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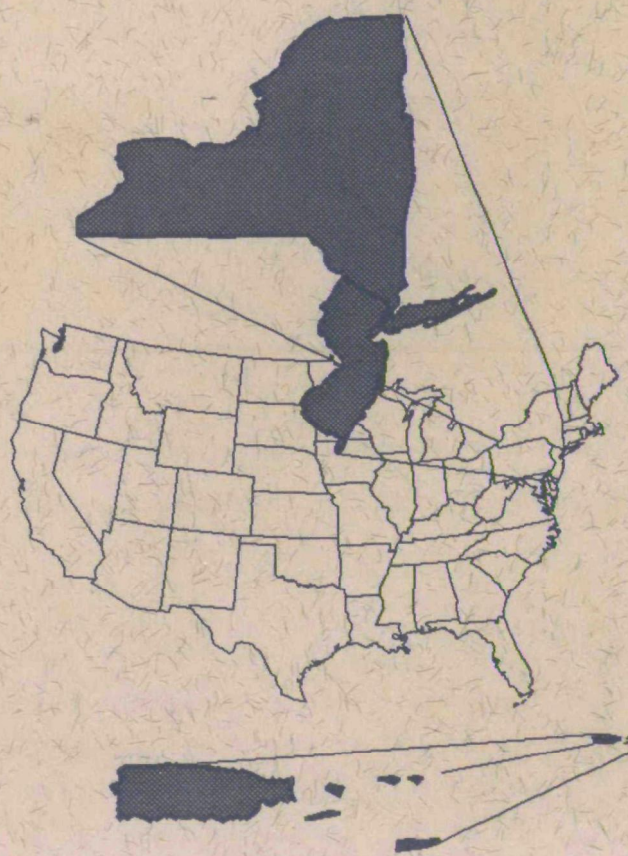
Risk Ranking Project Region 2

Comparative Risk Ranking Of The Health, Ecological, And Welfare Effects Of Twenty-Seven Environmental Problem Areas Overview Report

ECOLOGY



HEALTH

WELFARE/
ECONOMICS

Risk Ranking Project
Region 2

Comparative Risk Ranking of the Health, Ecological, and Welfare Effects of Twenty-Seven Environmental Problem Areas

Overview Report

U.S. Environmental Protection Agency
Risk Ranking Work Group
Region 2
February 1991

Foreword

What are our nation's worst environmental problems? Pesticides in our foods, dwindling wetlands, toxic wastes, the hole in the ozone layer, radon lurking in the basement, acid rain, closed beaches, and urban smog are among the many problems that pose threats to our health, to the environment, and to our well being.

Over the last 20 years, the Environmental Protection Agency (EPA) has been given responsibility to deal with many of these problems under a patchwork of legislative mandates. Given the scarcity of resources available to confront the expanding list of threats to public health and to the environment, we need to know what the worst environmental problems are in terms of risks to people, natural systems, and our welfare. Then, we must assess whether our priorities make sense in light of the relative risks posed by these problems.

On a national level, *Unfinished Business: A Comparative Assessment of Environmental Problems*, a landmark study published by EPA in 1987, was designed to start answering these questions. In January 1990, EPA's Office of Policy, Planning and Evaluation requested that the seven EPA regions which had not yet completed comparative analyses of the risks posed by environmental problems at the regional level undertake such studies.

In Region II, a work group composed of staff members with varied backgrounds, representing each of the divisions was created, and asked by the Regional Administrator to undertake the Risk Ranking Project. The work group proceeded to: 1) define the regional list of environment problems; 2) develop the criteria and methodologies for evaluating the problem areas; 3) collect data and analyze the risks; and, 4) complete a relative ranking of the problem areas on the basis of their health, ecological and welfare risks. On October 1, 1990, the work group presented its rankings and the rationale for its findings to the Regional Administrator and the region's senior managers. The work group's recommendations were unanimously adopted by the senior managers.

This report contains an overview of the Region II's relative risk rankings for health, ecological and welfare effects, and the rationale for those rankings. There are three additional reports which contain the detailed health, ecological and welfare problem areas analyses on which the rankings are based.

Region II Risk Ranking Work Group

Chairwoman

Alice Jenik
Branch Chief
Office of Policy and Management

Members

Debra Curry
Hydrologist
Water Management Division

Ellen Parr-Doering
Hydrologist
Air and Waste Management Division

Kevin Doering
Program Analyst
Office of Policy and Management

Marcus Kantz
Section Chief
Environmental Services Division

Robert F. Kelly
Environmental Scientist
Air and Waste Management Division

Carlos O'Neill
Section Chief
Caribbean Field Office

Marian Olsen[1]
Environmental Scientist
Office of Policy and Management

Timothy J. Ream
Program Analyst
Office of Policy and Management

Ernest Regna
Branch Chief
Environmental Services Division

Palma Risler[2]
Program Analyst
Office of Policy and Management

Dennis Santella
Section Chief
Emergency and Remedial Response Division

Nancy Schlotter
Environmental Scientist
Water Management Division

Walter Schoepf
Environmental Scientist
Emergency and Remedial Response Division

Berry Shore
Congressional Relations Specialist
Office of External Programs

Harvey Simon[3]
Environmental Scientist
Office of Policy and Management

Marina Stefanidis
Environmental Scientist
Emergency and Remedial Response Division

Lawrence Tannenbaum
Environmental Scientist
Emergency and Remedial Response Division

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[1] *Lead analyst for health risks and editor of the health risk document.*

[2] *Lead analyst for welfare risks and editor of the welfare risk document.*

[3] *Lead analyst for ecological risks and editor of the ecological risk document.*

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Air and Waste Management
Larainne Koehler
Alan Fellman

Environmental Services
Diane Buxbaum

Policy and Management
Maeve Arthars
Steve Rubin
Robert Eckman
John Baglivi
Vicki Snitzler-Neeck
Mike Verhaar

Office of Policy, Planning and Evaluation
Catherine Tunis
Richard Worden

Water Management
Isaac Chen
Christopher Dere
Anthony Dore
Theresa Faber
Aristotle Harris
William Hoppes
Wayne Jackson
Edwin Khadaran
Bruce Kiselica
Maureen Krudner
Marit Larson
Alex Lechich
Elizabeth Lonoff
Robert Nyman
Douglas Pabst
Patrick Pergola
Eric Stern
Shari Stevens

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Chapter One: Introduction

The primary objective of the Region II Risk Ranking Project is to compare the risks posed by the different environmental problems facing the New York/New Jersey/Caribbean Region. The intent of the project is not only to inform EPA staff and managers, but to inform and to influence the public debate over environmental issues as well. Another objective is to use the results as a critical component of a strategic planning process for the region. The level of risk is only one factor that determines priorities. Strategic planning also takes into account a variety of other factors: cost/effectiveness; public concern; the effects of disinvestment; statutory and regulatory mandates; and, how well government effort leverages private investment in environmental improvement. The strategic planning process for the Fiscal Year 1993 budget began in the fall of 1990.

The Risk Ranking Project has two components: analysis and professional judgement. An interdivisional work group, composed of Region II staff with diverse academic backgrounds and encompassing all program areas, was named. On January 31, 1990 the Regional Administrator convened the work group and charged it with responsibility for completing a comparative risk analysis and ranking. In the ensuing months, the work group developed the list of environmental problem areas that were ranked (see Appendix A), and the methodologies and criteria for ranking the problems on the basis of their health, ecological and welfare effects. In many cases, individual staff members conducted research and analyzed the environmental problem areas. Additional support in conducting research and completing the analyses was provided by the Office of Policy, Planning and Evaluation (OPPE), and by firms under contract to OPPE.

After staff analyses were completed, initial meetings were held to determine the relative risks posed by environmental problems for health, ecological and welfare effects. The work group evaluated the data and analyses submitted as well as the professional judgement of the work group, especially the persons who completed the analyses. The group also considered the direction of the uncertainty, data gaps, consistency and the technical merit of the analysis.

After the initial rankings were developed, work group members had several weeks to review the analyses more thoroughly and to consider the relative rankings. Proposals to adjust the rankings were prepared during this period. At a subsequent meeting, the work group reached a consensus on the rankings. They were presented to the region's senior staff during September 1990. At a joint meeting on October 1, 1990, the Regional Administrator and his senior staff concurred with and adopted the work group's rankings.

The rankings are presented in the following chapters. Three separate rankings were developed: health, ecological and welfare/economics. Within the health area there are rankings for cancer, non-cancer and combined health effects. A brief introduction, the rankings, and a summary of the rationale for the rankings is included in each chapter. Additional information on the ranking criteria and methodologies and the detailed problem area analyses are included in three companion volumes.

In general, the rankings for the cancer effects and welfare were the most straightforward since standard numerical measures (i.e. cancer incidence and damage estimates in dollars, respectively, were available for comparison. This is particularly true for the cancer analysis since the Agency has collected data on carcinogens for years, and risk assessment methods provide a well-understood and widely-accepted basis for comparison. Economic methods and studies were fairly accessible and easily understood.

The methodologies for determining ecological and non-cancer health risks are not as well-developed. There is no single endpoint such as cancer cases or dollars that facilitates comparisons. Professional judgment played a larger role in each of these rankings.

Although the rankings were completed, the work group had concerns about different aspects of the process. A major concern was that because the problem areas were defined according to sources of pollution, programs such as toxic substances control and pollution prevention are not treated separately. The ranking of the problem area, Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons (CFC's), was also a constant anomaly because predicted impacts will occur in the future, unlike other environmental problems that are causing impacts now.

Members of the group also raised questions about the consistency of the exposure time frames that were used in the analyses, (for example, the 30-year time frame prescribed by the Superfund program versus the 70-year time frame prescribed by the Agency's risk guidelines). The question of how to deal with residual risk (i.e. the level of risk that remains after program controls are in place) was also discussed at length. These issues need to be considered during the strategic planning process.

Other general concerns on the part of the group include the need for better data on which to base problem analyses, and the heavy reliance on professional judgement in setting priorities. The project underscored the importance of environmental data, and its quality and reliability. On a positive note, the work group learned a lot about the complexity of the environmental problems that were analyzed, and achieved a better understanding of how the Agency's programs function. The group also learned how difficult it is at times to make a decision when faced with incomplete information.

Chapter Two: Human Health Effects Rankings

CANCER

Introduction

This chapter summarizes the results of the Region II Risk Ranking Work Group's comparative ranking of twenty-seven problem areas for cancer health effects. The rankings were based on individual problem area analyses prepared by work group members or by the Office of Policy, Planning and Evaluation staff and their contractors. The analyses defined the components of the problem areas in terms of the chemicals of concern, related exposure pathways (inhalation, groundwater ingestion, soil ingestion, etc.) and the potential cancer incidence per year associated with each.

Each problem area was analyzed using the four steps of risk assessment identified by the National Academy of Sciences (National Research Council, 1983)[1]: hazard identification, dose response, exposure assessment and risk characterization.

The projected cancer incidence was compared across all problem areas. It is important to remember that these risks are upper bound estimates at a 95 percent confidence limit, and the actual cancer incidence could be, and probably is, much lower. In addition, potential risks were added together as prescribed by EPA's Risk Assessment Guidelines (U. S. EPA, 1986a-e). The assumption of additivity of risk across exposure routes and between different chemicals can lead to either an over or under estimate of risk depending on the nature of the biological effects of the chemicals which are often not understood. Potential synergistic and antagonistic effects between chemicals could not be assessed.

Initial scoring recommendations were prepared by the work group member responsible for the analysis. In general, the work group did not alter these scores, but decided not to be bound strictly by the projected number of cancers in completing the rankings. The work group felt that the broad categories of cancer risks (very high, high, medium and low) represented significant differences in relative risks as evidenced by the cancer incidence per year. The projected cancer incidence was used to rank the problem areas within each category.

[1] Human health effects references are cited in Appendix B.

Methods

In developing the risk assessments for each problem area, the group attempted to assure that Agency guidance was used consistently. To achieve this goal, the EPA Risk Assessment Guidelines for carcinogens, mutagens, exposure assessment, and chemical mixtures (U. S. EPA, 1986a-e) were used as the basis for all of the analyses, and supplemented by program guidance for the specific problem area. Supplemental guidance included the Office of Emergency and Remedial Response, Risk Assessment Guidance (U. S. EPA, 1989a; 1989c), the Exposure Assessment Manual (U. S. EPA, 1989b), and the Office of Water Regulations Guidance on Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish (U. S. EPA, 1989d).

In addition, the Potency Slopes and Carcinogen Weight of Evidence Classification used in the analyses were taken from the Integrated Risk Information System (U. S. EPA, 1990a) maintained by the Office of Health and Environmental Assessment and the OSWER Health Effects Assessment Tables (U. S. EPA, 1990b). All calculations were developed using the Beta Test Version of the computer program Risk*Assistant (developed by the Hampshire Research Institute under contract to EPA's Exposure Assessment Group) to assure consistency in exposure parameters and calculations. The Risk*Assistant calculations were independently verified.

The exposure duration varied across the problem areas, but followed what was prescribed by program office guidance. In all cases the assessments evaluated the risks for exposure based on a 70-year lifetime although the exposure duration varied. For example, in the Superfund analysis 30 years was used for ingestion of contaminated drinking water. In the problem area analyses for point and non-point sources of water pollution, consumption of contaminated fish was assessed for a 70-year period. The differences were identified in each analysis and discussed during the ranking meetings.

The pathways evaluated also varied from problem area to problem area. The main pathways evaluated included: ingestion of contaminated drinking water, ingestion of contaminated fish, ingestion of soil, inhalation of volatiles from contaminated water during showering, and inhalation of contaminated air. The determination of exposure routes depended on the problem area and the availability of data. An attempt was also made to calculate the potential risks from soil exposure through inhalation of fugitive dusts. However, in the absence of specific models to calculate the potential air concentrations, these emissions were not evaluated.

In many of the assessments, all chemicals of concern could not be evaluated since toxicological information for both inhalation and ingestion was not available. In these cases, the chemicals were excluded from the analysis, and the analysis was based on those chemicals for which data was available.

The assessments evaluated the risks to the Maximum Exposed Individual (MEI) and the Average Exposed Individual (AEI) depending on the available data. In many cases, however, data was only available on either the maximum or average individual. A risk summary chart (Table I) was developed. It identifies the problem area, the risks for maximum and/or average individuals, the associated population, and the projected cancer incidence per year.

The analysis did not distinguish between the different types of cancer. It was noted that Chlorofluorocarbons are associated with skin cancer which has a high cure rate (American Cancer Society, 1990).

Table I identifies the potential number of cancers associated with the problem areas. Quantitative cancer incidences were calculated for 20 problem areas and qualitative estimates were developed for three. Based on the data in Table I the range of cancers associated with all problem areas is from 7,270 to 17,459. The projected number of cancers in Region II on a yearly basis is 101,785 (New Jersey Department of Health, 1988; New York State Department of Health, 1988; Puerto Rico Department of Health, 1988; and Virgin Islands Department of Health, 1988).

Four problem areas (accidental releases, Underground Injection Control (UIC) Class I - III wells and aquatic and terrestrial habitats) were not assessed and ranked low in the ranking. Accidental risks were determined to have acute impacts (death, lung damage, etc.); data on the potential long-term effects were not available. The potential health impacts from Class I - III wells were considered negligible since the Mechanical Integrity Tests would prevent potential human exposure. Aquatic and terrestrial habitats were considered to have primarily ecological impacts and were excluded from the human health ranking.

Ranking

Based on the analyses and discussions, the work group ranked the problems on the basis of the predicted cancer incidence. In addition, areas of uncertainty were identified. Where the uncertainty was high, the ranking of a problem area was adjusted to reflect the level and type of uncertainty. Best professional judgement played a major role in the final ranking. Discussions of these uncertainties, in some cases, resulted in a higher ranking of a problem area than would have occurred if only the projected cancer incidence was evaluated.

National Cancer Incidence vs. Region Specific Incidence

To assure that the potential cancer incidences are not overestimates for the region, the projected number of cancers based on the ranking were compared with those from other published studies (Doll and Peto, 1981; National Cancer Institute, 1985). Based on this analysis, which is described in

Appendix C, it was determined that the projected number of cancers associated with the Region II Risk Ranking Project are consistent with the apportionment of cancers suggested by current research.

Table I

Causes of Cancer Mortality

Factor	All cancer deaths, percentage Best Estimate	Range of Acceptable Estimates
Tobacco	30	25 - 40
Alcohol	3	2 - 4
Diet	35	10 - 70
Reproductive & sexual behavior	7	1 - 13
Occupation	4	2 - 8
Pollution	2	1 - 5
Industrial products	1	1 - 2
Medicines and medical procedures	1	.5 - 3
Geophysical factors	3	2 - 4

Uncertainties

The analyses involved a number of uncertainties which are described below:

- The cancer risks from a number of chemicals could not be evaluated since Slope Factors (both oral and inhalation) and the Weight of Evidence Classifications were not available.

