Appendix A6.2

Laos POPS Training Workshop

Hatfield
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Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia

Report of the National Training Workshop

Water Resources and Environment Research Institute (WRERI)

Vientiane, Lao PDR
January 28 - 31, 2009

Canadian International Development Agency

Agence canadienne de développement international

Hatfield CONSULTANTS

2007 Award Recipient
For Excellence in Corporate
Social and Ethical Responsibility

REPORT OF THE NATIONAL TRAINING WORKSHOP, VIENTIANE, LAO PDR JANUARY 28 – 31, 2009

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LIST OF ACRONYMS

CALUX	Chemically Activated Luciferase Gene Expression
CCME	Canadian Council of Ministers for the Environment
CIDA	Canadian International Development Agency
GCMS	Gas Chromatography Mass Spectroscopy
GIS	Geographic Information System
HHRA	Human Health Risk Assessment
HPT	Hatfield POPs Project Team
NC	National Consultant
NFP	National Focal Point for POPs
NIP	National Implementation Plan
PCBs	Polychlorinated Biphenyls
PF	Problem Formulation
PIP	Project Implementation Plan
POPs	Persistent Organic Pollutants
POPs Project	Regional Capacity Development Program for Management of Health Risks of Persistent Organic Pollutants in South East Asia
RA/RM	Risk Assessment/Risk Management
SOPs	Standard Operation Procedures
WREA	Water Resources and Environment Administration
WRERI	Water Resources and Environment Research Institute
USEPA	United States Environmental Protection Agency
XDS	Xenobiotic Detection Systems Inc.

ACKNOWLEDGEMENTS

Hatfield Consultants and the POPs Project Team would like to express our sincere appreciation to the many individuals who have played significant roles to date in the *Regional Capacity Development Program for Management of Health Risks of Persistent Organic Pollutants (POPs) in South East Asia* (hereafter referred to as the POPs Project).

Special acknowledgements are due to the World Bank Project Task Team, including Dr. Jitendra (Jitu) Shah, Dr. Catalina Marulanda and Mr. Manuel Cocco, for their support and assistance with all aspects of project implementation. We would also like to thank the Canadian International Development Agency's (CIDA) POPs Fund, for financially supporting the POPs Project.

We would also like to thank Mme. Monemany Nhoybouakong, Director General of the Environment Research Institute, Water Resources and Environment Administration (ERI/WREA) for her strong support and guidance. Our sincere thanks also go to all POPs Team members in Lao PDR, including the Department of Chemicals, Ministry of Defence, and the management of the Sok Pa Loung EDL Transformer Repair Workshop for their technical contributions and positive collaboration, which ultimately led to the success of the case study development and other project activities.

Our thanks also go to all relevant national agencies for their active support and invaluable contributions to the POPs Project. Special thanks also go to relevant Lao PDR ministries, organizations, universities, and research institutes for their active participation in the National Training Workshop.

1.0 INTRODUCTION

The enclosed report for the *Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia* (POPs Project) provides a brief summary of the National Training Workshop which took place in Vientiane, Lao PDR from 28th – 31st January, 2009.

The POPs Project was developed to complement the National Implementation Plans (NIP) for the Stockholm Convention on Persistent Organic Pollutants (POPs). Funding for the POPs Project is provided by the Canadian International Development Agency's (CIDA) POPs Fund, and is coordinated by the World Bank. Hatfield Consultants Partnership (Hatfield) has been commissioned by the World Bank to implement the technical components of the Project. Complementary program activities are also being implemented by national consultants and World Bank staff.

The National Training Program and training materials were developed through a series of consultations with key stakeholders in the World Bank and all participating countries. The Hatfield Project Team (HPT) and the World Bank conducted three rounds of consultations with the National Focal Points (NFPs) and other key National Stakeholders in Cambodia, Lao PDR, Malaysia and Thailand (in August, November, and December 2008). During the missions to Asia, the HPT discussed potential involvement of other regionally participating countries, China, Indonesia, the Philippines and Viet Nam, in one of the National Training Workshops. The Training Workshop participants were identified by the Project Team (Hatfield, National Consultant, and World Bank) and approved by the respective National Focal Points.

Lao PDR's National Training Workshop was organized by the World Bank and the Environment Research Institute of the Water Resources and Environment Administration (ERI/WREA), in Vientiane, Lao PDR from the 28th to 31st of January, 2009. The final training schedule is provided in ***Appendix A1***. The HPT was responsible for preparing the training material for the workshops, for delivering its content, and for providing facilitation and moderation of ensuing discussions.

In Lao PDR, 62 participants took part in the National Training Workshop, including representatives from all 17 Provinces of Lao PDR and Vientiane Capital City. The participants were from various government agencies, organizations and academic institutions. The World Bank and HPT took part in the training as facilitators and resource persons (***Appendix A2***).

1.1 OBJECTIVES OF THE NATIONAL TRAINING WORKSHOP

The primary objective of the POPs Project is to enhance the capacity of the key government officials and decision makers in the South East Asia Region[1] to apply Risk Assessment (RA) in the setting of Risk Management (RM) strategies to reduce chemical exposure-related human health risks to an acceptable level. Improved regional cooperation as part of a broader chemical agenda is a secondary objective of the program.

In line with the overall objective of the POPs Project, the main objective of the National Training Workshop was to provide participants from key government agencies, academic institutions and other relevant organizations with background knowledge concerning RA and RM of POPs contaminated sites, and also to raise awareness of information and tools available on the POPs Toolkit website (www.popstoolkit.com).

2.0 OPENING SESSION

Mme. Monemany Nhoybouakong, Director General of the ERI/WREA, and Member of Cabinet of WREA delivered an opening speech on behalf of the Government of Lao PDR. She warmly welcomed all the participants, the World Bank Team and the POPs HPT to the National Training Workshop.

Mme. Monemany highlighted the importance of the POPs Project for improving the capacity of government officials, decision-makers and academic researchers in Human Health Risk Assessment (HHRA). Mme. Monemany extended her sincere appreciation to the World Bank and CIDA for their generous support of the project, and to the HPT for their technical inputs.

Dr. Catalina Marulanda, on behalf of the World Bank, welcomed all participants. She expressed appreciation to the WREA for hosting the National Training Workshop. Dr. Marulanda also acknowledged the Canadian Government for funding the POPs Project, and then made a brief presentation about the POPs Project progress and future activities. Dr. Marulanda's presentation is summarized below.

What Is the Purpose of the Training?

- The Workshop was designed to provide decision-makers with tools to evaluate the risks of environmental problems (e.g. exposure to hazardous chemicals from a hotspot).

[1] This includes relevant agencies in the program countries - Cambodia, Lao PDR, Malaysia, and Thailand, as well as countries which were invited to participate in the regional workshops, namely China, Indonesia, the Philippines, and Viet Nam.

Why?

- Too many problems and not enough resources - financial, human, or technical:
    - Need to prioritize to make better use of resources, and
    - Need to be strategic to maximize impacts.

How Will this Training Help?

- The goal is to strengthen local capacity to:
    1. Assess health risks from exposure to chemicals;
    2. Manage risks by identifying and prioritizing interventions and by putting in place adequate measures to reduce risk; and
    3. Promote regional cooperation when tackling complex environmental problems.

Risk Assessment/ Risk Management Training

- Training has provided the foundation to conduct risk screening. Practice will be needed to become expert risk assessors/managers;
- Methodology for RA can be applied to all types of chemicals from all types of sources;
- Risk communication is critical as the first step in risk management (i.e. awareness raising); and
- Economic valuation/assessment is also a way to convince policy-makers that the problem is important.

Information Exchange

- Interagency coordination is key;
- Decision makers from all relevant sectors should be involved in order to make the right decisions;
- Regional cooperation will be critical in the future to tackle the complex challenges of environmental management; experience is available in the region, so there is no need to reinvent the wheel; and
- The POPs Toolkit website (www.popstoolkit.com) will continue to exist beyond the lifetime of the project. The website can be used to share information between country participants (e.g. public awareness initiatives and material, regulatory frameworks, etc.). A discussion board is available to participants from eight countries for ease of information exchange until the end of the project.

Final Regional Workshop

- The Final Regional Workshop will be conducted in late May 2009;
- All 8 countries will be invited to participate; and
- Venue is yet to be decided.

Dr. Marulanda also invited participants to share their ideas/topics, and to suggest possible locations for the Final Regional Workshop. She encouraged all participants to take an active part in the Training Workshop, and to use the POPs Toolkit in the future for HHRA and RM for POPs and other persistent toxic substances.

Figure 2.1 Opening Session of National Training Workshop, Vientiane, Lao PDR, January 28, 2009

3.0 OVERALL WORKSHOP PROGRAM

The National Training Workshop covered the following training modules/sessions:

- Session 1: Key Objectives of the National Training Workshop, and Background on the POPs Project and POPs Issues;
- Session 2: Introduction to the POPs Toolkit;
- Session 3: Overview of Human Health Risk Assessment;
- Session 4: Site Prioritization Tool - Overview and Hands-on Application;
- Session 5: Presentation of Sok Pa Loung EDL Site Case Study;
- Session 6: Key Steps in the Risk Assessment Process;
- Session 7: Introduction to the Preliminary Quantitative Risk Assessment;
- Session 8: Introduction to the Economic Analysis Training Module;
- Session 9: Risk Governance Framework - Risk Management Process and Group Discussion on the Risk Management Strategy for the Selected Study Site; and
- Session 10: Wrap-up and Evaluation of the Toolkit and Workshop.

3.1 SESSION 1: BACKGROUND ON THE POPS PROJECT AND POPS ISSUES AND KEY OBJECTIVES OF NATIONAL TRAINING WORKSHOP

Mr. Thomas Boivin, on behalf of the POPs HPT, thanked the WREA for hosting the workshop, and all Lao PDR representatives for participating. Mr. Boivin explained that POPs management involves various disciplines including science/toxicology, social sciences, economics and governance issues, and requires collaboration among concerned government agencies and stakeholders at the national and local levels. Mr. Boivin stated that at the Training Workshop participants would become familiar with the methodologies, tools and step-by-step process of POPs HHRA and management, and he invited participants to provide comments and suggestions for improving and finalizing the POPs Toolkit.

Mr. Boivin then presented background information on POPs issues, the POPs Project, and the key objectives of the National Training Workshop. The presentation is provided in ***Appendix A3***.

3.2 SESSION 2 – INTRODUCTION TO THE POPS TOOLKIT

Mr. Thomas Boivin introduced key sections and sub-sections, and other features and links available in the POPs Toolkit. He stressed that the main objective of the session was to familiarize the participants with content and features of the Toolkit. A summary of the Toolkit in the English language is provided in ***Appendix A4***.

3.3 SESSION 3– OVERVIEW OF HUMAN HEALTH RISK ASSESSMENT

Session 3 included a presentation and plenary discussion, as described below.

3.3.1 Presentation

Mr. Mike Rankin presented an overview of the RA Framework (***Appendix A5***). The presentation covered the following key areas:

- Main Characteristics of POPs;
- Rationale and Objectives of Risk Assessment;
- Integrated Risk Management Framework for Contaminated Sites;
- Basic Elements to Successful Risk Assessment;
- Key Questions for Multi-Site POPs Programs;
- Concepts and Components of Risk;
- Elements and Steps of Risk Assessment; and
- Risk Characterization.

3.3.2 Questions and Comments about Risk Assessment

A number of questions were raised regarding the toxicity of POPs, location of key hotspots, and appropriate means of identifying toxic chemicals.

The discussion centred on the applicability of risk assessment methodologies and tools in the POPs Toolkit for other hazardous substances. The HPT emphasized that the POPs Toolkit could also be used for assessing risks from other contaminants (e.g. lead, arsenic, etc.).

3.4 SESSION 4 - SITE PRIORITIZATION TOOLS

Session 4 included an introduction to the site prioritization tools (pre-screening tool and site prioritization tools), as well as the hands-on application of the tools, followed by a general discussion.

3.4.1 Overview of the Tools

Mr. Rankin presented the background on site prioritization, emphasizing the need for countries to select the most important contaminated sites for assessment (***Appendix A6***).

3.4.2 Hands-on Application of the Tools and General Discussion

The participants were split into small groups of three people and asked to use the Toolkit to prioritize their sites (real or make believe). In general, the participants found the tool very useful in supporting decision making of priority sites for risk assessment and management.

The pre-screening tool was used to assess suitability of the sites according to the following: i) data availability; ii) presence of chemical hazards of concern; and iii) safety for conducting risk assessment, e.g. potential risk from landmines and UXOs.

