Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands

HUMAN HEALTH RISK ASSESSMENT PANEL REPORT

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Introduction

This report addresses the potential human health risks posed by chemical contaminants at the St. Regis/Wheeler Superfund site in the town of Cass Lake, Minnesota, and within the boundaries of the Leech Lake Reservation. The report is the result of discussions that occurred during an expert panel review held at Cass Lake, Minnesota, on May 13–15, 2002. This report uses the framework for human health risk assessment as a vehicle for organizing and presenting the deliberations and concerns of the panel.

The fundamental objective of the Human Health Risk Panel (hereafter "the panel") was to determine if clean-up and remediation actions taken thus far have provided an environment that poses minimal and acceptable risks to human health, particularly in relation to the cultural traditions and practices of the Native American inhabitants of Cass Lake and the surrounding area. A companion report, Bartell et al. (2002), examines potential ecological risks posed by on-site and off-site contamination from the St. Regis/Wheelers Superfund site.

Another objective of the review participants was to identify issues and formulate questions for the United States Environmental Protection Agency (USEPA) in order to determine how to restore traditional, unrestricted use of the site. Conventional superfund risk assessments focus on current and future risks to human health using fairly standardized scenarios of exposure. In contrast, the stated needs of the tribe emphasize the need to know and understand the implications of residual contamination in terms of the tribe's ability to utilize local environmental resources and continue or resume longstanding cultural practices unique to the tribe.

The health of the environment is a key issue in relation to perceptions of human health and well-being among tribal members. Although human health and ecological risks posed by the St. Regis/Wheelers site are addressed in two separate reports, it is emphasized that an integrated human health and ecological approach to risk assessment, risk communication, and risk management is fundamental to successful remediation and restoration of the site.

Review Participants and Human Health Risk Panel

The review participants and Human Health Risk Assessment Panel consisted of the following individuals:

Groundwater Panel Representative

The discussion of potential human health risks during this review benefited from the insights developed during a previous panel effort that focused on groundwater issues. Dr. Howard Mooers, Department of Geology, University of Minnesota Duluth participated in the groundwater expert panel and presented key findings to the human health expert panel (McDonald et al. 1999).

Environmental Justice Project Principal Staff

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Other Participants

The following individuals also participated in the May 2002 review and contributed to the preparation of this summary report:

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Environmental Justice (EJ) Project staff prepared a 3-ring binder of reports, data summaries and other written materials that was distributed to the Human Health and Ecological Risk Assessment panel members prior to the May 2002 meeting at Cass Lake, MN. This binder is cited in this report as NRRI 2001 (Risk Information Packet) and its Table of Contents is attached as Appendix 1. EJ staff has also compiled a list of essential references (Appendix 2) from the period 1985-2002 pertinent to any assessment of the current or historical environmental issues at the St. Regis/Wheelers Superfund site at Cass Lake, MN. It is important to note that there are many additional, potentially important documents and data that may also be relevant to future assessments of the Site that are not included in these lists.

Background

The panel was provided information concerning the history of the site in relation to potential human health impacts and risk.

The City of Cass Lake owns much of the land previously occupied by the St. Regis/Wheelers site, subsequently Champion International, and then International Paper. International retains some of this land. A portion of the former site is owned by Champion, which also owns the soil vault. The Cass Lake city dump is owned by Cass Lake. The U.S. Forest Service manages the lands in between the site and dump as part of the Chippewa National Forest.

The St. Regis/Wheelers site was never formally listed as a Superfund site. In the absence of this federal oversight, the Minnesota Pollution Control Agency (MPCA) served as the leading governmental unit onsite until 1996. However, the USEPA became the responsible governmental unit in 1996 at the request of the Leech Lake Tribal Council. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process was never officially followed because the Remedial Action was voluntary. The Agency for Toxic Substances and Disease Registry (ATSDR) commented formally on the site, but stated that insufficient information precluded a human health risk assessment for the site (ATSDR 1989). Consequently, health-based cleanup levels for soils were never established and follow up monitoring of site soils for chemicals of concern (COCs) did not begin until October 2001. Water resources associated with the site were assessed as not being impacted by previous operations at the site (Barr Engineering Co. 1999).

Further, the panel, as well as the EJ Project partnership, remains confused concerning the status of the Quality Assurance Project Plan (QAPP) for Barr/Champion/International Paper routine monitoring activities at the site. It appears that there has never been a Asigned off@ certified Quality Assurance Project Plan (QAPP) for the Champion/Barr annual monitoring program. The QAPP was apparently either not available or not used to standardize analytical methods and/or levels of detection since the inception of the Remedial Action. Our understanding is that an unsigned draft dated January 24, 1995, with a Revision 2 February 1999 note was sent to the Band with a March 10, 1999, date stamp, but it remains unclear if it was ever carefully reviewed by regulatory agencies, accepted and implemented.

Subsequent to assuming authority for the site, the USEPA periodically reviewed the status of the site in the context of continued, limited monitoring of residual contamination. The first five-year review for the site was due in 1991, but was not drafted by the MPCA until 1995, although there are various state agency draft reports dating from 1993 (MDH 1993, 1995). The 1995 report (MPCA 1995) was not finalized until 1998 (without further changes), possibly in response to queries from the EJ Project partnership near the time of the June 1998 EJ Project Groundwater Panel meeting. Importantly, the "1995" review is the first and only five-year review since the project=s inception more than 15 years ago. Additionally, the National Pollution Discharge Elimination System (NPDES) permit established in 1992 for site-related effluent discharges to Pike Bay expired in 1997 (NPDES/MN State Discharge System (SDS) Permit No. MN0056537).