- The risk assessments in most cases were screening risk assessments and, because of the short time period for completing the ranking project, in-depth site-specific risk assessments could not be developed. It was not possible, therefore, to refine the project cancer incidences.

- The lack of data in several problem areas made it difficult to completely assess all the problem areas. This lack of data was considered in the description of uncertainty for these analyses and during the ranking.

- The quality of the data used in each assessment varied. In some cases actual site-specific data was used while in other cases it was necessary to extrapolate from national studies to the region.

- The estimation of the potential population exposed was not refined since specific demographics on communities exposed were not available.

- The air risks at hazardous waste facilities managed under the Resource Conservation and Recovery Act (RCRA), abandoned hazardous waste sites (Superfund), and other problem areas could not be adequately assessed since many of these sites lacked specific sampling data and toxicological information. There is a potential underestimate of the risks from these problem areas since many work group members felt this was a route of concern.

- It was not always possible to assess the potential risks to sensitive subpopulations since they could not always be addressed separately.

- The risks are potential overestimates since the 95 percent upper confidence limit was used for cancer risks and the risks were added together across routes of exposure. However, it is also important to keep in mind, as indicated above, that because of a lack of toxicological information, not all chemicals and exposure routes could be determined. This is a potential underestimate of risk.

TABLE II

CANCER HEALTH EFFECTS RANKING

Very High

Chemical Use That Depletes the Ozone Layer - Chlorofluorocarbons
Radon
Indoor Air Pollutants Other Than Radon

High

Mobile Sources of Air Pollution - Motor Vehicles
Area Sources/Non-Point Sources of Air Pollution
Stationary and Point Sources of Air Pollution
Abandoned Hazardous Waste Sites/Superfund Sites
Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C
Non Point Sources of Water Pollution
Pesticides Residues in Food
Municipal Solid Waste - Storage and Landfills

Medium

Non-Traditional Underground Injection Control Wells (Class IV and V)
Operation and Maintenance of Drinking Water Systems
Pesticide Contamination During Application
Accidental Releases During Transport or Production
Material Storage Tanks, Sites and Pipelines Not Regulated Under RCRA Subtitle C
Industrial Point and Municipal/Public Wastewater Treatment Discharges to Water
Radiation Other Than Radon
Municipal Sludge Disposal and Treatment
Municipal Solid Waste - Incinerators

Low

Dredging and Dredge Disposal
Combined Sewer Overflow Discharges to Water
Sources of Air Pollution that Lead to Acid Deposition, Primarily from Tall Stacks
Traditional Underground Injection Control Wells (Class I - III)
Wastewood Disposal and Treatment

Not Ranked

Land Use Changes/Physical Modifications of Terrestrial Habitats
Land Use Changes/Physical Modifications of Aquatic Habitats (except Dredging)

RATIONALE FOR CANCER HEALTH EFFECTS RANKING

Application of Ranking Criteria

Consistency: The analyses of problem areas were not consistent in factoring in EPA actions. Various analyses assumed business as usual, no action, or future corrective action. Because every program will behave differently in the future, it is difficult to achieve consistency. Therefore, it was decided that the assumptions made regarding EPA action should be clearly stated in the discussion of the rationale for the rankings.

Individual Risk vs. Total Risk: The group decided to rank according to total incidence rather than on the basis of the maximum exposed individual alone.

Uncertainty: If the direction of the uncertainty was such that the cancer incidence could be higher than predicted, the problem area was given a higher ranking.

Qualitative vs. Quantitative: Qualitative assessments were not necessarily ranked lower than quantitative assessments. The group relied on the best professional judgement of the individuals most familiar with the problem area. For areas where a quantitative risk assessment was developed, the group used best professional judgment to rank the problem area in relation to those with a quantitative analysis. This affected only a small number of problem areas.

Trends: If the future risk was predicted to be greater than the current risk, the problem area was given a higher ranking.

Relative Ranking: The work group felt that the broad groupings of cancer risk (very high, high, medium and low) represented the significant differences in relative risks.

Discussion of Rankings

VERY HIGH

Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons

The cancer incidence numbers are for skin tumors. While the potential fatality rates associated with skin cancers are lower, Agency guidance considers all cancer sites equal (U. S. EPA, 1986a). Therefore the work group did not discount the cancer incidence numbers for Chlorofluorocarbons. The predictions were based on a national study (U. S. EPA, 1989g) which modeled projected cancer incidence, and Region II incidences were extrapolated based on a ratio of the population (i.e., Region II/nation). The national study used all modeled

information to calculate the number of cancer cases caused by ozone depletion. However, even if all anticipated actions are taken to reduce emissions of stratospheric ozone-depleting compounds, the projected cancer incidence will occur as predicted (at the low end of the range).

Issues of Concern:

There was moderate uncertainty in the methodology, however, the group was confident that the magnitude of the total incidence numbers was real. The model only includes people alive in 1986. Concerns were also raised regarding the timing of the model. The cancer incidence per year shown in Table I represents the total incidence for 74 years divided by the total number of years (74) to provide a yearly average incidence. The incidence numbers are not really what will be seen next year, but rather what will be seen in future years as ozone depletion increases the number of cancers.

Radon

Cancer incidence numbers for radon are lower than the high end of the range for indoor air. The work group thought this problem area should be ranked higher because the problem was well understood, the uncertainty was low, and the risks for indoor air and pesticides were considered overestimates. The analysis excludes Puerto Rico and the Virgin Islands because of the lack of data. The projected cancer deaths were based on monitoring data from the New Jersey Department of Environmental Protection. Estimates were made for New York's population.

The projected number of cancers represent cancer deaths since it is anticipated that the exposure will result in lung cancer which is currently 95 percent fatal.

Issues of Concern:

The group felt that extrapolating the numbers for New York made good sense, since New York and New Jersey have similar housing demographics (i.e., percentages of population residing in houses vs. high-rise apartments) and radon exposure.

Indoor Air Pollutants Other Than Radon

These cancer risks are caused primarily by second hand tobacco smoke, asbestos, and volatile organic compounds (e.g., formaldehyde) from building materials. The analysis was developed by a contractor who used a national risk study and factored out Region II numbers as a ratio of the total population.

Issues of Concern:

The national study was based primarily on homes, not workplaces, although environmental smoke probably includes offices. Consistent, monitored data were used, but the data were based on only a few studies. Uncertainty ranged from medium to low. The uncertainty arose from the number of sources (few studies), and the fact that it was difficult to quantify exposure. The assessment also assumed a 24-hour exposure while the period of exposure might be lower (because people are traveling to work, working outdoors, etc.). The assessment also included a number of pesticides that have been cancelled, thus potentially overestimating the risks.

HIGH

Mobile Sources of Air Pollution - Motor Vehicles

The risk for this problem area was calculated using the "Cancer Risk from Outdoor Exposure to Air Toxics" report developed by EPA (U. S. EPA, 1989e) which summarized information in 10 area-specific or national air quality based risk-related reports on air toxics, 14 EPA source category and pollutant-specific studies, risk assessments performed for the development of National Emission Standards for Hazardous Air Pollutants and source specific risk data contained in the EPA Air Toxic Exposure and Risk Information System (ATERIS). Predicted cancer incidence for Region II ranged from 65 to 124 cases per year. Cancer incidence from air toxics was considered to be underestimated and the air problem areas were ranked ahead of toxic waste sites. Another factor leading to air toxic sources being ranked higher than other problem areas is that the air route of exposure is more constant and more difficult to control than the groundwater and soil routes of exposure (the routes of most concern at toxic waste sites).

Issues of Concern:

The group decided to rank area and mobile air sources "back-to-back" due to difficulties in apportioning risk between the two.

Area Sources/Non-Point Sources of Air Pollution

This risk assessment was based on a national study and extrapolated to Region II for an estimated incidence of 36-57 cases per year. Another factor leading to air toxic sources being ranked higher than other problem areas is that the air route of exposure is more constant and more difficult to control than the groundwater and soil routes of exposure (the routes of most concern at toxic waste sites).

Issues of Concern:

Area and mobile air sources are difficult to model or quantify and separate.

Stationary Point Sources of Air Pollution

This problem area has a lower uncertainty and is easier to quantify than mobile or area air. Between 25 and 35 cancer cases are predicted per year. (See discussion for Mobile and Area sources).

Issues of Concern:

Due to difficulties in apportioning risk among the three air source problems the group decided to rank them together.

Abandoned Hazardous Waste Sites/Superfund Sites

This problem area includes sites regulated by CERCLA. Data for the analyses was retrieved from the Agency for Toxic Substances and Disease Registry (ATSDR) reports. Assessment of the health risks at Superfund sites are based on data before sites were cleaned up. The work group decided that this approach was reasonable because many non-National Priority List (NPL) sites have not yet been remediated. A potential increased individual cancer risk of 9.6×10^{-3} and a total population cancer incidence per year between 128 to 640 was calculated based on a range of 200 to 1,000 National Priority List and potential National Priority List sites. The projected cancer incidence is based on no remediation at the sites.

The exposure scenario resulting in the greatest cancer risk is the ingestion of drinking water. The ingestion of soil, however, also poses a significant risks and the cancer risks numbers are comparable to those found for drinking water. The uncertainty was high because the inhalation route of exposure and very high risk radiation sites were not addressed. It was also not possible to account for the effect that individuals may be exposed to several sites and may suffer deleterious health outcomes as a result.

Issues of Concern:

In the analysis, conservative assumptions were made in accordance with EPA and Superfund risk assessment guidance (U. S. EPA, 1986a-f; 1989a; 1989c). An effort was made to make the assumptions consistent with those in the other problem areas.

Considerable discussion took place in the work group meetings over the assumption that soil ingestion is a significant route of exposure and the number of people potentially exposed. Although significant risks also result from soil inhalation it was not possible to analyze this pathway because of the lack of inhalation toxicity numbers and appropriate models.

The work group decided that even though uncertainties existed in the Superfund analyses, these uncertainties exist for many problem areas and the relative ranking of Superfund (below air and above ingestion of contaminated fish) was appropriate.

Active Hazardous Waste Sites, Sites Currently Regulated under RCRA's Subtitle C

The problem area was ranked based on the similarities of the anticipated exposures from abandoned (CERCLA) and active sites (RCRA) requiring corrective action although there is much less data for the RCRA sites than for CERCLA sites. For purposes of this analysis, the sites were evaluated on the basis of the risks posed before permit/corrective actions are taken. Attempts were made to use information from sites in the region but that information was largely unavailable for these purposes. The group used the assumption that RCRA sites pose a risk level between 1×10^{-3} to 1×10^{-4}. There are 35,000 RCRA facilities in the region; these include not only Treatment Storage and Disposal facilities subject to permitting but also generators.

Issues of Concern:

The incidence numbers were much lower for this problem area compared to other problem areas given a high ranking. Even lacking quantitative data the group linked this problem with the Superfund problem in terms of severity based on the similarity of sites and an assumption of similarity in severity. Special concerns were raised about the large number of RCRA facilities in the region.

Non-point Sources of Water Pollution

Of all the water related problems, non-point sources were seen as the largest cancer risks based on potential exposure to polychlorinated biphenyls (PCBs), dioxin and chlordane. The two routes of exposure of greatest concern are drinking contaminated water and eating contaminated fish. Of these consumption of contaminated fish is considered the primary route of exposure since toxic substances are bioaccumulated from the sediments in fish tissues.

Following the initial ranking, the Water Management Division calculated potential risks for consumers of fish from non-point sources. The estimated risks were calculated for two consumer populations i.e., those ingesting 6.5 or 33

grams of fish/day. The risk calculations were based on potential fish tissue levels of 0.5 to 4.5 ppm of PCBs. The calculated potential cancer risks ranged from 1×10^{-2} to 1×10^{-4}. The estimated risks assumed that non-point sources were the only source of the PCBs. However, EPA's ambient water quality criteria are based on an incremental risk level of 1×10^{-6}.

Issues of Concern:

Site-specific information on the populations potentially exposed, the type of fish consumed, contributions to fish contamination from other sources (point sources and combined sewer overflows [CSOs]) were not available for this analysis. Populations of anglers were used in the absence of more specific data. Depending upon the type of fish and consumption pattern there is a potential for underestimation (research continues in the area of toxics in fish and state health department sampling and health advisories). The data that exist are insufficient to discriminate between point sources, non-point sources, and CSO contributions to fish contamination, but it does indicate that non-point sources contribute a considerably larger share. While in-place contaminated sediments were categorized as non-point sources, in many cases the sediments were initially polluted by point sources. Best professional judgment was used in ranking this problem area since data on shellfish contamination and the relative contributions of point and non-point sources could not be determined.

Information on the populations potentially ingesting these fish were also not available. General numbers of recreational anglers were estimated in the absence of more specific information. The potential for some ethnic populations to consume the entire fish was not assessed since specific information was lacking.

Pesticide Residues in Food

Cancer risks from dietary exposure to pesticide residues on food were estimated using EPA Office of Pesticide Program's Dietary Risk Evaluation System (DRES) and State and federal residue data. The analysis was developed by the Office of Policy, Planning and Evaluation (OPPE) and the Office of Pesticide Programs (OPP). In their study, OPP did not use the additive risk of different chemicals. The region used additive risk as indicated in the Agency's Risk Assessment Guidelines (U. S. EPA, 1986a). The potential cancer incidence ranged from 16.24 to 57.4 cancers per year.

Issues of Concern:

Only 7 chemicals were chosen for the OPP study out of more than 600 active chemicals, therefore the direction of the uncertainty is towards an underestimate. The uncertainty in the numbers was high. The analysis did not address potential risks from ingestion of dairy products, meats and poultry. Only fruits and vegetables were assessed.

With both Pesticide Residues in Foods and Pesticide Application, a major data gap is that information regarding the bioaccumulation of new pesticides is lacking. In addition, the carcinogens used in the analysis are B2 carcinogens (i.e., probable human carcinogens based on animal studies).

Municipal Solid Waste - Storage and Landfills

The analysis indicated an average risk of 1×10^{-4} with 2.85 million people potentially exposed. The problem did not address alternatives to municipal solid waste sites which will be potential problems for the future. Sixteen percent of municipal solid waste landfills in New York are known to exceed groundwater standards based on monitoring results. Monitoring data are not yet available for many of the active and inactive landfills. It is possible that 33 percent of the municipal solid waste landfills could be exceeding groundwater standards.

Based on EPA's Office of Solid Waste and Emergency Response (OSWER's) modelling of municipal solid waste landfills nationwide 40 percent are assumed to have risks of 1×10^{-4} or greater due to the existence of drinking water wells within 1 mile of the facility.

Issues of Concern:

The numbers probably underestimated the risk, because drinking water was the only route of exposure examined. There were no data available for other exposure routes. Some work group members felt it was the highest risk of all the hazardous waste problem areas. Thirty percent of all Superfund sites started as municipal solid waste sites. The risk calculations assumed the sites were being addressed by EPA. The uncertainty was high since the conclusions are primarily based on modeling data and site-specific information was not available.

MEDIUM

Non-Traditional Underground Injection Control Wells (Class IV and V)

Class IV wells are shallow injection wells which receive hazardous waste. Class V wells include sewage related, drainage, industrial drainage and service bay discharge. It was estimated that there are well over 50,000 Class V wells in Region II. The exact location of these wells was not available.

The primary risk from Class IV and V UIC wells is the potential contamination of groundwater by the chemicals injected into the wells. Potential exposures may occur through ingestion of contaminated water, dermal exposure (when bathing) and inhalation of volatiles while showering. The

population at risk are people located in industrialized areas and using drinking water supplied by private wells.

Using actual data from contaminated wells risk levels of 5×10^{-4} were calculated and the population potentially exposed was estimated at 3.67 million people. For the highest concentrations found at the wells only showering risks were calculated since the residents are drinking bottled water.

Issues of Concern:

The uncertainty associated with this problem area was high based on the lack of specific information on the number of wells, sampling methodologies, and the number of people potentially exposed. The exposure was based on 5 actual well concentrations and extrapolated to the rest of the region.

There was concern that the estimated population affected by Class IV and V was too high. It was placed as a medium risk because there will be more wells in the future and the wells are located within population centers. Using the same assumptions as the Superfund analysis (i.e., 30 year groundwater consumption), the incidence numbers for Class IV and V wells would increase dramatically.

Operation and Maintenance of Drinking Water Systems - Trihalomethanes, Lead, Microbiological Contamination

This problem area is not only a source, but also a route of exposure for other problem areas. It was artificially defined by using only those sources introduced by system maintenance, treatment and delivery systems (e.g., lead from delivery pipes, trihalomethanes (THM's), and by non-anthropogenic sources (e.g., bacteria and cryptosporidium), thereby eliminating the possibility of double counting. Chloroform was used as an indicator for THMs.

