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UNDERGROUND STORAGE TANKS (UST) CLEANUP & RESOURCE CONSERVATION & RECOVERY ACT (RCRA) SUBTITLE C PROGRAM BENEFITS, COSTS, & IMPACTS (BCI) ASSESSMENTS: AN SAB ADVISORY

REVIEW OF THE UST/RCRA BENEFITS, COSTS & IMPACTS (BCI) ASSESSMENTS BY THE UST/RCRA BCI REVIEW PANEL OF THE SAB'S EXECUTIVE COMMITTEE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

December 20, 2002

EPA-SAB-EC-ADV-03-001

Honorable Christine Todd Whitman
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue. NW
Washington, DC 20460

Subject: Underground Storage Tanks (UST) Cleanup and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs, and Impacts Assessments: An EPA Science Advisory Board Advisory

Dear Governor Whitman:

On May 20-21, 2002, the Underground Storage Tanks (UST) Cleanup and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs, and Impacts Review Panel ("the Panel;") met to provide advice on four charge questions relating to the planning of economic assessments of the UST Cleanup and RCRA Subtitle C Programs as described in two Agency Draft Reports: *Approaches to Assessing the Benefits, Costs, and Impacts of the Office of Underground Storage Tanks Cleanup Program*, October 2000; and *Approaches to Assessing the Benefits, Costs, and Impacts of the RCRA Subtitle C Program*, October 2000. These documents describe the fundamental methodological approaches being considered by the Agency as a framework for assessing the benefits, costs and other impacts of the RCRA Subtitle C and UST cleanup environmental programs. The Panel reviewed these documents and received briefings from Agency staff from the Office of Solid Waste and Emergency Response (OSWER). Subsequent discussions occurred in a technical editing session public conference call on June 18, 2002. The EPA Science Advisory Board Executive Committee approved this advisory on October 1, 2002.

As result of these deliberations, the Panel has prepared an Advisory Report with detailed comments and suggestions. This report is attached to this letter. In our judgement, the Agency has made a good start in developing a framework for assessing the benefits, costs, and other impacts of these two programs. Most of our comments in the Advisory involve suggestions for improving the planned assessments. However, we had serious reservations about the Agency's efforts to expand the scope of the assessments to include some of the so-called "non-traditional attributes" listed under the category of Program Context Attributes. We provide more detail

about these reservations and offer suggestions for changes in the framework in our Advisory and in Item #2 in this letter.

We appreciate being consulted in the relatively early phases of this substantial exercise; and we recommend further SAB involvement in the Agency assessment process at appropriate stages in reviewing, for example, significant revisions to these methodological documents, as well as future work plans and draft assessments.

We wish to bring to your attention the following regarding overall study design:

The Agency proposes a combination of retrospective and prospective analyses of these two programs. A retrospective study deals with what are now sunk costs; and although it can provide a useful picture of what has been accomplished, it might have little direct implication for future policy choices. However, we believe that it is possible in this case to frame a retrospective study in ways that will also generate information useful for policy analysis. We recommend that the Agency design these studies to take advantage of differences in approaches to implementation across states or industrial sectors in an effort to learn if and how these differences affected the economic performances of the programs. This kind of information could inform future decision making by EPA managers.

We also wish to bring to your attention the following items regarding four charge questions:

1. In Charge Question #1 the Agency asked for our evaluation of the "OSWER Program Attributes Matrix" that is used to list impacts to be included in these studies. The Panel believes that the Attributes Matrix contained in the UST and RCRA documents (US EPA 2000b and US EPA. 2000c) creates potential problems for those efforts by loading too many extra considerations onto the conceptual framework provided by EPA's Guidelines for Preparing Economic Analyses (US EPA. 2000a) and by introducing distinctions that are not helpful to the analysis. We have proposed a revised Attributes matrix that lists Social Benefits, Social Costs, and Distributional Impacts for analysis. Many of the items listed by the Agency in the category of "Program Context Attributes" have been moved into one of the remaining three categories. The others have been left out since we believe that they fall outside of the appropriate conceptual framework of program assessment.

2. In Charge Question #2 the Agency asked for our comments on the methods proposed for the evaluation. In two instances where alternative methodologies or approaches are presented, we believe that it is premature to select only one methodology for analysis of the whole program. Rather we recommend doing case studies with two or more methodologies to learn more about possible implementation problems and their relative performance. These instances are the alternative approaches for assessing health impacts for RCRA-C and the UST program.

3. Concerning the quantification and monetization of health benefits for RCRA-C, because of the variety of substances handled at subject facilities and the variety of possible routes of human exposure, a range of both cancer and non-cancer health effects must be assessed. But

for many of these substances, the available toxicological data can not support meaningful assessments of health benefits. For many of the substances that are categorized as carcinogens, the only available risk information is the 95% upper confidence interval on cancer potency or cancer risk. For many of the noncarcinogenic substances, the available toxicological data are in the form of Reference Doses (RfD) and reference concentrations (RfC) (doses and concentrations that are not to be exceeded in order to protect human health). These include built in margins of safety do not permit the quantification of either the number or severity of the health impacts of exceeding them. These are problems that have been identified in earlier SAB reports (see EPA-SAB-COUNCIL-ADV-99-005, 1999, p. 10 (U.S. EPA/SAB. 1999); EPA-SAB-COUNCIL-ADV-99-012, 1999, pp. 12-13 (U.S. EPA/SAB. 1999a), and EPA-SAB-EEAC-LTR-94-001, esp. pp. A-1 and A-2(U.S. EPA/SAB. 1994)). These comments point to the inadequacy of the current toxicological data bases for supporting economic analyses of policies to reduce exposures to these substances. This continues to be a problem that requires the attention of the Agency and research community.

Also, the Agency proposes calculating individual-based risk measures for the maximally exposed individual (MEI). Although such conservative measures may serve as an appropriate guide for some risk policy decisions, they should not be the basis for conducting benefit-cost analyses.

4. In describing the methods for assessing health benefits from the UST cleanup program, the Agency mentions only in passing the possibility of using the value of statistical life concept to obtain a monetary benefit measure. We believe that whenever the Agency can develop quantitative estimate of health impacts, it should also use the available methodologies to convert these to dollar values.

5. The Agency proposes to transfer values from three existing contingent valuation studies of groundwater contamination to estimate total (both use and non-use) values of the UST cleanup program. We have serious reservations about this proposal because, for several reasons, there is poor correspondence between the specifically cited studies and the UST and RCRA situations.

6. The Agency proposes to include a quantification of ecosystem impacts in its assessments of these two programs without estimating dollar values for these impacts. We recognize that ecosystem service benefits are particularly difficult to value in monetary terms and we would not push for the pursuit of dollar-based evaluation of ecosystem benefits in this particular regulatory context. However, we believe that it is possible to generate more informative indicators of the possible magnitude of ecological effects than those suggested in the draft reports, and we encourage the Agency to do so.

7. Charge Question #3 asks whether the methods are clearly and adequately described. For the most part, the answer is "yes." But there are several cases where descriptions of methods are incomplete or inadequate, and where problems of implementation are not identified or addressed. Examples include the quantification of health effects of RCRA-C, using the existing property value study literature to estimate program benefits, and the valuation of reductions in

cancer risks.

8. Charge Question #4 asks for our recommendations on evaluating some of the more non-traditional attributes identified in the Program Attributes Matrix, such as information provision and sustainability. Our views on many of the nontraditional attributes are presented in Section 4 of the Report. As for sustainability, this term refers to an economy's ability to maintain at least the current standard of living or level of well-being over multiple generations. The economic analysis of sustainability focuses on the roles of nonrenewable and renewable resources and capital in supporting the production of the goods and services necessary to maintain current levels of well-being. To the extent that the provisions of RCRA-C and the UST regulations result in reduced use of nonrenewable resources or substitution of renewable resources for nonrenewables, they would contribute in at least a small way to sustainability. But the benefits of such changes would normally be reflected in changes in costs of production at affected facilities. Thus a separate category of sustainability benefits is not appropriate.

We thank the Agency for the opportunity to be of service in reviewing these documents. If the Agency decides to go forward with assessments of these two programs, we would be pleased to be able to review revisions to these documents, more detailed work plans, and/or draft assessments. We look forward to your response, particularly to the items raised in this cover letter to you.

Sincerely,

/Signed/

Dr. William H. Glaze, Chair
EPA Science Advisory Board

/Signed/

Dr. A. Myrick Freeman, Chair
UST/RCRA BCI Review Panel
EPA Science Advisory Board

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ABSTRACT

The Underground Storage Tanks (UST) Cleanup and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs and Impacts Review Panel (UST/RCRA BCI Review Panel, or "the Panel") provided advice on four charge questions relating to the planning of economic assessments of the UST Cleanup and RCRA Subtitle C Programs as described in two Agency draft reports. The Panel focused on providing advice pertaining to study design, and advice pertaining to evaluation of a range of methodological options. The Panel commented on the relative advantages, disadvantages and data requirements for each option, as well as possible alternative methods or modifications of methods presented in the two Agency draft documents to make informed decisions. The Panel also assessed whether the methods are consistent with EPA's *Guidelines for Preparing Economic Analyses*.

The Panel critiqued the proposed attributes matrix which is a common element of each Agency draft document, and noted that the proposed attributes matrix creates potential problems by loading too many extra considerations onto the conceptual framework provided by EPA's *Guidelines for Preparing Economic Analyses*, and by introducing distinctions that are not helpful to the analysis.

The Panel offered advice pertaining to the UST Cleanup and RCRA Subtitle C Program in terms of human health benefits, ecological benefits, indicators, avoided costs, the property value approach, as well as alternative approaches. Other topics touched upon dealt with distributional impacts, including environmental justice, intragenerational impacts, economic impacts, risk tradeoffs and intergenerational equity.

Key Words: Costs, Benefits, Benefit-Cost Analysis, Underground Storage Tanks, Resource Conservation Recovery Act, Hazardous Wastes, Valuation, Valuation Methodologies

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Science Advisory Board
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1. EXECUTIVE SUMMARY

On May 20-21, 2002, the Underground Storage Tanks (UST) Cleanup and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs, and Impacts (BCI) Review Panel ("the Panel;") met to provide advice on four charge questions[1] relating to the planning of economic assessments of the UST Cleanup and RCRA Subtitle C Programs as described in two Agency Draft Reports: *Approaches to Assessing the Benefits, Costs, and Impacts of the Office of Underground Storage Tanks Cleanup Program*, October 2000 (U.S. EPA. 2000b); and *Approaches to Assessing the Benefits, Costs, and Impacts of the RCRA Subtitle C Program*, October 2000 (U.S. EPA. 2000c). The Panel reviewed these documents and received briefings from Agency staff from the Office of Solid Waste and Emergency Response (OSWER). Subsequent discussions occurred in a technical editing session public conference call on June 18, 2002. The EPA Science Advisory Board's (SAB's) Executive Committee approved this advisory on October 1, 2002 in a public meeting.