The primary concern of the tribe is that the site has never been adequately or sufficiently evaluated to determine whether remediation actions completed to-date protect human health or the environment (see report from Ecological Risk Assessment Panel, (Bartell et al. 2002). Such concern derives in part from Minnesota law that essentially permits a company that volunteers to clean up its facility the authority to design and implement sampling protocols, sample designs, limits of detection, and other quality assurance/quality control matters. Other causes of concern include changing laboratories that process samples and perform chemical analyses, changing detection limits, and an erratic sampling schedule (e.g., Barr Annual Monitoring Report, Barr Engineering Co. 2001).

Human Health Risk Assessment

The conventional paradigm for assessing human health risks (i.e., the "Red Book," National Research Council 1983) has been adapted to address risks posed by toxic chemicals at Superfund sites (EPA 1989a,b). This process of assessing human health risks includes four steps: (1) hazard identification, (2) dose-response assessment, (3) exposure assessment, and (4) risk characterization. This four-step process has been used to organize and present the expert panel conclusions concerning the potential human health risks posed by the current conditions at the St. Regis/Wheelers site.

This risk assessment approach for summarizing the expert panel deliberations was selected to (1) help evaluate the current assessment of human health risks in relation to conditions at Cass Lake, and (2) assist in identifying critical data and information needs to perform a more rigorous and scientifically defensible assessment of current and future risks to the residents of Cass Lake and nearby areas.

Hazard Identification

One of the problems in assessing tribal health risks from contamination is that the people and their lifestyles are seldom well described. A modification to the conventional approach to hazard identification that better addresses tribal risks would be to strengthen this step in the risk assessment process. A more comprehensive description is needed of the cultural risks or losses that arise because tribal members are forced to modify traditional practices to avoid or minimize exposures (Harper et al. 2000, Harris and Harper 2000). A clear delineation of human systems and traditional uses placed at risk may assist in the hazard identification phase, as well as in the other components of a human health risk assessment more specific to cultural needs of the tribe.

Fundamental aspects of hazard identification steps include: (1) characterization of the site, (2) delineation of COCs, and (3) completion of a screening-level assessment to identify the COCs by media and pathways that are most likely to contribute to health risks (Kolluru 1996).

Site Characterization

Site-related chemical contamination at Cass Lake has not been adequately characterized to support a comprehensive and scientifically defensible assessment of human health risks. The major limitations in the current and previous site characterization include (1) lack of a comprehensive reconstruction of the nature, inventories, and possible amounts of COC released historically into the Cass Lake environment; (2) incomplete quantitative description of the locations, concentrations, and movement of chemicals of concern; and (3) overall data quality.

The site characterization could be improved to support more rigorous assessment of previous and current human health risks by performing a thorough analysis of the historical operations of the International and Champion facilities. The objectives of such a reconstruction would be to describe the various activities performed on-site during the history of operations in order to re-evaluate the current list of COCs and identify any additional compounds that might pose a risk. All credible sources of information (e.g., company records, newspapers, former employees) should be examined to reconstruct the inventories, storage, uses, and disposal of site-related chemicals. Such information might prove extremely useful in estimating the nature and magnitudes of possible releases of COCs into the Cass Lake environment, identifying additional contaminated media, and defining pathways of exposure. For example, review participants noted that it was common practice during the 1970s and early 1980s to take water from the on-site treatment ponds and use this water to suppress grassfires or spray on roads (both in town and out of town) to reduce dust. The community has expressed concerns that contaminants were taken off-site and dumped in poorly known locations; these sites may provide sources and pathways to humans that have not been previously examined. Unfortunately, no samples from the original site remediation excavations done in the mid-1980s appear to have been archived; these excavations were overseen by the MPCA (MJ 1997, Champion International 1995).

There appear to be inconsistencies in COC concentration data. For example, high concentrations of 2,3,7,8-tetrachlorodibenzo-1,4-dioxin (TCDD) were reported at a location on the southwest part of the site that might have been a product storage area. The next highest TCDD value is for a location on the northwest part of the site. Yet it remains unclear as to how dioxins became so high at this location. There may be additional areas that are contaminated with dioxins and have never been identified, in part, because only the top foot of soil was sampled. Dioxins remain largely intact in soils.

The current quantitative characterizations of the distribution and movement of contaminants both on-site and off-site remains inadequate to support a meaningful assessment of human health risks. As outlined previously, the concentrations of specific COCs, e.g., light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs) in groundwater are highly heterogeneous in space and time. The dynamics of groundwater flow (i.e., plume movement) and possible off-site contamination remain poorly described. The nature of the confining layer surface and possibility of any dense phases (e.g., DNAPLs) sitting on this till need to be studied further to determine if DNAPLs could be serving as a long-term source of groundwater contamination. The adsorptive properties (KDs) of the till in relation to the COC need to be quantified. This is especially important given observations that the deep aquifer layer is discharging to the surface aquifer layer, and potentially to surface waters.

Additional data are needed to better characterize soil types (e.g., organic carbon content). In addition to data collected previously to characterize contamination in fish and benthic invertebrates, samples of birds, wildlife, and other terrestrial organisms, including plants (e.g., cattails) and plant parts (e.g., cambial tissue, roots) should be collected and analyzed for COCs to characterize the bioavailability of contaminants from the terrestrial environment.

