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PROPOSED FRAMEWORK FOR THE WESTERN AREA POWER ADMINISTRATION ENVIRONMENTAL RISK MANAGEMENT PROGRAM

C. S. Glantz
F. V. Di Massa
P. J. Pelto
A. J. Brothers
A. L. Roybal[a]

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Pacific Northwest Laboratory
Richland, Washington 99352

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SUMMARY

The Western Area Power Administration (Western) views environmental protection and compliance as a top priority as it manages the construction, operation, and maintenance of its vast network of transmission lines, substations, and other facilities. A recent Department of Energy audit of Western's environmental management activities recommends that Western adopt a formal environmental risk program. To accomplish this goal, Western, in conjunction with Pacific Northwest Laboratory, is in the process of developing a centrally coordinated environmental risk program. This report presents the results of this design effort, and indicates the direction in which Western's environmental risk program is heading.

Western's environmental risk program will consist of three main components: risk communication, risk assessment, and risk management/decision making. Risk communication is defined as an exchange of information on the potential for threats to human health, public safety, or the environment. This information exchange provides a mechanism for public involvement, and also for the participation in the risk assessment and management process by diverse groups or offices within Western.

The objective of risk assessment is to evaluate and rank the relative magnitude of risks associated with specific environmental issues that are facing Western. The evaluation and ranking is based on the best available scientific information and judgment and serves as input to the risk management process. Risk management takes risk information and combines it with relevant non-risk factors (e.g., legal mandates, public opinion, costs) to generate risk management options. A risk management tool, such as decision analysis, can be used to help make risk management choices.

Initial work in the development of Western's environmental risk program involved the following phases:

- A literature review to determine what other power marketing agencies, utilities and the Electric Power Research Institute (EPRI) were doing in the development of environmental risk programs;

- Visits to Western's Headquarters and selected Area Offices to learn about current environmental issues and existing risk management activities;

- Development of an outline for a preliminary environmental risk program that would address risk assessment, management, and communication;

- Development of a qualitative and semi-quantitative approach for risk assessment; and

- Preparation of a report to document progress in the development of the environmental risk program.

After completing the literature review and site visits, the project team focused on developing an outline for Western's environmental risk program. For the risk assessment approaches, the team focused on simple methods to use for preliminary evaluations of risk, risk rankings, and risk comparisons. One assessment method that is proposed for adoption is the "Qualitative Issue Characterization" (QuIC) approach. In the QuIC approach, a short form is used to characterize each of the identified environmental issues that might potentially impact Western's operations. The QuIC approach focuses on determining the Western personnel responsible for an issue; the current regulatory, stakeholder, and Western position on the issue; the potential human health and ecosystem, business, regulatory, and public perception impacts of the issue; and other information.

The second assessment method proposed for adoption is the "The Semi-Quantitative Evaluation" (SEQUEL) approach. This approach is designed to use the information obtained through the QuIC process to develop a semi-quantitative assessment of environmental risk and to couple this with a semi-quantitative assessment of Western's ability to manage the risk associated with a particular issue. With assessments of both environmental risk and Western's ability to manage risk, environmental issues can be compared to determine the relative priorities that need to be established to address these problems. In addition, this method pinpoints areas in which Western is properly poised to address environmental risk and areas in which Western needs to improve its capabilities. In its semi-quantitative assessment of environmental risk, the SEQUEL approach focuses on four distinct categories of risk. These are:

- Human health and ecosystems impacts;
- Regulatory impacts (i.e., risks posed by not complying with environmental regulations);
- Business implications (i.e., costs associated with reducing risks and costs resulting from a failure to prevent a risk from becoming an incident); and
- Public perception implications (i.e., risks associated with changes in Western's public image and its resulting impacts on Western being able to perform its function).

The risk characterized for each category is obtained by estimating the product of the probability and severity of a risk (the probability and severity of each ranked on a 1- to 4-point scale). Total environmental risk is the sum of the risk score for each category.

The SEQUEL approach grades Western's ability to manage risk in three areas: Environmental Policy, Human Resources, and Policy Implementation. After a score has been assigned to denote the status in each of the three broad areas (using a 1- to 4-point scale), the individual scores are multiplied to determine the overall score for Western's ability to manage risk.

A risk evaluation matrix is used to help examine the relationship between the level of risk for an issue and Western's ability to manage that risk. The matrix also allows different environmental issues to be evaluated against each other, both in terms of their overall environmental risk and the organization's ability to manage that risk. This pinpoints areas in which Western is properly poised to address environmental risk and areas in which Western needs to improve its capabilities; allowing priorities to be set for dealing with issues (including allocating funding for additional assessment, monitoring, and remediation activities).

The QuIC and SEQUEL approaches are seen as complementary approaches that should be used together. The QuIC approach allows Western to gather the information needed to make decisions about environmental issues. The SEQUEL approach uses this information to develop a numerical scoring of the risk, and it also evaluates Western's ability to manage risk.

The results from risk assessments are used in the risk management component of the environmental risk program. Risk management provides a methodology for responding to potential risks. The response is typically a decision to commit resources to one of several possible courses of action. It is often not initially obvious what alternatives are available, and how to decide among them. In addition, the relationship between alternatives and outcomes may be fraught with uncertainty. A risk management program must specify how to identify alternatives and include an evaluation procedure that considers relevant uncertainties. It must provide a defensible rationale for the course of action taken. It must also consider the values of the various stakeholders.

A variety of analytical approaches can be utilized in making risk management decisions. These include cost/benefit analysis, social judgment theory, delphi method, and decision analysis. An analytical approach is not needed for every decision, but for complicated issues or making tough choices an analytical approach can be helpful for making and defending decisions.

The methodology that seems to be best suited to Western's environmental risk program is decision analysis. Decision analysis creates defensible decisions by documenting the decision process so that it is open for all to see. Decision analysis clearly specifies what factors are to be considered, how they are to be measured and evaluated, and their relative importance, thus the basis for the alternative selection is clearly specified. This makes it possible to have open discussion and "fine tuning" of the decision process. The final result is a decision that is well understood and which can be clearly explained and justified in a public arena if the need should arise.

The decision analysis process consists of the following steps:

- Identify the objectives to be achieved;

- Identify candidate alternatives;
- Develop measures and value functions for each objective;
- Assess weights for the objectives based on their relative importance;
- Evaluate the alternatives using an objective function and relative weights;
- Perform sensitivity analysis; and
- Expand analysis to model risk as necessary.

It is understood that an effective environmental risk program requires not only risk assessment and risk management components, but also a risk communication component. Effective risk communication at Western requires interdisciplinary and cooperative participation between divisions within Western. This includes interactions between different groups at Headquarters, between different groups in the Area Offices, and between the Area Offices and Headquarters. Additional work is required in this subject area to formalize procedures for internal risk communication. An effective environmental risk program also requires risk communication with the public; in particular with key stakeholder groups, credible sources of information, and regulatory agencies. Western's Public Affairs Office has recently prepared a guidance manual on external communications. If implemented, the procedures outlined in this manual would significantly upgrade Western's current level of external risk communication.

To implement the proposed environmental risk program at Western, a number of steps are being implemented. The first step involves applying the program's components to several different environmental issues on a trial basis. Results of this exercise are being used to modify QuIC, SEQUEL, and the decision analysis tools to better fit Western's requirements. The next step involves an instructional seminar that will transfer the risk program techniques to the Western staff responsible for risk program implementation. Finally, results of the program will be formally adopted by including them in Western's forthcoming environmental manual.

As part of the training and implementation phases of the environmental risk program, it is envisioned that the PNL project team will provide additional technical assistance to Western. Potential areas identified include:

- assist Headquarters and one Area Office on a pilot basis to implement the environmental risk management program;
- using multimedia software tools, computerize the QuIC and SEQUEL processes; and
- continue to develop methods to understand and estimate uncertainty in the decision making process.

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TABLES

1.0 INTRODUCTION

The Western Area Power Administration (Western) is an agency of the U.S. Department of Energy (DOE), whose mission is to market and transmit Federal electric power in 15 Central and Western States. Western's service area encompasses nearly 3.4 million square kilometers (1.3 million square miles) and electric power is provided to over 600 wholesale customers (including electric power cooperatives, municipalities, private and public utility districts, Federal and State agencies, and irrigation districts). Western's customers, in turn, provide electric power for about 50 million Americans. Electric power marketed by Western is obtained from over 50 hydroelectric generating plants and the Navajo coal-fired plant. To fulfill its mission, Western operates and maintains more than 26,000 circuit kilometers (16,400 miles) of transmission lines, 265 substations, and other power facilities in its service area. Western's headquarters is located in Golden, Colorado, and its operations are conducted out of five Area Offices that are located in Billings, Montana; Loveland, Colorado; Phoenix, Arizona; Sacramento, California; and Salt Lake City, Utah.

Environmental protection and compliance activities are important in managing the construction, operation, and maintenance of Western's vast network of transmission lines, substations, and other facilities. Western has an Environmental Affairs Division that is responsible for environmental protection and compliance activities. However, in a 1991 Line Program Environmental Management Audit of Western (DOE 1992), DOE found that Western had taken a "reactive" approach towards environmental protection and compliance and that effective programs had not been established to ensure consistent and comprehensive regulatory compliance. The Line Audit also noted that Western did not have a formal approach to environmental risk management; had not allocated resources to address this issue; and had not developed policies, procedures, and criteria for the identification, evaluation, and management of environmental risk.

Western recognized the need to improve its environmental management program. As one step in this process, Western requested technical support from

Pacific Northwest Laboratory[a] to help Western develop a centrally coordinated environmental risk program. This report summarizes the results of this effort, which has the objective of developing a preliminary environmental risk program framework.

1.1 MAJOR COMPONENTS OF AN ENVIRONMENTAL RISK PROGRAM

A risk management program consists of three general components: risk assessment, risk management/decision making, and risk communication. The terms risk assessment and risk management have a variety of definitions in the technical literature. For the purposes of this report and in the context of environmental risk, risk assessment and risk management are described as two separate but interconnected processes. Risk assessment asks the question, "What are the risks associated with different problem areas?" The objective of risk assessment is to evaluate and rank the relative magnitude of risks associated with problem areas on the basis of the best available scientific information and judgment. The risk ranking then serves as input to the risk management process.

Risk management asks the question, "What can be done to manage risks associated with different problem areas?" Risk management takes the ranking results and combines them with relevant non-risk factors (e.g., legal mandates, public opinion, and costs) to generate options that maximize the reduction of risk to the public as well as to Western. The risk management process shifts the emphasis from identifying, evaluating, and ranking environmental problems to seeking solutions or control strategies for these risks by considering all relevant factors.

In addition to risk assessment and risk management, risk communication is a key to any effective risk program. Risk communication examines such issues as perception of risk, identification of stakeholders, and stakeholder input to the decision process. Table 1.1 summarizes the three components of an effective risk program.

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TABLE 1.1. Three Components of an Effective Risk Program

Risk Assessment:	Identify sources of potential harm, determine consequences
Risk Management:	Integrate results of risk assessments with options and costs for reducing risks
Risk Communication:	Listen to stakeholder's concerns, involve them in decision making, gain their trust/support for decisions

When implemented, Western's risk program (this report will also use the term risk management program in the broad sense to include all the risk components) will consist of policies, procedures, criteria, and resources to identify, evaluate, and manage environmental risks in a comprehensive and coordinated manner. Some of benefits of an environmental risk program include the ability to set priorities, establish criteria, conduct risk assessments, track performance, handle crises, communicate risk information, and manage risk in an integrated and comprehensive manner. The methods developed and implemented for environmental risk management may also be suitable to a broader range of Western risk issues, including programmatic/business risk and safety risk.

In both the development and implementation of an environmental risk program, other Western divisions (rather than just Environmental Affairs) must play a key role. Western's environmental risk management functions may vary across Area Offices and may be shared by several Headquarters/Area divisions, including Operations, Maintenance, Constuction, Lands, Engineering, General Council, Public Affairs, Safety, and Security. The early and continuing involvement of all of Western's divisions is key to the development of a successful environmental risk program.

1.2 STRUCTURE OF THE REPORT

The remainder of this report is organized as follows. Section 2 presents an overview of the approach used to develop a preliminary environmental risk program framework. The results of the literature review and the survey of related risk management activities at selected utilities and power marketing agencies are described in Section 3. Section 4 summarizes the results of visits to Western's Area Offices. The three key elements of an effective risk program—risk communication, risk assessment, and risk management—are discussed in Sections 5 and 6, respectively. Section 8 presents alternatives for implementing the proposed environmental risk program and the major conclusions and recommendations of the study. References are provided in Section 9. Appendix A describes models that can be used for risk assessment.

2.0 APPROACH USED TO DEVELOP A PRELIMINARY ENVIRONMENTAL RISK PROGRAM

2.1 OBJECTIVE

Pacific Northwest Laboratory is providing technical support to Western to develop and implement a centrally coordinated environmental risk program. In this section, we discuss the approach used to develop a preliminary environmental risk program framework and implementation process.

2.2 PROJECT ORGANIZATION AND WORK BREAKDOWN STRUCTURE

A small, multidisciplinary task team has been assembled at PNL to perform work in the following areas:

Perform Literature Review
Conduct Site Visits
Develop Risk Management Approach
Develop Preliminary Risk Program Framework
Hold Trial Sessions
Prepare Final Report
Conduct Teach-the-Teachers Workshop

The findings of the team's work are summarized in this report which contains a description of a preliminary environmental risk program and the basis for selecting it. The report identifies risk assessment and risk management areas requiring further analysis and provides and presents a plan for the development and implementation of a risk management program at Western. Each of the activities identified above are discussed in more detail below.

Perform Literature Review: This activity involves obtaining literature from Western, other power marketing agencies, and selected utilities on existing risk management activities, sources of environmental risk, and existing environmental risk management programs.

Conduct Site Visits: Based on information gathered in the literature review and discussions with the Western Project Manager, a number of Area Offices and associated installations are visited to obtain additional Western specific information on existing risk management activities and information on sources of environmental risk.

Develop Risk Management Approach: Based on information obtained from the above two activities, plus the previous experience of the task participants, a preliminary risk management approach is developed. This approach involves a consideration of risk assessment, risk management, and risk communication. Workshops are held to introduce risk assessment concepts to Western staff and to obtain feedback on initial program design.

Develop Preliminary Risk Program Framework/Conduct Workshops: Using the risk information obtained from the literature review and the site visits, a preliminary risk-prioritization method is developed for Western. This involves development work on a qualitative and semi-quantitative approach for risk assessment. The results of this work are presented for review, comment, and modification at a workshop for Western Headquarters staff and at a second workshop for Area Office Environmental Managers.

Hold Trial Session: A test, or trial, is required to ascertain the effectiveness of the process and to identify areas for improvement. Because of the multi-disciplinary nature of the risk program, participation from other Western divisions in addition to Environmental Affairs is required including: Public Affairs, General Council, Engineering, Construction, Maintenance, Security, Lands, and Budget. During the trial sessions, selected environmental issues are assessed using the Qualitative Issue Characterization (QuIC) and the Semi-Quantitative Evaluation (SEQUEL) approaches. In addition, the Decision Analysis process is illustrated for a selected issue. Participants provide feedback on the risk assessment methods employed in the session meetings. Modifications, alternative scoring systems and changes in approach are pursued based on what the PNL and Western participants learn during the session.

Prepare Final Report: This final draft of the report contains a description of a preliminary environmental risk program framework and recommendations for program implementation for Western.

Conduct Teach-the-Teachers Workshop: PNL instructs selected Western staff on the application of the environmental risk management program. Descriptive curriculum, reproducible for use by Western instructors, is prepared by PNL and disseminated during the workshop.

3.0 LITERATURE REVIEW AND SURVEY

The literature review task includes two components: 1) telephone interviews with the power marketing agencies (PMAs), the Tennessee Valley Authority (TVA), the Electric Power Research Institute (EPRI) and selected investor-owned electric utilities; and 2) a literature search of written material on environmental risk assessment, communication and management. Three major reference sources were used during the literature search: first, various EPA, EPRI, and DOE reference databases were queried electronically; second, information was obtained directly from internal PNL sources; and third, during the course of the site assessments, a large volume of Western's environmental plans, programs, impact statements and other documents were gathered and later reviewed.

The results of the literature review task are presented in the following major categories: PMAs and TVA, EPRI, Electric Utilities, and Western documents.

3.1 SURVEY OF THE POWER MARKETING ADMINISTRATIONS AND TVA

All of the PMAs as well as TVA were contacted. Only the Bonneville Power Administration (BPA) has initiated the development of a formalized risk program. Southwestern has performed some preliminary work on substation ranking and prioritizing. Alaska Power Administration (APA) does not anticipate doing anything for another two years, and Southeastern has no generation, transmission or distribution equipment and appears to have no need for a risk program. BPA, working closely with BC Hydro, has developed a documented preliminary risk assessment process.

Southwestern Power Administration (SWPA)

SWPA provided PNL with its "Preliminary Draft Substation Ranking Report," a preliminary assessment (PA) for the 24 substations it owns and operates. The 24 substations were ranked on the basis of their potential threat to human health and the environment. A simple rating criteria system was applied that establishes the relative importance of variables such as volume of hazardous materials, proximity and accessibility to groundwater and drinking water supplies, density and character of surrounding population, flooding, and sensitive environments. Apparently, Western had a hand in the development of the rating criteria system and is therefore familiar with SWPA's efforts.

Bonneville Power Administration

BPA worked closely with BC Hydro in the development of its risk assessment plan. The plan uses a semi-quantitative approach for evaluating the risks associated with an environmental issue and provides an action matrix that yields guidance on the level of concentration the issue requires. The BPA/BC Hydro approach has been adopted by Western in the preliminary development stages of its risk program.

BPA also provided the project team with a copy of its Oil Spill Environmental Sensitivity Listing which included actual scoring criteria and methodology for systematic prioritization of facilities.

Southeastern Power Administration (SEPA)

SEPA is a small organization relative to the other PMAs and does not own or operate or maintain any generation, transmission or distribution equipment. SEPA reported that the DOE has not required them to develop an environmental risk assessment plan.

Alaska Power Administration

APA reported that it has not performed a formal risk assessment and probably will not need to for the next two years.

Tennessee Valley Authority

We spoke with several people at TVA. There are four groups that looked specifically at PCB management and they appear to act separately on environmental issues (Fossil & Hydro, Transmission, Nuclear, and the Resource Group). A corporate risk management plan does not appear to have been developed and there was no indication that one is in progress. TVA's primary focus has been on the elimination of PCBs.

3.2 SURVEY OF SELECTED ELECTRIC UTILITIES

Several electric utilities of various sizes were contacted and some relevant information was obtained. A list of environmental issues from an impact analysis report provided by Niagara Mohawk Power Company in upstate New York and an Environmental Annual Report from Pacific Gas & Electric Company of California were the most notable and useful items received.

Niagara Mohawk Power Company (NMPC)

NMPC initiated a formal risk assessment process and hired several risk management consulting firms to review its preliminary approach. Comments from the consultants encouraged NMPC to revise its risk assessment plan and develop a plan that could be readily implemented at all levels of the organization. NMPC is in the process of developing this type of a program and could not offer us any written information at this stage. It did, however, provide the table of contents page to its Environmental Issue Impact Analysis document. The table of contents contains a listing of environmental issues of High, Medium, and Low priority. NMPC also provided several example "chapters" from the report. The NMPC environmental issue impact analysis format follows:

Issue: Description of the environmental issue

Priority: High, Medium or Low

Responsibility: The person and department in charge of the issue

Regulatory Position: Federal, State and local legislation and regulatory agencies' position regarding the issue

Interest Group Position: Stakeholders views, opinions and attitudes relative to the issue

Expected Value Impact ($ Magnitude): Current budget and anticipated expenditures related to the issue

Expected Value Impact (Likelihood): Probability of expenditures occurring

NMPC Position: Description of NMPC's corporate philosophy and approach in regards to the issue

Recommended NMPC Approach: Action items required to successfully manage the issue

Concerns/Skill Gaps: Availability of staff, technical skills, availability of support from other departments, timely availability of contract support, training requirements, etc.

