Chapter 8 Risk Reduction Options

Table of Contents

8.0 Introduction

This chapter discusses the process of managing the risks identified in a multisource cumulative assessment (see Exhibit 8-1). This chapter draws on and augments the discussion in ATRA Volume 1, Chapter 27, by providing additional information pertinent to communities assessing and responding to the cumulative impact of numerous sources of air toxics. Risk managers and others with a stake in the risk management process are referred to the ATRA Volume 1 chapter for more information on this subject..

8.1 Role of Risk Management in Multisource Cumulative Assessment

The multisource cumulative assessment will result in a risk characterization that describes the cumulative risk posed by sources in a study area to populations in the study area. The risk managers will have to decide whether the risks are acceptably low or whether risk reduction options should be considered.

In order to help the risk managers with this task, the risk characterization will commonly provide a source apportionment of the risks to identify the percentage that each chemical/source combination contributes to the overall risk. These data, along with other relevant information such as technological feasibility and cost (see Exhibit 8-2) of risk reduction alternatives, are then factored into decisions about how to reduce risk to the exposed populations.

This relationship between risk assessment and risk management has been discussed by a variety of people and institutions. In addition to Exhibit 8-2, another helpful approach to understanding the interplay of risk assessment and risk management is that described by the Presidential/Congressional Commission on Risk Assessment and Risk Management (CRARM) in their Reports *Framework for Environmental Health Risk Management* and *Risk Assessment and Risk Management In Regulatory Decision-Making* (the two-volume "White Book").[(1)] The Commission developed a six-stage integrated framework for environmental health risk management that can be applied to most situations (Exhibit 8-3):

- Define the problem and put it in context;
- Analyze the risks associated with the problem in context;
- Examine options for addressing the risks;
- Make decisions about which options to implement;
- Take actions to implement the decisions; and
- Conduct an evaluation of the action's results.

The Commission noted that the process of examining risk management options does not have to wait until the risk analysis is completed, although a risk analysis often will provide important information for identifying and evaluating risk management options. In some cases, examining risk management options may help refine a risk analysis. The Commission also recommended that all of these steps involve stakeholders (see ATRA Volume 1, Chapter 28).

Exhibit 8-1. The General Multisource Cumulative Assessment Process For Community Assessment – Focus on Risk Management

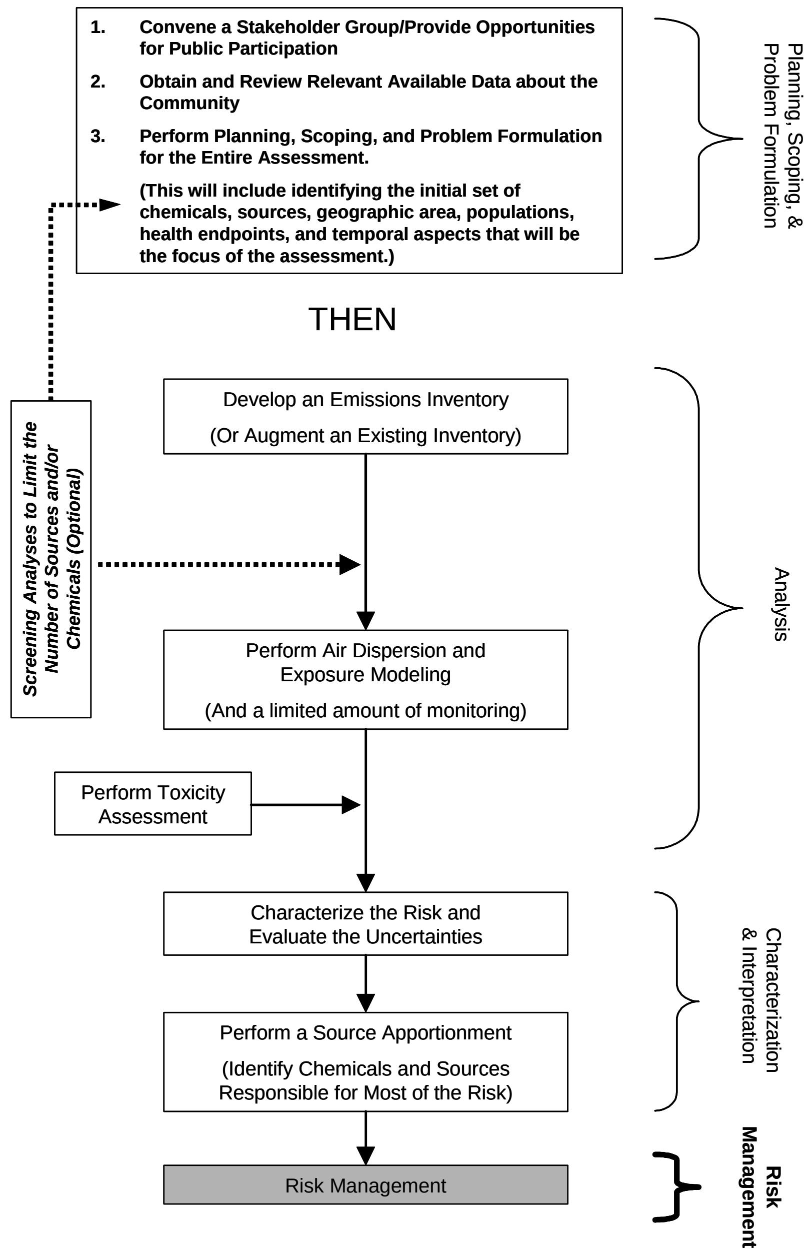


Exhibit 8-2. Illustration of the Relationship Between Risk Assessment and Risk Management(2)