During the workshop, the issue of use/misuse of agricultural and industrial chemicals was discussed. The HPT confirmed that at high concentrations, these chemicals can be very toxic and hazardous to receptors. Precautions should be taken when applying and handling all agricultural and industrial chemicals. Specific information about the chemicals used in each product should be obtained to understand its potential toxicity and ability to persist in the environment. Another group of chemicals that can be toxic or cause allergic reactions are food preservatives.

Dr. Jitu Shah, World Bank, asked the participants to identify and prioritize POPs issues that could be addressed with available resources (financial and human). Dr. Shah emphasized that the POPs problem will only be resolved if key stakeholders from various disciplines are involved in the solution, and by providing capacity building for future risk assessors and chemical managers.

Figure 3.1 Plenary Session and Hands-on Application of the POPs Toolkit, Vientiane, Lao PDR

3.5 SESSION 5: PRESENTATION OF SOK PA LUONG EDL SITE CASE STUDY

Session 6 included a presentation of the case studyconducted at the Sok Pa Loung EDL site, Vientiane, Lao PDR, and a general discussion.

3.5.1 Presentation on Sok Pa Loung EDL Site Case Study

Mr. Khonekeo Kingkhambang, representative of Lao PDR POPs Team, presented the case study results for the Sok Pa Loung EDL site (***Appendix A7***). The presentation was followed by a 40-minute plenary discussion.

3.5.2 Comments and Discussion

The participants noted that it was challenging to categorize a contaminated site based only on a screening level risk assessment. The risk assessment performed as part of this case study only examined a specific group of toxic chemicals (i.e., POPs, not metals or other contaminants) and was based on a limited number of

samples. However, the results of the preliminary risk assessment of the site indicated that there is a potential elevated human health risk associated from exposure to PCBs.

The participants proposed that the results be disseminated to policy makers and the responsible authorities, so that immediate action could be taken. They also recommended that a public awareness campaign and training on PCB hazards be conducted in Lao PDR. Methods for improving risk communication and accountability were also discussed.

Dr. Marulanda encouraged the participants to do more research to determine if there might be other sites that may be of greater concern, requiring the application of a RA and RM approach.

3.6 SESSION 6: KEY STEPS IN THE RISK ASSESSMENT PROCESS

Mike Rankin introduced the key steps in the Risk Assessment process (***Appendix A8***), including:

- Preliminary Data Collection;
- Field Data Collection and Analysis;
- Problem Formulation and Risk Assessment Problem Formulation Worksheet Tool;
- Identification of Chemical Hazards:
- Identification of Receptors;
- Identification of Exposure Pathways;
- Conceptual Site Exposure Model;
- Exposure Analysis;
- Toxicity Analysis; and
- Risk Characterization.

3.7 SESSION 7: RISK CALCULATION TOOL – PRELIMINARY QUANTITATIVE RISK ASSESSMENT (PQRA)

Session 8 included an introduction to the risk calculation tool, hands-on application of the tool, and a general discussion.

3.7.1 Presentation and Hands-on Application of the Risk Calculation Tool – Preliminary Quantitative Risk Assessment (PQRA)

Mr. Rankin introduced the Preliminary Quantitative Risk Assessment (PQRA). The session covered selected risk assessment tools available in the POPs Toolkit for estimating human health risks (***Appendix A9***).

3.7.2 Comments and Discussion

Use of the PQRA tool was challenging for some of the participants, as many had limited experience with performing risk assessments. Additional training was requested to help improve understanding of basic concepts related to toxic chemicals and risk assessment.

The HPT explained that, to determine if a chemical was present at potentially hazardous concentrations, site chemical data were screened against environmental quality guidelines. For the purposes of the Sok Pa Loung EDL Site risk assessment, the USEPA Risk Based Concentrations were chosen because they are relatively complete, covering a large number of potential chemical contaminants. In addition, by using a common guideline, risk assessments could be compared between each of the four participating countries (Lao PDR, Cambodia, Thailand and Malaysia).

3.8 SESSION 8: ECONOMIC VALUATION OF POPS IMPACTS

Mr. Boivin introduced the main objective and progress of the economic valuation component; an important part of the overall risk assessment and risk management process. He also presented the training module on economic aspects, focusing primarily on the preliminary results of the economic analysis, and the significance and usefulness of such analysis for policy-making (***Appendix A10***).

3.9 SESSION 9: RISK MANAGEMENT DECISION MAKING PROCESS

Session 9 included two major parts, namely the presentation of the risk management process, and a group discussion on the proposed risk management strategy and action plan for the Sok Pa Loung Case Study Site.

3.9.1 Presentation on the Risk Management Decision Making Process

Mr. Sokhem Pech presented the role of risk management in the overall risk governance framework and major steps and characteristics of successful risk management (See ***Appendix A11***). The presentation was followed by a group discussion session to develop the risk management strategy and action plan for the Sok Pa Loung Case Study Site.

Figure 3.2 Group Discussion on Risk Management Strategy and Action Plan for the Case Study Site, Vientiane, Lao PDR

3.10 GROUP DISCUSSION ON RISK MANAGEMENT FOR SOK PA LUONG EDL SITE

The participants were assigned to four groups to discuss risk management options for the Sok Pa Loung Case Study Site (See ***Appendix A12***). The topics for the Group Discussion were prepared by the HPT in consultation with the World Bank and WREA (***Appendix A13***).

During the risk management group discussion and plenary session, the Workshop discussed the following key topics:

1. What are the potential risks associated with the site? How will risks evolve with time and is there a need to worry about this?

2. What are the management options for the site? What are the potential costs of implementing them?

3. What additional monitoring and remediation should be conducted? What are the potential costs of implementing them? Who should be reviewing the monitoring results and how often? Who should be notified of the monitoring results?

The Group Discussion was followed by a presentation of the Group Discussion results and a plenary discussion of the outcomes (***Appendix A14***). The revised risk management goals, objectives, indicators, and shortlisted risk management options were incorporated into the risk management section of the Risk Assessment Report for the Sok Pa Loung Site (**see *Appendix A4*** of Progress Report 2).

Key outcomes from the group discussion are summarized below:

- It was understood that there are currently no specific actions undertaken by the responsible authorities to mitigate potential PCB exposure at the site. However, the preliminary quantitative RA suggests that the human health risk level is high, and the concentrations of PCBs in the environment samples and blood of workshop workers are notably higher than international and Lao PDR background concentrations;

- Risk is expected to evolve with time if proper RM actions are not undertaken now. The greatest concern is for the health of the workers, families and local ecosystems. Without treatment and proper prevention, contaminant releases into the environment are expected to increase. The potential risk also increases with rapid population growth, and land use changes occurring in the area; and

- The site is a concern because of:

    - The potential risks to human health (from the results of the risk assessment); and

    - Responsibility/liability that the site may pose to the authorities (e.g. cost of remediation, reputation and relations with community, and potential health risks to workers at the site, and nearby property owners).

The following section provides the key recommendations for the risk management of the SPL site:

- Develop and enforce an occupational health and safety plan;

- Monitor and verify effectiveness of mitigation strategies;

- Conduct risk communication and training;

- Undertake measures for controlling and containing PCB Hazards;

- Cap the hot spot surface to control erosion of soil surfaces by rain and wind, and to reduce potential off-site transport; and

- Governance – adopting and enforcing law and regulations controlling POPs.

Given the limited resources and competing priorities, the risk management strategy for the site should focus primarily on simple and implementable risk management options for the site, with more detailed clean-up operations follow later. The emphasis of risk management should be on capacity building, public awareness, and putting in place and enforcing a health and safety plan and other emergency prevention and control procedures.

Dr. Marulanda stated that simple and cost-efficient risk management options for the site should be considered. Preventing POPs releases into the environment should be the priority.

3.11 SESSION 10: WRAP-UP OF THE TRAINING WORKSHOP

Dr. Marulanda thanked the participants for their active participation. She stated that the National Training Workshop attained its goal of increasing participants' awareness and capacity. She underlined that the POPs Toolkit would be finalized in the coming months and made available for future risk assessment and management in Lao PDR.

Mr. Boivin thanked Mme. Monemany from WREA for organizing the training workshop, and all participants for their active involvement. Mr. Boivin also acknowledged the World Bank and the Canadian Government for their technical and financial support.

Mme. Monemany, on behalf of the WREA, expressed her appreciation to the World Bank and HPT for conducting the training workshop. She stated that the participants had grasped the basic concepts of risk assessment and risk management. Mme. Monemany also emphasized the importance of the economic valuation in drawing attention of the policy makers to the issue of POPs impacts. Mme. Monemany stated that, in spite of budget constraints, Lao PDR would develop a risk management action plan for the Sok Pa Luang site including public awareness, training, and other cost-effective risk reduction measures. She hoped that participants would make good use of the POPs Toolkit and provide comments for improvement.

In recognition of the successful completion of the training program, Mme. Monemany, Dr. Marulanda and Mr. Boivin presented all participants with a Certificate of Completion for the RA/RM Training.

Figure 3.3 Closing Ceremony of National Training Workshop, Vientiane, Lao PDR

3.12 TECHNICAL VISIT TO CASE STUDY SITE

On Saturday, January 31, 40 participants took part in a field visit to the Sok Pa Loung Site organized by EDL. Before the start of the tour, the HPT and WREA staff asked the participants to apply their risk assessment and risk management knowledge to identify potential hazards, pathways and potential receptors, and to consider appropriate risk management options.

Mr. Senthep, Deputy Manager of the Sok Pa Loung Transformer Repair Workshop, gave a tour of the Workshop, EDL compound, and nearby residential areas. A discussion followed on the problem formulation and risk management options for the site. The participants demonstrated a good understanding of the case study by pointing to all relevant hazards/risks, pathway and receptors. The discussion then focused on the preferred risk management options, including: i) site clean-up through removing contaminants from the workshop and nearby environment (sediment drainage, sediment soil/dust); ii) a containment facility and control of off-site transport of contaminants; iii) health and safety plan, with enforcement; and, iii) awareness raising and capacity building for the Sok Pa Loung staff and community.

Figure 3.4 Technical Visit to the Case Study site, Sok Pa Loung EDL Center, Vientiane, Lao PDR.

4.0 POPS TOOLKIT AND NATIONAL TRAINING WORKSHOP EVALUATION

The participants were asked to complete questionnaires/evaluation forms at the end of the National Training Workshop. The POPs Toolkit and National Training Workshop Evaluation forms were administered to the participants by the World Bank Team. The responses to the workshop were generally very positive.

The HPT appreciates the feedback provided by all respondents. The results allowed the HPT to evaluate the technical content, usability and user-friendliness of the POPs Toolkit, and the quality of the Training Workshop. The responses by participants are summarized in the figures and graphs in the following sections.

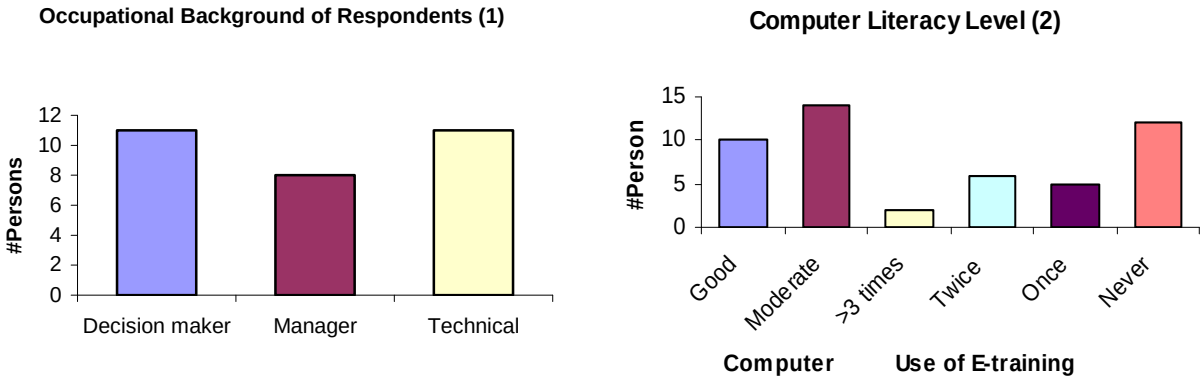
4.1 RESPONDENTS BACKGROUND

A total of 32 of the 53 trainees (60%) submitted their Evaluation Forms; however, 3 questionnaires were excluded from the evaluation because they had not been properly completed. Valid responses are therefore available from 29 respondents; of these, 17% were female and 83% were male. The Evaluation Forms were decoded, data were entered into a spreadsheet, and then results plotted on charts for presentation.