The Panel's major comments and recommendations are as follows.

1.1 Study Design

The Agency proposes a combination of retrospective and prospective analyses of these two programs. A retrospective study deals with what are now sunk costs, and therefore the analysis may have little direct implication for future policy choices. However, we believe that it is possible in this case to frame a retrospective study in ways that will generate information useful for policy analysis. We recommend that the Agency design these studies to take advantage of differences in approaches to implementation across states or industrial sectors in an effort to learn if and how these differences affected the economic performances of the programs. This kind of information could inform future decision making by EPA managers.

1.2 Charge Question #1: The Attributes Matrix

The Panel believes that the Attributes Matrix, which lists impacts to be included in these studies, creates potential problems for those efforts by loading too many extra considerations onto the conceptual framework provided by EPA's Guidelines for Preparing Economic Analyses (US EPA. 2000a) and by introducing distinctions that are not helpful to the analysis. We have proposed a revised Attributes Matrix that lists Social Benefits, Social Costs, and Distributional Impacts for analysis. Many of the items listed by the Agency in the category of "Program Context Attributes" have been moved into one of the remaining three categories. The others have been left out since we believe that they fall outside of the appropriate conceptual framework of program assessment.

[1] Each charge question is reproduced at the beginning of the appropriate section of this advisory dealing with it.

1.3 Benefits: Human Health

In describing the methods for assessing health benefits from the UST cleanup program, the Agency mentions only in passing the possibility of using the value of statistical life concept to obtain a monetary benefit measure. We believe that whenever the Agency can develop quantitative estimates of health impacts, it should also use the available methodologies to convert these to dollar values. The Agency should be explicit about its plans to assess monetary values and how it will deal with such issues as determining the appropriate value of statistical life, treating latency and so forth.

While individual-based risk measures like that for the maximally exposed individual (MEI) may serve as an appropriate guide for some risk policy decisions, such conservative measures should not be the basis for conducting benefit-cost analyses. What is relevant for benefits assessment is the mean exposure, or in the case of nonlinear dose-response functions, the whole distribution of actual exposure for the affected population.

Concerning the quantification and monetization of health benefits for RCRA-C, because of the variety of substances handled at subject facilities and the variety of possible routes of human exposure, a range of both cancer and non-cancer health effects must be assessed. But for many of these substances, the available toxicological data can not support meaningful assessments of health benefits. For many of the substances that are categorized as carcinogens, the only available risk information is the 95% upper confidence interval on cancer potency or cancer risk. For many of the noncarcinogenic substances, the available toxicological data are in the form of Reference Doses (RfD) and reference concentrations (RfC) (doses and concentrations that are not to be exceeded in order to protect human health). These include built in margins of safety and do not permit the quantification of either the number or severity of the health impacts of exceeding them. These are problems that have been identified in earlier SAB reports (see EPA-SAB-COUNCIL-ADV-99-005, 1999, p. 10(U.S. EPA/SAB. 1999); EPA-SAB-COUNCIL-ADV-99-012, 1999, pp. 12-13 (U.S. EPA/SAB. 1999a), and EPA-SAB-EEAC-LTR-94-001, esp. pp. A-1 and A-2(U.S. EPA/SAB. 1994)). These comments point to the inadequacy of the current toxicological data bases for supporting economic analyses of policies to reduce exposures to these substances. This continues to be a problem that requires the attention of the Agency and research community.

The Agency proposes to transfer values from three existing contingent valuation studies of groundwater contamination to estimate total (both use and nonuse) values of the UST cleanup program. We have serious reservations about this proposal because there is poor correspondence between the specifically cited studies and the UST and RCRA situations. We suggest that the Agency consider funding contingent valuation studies of groundwater contamination with single or multiple contaminants that have a known probability of cancer risk. The values obtained from such research could be compared with the existing body of literature on the value of statistical lives, and could provide a better source for benefits transfer than the existing research on groundwater evaluation. To date, no such tests of convergent validity exist between groundwater valuation research and the broader valuation of risks literature.

1.4 Benefits: Ecosystem Impacts

The Agency proposes to include a quantification of ecosystem impacts in its assessments of these two programs without estimating dollar values for these impacts. We recognize that ecosystem service benefits are particularly difficult to value in monetary terms, and we would not push for the pursuit of dollar-based evaluation of ecosystem benefits in this particular regulatory context. However, we believe that it is possible to generate more informative indicators of the possible magnitude of ecological effects than those suggested in the draft reports, and we encourage the Agency to do so.

An issue of particular importance is that economic analysis requires ecological analysis of effects on populations of species, not analysis of individual toxicity effects. This presents a practical difficulty because ecological analysis typically generates individual toxicity estimates. The reason population effects are the desirable endpoint is that populations, rather than individuals, are what is actually economically valuable and estimable.

Ecological benefits for both bio-physical and economic reasons are highly idiosyncratic to local conditions. Attempts to generate numbers will exhibit a false rigor. The most intellectually honest approach, at this time, is to acknowledge limitations in the data and our ability to model complex physical, ecological and economic systems.

We strongly encourage EPA to develop quantitative indicators of ecosystem service benefits. Quantitative landscape analysis, using GIS tools, can be used to derive indicators of preserved ecosystem service benefits. A variety of types of indicators could be collected, including indicators of primary demand, scarcity, and complementary inputs. Integrating this kind of data into "contamination events avoided" analysis would improve the salience of the benefits assessment.

1.5 Benefits: The Property Value Approach

One of the approaches proposed by the Agency for estimating the benefits of UST Cleanup requirements and RCRA-C is to estimate the number of sites avoided by these provisions and to value each avoided site by the predicted reduction in housing prices based on a review of the literature on hedonic property values around Superfund sites, hazardous waste sites, and other local disamenities. If this approach is utilized, the issues of the relationship between property value changes and welfare, amenity effects on property values, and benefits transfer need to be addressed. But given the problems with the other approaches proposed, this approach may be a relatively simple way to get obtain a "ball park" or order-of-magnitude estimate of benefits.

1.6 Alternative Approaches to Benefits Modeling

In the cases of assessing health impacts for RCRA-C and the UST programs, two alternative methodologies or approaches are presented. We believe that it is premature to select only one for analysis of the whole program. Rather we recommend doing case studies with two or more methodologies to learn more about possible implementation problems and their relative performance.

1.7 Distributional Impacts

The RCRA and UST documents introduce a large number of dimensions of distribution to evaluate and methods for doing this evaluation. The Panel urges a more parsimonious choice of distributional impacts for quantification. We recommend that the assessments focus on the distribution of beneficial and adverse effects across groups organized by, for example, income, race, and geographic unit. An assessment of the effect of the RCRA and UST programs on disadvantaged populations is critical to evaluating their success. The documents discuss approaches to assessing half of this effect, namely the distribution of benefits. They do not discuss the equally important other half, namely whether the burden of costs disproportionately falls on disadvantaged populations. Neither document discusses an assessment of the distribution of costs by income. The distribution of costs depends on the extent to which compliance costs are passed forward to consumers in the form of higher prices, which in turn depends on the elasticities of supply and demand, the extent to which compliance alters marginal costs, and the market structure of the industry.

1.8 Charge Question #3: Descriptions of Methods

This question asks whether the methods are clearly and adequately described. For the most part, the answer is "yes." But there are several cases where descriptions of methods are incomplete or inadequate, and where problems of implementation are not identified or addressed. Examples include the quantification of health effects of RCRA-C, using the existing property value study literature to estimate program benefits, and the valuation of reductions in cancer risks.

1.9 Charge Question #4: Nontraditional Attributes - Sustainability

This question asks about "better ways to characterize and/or quantify some of the more 'non-traditional attributes' ... [including] ... sustainability." Our views on many of the nontraditional attributes are presented in Section 4 of the Report. As for sustainability, this term refers to an economy's ability to maintain at least the current standard of living or level of well-being over multiple generations. The economic analysis of sustainability focuses on the roles of nonrenewable and renewable resources and capital in supporting the production of the goods and services necessary to maintain current levels of well-being. To the extent that the provisions of RCRA-C and the UST regulations result in reduced use of nonrenewable resources or substitution of renewable resources for nonrenewables, they would contribute in at least a small way to sustainability. But the benefits of such changes would normally be reflected in changes in costs of production at affected facilities. Thus a separate category of sustainability benefits is not appropriate.

2. INTRODUCTION AND CHARGE

On May 20-21, 2002, the Underground Storage Tanks (UST) Cleanup and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs, and Impacts (BCI) Review Panel ("the Panel;") met to provide advice on four charge questions relating to the planning of economic assessments of the UST Cleanup and RCRA Subtitle C Programs as described in two Agency Draft Reports: *Approaches to Assessing the Benefits, Costs, and Impacts of the Office of Underground Storage Tanks Cleanup Program*, October 2000; and *Approaches to Assessing the Benefits, Costs, and Impacts of the RCRA Subtitle C Program*, October 2000. The Panel reviewed these documents and received briefings form Agency staff from the Office of Solid Waste and Emergency Response (OSWER). Subsequent discussions occurred in a technical editing session public conference call on June 18, 2002. The EPA SAB's Executive Committee approved this advisory on October 1, 2002 in a public meeting.

The Charge to the SAB is as follows:

1. Does the "OSWER Attributes Matrix" (Exhibit 1-1 in both reports) provide a good list of program attributes that could appropriately be used to describe OSWER program benefits, costs, impacts, and other key factors influencing program performance? Does the list provide a reasonable starting point for an analysis of an OSWER program that would ensure consideration of a broad range of program impacts and features? Should any attributes be modified, or deleted or added to this list, and if so, why?

2. Keeping in mind that it was OSWER's intention to evaluate a range of methodological options, and to include some relatively less resource-intensive options (recognizing these are likely to be less technically rigorous), are the methods presented viable and technically sound? Will the methods lead to defensible conclusions? Are the assumptions associated with the methods reasonable? If you believe any of these methods or assumptions are not viable, sound, or defensible, why not? Are the methods consistent with EPA's Guidelines for Economic Analyses, to the extent the guidelines address the OSWER program attributes?

3. Are the methods clearly and adequately described, for purposes of making a decision to select preferred methods for additional development and implementation? Are the advantages, disadvantages, and data requirements associated with each option clearly and adequately described? Is additional information needed for any of these methods in order for OSWER management to make an informed decision? If so, what information?

4. Are there alternative methods (or modifications of methods presented in the reports) that could be used to better characterize any of the attributes addressed in the two reports, keeping potential resource limitations in mind? If so, why? We are particularly interested in seeking SAB advice on methodologies to characterize the more traditional human health/environmental benefits (which represent EPA's core areas of responsibility), but OSWER would also welcome any

recommendations the SAB might have on better ways to characterize and/or quantify some of the more "non-traditional" attributes. These include sustainability and other long-term program impacts; the value of regulatory requirements that focus on providing information to the public; and the influence on program performance of factors such as stakeholder concerns and statutory/legal constraints.