The analysis estimated that 20 million people could potentially be exposed to an average concentration of 34 ug/l of chloroform and 6 million people could potentially be exposed to a concentration of 209 ug/l of chloroform. The potential cancer risks associated with the average and maximum concentrations were 4.29 and 2.25 cases/year, respectively.

Issues of Concern:

The potential contribution of lead to the total cancer incidence was not evaluated since a slope factor was not available. The levels of THM's are potentially underestimated since there is the possibility for increases in these levels after they leave the treatment plant and before they reach the consumer.

Pesticide Contamination Associated with Application

The estimates were quantitative and based on a California study. The California numbers may not truly reflect Region II pesticide use, because different chemicals are used. Workers were identified with a potential 6 times higher rate of non-Hodgkins lymphoma than the general population.

The data from the Office of Pesticide Program's evaluation of risks from pesticides were also used to calculate the potential cancer risks for Region II. The results are provided in Table I.

Issues of Concern:

The study only looked at the farm community. It did not consider home or garden use, because of low exposure frequency. It was also noted that home users of pesticides tend to use 10 times more pesticides than recommended by the manufacturer. Potential acute impacts were evaluated under non-cancer analysis. The uncertainty is high due to major data gaps regarding bioaccumulation of newer pesticides.

Accidental Releases During Transport or Production

This problem area is highly unpredictable and difficult to quantify. The analysis is qualitative only. Currently, oil spills are the major group of accidental spills.

Issues of Concern:

Analysis of potential health impacts could not be calculated since routes and degree of exposure have not been well documented. Accidental releases were placed in the medium range with the caveat that it has the potential to be a very high risk problem (in the case of a Bhopal-like accident).

Materials Storage Tanks, Sites and Pipelines Not Regulated Under RCRA Subtitle C. (Underground Storage Tanks [USTS] and Others)

103,361 tanks were identified in this area. 5,461 confirmed releases were reported in 1989. In 1987 there were 935 releases that discharged directly into rivers, streams and lakes. It is a greater problem in rural areas where shallow domestic wells are more prevalent.

Issues of Concern:

This area had a high degree of uncertainty; actual releases may be higher. Although UST's are a major risk in a few select areas, overall it was concluded to be a medium risk.

Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water

This problem area includes all municipal and industrial wastewater treatment plants requiring National Pollution Discharge Elimination System (NPDES) permits. Primary industries such as paper manufacturers, pharmaceuticals, petroleum, organic or inorganic chemical producers, etc. discharge toxic substances including heavy metals, priority organics and inorganics.

The two routes of exposure of greatest concern are drinking contaminated water and eating contaminated fish. Of these, consumption of contaminated fish is considered the primary route of exposure since toxic substances are bioaccumulated from the sediments in fish tissue.

Following the initial ranking the Water Management Division calculated potential risks to consumers of fish from non-point sources. The estimated risks were calculated for two consumer populations i.e., those ingesting 6.5 or 33 grams of fish/day. The calculations were based on potential fish tissue levels of 0.5 to 4.5 ppm of PCBs. The calculated potential cancer risks ranged from 1×10^{-2} to 1×10^{-4}. The estimated risks assumed that non-point sources were the only source of the PCBs. However, EPA's ambient water quality criteria are based on an incremental cancer risk level of 1×10^{-6}.

Issues of Concern:

Previously unregulated point sources can contribute to non-point problems such as contaminated sediments. Some believe that even current levels of point source discharge of some toxics (e.g., PCB's) are adding to the problem; however, there are no definitive data. Pollution in the New York/New Jersey harbor area is a point source driven problem. High uncertainty was identified in this area since information on the types of fish, methods of fish sampling, consumption patterns for different types of fish, etc. were not available.

Information on the populations potentially ingesting these fish was also not available. General numbers of recreational anglers were estimated in the absence of more specific information. The potential for some ethnic populations to consume the entire fish were not assessed since specific information were not available.

Depending on the type of fish and consumption patterns there is a potential that the risks might be underestimated, however, the degree of underestimation could not be calculated. The data that exists is insufficient to discriminate between point sources, non-point sources and CSO contributions to

fish contamination, but it does indicate that non-point sources contribute to a considerably larger share.

Radiation Other Than Radon

The work group decided to modify the national definition of this problem area. Natural background radiation and medical exposure were eliminated. Medical exposure was excluded from the quantitative analysis since it is not an environmental risk. Some work group members felt radiation from electrical wires should be included in the definition.

Issues of Concern:

This area had a very high degree of uncertainty. A major caveat in this problem area is that not enough is known about non-ionizing radiation.

Municipal Sludge Disposal and Treatment

Assuming business as usual (i.e., dumping at the 106 mile site), this area is a low cancer risk. By December 31, 1991, however, ocean dumping will be banned and other forms of sludge disposal will have to be employed. These other forms of disposal (e.g., incineration, landfilling) have higher cancer risks associated with them. (see U. S. EPA, 1989f).

Issues of Concern:

Region-specific information on potential risks from incineration were unavailable and the cancer risks were based on national risks. There is a potential that these risks are underestimated because Region II has a potentially higher level of metals in its sludge. Based on present conditions this problem warranted a low ranking, but it was given a medium ranking on the basis of future trends.

Municipal Solid Waste - Incinerators

This analysis was primarily based on the proposed Brooklyn Navy Yard emissions and extrapolation from national incidence to Region II.

Issues of Concern:

Currently, there are 16 municipal solid waste incinerators in Region II, but this number is projected to increase. Potential risks when the number of incinerators is expanded to accommodate municipal waste and sludge were not included in this assessment. A report by the New York State Department of

Environmental Conservation that evaluates the potential risks associated with these incinerators is anticipated next year.

LOW

Dredging and Dredge Disposal

This problem area includes dredging of sediments from navigation channels, harbors, marinas and contaminated sediment remediation as well as the disposal of the dredge soils. PCBs and dioxin are major contaminants of concern for estimating cancer risks. The route of exposure would be ingestion of contaminated fish and shellfish.

Dredging was considered to be a low risk problem, because it is not very widespread compared to other water problems such as non-point source pollution, and the most contaminated sediments are left in place under current dredging protocols. Based on current information, one can assume that testing methods have reasonably characterized bioaccumulation impacts. Combined with current information on food chain transfer to human consumer species, it can be estimated that there is probably a low intensity of impact.

Issues of Concern:

Monitoring studies are underway to assess the bioavailability of the toxics in the dredge material. This information is necessary to assess human health risk.

Combined Sewer Overflow Discharges to Water

CSO's are a pathogen-driven problem area, and although it is a high non-cancer human health risk, it presents a low cancer risk.

Issues of Concern:

The amount of contamination contributed by CSO's, non point sources and point sources cannot be differentiated easily. See Non-Point Source and Point Source write-ups for additional information.

Sources of Air Pollution that Lead to Acid Deposition, Primarily from Tall Stacks

Potential cancer health impacts include releases of asbestos from asbestos-lined concrete containing systems resulting in a potential risk of 1.4 excess

cancers/year with a lower risk of 0. The potential risks from airborne exposure is 1.2 cancers/year with a lower estimate of 0.

Issues of Concern:

The estimates for this problem area were very rough with high uncertainty because it was difficult to quantify. Research on the potential human health impacts in this area are rated high since information on the toxicology is not available. Some work group members felt the incidence estimates were too high, and generally acid deposition was seen as a very low cancer risk.

Traditional Underground Injection Control Wells (Class I-III)

Class I wells include injecting deep hazardous and non-hazardous waste below drinking water aquifers. Class II wells are oil and gas recovery wells and Class III are solution mining wells. The wells are primarily located in New York State. Region II has no Class I wells; 1,190 Class II wells; and approximately 90 Class III wells.

Analysis of this problem area revealed a very low potential for groundwater contamination due to Class I-III wells. There have only been one or two instances of possible discharges into potable aquifers in this region, and there have been no documented contamination incidents. Use of Mechanical Integrity Tests that Class I - III wells must undergo assure against potential contamination.

Wastewood Disposal and Treatment

The human health impacts from wastewood burning are probably low or non-existent.

Not Ranked

Land Use Changes/Physical Modifications of Terrestrial Habitats
Land Use Changes/Physical Modifications of Aquatic Habitats (except Dredging)

NON-CANCER

Introduction

To complete an evaluation of the potential toxic effects from exposure to environmental contaminants, it is important to consider both the cancer and non-cancer health impacts for each problem area. Non-cancer health impacts vary depending on the dose, the exposure and the organ impacts. The health impacts can range from irritation of the upper respiratory tract to severe acute health impacts, including death.

In evaluating non-cancer health effects the Agency assumes there is a threshold, i.e., a safe level that a person can be exposed to without adverse effects. The degree to which the exposure is higher than the threshold indicates the potential for increased non-cancer health impacts. This analysis differs from the evaluation of cancer risks where the Agency assumes there is no threshold, i.e., no safe level of exposure, and each incremental increase in exposure results in an increased risk of cancer.

One problem in assessing non-cancer health impacts is the wide variety of health impacts associated with exposure, and the need to develop a weighting factor for assessing these impacts. The variety of health impacts makes the comparison of health problems difficult. Specific guidance for comparing health impacts and the assessment of systemic toxic effects is being developed by the EPA.

The Region II Risk Ranking project evaluation of potential non-cancer health impacts is based on the Unfinished Business report methodology (U. S. EPA, 1987), as modified by Region I. The methodology is described below.

Methodology

To assess the potential non-cancer health impacts from each problem area, the work group applied a scoring system that included three aspects of the risks associated with exposure: the severity of the health effects; the number of people exposed; and the potency of the exposure. A scoring system ranging from 1 to 4 was used. Under the system, 1 is the lowest or least effect score; 4, the highest or greatest effect score. The scores were then added to provide a numerical guide for the final ranking process.

The work group first evaluated the health endpoints using a severity scoring scale. Severity is essentially based on the reversibility of the potential health impacts. The scoring for potential chemical exposure in each problem area was based on available information on toxicological health impacts. Unfortunately, specific information on the effects of exposure to low levels of the chemicals was not available. In many cases, data on the identified occupational

health impacts (NIOSH, 1985) were used as an indicator of the potential health impacts for exposure to the chemicals of concern.

In specific cases direct information on environmental health effects was used. In the assessment of the potential impacts of Chlorofluorocarbons, cataracts were used as an indicator. In assessing the air problems, restricted activity days, increased asthma attacks, and angina were used to develop the score. Lead was rated a 4 based on the potential for several health impacts (i.e., effects on the central nervous system).

The severity score for pesticides on food was not easily determined since the potential impacts from exposure to low levels of pesticides found on fruit and vegetables are still being researched. Currently, there is a significant database of information on the acute effects from exposure to pesticides, but data on the long-term, low-level effects are not available. Therefore, the severity was qualitatively placed at 2-3 for the purposes of this analysis.

In addition to developing the severity score, the population potentially exposed was also evaluated. A scoring system of 1 to 4 was developed to evaluate the population exposed. A score of 1 represents 0 to 500,000 people; 2, 500,000 to 2,000,000 people; 3, 2,000,000 to 8,000,000 people; and, 4, 8,000,000 to 28,500,000 people. Attempts were made to assure that the severity score was associated with the correct population; however, the association was not always clear.

To characterize the potency of exposure, the group used two approaches, depending on what type of data was available. The first approach characterized whether the exposure level was above the oral Reference Dose (RfD) or inhalation Reference Concentration (RfC), the assumed thresholds for exposure. The order of magnitude by which the exposure level was above the RfD or RfC was scored using the following system: 1, 1 to 10; 2, 10 to 100; 3, 100 to 1,000 and 4 for greater than 1,000. In most cases, at least 1 or more of the chemicals of concern were above the RfD or RfC, and the problem area was scored appropriately.

If an RfD or RfC was not available, the alternative approach was to use available incidence data, i.e. the number of cases of a disease associated with the population exposed. The incidence data were converted to a number which represented the risk (e.g., 1×10^{-6} or one in a million) of contracting a disease in a specific population. A ratio score was calculated by dividing the annual incidence by the estimated population at risk. Incidence data was used to characterize many of the air and water problem areas where projections of the number of restricted activity days due to air pollution; asthma attacks; gastro-intestinal disturbances; etc., were available. The incidence data provides a better indicator of the potential health impacts than do exceedences of the RfD .

In the assessment of potential health impacts from lead, the group used the proposed Maximum Contaminant Level (MCL) of 15 micrograms/liter (ug/l) and the Ambient Air Quality Standard for air (1.5 ug/cubic meter). These were used in the absence of an RfD and RfC for the chemical.

The combined scores for severity; population exposed; and incidence or exceedence above the RfD or RfC were then combined to develop the total score for each problem area. The maximum possible score using this system was 12. In addition, an uncertainty estimate associated with each problem area was also developed to identify the data gaps in each problem area. As in the cancer analysis, uncertainty could be used to move a problem area up in the ranking.

Results

Using the ranking criteria, the very high problem areas scored a minimum of 8, with many having a total of 9 or 10. The medium scores ranged from 6 to 7. The low scores were less than 5, reflecting projected low impacts for the health effects, population exposed or severity.

During the rankings, it was obvious that although the scores provided an indication of the grouping of the problem areas, the method did not adequately address the large populations that are potentially affected in Region II. In many cases, the rankings were based on the best professional judgment of the group since the scoring did not provide the refinement needed to rank the problem areas more scientifically. It is important to remember that the methods and tools for non-cancer risk assessment are still evolving.

Uncertainties

A number of uncertainties were identified in the non-cancer ranking:

- Many chemicals lacked RfDs so that it was impossible to analyze the potential non-cancer health impacts from these chemicals. This could potentially lead to underestimation of the risks.

- Only 2 RfCs are available on IRIS (as of July 1990) so that an assessment of the non-cancer health impacts through inhalation could not be evaluated.

- The assessment of all potential routes of exposure could not be completed; only those routes where information was available were assessed. Specific exclusions include inhalation of dusts; soil ingestion; and exposure to contaminants on fruits and vegetables. This could potentially lead to underestimating the risks.

- Lead was addressed using the proposed MCL in water and the National Ambient Air Quality standards in air. This is a potential underestimate of

risk since EPA's Reference Dose Work Groups have not determined a threshold for this chemical.

- The association of population exposed to the level of exposure was not exact. In most cases the population could potentially be overestimated; however, this was a conservative approach.

- A description of the non-cancer health impacts from ingestion of pesticide residues on food was not developed by the Office of Policy, Planning and Evaluation (OPPE), the group that analyzed this problem. The analysis of the potential health impacts was based on a qualitative assessment of the problem in the absence of more specific data.

- The methodology was based on previous regional and Headquarters' risk ranking projects since specific Risk Assessment Guidelines on Systemic Toxicants are not available at this time.

- Significant uncertainties were associated with the assessment of the populations exposed. Given the population size of Region II (approximately 28.5 million in 1990) the uncertainty seriously complicated relative ranking judgments.

RATIONALE FOR NON-CANCER HEALTH EFFECTS RANKING

Application of Ranking Criteria

A scoring system was developed to rank the non-cancer human health impacts of the twenty-seven problem areas based on the rankings used for in the Unfinished Business Report (U. S. EPA, 1987) and the Region I Regional Ranking. The system was reviewed and modified by the work group. Health impacts, population at risk and severity of problem were scored 1 to 4 for each problem area. The three factors were summed for a total non-cancer health impact score. The group decided it would be inappropriate to consider the three factors independently.