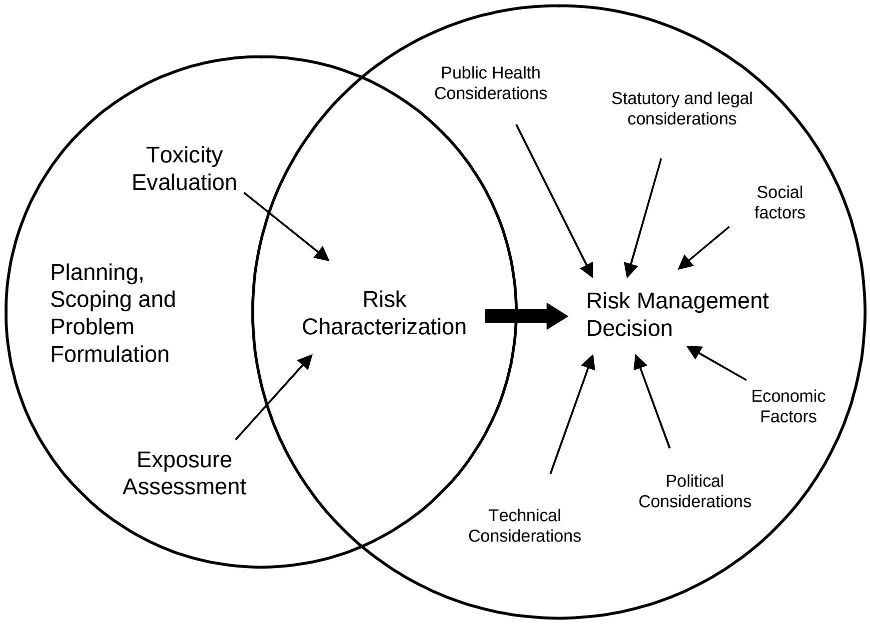
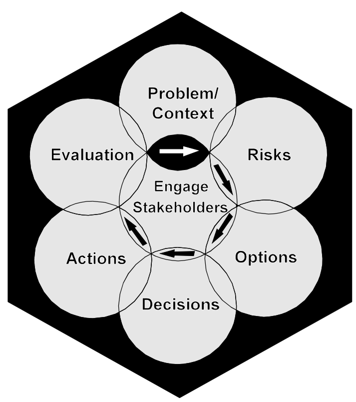


Exhibit 8-3. The CRARM Framework for Risk Management



Other than defining the problem and putting it in context and then analyzing the risks, the remainder of the steps identified by the CRARM constitute the risk management phase. (Note that the risk assessment/risk management framework outlined by the CRARM in Exhibit 8-3 is drawn as a circle, indicating that as stakeholders learn more and as things change in the study area, the process may need to go through a continual set of iterations to achieve and maintain a healthy environment.)

8.2 The Role of Risk Estimates in Decision-Making

Decision-makers have a number of options when deciding what types of risk estimates to consider as inputs to risk management decisions. Estimates of human health risk generally fall into two categories, estimated **cancer risk** and the estimated **noncancer hazard** magnitude of exposure concentration or dietary intake greater than a pre-established reference exposure level), as described in more detail in ATRA Volume 1, Chapters 13 and 22. Non-cancer hazard may be considered for both acute (short-term) and chronic (longer-term) exposures. In some cases, **ecological risk** may be a factor in decision-making.

In some situations, risk managers may choose to consider EPA's approach for assessing an "ample margin of safety." For cancer risks, EPA generally considers incremental risk (or probability) of cancer for an individual potentially exposed to one or more air toxics. In protecting public health with an ample margin of safety, EPA strives to provide maximum feasible protection against risks to health from HAPs by (1) protecting the greatest number of persons possible to an individual lifetime risk level no higher than 1×10^{-6} (one in one million) and (2) limiting to no higher than approximately 1×10^{-4} (one in ten thousand) the estimated risk that a person living near a source would have if exposed to the maximum pollutant concentrations for 70 years. These goals are described in the preamble to the benzene National Emissions Standards for Hazardous Air Pollutants (NESHAP) rulemaking (54 *Federal Register* 38044, September 14, 1989) and are the goals incorporated by Congress for EPA's residual risk program under Clean Air Act (CAA) section 112(f). Exhibit 8-4 describes some of the key steps in the development of the 1×10^{-4} to 1×10^{-6} carcinogenic risk range.

For non-carcinogenic substances, on the other hand, risk managers may consider a reference level that is developed based on data from laboratory animal or human epidemiology studies (see ATRA Volume 1, Chapter 12), and to which uncertainty factors are applied. The reference level is usually an exposure level below which there are not likely to be any adverse effects from exposure to the chemical. Exposures above the reference level may have some potential for causing adverse effects. This concept may also be applied generally to ecological risks.

Risk estimate options generally revolve around estimates of individual risk, the number of people at different risk levels (population risk), and occasionally include the expected incidence of disease in the entire population. Risk estimates can be derived for the current population as currently distributed in an area or for a population size and geographic distribution that might occur in the future; similarly, they may focus on risk estimates for persons currently exposed or possible risks calculated for a hypothetical individual located where exposures are expected to be relatively high. It is important to note that risk estimates should strive to take into account both **indoor** and **outdoor** exposure to toxics, when possible.

Exhibit 8-4. Development of the 10^{-4} to 10^{-6} Carcinogenic Risk Range

The 1970 CAA established Section 112 to deal with hazardous air pollutants. Once the EPA Administrator had identified such a pollutant and "listed" it, he/she was directed to set emission standards for sources emitting it at levels that would "provide an ample margin of safety to protect the public health." The regulation of benzene pursuant to Section 112 illustrates the evolution of risk-based decision-making for carcinogens and the consideration of the "ample margin of safety."

- EPA listed benzene as a HAP in June 1977 and indicated that the "relative risk to the public" would be considered in judging "the degree of control which can and should be required."
- In 1980, the first round of benzene standards followed the proposed procedures in EPA's 1979 draft airborne carcinogen policy, which reflected a technology-based approach to emission standard development with a limited role for quantitative risk assessment in establishing priorities and ensuring that the residual risks following the application of "best available technology" (BAT) were not unreasonable.
- In 1984, after "weighing all factors," EPA made several changes to the proposed benzene rules, arguing that the risks were "too small to warrant federal regulatory action." These decisions were promptly challenged by the Natural Resources Defense Council, who argued about the uncertainties in the risk estimates and the inappropriate consideration of cost in regulatory decisions made under Section 112. The issues raised were similar to litigation already pending on amendments to the original vinyl chloride standards.
- On July 28, 1987, Judge Robert Bork, writing for the D.C. Circuit Court of Appeals, remanded the vinyl chloride amendments to EPA, finding that the Agency had placed too great an emphasis on technical feasibility and cost rather than the provision of an "ample margin of safety" as required by the statute. The opinion also laid out a process for making decisions, consistent with the requirements of the law. The Bork opinion held that EPA must first determine a "safe" or "acceptable" level considering only the potential health impacts of the pollutant. Once an acceptable level was identified, the level could be reduced further, as appropriate and in consideration of other factors, including cost and technical feasibility to provide the required ample margin of safety. The Court also held, however, that "safe" did not require a finding of "risk-free" and that EPA should recognize that activities such as "driving a car or breathing city air" may not be considered "unsafe."
- In September of 1989, after proposing several options and receiving considerable public comment, EPA promulgated emission standards for several categories of benzene sources. EPA argued for the consideration of all relevant health information and established "presumptive benchmarks" for risks that would be deemed "acceptable." The goal, which came to be known as the "fuzzy bright line," is to protect the greatest number of persons possible to an individual lifetime risk no higher than one in 1,000,000 and to limit to no higher than approximately one in 10,000 the estimated maximum individual risk. The selection of even "fuzzy" risk targets placed greater emphasis on the development and communication of risk characterization results.

