Comments on January 13, 2004, Draft Preliminary Problem Formulation Technical Memorandum for the West Branch of the Grand Calumet River Lake County, Indiana Prepared by Tetra Tech for the US Fish and Wildlife Service

Comments Submitted by
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In response to a request from Dr. Michael Unger, District Manager of the Sanitary District of Hammond, Indiana, I have reviewed the Draft Technical Memorandum Preliminary Problem Formulation for restoration of the West Branch of the Grand Calumet River prepared by Tetra Tech for the US Fish and Wildlife Service, dated January 13, 2004. My comments on the technical problems with the US Fish and Wildlife Service's approach for defining constituents that are impairing the beneficial uses of the West Branch of the Grand Calumet River are presented herein.

My experience and expertise, which serve as a foundation for these comments, include a Master of Science in Public Health degree from the University of North Carolina focusing on water quality issues, a PhD from Harvard University in environmental engineering and environmental sciences focusing on aquatic chemistry issues, and 30 years of university graduate-level teaching and research devoted to defining and managing the water quality impacts of chemical contaminants in waters, aquatic sediments and wastes. In addition, while a university professor I was a part-time consultant to governmental agencies and industry in these areas and have been a full-time consultant since 1989 when I retired from university teaching and research. One of the areas of particular emphasis that is pertinent to these comments is my extensive work on properly evaluating the water quality significance of contaminants in aquatic sediments. In addition, I have considerable experience in Superfund site investigation and remediation issues.

Dr. Anne Jones-Lee (my wife) has a bachelors degree in biology from Southern Methodist University and a masters and PhD in environmental sciences from the University of Texas, Dallas. Her PhD dissertation was on evaluating the water quality significance of selected chemicals in aquatic sediments. She has considerable expertise and experience in aquatic life toxicity testing and evaluation. Dr. Jones-Lee and I have worked together as a team since the 1970s on a variety of water quality issues at several locations in the US and in other countries. Our recent work is available in papers and reports from our website, www.gfredlee.com. Additional information on my qualifications to make these comments is appended.

Dr. Jones-Lee and I became familiar with the water quality problems in the West Branch of the Grand Calumet River (WBGCR) in the mid-1990s through serving as consultants to the Sanitary District of Hammond.

Restoration Goals for the WBGCR

Tetra Tech (Tt) on behalf of the US Fish and Wildlife Service (USFWS) has stated that the goal of the Grand Calumet River Restoration Foundation (GCRRF) Council is

> "*… to address the effects of sediment contamination in the WBGCR, specifically for the purpose of addressing and correcting environmental contamination in the area of concern, including the cleanup of contaminated sediments in GCR, and the remediation and restoration of natural resource damages within the area of concern."*

This draft Preliminary Problem Formulation (PPF) report is to set the stage for accomplishing these objectives through establishing an approach for identifying the chemicals of concern for public health and environmental impacts (water quality). Based on my over 40 years of work on chemicals in wastewaters and wastes in the environment with respect to determining the sources of potential pollutants, their environmental fate, and impacts on public health and aquatic life, and to developing technically valid, cost-effective management programs, **I find the draft PPF proposed approach falls short of providing a reliable approach for formulating a technically valid, cost-effective water quality problem definition and a framework for management of real significant public health and environment impairments caused by chemicals in the sediments of the WBGCR.**

A review of the existing water quality characteristic data shows that the West Branch of the Grand Calumet River contains a variety of chemicals that are **potential** pollutants that could

- cause aquatic life toxicity
- be bioaccumulating to excessive levels in edible organisms
- represent a threat to human health through body contact with the sediments.

Most importantly, the existing database also shows that there is aquatic life toxicity in the WBGCR sediments and that edible aquatic organisms collected from this area contain sufficient concentrations of hazardous chemicals to be a threat to those who use these organisms as food. However, the sediment toxicity data that are available thus far do not distinguish between naturally occurring sediment toxicity associated with eutrophic waterbodies and the toxicity due to anthropogenic inputs of chemicals that in the WBGCR are in toxic/available forms and thereby are causing significant adverse impacts on the numbers and types of desirable forms of aquatic life in the WBGCR. Further, it is not clear from the data available that the chemicals in the WBGCR sediments are the exclusive source of the chemicals that are bioaccumulating to excessive levels in edible organisms taken from the WBGCR.