Remarks: General information and status of issue.

This approach is considered a good comprehensive reporting platform and is being augmented and enhanced by Western in the preliminary development stages of its risk program.

Pacific Gas & Electric Company (PG&E)

PG&E's corporate environmental department stated that it does not have a formal risk assessment plan. It did, however, provide us with its 1992 Environmental Report Commitment to Environmental Quality. This report provides some information on PG&E's activities and environmental risk disposition. For example, the report noted 33 environmental violations of which six involved actual releases and 27 involved violations of an administrative or procedural nature such as labeling and record keeping requirements. The steps being taken by PG&E to improve corporate environmental compliance that may have relevance to Western's risk program are as follows:

- Improved sharing of agency inspection results with other facilities having similar operations to benefit more fully from lessons learned.
- Formation of an interdepartmental Compliance Guidance Working Group to resolve regulatory ambiguity and uncertainty issues.
- Implementation of an environmental reporting policy in the Electric Supply Business Unit to raise the awareness of compliance issues at all levels of management. Reporting requirements include root cause analysis for identifying the cause of specific compliance problems, and development of action plans for resolving more root causes.

Northern States Power Company (NSPC)

Western provided PNL with a copy of the overhead transparencies from a presentation on decision analysis for resource and bulk power management by Rick Free of NSPC. NSPC is using the decision analysis (DA) process and a DA model to make price and volume decisions on selling power in the "optimal" manner. The DA model they are using performs large quantities of deterministic calculations.

NSPC stresses that the two key benefits of the D/A process are that D/A helps manage the internal and external evolution process utilities are undergoing and that it can integrate uncertainties into deterministic analyses. Analogous to and in accordance with the former benefit, after the two recent Western risk assessment workshops led by PNL, it became apparent that the risk assessment processes themselves (QuIC/SEQUEL) provide the forum for interaction, discussion and information exchange vital to an effective risk management program.

Kansas City Power & Light Company (KCP&L)

Western provided PNL with a copy of brief paper and the overhead transparencies from KCP&L's presentation on the use of EPRI's Catalyst process. The EPRI Catalyst process is a structured approach to brainstorming. It is analogous to the qualitative and semi-quantitative risk assessment and management processes Western has been exploring, in that it creates a forum for focused multidisciplinary discussion of environmental issues; issues that involve various levels of uncertainty. Of particular interest in the Catalyst approach is the Catalyst Strategy-Scenario Matrix which establishes a set of scenarios, each assigned a probability of occurrence and develops strategies for decisions relating to each scenario. This is a qualitative analysis and relies on the knowledge of the experts participating in the meeting. PNL has ordered the document CATALYST, A Group Process for Strategic Decision Making: Facilitators' Guidebook and will review the document to identify potentially useful approaches and techniques.

Salt River Project (SRP)

Western provided PNL with a copy of the presentation made by a member of the Issues Management Group in the Environmental Services Department of the Salt River Project. This is a new group chartered to investigate the "science/scanning" of major future environmental issues. Current areas of interest include: global climate change; EMF; air quality; telecommuting; and environmental equity. Typically this group addresses only upcoming issues not yet regulated. Other groups in the Environmental Services Department handle regulatory- and compliance-related issues. This group works with decision analysis contractors and the presentation on global warming at the seminar is a good example of the typical approach they use. Decision analysis seems to be used on a case-by-case basis for specific issues and not as part of an integrated risk management plan.

The Salt River Project has no formal environmental risk management program. The ESD has around 50 staff members and consists of six divisions: air quality, water and waste, information resources, lab and field services, environmental studies, and environmental planning and issues management. The Water and Waste Division (RCRA/CERCLA, PCB/oil spills containment) and the Environmental Studies Division (NEPA, permitting, environmental support for construction/modification, auditing) seem to be the groups that perform the typical Western environmental activities. Richard Hayslip (who gave seminar presentation) is the department manager. A separate organization analogous to Salt River's environmental planning and issues management division may be useful to Western in coordinating any proposed risk management program.

3.3 SURVEY OF THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI)

The EPRI has an environmental risk analysis program group. The journal articles and reports obtained from this group provide relevant and valuable information and approaches to risk assessment and decision making.

Two reports and three relevant journal articles were obtained from the preliminary search of EPRI references with the following results:

"Risk Communication Manual for Electric Utilities Volume 1: Practitioner's Guide and Volume 2: Case Studies," Case studies provide important lessons learned in the area of risk communication. Volume 1 presents risk communication guidelines, with separate sections on risk perception, use of risk comparisons, and planning for risk communication. Volume 2 demonstrates the practical application of the risk communications tenets in Volume 1.

"Operational Procedures to Evaluate Decisions With Multiple Objectives," prepared by the University of Southern California - Presented in a workbook format, the report provides procedures and checklists for assigning values to potential outcomes of multi-objective decisions. This document contains technically detailed information of marginal applicability to the Western Environmental Risk Management Project.

"What are you Afraid Of?," written by Leslie Lamarre - An excellent article focussing on public perceptions and bridging the gap between risk experts and the public. Provides an overview of risk studies at EPRI including the "Risk Communication Manual for Electric Utilities" and several microcomputer-based models: AERAM, ORGRISK, and SITES (on order). In addition, the article cites a tangentially relevant environmental risk assessment case study involving BPA and the siting of transmission lines near Missoula, Montana.

"Air Toxics Risk Analysis," written by Leonard Levin - This journal article describes three EPRI air toxics risk analysis computer programs; AERAM, AirTox, and RiskPISCES and the Comprehensive Risk Evaluation (CORE) three-year study to synthesize information from individual power plant air toxics risk assessments. Further research is needed to determine the applicability of these programs or elements of these programs to the Western environmental risk management project.

"Ashley Brown: Seeing the Prudence of Risk," by Ralph Whitaker - This article contains a PUC commissioner's perspective on the electric utility industry and corporate risk. It provides some good insight on utility regulation, social equity and economic efficiency.

EPRI Computer Programs

The mineral oil spill evaluation system (MOSES) computer program guidebook was also obtained and reviewed. The MOSES computer program may serve some useful purposes in making specific decisions pertaining to secondary containment. Western engineering personnel are aware of MOSES and have considered its applicability.

Western has ordered three other computer programs--Sites, NCW Manager and Catalyst--for PNL to review. The programs were not received in time to evaluate and include in this report.

4.0 REPORT ON THE PROJECT TEAM'S VISITS TO WESTERN AREA POWER ADMINISTRATION AREA OFFICES AND SELECTED FACILITIES

PNL traveled to meet with the Environmental Managers from the Loveland (LAO), Salt Lake City (SLC), Billings (BAO), and Phoenix (PAO) Area Offices, and held a telephone interview with the Environmental Manager from the Sacramento Area Office (SAO). Site visits were performed at substations in the Loveland and Phoenix areas. The purpose of the site visits was to become familiar with Western operations, identify key environmental and related issues, and to ascertain the similarities and differences between Area Offices pertaining to environmental risk.

A questionnaire, based on a DoD survey instrument, was used as a format for discussion during the interviews and site visits. Environmental areas covered in the questionnaire included: air emissions, hazardous materials management, hazardous waste management, natural and cultural resource management, fuels and oils, underground storage tanks, solid waste management, PCBs, asbestos, radon gas, water quality, and waste water discharge. In addition, several specific questions under the general information category were posed as follows:

1. What existing environmental risk ranking studies have you performed or are you currently performing?
2. How many people are there on staff in your environmental program and what are their major areas of responsibility?
3. What are the major environmental issues in your area?
4. Describe your information management system as it pertains to reporting and documenting environmental issues (facilities audits, self assessments, other).
5. Does your Area Office service territory include more than one EPA region and have you experienced problems with inconsistencies between EPA regional offices? In other words have regional offices imposed different requirements or handled similar problems in a different way?
6. Please describe the budget process for environmental projects.

7. In your opinion, which environmental problems currently hold the highest risk and who are the major stakeholders associated with these problems?

8. Please describe your interactions with the Safety Division.

9. Please describe your interactions with the O&M Division.

10. Please describe your interactions with the Engineering Division.

11. Please describe your interactions with Western Headquarter's environmental staff.

The notes and observations from the site visits were compiled into summary sheets for each area. Summary information was grouped under the following titles:

Resources - a listing of the environmental staff and a brief description of their education and background.

Key Environmental Issues - a listing of the major environmental problems as discussed in the meetings or observed in the field.

Key Related Issues - institutional or other related important issues that present risk to Western.

Environmental Plans, Programs, and Software - a listing of all the documents acquired from each area.

What You Would Like To See in a Risk Management Program - Western environmental personnel's expectations of a risk management program.

Interrelationships - a description of the working relationship between departments at Western.

A synopsis of Area Office summaries follows.

4.1 ASSESSMENT OF THE RESOURCES AT THE AREA OFFICES

Each Area Office has an Environmental Manager and a small staff of Environmental Specialists/Planners (Salt Lake City also has a Public Utilities Specialist and a Public Affairs Specialist). The Environmental Manager reports to the Deputy Area Manager.

Contract employees and student interns are also utilized. The Area Offices use consulting firms to perform environmental assessments and studies, and contractors for environmental monitoring and testing, remediation, and waste disposal.

Most of the Area Offices claimed to be understaffed and pointed out that Western is currently operating under a hiring freeze.

4.2 ASSESSMENT OF KEY ENVIRONMENTAL ISSUES

Key environmental issues were identified through discussions with Western staff, through observation, and through the review of Western literature. The following is a list of these issues:

- Potential oil spills at substations located in sensitive areas (navigable waters, groundwater, flood control culverts).
- Purchase of properties that are polluted, facilities that are old, or facilities with historic spills of oils or hazardous substances (e.g., PCBs).
- Power Marketing - changing operating strategies at dams due to environmental regulations/determinations. Ecological problems above and below dams.
- Siting and construction of power lines:
  - Archeological resources
  - Endangered Species
  - Visual Impacts
  - Electric and Magnetic Fields
- Proper and timely disposal of hazardous wastes.
- Urban encroachment on high-voltage power lines.
- Oil/water separators - proper maintenance.
- Federal Facility Compliance Act of 1992.
- Leaking underground storage tanks.
- Storms, floods - responsiveness of crews.
- Electric and Magnetic Fields - South Dakota PUC setting standards.
- Pesticide/herbicide use.

4.3 ASSESSMENT OF KEY RELATED ISSUES

The category entitled "Key Related Issues" pertains to institutional situations that may increase Western's risk. The following is a list of these issues:

- Documentation and administration - are permits current? databases accurate and maintained?
- "Shared Facilities" - Bureau of Reclamation's or Western customers' equipment in Western's yard - Agreements need to delineate responsibility for spills.
- Manpower shortage, including linesman and operators.
- DOE mandates - historically DOE has made requirements on facilities that are too onerous.
- Is there an environmental policy on purchasing?
- Trouble keeping up with the dynamic nature of the environmental industry. Need to internally reorganize to meet changing priorities.
- Headquarters used worst case (California) and applied it to every other state for writing USPCI contract.
- Environmental budget set by "best guess/best estimate." Problem with projecting accurate figures for the out-years.
- EMF - public perception and public relations.
- Regulation by several EPA regions in the same Area (inconsistency within the regulatory agencies).

4.4 ASSESSMENT OF ENVIRONMENTAL PLANS, PROGRAMS AND SOFTWARE TOOLS

Each Area has a number of plans and programs as illustrated by the following comprehensive list of environmental plans from the Salt Lake City Office.

- Comprehensive Environmental and Public Affairs Program Plan
- Hazardous Waste Management Plan
- PCB Management Plan
- PCB Information System Procedure

- Environmental Incident Plan and Procedures
- Environmental Training Plan
- Asbestos Management Plan
- Underground Storage Tank Management Program
- Chemical Management Program
- Environmental Protection and Community Right to Know Program
- Surface Water Management Program
- Comprehensive Environmental Response, Compensation, and Liability Act Program
- Underground Injection Control and Well Closure
- Baseline Characterization of New Facilities
- Environmental Monitoring Plan
- Meteorological Monitoring Program
- Headquarters Ground Water Monitoring Program
- Quality Assurance/Quality Control Program
- Headquarters Pesticide Management Program
- Environmental Impact Mitigation Program
- Environmental Protection Implementation Plan
- Long Range Environmental Protection Plan
- Spill Prevention Control and Countermeasures (SPCC)
- Headquarters Vegetation Management Program

Several questions came up during the course of the site visits. Is there consistency of documentation across the Area Offices? How close are the Area Offices to achieving complete documentation? Do the Area Offices know what they need to be fully documented? Could the Area Offices benefit from a coordinated documentation effort and sharing of information between Areas?

Headquarters is developing an Environmental Manual, and this may serve as a source which provides coordination and consistent understanding of environmental plans and programs.

Only one Area Office (Billings) mentioned the use of environmental software programs. Billings District environmental engineers make limited use of EPRI's Mineral Oil Spill Evaluation System (MOSES) program. The U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) is also utilized.

4.5 WHAT WOULD YOU LIKE TO SEE IN A RISK MANAGEMENT PROGRAM?

The following is a list of responses to this question obtained from the Area Offices.

- A clear picture of where the risks really are.
- Categorized short-term versus long-term problems.
- Targeting issues of high potential for public concern.
- Streamline our current process by developing a risk rating - somehow or other help us assign risk, consistency across areas - so we can concentrate on the most important issues.
- Its troublesome for people out in the field to interpret guidance documents, they need something easy to use that helps them to understand the problems and what they should do.
- We need guidance or procedures to determine which sites need Spill Prevention, Control, and Countermeasures plan reviews. Need help in prioritization.
- Volume requirements and potential for spill into navigable water. Criteria are showing that a SPCC plan will be required for ALL substations. DOE audit says SLC needs a quantitative system for ranking substations.
- We need to be more quantitative - so we can quantify our risk, then we will have it documented in black and white. Employees can go to jail, so the risk plan can show that the risk was evaluated.

4.6 ASSESSMENT OF INTERRELATIONSHIPS

The overall sentiment drawn from the interviews is that interrelationships between the environmental departments and the other departments within Western are getting better with time. The following is a synopsis of specific comments and observations on interrelations between Environmental and other selected departments.

- Headquarters: An understanding of how Headquarters sets priorities and assigns projects would be helpful.
- Safety: Joint reviews widely accepted and appreciated. Some gray areas remain.
- Maintenance: Should feel like they can go to Environmental whenever they have doubts.
- Engineering: There are good reasons for Engineering and Environmental to talk early in the development of a project, and this is happening more consistently.
  - The Area offices work with Headquarters who actually do the design for the secondary containment (note: secondary containment refers to structures or systems designed to contain oil spills). Trying to combine secondary containment with other projects but leaning towards just going with secondary containment as a stand alone project.
- Construction: Construction section does its own inspecting. Environmental has provided some training. Construction inspectors are not environmental people, therefore they don't know what to look for. In the past, the environmental language in the specifications were vague. If specifications were more detailed the inspectors would do a better job. Headquarters and Engineering are working to write the specs with more details pertaining to environmental requirements.
  - Environmental may not find out about a construction project until after site work has commenced. Communication problem - need to be involved earlier so as not to hold up the project and increase overall costs.
- Lands: Purchasing property with environmental problems can be very costly. It appears that early discussions with Environmental have not occurred.

5.0 THE RISK COMMUNICATION COMPONENT OF AN ENVIRONMENTAL RISK PROGRAM

Risk communication is a fundamental part of an effective risk management program. Risk communication is defined as an exchange of information between interested parties on the potential for threats to human health, public safety, or the environment (Covello et al. 1988). Interested parties include not only members of the general public, but governmental agencies, stakeholder groups, and internal audiences within the organization initiating the risk communication.

Risk communication often covers such topics as existence of a risk, its potential severity, and acceptability of that risk. From a technical perspective, risk can be evaluated in terms of the probability of an incident occurring and the severity of the incident if it does occur. The public tends to evaluate risk in a much broader context; the public recognizes the technical perspective but also considers the social, economic, and cultural implications of an incident (Morgan 1993). Risk communication must therefore include not only the dissemination of technical information, but also a method to learn how the public and other groups are assessing risk in a broader context. Risk communication must also provide a vehicle for demonstrating the organization's respect and concern for the public's interests.

A properly developed and administered risk communication program can assist an organization during both routine activities and emergency situations. There are a number of highly visible examples that can illustrate the benefits of an effective risk communication program. These include the actions by Pepsi Co., during their 1993 product tampering incident and by Johnson and Johnson Co. during the 1980's Tylenol tampering incident. In both cases the companies acted in an honest and open manner, they listened to the public's safety concerns, worked effectively with other credible organizations (e.g., the FBI and the Surgeon General's Office) and the media, and carefully evaluated their communication efforts throughout the crises. In conjunction with the long-standing positive image that these companies worked to cultivate, their effective risk communication program allowed them to emerge virtually unscathed from these incidents.

Alternatively, the performance of the Exxon Corporation in the Exxon Valdez oil spill and of Dow Chemical in the Bhopal chemical disaster showed how poor risk communication can leave a legacy of public distrust and anger (Swanson et al. 1991). In these incidents, the companies provided minimal information or delayed the release of key data, were in conflict with credible organizations, were not overly cooperative with the media, and responded slowly to indications that their message was not being well received.

In this section, we discuss the fundamental principles of risk communication, the perception of risk and risk communication, methods of incorporating risk communication into an effective risk management program, and the importance of internal risk communication.

5.1 FUNDAMENTAL PRINCIPLES OF RISK COMMUNICATION

When evaluating the need for a risk communication program, it is often difficult for some decision makers to accept the notion of public involvement in an organization's own policy-making. To get past this stumbling block, decision makers must keep in mind that in a democracy, people have the right to influence decisions that will affect their lives, property, and the things they value. The goal of risk communication is to produce a public that is involved, thoughtful, reasonable, and solution-oriented--the goal is not to alleviate public concerns or halt public actions (Covello, McCallum and Pavlova 1989).

The level of risk communication needed will vary depending on the level of public involvement. Figure 5.1 illustrates several levels of public involvement and appropriate techniques to facilitate this involvement. In the past, public involvement was minimal and the role of risk communication was primarily to inform the public of the decision that was made. In the late 1960s and early 1970s laws were changed to require that the public's input be obtained before a decision was made. In this situation, risk communication evolved to allow internal decision makers to listen to the public's concerns before actions were adopted; however, this level of public involvement did not allow the public or interested stakeholders to participate in actual decision making.