3. STUDY DESIGN

While the charge questions focus largely on various aspects of implementing a specific approach to assessing the benefits, costs, and impacts of RCRA Subtitle C and the UST Cleanup Program based on the Attributes Matrix, the Panel also has comments on a basic issue concerning the design of these studies.

For RCRA-C, the Agency proposed a retrospective analysis of the overall benefits and costs of the program from 1980 to 2000. For the UST regulations, the Agency proposed a retrospective analysis of program benefits and costs covering the period between 1988 (the implementation of the program) and the present and a prospective analysis of benefits and costs from the present to 2005.[2] The Panel understands the need for, and value of, retrospective studies for the administrative purpose of the Government Performance and Results Act (GPRA) as well as for the general purpose of informing the public about what has been accomplished through the expenditure of funds under these acts. However, we also believe it desirable to try to design such studies so as to maximize the usefulness and applicability of the information they generate for guiding future policy decisions.

A retrospective study deals with what are now sunk costs, and therefore the analysis may have little direct implication for future policy choices. However, we believe that it is possible in this case to frame a retrospective study in ways that will also generate information useful for policy analysis. For example, to the extent that the UST or RCRA-C programs were implemented differently in different states or, in the case of the UST program, to the extent that states adopted a class approach to UST regulation, the retrospective studies could compare the different implementations and ask questions such as: Was one implementation (or class approach) more effective than others in terms of the cleanup benefits achieved, and why? Did one approach cost more than others, and why? Which approach had the highest benefit/cost ratio? Likewise, in the case of RCRA-C programs involving different pollutants emitted by different polluters (e.g., different industrial sectors), the questions to be asked could include: Which industrial sectors were the most expensive to clean up, and why? Which industrial sectors could be most completely and effectively cleaned up, and why? We believe that the answers to questions such as these could usefully inform future decision making by EPA managers.

[2] For the UST analysis, we felt that the use of 1987 data to capture program impacts was particularly problematic. 1987 data on cleanup activity and the detection of contamination events are unlikely to be representative of subsequent UST Program experience. Compliance deadlines for new tank system installations and the increased availability of public monies to finance cleanup are likely to have affected detection probabilities and the rate of cleanup. More current OUST and state data on releases and cleanups are available. Any retrospective analysis should take these data into account.

4. RESPONSE TO CHARGE QUESTION #1

Charge Question #1 is:

> *Does the "OSWER Attributes Matrix" (Exhibit 1-1 in both reports) provide a good list of program attributes that could appropriately be used to describe OSWER program benefits, costs, impacts, and other key factors influencing program performance? Does the list provide a reasonable starting point for an analysis of an OSWER program that would ensure consideration of a broad range of program impacts and features? Should any attributes be modified, or deleted or added to this list, and if so, why?*

Before turning to the content of the Attributes Matrix, the Panel wishes to make a general observation about the valuation, quantification, and description of program impacts. One purpose of an economic assessment of a program is to determine whether it results in an increase in the aggregate level of well-being (net benefits greater than zero). In principle, answering this question requires a complete accounting of the positive and negative effects on all individuals where effects are quantified and valued in dollars. It is rarely, if ever, possible to obtain such a complete accounting. Rather, it will usually be necessary to distinguish among three levels of data: (a) those impacts that can be quantified and measured in dollars; (b) those impacts that can be quantified in some meaningful units but that can not be measured in dollars based on currently available information; and (c) those impacts that can only be described qualitatively. The Agency understands this. But the Panel believes that for the presentations of the program attributes, proposed approaches to the assessments, and in the assessments themselves, it would be helpful to make this point explicitly and to indicate which impacts fall into each category.

The Panel believes that the Attributes Matrix as proposed creates potential problems for those efforts by loading too many extra considerations onto the conceptual framework provided by EPA's Guidelines for Preparing Economic Analyses (US EPA. 2000a)[3] and by introducing distinctions that are not helpful to the analysis, however sincere the intentions behind them. Specific comments and recommendations follow along with our proposed revised Attributes Matrix. See Exhibit 1. There is also further discussion of some of the elements of the matrix in the responses to Charge Questions #2 and #3.

4.1 Attributes Matrix: Categories

The proposed OSWER Attributes Matrix has four broad categories: Social Benefits, Social Costs, Distributional Impacts, and Program Context Attributes. Concerning the fourth category, the Agency has indicated that one of its goals is to evaluate impacts beyond consideration of overall costs and benefits and the distribution of these costs and benefits. The Program Context Attributes section of the matrix undoubtedly draws attention to constraints and goals highly relevant to the program's design and operation. The difficulty with this goal is that major programs such as RCRA-C and UST have a large number of such impacts. The cost/benefit framework and its extension to distribution limit the focus to those impacts of the

[3] See Exhibit 7-1 "Benefits" (p. 67); Exhibit 8-2 "Costs" (p. 120); and Exhibit 9-2 "Distribution" (p. 145) in US EPA. (2000a).

program on overall welfare and the welfare of sensitive populations. We believe, however, that the inclusion of the Program Context Attributes category implies a symmetry between these impacts and the measures of benefits, costs, and distributional impacts that is unhelpful at best and misleading at worst. Most of the entries in this category appear to us either to be forms of social benefits or social costs or to fall outside of the appropriate conceptual framework of program assessment. For this reason, the Panel recommends deleting the Program Context Attributes section of the Matrix and incorporating relevant impacts into the remaining sections as appropriate.

The material covered in this section can be dealt with in one of two ways:

a) Much of the "context setting" can usefully be handled in the introduction to the analysis. This would include: The "Constraints" category; and the "empowerment," "leveraged public private investment," and "reinvention support" attributes.

b) Most of the other attributes can be reflected in the Social Benefit, Social Cost, and Distributional Impact sections of the matrix. For example, "technology forcing" (which we believe might more usefully be labeled "incentives for technological change") can be reflected in projections of long run program costs and, to the extent the case can be made, in discussions of technology spill-overs to other programs. Similarly, for "long-term behavioral change," "streamlining" of clean-ups, and "intensity of feeling."[4]

4.2 Attributes Matrix: Short Run versus Long Run

We have introduced an explicit distinction between the short and long runs, and a recognition of sources of uncertainty applying with greater force to the long run. This recognizes the motivation behind the "long-term" categories of benefits and costs in the present Attributes Matrix without implying that there is something fundamentally different about benefits and costs occurring over different time horizons.

4.3 Distributional Impacts

The Distributional Impacts section of the matrix touches on some quite difficult analytical matters. Our recommendation is in the nature of a suggestion for recognizing first that, assuming the ability to do the calculations, differential distribution can be seen to happen over geographic or political areas, economic sectors, or population groups (defined, for example, by race, income, or occupation). Second, we think it will be helpful to divide the impacts into short and longer run. Thus, a program such as UST can lead to short run shifts in economic activity, with business closures in a location affected by a clean-up. Long term impacts can include redistribution of benefits and costs across generations.

[4] The Panel observed that all programs generate information, and that to take credit for this as a program attribute would require making the case that the information provides a benefit elsewhere.

4.4 Social Benefits

Concerning the Social Benefits section, we make the following recommendations:

a) Regarding the Avoided Materials Damages category, the Panel recommends that aesthetic effects at sites of historic interest and "taste and odor" and "visibility" be moved to an "Amenity" category as in the "Guidelines" matrix. Also, the avoided costs from fire and explosion due to migrating vapor are certainly legitimate benefits. But if it is possible to estimate health damages from such incidents, they would better be included in the health damage category.

b) The category "Ecological Benefits" should be reorganized to make it more clearly applicable to the programs in question and to stress the "biodiversity" attribute, which lay behind several specific attributes.

c) The "Individual risk" sub-category should be removed for consistency with the "Guidelines." This is <u>not</u> to say that classical individual risk calculations are irrelevant to program evaluation, but only to make it clear that they do not fit into program benefit-cost analyses. See the section of this advisory dealing explicitly with risk to the maximally exposed individual.

d) In the category of "Potential Long-Term Benefits (Sustainability)," the Panel recommends eliminating the word "sustainability," since what is involved does not match any definition of sustainability of which we are aware. For more on this, see our response to Charge Question #4.

e) The Panel believes that the items listed as examples of "long-term benefits" would be better handled as part of the main long-term damage/benefit estimation process. For example, changes in populations and in per-unit values of environmental quality can be reflected, to the extent they can be justified, directly in the estimates of benefits.

f) Because "unforeseen events" are just that and in principle can be either beneficial or adverse, the Panel doubts that taking credit for avoiding them is wise or justifiable.

4.5 Social Costs

Concerning the Social Costs section, we make the following recommendations:

a) We recommend adding transportation cost and its associated risks to the list of compliance costs, since transportation of wastes or contaminated soil is likely to be part of the compliance picture.

b) We recommend adding consideration of a broad "transactions cost" category that would include the effects of "streamlining," which we interpret as reducing transactions and regulatory costs.

c) We recommend adding a category that might be labeled: "Private Actions." This would include the resource costs of private litigation related to the program and the responses of unregulated parties who act and incur costs because, for example, the program causes them to fear greater costs if they are swept up in a new wave of regulatory action. These are costs to private parties that are in addition to the compliance costs listed above. The benefits of these actions can be included in the appropriate benefit category.

d) The category of "Social Welfare Losses" should be eliminated. Higher prices will just be reflections of the costs elsewhere counted. Legal and administrative costs would be captured under "transactions" and "private litigation" costs.

e) We recommend moving the category presently labeled "Risk Tradeoffs" from Distributional Impacts to Social Costs and renaming it "Added Risks."

f) We do not endorse inclusion of a separate category of Long-term Costs. It is inappropriate to consider the two examples presented in the Matrix as costs. The "potential failure to benefit from [future possible] technological advances" could be considered a cost of undertaking clean-up or corrective action now rather than postponing it to some future date. But the assessments being planned here are asking a different question: What are the costs and benefits of taking action now compared with doing nothing? As for "Potential failure to invest in more productive activities," we interpret this as an implicit challenge to the assumption that the discount rate and the market prices of resources devoted to clean-up and corrective action are the best estimates of the true opportunity costs of these resources. Absent any justification for challenging this fundamental assumption of benefit-cost analysis, this category of costs should be deleted.