The approach that the US Fish and Wildlife Service has adopted for addressing the Natural Resources Damage Assessment (NRDA) issues in the West Branch of the Grand Calumet River is not technically valid, from several perspectives. Foster Wheeler (2002) has provided a summary discussion of NRDA restoration issues, where the emphasis is on restoration of degraded aquatic ecosystems to their full beneficial use potential. As quoted

above, the GCRRF Council has stated that their goal is restoration of the degraded WBGCR ecosystem. **The current US Fish and Wildlife Service approach for restoration of the West Branch of the Grand Calumet River could result in expenditures of many millions of dollars, yet fail to restore the West Branch of the Grand Calumet River to a healthy ecosystem.** The basic problem is that there are several major current sources of pollutants which, until they are controlled, will almost certainly continue to add constituents that can cause the WBGCR sediments after restoration to still be toxic to aquatic life and still be a source of bioaccumulatable chemicals that would be a threat to human health through body contact and through bioaccumulation in the food web to edible organisms.

Failure to Define Current Sources of Aquatic Ecosystem Stressors to the WBGCR

The US Fish and Wildlife Service has approached the NRDA from an overly simplistic approach. The approach is similar to one that would be used if a train car load of a hazardous chemical had been spilled into a high-value trout stream, where the chemicals in the tank car that spilled were highly toxic to fish and were also persistent and accumulated in sediments. As a result there would be need to develop sediment remediation approaches to restore this aquatic ecosystem to its full beneficial uses. This is not the system that exists in the WBGCR. The WBGCR has a variety of potential stressors – some of which have been measured, and some of which have not – that can cause aquatic life toxicity and be adverse to the beneficial uses of this waterbody. Many of the stressors are likely present in current discharges. Until the constituents responsible for the aquatic life toxicity are properly defined through toxicity investigation evaluations (TIEs), their sources identified, and their aqueous environmental chemistry, fate and transport are understood, the potential for achieving the desired goals for the restoration of the WBGCR is questionable.

One of the primary issues of concern with respect to restoring the WBGCR is the current inputs of combined sewer overflows (CSOs) which are adding raw sewage and sewage sludge to the WBGCR. In addition, there is urban, industrial and undeveloped area stormwater runoff that is contributing a variety of chemical constituents that are potential pollutants to the WBGCR.

Another potentially significant source that is not included in the PPF is groundwater input of pollutants. Groundwater inputs of pollutants are being ignored in this document. Even without the combined sewer overflows and urban and industrial stormwater runoff, there can be groundwater inputs of pollutants that could negate any significant restoration of the WBGCR natural resources. While mention was made at several locations in the PPF about inputs from landfills to the WBGCR, there is no quantitative information presented to evaluate the significance of this source. The potential for groundwaters/landfills to provide hazardous and deleterious chemicals to the WBGCR is a highly significant information gap that must be evaluated in any credible NRDA preliminary problem formulation.

There is another unregulated source of chemicals that could be potentially adverse to aquatic life in the WBGCR. These are the PPCPs (pharmaceuticals and personal care products) that are discharged to the WBGCR through the Hammond and other sanitary districts' wastewater discharges and combined sewer overflows. There is increasing concern in the water quality management field about pharmaceuticals and personal care products that are legally discharged to domestic wastewaters, which are known to pass through domestic wastewater

treatment plants such as the Hammond Sanitary District treatment plant and can be adverse to aquatic life in the receiving waters. The US EPA has established a PPCP program (http://www.epa.gov/nerlesd1/chemistry/ppcp/greenpharmacy.htm) which presents information on the potential ramifications of PPCPs present in domestic wastewaters and other sources, which are passing through conventional wastewater treatment plants into the environment and which cause adverse impacts to aquatic resources. This is yet another source of chemicals that could lead to aquatic life toxicity, altered aquatic organism populations, etc., which would essentially negate restoration of the WBGCR to a fully functioning, uninhibited aquatic habitat. Recently I attended a California Bay-Delta Authority Contaminant Stressor workshop at which a series of lectures on contaminant stressors in the environment were presented. Dr. Tracy Collier, of the NOAA Northwest Fisheries Science Center, discussed in his presentation, "Emerging Issues in Estuarine Toxicology: Reproductive and Developmental Effects," that it is being found that the city of Seattle's combined sewer overflows are likely the source of stressors to aquatic ecosystems that are potentially significantly adverse to parts of the Puget Sound ecosystem near Seattle.