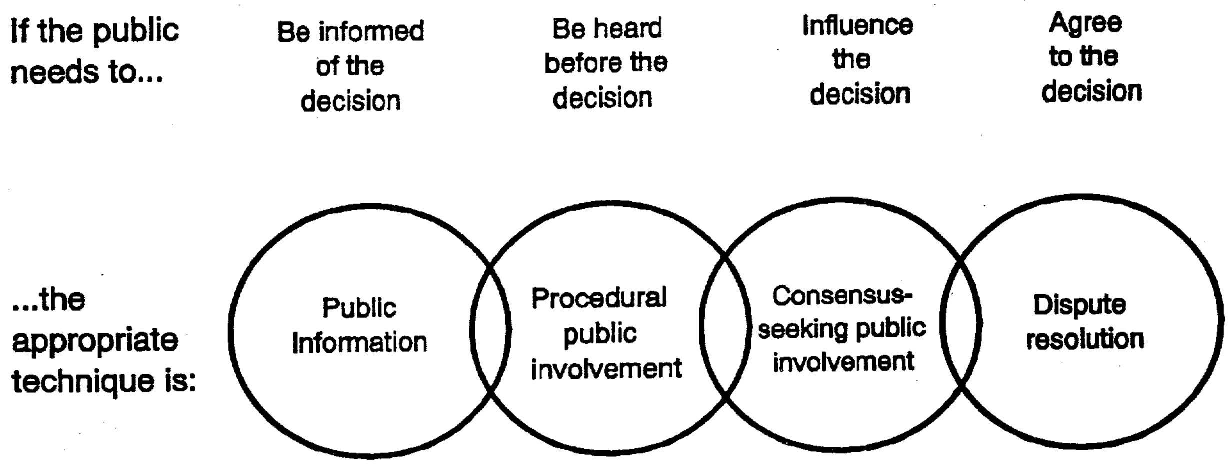


FIGURE 5.1. Levels of Public Involvement and Techniques for Facilitating this Involvement

In today's business and regulatory environment, the public plays an increasing role in decision making. Members of the public often want to participate in the decision making process not just because of their concerns about risk, but because of concerns about lack of control over their environment or lives (Sandman, 1986). To successfully include external stakeholders in decision making, all parties must strive to reach a consensus decision. In some cases, dispute resolution techniques are used to assist the parties in reaching a decision if a consensus opinion cannot be achieved through initial discussions. With active stakeholder involvement in decision making, there is a heightened need for effective risk communication so that all parties can start with the same basic understanding of the risks and the alternatives available to them.

To be effective, a risk communication must be conducted as part of an ongoing program. Careful planning and constant evaluation of the program's performance are characteristics of successful risk communication programs. Experience has shown time and time again that an effective risk communication program cannot be put into place in a short period of time, as is often attempted to address the needs of a fast-paced, high-visibility incident. For a risk communication program to succeed, it needs to: develop conduits for communication with the public (e.g., through the media), measure public perceptions, factor public perceptions and needs into decisions, and include external stakeholders in the decision making process.

The Environmental Protection Agency has published a list of "Seven Cardinal Rules of Risk Communication" (Clement and Allen 1988). These rules are:

- Accept and involve the public as a legitimate partner.
- Plan carefully and evaluate your efforts.
- Listen to the public's specific concerns.
- Be honest, frank, and open.
- Coordinate and collaborate with other credible sources.
- Meet the needs of the media.
- Speak clearly and with compassion.

Risk communication is a process that an organization must undertake fully; one of the worst mistakes an organization can make is to begin communication before accepting the public as having a legitimate interest in their decision-making activities. Risk communication must be carefully planned to fit the needs of the organization and its audience. Plans must not be followed blindly, a risk communication program must be flexible enough to allow efforts to be evaluated and modified as needed. In risk communication, the organization must listen and acknowledge the public's concerns--the organization may not agree, but it must respect that the public's concerns are real to them, and therefore of concern to the organization. In dealing with the public, the organization's representatives must be open and honest; withholding important information or lying will eventually destroy the organization's credibility and create a negative image that is extremely difficult to dispel.

Credible allies, those with little or no vested interest in your proposed actions, can be effective in raising public confidence in the decision and communicating risk information. For example, if representatives of the Sierra Club, National Wildlife Federation, and Audubon Society are involved in reaching a consensus decision with internal decision makers, such a consensus decision will have an enhanced degree of credibility with a large percentage of the public who might have normally been more skeptical. The public and external stakeholders realize that an organization proposing a specific action has a "selfish" interest in taking that action. If respected external stakeholder groups participate in the decision making process that produces a proposed action, their involvement in the process indicates that the decision reached is at least acceptable to groups with different (and hopefully less self-serving) concerns and interests.

The media are a prime transmitter of information to the public--they play a key role in setting agendas, framing arguments, disseminating information, and determining outcomes. Relationships with the media can be cultivated so that at the very least, the information relayed to the public is an accurate characterization of the situation that reflects the viewpoints of the principal parties. The failure to meet the media's need for information, or the failure to properly brief the media so that they at least understand the problem being faced and potential options for resolution, can severely damage or hinder the decision making process. The language used in communication with the public, by both decision makers and the media, must be one the public can understand.

5.2 PERCEPTION OF RISK AND RISK COMMUNICATION

An important component of risk communication is understanding how the public perceives risk. Understanding the criteria the public uses to evaluate risks can be extremely useful in framing an appropriate message and appreciating the public's concerns. In addition to the "level of risk" the public is also concerned with such factors as fairness, benefits, alternatives, control, and voluntariness. Let's illustrate each of these concerns using the example of a hazardous material landfill proposed for a rural community.

The public is more likely to accept a risk if it is fairly distributed through the general population, as opposed to being concentrated in their neighborhood. For example, the public may be more willing to accept a landfill in their community if neighboring communities also are required to provide landfills to meet their own needs. If however, the landfill is being targeted as a regional facility, the local population may be less likely to accept the associated risks if they think others are unfairly relegating all of the risks to their community.

Similarly, the public is more likely to accept a risk if there are benefits to them or their community. If the proposed landfill would provide a significant number of high paying jobs, thereby providing an economic benefit to the community, the public may be more likely to be favorably disposed toward the facility. If, however, facility jobs were limited in number and relatively low paying, the public might not see an economic benefit that would compensate for the perceived increase in risks.

The public considers the availability of other alternatives in their evaluation of risk. A risk for which there are no alternatives is more easily acceptable than a similar level of risk when alternatives exist. The disposal of hazardous materials in a landfill might be more acceptable if there are no alternative methods of dealing with this waste; however, if commercial recycling or vitrification processes are available, the public might be much less excepting of the risk of disposing of this material at a landfill.

The public is more likely to accept a risk if they have some voice or control in how a risk generating activity is conducted. If members of the local public and concerned stakeholder groups are on the landfill's board of directors and have a say in how the facility is operated, the public might be more excepting of the risks than they would if decision making for landfill operations were made only by corporate managers who may or may not be members of the community.

Finally, members of the public are more likely to accept a risk if it is a voluntarily (as opposed to involuntary) decision. Individuals might chose to relocate their families to a site near an existing landfill and voluntarily accept this risk after factoring in other mitigating considerations (e.g., low crime rate, no other nearby sources of industrial pollution, good community schools). Conversely, someone living in the community might not be as willing to accept the involuntary addition of the risk imposed upon them by an outsider's development of a new landfill.

In addition to the factors illustrated above, social impact is an important component the public uses to evaluate risk. Swanson et al. (1991) reports that:

> "an accident that takes many lives but produces little social disturbance at large is familiar and well understood - such as an airplane crash - does not have much signal value. But a small accident in an unfamiliar system or one that is poorly understood, such as a nuclear reactor accident, has an important signal for future potentially catastrophic mishaps that could have major social consequences."

Among the other factors that the public uses to assign a level of risk to a process or activity are:

- How well understood is the risk-causing activity? Often, just the lack of information about risk leads the public to significantly overestimate the actual risk.

- How "bad" are the human health implications? For example, risks that can lead to fatalities are considered more risky than those that can lead to injuries--even if the potential number of injuries is relatively high and the number of potential fatalities is low.

- How catastrophic are the consequences from the risk? This concern involves a consideration of the number and severity of human health impacts, but also whether the risk jeopardizes society. An accident at a nuclear power plant may result in few fatalities because people would be evacuated before their radiological exposure reaches high levels, but such an incident might require homes and communities to be permanently abandoned due to residual contamination. This scenario results in an extremely high risk ranking with the public because of the potential for major impact on the local society.

- Are risks to be borne by future generations? People are more likely to accept risks for themselves than they are for their children, grandchildren, and future generations.

- How dread-inducing is the activity?

Great care must be taken when attempting to characterize and compare risks because of the broad conceptions of risk and concerns that underlie the public's concerns. Swanson et al. (1991) reports that:

> "To many citizens, statements such as 'the annual risk from living near a nuclear power plant is equivalent to the risk of riding an extra three miles in an automobile' appear ludicrous. This is because such statements fail to consider the important differences

in the nature of risks from the two technologies. First, riding in a [sic] automobile is a voluntary action; living near a nuclear plant may have been an imposed situation. Exposure to escaping radiation, however unlikely, is dreaded and can affect future generations. An accident at a nuclear plant has the potential for being catastrophic not only for individuals but also for the larger society. None of this is true for driving three extra miles in a car. Therefore, the two risks are not comparable in most people's minds, even though such a comparison can be made statistically."

Trying to argue that people accept a risk just because it is small in comparison to other risks they do accept, is not advised. Such an approach tends to lower the level of trust people have in you and jeopardize your credibility. When discussing risk, trustworthiness and credibility are extremely important. In addition, people want you to acknowledge, respect, and share their concerns.

5.3 METHODS OF INCORPORATING RISK COMMUNICATION INTO AN EFFECTIVE RISK MANAGEMENT PROGRAM

Because risk communication is such a fundamental part of an effective risk management program, a number of important steps need to be taken by Western to improve its environmental risk communication. The first step is for Western to identify the credible stakeholders that can represent the public in certain decision making situations. When we refer to this decision making, we are not talking about day-to-day decisions or management of activities, we are talking about public involvement in setting broad goals and priorities for environmental risk management. Early risk communication and stakeholder involvement allows public concerns to be factored into decisions at a point far enough upstream in the process so that litigation can be reduced and operational delays minimized.

Credible stakeholders can be representatives of national or regional environmental organizations; Native American tribal groups; organizations that are concerned with minority issues and environmental equity; medical associations; regulatory agencies; and educational groups. Stakeholders can be involved in setting Western-wide environmental priorities, or they can be involved in addressing regional or more site-specific issues.

Before working with stakeholders, effective risk communication strategies must be developed. The scope of the issue to be addressed needs to be clearly defined, Western's own priorities and limitations must be clearly understood, and the role that stakeholders will be asked to play must be clearly defined. Initial communication with the stakeholders needs to be coordinated through a single channel--in most organizations the public affair's office is probably the group that makes initial contacts with stakeholders and coordinates follow-up communication. Direct contact between stakeholder and environmental affairs staff can take place at working meetings during which issues are presented and discussed.

When consensus decisions have been made between Western's staff and selected stakeholders, these decisions need to be communicated to the general public. The language of risk communication must be carefully assessed. Swanson et al. (1991) calls for:

- Using concrete images to give substance to information that may involve abstract concepts that the public may not be familiar.
- Discussions about the potential for death, injury, and environmental degradation must be presented in terms that show the organization cares about the public and the environment and actively strives to reduce risk.
- Showing the public that the organization listens to and cares about their concerns. The organization must also show that it respects the comments and strong feelings that the public has on issues that affect them.
- Using risk numbers that both the organization and the audience consider both fair and relevant.
- If others are presenting their own risk assessments, the organization should try and present their results in the same format--changing the yardstick only confuses the measurement.

Risk communicators need to understand that people realize that the organization has a vested interest in minimizing public perceptions of risk and therefore may distrust their assessments and decisions. In particular, there will be some individuals that will believe that the organization's risk assessments will consistently underestimate risk.

5.4 THE IMPORTANCE OF INTERNAL RISK COMMUNICATION

In discussions of risk communication, the emphasis is generally on communication with the public. While this is extremely important, it is also essential that internal risk communication occur. Inside an organization, environmental risk issues are not exclusively the domain of the headquarter's environmental affairs group. Other Headquarter's divisions or organizations involved in environmental issues include: Public Affairs, General Council, Operations and Maintenance, Planning, Budget, Lands, Engineering, Environmental Affairs and upper level management.

Effective risk management cannot be done without the coordination and input of the internal stakeholders described above. The public relations office is the group in the position to coordinate organizational contact with external stakeholders and the media. The legal office needs to be involved to determine the potential legal ramifications of environmental decisions and to provide advance warning about new and proposed regulations that may impact an organization's responsibilities for environmental issues. Maintenance and operations personnel have information that may be needed to address stakeholder concerns or shed light on the feasibility of changing certain practices. They also have the responsibility of implementing many decisions made to address environmental issues. Environmental planning personnel need to be involved because they need to be kept informed of environmental policy and decisions to effectively perform their job function. Staff involved in acquiring and managing land for Western operations need to be aware of potential environmental issues when performing their work. For example, a few years ago Western acquired a parcel of land adjacent to an existing substation that turned out to contain a hazardous waste disposal site. The remediation of the waste site is requiring a significant allocation of funds by Western that could have been used to improve service or reduce rates to customers. Engineering staff needs to be aware of environmental issues when designing structures and facilities. Slight modifications to designs in the planning stage of projects can lead to major cost savings in the long-term.

Outside of Headquarters, personnel in Area and District Offices need to also communicate across organizational boundaries on environmental issues.

This involves not only communication between diverse groups within the local office, but communication between Area Office and Headquarters staff.

There are a number of ways to implement risk communication throughout an organization. Newsletters and memos are one way of communicating information from Headquarters to Area staff. Arranging for the routine participation by non-environmental staff members in environmental meetings is another method, as is Area briefing on key issues. Another method of risk communication is establishment of an active list of internal contacts who are routinely informed of the status of, and whose opinions are solicited on strategies for dealing with key issues.

6.0 THE RISK ASSESSMENT COMPONENT OF AN ENVIRONMENTAL RISK PROGRAM

Risk assessment is a critically important component of an effective risk management program. A large organization like Western deals with a variety of environmental risks; it is important that risks be evaluated so that the most important environmental issues can be identified and all issues receive the appropriate level of attention. In this way, issues can be dealt with before they become major problems, sparing the public from undue injury and providing Western with significant cost savings.

6.1 METHODS OF RISK ASSESSMENT

There is a wide range of risk assessment capabilities that are available to Western. These capabilities range from simple qualitative assessments to full quantitative studies. In the simplest sense, a qualitative assessment of risk is designed to determine what risks are present but not to attempt to assign numerical rankings for the risk. Qualitative risk assessments involve a description of the underlying issue and the broad range of risks associated with it. The description of risks can involve a characterization of potential impacts on human health, ecosystems, regulatory compliance, liability, business costs, scheduled operations, public perception, and other areas of concern.

In a quantitative assessment, research is conducted to determine how much risk is present; to provide numerical estimations of risk. Quantitative assessments can involve simple "back-of-the-envelope" estimations of risk or complex numerical modeling. Quantitative assessments can be time-consuming and expensive. Sometimes these assessments can shed light on a problem and provide novel insights, on other occasions extensive numerical studies may provide little new information on a subject. In poorly designed studies, the costs of numerical modeling can even exceed or be a significant portion of the total cost of remediating a problem. For these reasons, a semi-quantitative assessment is often conducted to allow a preliminary ranking of risk. Such rankings can be used to identify the elements of risk that pose the greatest potential impact or to determine if any of the risk elements require a more quantitative assessment.

Western's Environmental Affairs staff have at their disposal a variety of assessment tools, including simple screening models and more detailed quantitative models. In Appendix A, we provide a brief description of some models that Western is currently using, or may choose to use for future risk assessment work.

In the remainder of this section, we will focus on the simpler risk assessment methods that are used for preliminary evaluations of risk, risk rankings, and risk comparisons. This level of assessment tool plays a key role in designing risk management strategies.

6.2 METHODS OF RISK ASSESSMENT EMPLOYED BY UTILITIES AND OTHER POWER MARKETING AGENCIES

In this section we discuss in some detail the methods of risk assessment employed by Niagara Mohawk Power Company, BC Hydro, and the Bonneville Power Administration. These risk assessment methods are designed to support new risk management programs.

6.2.1 The Niagara Mohawk Power Company Approach

The Niagara Mohawk Power Company has developed a qualitative approach to assessing environmental risk (as briefly discussed in Section 3.2). The approach involves identifying individual environmental issues, internal staff members or departments responsible for the identified issue, regulatory agency and interest group positions, the potential cost of dealing with the issue and the probability that these expenditures will be required, NMPC's corporate philosophy and approach to the issue, a recommendation for continuing or revising this policy, staff ability to deal with this issue, and an assessment of the priority attached to the issue. It is assumed that NMPC's environmental department requests input from public relations, legal, business planning, operations, and management staff. The end product that NMPC is looking for from this approach is an efficient method for ranking issues in the categories of high, medium, and low. PNL has adapted the NMPC format into a form to be filled out by Western's Environmental Managers.

6.2.2 The BC Hydro Approach

The British Columbia Hydro and Power Authority has developed a method for assessing its corporate-wide environmental risk. The objectives for its assessment program are to:

- Identify and rank the key environmental risks facing BC Hydro.
- Identify high priority issues for which more intensive assessments may be required.
- Assist decision makers in reallocating resources to address issues that pose a high level of risk.

BC Hydro's policy is not to have risk evaluations be the sole determinant of when or how aggressively an issue needs to be addressed; however, the assessment of risk is designed to be one of several important considerations in the decision-making process. Six steps are used in the BC Hydro risk assessment process for any particular environmental issue. These are:

1. **Describing the underlying risk.** This includes defining and characterizing the environmental impacts that can occur if a risk event occurred. The air, water, land, and social implications of the risk are considered.

2. **Defining the nature of the consequences.** This is an evaluation of the consequences to BC Hydro if a risk event occurred. Consequences are evaluated in three categories: "legal" (which might best be redefined as "regulatory"), "business," and "public perception." Legal includes the regulatory penalties, change in enforcement practices, and additional regulatory restrictions that might be imposed as the result of an incident; civil liability is not included in this category. Business involves a consideration of the cost of changing operations, developing new procedures, purchasing equipment, modifying facilities, obtaining permits, and compensating victims of an incident. Public perception involves a consideration of changes in how the public views BC Hydro and how this can affect BC Hydro's ability to perform its function.

3. **Assessing and scoring risk.** This involves preparing simple estimates of the probability and severity of the risk in each of the legal, business, and public perception categories.

4. **Deriving numerical scores from the evaluation.** For each risk, a total numerical score is derived. This score represents the sum of the risk scores derived for the legal, business, and public perception categories.

5. **Assessing the ability to manage risk.** Once an estimate for risk has been derived, the next step is to assess BC Hydro's ability to manage the risk. BC Hydro grades its ability to manage risk in six different areas: policy and management leadership, plans and procedures, organization and training, measuring and monitoring, incident reporting and tracking, and program development and issue tracking.

6. **Prepare a risk management matrix.** The final step in the process is the preparation of a simple risk management matrix which allows BC Hydro to graphically compare the environmental risk associated with an issue and its ability to manage this risk. Multiple issues can be characterized on a single matrix; this facilitates the simultaneous comparison of risk and ability to manage risk for a number of issues.

The BC Hydro approach for risk assessment is a method that is still under development. Modifications and improvements to the approach described in the following subsections are routinely considered. The reader is cautioned that the approach we describe here may not represent the most recent version being used by BC Hydro.

<u>Scoring Environmental Risk</u>

In assessing scores for environmental risk, both the probability and severity of an event needs to be estimated. For the legal category, probability was defined as "the probability of an incident <u>and</u> the prevailing legal system detecting it and proceeding to formal charges, court action(s), prosecution, conviction and sentencing." For business, probability was defined as "the probability of an incident or the probability of a risk assuming a high profile on the public or government agenda <u>and</u> BC Hydro having to bear additional expenditure and/or change its operating practices in response to the incident or the emergency or the risk itself." For public perception, probability was defined as "the probability of an incident or the probability of the public (within the province) becoming concerned or agitated over a specific incident <u>or</u> the threat of a specific incident <u>or</u> the emergence of a particular environmental risk."

BC Hydro evaluates probability for each category using a three-point ranking system:

- High probability (3 points) - Almost inevitable that the event will occur (1:10)

- Moderate probability (2 points) - Moderate chance that the event will occur (1:100)

- Low probability (1 point) - Very unlikely that the event will occur (1:1000)

For the legal category, severity was defined based on the penalties the Canadian courts have issued for the failure of corporations, their officers, and their employees to comply with environmental regulations. BC Hydro evaluates legal severity using a four-point ranking system:

- High severity (4 points) - Jail term of any length or a fine exceeding $275,000

- High/moderate severity (3 points) - Fines ranging from $75,000 to $275,000

- Low/moderate severity (2 points) - Fines ranging from $25,000 to $75,000

- Low severity (1 point) - Fines of less than $25,000.