Exhibit 1. Suggested Revision of Attributes Matrix			
SOCIAL BENEFITS	Short Term	Long Term	Sources of Uncertainty
Human Health	Acute	Chronic	
Population Risk only Mortality Morbidity	Explosive Fire Poisoning Asthma Nausea Poisoning	Cancer (Other?) Cancer (Other)	Long latency Contaminant interactions Changes in behavior Risk aversion Popular perception vs. technical "reality"
Amenity			
Taste & odor Historic preservation	Water Air Traffic		Desensitization
Ecological			
Market Products Non-market use Recreation Ecosystem Services Biodiversity Non-use/Knowledge	Ground & Surface water contamination Experience quality Resource quality Mortality (resource quantity) Habitat Mortality Morbidity	Habitat Reproduction Bioconcentration	Plume behavior Treatment cost at intake Increasing substitute scarcity "Food Web" interaction
Avoided Costs			
Of new drinking water Supplies Of future spills Of materials damage from fire and explosion			
SOCIAL COSTS	Short Term	Long Term	Sources of Uncertainty
Compliance			

Capital OMR (operation, maintenance, and replacement) Added Risks Transport (with risks) Transitional Costs	 Temporary losses in jobs, etc., associated with adjustment to a new equilibrium		Technological Changes
<u>Regulation Itself</u>			
Monitoring & Enforcement Administration Transactions costs			Behavioral change
<u>Private Actions</u>			
Litigation Response of unregulated parties (spillovers)			
DISTRIBUTIONAL IMPACTS	<u>Short Term</u>	<u>Long Term</u>	<u>Sources of Uncertainty</u>
By sector By area By group income race occupation By jurisdiction	Impacts on sectoral outputs, jobs, etc. Expenditures and Taxes	Benefits & Cost, including across generations	Length of transition

5. RESPONSES TO CHARGE QUESTIONS #2 AND #3

Charge Question #2 is:

> *Keeping in mind that it was OSWER's intention to evaluate a range of methodological options, and to include some relatively less resource-intensive options (recognizing these are likely to be less technically rigorous), are the methods presented viable and technically sound? Will the methods lead to defensible conclusions? Are the assumptions associated with the methods reasonable? If you believe any of these methods or assumptions are not viable, sound, or defensible, why not? Are the methods consistent with EPA's Guidelines for Economic Analyses, to the extent the guidelines address the OSWER program attributes?*

Charge Question #3 is:

> *Are the methods clearly and adequately described, for purposes of making a decision to select preferred methods for additional development and implementation? Are the advantages, disadvantages, and data requirements associated with each option clearly and adequately described? Is additional information needed for any of these methods in order for OSWER management to make an informed decision? If so, what information?*

In commenting on the various methodological options for each category of impact, the Panel decided that it would be better to combine the discussions of the viability and technical soundness of each method and the adequacy of its description, rather than to develop separate answers to each of the two charge questions. Hence, in what follows, our answers to questions #2 and #3 are combined for each impact and method.

5.1 Benefits: Human Health

The two documents under review adopt distinctly different approaches to the monetization of health benefits. But before commenting on the specifics of each document, the Panel wishes to make two comments concerning the overall assessment of health impacts.

The first concerns the importance of carrying the analysis through to the assessment of monetary values for reductions in the risk of premature mortality and other adverse health effects. In particular, the UST document merely mentions the possibility of doing this (p. 4-3). And neither document provides any detail about methods to be used. The Agency should be explicit about its plans to assess monetary values to health benefits and how it will deal with such issues as determining the appropriate value of statistical life, treating latency, and so forth. See the Agency's Guidelines for Preparing Economic Analyses (U.S. EPA. 2000a).

The second comment concerns the proposal to report risk reductions for the maximally exposed individual (MEI). While individual-based risk measures like that for the MEI may serve as an appropriate guide for some risk policy decisions, such conservative measures should not be the basis for conducting benefit-cost analyses. Often such calculations result in an exposure that might best be termed the maximum conceivable exposure and which might be substantially greater than the exposure of any actual individual. What is relevant for benefits assessment is the

mean exposure, or in the case of nonlinear dose-response functions, the whole distribution of actual exposures for the affected population.

For the UST analysis, the Agency proposes to assess only the risk of cancer from exposure to benzene. Given the importance of gasoline storage tanks, this seems to the Panel to be a reasonable simplification of the problem.

A principal component of the health benefits assessment is the estimation of the potential human exposure to benzene from each leaking tank. The Agency proposes three alternative approaches for carrying out this part of the analysis. With regard to the question of using a simple benefits analysis versus a spatial analysis with or without pathway modeling, we are concerned that, because of the underlying heterogeneity among UST sites and the potential non-linearities in the cost and benefit functions, it is unlikely that accurate or reliable results can be obtained using a simple benefits analysis. Essentially the same concern applies to the spatial analysis. The preferred way to make either of these two alternatives credible is to conduct some case studies using a spatial analysis with pathway modeling to see whether these latter are unbiased on average in relation to the more sophisticated method. If they are biased, then the spatial analysis with pathway modeling, as presumably more accurate in its predictions, should be employed. If they are not then using one of the simpler approaches will generally be more cost effective, though it may be desirable to include calibration factors, if any are discovered from the case studies for particular physical situations in which the methods do differ.

The UST document goes on in Sections 4-2 to 4-4 to discuss ecological benefits, avoided costs, and the use of property value studies. Our comments on the assessment of ecological and property value benefits are presented below. The section of the UST document on ecological benefits concludes (Section 4.2.2) with a suggestion that benefit transfers of contingent valuation estimates from previous groundwater research be used as a way of measuring total use and non-use values. Specifically, it is proposed that values from three existing contingent valuation groundwater studies (Edwards, 1988; McClelland et al. 1993; Powell, Allee, and McLintock. 1994) be used to assess the total value (including, health benefits, ecological benefits, and non-use benefits).

The Panel has serious reservations about this proposal. First, the perceived benefits, as measured by willingness to pay, are likely to be context and/or contaminant specific. None of the studies cited addresses benzene, a carcinogen. Two of the studies (Edwards. 1988; McClelland et al.1992) told respondents that there would be no health risks since wells would be monitored. Only the McClelland et al. study explicitly mentioned cancer risks, a consideration that is believed to elevate stated values relative to non-carcinogenic groundwater risks (Boyle, Poe, and Bergstrom. 1994). Thus, there is poor correspondence between the specifically cited studies and the UST and RCRA situations.

A second point of concern with adopting a contingent valuation based benefits transfer approach is that, despite meta analyses suggesting that groundwater valuation studies exhibit "systematic consistency" (Boyle, Poe, and Bergstrom.1994; Poe, Boyle, and Bergstrom. 2001), the accuracy of such transfers for groundwater is open to question, even when contaminants are similar and common survey materials are utilized (see Bergstrom, Boyle and Poe. 2001). Moreover, substantial concerns about the use of the McClelland et al. (1993) study have been

raised in a previous SAB report (EPA-SAB-EEAC-LTR-94-001, 1993 (U.S. EPA/SAB. 1994) specifically related to RCRA. See also Boyle (1993, 1994).

For these reasons, we believe that the three studies cited, and to our knowledge any existing contingent valuation groundwater research, should not be used as estimates of total value (or the subset of health benefits) for the UST programs. However, we suggest that the Agency consider funding groundwater contamination research with single or multiple contaminants that have a known probability of cancer risk. The values obtained from such research could be compared with the existing body of literature on the value of statistical lives and would provide a better source for benefits transfer than the existing research on groundwater valuation. To date, no such tests of convergent validity exist between groundwater valuation research and the broader valuation of risks literature.

Regarding the use of avoided costs as a component of benefits, we have two specific comments.

1. For public water systems, the probability of averting is assumed to equal one, i.e., once a leak is detected the water will be treated. For private wells there is some evidence (see UST US EPA 2000b, p. 4-30) indicating that the probability that individuals will undertake averting actions is substantially less than one but greater than zero. These probabilities need to be identified for a "typical" case of groundwater benzene contamination. The need to identify a benzene-specific probability of private averting actions is particularly of concern if the odor/taste threshold for benzene differs from the health threshold, as appears to be the case for Methyl Tertiary Butyl Ether (MTBE). In particular, should the odor/taste threshold be lower than the health standards for benzene, then individuals' amenity-based averting actions undertaken prior to actual determination of a health-related contamination incident need to be accounted for in providing estimates of benefits. For the proportion of the population that fails to take averting activities even when such actions are recommended by health authorities, the reductions in health risks associated with cleanup should be estimated and valued as long as the risk measures for benzene are based on maximum likelihood estimates and latency and other risk-specific factors have been accounted for in the valuation.

2. The relationship of avoided costs/averting/ remediation values to actual willingness to pay for avoiding a risk is an open theoretical and empirical question. Whereas much of the literature on this subject argues that, under certain theoretical conditions, averting/avoidance/ remedial costs should be treated as a lower bound (see for example, Courant and Porter. 1981; Bartik. 1988a; Harrington, Krupnick and Spofford. 1991; Quiggen. 1992) of damages, recent theoretical work by Shogren and Crocker (1991, 1999) suggests that the endogeneity and lumpiness of risk averting actions is such that self-protection activities need not represent a lower bound on the value of risk reductions. Hence, at this point any estimate of averting costs represents, at best, a rough estimate of avoided damages. The precision and potential bias of this type of measure may be further complicated if the odor/taste thresholds differ from the health risk threshold set by the EPA, and needs to be specifically accounted for in a quantitative analysis or qualitative discussion.

Concerning the quantification and monetization of health benefits for RCRA-C, the document states that because of the variety of substances handled at subject facilities and the variety of possible routes of human exposure, a range of both cancer and non-cancer health

effects must be assessed. But the document does not address two major problems that must be confronted.

First, for many of the substances that are categorized as carcinogens, the only available risk information is the 95% upper confidence interval on cancer potency or cancer risk. The problem is that these upper-bound estimates of risks are not consistent with the best estimates of risk necessary for unbiased benefit-cost analyses. Previous SAB review panels have noted similar concerns in the context of hazardous air pollutants (see EPA-SAB-COUNCIL-ADV-99-005, 1999, p. 10 (U.S. EPA/SAB. 1999); EPA-SAB-COUNCIL-ADV-99-012, 1999, pp. 12-13 (U.S. EPA/SAB. 1999a)). See also, EPA (2002).

Second, for many of the noncarcinogenic substances, the available toxicological data do not come in the form of the dose-response functions used to quantify health impacts. Rather they are in the form of Reference Doses (RfD) and reference concentrations (RfC) (doses and concentrations that are not to be exceeded in order to protect human health). These include built in margins of safety and do not permit the quantification of either the number or severity of the health impacts of exceeding them. This problem has also been discussed in at least one earlier SAB report dealing with the evaluation of RCRA corrective action rule (EPA-SAB-EEAC-LTR-94-001, esp. pp. A-1 and A-2(U.S. EPA/SAB. 1994)).

The Agency has not explained how it plans to deal with these two problems. In the absence of such a plan, the Panel questions whether it will be possible to provide credible estimates of either numbers of adverse health effects avoided or the monetary value of health benefits associated with RCRA-C. We hope that the Agency can successfully address these problems.

5.2 Benefits - Ecological

The proposed ecological benefit assessment methods vary in their sophistication and complexity. All of the methods, however, are "physical" fate and transport models. None of them promise to calculate dollar-denominated benefits arising from ecological services. Instead, the models differ primarily in terms of the data they use and the physical modeling of transport. For example, in the UST document, the methods proposed seek to estimate the number of surface water contamination events avoided, while the Subtitle C methods generate estimates of avoided contamination incidents or, at best, avoided contaminant concentrations in surface waters. Counting avoided surface water contamination incidents is an important analytical step. But this kind of bio-physical indicator bears only a crude relation to the social benefits of the program.