The respondents represented a mixed group of people with different professional and educational backgrounds: decision makers (11 persons – both from the national and provincial levels); environmental and health managers (8 persons); and technical experts (11 persons). Figure 4.1 below depicts the distribution of the participants by their occupation and level of computer literacy.

Only 52% of all respondents (N=15) had access to the internet at work, and 12% (N=3) had internet access at home. Approximately 31% of all respondents (N=9) said they were experienced with computers and familiar with email, internet browsing, spreadsheets, word processing and some programming. 48% (N= 14) said they were moderately experienced with computers, and 21% (N=6) said they had no computer experience. Many respondents (41%; N=12) had never used web-based learning tools or e-learning platforms before.

Figure 4.1 Respondents' Occupational Background and Internet/Computer Literacy Level (Total respondents N=25).



4.2 SELF ASSESSMENT OF RELEVANT KNOWLEDGE BEFORE AND AFTER THE TRAINING WORKSHOP

Figures 4.2 (charts 1, 2, 3 & 4) present the participants' self assessment of their knowledge prior to and after completing the Training Workshop.

Figure 4.2 (chart 1) shows that most respondents (66%; N=19) had "poor" to "fair" knowledge about POPs before the training. After the training, 20 respondents stated that they had "very good" POPs knowledge, and 8 said they had "good" knowledge.

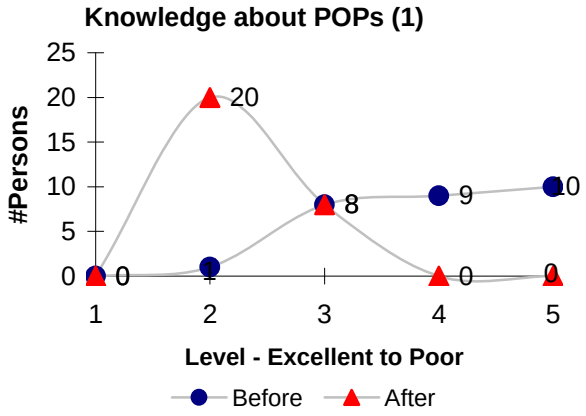
Fourteen (14) respondents thought that they had "poor" knowledge about the Stockholm Convention, while the rest had "fair" to "good" knowledge about the Convention prior to the training. All respondents assessed that their knowledge about the Stockholm Convention improved after the training (Figure 4.2, chart 2).

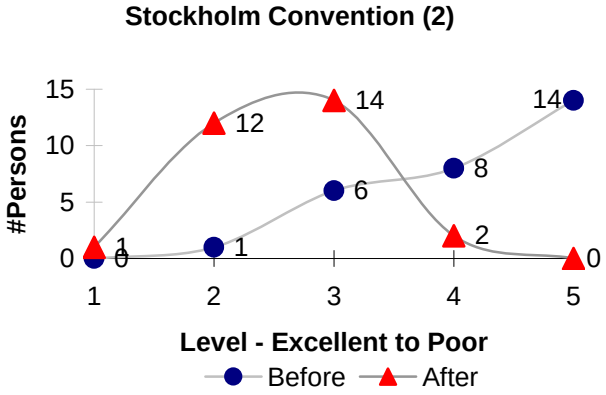
Figure 4.2 (chart 3) shows that most of the respondents (86%; N=25) had "poor" to "fair" knowledge about site prioritization tools before the training. After the training, 26 stated that they had "good" or "very good" POPs knowledge, 1 claimed to have "excellent" knowledge, and 1 thought he had only "fair" knowledge about site prioritization tools.

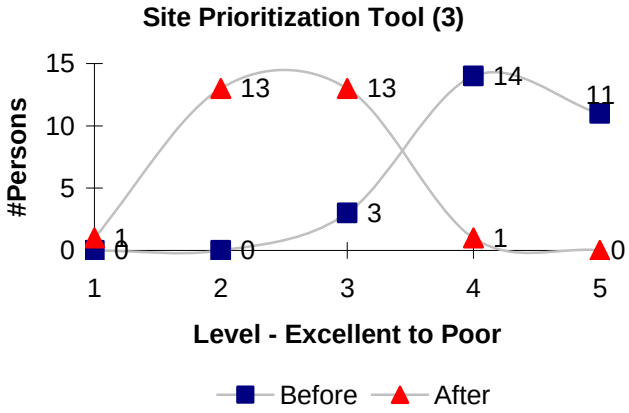
Chart 4 (Figure 4.2) shows that all respondents (N=26) had "good", "very good" or "excellent" knowledge about the Case Study after the training. This increase was impressive, since prior to the training, the HPT had worked very closely only with the WREA and Sok Pa Loung EDL Center in developing the case study.

Most participants (N=25; 86%) thought that they had limited knowledge of risk calculation tools before the training (Figure 4.3). After the training, the respondents stated that their knowledge level had increased significantly. Charts 5, 6 and 7 also show an impressive increase of knowledge in: Human Health Risk Assessment (HHRA); Problem Formulation; and Exposure Pathways, Toxicity Analysis and Risk Characterization, following the Training Workshop.

Figure 4.2 **Self Assessment of Knowledge about POPs, Stockholm Convention, Site Prioritization Tools, and Selected Site Case Study (Total respondents N=29).**







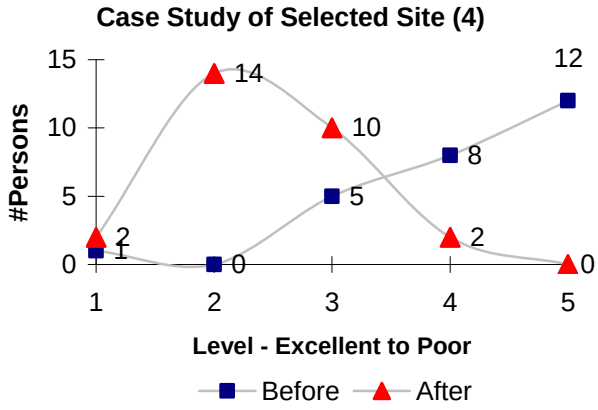
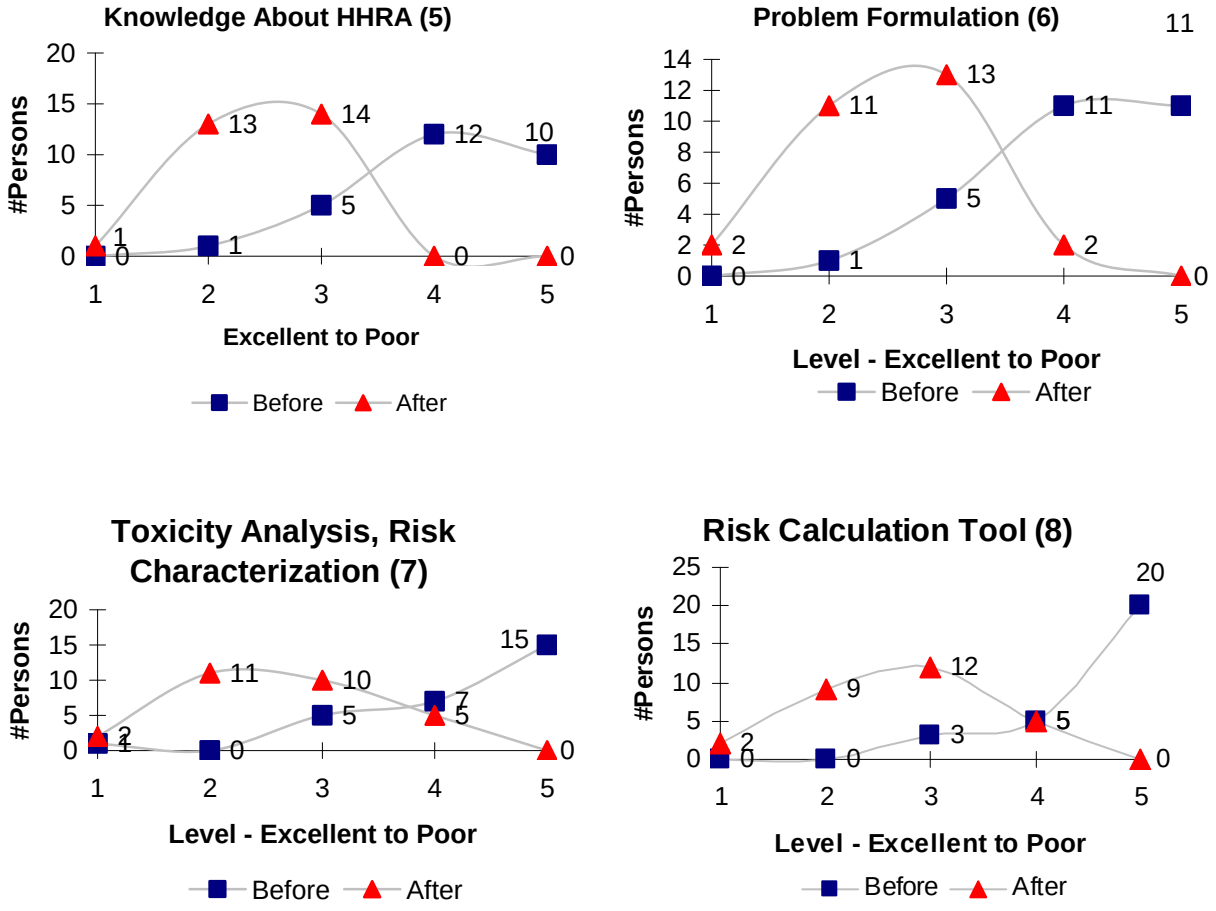
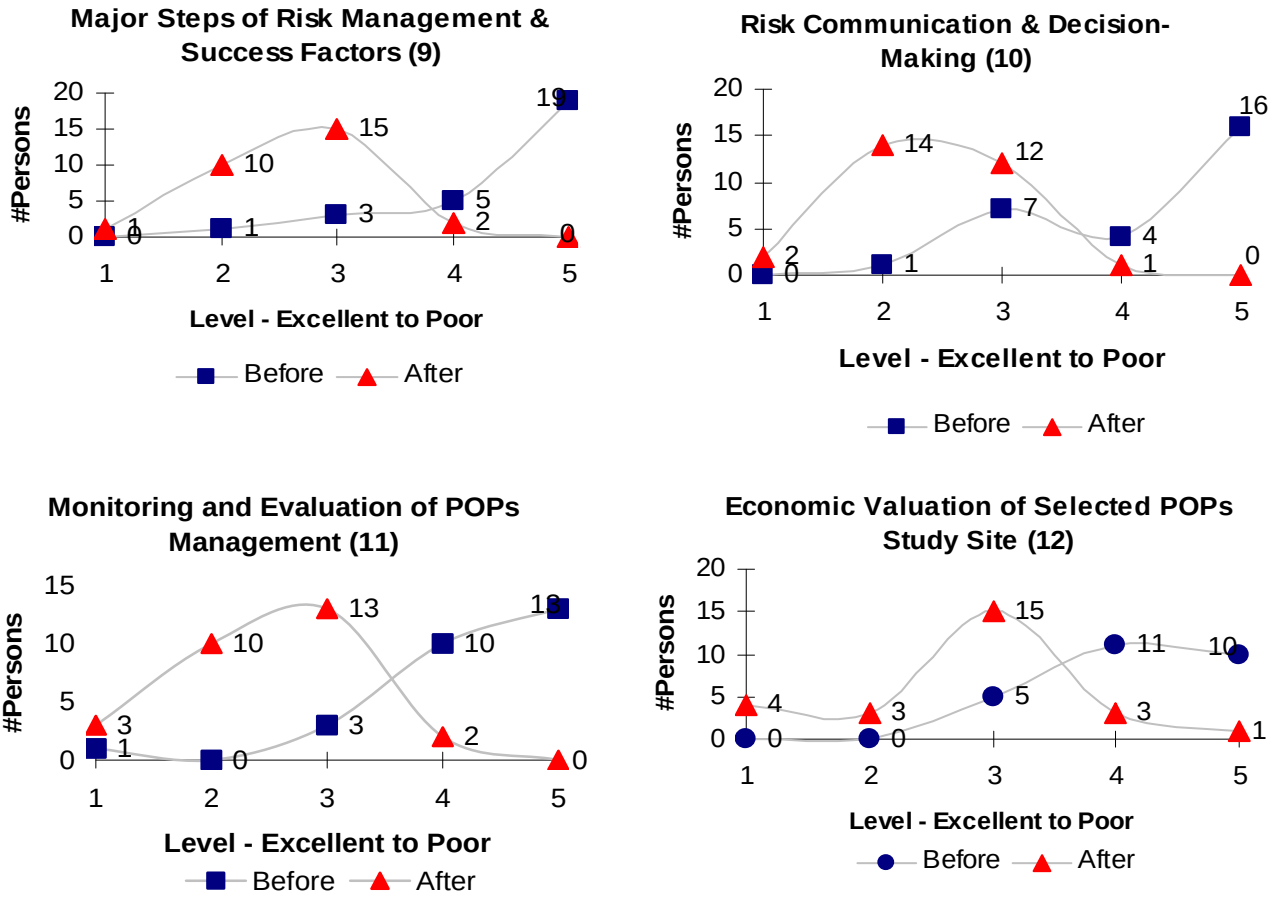


Figure 4.3 Self Assessment of Knowledge about Risk Assessment Framework
(Total respondents N=29)



As shown in Figure 4.4, most respondents (N=24, 83%), stated that their knowledge about risk management, key steps of the risk management process, and economic valuation was low (poor and fair) before the training. Their knowledge level after the training increased to "good" or "very good". The respondents requested further training in risk management and economic valuation (discussed in Section 4.6).