For the business category, severity was based on the cost of remediation activities, required changes in business practices, and restrictions imposed on operations. BC Hydro's system includes a consideration of fatalities to the public in its business category because it "could have a significant business impact if it resulted in a change in operating practices." BC Hydro evaluates business severity using a four-point ranking system:

- High severity (4 points) - One or more deaths or increased costs exceeding $10 million

- High/moderate severity (3 points) - Increased costs ranging from $5 million to $10 million

- Low/moderate severity (2 points) - Increased costs ranging from $1 million to $5 million

- Low severity (1 point) - Increased costs less than $1 million

For the public perception category, severity was based on the intensity and breadth of the public reaction to an incident, the threat of an incident <u>or</u> the emergence of the particular environmental risk. BC Hydro evaluates public perception severity using a four-point ranking system:

- High severity (4 points) - Most of the province dissatisfied with practices or position
- Moderate severity (2.5 points) - Most of the province moderately dissatisfied <u>or</u> a segment of the province very dissatisfied with practices or position
- Low severity (1 point) - A segment of the province moderately dissatisfied with practices or position

When deriving a numerical score for each risk, BC Hydro assigns an importance weighing to each risk category. The legal and business categories are assigned twice the weight of the public perception category. In practice, a weighing factor of 4 is assigned to the legal and business categories, and the public perception category is assigned a weighing factor of 2.

The equation used to estimate the total environmental risk for an issue is:

$$R_n = \sum_{x=1}^{3} \left(P_x \cdot S_x \cdot W_x\right) \tag{6.1}$$

where x = represents the three risk categories

R_n = is the environmental risk score for risk "n"

P_x = is the probability score for category "x" for risk n

S_x = is the severity score for category "x" for risk n

W_x = is the weighing for category "x" risk

Using this scoring method, environmental risk can range from a low of "10" to a maximum of "120."

<u>Scoring Ability to Manage Risk</u>

An environmental management system provides a formal, structured mechanism for achieving a continuous, consistent level of performance on environmental issues. BC Hydro grades its ability to manage risk in each of the different management areas as either low (1 point), medium (2 points), or high (3 points). The criteria used to judge performance in each area are as follows:

- Policy and management leadership
  - Is there an environmental management policy in-place?
  - Are there company-wide objectives and standards?
  - Do senior decision makers demonstrate a commitment to environmental management?
- Plans and procedures
  - Are there strategies that integrate environmental protection through the entire organization?
  - Are there specific procedures for dealing with each environmental issue?
- Organization and training
  - Is the organizational structure responsive to environmental requirements?
  - Is the staff dealing with environmental issues both competent and well trained for their duties?
  - Is appropriate containment equipment installed at sites?
- Measuring and monitoring
  - Are environmental audits conducted?
  - Is environmental performance continually measured?
  - Are performance reports regularly provided to and reviewed by senior decision makers?
  - Are corrective actions taken immediately whenever deviations are noted?
- Incident reporting and tracking
  - Are all potential environmental incidents and their consequences recognized and assessed?
  - Are incident response plans and procedures in place?
  - Are incidents analyzed so that corrective actions can be taken when required?

- Program development and issue tracking
  - Are policies, procedures, processes, and products being continually improved?
  - Are legislation and public opinion tracked?

After grading performance in each area, scores are summed. The minimum score for environmental management is "6" and the maximum score is "18."

<u>The Risk Evaluation Matrix</u>

The relationship between environmental risk and the ability to manage a risk is important. A high risk issue that is carefully addressed and continuously monitored by an effective environmental management program often needs to be treated as a much lower priority item than a moderate risk that is not being adequately addressed.

BC Hydro uses a simple matrix to assess the relationship between environmental risk and the ability to manage risk. The matrix also allows different risk issues to be evaluated against each other, both in terms of their overall environmental risk and BC Hydro's ability to manage that risk. This comparison can be an effective tool in setting organizational priorities for dealing with various issues (including allocating funding for additional assessment, monitoring, and remediation activities).

The BC Hydro risk evaluation matrix is presented in Table 6.1. An issue that falls in the upper left hand corner of the matrix involves a high level of risk and a low level of preparedness to deal with the issue. Such issues require aggressive corporate action to either reduce the environmental risk or increase the organization's ability to manage that risk. An issue that falls along the diagonal from high risk/high preparedness to low risk/low preparedness requires periodic monitoring; such issues represent a reasonable balance between risk and risk management. An issue that falls in the lower right hand corner of the matrix involves relatively low risk and a high degree of readiness to manage that risk. An effective risk management program that is developed to deal with high risk issues will also tend to enhance the organization's ability to deal with relatively lower risk concerns. This is a positive benefit from an effective program, but in such cases resources

TABLE 6.1. The BC Hydro Risk Evaluation Matrix

Current Readiness of Environmental Management System	Overall Level of Environmental Risk 120<---->10: max risk		min risk
min 6 ↑ Low			
	Aggressive Action	Monitor	
Moderate			
	Periodic Audit	Reduce Effort?	
↓ 18 max High			

devoted exclusively to a low risk issue might be considered for reallocation to address more pressing environmental concerns.

6.2.3 The Bonneville Power Administration Approach

The Bonneville Power Administration approach is based on, and is very similar to, the BC Hydro approach. As is the case for BC Hydro, the BPA approach is a method also under development. Refinements and modifications are being routinely considered and tested. BPA has adopted the same objectives as the BC Hydro approach, and BPA also uses the same six steps in assessing risk for any particular environmental issue.

The current BPA approach utilizes a method for scoring environmental risk assessment that is essentially identical to that employed by BC Hydro. There are, however, some significant differences between the BC Hydro approach and the method the BPA uses to assess its ability to manage risk. BPA bases its risk management criteria on the Principles for Environmental Management established in 1991 by the International Chamber of Commerce. These principles were designed to "assist enterprises in fulfilling their commitment to promote environmental stewardship in a comprehensive fashion."

Instead of the six categories used by BC Hydro for evaluating its ability to manage risk, the BPA approach assesses its ability in this area using four broad categories. These categories are:

1. Policy Setting and Management
   Leadership
   Corporate Priority
   Products and Services
   Precautionary Approach

2. Systems and Procedures
   Integrated Management
   Facilities and Operations
   Research
   Emergency Preparedness

3. Implementation and Education
   Employee Education
   Customer Advice
   Transfer of Technology
   Contributing to the Common Effort

4. Monitoring and Reporting
   Improvement Process
   Openness to Concerns
   Compliance and Reporting

The scoring criteria used to evaluate performance in each of the four categories are:

- Not Applicable - indicates a particular category is not relevant to BPA's operations.

- Compliance Level (1 point) - is a policy of compliance with health, safety, and environmental regulations. Once identified, problems are responded to in a timely and responsible fashion.

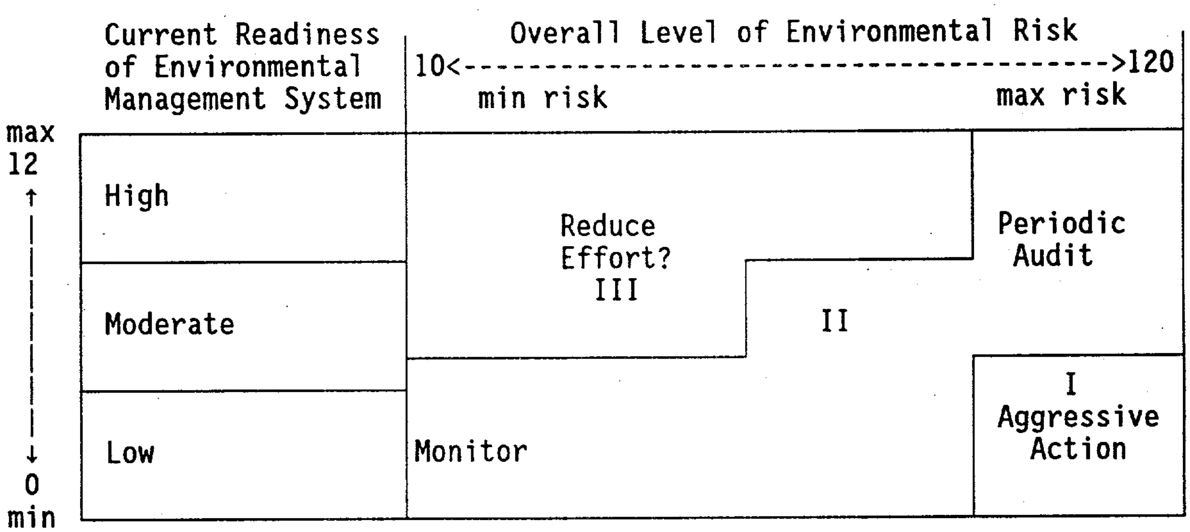
- Systems Development and Implementation (2 points) - a formal environmental management system is in place that meets or exceeds regulatory compliance and also facilitates efforts to consider environmental issues when addressing organizational policies. This system identifies environmental investment opportunities (using cost/benefit assessments) that offer the greatest environmental and/or financial returns.

- Integration into General Business Functions (3 points) - a formal environmental management system is in place that routinely integrates environmental concerns into business decision making. This includes considering environmental issues in formulating organizational policies, budgets, marketing, hiring, program implementation, and reporting. Environmental concerns include both the direct and indirect impacts of operations and services (extending well beyond simply maintaining regulatory compliance).

After a score has been assigned to denote the status in each of the four broad categories, a final overall score is obtained by summing the results from each of the four categories. The minimum overall score for BPA's ability to manage risk is "0" and the maximum score is "12."

The BPA risk evaluation matrix is presented in Table 6.2. Although similar to the BC Hydro matrix, each of the axes is reversed so that scores increase from left to right and from bottom to top. An issue that falls in the lower right hand corner of the matrix involves a high level of risk and a low level of preparedness to deal with the issue. Such issues require aggressive corporate action to either reduce the environmental risk or increase the organization's ability to manage that risk. An issue that falls along the diagonal from high risk/high preparedness to low risk/low preparedness requires periodic monitoring; such issues represent a reasonable balance between risk and risk management. An issue that falls in the upper left hand corner of the matrix involves relatively low risk and a high degree of readiness to manage that risk. As with BC Hydro, an effective risk management program that is developed to deal with high risk issues will also tend to enhance the organization's ability to deal with relatively lower risk

TABLE 6.2. The BPA Risk Evaluation Matrix



concerns. This is a positive benefit from an effective program, but in such cases resources devoted exclusively to a low risk issue might be considered for reallocation to address more pressing environmental concerns.

6.3 THE QUALITATIVE ISSUE CHARACTERIZATION APPROACH

Using the NMPC environmental issue analysis format, a framework has been developed for Western to perform its own qualitative environmental issue characterizations. The Western approach is called "Qualitative Issue Characterization" (QuIC). Completing each element in the QuIC form compels Western's staff to define and bound each environmental issue, characterize the risk in a qualitative form, and identify actions that will lead to the minimization of the risks associated with the issue. This type of approach is illustrative of an organization taking proactive steps toward environmental responsibility and should be very useful in supporting more detailed assessments and in meeting DOE-imposed documentation requirements. In this subsection, the QuIC format is described and a key environmental issue is used as a model to describe the process.

6.3.1 The QuIC Format

In the QuIC approach, a short form is used to characterize each of the identified environmental issues that might impact Western's operations. While the format of the QuIC form is based on the NMPC format discussed in Sections 3.2 and 6.2.1, it has been modified to address a broader range of concerns. This "broadening" was needed because in assessing organizational impacts the NMPC approach tends to focus on the business impact of the issue (e.g., expenditures required to deal with the issue and probability that these expenditures will need to be made); the NMPC approach does not explicitly assess the potential human health, ecosystem, and public perception impacts or "costs" posed by an issue.

The following is a brief description of the input fields on the QuIC form. Note that some of these fields are items that Western's Environmental Affairs staff may not be able to assess on their own. While the QuIC form is designed to be filled out by a single staff member, it is anticipated that this will be done only after consulting with other Western staff members with different areas of expertise.

Issue: A description of the environmental issue including a discussion of sub-issue(s).

Western Personnel Responsible or Involved: This section has two purposes - to identify a Headquarters or Area Office level program or project manager and to identify and discuss other personnel involved in the issue.

Regulatory Position: Federal, State, and local regulatory agencies' positions regarding the issue. This may also include a discussion of pending legislation.

Stakeholder Positions: Stakeholder views, opinions, and attitudes relative to the issue. Stakeholders may include environmental organizations, community groups, ethnic organizations, business interests, regulatory agencies, and key public figures (e.g., federal and state elected officials).

Western Position: Description of Western's policy, organizational philosophy and approach on the issue.

Potential Human Health and Ecosystem Impact: Identification of the potential human health and ecosystem impacts related to this issue. This discussion should include simple assessments of the probability of the various impacts occurring and the potential severity of these impacts.

Potential Business Impact: Business impacts to Western that could arise as a result of both (1) Western taking steps to more effectively manage the issue and (2) Western failure to more aggressively address the issue. This section should include a discussion of the current budget, the potential additional current and future expenditures related to this issue, and the probability of these expenditures being required.

Potential Regulatory Impact: Identification of the potential regulatory impacts associated with (1) failing to meet current regulations, (2) failing to take actions to prevent an environmental incident from occurring, and (3) failure to exceed existing environmental regulations in critical areas (i.e., so that a "new" issue does not become a new regulatory priority because of poor environmental stewardship by Western).

Potential Public Perception Impact: Assess how Western's position and actions in regard to this issue makes Western look to the public. Consider Western's position in view of the general public's and key stakeholder's current and potential future positions on the issue.

Concerns/Skill Gaps: Discussion of the human and other resources required to address this issue. This would include such considerations as the availability of Western Environmental Affairs staff, support from other Western divisions, contractor staff, worker technical skills, training requirements, computer resources, monitoring equipment, etc.

Decisions Required: A discussion of high-level decisions that need to be made in association with this issue.

Recommended Western Approach: This section contains action items recommended to appropriately manage the issue.

Additional Information: Pertinent information not covered by previous items and current status of issue.

Priority: Assigns a simple priority rating to an issue - high, medium, or low.

6.3.2 Guidance for Employing the QuIC Approach

In this section we provide more detail and guidance on the QuIC approach and use a sample issue for purposes of illustrating the QuIC process. The environmental issue used in the example is related to "Potential oil spills at substations and other facilities located in sensitive areas (navigable waters, groundwater, flood control culverts, etc.)."

ISSUE

Guidance:

- The environmental issue can be almost any problem Western is facing or may face. For example, the issue could focus on a change in a regulation or on a new regulation, a decision to delay or expedite an action, a decision to perform work in-house or contract out, etc.

- It is important to clearly define the environmental issue being characterized. It may be necessary to delimit the issue into sub-issues (these may require separate characterization using QuIC).

Example:

- This issues focuses on the risks associated with the potential for oil spills at substations located in environmentally sensitive areas. Western operates and maintains many substations, switchyards and other facilities with equipment containing mineral oil. Many of these facilities are located adjacent to rivers, lakes and other major bodies of water, or to populated and/or environmentally sensitive areas. Oil spills may involve the spill of Polychlorinated biphenyl-laden oil or uncontaminated mineral oil. The volume of spill can range from less than a gallon to thousands of gallons. The impact of an oil spill is dependent on a number of factors including: the proximity to surface water, the slope of the ground surface near the substation, the effect of local climate, soil permeability, proximity to populated/public use areas, etc.

- This issue has a variety of sub-issues including: preparing and maintaining valid Spill Prevention, Control, and Countermeasures (SPCC) plans; standardizing the secondary containment system selection process; dealing with oil spill problems at facilities that are shared with other organizations; keeping the maintenance information system current, etc.

WESTERN PERSONNEL RESPONSIBLE

Guidance:

- A contact person is identified for the issue. A project or program manager may be identified if appropriate.
- All key personnel with an involvement or responsibility in the issue from the perspective of its occurrence, management and resolution should be identified here.

Example:

- Program Manager: John Smith, Environmental Manager
- Electricians, Maintenance Division personnel, environmental specialists, engineers, Deputy Area Managers.

REGULATORY POSITION

Guidance:

- For most issues, if the issue is clearly defined, the regulatory agencies' position can be established by referring to the legislation.
- If the issue is not clearly defined, ask the regulatory agency for a position statement. Headquarters environmental specialists can provide guidance or refer to Headquarters Office of General Council if necessary.

Example:

- Title 40 Code of Federal Regulations Part 112 "Oil Pollution Prevention for Non-Transportation Related Onshore and Offshore Facilities" sets requirements for SPCC plans and spill control. Regulatory agencies that have jurisdiction in this area are the State Environmental Protection Agency, State Water Board, the US Coast Guard, and the Regional Water Resource Control Board.

- National Oil and Hazardous Substances Contingency Plan. Superfund, Clean Water Act statutes.

STAKEHOLDER POSITIONS

Guidance:

- Stakeholder positions are usually well known; however, they can be easily misinterpreted. List the stakeholders that have shown, or you suspect may show a concern for this issue. Contact your public affairs representative or the Headquarters Public Affairs Office to discuss stakeholder positions.

- Communication (especially listening and acknowledging stakeholder concerns) is a key element in public involvement.

Example:

- Stakeholders are sensitive to oil spills on waterways because of their potential impact on human health and wildlife. Major spills (e.g., the Exxon Valdez, the spill of hazardous chemicals into the Sacramento River) have focused tremendous public attention on such issues. Stakeholders that have been involved in this issue include the Sierra Club and the Wildlife Foundation.

WESTERN POSITION

Guidance:

- Western's management philosophy and approach on the issue should be provided by Headquarters with input from Area Office personnel.

- Western's position should be assessed for its consistency with its formal goals and standards of operation.

Example:

- Headquarters Environmental Affairs staff are addressing the issues of SPCC planning and secondary containment. The Headquarters Engineering staff is working with Environmental Affairs to produce a prioritization and secondary containment system selection matrix.

POTENTIAL HUMAN HEALTH AND ECOSYSTEM IMPACT

Guidance:

- Human health impacts can be identified qualitatively based on the nature of the risk, its health threat, and the proximity to populated areas. Information from environmental scientists, industrial hygienists, and other technical staff may be required to adequately assess this impact.

- Ecosystem impacts can be identified qualitatively based on the nature of the risk and the sensitivity of the local ecosystem. Information from environmental scientists, wildlife experts, and other technical staff may be required to adequately assess this impact.

Example:

- Within Area Office parameters, substations and switchyards containing large volumes of oil are located in both environmentally sensitive areas and heavily populated areas. In many cases wind, rain, freezing, and other climactic conditions could lead to dispersion of spilled oil into the surrounding areas. Under severe conditions, there is a possibility of ecosystem damage and human health impacts.

POTENTIAL BUSINESS IMPACT

Guidance:

- For some issues, the business impact will be easy to estimate, for others it may be very difficult to determine. The assistance of planning, operations, and budget staff may be required.

- In preparing an estimate, it is often helpful to start with this year's budget and establish a range based on best and worst case for your out-year projections.

Example:

- The fiscal year 1994 budget for secondary containment is $370,000, which includes projects at eight substations. The costs for secondary containment systems vary based on the system type, size of the project, and whether the work is completed as part of a larger renovation project, as a separate project, or as part of a new construction project.

- Potential expenditures for secondary containment over the next five years could exceed $15,000,000, if secondary containment is required at all substations near navigable waters.

- Associated SPCC planning expenditures are estimated at $275,000 and legal review and modification of maintenance contracts could result in costs of $45,000.

- There is a high probability that all substations near "waters of the State" will require an SPCC plan <u>and</u> the addition of some type of secondary containment.

- There is a high probability that all maintenance contracts will need review and revision.

POTENTIAL REGULATORY IMPACT

Guidance:

- Determine the fines/criminal penalties resulting from an environmental incident. Determine the potential regulatory implications of the incident (increased surveillance, new regulations).