Monetized benefit estimates are the appropriate aspiration for evaluation. Unfortunately, ecosystem service benefits are particularly difficult to value in this way. Accordingly, and for reasons detailed below, we do not recommend the pursuit of dollar-based evaluation of ecosystem benefits in this particular regulatory context. However, we do have suggestions for the development of more informative data about ecosystem impacts.

Concerning the difficulties in developing monetary estimates of ecosystem benefits, the first is the significant complexity that is associated with the analysis of the physical and biological processes that give rise to socially valuable ecosystem services. Second, there is a significant problem associated with the "linkage" between bio-physical modeling and the economic

modeling necessary to generate monetary benefit estimates. The generic difficulty can be presented as follows: How does physical analysis (e.g., engineering, hydrology, soil chemistry) generate data that are useful for ecological analysis of toxicity to species? Assuming that problem is solved, how does the resulting ecological analysis generate data that are useful for economic analysis? Existing modeling techniques achieve these linkages only with great difficulty. Yet they are a necessary condition for the generation of defensible monetary benefit estimates. Finally, assuming these linkages can be established, the choice of economic estimation technique must be made. The appropriate estimation technique will depend on the affected ecosystem service being analyzed—an economic challenge that is itself significant. But that challenge is not worth confronting until a better ecological and economic linkage can be made.

An issue of particular importance is that economic analysis requires ecological analysis of effects on populations of species, not analysis of individual toxicity effects. This presents a practical difficulty because ecological analysis typically generates individual toxicity estimates. The reason population effects are the desirable endpoint is that populations, rather than individuals, are what is actually economically valuable and estimable. Generally, people value the ability to observe, appreciate, fish, or hunt, a *population*.[5] The size and health of that population determines the value of the service the population provides. Because population effects will be very difficult to estimate, there is no clear point of linkage between the engineering/ecological analysis and an economic analysis of monetizable benefits.

Ecological benefits, for both bio-physical and economic reasons, are highly idiosyncratic to local conditions. Detailed analysis of a small number of sites could yield defensible benefit estimates at a relatively high cost. But the transfer of such estimates to the universe of sites is, in our judgment, not defensible. Attempts to generate numbers will exhibit a false rigor. The most intellectually honest approach is to acknowledge limitations in data and our ability to model complex physical, ecological, and economic systems.

We have three specific recommendations for the assessment of ecosystem impacts.

5.2.1 Ecosystem indicators

We strongly encourage EPA to develop quantitative indicators of ecosystem service benefits. In general, the reports could more strongly emphasize the way in which site cleanups and release prevention contribute to the provision of ecosystem services that are valuable to society. The basic categories of service benefits being generated are recreational benefits, aesthetic benefits, and existence benefits associated with the preservation of focal species. A quantitative (but non-monetary) analysis of ecosystem services should feature: (1) A description of the bio-physical *functions* preserved by RCRA, in particular, a discussion of the ways in which improved surface water quality affects a range of terrestrial and aquatic species (both flora and fauna). (2) A discussion of the socially valuable services dependent on those functions. (3) Analysis of factors that contribute to the value of those services. Important factors include proximity to populations that can benefit (primary demand), complementary assets, and the scarcity of the service at different geographic scales.

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[5] Focal species are an exception, since individual effects are closely related to the effect on the population. Focal species are species that exert a disproportionately important influence on the condition of an ecosystem.

Quantitative landscape analysis, using Geographic Information System (GIS) tools, can be used to derive indicators of preserved ecosystem service benefits. Landscape analysis can effectively combine economic valuation principles with existing data sources to improve understanding of the relative benefits generated by different ecological systems. Indicators can be used to evaluate the scarcity of ecosystem services in the landscape, the accessibility of sites for recreation and aesthetic enjoyment, future risks to the ecological system, and the ecological system's marginal impact on a larger area's provision of ecosystem services. For example, in the UST study it is possible to characterize the "avoided contaminated water bodies" generated by the pathway models. The proposed models associate plumes with particular water bodies. It would be relatively straightforward to classify or rank those water bodies in terms of whether or not they are "service rich." For example, GIS data on boat ramps and docks can be used to determine whether a water body is used for recreational fishing.

A variety of types of indicators could be collected, including indicators of primary demand, scarcity, and complementary inputs. Consider primary demand indicators first. The values of the services provided by ecosystem functions depend, in part, on the demands for these services. Demand for services can arise, for example, when the ecological system provides an amenity or helps avoid a disamenity. For an amenity (e.g., aesthetic enjoyment) to be provided, proximity to populations that benefit is a necessary condition for demand.[6] For a disamenity to be avoided there has to be such a disamenity (e.g., water contamination) and a population that benefits. Scarcity indicators are important because scarcity increases the value of a service. Scarcity indicators relate to the local prevalence of other similar resources. Complementary input indicators are important because some services can be enjoyed only if accompanied by complementary landscape characteristics or infrastructure. This is particularly important for recreation, where access is a key determinant of the ability to enjoy the service.

The following specific types of GIS data could be collected, all of which speak to the benefits associated with avoided surface water contamination:

a) proximity to globally or locally endangered species habitat
b) proximity to flyways or green ways relied upon by recreationally valuable migratory species
c) proximity to recreational areas (parks, beaches, public forests)
d) proximity to sensitive areas (preserves)
e) proximity to commercial fishing operations
f) presence of complementary infrastructure (docks, ramps, trails), and
g) relative abundance of water bodies (to assess scarcity)

Integrating this kind of data into the "contamination events avoided" analysis would improve the salience of the benefits assessment. With this kind of exercise, the assessment could move beyond saying "x water bodies avoided contamination under RCRA," to something more evocative of the benefits. For example, "x water bodies used for recreational angling avoided contamination." Or "x water bodies that support protected areas important to bird migration avoided contamination." Note that the "Facility Siting Restrictions Analysis" in the Subtitle C report seems to be closest in spirit to this kind of activity. The proposal there is to collect GIS

[6] An exception is the existence value of species, where demand does not depend on proximity.

data on flood plains, flood events, and "fragile systems" in order to identify beneficial siting trends, presumably away from flood-prone and ecologically sensitive areas.

5.2.2 Population-Level Bio-Physical Analysis

Program evaluations will benefit greatly from a successful marriage of bio-physical impact models and economic estimation of those impacts. While many of the tools are in place, the crucial point of linkage between physical and economic modeling is not yet in place. The point of linkage is the estimation of population impacts. Population, not individual, impacts provide the "endpoint" where economic and bio-physical assessment can engage.

Econometric analysis can be linked with bio-physical pathway models only if they generate population-level impact estimates. Investigation of methods designed to specifically address this issue would be extremely valuable. The endpoint problem is not unique to this specific evaluation exercise. The need to link the endpoints of ecological analysis with economic analysis of services is a challenge for both the ecological and economic professions and arises in many other agency contexts. The challenge should be placed in this larger context.

5.2.3 Review of the 3MRA Model

We urge the SAB 3MRA Review Panel to devote attention to the model's ability to estimate population-level rather than individual ecological effects. A way in which to judge 3MRA is on its ability to provide a linkage with economic assessment of ecosystem services.

5.3 Benefits: Avoided Costs

The reports recognize that there is a connection between "avoided costs of providing government-mandated alternate drinking water supplies" and the health damages estimated for a program. Thus, speaking roughly, if alternative supply costs are incurred, they will in general reduce damages. It is necessary, therefore, to be consistent in the assumptions that lie behind the two category estimates. One way of thinking about the problem is as the minimization of the sum of averting costs and residual damages for any particular incident or program decision. The calculation in reality is greatly complicated by the timing of the discovery of the need for action and of the action itself. A similar line of comment applies to the attribute labeled, "Avoided costs. . .of mandated clean-ups. . ."

5.4 Benefits: Property Value Approach

One of the approaches proposed by the Agency for estimating the benefits of UST Cleanup requirements and RCRA-C is to estimate the number of sites avoided by these provisions and to value each avoided site by the predicted reduction in housing prices based on a review of the literature on hedonic property values around Superfund sites, hazardous waste sites, and other local disamenities (e.g., trash incinerators and landfills). There are three sets of issues concerning this approach.

5.4.1 Property Values and Welfare Change

Is the change in property values a correct indicator of welfare change in principle? Under the assumptions that the hedonic price function for the housing market does not change with the introduction of a disamenity (or its removal) and that transactions and moving costs are zero, the change in housing prices is a valid measure of the welfare change or benefit (Palmquist. 1992a, 1992b). However, if either assumption is not satisfied, this approach is likely to lead to an overestimate of true benefits (Bartik. 1988b). The hedonic price function is likely to shift if policy affects amenity levels at a substantial proportion of the properties in a market. Our concern with this issue was prompted, in part, by a recent report that 23% of all residents of New York State live within 1 mile of a Superfund site (Stashenko. 2002). If RCRA-C facilities are as numerous and widespread as Superfund sites in New York, the assumption of an unchanged hedonic price function may be difficult to justify. This issue should be discussed before a decision is made to proceed with this approach.

5.4.2 Amenity Effects on Property Prices

Will the full range of likely beneficial effects be reflected in property prices? There is little doubt that a range of environmental disamenities is reflected in lower property prices near facilities such as hazardous waste sites and that eliminating those disamenities will result in increases in the values of the affected houses. But several issues must be addressed. It is possible that the individual behaviors that lead to changes in property prices are based on incorrect perceptions of the risks created by the facility in question, in which case the changes in prices will be biased estimates of the true benefits of reducing the disamenities in question. Also, to the extent that ecological benefits and historical preservation benefits (if any) accrue also to people not residing in proximity to the facility, property price changes will underestimate the true benefit. And finally, since the property price studies available in the literature focus on single family dwellings, these studies provide no information on potential benefits to owners or occupiers of multiple family housing or owners of commercial properties. These issues need to be addressed before a decision is made to proceed with this approach.

5.4.3 Benefits Transfer

Can estimates of changes in property values from other studies be "transferred" to the sites in question? It is not clear that the attributes of the RCRA-C facilities match those of the facilities in the studies reviewed for the RCRA-C document. The percentage reduction in housing prices at any given distance from the facility is likely to depend on the characteristics of the facility as well as socioeconomic characteristics of the population in the housing market being analyzed. Also, it is not clear that the analysis should consider only houses within one mile of the facility. It would be desirable to use meta-analysis to estimate a function that relates the percentage change in housing prices to facility characteristics and distance from the site. Also, we are not familiar with the unpublished report on property value effects of LUSTs (see footnote 54 on p. 4-36 of the UST document, US EPA. 2000b). So we can not comment on the quality of the data available for benefits transfer in the case of UST.

