This chapter discusses our proposed methods for characterizing distributional impacts of the UST cleanup program, including environmental justice impacts, risk tradeoffs, economic impacts (including employment and economic growth effects), and promotion of brownfields redevelopment. We also provide a separate assessment of potential long-term intergenerational impacts.

6.1 ENVIRONMENTAL JUSTICE IMPACTS

The equity effects attribute refers to potential impacts on disadvantaged populations of LUSTs cleanups. Disadvantaged populations may experience disproportionately high health risks from leaking USTs if USTs are located disproportionately in their neighborhoods. As a result the UST cleanup program may contribute to improvement of environmental justice by cleaning up USTs located in these areas. Since potential impacts would be derived from an improvement of environmental justice associated with the distribution of environmental contamination, this attribute is not a measure of net benefits.

Currently, EPA does not expect large equity effects related to this attribute because fuels and gasoline are so widely used that it is unlikely USTs have a strong tendency to be grouped specifically in areas with disadvantaged populations.[1] OSWER determined, however, that methodologies should be included in the report because the methods are relatively straightforward, and may also have application to other OSWER programs.

In addition, disadvantaged populations may be exposed to a variety of other environmental pollution sources because manufacturing, waste treatment and disposal, and other industrial facilities

[1] USTs tend to be concentrated in areas with heavy motor vehicle traffic; this includes densely populated areas, as well as industrial areas and highways where population densities are much lower. Also, while densely populated urban areas may be associated with disadvantaged populations, the widespread use of municipal water sources in these areas may mitigate UST-related human health risks.

are frequently located in and around such neighborhoods. The cumulative risk resulting from exposure to these sources and to LUST contamination may lead to unacceptable health risks in some communities. EPA currently encourages UST implementing agencies to ensure that the cumulative health risks to people living in such areas are taken into consideration in determining the extent and urgency of needed cleanups of releases from USTs.[2]

Our method for assessing potential environmental justice impacts associated with the UST cleanup program would focus on a spatial correlation of UST locations in relation to ethnicity and income of potentially affected households.

Approach: For selected counties, we would analyze the location of USTs in relation to the ethnicity and income of potentially affected households, using the GIS and stabilized benzene plumes. Should we identify statistically significant spatial correlation, we would apply the analysis to a representative sample of counties and extrapolate the percentage of potentially affected households to the national level.

Data Sources: We would derive information on ethnicity and income from census block group data and combine this information with digital census block group maps.

Evaluation: The analysis provides an easy and quick characterization of potential environmental justice issues associated with the UST cleanup program. The results would identify the strength of any correlation between LUST cleanups and disadvantaged populations, and could support quantitative estimates of the level of program funding associated with cleanups in different areas. However, because this attribute is distributional in nature, the approach would not provide monetary estimate of the value of the OUST cleanup program in environmental justice issues. In addition, uncertainty is associated with the selection of counties for this analysis. To address this uncertainty, we can select a set of counties representing various income levels and ethnic mixes.

6.2 RISK TRADEOFFS

LUST cleanups can reduce risks from chemical exposure to nearby residents, but may also pose risks to workers performing remediation activities and to neighbors exposed to volatile compounds during the cleanup activities. For hazardous waste sites, available literature data suggest that fatality rates associated with typical remedial activities can be measurable.[3]

---

[2] *Use Of Risk-Based Decision-Making In UST Corrective Action Programs*, OSWER Directive 9610.17, March 1, 1996. available at: http://www.epa.gov/swerust1/directiv/od961017.htm

[3] One study found that the probability of experiencing at least one fatality during the course of a cleanup of hazardous waste site was 0.149 x 10-6 for excavation and landfill, 0.012 x 10-6 for capping, and 0.014 x 10-6 for capping plus slurry wall. (Hoskin, A.F., J.P. Leigh, and T.W. Planek,

Occupational risks may be qualitatively different from risk to the general public due to the consent by and compensation of the workers exposed to risks. The degree to which workers understand the risks they accept or receive compensating wages will determine whether or not there are uncompensated risks to workers that should be considered. For this reason, voluntary worker risks may not be comparable to involuntary risks experienced by neighbors. However, evaluating worker risk can provide valuable information on short-term risks associated with site cleanup. For example, risk tradeoff studies can be designed to compare worker risks among the various cleanup technologies, information that may be used to minimize worker risks associated with cleanups.

We propose two methods for estimating risk tradeoffs, one focusing on a qualitative discussion of accidents, and a more detailed method focusing on accident risks to specific occupations involved in cleanup activities. We do not propose methods for measuring worker exposure to contaminants or short-term risks to neighbors during cleanup activities because we have been unable to identify data on exposure levels during UST cleanup activities that would be sufficient to estimate associated risk.

6.2.1 *Qualitative Discussion of Risk Tradeoffs*

Approach: This method would focus on a qualitative discussion of accident risks potentially associated with UST cleanup activities, a review of existing literature in terms of identified risk and comparability to UST cleanups, and an examination of work related fatal and non-fatal injuries associated with tanks using available databases.

Data Sources: Databases available from the Bureau of Labor Statistics (BLS) contain information on work related fatal and non-fatal injuries. While these databases do not specifically record incidents associated with LUSTs, they do record incidents associated with 'tanks' (i.e., above ground and underground) and sometimes indicate UST in the "notes" column of the database.

6.2.2 *Quantitative Evaluation of Risk Tradeoffs*

Approach: This method would quantify accident risk associated with UST cleanups. We would first obtain literature information on the mix of occupations (e.g., civil engineers, truck drivers, and dozer operators) and labor hours required for various cleanup technologies. We would supplement this information by conducting interviews with engineering companies to refine

---

1994. "Estimated Risk of Occupational Fatalities Associated With Hazardous Waste Site Remediation." *Risk Analysis* 14(6):1011-1017).

estimates of occupations and hours associated with UST cleanup activities.[4] We would then estimate risk for all occupations and cleanup technologies using literature data and risk weighted by number of hours worked in specific occupations.

Data Sources: The frequency of fatal injuries per occupation would be available from BLS publications (e.g., *Fatal Workplace Injuries in 1996: A Collection of Data and Analysis*. U.S. Department of Labor, Bureau of Labor Statistics, June 1998). Hoskin et al. provide information on man hours per remediation activity and occupational risks for hazardous waste sites remediation (*Estimated Risk of Occupational Fatalities Associated With Hazardous Waste Site Remediation*. Hoskin, A.F., J.P. Leigh, and T.W. Planek, 1994. Risk Analysis 14(6):1011-1017), and Leigh gives information on the probability of job related death in various occupations (*Causes of Death in the Workplace*. Leigh, J.P., 1995. Quorum Books, Westport, CT).

6.2.3 *Evaluation of Proposed Methods and Addressing Uncertainties*

The qualitative discussion would provide a rough estimate of worker accident risks associated with tanks, including ranges of potential fatal and non-fatal accidents and causes for these accidents. While data for this analysis would be readily accessible, they are not specific to accidents involving UST cleanup activities. Instead, they include accidents involving aboveground storage tanks and activities not directly related to the UST cleanup program such as tank removals associated with UST technical standards.

The more extensive evaluation would provide quantitative estimates of worker accident risk. This information could, for example, be used to compare accident risk to population risks associated with contaminated groundwater. In addition, this method would provide a comparison of various cleanup technologies in terms of associated worker risk. Uncertainties associated with this method include the mix of occupations, hours worked in various cleanup activities, and potentially disproportionate representations of accident causes not related to cleanup activities in data on occupational risk.

6.3 ECONOMIC IMPACTS

The economic impacts attribute comprises a range of positive and negative impacts that the UST cleanup program might have on local economies, including local effects on business profitability, employment, government revenues or expenditures, and other changes of concern for policy makers. Positive impacts may include:

---

[4] Information on the number of hours worked per occupation may also be available from state billing data.

- Creation and/or support of local jobs associated with site cleanup efforts, increases in municipal tax revenues, and small business cost savings.

- Job and income creation in disadvantaged neighborhoods, increased property values, and associated municipal tax revenues due to the promotion of brownfields development.

Negative impacts may include closure of facilities for which it is economically infeasible to comply with cleanup regulations, decrease in the number of local jobs due to facility closures, and closure of small businesses.

In evaluating positive and negative economic impacts of the UST cleanup program, it is essential to consider two aspects of this attribute category: (1) its focus on impacts rather than net benefits, and (2) potential double counting of economic impacts since municipal tax revenues will increase as a consequence of increases in local jobs and income.

All economic impacts represented by this attribute measure gross economic impacts of the UST cleanup program, rather than net economic benefits and costs. Characterization of these gross economic impacts is intended to provide information for policy makers and other stakeholders on the impacts of the UST cleanup program on local economies. For example, creation of jobs associated with site cleanup and technology development may have significant positive impacts on local economies, if new or better jobs are created for previously unemployed or underemployed individuals. Seen from the broader perspective of the national economy, however, creation of local jobs may not indicate a net benefit because the new jobs may simply represent economic transfers from other more profitable business activities.