- Consultation between Environmental and Legal staff should provide reasonable assessments.

Example:

- Fines of $25,000 per day under National Oil and Hazardous Substances Contingency Plan, Superfund, and/or Clean Water Act statutes are possible.

- Costs for surveying other oil-containing devices and assessing their potential for leaking and costs of additional record keeping and reporting to regulatory agencies are approximated at $300,000. Assess probability of new oil spill regulations and their impact on Western operations.

- Cost of clean-up could range from $50,000 to $10,000,000.

POTENTIAL PUBLIC PERCEPTION IMPACT

Guidance:

- Use information obtained in assessing human health and ecosystem impacts to estimate the media attention that would be focused on an oil spill. Public Affairs staff could help contribute to this assessment.

- Assess the potential public reaction to the spill at various levels of media coverage. Assess stakeholder reaction to the spill.

- Assess how this incident can affect other Western operations and attention focused on other environmental issues.

Example:

- The majority of the public will learn about any major incident involving the release of oil into waters, ecologically sensitive, or highly populated areas.

- The degree of interest and concern from stakeholder groups would be high.
- A major oil spill would refocus Western's operations and planning process.

CONCERNS/SKILL GAPS

Guidance:

- Important to identify the resources required - use creativity to discuss possible solutions.
- Honesty is the best policy.

Example:

- Western Headquarters Engineering staff are developing a methodology to determine the appropriate secondary containment system for substations. The methodology should be thoroughly tested by Environmental and Engineering staff and a determination should be made on whether outside consultative support is required to refine or augment the approach.
- Technical training on secondary containment for key Engineering and Environmental staff should be considered.
- Western Area Office personnel indicate that SPCC plans could be completed in-house, yet there is a shortage of Western certified Professional Engineers that are willing to take the responsibility of signing or certifying the plans.
- Western Legal staff have the expertise required to review existing maintenance agreements and to determine the need for new language to limit Western's liability in the event of a spill involving other agency's equipment.

DECISIONS REQUIRED

Guidance:

- To resolve issues, decisions on steps to take are required. These action-oriented decisions will provide guidance and empowerment to the Areas towards issue resolution.
- Input from the Area Offices can be structured in the form of a question.

Example:

- Should SPCC plans be required for every substation?
- Which substations/electrical facilities should receive secondary containment systems? (and further which type of secondary containment systems should be used? and should the containment systems be vandal resistant?)
- Should the maintenance agreements with other agencies for shared facilities be reviewed and updated to delineate environmental responsibilities?

RECOMMENDED WESTERN APPROACH/ACTION ITEMS

Guidance:

- Headquarters' guidance on management and resolution of the issue.
- Delineate all action items. Include language such as develop, conduct, utilize, work, monitor, continue to, etc.

Example:

- Headquarters Environmental staff will continue to address the issues of SPCC planning and secondary containment.
- The Headquarters Engineering group will continue to work with Environmental Affairs to produce a prioritization and secondary containment system selection matrix. All of the Area Offices will be advised of this activity.
- Western's legal staff will review all maintenance agreements and modify to reduce corporate liability and risk.
- Each Area Office will develop a program plan to address these issues to include a timeline for completion.

ADDITIONAL INFORMATION

Guidance:

- This section can be used to update the status of the issue.
- Also to provide information not covered in the other sections.

Example:

- This issue was discussed at the most recent Environmental Managers meeting and action items have been identified. Decisions on action items will follow at the next meeting.

PRIORITY

Guidance:

- Everything is relative - so as you develop all of your issues, the high, medium or low rating may become clearer.

Example:

- The environmental risks and potential liabilities surrounding this issue as characterized through the qualitative assessment indicate that the issue gets a priority rating of HIGH relative to the other issues assessed.

6.4 THE SEMI-QUANTITATIVE EVALUATION APPROACH

The Semi-Quantitative Evaluation (SEQUEL) approach is designed to use the information obtained through the QuIC process to develop a semi-quantitative assessment of environmental risk and to couple this with a semi-quantitative assessment of Western's ability to manage the risk associated with a particular issue. With assessments of both environmental risk and Western's ability to manage risk, environmental issues can be compared to determine the relative priorities that need to be established to address these problems. In addition, this method pinpoints areas in which Western is properly poised to address environmental risk and areas in which Western needs to improve its capabilities.

The SEQUEL approach is largely based on the semi-quantitative assessment method developed by BC Hydro and later modified by BPA (as described in Section 6.2). Some significant changes have been made to reflect Western's philosophy on risk management with its emphasis on safeguarding human health and preserving environmental quality.

6.4.1 Assessment of Environmental Risk

In its semi-quantitative assessment of environmental risk, the SEQUEL approach focuses on four distinct categories of risk. These are:

- Human health and ecosystems impacts
- Regulatory impacts (risks posed by not complying with environmental regulations)
- Business implications (i.e., costs associated with reducing risks and costs resulting from a failure to prevent a risk from becoming an incident)
- Public perception implications (i.e., risks and costs associated with changes in Western's public image and its resulting impacts on Western being able to perform its function)

The first of these four categories is new, the last three are based on the BC Hydro/BPA approaches. The human health and ecosystem impacts of an issue have been added as an explicit category because of concern that the BC Hydro/BPA approach did not provide an appropriate emphasis in this area. In particular, it was thought that the failure of the BC Hydro/BPA approach to consider any non-fatal human health affects or any ecosystem concerns that were not associated with current environmental regulations or significant business costs could seriously damage the credibility of any risk management program. Concerns were raised that a regulatory or public review of the BC Hydro/BPA approaches might lead to the erroneous conclusion that these organizations were overly concerned with business costs and regulatory compliance, and that public health, ecosystem impacts, and public perception were of only secondary concern.

To try and avoid this situation, the SEQUEL approach explicitly considers human health and ecosystem impacts and does not attempt to assign a weighting factor to emphasize or de-emphasize any of the categories in relation to the others. By avoiding the entire question of the relative weights of the categories, it is hoped that Western can avoid the criticism and controversy that could arise from various stakeholders in a review of a risk evaluation ranking system. For example, one can imagine community and environmental organizations arguing for the maximum weighting to be assigned to the environmental and public perception categories, with business implications to be minimized. Conversely, Western's operation staff may argue for the opposite and regulators might argue for the maximum weight to be put on regulatory compliance. Hopefully, by rejecting the assignment of weights to each category for this level of risk ranking, this potential controversy can be avoided.

During the initial review process for SEQUEL, some Western managers suggested that human health and ecosystem impacts be broken out into two distinct categories. While this suggestion has merit, it was decided to keep them as one category for the time being. This decision was based on the concern that human health and ecosystem impacts often coincide on major issues (e.g., hazardous material accidents, pesticide application) and that the expansion from four to five categories would tend to "dilute" regulatory, business, and public perception concerns.

6.4.2 Scoring Environmental Risk

In assessing scores for environmental risk, both the probability and severity of an event need to be estimated. For the human health and ecosystem category, probability is defined as "the probability of an incident and there being potential human health and ecosystem implications."

In the regulatory category, probability is defined as "the probability of an incident occurring and its resulting in the violation of current regulations." The BC Hydro/BPA approaches' definition is somewhat different in that it also includes the probability of the incident being detected and regulators proceeding with prosecution. This definition gives "credit" to an organization for a regulatory agency's failure to detect an incident or prosecute violators. The adoption of this definition by Western may give the impression that the organization considers it an acceptable risk to violate regulations if it thinks it can "get away with it." To avoid even the appearance of this attitude, this provision has been dropped from Western's probability assessment for regulatory risk.

For the business category, probability is defined as "the probability of an incident occurring (or becoming a significant issue) and producing an increase in Western expenditures."

For public perception, probability is defined as "the probability of the public becoming concerned over an issue that involves Western's mission or business practices."

Western evaluates probability for each category using a three-point ranking system. This probability system and associated probabilities can be adjusted to fit the changing needs and scales of concerns for Western Headquarters and its Area Offices. An example of a scoring system is:

- High probability (3 points) - Good chance that the event will occur (probability greater than 1:10)
- Moderate probability (2 points) - Moderate chance that the event will occur (probability between 1:10 and 1:100)
- Low probability (1 point) - Unlikely that the event will occur (probability less than 1:100)

Western evaluates severity for each category using a four-part ranking system. This severity scoring system can be modified to reflect different valuations. For example, if this system is being used on the Area or District level, measurement of impact might need to be assessed using a different, more sensitive scoring criteria than in a Western-wide assessment.

For the human health and ecosystem category, a sample sensitivity scale is:

- High severity (4 points) - One or more human fatalities (acute) or major impacts on a sensitive species or ecosystem
- High/moderate severity (3 points) - One or more human fatalities (chronic) or significant impacts on a sensitive species or ecosystem
- Low/moderate severity (2 points) - Non-fatal human health impacts or low level of injury to an ecosystem
- Low severity (1 point) - Uncertainty about whether human health impacts or injury to an ecosystem could occur

To reflect different levels of concern, the scale can be modified to focus on specific health impacts or impacts on specific wildlife species.

For the regulatory category, severity was evaluated based on the potential for jail terms for Western staff members and fines. A sample severity scale is:

- High severity (4 points) - Jail term for Western employees or fines exceeding $500,000
- High/moderate severity (3 points) - Employee indictments or fines ranging from $100,000 to $500,000
- Low/moderate severity (2 points) - Fines ranging from $10,000 to $100,000
- Low severity (1 point) - Fines of less than $10,000

This ranking scale explicitly addresses only the prosecution of employees and fines. Implicit in this assessment is the understanding that additional regulatory oversight and new regulations may result from violations of existing statutes. This scoring system can be easily modified to reflect different priorities or concerns. This could include changes in the dollar values of the fines or the explicit consideration of the costs that would result from increases in surveillance activities by regulatory agencies or the potential for new environmental regulations in the wake of an incident.

For the business category, severity was based on the cost of remediation activities, required changes in business practices, cost of litigation, and restrictions imposed on operations. A sample severity scale is:

- High severity (4 points) - Increased costs exceeding $10 million
- High/moderate severity (3 points) - Increased costs ranging from $5 million to $10 million
- Low/moderate severity (2 points) - Increased costs ranging from $1 million to $5 million
- Low severity (1 point) - Increased costs less than $1 million

This scoring system can be modified to reflect different dollar amounts. This could include scaling up the business costs to represent activities on a Western-wide basis, or the scaling down of the cost estimates to reflect concerns on the Area or District Office level.

For the public perception category, severity was based on the intensity and breadth of the public reaction to an incident, the threat of an incident, or the emergence of the particular environmental risk. A sample severity scale is:

- High severity (4 points) - Most of the public in Western's service area or a key government official (with Western oversight responsibilities) is very dissatisfied with Western's practice or position
- High/moderate severity (3 pts) - Most of the public in Western's service area or a key government official is somewhat dissatisfied or a significant segment of the public is very dissatisfied with Western's practice or position
- Low/moderate severity (2 points) - A significant segment of the public in Western's service area is somewhat dissatisfied or a small segment of the public is very dissatisfied with Western's practice or position
- Low severity (1 points) - Only a small segment of the public is somewhat dissatisfied with Western's practice or position

This severity scoring system can be modified to also consider key stakeholder reactions to Western (as opposed to just general public opinion). Alternatively, the levels of public dissatisfaction can be adjusted to fit Western's criteria.

The final equation used to estimate environmental risk for an issue is:

$$R_n = \sum_{x=1}^{4} \left(P_x \cdot S_x\right) \qquad (6.2)$$

where x = represents the three risk categories

R_n = is the environmental risk score for risk "n"

P_{xn} = is the probability score for category "x" for risk n

S_{xn} = is the severity score for category "x" for risk n

Using this scoring method, environmental risk can range from a low of "4" to a maximum of "48."

6.4.3 Scoring Ability to Manage Risk

The SEQUEL approach grades Western's ability to manage risk in three categories: Environmental Policy, Human Resources, and Policy Implementation. These categories and their evaluation standards are defined as follows:

- Environmental Policy
  - Commitment: Do decision makers demonstrate a high level of commitment toward addressing environmental issues?
  - Official Policy: Is there an official policy on environmental management?
  - Plans and Procedures: Are there formal plans and procedures for dealing with existing environmental issues and addressing new issues?
  - Coordination: Is coordination and cooperation between Western divisions encouraged and rewarded? Is coordination and cooperation between Western's Headquarters and Area Offices encouraged and rewarded?
  - Public Involvement: Does Western allow the public and credible stakeholders to play an active role in setting Western's environmental priorities?
- Human Resources
  - Staffing: Are adequate personnel and equipment readily available to address environmental issues? If Western staff are not available are contractor staff able to fill this void?
  - Training: Are all the staff members that are assigned to deal with environmental issues properly trained for this work?

- Resource Allocation: Are environmental issues assigned a high enough priority so that the staff has the time and resources to support risk management activities?

- Policy Implementation

  - Implementing Policy: Do staff members effectively implement Western's policy on environmental issues?

  - Monitoring and Reporting: Are environmental audits routinely performed? Are corrective actions promptly taken? Are audit results routinely reviewed by senior decision makers?

  - Risk communication: Do Western divisions effectively perform internal and external risk communication?

  - Issue Tracking: Are policies, procedures, and products routinely assessed and upgraded? Are legislation, regulatory administration, and public opinion monitored?

  - Emergency Response: Are potential accidents fully understood? Are response plans in place? Are emergency response procedures ready to be effectively implemented? Is emergency response material effectively maintained and deployed? Are adequate staff prepared and available for the timely performance of their emergency response function?

The scoring criteria used by SEQUEL to evaluate Western's performance in each of the three categories are:

- High Performance (4 points) - Western meets satisfactory performance levels in each of the category evaluation standards

- High/Moderate (3 points) - Western meets satisfactory performance levels in most of the category evaluation standards but is working to address deficiencies

- Low/Moderate (2 points) - Western meets satisfactory performance levels in most of the category evaluation standards but some deficiencies are not being addressed <u>or</u> Western does not meet satisfactory performance levels in most of the category evaluation standards but is working to address all deficiencies

- Low Performance (1 point) - Western does not meet satisfactory performance levels in most of the category evaluation standards and some deficiencies are not being addressed

After a score has been assigned to denote the status in each of the three broad categories, the individual scores are multiplied to determine the overall score for Western's ability to manage risk. The minimum score for evaluating Western's ability to manage risk is "1" and the maximum is "64."

A major difference between the BC Hydro/BPA approaches and the SEQUEL approach in grading the organization's ability to manage environmental risk is that BC Hydro and BPA sum their performance scores for each category, while SEQUEL multiplies these scores together. The reason SEQUEL does this is that the SEQUEL approach considers that an effective environmental management program tends to only be as strong as its weakest link. For example, if an organization has a great environmental policy and superb human resources but their implementation is weak, the overall performance of that program must be weak. In the BC Hydro/BPA evaluation scheme, this same scenario could receive a moderately high score. The SEQUEL approach therefore judges a program on its overall effectiveness and does not overemphasize high performance in some aspects of a system that might have a poor overall performance. In this manner, the SEQUEL approach provides a higher effectiveness rating to a program that has moderate performance in all categories (3 x 3 x 3 = 27 points) than it does for a program that scores very high in two categories but has poor performance in the remaining category (4 x 4 x 1 = 16 points).

6.4.4 The Risk Evaluation Matrix

The risk evaluation matrix for the SEQUEL approach is almost identical in appearance to the BPA approach, although the scores used to judge the level of risk and the ability to manage risk are different. As for the BC Hydro and BPA risk evaluation matrices, the SEQUEL matrix allows Western to assess the relationship between environmental risk and its ability to manage risk. The matrix also allows different risk issues to be evaluated against each other, both in terms of their overall environmental risk and the organization's ability to manage that risk. This allows priorities to be set for dealing with issues (including allocating funding for additional assessment, monitoring, and remediation activities).

The Western risk evaluation matrix is presented in Table 6.3. An issue that falls in the upper left hand corner of the matrix involves a high level of risk and a low level of preparedness to deal with the issue. Such issues require aggressive action to either reduce the environmental risk or increase the organization's ability to manage that risk. An issue that falls along the diagonal from high risk/high preparedness to low risk/low preparedness requires periodic monitoring; such issues represent a reasonable balance between risk and risk management. An issue that falls in the lower right hand corner of the matrix involves relatively low risk and a high degree of readiness to manage that risk. An effective risk management program that is developed to deal with high risk issues will also tend to enhance the organization's ability to deal with relatively lower risk concerns.

TABLE 6.3. The SEQUEL Risk Evaluation Matrix

	Current Readiness of Environmental Management System	Overall Level of Environmental Risk 4<------------------------------------>48 min risk max risk
max 64 ↑	High	Consider Reallocating Resources
27	Moderate	
↓ 1 min	Low	Aggressive Action Needed

This is a positive benefit from an effective program, but in such cases resources devoted exclusively to a low risk issue might be considered for reallocation to address more pressing environmental concerns.

6.5 INTEGRATION OF THE QUALITATIVE AND SEMI-QUANTITATIVE APPROACHES

The QuIC and SEQUEL approaches proposed for use by Western should be seen as complementary approaches that should be used together. The QuIC approach allows Western to gather the information needed to make decisions about environmental issues. The SEQUEL approach uses this information to develop a numerical scoring of the risk, and it also evaluates Western's ability to manage risk. QuIC results can be used without proceeding with the SEQUEL assessment, but SEQUEL makes environmental issues easier to assess and compare.

Operationally, QuIC assessments would be done simultaneously on a number of issues. Interviews with Western's Public Affairs staff (to assess public perceptions), General Council staff (to assess regulatory impacts), and other groups within Western could be conducted to assess different aspects of the risks posed by various environmental issues. After the QuIC assessments are completed, a group of issues can be addressed using the SEQUEL approach and a common set of severity scales. The relative ranking of the risk and Western's ability to manage this risk can be assessed. The comparison of results from different issues can be used to adjust Western priorities, redeploy resources, or modify Western's environmental issue management structure.

When used together, the QuIC and SEQUEL approaches should provide Western with a powerful resource for assessing risk and setting environmental priorities.

7.0 THE RISK MANAGEMENT/DECISION ANALYSIS COMPONENT OF AN ENVIRONMENTAL RISK PROGRAM

Risk assessment identifies and prioritizes potential sources of risk. Risk management provides a methodology for responding to potential risks. The response is typically a decision to commit resources to one of several possible courses of action. It is often not initially obvious what alternatives are available, and how to decide among them. In addition, the relationship between alternatives and outcomes may be fraught with uncertainty. Furthermore, it may not even be clear what considerations are important in evaluating the outcomes. To be effective, a risk management program must specify how to identify alternatives and provide an evaluation procedure that considers relevant uncertainties. It must provide a defensible rationale for the course of action taken. It must also consider the values of the various stakeholders.

There are a variety of analytical approaches that can be utilized in a risk management program. In this section, several approaches are briefly described and a recommendation is made on the approach considered most applicable to Western's environmental risk program.

7.1 VARIOUS APPROACHES USED IN RISK MANAGEMENT

In this section we describe four different approaches for making risk management decisions. These are: cost/benefit analysis, social judgment theory, delphi method, and decision analysis.

7.1.1 Cost/benefit Analysis

Cost/benefit analysis arises from utilitarian economic theory of the greatest good for the greatest number. It evaluates alternatives by considering the net difference of all economic benefits and costs and is usually expressed in dollars. The alternative that maximizes the benefit-to-cost ratio is selected.

A criticism of cost/benefit analysis is that it fails to account for the equity of "who benefits" and "who pays" the costs. Attempts to remedy this shortcoming have not proven satisfactory. Pareto optimality requires a constraint that no one be made worse off by the decision. The Kaldor-Hicks criterion provides relief by having the beneficiaries compensate those who would loose (Fischhoff et al. 1981). This requirement, however, is only met in principle; so in effect, equity is still not satisfied.