5.4.4 Conclusions

If this approach is utilized, the above issues need to be addressed. But given the problems with the other approaches proposed, this approach may be a relatively simple way to obtain a "ball park" or order-of-magnitude estimate of benefits. However, if this approach is followed, the review of the literature should be updated and restricted to studies appearing in peer reviewed economics journals. Consideration should also be given to conducting new hedonic property value analyses designed specifically to support this economic assessment and to deal with the shortcomings of the available studies.

5.5 Benefits for RCRA Subtitle C: Alternative Approaches

The document proposes three methodologies to estimate the health and ecosystem effects of RCRA Subtitle C. The choice among these methodologies involves trade-offs in three important dimensions:

a) The plausibility of without-RCRA scenario. Approaches B and C assume hazardous waste would continue to be managed in the management units used before RCRA. Approach D assumes that hazardous waste would be managed as ordinary (non-hazardous) industrial waste. The assumption involves a different set of management facilities and thus creates an artificial break with the inception of the program in the without-RCRA scenario.

b) The sophistication of the pathway modeling. Approach D would use the 3MRA model to generate estimates of health and ecosystem effects, whereas Approach B would use the older MMSOILS model. The 3MRA model considers a broader set of ecological endpoints and uses more sophisticated analytical methods. (The document describes approach C as using MMSOILS. However, Agency staff suggested that if effort were expended to collect the extra data envisioned by Approach C, 3MRA might be used instead), and

c) Cost. According to OSW staff, Approach D would be the least costly to undertake, but is similar in cost to Approach B. Approach C involves collection of substantial additional data, along the lines of those used from the 1988 RIA under Approach B, but with some modification of the sample and the releases evaluated.

The Panel has several reactions to the evaluation of these tradeoffs, especially the comparison of the pathway models. First, we encourage the Agency to take an empirical approach to the presumed superiority of the 3MRA model. A preliminary analysis should compare the difference in the estimated effects from 3MRA with MMSOILS at some sample of facilities. Second, we are concerned that the ecological effects estimated by 3MRA, although more complete and delineated than those from MMSOILS, may still be too abstract to provide meaningful policy evaluation (see the discussion above on ecosystem effects). This limitation renders superiority in this dimension not especially useful. Finally, we are very concerned about the use of 95% confidence values for health risks (see the discussion above on health effects). Agency staff indicated that 3MRA might make it possible to conduct estimates with the full distribution of risk values for some contaminants. If this is not possible with MMSOILS, this consideration provides strong support for an approach that uses 3MRA.

Our skepticism about the value of a retrospective analysis and its accuracy (given the difficulty of any certainty about the without RCRA counterfactual) make us discourage a large commitment of resources to this exercise. As a result, we encourage the use of available data, such as through Approaches B and D, rather than the costly data collection exercise suggested in Approach C.

5.6 Costs

The two documents under review differ in their methods proposed for estimating program costs, apparently for two reasons: (1) In the case of RCRA-C there would be costs of dealing with hazardous wastes even in the absence of the particular subtitle C rules, while in the absence of the UST program, it is reasonable enough to assume that no costs would be incurred (though damages would be); (2) The RCRA-C document only discusses costs already incurred (through 2000).

The UST methodology is straightforward. Data will be obtained from the states on the costs incurred in actual cleanups. From this an average cost per site will be calculated, which will then be applied to projections of future sites to be dealt with. The Panel believes this to be feasible and defensible in this context.

The approach to estimating the with-RCRA-C costs stresses aggregate annual costs over the period 1983 – 2000. There is no effort made to project future costs. This is consistent with an evaluation of the effect so far of the program. But it sits oddly with the reference on page 1-4 to the GPRA "sub-objectives" for 2005, unless the assumption is that all the costs that matter for those sub-objectives have already been incurred.

The problem of estimating without-RCRA-C costs to subtract from the with variety to get program costs is the subject of two suggested methods: "simple" and "industry-specific." The simple approach assumes that the volume of hazardous wastes to be disposed of in the absence of RCRA-C would have been dealt with as per the requirements of schedule D of the law, the per unit costs for which can be estimated. The trick then is estimating the volumes to be disposed of. For this, three methods, of increasing complexity, are suggested, with the simplest being to assume that hazardous wastes would have been a constant fraction of total solid wastes in the absence of the law's requirements for management. The panel is concerned that none of the methods try to reflect the incentive effects on volumes that lie behind the observed pattern of total annual costs, and that are recorded in the TRI inventories for the years since 1989. These incentive effects reflect the complex mix of legislation and litigation outcomes over the period (most importantly RCRA, Superfund, and TRI), and separating out what would have happened without only RCRA-C will be extremely difficult at best. But ignoring these effects implies the likelihood of underestimating program costs by overestimating the without costs.

The more complex possible method for obtaining the without scenario in the RCRA document involves trying to find "pre-1983, industry-specific" cost estimates for hazardous waste disposal. In the experience of at least one member of the Panel, finding the necessary pre-RCRA hazardous waste volumes and costs will be very difficult, leading us to doubt that this will prove

feasible.[7] Such data as exists on these matters seem to be both very limited and very closely guarded.

Turning to transitional costs, these are real costs; but, in an economy operating at close to full employment and with mobility of resources, they should not persist as displaced workers find jobs elsewhere in the economy.[8] If transition costs are to be counted, the adjustment processes of the relevant markets must be modeled to predict the likely duration of unemployment and likely earnings in the new jobs.

Long-term costs, as discussed in the documents, seem to the Panel to belong elsewhere, as already noted in the discussion of the Matrix. The matter of technical change, leading to lower costs, may even be irrelevant to the RCRA analysis if it is going to remain focused on the years before 2000. To the extent it has happened, it will be in the numbers already found and used.

5.7 Distributional Impacts

An analysis of the distributional impacts of the RCRA and UST programs can provide important information for policy makers. Studying these impacts may also help improve future policy by showing components of the program that have been a particular success or hindrance.

The RCRA and UST documents introduce a large number of aspects of distribution to evaluate and methods for doing this evaluation. The Panel urges a more parsimonious choice of distributional impacts for quantification. Quantifying too many issues obscures the most important dimensions of the program and appears to provide false precision. As suggested in our Revised Attributes Matrix (Exhibit 1), we recommend that the assessments focus on the distribution of beneficial and adverse effects across groups organized by, for example, income, race, and geographic unit. In addition we offer the following comments on the Agency's proposed methods as described in the volumes under review.

5.7.1 Environmental Justice

An assessment of the effect of the RCRA and UST programs on disadvantaged populations is critical to evaluating their success. The documents discuss approaches to assessing half of this effect, namely the distribution of benefits. They do not discuss the equally important other half, namely whether the burden of costs disproportionately falls on disadvantaged populations.

Two options are presented for evaluating environmental justice in RCRA. Option 1, "use existing literature to identify possible negative environmental justice impacts associated with RCRA," lacks a clear definition of the without-RCRA baseline. Thus, any effects identified cannot clearly be associated with the program, and risk confusing the assessment.

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[7] See Timothy T. Greene, Hazardous Waste Matters: Three Essays in Corporate Environmental Management and Performance, PhD. Dissertation, Vanderbilt University, December 1998.

[8] Similarly, jobs "created" in response to regulation have opportunity costs as workers are drawn from other activities. Any effort to estimate job creation benefits must take account of these opportunity costs. See, for example, Haveman and Krutilla (1967).

The method sketched in Option 2 should be linked more directly to the methods for evaluating overall benefits proposed in Chapter 3. Chapter 3 identified two components of RCRA's effects to value: avoided TSDs and changes in practice at TSDs. An appropriate and consistent methodology would locate the avoided TSDs and (if Approach B is used) TSDs that appear to have improved practice and then compare the local demographics with the population at large. If a pathway analysis is used for overall benefits, the evaluation should consider the distribution of exposure, rather than the location of facilities.

For USTs, the document contains an assertion (US EPA. 2000b, p. 6-1) that the UST program does not have a significant environmental justice impact. Despite the ubiquity of USTs , disadvantaged groups may benefit from cleanup. Facilities with USTs are likely to be associated with other disamenities, such as traffic, and therefore may be concentrated in low-income communities. Substandard tanks and thus Leaking Underground Storage Tanks (LUSTs) may be even more skewed toward lower income regions and communities. In short, the document slights this dimension of the program's impacts, particularly by comparison with some more ambiguous measures later in this chapter.

The approach suggested in the document is to compare the demographic characteristics of communities neighboring USTs with the population as a whole. However, the approach should focus more on the distribution of exposures eliminated. This would require considering the locations of remediated USTs to account for distribution of the tanks most prone to leaks and the effort devoted to cleanup. In addition, the analysis should consider household characteristics that effect exposure, such as reliance on well water and avoided exposure of children to contaminated soils (if there is a pathway analysis).

Neither document discusses an assessment of the distribution of costs by income. The distribution of costs depends on the extent to which compliance costs are passed forward to consumers in the form of higher prices, which in turn depends on the elasticities of supply and demand, the extent to which compliance alters marginal costs, and the market structure of the industry. A description of the breakdown on the compliance costs (from chapter 5) across industries would be somewhat informative. A full analysis would require tracing these costs through the consumers' prices and expenditures with an input-output table or a more sophisticated equilibrium model. [9]

5.7.2 Intragenerational Impacts

A section called "Intrageneration Impacts" in the RCRA-C document (US EPA. 2000c) discusses the "public/private distribution of costs" and the "polluter pays principle." If it considers the "polluter pays principle," the Panel urges the Agency to consider a version of the principle that one might call "beneficiary pays." It would require that those who benefit from pollution --- whether they be producers or consumers --- pay for its reduction and cleanup. A desirable public/private distribution of costs would follow and not require separate analysis. This version of polluter pays is satisfied by RCRA, which raises waste management costs, and would

[9] Fullerton and Tsang (1996) provide an example of the use of an input-output approach. For an earlier example, see Gianessi and Peskin (1980).

not require additional analysis. For clean-up programs such as the LUST program, evaluating this fairness principle would require a more complex analysis of the incidence of the costs.

Another interpretation of the polluter pays principle requires that the firm that initially produced the pollution pay for its cleanup. This interpretation may not impose the burden of cleanup on the true beneficiaries, for example, when they are consumers who purchased lower price goods because of the pollution. The importance of implementing this version of the polluter pays principle lies in its creation of incentives for polluters to reduce their pollution by "internalizing the externality." The principal economic impacts of implementing the principle would be captured by measures of the benefits and costs of the program and the distribution of benefits and costs across relevant groups. And these impacts are already dealt with elsewhere in the document. Thus, the analysis described in Section 6.1 does not assist in evaluating the program.

5.7.3 Economic Impacts

The methodologies presented for a quantitative evaluation of the economic impacts of RCRA and UST rely heavily on surveying facilities to obtain information on plant closures and layoffs as a result of the program. It is difficult to link the program to closures or job losses using a survey. Costs imposed by the program may increase the probability of these changes but will rarely be the only cause. Thus, even a careful survey is unlikely to be definitive.