Figure 4.4 Self Assessment of Knowledge about Risk Management, Risk Communication and Economic Valuation (Total respondents N=29)



4.3 USER EVALUATION OF THE POPS TOOLKIT TECHNICAL CONTENT

Figure 4.5 below presents the participants' overall assessment of the POPs Toolkit technical content. In general, the participants gave the POPs Toolkit an extremely high rating. As illustrated by the pie chart, 9% of the participants (N= 3) thought the Toolkit technical content was "excellent", 51% (N=15) thought it was "very good", and another 37% (N=10) said it was "good".

Figure 4.5 Overall Evaluation of the POPs Toolkit Technical Content (Total respondent N=29)

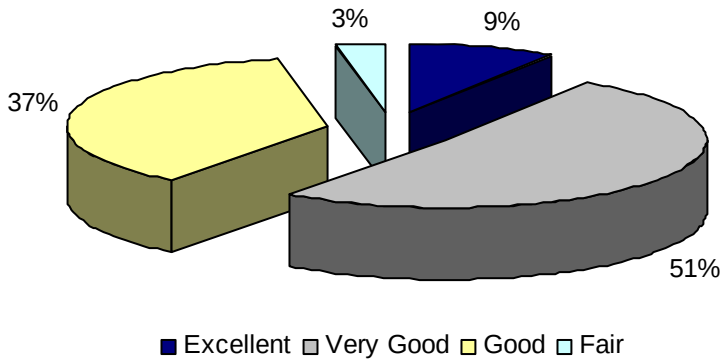


Table 4.1 provides the participants' rating of the POPs Toolkit technical content by section and sub-section. In general, all sections were rated high by the respondents.

Table 4.1 Detailed Evaluation of POPs Toolkit Technical Content (Total respondents N=29)

Section/subsection of Toolkit	Total Number	Excellent (1)	V. Good (2)	Good (3)	Fair (4)	Poor (5)
Home Page	28	4	15	9	0	0
Knowledge & Collaboration	27	1	10	15	1	0
About POPs Section	29	1	17	11	0	0
Human Health Implication	29	3	15	11	0	0
Exposure Pathway	29	2	16	11	0	0
POPs Convention	29	2	13	13	1	0
POPs Profile	29	2	11	15	1	0
POPs in Asia	29	3	14	12	0	0
POPs Articles	29	2	14	11	2	0
POPs Websites	29	2	12	13	2	0
Site Pre-Screening	29	0	18	8	3	0
Site Prioritization	29	1	13	12	3	0
SOPs	28	2	15	10	1	0
Field Sampling Design	28	3	16	9	0	0
QA/QC	28	1	15	12	0	0
Field Organization	28	1	16	9	2	0
Field Equipment	27	1	14	10	2	0
Data Sheets	28	2	13	11	2	0
Sampling & Analysis	28	4	13	8	3	0
Sampling Methodologies	28	2	18	7	1	0
RA Framework	29	5	12	11	1	0
Pre Data Collection	29	1	18	9	1	0
Problem Formulate	29	2	17	7	3	0

Table 4.1 Cont'd.

Section/subsection of Toolkit	Total Number	Excellent (1)	V. Good (2)	Good (3)	Fair (4)	Poor (5)
Exposure Analysis	29	4	14	11	0	0
HHRA	29	5	13	10	1	0
Risk Characterization	29	3	15	11	0	0
Risk Calculation tool	29	3	14	11	1	0
Eco RA	29	1	20	7	1	0
References	29	3	18	8	0	0
RM Introduction	29	6	17	5	1	0
Baseline Review	29	6	15	8	0	0
Setting Goals	29	4	16	9	0	0
Developing RM Options	29	4	19	6	0	0
Risk Communication	29	4	16	9	0	0
Monitoring & Evaluating	29	4	16	9	0	0
RM Option Tool	29	3	16	10	0	0
References	30	2	12	15	1	0
Economic Valuation	29	0	9	20	0	0
Case Study	29	2	14	12	1	0
Glossary	28	2	13	12	1	0
Summary	29	4	12	13	0	0

4.4 EVALUATION OF THE POPS TOOLKIT USER FRIENDLINESS

Figures 4.6-4.7 below illustrate the participants' overall assessment of the POPs Toolkit user friendliness and usability. The participants gave the POPs Toolkit a high rating overall: 10% of the participants (N=3) thought the Toolkit format, style and scientific content were "excellent"; 51% (N=14) stated it was "very good"; and 35% (N=10) rated it as "good".

Figure 4.6 Overall Evaluation of POPs Toolkit Usability and User Friendliness
(Total respondents N=29)

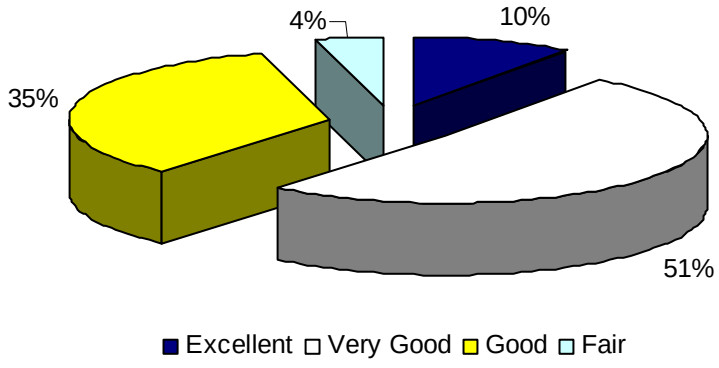
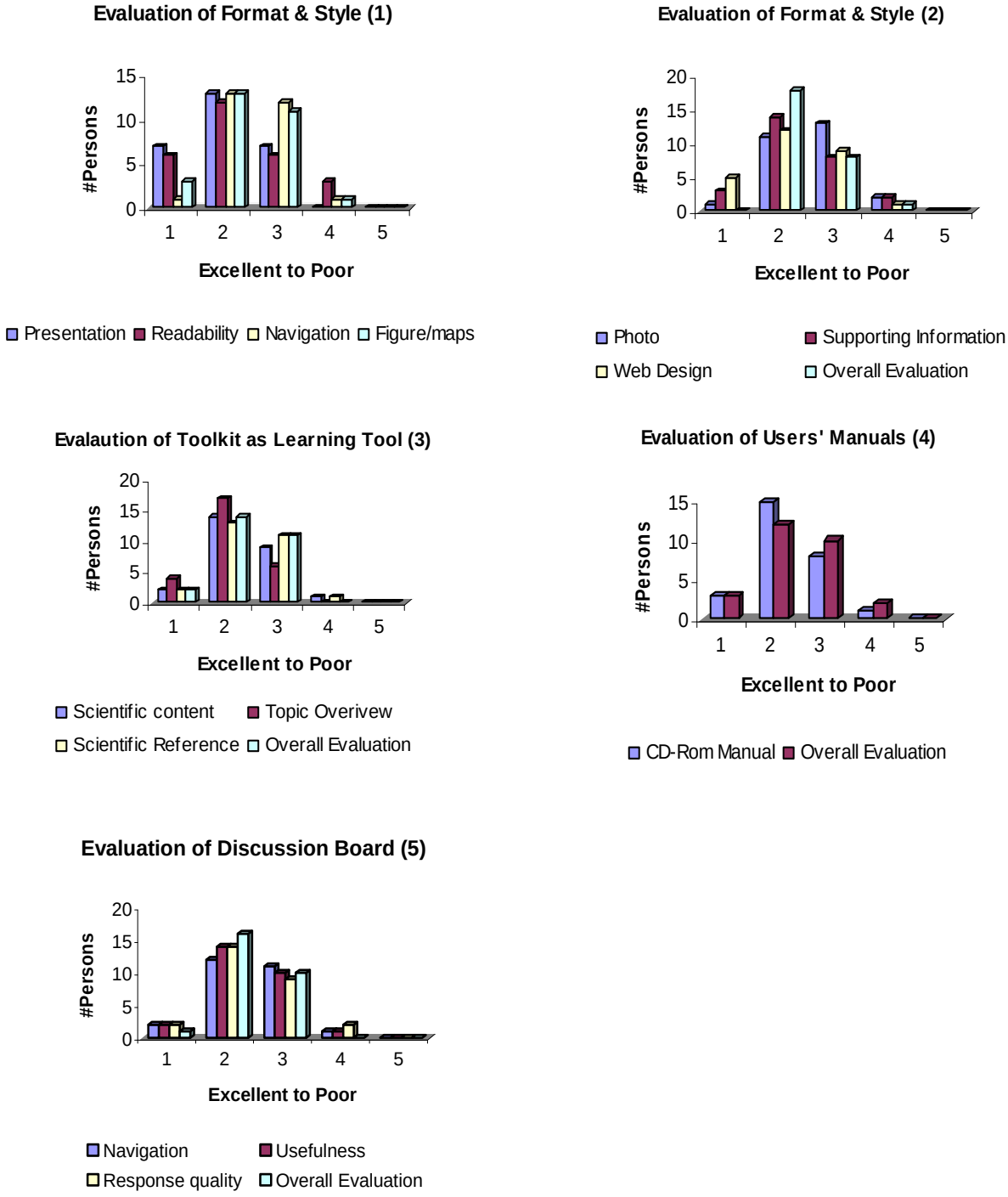


Figure 4.7 presents the detailed evaluation of each section of the toolkit for its usability and user friendliness. The results reveal the need for further improvement in "figures" and "maps" and the "services of the discussion board".

Figure 4.7 Detailed Evaluation of Format, Style and Key Features of the POPs Toolkit (Total respondents N=29).



4.5 GENERAL COMMENTS ON NATIONAL TRAINING WORKSHOP

Figure 4.8 illustrates the participants' assessment of the quality of the National Training Workshop. As shown by the bar chart, the participants were impressed by the high quality of the National Training Workshop. For example, 83% of respondents (N=24) rated the overall presentation of the training workshop as "excellent" or "very good", and 14% (N=4) rated it as "good". 71% of respondents (N=20) rated the facilitation of the group discussion and plenary discussion as "very good", and 29% (N=8) rated it as "good".