Concerns were expressed regarding the collection of samples and the overall quality of existing data for completing a defensible risk assessment. Examination of the current data suggests that there was no clear rationale for the location or timing of samples collected. For example, some monitoring wells were sampled quarterly, while others were sampled only once a year. Many of these concerns were also presented in the EJ Project Groundwater Panel Report (McDonald et al. 1999). Several specific answers were provided subsequently by Champion (Champion International 1999). However, the overall assessment by the expert panel is that: (1) the existing groundwater models are currently inadequate to accurately predict the off-site movement of COCs, and (2) the groundwater situation at the St. Regis/Wheelers site should be re-evaluated with respect to the more recent data and the concerns expressed by the independent EJ Project Groundwater Panel.

Another issue of concern to the panel was the order of magnitude differences in chemical analyses from one laboratory relative to another. In addition to concerns regarding data quality, review participants also discussed the critical need for more effective data reduction and summarization.

Groundwater System at Cass Lake

The groundwater system at Cass Lake is fundamentally important in determining the on- and off-site movement of residual contaminants; groundwater also serves as a potential source of contaminated well water, which can directly impact human health. Developing effective clean-up and remediation activities to protect the health of Cass Lake residents depends on a quantitative understanding of the distribution and pattern of movement of contaminants in groundwater. Dr. Howard Mooers presented key findings of the previous Groundwater Panel. The following paragraphs briefly summarize these findings in relation to the assessment of human health risks. Additional details concerning groundwater are provided in the report of the Groundwater Panel (McDonald et al. 1999).

The geology of the site, particularly as it pertains to groundwater dynamics, has not been studied extensively. Current understanding is limited and the geology of this complex system is sometimes misrepresented. The geology of the groundwater system is essentially two layers of a sand aquifer separated by a layer of glacial till. The sands are sub-angular, fairly clean, with high permeability. The till is a sandy loam, calcareous, and varies in thickness from 2–5 meter. This till acts as a regional confining layer. While previous reports have simplistically characterized the till layer as continuous, the layer is more realistically described as permeated with fractures and macropores that cause this layer to be highly fragmented and discontinuous. Such fractures can functionally connect the upper and lower sand layers and facilitate the movement of groundwater and associated contaminants, e.g., light nonaqueous phase liquids (LNAPL) and dense nonaqueous phase liquids (DNAPL). For example, there is evidence of such a connection between the upper and lower aquifers near the fish hatchery. A recent preliminary ground penetrating radar survey by the University of Minnesota-Duluth has confirmed the site’s hydrogeological complexity (Mooers 2002; see also Appendix 3).

Wells have been used to monitor groundwater quality and develop an understanding of the distribution and movement of contaminants. Several of the deeper monitoring wells respond differentially to pumping at city wells, which supports contentions that the groundwater system is geologically more complex than previously represented. City wells are predominantly in the lower aquifer; remaining residential wells are located in both aquifers. Two city wells have been abandoned and the current city well has no detectable contamination. Shallow residential wells are used for a variety of purposes including irrigation and drinking water. Several wells located near the bottom of the upper aquifer exhibited high concentrations of polycyclic aromatic hydrocarbons (PAHs), which suggests that these nonaqueous contaminants are sitting on top of the till layer.

The direction of groundwater flowing from the site is somewhat disputed. Regionally, the expected direction of flow should be in a generally easterly direction toward the lake. However, a groundwater model predicted groundwater to flow from the contaminated site towards the southeast. Monitoring wells were largely confined to the northern part of the site. Only two wells are located off-site, one to the south and the other to the east of the contaminated areas. Champion installed a groundwater extraction system of wells that is supposedly catching all contaminants coming off-site. However, these extraction wells are located to the east of the site, instead of southeast, where groundwater is presumably flowing, according to the model. Samples collected from the deep well at the fish hatchery located southwest of the site have detectable contaminants, and the monitoring well is up gradient from the site. Regionally, the lower aquifer has a higher head than the upper, so flows appear to be from the lower to the upper aquifer, except when pumping from the lower aquifer affects the normal flow pattern. The hatchery well pumps sufficient groundwater several times a year to create a hydraulic gradient that might influence subsequent groundwater flow and contaminant transport. The porous bed underlying the railroad tracks north of the site might act as an effective conduit for groundwater flow and contaminant transport to the lake. The effects of annual groundwater recharge might also affect the movement and distribution of contaminants.

<u>COCs</u>

A standard Superfund list of possible COCs seems to have been used thus far to identify contaminants of concern for the St. Regis/Wheelers site. The COC list is not consistent through the various media. There hasn't been adequate discussion to make decisions about what should be measured. Selection of COCs needs to support a cumulative risk assessment, and the panel recommends consideration of additional contaminants. For example, fuel oil – e.g., alkyl PAHs and retene would be expected because of all the wood, but these possible COCs were not measured. Ketones were likely used to make hydrophobic compounds (e.g., many PAHs) more soluble and should be assessed. Cutting oils, gasoline and other chemicals might have been used routinely to clean up creosote-laden tools and machinery and should also be assessed. Chemicals in creosote might not have been adequately represented in the current list of COCs, in addition to mercury and polychlorinated biphenyls (PCBs).

In addition, metabolites and reaction products of PAHs were not measured. Similarly, pentachloroanisol (PCA), a degradation product of pentachlorophenol (PCP), should have been analyzed in environmental and biological samples, as was done for the EJ pilot study in 1998 (NRRI 2001).

<u>USEPA Screening-level Assessment (EPA 2002)</u>

The recently completed screening-level assessment funded by the USEPA contributed significant new data that quantified concentrations of selected COCs in environmental media at the St. Regis/Wheelers site (EPA 2002). Samples were obtained in October 2001, and a draft report was released in April 2002, less than two weeks prior to the EJ Risk Panel meetings in May 2002. This data report was finalized in August 2002 without changes to the data, according to EPA Region V (L. Kern, pers. comm.) The Health Risk Panel members and EJ Project Principal Investigators were unanimous in concluding that the assessment addressed a very limited number of exposure pathways and may well have missed important sources of contamination (e.g., additional COCs and their metabolites) and pathways of exposure (e.g., contamination of road surfaces sprayed with pond liquids). The results of even this limited screening-level assessment underscore the need for a more comprehensive human health risk assessment.