The UST document also has a method for quantifying the job creation from the program. This implies that job creation is a benefit. But workers pulled from alternative employment represent opportunity costs. It is true that job creation may yield benefits if the workers in relevant labor market sectors experience unemployment. The evaluation would require an analysis of labor market conditions to determine whether job creation does create benefits.

5.7.4 Risk Tradeoffs

The RCRA (US EPA. 2000c) and UST (US EPA 2000b) documents propose similar methods for examining risk tradeoffs. We have four comments on risk tradeoffs. First, since increases in risks are adverse, the Panel recommends that they be analyzed as a component of Social Cost. See Exhibit 1. Second, both documents propose to estimate occupational risks to cleanup workers. The evidence presented in the document suggests that elevated risks to cleanup workers are not great, so it does not appear that leaving out this calculation would constitute a serious omission from the overall evaluation. More importantly, it is not clear that these costs are additive with compliance costs already identified, with implications for their distribution. Cleanup workers may receive higher wages as compensation for elevated risks: thus, cleanup costs would already include a valuation of these risks. The incidence of these costs would not be on the workers (who are compensated), but on whomever bears the rest of cleanup cost.

Third, the RCRA document also includes an estimate of transportation risks, which is not subject to this interpretative problem. The methodology presented here seems a sensible approach to estimating the overall magnitude of this risks, but, as described, does not break out the groups (geographic or income based) on which these risks fall. It would be preferable to conduct a preliminary analysis to determine whether these costs are significant before embarking on a full evaluation.

Fourth, risks from illegal disposal are a missing category of risks from RCRA. By raising the costs of legal waste management, the program may encourage some generators, especially small quantity generators, to substitute illegal waste management, either through mixing wastes with ordinary solid waste or through direct environmental releases. Although nearly impossible to quantify, these risks deserve mention if other risk tradeoffs are considered.

5.7.5 Intergenerational Equity

Intergenerational equity may be an important equity impact of the RCRA and UST programs when contaminants persist in the environment. The UST document (US EPA. 2000b) suggests a qualitative discussion of the benefits of the program for future generations. This approach may be desirable because distant future benefits are very difficult to assess given uncertain future exposures and cleanup activities. By contrast, the RCRA document attempts to quantify this aspect of the program. It calls for evaluation of land disposal reductions and avoided cleanup delays. The use of these numbers in evaluating the intergenerational distribution of program benefits is not clear. A qualitative discussion of the problems the program avoids for future generations might be preferable.

If monetary estimates of long term costs and benefits are generated, they should be presented both as undiscounted flows and as present values discounted at alternative discount rates, as outlined in the EPA Guidelines (US EPA. 2000a, p. 52).

6. RESPONSE TO CHARGE QUESTION #4

Charge question #4 is:

Are there alternative methods (or modifications of methods presented in the reports) that could be used to better characterize any of the attributes addressed in the two reports, keeping potential resource limitations in mind? If so, why? We are particularly interested in seeking SAB advice on methodologies to characterize the more traditional human health/environmental benefits (which represent EPA's core areas of responsibility), but OSWER would also welcome any recommendations the SAB might have on better ways to characterize and/or quantify some of the more "non-traditional" attributes. These include sustainability and other long-term program impacts; the value of regulatory requirements that focus on providing information to the public; and the influence on program performance of factors such as stakeholder concerns and statutory/legal constraints.

Advice on methodologies for evaluating traditional human health and environmental benefits is offered in Section 5 as part of our responses to Charge Questions #2 and #3. Similarly, our views on many of the nontraditional attributes are presented in Section 4, especially Section 4.1.

As for sustainability, this term refers to an economy's ability to maintain at least the current standard of living or level of well-being over multiple generations.[10] The economic analysis of sustainability focuses on the roles of nonrenewable and renewable resources and capital in supporting the production of the goods and services necessary to maintain current levels of well-being. To the extent that the provisions of RCRA-C and the UST regulations result in reduced use of nonrenewable resources or substitution of renewable resources for nonrenewables, they would contribute in at least a small way to sustainability. But the benefits of such changes would normally be reflected in changes in costs of production at affected facilities. Thus a separate category of sustainability benefits is not appropriate.

[10] For example, the World Commission on Environment and Development (also known as the Bruntland Commission) said "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (1987, p. 43)."

APPENDIX A - A MORE DETAILED DESCRIPTION OF THE SAB PROCESS

The SAB recruited Dr. A. Myrick Freeman to be Chair of the Underground Storage Tanks (UST) and Resource Conservation and Recovery Act (RCRA) Subtitle C Program Benefits, Costs and Impacts (BCI) Review Panel of the Science Advisory Board's (SAB) Executive Committee (EC). Working with the Chair, other SAB Members and Consultants, Agency Staff and suggestions from the public through a Federal Register solicitation of August 23, 2001 (see FR, Vol. 66, No. 164, pp. 44343-44344), the SAB Staff selected a list of over 120 scientists and engineers ("Wide Cast") whose expertise appeared to be relevant to answering the questions in the Charge. Nearly two-dozen nominations were received as a result of the FR solicitation process. In the FR solicitation, the expertise needed included environmental economics, preferably with experience in waste, groundwater and surface water contamination issues, particularly in the UST and RCRA contexts, health risk assessment, and ecological impact assessment, as well as a reviewer who is familiar with social science issues related to topics such as environmental justice, stakeholder values, the value of regulations requiring that information be provided to the public, and changes in the long-term behavior of the regulated community resulting from environmental regulatory requirements.

A communication was sent by the DFO enquiring as to interest and availability on specific dates for the review and over 50 individuals who might be interested and available ("Middle-Cast") were identified. Subsequently, the Panel Chair, the SAB Staff Director and the DFO reviewed the list in some detail and identified nearly 30 individuals ("Narrow Cast") who were available and interested in serving on the Panel and whose expertise and experience would be especially suitable to answer the specific charge questions. Based on this information and the importance of having a balanced range of views on the technical issues represented on the Panel, the Chair and the DFO made recommendations for membership to the Staff Director, who made the final decision on the composition of the Panel. This process included assigning each person responsibilities to specific charge questions.

The Agency provided the review and background materials for a mailing to the Panel on April 19, 2002. In the Federal Register solicitation announcing the meetings (see FR, Vol.67, No. 77, pp. 19572-19575, dated April 22, 2002), the Agency announced a May 9, 2002 public conference call meeting to a) discuss the Charge and the adequacy of the review materials provided to the Panel; b) to clarify any questions and issues relating to the charge and the review materials; c) to discuss specific charge assignments to the Panelists; and d) to clarify specific points of interest raised by the Panelists in preparation for the face-to-face meeting of May 20 and 21, 2002. In this FR announcement, the Agency also announced the May 20 & 21 face-to-face meeting, and a contingent conference call for June 18, 2002 to conduct edits to an anticipated draft advisory.

The Panel met and convened a public meeting in conformance to the Federal Advisory Committee Act (Public Law 92-463)on May 20 & 21, 2002 in the Washington, DC area at EPA Headquarters and conducted a review of the UST and RCRA Subtitle C Benefit, Cost and Impact documents (U.S. EPA. 2000b and U.S. EPA. 2000c). The Panel engaged in dialogue with the Agency officials who were responsible for preparation and utilization of the draft documents dated October 2000, received public comments from a representative of the American Chemistry Council, and began to prepare responses to the charge questions.

The Panel met on June 18, 2002 in a public conference call to discuss edits to its draft advisory (see FR, Vol. 67, No. 77, pages 19572-19575). The Panel conducted edits to its working draft document dated June 14, 2002 and agreed to prepare a public draft following this work session. A public draft was released on June 25, 2002 and was posted to the SAB website (www.epa.gov/sab). The Panel completed its edits on July 22, 2002, and at which time the Chair of the Panel forwarded an electronic draft to the DFO. The DFO prepared this draft for the SAB Executive Committee (EC)review, having prepared a draft dated August 8, 2002. The SAB EC reviewed and approved this draft in a public session on October 1, 2002 (See FR, Vol 67, No. 180, pp. 58604-58605 for the announcement of this public meeting). The Panel incorporated recommended edits in October and November following the meeting and forwarded the final, approved Advisory to the EPA Administrator.

APPENDIX B - ACRONYMS

ADV	Advisory
BCI	Benefits, Costs and Impacts
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COUNCIL	Advisory Council on Clean Air Act Compliance Analysis
DFO	Designated Federal Official
EC	Executive Committee (of the U.S. EPA/SAB/EC)
EEAC	Environmental Economics Advisory Committee (U.S. EPA/SAB/EEAC)
EPA	Environmental Protection Agency (U.S. EPA)
FR	Federal Register
GIS	Geographic Information System
GPRA	Government Performance and Results Act
LTR	Letter Report
LUST	Leaking Underground Storage Tank
MEI	Maximally Exposed Individual
MMSOILS	Multi-Media Soils Model
3MRA	Multi-Media Risk Assessment Model (Air, Land, Water and Ground-Water)
MTBE	Methyl Tertiary Butyl Ether
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
OUST	Office of Underground Storage Tanks
RCRA	Resource Conservation and Recovery Act
RCRA-C	Resource Conservation and Recovery Act - Subtitle C (Hazardous Wastes)
RCRA-D	Resource Conservation and Recovery Act - Subtitle D (Non-Hazardous Wastes)
RfD	Reference Doses (doses and concentrations that are not to be exceeded in order to protect human health)
RfC	Reference Concentrations (concentrations that are not to be exceeded in order to protect human health)
SAB	Science Advisory Board (U.S. EPA/SAB)
TRI	Toxics Release Inventory
TSDs	Treatment, Storage and Disposal Facilities
UST	Underground Storage Tanks

APPENDIX C - BRIEF BIOSKETCHES OF UST/RCRA BCI REVIEW PANEL

Dr. Bruce Bauman is the research program coordinator in the soil, groundwater, health and environmental sciences, and regulatory affairs departments at the American Petroleum Institute (API) in Washington, DC. Since 1990 he has served as API's technical program coordinator 1990 for the annual API-National Ground Water Association Conference. He is a member of the editorial board of the *Journal of Soil Contamination* since 1996. From 1992 to 1995 Dr. Bauman was a Consultant to the EPA Science Advisory Board's Environmental Engineering Committee's Underground Storage Tank (UST) Research Subcommittee during the time that it generated [Review of the Underground Storage Tank (UST) Research Program, EPA-SAB-EEC-93-008].

Dr. Bauman received his Ph.D. in Soil Science with a minor in water resources from Montana State University, and a B.S. in soil science from the University of Wisconsin-Madison.