Figure 4.8 Detailed Evaluation of National Training Workshop (Total respondents N=29)

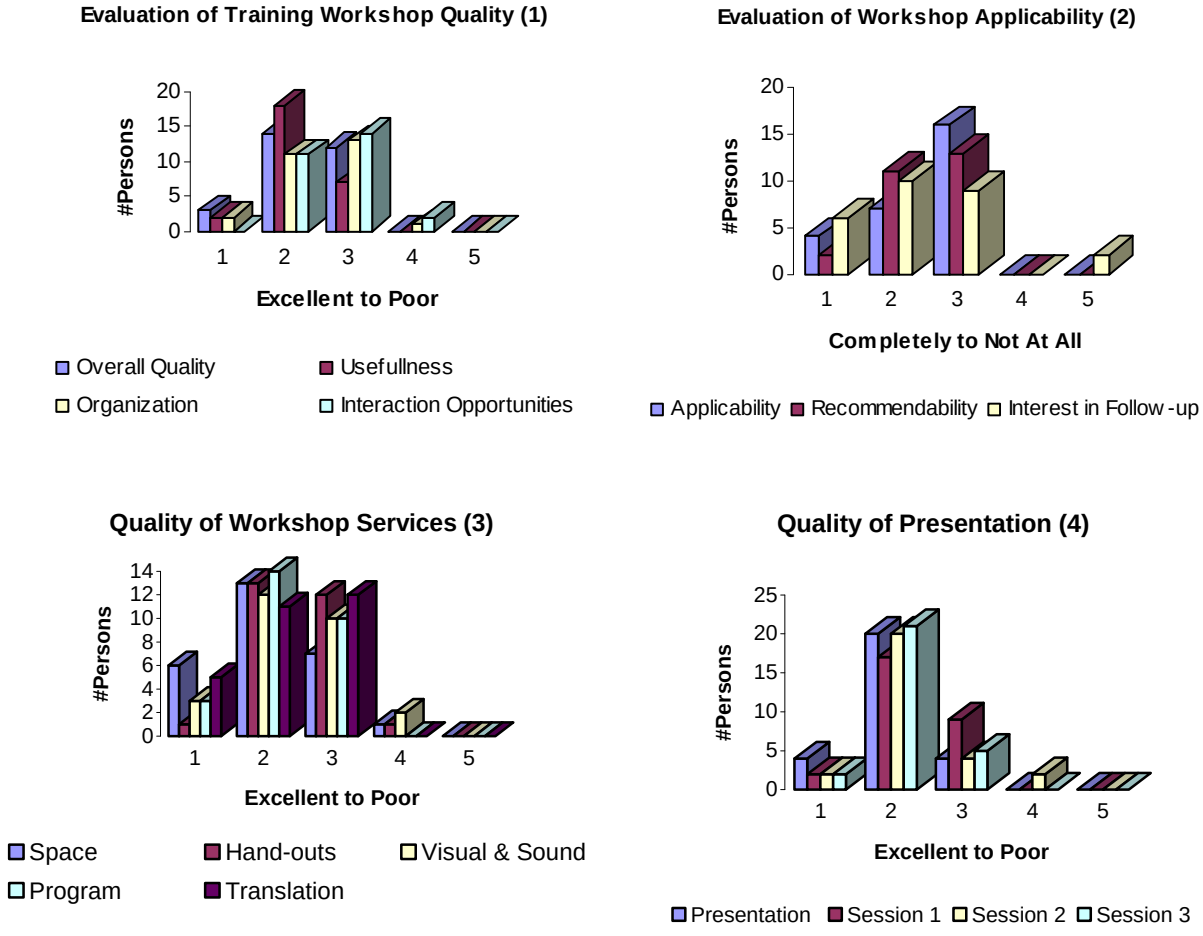
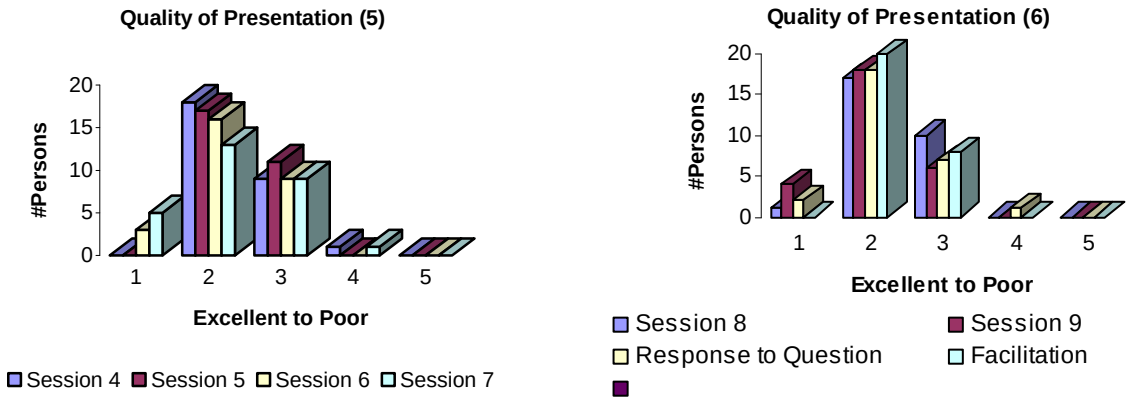


Figure 4.8 Cont'd.



43% (N=12) of the respondents stated that the Training Workshop was "completely" or "to a great extent" applicable to their work;. 57% (N=16) found the training relevant to their work "to some extent" (Figure 4.8, Chart 2).

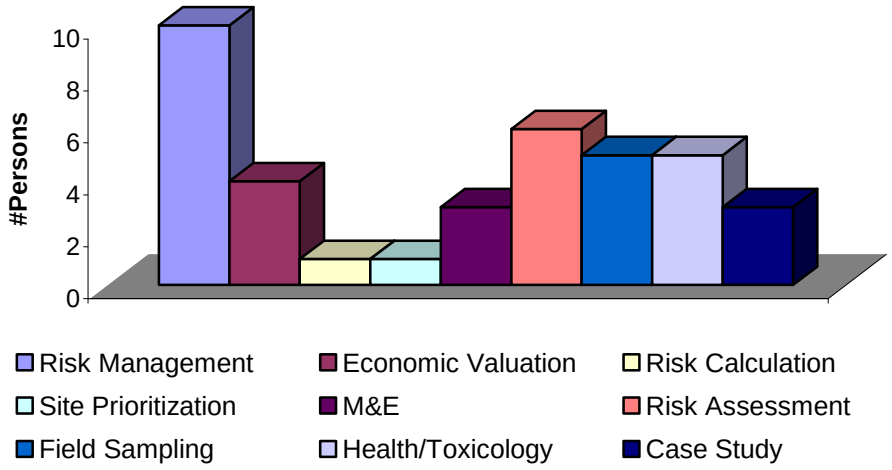
In general, all respondents rated the National Training Workshop very positively. Nonetheless, 9 respondents (31%) thought that the duration of the workshop (3.5 days) was too short to cover all of the topics and material in the POPs Toolkit and the complex subject of a risk governance framework. 59% (N=17) thought that the duration was "fine", and 3 respondents stated that the workshop duration was "too long".

4.6 FUTURE NEED FOR TRAINING

Most respondents (93%, N=25) expressed an interest in attending follow-up training at a more intermediate or advanced level (workshop/seminar, interactive distance learning and self-study). Most respondents (N=26) said that they would recommend the training workshop to others (see Figure 4.8, Chart 2 above).

Figure 4.9 presents an overall assessment by the respondents (N=16) of the top 2-3 topic areas for which they wish to receive further training. As shown in the bar graph, the respondents requested further training in: Risk Management (62%); Risk Assessment Framework (37%); Field Sampling Procedures (31%); POPs and Human Health Impacts (31%); Economic Valuation of POPs Impacts (25%); POPs Case Study (19%); Monitoring and Evaluation (19%); and Risk Calculation and Site Prioritization (6% each).

Figure 4.9 Preferred Topics For Further Training (Total respondents N=29).



4.7 OTHER COMMENTS

Respondents said that the POPs Toolkit had an educational value for students, workers and government employees and could be used for informed decision making and for self-study. However, the participants found that the lack of internet connection may restrict its usability. A CD-ROM version is therefore important for Lao PDR.

Most respondents found that the POPs Toolkit was a very good repository of scientific information and tools for supporting decision making and monitoring.

Respondents recommended that POPs Toolkit be translated into the Lao language, as many respondents from the provinces felt that they could not adequately appreciate the technical content and usability of the POPs Toolkit due to the language barrier.

5.0 CLOSURE

We trust the above information meets your requirements. If you have any questions or comments, please contact the undersigned.

HATFIELD CONSULTANTS:

Approved by: 

March 5, 2009

Sokhem Pech , Assistant Project Manager — Date

Approved by: 

March 5, 2009

Thomas Boivin, Project Manager — Date

APPENDICES

Appendix A1

Final Training Schedule

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Appendix A1

REGIONAL CAPACITY BUILDING PROGRAM

FOR RISK MANAGEMENT OF POPS IN SOUTH EAST ASIA

National Training Workshop on Human Health Risk Assessment and Management of POPs

DETAILED TRAINING SCHEDULE

Vientiane, Lao PDR, January 28 – 31, 2009

Day I: January 28, 2009

Time	Description	Person Responsible
13.00-13.30	Registration of Participants	World Bank Vientiane & WREI/WREA
13.30 – 13.45	Official Opening and Welcome Speeches Group Photo	Mme. Monemany Ngoybouakong, WRERI, Dr. Catalina Marulanda, World Bank
13.45 – 15.00	Key Objectives of the National Training Workshop, and Background on POPs Project and POPs Issues	Thomas Boivin
15.00-15.15	Coffee Break	
15.15 – 16.15	Introduction to the POPs Toolkit	Thomas Boivin
16.15 – 17.15	Human Health Hazard and Risk Assessment: Theory and Approach	Thomas Boivin
17.15 – 17.45	Wrap-up of Day 1 by Chairpersons	WB and Host Agency
18.30 – 20.30	Reception Dinner hosted by the World Bank: ▪ Presentations and Slide Show by National Participants on Lessons Learned from Field Sampling at the "EDL Sok Pa Luang" Case Study Site	World Bank; National Consultant

Day II: January 29, 2009

Time	Description	Person Responsible
08.00 – 08.30	Site Prioritization Tool – Overview	Mike Rankin
08.30-09.00	Hands-on application of Site Prioritization Tool	All Participants, Facilitated by Project Team
09.00 – 10.15	Problem Formulation, Exposure Analysis, Toxicity Analysis, Risk Estimation and Characterization	Mike Rankin
10.15-10.30	Discussion	All Participants, Facilitated by Thomas Boivin
10.30– 10.40	Coffee Break	
10.40 – 11.30	Presentation on EDL Sok Pa Luang Case Study	National Focal Point and National Consultant (NC)
11.30 – 12.30	Discussion on EDL Sok Pa Loung Case Study	All Participants, facilitated by NC, Thomas Boivin
12. 30 – 13.30	Lunch Break	
13.30 – 14.30	Introduction to Preliminary Quantitative Risk Assessment (PQRA) Tool	Mike Rankin
14.00 – 14.30	General Discussion	All Participants Facilitated by Thomas Boivin and NC
14:30 – 16.00	Hands-on Application of PQRA Tool + Coffee break	All Participants, Facilitated by Mike Rankin, Thomas Boivin and NC
16.00 – 17.00	Discussion on Application of PQRA Tool	All Participants, Facilitated by Thomas Boivin and NC
17.00 – 17.15	Wrap-up of Day 1 by Chairpersons	Mme. Monemany Ngoybouakong, WRERI,

Day III: January 30, 2009

Time	Description	Person Responsible
08.00 – 08.15	Feedback and Recap of Day 2	Thomas Boivin, and Mme. Monemany, WRERI,
08.15 – 09.15	Introduction to Economic Analysis Training Module	Thomas Boivin
09.15 – 10.15	General Discussion on Economic Valuation and Risk Management in the Lao PDR Context	All participants, Facilitated by Thomas Boivin, Sokhem Pech and Mike Rankin
10.15– 10.30	Coffee Break	
10.30 – 11.15	Introduction to Risk Management Decision-Making Process	Sokhem Pech
11.15 – 12.15	Question and Answer Session	All Participants, Facilitated by Thomas Boivin
12.15 – 13.15	Lunch Break	
13.15 – 15.15	Group Discussion on: 1) Developing Risk Management Goals, Sub-goals (Objectives), and Indicators; 2) Long and Short-listing of Management Options (developing selection criteria, weighting factors, and management options) – EDL Sok Pa Loung Case Study Example	All participants, facilitated by Thomas Boivin, Sokhem Pech, Mike Rankin, and NC
15.15 – 15.45	Coffee Break	
15.45 – 16.45	Presentation of Group Discussion Results of Risk Management Options for Sok Pa Loung Site	Groups leaders and all participants, Facilitated by National Consultant
16.45-17.00	Toolkit and Training Evaluation	All Participants
17.00 – 17.30	Wrap-up and Closing	Mme. Monemany Ngoybouakong, WRERI, Dr. Catalina Marulanda, World Bank, Mr. Thomas Boivin, Hatfield
18.30 – 20.30	Dinner Hosted by Hatfield	All Participants

Day IV: January 31, 2009

Time	Description	Person Responsible
09.00 – 12.00	Field Visit and Meeting with Community Near Sok Pa Loung Case Study Site	SPL EDL. National Focal Point, NC and All Participants
12.00 – 13.30	Lunch	

Appendix A2

List of Participants

Appendix A2

National Training Workshop on Human Health Risk Assessment and Management of POPs