7.1.2 Social Judgment Theory

Social judgment theory has it origins in psychology, and is an attempt to both describe and improve upon human judgment--especially with respect to social decision theory (Hammond et al. 1986). It requires holistic judgments of preference among alternatives. It then uses regression analysis to determine the relative importance of the various attributes, which are referred to as "cues." This derived regression equation, which is usually additive linear, serves a role similar to an objective function in decision analysis.

Social judgment theory is most appropriate for situations requiring repetitive judgments of a similar nature. For example, in screening applicants to a university, holistic judgments of the applicants acceptability would be obtained, the relevant cues identified (e.g., SAT scores, grade point averages), and a multiple regression equation used determine how to weight these attributes. This can then be used to guide subsequent selection of applicants. Furthermore, judgments can be compared with actual performance and the attribute weights revised so as to improve the decision making.

This approach has limited applicability to risk management decisions in which each decision is made in a unique decision environment that may only be encountered once.

7.1.3 Delphi Method

The delphi method is a process for obtaining the judgments of many experts and arriving at a single evaluation that reflects the best collective thoughts of the group. The process has many variants, but it is usually an iterative process where alternatives are first evaluated individually, and then the results of the evaluations and supporting rationale are made available to the group. Group members revise their own judgments in light of the judgments and rationale of other members. Anonymity is generally preserved so as to eliminate the effects of dominant personalities. By making the decision rationale of each member available to all other members--and by doing this anonymously--the strongest arguments tend to win the day and the best alternative prevails. Usually after approximately three rounds a consensus can be reached. Thus, by the delphi method a collective consciousness is created that taps the best that is in the minds of all the experts.

The rankings used in the delphi method are based upon holistic judgments; i.e., each individual considers the relative merits of each alternative based upon arguments that were put forth as to their impacts on the various criteria, and considers the relative importance of the various criteria as he or she sees it, and makes an overall judgment of which process is best, which is second best, and so on.

Critics of the delphi approach argue that when there are so many factors to be considered, it is not possible to keep all the relevant criteria in mind at once and arrive at an overall holistic judgment that correctly considers all the information necessary to make valid judgments. This requires that explicit numerical judgments be made as to how well each process would perform on each of the criteria, and also numerical judgments be made as to the relative importance of the criteria; these judgments are then combined (often with an additive linear model) to form an overall score for each of the processes.

7.1.4 Decision Analysis

Decision analysis has its theoretical foundation in a set of axioms that capture the basic principles of rational decision making, and the decision rules are derived as a consequence of these axioms. The result is a logically defensible decision, and a decision logic that is clearly specified and available for open discussion. This approach is amenable to public policy decisions in which there are a variety of stakeholders with possibly conflicting values.

Decision analysis captures many of the advantages of the methods reviewed in the previous section. The decision analysis process can be modified as necessary to accommodate the complexity and importance of the risk management decision. Versions of decision analysis can be carried out on a qualitative level to provide an initial understanding; and it may prove to be all that is required. On the other hand, decision analysis will support detailed quantitative models. Decision analysis is able to incorporate the important aspects of cost/benefit analysis, while providing a fuller consideration of less tangible objectives such as public perception. It is able to explicitly model uncertainty to whatever extent is appropriate. It can also incorporate collective judgment processes of the Delphi method described above.

Decision analysis has the advantage that it can explicitly consider less tangible criteria such as equity in the analysis. It can also consider a broad range of other criteria, such as public acceptance, or environmental impacts, which are difficult to measure in purely economic terms (i.e., dollars).

7.2 RISK MANAGEMENT THROUGH DECISION ANALYSIS

The methodology that seems to be best suited to Western's environmental risk program is decision analysis. Decision analysis creates defensible decisions by documenting the decision process so that it is open for all to see. This is in contrast with "intuitive" or less well-specified decision procedures, in which the method for arriving at the decision may be unclear. Decision analysis clearly specifies what factors are to be considered, how they are to be measured and evaluated, and their relative importance, thus the basis for the alternative selection is clearly specified. This makes it possible to have open discussion and "fine tuning" of the decision process. The final result is a decision that is well understood and which can be clearly explained and justified in a public arena if the need should arise.

Decision analysis is based upon the assumption that the best strategy for complex decisions is to analyze the various components separately and then integrate the individual judgments to arrive at an overall decision. This assures that all the relevant factors are identified and their relative importance is considered. The procedures for obtaining the individual judgments, and the decision rules for combining them and identifying the best alternative, have both theoretical and empirical foundations in mathematics, economics, and psychology.

Decision analysis uses separate judgments of value and performance. The value judgments of the relative importance of the criteria are distinct from the technical judgments of an alternative's performance on the criteria. This makes it possible to obtain the judgments from separate groups of individuals: the judgments of value can be made by the policy people and other stakeholders, and judgments of technical performance by scientific and engineering staff with the appropriate technical knowledge.

Numbers rather than qualitative expressions are used to construct scales, represent preferences, and express uncertainties. The relationship between qualitative preference structures and quantitative scales is given a precise and rigorous description in the mathematical discipline of measurement theory (Krantz et al. 1971). Quantification fosters clear and precise communication. Numerous studies have documented the ambiguity of verbal expressions when used to express likelihood (Bryant and Norman 1980).

Because the factors that enter into the decisions are clearly specified in decision analysis, it is possible to explore with sensitivity analysis the impact of changing the weights, or even changing the performance judgments. Thus, factors most critical to determining the best alternative can be known, and the gathering of any additional information can focus on those factors.

7.3 ELEMENTS OF DECISION ANALYSIS

This section presents a discussion of the steps in the decision analysis process for risk management. While we present it as a sequence of steps, it is an iterative process both within and across the various steps and terminates only when sensitivity analysis has shown the decision to be robust to the satisfaction of the decision maker. Also, depending on the complexity of the decision and importance of uncertainty in the evaluation of alternatives, some of the steps may not be required.

The decision analysis process consists of the following steps:

- Identify the objectives to be achieved
- Identify candidate alternatives
- Develop measures and value functions for each objective
- Assess weights for the objectives based on their relative importance

- Evaluate the alternatives using an objective function and relative weights
- Perform sensitivity analysis
- Expand analysis to model risk as necessary.

The important elements of these steps are further described below.

7.3.1 Objectives

Objectives should capture stakeholders' concerns and preferences. Stakeholders include the decision maker and all groups with a legitimate and/or perceived interest in the outcome. Developing a set of objectives for the evaluation of alternatives can be quite challenging. However, the effort is well spent and will pay dividends in the end. Well thought out objectives are essential if there is to be a logical basis for the decision and if the chosen alternative is to have the highest expectation of meeting the requirements of the decision situation. Objectives that are clearly specified in advance can also provide a basis for identifying a broad range of alternatives, thus increasing the likelihood of making an optimal decision. Objectives are statements of what we want to achieve (Keeney 1992). For evaluation purposes, objectives are put into a hierarchical form, starting with the overall goal and the fundamental objectives. Fundamental objectives are objectives that are of basic importance to the decision situation. They are ends in themselves; however, they should not be too broad in scope for the decision situation. When constructing the goals hierarchy, fundamental objectives are further broken down into more specific aspects of those objectives. This process continues until one arrives at a level at which the objectives can be quantifiably measured. The objectives at this level are called criteria.

7.3.2 Alternatives

The identification of alternatives requires a high level of creativity, and should be guided by the overall goal and the specific objectives to be achieved (Keeney 1992). A varied set of alternatives increases the likelihood that a near optimal alternative will be selected. Techniques exist for fostering creativity in the identification of alternatives. It is common initially to identify one or two options that serve as anchors and prevent a broader range of ideas from being explored. Alternatives need to be precisely defined if they are to be evaluated.

7.3.3 Criteria - Performance Measures/Attributes

Criteria are also known as performance measures or attributes. These measure the degree to which the objectives are achieved by the various alternatives. The criteria make possible a quantitative evaluation of alternatives. Public morbidity measured in person-years of work time lost is an example of an attribute. Years is a natural scale. Often natural scales are not available, in which case scales must be constructed. Scales should be constructed so as to minimize ambiguity as to what is meant by a given level of performance. A measure of the objectivity of scales is whether they can pass the clarity test (Howard 1988). The clarity test is said to be met if a clairvoyant with knowledge of all events past and future would be able to unambiguously assign the performance level for a given alternative. Notice that this requires that both the scales and the alternatives be well specified. Scales that depend on quantifiers such as "high," "medium," and "low," unless further qualified, are especially ambiguous in that one person may evaluate an alternative as high, while another may evaluate it as medium, even though they both had the same underlying performance in mind.

7.3.4 Sensitivity Analysis

Sensitivity analysis explores the robustness of the decision under various assumptions or conditions. It should be carried out to whatever extent is necessary until the decision maker is satisfied that the best alternative has been identified. Various types of sensitivity analysis are possible. The most common is sensitivity on the criteria weights. This is typically carried out for each of the performance measures to determine the relationship between the weight placed upon that criterion and the overall performance of the various alternatives. Of particular interest is to what extent the optimal alternative is sensitive to a particular criterion's weighting. In a similar vein, sensitivity analysis can be used to explore the sensitivity of decisions to the different values of various stakeholders. One can extend this analysis to determine dominant options in a multiple stakeholder preference space. Sensitivity analysis can also be used to determine the impact of various variables on the outcome measures.

7.4 DECISION ANALYSIS AND THE WESTERN ENVIRONMENTAL RISK PROGRAM

Decision analysis meets many of the important risk management requirements for Western's environmental risk program. These include:

- Providing defensible decisions through documentation of the decision process.
- Allowing the use of input and judgments from a number of different groups and individuals. This includes the differing perspectives of internal Western stakeholders (e.g., Environmental Affairs, Public Affairs, Safety, Lands).
- The flexibility to consider less tangible objectives such as public perception.
- Makes effective use of the proposed risk assessment tools (QuIC and SEQUEL).
- Provides a method for conducting sensitivity analyses for more complicated risk issues.

The structure inherent in the decision analysis approach may also be applicable beyond the environmental arena and could be utilized for policy, financial, regulatory and technical decisions in other areas of Western affairs. The evaluation factors used in risk management/decision analysis including costs, schedules, regulatory climate, health and safety, technical performance, public credibility and acceptance, and political acceptance are of common concern to Western "across the board." Ultimately, Western personnel could utilize the same decision analysis approach and techniques developed in the environmental risk program to meet their other corporate objectives.

8.0 PROPOSED ENVIRONMENTAL RISK PROGRAM FRAMEWORK AND IMPLEMENTATION

As currently envisioned, there are three components proposed for Western's environmental risk program: the qualitative issue characterization (QuIC), the semi-quantitative evaluation (SEQUEL), and a decision analysis approach to risk management. The QuIC and SEQUEL tools are designed to address Western's need for a method to generate qualitative and semi-quantitative assessments of risk and to evaluate and improve its organization's ability to manage risk. Decision analysis provides a means for Western to formally and consistently utilize risk information and other parameters to determine the optimal course of action for key issues. Figure 8.1 illustrates the relationship of these three components in the process of environmental issue resolution.

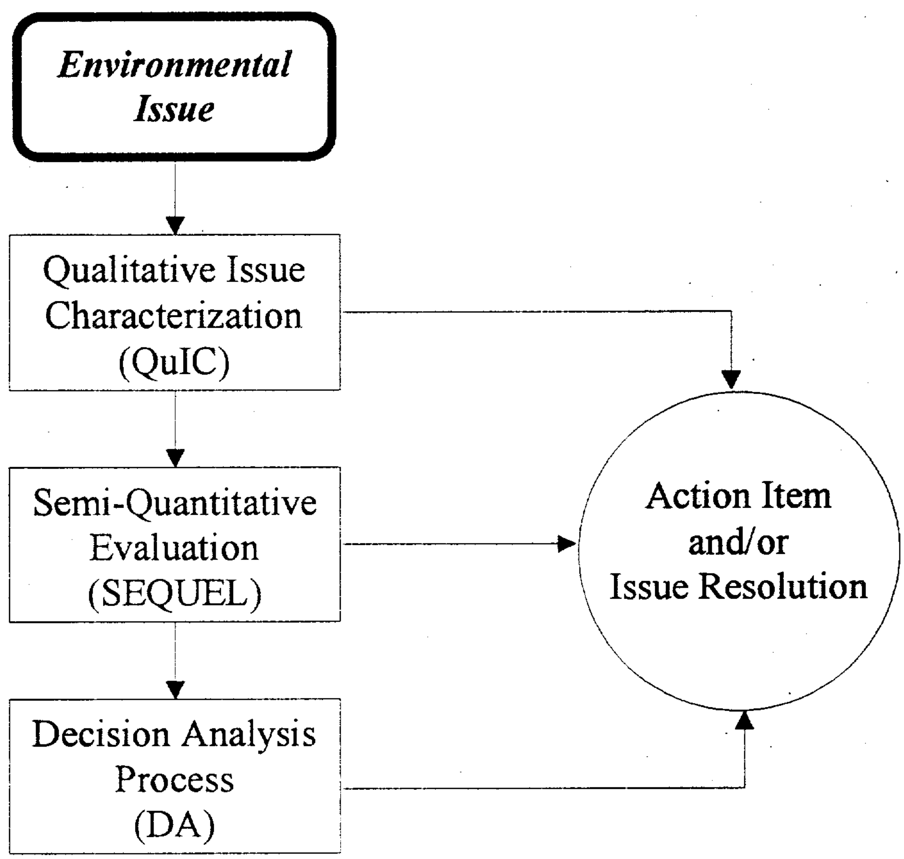


FIGURE 8.1. Process Flow Diagram for Environmental Risk Program

As the flow diagram illustrates, the QuIC process is the initial risk assessment technique that can be applied to every environmental issue. In some cases, the information gathered during this process can be sufficient to formulate action items and achieve issue resolution. However, because of the large number and variety of issues that may face environmental managers, a numerical ranking of the potential risk and Western's ability to manage risk is often useful in making risk management decisions. The SEQUEL process is designed to provide this kind of guidance. After issues are prioritized, selected risk issues may require more guidance to facilitate or justify decision making. The decision analysis process can then be used to determine the optimal course of action for a specific issue. The results of the QuIC and SEQUEL assessments are designed to support information needs in the decision analysis process.

Another relationship between QuIC, SEQUEL, and DA is illustrated using Figure 8.2. In this figure, QuIC is seen as the base of a risk assessment

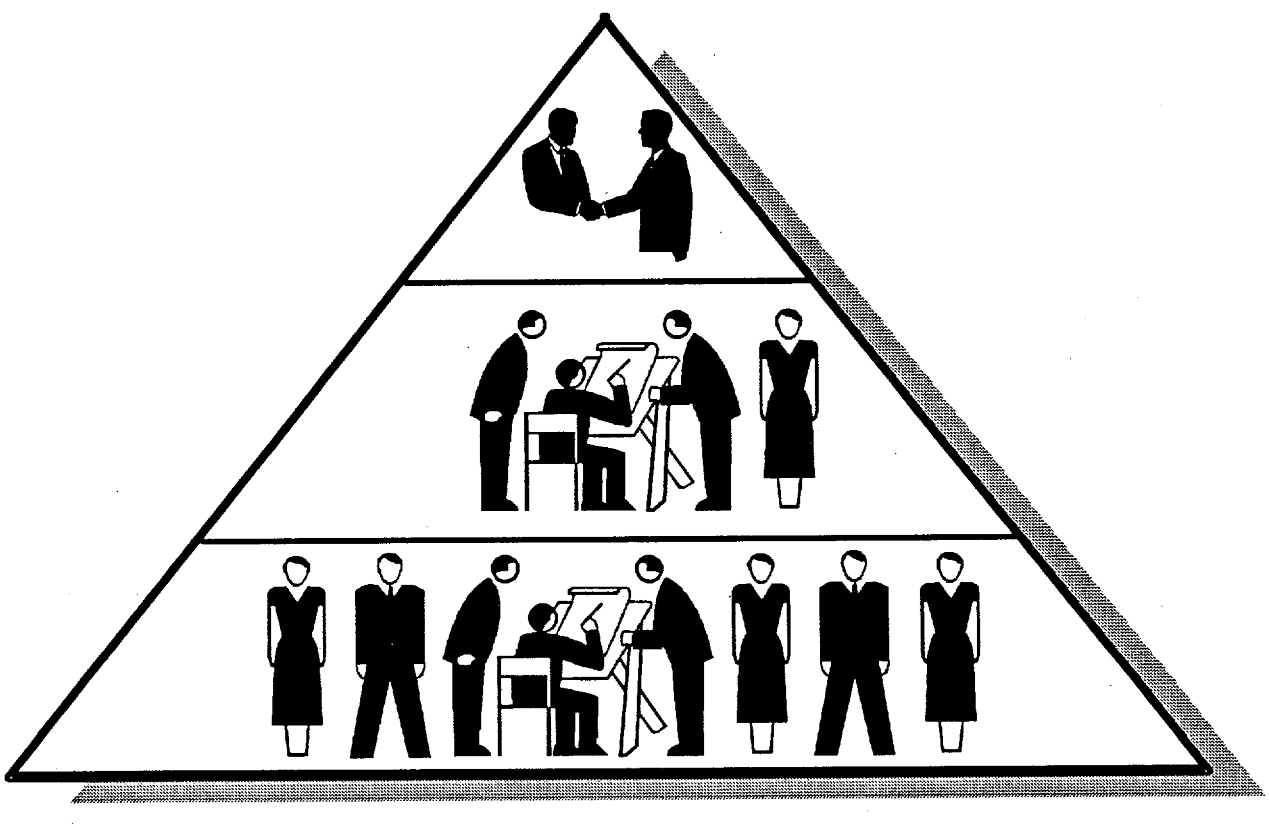


FIGURE 8.2. Risk Assessment and Management Pyramid

pyramid. QuIC is used to address a wide range of environmental issues and contributions to QuIC analyses can be made by a broad range of technical staff. The SEQUEL approach is the next level up the pyramid. SEQUEL is used to assess a potentially narrower band of issues and involves participation by a smaller group of the technical staff who have received specific training in the use of SEQUEL. Decision analysis is at the top of the pyramid. This process would be used to address only select issues, and participation in this process would be limited to a small group of highly trained staff members.

It is understood that an effective environmental risk program requires not only risk assessment and risk management components, but also a risk communication component. Effective risk communication at Western requires interdisciplinary and cooperative participation between organizations within Western. This includes interactions between different divisions at Headquarters, between divisions in the Area Offices, and between the Area Offices and Headquarters. Additional work is required in this subject area to formalize procedures for internal risk communication. An effective environmental risk program also requires risk communication with the public, in particular with key stakeholder groups, credible sources of information, and regulatory agencies. Western's Public Affairs office has recently prepared a guidance manual on external communications. If implemented, the procedures outlined in this manual would significantly upgrade Western's current level of external risk communication.

8.1 PROPOSED ENVIRONMENTAL RISK PROGRAM FRAMEWORK

This section proposes a framework for Western's risk management program. The design of the program embodies two separate components: a framework for Western's Headquarters (HQ) staff and a framework for Western's Area Offices.

8.1.1 The Risk Management Framework at Headquarters

In addition to providing key roles for Western's Environmental staff, this framework requires the participation of staff members from other Headquarter divisions including: General Council; Division of Budget, Analysis, and Compliance; Public Affairs; Engineering Division of Substation Design; Division of Power System Maintenance; Division of Lands; Division of Security Affairs; Division of Safety; and the Division of Construction. This multidisciplinary approach will allow Western to address environmental issues in a manner that considers the human health, ecosystem, regulatory, business, and public perception impacts of environmental issues. The risk program framework will initially require a significant level of effort for implementation, but the level of effort needed to maintain this program will drop after set-up activities are completed. The implementation of the program is divided into five steps:

- identify significant environmental issues,
- characterize issues qualitatively,
- characterize issues semi-quantitatively,
- make decisions,
- monitor progress and reassess issues.

