Stormwater Runoff Water Quality Science/Engineering Newsletter

Devoted to Stormwater-Runoff Water Quality Management Issues

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Editor: Anne Jones-Lee, PhD
Contributor to This Issue:
G. Fred Lee, PhD, PE, DEE

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Preface to Volume 1, Number 4 Newsletter

This, the fourth issue of the Stormwater Runoff Water Quality Science/Engineering Newsletter, is primarily devoted to a discussion of stormwater runoff water quality monitoring data review that evolved out of the July 11,1998 California Stormwater Quality Task Force presentations. These presentations raised several issues on the appropriate approach for stormwater runoff water quality data evaluation relative to detecting trends in the data that are pertinent to assessing the efficacy of the stormwater runoff water quality management agencies' implementation of non-structural and structural BMPs. Further, at the July 11th Task Force meeting, there were discussions about various approaches for assessing the impacts of urban area and highway stormwater runoff associated constituents on the beneficial uses of the receiving waters for the runoff. This Newsletter discusses some of the author's experience with various approaches to detecting water quality use impairments associated with urban area and highway stormwater runoff derived constituents.

Past issues of the Newsletter are available from http://members.aol.com/gfredlee/gfl.htm. Readers are encouraged to share this Newsletter with others who may be interested. Any one who wishes to receive future issues that are not now on the email list of Newsletter recipients, should send an email note to gfredlee@aol.com indicating their interest. Anyone who does not wish to continue to receive this Newsletter should send a "reply" asking to be deleted from the email list.

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Stormwater Runoff Short Course Devoted to "Urban Stormwater Water Quality Impact and Management Issues, With Emphasis on BMP Ratcheting Down Process"

A two-day short course devoted to urban area and highway stormwater runoff water quality impact assessment and management will be offered November 18-19, 1998 in Orange, California. The course is being presented by Dr. G. Fred Lee of G. Fred Lee & Associates of El Macero, California, and Mr. Scott Taylor of Robert Bein, William Frost and Associates of Irvine, California. Additional information on the short course content, organization, and a registration form is appended to this Newsletter.

Review of Urban Area and Highway Stormwater Runoff Water Quality Data

NPDES permitted stormwater management agencies are conducting stormwater runoff water quality monitoring programs. In some areas large amounts of chemical characteristic data is being collected as part of fulfilling the stormwater NPDES permit requirements. One of the issues of concern to stormwater runoff water quality management agencies, regulatory agencies, as well as others, is an assessment of what the traditional end-of-the-pipe, edge-of-the-pavement "water quality" monitoring data reveals about the potential impacts of the stormwater runoff associated constituents on the beneficial uses of the receiving waters for the runoff.

Previous issues of the Newsletter have discussed that the traditional stormwater runoff water quality monitoring program, in which a suite of chemical constituents and certain pathogen indicator organisms are monitored for several storms each year, is of limited value in assessing the water quality use impairments of concern to the public. As discussed in the second Newsletter, it is not possible to reliably translate concentrations of constituents in stormwater runoff to water quality impacts without acquiring a significant amount of receiving water characteristic information on the aquatic chemistry/toxicology and water quality impacts for the runoff constituents of concern in the receiving waters for the runoff.

Some urban area and highway stormwater runoff water quality management agencies are "analyzing" the stormwater runoff monitoring data that has been collected as part of meeting NPDES monitoring requirements for trends in the data that could reveal the efficacy of structural and non-structural BMPs. The July 11, 1998 State Storm Water Quality Task Force meeting included several presentations concerned with assessing the water quality impact of urban area and highway stormwater runoff. This part of the Newsletter addresses some of the issues that were raised in these presentations and their discussion and provides information on issues that need to be considered to reliably assess the water quality impacts of urban area and highway stormwater runoff associated constituents, as well as reliable detection of water quality trends related to BMP implementation.

As discussed in previous Newsletters and reviewed below, the traditional approach used to "evaluate" the efficacy of stormwater runoff BMPs, such as detention basins,

grassy swales, filters, etc., involving the measurement of the removal of chemical constituents across the BMP unit, provides little in the way of useful information on the real efficacy of the BMP in addressing water quality management issues. For the same reason that edge-of-the-pavement or end-of-the-pipe traditional monitoring of stormwater runoff is unreliable for assessing the water quality impacts of the runoff associated constituents on the beneficial uses of the receiving waters, measurement of the removal of a constituent across a BMP unit is unreliable in assessing the water quality impacts of concern to the public of the BMP "treated" runoff. **It is essential that the efficacy of BMPs be assessed based on actual changes in the receiving water beneficial uses, rather than changes in concentrations of a constituent in a runoff water arising from passing the runoff water through a detention basin, filter, etc.** As part of evaluating the efficacy of BMPs, it is important to reliably detect trends in receiving water beneficial use characteristics arising from monitoring the receiving waters. The detection of trends in stormwater runoff water quality monitoring data was one of the issues discussed at the July 11 Task Force meeting. As discussed below, however, the mechanical application of trend analysis using statistical techniques can lead to erroneous conclusions concerning the efficacy of non-structural and structural BMPs in addressing water quality issues of concern to the public.