List of Participants

Vientiane, Lao PDR, January 28 – 31 , 2009

No	Name/Surname	Section
1	Mr. Soulaphone THILAKOUNE	Luang Prabang
2	Mr. Aloun MANOSANE	Luang Prabang
3	Mr. Onsy DUANGBOUNTHAM	Houaphan
4	Mr. Phounmysay PHENGKHAMHACK	Houaphan
5	Mr. Som SYHATHEP	LuangNamtha
6	Mr. Khamngeun ONLUESAY	LuangNamtha
7	Mr. Khammanh CHANTHAKEO	Bokeo
8	Mr. Keo udom PHANYAXAY	Bokeo
9	Mr. Phetdavong BOUNMISAVATH	Sekong
10	Mr. Amphaivanh SANiPHONH	Sekong
11	Mr. Oukham KEOVILAY	Sayaboury
12	Mr. Sinsalerm PHOMMACHANH	Sayaboury
13	Mr. Sharnvansay Sengmany	Phongsaly
14	Mr. Phonesay LEX	Phongsaly
15	Mr. Thoumma LUEMXAY	Xiengkouang
16	Mr. Vilaiphone Manivong	Xiengkouang
17	Dr. Khamphew TAYBOUAVONE	Oudomxay
18	Mrs. Phetdala PHONTHASI	Oudomxay
19	Mr. Khampasong VONGTHANA	Boilikhamsay
20	Mr. Outhone SINGHADUANGPHANYA	Bolikhamsay
21	Mr. Khamphay PHENGPHEANGMOUNG	Khammouane
22	Mr. Phonevisith KHOUNBOULOM	Khammouane
23	Mr. Synouane SIHARATH	Savannaket
24	Mrs. Vayouvet VISAYSOMBOUN	Savannaket
25	Mr. Bounkham PHOETHISARN	Champasak
26	Mr. Aloon PHENGMANY	Champasak
27	Mr. Bouankeuam SIMMA	Saravan
28	Mr. Sengchan KHAMMANIVONG	Saravan
29	Mr. Navalat NOUANTHONG	Attapue
30	Mr. Chanhsamy PHOMMALA	Attapue
31	Mr. Khamphua PHENGPHANHACK	Vientiane
32	Mr. Bounmai KHOUNMYSAY	Vientiane
33	Mrs. Khamfong PHOUMVONGXAY	Vientiane Capital
34	Mr. Vilavong KENSOULINE	Vientiane Capital
35	Mr. Vaiyakone SYSAVATH	Industry Department
36	Mr. Sommay VONG INH	EDL, Sok Paluang
37	Dr. Somchith VONGSASITH	103 Hospital

38	Mr. Soukvilay INPANYA	Environment social impact Assessment
39	Mr. Kongmnoun VONGSAY	Ministry of defense
40	Mr. Sylathong	Ministry of defense
41	Dr. Khamla PHOUMMANY	Ministry of health
42	Mrs. Vanh VOLASANE	EDL
43	Mr. Phongsavath YINGYONG	WREA
44	Mr. Vanhna Phanphongsa	WREA
45	Mr. Keosangkhoum PHOMMASENG	Environment department
46	Mr. Keosangkhom PHOMMASENG	Environment department
47	Dr. Thongsavanh VONGMANY	UXO
48	Mr. Souphone SENGTHEP	EDL,Sok Praluang
49	Mr. Som Oula YAPHICHIT	WREA
50	Mr. Sivannakone MALIVARN	WREA
51	Mr. Bounthanong	Environment social impact assessment
52	Mr. Khonekeo KINGKHAMBANG	WREA
53	Mr. BounEua KHAMPHILAVANH	WREA
54	Ms. Malaythong KEONGOTHI	WREA
55	Mrs. Johnnaly KEOBOUNPHANH	WREA
56	Mme. Monemany NGOYBOUAKONG	WREA
57	Mr. Jitu SHAH	WB
58	Ms. Catalina MARUVANDA	WB
59	Mr. Manuel COCCO	WB
60	Mr. Andres ZANCIDA	WB
61	Ms. Vilayvanh	WB
62	Mr. Thalavanh VONGSONEPHET	WB

Appendix A3

Presentation on Background of POPs Issues, the POPs Project, and the Key Objectives of the National Training Workshop

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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"Key Objectives of the National Training Workshop, and Background on the POPs Project and POPs Issues"

by Thomas G. Boivin
National Training Workshop
Vientiane, Lao PDR, January 28, 2009

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Background

- Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted in 2001 and entered into force in May 2004;
- Overall goal is to protect human health and the environment;
- Targets 12 particularly toxic POPs for reduction and eventual elimination; and
- Establishes a system for tackling additional unacceptably hazardous chemicals.

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POPs Project Objective

- The POPs Program is designed to :
  - Improve the ability of government agencies in the South East Asian Region to manage POPs and other POPs-like chemicals using a health risk-based approach.
  - Improve inter-governmental cooperation on hazardous chemicals issues in the region.

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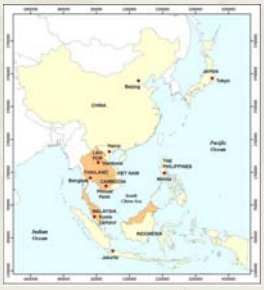
Geographical Scope and Stakeholders

- Participating: Cambodia, Lao PDR, Malaysia, and Thailand.
- Other participating countries (regional workshops)
  - China;
  - Indonesia;
  - Japan;
  - Philippines; and
  - Viet Nam.



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Key Project Elements

- Key Activities:
  - Identification of Key Issues/Hot Spots;
  - Collection of background information;
  - Sampling and analysis of environmental media (supplementary data collection);
  - Risk Assessment/Risk Management;
  - Economic Assessment;
  - POPs Toolkit (www.popstoolkit.com);
  - Training Workshops (4) + Regional Workshop (2); and
  - Reporting and Documentation.

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Key Activities and Achievements

- Regional Launch Workshop April 3-4, 2008 – official start of the project and approval of Project Implementation Plan.
- Hatfield Project Team visited candidate study sites in Cambodia, Lao PDR, and visited Thailand and Malaysia in April 2008:
  - To discuss site selection;
  - To collect available data; and
  - To recruit national consultants.

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Key Activities and Achievements (2)
Selection of Study Site for Risk Assessment

Sambour EDC site, April 2008, Cambodia

Sok Pa Loung EDL site, April 2008, Lao PDR

MEA Site, Samut Prakan Thailand, late May 2008

Air Hitam Landfill, Malaysia, August 2008

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Key Activities and Achievements (3)
1st Field Sampling Program May 2009

- Environmental sample collection in Lao PDR and Cambodia 12 – 24 May 2008:
  - Training on field sampling and analysis;
  - Stakeholder Consultation on POPs activities; and
  - Hands-on demonstration on field sampling.
- Site reconnaissance visit in Samut Prakan, Thailand, 15 – 17 May 2008.

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Key Activities and Achievement (4)
2nd Field Sampling Program July-August 2009

- Environmental sample collection in Thailand July 28 – Aug 2, and Malaysia 16-22 Aug 2008:
  - Stakeholder Consultation on POPs activities;
  - Training on field sampling and analysis; and
  - Hands-on demonstration and field sampling.
- Blood sample collection in Lao PDR August 1-5, and Cambodia August 6-8, 2008:
  - Training on blood sampling and analysis;
  - Stakeholders Consultation on POPs activities; and
  - Hands-on demonstration on blood sampling.

Key Activities and Achievement (4)
Samples Analysis by Hiyoshi, Japan and AXYS, Canada

- 121 environmental samples were collected in triplicate - 33 samples from Lao PDR, 30 from Cambodia, 40 samples from Thailand and 18 from Malaysia.
- 25 blood samples were collected from potentially impacted people in Lao PDR and Cambodia.
- All samples were handled according to Standard Operation Procedures (SOPs) that meet international standards.

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Key Activities and Achievement (5)
Risk Assessment and Risk Management

- Last CALUX results received from Hiyoshi on October 4, 2008.
- Last batch of analytical results was obtained from AXYS on December 30, 2008.
- Steps were taken to organize data into a form appropriate for a risk assessment.
- Analytical results were reviewed and the risk assessment reports for all selected study site were drafted jointly with the key stakeholders from Dec 1 – 19, 2008.
- Economic Valuation Report for each site was drafted.

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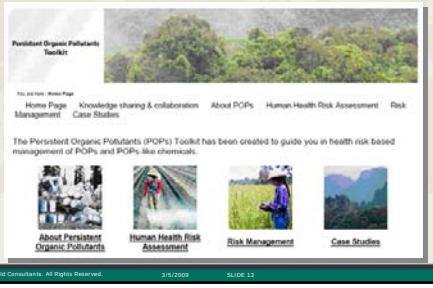
Key Activities and Achievement (6)
Capacity Building & Knowledge Sharing

- POPs Toolkit (www.popstoolkit.com)
- Consultation on toolkit and training program were conducted in August – Dec 2008



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 3/5/2009 SLIDE 13

Key Activities and Achievement (7)
Capacity Building & Knowledge Sharing

- On-the-job training and 'learning by doing';



- National Training Program – 19 – 31 January 2009

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 3/5/2009 SLIDE 14

Key Project Goals and National Training Workshop Objective

Primary objective of the POPs Project

To enhance the capacity of government agencies in the South East Asia region to manage POPs and POPs-like chemicals using a health risk-based and regional approach.

National Training Program Objective

To provide background knowledge on risk assessment methodologies and management of POPs contaminated sites, and also raise awareness of available information and tools in the POPs Toolkit website.

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 3/5/2009 SLIDE 15

Overview of Training Workshop Agenda

- Opening and closing by Senior Government Official;
- Session 1: Key Objectives of the National Training Workshop and Background on the POPs Project and POPs Issues;
- Session 2: National Presentation on POPs Management;
- Session 3: Introduction to the POPs toolkit;
- Session 4: Human Health Risk Assessment Overview & Site Prioritization:
  - Hands-on application of Site Prioritization Tool;


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 SLIDE 16

Overview of Training Workshop Agenda (2)

- Session 5: Risk Assessment Steps;
- Session 6: Case Study of Selected Study Sites;
- Session 7: Risk Calculation Tools
  - Hands-on application of Preliminary Quantitative Risk Assessment (PQRA) Tool;
- Session 8: Economic Valuation of Sambour Case Study Site;
- Session 9: Risk Management Decision-Making Process
  - Group Discussion on Development and Selection of Risk Management Options for Selected Sites.


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 SLIDE 17

Thank You

For further information contact:

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Canadian International Development Agency

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 3/5/2009 SLIDE 18

Appendix A4

Summary of the POPs Toolkit

Summary of POPs Toolkit

The Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Project, referred to as the "POPs Project", was developed to complement the National Implementation Plans for the Stockholm Convention on POPs. The POPs Project was designed to enhance the capacity, understanding and use of risk-based approaches to manage POPs and POP-like chemicals in South East Asia. The four countries participating in the POPs Project include Cambodia, Lao PDR, Malaysia, and Thailand. However, China, Indonesia, Japan, Philippines and Viet Nam are also included in regional activities under the program. Improved regional cooperation on a broader list of pollutants, including persistent toxic substances (PTSs) is a secondary objective of the program.

Funding for the POPs Project was provided by the Canadian International Development Agency's (CIDA) POPs Fund, and is coordinated by the World Bank. Hatfield Consultants (Vancouver, Canada) was commissioned by the World Bank to implement the technical components of the Project. Complementary program activities are also implemented by national consultants and World Bank staff.

Objective of the POPs Toolkit:

POPs Toolkit is the main output of the health risk management component (Component 2) of the POPs Project. The goal of this component is to enhance the capacity of key decision makers to apply the understanding gleaned from the risk assessment (RA) activities in order to set risk management strategies and identify priority interventions to reduce POPs risks to an acceptable level. The **health risk management toolkit** provides guidance on:

(i) evaluating health risks from exposure to chemicals in locally relevant sectors based on standardized guidelines; and

(ii) developing strategies for the management of human health risks through regulation, monitoring, and evaluating alternative scenarios.

The toolkit is also used as a repository of the training materials for the National Training Workshops organized in Cambodia, Malaysia, Thailand and Lao PDR from 19 – 31 January 2009. The training is intended to provide general knowledge on the risk assessment process and management for POPs, and also to raise awareness of information and tools available on the POPs Toolkit website.

Main characteristics of Toolkit:

The purpose of the POPs Toolkit is to provide general information on POPs, and to guide readers through the risk assessment process. The POPs Toolkit website – located at www.POPsToolkit.com – will be a valuable resource for POPs researchers in future. The web-based POPs toolkit has been designed for an audience with diverse backgrounds and levels of experience; hence the toolkit has to accommodate readers with a variety of educational backgrounds, English language skills, and differing levels

of experience in the use of e-learning tools. The navigation, interactivity, content and appearance of the POPs Toolkit have been developed with these key points in mind.

Key Architecture of Toolkit:

The content in the toolkit is presented using a combination of HTML, JavaScript and Adobe Flash. Interactive tools have been developed using both JavaScript and Microsoft ASP.Net technologies. The use of these technologies ensures compatibility with all web browsers.