Identify Significant Environmental Issues Facing Western

The first step in implementing the risk management program is to identify Western's significant environmental risk issues. This step should be conducted by HQ Environmental staff in consultation with the Area Offices and the other divisions mentioned above. The other divisions provide valuable information to the process. For example, Public Affairs staff could provide information based directly on their experience working with stakeholders, or they might coordinate the involvement of stakeholder representatives from a variety of credible interest groups in the issue identification process.

It is likely that both broad-based issues and specific issues will be identified. The broad-based issues can be subdivided into more specific and easily evaluated issues. Exhibit 1 provides an example of three general issues and an example of two specific issues for each general issue.

Perform Qualitative Characterization of Issues

The QuIC process can be used to record necessary information and gauge the relative importance of an environmental issue. A QuIC evaluation should be performed on each environmental issue. The Headquarter's Environmental staff will need to conduct interviews with staff from other divisions to obtain preliminary information on the position of regulators, stakeholders, and other Western divisions in regards to the environmental issues; and to obtain estimates of potential human health, ecosystem, business, regulatory, and public perception impacts.

EXHIBIT 1. Example of General and Specific Environmental Issues

General Issues	Specific Issues
Storage and Use of Herbicides	The use of herbicides to control vegetation growth at or around substations
	The use of herbicides to control vegetation growth along the right-of-way for high voltage transmission lines
Oil Spills at Western's Facilities	Are valid SPCC plans in place?
	Is there the appropriate level of secondary containment at all facilities?
Potential Impacts from EMF	EMF along the right-of-way for high voltage transmission lines
	EMF impacts on Western employees

Although the Public Affairs staff may be able to provide informed opinions on stakeholder positions, it is suggested that selected stakeholders be considered for involvement in the information gathering process.

Based on the QuIC evaluation of issues, those issues seen as requiring more attention and prioritization can be further analyzed in a semi-quantitative fashion.

Perform Semi-Quantitative Characterization of Issues

Using the information gained in the QuIC assessment, a semi-quantitative analysis can be performed to estimate the risk posed by an issue and Western's ability to manage that risk. The SEQUEL process is the tool proposed for use in the semi-quantitative analysis. When using SEQUEL, follow-up communication with technical experts from other Western departments or stakeholders may be needed to supplement information available from QuIC. The SEQUEL process is designed to accept different ranking or scoring schemes based on the scope of the issues being evaluated. In SEQUEL, it is important that broad issues be ranked relative to other broad issues and that specific issues be ranked against other specific issues using a more appropriate set of scales. The scoring scheme used to assess a group of issues can be adjusted if the initial assessment cannot differentiate between the issues. For example, if a group of issues all have business impacts of less than a million dollars (the lowest impact category in the example scoring scale presented in Section 6.4.2) the scale can be adjusted for this group of issues to focus on cost impacts in the zero to million dollar range. Figure 8.3 provides a display of the SEQUEL ranking matrix. Figure 8.4 provides an example showing the distribution of ten issues according to how the risk compares with Western's ability to manage this risk.

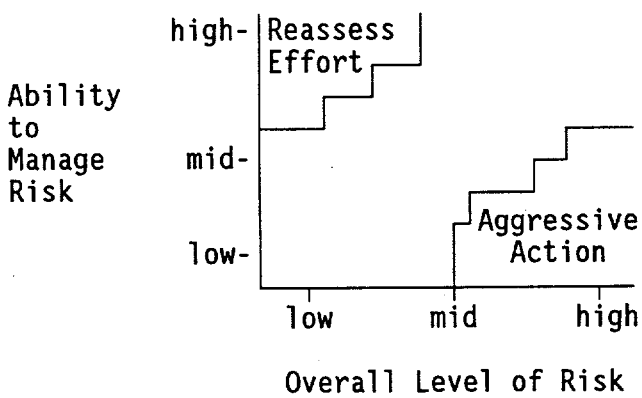


FIGURE 8.3. SEQUEL Ranking Matrix

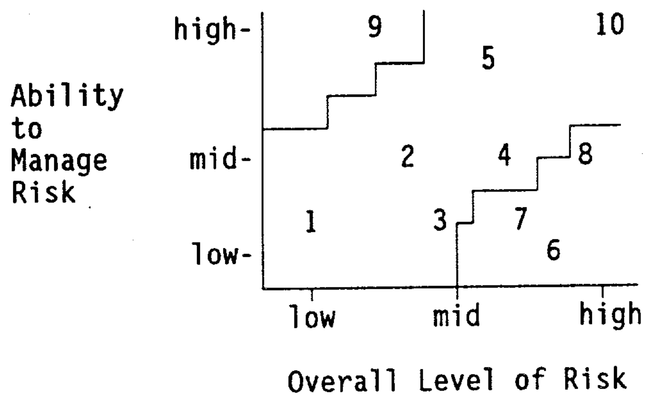


FIGURE 8.4. Example of a Useful SEQUEL Ranking for Ten Issues

Make Decisions

After completing the first three risk assessment steps and evaluating the results, assessments are ready to be presented to a multidisciplinary HQ decision-making team. The team should identify the most difficult environmental decisions facing Western and consider the use of decision analysis techniques to determine the optimal course of action. Because the application of decision analysis techniques should be directed by a "neutral" party and Western may not have an in-house expert on decision analysis, this should probably be a process facilitated by an "outside" expert.

The facilitated decision analysis process could focus on key high risk/low preparedness issues identified in the SEQUEL process as requiring aggressive action. The decision analysis approach would assess in more detail, document, and verify the need for aggressive actions. Using the example provided in Figure 8.4, Issues 6, 7, and 8 would be candidates for decision analysis because they fall within our criteria for needing aggressive action. Issues 3 and 4 could also be assessed, depending on time and budget constraints, because of their relative proximity to the aggressive action section of the figure. Although Issue 10 has the highest risk, Western is already demonstrating its ability to effectively manage this risk issue and additional study using decision analysis might not be needed.

Another application for decision analysis involves using this approach to choose between a number of alternatives for dealing with an environmental issue once the decision has been made to address that issue. In this case, the decision to use decision analysis is not based on the balance between environmental risk and Western's ability to manage the risk, but on the cost effectiveness of using decision analysis to decide between expensive alternatives.

Results of the QuIC, SEQUEL, and decision analysis process should be written up and could be used in the resource allocation decision making process and to guide Western environmental policy decisions. In addition, as a follow-up to decision analysis process, a more detailed action plan should be prepared for dealing with each issue. Results could be presented at the Environmental Manager's meetings and at Area Manager's meetings.

Monitoring Progress and Reassessment of Environmental Issues

After the completion of the previous steps, periodic attention needs to be focused on the status of environmental issues. This would include reassessing risks on selected issues as measures are taken to address them. In addition, new issues will arise and old issues will need to be periodically reassessed because of changes in perceived risks and changes in Western's ability to manage risk.

Both old issues and new issues should be characterized as part of a comprehensive annual or biennial reassessment of all environmental issues. This reassessment would include some participation by staff from other divisions and Area Office Environmental staff, although the level of work required should be significantly less than required by the first characterization.

8.1.2 The Risk Management Framework at the Area Offices

The implementation of the risk management framework at Headquarters establishes Western-wide environmental priorities. In the individual Area Offices a modified prioritization may be needed to characterize and prioritize environmental issues that are more specific than considered at the HQ level. The Area Offices may also need to address specific local issues that may not extend to, or be as important in other Western Area Offices. Exhibit 2 provides an example of how environmental issues that require local attention may be derived from the general and specific issues considered by HQ.

<u>EXHIBIT 2</u>. Example of Area Office Specific Issues that are Derived from More General HQ Issues

Potential Impacts from EMF (HQ general issue)

EMF along the right-of-way for high voltage transmission lines (HQ specific issue)

<u>Area Office Specific Issues</u>

- EMF in a specific residential area (e.g., Greely, Colorado)
- EMF in the vicinity of a suburban or rural school or hospital

The implementation of the Area Offices' risk management framework would follow the program conducted at HQ. After receiving and reviewing the Western-wide findings of the HQ team, the Area Office environmental staff would then follow the approach developed for HQ:

- identify significant environmental issues,
- characterize issues qualitatively,
- characterize issues semi-quantitatively,
- make decisions,
- monitor progress.

Area Office environmental staff would perform these assessments using information gathered from their own staff, other Area Office divisions, and HQ personnel. The same tools (QuIC, SEQUEL, and decision analysis) would be used at the Area Office level as in Western-wide assessments. Results gathered at each Area Office would be shared with the other Area Offices and HQ and used to refine assessments and prioritization. A final Area Office report on environmental issue prioritization and recommendations can then be issued for use in risk decision making and the subsequent allocation of resources.

8.2 PROPOSED ENVIRONMENTAL RISK PROGRAM DEVELOPMENT AND IMPLEMENTATION PROCESS

An important underlying goal of this project is the development of an environmental risk management program that is effective and easy to use. To this end, efforts were made throughout the process of developing the risk program framework to obtain feedback on usability from Western staff. The components of the risk program: QuIC, SEQUEL, and decision analysis were formally reviewed during a trial session held at Western HQ in October 1994. Area Office Environmental Managers and Specialists and representative from the following HQ divisions participated: Environmental Affairs, Maintenance, Security, Lands, Engineering, General Council, and Budget. The multi-disciplinary review process led to selected modifications and improvements to both QuIC and SEQUEL.

For the implementation phase of the risk management program, PNL will assist Western in the development of a procedures document to describe the risk program framework and the steps to be taken to implement the program. PNL will also provide in-depth instruction to key Western staff in a teach-the-teachers workshop. Western participants in the workshop will proceed to implement the risk management program in their current work and will provide instruction and assistance to other Western staff. A description of the procedures document, the teach-the-teachers workshop, and Western's internal implementation of the program is provided in the sections that follow.

8.2.1 Chapter for Western's Environmental Handbook

Western is producing a comprehensive Environmental Handbook designed to provide Western staff with a centralized location for Environmental policy and procedures. PNL is assisting Western in the development of the Risk Management Program Chapter for the Handbook that will provide detailed procedures for implementing the risk management process described in this report.

8.2.2 Teach the Teachers Workshop

Once the final program framework is designed, a workshop will be conducted for the Western Environmental staff responsible for implementing and instituting the environmental risk program throughout Western. The workshop's content will embody all aspects of the risk program framework.

8.2.3 Western's Internal Implementation of the Program

After the workshop, Western personnel will begin implementing the environmental risk management program. A schedule will be established that calls for:

- identifying key environmental issues that need to be addressed on the HQ and Area Office level,
- performing initial QuIC assessments and sharing this information between Area Office and HQ Environmental staff. For this process, personnel from other Western divisions will be involved in assessing the non-environmental component of the risk issues (e.g., business, regulatory, public perception impacts),
- comparing and prioritizing issues using SEQUEL, refining ranking techniques, and communicating results to Western decision makers,
- Processing key issues using decision analysis techniques.

The design and implementation of the proposed environmental risk program should go a long way in establishing the type of proactive risk management called for in DOE's 1991 Line Program Environmental Management Audit of Western (DOE 1992). The proposed program provides a formal approach to environmental risk management and will be instrumental in the formulation of policies, procedures, and criteria for the identification, evaluation, and management of environmental risk.

The environmental risk program will initially require an investment of financial and staff resources. However, when fully implemented the program should achieve a net reduction in costs to Western, as environmental resource funding is allocated more efficiently and many issues can be dealt with or defused before they require much larger allocations of resources to satisfactorily address. This program also opens new avenues for interdepartmental communication and should assist Western staff members in taking multidisciplinary views of issues that cut across multiple areas of interest and expertise.

A key component of the proposed risk management program is flexibility. This document provides a suggested framework and implementation plan, but it also allows Western staff members to make effective use of their broad knowledge base and familiarity with issues in modifying the program as new and improved risk assessment, communication, and management techniques and methods are uncovered. In this program, experimentation and exploration are encouraged, with the result hopefully being the development of a flexible and effective method for managing risk, decreasing costs, and increasing stakeholder support of Western and its mission.

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APPENDIX A

A BRIEF DESCRIPTION OF MODELS THAT CAN BE USED FOR RISK ASSESSMENT

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There are large number of models that are available for assessing risk for a variety of environmental problems. Some of these models directly calculate human health, ecosystem, and other risk factors; other models provide information on the environmental concentration of contaminants that can be used to assess risk.

The following provides a brief description of a variety of models that can be used in the risk assessment process. Some of these models should be quite familiar to Western staff, other models may be unfamiliar because of their limited application, general application to fields not of interest to Western, or their overall newness.

A.1 HUMAN HEALTH RISK ASSESSMENT MODELS

The following group of models are used to directly assess human health impacts from the environmental transport of contaminants.

MEPAS

The Multimedia Environmental Pollutant Assessment System (MEPAS) is used to estimate concentrations in environmental media and chronic human health impacts from contaminants released to the environment (Whelan et al. 1987, Droppo et al. 1989). MEPAS algorithms are used to simulate the:

- Release of from 1 to 20 different contaminants into the environment
- Transport of the contaminants through atmospheric, surface water, ground water, and overland (runoff) pathways as appropriate
- Exposure to the surrounding environment and human populations from contaminants
- Impacts and health effects (i.e., risk) associated with the exposure.

By allowing the consideration of a number of environmental pathways, the MEPAS model can more accurately evaluate situations in which several routes of pollutant exposure are affecting the surrounding area. If only one pollutant exposure route is significant, the model's operations can be restricted to that critical pathway. The modeling system can address both chemical and radioactive wastes.

MEPAS makes use of joint frequency distribution data from the best available meteorological monitoring site to represent dispersion conditions throughout the modeling domain. Groundwater transport is computed using a one-dimensional advective, three-dimensional dispersive algorithm. The algorithm assumes movement through a porous medium with a unidirectional, constant flow velocity with degradation and decay of contaminants. Up to eight distinct partially saturated zones are allowed to overlay the saturated zone used for groundwater transport.

The MEPAS model is a PC-based modeling system that uses a user-friendly shell to allow easy data entry, quality assurance checks, and batch mode operation of the modeling system. The MEPAS model has been used by staff at PNL to survey all DOE facilities, 20 EPA superfund sites, and numerous other sites. The modeling system has been used to rank sites to prioritize environmental clean-up efforts and to assess the population risk at particular facilities. In addition to its use by PNL staff, MEPAS is used by other national laboratory's, universities, consulting firms, and foreign governments.

HEM

The Human Exposure Model (HEM) is designed to provide quantitative estimates of public exposure to pollutants emitted to the atmosphere from stationary sources (EPA 1986b). The modeling system consists of an atmospheric dispersion model, population distribution data base, and a risk assessment algorithm. Estimates of population exposure can be made at locations within a radial distance of 50 km of the pollution source.

The atmospheric dispersion model for HEM is a simplified version of the EPA's basic CDM2 model (EPA 1986a). The model uses joint frequency distribution data from the nearest meteorological monitoring site to represent dispersion conditions throughout the modeling domain. As a result, the model is appropriate only for simple terrain. Although the HEM's atmospheric dispersion model is simple, output from other dispersion models can be used by HEM if this output is in a compatible format.

Population data for HEM are obtained from the master area reference file from the U.S. Census Bureau. The model identifies each enumeration district/ block group that falls within the modeling domain. A population is then associated with each of the 160 receptor locations in the system's atmospheric dispersion model. Population exposure is computed by multiplying the estimated ground-level concentrations at each grid point by the population value for the grid point. The modeling system uses these data to estimate aggregate risk and maximum individual lifetime risk.

The HEM model is available at the National Climatic Center's UNIVAC computer. To access the modeling system, a contract must be set up with the National Technical Information Service. At present, there is no indication that the model is being made available for distribution or that a PC version is available.

MULTIMED

The MULTIMEDia Exposure Assessment Model (MULTIMED) calculates contaminant concentrations in groundwater, surface water and air resulting from emission from hazardous waste sites. MULTIMED models both the hydrologic and atmospheric pathways but does not allow the transfer of contaminants between pathways. The model performs limited assessments of human exposure resulting from ingestion of contaminated water and fish (INTERA 1992).

MULTIMED is a PC-based system that includes a "user-friendly" pre-processor to prepare and modify input files and a post-processor to generate simple plots of model output. MULTIMED was developed for the U.S. EPA's Environmental Research Laboratory by several consultants.

RESRAD

The RESidual RADioactive material code (RESRAD) is an analytical method for deriving guidelines for allowable concentrations of residual radioactive material in soil (Gilbert et al. 1989). The model considers external radiation from the ground and air, inhalation of particulate and gaseous radionuclides, and the ingestion of contaminated food, water, and soil. The groundwater pathway can be modeled with a simple mass-balance or nondispersive model. The surface water pathway is computed for a pond in which water inflow and outflow are in steady-state equilibrium. The code is designed for use on IBM-compatible personal computers.

The Air Emission Risk Assessment Model (AERAM) and AirTox

The AREM model is designed to evaluate human health risks from power plant emissions under a variety of plant configurations (Levin 1992). AERAM Version 2.01 can assess the impacts of emissions from both traditional oil-fired power plants and plants that use alternative fuels. The model is PC-based, requiring an MS-DOS operating system. User's can create three-dimensional graphs to present pollutant exposure and environmental concentration results. Used in conjunction with the AirTox model, AERAM output can be manipulated to provide estimates of the human health risk from changes in fuel, stack height, and other key power plant operational parameters. AirTox can also be used to carry uncertainty estimates throughput model calculations.

A.2 ATMOSPHERIC DISPERSION MODELS

A wide variety of atmospheric dispersion models are available to address particular problems. General information on atmospheric dispersion models can be found in EPA (1986a).

Buoyant Line and Point Source Dispersion Model (BLP)

The BLP model is a Gaussian plume model designed to handle problems associated with industrial sources where plume rise and downwash effects from stationary line sources are important (the model was developed to address emissions from aluminum smelters). The model is appropriate for use in rural areas, modeling domains with a radius of less than 50 km, simple terrain, and one-hour to one-year averaging periods. This model is EPA approved for specific regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. Up to 50 point sources and 10 parallel line sources are allowed. The model uses hourly meteorological data to compute straightline plume transport.

The model computes total pollutant concentrations, and monthly and annual 1-, 3-, 24-hour average pollutant concentrations on a user-specified receptor grid of up to 100 points. The model does not treat deposition processes, but allows the linear decay of pollutants.

Climatological Dispersion Model (CDM2)

The CDM2 is a steady-state Gaussian plume model designed to estimate the long-term average pollutant concentrations in an urban environment. The model is appropriate for simple terrain, modeling domains with a radius of less than 50 km, and point and area pollution sources. This model is EPA approved for specific regulatory applications. A PC version of the model is available.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The user may define both point and area sources. The model uses climatological data (joint frequency distributions) to compute straightline plume transport. Plume rise and stack-tip downwash can be computed for point sources.

The model output consists of average pollutant concentrations at user-specified grid points for periods from 1 month to over a year. The model does not treat deposition processes, but allows the exponential decay of pollutants.

Gaussian-Plume Multiple Source Air Quality Algorithm (RAM)

The RAM is a steady-state Gaussian plume model designed to estimate pollutant concentrations of relatively stable pollutants. The model can be applied to short- or long-term problems. The model is appropriate for simple terrain, modeling domains with a radius of less than 50 km, and urban or rural environments. This model is EPA approved for specific regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The user may define both point and area sources. The model uses hourly meteorological data to compute straightline plume transport. Plume rise and stack-tip downwash can be computed for point sources.

The model output consists of 1- to 24-hour average pollutant concentrations and annual average pollutant concentrations at user-specified grid points or on gridded receptor array. The model does not treat deposition processes, but allows the exponential decay of pollutants. Building wake processes are not treated.