Health Impacts: This category was based on toxicity (i.e., the endpoint health impacts). An issue of concern was whether the most frequent or most severe health effects should be considered. The group decided to use the most severe health impact. Examples of the scoring are provided below:

1) irritation, dermal sensitivity, tooth mottling
2) jaundice, irritability, allergic reactions
3) aggravation of angina, bone marrow hypoplasia
4) heart attacks, death, birth defects

TABLE III

NON-CANCER HEALTH EFFECTS RANKING

Very High

Mobile Sources of Air Pollution - Motor Vehicles
Area Sources/Non-Point Sources of Air Pollution
Abandoned Hazardous Sites/Superfund Sites
Active Hazardous Waste Sites Currently Regulated under RCRA Subtitle C
Chemical Use that Depletes the Ozone Layer -Chlorofluorocarbons
Indoor Air Pollutants Other Than Radon
Operation and Maintenance of Drinking Water Systems
Pesticide Residues in Food

High

Non-Point Sources of Water Pollution
Combined Sewer Overflow Discharges to Water
Industrial Point and Municipal/Public Wastewater Treatment Discharges to Water
Accidental Releases During Transport or Production
Pesticide Contamination During Application
Stationary and Point Sources of Air Pollution
Non-Traditional Underground Injection Control Wells (Class IV - V)

Medium

Municipal Solid Waste - Storage and Landfills
Material Storage Tanks, Sites and Pipelines Not Regulated Under RCRA Subtitle C
Sources of Air Pollution that Lead to Acid Deposition, Primarily from Tall Stacks
Dredging and Dredge Disposal
Municipal Solid Waste - Incinerators

Low

Municipal Sludge Disposal and Treatment
Traditional Underground Injection Control Wells (Class I - III)
Wastewood Disposal and Treatment

Not Ranked

Radon
Radiation Other Than Radon
Land Use Changes/Physical Modifications of Aquatic Habitats
Land Use Changes/Physical Modifications of Terrestrial Habitats

Population: The population categories were:

1) 0-500,000
2) 500,000-2,000,000
3) 2,000,000-8,000,000
4) 8,000,000-28,500,000

Severity: The severity index was used to rank the potential impacts from exposure. Two indices were used based on the available data. If available, the severity index was based on a comparison to the oral reference dose (RfD's). RfD's identify the threshold to which an individual can be exposed without adverse health effects. If the exposure is less than the RfD (or threshold), the health impacts are not considered significant. However, if the exposure dose is greater than the RfD (i.e., greater than 1) there is an increased concern about the health impact. The greater the exposure above the RfD, the greater the potential health impacts. The second approach used projected health incidence (i.e., number of gastro-intestinal upsets/population exposed, etc.) based on the estimate of the fraction of people exposed who exhibit a specific disease.

A major data gap with all problem areas is the lack of inhalation Reference Concentrations (RfCs). An issue of concern was that the air problems were limited to a severity of 1 to 2. In lieu of an RfC, the group determined a severity ranking based on the likelihood of the population at risk to develop the health impact. The RfD Scale is

1) 1-10 times the RfD or RfC;
2) 10-100 times;
3) 100-1000 times; and
4) > 1000 times.

The incidence score is:

1) $< 10^{-6}$ (less than 1 in a million);
2) 10^{-4} - 10^{-6} (from 1 in 10,000 to 1 in a million);
3) 10^{-2} - 10^{-4} (from 1 in 100 to 1 in 10,000); and,
4) $> 10^{-2}$ (greater than 1 in 100).

Discussion of Rankings

VERY HIGH

Mobile Sources of Air Pollution - Motor Vehicles

Exposure to particulate matter (10 microns per cubic meter or less, PM_{10}), can cause severe upper respiratory problems. Ozone (O_3) and carbon monoxide (CO) also contribute to a number of respiratory ailments and other

health problems. Mobile air sources contribute approximately 50 percent of O_3, 70 percent of CO and 25 percent of PM_{10}. The analysis looked at the potential health impacts from CO and lead. The health impacts were based on CO exposure leading to impaired mental capacity. Potential health impacts from angina were also evaluated but the score was less than that for CO. The potential health impacts from the other criteria air pollutants are evaluated in the area and stationary air problem areas where the contribution is the highest.

Issues of Concern:

It was difficult to apportion health impacts to mobile, area and stationary air sources.

Score: 1 - 2 health, 3 pop., 4 severity; total 8-9, uncertainty Medium

Area Sources/Non-Point Sources of Air Pollution

A major health concern is an increase in asthma cases which may be related to ozone exceedences. Area air sources contribute approximately 40 percent of O_3.

Issue of Concern: It was difficult to apportion health impacts to mobile, stationary and area air sources.

Score: 2-3 health, 4 pop., 1 severity; total 7-8, uncertainty Medium

Abandoned Hazardous Waste Sites/Superfund Sites

The pathways evaluated included drinking water, showering, soil and fish ingestion. The assessment of the health risks at Superfund sites are based on exposure data before sites were cleaned-up. The work group decided that this approach was reasonable because many non-NPL sites have not yet been remediated. The uncertainty is high because the inhalation route of exposure was not evaluated since there were no ambient air data or inhalation reference concentrations for the chemicals of concern.

Issues of Concern:

A major problem in the analysis was the lack of non-cancer data on the various chemicals to which the population is potentially exposed from Superfund sites. Considerable discussion took place in the work group meetings over the soil ingestion assumptions and the number of potentially exposed people. Although significant risks also result from inhalation of soil particulates, the group was unable to analyze this pathway because of the lack of inhalation Reference Concentrations and appropriate models.

Potential impacts of lead could not be assessed in the absence of a lead RfD and RfC. Potential impacts of exposure to multiple chemicals could not be assessed using an approach other than additivity, since research on synergism, antagonism, etc. is not available.

Score: 3 health, 3 pop., 3 severity; total 9, uncertainty High

Active Hazardous Waste Sites, Sites Currently Regulated Under RCRA's Subtitle C

The potential health impacts include responses to a variety of toxic chemicals also identified under the Superfund problem area since the sites are similar in severity and type.

Issues of Concern:

(Same issues of concern as Superfund). Specific site information is lacking since the program is only beginning to develop risk assessments for sites. Concerns were also raised about the large number of RCRA facilities and the number of corrective actions required. There was high uncertainty associated with the population score. The affected population may be lower than predicted.

Score: 3 health, 3 pop., 3 severity; total 9, uncertainty High

Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons

Cataracts are a major health problem associated with depletion of the ozone layer. The data are based on a national model (U. S. EPA, 1989g). The severity was based on projected incidence data.

Issues of Concern:

Yearly incidence was based on a model of the next 74 years and dividing by 74. Actual incidence may be considerably lower. The population at risk may be overestimated.

Score: 3 health, 4 pop., 2 severity; total 9, uncertainty High

Indoor Air Pollutants - Non-Radon

Environmental tobacco smoke is the major source of non-cancer human health impacts. CO and NO_x contribute to the non-cancer impacts for indoor air. The assessment included pesticides that are banned.

Issues of Concern:

Specific data were unavailable for the Virgin Islands and Puerto Rico. The analysis assumed they were at the same risk as the U.S. There was also a lack of severity data. The severity may be higher than 1.

Score: 3 health, 4 pop., 1 severity; total 8, uncertainty High

Operation and Maintenance of Drinking Water Systems, Trihalomethanes, Lead, Microbiological Contamination

This problem area is not only a source, but also a route of exposure for other problem areas. It was artificially defined by using only those sources introduced by system maintenance, treatment and delivery systems (e.g., lead from delivery pipes, trihalomethanes (THM's), and by non-anthropogenic sources (e.g., bacteria and cryptosporidium), thereby eliminating the possibility of double counting. Chloroform was used as an indicator for THMs.

Non-cancer estimates were calculated for chloroform, lead, Giardia and coliform. Lead, a cause of central nervous system damage, drives the health impact score. Since the RfD Work Group has not developed an RfD for lead the proposed MCL of 15 ug/l was used.

Chloroform was used as the indicator for trihalomethanes. However, since the other trihalomethanes, and some bacteria and viruses (e.g., Legionella and cryptosporidium) were not addressed, the risks from these problems could be significantly higher.

Issue of Concern:

The proposed MCL for lead was used in absence of an oral RfD.

Score: 4 health, 3 pop., 1 severity; total 8, uncertainty Medium-High

Pesticide Residues in Food

Pesticide exposure in occupational settings can result in potential damage to the central nervous system, teratogenic effects, etc. However, studies of the

potential health impacts from exposure to the low levels of pesticides that might be found on fruits and vegetables are currently being investigated.

The analysis for cancer was prepared by the Office of Policy, Planning and Evaluation with input from the Office of Pesticide Programs but an analysis for non-cancer effects was not provided. The work group developed the score for this problem area based on best professional judgement.

Issues of Concern:

Specific data on the potential central nervous system effects of pesticides in food are difficult to evaluate since experimental data on low level effects of pesticides are not available. There is a continuing need for additional research in this area. The uncertainty with this problem area was high, and the group felt the severity may be greater than 1.

Score: 2-3 health, 4 pop., 1 severity; total 7-8, uncertainty High

HIGH

Non-point Sources of Water Pollution

Potential ingestion of contaminated fish is considered the major route of exposure. Non-point sources are a pathogen-driven health impact. In addition, non-point source contaminants of concern include mercury, cadmium, lead, dieldrin and heptachlor epoxides.

Issue of Concern:

Site-specific information on the populations potentially exposed, the type of fish consumed, contributions to fish contamination from other sources (point sources and CSOs) were not available for this analysis. The data that exist are insufficient to discriminate between point source, non-point sources and CSO contributions to fish contamination, but it does indicate that non-point sources contribute a considerably larger share. While in-place contaminated sediments were categorized at non-point sources, in many cases the sediments were initially polluted by point sources. Best professional judgment was used in ranking this problem area since data on shellfish contamination and the relative contributions of point and non-point sources could not be determined.

Information on the populations potentially ingesting these fish were also not available. General numbers of recreational anglers were estimated in the absence of more specific information. The potential for some ethnic populations to consumer the entire fish was not assessed since specific information was lacking.

Potential impacts from drinking pathogenically contaminated water are a part of the drinking water problem area.

Score: 3 health, 3 pop., 2 severity; total 8, uncertainty High

Combined Sewer Overflow (CSO) Discharges to Water

This problem area is pathogen driven. Although the CSOs are confined to a limited geographic area, the impacts in these areas can be severe. The primary routes of exposure are ingestion of contaminated fish/shellfish and primary contact recreation. Recreational fisherman and lower income groups who eat contaminated fish and shellfish regardless of fishing bans represent the population at the greatest risk.

Issues of Concern:

The amount of contamination contributed by CSOs, non-point sources and point sources cannot easily be differentiated or quantified. Also there is some uncertainty associated with the population actually exposed.

Score: 3 health, 3 pop., 2 severity; total 8, uncertainty Low

Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water

The major contributors to point source problems are publicly owned wastewater treatment plant (POTW) breakdowns. Point sources have been regulated for a long time and the program has had a very positive effect; however, this problem area still ranks high due to treatment plant breakdowns that cause untreated discharge. In Region II, a number of New York/New Jersey interstate waters fail to meet the fishable/swimmable goals of the Clean Water Act due to high levels of fecal coliform bacteria.

Issue of Concern:

There has been much recent research on anthropogenic impacts to reefs in the Caribbean. Some believe that point source discharges and land use changes on Puerto Rico and other islands have contributed to the growth of undesirable algae that cause neurotoxic impacts (e.g., Ciguera toxin).

The amount of contamination contributed by CSOs, non-point sources and point sources cannot easily be differentiated or quantified. Also there is some uncertainty associated with the population actually exposed.
Score: 2-3 health, 3 pop., 2 severity; total 7-8, uncertainty High

Accidental Releases During Transport or Production

There are two possible scenarios of non-cancer health impacts: 1) acute impacts (e.g., explosion, fire, acute toxic chemical exposure, and multiple exposures), and 2) chronic impacts based on a single acute exposure.

Issues of Concern:

This area is impossible to predict. A Bhopal-type accident would cause the ranking for this problem area to skyrocket. The group decided to give it a score of 8 with the understanding that there was a high uncertainty resulting from the lack of data.

Score: 4 health, 1 pop., 3 severity; total 8, uncertainty High

Pesticide Contamination Associated with Application

Impacts include acute effects to the central nervous system and potential teratogenic effects. Data from actual cases within Region II were used in assessing this problem area.

Issue of Concern:

The assessment did not address residential use/abuse of pesticides.

Score: 4 health, 1 pop., 3 severity; total 8, uncertainty Medium

Stationary Point Sources of Air Pollution

Stationary sources contribute approximately 95 percent of sulfur dioxide (SO_2) emissions produced within the region. SO_2 was used as the chemical of concern to identify health impacts from this problem area. Based on the analysis the health impact was rated a 1 for restricted activity days; the population in the non-attainment area is 9,351,534 and the incidence calculated at 3,700,759 people with restricted activity (3.95×10^{-1}). The projected incidence was based on a model.

Lack of RfCs and chemical specific data did not allow the group to evaluate the potential health impacts from the chemicals of concern (i.e., benzene, products of incomplete combustion, etc.).

See descriptions of mobile and area sources for a discussion of the uncertainties associated with the separation of these three problem areas.

Issues of Concern:

There is a need for specific separation of mobile, area and stationary air sources. The severity, which was based on the projected number of asthma cases from exposure to stationary air sources. Potential contributions to other health effects could not be evaluated.

Score: 1 health, 4 pop., 4 severity; total 9, uncertainty Medium

Non-traditional Underground Injection Control Wells (Class IV-V)

Health impacts can be caused by a large number of toxic chemicals which are found in these wells leaching into the groundwater. The calculations were based on one documented incident in which there was gross contamination of a private well by a few chemicals.

Issue of Concern:

Because this is a new program, the actual number and location of injection wells, their contribution to the concentration of toxics in drinking water wells and the population exposed are not well defined. Possible chemical synergistic and antagonistic effects could not be evaluated. The uncertainty was high because the actual number of wells and population potentially impacted is not known.

Score: 3 health, 3 pop., 2 severity; total 8, uncertainty High

MEDIUM

Municipal Solid Waste - Storage and Landfills

The ranking is based on current impacts on drinking water.

Issues of Concern:

The potential for further problems based on the inability to develop additional landfills was not addressed. Based on the paucity of exposure data the severity was rated 1; the severity may be too low.

Score: 3 health, 3 pop., 1 severity; total 7, uncertainty High

Material Storage Tanks, Sites and Pipelines Not Regulated Under RCRA Subtitle C (Underground Storage Tanks [USTs] and Others)

UST's are a problem of special concern in rural areas where wells are shallow. Potential exposures include petroleum products, gasoline, etc.

Issue of Concern:

Data gaps exist with severity, it may be greater than 1.

Score: 3 health, 3 pop., 1 severity; total 7, uncertainty High

Sources of Air Pollution that Lead to Acid Deposition, Primarily from Tall Stacks

Health impacts include lung damage caused by asbestos or particulate deposition.

Issues of Concern:

Work group members questioned the degree to which this area is a sulfate-driven problem. The uncertainty is extremely high due to a lack of toxicological information. Population and severity may merit higher scores.

Score: 3 health, 1 pop., 1 severity; total 5, uncertainty Very High

Dredging and Dredge Disposal

Dredging is a problem with contaminated sediment in urban areas. The primary route of exposure is through consumption of contaminated fish and shellfish.

Based on current information, the major potential impact is to the benthos. In order to assess health impacts it is necessary to assess food chain transfer or magnification to consumer species from the benthos. It is also necessary to assess human fish consumption information for Region II populations. Based on current information, it was assumed that testing methods have reasonably characterized bioaccumulation impacts. Combined with current information, on food chain transfer to species consumed by humans, it was estimated that there is probably a low intensity of impact. However, without field monitoring results, high confidence inferences on health impact are difficult.

Issues of Concern:

Data on fish species, chemical concentrations, etc. were not available for evaluation. The high uncertainty was due to a lack of bioaccumulation information. Monitoring studies are underway to assess the bioavailability of the toxics in the dredge material. This information is necessary to assess human health risks.

Score: 2 health, 2 pop., 1 severity; total 5, uncertainty High

Municipal Solid Waste - Incinerators

The health impacts were predicted to be higher in the future as the number of incinerators increases.

Issues of Concern:

Specific data on health impacts from current incinerators will not be available until next year. The potential impacts of increasing the number of sludge incinerators were not addressed under this problem area.

Score: 2 health, 1 pop., 1 severity; total 4, uncertainty Medium

LOW

Municipal Sludge Disposal and Treatment

There seems to be no impact now, but the work group did not discuss future problems when disposal of municipal sludge is banned from the ocean. The risks were based on the national studies (U. S. EPA, 1989f).

Score: 0 health, 0 pop., 0 severity; total 0, uncertainty High

Traditional Underground Injection Control Wells (Class I-III)

These are wells that inject fluid below drinking water aquifers. There have been only one or two instances of possible discharge into potable aquifers in this region, and there have been no documented contamination incidents.

Score: 0 health, 0 pop., 0 severity; total 0, uncertainty High

Wastewood Disposal and Treatment

Currently the Army Corps of Engineers is the only woodburning at sea permittee and operates under a one year interim permit issued by EPA. The permit contains several special conditions to assure minimal environmental and health impacts.

It is expected that wood-burning at sea will be phased out by the end of 1991. Based on this information the work group concluded that the potential human health risks were negligible.

Score: 0 health, 0 pop., 0 severity; total 0, uncertainty Low

Not Ranked

Radon
Non-Radon Radiation
Land Use Changes/Physical Modifications of Aquatic Habitats (except Dredging)
Land Use Changes/Physical Modifications of Terrestrial Habitats

COMBINED CANCER AND NON-CANCER

The work group attempted to combine the cancer and non-cancer rankings for each problem area in an effort to understand the total health impacts presented by the problem areas. It is important to realize that the Agency uses distinctly different approaches in analyzing health risks for cancer and non-cancer effects based on the biological mechanisms of action.