In addition, economic impacts summarized by this attribute may overlap considerably with each other and cannot be added to estimate total impacts. For example, impacts associated with job creation and municipal tax revenues may represent a chain of impacts associated with movement of the same dollar through the economy job rather than distinct benefits. Job and income creation benefits private citizens who hold the new jobs. As a result of such personal income generation, the private sector benefits from revenues associated with private citizens' personal expenditures, and the public sector receives income tax payments. Personal expenditures also lead to a public sector benefit in terms of sales tax and other public revenues. While describing both job creation and associated tax revenues provides information on the variety of economic impacts associated with the UST cleanup program, they do not represent separable benefits.

In order to avoid such double counting of impacts, our proposed method for characterizing positive economic impacts would focus only on a quantification of jobs created by activities associated with cleanup activities.[5] This would provide a high-end estimate of one measure of economic impacts (i.e., job creation) and would help identify the potential magnitude of impacts from the UST cleanup program. We would then augment this analysis with a qualitative discussion of the potential positive and negative economic impacts associated with the clean-up program, noting in particular the issues related to regional versus national estimates of economic impacts, and issues related to identifying impacts as costs, benefits, or transfers.

6.3.1 *Positive Employment and Economic Growth Effects*

Approach: First, we would identify average number of labor hours reimbursed by UST funds per incident. We would then calculate the number of jobs created/supported per incident based on annual equivalent full-time jobs. Finally, we would extrapolate to the national level and prospective impacts using estimated nationwide past and future cleanup activities.

Data Sources: The number of labor hours is available from state UST funds, which generally track expenses associated with cleanup activities, including reimbursed labor hours for various occupations. It is possible to obtain occupation-specific labor hours from UST funds, which would allow for more refined impacts estimates. Note, however, that if these data are not in a form readily available to the public, then collection of this information from more than nine states may require an ICR.

Evaluation: The method would provide a quick estimate of the number of jobs created or supported by activities related to cleanups, including a variety of occupations involved in cleanup activities (e.g., truck drivers, engineers, workers, and managerial staff). The method, however, does not account for all jobs potentially created (e.g., jobs in technology development), and it would provide no information on either the net number of jobs created nationally (because jobs may represent transfers among locations) or on the quality of jobs created relative to jobs lost. We would then augment this analysis with a qualitative discussion of the other potential positive direct and indirect economic impacts associated with the clean-up program at both local and national levels.

6.3.2 *Negative Employment and Economic Growth Effects*

One key aspect in estimating potential negative economic impacts associated with the cleanup program are existing financial responsibility requirements that will limit economic impacts

[5] To the extent that there might be net changes we could use also use economic impact multipliers to characterize program impacts. We will revisit this issue as part of the implementation.

on tank owners and operators.[6] Most states have developed UST financial assurance funds to reduce the economic hardship of compliance with financial responsibility requirements and to help cover the costs of cleanups.[7] UST funds substitute for or supplement private insurance by providing partial reimbursement to owners or operators of USTs for costs, expenses and third party obligations associated with a leaking tank. While details about the funds are specific to each state, most state funds contain some deductible that the owner or operator is responsible for paying in case of a release. In many states, owners and operators are responsible for the first $5,000 to $10,000 of cleanup per site.[8] Cleanup costs above this are reimbursed from the fund, typically up to $1 million. Any cost beyond this becomes the responsibility of the site owner.[9]

Due to the existence of financial responsibility requirements and state UST funds, we believe that facility closures and associated job losses associated with LUST incidents will be limited. In some cases, however, cleanup requirements may significantly affect businesses, especially if associated costs exceed reimbursement thresholds of UST funds.

Our proposed method for characterizing negative impacts of the UST cleanup program on local economies would focus on a quantification of the number of incidents that exceed reimbursement thresholds of UST funds and an assessment of the number of associated facility closures and job losses, accompanied by a qualitative discussion of other negative economic impacts.

Approach and Data Sources: To identify the number of incidents exceeding the $1 million reimbursement threshold, we would first conduct a survey of a representative sample of UST funds.

---

[6] EPA requires owners and operators of USTs to show that they have the financial resources to clean up a site if a release occurs, correct environmental damage, and compensate third parties for injury to their property or themselves. These requirements obligate owners and operators to demonstrate financial responsibility by: (1) obtaining commercial environmental impairment liability insurance, (2) demonstrating self-insurance, (3) obtaining guarantees, surety bonds, or letters of credit, (4) placing the required amount into a trust fund administered by a third party, or (5) relying on coverage provided by a state financial assurance fund. Also, it is important to point out again that this report addresses only the UST cleanup program, and not the impacts of UST prevention regulations.

[7] As of September 1996, 42 state funds had implemented financial assurance funds.

[8] In addition, some state regulations exempt certain responsible parties from these requirements. For example, in California, residential tank owners do not have a deductible.

[9] Costs of remediating sites with soil contamination generally vary between $10,000 and $125,000. Depending on the extent of contamination, costs for remediating sites with groundwater contamination can range from $100,000 to over $1 million. (*EPA, 1996. How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers*. EPA 510-B-94-003).

We would then conduct a survey of affected businesses to characterize economic impacts on the business associated with the incident (i.e., facility closure, number of jobs lost).[10] Finally, we would estimate the nationwide number of incidents exceeding the reimbursement threshold and extrapolate associated impacts to the national level and to prospective impacts. We would augment this analysis with a qualitative discussion of other potential negative economic impacts related to the program.

Evaluation: The method would provide a reasonable quantification of "worst case incidents," which account for the number of facility closures and possibly associated job losses. It may, however, underestimate negative economic impacts in states that currently do not have UST funds (e.g., New Jersey). The estimated frequency of future incidents exceeding the threshold would also be uncertain due to potential reductions in leaks as a result of the UST technical standards.

6.4 CONSERVATION OF GREEN-SPACE AND BROWNFIELDS DEVELOPMENT

Former commercial and industrial sites containing old or abandoned USTs may not be redeveloped due to fear of potential liability for cleanup of contamination. Such lack of interest in cleaning up or reusing these sites may have contributed to the general deterioration of urban areas. EPA's Brownfields Program specifically addresses these problems by promoting and accelerating urban infill redevelopment and communicating strategies for redevelopment. While some of the estimated 100,000 to 450,000 brownfields sites in the U.S. are Superfund sites, a significant percentage of the remaining sites may be old or abandoned gasoline stations and other commercial or industrial properties with USTs. For example, Illinois estimates that half of the state's brownfields sites are former UST/LUST sites.[11]

Potential distributional impacts associated with brownfield redevelopment include job and income creation in disadvantaged neighborhoods, increased property values, and associated municipal tax revenues. Since increased infill of urban areas may limit sprawl, brownfield

---

[10] A representative sample would include UST funds from a variety of states representing various cleanup requirements and environmental conditions. Information about UST funds and number of affected businesses may be readily available from states for public distribution; if it is not, then collection of these data from more than nine states or businesses might require an ICR. Note, however, that specific data on job losses may be difficult to obtain from businesses or states.

[11] EPA, 1996. *UST Program Facts: Implementing Federal Requirements for Underground Storage Tanks*. EPA 510-B-96-011.

development may also have economic, social, and ecological benefits associated with the conservation of green-space at the urban fringe.[12]

OSWER is currently developing a strategy that will outline measures to facilitate assessment, cleanup, and reuse of sites already contaminated by UST releases. Prevention measures will include promulgating a regulation dealing with lender liability for cleanup of contaminated sites. Measures aimed at helping states address brownfield sites more efficiently include streamlining of cleanup efforts, development of strong state insurance funds, and the use of RBDM.

Our proposed method for characterizing redevelopment impacts associated with the UST cleanup program would focus on identifying an estimate of the number and percentage of LUST sites located in Brownfields areas that are redeveloped, coupled with a qualitative discussion of impacts.

Approach and Data Sources: For the purpose of identifying potential impacts of the UST cleanup program on the number of redeveloped LUST sites, we would examine available state data on LUST sites to determine how many sites have been rendered suitable for redevelopment. To determine a low-end estimate of the number of suitable LUST sites that are or have been redeveloped, we would examine national brownfields program sites and identify the number of LUST sites in those programs.[13] The qualitative discussion would then focus on potential effects of redevelopment, such as economic and social impacts resulting from the utilization of urban properties. The discussion would also include potential ecological benefits derived from the conservation of green-space including protection of wildlife habitat and agricultural land, and reduction in transportation costs and associated air pollution.

Evaluation: The proposed approach would provide an estimate of the percentage of LUST sites located in Brownfields areas that are being redeveloped and a general discussion of associated impacts. While it would be possible to quantify certain impacts (e.g., increases in property value benefits of LUST sites after cleanup), we do not propose a quantitative estimate because it would be difficult to disentangle the impact of cleanups on promoting redevelopment from other factors influencing redevelopment such as business incentives to relocate to the site.

