Assessing and Communicating Risk:

A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands

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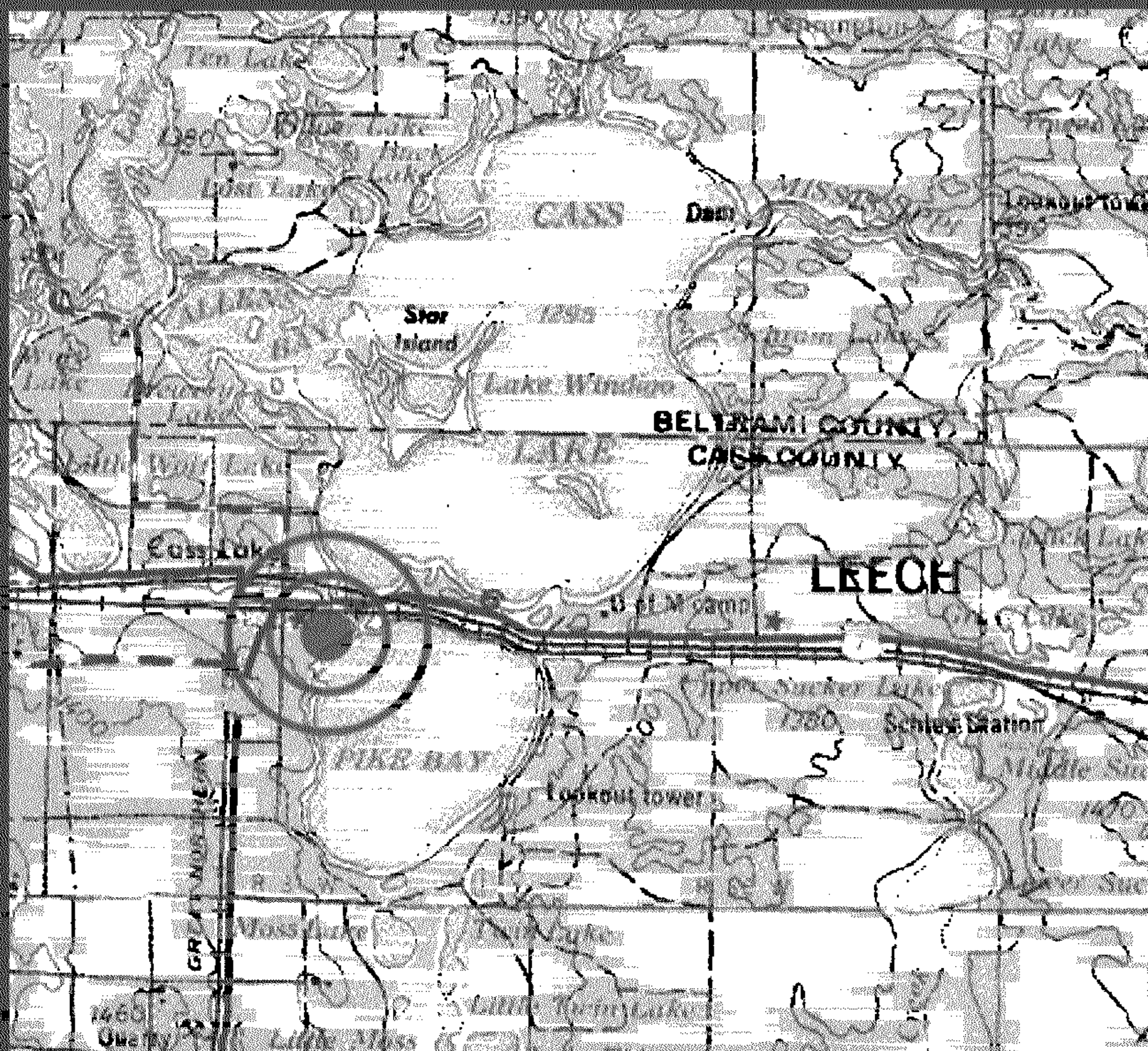

Carl Richards

Richard P. Axler

Jeffrey L. Gunderson

Cynthia A. Hagley

Michael E. McDonald

2002

University of Minnesota

University of Minnesota Sea Grant Program, Duluth, MN 55812, Publication No. CT 13.

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

University of Minnesota Sea Grant and Natural Resources Research Institute

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

Executive Summary

Background

This summary highlights findings and output of from a series of panels assembled to evaluate a Superfund site on Leech Lake tribal lands. The "partnership" refers to the collaboration between the University of Minnesota Sea Grant Program (including several researchers for the Natural Resources Research Institute at the University Minnesota-Duluth) and the Leech Lake Tribal Council. The area of concern is a former wood preserving facility (the "site") owned by Champion International Paper Company (the "company") currently being remediated as a federal Superfund site. This project was funded by a grant from the U.S. EPA's Environmental Justice Program to Minnesota Sea Grant.

The site has had a groundwater extraction/containment system since 1985, but more recently there is evidence that a remnant plume has moved off-site, potentially impacting surface and groundwater resources on Leech Lake Band of Chippewa tribal lands. Contaminants of concern include the priority pollutants PAHs, PCP, CCA (mixture of Cu, Cr and As), and PCDDs. PAHs and PCP have been measured in groundwater off-site at levels far in excess of state standards. Immediately adjacent to the site is a large lake and bay used extensively for fishing and recreation and four wells draw groundwater from the aquifer in the vicinity for use as drinking water and for a fish hatchery immediately adjacent to the site.

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. 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.

A major objective of the grant was to assemble and conduct three expert panels that were asked to 1) evaluate the available groundwater contaminant information, assess potential risk of exposure, and suggest further action, 2) conduct a preliminary ecological risk assessment to evaluate available ecological information, assess potential risk of exposure, and suggest further action, and 3) to evaluate the potential tribal human health impacts based on an understanding of tribal resource use, and available groundwater and ecological information, and suggest further action, if needed.

Additional products and accomplishments from this project are detailed in a compendium of existing and new information collected for the panels (NRRI 2001), the results of a Ground Penetrating Radar survey that documents the undulating nature of the till surface in the contaminated area (Appendix 3), and a summary of outreach materials that were provided to the tribe in the course of the project.

Panel Summaries:

Groundwater Panel Recommendations

1. There needs to be a better interpretation of existing data and better use of all available data.

2. There needs to be a more complete geologic site characterization. This becomes especially important for understanding and modeling the transport of dense non-aqeuous phase liquids by gravity flow.

Options

- Possibly use Ground Penetrating Radar (GPR) or seismic investigations to improve geologic site characterization.

- Drill additional test holes for geologic characterization and additional sampling wells (particularly to the south of the treating facility) for better contaminant plume definition. If high concentrations are found in the initial wells, we suggest using an exploratory Geoprobe to determine locations for subsequent permanent wells. Because of the current poor plume definition, the simulated capture zones for the extraction wells are based on inadequate information.

- We recommend screening additional private wells in the area for contaminants.

- The source of contaminants in the DRM fish hatchery's well needs to be determined. The contaminants may be coming from the containment vault, and, if so, then the containment vault is leaking. Alternatives include: 1) the draw down of groundwater during peak pumping may be pulling contaminants in from a greater distance (this has possible implications for the city wells) or 2) the bore hole for the hatchery's well may be improperly sealed.

- Locations for any additional wells (but especially deep wells) need to be agreed upon and approved by all parties.

- There is a need for better hydraulic conductivity values (how fast water moves through the glacial deposits). Also a better understanding of the three dimensional complexity of the glacial deposits is needed in order for modeled predictions to more accurately depict actual field conditions. Stratigraphy could be better understood by geophysical investigations.

3. Based on additional well and geologic information, the conceptual model and, subsequently the analytical model, should be re-evaluated.

- For the analytical model, at a minimum we suggest a change from specified (fixed) heads at the boundaries to a fluctuating head at the boundaries that is based on flow measurements, especially for Fox Creek. Possibly one specified head at Cass Lake or some other downstream location could be used, and then Fox Creek, Pike Bay, and the channel could be included in the model's calibration. This would allow a more realistic modeling assessment of whether the contaminants could migrate into Fox Creek and the channel, rather than just assuming they will not, and setting a specified (fixed) head at these sites.

- The complexity of this geological environment is greater than has been realized, and more realistic 3-D modeling is required.

4. The model must be calibrated to agree with existing data on well head and contaminant concentration levels.

- The model should then be tested on an independent data set, not used in calibration. Levels of contaminants in new wells could be used as a possible check on the recalibrated model.

5. Finally, all sampling and well drilling activities should follow standardized and technically acceptable protocols for contaminant investigations. All parties, including the tribe, governmental agencies, and an independent expert as determined by the tribe should approve these.

- Because there are two types of contaminant plumes (sinking dense non-aqueous phase liquids -- DNAPLs and floating light non-aqueous phase liquids -- LNAPLs), there is obvious concern about the potential for cross-contamination of wells, especially in the construction of new wells. Extreme care should be taken in drilling new wells and in sampling all wells. We recommend that dedicated sampling equipment be established for each individual well (if this is not currently occurring) to prevent sample cross-contamination.

- All parties must agree upon any changes in the well contaminant sampling scheme. (Well 118 was sampled for PAHs in 1991 and then never sampled again. Values in 1991 were 1500 ? g l-1 /45000 ? g l-1 for list 1/and list 2 PAHs. Well 118 was sampled for PCP in 1991 (60,000 ? g l-1) and again in 1996 (<50? g l-1)).

- All affected parties must agree upon any changes in analytical laboratories or detection limits.

Human Health Risk Assessment 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 not 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 Environmental Justice 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 Environmental Justice Groundwater Panel (McDonald et al. 1999), reinforced by the Human Health Risk Panel, and confirmed by an initial Ground Penetrating Radar (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 LNAPLs and DNAPLs.

Ecological Risk Assessment Conclusions and Recommendations

Based on the results of the expert panel review, the Ecological Risk Assessment Panel arrived at the following conclusions and offers several recommendations concerning ecological risks posed by the St. Regis/Wheelers Superfund site.

Conclusions

The essential issues of concern for assessing ecological risks are similar to those expressed in relation to the human health assessment (Bartell et al. 2002).

1. An incomplete screening-level assessment has been completed and the results of the screening indicate that a more comprehensive risk assessment is justified (Tables 1–4).

2. The characterization of on-site and off-site contamination is inadequate to support a meaningful examination of impacts and risks posed by site-related contamination.

3. Evaluation of the quantity and quality of existing data is difficult given current levels of data reduction, analysis, and summarization.

4. Pathways of exposure have not been comprehensively investigated for the diverse assemblages of species potentially at risk.

If the contaminated groundwater plume continues its suspected pattern of movement toward Cass Lake, risks posed by the chemicals of concern (COCs) in the plume to fish and other aquatic organisms could increase markedly in the future.

Limited efforts in ecological assessment at the Leech lake site to-date have focused on dioxin and fish. As a result of reviewing existing information and panel discussions, the panel concludes that the assessment needs to be expanded in terms of ecological endpoints and COCs. The selection of additional species as assessment/measurement endpoints should be guided by cultural practices involving plants and animals valued by the tribe, as well as by the ecological uniqueness of the region.

Recommendations

The panel recommends the following actions to facilitate the necessary ecological risk assessment for the St. Regis/Wheelers Superfund site:

1. Based on the preliminary screening-level results, a scientifically credible and technically defensible assessment of ecological risks should be performed.

2. A more comprehensive ecological assessment will require the collection of additional samples to characterize exposure and additional toxicity benchmark data.

3. The collection and processing of additional samples should be coordinated to improve the characterization of site contamination and provide data and information relevant for both the human health and ecological risk assessments.

4. An important component in improving the site characterization necessary to support an ecological risk assessment involves the derivation of bioaccumulation factors across media, COCs, and species at risk. For hydrophobic organic contaminants, measures of organic carbon in soils and sediments are unavoidable. Lipid concentrations in species of concern are also necessary to evaluate the potential for bioaccumulation of organic contaminants.

5. In contrast to the Environmental Justice Human Health Risk Assessment Report (Bartell et al. 2002), the identification of appropriate reference sites will be necessary to complete a meaningful ecological risk assessment. The reference sites should be selected to reflect ecological similarities to the conditions that existed at the St. Regis/Wheelers site prior to the onset of commercial activities.

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

Groundwater Panel Report

Groundwater Panel

Dr. Michael McDonald, Chair
Minnesota Sea Grant Program
2305 East Fifth Street
Duluth, MN 55812-1445

Dr. Robert Striegl
Geological Survey, Water Resources Division
Box 25046 M.S. 413, Denver Federal Center
Denver, CO 80225

Dr. Howard Mooers
Geology Department, University of Minnesota
10 University Drive
Duluth, MN 55812

Ms. Mary Manydeeds
Bureau of Indian Affairs
331 South Second Street
Minneapolis, MN 55401

Dr. Joseph D'Lugosz
Environmental Protection Agency
6201 Congdon Boulevard
Duluth, MN 55804

Dr. Richard Soule
Minnesota Department of Health
121 East Seventh Place, POB 64975
St. Paul, MN 55164-0975

Mr. Don Rosenberry
Geological Survey, Water Resources Division
Box 25046 M.S. 413, Denver Federal Center
Denver, CO 80225

Environmental Justice Project
U.S. Environmental Protection Agency
Office of Environmental Justice
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January 11, 1999

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

Groundwater Panel Report

Background:

Groundwater was contaminated by the operation of a wood preserving business located on the Leech Lake Chippewa Tribal Lands in the city of Cass Lake in the Chippewa National Forest. It is bounded on the north by Burlington Northern and Soo Line Railroads, and on the west by Minnesota Highway 371 (Fig. 1). The surface waters drain to Pike Bay and the channel that flows from Pike Bay to Cass Lake. These waters then empty into the headwater area of the Mississippi River. Groundwater flow in the area is generally from west to east.

Beginning in 1957, the St. Regis Company operated a wood preserving business at the site on land leased from the Great Northern Railroad (subsequently becoming part of BN Railroad). The site was later expanded to the south. Creosote use began in 1957, and pentachlorophenol (PCP) in 1960. Both chemicals were in use until the facility closed in 1985. PCP was generally combined with #2 fuel oil, and this mixture tends to float on groundwater. In later years of operation a water-dispersible PCP concentrate (PCP and ketone mixture) was used; this mixture is more dense than water and sinks in groundwater. From 1969 until 1973 a water-soluble copper-chromium-arsenate salt solution was also used for wood treating.

Champion International Corporation assumed responsibility for the site when it acquired and merged with St. Regis Company in January 1985. The wood preserving operation ceased in September of 1985, and in 1986 Champion dismantled facilities on the site.