Following internal quality control procedures, the final phase of quality assurance is client and end-user review of all content. This client and end-user review has included three steps:

- The Review Mission by the World Bank and Hatfield Project Team to the four countries in October and November 2008;
- Toolkit Consultation Meetings in all four countries from December 1 – 19, 2008; and
- On-line discussion using the Discussion Board in the Knowledge Sharing and Collaboration section of the POPs Toolkit.

Toolkit Content:

Major toolkit themes/sections include:

- Information About Persistent Organic Pollutants;
- Knowledge Sharing and Collaboration;
- Site Prioritization for Risk Assessment;
- Field Sampling Procedures;
- Human Health Risk Assessment;
- Risk Management;
- Economic Valuation of Health Impacts from POPs; and
- Case Studies.

Each main theme/section is accompanied by a sub-topic menu that contains interactive tools and training materials.

The following is a brief description of each section and sub-section:

1.0 About persistent organic pollutants:

This section contains information about POPs, their health and environmental impacts, background on the Stockholm Convention on POPs, profiles of various POPs, and links to major POPs related web-sites.

The reader may find more useful information by clicking on relevant links such as:

- The Concern About POPs;
- Human Health Implications;
- Possible Human Exposure Pathways;
- The Stockholm Convention;
- POP Substance Profiles;
- POPs Use in South East Asia;
- Articles about POPs; and
- Links to POPs Websites.

2.0 Knowledge Sharing and Collaboration

The section was designed for key stakeholders in the POPs project to share data, information, knowledge, and tools, and to post their comments and exchange their stories and experience.

This section includes:

- ***Document/Data Library***: for downloading or uploading documents or data related to the POPs project – including project reports and workshop outputs;
- ***Image Library:*** for downloading or uploading maps, images or photographs of project activities – including photos of the Launch Workshop and field sampling activities;
- ***Schedule & Events:*** for communicating with stakeholders on planned activities and events under the POPs Project; and
- ***Discussion Forums:*** for offering to key stakeholders and the project team an arena to discuss the progress of POPs project implementation, and exchange experiences in POPs management.

3.0 Site Prioritization for Risk Assessment

The Site Prioritization for Risk Assessment section of the toolkit aims to provide countries with the tools to prioritize contaminated sites for further investigation among multiple sites in a country.

In this section, two semi-quantitative tools – a ***Site Pre-Screening Tool*** and a ***Site Prioritization Tool*** - are provided that allow the user to determine which sites should be assessed, and then to prioritize sites based on their potential for causing unacceptable risks to humans and/or the natural environment. The tools leads the user through a series of questions regarding: contaminant characteristics; off-site migration potential; exposure; and, socio-economic factors. Based on the user's answers, a semi-quantitative score for a site is given which indicates the site's priority for risk assessment.

4.0 Field Sampling Procedures

The section "**Field Sampling Procedures"** contains important guidance and key steps for collection and analysis of samples for selected risk assessment sites. The use of Standard Operation Procedures (SOPs) facilitates sampling and analysis in a consistent and coordinated manner which helps ensure quality and comparability of the laboratory analytical results. The SOPs provided in the Toolkit were developed based on the 2007 UNEP Guide Guidance for Analysis of Persistent Organic Pollutants (POPs), Hatfield's Standard Operation Procedures Manual (2008), and Hatfield's first-hand knowledge and experience with similar field assignments in the South East Asia and Canada.

In addition to striving for simplicity and clarity of the sampling program design, and establishing clear expectations for analytical performance and QA/QC, the SOPs help foster continuity, inclusiveness and transparency during data collection and analysis.

The section covers a wide-range of topics, including:

- Objectives of Standard Operating Procedures and General Principles;
- Field Sampling Design;
- Quality Assurance and Quality Control (QA/QC);
- Field Sampling Organization;
- Field Equipment;
- Example Field Data Sheets;
- General Sample Collection and Analysis;
- Sampling Methodologies of Key Media;
- Sample Handling;
- Number of Samples Needed;
- Data Quality Analysis and Management; and
- References for further reading.

5.0 Human Health Risk Assessment

This section of the POPs Toolkit provides an introduction to Human Health Risk Assessment (HHRA) as well as several interactive tools – a ***Problem Formulation Tool*** and a ***Risk Calculation Tool***.

After reviewing this section the reader should:

1. Know the different components of the risk assessment process;
2. Know how risk assessments are conducted;
3. Be able to use some basic equations to calculate human exposure to contaminants via ingestion, inhalation and dermal contact;
4. Be able to make screening level risk estimates using exposure data; and
5. Understand the difference between threshold and non-threshold contaminants.

5.1 Human Health Risk Assessment Overview

In this section, the reader is led through an iterative process to help in the quantification of potential risk due to POPs at a contaminated site.

The main components of a risk assessment are:

- ***Preliminary data collection*** - to choose data quality objectives and to gather data;
- ***Problem formulation*** – to define the problem by identifying the three **components** of risk (chemical hazard, pathway and receptors) and developing a conceptual exposure model to illustrate and explain how these three components form the potential for health risk;
- ***Exposure and toxicity analysis*** – to quantify exposure (or dose) as well as the toxic potency of the chemical hazard(s); and
- ***Risk characterization*** – to integrate the information from the exposure and toxicity analysis to derive a quantitative estimate of human health risk.

5.1.1 Preliminary Quantitative Risk Assessment (PQRA)

Risk assessments start off simply, using a minimum of data, making simple assumptions and using simple calculations. At this initial stage, the methods and assumptions prescribed in a PQRA are conservative and generally ensure that risks are not underestimated. Thus, if acceptable or negligible risks are predicted, then it is almost certain that risks are either acceptable or negligible. If the earliest iterations of the risk assessment predict high potential of risk, it doesn't necessarily mean that there is elevated risk, but additional work needs to be done to refine the risk assessment.

5.1.2 *Risk Assessment Problem Formulation Worksheet Tool*

In the Risk Assessment Section, a tool has been provided that helps the risk assessor to identify the components of the risk assessment. The reader may use this worksheet to work through all parts of the problem formulation.

5.1.3 *Risk Calculation Tools*

Two quantitative risk calculation tools are provided that help to calculate contaminant exposure (i.e., dose) via ingestion, inhalation and dermal contact. Because of their differing characteristics, two calculation tools are provided based on the chemical of concern:

- ***Risk Calculation Tool for a Non-Carcinogen*** (Threshold) Contaminant - for a non-carcinogenic (involving cancer) substance or agent; and
- ***Risk Calculation Tool for a Carcinogen*** (Non-Threshold) Contaminant – for a substance or agent that is capable of causing cancer in humans or animals.

5.1.4 *Ecological Risk Assessments and Other References*

The Risk Assessment Section also provides background information on conducting ecological risk assessments, and key references for further reading.

6.0 Risk Management

The Risk Management section of the POPs toolkit leads the reader through the process related to managing unacceptable human health risks at POP contaminated sites. After reviewing this section the reader should:

- be familiar with the process leading to the choice of risk management strategies; and
- be able to identify priority interventions to reduce risks to an acceptable level.

6.1 Risk Management Linkages with Risk Assessment and Economic Valuation

Quantitative Risk Assessment results, and the results from the first stream of the economic valuation (where cost of impacts are estimated) feed directly into the Risk Management phase. With this information, the Risk Management process is used to:

- Decide whether a level of risk is acceptable in a larger context (socially, economically and politically);
- Select risk reduction options (i.e., either technical or policy-based solutions); and
- Conduct a Simple Economic Valuation to calculate the cost-benefit of selected remediation or risk management options.

6.2 Key Characteristics of Effective Risk Management

In order to be effective and successful, risk management strategies need to remain ***up to date***, be ***participatory;*** be ***well informed*** and be ***contextual*** (***i.e. be appropriate to the local*** political, cultural and socio-economic context).

6.3 Five Steps in the Risk Management Process

The Risk Management Training Module includes five major steps:

(i) Baseline Review;

(ii) Setting Risk Reduction Goals;

(iii) Developing and Evaluating Management Options;

(iv) Risk Communication and Policy Making; and

(v) Monitoring and Evaluation.

This five step process can be used for planning risk management activities on either a site-specific or a nation-wide basis.

6.3.1 Step 1 - Baseline Review:

Conducting a baseline review includes developing two key statements:

- The **Situation Statement** that assesses: i) where challenges and opportunities may exist; ii) strengths and weaknesses of the legal, technical, administrative or institutional aspects, and knowledge; iii) why exposure to a chemical is occurring; and, iv) the broader environmental and socio-economic context of a chemical-related problem; and

- The ***Problem Statement*** which: i) relates the main conclusions of the situation analysis to the broader chemicals management context; ii) develops the problem statement, i.e. the main reasons for risk reduction measures (magnitude of severity; persistence; reversibility; current or potential etc.); iii) characterizes associated key environmental and human health risks; and iv) specifies particularly vulnerable target groups or stages in the chemical's life-cycle.

6.3.2 Step 2 - Setting Risk Reduction Goals:

Setting clearly defined goals that protect human health and/or the environment from POPs-related risks provides the framework and benchmarks for monitoring and evaluating Risk Management Options. Setting Risk Reduction Goals involves the following sub-tasks:

- Developing well-defined risk reduction goals to address the chemical problem through a transparent and participatory process;

- Prioritizing problem-solving sub-goals in order to reduce risks to human health and the environment in order of importance;
- Linking the selected goal and/or sub-goals into the wider national chemicals forum; and
- Establishing qualitative and quantitative indicators to benchmark progress towards attainment of the goal and/or sub-goals.

6.3.3 Step 3 - Developing and Evaluating Management Options:

The main output of the *Developing and Evaluation Management Options* step is an evaluation of the advantages and drawbacks of various risk reduction options that can be used to prevent, reduce or mitigate the risk of concern. This involves:

- Compiling an open-ended list of known risk reduction measures as options, technologies and processes to address the identified POPs risk;
- Identifying the options that make existing measures more effective, and outline new initiatives;
- Considering whether all the options listed will achieve the required risk reduction goal, bearing in mind risk factors;
- Obtaining key stakeholder agreement on which decision-criteria to use in order to select management options; and
- On the basis of the decision-criteria, evaluating strengths and weaknesses of each option.

6.3.4 Step 4 - Risk Communication and Policy Making:

The main purpose of the ***Risk Communication and Policy Making*** step is to discuss how Risk Management strategies can be communicated to the public, and be mainstreamed into the national political agenda.

This step involves:

- Identifying the decision-makers who need to endorse/adopt relevant documents (policies, strategies, programs, projects, etc.) and provide them with relevant knowledge and information;
- Selecting and conducting appropriate communication approaches and activities for different stakeholders;
- Identifying whether any initial steps are needed to ensure effective implementation, e.g. training of those involved in implementation; and
- Involving interested and affected parties and identifying milestones and other important timelines.

6.3.5 *Step 5- Monitoring and Evaluation:*

Monitoring and evaluation are integral parts of the risk management decision-making process. Monitoring and evaluating involves looking at how management measures were implementation in order to check for any deviation from the plans, and documenting the reasons for any changes over time.

This step involves:

- Assessing if the agreed-upon goal and sub-goals were met or achieved, and if the actions were cost-effective;
- Evaluating if further action is required to modify the strategy and/or to continue with the implementation; and
- Evaluating what lessons can be learned regarding the basis for the strategy, i.e. a review of adverse problems, unexpected effects, and institutional cooperation.

6.4 Risk Management Options Evaluation Tools

The Risk Management section also contains two tools:

1. A Tool to Develop a Long List of Risk Management Options to address components of risk – chemical hazards, pathway, and receptors; and
2. A Tool to Evaluate Risk Management Options that helps users to assess and prioritize risk management options against selected criteria/balancing factors including:
    - Effectiveness;
    - Long term Reliability;
    - Ease of Implementation;
    - Implementation Risk;
    - Cost for Implementation; and
    - Cost for Operation and Maintenance.

7.0 Economic Valuation of Health Impacts from POPs

7.1 Objectives of Economic Valuation

The objectives of the economic valuation in the POPs Toolkit are to:

- Estimate (in *quantitative* terms) the dollar value of the human health impact of POPs contamination at a designated 'hot spot ';
- Compare the estimate with the cost of remediation measures; and

- Describe (in *qualitative* terms) the value of POPs impacts on other economic and environmental activities.

After reviewing this section the reader should:

- Know how to include an economic element in the prioritization of POPs contaminated sites by quantifying human health impact in physical terms (i.e., in Disability Adjusted Life Years - DALYs); and
- Be able to quantify human health impact in monetary terms using the benefits transfer approach.