At the Contaminant Stressor workshop, Dr. Christian Daughton of the US EPA National Exposure Research Laboratory, who is the head of the PPCP program, provided a discussion of this issue, "Ubiquitous Pollution from Health and Cosmetic Care: Significance, Concern, Solutions, Stewardship." I have obtained an electronic copy of his PowerPoint slides, which summarize key PPCP issues that are pertinent to attempts to restore the WBGCR ecosystem. I can make these slides available to anyone interested. They provide information on the potential significance of the presence of these chemicals in wastewaters and stormwater runoff.

An important issue that has to be considered in developing a restoration program is that the WBGCR at times consists almost entirely of domestic wastewaters. At times there are very few other sources of flow through the WBGCR. At these times this system is more akin to being a sewage lagoon than an aquatic ecosystem. The restoration of this system may not be possible without massive expenditures for control of the CSOs and all stormwater runoff, and very high degrees of advanced domestic wastewater treatment, far beyond anything practiced anywhere in the world. Even then, normal runoff from wetland areas along the WBGCR at times could introduce enough natural pollutants to lead to highly degraded water quality. Those who are familiar with wetlands water quality impacts know that wetlands, such as along and near the WBGCR, are at times significant sources of natural pollutants. Under conditions where there is little or no water in the WBGCR to dilute these constituents, the system could have highly degraded water quality and may never, even without CSOs, stormwater runoff and highly treated domestic wastewater inputs, achieve its full potential for designated aquatic-life-related beneficial uses. It is my understanding that the Sanitary District of Hammond is at its limit of borrowing capacity and is not in a position to acquire funds to control the CSOs or to provide ultra-high degrees of treatment of its domestic wastewater effluent and stormwater runoff.

Dredging and/or capping of WBGCR sediments may have little or no impact on the natural resources in the WBGCR that could be occurring if there were no combined sewer overflows or stormwater runoff to this waterbody. Without proper evaluation of current sources, the proposed restoration approaches could represent a massive waste of public and private funds in an ill-defined, improperly investigated NRDA.

Unreliable Designation of Constituents Responsible for Toxicity

The most significant problem with the Tt/USFWS proposed approach is that the proposed water quality problem identification largely ignores the aqueous environmental chemistry of the potential pollutants. Many of the WBGCR sediment-associated chemicals listed in the PPF as chemicals that need to be remediated have complex aquatic chemistry, where substantial parts of the total concentration in a sediment is non-toxic/non-available. The chemical concentration-based approach for water quality problem identification used by Tt/USFWS is well known to be technically invalid and can readily misidentify chemicals in sediments as a cause of toxicity.

The US Fish and Wildlife Service has unfortunately followed unreliable approaches for designating constituents of concern that are responsible for the aquatic life toxicity in the WBGCR sediments. The approach of trying to use total concentrations of contaminants present relative to the co-occurrence-based so-called guidelines, such as the D. D. MacDonald PECs, is well known to be technically invalid and highly unreliable in predicting the cause of aquatic life toxicity. Those of us with aquatic chemistry and aquatic toxicology expertise and experience, who work in the sediment quality evaluation field, have known since the early 1970s that total concentrations of a chemical, such as used in the D. D. MacDonald PEC values, are unreliable for predicting water quality impacts due to specific constituents in a system where there are potentially multiple stressors. While the fundamentally flawed nature of co-occurrence-based sediment quality guidelines has been understood since they were first developed by Long and Morgan, and subsequently by D. D. MacDonald in the early 1990s, by those who understand aquatic chemistry, aquatic toxicology and water quality issues, there is growing recognition by many experts in the field who understand these issues about the unreliability of the co-occurrence-based D. D. MacDonald PEC approach for defining the causes of toxicity in aquatic sediments.

In October 2002 the Aquatic Ecosystems Health and Management Society held an international conference in Chicago (Fifth International Symposium on Sediment Quality Assessment – SQA5) where these issues were discussed in detail. A number of the world's recognized experts on sediment quality evaluation unanimously agreed about the unreliability of the co-occurrence-based sediment quality guidelines. As Dr. Dominic DiToro, now a distinguished professor at the University of Delaware, pointed out, to the extent that these co-occurrence-based guidelines appear to have any predictive capability, it is purely a coincidence. Dr. Tom O'Connor of NOAA has indicated that, based on his review of existing databases, this approach can be wrong in predicting toxicity more times than it is right – i.e., flipping a coin would give a more correct answer on whether sediments are toxic than using the co-occurrence-based sediment quality guidelines used by the US Fish and Wildlife Service.