6.5 LONG-TERM DISTRIBUTIONAL IMPACTS

[12] There may ultimately be measurable net benefits or costs associated with development, but because of the causal complexity and problems associated with redevelopment we limit our discussion of this attribute to its distributional impacts.

[13] While many Superfund sites have on-site LUSTs, we do not consider these to be LUST sites because they are addressed by the Superfund program (and not the UST cleanup program).

The UST cleanup program may lead to long-term distributional impacts in addition to those characterized in our impacts analyses. Since many long-term effects of the UST cleanup program could have implications for future generations, intergenerational equity might constitute an important aspect of distributional impact considerations. We discuss potential long-term benefits and costs of the program and methods that could be use to characterize these impacts in Chapters 4 and 5. The long-term distributional impacts considerations focus specifically on how long-term benefits and costs might lead to increases or decreases in intergenerational equity.[14]

The principle of intergenerational equity implies that decisions taken today should ensure that at least an equivalent set of opportunities is available to succeeding generations. One important aspect of intergenerational equity is that the resource use of each present generation might be depriving future generations of the same resource. This is particularly relevant in cases of non-renewable resources but is also possibly true in the case of renewable resources if the resource use exceeds the regeneration capacity of the resource.

Another important aspect of intergenerational equity is the belief of some social theorists that the value of natural resources and environment to the society is not merely the sum of values of individuals. Because society as a whole has a much longer life expectancy than individuals, it is likely to have different values from those of individuals.[15] In addition, social values and individual preferences are changing over time in ways that the present generation cannot know and intergenerational equity considerations will at least in part be driven by current values. Nevertheless considering intergenerational equity in a comprehensive assessment of program distributional impacts provides an important opportunity to explicitly address values society might place on intergenerational equity aspects of the program.

To the extent that the UST cleanup program contributes to preserving available resources for future generations, the program might have the following positive intergenerational equity impacts:

- Preservation of environmental assets (e.g., groundwater) that are highly valued by future generations.

- Avoidance of high cleanup costs borne by future generations especially in cases where cleanups at an earlier point in time would have avoided extensive contamination.

---

[14] While characterizing long-term benefits and costs of the program is necessary to start understanding potential implications of current actions on future generations, distributional impacts add another layer to the discussion by focusing on how the program contributes to ensuring equity from one generation to the next.

[15] Klaassen, G.A.J. and Opschoor, J.B., 1991. Economics of Sustainability or the Sustainability of Economics: Different Paradigms. *Ecological Economics* 4:93-115.

Together, these might lead to decreases in costs of clean water for future generations due to the preservation of adequate amounts of clean ground water. Alternatively, the UST cleanup program might have negative impacts on intergenerational equity in cases where the program imposes unexpected costs on future generations. While it is possible that some of these costs might be avoidable, future generations' values are not known making it difficult to even start considering implications for future generations.

Approach and Data Sources: We would provide a qualitative discussion of the types of potential positive and negative intergenerational equity effects of the UST cleanup program and their likelihood based on insights gained through our characterizations of potential long-term benefits and costs of the program and a review of the literature on intergenerational equity effects and case studies of how past actions affected later generations.

Evaluation: The method would provide information on aspects of intergenerational equity that might be especially relevant for the UST cleanup program, including examples of how the program might lead to positive and negative impacts and what their relative importance might be. The method may, however, completely fail to identify important impacts due to uncertainties about future generations' values and scientific knowledge.

In this chapter, we address our proposed methods for characterizing "program context attributes." These are additional attributes of the UST cleanup program not covered in the previous sections. As explained in Chapter 1, OSWER is developing a process for evaluating a broad set of program impacts and features that go beyond those evaluated in traditional benefit-cost analyses. The results of implementing the methods described in this report are expected to be reviewed and used by both internal EPA managers as well as external stakeholders with an interest in the performance of the UST cleanup program. Therefore, OSWER believes it is important to go beyond the attributes typically considered in a traditional cost/benefit analysis and characterize and describe other program features and factors that influence the design, implementation, performance, and impacts of OSWER programs. OSWER believes that these "program context attributes" may be relevant to those internal and external reviewers trying to gain a better understanding of the impacts and drivers behind OSWER programs.

Some of these attributes may, in fact, be associated with real benefits or costs, but it is not generally possible to identify the net effects of these attributes using available data. Others simply represent factors that can influence the performance of the UST cleanup program. Program context attributes associated with the UST cleanup program include:

- **Technology Forcing: promoting alternative cleanup technologies and better tanks.** This attribute describes the extent to which the UST cleanup program has been associated with advances in cleanup technologies.

- **Long-Term Behavioral Change.** This attribute describes permanent changes in behavior that may have been caused or supported by requirements of and information made available under the UST cleanup program.

- **Streamlining of the Cleanup Process.** This attribute describes efforts by EPA and state agencies to improve the efficiency of the cleanup process by targeting high risk LUSTs and seeking cost-effective remedies for LUSTs presenting low risks.

- **Stakeholder Issues.** This attribute reflects the program priorities that are most affected by and related to input from members of the public and regulated communities.

Below we suggest approaches for characterizing these attributes. Where possible, we identify quantitative information that helps describe the magnitude of the effects of these attributes on the UST cleanup program.

7.1 TECHNOLOGY FORCING: PROMOTING ALTERNATIVE CLEANUP TECHNOLOGIES AND BETTER TANKS

The UST cleanup program may lead to the development and increased application of new technologies that meet site remediation objectives more efficiently than traditional methods. These technologies may help reduce the time required to achieve remediation goals and/or reduce costs of site remediation.[1] Requirements to clean up contaminated sites may also encourage tank owners and operators to upgrade tanks.

EPA encourages the use of alternative technologies provided that these remediation measures are protective of human health and the environment and meet remediation goals within reasonable time frames.[2] States may collaborate with EPA to identify new technologies or may benefit from information provided by EPA. Currently, some states promote the use of alternative technologies or certain types of cleanup approaches and technologies.

Our proposed method for characterizing technology change would focus on a qualitative description of changes in technology over time.

Approach: We would first characterize qualitative changes in technologies over time through an examination of state data on technologies used in cleanup efforts and information in trade journals. We would then discuss these technologies in terms of their costs and the duration of cleanup efforts necessary to reach remediation goals.

---

[1] As noted earlier, this attribute may overlap considerably with the streamlining attribute, since the streamlining attribute is a comprehensive measurement of cleanup efficiency. We address potential double counting below in Chapter 8.

[2] OUST defines "alternative cleanup technologies" as those which are alternatives to more traditional methods such as pump-and-treat for groundwater remediation, and excavation and disposal for soil cleanup. Examples of alternative cleanup technologies include soil vapor extraction, air sparging, biosparging, landfarming, biopiles, bioventing, low-temperature thermal desorption, in situ groundwater bioremediation, dual-phase extraction, and natural attenuation.

Data Sources: Some states keep records of cleanup technologies used in site remediation. While this information may not be available in databases, case file records often contain information on technologies used. Information on costs associated with the various technologies may be derived from state UST funds and from cost control tools developed by EPA, such as *Tank Racer*, a software program that provides cost estimates for cleanups at UST sites. Finally, information on the duration of cleanup efforts is available in state databases and case file records. Because this approach is not designed to develop a quantitative estimate of benefits associated with technology trends, it is not necessary that the state programs be a representative sample; it may be more efficient to examine well organized programs to determine whether there are measurable results.[3]

Evaluation: The method would provide a qualitative overview of changes in technology and potential trends in duration of cleanups and associated costs. The approach would not provide any aggregate quantitative valuation of benefits associated with technological innovation because it would be difficult to calculate the total benefits or to attribute these benefits specifically to the OUST cleanup programs.

7.2 LONG-TERM BEHAVIORAL CHANGE

This attribute measures the extent to which behavior has undergone permanent change as a result of regulation. The true measure of permanent behavior changes is the notion that the removal of the regulation would not result in a reversion to earlier practices. Behavioral change often manifests itself in use of new technologies and systems, but the most dramatic long-term behavioral changes that may be associated with the UST cleanup program is a recent increase in the emphasis on "clean" properties among banks and insurers in real estate transactions.[4] The expectation of proper management of storage tanks by property owners likely represents a permanent change in the perception of liability and responsibility. However, identifying the extent to which this change may be due to UST (as opposed to CERCLA, for example) may be impossible. Our proposed method for characterizing long-term behavioral change would therefore be limited to identifying changes in terms of real estate transactions.

---

[3] Note that because this sample is not required to be representative and can focus on states with the most organized programs (and, therefore, the most organized and publicly available data), it is not likely to require an ICR. However, if EPA collects data from more than nine states and the data are not publicly accessible, then an ICR may be necessary.

[4] The technological measure of behavioral change may overlap with the separate attribute of technology forcing, which is the encouragement of rapid technological advance through strict standards or other means. To address this issue, we narrowly define technology forcing benefits as the extent to which advancement in a particular regulated technology is faster than the rest of the market.