Detection of Trends in Stormwater Runoff Water Quality Monitoring Data. At the July 11 Task Force meeting, Dr. Brock Bernstein provided an overview discussion of some of the issues that need to be considered in analyzing chemical constituent data associated with urban area and highway stormwater runoff water quality monitoring programs. He indicated that the stormwater runoff water quality management agency with whom he worked was interested in assessing water quality **"trends"** in the data related to assessing the efficacy of the BMPs being implemented. The implication from such an analysis is that through detecting trends in chemical concentration data of the type generated in this monitoring program, it would be possible to detect trends in water quality as impacted by various stormwater management control programs undertaken by the management agency. As was brought out in the discussions following Dr. Bernstein's presentation, much of the trend data examined has nothing to do with water quality as it should be defined relating to the changes in the beneficial uses of the receiving waters as a function of stormwater management program implementation.

The basic problem with the data review of the type that was conducted being related to water quality issues is that much of the data generated in the management agency's traditional stormwater quality monitoring program has little or no relevance to true water quality of concern to the public, i.e. beneficial uses of the waterbodies which were sampled as part of the monitoring program. As discussed in Issue No. 2 of the Newsletter, Drs. A. Jones-Lee and G.F. Lee presented a comprehensive review paper, "Evaluation Monitoring as an Alternative to Conventional Water Quality Monitoring for Water Quality Characterization/Management," at the Inter-Agency Water Quality Monitoring Forum that

was held in Reno, Nevada in July 1998. This paper is in press in proceedings of this conference, and preprints of this paper are available from Dr. Lee's web site.

The Evaluation Monitoring approach that has been developed by Dr. Lee and his associates specifically focuses on using the monitoring resources to first define through a watershed-based consensus approach the significant water quality - use impairments that are occurring in a particular waterbody. This is followed by developing a watershed-based water quality management program that is designed to control the use impairments to the maximum extent practicable and economically feasible using appropriately selected, site-specific best management practices. Evaluation Monitoring is significantly different than conventional runoff monitoring in that it focuses on chemical impacts on beneficial uses, rather than chemical concentrations which often have little or no relation to impacts.

That paper specifically discusses why chemical monitoring data of the type that is typically developed by stormwater management agencies is of limited value in describing real water quality issues. The stormwater monitoring agency's program data, and especially Dr. Bernstein's discussion of these data as it relates to discerning trends in water quality, provides an example of how caution must be exercised in relating chemical concentration data or any trends in these data to trends in true water quality issues. An example of how inappropriate conclusions can be drawn from data from traditional stormwater runoff monitoring programs is the data that Dr. Bernstein reported on nitrate. One of the major water quality issues in the waterbody receiving the stormwater runoff discussed by Dr. Bernstein is the excessive fertility of this waterbody which, during late spring, summer and early fall, experiences excessive growths of marine algae. To much of the public, these growths are aesthetically unpleasing. They also, under certain conditions, lead to depression of dissolved oxygen in the early morning hours below current aquatic life standards. The beneficial uses of the waterbody have been declared impaired by a regulatory agency because of excessive growths of this algae every summer. The algae problem is principally a late spring - summer - early fall problem that typically does not extend over the winter and early spring. The waterbody has a 10-day tidal flushing time, which means that much of the nitrate added each year to the waterbody does not stimulate algal growth in the waterbody, since it is flushed through the waterbody during non-algal growth periods.

It is important in assessing the impact of nitrate loads on the waterbody's water quality to consider the issue of what nitrate loads impact the algal-related beneficial uses of the waterbody. Because of this short tidal flushing time, nitrate loads that occur in the fall, winter and early spring have no impact on the excessive fertility problems that occur in the waterbody the following summer. They are flushed through the waterbody within a couple of weeks of when they are introduced to it. The nitrate loads that are crucial, however, are late spring - summer loads. Sufficient work has been done on the waterbody's nutrient load algal response relationships to demonstrate that there is a relationship between nitrate loads during certain parts of the year and excessive algae that

develop in the waterbody, i.e. nitrate is the key limiting element governing algal growth. Its concentration is depressed sufficiently at some times during the late summer as to limit the total biomass of algae developed.

Dr. Bernstein presented data showing trends for the annual loads of nitrate. Such trends, however, can readily have no relationship to nitrate-caused water quality use impairments. In order to reliably use nitrate data in an analysis of trends of the effectiveness of nitrate control programs as they impact a waterbody's water quality, the nitrate data from late spring and summer are the data that should be analyzed in the trend analysis, not the annual loads. This can be a small part of the total load to the waterbody. However most of the nitrate load to the waterbody is of no consequence to the excessive fertility problems in the waterbody since, in this particular case, it is flushed through the waterbody during the part of the year when excessive algal growth is not occurring

The message from this discussion is that in attempting to use a chemical surrogate, such as nitrate, for water quality, which in itself is not a problem, but only becomes a problem when the nitrate is converted into algal biomass that is adverse to the beneficial uses of a waterbody, it is necessary to understand how the chemical surrogate concentration relates to beneficial uses. Annual loads of nitrate could increase, decrease or remain the same in a trend analysis which would have no relationship to evaluating the reliability of nitrate reduction programs on a waterbody's water quality that has a short hydraulic residence time and where the water quality problems occur only during limited parts of the year.

Another problem with the trend analysis that was reported on by Dr. Bernstein where the analysis could yield incorrect water quality information was his discussion of examination of co-relationships between various metals. He reported that zinc was a surrogate for other metals. While his report is correct from a chemical constituent perspective, it can be in significant error with respect to the impact of chemical constituents on beneficial uses of waterbodies. The only time that this co-relationship is a valid tool for water quality assessment is when the work has been done to examine the toxic - available forms of metals to a sufficient extent so that the co-relationship between the toxic - available forms of zinc, copper, etc. are examined. Again, co-relationships of total or dissolved metals do not necessarily and frequently bear no relationship to toxic - available forms. Further, there may be significant seasonal impacts on toxic - available forms from one season to the next so that a co-relationship analysis that extends over a year may provide erroneous conclusions on water quality issues since the toxic available forms at one time of the year for one metal is not the same at other times of the year for the same metals or other metals.