In December 2002, for the California State Water Resources Control Board and the Central Valley Regional Water Quality Control Board, Dr. Anne Jones-Lee (my wife) and I prepared a comprehensive report which included a section on why co-occurrence-based sediment quality guidelines are unreliable for any purpose. A copy of our review of this topic is available from our website:

Lee, G. F. and Jones-Lee, A., "Unreliability of Sediment Co-Occurrence-Based Approaches for Evaluating Aquatic Sediment Quality," Excerpts from Lee, G. F. and Jones-Lee, A., "Organochlorine Pesticide, PCB and Dioxin/Furan Excessive Bioaccumulation Management Guidance," California Water Institute Report TP 02-06 to the California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 170 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/UnrelSedCooccur.pdf

In addition to Dr. Dominic DiToro, individuals such as Dr. Allen Burton and Dr. Peter Chapman, in keynote presentations at the Sediment Quality Assessment (SQA5) symposium, discussed the unreliability and inappropriateness of using total concentration-based sediment guidelines for any purpose. As we have discussed in our review, in order to determine whether sediments are toxic, toxicity should be measured using a suite of sensitive organisms. In order to determine the cause of this toxicity, sediment toxicity investigation evaluations (TIEs) **must** be conducted. There is no shortcut to this approach. I presented a paper at SQA5 on the use of chemical information in a weight of evidence evaluation of sediment quality. A copy of our paper is available on our website:

Lee, G. F. and Jones-Lee, A., "Appropriate Incorporation of Chemical Information in a Best Professional Judgment 'Triad' Weight of Evidence Evaluation of Sediment Quality," Presented at the Fifth International Symposium on Sediment Quality Assessment (SQA5), "Aquatic Ecosystems and Public Health: Linking Chemical, Nutrient, Habitat and Pathogen Issues," Aquatic Ecosystems Health and Management Society, Burlington, Ontario, Canada (2003). (In press.)
http://www.gfredlee.com/BPJWOEpaper.pdf

The proceedings of this conference are in press and should be available in the near future.

Specific Comments

Page 1-3 of the PPF, in section 1.2.1 Ecological Impacts, states,

"Several investigations have been conducted to asses the effects on ecological receptors associated with exposure to chemicals of potential ecological concern (COPECs) in the WBGCR. For example, Ingersoll and MacDonald (1999) conducted an assessment of sediment injury in the WBGCR. The results of this investigation demonstrated that the concentrations of sediment-associated COPECs in the WBGCR were sufficient to injure sediment-dwelling organisms."

Those who understand aquatic chemistry and aquatic toxicology know that such statements can readily be in error with respect to defining the cause of sediment toxicity. It has been known since the early 1970s that it is not possible to relate concentrations directly to impacts. While individuals like Long and Morgan and D. D. MacDonald claim that they can do this, their claims are without technical merit. It is pure coincidence if a particular set of data that they use happen to show a relationship. It should not be interpreted to mean cause and effect. As discussed in our review and as is obvious, the toxicity that is found in sediments could readily be due to a

variety of chemical constituents acting alone or in combination with other chemicals to cause toxicity. The only reliable way to assess cause and effect is through TIEs.

On page 1-3, the last sentence states, "*Fish populations were also reduced in the WBGCR, due to the loss or degradation of habitat associated with inputs of sewage sludge and other substances.*" Since sewage sludge continues to be added to the WBGCR associated with CSOs, problems due to sewage sludge in the past will continue, even though many millions of dollars may be spent removing the existing deposits.

On the bottom of page 1-3 and top of page 1-4, a number of chemicals are listed that have been identified as substances that are causing or substantially contributing to sediment injury in the WBGCR. That analysis is based on the fundamentally flawed approach of finding a contaminant in sediments and assuming that there is a relationship between its presence and an adverse impact. As just one example, one of the constituents listed is total organic carbon. Total organic carbon typically is a detoxifying agent – not a toxicant.