Approach: We would first examine legal and real estate literature to identify trends in the use of hazardous waste inspections as a condition of financing and/or sale of properties. To provide an estimate of the magnitude of this effect, we would supplement our research with state data correlating discovery of LUSTs and cleanup actions with property transfer attempts.

Data Sources and Evaluation: In addition to legal and real estate literature, some states maintain data on the circumstances under which a LUST is discovered (i.e., routine inspection, damage report, or property transfer). Because the analysis would be illustrative, it would not necessary to collect data from multiple states, and an ICR would not be necessary.

Evaluation: The method would provide a qualitative overview of the potential link between the UST cleanup program and inspections at the point of property transfer. The approach would not provide a quantitative valuation of impacts associated with behavioral change. This approach does not address causality because it will be difficult to attribute activities and benefits specifically to the UST clean-up program.

7.3 STREAMLINING OF THE CLEANUP PROCESS

The "streamlining" attribute of the UST cleanup program includes any measures aimed at reducing costs of cleanups, associated administrative expenses, litigation costs, or costs for regulatory purposes. The various approaches taken by OUST to streamline the cleanup process include promotion of the pay for performance (PFP) cleanup agreements, Risk Based Decision Making (RBDM), expedited site assessments (ESAs), and provision of information and data aimed at reducing or eliminating duplication of efforts. The reason for examining the effects of streamlining efforts as part of an overall methodology to evaluate the costs, benefits, and impacts of the UST cleanup program is that EPA expects that over the long-term, implementation of these streamlining initiatives will reduce the costs of the program. Thus, this information can provide additional context for understanding the performance of the UST cleanup program over time.

A Pay for Performance (PFP) cleanup agreement sets a fixed price for a cleanup at a specific site. The cleanup contractor gets payment as contamination is reduced to specified levels established in the remediation goal. This approach is likely to encourage efficient use of resources and fast, efficient, and competitively priced cleanups. Specific components of PFP include establishing the baseline, determining the endpoint, installing monitoring wells, and maintaining cleanup levels.

OUST also promotes the development and implementation of RBDM processes through information sharing and technical assistance. The agency has developed comprehensive guidance and directives that explain the use of risk-based approaches at UST sites and is working with EPA's regional offices and with state and local UST programs to encourage the use of RBDM in their corrective action programs. Numerous states have enacted RBDM processes or improved the operation of existing programs.

Another effort contributing to the streamlining of the cleanup process, the improvement of data collection, and reduction in the overall cost of remediation, is the promotion of expedited site assessments as part of RBDM efforts. The ESA process provides a framework for rapidly characterizing UST site conditions for corrective action decisions, including cost-effective methods for rapid collection and field analysis of soil, soil-gas, and groundwater samples. While ESA does not advocate the use of one technology over another, it emphasizes the use of technologies in a way that minimizes the time required for complete characterization and maximizes the data availability for making corrective action decisions.

Our proposed method would focus on changes in expenses due to the implementation of RBDM approaches in various states. The simple method for measuring streamlining efforts would focus on an assessment of cost savings associated with RBDM approaches based on existing studies and an assessment of changes in average costs and average duration per cleanup over time in various states. Our proposed spatial method would focus on a retrospective assessment of changes in annual expenses per "reduced risk" over time (i.e., changes in expenses per risk reduction at well contamination sites).[5]

7.3.1 *Simple Analysis of Streamlining*

Approach: We would first provide a qualitative discussion of potential cost savings associated with RBDM approaches using existing studies. In addition to this effort, we would identify a representative sample of states (i.e., states with various environmental conditions and RBDM approaches) and analyze state data for changes in average cost per cleanup and average duration per cleanup over time (including pre- and post- RBDM).

Data Sources: Studies on cost savings associated with RBDM approaches are available from a number of states, including Iowa, Texas, Florida and Utah. We would obtain information on the number of cleanups, their duration, and associated costs from state data.

Evaluation: The simple method would provide a summary of available information on potential cost savings associated with RBDM approaches and a scoping analysis of changes in costs per cleanup over time. However, because RBDM approaches target those incidents that pose the highest risk (i.e., including LUSTs requiring extensive cleanups and associated costs), an analysis of state data in terms of average costs per site might show increases of costs at this point in time. In the long run, however, we would expect overall cost reduction but at this point in time RBDM approaches may not have been implemented for long enough to reflect long-term savings. Uncertainty is also associated with cost savings due to improvements in technology efficiency, which may reduce average costs even in the absence of RBDM.

---

[5] We also note that the spatial method could be combined with multi-pathway modeling to provide new estimates of the extent of benzene plumes (see reduction in cancer risk attribute).

7.3.2 *Spatial Analysis of Streamlining*

Approach: This analysis would yield annual estimates of changes in the cost per "reduced or avoided well contamination incident" over time. Streamlining effects would be expressed as marginal changes in these costs after implementation of RBDM approaches.[6] To characterize changes in expenses per reduced or avoided well contamination event over time, we would first identify a sample of representative states with various environmental conditions and various RBDM approaches. Then, for time periods covering pre- and post- RBDM approaches, we would identify the number of LUSTs detected each year and the number and types of cleanup activities initiated each year.

To estimate the number of well contamination incidents reduced or avoided each year through cleanup activities, we would use a GIS approach (see the health risk attribute). Finally, we would identify total annual costs for cleanups for each state (including compliance costs and agency resource costs) and would calculate annual costs per avoided contamination incident. Effects would be expressed in changes in costs per reduced or avoided well contamination incident per year.

Data Sources: We describe data required for the spatial analysis of well contamination incidents and effects of cleanup activities in the section on reduction in health risk, and data required for cost estimates in the section on costs associated with the cleanup program.

Evaluation: The method would provide an example of the types of effects associated with RBDM approaches expressed as changes in costs per avoided well contamination event pre- and post-RBDM. Since RBDM approaches prioritize those LUSTs posing the highest risk, this approach would target efficiency in risk reduction rather than mere cost efficiency. However, similar to the simple approach, this method would be associated with significant uncertainty about the impacts technology improvements have on reducing costs since increases in efficiency also would decrease cleanup costs.[7] Since it is not possible to disentangle technology forcing effects from those effects measured by the streamlining attribute, this method for characterizing streamlining would provide an indicator for the types of effects associated with RBDM approaches rather than net benefits.

---

[6] The spatial analysis measures both the number of completely avoided well contamination incidents and the number of well contamination incidents reduced in duration. Therefore,"reduced well contamination incident" refers to both completely avoided incidents and well contamination incidents reduced in duration.

[7] Significant uncertainty would also be associated with the aggregation of effects from cleanup activities to estimate annual effects. Since we would attribute effects to cleanup activities initiated each year of the analysis, we would overestimate annual effects in cases where cleanup activities take longer than a year or in cases of completely avoided incidents where effects would have accrued at some point in the future.

7.4 STAKEHOLDER ISSUES

The design and implementation of EPA programs, and hence the performance of the programs, is often influenced by a variety of factors, including statutory requirements, scientific and technical considerations, and the views of various stakeholders affected by or interested in the program. In general, it seems reasonable to conclude that the performance of EPA programs with high stakeholder interest and involvement may be more affected by stakeholder views and concerns than programs with low stakeholder interest. The purpose of including a discussion of stakeholder issues in an overall methodology to evaluate the costs, benefits, and impacts of the UST cleanup program is to provide an opportunity to identify aspects of the program that stakeholders are most interested in and explain how stakeholder issues might affect the performance of the program. It is also important for any decision-maker who might want to use the results of an overall evaluation of the UST or other EPA program to understand and consider the general context of stakeholder interest in the program.

We also examine two related stakeholder attributes that describe different aspects of how well the UST cleanup program is performing. The first is whether and to what extent the public perceives value in receipt of the information that is provided by the program. The second is whether the public is satisfied with the extent of their involvement in the UST cleanup program decision processes.

Several categories of stakeholders are likely to be interested in being involved in decision making processes of the UST cleanup program, including environmental and citizen groups, and industry associations. Potential stakeholder issues associated with the UST cleanup program could be related to public health and environmental protection, efficiency of the program in addressing these issues, and potential negative economic impacts of the UST cleanup program.

The desire of stakeholders to become involved in decision making processes will depend to a large extent on the intensity of feelings associated with aspects of the cleanup program. While it is difficult to measure intensity of feeling, the degree of stakeholder involvement in existing initiatives indicates issues of concern and can be used to identify specific aspects of the cleanup program especially relevant to the public.

One example of current stakeholder involvement is the Blue Ribbon Panel EPA established to review the use of MTBE and other oxygenates in gasoline, examine the role of these compounds in meeting clean air goals, assess their behavior in the environment, and review known health effects. Parties involved in the Blue Ribbon Panel include representatives of state agencies, petroleum corporations and associations, scientists, and federal officials.