Dr. Bernstein reported on decreases of lead as an example of trend analysis in stormwater runoff data. He mentioned, however, that the significant decreases for the data for a particular location where there is a significant downward trend in lead concentrations

over the years beginning in the early 1970s is possibly related to the decreased use of lead as an additive in gasoline. Recently, in connection with the report that Scott Taylor of RBF and Dr. G. Fred Lee developed for Caltrans in examining the Caltrans highway stormwater runoff data, "Proposed Soil Lead Management Criteria as Part of Caltrans Highway Construction and Maintenance," which Caltrans submitted to the State Water Board in connection with review of their statewide permit, Dr. Lee discussed the situation with respect to trends in lead highway stormwater runoff data. He reported that a number of investigators have found the same decreasing lead concentrations with time relationship reported by Dr. Bernstein for one sampling location, but had not found it for other locations in the same or other watersheds. The issue, as discussed by Dr. Lee in the Caltrans report, is that while there is no doubt that there was a significant decrease in the total lead content of urban area street and highway stormwater runoff beginning in the early 1970s through probably the mid-1980s due to the decreased use of lead in gasoline, when lead concentrations are measured at a particular location that receives stormwater from a variety of sources, not just the street or highway runoff, there can be little or no relationship between the concentrations of lead found in runoff waters and the changes of the lead content of gasoline which most directly affects highway and urban area street stormwater runoff-associated lead. The lead concentration at a sampling point in a stream is an integrator of lead from all sources including resuspension of historic lead in sediments associated with runoff events.

It is important to note, as discussed in previous Newsletters and will be discussed in greater detail in subsequent Newsletters, that lead in urban area and highway stormwater runoff, while exceeding the US EPA worst-case water quality criteria, has been repeatedly found to be in non-toxic, non-available forms and therefore, except possibly for extremely soft, low pH waters which receive urban area and highway stormwater runoff with little or no dilution, it would be unlikely that the lead in this runoff is adverse to the beneficial uses of the receiving waters for the runoff.

Dr. Bernstein discussed the potential use of power analyses to determine where to devote monitoring resources so they are more cost-effective in providing useful information. He discussed how power analysis can help guide monitoring resource allocation, especially as it relates to how many samples need to be taken to detect trends of a certain magnitude. However, caution must be exercised in using power analysis if the purpose is to relate the results to water quality issues of concern to the public. The basic problem is that the mechanical application of power analysis to chemical concentration data sets arising out of a so-called water quality monitoring program does not necessarily address real water quality issues. It focuses on chemical constituents which may have nothing to do with real water quality of concern to the public that is directly related to impairment of beneficial uses.

The appropriate use of power analysis on chemical constituent concentration data must be conducted with data that have a direct constant relationship between the

measured parameters and the water quality of the waterbody of concern that is impacted by the chemicals. Dr. Bernstein's discussion of power analysis for nitrate data is an example of how including nitrate data that have nothing to do with the algal problem, i.e. because the nitrate flushes through the waterbody during the late fall, winter and early spring, and does not cause excessive algal growth, in the power analysis can give misleading results on how to allocate monitoring resources. Again, as with all other aspects of trying to use chemical data to characterize water quality, the direct relationship between the chemical data and a water quality response of concern to the public must be available or else the chemical data may be a poor indicator of water quality and could readily lead to erroneous conclusions on the effectiveness of stormwater runoff water quality BMPs.

The reliable way to assess the impact of a BMP on water quality - beneficial uses is to examine how the BMP impacts the receiving water beneficial uses, i.e., the reduction of nitrate that grows excessive algae or the reduction of toxic - available forms of copper that are significantly adverse to the numbers, types and characteristics of desirable forms of aquatic life in the receiving waters for the runoff that is treated by the BMP. BMP efficacy studies that focus on across-the-unit removal do not represent a water quality impact evaluation, but are a chemical constituent evaluation unless a relationship is established between the removal of the constituent and the improvements in the beneficial uses of the receiving waters for the treated runoff.

As mentioned in Newsletter Issue No. 2, the Inter-Agency Water Quality Monitoring Council organized the first of what will be a series of monitoring forums which was held in Reno in early July. The Inter-Agency Water Quality Monitoring Council is an outgrowth of a national understanding of the significant deficiencies that exist in water quality monitoring across the country. Those interested in this topic should obtain a copy of the proceedings from the Reno conference when they become available. They will find that there are many individuals who work in water quality monitoring who understand that the conventional chemical constituent-based monitoring is of little or no value in assessing the water quality of a waterbody of concern to the public. The National Water Quality Monitoring Council (NWQMC) maintains a web page (http://water.usgs.gov/public/wicp/nwqmc.html) where additional information on the Council and its activities is available.

The theme of the first day's discussions by many of the speakers at the Reno meeting was how to conduct water quality monitoring programs to answer the questions that the public has about water quality. It is clear that the typical compliance-type monitoring focusing on chemical constituent concentrations does not address true water quality issues. There must be a major shift away from focusing on a suite of chemicals periodically monitored to monitoring receiving water or ambient water characteristics that relate to beneficial uses, which for aquatic life-related uses can and should be the numbers, types and characteristics of desirable forms of aquatic life in a waterbody relative to the habitat characteristics of that waterbody.