Initially, the work group discussed the possibility of a numerical approach to combining both scorings. However, this approach involved the following uncertainties:

- The biological mechanisms are different.
- Different methodologies are used to assess the potential health impacts for cancer and non-cancer and a method for addressing these uncertainties was not available.
- Different guidance is available for developing risk assessments in these areas.
- Each individual cancer and non-cancer ranking involves a number of uncertainties which in turn must be considered in the combined cancer/non-cancer assessment.
- The cancer analysis was primarily quantitative while portions of the non-cancer analysis were based on a qualitative approach.
- The ranking methods and uncertainties associated with each problem area in the cancer and non-cancer ranking varied.

In addition, any attempt to combine the rankings quantitatively requires an implicit weighting of cancer and non-cancer effects which is beyond the scope of this project.

In the absence of a quantitative method for assessing the cancer/non-cancer health impacts, the work group used a qualitative approach to combine the rankings. First, the problem areas that were ranked very high in both cancer and non-cancer were combined into the very high category of the cancer/non-cancer ranking. This process was followed for each of the other ranking categories.

The problem areas that did not appear in the same category on both lists were reviewed and discussed, and a qualitative judgment made as to the relative position of the problem area for the combined ranking. In most cases, the higher ranking was used to determine the combined ranking.

Following the initial categorization of the problem areas, attempts were made to rank the problem areas in the very high, high, medium and low categories. The final ranking, shown in Table IV, reflects a qualitative assessment only.

TABLE IV

COMBINED CANCER AND NON-CANCER HEALTH EFFECTS RANKING

Very High

Chemical Use that Depletes the Ozone Layer -Chlorofluorocarbons
Radon
Indoor Air Pollutants Other Than Radon
Mobile Sources of Air Pollution - Motor Vehicles

High

Area Sources/Non-Point Sources of Air Pollution
Abandoned Hazardous Waste Sites/Superfund Sites
Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C
Non-Point Sources of Water Pollution
Pesticide Residues in Food
Stationary and Point Sources of Air Pollution
Operation and Maintenance of Drinking Water Systems

Medium

Combined Sewer Overflow Discharges to Water
Municipal Solid Waste - Storage and Landfills
Other Underground Injection Wells (Class IV and V)
Accidental Releases During Transport or Production
Pesticide Contamination Associated with Application
Industrial Point and Municipal/Public Wastewater Treatment Discharges to Water
Material Storage Tanks, Sites and Pipelines Not Regulated Under RCRA Subtitle C

Low

Municipal Sludge Disposal and Treatment
Dredging and Dredge Disposal
Municipal Solid Waste - Incinerators
Sources of Air Pollution that Lead to Acid Deposition, Primarily from Tall Stacks
Radiation Other Than Radon
Traditional Underground Injection Control Wells (Class I - III)
Wastewood Disposal or Treatment

Not Ranked

Land Use Changes/Physical Modifications of Terrestrial Habitats
Land Use Changes/Physical Modifications of Aquatic Habitats

Chapter Three: Ecological Effects Ranking

Introduction

The following is a summary of the results of the Region II Risk Ranking Work Group's comparative ranking of twenty-three ecological problem areas (See Table V). The rankings are based on individual problem area reports prepared by work group members, other EPA staff, or by EPA contractors. The object of each report was to analyze the components of the problem in terms of the associated chemical or physical stressors, the related exposure pathways for each stressor, and the expected ecological risk or harm from each stressor to each major ecosystem category. The broad ecosystem categories that were considered are described in Figure 1.

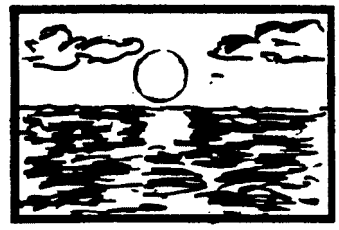
The problem area ranking was based in large part on combining scores for the following criteria: ***intensity*** of ecological impact, ***scale*** (i.e., fraction of the resource affected), and the ecological ***value*** of the affected resource. The three separate scores were summed for each problem area, with the highest scores indicating the worst effects. An additional criterion, ***uncertainty***, provided a subjective evaluation of the overall uncertainty of the risk estimates for each analysis. (See Table VI.)

An important consideration in the scoring was maintaining consistency across the criteria. In other words, if the intensity score was 5, the scale and value scores would have to be based on the ecosystems subject to that intensity (5) of impact. Initial scoring recommendations for each problem area were provided by the work group member responsible for each analysis. Generally, the work group did not alter these scores. However, the group decided not to follow those scores strictly when assigning rankings to the problems.

The decision to avoid a strict adherence to the scores during the relative ranking was designed to counterbalance some of the subjective values that influenced those scores and to ensure that professional judgment about severity and impact had some influence on the final rankings. This decision also allowed the work group to focus its discussions on the nature and impacts of the problems rather than on the scoring system and its application.

Final rankings were based on group consensus about the relative threats posed by the problems, taking into consideration the scoring recommendations and the group discussion. The problem area summaries that follow describe the major issues that went into the ranking considerations. The broad groupings of ecological risk (very high, high, medium, and low) are intended to represent

ECOSYSTEM/RECEPTOR CATEGORIES



Oceans - *All deep coastal waters, extending to international boundaries and including near coastal waters that are not estuarine.*

Estuaries - *Semi-enclosed areas where fresh and marine waters mix and/or river flows are influenced by the tides. This category includes tidal wetlands.*

Freshwater Wetlands - *All inland areas that exhibit the characteristics of a wetland as defined by the Army Corps of Engineers.*

Rivers, streams and lakes - *All navigable waterways and their tributaries, as well as all man-made and naturally occurring inland bodies of water other than the Great Lakes.*

Great Lakes - *Treated separately from other lakes in the Region because of size and complexity.*

Forest and other Non-Agricultural Upland - *All wooded areas including parks,wildlife refuges, commercial forest lands, and other non-agricultural upland habitats such as meadows and grassland.*

Agroecosystems - *All farmland and surrounding buffer areas.*

Figure I

TABLE V

Ecological Problem List[1]

1. Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water
2. Combined Sewer Overflow Discharges to Water
4. Non-point Sources of Water Pollution
5. Traditional Underground Injection Wells (Classes I-III)
6. Other Underground Injection Wells (Class IV-V)
7. Land Use Changes/Physical Modifications of Aquatic Habitats other than Dredging
8. Land Use Changes/Physical Modifications of Terrestrial Habitats
9. Dredging and Dredge Disposal
10. Municipal Sludge Disposal and Treatment
11. Wastewood Disposal or Treatment
12. Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C
13. Abandoned Hazardous Sites/Superfund Sites
14. Municipal Solid Waste - Storage and Landfills
15. Municipal Solid Waste - Incinerators
16. Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C
17. Accidental Releases During Production or Transport
18. Pesticides Contamination during Application
20. Stationary and Point Sources of Air Pollution
21. Mobile Sources of Air Pollution - Motor Vehicles
22. Area/Non-point Sources of Air Pollution other than Chlorofluorocarbons
23. Extra-Regional Sources Leading to Acid Deposition
26. Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons
27. Radiation other than Radon (effects from uncontrolled waste considered under problems 12 and 13)

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[1]*The following problems areas were not evaluated since they were presumed to present negligible threats to ecosystems: 3. Operation and Maintenance of Drinking Water Systems; 19. Pesticide Residues on Food; 24. Radon; and 25. Indoor Air Pollutants other than Radon. This list follows the numbering scheme of the master list for the Regional Ranking Project. The order of the master list is* **not** *related to the rankings.*

TABLE VI

Ecological Ranking Criteria

Intensity of Impact	5 =	Severe impact, major changes in species composition, decreased biodiversity, high mortality of indicator species, low reversibility, or outright habitat destruction.
	3 =	Moderate impact compared to above
	1 =	Negligible or minor impacts
Scale	5 =	Widespread impacts; greater than 50% of resource affected
	3 =	20-30% of resource affected
	1 =	<10% of resource affected
Value	5 =	Impacted systems are of vital ecological significance (areas of high diversity or productivity, major spawning grounds or migratory pathways, highly sensitive to perturbation, unique ecologically, important to other systems for uptake/cycling of nutrients or contaminants, etc.)
	3 =	Moderate ecological value (commonly found species, widely found habitat type, etc.)
	1 =	Low value (e.g., highly industrialized, or developed areas)
Uncertainty		High, Medium , or Low descriptor for the overall uncertainty in the analysis, its relevance to the ranking criteria, and the accuracy of the risk estimates.

significant differences in relative risks (Table VII). There was less confidence in the placement of problem areas within each group. For example, the work group is confident that areas ranked "high" pose greater threats than those ranked "low", but has less confidence that the order of priorities within each group is exact.

Several aspects of the ranking are noteworthy.

- The two highest-ranking problems deal with the effects of land use on aquatic and terrestrial habitats. Although EPA has limited authority over land use, there was strong agreement that development is the major threat to some of Region II's important ecological resources. Risks to coastal systems and fresh water wetlands were considered to be particularly significant. The Science Advisory Board (SAB) has also identified habitat loss as a major problem that EPA needs to address.

- Sources of acid deposition and non-point source pollution to surface water were also ranked very high. Acid precipitation is widespread in the Northeast and threatens forest systems, high-altitude lakes, and the pine barrens. Nonpoint source pollution generates a wide variety of ecological stressors and adversely impacts a high percentage of Region II's surface waters.

- Although the work group placed chemical uses that deplete the ozone layer into the "high" rather than "very high" risk category, there are some unusual aspects to this problem that should be noted. The ranking is based on predicted effects on plants at *current* exposure levels. Although the work group was skeptical of some of the scenarios presented in an Agency study, future damage to terrestrial vegetation and phytoplankton and contribution to global warming *could* be catastrophic. The SAB has recommended that this type of problem, which has a very high uncertainty, but has huge potential risk and low reversibility, should be acted on even before additional research can confirm the predictions.

- Global climate change was the SAB's most highly ranked ecological problem, and was another large scale problem that the SAB recommended action on in the face of uncertainty. However, the Region II list did not include climate change as a separate problem area, since it was a list of pollution sources rather than effects. However, climate change impacts are discussed separately under the problem areas that contribute to the emission of "greenhouse" gases such as carbon dioxide, methane, chlorofluorocarbons and nitrous oxide (i.e., all of the air pollution problem areas, and the land use problem areas). However, the work group considered climate change to be one of the most significant threats to the region's ecosystems.

- Accidental releases also present a difficult problem in terms of relative risk ranking. The "medium" ranking was based on spills occurring in an "average" year. But the prospect of a very large release into ecologically important areas is difficult to factor into the overall analysis.

- Problems that involved toxic contamination were generally ranked lower than problems that cause more overt damage via habitat degradation, nutrient loadings, reduced oxygen levels, and acidification. However, certain geographic regions (e.g., the Niagara Frontier, the Hackensack Meadowlands) were identified; these ecosystems are significantly threatened by toxic pollutants.

- Two problem areas -- municipal sludge disposal and dredging -- were ranked low in terms of ecological risk, even though these areas have generated significant public concern. Although monitoring at the deep water sludge disposal site in the Atlantic is still under way, ocean disposal of sludge at that site is not anticipated to produce significant impacts on oceanic or coastal ecosystems. There is some uncertainty about the severity of impacts on bottom-living (benthic) communities from dredging. Nevertheless, impacts at disposal sites and dredged channels are localized, and the problem area was ranked lower in priority than many others.

Because of extensive data gaps and the lack of any generally accepted quantitative model for comparing ecological risks, best professional judgment was relied on rather heavily in this analysis. The final ranking represents a qualitative evaluation of the effect of various pollutant sources and human activities on the region's ecological resources. For a majority of the problem areas, ecological resource data and direct measures of impacts on biota and biological communities were either unavailable or difficult to obtain. This was particularly true in regard to the information needed to support judgments about intensity of impact (changes in biodiversity, population numbers of select species, biomass, and community structure related to environmental stressors), and ecological value of threatened or impacted resources in Region II.

A more quantitatively based analysis would require a shift in the way the Agency currently monitors ecosystems and stores and interprets environmental data. Such a shift is already occurring, with recent changes in EPA data systems, the advancement of geographic information system technology, the ongoing development of biocriteria and bioindicators, and the Office of Research and Development's environmental mapping efforts. However, the Agency has long focused on human health concerns, and a shift in its culture and capabilities is likely to take some time.

TABLE VII

ECOLOGICAL EFFECTS RANKING

Very High

Land Use Changes/Physical Modifications of Aquatic Habitats other than Dredging
Land Use Changes/Physical Modifications of Terrestrial Habitats
Extra-Regional Sources Leading to Acid Deposition, Primarily from Tall Stacks
Non-point Sources of Water Pollution

High

Pesticides Contamination During Application
Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water
Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons[1]
Combined Sewer Overflow Discharges to Water

Medium

Mobile Sources of Air Pollution - Motor Vehicles
Area/Non-point Sources of Air Pollution Other Than Chlorofluorocarbons
Accidental Releases During Production or Transport
Stationary and Point Sources of Air Pollution
Municipal Solid Waste - Storage and Landfills
Abandoned Hazardous Sites/Superfund Sites
Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C

Low

Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C
Dredging and Dredge Disposal
Municipal Solid Waste - Incinerators
Other Underground Injection Wells (Class IV-V)
Municipal Sludge Disposal and Treatment
Radiation other than Radon
Traditional Underground Injection Wells (Classes I-III)
Wastewood Disposal or Treatment

Not Ranked

Operation and Maintenance of Drinking Water Systems
Pesticide Residues on Food
Radon
Indoor Air Pollutants Other Than Radon

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[1]*Based on current impacts on plants. Ecological risks could be catastrophic if predictions are accurate. Analysis, however, has very high uncertainty.*

RATIONALE FOR ECOLOGICAL RANKINGS

VERY HIGH

Land Use Changes/Physical Modifications of Aquatic Habitats other than Dredging

Includes physical modifications that cause disruption of aquatic habitats such as dam construction and operation; flood control channelization; filling for highways, housing, industrial areas and landfills. The geographic extent of land use changes/physical modifications of aquatic habitats encompasses most of the region. Impacts are particularly severe in the region's coastal areas. While much of the ecologically important aquatic habitat has already been lost in urban areas, the few remaining areas are oases for rare and endangered species. The undeveloped areas in the region are at high risk for habitat loss or degradation. Wetlands are vital ecological breeding grounds and habitats for many aquatic species. Wetland modifications are highly irreversible and severely impact aquatic species. There was a strong consensus among work group members that this problem area presented the highest ecological risk.

Issues of concern: Work group members questioned whether all wetlands are high value ecosystems. Wetland acreage losses are estimates, there are no data on total acreage losses.

Information Sources: Several technical reports and contractor habitat loss estimates.

Score: Intensity 5, Scale 5, Value 5, Total 15, Uncertainty M-H

Land Use Changes/Physical Modifications of Terrestrial Habitats

Includes physical modifications that cause disruption of terrestrial habitats such as flooding from dams; pipeline construction; flood control channelization. This problem area focused on the loss or conversion of forests and agricultural land. Urban sprawl is contributing to piecemeal elimination of farmland and forest areas in the region and is reducing or degrading habitat for wildlife and crop production. Although some increase in forested areas has been observed in New York and Puerto Rico, replacement forests are of lower value as wildlife habitat.

Issues of concern: Some group members did not feel that all terrestrial habitats warranted a value score of 5. Therefore, even though they have equal scores, wetlands loss was ranked higher. Also, not all the forest or rural lands are being degraded. Much of the interior of New York State, for example, is not being developed.

Information Sources: Several technical reports and contractor habitat loss estimates.

Score: Intensity 5, Scale 5, Value 5, Total 15, Uncertainty M-H

Extra-Regional Sources Leading to Acid Deposition

This problem area includes sources of precursor pollutants contributing to acid precipitation originating from outside the region including utilities, transportation, and other industrial and commercial processes. The deposition of acidic particulates is exceeding calculated environmental threshold values over much of the New York and New Jersey region. Detrimental effects have been observed in several of the region's sensitive ecosystems, including the Adirondack and Catskill regions of New York and the Pine Barrens in New Jersey. Adverse impacts range from moderate to severe, however both the severity and some of the causes are still widely debated amongst different members of the regulatory and scientific community. Detrimental effects of acid deposition have been observed in several of Region II's most sensitive ecosystems. The impacts vary from moderate to severe, but the systems worst hit are the most pristine.

Issues of concern: The description of ecological impacts varies greatly depending on the data source. The extent of the ecological threat from acid precipitation is still the subject of debate in the regulatory and scientific community.