Another issue raised by the panel addressed the question concerning how to handle non-detects for COCs in environmental media. The panel questioned the use of detection limits to derive toxic equivalent concentrations (TEQs) for the purpose of risk assessment without specifying and using a range of such values.

Review participants discussed the applicability of conventional Superfund exposure factors to the St. Regis/Wheelers site because of culturally-unique pathways of exposure and the potential need to modify the screening-level risk estimation parameters (e.g., cancer slope factors, toxicity reference doses) given differential sensitivities of area residents to the COCs and the concurrent exposure to other stressors. The conventional Superfund human health assessment procedures will have to be modified to provide a fair and accurate assessment of human health risks. The following sections describe the major components of the modified health risk assessment paradigm and highlight necessary modifications for the St. Regis/Wheelers site.

Dose-Response Assessment

The purpose of the dose-response assessment is to establish a relationship between the estimated exposure and the likelihood of an adverse human health effect for the chemical stressors of concern (i.e., the COCs). The expert panel and review participants discussed several aspects of dose-response assessment in relation to the specific needs of individuals exposed to the Cass Lake contamination. The review objective was not to derive the necessary dose-response relationships, but to identify concerns and data needed to support a thorough and rigorous assessment of health risks at Cass Lake.

The review participants questioned the relevance of the primary sources of slope factors and reference doses (or concentrations) in assessing health risks to the tribal members in the Cass Lake area. The standard USEPA sources of these benchmark values include the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST). Additional sources of human health benchmarks are the USEPA Environmental Criteria and Assessment Office (ECAO), the toxicological profiles provided by the ATSDR, and databases (e.g., HSDB, RTECS) accessible through the National Library of Medicine (NLM-TOXNET). It is not clear whether these standard toxicity benchmarks can be used directly to assess health risks for tribal members. An appropriate application factor or correction factor (e.g., analogous to risk assessment for children) might be justified in accounting for generally poorer health care, underlying patterns of disease, loss of traditional diets, and exposure to other stressors – all of which might result in a potentially more sensitive population at Cass Lake.

In addition to the standard cancer and toxicity endpoints, the health risk assessments for the St. Regis/Wheelers site might reasonably address developmental effects. Developmental effects might need special consideration given the nature of the chemicals that were used at the St. Regis/Wheelers facility. Also there is anecdotal reporting of deformities among grandchildren of people who worked on-site and lived within the site boundaries or nearby.

Additional economic endpoints that might be included in a comprehensive assessment of health risks were also raised at the risk assessment expert panel. Individuals whose financial livelihoods depend significantly on harvesting wild rice, rough fish, and other local resources might be indirectly impacted by the contamination of these resources – or even the perception that such resources have been contaminated by the off-site migration of COCs. The panel recognizes that such "takings" are not likely to directly affect human health. However, the indirect impacts on the health and well being of individuals so closely tied to the local resource base might be just as real and significant as the cancer or toxicity endpoints emphasized in standard health risk assessments.

The panel inquired whether the Indian Health Service (IHS) records could be used to search for patterns of health effects that might point to toxic chemical exposure. It was concluded that reconstructing possible patterns of health effects using the local IHS clinic records would be extremely difficult and fraught with uncertainties. However, analyzing referrals made by the clinic could provide information that, while not supporting a quantitative risk assessment, might prove useful in a weight of evidence approach to assessing and evaluating health risks for Cass Lake individuals. Similarly, the historical worker registry or other sources of population demographics could be examined to determine if Cass Lake demographics showed any unusual pattern (e.g., births, deaths, longevity) that might be related to exposure to COCs or might point out portions of the population particularly at risk (e.g., children).

Exposure Assessment

Exposure is the process whereby an individual comes into contact with a COC; exposure bridges the gap between hazard and risk (Kolluru 1996). Individual exposures to COCs can occur *via* inhalation of airborne contaminants, direct ingestion of contaminated food or water, inadvertent ingestion of contaminated soils, or dermal contact. The panel and review participants evaluated the analysis of exposures used in support of the current screening-level assessment. The panel subsequently identified concerns with the current assessment, and outlined additional information needs required for a rigorous and defensible health risk assessment for Cass Lake.

It was recognized at the review that the USEPA, in its periodic review of the Cass Lake situation, would use existing data to determine whether the site poses health risks. Therefore, it is critical that data be collected to develop a detailed and comprehensive exposure assessment necessary to support a risk assessment relevant and applicable to the St. Regis/Wheelers site. Furthermore, it is imperative that exposure scenarios realistic to the Cass Lake population be developed to replace the more conventional (e.g., suburban) scenarios that characterize a more routine assessment of health risks. Defining the set of exposure scenarios for the Cass Lake situation may be difficult and could include, for example, a child playing on-site, a worker remediating the site, or an elder who uses contaminated materials collected on-site or off-site. Lifetime cancer risks must be assessed in addition to looking at shorter-term risks for sensitive segments of the population (e.g., children). Parameters used to estimate realistic, site-specific exposures for the Cass Lake risk assessment scenarios will have to be estimated and replace the more generic values used in standard assessments.