Identifying Causes of Toxicity. At the July 1998 Storm Water Quality Task Force meeting, Dr. Steve Bay discussed the use of toxicity investigation evaluations (TIEs) to determine the potential cause of toxicity. This topic was also addressed by Dr. Michael Stenstrom. The comment was made after this discussion that caution must be exercised in doing a partial TIE as reported on by Bay and Stenstrom in identifying the real toxicants responsible for a particular toxicity. The addition of EDTA and the associated decrease in toxicity is not adequate proof that heavy metals at elevated concentrations in a stormwater runoff sample or an ambient water receiving stormwater runoff is a cause of the toxic response observed. A properly conducted TIE must include Phase III confirmation to be certain that zinc or some other heavy metals or, for that matter, an organic that is a suspected cause of toxicity is, in fact, the real cause of toxicity. Failure to follow these approaches could readily lead to erroneous conclusions about the need to control heavy metals in urban area and highway stormwater runoff. Under no circumstance should anyone assume that because there is an elevated concentration of a potentially toxic constituent relative to a water quality standard that that constituent responsible for the toxicity. There are numerous examples in the literature where such approaches have been repeatedly found to yield erroneous conclusions on the cause of toxicity.

There was discussion during the July Task Force meeting about the potential significance of vehicular traffic as a source of heavy metals that causes stormwater runoff from urban area streets and highways to be toxic to some forms of aquatic life. As Dr. Lee pointed out, there have been a number of studies of urban area street and highway stormwater runoff in the San Francisco Bay Area and the Central Valley area which have demonstrated that the heavy metals in this runoff are in non-toxic forms. From the information available, it appears that vehicular traffic is not a source of toxic forms of heavy metals. M. Stenstrom indicated that his information did not support this position, although he has not provided data in support of his position that vehicular traffic-derived metals are the source of toxic heavy metals in urban area and highway stormwater runoff.

It seems unlikely that the studies conducted in San Francisco Bay and the Sacramento areas which demonstrate that heavy metals in urban area and highway stormwater runoff are not toxic would not also be applicable to the Los Angeles region, as well. As discussed in the second issue of the Newsletter, there can be toxic heavy metals in urban area stormwater runoff. However the metals are not derived from urban area streets and highways, but from industrial properties. In a stormwater runoff water quality management program it is important to critically examine the cause of toxicity which is apparently due to heavy metals to determine whether or not heavy metals or, for that matter, any constituents in urban area street and highway runoff are, in fact, in toxic forms that are significantly adverse to the beneficial uses of the waterbody. This must be done through properly conducted toxicity tests using a suite of sensitive organisms where the response of the test could be related to beneficial use impacts. This issue is important, especially when using certain types of tests, such as a sea urchin fertilization test, since

the use of this test was the basis upon which much of the data that were presented at the July Task Force meeting were developed. Much of the heavy metal toxicity data from the Los Angeles area has been demonstrated to provide a significant number of false positives and unreliable assessments of water quality impacts where the test gives a positive response indicating an impairment of echinoderm (sea urchin) or sand dollar reproduction, yet the waters in which this response is found have been found to have substantial populations of sea urchins and/or sand dollars.

Dr. Sam Luoma's discussions at the July Task Force meeting of the copper situation in south San Francisco Bay as influenced by the City of Palo Alto's domestic wastewater discharges to the Bay demonstrates that it is possible to overload the detoxification capacity of the system. His data show that during the time when the wastewater treatment plant was discharging large amounts of copper, there were likely adverse impacts on the clam population and, for that matter, other organisms in the vicinity near the discharge. The situation today is that the copper that is accumulating in clam tissue appears to be derived primarily from stormwater runoff. The amount of that runoff-derived copper that is present in the clams is below the level that appears to be adverse to them.

There is considerable concern about the appropriateness of the TMDL for copper for San Francisco Bay which could readily cost the public in that region hundreds of millions to possibly as much as a billion dollars to achieve the copper criterion in the stormwater runoff so that no more than one exceedance every three years occurs in the runoff waters. While there has been discussion about requiring the removal of copper from auto brake pads, such removal, while reducing the frequency of exceeding water quality objectives, will not eliminate the exceedance of the US EPA criteria - water quality site-specific objective developed for copper in San Francisco Bay. The Bay waters will continue to have these exceedances if all urban area and highway stormwater runoff inputs to the Bay were terminated. This arises from the presence of copper in the Bay sediments. While the copper in sediments is not especially high, and in fact is apparently less than normal crustal abundance, it still is sufficient to cause exceedances of the site-specific water quality objectives for the Bay.

As discussed in the paper by Lee and Jones-Lee, "Regulating Copper in San Francisco Bay: Importance of Appropriate Use of Aquatic Chemistry and Toxicology," which is available from their web site, the San Francisco Estuary Institute has been testing Bay waters over the past several years for toxicity using the same organism as was used to establish the national water quality criterion for copper. SFEI has found that these waters are not toxic to this organism, even though the copper exceeds the site-specific criterion. Further, SFEI studies have indicated that while there is toxicity in the Bay sediments, this toxicity does not correlate well with copper concentrations in the sediments.