The panel agreed that the use of MTBE should be reduced substantially in order to minimize current and future threats to drinking water. Several members of the panel indicated that the use of MTBE should be phased out completely, and EPA recently announced that it is considering a phase-out of MTBE use under TSCA. Panel recommendations related specifically to remediation of contaminated sites included a proposal that EPA work with Congress to expand resources available for the funding of the treatment of drinking water supplies contaminated with MTBE and other gasoline components to ensure that affected supplies can be rapidly treated and returned to service, or that an alternative water supply be provided.[8]

Our proposed method for characterizing the stakeholder issues attribute would focus on a qualitative discussion of stakeholder issues associated with MTBE because of the high degree of public concern over MTBE contamination, and would also examine changes in stakeholder satisfaction with their involvement in the decision making process and with the amount of information provided by EPA.

Approach and Data Sources: We would first provide a general discussion of the range of stakeholder issues raised by the UST cleanup program, accompanied by a discussion specifically focusing on intensity of feelings related to MTBE. For that purpose, we would conduct interviews with state representatives to obtain information on the kinds of stakeholder issues present in the states and changes in the number or types of cleanup activities due to MTBE. We would also examine legislative indicators for intensity of feeling based on the number and types of proposed bills associated with MTBE, using the legislative calendars.

We would then characterize changes in perceived stakeholder involvement and satisfaction with the amount of available information. For this purpose, we would conduct interviews with representatives of state agencies, environmental groups, and industry to examine changes in their satisfaction with involvement in decision making processes, their use of information provided by EPA, and their views of the kind of information that is especially relevant and its accessibility.

Evaluation: The method would provide information on the types of stakeholder issues associated with the cleanup program, changes in stakeholder satisfaction over time, and their use of and satisfaction with information provided by EPA. One significant limitation of the method would be its sensitivity to the number and types of stakeholder interviewed to characterize the attribute. Also, if a broad-based survey is used, it may be necessary to first obtain OMB approval of an Information Collection Request.

---

[8] EPA, 1999. *The Blue Ribbon Panel on Oxygenates in Gasoline Executive Summary and Recommendations*. Final, July 27, 1999.

AGGREGATION OF RESULTS AND SUMMARY OF PROPOSED METHODS — CHAPTER 8

The proposed methods for characterizing each of the attributes of the UST cleanup program represent a range of analytic approaches that differ in terms of scope, resource and data requirements, and limitations. Below we discuss issues relating to the aggregation of the results of the various analyses we have outlined, and then provide a summary of the key characteristics of the approaches.

8.1 INTEGRATION OF RESULTS

To characterize the overall benefits, costs, distributional impacts, and program context attributes of the UST cleanup program, decision makers will need to integrate the results of various approaches for addressing specific attributes. To identify the most effective set of approaches for a specific analytic objective, it is important to consider the issues relating to aggregation of results. The two most important considerations are the efficiency of analysis that can be achieved by selecting a certain set of approaches, and the extent to which various attribute measures may overlap with one another.

8.1.1 *Potential for Efficiency in Designing Approaches*

Analytical efficiency is an important consideration in developing an approach to assessing the total costs and benefits of the UST program. Although our proposed approaches are designed to address individual attributes and are presented individually in this report, there are opportunities for maximizing the efficiency of an overall analysis by adopting certain approaches. The most important of these are:

- **Implementing an initial screening-level analysis:** While we have presented a potential "simple approach" to address general benefits of the UST cleanup program for all attributes, an abbreviated version of this approach could also be used as an initial analysis to establish the scope of potential benefits before identifying an appropriate level of effort for a full-scale analysis. By limiting the number of attributes addressed, EPA could establish an initial low end estimate of potential benefits of the program without expending considerable resources, either by performing the simple analysis or by identifying a preliminary estimate of potential property value benefits. Depending on the results of the scoping analysis, EPA could either extend the simple approach to address additional attributes and aggregate these results with the initial analysis, or develop a separate estimate of benefits, costs, and impacts using a more detailed set of methodologies. The implementation of an initial scoping analysis is a low cost method of determining the appropriate level of analysis for a final estimate of the programs benefits and costs.

- **Implementing multiple analyses that use spatial data and approaches:** The most resource intensive aspect of a spatial approach to measuring attributes is the initial collection of the data locating existing and potential UST sites with contamination and endangered wells.[9] Additional data that describe the environmental and population characteristics surrounding these sites is more readily available and can often support multiple analyses (e.g., census data can be used to identify drinking well density and potential environmental equity issues). As a result, an approach using spatial analysis can be designed to address certain additional attributes without demanding significant additional resources.

8.1.2 *Double Counting of Benefits, Costs, and Distributional Impacts*

One step in aggregating the results of analyses for different attributes would be to address potential double counting of benefits, costs, or distributional impacts that could occur through implementation of the full suite of approaches.

8.1.3 *Human Health and Avoided Cost of Providing Alternative Water Supplies*

The human health and avoided cost attributes both measure groundwater use values, since households taking averting actions should reduce their risk of exposure to contaminants. Therefore, when measuring this it is important to identify when averting behavior would begin and adjust the exposure levels accordingly.

---

[9] New sources of spatial data (e.g., new efforts by EPA and states to map UST and LUST locations) as well as commercial data sources (e.g., Starview real estate data), may reduce the level of effort needed to collect this information. However, commercial data may be expensive.

8.1.4 *Property Value Benefits*

Property value changes associated with proximity to a LUST site may reflect property owners' evaluations of multiple characteristics, including human health risk (from contaminated wells as well as acute incidents), ecological damage, cost of alternative water supplies, and economic effects such as changes in employment opportunities. However, the extent to which property values accurately capture these attributes (and therefore the extent of overlap) is uncertain. For example, property value benefits may not entirely account for human health risk in cases where property buyers are not fully informed about contamination or true health risk associated with a site. Alternatively, property value effects may exceed the total value of other benefits in cases where perceived contamination and risk exceeds actual levels. Because of both the potential overlap and the uncertainty associated with property value benefits, we suggest using this attribute as a general alternative method for calculating a set of benefits, and do not recommend "adding it" to other attributes.

8.1.5 *Total Groundwater Use and Non-Use Value*

The groundwater use and non-use value attribute based on existing CV surveys would provide a comprehensive estimate of values associated with the current use of groundwater as well as with option and existence values. However, there is not yet a suitable method available for separately evaluating use and non-use values for groundwater based on existing CV surveys. As a result, the values derived from our proposed methodology for this attribute would provide an upper bound on total values that includes human health benefits, avoided costs, and ecological benefits. In addition, since the attribute comprises option and existence values in addition to use values, it would also overlap with long-term benefits.

Since CV estimates are associated with high degrees of uncertainty, we recommend using this attribute as an indicator of total groundwater value but do not recommend "adding benefits" to other attributes. CV estimates in combination with human health benefits, avoided costs, and ecological benefits could also be used as an alternative to separate characterizations of long-term benefits, since CV estimates capture perceived sustainability benefits associated with clean groundwater. This approach, however, would only indicate total values and would not provide information on the portion of these benefits potentially attributable to long-term benefits.

8.1.6 *Streamlining of the Cleanup Process and Encouraging Alternative Technologies*

The streamlining attribute is a comprehensive measurement for the general 'efficiency' of the cleanup process, in terms of risk reduction and reduction in costs. Since this attribute will be affected by the development and application of alternative technologies, it may overlap with the technology forcing attribute. To address this issue, we suggest including our proposed qualitative discussion of technology forcing factors in a section on potential effects that technology improvements would have on the streamlining attribute.

8.1.7 *Stakeholder Issues and Long-Term Benefits*

The stakeholder issues attribute would characterize strong feelings associated with MTBE. Since this attribute would to some extent describe 'dread' due to perceived risk associated with MTBE contamination, it may overlap with effects measured in the long-term benefits attributes. To address this issue, we suggest including a discussion of potential extent of double-counting in the both the stakeholder issues and the long-term benefits attributes.

8.2 SUMMARY OF THE APPROACHES

Exhibit 8-1 summarizes the scope of our approaches for measuring program benefits and Exhibits 8-2 and 8-3 provide an overview of the scope of our methods for characterizing costs, distributional impacts, and program context attributes.

Exhibit 8-1

SCOPE OF PROPOSED METHODS FOR MEASURING BENEFITS

Attribute Category	Attribute	Simple Benefits Analysis	Spatial Analysis or Alternative Approach[10]	Spatial Analysis/ Pathway Modeling
Human Health Benefits	Reduction In Cancer Risk	Quantitative estimate of reduced population risk and reduced number of individuals exposed to high-end risk.	Quantitative estimate of reduced population risk and reduced number of individuals exposed to high-end risks. New estimates of high-end risks.	
Ecological Benefits	Reduction in Surface Water Contamination	Quantitative estimate of reduced surface water contamination incidents.	Quantitative estimate of reduced surface water contamination incidents and potentially reduced ecological risk.	Quantitative estimate of reduced ecological risk.
	Total Groundwater Use and Non-Use Values	Quantitative estimate of use and non-use values associated with clean groundwater based on existing CV studies.		
Avoided Costs	Provision of Alternative Water Supplies	Quantitative estimate of avoided costs of providing alternative water supplies.		
	Reduced Fire and Explosion Incidents and Vapor Damages	Quantitative estimate of reduced number of incidents and avoided costs.	Quantitative estimate of reduced number of incidents, avoided costs, and potentially reduced number of people threatened by incidents.	
Property Value Benefits	Property Value Benefits	Quantitative estimate of property value benefits.		
Long-term Benefits	Benefits from Avoided Continuation of Damages	None.	Qualitative description and projection of benefits over long time horizons.	
	Benefits from Avoided Increase in Damages	None.	Qualitative description of benefits and analysis of sensitivity to future population growth.	
	Benefits from Future Increase in Risk Aversion	Qualitative characterization of changes in acceptable risk and resource valuation over time.		
	Benefits from Avoiding Occurrence of Unforseen Events	None.	Qualitative discussion and quantitative estimate of long-term avoided costs associated with reduced MTBE contamination.	