Source: National Academy of Sciences' *Science and Judgment in Risk Assessment* (The Blue Book).(2)

As introduced in the last chapter, risk managers will often be interested in several different descriptions of risk when evaluating the need for risk reduction. To reiterate, these "risk descriptors" commonly include:

- **Risk to a specified individual**. Most risk assessments focus on estimating individual risk rather than the incidence of adverse effects (e.g., numbers of predicted cancer cases per year) in a population. There are two general estimates of individual risk:

  – **High-end** risk estimates seek to determine a "plausible worst case" situation among all of the individual risks in the population. This estimate is meant to describe an individual who, as a result of where they live and what they do, experiences the highest level of exposure within some reasonable bounds. Reasonable maximum risk estimates are often defined conceptually as "above the 90th percentile of the population"(3) but not at a higher exposure level than the person exposed at the highest level in the population. When calculated using deterministic methods, the high-end individual is calculated by combining upper-bound and mid-range exposure factors (e.g., an average body weight, but high-end ingestion rate) so that the result represents an exposure scenario that is both protective and reasonable, but not higher than the worst possible case.

  – **Central-tendency** risk estimates seek to determine a reasonable "average" or "mid-range" situation among all of the individual risks in the population. Many risk management decisions related to exposure to radioactive substances (e.g., in nuclear power plants) are based on central-tendency risk estimates.

  Note that when calculating deterministic risk estimates, both a high-end and central-tendency estimate of risk give the risk manager some sense of the range of risks in the population. When risks to a population are developed using probabilistic methods, this becomes a moot point, since the result is a distribution of risks across the population, which necessarily includes information about the full variability of risk across the population – including both high-end and central-tendency risks. See ATRA Volume 1, Chapter 31, for more information on probabilistic approaches to risk assessment.

- **Risk to the total population**. Whether or not risk to the total population is considered by EPA may depend on the regulatory authority provided by the CAA. For example, Section 112(k) of the CAA requires EPA to develop an Urban Air Toxics Strategy (see Chapter 2) to reduce HAPs from area sources to achieve a 75 percent reduction in cancer incidences attributable to such sources. Two general types of descriptors are used for population risk. The first type, sometimes termed **population at risk**, is derived by determining the number of people in a population with a particular individual risk level (e.g., "1,340,000 people are exposed at the 1×10^{-6} level, and 320 people are exposed at the 1×10^{-4} level"). This is a useful estimate of the variability of risk in a population.

  Incidence, another descriptor used for population risk, is an estimate of the total number (incidence) of adverse effects in a population over a specified time period (e.g., a period of 70 years). A screening approach to deriving this estimate for a 70-year period involves multiplying the estimate of individual risk (central tendency and/or reasonable maximum) by the number of persons for which that risk estimate was predicted. For example, in a population of 200 million persons, an individual cancer risk of 1×10^{-4} (i.e., one in ten thousand) for everyone in the population would translate to an incidence of hundreds or thousands of excess cancer cases over a 70-year period (depending on the exposure assumptions). However, in a small population (e.g., a town of 200 persons), the same individual cancer risk to everyone would translate to an excess incidence of cancer of less than one over a 70-year period.

- **Present versus future scenarios**. Risks may be characterized using present or future scenarios. Use of present scenarios involves predicting risks associated with the current exposures to individuals (or populations) that currently reside in areas where exposures are predicted to occur. For example, a current population risk estimate would use the existing population within some specified area. The resultant risk estimates are associated with the presumption that the current exposure conditions exist for the current population over the period of time associated with the assessment (e.g., into the future). Use of future population scenarios involves estimating risks associated with exposure conditions to individuals that might reside, at some future point, in areas where potential exposures may occur (e.g., if a housing development were built on currently vacant land).

- **Potential risk**. Risks may sometimes be characterized for hypothetical exposures. For example, in a screening air toxics modeling application, a potential risk estimate may be derived using the location where the maximum modeled exposure concentration occurs, regardless of whether there is a person there or not. This estimate may be considered along with the predicted individual risk associated with a currently populated area, such as the MIR, which reflects risk associated with the maximum exposure concentration at an actual residence or in a census block with a non-zero population (see ATRA Volume 1, Chapter 11).

8.3 Types of Risk Management Decisions Related to Air Toxics

When responding to the results of a multisource cumulative assessment, the natural inclination of many risk managers will be to focus on two broad categories of risk management options: emissions controls and placement/location of sources (e.g., siting).

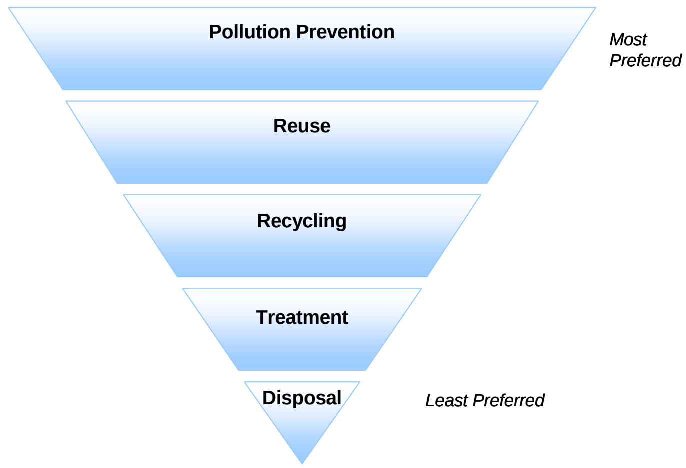
- **Emissions control**. Emissions control can include either installing some type of emission control equipment, instituting a workplace practice or other technical approach, or eliminating the emission altogether. Emissions controls may be either:

  - "Command-and-control" approaches such as regulatory emissions limits under the MACT program or gasoline formulation requirements; or
  - Voluntary approaches such as anti-idling campaigns, Tools for Schools (see http://www.epa.gov/iaq/schools/), pest management plans, or gas can trade-in campaigns.