Information Sources: The NAPAP Study and other research literature.

Score: Intensity 5, Scale 3, Value 5, Total 13, Uncertainty Medium

Non-point Sources of Water Pollution

Non-point sources (NPSs) of water pollution include contaminated and non-contaminated sediments, airborne deposition of toxic compounds, and runoff from urban, agricultural, silvicultural and resource extraction activities. Atmospheric deposition, nutrients, and sediments are the most frequently occurring NPS pollutants in Region II. Principle ecological stressors include sediments, nutrients, acids, heavy metals, toxic organics, and oxygen demanding compounds. Nutrients cause eutrophication in impoundments, and sediments destroy benthic organisms and pose a threat to the unique coral reefs in the Virgin Islands. Because much of the region is highly urbanized, urban runoff presents a significant problem. Impacts from nutrients associated with agriculture continue to pose problems in New Jersey, New York and Puerto Rico.

Issues of Concern: In order to avoid double counting, non-point sources were artificially defined to exclude pesticides. Scores for this problem area were driven by contaminated sediments. Due to data limitations, non-point source impacts are difficult to quantify and the analysis has high uncertainty.

Information Sources: State NPS Assessment Reports, and 305(b) Reports.

Score: Scores were determined for each area in Region II:
NY: Intensity 4, Scale 4, Value 4, Total 12
NJ: Intensity 5, Scale 4, Value 4, Total 13
PR: Intensity 4, Scale 4, Value 5, Total 13
VI: Intensity 3, Scale 2, Value 5, Total 10

The total score is not necessarily an average of these scores. The group member responsible for developing the scoring was also responsible for determining an aggregate score for the region.

Aggregate Score: Intensity 4, Scale 4, Value 4.5, Total 12.5, Uncertainty High

HIGH

Pesticides Contamination during Application

Pesticide application includes air pollution drift and non-point source runoff. Acute impacts to non-target biota are likely during application, but data are sparse. Most non-point source pesticides impacts are from pesticides no longer in use such as DDT. NPS impacts can range from fish kills (short term) to various chronic impacts on fish populations and aquatic communities.

Issues of Concern: High uncertainty was associated with the fact that this is a difficult problem to quantify or model and environmental exposure data are limited.

Information Sources: Various literature sources, Headquarters contractor analysis.

Score: Intensity 4, Scale 4, Value 4, Total 12, Uncertainty High

Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water

This area includes industrial point discharges and municipal/public wastewater treatment discharges. Due to effective regulation, most of Region II's waters are not severely impacted by point source pollution, however, some

waters in industrialized areas have been significantly impacted. The 304(l) short list describes all point source driven toxic problems. Point sources also contribute to nontoxic ecological problems (i.e., excessive nutrients).

Issues of Concern: Some group members felt the value was too high, because the impacts occur in industrialized areas. However, since 84 percent of all commercial fish species come into estuaries and harbors (e.g., New York Harbor) to spawn, it was decided the value did merit a 5. The intensity was given a 4, due to waters not meeting standards for fish propagation or fish passage. According to New Jersey's State Water Quality Assessment (305(b) Report), 38 percent of New Jersey's waters do not meet the standards for fish propagation. The report does not differentiate, however, between point and non-point sources. The group felt point sources were a lesser ecological risk than non-point sources (New York's 305(b) report apportions 80 percent of water pollution impacts to non-point sources and 20 percent to point sources).

Information sources: State 305(b) Reports and State 304(l) Lists.

Score: A score was determined for each area in Region II:
NY: Intensity 4, Scale 3, Value 3, Total 10
NJ: Intensity 4, Scale 4, Value 3, Total 11
PR: Intensity 5, Scale 3, Value 5, Total 13
VI: Intensity 4, Scale 1, Value 5, Total 10

The total score is not necessarily an average of these scores. The group member responsible for developing the scoring was also responsible for determining an aggregate score for the region.

Aggregate Score: Intensity 4, Scale 3, Value 5, Total 12, Uncertainty Medium

Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons

Includes impacts resulting from increased UV radiation due to man-induced thinning of the stratospheric ozone layer. Increased UV radiation can disrupt terrestrial and aquatic ecosystems, and lead to increased mutation rates. Ranking is based primarily on current impacts on plants. Ecological risks could potentially be catastrophic if predictions concerning impacts on phytoplankton and resulting food chain effects are accurate. The analysis, however, has very high uncertainty.

Issues of Concern: The ecological impacts from CFCs are potentially cataclysmic, but the projected impacts are all future theoretical damages. The uncertainty of this area was very high, and the impacts may not be seen for several years. CFCs were originally ranked higher, but the ranking was reduced because the work group viewed some of the predicted impacts with skepticism. The group

decided to rank this problem area in the "High" rather than "Very High" risk category, with the caveat that the ecological impacts could be much greater.

Information Sources: One EPA and one UN study.

Score: Intensity 4, Scale 4, Value 4, Total 12, Uncertainty Very High

Combined Sewer Overflow Discharges to Water

Combined sewer overflows (CSOs) occur when storm events cause such a large volume of water to flow through sewers that treatment works must allow a significant amount to bypass the plant without treatment. Floatables from CSOs represent a hazard to marine life and birds. High levels of nutrients and oxygen demanding substances following storm events can lead to low oxygen conditions and result in degradation of aquatic communities and fish kills. In industrial areas oils, grease, and toxic organics, which present both acute and chronic risks to aquatic organisms, are also released following storm events. New York/New Jersey Harbor shows significant impacts. Moderate impacts also noted for Lake Ontario, and minor or negligible impacts described for Camden County, Puerto Rico and the Virgin Impacts.

Issues of Concern: CSOs were initially ranked below air and hazardous waste problem areas but CSOs were later elevated with non-point and point sources on the basis of high values assigned to harbors and estuaries. CSOs are only a major problem in the Hudson/Raritan Estuary, therefore the scale merited a 1.

Information sources: State 305(b) Reports, and State 304(l) Lists, New York Harbor Floatables Study.

Score: Intensity 3, Scale 1, Value 5, Total 9, Uncertainty Medium

MEDIUM

Mobile Sources of Air Pollution - Motor Vehicles

This category includes automobiles, trucks and buses. Emissions include some criteria pollutants, air toxics and contributions to low level ozone and global warming. The ranking is based primarily on the contribution of mobile sources to stresses on plants from ground level ozone.

Issues of Concern: The impacts of low level ozone are complex and it is difficult to characterize how mobile source stressors interact with other stressors such as acid rain. The uncertainty is therefore high. Criteria pollutant emission

impacts are relatively low and toxic emissions are moderate from mobile sources. Information about the effects of pollutants other than ozone is sparse.

Information Sources: Contractor analysis, and other technical literature.

Score: Intensity 3, Scale 3, Value 3-4, Total 9-10,
Uncertainty Medium-High

Area/Non-point Sources of Air Pollution other than Chlorofluorocarbons

This problem area includes sources not usually regulated as a stationary source but having estimated contributions to global warming, criteria air pollution (especially ozone), and air toxics. Sources include: incinerators in residential buildings, wood burning stoves, and VOC emissions from small sources such as dry cleaners.

Issues of Concern: This problem area is difficult to quantify or model, hence the high uncertainty. This area was ranked below mobile sources because of best professional judgement that it represented a relatively smaller contribution to precursors to ground level ozone.

Score: Intensity 3, Scale 3, Value 3-4, Total 9-10, Uncertainty High

Accidental Releases During Production or Transport

Includes accidental releases with acute impacts, some requiring some sort of emergency response (oil spills, Bhopal like releases) as well as smaller releases that have no obvious impacts and go relatively unnoticed. The impacts from accidental releases can be acute or chronic. Accidental releases of hazardous substances, oil, and other substances contribute to the degradation of both terrestrial and aquatic environments. The extent of the impacts depends on the nature of the release, the environmental conditions at the time of the spill, and the nature of the emergency response.

Issues of Concern: Large data gaps exist with accidental releases. The potential impacts are very high in the case of a Valdez-like spill. The group cited a need to make it mandatory to collect ecological impact data from spill sites. The uncertainty is very high due to unpredictability of spills. Comparisons of relative risk are difficult, since the most serious impacts would result from high risk, low probability events, while other problem areas deal with more predictable and known exposures.

Information Sources: ERNS and other accidental release data bases.

Score: Intensity 4, Scale 1-2, Value 4, Total 9-10, Uncertainty Very High

Stationary and Point Sources of Air Pollution

Stationary air sources include industrial point sources and power plants. They emit some criteria pollutants and air toxics and contribute to ozone problems and global warming. The primary ranking consideration was the problem area's contribution to the formation of low-level ozone, which was considered to be less significant than mobile or area sources.

Issues of Concern: The medium uncertainty is the result of uncertainties about global warming and ozone impacts. The air toxic and criteria pollutants data for stationary air sources are more accurate and complete than data available for other air related problem areas.

Score: Intensity 3, Scale 2, Value 2, Total 7, Uncertainty Medium

Municipal Solid Waste - Storage and Landfills

This area includes municipal waste or storage sites containing primarily non-hazardous wastes such as: municipal landfills, and municipal surface impoundments. Some municipal solid waste sites eventually become Superfund sites and many are located in high value wetlands. The nature of the impacts for Superfund, active hazardous waste, and solid waste sites are likely to be similar, in that they involve acute and chronic toxic impacts on organisms via surface run-off and groundwater leachates to surface water. Municipal solid waste sites were judged to present the highest relative ecological risk of these problem areas, because of the great number of sites, their high potential to become Superfund sites, and their proximity to wetlands.

Issues of Concern: The value score of 4 relates to the fact that many landfills are situated in wetlands. The intensity was given a 3, due to non-point source runoff from surface landfills. The high uncertainty is the result of lack of data.

Score: Intensity 3, Scale 1, Value 4, Total 8, Uncertainty High

Abandoned Hazardous Sites/Superfund Sites

This area includes all hazardous waste sites that are not regulated by RCRA. For the purposes of this analysis, the sites were evaluated on the basis of risks posed before any corrective actions are taken. Generally they are inactive and abandoned hazardous waste sites. This problem area is better documented than RCRA. Although contaminants from some sites can cause relatively severe ecological impacts, observed effects are usually localized. In addition, roughly 35 percent to 46 percent of the region's sites are within three miles of a sensitive environment (estuary, critical habitat, 100 year flood plain, barrier island/coastal high hazard area) and can potentially impact valuable

ecological resources. Judged to be greater risk than RCRA sites because of proximity to sensitive environments.

Issues of Concern: Major sources of uncertainty in this analysis include the difficulty of making generalizations about average risks or impacts from sites that vary widely in terms of their ecology and contamination, the lack of detailed information about ecological risks at CERCLIS sites, and much of the available data is not in a centralized database.

Information Sources: CERCLIS and NPL Characterization Studies, OPPE study of ecological risks at Superfund and RCRA sites.

Score: Intensity 3-4, Scale 1, Value 5, Total 9-10, Uncertainty High

Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C

This problem area includes active hazardous waste sites regulated under RCRA Subtitle C. For purposes of this analysis, the sites were evaluated on the basis of the risks posed before permit/ corrective actions are taken. Many sites are in areas that are currently of low ecological value, because habitats were destroyed or degraded when the facilities were originally developed. Secondary impacts of chemical contamination range from moderate to negligible depending on the site. The group decided to rank RCRA below Superfund because RCRA sites were considered to be less frequently in proximity to sensitive or high value ecosystems.

Issues of Concern: This problem area is not as well documented as Superfund and the analysis is based largely on professional judgement. This is due to the scarcity of ecological assessments for RCRA sites. A major source of uncertainty is that the total number of RCRA sites with ecological effects is unknown. The medium-high uncertainty is due to lack of data.

Score: Intensity 3-4, Scale 1, Value 1-3, Total 7-8, Uncertainty Med-High

LOW

Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C

Includes industrial waste or storage sites containing primarily non-hazardous wastes such as: industrial landfills, industrial surface impoundments, oil and gas waste impoundments, incinerators and land application units. Also includes all types of storage units and associated pipelines such as above and below ground storage tanks, barrels, etc. which contain non-hazardous materials

such as motor fuels, heating fuels, solvents and lubricants. Although data are sparse about this problem area, effects on terrestrial and aquatic systems are assumed to be localized and most USTs are in relatively degraded areas. The greatest risk to ecosystems is from tanks that are in shallow soil where a leak could easily impact adjacent surface water systems, particularly for small streams.

Issues of Concern: Impacts on small streams could be high. The high uncertainty was from inability to compare the location of the tanks to the location of sensitive ecological receptors (i.e., are they located in high value ecosystems?).

Information Sources: EPA study of ecological effects of underground storage tanks, EPA national survey of motor vehicle fuel tanks, Region I's comparative risk study, and contractor analysis.

Score: Intensity 2, Scale 1, Value 3, Total 6, Uncertainty High

Dredging and Dredge Disposal

This area includes dredging of sediments for navigation channels, harbors, marinas, and contaminated sediment remediation as well as the disposal of dredge spoils. Ecological stressors of concern include PCBs, cadmium, mercury and petroleum products, as well as physical disruption of benthic habitats. Although the Army Corps of Engineers has established protocols based on testing of sediments which are intended to protect aquatic life, the protocols are being revised on a national level, and there is a fair amount of uncertainty in characterizing risks to ecosystems from dredging. The major potential impact with regard to ocean disposal of dredged material is to benthic communities. Impacts are probably restricted, for the most part, to disposal sites. Impacts to dredged sites are intermittent and limited to navigational channels which have been historically disturbed. Intensity of impacts are probably low.

Issues of Concern: The intensity was questioned because of concerns with the Corps disposal practices. The scale is low, because dredging only occurs in navigational channels, harbors and marinas, and disposal sites encompass a limited area.

Information Sources: EPA/COE dredged materials testing protocols, monitoring studies.

Score: Intensity 2, Scale 1, Value 2, Total 5, Uncertainty Medium

Municipal Solid Waste - Incinerators

Includes refuse and resource recovery incinerators. Currently in Region II, there are 16 active solid waste incinerators. In the future, the number of incinerators is expected to increase. The overall ecological impacts are minimal from criteria air pollutants, due to low emission rates from those incinerators.

Issues of Concern: This ranking was determined considering incinerators currently in place. The intensity of 1 is due to stack emissions and 2 is for the ash disposal. Ash waste potentially contains toxic contaminants. The medium uncertainty is due to a lack of data.

Information Sources: Municipal Waste combustion Study, Contractor Analysis.

Score: Intensity 1-2, Scale 1, Value 1, Total 3-4, Uncertainty High

Other Underground Injection Wells (Class IV-V)

Includes Class IV (shallow hazardous waste wells) and Class V wells (includes dry wells, commercial septic tanks, and drainage fields). Class IV and V UIC wells are sources of potential contamination of groundwater by the chemicals injected into the wells. Groundwater contaminants from these wells that are dispersed to soils, sediments, and surface waters represent a potential source of risk to regional ecosystems. These wells probably contribute to non-point source pollution, however, there is little information available on the ecological impacts of these wells. In general, however, these sources probably represent some portion of total non-point source loadings to regional ecosystems.

Issues of Concern: The value was considered to be low since most wells were assumed to be in urban areas. The high uncertainty is the result of a large data gap associated with Class IV-V wells. Because the work group felt that the risk may be underestimated for this problem area, Class IV-V wells were ranked higher than sludge disposal.

Score: Intensity 1, Scale 1, Value 1, Total 3, Uncertainty High

Municipal Sludge Disposal and Treatment

This area includes the ocean dumping of sludge as well as alternatives such as land application, incineration or composting of municipal sewage sludge from municipal wastewater treatment works. A monitoring program of the current deep water disposal site off of New Jersey is still underway. Results to date have not identified significant impacts. Ecological impacts of land disposal practices are difficult to characterize but they were judged to be localized and relatively minor.

Issues of Concern: This ranking was based on present conditions; it did not consider alternative disposal methods which will occur after the ocean dumping ban act is activated. Although the current low level risks to ocean ecosystems will be eliminated by the use of these alternatives, ecological risks to terrestrial, freshwater and inshore ecosystems in proximity to disposal sites are likely to increase. The analysis lacks detailed description of current risks from land disposal and discussion about future disposal scenarios and trends. The 106-mile site was determined to have a low ecological value based on the site selection criteria. A monitoring program at the 106-mile site has not identified significant impacts to date. Monitoring at the site is continuing, however, and additional results will be available in the near future.

Information Sources: 106-Site monitoring reports, and sludge regulations.

Score: Intensity 1, Scale 1, Value 1, Total 3, Uncertainty Low

Radiation other than Radon

The study provided by OPPE identifies natural and manmade sources of ionizing radiation other than radon, and their potential for impacts on ecosystems. Ionizing radiation is a known carcinogen, and can also cause genetic and teratogenic (birth defects) effects. According to the provided analysis, no known ecological impacts are attributable to ionizing radiation under current exposure scenarios. No estimates of ecological impacts from exposure to non-ionizing radiation are given.