The statement is made on page 1-4, second paragraph, that, "*In addition, the results of toxicity tests confirmed that whole sediments, pore water, and/or elutriates were toxic to aquatic organisms.*" As we and others discuss, sediment tests are reliable for assessing toxicity, while chemical concentrations are not. Those who understand aquatic chemistry in sediments know that many of the chemicals listed in the first paragraph on page 1-4 exist in a variety of chemical forms, only some of which are toxic. It is inappropriate to conclude that those chemicals listed in the first paragraph of page 1-4 are responsible for toxicity without doing the TIE work to demonstrate that the toxicity is caused by one or more of these chemicals. Further, there could readily be other chemicals in the sediments that are the primary cause of toxicity, which are not on the D. D. MacDonald PEC list. Without identifying the chemicals responsible for toxicity through reliable approaches and determining whether they are still being input to the WBGCR, it is readily possible that large amounts of public and private funds could be spent removing or controlling sediment-associated constituents only to find that there is no real change in the WBGCR ecosystem characteristics/beneficial uses. It is almost certain that the sediments will still be toxic after restoration.

Page 1-5, section 1.3 Purpose and Scope of Technical Memorandum states,

> "*The purpose of the WBGCR Phase III activities are* [sic] *to provide the GCRRF Council with specialized technical support for identifying and evaluating remedial restoration alternatives for the West Branch of the Grand Calumet River, IN and to conduct a focused baseline human health risk assessment for this area. More specifically, this technical memorandum centers on establishing preliminary Conceptual Site Models (CSM) for both ecological and human health receptors and the development of preliminary Remedial Action Objectives (RAOs).*"

That purpose needs to be significantly expanded, and preceded by properly conducted studies by knowledgeable individuals who incorporate aquatic chemistry and aquatic toxicology into evaluating the cause of the toxicity, the source(s) of the toxicant(s) responsible, whether these toxicants are still being added to the WBGCR from combined sewer overflows, stormwater

runoff, runoff from nearby lands, domestic wastewater discharges, discharges of PPCPs, etc. With the additional information it then should be possible to make an assessment of whether any funds should be spent in attempting to remediate sediments in the WBGCR until such time as the sources of the constituents responsible are under control.

On page 1-6, the first full paragraph, mid-paragraph states,

> *"The findings from these risk assessments will be considered together to develop and compare ecological and human health PRGs. This will allow for risk management decision makers to select the most appropriate restoration alternatives. Successful completion of this project involves a cooperative effort between the risk managers (i.e., GCRRF Council), and the human health and ecological risk assessors."*

This statement is significantly deficient in not including an assessment of the sources of constituents that will continue to be added to the WBGCR.

Appendix A presents a Baseline Human Health Risk and Analysis Plan, while Appendix B presents an Analysis Plan for Development of Ecological Risk-Based Preliminary Remediation Goals. These appendices provide the overall approach that is proposed to assess the risk of contaminants in the WBGCR.

On page A-1, in the second paragraph is a list of the requirements of applicable regulatory and other guidance documents for conducting a baseline human health risk assessment. The approach that is proposed follows conventional Superfund methodology. The component of this that is missing, which could become very important in a proper risk assessment, is an assessment of the bioavailability of constituents in the sediments. While the conventional Superfund approach assumes that all measured concentrations represent toxic available forms, it is well established that, for many constituents – and this would be especially true for contaminated sediments, such as in the WBGCR – the contaminants are bound to the sediment matrix in such a way as to be not available to cause toxicity or uptake, either through contact by humans or through the food web.

Page A-1, section 1.1.1 Identification of Chemicals of Concern has the same deficiencies as discussed in the comments on the main body of this report, in that it is assumed that all of the potentially hazardous contaminants in the sediments for human health or aquatic and terrestrial life have been measured and their concentrations are known.

Page A-2, first sentence states,

> *"The primary criterion to be used for the screening of chemicals as potential COPCs is a comparison of maximum detected concentrations to a toxicity-based concentration screen."*

This approach is not technically valid, since, as discussed above, the so-called "toxicity-based concentration screens" are based on co-occurrence and not on cause and effect. Therefore, erroneous conclusions can readily be developed using this approach. The use of PRG values as a

screen can lead to gross overestimates of hazard, because of the fact that substantial parts of the contaminants that are being analyzed for are in nontoxic, non-available forms.

Beginning on page A-3, the various constituents that have been identified as being of concern to human health are listed for each of the reaches of the WBGCR. A number of these constituents would not be expected to be toxic or adverse to humans.