This situation points to the inadequacies of the US EPA's water effects ratio approach in properly adjusting the national criteria to site-specific conditions considering the forms of the copper added to the waterbody and the aquatic chemistry of copper within the waterbody. There is sufficient evidence today to justify not causing the public in the San Francisco Bay region to spend hundreds of millions to $1 billion or so controlling copper inputs to the Bay in urban area and highway stormwater runoff in order to comply with the copper site-specific criterion/objective in the runoff waters. It is Dr. Lee's recommendation that, rather than implementing a TMDL for copper which would control the input of copper to the Bay, what should be done is for the stormwater and wastewater dischargers to the Bay to fund studies to search for yet unknown problems due to copper or, for that matter, other constituents that, while not now having been shown to be adverse to the beneficial uses of the Bay, could be adverse. If such problems are found, then develop control programs to control the constituents that are responsible at their source. This is a far more cost-effective, technically valid approach than the US EPA mechanical approach, which ignores 20 years of work on the aqueous environmental chemistry of copper and its toxicology.

Dr. Alex Horne of the University of California, Berkeley, has recently reported in the annual report of the University of California Water Resources Center on the speciation (chemical forms) of copper present in stormwater runoff to San Francisco Bay. He found that urban stormwater runoff and San Francisco Bay waters contain considerable copper complexing capacity. Complexes are a special form of a metal species that results from the electropositive charge of a metal ion interacting with a ligand or ligand-containing molecule, i.e. one with an excess pair of electrons, forms a bond which changes the chemical characteristics of the metal. Many, but not all, complexes of heavy metals are non-toxic. Typically, copper complexes with natural organic matter have been found to be non-toxic. It is, therefore, clear from Dr. Horne's work that the reason that the dissolved copper in San Francisco Bay is in a non-toxic form is because of complexation with organics. This type of situation is well-known in the aquatic chemistry/aquatic toxicology literature. It has been largely ignored by those who are calling for a ban on the use of copper in auto brake pads.

The work of Dr. Horne is in accord with what would be predicted based on the work that has been done over the last 20 years on the aqueous environmental chemistry of copper. It is another example of the importance of appropriately incorporating aquatic chemistry/toxicology into assessing the real water quality impacts of constituents in urban area and highway stormwater runoff on the beneficial uses of receiving waters.

As discussed in previous Newsletters, it is important not to assume that what is found in the San Francisco Bay will be applicable to all urban area and highway stormwater runoff. There can be situations where the ambient waters coupled with the stormwater runoff do not have sufficient complexing capacity so that the copper in the runoff would be in a toxic - available form when mixed into the receiving waters.

The statement was made during the July 11 Task Force meeting presentations that metals are permanent, i.e. do not degrade, and therefore once toxic, always toxic. That type of statement is unreliable and reflects a lack of understanding of basic principles of aquatic chemistry/toxicology. While metals and many other persistent chemicals persist in the environment, especially in the receiving water sediments, there are a variety of chemical reactions and transformations that occur that can cause a toxic form of a constituent to become non-toxic. The reverse can also occur, although the primary direction of reactions occurring in sediments is to detoxify and immobilize potential pollutants. Study after study over the last 20 years have shown that only a small part of the chemical constituents in sediments that are pollutants in other situations, are in toxic - available forms in aquatic sediments.

While toxicity tests are more reliable for addressing a potential adverse impact on a beneficial use than chemical concentrations of potentially toxic constituents, they should not be mechanically used as is being done by some today to conclude that the presence of toxicity in a test necessarily means that the public should spend money managing chemical constituents in urban area and highway stormwater runoff because this toxicity is significantly impacting the beneficial uses of the waterbody of concern to the public. Elevated concentrations of a potentially toxic constituent above the US EPA water quality criterion for a potentially toxic constituent should only be used to indicate that under worst-case conditions there could be aquatic life toxicity. Toxicity tests which include proper TIE evaluations, including Phase III, to confirm that a particular constituent is, in fact, responsible for toxicity is an indication that the constituent is responsible for a **potential** adverse impact. This is much more reliable for assessing potential use impairments than the exceedance of a water quality standard approach that is frequently used today.

If there is interest in addressing real water quality issues, it is necessary to relate the toxicity found to impairments of uses that are of concern to the public before the millions to tens of billions of dollars that will ultimately be needed per community to treat urban area and highway stormwater runoff to prevent exceedance of worst-case-based water quality criteria/standards or exceedance of a narrative toxicity standard from occurring once every three years. The costs of treating urban area and highway stormwater runoff to achieve this level of control are sufficient so that a reliable evaluation of cause and effect between the presence of a constituent in urban area and highway stormwater runoff and impacts on the beneficial uses of a waterbody should be developed.

While, from the information available, it appears that urban area street and highway stormwater runoff heavy metals, such as copper, zinc, cadmium, and lead, are not a cause of aquatic life toxicity, urban area residential and commercial street stormwater runoff is highly toxic to some forms of aquatic life. As discussed in previous Newsletters, the cause of this toxicity is the residential and commercial use of organophosphate pesticides, diazinon and chlorpyrifos, that are used for structural (termites and ants) and lawn and garden pest control. This issue has been reviewed by: Lee, G.F. and Jones-Lee, A.,

"Development of a Regulatory Approach for OP Pesticide Toxicity to Aquatic Life in Receiving Waters for Urban Stormwater Runoff," Presented at NorCal SETAC meeting, Reno, NV, June (1998). - available from http://members.aol.com/gfredlee/gfl.htm. These pesticides are largely unregulated at this time with respect to their water quality impacts.