Issues of Concern: The work group was somewhat skeptical of the OPPE study's conclusions. Some recently released studies have identified significant environmental transport and bioaccumulation of radionuclides around Department of Energy weapons production facilities, and the work group felt that there were potential localized impacts at high level waste sites in Region II.

Information Sources: OPPE contractor analysis.

Score: Intensity 1, Scale 1, Value 1, Total 3, Uncertainty Medium

Traditional Underground Injection Wells (Classes I-III)

Includes Class I injection wells (deep hazardous and non-hazardous waste below an underground source of drinking water); Class II injection wells (Oil and gas recovery wells); and Class III injection wells (solution mining). There is a low potential for ecological impacts associated with groundwater contamination as a source of exposure to surface ecosystems due to the depth of

the wells and their small number in Region II. The impacts of the surface operations for these wells present more of a potential threat in terms of their contribution to habitat loss and non-point source pollution. Information about the ecosystem resources around these wells is not available to make any quantitative estimates of risk.

Information Sources: Unfinished Business Report, Region I comparative risk study.

Score: Intensity 1, Scale 1, Value 1, Total 3, Uncertainty High

Wastewood Disposal or Treatment

The ecological impacts from wastewood burning are probably low or non-existent. The program is also being phased out. Disposal alternatives were not evaluated.

Information Sources: Wastewood Disposal Environmental Impact Statement

Score: Intensity 1, Scale 1, Value 1, Total 3, Uncertainty Low

Chapter Four: Economics/Welfare Effects Ranking

Along with EPA's mandate to protect human health and ecosytems is a concern about reducing the negative effects of pollution on the welfare and economic well being of society.[1] The effects of environmental problems on human welfare include a variety of damages to property and resources that affect human use or enjoyment.

The economic/welfare damages analyzed include: damages to commercial and recreational fishing; the need for treatment of surface water supplies; loss of commercially valuable forests; loss of recreational opportunities in wetlands, forests or coastal areas; declines in property value around toxic waste sites or other polluted areas; buildings and cultural monuments damaged by air pollution; reduced visibility; destruction of watersheds; increased health care costs; and, destruction of groundwater resources. Health care costs were included because health problems caused by pollution are concern to EPA in and of themselves, and the cost of health care is also an economic concern. This list is not all inclusive but serves to illustrate the major categories of economic damages from pollution considered.

Although economic losses do parallel health or ecosystem problems, some important areas are captured only in the welfare ranking. The negative effects of losses in property value, closing of fisheries, destruction of groundwater resources and destruction of watersheds may have negligible health or ecological effects but do have large economic effects. If priorities were set on health and ecological criteria alone, EPA would not be troubled by beach closings or closing of drinking water wells because health concerns have been eliminated and the ecological impacts are negligible. But protecting society from the economic damages of pollution and environmental destruction is one of the Environmental Protection Agency's roles. This role can be especially important because environmental problems are often characterized by an unequal distribution of benefits and costs. Often the individuals whose well being is reduced by a soiled beach or a closed shellfish bed are different from those who benefit from the reduces costs that created the pollution in the first place.

It is important to distinguish between the losses and damages caused by pollution that are encompassed in the analysis and ranking, and the economic costs of controlling pollution. The costs of control are not included. The

[1] Although the term "welfare" connotes a broader range of impacts than economics effects alone, both terms can be used for this analysis. The type of economic effects considered include monetization of damages to an individual's welfare such as loss of recreational opportunities and other public goods. Although individuals are not currently paying for enjoyment, there is definite evidence that individuals value these goods and would be willing to pay for continued use.

economic damages caused by pollution are sometimes referred to as economic benefits, when and if the pollution were eliminated. Again, the control costs are not included in this analysis.

It is tempting but incorrect to try to compare the estimates of damages to control costs. First, the analysis could not be conducted with sufficient detail to lead to any conclusions about cost versus benefits. Second, neither time frame or equity concerns have been addressed, and these are very important components of cost/benefit analysis. For many environmental issues, the control costs are large but they are incurred in the present, while benefits characteristically continue infinitely into the future. Thus, comparing the level of costs and benefits can hinge upon the time frame and discount rate considered appropriate. An example may help to illustrate the nuances involved. In our analysis, acid rain was found to result in approximately $400 million in losses to society yearly. While the present day control costs are probably higher than this, the benefits of healthy forests and fisheries will continue for generations. In addition, the people who benefit from the lower cost of electricity that results in acid rain are different from those who are hurt by the effects of the pollution. Equity concerns, even intergenerational equity, need to be considered, along with the level of dollars estimated.

This report is a summary of both the analysis prepared for the regional ranking project and the work group discussions and decisions on that analysis. The analysis prepared for the regional ranking project was a review of existing research in the area of economic damages from pollution for Region II, followed by preliminary analyses completed by Region II staff and contractors. Both the review of the literature and the staff analyses were constrained by time and resources. While there is confidence in the order of magnitude of the damages and their legitimacy for ranking purposes, the actual dollar figures are far from exact. Dollar estimates were not included for two very important damages - the loss of a life and the existence of ecosystems. The methods for putting dollar values on these types of damages are controversial and unreliable. It is noted here because damages that are not quantified are often minimized in value, and this is not intended.

The work group reviewed the results of the analyses, and determined the relative ranking of each problem area. This was a difficult task because some evaluations contained only part of the total economic impact because certain factors could not be quantified; some environmental problems had no dollar estimates at all. The group did not want to restrict the ranking to quantitative problem areas, so they used best professional judgement to rank the more qualitative problem areas. The differences between problems ranked close to another are often minimal.

The categories are more reliable and are in general order of magnitude; they are:

- o Very high = over 1/2 billion dollars annually
- o High = $ 500 - 50 million
- o Medium = $ 50 - 1 million
- o Low = minimal damages

The limits and uncertainties of the data and methods used are discussed fully in the draft report. The uncertainties are in the following areas:

1) Does the economic damage exist or is it theoretical?

2) Does data exist on the size or extent of the damage?

3) Is the method for estimating the dollar value of the damage sound?

4) Does the data accurately reflect what we are trying to estimate?

The welfare ranking of the problem areas is contained in Table VII. A narrative summary of the rationale for the ranking follows.

TABLE VIII

WELFARE/ECONOMIC RANKING

Very High

Non-point Sources of Water Pollution
Industrial Point and Municipal/Public Wastewater Treatment Discharges to Water
Combined Sewer Overflow Discharges to Water
Land Use Changes/Physical Modifications of Terrestrial Habitats
Land Use Changes/Physical Modifications of Aquatic Habitats
Indoor Air Pollutants Other Than Radon
Mobile Sources of Air Pollution - Motor Vehicles
Area/Non-point Sources of Air Pollution other than Chlorofluorocarbons
Extra-Regional Sources Leading to Acid Deposition

High

Stationary Sources of Air Pollution
Accidental Releases during Production or Transport
Radon
Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons
Abandoned Hazardous Waste Sites/Superfund Sites
Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA
Active Hazardous Waste Sites Currently Regulated Under RCRA Subtitle C
Municipal Solid Waste - Storage and Landfills

Medium

Pesticide Residues on Food
Other Underground Injection Wells (Class IV-V)
Pesticides Contamination During Application
Municipal Solid Waste - Incinerators
Operation and Maintenance of Drinking Water Systems
Radiation Other Than Radon

Low

Municipal Sludge Disposal and Treatment
Dredging and Dredge Disposal
Wastewood Disposal or Treatment

RATIONALE FOR ECONOMICS/WELFARE RANKINGS

VERY HIGH

Non-point Sources of Water Pollution

Non-point sources of surface water pollution were determined to cause the largest economic damages because the value of the resources they affect - primarily fisheries, recreation and surface water supplies - are high. A State University of New York at Stony Brook report on the New York Bight estimated that losses to fish and shellfish resources equalled over $1.4 billion annually, including indirect economic losses. Additional studies estimated navigation impacts at $500 million, and the striped bass fishery closure at $100 million. Proportioning between non-point sources and point sources is inexact, however, the work group agreed with Water Management Division staff that non-point sources generally cause more damage.

These estimates, although the highest in the quantitative analysis, have a very low uncertainty, and are not all inclusive further confirming their place at the top of the economic damages ranking.

Industrial Point Sources and Municipal/Public Wastewater Discharges to Water

(See non-point source discussion.)

Combined Sewer Overflow (CSO) Discharges to Water

The main concern with CSO's is their impact on beach recreation. The economic damages due to beach closings have been studied by several authors who estimate losses between $1.4 - 5.8 billion dollars for the worst years. Since the economic losses were based on the worst years, the group felt that these estimates should not be considered yearly estimates, and should be ranked lower than the yearly fishery losses. Despite this concern, the economic damages of beach closings are substantial and well documented.

Land Use Changes/Physical Modifications of Terrestrial Habitat

Although there are many types of damages from land use changes including losses in recreation areas; increased dredging costs and surface water quality degradation due to soil erosion; and increased air pollution, none of these damages could be realistically measured. However, large and very real economic costs will be incurred in the region due to overdevelopment of important watersheds. Estimated costs to treat New York City's previously untreated

water will cost approximately $3 to $4 billion dollars. The sole source aquifer in Long Island is another example of a relatively inexpensive but valuable natural resource where costs to society are increasing due to overdevelopment in the watershed. Current programs and bond issues may reduce this liability; however the work group determined that this problem area deserved a very high ranking because of the estimated costs of watershed destruction along with the unestimated costs.

Land Use Changes/Physical Modifications to Aquatic Habitat

That wetlands have important economic value is undeniable. Wetlands provide fishery habitat, flood protection, water purification and recreational resources that translate into direct economic benefits to industry or individuals. For example, 60 to 90 percent of commercially valuable marine fish in the Atlantic depend on coastal wetlands for part of their life cycle. However, economic methods to trace these values back to particular wetlands are not reliable theoretically or empirically. Despite the fact that no dollar estimates were generated, the work group felt that wetlands deserved to be ranked in the very high category. Another area of uncertainty is that the amount of wetlands lost historically is not known, and estimates of the current loss rates are unreliable.

Indoor Air Pollutants other than Radon

The only economic damages estimated for indoor air are the health care costs from cancer. The very large cancer incidence numbers estimated result in this problem area rating a very high ranking. Health care costs include direct medical expenditures as well as lost productivity. Using the wide range of estimates from the cancer ranking and a smaller range of estimates on health care costs resulted in annual losses of $56 to 904 million annually. Given this wide range and the fact that this estimate is all inclusive, indoor air was ranked very high but below damage estimates of fisheries, beach closing and wetlands where dollar estimated may not be as high as the high end of the range of values. By comparison, fisheries, beach closings and wetlands estimates do not include all damages. .

Mobile Sources of Air Pollution

Mobile and area sources of air pollution contribute to health care costs, materials damages, agricultural and forestry damages from ozone, increased soiling of buildings and materials, reduced visibility and to possible damages from global warming such as sea level rise, crop losses and increased electricity demand. While each of these damages was estimated with varying degrees of confidence, estimates of economic damages from mobile and area sources,

excluding possible global warming damages, were approximately $400 million yearly. The workgroup determined that mobile and area sources should be ranked in the very high category.

Area Sources of Air Pollution

(See mobile sources of air pollution)

Extra-Regional Sources Leading to Acid Deposition

Acid Rain causes damages to materials, fisheries and forests, losses in agricultural productivity and visibility problems that create economic impacts upon society. It is difficult to determine any exact dollar figures primarily because the extent of damages from acid rain are not well established scientifically. Using available studies of current damages only, estimates of approximately $270 million annually are possible. (Note that the Adirondack fishery is but a small proportion of the total, 5 percent.) Adding the value of visibility decreases could increase acid rain damages to nearly $500 million annually. The uncertainty associated with these figures is extremely high. Researchers indicate that "... benefit/cost measurements of acid deposition may well involve major errors of commission and omission."

HIGH

Stationary Sources of Air Pollution

Stationary sources of air pollution create the same damages to society as mobile and area sources. (See discussion above.) Stationary sources are ranked lower because in Region II, stationary sources are responsible for a much smaller contribution to the damages noted.

Accidental Releases during Transport or Production

Data were not available to conduct a quantitative economic assessment of this problem area. Baseline data on the number, size and type of releases must be established along with the ecological and health impacts. However, largely because of evacuation costs, property damage and oil spills the workgroup determined that this was a high risk problem with the potential to be even greater, e.g. in the case of a Valdez-like spill.

Radon

Health care costs are the relevant area of concern. Health care estimates range from $60 to 274 million.

Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons

Ozone depletion can cause both health and non-health economic damages. The estimates used in the ranking were for the cost of health problems from skin cancer and cataracts. Research is underway to determine how the cost of skin cancer compares to the health care costs of other cancers; however, preliminary figures indicate that it could be one quarter lower, leading to estimates of health care costs of approximately $100 - 200 million. The non-health problems associated with CFC's include crop loss and habitat change, in addition, CFC's are predicted to add to global warming problems. The uncertainty associated with both the cancer estimates and the health care estimates are high.

Abandoned Hazardous Waste Sites/Superfund Sites

Three types of economic concerns - increased health care costs, damages to the groundwater resource, and property value declines - are caused by Superfund sites. The largest economic damage is the declines in property values for homes located near Superfund sites. These declines have been noted in several statistical studies, however, there is no general consensus on the size or conditions necessary for the existence of property value declines. The analysis encompassed a wide range of assumptions regarding amount of loss per home and number of sites. The estimates range from $173 million to $1 billion. The work group agreed that the most reasonable estimates were on the low end of the range. In its assessment, the work group chose to consider only current NPL sites for the economic assessment, while the Superfund analysis for health and ecological considered all the potential NPL sites. In addition, Superfund also contributed approximately 5 percent or $22 million to ground water contamination not including future use losses, plus approximately $31 million - $52 million in health care costs.

Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C

The New York State 305(b) report indicates that 65 percent of private well contamination is related to UST's. Therefore, 65 percent of groundwater contamination was attributed to UST's for the purpose of this analysis. UST's were estimated to be causing $200 million dollars worth of damage. This estimate does not include future use (i.e., contamination which has not closed wells, but is reducing the available stock of groundwater).

Active Hazardous Waste Sites Currently Regulated under RCRA Subtitle C

Groundwater contamination due to RCRA sources is estimated at 5 percent of total groundwater damages, or $22 million annually not including future use. Although there are no statistical studies on property value decline near RCRA sites, the work group assumed that losses in property values would be about half that of Superfund sites. Therefore, the total economic damages due to RCRA sites was estimated at $120 million.

Municipal Solid Waste - Storage and Landfills

The group used the same assumptions for municipal solid waste sites as for RCRA sites (contribution to groundwater contamination and loss of property value) to come up with an estimated $120 million in economic damages. Some of the property value studies are based on Superfund sites that are also municipal solid waste sites.

MEDIUM

Pesticides Residues on Food

Health care costs for cancer were the only area of concern.

Other UIC Wells (Class IV-V)

Contribution to groundwater contamination is estimated at $22 million plus future use.

Pesticides Contamination during Application

Contribution to groundwater contamination is estimated at $22 million plus future use.

Municipal Solid Waste - Incinerators

Health care cost increases were estimated at $10 million. In the future, as more incinerators are sited this problem area is expected to have greater economic damages associated with it. One issue of concern is whether or not property value declines should be considered for incinerators.

THM, Lead and Microbiological Contamination of Drinking Water Supplies

The main costs to society from THM's, Lead and microbiological contamination are costs of increased health care. These costs are estimated for cancer at approximately $1 million per year. Health care costs from microbiological contamination must be added to these figures. That the benefits from reducing lead in air and in water are large is a well documented. For example, reducing lead levels in the drinking water in Boston would result in approximately $8 million dollars annually in decreased health care costs for hypertension and cardiovascular disease in adults, reduced materials damage due to corrosion and avoided neurological damage in children. Therefore, it is likely that the economic damages from lead in New York and New Jersey are at least as large and most likely much greater.

Non-Radon Radiation

Health only economic damages were estimated at $10 million.

LOW

Sludge Disposal

The economic damages associated with sludge disposal are estimated to be minimal or non-existent. A possible, but impossible to verify, economic impact is that some proportion of the decline in beach attendance is due to the perception that ocean dumping of sludge causes beach pollution. After ocean dumping ceases, alternative methods of disposal may have increased economic damages associate with them.

Dredging

The economic damages are minimal or none. The possible negative impacts on shipping due to the problem of contaminated sediments that cannot be safely dredged is considered an economic damage from the causes of contaminated sediments rather than dredging. Estimates of damages to shipping were not available.