[10] Spatial analyses apply to attributes with spatial characteristics. We also include in this column more detailed non-spatial approaches for relevant attributes.

Exhibit 8-2

SCOPE OF PROPOSED METHODS FOR MEASURING COSTS AND DISTRIBUTIONAL IMPACTS

Attribute Category	Attribute	Simple Analysis	Spatial Analysis or Alternative Approach[11]	Spatial Analysis/ Pathway Modeling
Costs	Compliance and Government Sector Regulatory Costs	Quantitative estimate of total compliance costs and agency resource costs.		
Long-term Costs	Failure to Benefit From Future Decreases in Cleanup Costs	Qualitative description of potential increases in overall costs due to currently not available technologies.		
	Failure to Invest In More Productive Economic Activities	Qualitative description of long-term costs associated with forgone investments.		
Distributional Impacts	Environmental Justice Impacts	None.	Correlation of the number of LUSTs and income and ethnicity of potentially affected households.	
	Risk Tradeoffs	Qualitative discussion of the types of worker accidents associated with tanks (underground and aboveground) and the number of fatal and non-fatal incidents.	Quantification of worker accidents risk associated with various cleanup technologies.	
	Employment and Economic Growth Effects	Quantitative estimate of the number of local jobs created and/or supported by cleanup activities and quantitative estimate of the number of facility closures and associated job losses.		
	Promotion of Brownfield Redevelopment and Conservation of Greenspace	Quantitative estimate of the number of LUST sites that are being redeveloped. Qualitative discussion of potential distributional effects associated with redevelopment.		
Long-term Distributional Impacts	Intergenerational Equity	Qualitative description of potential positive and negative intergenerational equity impacts.		

[11] Spatial analyses apply to attributes with spatial characteristics. We also include in this column more detailed non-spatial approaches for relevant attributes.

<table>
<tr><th colspan="5">Exhibit 8-3

SCOPE OF PROPOSED METHODS FOR MEASURING
ADDITIONAL PROGRAM - RELATED ATTRIBUTES</th></tr>
<tr><th>Attribute Category</th><th>Attribute</th><th>Simple Analysis</th><th>Spatial Analysis or Alternative Approach [12]</th><th>Spatial Analysis / Pathway Modeling</th></tr>
<tr><td rowspan="3">Additional Program - related Attributes</td><td>"Streamlining of the Cleanup Process"</td><td>Summary of available information on cost savings associated with RBDM approaches and examination of changes in cost per cleanup and duration of cleanups.</td><td colspan="2">Quantitative estimate of changes in expenses per reduced well contamination incident.</td></tr>
<tr><td>Encouragement of Alternative Technologies And Better Tanks</td><td colspan="3">Qualitative discussion of changes in technology and associated changes in costs and duration of cleanup efforts.</td></tr>
<tr><td>Stakeholder Issues</td><td colspan="3">Qualitative discussion of stakeholder issues associated the program with a specific focus on strong feelings involving MTBE and qualitative discussion of changes in stakeholder satisfaction with involvement in the decision making process and with available information.</td></tr>
</table>

While all proposed approaches would provide plausible characterizations of risk, benefits, or costs associated with specific program attributes, the methods differ in terms of resource and data requirements, and limitations. One significant limitation of the proposed approaches is associated with attributes for which no or only very limited quantitative measurements are available. These attributes include promotion of brownfield redevelopment, promotion of alternative technologies, and stakeholder issues. For many of the attributes, however, we propose simple, spatial, and/or spatial analyses with multi-pathway modeling. Below we summarize key characteristics of these approaches including resource and data requirements, flexibility, and limitations.

8.2.1 *Data Needs*

Exhibit 8-4 summarizes the types of data needed for the simple benefits analysis, the spatial analysis and the spatial analysis with pathway modeling. Since it would be possible to augment the simple benefits analyses using state data, Exhibit 8-4 also provides information on the types of state data that we could employ in the simple benefits analysis. Spatial analyses for all attributes would use information obtained for the measurement of reduction in human health risk. We therefore present all data needs for measuring reduction in health risk but only data needed in addition to these

---

[12] Spatial analyses apply to attributes with spatial characteristics. We also include in this column more detailed non-spatial approaches for relevant attributes.

data to characterize other attributes.[13] Note that for certain analyses the "simple benefits approach" is not currently possible due to a lack of available data (e.g., there is no current national level estimate of MTBE contamination). However, new or expanded national and state data may emerge that could provide additional information to support either a simple analysis or an analysis based on state data.

Exhibit 8-4

COMPARISON OF DATA NEEDS FOR MEASURING ATTRIBUTES WITH SPATIAL CHARACTERISTICS

Data Type	Simple Benefits Analysis (Using Only 1988 RIA Data)	Simple Benefits Analysis (Using Only State Data)	Spatial Analysis	Spatial Analysis / Pathway Modeling
Reduction in Cancer Risk				
Total Number of LUSTs	✔	✔	✔	✔
Cancer Risk Estimates (1988 RIA)	✔	-	-	-
Past Mix of Upgraded and Substandard Tanks	✔	-	-	-
Number Cleanups (State Data)	-	✔	✔	✔
Frequency of Well Contamination Incidents (State Data)	-	✔	✔	-
Concentration of Benzene in Drinking Water Wells (State Data)	-	✔	(✔)[14]	(✔)
Location of USTs	-	-	✔	✔
Location of Private Wells	-	-	✔	✔
Location of Public Drinking Water Sources	-	-	✔	✔

[13] We do not present data needs for estimating long-term benefits in case of continuation of damages since the analysis would require no data in addition to those for the reduction in cancer risk estimate.

[14] For the spatial analyses and the spatial analyses with pathway modeling, state data on the concentration of contaminants in drinking water wells may not be necessary since we could base our estimates on the typical benzene gradients found in groundwater plumes assuming an even distribution of wells within the impact radii of benzene plumes.

Exhibit 8-4 COMPARISON OF DATA NEEDS FOR MEASURING ATTRIBUTES WITH SPATIAL CHARACTERISTICS				
Data Type	**Simple Benefits Analysis (Using Only 1988 RIA Data)**	**Simple Benefits Analysis (Using Only State Data)**	**Spatial Analysis**	**Spatial Analysis / Pathway Modeling**
Number of People Exposed to Contamination Based on Census Data	-	-[15]	✔	✔
Digital Maps of Local Environmental Conditions	-	-	-	✔
Source Mass	-	-	-	✔
Soil-Groundwater Pathway and Groundwater Transportation Pathway Model	-	-	-	✔
Future Tank Failure Rates of Upgraded Tanks	✔	✔	✔	✔
Future Mix of Upgraded and Substandard Tanks	-	✔	✔	✔
Number of Detected But Not Yet Cleaned Up LUSTs and Number of Not Yet Detected LUSTs	-	✔	✔	✔
Reduction in Contaminated Surface Waters				
Frequency of LUSTs Leading to Surface Water Contamination	✔	✔	✔	-
Digital Maps of Surface Water Locations	-	-	✔	✔
Concentration of Contaminants in Surface Waters and Duration of Exposure	-	(✔)[16]	(✔)	-
Groundwater -Surface Water Pathway Model	-	-	-	✔
Provision of Alternative Water Supplies				
Literature Estimates on Costs for Alternative Water Supplies or Replacement of Public Wells	✔	✔	✔	✔
Average Duration of Groundwater Cleanups	✔	✔	-	-
Time of Leak Detection	-	-	✔	✔
Time of Initiation of Cleanup Efforts	-	-	✔	✔

[15] The simple benefits analyses would assume one household per contaminated well.

[16] This information would be necessary to estimate ecological risks. In absence of this information the endpoint of the spatial analyses would be reduced surface water contamination.