Champion installed a groundwater containment/extraction system for the contaminants on the site using a series of extraction wells, and subsequent treatment with granular activated charcoal, prior to discharge to Pike Bay/channel. Unfortunately, a plume of contaminated groundwater has migrated generally to the east, off-site. In this area, there appears to be two aquifers separated by till. There are two types of contaminant plumes that have been detected, a sinking dense non-aqueous phase liquid, DNAPL, and a light, floating non-aqueous phase liquid, LNAPL, which move at the bottom and top of the aquifers, respectively.

(The above background is taken from Minnesota Pollution Control Agency 1995, five year review report, St. Regis Company site, Cass Lake, Minnesota.)

The glacial geology of this area is complex. There are areas where there appear to be two aquifers separated by till. In other areas, there is evidence that the confining till layers are absent between the upper and lower aquifers. There are numerous monitoring wells east of the treatment facility site. In recent years, contaminated groundwater has been detected in some of these wells off the site to the east, indicating a possible migration of the original plume away from the extraction system. It is not known how the migration occurred, but this makes a good geologic characterization of the aquifer critical to effective remediation.

Groundwater Panel of Experts:

To assess the availability, quality, and interpretation of the existing groundwater data, the University of Minnesota Sea Grant Program and the Leech Lake Tribal Council convened a national panel of groundwater experts. The panel was made up of the following members:

Dr. Michael E. McDonald, UM Sea Grant, Chair
Dr. Rob Striegl, US Geological Survey
Dr. Howard Mooers, UM Duluth Geology Dept.
Ms. Mary Manydeeds, Bureau of Indian Affairs
Dr. Joseph D'Lugosz, US EPA
Mr. Richard Soule, MN Dept. Health*
Mr. Don Rosenberry, USGS*

* Panel members providing written comments

For a list of all attendees of the Groundwater Panel meeting, see Table 1.

Panel Findings:

The groundwater panel has identified a number of problems based on analysis of data in the consultant's reports. We feel that these problems are due to an inadequate geological assessment (poor conceptual model) of the site and surrounding area. This causes subsequent problems with the computer simulations of groundwater flow and its interpretation. The problems are identified below, but are not necessarily in order of importance.

Geology and Sampling

1. It was noted in reports (Remedial Investigation/Alternatives Report Cass Lake Sites, April 1985, prepared for Champion International by Barr Engineering) that pumping of city well #3 caused fluctuation in deep well 302 but not deep well 306. It was suggested that well 306 was beyond the influence of pumping. The two deep wells are roughly the same distance from the city well, and the extent of a cone of influence in coarse sandy material is large. The suggestion that well 306 is beyond the influence is unfounded. An alternative is that city well #3 and well 302 are in the same unit, and well 306 lies in a different sand and gravel unit that is isolated from the effects of city well #3 (i.e., different aquifers). Thus pumping from the city well

could have changed the groundwater flow direction and pulled contaminants from the site back into the city's well field. This could have subsequently contaminated the city's water supply (see also Panel Finding #6, page 4). However, well #3 was sold to Champion and is currently being used as a monitoring well (MW3). City wells #1 and #2 were abandoned around 1990 when city well #5 was installed. Cass Lake city well #5 is currently non-detect for PAHs, VOCs, and PCP (MPCA personal communication).

2. In the reports (e.g., Remedial Investigation/Alternatives Report, 1985, figures 23, 24, 26, 27) hydraulic heads and contaminant concentrations suggest that groundwater flow is west to east. Such a flow direction explains high contaminant concentrations in wells 118 (very high concentration) and 104. However, the analytic modeling suggests the flow is to the southeast from the treating facility site. That is about a 30° to 45° difference in flow direction as calculated by the model, relative to that determined from actual well head and contaminant data. The model's predicted direction is contradicted by Champion's own extraction well locations, which were apparently based on a hydraulic gradient determined from contaminant concentration and well head data. Also, a southeast flow component does not account for the high contaminant concentrations in wells 118 and 104. Therefore, either the interpretation of the subsurface geology or the model is in error. There are no wells to the south and southeast of the treating facility to verify contaminant levels or the depth to groundwater that might help determine the correct interpretation.

3. The erratic sampling schedule is a cause of concern. Numerous modifications have been made to sampling intervals, protocol, and detection limits without written agreement of all the parties. For example, well 118 was sampled annually through 1991 and PAH levels were rather erratic (Table 2). The well was not sampled again until 1997 and contaminant levels had dropped below detection limits. Although a drop to non-detect may be possible, it seems rather unlikely, especially since detection limits for PCP and PAHs have increased 10-fold and >50-fold, respectively in 1996 and 1997. The absence of sample analyses for several years adds to the skepticism. There are numerous other examples of nonconformity with the mandated sampling protocols. There is also a lack of documentation regarding quality assurance procedures used for the samples.

4. High PCPs at wells 215 and 220 (Table 3) suggest that contaminants may be moving to the east and east-southeast from the treating facility. Well 220 was only installed recently, but data from it suggest that the extraction wells are not containing the contaminants. There are no other wells available in this area to confirm this finding. The southern extent of the contaminant plume from the treating facility site is unknown and needs to be determined.

5. PAHs across the channel at well 219 (Table 2) suggest the potential for flow from west to east under the channel, but the source of the PAHs are unknown. If these PAHs are from the site, the groundwater flow simulation model cannot account for these levels. A possible scenario for this is that in building the railroad grade all the

organic material was removed and replaced with coarse ballast. The grade then would act like a pipeline for movement of groundwater and contaminants. Further investigation of the area around well 219 is required.

6. The Leech Lake Tribal Division of Resource Management (DRM) fish hatchery is located to the west of all identified contaminated sites, although it is near the containment vault. DRM wells pump 300-500 gpm from February through June. Contaminants are detected during the active pumping season, even though the wells are screened in the lower aquifer. This indicates that there is interaction between the deep aquifer and the more shallow aquifer. Well logs from the hatchery and other locations suggest there is not a continuous confining layer between the two aquifers. It is possible that pumping the DRM wells at 300-500 gpm is drawing the contaminants from the east and into the water pumped from the well. It is unknown whether this condition has existed elsewhere, such as city well #3, because of poor geological understanding of the area, including the extent and continuity of the confining till layer.

7. Are there available data for As, Cu, and Cr? We understand that other contaminants have been deemed more useful for determining transport. However, we also believe it is essential to document the fate of chemicals associated with the copper-chromium-arsenate wood preservation operation, especially since they were in a water-soluble solution.

Panel Comments:

After 14 years of study and remediation at this site, its geological and geochemical characterization is still remarkably poor. Without a better, more comprehensive conceptual model of this site, the quality of future decisions may be flawed and unsupportable.

Problems Associated with the Groundwater Modeling Efforts

Assumptions

1. The reports are contradictory when referring to the nature of the confining layer between the surficial aquifer (upper aquifer in contact with the soil and air) and the upper confined aquifer (deeper aquifer, isolated from the surficial aquifer by a "confining layer.") There are numerous references to the "continuous confining layer" but also numerous instances where gaps in the confining till are noted (e.g., the DRM fish hatchery and near the city dump site). It is the nature of melt-out tills to have interspersed discontinuous layers of sands and gravels (interstratified glaciofluvial sediments) within, and contacting, aquifers. The model assumes a continuous confining layer between aquifers, which has been shown to be inaccurate. The three-dimensional complexities of the till deposits in this area are not accounted for in the conceptual or analytic model.

2. In the analytic model the hydrogeologic boundaries for the site are specified heads (or fixed head - the head in a well is fixed at a certain level in the model) at Fox Creek, Pike Bay, and the channel. The specified head at the channel precludes modeled transport of contaminants to the east of the channel. However, well 219 located to the east of the channel has PAHs. The origin of these PAHs remains unknown, but they have been consistently present. The specified head at Fox Creek results in essentially southerly flow from the city dump site to the creek. Yet on some report figures, there is a sense that the plume at the dump site is moving to the east. This suggests that specified (fixed) heads at the boundaries are not good assumptions for the model.

Predictions

3. The model predicts a northwest - southeast flow, approximately 30°- 45° southward from a due east - west line. This is not supported by well head data in pumping wells prior to extraction. We do not know where the plumes are, particularly to the south of the treating facility. New test wells in this area could add credibility to the model.

4. The current model does not explain contaminants in DRM wells. The fish hatchery's deep wells pump at 300-500 gpm from February - June. This is not accounted for. If the fish hatchery wells can change the flow gradient, did city wells influence the gradient enough to become contaminated prior to their removal from service? We know the influence of pumping at deep monitoring well 302 is substantial and is within the capture zone of the city wells.

Panel Recommendations:

1. There needs to be a better interpretation of existing data and better use of all available data.

2. There needs to be a more complete geologic site characterization. This becomes especially important for understanding and modeling the transport of DNAPLs by gravity flow.

Options

- Possibly use Ground Penetrating Radar (GPR) or seismic investigations to improve geologic site characterization.

- Drill additional test holes for geologic characterization and additional sampling wells (particularly to the south of the treating facility) for better contaminant plume definition. If high concentrations are found in the initial wells, we suggest using an exploratory Geoprobe to determine locations for subsequent permanent wells. Because of the current poor plume definition, the simulated capture zones for the extraction wells are based on inadequate information.

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3. Based on additional well and geologic information, the conceptual model and, subsequently the analytical model, should be re-evaluated.

    - For the analytical model, at a minimum we suggest a change from specified (fixed) heads at the boundaries to a fluctuating head at the boundaries that is based on flow measurements, especially for Fox Creek. Possibly one specified head at Cass Lake or some other downstream location could be used, and then Fox Creek, Pike Bay, and the channel could be included in the model's calibration. This would allow a more realistic modeling assessment of whether the contaminants could migrate into Fox Creek and the channel, rather than just assuming they will not, and setting a specified (fixed) head at these sites.

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    - The model should then be tested on an independent data set, not used in calibration. Levels of contaminants in new wells could be used as a possible check on the recalibrated model.

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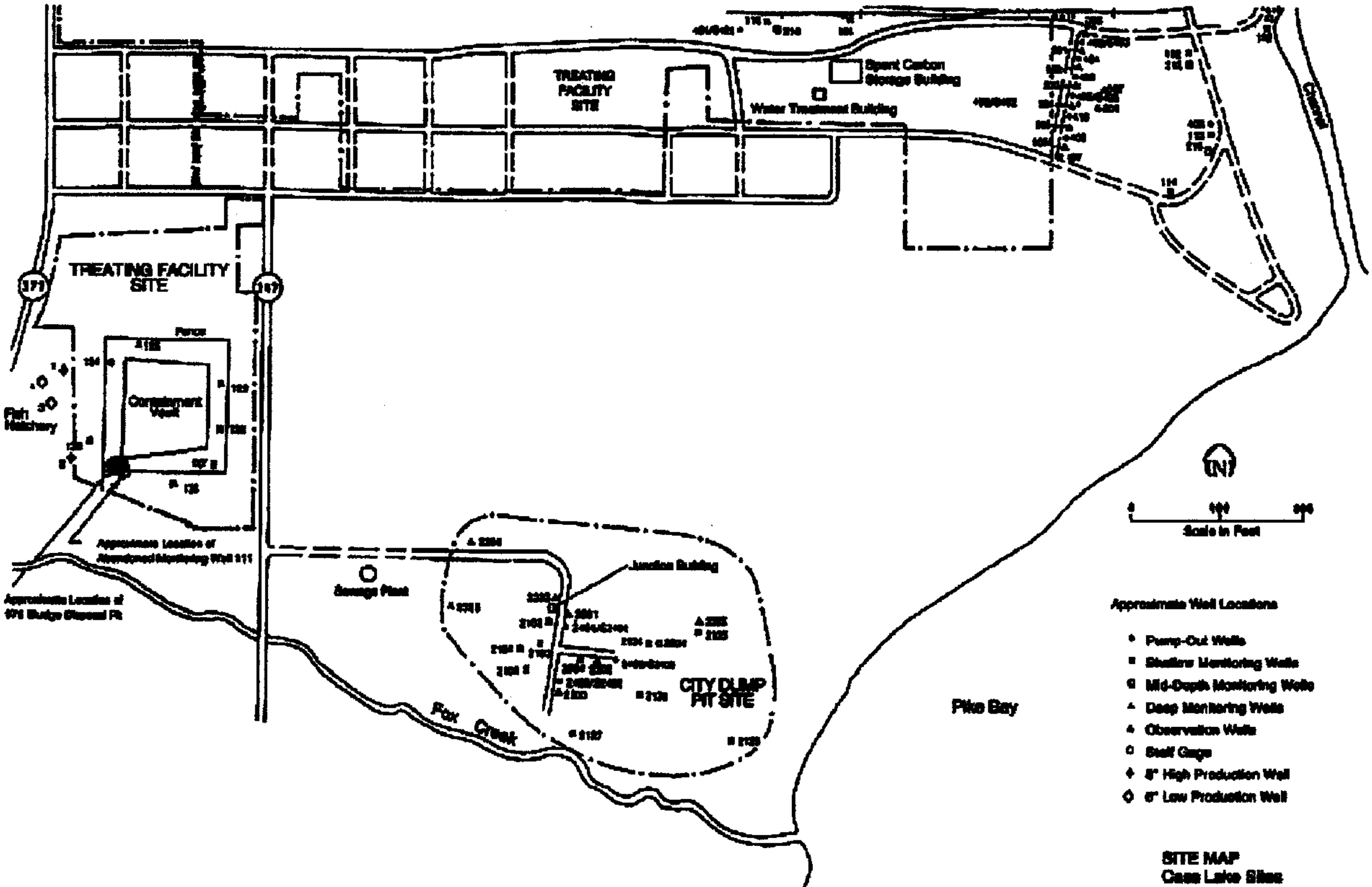
- All parties must agree upon any changes in the well contaminant sampling scheme. (Well 118 was sampled for PAHs in 1991 and then never sampled again. Values in 1991 were 1500 $\mu g\,l^{-1}$ /45000 $\mu g\,l^{-1}$ for list 1/and list 2 PAHs. Well 118 was sampled for PCP in 1991 (60,000 $\mu g\,l^{-1}$) and again in 1996 (<50$\mu g\,l^{-1}$)).