A comprehensive and realistic conceptual model for exposure analysis should be developed for the Cass Lake health risk assessment. This model should include the multiple stressors and pathways of exposure relevant to the Cass Lake situation. Expert panel participants identified several pathways of exposure to be represented in a multi-pathway model for Cass Lake:

- Inhalation of dust and incidental ingestion of soils by children playing in areas where COCs are present (particularly the former work-area field);
- Dermal (occupational) exposures to on-site tribal workers;
- Dermal, inhalation, and ingestion pathways associated with the sweat-lodge practice or general bathing;
- Ingestion of drinking water (i.e., PAHs, perhaps dioxins from well water);
- Utilization of local ecological resources in addition to fish and wild rice (e.g., mussels, crayfish, snapping turtles, rabbits, muskrats, beaver, deer, and grouse, as well as wild fowl, including eggs and young);
- Ingestion of diverse species of local plants, berries, nuts, mushrooms, and roots;
- Medicinal use of plants (e.g., teas, poultices);
- Production and consumption of honey, utilization of beeswax; and
- Construction and use of clay pottery (Fox Creek clays), basket-making, wood burning, and smudging.

Additional, highly-specific data will have to be collected to complete a realistic assessment of exposures for the COCs at the St. Regis/Wheelers site. Tissue-specific sampling (e.g., gills, livers), as well as samples of eggs and juvenile organisms, may be necessary to develop realistic estimates of exposure for pathways unique to tribal practices and patterns of resource utilization.

It was further recognized and discussed that development of a realistic multiple pathway model of exposure can become difficult in some respects because (1) specific resources valuable to the tribe might not be identified and (2) certain tribal practices that might result in exposure to COCs will not be described in great detail (i.e., proprietary information).

Risk Characterization

The results of the dose-response assessment (e.g., slope factors, reference doses) are integrated with the exposure estimates to arrive at quantitative descriptions of incremental cancer risks and toxicity related health endpoints (i.e., hazard quotients) to characterize risk in standard health risk assessment (EPA 1989a,b; Kolluru 1996). The panel members and expert panel participants discussed and evaluated the current status of risk characterization for the St. Regis/Wheelers site.

The panel concluded that what has been accomplished to date is an initial screening level assessment of limited validity and utility in ascertaining health risks for individuals currently living and working at Cass Lake. All present agreed that the overall risk assessment approach would be useful in assessing health effects at Cass Lake. However, the conceptual model and corresponding methods of analysis need to be customized to reflect unique cultural practices of tribal members. Specific parameters and supporting data are needed to characterize risks in relation to the customized conceptual model, including exposure pathways and scenarios that are particular to Cass Lake individuals.

Two important challenges resulted from the panel discussions of a health risk assessment tailored to the specific cultural practices and needs of the tribe. The first issue concerns an operational definition of risk for the Cass Lake assessment. Conventional health risk assessments focus on an incremental cancer risk $>10^{-6}$ (1 in a million) or hazard quotients > 1 as indicative of unacceptable risks; cancer risks ranging higher than 10^{-6} to 10^{-4} are generally considered to be of regulatory concern (Kolluru 1996). The decisions concerning risks for the Cass Lake situation are important matters of tribal policy. For example, tribal policy might define unrestricted cultural practices and traditional uses of tribal resources as requiring a cumulative, multipathway, multicontaminant risk not to exceed 10^{-6} (i.e., excess cancer). Again, the specification of appropriate levels of acceptable/unacceptable risk, although discussed at the review, is explicitly recognized by the panel as tribal policy to be ultimately determined by the tribal council. The second issue that separates the Cass Lake assessment from more conventional Superfund health assessments is the requirement of “pure” or uncontaminated resources for certain cultural practices and traditional uses. A requirement of zero contamination associated with specific cultural practices or resource use may challenge current remediation and restoration technologies; compensation or replacement may be the only viable risk management alternative in these instances.

Second, in developing an approach to risk characterization germane to the Cass Lake assessment, it must be remembered that the fundamental tribal objectives in relation to site remediation and clean-up is the return to unrestricted, traditional use of natural resources that have been affected by the St. Regis/Wheelers site. If the assessment results indicate that unrestricted use has not been restored or cannot be obtained through previous and proposed remediation activities, prescriptions concerning the degree of risk associated with different levels of exposure will have to be explicitly and clearly incorporated into the Cass Lake risk characterization. Importantly, such prescriptions are not intended merely to advocate changes in human behavior that will reduce exposure (i.e., chemical assimilation) but rather, the intention is to develop a clear understanding among regulators and the affected people of the human, ecological, and cultural harm that has resulted from contamination and that might continue after remediation is completed. Differences between "complete cleanup" from a regulatory perspective and from a health and cultural perspective will need to be clearly explained.

Review participants and the expert panel were concerned about the absence of any assessment of cumulative risks posed by the realistic exposure to multiple contaminants via many pathways, several which appear specific to the traditional tribal uses of resources. Conventional assessments address single COCs and at most, use a simple additive model to address risks posed by multiple contaminants. Panel members expressed concern that measuring and assessing individual contaminants do not provide an accurate characterization of human health risks (i.e., multiple COCs, multiple pathways, multiple health effects). The complexities of this kind of cumulative assessment may require the use of a weight of evidence approach; wherein, all of the key issues and concerns can enter meaningfully into the assessment, even if they do not fit neatly into the prescribed calculations used in more conventional human health risk assessment (e.g., EPA 1989a, b).

Uncertainties

The identification and characterization of uncertainties are fundamental to the practice of risk assessment. Uncertainties inherent to complex assessments are propagated through the risk estimation process and risks are characterized in probabilistic terms (e.g., 10^{-6} incremental cancer risk). Uncertainties associated with the estimation of health risks to Cass Lake individuals should be included as part of a comprehensive and defensible risk assessment. The panel and review participants identified several key sources of uncertainty that can influence the accuracy and precision of health risks estimated for the Cass Lake site.