Wastewood

The economic damages are minimal or none.

Appendix A

Environmental Problem Areas

Following are the twenty-seven source categories that were ranked as part of the Region II Risk Ranking Project. Each category is intended to be mutually exclusive. Some smaller sources (e.g. municipal sludge disposal and wastewood disposal) are defined separately because they are the focus of a high degree of public concern.

1. Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water

Includes all municipal and industrial wastewater treatment plans requiring permits under the National Pollutant Discharge Elimination System (NPDES). Typical sources of discharge include coal and ore mining, metal finishing, pulp and paper processing, iron and steel production, chemical manufacturing, electroplating, metal finishing, and landfill leachates. Also includes both municipal sewage treatment outfalls and industrial discharges that flow through publicly operated treatment works.

2. Combined Sewer Overflow Discharges to Water

Includes Combined Sewer Overflows (CSOs). These are "overflows" that occur when storm events cause such a large amount of water to flow through the sewers that some water must be diverted away from the treatment plant.

3. Operation and Maintenance of Drinking Water Systems - Trihalomethanes, Lead, Microbiological Contamination

Includes contaminants resulting from the operation and maintenance of drinking water systems such as the formation of trihalomethanes as a result of chlorination and the introduction of lead from distribution system pipes and solder. Microbiological and other contamination from cross connections and microbiological contamination from improper or nonexistent treatment is also included.

4. Non-point Sources of Water Pollution

Includes stormwater runoff such as oils and salts, private septic tanks, and agricultural and silvicultural runoff such as nitrates.

5. **Traditional Underground Injection Wells (Class I-III)**

Includes Class I injection wells (deep hazardous and non-hazardous waste below an underground source of drinking water); Class II injection wells (Oil and gas recovery wells); Class III injection wells (solution mining) and Class 4 injection wells (shallow hazardous waste wells).

6. **Other Underground Injection (Class IV and V)**

Includes Class V underground injection wells which are everything other than class 1,2,3 and 4 (e.g. dry wells, commercial septic tanks, drainage fields). This class was kept separate because separate data is available and the program is a new emphasis which differs substantially from the traditional UIC classes.

7. **Land Use Changes/Physical Modifications of Aquatic Habitats (except dredging)**

Includes physical modifications that cause disruption of aquatic habitats such as dam construction and operation; flood control channelization; filling for highways, housing, industrial areas and landfills; and mining and resource extraction.

8. **Land Use Changes/Physical Modifications of Terrestrial Habitats**

Includes physical modifications that cause disruption of terrestrial habitats such as flooding from dams; pipeline construction; flood control channelization; mining and resource extraction.

9. **Dredging and Dredge Disposal**

Includes dredging of sediments for navigation channels, harbors, marinas, and contaminated sediment remediation as well as the dumping/disposal of the dredge spoils.

10. **Municipal Sludge Disposal and Treatment**

Covers the disposal of sludge generated by municipal wastewater treatment plants in the ocean and though alternatives such as land application, incineration or composting. Does not include industrial sludge which is covered in No. 14.

11. Wastewood Disposal or Treatment

Includes releases to air and water from woodburning currently conducted at sea and potential alternative disposal methods such as landfill, gasification, and incineration.

12. 'Active' Hazardous Waste Sites, Sites currently regulated under RCRA's Subtitle C

Includes hazardous waste sites regulated under the Resource Conservation and Recovery Act (RCRA) Subtitle C program. For purposes of this analysis, these sites were evaluated before any permit/corrective actions were taken. These sites include RCRA open and closed landfills and surface impoundments, hazardous waste storage tanks, hazardous waste burned in boilers and furnaces, hazardous waste incinerators, and associated hazardous waste management units. Also included are associated solid waste management sites and some leaking storage tanks containing industrial products.

13. Abandoned Hazardous Sites/Superfund Sites

Includes hazardous waste sites not covered by RCRA but by Superfund. Generally they are inactive and abandoned. For purposes of this project, sites were evaluated before any corrective actions were taken. Sites may be on the National Priority List (NPL), deleted from the NPL, candidates for the NPL, or simply be noted by the Federal government or states as unmanaged locations containing hazardous waste. Although some RCRA sites may be double listed as Superfund sites, care will be taken to allocate the risks in one category or another. Does not include dredging of contaminated sediments, which is included under No. 8.

14. Municipal Solid Waste - Storage and Landfills

Includes municipal waste or storage sites containing primarily non-hazardous wastes such as: open and closed municipal landfills, and municipal surface impoundments. The landfill portion of this category is parallel to the RCRA Subtitle D Program. This category also excludes municipal sludge.

15. Municipal Solid Waste - Incinerators

Includes refuse and resource recovery incinerators.

16. Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA subtitle C. (Underground Storage Tanks and other)

Includes industrial waste or storage sites containing primarily non-hazardous wastes such as: industrial landfills, industrial surface impoundments, oil and gas waste impoundments, incinerators and land application units. Also includes all types of storage units and associated pipelines such as above and below ground storage tanks; barrels etc. which contain non-hazardous materials such as motor fuels, heating fuels, solvents and lubricants. This category is not limited to storage of wastes.

17. Accidental Releases during Transport or Production

Includes accidental releases with acute impacts, some requiring some sort of emergency response (oil spills, Bhopal like releases) however, many accidental releases go relatively unnoticed. Accidental releases may occur during transport, production, or use. Examples are: industrial unit explosion, railroad tank car spill, and oil spills. This category excludes releases from storage unites covered in No. 11, RCRA sites and No. 14, Underground Storage Tanks.

18. Pesticides Contamination Associated with Application

Includes worker exposures, air pollution drift and non-point source runoff.

19. Pesticide Residues in Food

20. Stationary Point Sources of Air Pollution

Includes industrial point sources and power plants. These sources directly emit some criteria pollutants, some air toxics and some contribute to low-level ozone problems and global warming, often through complex interactions with emissions from other sources and natural parameters.

21. Mobile Sources of Air Pollution - Motor Vehicles

This category includes automobiles, trucks and buses. These sources directly emit some criteria pollutants, some air toxics and some contribute to low-level ozone problems and global warming, often through complex interactions with emissions from other sources and natural parameters.

22. **Area Sources/Non-point Sources of Air Pollution**

This category includes sources not usually regulated as a stationary source (No.18) but having estimated contributions to global warming, criteria air pollution (especially ozone), and air toxics. Sources include: incinerators in residential buildings, woodburning stoves, VOC emissions from small sources such as dry cleaners. If data existed, all sources of combustion including barbecues would be included.

23. **Sources of Air Pollution that lead to Acid Deposition, Primarily from Tall Stacks**

24. **Radon**

Includes naturally occurring radon gas that leaks into buildings.

25. **Indoor Air Pollutants**

26. **Chemical Use that depletes the Ozone layer - Chlorofluorocarbons**

27. **Radiation other than radon**

Human Health References

American Cancer Society (1990) Cancer Facts and Figures 1990, American Cancer Society National Headquarters, Atlanta, Georgia.

Doll, R. and Peto, R. (1981) The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. J. Natl. Cancer Inst. 66:1193-1308, 1981.

National Cancer Institute (1985) Monograph on Cancer Control Objectives for the Nation: 1985 to 2,000. National Institutes of Health Publication 85-691, April, 1985.

National Institute of Occupational Safety and Health (1985) NIOSH Pocket Guide to Chemical Hazards. U. S. Department of Health and Human Services, Washington, D.C.

National Research Council (1983) Risk Assessment in the Federal Government: Managing the Process. National Academy Press, Washington, D.C.

New Jersey Department of Health (1988) New Jersey Principal Causes of Resident Deaths by Age, 1988. New Jersey Department of Health, Center for Health Statistics, Trenton, New Jersey.

New York State Department of Health (1988) Table of Deaths and Death Rates from Selected Causes: New York State, 1988. New York State Department of Health, Vital Statistics, Albany, New York.

Puerto Rico Department of Health (1988) Fifteen leading causes of death in Puerto Rico in 1987. Puerto Rico Department of Health, Division of Epidemiology, San Juan, Puerto Rico.

U. S. Environmental Protection Agency (1986a) Guidelines for Carcinogen Risk Assessment. Federal Register 51 FR 33992, September 24, 1986.

U. S. Environmental Protection Agency (1986b) Guidelines for Mutagenicity Risk Assessment. Federal Register 51 FR 34006, September 24, 1986.

U. S. Environmental Protection Agency (1986c) Guidelines for Chemical Mixtures. Federal Register 51 FR 34014, September 24, 1986.

U. S. Environmental Protection Agency (1986d) Guidelines for Suspect Developmental Toxicants. Federal Register 51 FR 34028, September 24, 1986.

U. S. Environmental Protection Agency (1986e) Guidelines for Estimating Exposures. Federal Register 51 FR 34042, September 24, 1986.

U. S. Environmental Protection Agency (1987) Unfinished Business: A Comparative Assessment of Environmental Problems. U. S. Environmental Protection Agency, Office of Policy, Planning and Evaluation, Washington, D.C.

U. S. Environmental Protection Agency (1989a) Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual (Part A) - Interim Final. U. S. Environmental Protection Agency, Office of Emergency and Remedial Response, EPA/540/1-89/002, December 1989, Washington, D.C.

U. S. Environmental Protection Agency (1989b) Exposure Factors Handbook - Final Report. U. S. Environmental Protection Agency, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600-8-89/043, March 1989, Washington, D.C.

U. S. Environmental Protection Agency (1989c) Superfund Exposure Assessment Manual. U. S. Environmental Protection Agency, Office of Remedial Response, EPA/540/1-88/001, April 1988, Washington, D.C.

U. S. Environmental Protection Agency (1989d) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual. U. S. Environmental Protection Agency, Office of Marine and Estuarine Protection and Office of Water Regulations, EPA-503/8-89/002, September 1989, Washington, D.C.

U. S. Environmental Protection Agency (1989e) Cancer Risk from Outdoor Exposure to Air Toxics. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, EPA-450/89- , Research Triangle Park, North Carolina.

U. S. Environmental Protection Agency (1989f) Standards for the Disposal of Sewage Sludge; Proposed Rule. 40 CFR Parts 257 and 503, pp. 5746-5902, February 6, 1989.

U. S. Environmental Protection Agency (1989g) Costs and benefits of phasing out production of chlorofluorocarbons and halons in the U. S. U. S. Environmental Protection Agency, Office of Air and Radiation, November 1989, Washington, D.C.

U. S. Environmental Protection Agency (1990a) Integrated Risk Information System (IRIS). Office of Health and Environmental Assessment, Office of Research and Development, U. S. Environmental Protection Agency, Washington, D.C.

U. S. Environmental Protection Agency (1990b) Health Effects Assessment Summary Tables, U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, (OERR 9200, 6-303, (90-3) July 1989, Washington, D.C.

U. S. Environmental Protection Agency (1990c) Dietary Risk Evaluation System. U. S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C.

Virgin Islands Department of Health (1988) Summary of five leading causes of death in the Virgin Islands, Virgin Islands Department of Health, St. Thomas, Virgin Islands.

National Cancer Incidence vs. Region Specific Incidence

To assure that the potential cancer incidences are not overestimates for the region, the projected number of cancers based on the ranking were compared with those from other published studies.

The Doll and Peto (1981) investigation of cancers risks based on epidemiological research is an excellent source of information on potential causes of cancer. The National Cancer Institute's "Monograph on Cancer Control Objectives for the Nation: 1985 to 2000" (1985) summarized the causes of cancer mortality in the following table based on the epidemiological studies of Doll and Peto (1981).

Causes of Cancer Mortality

	All cancer deaths, percentage	
Factor	Best Estimate	Range of Acceptable estimates
Tobacco	30	25 - 40
Alcohol	3	2 - 4
Diet	35	10 - 70
Reproductive & sexual behavior	7	1 - 13
Occupation	4	2 - 8
Pollution	2	1 - 5
Industrial products	1	1 - 2
Medicines and medical procedures	1	.5 - 3
Geophysical factors	3	2 - 4

It is important to note that the Doll and Peto research is based on epidemiological studies of cancer deaths and that these studies do not allow refined assessments of potential environmental risks for cancer. In addition, Doll and Peto were essentially able to categorize the major risk factors (tobacco, and diet) but the potential interactions among these factors could not be

assessed. The best estimates listed in the table add up to 86 percent of all cancer deaths.

Based on an analysis of regional data shown in the introduction, the annual cancer deaths in the region from all forms of cancer is 59,395. As indicated in the U. S. Department of Health and Human Services publication, "Cancer Rates and Risks", (NIH, 1985) most cancers are caused by a variable mix of hereditary and environmental factors.

Some rare cancers such as retinoblastoma are inherited, and usually appear at an early age. A number of rare hereditary disorders may predispose a person to cancer,but the added action of one or more environmental factors such as viruses or diet is often needed for the cancer to develop. Other individuals seem to be resistant to some cancers.

Subgroups of some of the common cancers have a genetic component but may require an environmental trigger. Some non-hereditary cancers seem to run in families, but this may reflect chance or a common environmental exposure. How a person reacts to the environment is also a part of the equation. For example, occupational exposures to vinyl chloride are associated with increased human cancer incidence. In addition, environmental exposures to asbestos or radon, coupled with lifestyle factors such as smoking, alcohol consumption and diet, have been associated with increased cancer incidence.

The publication also indicates that based on cancer incidence statistics, it is chiefly a disease of middle and old age. It is rare in children and young adults. More than half of all cases of cancer are diagnosed after age 65. Up to age 50, the incidence is higher in women. After age 60, there is a dramatic increase in cancer incidence among men.

Within Region II, the following cancer deaths and rates per 100,000 people in 1988 were identified:

State	Cancer Deaths	Rate Per 100,000
NY	38,628	215.6
NJ	17,073	221.1
PR	3,693	112.1
VI	66	66

The data is from the death statistics for each state developed by the Departments of Health (New York State Department of Health, 1988; New Jersey Department of Health, 1988; Puerto Rico Department of Health, 1988; and the Virgin Islands Department of Health, 1988).

The national overall risk of developing cancer over a lifetime is 1 in 4 (American Cancer Society, 1990). Based on this information the projected cancer incidence in Region II was calculated at 101,785 cases per year, based on a population of 28,500,000. The projected cancer incidence based on the potential that 25 percent of the population will develop cancer during their lifetime and annualized to one year is 101,785. This data was used in the analysis.

To determine whether the cancers projected in the analysis were in line with the data from Doll and Peto (1981) the following analysis was performed.

1. Cancer Deaths.

   The Regional Ranking projected a total of 2,000 deaths in Region II from radon exposure - specifically lung cancer. The number of respiratory cancer deaths in New York State in 1988 was 9,998 and the number in New Jersey for the same year is 4,268 (based on 25 percent of the total cancer deaths in New Jersey). Therefore, the total number of lung cancer deaths in New York and New Jersey is 14,266.

   Based on this analysis, radon is responsible for approximately 14 percent of the lung cancers in the region. This is consistent EPA's report indicating that 20,000 lung cancer deaths a year in the U.S. may be attributed to radon while the American Cancer Society estimates there will be a total of about 139,000 lung cancer deaths in 1988 from all causes. Therefore, our estimate that 14 percent of the lung cancer deaths in the region are associated with radon is consistent with national predictions.

2. Skin Cancer.

   The projected cancer incidence for exposure to Chlorofluorocarbons included an estimate of 3,872 to 8,810 excess cancers, specifically skin cancers. It is anticipated that from 1 to 5 percent of these cancers would be fatal.

   It was not clear how skin cancers are addressed in the cancer mortality figures developed by Doll and Peto since it is anticipated that skin cancer would not be reported on a death certificate. Therefore, it is not appropriate to compare this number to the 2 percent contribution identified in the Doll and Peto analysis.

3. Occupational Exposure.

   Doll and Peto projected 4 percent of the cancer deaths are associated with occupational exposure. In the ranking occupational risks were identified only for pesticide applicators. The number of associated

cancers is 2 to 68 for applicators. This number is well below the 4,040 cancers projected for occupational exposure in the region (4 percent of 101,000).

4. Remaining Cancers.

If the cancers associated with the previous sections are excluded; the total number of remaining cancers is 1,396 to 8,581. Based on the Doll and Peto study, the anticipated number of cancers from exposure to pollution projected for Region II is 2,020 to 5,050. The Doll and Peto projections fall within the work groups estimated range, with those for the region indicate that the numbers are underestimates for the lower projections but are potentially overestimates for the higher range.

5. Industrial Area.

It is important to consider that the region has a high population density in a large industrial area and there is a potential for higher levels of exposure to toxics than in other parts of the country.

Based on this analysis, it was determined that the projected number of cancers associated with the Region II Risk Ranking Project are consistent with the apportionment of cancers suggested by Doll and Peto's research for environmental cancers.