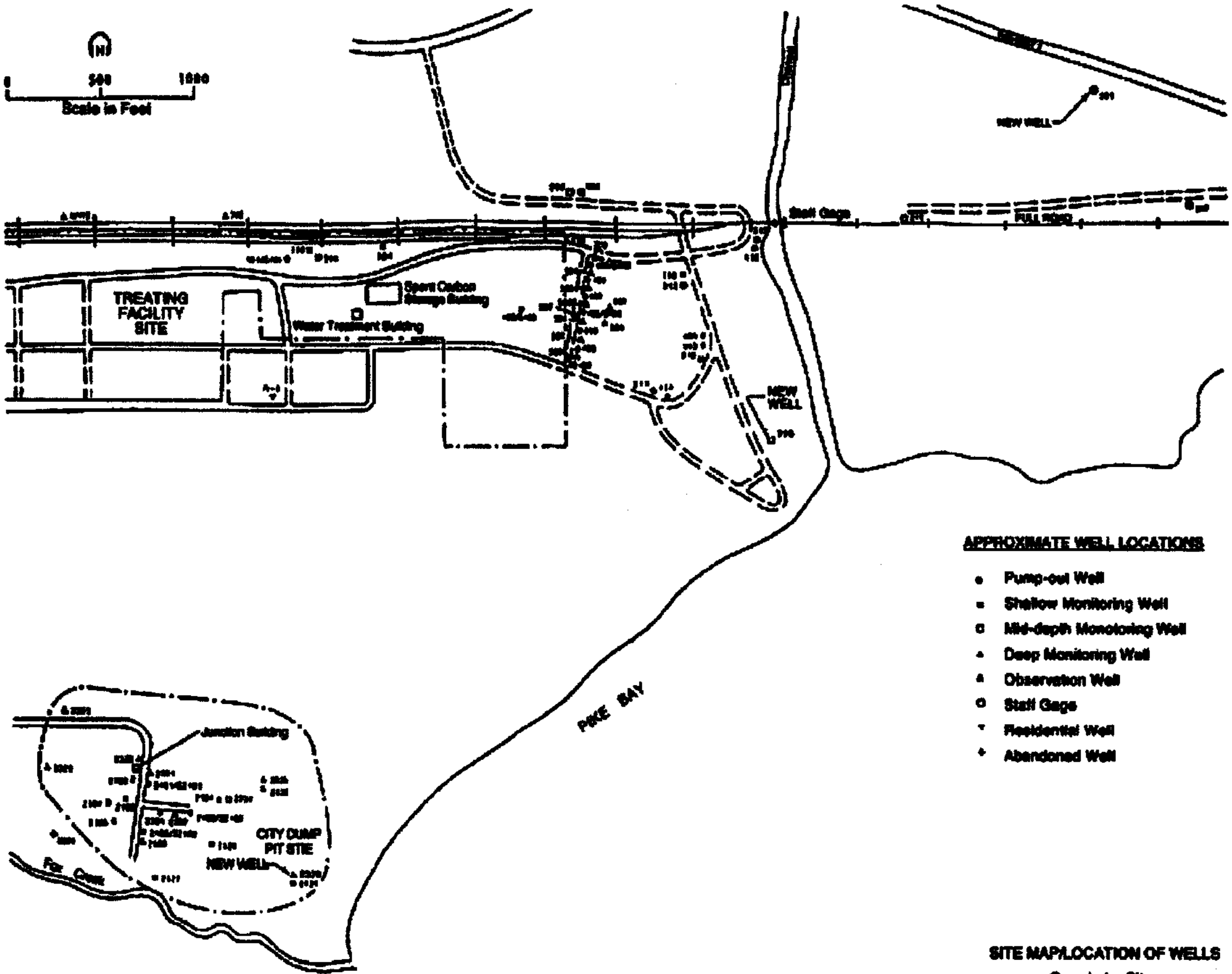
- All affected parties must agree upon any changes in analytical laboratories or detection limits.



ENVIRONMENTAL CONSULTANTS INC.

Map Reference: Barr Engineering, March 1996

FIGURE 1



SITE MAP/LOCATION OF WELLS
Cass Lake Sites

FIGURE 1 (con't)

TABLE 1
GROUNDWATER PANEL MEETING ATTENDEES
June 16-17, 1998

Thomas M. Ware
Leech Lake Reservation Tribal Council
Rte. 3, Box 100
Cass Lake, MN 56633
Tel: (218) 335-7412
Fax: (218) 335-7412

Rich Robinson Jr.
Leech Lake Reservation Tribal Council
Rte. 3, Box 100
Cass Lake, MN 56633
Tel: (218) 335-7400
Fax: (218) 722-5764

John Ringle
email: LLfish@mail.PaulBunyan.net
Leech Lake Division of Resource Management
Rte. 3, Box 100
Cass Lake, MN 56633
Tel: (218) 335-7421
Fax: (218) 722-5764

Carl Richards
email: crichard@sage.nrri.umn.edu
Natural Resources Research Institute
423 N R R I
5013 Miller Trunk Highway
Duluth, MN 55811
Tel: (218) 720-4332

Greg Peterson
email: gpeterso@sage.nrri.umn.edu
Natural Resources Research Institute
N R R I
5013 Miller Trunk Highway
Duluth, MN 55811
Tel: (218) 720-4389

Rich Axler
email: raxler@sage.nrri.umn.edu
Natural Resources Research Institute
427 N R R I
5013 Miller Trunk Highway
Duluth, MN 55811
Tel: (218) 720-4316

Jeff Gunderson
email: jgunderson@extension.umn.edu
MN Sea Grant College Program
2305 East Fifth Street
Duluth, MN 55812-1445
Tel: (218) 726-8715
Fax: (218) 726-6556

Mike McDonald
email: mmcdonal@d.umn.edu
MN Sea Grant College Program
2305 East Fifth Street
Duluth, MN 55812-1445
Tel: (218) 726-8710
Fax: (218) 726-6556

Cindy Hagley
email: chagley@extension.umn.edu
MN Sea Grant College Program
2305 East Fifth Street
Duluth, MN 55812-1445
Tel: (218) 726-8713
Fax: (218) 726-6556

Dr. Robert Striegl (Chair)*
email: rstriegl@swampgas.cr.usgs.gov
Geological Survey, Water Resources Div.
Box 25046 M.S. 413, Denver Federal Center
Denver, Colorado 80225
Tel: (303) 236-4993

Table 1 Con't

Dr. Howard Mooers*
email: hmooers@d.umn.edu
Geology Department
University of MN
10 University Drive
Duluth, MN 55812
Tel: (218) 726-7239

Dr. Joseph D'Lugosz*
email: dlugosz.joseph@epamail.gov
EPA
6201 Congdon Boulevard
Duluth, MN 55804
Tel: (218) 529-5215

Mary Manydeeds*
email: mary_manydeeds@mail.bia.gov
Bureau of Indian Affairs
331 South 2nd Street
Minneapolis, MN 55401
Tel: (612) 373-1000 Ext.1068

John Persell
Minnesota Chippewa Tribe
Box 217
Cass Lake, MN 56633-0217
Tel: (218) 335-6303

John Morrow
Leech Lake Reservation Tribal Council
Rte. 3, Box 100
Cass Lake, MN 56633
Tel: (218) 335-7400
Fax: (218) 722-5764

George Garklavs
email: garklavs@usgs.gov
District Chief
U.S. Geological Survey
2280 Woodale Drive
Mounds View, MN 55112
Tel: (612) 783-3106
Fax: (612) 783-3103

Linda Kern
U. S.Environmental Protection Agency
Mail Code SR6J
77 West Jackson Blvd
Chicago, IL 60604
Tel: (312) 886-7341
Fax: (312) 886-4071

Miriam Horneff, Project Manager
Minnesota Pollution Control Agency
Response Unit II
Site Response Section
Ground Water and Solid Waste Division
520 Lafayette Road N.
St. Paul, MN 55155-4194
Tel: (612) 296-7228

Jim Seaberg
Minnesota Pollution Control Agency
520 Lafayette Road N.
St. Paul, MN 55155-4194
Tel: (612) 296-7823

Shirley Nordrum
Division of Resources Management
Leech Lake Tribal Council
RR 3, Box 100
Cass Lake, MN 56633
Tel: (218) 335-7430

DID NOT ATTEND MEETING

Dr. Richard Soule*
email: souler@mdh-envh.health.state.mn.us
Minnesota Department of Health
121 East Seventh Place
Box 64975
St. Paul, MN 55164-0975

Dr. Don Rosenberrry*
email: rosenber@usgs.gov
Geological Survey, Water Resources Div.
Box 25046 M.S. 413, Denver Federal Center
Denver, Colorado 80225

*Panel Members

Table 2

PAH Data
Treating Facility Site
1986-1996 (concentration in μg/L)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Shallow Surficial Aquifer											
W104	<0.6/24	<6/14	<6/61	<10/<10	<10/53	<10/2	<10/<10	<0.432/15.5	<0.8/19.7	<4/69	—
W112	0.0096/0.20	0.012/0.29	0.0091/0.24	0.03/0.36	0.013/0.24	<0.12/0.25	<0.006/0.17	<0.006/0.107	0.019/0.202	0.010/0.18	—
W113	<0.0043/0.048	6.3/6.6	0.012/0.058	<0.0017/0.01	0.0022/0.017	<0.098/1.9	0.066/0.80	<0.012/0.101	<0.2/<0.36	—	—
W114	<0.0043/0.068	<0.0017/0.063	<0.0017/0.048	<0.0017/0.001	<0.0017/0.011	<0.003/0.031	<0.012/<0.012	<0.006/0.0132	<0.02/0.036	<0.02/0.007	<10/<10
W115	<0.0017/0.0091	0.0086/0.05	0.0025/0.034	<0.0017/0.017	<0.0017/0.033	<0.003/0.0030	<0.006/0.037	<<0.006/0.0205	<0.02/0.009	<0.02/0.003	<10/<10
W118	—	<1,200/29,000	<600/51,000	360/5,900	470/5,300	1500/45,000	—	—	—	—	—
Base of Surficial Aquifer											
W212	47/1,500	<120/740	<6/920	<20/380	<10/150	<100/28	<150/<150	<10/42	<10/46a	<750/750	<10/27
W213	1,700/2,600	1,000/4,600	160/2,100	700/2,000	19/1,100	<40/1,100	<10/330	<10/250	<20/240a	<10/150a	<10/90
W215	<0.0017/0.020	<6/59	<6/63	<10/20	<10/66	<100/22	<75/16	<10/29	<10/46a	<600/<600	<10/29
W217	<0.0043/0.13	0.0018/0.062	<0.0017/0.026	<0.0017/0.013	<0.0017/0.0047	<0.003/0.0037	0.0038/0.042	<0.006/0.00306	<0.04/0.026	<0.02/<0.036	—
W218	—	0.26/11	<0.0017/8.3	<<0.068/13	<0.24/17	<0.006/3.4	<0.048/0.39	0.0215/0.858	<0.4/0.365	<0.08/0.37	—
W219	<0.034/1.2	<6/8.6	<6/9.7	<0.068/18	<10/16	<10/8	<10/8	<0.192/6.21	<2.4/8.27	<3.0/7.0	—
W220	—	—	—	—	—	—	—	—	<20/527	<200/250a	<10/120
W221	—	—	—	—	—	—	—	—	<0.4/0.008	<0.02/<0.035	—
Lower Aquifer											
W302	0.0019/0.026	0.0053/0.11	0.13/0.21	0.0022/0.091	0.013/0.070	0.016/0.059	.0032/0.24	<0.006/0.0170	<0.08/0.883	<0.02/0.059	—
W308	<0.0017/0.0036	0.0044/0.13	0.010/0.050	<0.0017/0.011	<0.0017/0.0064	<0.003/0.34	<0.012/0.016	<0.006/<0.006	0.023/0.022	<0.02/0.018	<10/<10
MW3	<0.0017/0.005	0.0036/0.073	<0.0017/0.018	<0.0017/0.017	0.0022/0.050	<0.003/0.012	<0.006/0.050	<0.003/0.0092	0.010/0.014	<0.02/0.048	—

List I/List 2 PAH compounds.
If <, all compounds in list were below that detection limit.
If value, it is the sum of detected values.
* LNAPL present in this well.
a = Estimated value, calculated using some or all values that are estimates.

Table 7 from *Annual Monitoring Report*
January 1996 through December 1996
Groundwater and Surface Water Monitoring
St. Regis Paper Company Site
Cass Lake, Minnesota
Prepared for Champion International by
Barr Engineering, Minneapolis, MN

2311005\47946-1/YMH

Table 3

Pentachlorophenol Data
Treating Facility Operable Unit
1986-1996
(concentration in µg/L)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Shallow Surficial Aquifer											
W104	670	1,000	990	330	820	200	84	250	110	590	—
W112	<6	<6	<6	<6	<6	<6	<6	<6	<3	<3	—
W113	<5	100	<6	<6	<6	<6	<6	<6	<3	—	—
W114	<5	<6	<6	<6	<6	<6	<6	<6	<3	<3	—
W115	<6	<6	<6	<6	<6	<6	<6	<6	<3	<3	<50
W118	—	150,000	49,000	46,000	54,000	60,000	—	—	—	—	<50
Base of Surficial Aquifer											
W212	8,900	4,000	3,800	3,500	5,100	2,200	2,200	2,900	3,900	2,300	1,300
W213	20,000	12,000	4,800	13,000	5,800	830	300	<10	<20	<10	<50
W215	<6	27,000	4,400	2,700	4,200	2,800	1,900	2,200	3,400	1,600	1,100
W217	<6	<6	<6	<6	<6	<6	<6	<6	<3	3	—
W218	—	3,000	860	78	570	170	14	26	13	26	—
W219	<6	<6	<6	16	<10	<10	<10	<6	<3	<3	—
W220	—	—	—	—	—	—	—	—	1,000	570	180
W221	—	—	—	—	—	—	—	—	<3	<3	—
Lower Aquifer											
W302	<6	<6	<6	<6	<6	<6	<6	<6	<3	<3	—
W308	<6	<6	<6	<6	<6	<6	<6	<6	<3	<3	<50
MW3	<5	<6	<6	<6	<6	<6	<6	<6	<3	<3	—

— Not analyzed

Table 8 from *Annual Monitoring Report*
January 1996 through December 1996
Groundwater and Surface Water Monitoring
St. Regis Paper Company Site
Cass Lake, Minnesota
Prepared for Champion International by
Barr Engineering, Minneapolis, MN

2311005\47946-1/YMH

Table 3 cont.