Uncertainties can result from variability in measurements. Variability can result from inadequate sampling, improper processing of samples, and errors introduced in data management and reporting. The number, timing, and location of samples collected in various media and variations in analytical capabilities (e.g., detection limits) among different laboratories are examples of variability that can be reduced through additional sampling and implementation of appropriate data quality objectives and QA/QC procedures.

Variability can also result from real spatial and temporal differences in the phenomena being measured. This kind of variability might not be reduced through additional sampling and analysis. For example, heterogeneities in the distributions of COCs in the upper and lower aquifers that result from variations in thickness and discontinuities in the till layer can be accurately and precisely quantified with sufficient sampling. But once described to a certain level of precision, remaining variability in COC distributions might not necessarily be reduced through additional sampling.

Sensitivity and uncertainty analyses (e.g., Bartell et al. 1992) can be performed to identify the most important contributors of uncertainty to the Cass Lake human health risk assessment. Knowledge of the key sources of uncertainty can be used to efficiently allocate limited resources (time, money) to collect the necessary data to reduce uncertainties to acceptable levels.

Risk Communication

The purpose of risk communication is to present the results of the risk assessment in terms that are understandable and meaningful to stakeholders (i.e., the Leech Lake Reservation population) and the regulatory community (e.g., the Leech Lake Band, USEPA, State of Minnesota). The main challenges concerning risk communication for Cass Lake will be to (1) help tribal members understand the potential health risks posed by the remaining contamination, particularly in relation to COCs that have moved off-site or that were disposed of improperly (i.e., local “hot spots”); (2) use the results of current (and future) assessments of health risks to effectively influence the manner in which individuals use (or avoid) potentially-contaminated local resources; (3) communicate the full magnitude of impacts to regulatory agencies; and (4) re-establish credibility and trust among the responsible parties, the tribe, and the regulators.

The highly technical concepts, methods, and results of a quantitative human health risk assessment will need to be presented in a straightforward and clearly understandable manner that would inform people about their potential health risks and effectively alter their behavior to manage or reduce these risks (e.g., Davies et al., 1987). This challenge applies to communicating the results of the limited screening-level studies performed to date and, even more importantly, to presenting the results of a more comprehensive and competent health risk assessment. The meaning of incremental cancer risk estimates (e.g., 10^{-6}) and hazard quotients will have to be plainly explained in lay terminology. The supporting sample collection, data processing, and risk estimation procedures will have to be similarly presented in understandable language. The nature, sources, and implications of uncertainties associated with the risk estimates will also have to be described in terms easily understood by the Cass Lake community of stakeholders. Impacts to the culture will also have to be described in terms that are easily understood by the regulatory community.

Based on comments provided by EJ Project review participants, it is apparent that there is significant uncertainty and lack of trust regarding the Cass Lake situation. As a result, tribal leaders are reluctant to accept current assessments of risk and find it difficult to define reasonable responses to potential health risks (e.g., health alerts). Thus, a key aspect in effective risk communication requires the re-establishment of credibility and trust among the stakeholders and the regulators. The completion of a scientifically rigorous and defensible human health risk assessment and presentation of its results in a straightforward and transparent manner to all interested parties would serve as a valuable initial step towards re-building this trust.

Risk Management

Given a clear understanding of health risks associated with historical and continuing exposures to chemicals from the St. Regis/Wheelers operations, analyses and actions will be required to manage these risks. Risk management activities include selecting from among various available technologies for reducing risks, as well as for remediating and restoring contaminated media. Risk managers may also evaluate and recommend compensation for damages that cannot otherwise be redressed. The primary risk management issues that emerged from discussions during the Cass Lake EJ review are (1) the establishment of remediation or clean-up goals consistent with unrestricted human use of local environmental resources; (2) the evaluation of remediation activities undertaken thus far by the responsible parties in relation to the protection of human health (and the environment); and (3) the specification of actions that might be reasonably taken in relation to current assessment of health risks.

A principal challenge in managing health risks at Cass Lake will be to identify acceptable levels of risk and the associated permissible levels of contamination for various environmental media (e.g., soils, sediments, surface waters, groundwater) and ecological resources (e.g., fish, plants, wildlife). Successfully addressing this challenge, which is commonly encountered in health assessments, is made more difficult in the context of Cass Lake because of special tribal needs and uses of local (and potentially contaminated) resources. In some instances, the tribe will not disclose the detailed nature and tribal use of valued resources. The concept of "zero risk," whether technically achievable or not, does not necessarily equate with the tribal definition of pristine for selected, valued resources. Thus, for some (perhaps unstated) uses of potentially contaminated resources, an acceptable level of contamination and risk will not be negotiable, by definition, and compensation may be the only practical recourse.

Once acceptable levels of health risk have been defined, the derivation of meaningful clean-up goals for future remediation and/or restoration of the St. Regis/Wheelers site should proceed from a solid understanding of current risks. Current risks are due to the residual contamination following the implementation of clean-up activities (e.g., extraction wells) by the responsible parties. Thus, derivation of meaningful clean-up goals and objectives (i.e., unrestricted use) depends importantly on an accurate characterization of the distribution and fate of contaminants resulting from the historical operations of the St. Regis/Wheelers facility and subsequent clean-up efforts. The strengths and limitations in this characterization have been discussed previously (i.e., Risk Assessment) in this report.