  When deciding on an emission control approach, EPA's preference is to encourage pollution prevention over regulatory requirements whenever feasible (see Exhibit 8-5).

Exhibit 8-5. Pollution Prevention Hierarchy

In the Pollution Prevention Act of 1990, Congress established a hierarchy for the handling of pollution (see graphic). The Act established as United States policy that pollution should be prevented or reduced at the source whenever feasible, that pollution which cannot be prevented should be recycled in an environmentally safe manner whenever feasible, and that pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible. Disposal or other release into the environment (e.g., fugitive and stack emissions of air toxics) should be employed only as a last resort and should be conducted in an environmentally safe manner.



Pollution prevention is the reduction or elimination of pollutants at the source. As defined in the Pollution Prevention Act, "source reduction" means any practice which (1) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal, and (2) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. It includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. Examples of the value of pollution prevention for reducing environmental risks at the community level are demonstrated by EPA's Environmental Justice through Pollution Prevention (EJP2) grant program. EPA encouraged community groups, tribes, and local governments to identify environmental problems and generate potential pollution prevention solutions for their communities.

Source: U.S. Environmental Protection Agency. 2002. *Environmental Justice Through Pollution Prevention Program.* Updated July 9, 2002. Available at: http://www.epa.gov/opptintr/ejp2/.

- **Source placement**. These decisions involve where to locate industrial facilities, businesses, waste disposal facilities, transportation routes, and other sources of air toxics. Siting decisions for specific sources are typically made by SLT governments through mechanisms such as zoning, deed restrictions and other property controls, and other regulatory approaches. Many of these decision-making processes include public involvement in which citizens may seek to influence the final decision. These siting decisions may involve assessment of environmental impacts pursuant to the National Environmental Policy Act, other federal statutes, or similar state statutes. Risk management decisions of this type are not relegated only to sources emitting chemicals to outdoor air. Rules affecting indoor air quality may also be imposed, such as ordinances banning smoking in public areas.

Note that while some risk management decisions and mitigation requirements can be made by EPA or SLT regulators pursuant to specific legal authorities, government environmental agencies sometimes have limited authority to effect change and may need to work with other government agencies that do have the jurisdiction to implement a risk reduction strategy. For example, the need to reroute truck traffic to decrease diesel emissions in a residential area may require the assistance of the appropriate municipal or county road authority.

In some cases, there may be no regulatory requirements that can address an identified issue and voluntary approaches might be the best way to achieve environmentally beneficial results. Specifically, some important reasons risk managers may select voluntary approaches include the following:

- The types of problems identified may not lend themselves to regulatory solutions (e.g., they may require changes in the behavior of the exposed population). Examples include commuting choices and smoking in homes.

- Voluntary programs may encourage sources to participate in the risk reduction effort if it can be shown that their upfront costs will save them money in the long run. As an example, a pollution prevention assistance program may be able to show an emitting company that a straightforward change in a process to a cheaper, less toxic material will maintain product integrity and reduce their environmental regulatory burden.

- Money saving incentives such as tax credits or consumer rebates can be used to encourage voluntary risk reduction activities. Some examples include supporting the sale of low emission fuels in a metro area, tax credits on low energy consuming home products, and incentives for small business pollution control upgrades.

An example of one community's approach to reducing air pollution, primarily through voluntary programs (The Cleveland Clean Air Century Campaign), is highlighted on the next page.

The risk management options selected will usually depend, in large part, on the types of sources involved. In a community with multiple types of air toxics emissions, the focus of the risk management will usually be on three types of sources; namely, stationary sources, mobile sources, and indoor sources. The following subsections discusses each of these types of sources in detail. Additional information on air pollution, its potential impacts, and methods for reducing exposures can be found at www.epa.gov/air. The following sections focus on responding to the different types of risks posed by different types of sources. Information on several additional common types of air pollution issues that communities commonly face (e.g., mold) are also provided to give the reader a broader sense of the types of actions that will often been pursued as part of an overall community risk-reduction scheme.

The Cleveland Clean Air Century Campaign

The Cleveland Clean Air Century Campaign (CCACC) is a voluntary, community-based initiative to reduce health and environmental risk from air toxics in urban areas. The U.S. EPA and the city of Cleveland, Ohio are working together on this new approach to air toxics control that will serve as a model for communities nationwide.

A dedicated group of Cleveland residents, organizations, agencies and businesses are coming together with the U.S. EPA and Ohio EPA to begin projects that will protect public health in the city. The projects are addressing pollutants from many sources, both indoors and outdoors. The EPA has made an initial investment in the Campaign, which is administered by the American Lung Association® of Ohio.

The campaign has three goals: (1) reduce air toxics in Cleveland within a year; (2) ensure the project is sustainable over time within the community; and, (3) ensure the approach can be replicated in other counties across the United States. A central component of this campaign was the creation of a Working Group comprised of representatives from a range of interested neighborhoods, organizations, businesses, and government agencies. This Working Group guides the campaign. This project also includes an evaluation of the overall process to help improve the ongoing project as it moves forward and to capture key lessons and findings to ensure the success of future projects in other cities.
For more information on the Cleveland Clean Air Century Campaign, see http://www.ohiolung.org/ccacc.htm and a case study of this project in Appendix A.