Pentachlorophenol Data
Extraction Wells
1987-1996
(concentration in µg/L)

Extraction Wells	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
401	3,000	2,000	56	1,500	3,900	1,500	970	2,000	890	—
402	1,600	1,300	1,200	700	1,600	1,100	810	2,200	1,200	—
403	9,300	2,200	1,500	790	1,200	560	300	320	190	—
404	17,000	6,300	9,900	—	—	—	—	—	—	—
405	8,000	4,500	7,000	5,500	1,500	840	6,400	6,500	5,300	—
406	<6	12	<5	—	<10	—	—	<5	<5	—
407	<6	<5	—	—	—	—	—	<5	<5	—
408	9,900	5,000	5,600	4,800	9,100	3,800	4,400	3,100	1,800	2,000
409	21,000	18,000	8,900	5,800	11,000	5,400	4,800	3,700	2,100	—
410	<6	280	130	39	<10	<5	<5	8	14	—
2401	—	16,000	—	—	—	—	3,100	3,800	1,800	—
2402	—	17,000	2,500	700	820	580	450	280	220	—
2403	—	6,900	4,500	2,600	3,800	3,400	2,800	1,900	1,600	—

— Not analyzed.

Table 21 from *Annual Monitoring Report*
January 1996 through December 1996
Groundwater and Surface Water Monitoring
St. Regis Paper Company Site
Cass Lake, Minnesota
Prepared for Champion International by
Barr Engineering, Minneapolis, MN

2311005\47946-1/YMH

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

HUMAN HEALTH RISK ASSESSMENT PANEL REPORT

Steven M. Bartell
Carl Richards
Richard P. Axler
Jeffrey L. Gunderson
Cynthia A. Hagley

2002

ENVIRONMENTAL JUSTICE PROJECT

U.S Environmental Protection Agency Environmental Justice Program Grant No. EQ825741

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

Leech Lake Band (Cass Lake, MN)	
Shirley Nordrum	Leech Lake Tribal Council, Division of Resource Management
John Persell	Minnesota Chippewa Tribe Water Quality Laboratory
University of Minnesota Sea Grant (Duluth, MN)	
Carl Richards*	Director and Professor of Biology
Jeff Gunderson	Associate Director and Extension Professor
Cynthia Hagley	Extension Associate Professor and Water Quality Educator
University of Minnesota Natural Resources Research Institute (Duluth, MN)	
Richard Axler*	Senior Research Associate
Greg Peterson	Currently at U.S. Environmental Protection Agency Mid-Continent and Ecology Division (MED) Research Laboratory, Duluth, MN

Other Participants

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

Steve Bartell*,+	The Cadmus Group, Inc., Oak Ridge, TN
Barbara Harper*	Associated Environmental Scientists, Inc., West Richland, WA
Stuart Harris*	Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR
Matt Simcik*	University of Minnesota, Division of Environmental and Occupational Health, Minneapolis, MN
Mark Sprenger	USEPA ERT, Edison, NJ
Steve Diamond	USEPA MED Research Laboratory, Duluth, MN
Phil Cook*	USEPA MED Research Laboratory, Duluth, MN
Diane Thompson	Leech Lake Band of Ojibwe, Resource Management, Cass Lake, MN

* denotes Environmental Justice Human Health Risk Assessment Panel Member
\+ denotes Chair of Human Health Risk Panel

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.

COCs

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).

USEPA Screening-level Assessment (EPA 2002)

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

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

ECOLOGICAL RISK ASSESSMENT PANEL REPORT

Steven M. Bartell
Carl Richards
Richard P. Axler
Jeffrey L. Gunderson
Cynthia A. Hagley

2002

ENVIRONMENTAL JUSTICE PROJECT

U.S. Environmental Protection Agency Environmental Justice Program Grant No. EQ825741

Introduction

This report describes and summarizes discussions of the Ecological Risk Assessment Panel concerning ecological impacts and risks posed by previous and continuing contamination at the St. Regis/Wheelers Superfund site at Cass Lake, Minnesota. These discussions occurred during an expert panel review held in Cass Lake on May 13–15, 2002, as part of an Environmental Justice (EJ) project, organized through the University of Minnesota Sea Grant in partnership with the Leech Lake band of Ojibwa and funded by the US EPA.

The purpose of the review was to examine and evaluate the results of previous and ongoing studies directed towards a quantitative understanding of potential adverse impacts to ecological resources in the vicinity of the site. The review addressed the probable impacts of chemical contamination associated with previous site operations and continuing remediation activities. While not tasked with completing an ecological risk assessment, the review was organized and directed using ecological risk assessment principles and guidelines. This approach greatly facilitated evaluation of existing information and identification of information and data gaps. Ecological risk assessment focuses on the inherent value of the life-sustaining ecosystems, as well as the economic value of selected ecological resources to individuals inhabiting the region.

The primary objectives of the Ecological Risk Assessment Panel discussions were to (1) evaluate existing information for assessing the ecological impacts of site-related contamination, and (2) determine if previous clean-up efforts have resulted in conditions that are protective of ecological resources. The purpose of the panel was not to directly assess ecological risks posed by site-related contamination (i.e., conduct a risk assessment). Rather, the panel examined current ecological conditions, evaluated the nature and quality of existing data, and recommended additional studies that might be undertaken to collect additional data and information in support of a comprehensive and quantitative ecological risk assessment for the St.Regis/Wheelers Superfund site.

As stated in the companion report from the Human Health Risk Assessment Panel (Bartell et al. 2002), the interrelationship between human health and ecological concerns are fundamentally inseparable for the tribe, who is the primary stakeholder with ancient ties, both physical and spiritual, to the local ecology. Several important issues raised during the human health panel discussions re-emerged during the discussion of ecological risks. While this report focuses on ecological impacts, any meaningful remediation and/or restoration of the Leech Lake site will necessarily require an effective integration of human health and ecological perspectives in defining appropriate objectives and approaches for site clean-up.

Review Participants and Ecological Risk Assessment Panel

The review included the following participants and was facilitated by an Ecological Risk Assessment Expert Panel:

Groundwater Panel Representative

The review discussions concerning the role of groundwater in determining the transport and fate of site-related contaminants were greatly facilitated by the participation of Dr. Howard Mooers, Department of Geology, University of Minnesota Duluth, who participated in the Groundwater Panel (McDonald et al. 1999).

Environmental Justice Project Principal Staff

Leech Lake Band (Cass Lake, MN)

Shirley Nordrum	Leech Lake Tribal Council, Division of Resource Management
John Persell	Minnesota Chippewa Tribe Water Quality Laboratory

University of Minnesota Sea Grant (Duluth, MN)

Carl Richards*	Director and Professor of Biology (U of M Duluth)
Jeff Gunderson	Associate Director and Extension Professor
Cynthia Hagley	Extension Associate Professor and Water Quality Educator

University of Minnesota Natural Resources Research Institute (Duluth, MN)

Richard Axler*	Senior Research Associate
Greg Peterson	Currently at United States Environmental Protection Agency (USEPA) Mid-Continent Ecology Division (MED) Research Laboratory, Duluth, MN

Other Participants

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

Steve Bartell* +	The Cadmus Group, Inc., Oak Ridge, TN
Matt Simcik*	University of Minnesota, Division of Environmental and Occupational Health, Minneapolis, MN
Mark Sprenger*	USEPA ERT, Edison, NJ
Steve Diamond*	USEPA MED Research Laboratory, Duluth, MN
Phil Cook*	USEPA MED Research Laboratory, Duluth, MN
Barbara Harper	Associated Environmental Scientists, Inc., West Richland, WA
Stuart Harris	Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR
Diane Thompson	Leech Lake Band of Ojibwe, Resource Management, Cass Lake, Minnesota

* denotes Environmental Justice Ecological Risk Assessment Panel Member
+ denotes Chair of Ecological Risk Panel

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 which are not included in these lists.

Background

The Cass Lake region is ecologically distinct and reasonably unimpacted except for the Superfund site. This region provides a relatively unique intersection of different ecological biomes in North America and features four large lakes that are integral components of the Mississippi River headwaters. Diverse wetlands define an ecologically valuable land:water interface within the region. The avian, terrestrial, and aquatic communities within the Cass Lake region are diverse and highly productive.

The Cass Lake area includes a variety of valuable ecological resources, for example, wild rice, fish, birds, and mammals. Additionally, the wild rice beds provide nursery habitat for northern pike, perch, and walleye. Lake tributaries such as Fox Creek are ecologically important for suckers and other species of fish. Cass Lake also has comparatively abundant populations of rare unionid mussels. The proximity of this area to the Mississippi River may carry broader implications for ecological risks posed by chemical contamination of the Cass Lake area. Impacts in this region might affect the ecology of the headwaters of this large and nationally important river system.

Cass Lake derives from the melting of a large block of ice following the last glacial period. The deep pool (90 feet) in Pike Bay is below the till confining layer that separates the upper and lower aquifer in this region. Groundwater likely flows into the west side of Pike Bay and Cass Lake and flows out the east side of the lakes. Surface water can flow in either direction through the channel between Pike Bay and Cass Lake, although the natural flows are to the north from Pike Bay into Cass Lake.

Ecological Risk Assessment Framework

A formal ecological risk assessment has not yet been conducted for the St. Regis/Wheelers Superfund site, although some preliminary screening-level calculations have been completed (EPA 2002). Analogous to the human health risk assessment paradigm (e.g., National Research Council 1983), assessing ecological risks includes the following steps (EPA 1997, 1998): (1) problem formulation, (2) assessment of ecological effects, (3) analysis of exposure, and (4) risk characterization. To assist in understanding the current conditions of ecological resources and in determining additional data needs, the expert panel discussions have been summarized according to the framework and guidelines for performing an ecological risk assessment.

An ecological risk is the probability of an adverse ecological impact occurring, combined with some statement concerning its consequences (Kaplan and Garrick 1981). An ecological risk assessment attempts to answer three basic questions: What can go wrong? How likely is it to go wrong? So what if it does go wrong?

Problem Formulation

The problem formulation step essentially encapsulates the ecological risk assessment process. A conceptual model is developed that defines the ecological stressors (e.g., toxic chemicals in this case), identifies ecological receptors that might be at risk, defines the ecological responses of interest, identifies needed exposure-response relationships, and delineates the methods for characterizing risk.

An important component of problem formulation is the identification of *assessment endpoints* in the vernacular of risk assessment. These are "explicit expressions of the actual environmental value that is to be protected, operationally defined by an "ecological entity and its attributes" (EPA 1997, 1998). *Measurement endpoints* (EPA 1997) or the measures of effects (EPA 1998) are "measurable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor." These measures of effect could be distinguishable from the assessment endpoint. The panel and review participants suggested several categories of ecological risk assessment endpoints, measures of exposure, and measures of ecological effects for the St. Regis/Wheelers Superfund site:

Assessment endpoints

- Undesirable or unsustainable changes in the production dynamics of ecologically and economically important species (e.g., leeches);
- Impairment of ecological processes (e.g., energy flow, material cycling); and
- Adverse impacts on natural goods and ecosystem services provided to humans.

Measures of exposure

- Endocrine levels in key species; and
- Metabolites in bile, fish tumors, and chemical residues in livers.

Measures of effects

- Reproductive impairment in key species (e.g., bald eagles);
- Oxygenase functions in fish, polycyclic aromatic hydrocarbons (PAH) reactivity, phototoxicity;
- Alteration of plant community structure and associated fauna;
- Impacts on bacterial communities in groundwater, soil invertebrate communities, hyporheic communities;
- Modification of the natural seasonal progression of species assemblages;
- Degradation and loss of habitat; and
- Alteration in food web structures.

In delineating assessment endpoints, the principal communities occupying the site and nearby areas should be described and representative species selected from each community. Tribal participants identified the wild rice community, stream/beaver community, wetland community, lake community, and upland community as important components of the local and regional landscape. The risk assessment should address both changes in the composition of potentially impacted communities and alterations in the temporal progression of species compared to reference sites.

Impacts on threatened and endangered species should be considered as possible endpoints in the risk assessment. There are tribally-sensitive species of plants and animals that should be evaluated as well. Risk assessment should consider these species or taxonomic/functional analogs for them.

Phototoxicity (significantly increased potency triggered by solar radiation) associated with exposures to PAHs might also be of concern for sensitive aquatic organisms. Perhaps the greatest likelihood of phototoxicity will be in the fish nursery area where larvae are fairly well confined. In situ bioassays using caged benthic organisms at different levels in the water column, with appropriate controls, could potentially be a useful alternative to a more comprehensive and expensive field study.

Site Characterization

A credible assessment of ecological risks posed by site contamination requires a comprehensive and accurate characterization of the distribution and fate of chemicals of concern (COCs). Existing reports pertinent to site characterization underscore the absence of any organized and comprehensive sampling of the site prior to 1997 (e.g., MJ 1997; MPCA 1995; MDH 1995, 1993; ATSDR 1989). This includes a lack of any terrestrial soil or aquatic sediment data. The MJ (1997) report provides a useful summary of the chronology of site remediation and a general review of monitoring data through 1996. The reports were interpreted as recommending extensive sampling of soils, sediments, and biota to determine the nature and extent of contamination. 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. At that time, EPA began to discuss additional sampling of the site with the Leech Lake Band. The sampling effort was finally implemented in October 2001, and the data became available in draft form (EPA 2002) less than two weeks prior to the EJ Risk Assessment Panel meetings in May 2002. This data report was finalized in August 2002 without changes to the data (L. Kern, EPA Region 5, Chicago, IL, pers. comm.).

Review participants offered historical accounts of alleged off-site disposal of contaminants. However, minimal sampling for assessing ecological risks has been accomplished thus far. Prior to the EJ Project study (section 19 in NRRI 2001, which includes the data collected through the EJ Project grant) the major, if not only, biological data collected for the site or nearby aquatic systems were the biennial (every other year) analyses of a single, pooled composite of six northern pike and a single, pooled composite of six tullibee fish samples from Pike Bay in Cass Lake and nearby Lake Andrusia (as a "possible" reference) that were analyzed for hexachlorodibenzo-p-dioxin (HxCDD) as required by National Pollution Discharge Elimination System (NPDES) MN State Discharge System (SDS) Permit No. MN0056537. Apparently, no other biological samples associated with the St. Regis/Wheelers site were collected and analyzed for COCs until 1998–1999, when the EJ Project partnership conducted a limited baseline sampling program.

As part of the EJ Project partnership, the University of Minnesota Natural Resources Research Institute (NRRI) set up transects into Pike Bay and Cass Lake and collected and analyzed a very limited set of fish, invertebrate, and sediment samples. Semi-permeable membrane devices (SPMD), also known as lipid bags, were used to simulate bottom dwelling localized fish (Huckins et al. 1993). Sediments were analyzed for a suite of PAHs, pentachlorophenol (PCP), pentachloroanisol (PCA), copper (Cu), chromium (Cr), and arsenic (As). Additional soil samples were also screened for PAHs (Peterson et al. 2002) and Microtox toxicity (e.g., Day et al. 1995, Microbics 1994).