The effectiveness of previous and continuing remediation actions in reducing risks might be better evaluated through a reconstruction of the historical inventories, patterns of use, and disposal of chemical contaminants of concern. Production records might be examined and analyzed to estimate the timing and magnitude of releases of different COCs into the environment. Interviews with former workers might help to augment the analysis of existing records. Part of the disposal operation was a sludge pond and it should be possible to estimate rates of material loss from this pond. Similarly, sawdust was used to adsorb spills, hauled off-site, and deposited in various locations – known and unknown. It may prove possible to estimate the amount of material that was hauled off-site.

Analysis of reported treatment and removal of contaminants could be used to evaluate the effectiveness of current treatment methodologies and estimate the number of years required, for example, to pump and treat the LNAPL layer. The reported volumes of pumped water appear reasonable; 111 gallons of LNAPLs have been collected during seven years of treatment and the amounts of PCP and PAH removed have been reported (Barr et al. 2001). Curiously, the amounts of several contaminants reported to have been removed are inconsistent with known solubility properties of these compounds. That is, the amount of product removed given the treated volume of contaminated groundwater would require the concentration of the contaminants to exceed known solubility limits. For example, the reported removal values suggest that the groundwater is saturated with PCP. Yet, variations in concentrations of this chemical are obtained at different wells, which is inconsistent with saturation. Thus, more accurate characterizations of the removal rates are necessary, and such characterizations should be based on a comprehensive mass balance approach for selected COCs.

It is recognized that pump and treat methods will not effectively manage risks posed by DNAPLs and LNAPLs. It may prove more effective to locate areas of concentrated DNAPLs ("hot spots") and remove them directly, rather than attempting to re-solubilize these compounds and filter them using conventional pumping and treatment methods. Towards this end, an exploratory site survey using ground penetrating radar (GPR) was proposed by the EJ Principal Investigators and was to be conducted by University of Minnesota Duluth geologists, Drs. Mooers and Wattrus (Mooers 2002, Appendix 3). However, access to the site was denied by the EPA. A pilot survey was conducted instead on the periphery of the site, and preliminary results from October 2002 indicate that the surface of the underlying aquifer is undulating as the EJ Groundwater Panel suspected (McDonald et al. 1999) and not flat as assumed in the Remedial Action Plan and related documents from the Responsible Party (e.g., Barr Engineering Co. 1985 and Champion International 1999). This information certainly points to the possibility that pools of dense contaminants lie on that surface. Further discussion of the extraction system revealed the observation that large precipitation events can physically overwhelm the extraction system, fill up the surface ditch, and result in episodic releases of contaminants into surface waters. In addition, smaller amounts of rain can affect surface outflows because of the porous nature of the soils.

A final risk management issue that emerged from the review focused on possible actions for reducing exposures and risk for the St. Regis/Wheelers site. It was suggested that the main site and the landfill site be fenced off to eliminate access and use of these properties. At the same time, fencing may reduce exposure to on-site contaminants, but it will not reduce risks posed by contaminants that have moved off-site or that might move off-site in the future as a result of changes in hydrologic gradients. Thus, by itself, fencing should not be interpreted as a solution to risk management problems at Cass Lake. Signage might also be used to communicate risks posed by contamination at various operable units, on-site and off-site. Biodegradation technologies may prove useful for PCP and PAHs and should be further investigated for implementation at Cass Lake. Again, the ideal risk management is to remove risks so people can continue to use the site as they have historically.

Conclusions and Recommendations

On the basis of discussions during the expert panel and evaluation of data and information provided prior to the review, the Human Health Risk Assessment Panel reached several conclusions and offers the following recommendations concerning health risks at Cass Lake.

Conclusions

The panel developed consensus on the following conclusions regarding health risks in relation to the St. Regis/Wheelers site contamination:

1. A screening-level assessment of questionable value in determining health risks has been completed (e.g., EPA 2002). This assessment does not comprehensively examine pathways of exposure that might be important in relation to tribal practices and resource utilization. The screening-level assessment does not address other COCs that might reasonably have been used during the operation of the St. Regis/Wheelers' facilities.

2. Importantly, the screening-level assessment demonstrates that, based on comparisons of reported chemical concentrations in Cass Lake area soil and groundwater samples (i.e., Barr Engineering Co. 2001, EPA 2002) with generally accepted toxicity benchmarks, the previous site remediation has <u>not</u> resulted in conditions that are protective of human health for residents of Cass Lake (e.g., Tables 1–4).

3. The spatial extent of sampling and data collection for soils and groundwater has emphasized the central areas of the site property. Limited sampling of off-site areas makes it difficult to determine a "safe" distance where exposures are minimal and conditions are protective of human health.

4. Current characterization and understanding of the complex geology and hydrology of the site remain incomplete. Heterogeneities and discontinuities in the till layer lead to spatially complex patterns of contaminant distribution and concentrations (e.g., LNAPLs, DNAPLs) and these patterns have been inadequately quantified. This was also the major conclusion of the previous EJ Partnership Groundwater Panel (McDonald et al. 1999).

5. The existing site characterization data are insufficient to support a technically defensible human health risk assessment. The spatial location and temporal sampling of wells used to characterize site-related contamination and assess (screen) current

health risks, as reported in EPA 2002 and Annual Monitoring Reports (e.g., Barr Engineering Co. 2001), do not appear to reflect any statistically defensible sample design.

Recommendations

Based on the above conclusions, the panel offers the following recommendations to better characterize current health risks, improve the quality of future health assessments, and reduce risks to individuals exposed to contaminants at Cass Lake:

1. The results of the screening-level human health assessment (EPA 2002) strongly indicate the potential for serious health risks to children who live adjacent to the site and who might play at the site. Steps should be taken to manage exposures and reduce risks for this sensitive age group, as well as other potentially exposed members of the community.