Project	Costs	Description
Clean Cleveland heavy duty fleets	$243K	Retrofit school buses and other fleets with technology to reduce diesel PM
Highway diesel fuel for offroad use		Use highway instead of nonroad diesel fuel for nonroad fleets – focus on changing contract and bid specs of major users such as the Airport
Anti-idling campaign		Eliminate excessive vehicle idling within specified fleets through education, policy, and training – clean heavy-duty fleets will be required to implement anti-idling as part of the heavy-duty program; focus on school bus yards in two neighborhoods
Commuter choice		Encourage employers to offer incentives for carpooling, public transit, and other environmentally friendly commuter options
RTA bus/fuel replacement	$25K	Replace older circulator buses for St. Clair-Superior and Slavic Village with new ones and fuel with low-sulfur diesel
Household hazardous waste collection/exchange	$23K	As part of Cuyahoga County and other household hazardous waste collection, exchange toxic mercury thermometers, pesticides, and gas cans for less toxic alternatives; includes letter campaign to ban sale of mercury thermometers in counties, towns, cities
Gas can exchange program	$25K	Gas can exchange program through household hazardous waste collection days. Tools-for-Schools program and other means.
Home indoor air education campaign	$9K	Compile and distribute brochure with information about managing household toxics, including second-hand smoke and radon testing
Tools for schools		Pilot program in four schools; expand pilot program to more public and private schools throughout Cleveland
County to local toxic emissions inventory	$60K	Develop Cuyahoga County-specific inputs to emissions inventory for priority toxics
Electroplaters toxic reduction assessment Working group intern Capaign administration	 $10K $9K	Provide on-site survey and education about options for reducing toxics Data collection Community-based recipient of the EPA grant for project management
Total	**$600K**	

8.3.1 Stationary Sources

EPA has issued a number of rules to control emissions of air toxics from many large industrial and commercial operations like refineries and chemical plants. Once fully implemented, these rules will reduce annual emissions of nearly 200 different air toxics by about 1.7 million tons (from 1990 emissions). EPA is working on rules to reduce emissions from smaller, but numerous operations, like paint stripping and autobody paint shops. Exhibit 8-6 provides an outline of the various types of stationary sources impacting outdoor air and some of the common methods used to address those sources. To learn more about EPA's air toxics rules, see *Taking Toxics Out of the Air* brochure (http://www.epa.gov/oar/oaqps/takingtoxics/index_small.html).

Exhibit 8-6. Common Stationary Sources Impacting Outdoor Air Quality and Associated Risk Reduction Options

Emissions of chemicals to outdoor air can come from large stationary sources such as chemical plants, steel mills, oil refineries, and hazardous waste incinerators. These sources may release chemicals from equipment leaks, when materials are transferred from one location to another, or during discharge through emissions stacks or vents. Chemical releases can also come from a wide variety of smaller stationary sources such as neighborhood dry cleaners, gas stations, forest fires, autobody shops, backyard burning, and wood burning fireplaces. Although emissions from these individual small sources are often relatively small, collectively their emissions can be of concern—particularly where large numbers of these types of sources are located in heavily populated areas.

Given the wide array of types of stationary sources and chemicals emitted, a wide array of source control options may need to be considered. In general, the source control options that risk managers will commonly pursue in a multisource risk reduction effort include one or several of the following:

- Installing pollution control equipment;
- Implementing pollution reducing work habits (e.g., keeping containers closed when not in use);
- Instituting process changes to substitute one chemical with a less toxic alternative; and
- Providing education and outreach to sources on both the things they can do to reduce pollution and (hopefully) the money they may be able to save by doing so.

More information about EPA's programs to address stationary sources of air pollution can be found at www.epa.gov/air.

8.3.2 Mobile Sources

Mobile sources pollute the air through combustion and fuel evaporation. These emissions contribute greatly to air pollution nationwide and are the primary cause of air pollution in many urban areas. The most significant air pollutants from mobile sources include:

- Carbon monoxide;
- Hydrocarbons;
- Nitrogen oxides; and
- Particulate matter.

Mobile sources also emit several other important toxic air pollutants, such as benzene (see Section 3.2.3). Nationwide, mobile sources represent the largest contributor to air toxics. Air toxics are pollutants known or suspected to cause cancer or other serious health or environmental effects.

Successful pollution solutions for mobile sources involves a variety of approaches. From better engine design to better transit options, programs to reduce mobile source pollution must address not only vehicles, engines, and equipment, but also the fuels they use and the people who operate them. In some cases, straightforward solutions such as increasing the distance from a roadway can be effective in reducing exposure to mobile sources. The road to clean air also depends on extensive collaboration between EPA; vehicle, engine, and fuel manufacturers; state and local governments; transportation planners; and individual citizens.

This integrated approach to mobile source emission control is responsible for greatly reducing mobile source air pollution during the last 30 years. Technological advances in vehicle and engine design, together with cleaner, higher-quality fuels, have reduced emissions so much that EPA expects the progress to continue, even as people drive more miles and use more power equipment every year.

Of course, growth in the use of vehicles, engines, and equipment works against the improvements gained by making individual vehicles or engines cleaner. If our reliance on mobile sources keeps growing without further action, overall mobile source pollution will eventually start to increase again. EPA, therefore, continues to promote even cleaner technology as well as voluntary programs to reduce vehicle, engine, and equipment activity.

More information on the various types of mobile sources impacting outdoor air and the common methods used to address those sources is provided in Exhibit 8-7. In addition, a partial bibliography of near roadway health effects and exposure studies has been compiled by EPA's Office of Transportation and Air Quality (see http://www.westcoastcollaborative.org/files/outreach/Health%20Effects%20and%20Exposure%20Studies.pdf).

8.3.3 Indoor Sources

Air pollutants indoors can come from a wide variety of sources, including:

- Radon gas from the soil;
- Secondhand tobacco smoke;
- Mold and other biological contaminants;
- Carbon monoxide and other combustion gases;
- Pollution in outdoor air permeating indoor spaces; and
- Chemicals from indoor sources such as certain consumer products (e.g., glues and adhesives, floor polishes, hair care products, air fresheners).

The best solution for all of these problems is to control the source; use a radon removal system, for example, or ban smoking indoors. For mold, control the moisture that allows it to grow. Ventilation may also solve these problems. Air cleaners are never a complete solution, but may help lower levels.