Dr. James Boyd: is a Senior Fellow at Resources for the Future (RFF), and is currently Director, Energy and Natural Resources Division, having served as a Fellow at RFF from 1992-2000. He has been a visiting professor for Business strategy in the legal and regulatory environment in the Olin School of Business (1997) at Washington University in St. Louis, as well as a lecturer in managerial economics and public policy at the Wharton Business School at the University of Pennsylvania (1991 & 1992). His primary research interests are in the areas of law and economics, environmental policy and regulatory economics. He has published articles dealing with such topics as financial responsibility for environmental obligations, benefit-based transfer ratios as compensation for lost ecosystem services, wetland value indicators for scoring mitigation trades,analysis of easement acquisitions, the law and economics of habitat conservation, liabilities, the law and economics of implicit contracts, barriers and opportunities to corporate pollution prevention, expanding wetland assessment procedures, the economics of tailored regulation, and numerous other topics.

Dr. Boyd received his Ph.D. in Applied Microeconomics from the Wharton Business School, University of Pennsylvania, and his B.A. in History from the University of Michigan.

Dr. George Carpenter is currently employed in the Superfund Section of the Environmental Response Division of the Michigan Department of Environmental Quality. Dr. Carpenter has extensive state experience dealing with topics such as environmental impact assessments, remote sensing, evaluation of site assessment ranking models, quality assurance review of sites, site inspections, NPL scoring, evaluating the impacts of toxic substances on aquatic life and public health, recommending effluent limits for organic chemicals in industrial and public wastewater treatment system discharges, and administration of the Michigan Critical Materials Register Annual Wastewater Report System. In the private sector, he has experience as a laboratory manager for acute and chronic sediment bioassays of specific chemicals, industrial discharges, and other point source pollution using fish, invertebrates and algae. He also conducted zooplankton and plankton standing crop studies on many of the Great Lakes. He has authored or co-authored publications spanning many of the above topics. He served as a consultant(4 years) and member (6 years) of the Science Advisory Board's (SAB) Environmental Engineering Committee (EEC) from 1987 to 1997. He Chaired a Constructed Wetland Review Subcommittee for the SAB's EEC (Research-in Progress-Review of ORD's "Constructed Wetlands for Wastewater Treatment," EPA-SAB-EEC-LTR-92-006), which was jointly conducted with the SAB's Environmental Processes and Effects Committee (EPEC) review of wetlands ecology. His

experience with the SAB includes numerous groundwater reviews, including several groundwater contaminant transport models, database development plans, pollution prevention policy, redesign of the Hazard Ranking System for environmental contamination sites, evaluation of the Agency's municipal solid waste program, and evaluation of the Superfund Innovative Technology Evaluation (SITE) program.

He received his Ph.D. in Fisheries and Wildlife from Michigan State University, an M.S. in Limnology and Biology from McGill University, and B.A. in Zoology and Botany from Wabash College.

Dr. A. Myrick Freeman is the William D. Shipman Research Professor of Economics at Bowdoin College, where he has been on the faculty since 1965 and has served as Chair of the Economics Department, as well as Director of the Environmental Studies Program. He has also held appointments as Visiting Professor at the University of Washington, and the Robert M. La Follette Distinguished Visiting Professor at the University of Wisconsin-Madison and as a Senior Fellow at Resources for the Future, a research organization in Washington, DC.

Dr. Freeman's principal interests are in the areas of applied welfare economics, benefit-cost analysis, and risk management as applied to the development of models and techniques for estimating the welfare effects of environmental changes such as the benefits of controlling pollution and the damages to natural resources due to releases of chemicals into the environment. Dr. Freeman has authored or co-authored eight books including *The Economics of Environmental Policy* (with Robert Haveman and Allen Kneese), *The Benefits of Environmental Improvement: Theory and Practice*, *Air and Water Polltion Control: A Benefit-Cost Assessment*, and most recently *The Measurement of Environmental and Resource Values: Theory and Methods.* He has also published more than 70 articles and papers in academic journals and edited collections.

Dr. Freeman is presently a consultant to the SAB, having served as a member of the Advisory Council on Clean Air Compliance Analysis (the Council), as well as a member of the Environmental Economics Advisory Committee (EEAC).

Dr. Freeman received his Ph.D. and M.A. in Economics from the University of Washington, and his A.B. in Economics from Cornell University.

Dr .W. Michael Hannemann is Professor of Agricultural and Resource Economics at the University of California, Berkeley. He has worked on water resource economics since his days in graduate school at Harvard in 1970, working on the economics of water supply and wastewater disposal. He has recently served as the economics staff for the California State Water Resources Control Board. He has also served on a Blue Ribbon Panel for the Mayor of Los Angeles on designing the water rate schedule for LA, as well as a Blue Ribbon Panel on water pricing for the Metropolitan Water District of Southern California. He has been a consultant to the Urban Water Conservation Council of California and has co-authored three reports on water rate design and assessment of water conservation.

Dr. Hannemann is widely published, having authored or co-authored over 30 refereed articles, over 30 research reports, nearly 30 contributions to books, a number of books and monographs, and over 40 working papers dealing with economics and environmental issues.

Dr. Hannemann has served as a teaching fellow in the Department of Economics at Harvard University, a Lecturer in the Department of Economics at Northeastern University, a staff Economist and Consultant at Urban Systems Research in Cambridge, Massachusetts, and other teaching and consulting appointments. He was a member of the United Nations Environmental Program (UNEP) Working Group on Benefits of Biodiversity Conservation, a University Fellow at Resources for the Future, a Member of the Board of Directors for the

Association of Environmental & Resource Economists, and a Member of the National Academy of Sciences (NAS), National Research Council (NRC) Committee to Review the Glen Canyon Environmental Studies Program and the Committee on Wolf and Bear Control in Alaska.

Dr. Hannemann received his Ph.D. in Economics and his M.A. in Public Finance and Decision Theory from Harvard University, a M.Sc. in Development Economics from the London School of Economics, and a B.A. in Philosophy, Politics and Economics from Oxford University in England.

Dr. Gregory Poe is Associate Professor in the Department of Applied Economics and Management at Cornell University. His present appointment involves research, teaching, and extension in environmental, policy and welfare economics, non-market valuation, experimental economics, and non-point source pollution policy Other areas of research have included fisheries management in developing countries, geographical information systems, erosion economics, and technical efficiencies in agricultural production. While on sabbatical leave he recently served as a Visiting Fellow at the Jackson Environmental Institute and the Centre for Economic and Social Research on the Global Environment. He has published over 2-dozen articles in refereed journals a number of research manuscripts over two dozen monographs, nearly 40 presentations at professional meetings, over 40 extension publications, on a broad variety of economics topics. Topics covered include non-market valuation methodologies, contingent valuation, incremental benefits of groundwater benefits, measuring differences in willingness-to-pay, land allocation model to assess welfare implications of a conservation reserve program, connecting taxes and willingness to pay for farmland protection, valuation of ground water quality, nitrates in ground water, well testing programs and exposure and health risk perceptions, the evolution of federal water pollution control policies, and numerous related topics.

Dr. Poe has a recently funded grant though the National Science Foundation with other colleagues on "Ecosystem Values and Surface Water Protection: Basic Research on the Contingent Valuation Method." He also had recently received Hatch funds (from 2000 to 2002) on "Environmental Policy and Agriculture," as well as Hatch funds (1998-2000) for "Analyzing the Conflict Between 'Harm Preventing' versus 'Public Good Providing' Environmental Policies." He has received other funds in the past from NSF, NSF/EPA, Hatch Funds, Niagara Mohawk Power Corporation ("An Analysis of Niagara Mohawk's Green Pricing Program"), USDA, and the University of Wisconsin-Madison for a variety of research activities.

Dr. Poe has his Ph.D. in Natural Resource Economics and his M.S. in Production Economics from the University of Wisconsin, Madison. He has his B.A. in Economics from Pomona College.

Dr. Clifford S. Russell is currently Professor of Economics and Director, Vanderbilt Institute for Public Policy Studies. He has served on the EPA/SAB Joint Subcommittee on Industrial Ecology and Environmental Systems Management. He has served on a number of prestigious advisory committee appointments in other organizations. For instance, he has served on the National Academy/National Research Council Environmental Research Assessment Committee, 1975-77, the Committee on Steel Research, 1978, the Environmental Studies Board, 1983-85, the Committee on Multimedia Approaches to Pollution Control, 1986-88, the Committee on Water Resources Research, 1988-90, the Panel for the Review of the DOE Environmental Restoration Priority System, Chair, 1992-93, the Committee to Review Risk Management in the DOE's Environmental Remediation Program, 1993, and the Committee on Watershed Management, 1996. He has written and co-authored at least 8 textbooks on a variety of subjects, including drought and water supply, residuals management in industry: a case study of petroleum refining,

steel production: processes, products and residuals, environmental quality management, freshwater recreational fishing: the national benefits of water pollution control, enforcing pollution control laws, applying economics to the environment, and investing in water quality: benefits, costs and risks. He has edited at least 9 textbooks dealing with these and related topics, as well as publishing over 60 articles, nearly 40 notes, comments and reviews, and over 50 other products. He has served as a member of a variety of Governing Boards, including the Board of Trustees of the Environmental Defense Fund (1973-85), and the Tennessee Environmental Council (1989-present). He is Past President of the Association of Environmental and Resource Economists, and has served on a number of other advisory and organizing committees.

Dr. Russell has his Ph.D. in Economics from Harvard University, and his B.A. in Mathematics from Dartmouth University.

Dr. Hilary A. Sigman is currently Associate Professor in the Department of Economics at Rutgers University. Dr. Sigman has published over a dozen publications on such topics as the economics of international spillovers and water quality, liability for cleanup of contaminated sites under Superfund, hazardous waste and toxic substance policies, an empirical analysis of Superfund litigation, reforming hazardous waste policy, midnight dumping: public policies and illegal disposal of used oil, the cost of reducing municipal solid waste, cross-media pollution and responses on chlorinated solvent releases, the effects of hazardous waste taxes on waste generation and disposal, and a comparison of public policies for lead recycling. He has been a reviewer on a number of economics journals, and has conducted a number of presentations at over thirty organizations since 1994. Since 1994 to the present he has maintained a research affiliation as a Faculty Research Fellow with the National Bureau of Economic Research. He currently serves on the SAB's Environmental Economics Advisory Committee (EEAC). He has been a member of the Editorial Council of the *Journal of Environmental Economics and Management.* He is a recipient of a number of research contracts and grants. For instance, an NSF research grant (1999-2002) for "International spillovers and water quality in rivers," EPA/Office of Exploratory Research Grant (1994-97) "Liability funding and Superfund clean-up strategies," U.C. Toxic Substances Research and Teaching Program Research Grant, "Cross-media substitution in toxic chemical emissions," a Marine Policy Center, Woods Hole Oceanographic Institution Subcontract for focal study entitled "The cost of waste reduction," and others (such as a UCLA Academic Senate Committee on Research, and an MIT Center for Energy and Environmental Policy Research Dissertation Funding.)

Dr. Sigman received his Ph.D. in Economics from the Massachusetts Institute of Technology, his M.Phil. in Economics from Cambridge University (England), study in Human and Physical Geography from the University College of Wales, Alberystwyth, and a B.A. in Economics and Studies in the Environment from Yale College.

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