Review participants emphasized the need for a comprehensive characterization of on-site and off-site contamination to provide the basis for a quantitative ecological risk assessment. The panel concluded that the draft screening-level assessment (EPA 2002) indicates unacceptable exposures of wildlife to COC, particularly copper and semi-volatile organic chemicals (SVOC), in upland areas and in locations within the City of Cass Lake dump/landfill near Fox Creek. Data describing the concentrations of various COCs in soils, sediments, surface waters, groundwater, and biota that were obtained for the human health assessment are also useful in assessing ecological impacts (e.g., EPA 2002). As in the discussions of human health risks, it would prove useful to apply a mass balance approach to estimate releases of selected COCs, determine how much has been removed (e.g., by COC extraction and treatment), and how much contamination remains to pose future risks. As noted in the Human Health Risk Report (Bartell et al. 2002), the panel also surmises that the COC list and the spatial and temporal sampling design may be incomplete. Further site characterization based on a mass balance approach might be facilitated by

- obtaining information that defines the chemical composition of the raw materials used at the facility, as well as products. For example, knowledge of pentachlorophenol (PCP) sources might permit inferences concerning dioxin content;

- acquiring company records concerning site operations and maintenance, NPDES permits, permits to haul wastes off-site, railroad shipping and delivery documents;

- collecting and cataloging historical references and recollections of possible contaminant releases or "events" that could indicate locations, COCs, and amounts released;

- reviewing old newspapers (Cass Lake Times), obtaining existing aerial photographs (e.g., University of Minnesota library) taken during site operations, requesting assistance in obtaining remotely sensed data (e.g., infrared photographs) from USEPA as part of the 5-year review process;

- interviewing previous employees (e.g., 40–50 St. Regis employees; Chippewa National Forest Service employees) and long-time residents to learn of detailed operating procedures and waste disposal practices;

- setting up one or more permanent environmental grids that can be monitored using digital or film cameras;

- collecting (including Global Positioning System coordinates) and archiving for future analysis samples from areas of suspected historical releases or dumping of site-related chemical wastes (i.e., ditches near back roads);

- using ground penetrating radar to thoroughly characterize groundwater light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs) and possibly plumes of dissolved components (A recent preliminary ground penetrating radar survey by the University of Minnesota-Duluth has confirmed the site's hydrogeological complexity (Mooers 2002, Appendix 3);

- understanding the degradation compounds of parent COCs to assist in identifying compounds to analyze in any additional environmental samples (i.e., media, biota), for example, the PCP recovered from the extraction wells could be analyzed for constituent compounds before being shipped to South Dakota for reuse; and

- training several people from the Leech Lake Band Division of Natural Resource Management (or from another local agency) with chain of custody, collecting samples, quality assurance/quality control, etc., to provide assistance if there is an important episodic event that should be characterized in terms of site risks. This expertise might be obtained from the Minnesota Chippewa Tribal Laboratory directed by John Persell.

Reference Site

Ecological risk assessment requires the identification of one or more reference sites. The ecological conditions of the selected reference site(s) should be characteristic of regional ecological systems that remain comparatively less impacted by human activities. In some instances, ecological risks are inferred from comparisons of ecological conditions at reference and impacted sites. Conditions at reference sites can also be used to assess the likely magnitude of ecological impacts projected from comparisons of chemical exposures at contaminated sites to toxicity benchmark data for ecological receptors of concern. Clearly, sites that have been impacted by the chemicals of concern (or other similar stressors) should not be chosen as reference sites.

Quantitative description of ecological conditions at the reference site(s) should provide acceptable values of structural and functional measures (i.e., baseline conditions) for comparison with corresponding ecological measures obtained from potentially impacted ecosystems surrounding and including the St. Regis/Wheelers site. These measures of ecological structure and function define the *measurement endpoints* in an ecological risk assessment. Characterization of the reference (and impacted) sites should include quantification of spatial and temporal variability in the values of the measurement endpoints.

Additional Chemicals of Concern

A standard Superfund list of possible COCs seems to have been used thus far to identify contaminants of concern for the Cass Lake site. The COC list is not consistent throughout the various media. 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. Polychlorinated biphenyls (PCBs) might reasonably receive additional attention. Ketones were likely used to make hydrophobic compounds (e.g., many PAHs) more soluble. Cutting oils, gasoline and other chemicals might have been routinely used to clean up creosote-laden tools and machinery. Chemicals in creosote might not have been adequately represented in the current list of COCs. There are additional COCs of concern to the tribe as well, including mercury. Copper, arsenic, and zinc appear as additional metals of concern for the ecological risk assessment.

In addition, metabolites and reaction products of PAHs were not measured. Similarly, PCA, a degradation product of PCP, should have been analyzed in environmental and biological samples.

Exposure Analysis

As in human health risk assessment, pathways of exposure are identified that functionally link ecological receptors of interest to sources of contamination. Not surprisingly, many of the pathways are similar to human health exposure analysis: inhalation of contaminated air or dust; dermal exposure; ingestion of contaminated water, soils, and sediments; and ingestion of contaminated food or prey (i.e., bioaccumulation, bioconcentration, and biomagnification). Estimating exposure for the St. Regis/Wheelers Superfund site will necessitate characterization of on-site and off-site contamination. Participants were concerned that on-site contamination might result in a "sink" for organisms that immigrate on-site and accumulate sufficient contaminants to either die or become easy prey for local raptors and other predators. Movements of contaminants off-site may imperil valued terrestrial and aquatic species, as well as impact wetlands and other important ecological systems.

The expert panel and review participants addressed several issues regarding the quantity and quality of existing information for performing an ecological risk assessment. 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.

The panel was also concerned that vegetation growing in the wetlands just off site, between the extraction wells and channel, is directly exposed to groundwater. This vegetation should be sampled to determine possible contamination. Soils in this area should also be characterized for COCs, despite the operation of the extraction wells. Even though the wells have been in operation since 1987, LNAPLs are still being encountered on the other side of the channel.

More meaningful site characterization to support an exposure analysis would result from additional sampling north of the channel near the residential area. The presence of a pipeline and the measurement of PCP and PAHs in Well 118 suggest that sampling should not have been terminated in the well located north of the site. In addition, the possible contamination of aquatic organisms from SVOCs associated with the railroad should be investigated. The railway bed might act as an efficient conduit for the transport of COCs to the lake; contamination from treated railroad ties should also be examined as a possible confounding factor in understanding PAHs released from the site.

The higher molecular weight PAHs are more than likely bound in the sediments and not readily entering into solution. Measurement of PAH concentrations in sediment pore waters appears justified in determining exposure of organisms inhabiting the sediments as well as in quantifying exposures to fish.

Effects Assessment

The nature of effects assessment distinguishes ecological risk assessment from the assessment of human health risks. Ecological risk assessment includes a diverse set of potential ecological impacts of concern rather than the cancer and toxicity endpoints of health risk assessment. Potential effects of concern in ecological risk assessment include, for example, mortality and sublethal impacts (e.g., reduced growth, reproductive impairment, susceptibility to disease and vulnerability to parasites) on individual organisms, alterations in survivorship and fecundity of populations, changes in the structure of ecological communities (e.g., biodiversity), and impacts on ecosystem structure and function (e.g., energy flow, nutrient cycling, stability).

Effects assessment also establishes exposure- or dose-response relationships for the assessment and measurement endpoints. In some instances, the relationship might be defined by a single toxic benchmark concentration (e.g., LC_{50} or EC_{50}). Alternatively, more complex nonlinear dose-response functions with threshold values can define such relationships. Ecological risk assessments of complex sites involving multiple contaminants and many endpoints, such as the situation at Cass Lake, typically use combinations of these different relationships to estimate risks.

As the result of the expert panel review, several issues were raised in relation to assessing ecological effects and obtaining data sufficient to perform a baseline ecological risk assessment for the St. Regis/Wheelers site and areas surrounding Cass Lake. Importantly, a thorough evaluation of available toxicity benchmark databases should be undertaken to determine which, if any, of these data might prove applicable to the endpoints of interest in this assessment. In addition to the toxicity data used in the screening assessment, benchmark data developed at Oak Ridge National Laboratory, Los Alamos National Laboratory, and relevant data published in the peer-reviewed technical literature should be examined and evaluated for application in the Cass Lake assessment. Data developed for the Great Lakes Initiative may prove useful in this assessment and should be examined. The relevant data should be used to construct and manage a database of known quality designed specifically to support the Cass Lake ecological risk assessment.

It is important that toxic equivalency factors (TEFs) be used correctly and consistently throughout the assessment. The assessment should be based on TEFs established by the World Health Organization (WHO, e.g., van den Berg et al. 1998). However, the TEFs used in assessing dioxins and furans do not appear to be the WHO 1998 values. Existing exposure data (i.e., fish data) should be reevaluated using the appropriate TEFs. For samples where detection levels are in question, a range of TEFs should be used to assess the possible ecological ramifications of contamination.

Risk Characterization

In contrast to the emphasis on excess cancer risks and hazard quotients that characterize the estimation of human health risks, ecological risk assessment commonly involves a complex set of measures and models for quantifying risk. Methods for characterizing risks posed by toxic chemicals may include extrapolation of existing data for similar compounds and organisms, controlled experimentation under laboratory conditions, experiments performed under field conditions (e.g., mesocosms), field monitoring, ecological modeling (e.g., Pastorok et al. 2002, Bartell et al. 1992), and expert elicitation; wherein, standardized and generally accepted methods are used to characterize risks on the basis of professional judgment and informed opinion (Ayybub 2001). Usually, several of these methods are combined in an overall weight of evidence approach for estimating ecological risks (Bartell 1996, Suter 1992).

The screening-level assessments performed thus far have been based on simple quotient calculations analogous to the human health hazard quotients. Concerns were expressed that there were inconsistencies in the use of screening-level criteria (e.g., for sediments).

Uncertainties

Many sources of uncertainty are inherent in assessing risks posed by toxic chemicals in complex ecological systems. In addition to the kinds of uncertainties also associated with quantifying exposures in human health assessment (e.g., multiple pathways, spatial-temporal variability, environmental heterogeneity), ecological risk assessments must address uncertainties that result from the incomplete understanding of ecological systems (structural and functional), variability among individual organisms in their response to exposure to multiple chemical stressors, and the natural variability or heterogeneity in other environmental factors that determine the distribution and abundance of species of concern.

The design of sampling programs to collect additional data for an ecological risk assessment should address the above mentioned sources of uncertainty. Uncertainties should be characterized to the extent possible and propagated through the assessment. The estimated ecological risks should be expressed in probabilistic terms (e.g., based on statistical distributions of expected impacts), fuzzy sets, or other means (e.g., intervals) that convey the implications of ecological and toxicological uncertainties in assessing ecological risk.

Habitat-based Approach

Much of the review discussion focused on the kinds of studies that might be performed in specific habitat areas potentially impacted by site wastes. Importantly, the results of such studies, if properly designed and implemented, could provide data and information to support an ecological risk assessment of the site-related contamination.

The following sections briefly outline studies proposed by the panel and review participants for five habitats important to the St. Regis/Wheelers site: (1) the on-site field, (2) local wetlands, (3) the channel area between Pike Bay and Cass Lake, (4) Fox Creek, and (5) lands managed by the U.S. Forest Service. Special consideration was given to the definition of technically defensible studies that could be carried out by tribal staff members following a reasonable investment in training, supplies, and equipment. The list of studies is by no means exhaustive given the comparatively short duration of deliberations by the panel and review participants. In envisioning the proposed studies, the panel focused on three basic questions: what should be done? what can be done? and why should it be done? Refinements and additions to these suggested studies are anticipated.

On-site Field

Interest was expressed in obtaining measurements of the body burdens of organic contaminants in rodents inhabiting, foraging, or otherwise utilizing the large on-site field. The generalized foraging behavior of these organisms might provide an integrated measure of exposure to organisms at lower trophic levels. Impacts of contamination (e.g., increased mortality, reduced fecundity, poor growth) that reduce population sizes of rodents can indirectly affect populations of predators (e.g., raptors) that prey upon these organisms. Ingestion of contaminated rodents may also be an important exposure pathway for such higher level consumers. If possible, different sub-populations should be compared for this site.

Actual body burdens or evidence (i.e., biomarkers) of exposure to PAHs, dioxins, and PCP would be extremely valuable in characterizing risks to rodents and ecologically similar organisms. Many TEFs are derived from studies using rodents. Additionally, description of population sizes or at least determination of the age/sex profile would be useful, as well as observations concerning gonad development. Initial discussions focused on the feasibility of monitoring voles, deer mice, and white-footed mice, although it remains unclear whether these rodents inhabit the area of concern. It appears more likely that gophers could be collected at this site. If such organisms cannot be sampled reliably and in sufficient numbers, studies using caged animals might be conducted to obtain this valuable exposure information, despite the potential logistical problems associated with caged animal studies.

With corresponding sampling and analysis of soils and vegetation from this site, it would be possible to estimate soil-to-gopher or vegetation-to-gopher bioaccumulation factors. These factors would be useful for food chain modeling directed at estimating exposures to higher-level consumers (e.g., raptors) for which direct measures of exposure may prove difficult or infeasible.

Review participants also discussed the value and feasibility of characterizing the impacts of contaminants on plants that occupy this field. Previous observations suggest that many trees, especially pines that grow in this field are stunted. A comprehensive search of the literature for phytotoxicity (including root toxicity) data was recommended in relation to the COCs. Root toxicity could make it impossible for valued plants to grow and survive; surviving individuals may exhibit a reduced ability to resist disease or other stressors (e.g., drought). Concentrations of toxic metals could also be measured in these trees. Toxicity databases, including the USEPA ASTER (Assessment Tools for the Evaluation of Risk) database, should also be examined for existing and relevant phytotoxicity data. The ASTER database is located at the USEPA-MED laboratory in Duluth, Minnesota, and can be accessed through the Internet.

In addition to impacts on populations of plants and consumer organisms, the panel and review members discussed the feasibility of assessing possible impacts of chemical contamination on the ecological functioning (e.g., total respiration) of the soils in this field. Participants remarked that measures of soil respiration have not worked well and perhaps attention might be focused on some measure of nutrient cycling, for example, soil nitrogen. Other tests, such as the earthworm toxicity test, plant toxicity tests, and soil community evaluations, might provide insights regarding functional impacts of soil contamination.

Several participants mentioned the ubiquitous distribution of ground beetles and suggested that these organisms might provide an opportunity (i.e., "sentinel" species) for further examination of the possible impacts of contamination. Demonstrated absence of these organisms from areas known to provide favorable habitat might be indirect evidence of an impact.