Industrial Source Complex Model (ISC)

The ISC model is a steady-state Gaussian plume model designed to estimate pollutant concentrations from a wide variety of sources associated with industrial complexes. The model can operate in both short- and long-term modes. The model is appropriate for flat or rolling terrain, modeling domains with a radius of less than 50 km, and urban or rural environments. This model is EPA approved for specific regulatory applications. A PC version of the model is available.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The user may define a variety of point, line, area, and volume sources. In the short-term mode (ISCST), the model uses hourly meteorological data to compute straightline plume transport. In the long-term mode (ISCLT), the model uses joint frequency distribution data to compute straightline plume transport. Plume rise, stack-tip downwash, and building wake can be computed.

The model computes a variety of short- and long-term averaged products at user-specified receptor locations and receptor rings. The model treats deposition processes and allows the exponential decay of pollutants.

Multiple Point Gaussian Dispersion Algorithm with Terrain Adjustment (MPTER)

The MPTER model is a steady-state Gaussian plume model designed to estimate pollutant concentrations from multiple point sources. The model can operate in both short- and long-term modes. The model is appropriate for flat or rolling terrain, modeling domains with a radius of less than 50 km, and urban or rural environments. This model is EPA approved for specific regulatory applications. A PC version of the model is available.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data to compute straightline plume transport. Plume rise and stack-tip downwash can be computed.

The model output consists of a variety of short- and long-term averaged products at user specified receptor locations. The model does not treat deposition processes, but allows the exponential decay of pollutants.

<u>Single Source (CRSTER) Model</u>

The CRSTER model is a steady-state Gaussian plume model designed to estimate pollutant concentrations from point sources. The model can operate in both short- and long-term modes. The model is appropriate for flat or rolling terrain, modeling domains with a radius of < 50 km, and urban or rural environments. This model is EPA approved for specific regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data to compute straightline plume transport. The model assumes no vertical variation in wind direction or speed. Plume rise and stack-tip downwash can be computed.

The model output consists of a variety of short- and long-term averaged products at up to five user specified receptor rings. The model does not treat deposition processes, but allows the exponential decay of pollutants.

<u>Air Resources Regional Pollution Assessment (ARRPA) Model</u>

The ARRPA model is a medium/long-range Gaussian segmented plume model designed to compute air concentrations and surface dry deposition of sulfur dioxide and sulfate. The model is appropriate for transport distances from greater than 10 km to greater than 50 km. The model uses prognostic, 3-dimensional, meteorological output from the National Weather Service's

Boundary Layer Model. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly wind field components, potential temperature, and other meteorological data. Plume rise is computed and the model allows the spatial and temporal variation of plume rise.

The model output consists of a variety of short-term averaged products on a gridded receptor array. Nongridded receptors can also be specified. The model computes dry deposition and processes and the oxidation of sulfur dioxide to sulfate. The model was designed for larger computers, but may be transferrable to more powerful PCs.

MESOPUFF II

The MESOPUFF II model is a short-term, regional scale, Gaussian puff model designed to calculate concentrations of up to five pollutant species. The model allows spatial and temporal variations in winds, but does not explicitly treat complex terrain. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data from up to 25 surface stations and 10 upper air stations. Plume rise can be computed.

The model can simultaneously examine up to five pollutant species in a single simulation. Up to 25 point sources and 5 area sources can be modeled. The model uses a gridded field of receptors and allows the user to specify additional receptor locations. The model treats both wet (precipitation) and dry deposition processes. Hourly chemical rate constants are computed from empirical expressions derived from photochemical model simulations.

MESOI/MESORAD

The MESOI and MESORAD models are Gaussian puff dispersion models. The MESORAD model is the radiological version of MESOI; it includes algorithms that allow the model to compute radiological dose for selected radionuclides. The MESOI and MESORAD models allow spatial and temporal variations in the wind field, and explicitly treat complex terrain. These models were developed for use by the U.S. Department of Energy (DOE) and the NRC. Both models can be operated on PCs and come with user-friendly forms, menus, and output display programs.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses meteorological data (15-min or hourly data are typically used) from up to 40 surface stations to compute a near-surface wind field. Upper-level wind data are provided from one station. Plume rise can be computed.

The model can accommodate four point sources with time-varying emission rates. The model uses a gridded field of receptors to provide graphical or numerical information on pollutant exposures, deposition, and radiological doses (for MESORAD). The model treats both wet (precipitation) and dry deposition processes and allows the exponential decay of reactive pollutants. The MESOI model is documented in Ramsdell et al. 1983 and MESORAD is documented in Scherpelz et al. 1986.

GENII

The GENII code was designed for conducting radiological environmental transport and pathway analysis at the Hanford Site (Napier et al. 1988). The GENII acronym stands for GENeration II, the second generation of Hanford environmental pathway analysis models. The purpose of the GENII system is to provide a coupled system of computer codes for prediction of radiation doses to people from environmental sources of radioactive materials.

The environmental pathways considered in GENII include the following exposure pathways: surface water (swimming, boating, and fishing), soil (surface and buried sources), air immersion (semi-infinite cloud and finite cloud geometries), inhalation, ingestion of drinking water, and ingestion of both terrestrial and aquatic food products. GENII can be used to calculate radiation doses from both acute (short-term/accidental) and chronic (routine/long-term) releases of radioactive materials. The system incorporates the internal dosimetry models recommended by the International Commission on Radiological Protection (ICRP). The system has options for calculating annual dose, committed dose, and accumulated dose.

The GENII system is designed to operate on a personal computer and is under active configuration management. The system is documented in three volumes (a theoretical description of the system, user's manual, providing code structure, user's instructions, required system configurations, and topics related to quality assurance. Volume 3, the Code Maintenance Manual, is designed for the user who requires knowledge of code details, including code logic diagrams, global dictionary, worksheets for hand calculations, and listings of the code and associated data libraries. GENII was given external technical peer-review prior to release and is currently under configuration control.

Mesoscale Transport Diffusion and Deposition Model for Industrial Sources (MTDDIS)

The MTDDIS is a Gaussian puff model designed to simulate long-range transport. The model allows spatial and temporal variations in winds, but does not explicitly treat complex terrain. The model can be used for releases in simple through rolling terrain. It can be used to determine 3-hour maximum and 24-hour average pollutant concentrations. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data from up to 10 surface stations and a single upper air station. Plume rise can be computed.

The model can treat up to 10 point sources. Up to three rectangular receptor grids may be specified by the user. The model treats both wet (precipitation) and dry deposition processes. Chemical transformations are treated using the exponential decay of pollutants.

Offshore and Coastal Dispersion Model (OCD)

The OCD model is a steady-state Gaussian plume model designed to estimate pollutant concentrations under the special dispersion conditions found in coastal and offshore areas. The inland portion of the modeling domain can have simple or complex topography. Point sources of pollution may be located offshore, on the shoreline, or inland (within several kilometers of the shore). The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly data to represent meteorological parameters such as wind direction and speed, mixing height, water temperature, humidity (over water), and the vertical temperature gradient. The model computes a variety of short-term and long-term averaged products at user-specified receptor locations and receptor grids.

Point, Area, Line Source Algorithm (PAL-DS)

The PAL-DS model is a short-term Gaussian plume model. It is intended to assess the air quality impact of particular urban-type sources (e.g., airports, shopping centers, parking lots) over level terrain on scales of tens to hundreds of meters. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications. A PC version of the model is available.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model requires data on wind direction and speed, wind profile exponents, stability class, mixing height, and air temperature. Up to 99 sources are allowed. Sources may be of six types: point, area, and four types of line sources. The model can compute plume rise, but not downwash.

The model output includes hourly concentration, hourly deposition flux, and average concentrations (for up to 24 hour) for each source type at each receptor. The model can compute dry deposition but does not handle chemical transformations.

Random Walk Advection and Dispersion Model (RADM)

The RADM is a Lagrangian dispersion model that uses the random-walk method to simulate atmospheric dispersion. The model is applicable for both point and areas sources. In the RADM, the model computes the mean motion of a large number of pollutant "particles" and uses a probability distribution to compute the motion of the particles caused by turbulent motions. The program computes a random number, based on the probability distribution, for each particle to determine its turbulent movement. These computations are conducted for each advection time step. Pollutant concentrations are computed for a particular time by summing the mass of particles in a volume around each model receptor. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model requires gridded meteorological data (i.e., wind direction, wind speed, stability class, temperature, mixing height). A vertical wind speed profile is used to allow wind speeds to vary with height above the ground. Multiple point and area sources may be specified. The model can compute plume rise.

The model output consists of average concentrations by receptor for user-specified averaging times or for the entire simulation. The model can compute dry deposition and the exponential decay of chemical compounds.

Regional Transport Model (RTM-II)

The RTM-II is a hybrid Eulerian grid and Lagrangian Gaussian puff model that is used to estimate air pollution impacts from multiple point sources and area sources at large distances (hundreds to thousands of kilometers). The model can treat many different pollutant species during a single simulation, although it is primarily configured for sulfur dioxide and sulfate. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model requires data on grid wind fields and precipitation at user-specified time intervals.

Other detailed data requirements exist to define topography, land use, deposition velocities, initial boundary conditions, and other parameters. Point and area sources can be specified at each grid point (up to a total of 500) within the modeling domain. The model can compute plume rise.

The model output consists of instantaneous and average concentration fields at user specified time intervals. Cumulative wet and dry deposition values can also be produced. For chemical transformations, the model explicitly treats linear sulfur dioxide oxidation.

VALLEY Model

The VALLEY model is a straightline Gaussian plume model designed to provide screening estimates of 24-hour and annual pollutant concentrations in areas is which the elevation of neighboring terrain may exceed the emission stack height. The model uses joint frequency distribution data from the nearest meteorological monitoring site to represent dispersion conditions throughout the modeling domain. Estimates of pollutant concentrations are very sensitive to the elevation of the receptor locations. The EPA recommends the use of other models (e.g., MPTER) if more than simple screening estimates are required for complex terrain environments.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. Plume rise can be computed and plume height can be adjusted according to terrain elevations and atmospheric stability. The model can treat up to 50 point and area sources. The model can computes pollutant concentrations at 112 receptor locations arrayed on a radial grid of variable size.

A.3 ATMOSPHERIC VISIBILITY MODELS

A number of models are available for estimating the degradation of atmospheric visibility.

ERT Visibility Model

The ERT Visibility Model is a Gaussian plume model designed to estimate visibility impairment caused by emissions from isolated point sources. Visibility impairment results are provided for user-specified lines of sight. The

EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data to compute plume transport. The model requires information on background concentrations, deposition velocities, and chemical transformation rates for key pollutants. Plume rise can be computed.

The model output consists of a variety of parameters related to visibility impairment, including total calculated visual range reduction, and each pollutant's contribution to this term. The model treats dry deposition and uses first-order transformations of sulfates and nitrates.

PLUVUE II - Plume Visibility Model

The PLUVUE II model is a Gaussian plume model designed to estimate visibility impairment resulting from emissions of particles, nitrogen oxides, and sulfur oxides from a single source. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model assumes a constant wind direction and wind speed during a simulation. The model requires information on background pollutant concentrations. Plume rise can be computed.

The model output consists of plume concentrations and visual effects at specified downwind distances for calculated or specified lines of sight. The model treats dry deposition and the chemistry of key pollutant compounds.

A.4 ATMOSPHERIC CHEMISTRY MODELS

A variety of different models are available for simulating atmospheric chemistry processes.

Integrated Model for Plumes and Atmospheric Chemistry in Complex Terrain (IMPACT)

The IMPACT is an Eulerian, three-dimensional, finite-difference grid model designed to calculate the impact of pollutants from point or area sources. The model can be used to study dispersion in areas of simple or complex terrain. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model uses hourly meteorological data for surface and elevated monitoring stations within and surrounding the modeling domain. The model can also make use of vertical profiles of pollutant concentration, terrain height data, and surface roughness data. Plume rise is computed and chemical transformations are considered using a number of mechanisms. Physical removal is treated using the exponential decay of pollutants.

The model computes vertical and horizontal cross sections of pollutant concentrations averaged over periods specified by the user. The model can be used to model any inert pollutant or a number of reactive compounds (e.g., oxides of sulfur, oxides of nitrogen, ozone, hydrocarbons).

PLMSTAR Air Quality Simulation Model

The PLMSTAR model is a mesoscale Lagrangian photochemical model designed to simulate the behavior and predict the atmospheric concentrations of pollutants in chemically reactive plumes. The model's air parcel is subdivided into a 5-layer/9-column domain of computational cells. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model requires data on surface winds, winds aloft, temperature profiles, and other meteorological parameters. The model incorporates an explicit terrain adjustment of the wind field (with divergence minimization).

The model computes pollutant concentrations at specified times and receptor locations. The emission processors allow up to 250 point sources and an unlimited number of area sources. The model's photochemical algorithms can consider 62 reactions involving 38 species. Chemical transformations are computed by numerically integrating the nonlinear kinetic rate equations. Dry deposition processes are also computed.

Reactive Plume Model (RPM-II)

The RPM-II is a reactive plume model designed to estimate short-term concentrations of primary and secondary pollutants resulting from point or area source emissions. The model claims to offer a more realistic treatment of the entrainment process (by which ambient air mixes with the plume) through enhanced horizontal resolution within the plume. The model also offers the user the option of choosing various chemical kinetic mechanisms. The EPA has determined that the use of this model may be considered on a case-by-case basis for particular regulatory applications.

Input requirements include a variety of information that defines the source configuration and pollutant emission parameters. The model requires data on wind speeds as a function of time and other meteorological parameters. Wind direction data are not used. The model also requires that the user specify the initial concentration of pollutant species. The user can specify a single point, area, or volume source. The model can compute plume rise.

The model computes short-term concentrations of primary and secondary pollutants at either user-specified times or downwind distances. Currently, the model can be run using the Carbon-Bond II Mechanism developed by Whitten, Killus, and Hogo (1980). The model can handle other user input chemical kinetic mechanisms.

Urban Airshed Model (UAM)

The UAM is an urban scale, three-dimensional, grid-type, numerical model. It computes ozone and other pollutant concentrations by simulating photochemical processes in urban atmosphere. The UAM is a short-term model; simulations examine conditions for short periods (i.e., 3 days or less). The model assumes that ozone formation is a direct result of emissions of oxides of nitrogen and volatile organic compounds. This model is EPA approved for specific regulatory applications.

Input requirements include a variety of information that defines the source configuration, pollutant emission parameters, and initial boundary concentrations. The model uses hourly, gridded wind data for a number of vertical layers. The model also requires information on the temperature structure of the atmosphere, humidity, surface pressure, and gridded roughness lengths. Plume rise, dry deposition, and surface uptake by vegetation are computed.

The model computes gridded instantaneous concentration fields at user-specified time intervals and grid levels. The chemical transformation component of the model uses the Carbon-Bond II Mechanism developed by Whitten, Killus, and Hogo (1980). The model may be run on more powerful PCs.

A.5 SUBSURFACE FLOW AND TRANSPORT MODELS

A variety of different models are available for simulating flow and transport in both the unsaturated zone and groundwater.

UNSAT-H

The UNSAT-H code was developed to simulate water flow in the unsaturated zone in one dimension (Fayer and Gee 1985). The UNSAT-H code has been applied to evaluate water balance near the land surface within the root zone of vegetation and to evaluate the effects of barriers over waste sites. The water-balance simulations provide estimates of water drainage below the root zone of vegetation, which becomes recharge to the unsaturated zone.

TRANSS

Transport calculations for radionuclides evaluated for the Hanford Defense Waste Environmental Impact Statement (HDWEIS) and other waste-site evaluations were based on the TRANSS code (Simmons, Kincaid, and Reisenauer 1986). TRANSS is a simplified code that describes radionuclide transport along streamlines based on analytical solutions of the advection-dispersion equation. The analytical solutions along each streamline are combined in a streamtube. Thus, transverse dispersion associated with contaminant movement is not included in the solutions, although defining a streamtube of finite width accounts for transverse spreading of a contaminant plume. Longitudinal dispersion is accounted for explicitly in the code. The code is capable of simulating the release of contaminants from sources in the unsaturated zone and either predicting contaminant mass transfer to the river or to a well downgradient of the waste site. The flow component for the TRANSS code in the HDWEIS was derived from calculating unsaturated zone flow based on the assumption of gravity drainage.

TRACR3D and S301

TRACR3D is a finite-difference code (Travis and Birdsell 1990) capable of simulating drastic contrasts in hydraulic properties in the unsaturated zone, such as that expected between clay, sand, and gravel layers. The code was applied in two dimensions to describe flow in the unsaturated zone for the grout performance assessment at the Hanford site. The S301 code, developed at Winfrith, England (Wikramaratna and Farmer 1987), was used in conjunction with TRACR3D to simulate contaminant transport in the unsaturated zone.

PORFLO-3

PORFLO-3 is an integrated finite-difference code developed to describe fluid flow, heat, and mass transport in variably saturated (saturated and unsaturated) geologic media (Sagar and Runchal 1990; Runchal and Sagar 1989). The code has capabilities for simulating flow through both porous media and fractured rock under both saturated and unsaturated conditions. WHC funded the development of PORFLO-3 by Analytic and Computational Research, Inc., and testing at PNL. The code has been verified by comparison with analytical solutions and tested for its ability to simulate actual conditions of infiltration and contaminant transport by comparison with a field experiment conducted near Las Cruces, New Mexico. Simulating the Las Cruces trench experiment, Rockhold and Wurstner (1991) produced water content changes that matched the observed data reasonably well, but resulted in only fair agreement between simulated and observed solute concentrations. In addition to testing, the PORFLO-3 code was applied to evaluate the 241-T-106 single-shell tank leak (Smoot and Sagar 1990). The evaluation included simulating both liquid and contaminants (^{106}Ru and ^{137}CS) in three dimensions. The conclusions reached from the simulation were that the PORFLO-3 code is capable of simulating the three-dimensional behavior of a contamination plume in the unsaturated zone, but additional characterization data are needed to support the site-specific model.

VTT

The Variable Thickness Transient (VTT) flow code (Kipp et al. 1972) was developed to simulate transient water-table changes in the unconfined aquifer resulting from changes in waste-management operations and river-stage fluctuations. The two-dimensional flow model of the unconfined aquifer, calibrated with an iterative trial-and-error procedure based on flow in streamtubes (Cearlock, Kipp, and Friedrichs 1972), was applied to a number of different evaluations. These evaluations are documented in Cearlock and Mudd (1970), Arnett (1975), Arnett et al. (1977), Murthy et al. (1983), and DOE (1987).

CFEST

The Coupled Fluid, Energy, and Solute Transport (CFEST) code (Gupta et al. 1982) was developed for non-Hanford applications. Its predecessor, the Finite Element 3D Ground-water (FE3DGW) Flow code, was modified to simulate simultaneous heat and contaminant transport as part of an Aquifer Thermal Energy Storage project conducted by staff at PNL. Further development of CFEST was funded by the high-level nuclear waste program investigating the potential repository in salt deposits in Texas. The code can be applied to simulate water table (unconfined conditions), even though CFEST was formulated for confined aquifer simulations. In addition, the code has capabilities for generating submodels from larger regional models. For example, boundary conditions for an operable unit at Hanford could be generated from a Hanford Site-wide model. This capability will be important for generating models of specific waste sties while maintaining consistency with site-wide conditions. CFEST has been applied to the unconfined aquifer at the Hanford Site and calibrated to describe ground-water flow in two dimensions, based both on the transmissivity data in VTT and a modification of this transmissivity data with an inverse calibration technique (Jacobson and Freshley 1990).

MOSES

The Mineral Oil Spill Evaluation System (MOSES) was developed by EPRI for use in spill prevention and countermeasures and control (SPCC) assessments (Murarka 1991). The model is used to evaluate the probability of oil spilling from utility facilities and impacting surface waters. The model requires information on-site storage of oil, volatilization, soil and vegetation, rainfall, and infiltration and overland flow parameters. The model is designed to run on a PC.

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