Exhibit 8-7. Common Mobile Sources Impacting Outdoor Air Quality and Associated Risk Reduction Options

Pollution sources that move, such as cars, trucks, snowblowers, bulldozers, and trains, are known as "mobile sources." Mobile sources pollute the air through combustion of fuel and fuel evaporation. These emissions contribute greatly to air pollution nationwide and are the primary cause of outdoor air pollution in many urban areas. There are a wide array of risk reduction activities that stakeholder teams can pursue to help reduce mobile source emissions. Example projects include:

- Encouraging people to drive less (encouraging the use of alternative means of transportation such as buses, trains, or bicycles and commuting to work by carpooling, vanpooling, or telecommuting);
- Discourage the use of drive-through windows or ATMs;
- Encouraging the adoption of driving practices that improve mileage;
- Encouraging people to maintain vehicles on a regular basis to keep them in good shape;
- Encouraging the use of cleaner fuels (e.g., low sulfur diesel for construction equipment, natural gas for city buses);
- Encouraging the availability and purchase of energy efficient methods of transportation;
- Retrofitting diesel engines (e.g., in older school buses) with pollution reducing control devices;
- Anti-idling campaigns, especially for diesel engines that commonly idle for long periods of time (school buses, long-haul commercial trucks). This can also help with indoor air quality, especially of the idling occurs near buildings;
- Truck stop electrification to encourage anti-idling by long-haul commercial trucks;
- Discourage use of gasoline powered lawn mowers, leaf blowers, etc.;
- Transportation control measures such as timing stoplights to improve traffic flow; and
- Providing education and outreach to mobile source operators on both the things they can do to reduce pollution and (hopefully) the money they may be able to save by doing so.

More information about EPA's programs to address mobile sources of air pollution can be found at http://www.epa.gov/oms/transport.htm.

Exhibit 8-8 provides an outline of some of the various types of sources impacting indoor environments and some of the common methods used to address those sources. Several specific indoor air contaminant sources are highlighted below.

8.3.3.1 Radon

Radon is a radioactive gas found all over the U.S., and the second leading cause of lung cancer, causing an estimated 21,000 lung cancer deaths a year. Radon enters buildings from the soil beneath the building. EPA is concerned about homes because we spend more time there than anywhere else. Because radon is odorless and invisible, a test must be performed to determine if it is present above acceptable levels. For more information on radon, see www.epa.gov/radon.

Exhibit 8-8. Common Indoor Air Pollution Sources and Risk Reduction Options

There are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance, personal care, pesticides, or hobbies; central heating and cooling systems and humidification devices; and outdoor sources such as radon and outdoor air pollution.

There are three basic approaches to enhancing the quality of indoor air:

Source Control. Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, like those that contain asbestos, can be removed, sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions. In addition, the choice of consumer products brought into the home and the ways in which they are stored and used can help reduce emissions. In many cases, source control is also a more cost-efficient approach to protecting indoor air quality than increasing ventilation because increasing ventilation can increase energy costs.

Ventilation Improvements. Another approach to lowering the concentrations of indoor air pollutants is to increase the amount of outdoor air coming indoors. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Opening windows and doors, operating window or attic fans, when the weather permits, or running a window air conditioner with the vent control open increases the outdoor ventilation rate. Local bathroom or kitchen fans that exhaust outdoors remove contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate. As noted above, there are potential tradeoffs between increasing ventilation and increasing energy costs.

Air Cleaners. There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive table-top models to sophisticated and expensive whole-house systems. Some air cleaners are highly effective at particle removal, while others, including most table-top models, are much less so. Air cleaners are generally not designed to remove gaseous pollutants. (Note that there is a large body of written material on ozone and the use of ozone indoors. The results of some controlled studies show that concentrations of ozone considerably higher than public health standards are possible even when a user follows the manufacturer's operating instructions. For more information about the use of indoor ozone generators, see http://www.epa.gov/iaq/pubs/ozonegen.html#if%20i%20follow%20manuf.%20directions%20will%20i%20be%20harmed).

For more information on sources and control of indoor air pollutants, see http://www.epa.gov/iaq/index.html.

8.3.3.2 Secondhand Smoke

Secondhand smoke may be a community concern, because people who did not choose to smoke breath the secondhand smoke. Secondhand smoke is a known cause of lung cancer. It also causes many irritant effects, especially among children, annually causing the hospitalization of thousands of children under the age of 18 months. Both adults and children with asthma find their symptoms triggered by smoke exposure.

Some communities have used EPA materials to promote smoke-free homes and cars to protect children. Others have invested in helping people to stop smoking, since this also keeps homes and cars smoke-free. More information is available from U.S. EPA (http://www.epa.gov/iaq) or from a local chapter of the American Lung Association (http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=22542).

> **Asthma**
>
> Asthma affects millions of Americans by narrowing their airways during an asthma attack, so that they don't get enough air in their bodies. Such attacks kill thousands each year. Attacks typically occur due to exposure to indoor air "triggers;" such triggers include secondhand smoke, dust mites, molds, cockroaches and pests, pet dander, and some combustion products. Asthma can also be triggered by numerous outdoor pollutants such as ozone and pollen.
>
> Asthma can be controlled by medications; both adults and children with asthma should see a physician to create an asthma action plan to help avoid these triggers, and to use both preventive and rescue medications. Visit http://www.epa.gov/asthma to learn more about asthma and what can be done to prevent it.

8.3.3.3 Mold

Molds and other biological contaminants will grow whenever there is enough moisture. In community settings, these conditions may occur with floods, storms, or other natural disasters. Individual homes may also be affected by leaks, condensation, or activities which raise indoor humidity.

Molds cause allergic and irritant effects, and can also affect asthmatics. Given the prevalence of molds and the sensitivities of many people to molds, it is prudent to avoid exposure to molds and mold spores. Community-based environmental risk reduction projects will almost always have mold as an opportunity for attention and success. For more information, go to http://www.epa.gov/mold.

8.3.3.4 Carbon Monoxide

Carbon monoxide and other products of combustion will appear whenever something is burned, whether gasoline in a vehicle or power generator; candles in the dining room; an unvented heater in the fireplace; charcoal in the grill, or a forest fire a few miles away. Proper venting of combustion equipment removes these contaminants from home water heaters and furnaces.

> **Tools for Schools**
>
> Schools of all sorts may have indoor air problems. These can cause health problems and absentees, and interfere with education and student performance.
>
> EPA created the Indoor Air Quality Tools for Schools Action Kit to help schools improve their indoor air quality, using in-house personnel and low-and no-cost actions. For more information, visit http://www.epa.gov/iaq/schools.

Many combustion products are irritants, but one, carbon monoxide, is deadly and odorless. Symptoms of carbon monoxide exposure include headache, dizziness, nausea, confusion, chest pain in people with heart disease, and even a lethargy or flu-like symptoms. Because none of these symptoms is respiratory, most people do not recognize that their symptoms are due to the air quality.