One perhaps novel idea was to monitor the body burdens of local pets, particularly dogs and cats that use the site. In addition to direct dermal exposure, these domestic animals might ingest field soils and water, as well as prey upon organisms inhabiting the field.

Wetlands (spray/irrigation area)

Considerable emphasis and concern was expressed regarding the degree of contamination of the wetlands area located to the east of the major on-site field and extraction wells. Measurement of contaminants in soils, sediments, and surface water in this area should receive high priority. The spatial extent of contamination is poorly known because of the absence of samples collected from the fringe areas of the wetlands. This high priority is further justified given that the soils and sediments in this area are subject to groundwater discharge. The high organic content of these soils and sediments also suggests the potential for accumulation of hydrophobic chemical contaminants; the organic layers of wetlands soils (peat) should be sampled for organic COCs.

Samples should be collected in relation to major precipitation events. The existence of a seep along the site is evidence of the possible importance of storm water in the transport of contaminants off-site, possibly into the wetlands adjacent to the site.

In addition to samples of environmental media, the expert panel discussions led to the identification of possible studies and sampling of relevant organisms to further characterize the nature of contamination and potential ecological impacts in the wetlands. Measurements of short-term exposures to PAHs, metals, and PCBs, for example, might be obtained from samples of benthic invertebrates, crayfish, and amphibians. Exuvia from benthic invertebrates and amphibian eggs or tadpoles might provide good indication of exposure. Water beetles might also be collected and analyzed for selected COCs. Samples of vegetation, for example alders, might be obtained to determine if these plants accumulate COCs from contaminated groundwater that has moved off site.

Nesting habitat might be provided to attract tree swallows to the fringes of the wetlands. Sampling and analysis of eggs and nestlings of these birds could provide useful information concerning body burdens of selected COCs, as well as indicate diet composition, including potentially contaminated food items.

Channel Area

Considerable attention was devoted to identifying sampling efforts and studies that might be performed to better characterize contamination and evaluate possible ecological impacts in the channel that connects Pike Bay and Cass Lake. Several of the concerns and recommendations, similar to those outlined for the wetland areas, are directed towards better characterization of contaminants in water and sediments, as well as, sample collections for improved description of possible impacts on selected aquatic and riparian species.

The assessment of ecological risks posed would be greatly facilitated through better characterization of locations of possible inputs of contaminants in the channel. Discharge locations, areas of surface water runoff and groundwater flows into the channel might be identified through examination of existing aerial photographs or analysis of water temperatures, although the patterns of flow might be fairly diffuse. The major mechanisms of transport appear to be groundwater flow and surface runoff. It is important to note that groundwater which is pumped and treated enters the channel as surface water runoff following treatment. Contaminants not captured by the treatment process can readily enter the channel. It should be further noted that the NPDES permit for the surface discharge from the treatment facility to Pike Bay expired in 1997. Its renewal should only occur within the context of the ecological and human health risk assessments suggested by the EJ Panels (this report, Bartell et al. 2002, and McDonald et al. 1999).

High priority should be given to obtaining additional samples of sediments and organisms inhabiting the sediments, for example amphipods, as well as crayfish and other selected benthic invertebrates. At the same time, it was recognized that the interpretation of data developed from additional sediment samples might be difficult because of channel dredging that occurs every few years. These samples of sediments and biota should be analyzed to assess exposures to PAHs; PAH concentrations in sediment dwelling organisms may be in equilibrium with PAHs adsorbed to sediments (or in pore waters). SVOCs are also apparent in the channel sediments, but are not in the water column. Sediment toxicity testing was suggested, along with some simple experiments to assess phototoxicity. Sampling and analysis of larval fish for PAHs and other SVOC were also strongly recommended by the expert panel. Some additional data were collected according to EPA standard protocols (NRRI 1999) by NRRI staff in 1998 (Section 19 in NRRI 2001). These data also should be included in discussions of survey design and final assessment.

As suggested for the wetlands, tree swallow nest box studies could be performed to quantify body burdens of contaminants, including contaminants in tree swallow eggs and nestlings. Diet composition can be ascertained for these birds, and observations of nesting success can be made. The results might extrapolate to functionally similar bird species that inhabit or forage at the site.

Tribal participants expressed concerns that contaminants might be impacting the production of wild rice or perhaps contaminating the rice. As a result of these concerns, contamination should be evaluated in sediments that provide habitat for wild rice.

Fox Creek

Another major area of concern in assessing ecological risks is Fox Creek. One reason for concern is the proximity of the creek to the location of the Cass Lake city dump. LNAPLs have been reported in groundwater samples from the city dump area. In addition, sludge potentially contaminated with organics and metals has been disposed at the dump. As a result, there is considerable potential for contamination of Fox Creek surface waters and sediments. In fact, high concentrations of dioxins have been reported from samples collected at the mouth of Fox Creek and this contamination might well have resulted from dumping. The creek sediments contain high concentrations of metals. Apart from direct ecological considerations, concerns were expressed because local residents fish in Fox Creek. Thus, more comprehensive sampling and analyses of the nature (metals, PAHs, SVOC, and other COCs), distribution, and amounts of contaminants in Fox Creek are warranted. Sampling design should address the possibility of a gradient (i.e., upstream-downstream) of contamination in sediments and riparian soils. For example, organic COCs (e.g., PAH) will accumulate differentially in creek sediments that are enriched with organic carbon; thus, a gradient in the distribution of sediment organic carbon might produce a corresponding gradient in contaminant concentrations and exposure to sediment dwelling organisms. As in the channel connecting Pike Bay and Cass Lake, samples of contaminants in benthic invertebrates, crayfish, amphibians (eggs, tadpoles), and larval fish may provide valuable data for characterizing exposure to COC. Data should be developed and used to estimate sediment-to-fish and sediments-to-cattails bioaccumulation factors.

As in other site-related areas, studies of tree swallow diet composition, measures of body burdens (eggs and nestlings) for selected COCs, and observations of reproductive success can provide additional data and information for risk estimation, including a weight-of-evidence approach to risk characterization.

Food chain models should be constructed to address the accumulation of selected toxic chemicals by wildlife that inhabit or forage within the Fox Creek area, including mink, otter, raccoon, muskrat, and beaver. Contamination (i.e., dioxin) of creek chubs or larval and juvenile bluegill could serve as a source of contamination to fish-eating wildlife and should be evaluated. Additional exposure pathways include ingestion of water, soils, and sediments, as well as dermal exposures.

In addition to better quantifying the distribution of COCs in Fox Creek, more information concerning the toxic effects of site-related contamination on creek biota are needed to support a baseline ecological risk assessment. Clearly, the nature of the contamination argues for performing toxicity tests with Fox Creek sediments. Simple experiments can be performed to determine the relevance of phototoxicity in Fox Creek; samples of benthic invertebrates can be raised in the water column and subsequent mortality reported. Benthic community structure in Fox Creek could also be compared with communities in reference sites. Toxicity studies using surface soils in the Fox Creek watershed can be performed with earthworms, rodents (if available) and perhaps voles or shrews.

Forest Service Area

Discussions of the lands near the site that are managed by the U.S. Forest Service focused on identifying possible sites of historic chemical disposal.

Conclusions and Recommendations

Based on the results of the expert panel review, the Ecological Risk Assessment Panel arrived at the following conclusions and offers several recommendations concerning ecological risks posed by the St. Regis/Wheelers Superfund site.

Conclusions

The essential issues of concern for assessing ecological risks are similar to those expressed in relation to the human health assessment (Bartell et al. 2002).

1. An incomplete screening-level assessment has been completed and the results of the screening indicate that a more comprehensive risk assessment is justified (Tables 1–4).

2. The characterization of on-site and off-site contamination is inadequate to support a meaningful examination of impacts and risks posed by site-related contamination.

3. Evaluation of the quantity and quality of existing data is difficult given current levels of data reduction, analysis, and summarization.

4. Pathways of exposure have not been comprehensively investigated for the diverse assemblages of species potentially at risk.

If the contaminated groundwater plume continues its suspected pattern of movement toward Cass Lake, risks posed by the COCs in the plume to fish and other aquatic organisms could increase markedly in the future.

Limited efforts in ecological assessment at the Leech lake site to date have focused on dioxin and fish. As a result of reviewing existing information and panel discussions, the Panel concludes that the assessment needs to be expanded in terms of ecological endpoints and COCs. The selection of additional species as assessment/measurement endpoints should be guided by cultural practices involving plants and animals valued by the tribe, as well as by the ecological uniqueness of the region.

Recommendations

The panel recommends the following actions to facilitate the necessary ecological risk assessment for the St. Regis/Wheelers Superfund site:

1. Based on the preliminary screening-level results, a scientifically credible and technically defensible assessment of ecological risks should be performed.

2. A more comprehensive ecological assessment will require the collection of additional samples to characterize exposure and additional toxicity benchmark data.

3. The collection and processing of additional samples should be coordinated to improve the characterization of site contamination and provide data and information relevant for both the human health and ecological risk assessments.

4. An important component in improving the site characterization necessary to support an ecological risk assessment involves the derivation of bioaccumulation factors across media, COCs, and species at risk. For hydrophobic organic contaminants, measures of organic carbon in soils and sediments are unavoidable. Lipid concentrations in species of concern are also necessary to evaluate the potential for bioaccumulation of organic contaminants.

5. In contrast to the EJ Human Health Risk Assessment Report (Bartell et al. 2002), the identification of appropriate reference sites will be necessary to complete a meaningful ecological risk assessment. The reference sites should be selected to reflect ecological similarities to the conditions that existed at the St. Regis/Wheelers site prior to the onset of commercial activities.

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Table 1. Summary of ecological 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	5/20	20/20	Not included	-	0/20
Pond A	-	2/2	"	-	0/2
Pond B	-	1/1	"	-	0/1
Pond C	-	1/1	"	-	0/1
Spray/irrig Landfill	-	2/2	"	-	0/2
Residential	0/20	17/20	"	-	1/20
Seep location	0/1	1/1	"	-	0/1
SW/hatchery	1/6	6/6	"	-	0/6
City dump/Fox Creek	-	1/1	"	-	0/1
Other-reference	0/2	2/2	"	-	0/2

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

Table 2. Summary of ecological screening of sediments 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
City Dump/Fox Creek	9/13	9/13	Not evaluated	0/5	6/13
Channel	4/4	9/9	"	-	2/9
Reference	3/6	0/6	"	0/6 [DDT/DDE]	2/6
Cass Lake – deep	1/1	1/2	"	0/4 [DDT,DDE]	0/2
Pike Bay – deep	1/1	0/2	"	-	0/2
Pike Bay Shoreline	0/3	0/5	"	-	0/5

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

Table 3. Summary of ecological screening of surface water 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	2/3	0/4	Not evaluated
Channel	3/3	0/4	"
Reference	2/2	0/2	"
Cass Lake – deep	2/2	0/2	"
Pike Bay – deep	2/2	0/2	"
Pike Bay Shoreline	1/1	0/1	"

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

Table 4. Summary of St. Regis/Wheelers Superfund site ecological exceedences used for screening fish tissue concentrations. In the absence of an "accepted" screening level for dioxins/furans, mammalian and avian "benchmarks" were used for fish tissue (EPA 2002). Fractions indicate number of exceedences over number of samples. Note that units specified for screening levels for PCBs and dioxins/furans in Table C-7 of EPA (2002) appear to be erroneously reported as "micrograms per kilogram of body weight per day."

	Dioxins/furans		PCBs	
Areas	Mammalian	Avian	Mammalian	Avian
Ball Club Lake	3/3	0/3	3/3	3/3
Cass Lake	5/5	0/5	5/5	5/5
Pike Bay	5/5	0/5	5/5	5/5

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

Appendix 1

St. Regis Paper Company Site (Cass Lake, MN) Document List and Description

Provided for
Human Health and Ecological Risk Assessment Panel Participants

January 5, 2000

Site Related Documents

01) Remedial Investigation/Alternatives Report. Barr Engineering
April, 1985

The purpose of the remedial investigation (RI) was to define impacts of past facility operations and waste management practices on public health and the environment. The purpose of the remedial alternatives analysis was to evaluate several remedial actions that are available to mitigate the present or potential future impacts identified during the RI. The report identifies several issues of concern and makes recommendations for remedial action (pp. 106-107) including 1) Excavation and transfer of sludge and contaminated soil into an on site vault, and the construction of a groundwater pump and treat system, 2) Further assessment of the extent of groundwater contamination near the city dump site, including potential impacts on Fox Creek, Pike Bay and the lower aquifer, and 3) Development of a routine monitoring program for surface and groundwater. Included here are the table of contents, executive summary, recommendations and selected tables.

02) Five-Year Review Report, St. Regis Paper Company Site. MN Pollution Control Agency
March 27, 1995

This document evaluates the effectiveness of the remedial actions implemented at the site. It provides recommendations for future monitoring activities including an evaluation of the remnant plume and its potential for impacting the Pike Bay/Cass Lake system. Specifically, it suggests the following: 1) comprehensive sediment and surface water sampling from suspected discharge areas, 2) determination of whether the groundwater contamination is eluding the capture zone of the extraction system incuding the addition of another monitoring well to better define the southern edge of the remnant plume, 3) determine if DNAPL is present in the groundwater and assess its long term impacts on the remedial objectives, 4) conduct confirmatory soil sampling for PAHs, PCP, dioxin and metals to determine relative risk in areas where visibly contaminated soils and sludges have been excavated, and submit a report reviewing the data and making recommendations.

03) Site Review and Update, St. Regis Paper Company Site. — MN Department of Health, March 29, 1995

This report was intended to provide information to the agencies conducting the 5-year review (above). It summarizes current conditions and issues at the site and makes recommendations regarding public health concerns. Issues and concerns highlighted in this report include: 1) identification and continued monitoring of all water supply wells, 2) evaluating wild rice as an exposure pathway for sediment contaminants, 3) Fish contaminant monitoring and consumption, and 4) confirmatory soil sampling and analysis for areas excavated using a "visual" standard. Recommendations made in this report include sealing contaminated wells, continued monitoring of surface and groundwater, identification of eastern edge of the groundwater contaminant plume (which may include additional monitoring wells), and continued efforts toward educating the local population regarding the presence of contamination in the area. Note that comments written on this draft are of unknown origin.