Page B-1 begins a discussion of the ecological risk-based approach for establishing preliminary remediation goals. Since this approach is based on total concentrations of constituents, irrespective of whether they are toxic/available, and so-called sediment quality guidelines (i.e., PEC values), it is not technically valid.

Page B-2, paragraph 1.2.2 mentions the use of PEC quotients. This approach is no more valid than the individual PEC values. The so-called quotient approach has no technical validity for identifying specific constituents responsible for ecological effects. Without this identification and an understanding of the current sources, the process of restoration of the WBGCR sediments to eliminate risk can readily be erroneously conducted.

Basically, the approaches outlined in these appendices suffer from the same fundamental flaw as discussed above in the discussions about the main body of the report.

Overall Assessment

The Preliminary Problem Formulation is significantly deficient in serving as an appropriate basis for an NRDA restoration effort for pollutants in the WBGCR sediments. The failure to properly evaluate the impacts of current sources of pollutants that will continue to be discharged to the WBGCR after restoration is a significant deficiency in the PPF that must be corrected if a technically valid, cost-effective, reliable restoration program is to be undertaken.

The approach that has been used to define constituents of concern is at best naïve, in that it is based on technically invalid approaches for assessing chemicals that cause aquatic life toxicity in sediments.

Overall, the PPF needs to be redeveloped, in which the issues discussed herein are properly addressed. Basically, the ecological risk assessment approach that is presented herein needs to be discarded and redone by individuals who understand aquatic chemistry, aquatic biology, toxicology and water quality evaluation.

References

Foster Wheeler, “Technical Memorandum: Restoration Alternatives Development and Evaluation for the West Branch of the Grand Calumet River, Indiana,” Foster Wheeler Environmental Corporation, Lakewood, CO, February (2002).

Summary of Drs. G. Fred Lee and Anne Jones-Lee's Expertise and Experience Pertinent to Evaluating the Public Health and Aquatic Life Impacts of Chemical Constituents in Aquatic Sediments and their Associated Waters

Dr. G. Fred Lee is President of G. Fred Lee and Associates, which consists of Drs. G. Fred Lee and Anne Jones-Lee (Vice President) as the principals in the firm. They specialize in addressing advanced technical aspects of water supply water quality, water and wastewater treatment, water pollution control, and solid and hazardous waste impact evaluation and management.

After obtaining a bachelor's degree at San Jose State University in 1955, a Master of Science Degree in Public Health from the University of North Carolina in 1957 and a PhD from Harvard University in 1960 in Environmental Engineering and Environmental Sciences, Dr. Lee taught graduate-level university environmental engineering and environmental science courses for 30 years at several major U.S. universities. During this time, he conducted over $5 million of research and published over 500 papers and reports.

Dr. Lee was active as a part-time consultant during his 30-year university teaching and research career. Drs. Lee and Jones-Lee have been full-time consultants since 1989. Dr. Lee has extensive experience in developing approaches that work toward protection of water quality without significant unnecessary expenditures for chemical constituent control. He has been active in developing technically valid, cost-effective approaches for the evaluation and management of chemical constituents in domestic and industrial wastewater discharges and urban and rural stormwater runoff since 1960. One of his areas of particular expertise is evaluating the water quality significance of chemical constituents in aquatic sediments.

Dr. Anne Jones-Lee was a university professor for a period of 11 years in environmental engineering and environmental sciences. She has a BS degree from Southern Methodist University and obtained a PhD in Environmental Sciences in 1978 focusing on water quality evaluation and management from the University of Texas at Dallas. At the New Jersey Institute of Technology she held the position of Associate Professor of Civil and Environmental Engineering with tenure. She and Dr. G. F. Lee have worked together as a team since the mid-1970s. Their recent papers and reports are available from their website, www.gfredlee.com.

Dr. G. F. Lee has been a member of the APHA, *et al*., (1998) Standard Methods committee for development of Standard Methods for the Examination of Water and Wastewater since the early 1960s. Also during this time, he has been a member of the ASTM Committee D-19 on Water. This committee work involves his periodically reviewing new or revised analytical methods for water and wastewater components. It enables him to stay current with analytical methods development and their appropriate utilization. This is pertinent to relating measured concentrations of constituents to water quality impacts.

