry, aquatic toxicology and water quality about how chemical constituents impact aquatic organisms and other beneficial uses of waterbodies. Expensive structural BMPs should only be used where it is appropriately demonstrated that they will, in fact, be effective in controlling a real, significant water quality use impairment in the receiving waters for the runoff and appropriate consideration of MEP has been given. The current approach of placing a detention basin or a filter at a stormwater runoff location because it is listed in a BMP manual and has been used in the past at some locations will soon be terminated in favor of finding real water quality problems in the receiving waters for the runoff, determining their cause and developing site-specific BMPs for their control to the MEP.

EVALUATION OF THE EFFICACY OF STORMWATER RUNOFF WATER QUALITY BMPS

Water quality criteria and state standards are often used as goals to determine the efficacy of stormwater runoff water quality structural BMPs to "treat" stormwater runoff. Traditionally, an effective stormwater runoff water quality management BMP is one that results in a lower concentration of regulated constituents than enters the treatment unit. This approach ignores the fact that decreasing the concentration of regulated constituents often has no impact on the beneficial uses of the receiving waters for the treated stormwater runoff. A prime example of this type of inappropriate approach occurs with detention basins and filters which are designed to remove particulate forms of constituents, such as heavy metals. One hundred percent removal of particulate heavy metals in a filter or detention basin, while highly effective in removing total metal content, has no relevance to water quality since the particulate heavy metals removed are inert.

Lee and Jones-Lee (1996c) have discussed the approach that should be used to evaluate the efficacy of BMPs. The effectiveness of BMPs should not be based on across-the-unit percent removals of regulated constituents and/or achieving water quality standards in the discharge, but instead should focus on the improvement in the designated beneficial uses of the receiving waters for the stormwater runoff. This can only be assessed through site-specific investigations of reduced toxicity, reduced bioaccumulation, etc., neither of which can be assessed through measurement of chemical constituents relative to water quality standards.

RELIABILITY OF WATER QUALITY INDICATORS

There is widespread recognition today that the traditional stormwater runoff water quality "monitoring" is ineffective in providing information on what, if any, real water quality problems exist in the receiving waters for the stormwater runoff (Urbonas and Torno,1995; Lee and Jones-Lee, 1995c). Regulatory agencies and stormwater dischargers are shifting their monitoring efforts away from end-of-the-pipe, edge-of-the-pavement monitoring of a suite of chemicals to evaluation of the water quality impacts associated with stormwater runoff-associated constituents in the receiving waters. Recently there have been a number of attempts by the US EPA (1996a,b) and others (Claytor and Brown, 1996) to develop environmental "indicators" that can be used to assess water quality impacts of UAHSR-associated constituents. Caution must be exercised in using this approach since many of the so-called indicators proposed by the US EPA for assessing stormwater quality impacts are not real indicators of water quality problems - use impairments. It is essential in any reliable stormwater runoff water quality impact assessment to focus on use impairments as opposed to using a water quality "indicator" such as an exceedance of a water quality standard that is in some ill-defined way related to water quality issues of concern to the public. The public does not care how much copper or lead is in the water; they are concerned if the copper or lead impairs the use of the water for various purposes. The coupling between the concentration of copper/lead as normally measured and water quality impacts is poorly understood.

CONCLUSION

Because of the confusion that exists today in the role that water quality criteria/standards play in regulating UAHSR water quality impacts, there is an urgent need to revise the Clean Water Act to allow stormwater dischargers and regulatory agencies to focus the water pollution control programs on the goal of defining and solving water quality problems - use impairments. The misguided goal of achieving water quality standards in the receiving waters for the stormwater runoff should be abandoned. Adoption of this approach will result in much more cost-effective, technically valid management of real water quality problems associated with urban area and highway stormwater runoff than is occurring today.

ADDITIONAL INFORMATION

Additional information on the problems with current regulatory approaches for UAHSR and more appropriate regulatory approaches is available from the authors' web site: http://members.aol.com/gfredlee/gfl.htm

REFERENCES

Claytor, R.A. and Brown, W.E. (1996) "Environmental Indicators to Assess Stormwater Control Program and Practices--Final Report." Center for Watershed Protection, Silver Spring, MD.

Jones-Lee, A, and Lee, G. F. (1994) "Achieving Adequate BMPs for Stormwater Quality Management." Proc. 1994 National Conference on Environmental Engineering, "Critical Issues in Water and Wastewater Treatment," America Society of Civil Engineers, New York, NY, pp. #524-531.

Lee, G.F. and Jones, R.A. (1991) "Suggested Approach for Assessing Water Quality Impacts of Urban Stormwater Drainage." Symposium Proceedings on Urban Hydrology, American Water Resources Association Symposium, November 1990, AWRA Tech. Pub. Series TPS-91-4, AWRA, Bethesda, MD, pp. #139-151.