04) Environmental Review Report Champion Wood Treatment Facility — MJ Environmental Consultants Inc., 1997

The report was prepared for the Leech Lake Tribal Council who requested an independent review and evaluation of previous investigative work and remedial actions performed at the site. The report presents an evaluation of the remedial actions at the site and makes several recommendations for additional activities (p. 25) including: 1) collection and analysis of additional soil samples, 2) better define the southern edge of the density plume by installing an additional monitoring well, and 3) a more thorough review of the groundwater flow model currently used at the site. This report also provides an overview of pertinent site documents, reports and administrative orders associated with the remedial investigation and activities performed at the site. Note: appendices not included here.

05) Discussion of site investigation information relevant to five-year review issues. — Champion International Corp., June 1, 1995

This document was prepared for a technical discussion meeting between Champion Int'l., the U.S. EPA, and the Leech Lake Band of Chippewa. Several selected pages of this document have been included here which express Champion's response to some of the key issues raised in the five-year review. The first two pages describe the proposed installation of a new monitoring well (well 222) to better define the southern extent of the remnant plume. This well was to be located south of well 220. To our knowledge, this well was never installed, in fact, Champion refutes the need for a well in this area in their response to the groundwater report (document #8, p. 7). Page three outlines Champion's view on the feasibility of detecting and removing DNAPL (Dense Non-Aqueous Phase Liquids). Page four is Champion's response to the five-year reviews recommendation for additional soil testing. Pages 5-18 contain

Champion's description of the results of their ecological assessment, including several tables which shows the surface water and sediment data results for 1984-1995. We wish to point out that PAH data was only reported for surface water and not for sediments in this assessment (only phenolics in sediments), and further, that sediment data was only reported one year; 1984. Also included are the results of Champion's PCB analysis (pp. 19-20), water supply surveys (pp. 21-25), and city dump pit remedial activities (pp. 26-29).

06) Annual Monitoring Report, 1/98-12/98. Barr Engineering
March, 1999

Annual monitoring reports have been prepared by Barr Engineering for Champion International since 1986. This is the most recent of these reports, which summarizes of the results of monitoring activities at the site for the calendar year 1998. Several of the tables also include monitoring data from previous years, which shows trends of specific contaminants at different locations within the site. Of particular interest are tables 5, 7, 8, 14, 15 and 17. Note: no appendix included here.

NOTE - This section was updated by sending each expert panelist the Year 2000 monitoring data annual report (Barr 2001) prior to their attending the Risk Panel Meetings at Cass Lake, MN in May 2002. This was the most current Annual Report available at that time.

07) Groundwater Panel Report MN Sea Grant
Jan. 11, 1999

Panel was assembled June 16-17, 1998 as part of the EPA Office of Environmental Justice (EJ) grant project to assess the availability, quality and interpretation of existing groundwater data for the site. The report summarizes the panel findings and recommendations.

08) Comments to Groundwater Panel Report Champion International Corp.
March 23, 1999

This document is Champion's response to the groundwater panel report. It addresses specific points made in the groundwater report and also contains the company's chronological list of all reports and documents pertaining to the site.

<u>Future Sampling Efforts</u>

09) Draft field sampling plan for non-time-critical removal... US EPA Region 5
Sept. 1999

10) Draft quality assurance project plan for non-time-critical...

These documents describe the revised field sampling and quality assurance project plan (QAPP) for the proposed EPA/Tetra-Tech 1999-2000 site investigation work.

The entire draft field sampling plan (09), and a selected section of the quality assurance project plan (10) outlining study objectives and design, are included here. Our understanding is that funding for this new field sampling/St. Regis site assessment came from a reallocation of EPA dollars originally earmarked for a contaminated landfill site elsewhere in Minnesota and to be administered by the MPCA. We heard of it at our first meeting with the tribe following the EJ award. Since that time there have been numerous national conference calls and correspondence regarding the sampling design and quality assurance aspects of this study. Following our June 1998 groundwater panel meeting at Cass Lake, EPA region 5 staff indicated that the field survey was expected to be carried out that autumn. Unfortunately, for reasons unclear to us, it still has not occurred.

Points of interest: Table 1-2 of the field sampling plan gives the sampling design and analysis summary (same as Table 1-14 in the QAPP). Table 1-2 of the QAPP shows the types of human health and ecological screening levels to be used for each medium. Tables 1-3 through 1-8 of the QAPP present the specific screening values for each analyte by medium.

11) Draft comments to EPA field sampling plan — Champion International Corp. November, 1999

Champion was invited to review the EPA/Tetra-Tech draft field sampling plan listed above and their draft comments are found in this document.

Detection Levels and Background Concentrations

12) US EPA Region 5 Biological Technical Assistance Group (BTAG) Fish sampling Questions — Region 5 BTAG July 26, 1999

This document gives EPA's perspective on contaminant levels of concern in fish tissue based on risk assumptions, with respect to natural or atmospheric deposition (background) concentrations, and the appropriateness of detection limits based on these levels.

13) Liard River environmental quality monitoring program - selected sections

14) Slave River environmental quality monitoring program - selected sections

The above documents (13-14) describe studies conducted in relatively pristine areas within the Northwest Territories to provide baseline data for contaminants in fish, water and sediments. A general conclusion of these studies is that the measured contaminants levels represent "background" levels for this region, either naturally derived or globally distributed. These studies also used state of the art analytical techniques to achieve very low detection levels. The tribe believes that the contaminant levels in these studies are appropriate for determining "background" levels for the Cass Lake site, and would like to see similar levels of detection. Executive summaries along with data tables for contaminants that are relevant to the Cass Lake (St. Regis) site, are included for each study.

Other Site-Related Information

15) Analytical results from supply well sampling conducted by the MPCA — August 5, 1998

Included here is the cover letter Summary from Jim Seaberg (MPCA)

16) Cass Lake foodweb, precipitation data, maps, fish tissue analyses, and fish consumption advisories

a) Cass Lake-Pike Bay conceptual foodweb

This very general flowchart shows the probable pathways of energy with respect to the main organisms sampled or present in the Cass Lake-Pike Bay system.

b) Local monthly precipitation data (Leech Lake Dam) 1995-1999

This table shows monthly precipitation data for the Leech Lake Dam (approximately 20 miles SE of the Cass Lake site) from January 1995 through August of 1999. Four different statistics are shown for each month (see ELEM code key). Note that total monthly precipitation (TPCP) and departure from normal monthly precipitation (DPNP) are in units of .01 inches.

c) Mercury and PCB fish tissue data for Cass Lake-Pike Bay (1990 and 1996)

This table shows the Minnesota DNR's fish tissue data for Mercury and PCBs. This data was used to establish fish consumption limits. Samples were skin on fillets (FILSK). Six different species were sampled and are represented by the following species codes: WE = Walleye, WSU = White Sucker, YP = Yellow Perch, CIS = Cisco, NP = Northern Pike, LWH = Lake Whitefish.

d) Pike Bay fish tissue analytical summary for HxCDD (1995; 1987-1995).

Cover letter and tables describe the fish tissue sampling and analysis for dioxins (HxCDD) as required by the NPDES permit for the site. Table 2 summarizes all of the fish sampling results up to 1995.

e) MN DNR Fish netting surveys, Fish consumption advisory, and water quality data for Cass Lake and Pike Bay.

f) Lake maps showing depth contours, bottom substrate and primary vegetation for Cass lake and Pike Bay.

General Documents

17) Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 2, Risk Assessment and Fish Consumption Limits — US EPA, July, 1997

Selected tables from this document Provide consumption limits for fish tissue concentrations of the contaminants discussed in these documents. In addition, toxicity profiles for arsenic and PAHs are included as well as information on special group (subsistence population) considerations.

18) Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 3, Overview of Risk Management (Section 3) — US EPA, June, 1996

Describes the positive and negative impacts of fish consumption limits on various populations and subgroups including cultural and societal effects on Native American communities

19) EJ Grant ecological data

This section contains the results of the ecological sampling performed under the EJ Grant. Table 19.1 is a key for the various sampling locations. Figures 19.1a,b and c are maps showing the sampling locations in Cass Lake, Pike Bay and the channel wetland, respectively. The remaining pages are data tables and supporting documents showing the results of PAH and PCP/PCA analysis for the different matrices sampled as listed below:

Table 19.2. PAH and PCP analysis results for surficial (top 5 cm) sediment samples. Also included is a document describing the preliminary results and analysis of the sediment data from Dr. Swackhamer of the U of MN. In addition, Table 19.2a shows a comparison of these data to other "background level" study data.

Table 19.3. Results of metals analysis for surficial sediment samples.

Table 19.4. Results of PAH and PCP analysis of invertebrate tissue samples. Tissue consisted solely of chironomid species.

Table 19.5a. Relative amounts of PAHs and PCP measured in SPMD samplers. These data represent the net accumulation over a six week exposure period. Also included are several figures, tables, and text, demonstrating the principles and properties of contaminant monitoring using SPMDs, as well as some data from other studies which looked at PAH and PCP accumulation by SPMDs. Specifically, table

19.5b and 19.5c show the concentrations of individual PAHs per SPMD measured in an urban creek in Birmingham, Alabama. In addition, tables 19.5d and 19.5e compare concentrations of PCA and PCP sequestered by mussels and SPMDs respectively, in pulp-mill recipient waters in central Finland, while table 19.5f shows the concentration of PCA in SPMDs used to sample the upper Mississippi river.

Table 19.6a. Results of fish tissue analysis for PAHs and PCP/PCA. Also included is table 19.6b comparing the results of the EJ fish tissue data to other "background level" studies.

Microtox Assay: Table 19.7. *Microtox* sediment porewater screen assay results for Cass Lake/Pike Bay sediment samples. Site locations are shown on Figure 19.1 and these are the same sediments collected by NRRI, U of MN for contaminants analyses. The control is microtox diluent (i.e., osmotically adjusted DI water).

Benthic macroinvertebrates: This is a mini-report that presents and summarizes triplicate, petite Ponar dredge samples from transects adjacent to three potential contamination zones and at two reference areas (same transects used for other NRRI, U of MN sediment collections; see Figures 19.1a,b). Benthic macroinvertebrates were sampled from 1.5, 6, and 9 m along each transect.

Appendix 2

Reference List prepared by EJ staff and used over the course of the EJ study:

ATSDR. 1989. Health assessment for St. Regis Paper Company national priorities list site, Cass Lake, Minnesota. Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Public Health Service, April 10, 1989 (sent to EJ Risk Assessment Panelists on May 23, 2001, and added to NRRI 2001 prior to the Risk Assessment Panel meetings).

Barr Engineering Co. 1985. Remedial investigation/alternatives report: St. Regis site. Barr Engineering Co., Minneapolis, MN. Prepared for Champion International/Wheeler Division, (Section 1 in NRRI 2001).

Barr Engineering Co. 1999. Quality assurance project plan: Monitoring activities required by administrative order, January 24, 1995. St. Regis Paper Company Site, Cass Lake MN. Revision 2, February 1999 (stamped DRAFT Date 3-10-99).

Barr Engineering Co. 2001 (and previous years). Annual monitoring report (January 2000 through December 2000), Groundwater and surface water monitoring, St. Regis Paper Company site, Cass Lake, MN. Prepared for Champion International Corporation, March 2001. (Barr 1999 is Section 6 in NRRI 2001; Barr 2000 was sent to EJ Project Risk Assessment Panelists on May 6, 2002 prior to the Risk Assessment Panel meetings.

Bartell, S., C. Richards, R.P. Axler, J. L. Gunderson, and C.A. Hagley. 2002. Human health risk assessment panel report. 25 pp. In: Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. 2002. Assessing and communicating risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands. Final Report to US Environmental Protection Agency, Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program, Duluth, MN 55812 Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002/23.

Bartell, S. C. Richards, R. P. Axler, J.L. Gunderson, C.A. Hagley. 2002. Ecological risk assessment panel report. 24 pp. In: Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. 2002. Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands. Final Report to U.S. Environmental Protection Agency Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program, Duluth, MN 55812 Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002-23.

Champion International. 1995. Discussion of site investigation information relevant to five-year review issues at St. Regis Paper Company site, Cass Lake, MN. June 1,

1995. Prepared for technical discussion meeting of Champion International Corporation, USEPA, Leech Lake Band of Ojibwa. (Section 5 in NRRI 2001).

Champion International Co. 1999. Comments/response to groundwater panel report (McDonald et al. 1999). Champion International Corporation, March 23, 1999 (Section 8 in NRRI 2001).

Champion International Co. 1999. Draft review of field sampling plan. Prepared by Barr Engineering Co. for Champion International Corporation, November 10, 1999.

EPA. 2002. Data evaluation report, St. Regis Paper Company site, Cass Lake, MN (Draft 4-29-02). Prepared for US Environmental Protection Agency Region 5, Chicago, IL by Tetra Tech EM, Inc. Work Assignment No. 948-NS-EE-05J2. Note that this report was sent to EJ Project Human Health and Ecological Risk Panelists on May 6, 2002, prior to the EJ Project Risk Assessment Panel meetings.

EPA.1999a. Draft field sampling plan for non-time critical removal support, St. Regis Paper Company, Cass Lake, Minnesota (Sept. 10, 1999). Prepared for the U.S. Environmental Protection Agency Region 5, Chicago, IL by Tetra Tech EM, Inc. Work Assignment No. 030-NSBN-05J2. (Section 9 in NRRI 2001. Also note that Champion International Corp. submitted a review of this report entitled "Review of field sampling plan," on November 10, 1999, and these comments were included in NRRI 2001 as Section 11).

EPA.1999b. Draft quality assurance project plan for non-time critical removal support, St. Regis Paper Company, Cass Lake, Minnesota (Sept. 10, 1999). Prepared for the U.S. Environmental Protection Agency Region 5, Chicago, IL by Tetra Tech EM, Inc. Work Assignment No. 030-NSBN-05J2. (Section 10 in NRRI 2001).

McDonald, M.E., H. Mooers, and R. Striegl. 1999. Groundwater panel report. 11pp. In: Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. 2002. Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands. Final Report to U.S. Environmental Protection Agency Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program, Duluth, MN 55812 Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002/23.

MDH. 1995. Site review and update, Cerclis No. MND057597940 (March 29, 1995; contributed to MN Pollution Control Agency in 1995). Minnesota Department of Health, Minneapolis, MN. (Section 3 in NRRI 2001).

MDH. 1993. Draft site review and update, Cerclis No. MND057597940, July 22, 1993. By R. Roy and R. Soule. Minnesota Department of Health, Minneapolis, MN

(Sent to EJ Project Risk Assessment Panelists on May 23, 2001, and added to NRRI 2001 prior to the Risk Assessment Panel meetings).

MJ. 1997. Environmental review report: Champion wood treatment facility. MJ Environmental Consultants, Duluth, MN. Prepared for Leech Lake Tribal Council, Cass Lake, MN. (Section 4 in NRRI 2001).