A heavy metal that may be causing low levels of aquatic life toxicity in urban area stormwater runoff is chromium VI. The concentrations of dissolved chromium in urban area stormwater runoff are sufficient, if the chromium is present as chromium VI, to be toxic to several forms of zooplankton. While the US EPA chronic water quality criterion for chromium VI is 10 µg/L, chromium VI has been found to be toxic to several forms of common zooplankton at 0.5 µg/L. This is a situation in which the US EPA water quality criteria may not be protective of key forms of aquatic life that are important parts of the aquatic food web. Additional information on the chromium VI toxicity issue is available from: Lee, G.F. and Jones-Lee, A. "Chromium Speciation: Key to Reliable Control of Chromium Toxicity to Aquatic Life," Presented at the American Chemical Society National Meeting poster session, San Francisco, CA, April (1997); Lee, G.F. and Jones-Lee, A., "Under-Regulation of Chromium in Ambient Waters," Learned Discourses: Timely Scientific Opinions, SETAC News 18(4):22 July (1998); Lee, G.F. and Jones-Lee, A., "Under-Regulation of Chromium in Ambient Waters - Expanded Discussion," Report, G. Fred Lee & Associates, February (1998). - available from Dr. Lee's web site.

Comments were made at the July 11 Task Force meeting about a firm developing a grease that could greatly reduce the total amount of grease used for trucks. The implication was that this would reduce the pollution caused by highway stormwater runoff. However, it is important to critically review what is in the grease before a decision is made that one type of grease is less environmentally damaging than another. It is indeed rare that grease from highways is a major cause of water quality impairment. Also, greases of various types contain elevated concentrations of metals, some of which are fairly exotic, like molybdenum. This particular firm's grease which may reduce the total pounds used may be more harmful to the environment than the currently used grease.

The important message is that care must be exercised in substituting one type of product for another, especially when under a water quality management framework, to be sure that the new product is not more adverse to the environment than the current product. There have been a number of examples of this type of situation which have proven to be significantly detrimental to the public's interests. An example was the detergent phosphate ban that was adopted in some states many years ago where the substitute products that were available greatly shortened the life of washing machines and clothes that were washed in them compared to the expected life associated with detergents that use phosphates as complexing agents for hardness. The phosphorus content of detergents since the mid-1970s has never been a sufficient part of the total phosphorus of domestic wastewaters so that its removal would have any impact on the beneficial uses of the waterbody which received the domestic wastewaters.

Biocriteria. At the July 11 Task Force presentations, mention was made about the potential use of biocriteria to assess the impact of pollutants on the numbers and types of aquatic life in a waterbody relative to the populations that should be present based on the waterbody habitat characteristics. This is a topic that was addressed at the Reno Inter-Agency Water Quality Monitoring Forum as well as at the US EPA August 1998 national Water Quality Standards meeting that was held in Philadelphia. A number of states and the US EPA are developing biocriteria. The US EPA has indicated that there will be no national biocriteria. However, the Agency is pursuing the development of biocriteria approaches for regulating water quality impacts, including those from urban area stormwater runoff. Some states are developing numeric approaches for relating organism assemblage information to impaired uses. While this approach can provide valuable information on real water quality impacts of a particular constituent or group of constituents from a particular source(s), it can lead to inappropriate assessment of impaired uses. Except under gross pollution situations, the control of the numbers and types of organisms at a particular location is not sufficiently well understood to reliably use a numeric criterion value as an indicator of pollution - use impairments.

The benthic response index presented by Ken Schiff at the July Task Force meeting appears to be an appropriate approach to a general classification scheme for assessing major biological impacts. As Dr. Schiff mentioned, however, while it can detect major impacts, it is not sensitive to minor perturbations which can be used to develop cause and effect between urban area and highway stormwater runoff and beneficial use impairments.

The US EPA as part of their Interim Final "Water Quality Criteria and Standards Plan – Priorities for the Future," released in June 1998 for public review, has specifically mentioned the use of biocriteria for regulating stormwater runoff. The Agency states in this Plan,

> *"EPA envisions that biocriteria and bioassessment will be valuable in managing urban storm water runoff and other wet weather flows. Storm water discharge pollutant monitoring data indicates that pollutant concentrations in storm water runoff can fluctuate drastically from storm to storm. With high variabilities in pollutant concentrations it an be difficult to assess storm water discharge compliance with water quality standards using traditional steady-state chemical criteria. Biocriteria and bioassessments will help to identify the cumulative impact of storm water discharges over time. Using biocriteria and bioassessments, storm water managers will have a more useful management endpoint to determine if the storm water discharges are causing aquatic life impairments and to determine if storm water controls and pollution prevention efforts are effective. Bioassessments and biocriteria are being successfully use in a number of innovative applications for storm water management. EPA will assist Regions and the States and Tribes in using biocriteria and bioassessments more routinely in storm water management efforts."*

Dr. Ed Dammell's discussion at the July Task Force meeting of the impacts of flow on beneficial uses of a waterbody is an important topic that needs greater attention. There is increasing recognition being given to the fact that the primary impact of urban area and highway stormwater runoff is altered flow which, in turn, changes the habitat for aquatic life. It is important to consider in any properly conducted stormwater runoff impact studies whether habitat characteristics as controlled by flow or other physical factors are the controlling factor for the changes in populations that are observed.