Exhibit 8-4 COMPARISON OF DATA NEEDS FOR MEASURING ATTRIBUTES WITH SPATIAL CHARACTERISTICS				
Data Type	**Simple Benefits Analysis (Using Only 1988 RIA Data)**	**Simple Benefits Analysis (Using Only State Data)**	**Spatial Analysis**	**Spatial Analysis / Pathway Modeling**
Time of Completion of Cleanup Efforts	-	-	✔	✔
Property Value Benefits				
Literature Estimates on Reduction in Property Values Due to Contamination.	✔	✔	✔	✔
Median U.S. Property Values	✔	-	-	-
Geographic Information on Property Values Based on Census Data	-	-	✔	✔
Long-term Benefits (In Case of Increase in Damages)				
Population Growth Estimates	-	-	✔	✔
Long-Benefits (Protection Against Unforseen Events)				
Number of Tanks Containing MTBE	-	-	✔	✔
Extent of MTBE Plumes	-	-	✔	✔
Effect of Cleanup Activities On Reducing MTBE	-	-	✔	✔
MTBE Pathway Model	-	-	✔	✔
Environmental Justice Impacts				
Geographic Information on Ethnicity and Income Based on Census Data	-	-	✔	✔
"Streamlining of the cleanup process"				
Changes in Costs of Cleanups Over Time	✔	✔	✔	✔

8.2.2 *Key Characteristics and Uncertainties*

Simple Benefits Analyses: These analyses would require minimal resources and limited data in addition to the data available from the 1988 RIA. Using 1988 RIA data would, however, be associated with significant uncertainties. The analyses would provide only rough estimates of retrospective and prospective benefits, since the simple methods assume detection and immediate and complete cleanup of all LUSTs, and would not account for potential benefits associated with completely avoided incidents (i.e., because federal and state records do not appear to routinely track avoided damage). Additional significant uncertainties would include assumptions about the mix of substandard and upgraded tanks and the use of potentially biased data such as the pre-UST cleanup program frequency for LUST-induced fires and explosions. To address uncertainty associated with the mix of substandard and upgraded tanks, we could employ sensitivity tests using a range of tank combinations.

We could augment the simple benefits analyses by using empirical data from the states (see Exhibit 8-3). Using state data would not require assuming immediate and complete cleanup of LUSTs and may allow us to provide new cancer risk estimates based on empirical data. Obtaining and employing these data, however, would increase the level of effort required to conduct the analyses and would introduce uncertainties about data quality, comparability, and representativeness. As is the case for the simple analyses using only 1988 RIA data, using state data would not allow us to account for incidents completely avoided through cleanup activities. Augmented simple benefits analyses would also be sensitive to a potential under-reporting of well or surface water contamination incidents.

The simple analysis would provide total retrospective and prospective estimates of value for reduced human health effects and avoided costs. These estimates could be linked to the number of cleanups completed and would provide a "per cleanup" estimate of benefits that would be useful in evaluating the GPRA goal of completing 370,000 cleanups by 2005. Simple estimates of additional benefits attributed (e.g., ecological benefits) could also be characterized or quantified on a "per cleanup" basis to support an analysis of GPRA-related goals.

Spatial Analyses: These analyses would provide more defensible low and high end estimates of benefits, and would address uncertainties by providing new estimates of damages in the base case resulting from the proximity of USTs to sensitive resources. The spatial methods would take into account the number and types of cleanup activities undertaken in the states and would account for incidents completely avoided through cleanup activities. Another advantage of this method is that it provides prospective benefits estimates based on past compliance rates in addition to benefits estimates assuming full compliance. Significant uncertainties associated with the use of empirical and stabilized groundwater plume sizes and the effect of cleanup activities could be characterized through sensitivity tests, which would compare results using a range of plume sizes. The analysis would, however, assume that plumes and wells occur at similar depths. In this way, it would overstate potential benefits in situations where wells are at different depths than plumes and would therefore be unaffected by releases.

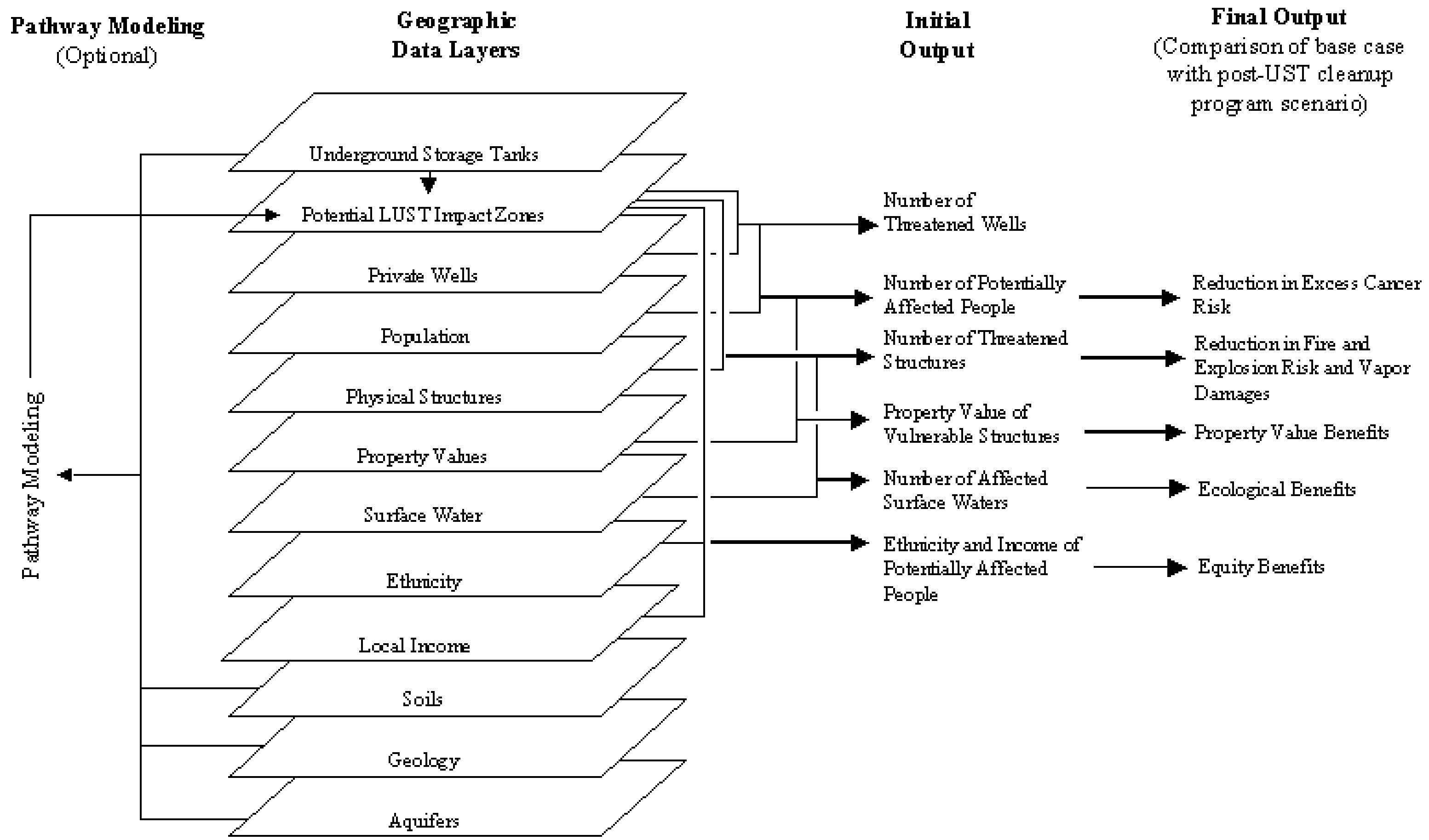
While the spatial analyses would require the effort (and cost) related to obtaining significant amounts of data from the states, acquiring digital maps, and establishing a GIS model, it would provide a basis for measuring a variety of attributes by adding additional layers of information. For example, digital maps of UST locations could be combined with spatial well density data to measure threats to drinking water sources as well as with spatial property value data to measure property value benefits (see Exhibit 8-3). GIS approaches are also flexible with respect to changes in approaches. For example, it is possible to update the model in case new data become available or to adapt the model to address additional aspects such as benefits associated with public wells or new GPRA considerations.

The spatial approach estimates of the value or quantitative extent of benefits for specific attributes in both the retrospective and prospective analysis; these estimates could be used to support an analysis of the benefits associated with OUST's GPRA goals.

Regarding the option of using the property value approach as the sole approach to calculating a set of benefits, it is important to note that it would not be possible in that case to provide separate estimates of the human health, ecological, and the other benefits encompassed in that approach for the UST cleanup program. The property value approach does not generate a description of the actual "environmental outcomes" of an environmental program; it provides only a dollar value estimate of its benefits. Property value-based estimates of total benefits would therefore not support a meaningful discussion of the specific benefits related to OUST's GPRA goals.

Pathway Modeling: For some attributes, we propose pathway modeling in addition to the spatial analysis, which would further address uncertainties associated with the use of empirical plume sizes and the effect of cleanup activities. While this approach would require substantial data and resources, modeling results obtained for the purpose of measuring one attribute could be applied in the GIS to measure a variety of attributes. Exhibit 8-5 illustrates the use of multi-pathway modeling in the GIS approach.