2. Reported concentrations of dioxins and furans in site soils indicate that the main site area should be secured and people should not be allowed on these lands. All closed wells should be identified, cased and plugged.

3. A comprehensive human health risk assessment should be performed. However, the special circumstances, unique cultural practices, and patterns of resource utilization characteristics of tribal members require modification of more conventional approaches to risk assessment (i.e., EPA 1989a, b). The overall paradigm may apply, but the methods and analyses will have to reflect a conceptual model more appropriate to tribal lifestyles. The assessment should be designed to address cumulative risks posed by simultaneous exposure to multiple COCs via multiple pathways of exposure.

4. A comprehensive conceptual model should be developed for estimating human health risks posed by historical and continuing contamination at Cass Lake. The model should include all appropriate sources of contaminants (on-site and off-site) and consider all relevant pathways, including those specific to tribal practices (e.g., sweat lodge) and utilization of local resources.

5. To the fullest possible extent, the inventories, patterns of use, and means of disposal of chemicals (e.g., LNAPLs, DNAPLs, metals, other organic contaminants) that might have been released during the course of site operations should be reconstructed. Historical releases (including uncertainties) of chemicals into air, soils, groundwater, surface waters, and sediments on-site and in the vicinity of Cass Lake should be estimated.

6. Time and resources should be directed at better collation, organization, analysis, and interpretation of data and information collected thus far for assessing human health impacts at Cass Lake. Professional database design, implementation, and

management with appropriate QA/QC procedures are fundamental to meaningful and credible assessment of health (and ecological) risks posed by contamination at Cass Lake. Cross-comparison of analyses of benchmark samples is necessary if samples are processed among different laboratories. Consistent with CERCLA protocols, the risk assessment process and supporting methods, data, and analyses should be carefully documented in support of the USEPA five-year review.

7. Careful, but serious consideration should be given to direct monitoring of human exposure to COCs. Individual body burdens of tribal members could be measured for persistent toxic chemicals, such as dioxins, furans, PCBs, biomarkers for PAHs, and volatile organic contaminants (VOC). Such measures should also include a reference or control group of individuals. The panel recognizes that there may be some cultural resistance to monitoring. However, if monitoring is thoughtfully planned and carried out, the resulting data might prove extremely useful in quantifying exposure and estimating potential health risks above and beyond the inferences that can be drawn from a baseline human health risk assessment.

8. If direct monitoring of human body burdens of chemicals proves infeasible, more accurate assessments of exposure to St. Regis/Wheelers contaminants might result from detailed mapping of patterns of current human use of the site (e.g., children's pattern of play, general utilization of the park). More samples of soils, surface waters, and sediments should be collected as appropriate from areas of intensive use.

9. A more accurate and spatially explicit quantitative description of the local geology (i.e., upper and lower aquifer, confining till layer) is needed to support a credible assessment of human health risks. As recommended by the EJ Groundwater Panel (McDonald et al. 1999), reinforced by the Human Health Risk Panel, and confirmed by an initial GPR survey (Mooers 2002), available technologies such as GPR should be used to develop a more realistic and accurate characterization of the nature of the till layer and corresponding architecture of the upper and lower aquifers. The aquifer system may serve as a long-term source of COCs that constitute significant fractions of the DNAPLs which have apparently concentrated at the surface of the till layer.

10. The technical feasibility of removing or minimizing the functional connections (i.e., groundwater flows) between the shallow and deep aquifers should be examined as part of risk management. The results of the GPR analyses could be used to better map the depth to deep aquifer and locations of likely accumulation of LNAPLs and DNAPLs.

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Table 1. Summary of human health screening of surface soils exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

Area	Dioxin/furan	SVOC	VOC*	Pesticides	Metals
N. Storage	20/20	14/20	Not included	-	0/20
Pond A	-	1/2	"	-	0/2
Pond B	-	0/1	"	-	0/1
Pond C	-	0/1	"	-	0/1
Spray/irrig Landfill	-	1/2	"	-	0/2
Residential	20/20	18/20	"	-	0/20
Seep location	1/1	1/1	"	-	0/1
SW/hatchery	6/6	5/6	"	-	0/6
City dump/ Fox Creek	-	0/1	"	-	0/1
Other-reference	0/2	0/2	"	-	0/2

*VOC not evaluated in this report at the request of EPA, although data are reported.

Table 2. Summary of human health screening of surface waters exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

Area	Metals	SVOC	VOC*
City Dump/Fox Creek	0/3	0/4	Not evaluated
Channel	0/3	0/4	"
Reference	0/2	0/2	"
Cass Lake - deep	0/2	0/2	"
Pike Bay – deep	0/2	0/2	"
Pike Bay Shoreline	0/1	0/1	"

*VOC not evaluated in this report at the request of EPA, although data are reported.

Table 3. Summary of human health screening of groundwater exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

	Human health screening			
Areas	PCBs	SVOC	Pesticides	Metals
11 wells (on-site, off-site)	0/10	4/11	0/10	1/11 (GW-2102-0014)*

*Denotes the sampling site.

Table 4. Summary of human health screening of fish tissue exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples, with the metal exceeded in parentheses.

	Human health screening		
Areas	PAHs	Metals	
		Individual species	Total
Ball Club Lake	0/9	3/3 Walleye (Hg) 2/3 White Suckers (Hg) 1/3 Whitefish (As)	6/9
Cass Lake	0/17	3/5 Walleye (Hg) 0/5 Whitefish 2/7 Whitefish (Hg)	5/17
Pike Bay	0/13	6/6 Walleye (Hg) 0/5 White Suckers 2/2 Whitefish (Hg)	8/13