An area where biological assessment, including toxicity testing, can provide valuable information is in examining the water quality significance of exceedance of a water quality standard. The purpose of an aquatic life-based water quality criteria/standard is to protect the aquatic life from adverse impact due to the constituent for which the criterion has been developed. As discussed in previous Newsletters, the US EPA water quality criteria and state standards based on these criteria are designed to be national criteria that will be protective under essentially all situations. This leads to over-protection in most situations related to the fact that the constituents for which the criterion has been developed exists in a variety of chemical forms, only some of which are toxic/available. Biological assessments of the numbers, types and characteristics of organisms in an area that is potentially impacted by the input of a particular source, such as stormwater runoff, represent a bottom-line tool that should be used to determine whether stormwater runoff-associated constituents are significantly adversely impacting the aquatic life-related beneficial uses of the waterbody. It is important, however, in conducting such assessments to critically evaluate whether altered numbers of organisms at a particular location are due to a chemical constituent(s) in the stormwater runoff or to physical or biological factors, such as flow, storms, grazing by other organisms, etc.

During the discussion at the July Task Force meeting, a question was asked about the adequacy of three years of bioassessment monitoring. Bioassessment monitoring, as typically practiced, involves measuring the numbers and density of various types of aquatic organisms in the water and/or sediments. There were a number of papers devoted to bioassessment techniques and appropriate use of data of this type at the Reno Inter-Agency Water Quality Monitoring Forum. While bioassessments can detect large-scale adverse impacts over short periods of monitoring, for subtle impacts like those typically associated with urban area and highway stormwater runoff, many years of data need to be collected in order to discern real trends in data of this type. The year-to-year variability and the multi-year, short-term trends in the numbers and types of organisms present in a particular waterbody which are associated with normal population changes that have nothing to do with pollutants make it difficult to use short-term databases of bioassessment information to detect subtle changes.

The question was asked at the Task Force meeting in response to the mention of chemical markers for stormwater runoff about the reliability of such an approach. This is an issue that has been of concern for some time. Benzthiazoles, which are derived from

automobile tire wear, can be a carcinogen when ingested by people. They have been found to be present in urban area and highway stormwater runoff-impacted waterbodies such as San Francisco Bay sediments. What the presence of this chemical means to the beneficial uses of the Bay is unknown. This situation is one example of the thousands of chemicals that are derived from the activities of man which could be present in urban area and highway stormwater runoff which are unregulated today, i.e. for which there are no water quality criteria/standards. While no one will ever be able to reliably conclude that urban area street and highway stormwater runoff-associated constituents are having no adverse impact on the beneficial uses of the receiving waters for the runoff, it is possible through appropriately conducted studies, such as those recommended in the Evaluation Monitoring approach, to detect major impairments and, through forensic studies, their cause and sources.

The appropriate approach to follow in urban area and highway stormwater runoff water quality monitoring is to conduct directed studies to determine if there are significant, readily discernible adverse impacts on the beneficial uses of a waterbody associated with urban area and highway stormwater runoff-derived constituents. Where such impacts are found, then control programs should be implemented to control the constituents responsible. These programs should not use a mass-load approach, but instead use a specific targeted approach where site-specific BMPs are used to control the constituents responsible. The mass load approach focusing on total copper or total zinc entering a waterbody will likely never be technically justified, since it is indeed rare that the total copper is a measure of toxic - available forms.

The July 11, 1998 Stormwater Quality Task Force discussions of receiving water impacts provided valuable background information on issues that ultimately all stormwater management agencies, regulatory agencies and others will need to address on the appropriate use of various measurement techniques and monitoring approaches to assess the real significant water quality impacts of urban area and highway stormwater runoff.

Stormwater Infiltration BMPs

With increasing attention being given to the potential surface water quality problems, and especially meeting water quality standards in urban area and highway stormwater runoff, increasing attention is being given to using infiltration basins and trenches as a stormwater management BMP. A review of the recent standard references on BMPs shows that they fail to discuss the potential problems associated with infiltration of urban area stormwater runoff into groundwater systems. Drs. G. F. Lee, A. Jones-Lee, and Mr. S. Taylor have recently published two papers: Lee, G.F., Jones-Lee, A., and Taylor, S., “Developing of Appropriate Stormwater Infiltration BMPs: Part I Potential Water Quality Impacts, Monitoring and Efficacy Evaluation,” Proc. of Ground Water Protection Council’s 98 Annual Forum, Sacramento, CA, pp. 55-72, Sept. (1998); and Taylor, S. and Lee, G.F., “Developing of Appropriate Stormwater Infiltration BMPs: Part II Design of Infiltration BMPs,” Proc. of Ground Water Protection Council’s 98 Annual Forum,

Sacramento, CA, pp. 73-80, Sept. (1998), that provide guidance on how stormwater infiltration BMPs should be developed to protect groundwaters from pollution by runoff associated constituents. They recommend that a plausible worst-case-based scenario failure approach be used to determine, on a site-specific basis, whether chemical constituents and pathogen indicator organisms present in urban area stormwater runoff could lead to groundwater pollution. They conclude that there are situations where stormwater infiltration is not an appropriate best management practice, since it can lead to groundwater pollution by urban area and highway stormwater runoff constituents. They also recommend that the permitting of stormwater infiltration BMPs include a monitoring program designed to detect groundwater pollution before widespread pollution occurs. These papers are also available from Dr. Lee's web site,
http://members.aol.com/gfredlee/gfl.htm.