Lee, G.F. and Jones-Lee, A. (1995a) "Appropriate Use of Numeric Chemical Water Quality Criteria." Health and Ecological Risk Assessment, Vol. 1, pp #5-11. Letter to the Editor, Supplemental Discussion, Vol 2, pp #233-234 (1996).

Lee, G.F. and Jones-Lee, A. (1995b) "Independent Applicability of Chemical and Biological Criteria/Standards and Effluent Toxicity Testing." The National Environmental Journal, 5(1):60-63, (1995), Part II, "An Alternative Approach," Vol. 5, Number 2, pp #66-67.

Lee, G.F. and Jones-Lee, A. (1995c) "Deficiencies in Stormwater Quality Monitoring." Proc. Engineering Foundation Conference, American Society of Civil Engineers, New York, NY, pp. #651-662.

Lee, G.F. and Jones-Lee, A. (1996a) "Assessing Water Quality Impacts of Stormwater Runoff." North American Water & Environment Congress, Published on CD-ROM, Amer. Soc. Civil Engr., New York, 6pp Available from: http://members.aol.com/gfredlee/gfl.htm.

Lee, G.F. and Jones-Lee, A. (1996b) "Evaluation of the Water Quality Significance of the Chemical Constituents in Aquatic Sediments: Coupling Sediment Quality Evaluation Results to Significant Water Quality Impacts." WEFTEC '96, Surface Water Quality and Ecology I & II, Vol 4, pp #317-328, Proc. Water Environ. Fed. Annual Conference.

Lee, G. F. and Jones-Lee, A. (1996c) "Stormwater Runoff Quality Monitoring: Chemical Constituent vs. Water Quality." *Public Works*, Part I Vol 147, pp. #50-53 (1996); Part II Vol. 147, pp #42-45,67.

Lee, G.F. and Jones-Lee, A. (1997a) "Evaluation Monitoring as an Alternative to Conventional Stormwater Runoff Monitoring and BMP Development." *SETAC News*, Vol 17. No. 2, pp. #20-21.

Lee, G. F. and Jones-Lee, A. (1997c) "Evaluation Monitoring for Stormwater Runoff Water Quality Impact Assessment and Management." Presented at Society of Environmental Toxicology & Chemistry 18th Annual Meeting, San Francisco, CA.

Lee, G. F. and Jones-Lee, A. (1998) "Stormwater Managers Beware of Snake-Oil BMPs for Water Quality Management." Proc. of conference, "Advances in Urban Wet Weather Pollution Reduction," Water Environment Federation, Cleveland, OH, June (in press).

NAS/NAE (National Academy of Sciences and National Academy of Engineering) (1973) *Water Quality Criteria - 1972*, EPA/R3-73-033, Washington, D.C. US Government Printing Office.

Perciasepe, R. (1996) "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits." Assistant Administrator, US Environmental Protection Agency, Washington, D.C. August 1.

Urbonas, B. and Torno, H.C. (1995) "Overview Summary of the Conference," Torno, H.C. (Ed) *Stormwater NPDES Related Monitoring Needs*, Proc. of Engineering Foundation Conference, American Society of Civil Engineers, New York, NY, pp. #1-5.

US EPA (1976) "Quality Criteria for Water." EPA-440/9-76-023, US EPA, Washington, D.C., July.

US EPA (1990) "National Pollutant Discharge Elimination System Permit Application Regulations for Stormwater Discharges; Final Rule." 40 CFR Parts 122, 123, and 124, *Federal Register.* Vol 55, Number 222, pp. #47990-48091, November 16.

US EPA (1996a) "Environmental Indicators of Water Quality in the United States." EPA 841-R-96-002, United States Environmental Protection Agency, Office of Water (4503F), Washington, D.C., June.

US EPA (1996b) "Environmental Indicators of Water Quality in the United States--Fact Sheets." EPA 841-F-96-001, United States Environmental Protection Agency, Office of Water (4503F), Washington, DC, June.

US EPA (1998) "National Pollutant Discharge Elimination System-Proposed Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges; Proposed Rule." 40 CFR *Federal Register* Vol. 63, No. 122, 123, pp. #1536-1643, January 9

1. To be presented at: Water Environment Federation conference "Advances in Urban Wet Weather Pollution Reduction," Cleveland, OH, June (1998).

Reference as:"Lee, G.F., and Jones-Lee, A, 'Appropriate Application of Water Quality Standards to Regulating Urban Stormwater Runoff,' to be presented at: Water Environment Federation conference "Advances in Urban Wet Weather Pollution Reduction," Cleveland, OH, June (1998)."