Carbon monoxide kills hundreds of Americans every year. Many deaths are caused by malfunctioning heating equipment, but some are due to vehicles running in an attached garage, and more each year come from use of improperly located power generators after a storm. Other deaths come from burning charcoal in a tent or house. Community efforts might publicize these dangers to warn citizens to be cautious. Another possible community project is to provide carbon monoxide sensors to homes and schools.

8.3.3.5 Consumer Products and Building Materials

Chemicals may be given off (or "outgas") from various building materials and consumer products brought into the home. We are all familiar with many of these chemical odors. Some people enjoy the "new car smell" or the fragrances in our cleaning supplies. The ability of these chemicals to cause health effects varies greatly, from those that are highly toxic, to those with no known health effects. Eyes and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms some people have experienced soon after exposure to some chemicals. To reduce exposures, follow label instructions carefully on household products; properly dispose of old or unneeded chemicals; buy limited quantities; and limit your exposure by using the chemicals in a well ventilated area.

8.4 Developing the Risk Management Strategy

An air toxics risk management strategy (also called a risk management plan) is a written statement of the specific set of goals and activities aimed at reducing exposures to toxic chemicals in the air (the plan will also need to carefully outline the time frames for implementation and the roles and responsibilities of the various people and organizations responsible for implementation of the plan and efforts to monitor progress). The specific chemicals and sources that become the focus of the risk management plan will depend on the mix of sources, chemicals, exposures and population characteristics of the study area.

Many times an initial "Framework for Risk Management" document is prepared and agreed to by the risk managers **prior** to the risk assessment to set the stage for how the results of an assessment will be judged and how to lay out the general strategies that may be used to identify and implement risk reduction options. A key benefit of this approach is to keep the risk estimates from automatically becoming the de facto acceptable risk levels. An obvious benefit to this approach is to build trust with the study-area community. A drawback is that it can set a "line in the sand" that becomes unreasonably inflexible in light of analysis uncertainties. If the partnership team develops a framework document for risk management, they should carefully consider the pros and cons, and ensure that all affected stakeholders understand the need for some flexibility in the risk management process, given the potential (and as yet, unknown) uncertainties in the risk estimates as well as other factors that can affect the risk management decision (cost, technical feasibility, etc.).

The multisource assessment may find that only a limited number of sources are responsible for most of the local risk (for example, in areas with a dense collection of heavy industry abutting a residential area). In other cases, the assessment may point to a variety of important chemicals and sources, some of which may be industry related and some of which may not be. For example, a typical urban area may have little or no "smokestack" industries and the majority of the risks will be associated with mobile sources, small area sources such as gas stations and autobody shops, and indoor sources such as consumer products and combustion. In addition, most communities will identify a variety of sources (e.g., diesel emissions from older school buses, second hand smoke) that are already well characterized in terms of the risks they pose and the options for reducing those risks. Communities may decide to address some or all of those sources, regardless of the timing or the findings from the multisource assessment.

In short, every study area will have a unique mix of sources, population characteristics, and other factors (e.g., meteorology, building stack characteristics, etc.) that will result in a unique set of exposure and risk conditions. To respond to these study area-specific conditions, the risk reduction strategy will need to be tailored to these circumstances.

The CRARM noted that a variety of stakeholders can play an important role in all facets of identifying and analyzing risk reduction options. They can help risk managers:

- Develop methods for identifying risk-reduction options;
- Develop and analyze options; and
- Evaluate the ability of each option to reduce or eliminate risk, along with its feasibility, costs, benefits, and legal, social, and cultural impacts.

Involved stakeholders are more likely to understand the decisions made by risk managers and are more likely to accept and implement a risk management decision they have participated in shaping. They will also have developed the relationships, knowledge, communication channels, and administrative mechanisms to help all the parties work together on implementing the risk reduction activities. Another way to look at it is that involving stakeholders and incorporating their recommendations where possible reorients the decision-making process from one dominated by regulators to one that includes those who must live with the consequences of the decisions. This not only fosters successful implementation, but can promote greater trust in government institutions.

The following discussion describes the process for developing a strategy for a study area and follows the risk management steps of the overall risk assessment/risk management framework articulated by the CRARM (see Section 8.1 above):

- Examine options for addressing the risks;
- Make decisions about which options to implement;
- Take actions to implement the decisions; and
- Conduct an evaluation of the action's results.

8.4.1 Examine Options for Addressing the Risks

This stage of the risk management process involves identifying potential risk management options and evaluating their effectiveness, feasibility, costs, benefits, unintended consequences, and cultural or social impacts. Specifically, the following factors (and perhaps others) will temper the actions the risk management group decides to take, when and how they will take action, or whether they will take no action at all.

- The type of emissions sources impacting the community and the contribution of those sources to overall risk;
- Existing regulatory programs (existing and upcoming regulations) that will reduce the risk over time;
- Technical feasibility of reducing emissions;
- Cost of risk reduction options such as the cost to install and operate pollution control equipment;
- Community support for risk reduction options;
- Industry support for risk reduction options;
- The desire to include known risk factors not quantitatively included in the multisource assessment (e.g., tobacco use, certain indoor air sources); and
- Background concentrations.

Alternative Solutions to Unique Problems

Project XL, which stands for "eXcellence and Leadership," is a national pilot program that allows state and local governments, businesses, and federal facilities to develop (with EPA) innovative strategies to test better or more cost-effective ways of achieving environmental and public health protection. In January 2001, EPA signed the 50th XL Final Project Agreement. Although EPA is no longer accepting proposals for new XL projects, EPA will continue to fulfill each of its commitments under Project XL and will track and monitor the progress of each XL pilot for the duration of the project. See www.epa.gov/projectxl for more information.

Supplemental Environmental Projects (SEPs) are part of enforcement settlements connected with violations of an environmental statutory or regulatory requirement. As part of the enforcement settlement, a violator voluntarily agrees to undertake an environmentally beneficial project in exchange for a reduction in the penalty. See http://www.epa.gov/compliance/civil/seps/index.html for more information.

8.4.2 Make Decisions About Which Options to Implement

In most risk management situations, decision-makers will have a number of options from which to choose. Which option is optimal depends on the particular situation (and in some cases, may be driven by statutory requirements, or public "buy-in"). When choosing among a variety of options, decision makers should consider the following useful principles:

- Base the decision on the best available scientific, economic, and other technical information;
- Be sure the decision accounts for the problem's multisource, multichemical context;
- Give priority to preventing risks, not just controlling them (see Exhibit 8-4 above);
- Use alternatives to command-and-control regulation (i.e., voluntary approaches), where applicable;
- Be sensitive to social and cultural considerations; and
- Include incentives for innovation, evaluation, and research.