Newsletter References Cited

A commentor on the second issue of the Newsletter indicated that he would like to see references cited to other work pertinent to the topics discussed, the implication being that the contributor only cites his own references. The situation is that often the references cited are designed to provide the reader with additional information on the topic discussed in the Newsletter. Typically in this additional information provided in the reference to the authors' work will be a more comprehensive literature review on the topic. It is Dr. Lee's position that whenever he can cite someone else who either supports or has documentation which is contrary to or supportive of his position, it is cited. The basic problem he finds, however, is that there are few individuals who are knowledgeable in the stormwater runoff water quality impact and management topic area who will take the time to provide written discussions of the issues. As indicated in previous issues of the Newsletter, comments are welcomed, including other references that the readers may know of that should be considered in reviewing an issue. Further, if anyone feels that the discussions of issues is not technically valid, a full public interactive peer review of the issue is encouraged.

Announcements

The Water Environment Federation has published a review of the Clean Water Act, updated for 1997, that may be of interest to Newsletter readers. This 25th Anniversary Edition provides historical background to the development of the Clean Water Act and the changes that have been made in it since its original adoption in 1972. Those interested in obtaining a copy should contact the Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994, USA. WEF also has an 800 number, 1-800-666-0206, through which it can be ordered. The members' price is $35.

Short-Course
◂ Urban Stormwater Runoff Water Quality Impact and Management Issues ▸
With Emphasis on BMP Ratcheting Down Process

Date and Location:(9:00-4:30 each day)
November 18-19, 1998
Santiago Oaks Regional Park
2145 North Windes Dr.,
Orange, CA (714) 538-4400

Cost: $25.00 to cover cost of refreshments-soft drinks and coffee and luncheon sandwiches

Course Organizer:
Dr. G. Fred Lee, PE (TX), DEE
G. Fred Lee & Associates
El Macero, CA
Ph: (530) 753-9630
Fx: (530) 753-9956
Em gfredlee@aol.com

Course Instructors:
G. Fred Lee, PhD, PE, DEE, G. Fred Lee & Associates, El Macero, CA
Scott Taylor, PE, Robert Bein, William Frost and Associates, Irvine, CA

Dr. Lee and Mr. Taylor have extensive experience in urban area and highway stormwater runoff water quality impact evaluation and management.

Objective of the Course: To provide an introduction to the basic water quality issues that are pertinent to understanding and evaluating the water quality impact and cost-effective management of urban area and highway stormwater runoff water quality. The goal of the course is to provide an introduction to technically valid cost effective urban area and highway stormwater runoff water quality management.

Who Should Attend Individuals interested in urban area and highway stormwater runoff water quality impact evaluation and management, including engineers, natural and social scientists, planners, attorneys and others.

Course Major Topics Areas

- Water quality characteristics of urban area street and highway stormwater runoff
- Current regulatory requirements - BMP ratcheting down process to achieve water quality standards/objectives,
- Urban area street and highway stormwater runoff water quality impact assessment and management - addressing over regulation and excessive costs
- Technical basis of regulatory requirements - water quality criteria/standards development and appropriate use in regulating urban stormwater runoff associated constituents
  - Why current worst case based water quality criteria over regulate stormwater runoff
  - Technically valid cost effective regulation of urban stormwater runoff water quality impacts
    - Evaluation Monitoring to define water quality impacts and select BMPs
- BMP selection, operation, maintenance and efficacy evaluation
- US EPA new regulatory initiatives for urban area stormwater runoff

Course Registration and Additional Information

The course will be offered if 20 individuals register for the course. It is important to register by contacting Dr. G. Fred Lee at 27298 E. El Macero Dr., El Macero, CA 95618. Tel: 530 753-9630; Fx: 530 753-9956; em: gfredlee@aol.com. The registration/attendance will be limited to 50 participants with first preference given to public agencies staff until November 13, 1998. A registration form is attached. Additional information on the course content is available from http://members.aol.com/gfredlee/gfl.htm. Contact Dr. Lee for additional information on the course organization, local arrangements and registration.

Registration for Stormwater Science/Engineering Short-Course
November 18-19, 1998; Orange County, CA

Those interested in attending the Stormwater Science/Engineering Short-Course that is being offered by Dr. G. Fred Lee and Scott Taylor should submit this form to Dr. Lee.

Name: _____Position: _____

Affiliation: _____

Mailing Address:

_____

_____

_____

Telephone:-_____Fax: _____

E-mail: _____

Years of Professional Experience in Water Quality Related Activities:_____

Undergraduate degree major: _____Yr of Degree: _____

Graduate degree major: _____Yr of Degree:_____

Are you involved in urban area and/or urban area stormwater runoff water quality management? If so, explain your involvement.

_____

_____

_____

Have you examined the course outline? Yes____No____ It is available at Dr. Lee's web site: http://members.aol.com/gfredlee/gfl.htm.

Please summarize your interest in taking the course.

_____

_____

_____

Please submit this form as soon as possible. Course registration is limited to 50 participants with preference give to governmental agency personnel. A minimum enrollment of 20 individuals is required by November 13, 1998 to avoid cancellation. Please send a check made out to G. Fred Lee and Associates in the amount of $25.00 to cover break refreshment and lunch sandwiches. If there are questions about the course, please contact Dr. G. Fred Lee: em: gfredlee@aol.com; Ph: 530-753-9630; Fax: 530-753-9956 or 27298 E. El Macero Drive, El Macero, CA 95618-1005