MPCA. 1995. Five-year review report: St. Regis Paper Company site (March 27, 1995). Minnesota Pollution Control Agency, St. Paul, MN 55155, (Section 2 in NRRI 2001).

NRRI. 2001. Risk assessment information packet: Assessing and communicating risk: A partnership to evaluate a Superfund site on Leech Lake tribal lands. Prepared by R.P. Axler and G.S. Peterson for the Leech Lake Tribal Council/University of Minnesota Sea Grant Environmental Justice Project (Grant No. EQ825741). Technical Report: NRRI/TR-2002/22. Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811.

NRRI. 2001b. Ecological data summary for Leech Lake Tribal Council / University of Minnesota Sea Grant Environmental Justice Project (Grant No. EQ825741). Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811. (Section 19 in NRRI 2001, which includes a limited set of tissue and sediment contaminants data collected as per the Quality Assurance Project Plan (NRRI 1999).

NRRI. 1999. Quality assurance project plan: Assessing and communicating risk: A partnership to evaluate a Superfund site on Leech Lake tribal lands. Prepared by G. S. Peterson and R. P. Axler for the Leech Lake Tribal Council/University of Minnesota Sea Grant Environmental Justice Project (Grant No. EQ825741). Submitted to US Environmental Protection Agency Office of Environmental Justice Program, Washington, D.C. (Revised March 12, 1999). Technical Report: NRRI/TR-99-41. Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811.

Richards, C., R.P. Axler, J.L. Gunderson, C.A. Hagley, and M.E. McDonald. 2002. Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands. Final Report to U.S. E.P.A., Environmental Justice Program, Grant No. EQ825741. University of Minnesota Sea Grant Program, Duluth, MN 55812 Publication No. CT 13 and Natural Resources Research Institute Technical Report No. NRRI/TR-2002/23.

Appendix 3

Preliminary Ground Penetrating Radar Survey

Conducted by Howard Mooers and Nigel Wattrus
University of Minnesota Duluth

Report prepared by Howard Mooers
Professor of Geology
Department of Geological Sciences
University of Minnesota
10 University Drive
Duluth, MN 55812

Introduction

One of the recommendations of the EJ Project Groundwater Expert Panel was that better characterization of the site stratigraphy would aid in the study of contaminant transport. A specific recommendation was better characterization of the surface of the till confining layer beneath the site. It was suggested that topographic undulations common to till surfaces could be serving to pool dense contaminant phases (DNAPLS) in low areas. The panel suggested that in this case it might be possible to recover some of the contaminants or at least better model their fate. The recommendation of the panel was to use ground penetrating radar to determine the microtopography of the till surface.

In rebuttal, consultants for Champion International Corporation suggested that the till surface was essentially a plane without any topography, and that if DNAPLS were present they would be expressed as a thin film on the level till surface and be unrecoverable.

To investigate the nature of the surface of the confining till layer, ground penetrating radar was used to survey the stratigraphy. The survey was done by the Department of Geological Sciences at the University of Minnesota Duluth under the direction of Howard Mooers and Nigel Wattrus. The results of the survey are presented below.

Till Basics

Deposition of till in glacial systems occurs by several mechanisms. These mechanisms are typically divided into four main groups: lodgement, meltout, flow till, and deformation tills.

a) Lodgement – the process where sediment melting out of ice at the base of a glacier is "lodged" into place by the weight of the overlying ice. This process leads to the deposition of dense sediment with low hydraulic conductivity (hence a confining layer).

b) Meltout till is formed by the melting of debris-laden stagnant ice. Sediment is simply let down and deposited as interstitial ice melts.

c) Flow till is typically an ice-surface meltout till that is redeposited by mass movement such as gravity flows.

d) Deformation till is formed from the subglacial deformation of sediment beneath an actively flowing glacier.

The till at the St. Regis site in Cass Lake is the Hewitt Till, which is defined as a lodgement till by Goldstein (1986, 1989, 1998). The topography of lodgement till surfaces typically ranges from undulating to hilly and can be characterized by a variety of landforms such as drumlins, flutes, etc. It is the very nature of lodgement till surfaces to be undulating, reflecting the conditions at the glacier base. A survey of lodgement till surfaces around Minnesota and Wisconsin, in particular a survey of the topography of the Hewitt till where it is exposed a few 10s of miles to the south of Cass Lake, reveals that that there are several scales of topography. At the large scale the till is drumlinized and at smaller scales the surface undulates. The typical undulations or microtopography, are on the order of a few meters (5-15 m) apart with vertical scales of 0.5 to 1 meter.

Ground Penetrating Radar (GPR) Survey

After consultation with the Tribe, it was decided to conduct a GPR survey on a privately-owned property adjacent to the St. Regis site (Figure 1). An area was chosen that was level, free of trees, and along a public street adjacent to the site. A reference marker was placed at the SE corner of the area to be surveyed from which all measurements, both spatial and vertical, were made. Transects were laid out in an east-west orientation along which the radar survey was made. Transects were 36 meters long and spaced 0.5 meters apart (Figure 1). It was calculated that the ideal spacing for the transmitting and receiving antennas was 2 meters, and that for best resolution the radar soundings should be made every 0.5 meters. A tape divided into 0.5-meter increments was laid out along each transect. Antennas were then moved and soundings made every 0.5 meters for a total of 72 sounding per transect. The elevation of each of the points at which sounding were taken was then surveyed with an optical level relative to the reference marker.

The GPR soundings were made with a Pulse Ekko system manufactured by Sensors and Software using 100MHz antennas. The data were then processed using PulseEkko Ekkotrace and SU seismic processing software from Colorado School of Mines. The data were reformatted to SEGY, the industry standard. Gains were applied, geometry was added, and the data were loaded into a seismic interpretation software, TKS by Seismic Micro Technology, where the data are treated as a 3-D seismic data volume.

Results

Figure 2 is an example of the radar profiles and Figure 3 is a color shaded contour map of the till surface below the study location adjacent to the St. Regis site. The microtopography on the till surface at this location is similar to that elsewhere on the Hewitt Till. Undulations have spatial dimensions of 5-15 meters; the vertical relief is up to 1.5 meters. These undulations are of the scale that was anticipated by the members of the Groundwater Panel, and their characterization would constitute an important component of site geological assessment. Given the scale and relief of the microtopography on the till surface, there is certainly the possibility that pools of DNAPLS are present at the site.

References Cited

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Goldstein, B. S. 1998. Quaternary stratigraphy and history of the Wadena drumlin region, central Minnesota. In: Contributions to Quaternary Studies in Minnesota. C.J. Patterson and H.E. Wright, Jr. Eds. Minnesota Geological Survy Report of Investigations 49.

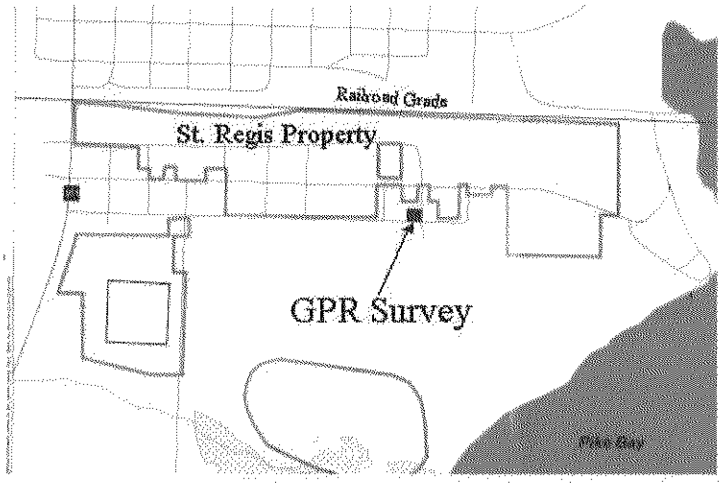

Figure 1. Location of GPR survey.

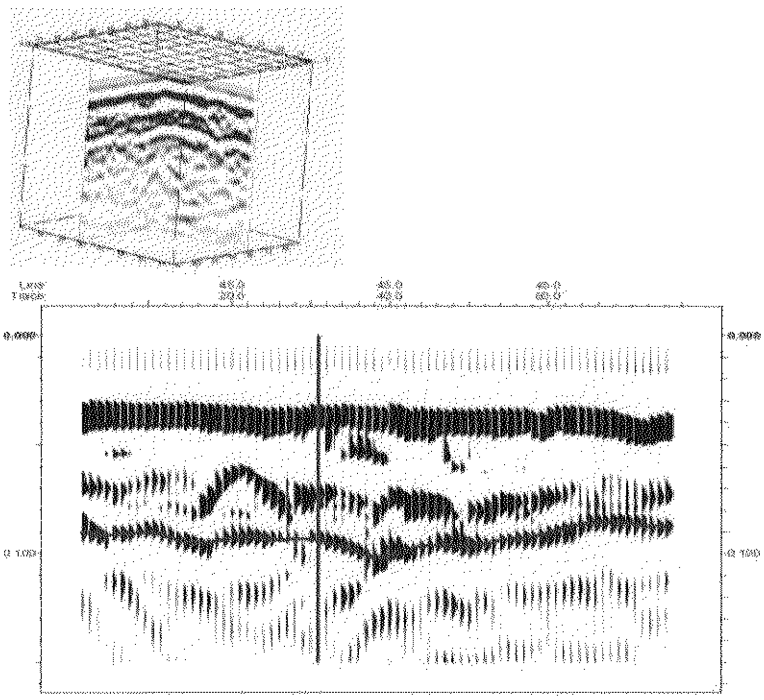

Figure 2. This is an example of the type of data collected during the site survey. Figure 2a is two intersecting sliced through the seismic volume and Figure 2b is a single line trace. Darkly shaded areas are those where there is a large impedance contrast caused by abrupt changes in material properties. The red line denotes the surface of the till confining layer.

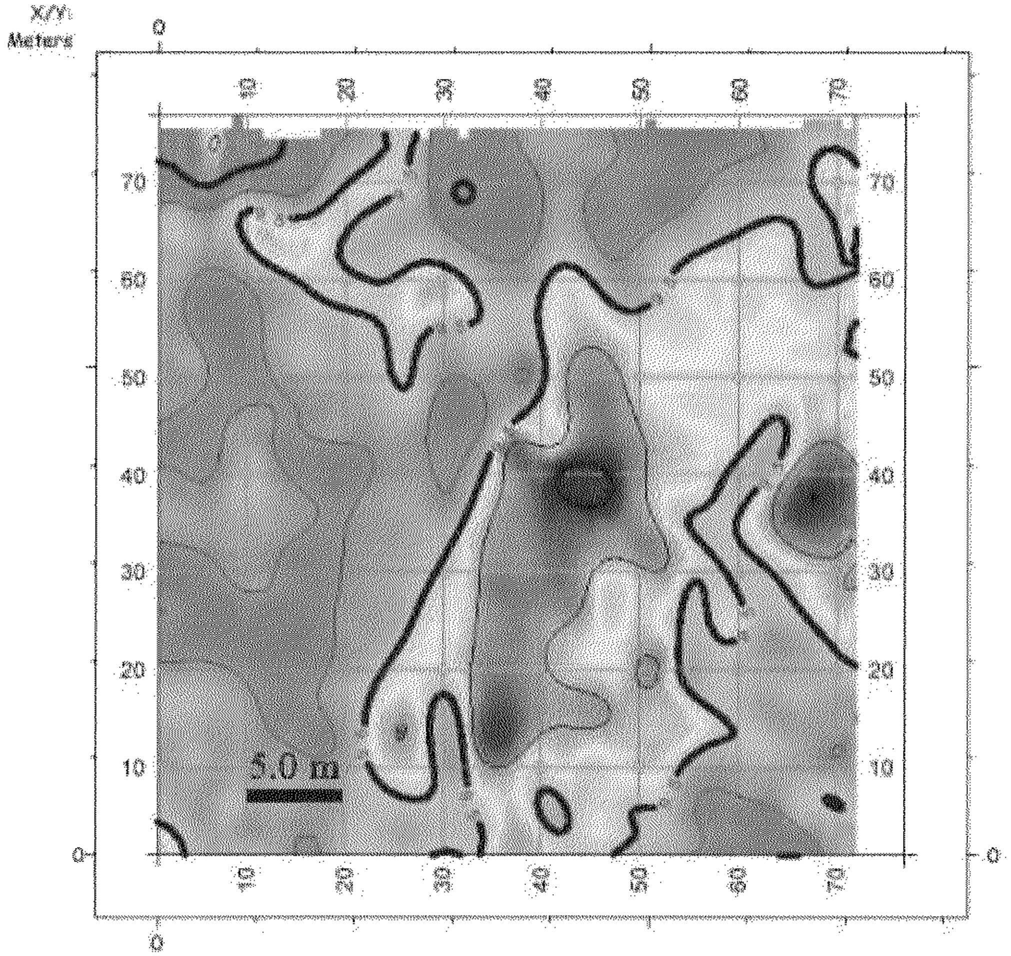

Figure 3. Color shaded contour map of the surface of the till confining layer. Contour interval is 0.5 meters with bold contours every one meter. Note that the maximum relief on the surface is approximately 2 meters with 1.5 meters. Bar scale is in meters. Numbers along the side of the diagram are seismic lines, each spaced 0.5 meters apart.

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

University of Minnesota Sea Grant and Natural Resources Research Institute

Contents of CD

Folder I. <u>**Adobe Acrobat**</u> – This folder contains Adobe Acrobat Reader for four different computer operating systems – Macintosh, Windows 2000/XP, Windows ME, and Windows 98.

Folder II. <u>**Environmental Justice Reports**</u> – This folder contains the reports from the U.S. EPA Environmental Justice project "Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands."

Folder III. <u>**Chemicals of Concern**</u> – This folder contains information collected from the ***Agency for Toxic Substances and Disease Registry*** (ATSDR) Web Site on contaminants that may be associated with the Superfund Site located in Cass Lake, MN. A sub-folder was created for 17 contaminants/chemicals of concern. Each sub-folder contains three files **(1) ToxFAQ, (2) Public Health Statement,** and **(3) Toxicity Profile.**

Folder IV. <u>**Helpful Information**</u> – This folder contains **(1) Concentrations.pdf**--This file contains information to help understand the units used to describe chemical concentrations. **(2) Conversion Tables.pdf**--This file helps convert between metric and English units. **(3) Glossary of Terms.pdf**--This file provides definitions for many of the terms frequently used in discussing contamination and health risks. **(4) Chemical Hazard Label.pdf**--This file describes the National Fire Protection Association standard system for indicating the health, flammability, and reactivity hazards of chemicals.