Sustaining the Risk Reduction Effort Over Time

A critical element to consider in the evaluation of the overall risk reduction effort is the sustainability of the project. Most risk reduction efforts are only meaningful when there is a sustained effort to reduce risk over the long term, and the stakeholder group will need to identify the impediments that may keep this from happening. For example, will community interest in the project or money to pay for risk reduction efforts dwindle over time? What types of things can be done now to ensure continued progress into the future? A discussion of risk reduction sustainability is provided in Section 12.5.

As noted above, decision makers will often have to also consider a variety of administrative and legals issues such as existing rules, regulations, policies, and standards in making their decision about what course to take. Several additional considerations are highlighted in the text box on the following page.

8.4.3 Take Actions to Implement the Decisions

Once a risk reduction plan is in place, the partnership team will move forward to implement the identified risk reduction options. It is this stage at which the goodwill that has been developed through the project will be rewarded. Stakeholders who have been involved from the beginning of the project and who have come to trust one another are more apt to accept the risk management plan and work to carry it out.

8.4.4 Conduct an Evaluation of the Action's Results

At an appropriate point after implementation of risk reduction actions, decision-makers and other stakeholders review how effective they have been at reducing risk. Evaluating effectiveness involves an analytical approach to measure results, as well as comparing the actual benefits and costs to estimates made in the decision-making stage. The effectiveness of the process leading to implementation should also be evaluated at this stage.

Example Factors to Consider When Evaluating Risk Management Options

- **Background concentrations**. Air toxics risk management decisions usually focus on the *incremental* risk associated with specified sources in the study area in the absence of background risks. However, background risk may be important in certain situations. For example, if a monitoring program measures concentrations of air toxics being transported into a given study area that result in risks above an "acceptable" level, no level of emissions control within the study area will be able to reduce risk to an "acceptable" level, and the community may wish to address the incoming air toxics via discussions beyond the local community.

- **Level of uncertainty in the analysis**. In the face of highly uncertain risks, decision-makers have to carefully weigh the consequences of two or more options: making a decision to control emissions or exposures only to find out later that there was little actual risk (e.g., incurring unnecessary "cost" to the community), or making a decision *not* to control emissions or exposures only to find out later that the risks were real and large (e.g., incurring potentially preventable harm to the community).

- **Implementation costs**, both for voluntary approaches (e.g., marketing, process changes, tax incentives) as well as to regulatory agencies, the regulated community, and the general community (consumers, employees). Are the benefits reasonably related to the costs?

- **Technical feasibility**. Short of removing the emission source altogether, is there an available technology to reduce or eliminate emissions?

- **Effectiveness/timing**. Will the risk reduction option provide effective management of the problem within a reasonable timeframe?

- **Political feasibility**. Does the option have the necessary political support?

- **Community acceptance**. Do the stakeholders buy-in to the proposed risk reduction alternatives?

Each of these factors may be more or less important depending on the context for the risk management decision. For example, the risk manager may be required by statute to weigh economic factors less than technical factors.

Evaluation provides important information about:

- Whether the actions were successful, whether they accomplished what was intended, and whether the predicted benefits and costs were accurate. For example, in a multisource analysis where several chemicals and sources have been targeted for risk reduction, yearly emissions estimates (as unit emissions rates) may be rerun through the risk model to recalculate risks, and risk trends are plotted over time. Risk managers will then be in a position to decide whether risk mitigation targets are adequately being addressed;

- Whether any modifications are needed to the risk management plan to improve success;

- Whether any critical information gaps hindered success;

- Whether any new information has emerged that indicates a decision or a stage of the process should be revisited. Examples include filling data gaps identified during the original assessment or the subsequent construction of a new emissions source;

- Whether the process was effective and how stakeholder involvement contributed to the outcome; and

- What lessons can be learned to guide future risk management decisions or to improve the decision-making process.

Reviewing and evaluating the results of a risk management effort is a critical first step in addressing an important challenge: how to ensure that the community's risk management efforts are sustainable over time. Section 12.5 discusses the challenges associated with sustainability and opportunities for a community to develop the institutional capability that can help maintain sustainability over long periods of time.

Environmental Public Health Indicators

Environmental Public Health Indicators are useful tools to help establish goals and assess progress in achieving these goals. Indicators may help show whether risk reductions are having the desired effects on public health, the economy, quality of life, or any other specific goals. In particular, effective indicators can:

- Tell the community how well strategies are working – what is going well or what might need to be changed;

- Help the community see the full effects of the risk reduction strategy on public health, quality of life, the economic health of the community; and

- Help the community decide how to focus community efforts and resources more efficiently and equitably.

Some useful resources on environmental indicators include the following:

- Environmental Indicators Initiatives (http://www.epa.gov/indicators/);
- Check Your Success: A Community Guide to Developing Indicators (http://www.uap.vt.edu/checkyoursuccess/);
- Fact Sheets and Tools for Evaluation (http://www.epa.gov/evaluate/tools.htm); and
- The Centers for Disease Control maintains a website that provides useful information on environmental public health indicators that can be used to assess our health status or risk as it relates to our environment (http://www.cdc.gov/nceh/indicators/default.htm).

References

1. Presidential/Congressional Commission on Risk Assessment and Risk Management.1997. *Framework for Environmental Health Risk Management* (Final Report, Volume 1). Available at www.riskworld.com/Nreports/1996/risk_rpt.

   Presidential/Congressional Commission on Risk Assessment and Risk Management. 1997. *Risk Assessment and Risk Management In Regulatory Decision-Making* (Final Report, Volume 2). Available at www.riskworld.com/Nreports/1996/risk_rpt.

2. Adapted from the National Research Council (NRC). 1983. *Risk Assessment in the Federal Government: Managing the Process (The "Red Book").* National Academy Press, Washington, D.C.

3. U.S. Environmental Protection Agency. 1995. *Guidance for Risk Characterization*. Science Policy Council, Washington, D.C., February 1995. Available at: http://www.epa.gov/osa/spc/pdfs/rcguide.pdf.