Dr. G. F. Lee has over 40 years of experience working on helping to develop, implement and evaluate water quality criteria and state standards based on US EPA criteria. This experience includes advising a number of states (such as Wisconsin, Texas and Colorado) on the development of appropriate water quality criteria/standards. Further, Dr. G. F. Lee was part of

the National Academies of Science and Engineering peer review panel that developed the "Blue Book" of water quality criteria in 1972. In the late 1970s he was a member of the American Fisheries Society Water Quality Section panel that reviewed the US EPA "Red Book" of water quality criteria released in 1976. Further, in the early 1980s Dr. G. F. Lee was a US EPA invited peer reviewer for the then proposed water quality criteria development approach. This is the approach that is still being used today to develop new water quality criteria. In addition, Dr. G. F. Lee served as an invited peer reviewer for several sections of the US EPA "Gold Book" of water quality criteria (ammonia and copper) as part of promulgating the Gold Book criteria in 1986.

Dr. G. F. Lee is familiar with how water quality criteria have been developed, their strengths and weaknesses, and, most importantly, their proper application in water quality management programs. He and Dr. Jones-Lee published an invited paper, "Appropriate Use of Numeric Chemical Water Quality Criteria," discussing how the US EPA criteria and state water quality standards based on these criteria should be implemented, considering the approach for their development and their appropriate use to regulate constituents in ambient waters from various sources.

Throughout his 30-year university graduate level teaching and research career Dr. Lee devoted considerable research effort to evaluating the water quality significance of chemicals in aquatic sediments. During the 1970s he conducted over a million dollars in research for the US Army Corps of Engineers Dredged Materials Research Program devoted to evaluating the water quality significance of open water disposal of dredged sediments. The issue of concern was to determine whether depositing contaminated dredged sediments in a waterbody could lead to significant adverse impacts to the beneficial uses of the waterbody. This research involved evaluating the release of potential pollutants from contaminated sediments that could be adverse to aquatic life associated with the sediments and in the overlying water column. Over 100 sites across the US were sampled and evaluated for about 30 potential pollutants, including organochlorine "legacy" pesticides, PCBs, a suite of heavy metals, nutrients, aquatic life toxicity, etc. Some of the sites that were studied, such as the Houston Ship Channel and Texas City Channel, were highly degraded and contained a variety of chemical constituents. It was through these studies that it was confirmed that the total concentrations of potential pollutants, such as heavy metals, many organics, etc., are unreliable predictors of sediment toxicity.

An area of particular concern to Drs. Lee and Jones-Lee in their research and consulting activities is reliable assessment of the significance of chemical constituents in aquatic sediments. They have repeatedly found that some investigators, consultants and governmental agencies attempt to assess the water quality significance of chemical contaminants in sediments based on the concentration of the chemical in the sediments. An understanding of the aqueous environmental chemistry of chemicals in sediments and their water quality impact shows that chemical concentrations are not reliable for assessing water quality impacts. They and others have published extensively on this topic. Many of their important recent papers are on their website, www.gfredlee.com.

Beginning in the mid-1980s, Drs. G. F. Lee and A. Jones-Lee became advisors on appropriate Superfund site investigation and remediation approaches. They were internal

consultants to Ebasco, Inc., on a variety of Superfund sites located east of the Mississippi River. In the mid-1990s, they became advisors to the public on the adequacy and reliability of investigation and remediation of two US EPA NPL Superfund sites. They were appointed as US EPA-supported Technical Assistance Grant (TAG) advisors on the UCD/DOE LEHR Superfund site and the Lava Cap Mine Superfund site. Work in connection with these continuing appointments include a detailed review of the water quality and public health significance of a variety of chemical constituents present in water, soils and sediments at the Superfund sites. As a result of these efforts, Drs. Lee and Jones-Lee have considerable familiarity with appropriate Superfund site investigation and remediation that is directly pertinent to evaluating the Preliminary Problem Formulation for the West Branch of the Grand Calumet River.

Drs. Lee and Jones-Lee first became familiar with the contamination of the West Branch of the Grand Calumet River in the mid-1990s while they were serving as consultants to the Sanitary District of Hammond. In this capacity they had the opportunity to review in detail the existing database on sediment contamination in this waterbody. They found that, while there is significant sediment contamination by a variety of chemicals, the governmental agency studies on the impacts of this contamination had not been adequately and reliably conducted.

Drs. Lee and Jones-Lee are highly qualified to provide comments on the adequacy and reliability of the US Fish and Wildlife Service approach for developing a Preliminary Problem Formulation that is to be used as part of remediation of the West Branch of the Grand Calumet River.