Exhibit 8-5
COMBINATION OF DIGITAL MAPS TO MEASURE VARIOUS ATTRIBUTES



BIBLIOGRAPHY

Abdalla, C. W., 1990. "Measuring the Economic Losses from Groundwater Contamination: An Investigation of Household Avoidance Costs." *Water Resources Bulletin* 26(3):451-463.

Abdalla, C.W., B.A. Roach, D.J. Epp., 1992. "Valuing Environmental Quality Changes Using Averting Expenditures: An Application to Groundwater Contamination." *Land Economics* 68(2): 163-169.

Belpoggi et al., 1997. "Results of Long-Term Experimental Studies on the Carcinogenicity of Methyl Tertiary-Butyl Ether." *Annals N.Y. Academy of Science*, 837, pp 77-95, December 26, 1997

BLS, 1998. *Fatal Workplace Injuries in 1996: A Collection of Data and Analysis.* U.S. Department of Labor, Bureau of Labor Statistics, June 1998.

Burleigh-Flayer, H. et al., 1992. "Methyl Tertiary-Butyl Ether: Vapor Inhalation Oncogenicity Study in C-1 Mice." *Bushy Run Research Center Report* No. 91N0013A, EPA/OPTS#42098, October 15, 1992.

Chun J. et al., 1992. "Methyl Tertiary Ether: Vapor Inhalation Oncogenicity Study in Fisher 344 Rats." *Bushy Run Research Center Report* No. 91N0013B, EPA/OPTS#42098, November 13, 1992.

Edwards, S.F., 1988. "Option Prices For Groundwater Protection" *J. Environ. Econ. and Management* 15:465-487.

EPA, 1986. *Analysis of the National Database of UST Incidents.*

EPA, 1988. *Regulatory Impact Analysis of Technical Standards For Underground Storage Tanks*. Office of Underground Storage Tanks. August 24, 1988.

EPA, 1996 *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers*. (EPA 510-B-94-003). September 1996.

EPA, 1996. *UST Program Facts: Implementing Federal Requirements for Underground Storage Tanks*. EPA 510-B-96-011, December 1996.

EPA, 1999. *Guidelines for Preparing Economic Analysis.* Review Draft. June 1999.

EPA, 1999. *The Blue Ribbon Panel on Oxygenates in Gasoline Executive Summary and Recommendations*. Final, July 27, 1999.

EPA, 2000. *Control of MTBE in Gasoline*. EPA420-F-00-010, March 2000.

Foster Wheeler Environmental Corporation, 1997. *Final Technical Memorandum: Preliminary Selection of Candidate Petroleum Hydrocarbons as Surrogates for Ecological Risk Revaluation of TPH*. Brownfields/TPH Project. Phase 2, Task 4, Subtask 4.2.1. August 22, 1997.

Happel, M., E. Beckenbach, and R. Halden, 1998. *Evaluation of MTBE Impacts to California Groundwater Resources*. Environmental Protection Department, Environmental Restoration Division, July, 1998.

Happel, A., B. Dooher, and E. Beckenbach, 1999*. Methyl Tertiary Butyl Ether (MTBE) Impacts to California Groundwater*. USEPA Blue Ribbon Panel Presentation, March 25, 1999.

Hoskin, A.F., J.P. Leigh, and T.W. Planek, 1994. "Estimated Risk of Occupational Fatalities Associated With Hazardous Waste Site Remediation." *Risk Analysis* 14(6):1011-1017.

Johnson, R., J. Pankow, D. Bender, C. Price, and J. Zogorski. "MTBE: To What Extent Will Past Releases Contaminate Community Water Supply Wells?" *Environmental Science and Technology,* Vol. 34, No. 9, May 1, 2000, pp. 210A-217A.

Klaassen, G.A.J. and Opschoor, J.B., 1991. Economics of Sustainability or the Sustainability of Economics: Different Paradigms. *Ecological Economics* 4:93-115.

Leigh, J.P., 1995. *Causes of Death in the Workplace*. Quorum Books, Westport, CT.

Mace, R.E., R.S. Fisher, D.M. Welch, and S.P. Parra, 1997. *Extent, Mass, And Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites In Texas*. Bureau of Economic Geology, University of Texas at Austin.

McClelland, G.H., et al, 1993. *Methods for Measuring Non-Use Values: A Contingent Valuation Study of Groundwater Cleanup*. Final Report, U.S.EPA, Office of Policy.

National Science and Technology Council. Committee on Environment and Natural Resources, 1997. *Interagency Assessment of Oxygenated Fuel*. June 1997.

Powell, J.R., D.J.Allee, and C. McClintok, 1994. 'Groundwater Protection Benefits and Local Community Planning: Impact of Contingent Valuation Information.' *Amer. J. of Agricultural. Economics* 76:1068-1075.

Rice, D.W., R.D. Grose, J.C. Michaelsen, B.P. Dooher, D.H. MacQueen, S.J. Cullen, W.E. Kastenberg, L.G., Everett, and M.A. Marino, 1995. *California Leaking Underground Fuel*

Tank (LUFT) Historical Case Analysis. Environmental Protection Department, Environmental Restoration Division, November, 1995.

Simons, R.A. W.M. Bowen, and A. Sementelli, 1997. *The Price and Liquidity Effects of UST Leaks From Gas Stations on Adjacent Contaminated Residential and Commercial Properties*. September 23, 1997. Unpublished report.

State Water Resources Control Board, 1997. *Policy for Investigation and Cleanup of Petroleum Discharges to Soil and Groundwater*. Draft. California, 1997.

APPENDIX A

USE OF EMPIRICAL GROUNDWATER PLUMES IN THE GIS ANALYSIS

Research has shown that benzene groundwater plumes may stabilize (i.e., cease to grow) after a certain period of time (Mace et al., 1997; Rice et al., 1995). While the time needed for plumes to stabilize is not known, sizes of stabilized plumes may be predictable. Furthermore, with the exception of limestone areas and cases in which plumes enter underground utility lines, the extent of stabilized plumes may be similar in a variety of geological settings.

In our proposed spatial analyses, we would use existing empirical information on typical groundwater benzene plumes in order to determine spatial entities (e.g., wells, surface waters) potentially threatened by LUST incidents. This would be done by superimposing circular benzene plumes (using information on the typical extent of groundwater plumes) on USTs to define their potential impact radii. Groundwater plumes, however, typically have shapes more similar to ellipses than circles with the longer axis of the ellipses pointing into the direction of the groundwater flow (see Exhibit A-2 below) . In the absence of information on groundwater flow direction, we propose to use circles as approximations of the true shape of groundwater plumes.

To address uncertainties associated with using empirical information on stabilized benzene plumes in various geological settings and to account for more realistic elliptical plume shapes, we could employ the following methods:

9 A sensitivity analysis to characterize the effects variations in plume sizes have on the analyses;

10 adjustments to account for larger plumes in calcareous settings; and

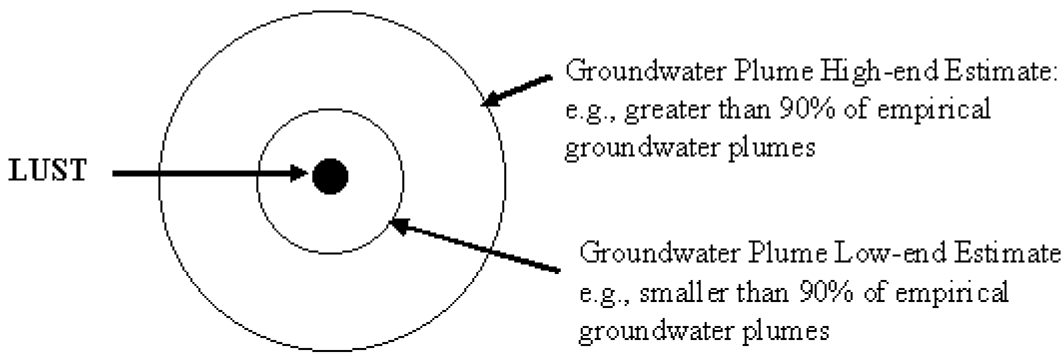
11 adjustments to account for more realistic elliptical shapes.

We describe these adjustments in more detail below:

Sensitivity Analysis: A sensitivity analysis to characterize uncertainty associated with variations in plume sizes would involve determining a range of plume lengths (based on literature data) and superimposing high and low-end estimates of plume lengths on USTs using the GIS (see Exhibit A-1).

Unusually Large Plumes: Adjustments to account for unusually large plumes in calcareous areas could focus on identifying limestone areas using geological maps and applying empirical information on the extent of groundwater plumes in limestone areas available from the literature.

Exhibit A-1
RANGE OF PLUME SIZES FOR THE SPATIAL ANALYSES



Shape of Plumes: We would adjust our estimates derived from circular plume shapes to account for the smaller areas covered by elliptical shapes using the percentage of the area that would be covered by elliptical shapes (see Exhibit A-2).

Exhibit A-2
SCALING CIRCULAR PLUME SHAPES TO ELLIPTICAL PLUMES SHAPES