7.2 Place of Economic Valuation within the Overall Risk Assessment and Risk Management Framework

The quantitative component of the economic valuation is closely integrated with the Human Health Risk Assessment through:

- The detailed implementation of the valuation methodology;
- The actual calculation of the economic costs of human health impacts; and
- The incorporation of the economic valuation methodology into the risk management options.

7.3 Selection of Methodology

Several methodologies for establishing an economic value were considered, including: i) Value of a Statistical Life (VSL); ii) Damage Function approach; or iii) Disability Adjusted Life Years (DALY). Each approach requires significant data collection to ensure accuracy of the results.

The DALY approach was selected because of:

- **Conceptual simplicity**: DALY covers both mortality and morbidity in one number. The equations are straightforward and can be linked to potential health impacts of POPs;
- **Data availability**: WHO has estimated DALY rates per 100,000 population for all countries, not just the four countries participating in the POPs study; and
- **Ethically Acceptable**: The DALY approach does not place a value on a human life; rather it places a value on the risk shared by members of an exposed population. As such, it avoids the ethical concerns over the valuation of a human life.

7.4 What is a DALY?

The disability-adjusted life year (DALY) is a measure of overall disease burden. Originally developed by the World Health Organization, it is designed to quantify the impact of premature death and disability on a population by combining them into a single, comparable measure. In so doing, mortality and morbidity are combined into a single, common metric.

One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

7.5 Economic Valuation Steps

The Training Module includes a step-by step cost-benefit analysis for a POPs contaminated site. Further, an interactive tool is provided that allows for these steps to be followed in an online, interactive manner.

The five steps involved in this process include:

- Step 1 – Obtain DALY;
- Step 2 – Scale DALY to Local Site;
- Step 3 – Calculate Unit Price per DALY;
- Step 4 – Estimate site remediation costs;
- Step 5 – Estimate Benefit of Remediation; and
- Step 6 – Calculate Cost-Benefit of Remediation.

8.0 Case Studies

The Case Studies section includes the preliminary risk assessment reports for POPs sites selected in Cambodia, Lao PDR, Malaysia and Thailand. These case studies present the results of human health risk assessment and risk management techniques applied in each country, including a description of each POPs site, sampling undertaken, and calculation of human health risk from POPs. Case studies were developed by the POPs Project Team, and will be a key component of the National Training Workshops in January 2009.

Appendix A5

Overview of the Risk Assessment Process

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

 3/5/2009 SLIDE 1

"Human Health Risk Assessment Overview"

presented by Thomas G Boivin

National Training Workshop

Vientiane, Lao PDR, January 28, 2009

 3/5/2009 SLIDE 2

Why Assess and Manage Health Risk?

 SLIDE 3

In Many Countries - Driven by Regulation

- Federal Regulations typically forbid contamination, and require remediation with option of risk management:
  - e.g., Canadian, US EPA, European, Australian Legislation
  - Protection of Human and Ecological Health
  - Protection of Livestock, Fisheries and Wildlife
  - Complements Environmental Numerical Standards
  - "Polluter Pays" principle
- Provisions for voluntary/mandatory and flexible risk management solutions
- Makes good sense and is also economically advantageous

 SLIDE 4

Environmental Risk Management of POPs – Why?

- Health protection at POPs contaminated sites and prevention of long-range POPs transport
- Environmental Stewardship – *sustainability* makes good economic sense
- Stockholm Convention – *compliance* makes good sense to foster international trade

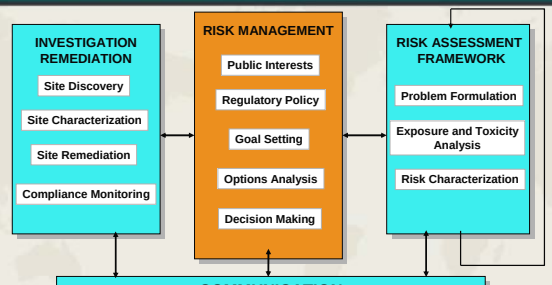
 SLIDE 5

Environmental Risk Management of POPs – Why? (2)

- Performed proactively – avoid/reduce risk (e.g., environmental and economic impact assessment)
- Performed retroactively – remediate/reduce health risk, economic gains
- Informed decisions are needed to manage human or ecological health risks

 SLIDE 6

Integrated Risk Management Framework for Contaminated Sites



Integrated Environmental Management Process

Successful Risk Management Decisions

Three Basic Elements to Risk Management Decisions

- Technically feasible and cost effective option
- Result in acceptable risk
- And…socially acceptable!

Key Questions for Multi-Site POPs Program

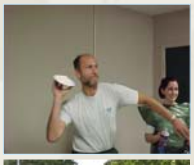
- Which sites are most in need of risk reduction, based on human and ecological considerations?
- Where can the greatest risk reduction be achieved for (a) human health, (b) ecological?
- How can I achieve the greatest risk reduction per remediation dollar that is available?

Concepts of Risk

- Risk – *probability* of *undesirable event*
  - Risk of losing money
  - Risk to corporate reputation/public opinion – business devalues
  - Risk to health and safety of people
  - **Risk to health from POPs**
- Risk Management – identification and actions to avoid/reduce risk to an acceptable level

What Is Risk?

- Risk is an intrinsic part of life
- Any activity is associated with some risk
- For a risk to exist there needs to be some kind of hazard
  - e.g., chemical, explosive, mechanical hazard

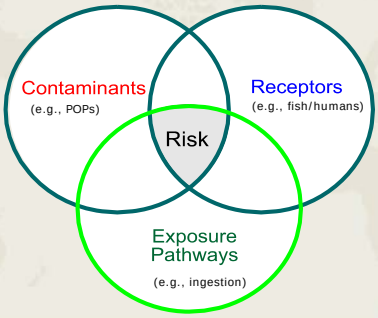


What is Environmental Risk?

- Environmental Risk:

  " …probability of an adverse event due to disturbances in the environment "
  Ontario MOE *Guidance* document
  - e.g., human health effect
  - e.g., fish health, reproduction
  - e.g., livestock health, livelihood
- But what causes environmental health risk?
  - Hazardous contamination

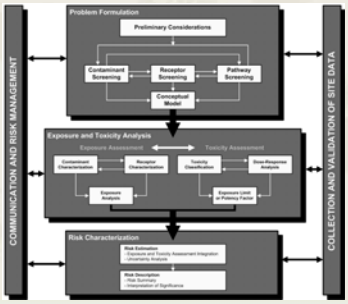
Health Risk Components



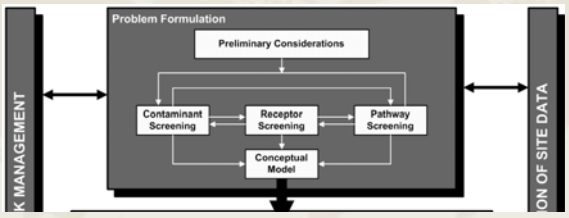
Elements of Risk Assessment

- Hazard Identification/ Assessment and Problem Formulation
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization

Environmental Risk Assessment Framework



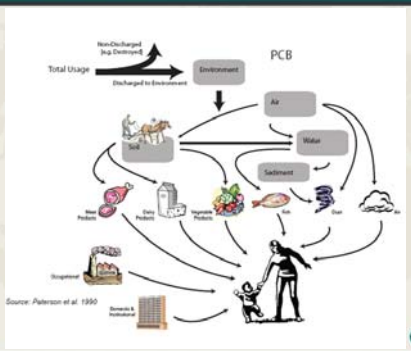
Environmental Risk Assessment Framework



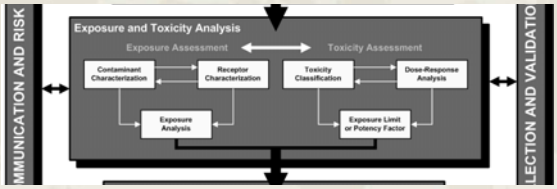
Contaminant Screening

- Contaminant screening generally involves comparison with criteria/standards
  - Criteria/standards typically risk-based using conservative scenarios
  - If contaminants don't exceed criteria/standards, likely safe, no further assessment required
  - Exceedances of criteria require further assessment (i.e. they "screen in" for our assessment)

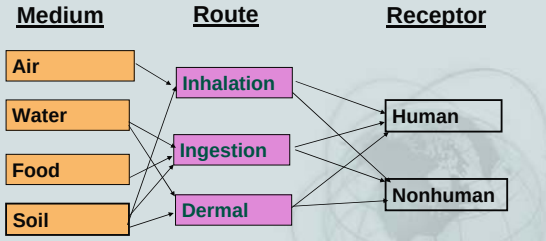
Human Exposure Pathways



Environmental Risk Assessment Framework



Intake Modelling

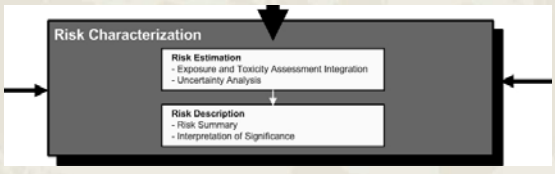


Example: Inhalation of Soil Dust and Particulates

$$\text{Dose} = \frac{Cs \times IRinh \times (1/PEF) \times EF \times ET \times ED \times PDD}{BW \times AT}$$

Dose = dose from dust/particulates inhalation (mg/kg body weight/day)
Cs = concentration of chemical in soil (mg/kg)
IRinh = inhalation rate (m^3/hr)
PEF = particulate emission factor (m^3/kg)
EF = exposure frequency (days/year)
ET = exposure time (hr/day)
ED = exposure duration (years)
PDD = portion of dry days (unitless)
BW = body weight (kg)
AT = averaging time (days): number of days in a lifetime for carcinogens
number of days in the exposure duration for non-carcinogens

Environmental Risk Assessment Framework



Risk Estimation for Threshold Substances

- Hazard Quotient (HQ) = Exposure Ratio
- HQ = Dose Rate/Reference Dose
- Hazard Index = ΣHQ for all pathways and similar toxic effects
- A HQ of <0.2 is often considered "acceptable"
- Other jurisdictions may use 1.0

Risk Estimation for Non-Threshold Substances

- Incremental Lifetime Cancer Risk (ILCR)
  - Probability of cancer occurring over a lifetime
  - Calculation requires cancer "slope factor" (SF) obtained from other studies
- ILCR = Dose Rate x SF
  - Acceptable cancer risk (ACR) < 1E-6 (Ontario)
  - Within Canada: typically 1E-6 to 1E-5
  - Within USA: typically 1E-6 to 1E-4

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 SLIDE 25

Risk Interpretation

- Uncertainty is inherent in risk assessments
- Caution is needed when interpreting the accuracy in risk estimates
- Understand the influence of conservative assumptions
- Perform sensitivity analysis for better insight on uncertainty

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 SLIDE 26

Risk Characterization Summary

- Integration of exposure and toxicity assessments
- Describe the nature and the magnitude of the risk
- Different methods used for evaluating risk for carcinogens and non-carcinogens
- Acceptable risk levels may differ between jurisdiction
- Site-specific criteria may be derived based on the RA results

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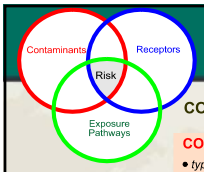
 SLIDE 27

Screening versus Comprehensive Risk Assessment

Screening Assessment		Comprehensive Assessment
simple	⇔	complex
qualitative	⇔	quantitative
descriptive	⇔	predictive
literature	⇔	field (site-specific)

Golder Associates

Risk Management Strategies



RISK COMPONENTS	RISK MANAGEMENT OPTIONS
CONTAMINANT • type • concentration • distribution • release	• removal • treatment
EXPOSURE PATHWAYS • media • migration • fate	• interception • ventilation • containment
RECEPTORS • type • sensitivity • land use	• relocations • land use restrictions

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 SLIDE 29

Recreational Park overtop contaminated soil – No exposure pathway, no migration, and no health risk.

Appendix A6

Introduction to the Site Prioritization Tools

Human Health Risk Assessment Training Module

Learning Objectives:

After reviewing this section the reader should:

- Know the components of a risk assessment
- Know how risk assessments are conducted
- Be able to use some basic equations to calculate human exposure to contaminants via ingestion, inhalation and dermal contact
- Be able to make screening level risk estimates using exposure data
- Understand the difference between threshold and non-threshold contaminants

Transformer storage yard in Phenom Penh, Cambodia
Source: Hatfield Consultants
(click to enlarge)

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Human Health Risk Assessment

Human Health Risk Assessment Overview

Risk assessment is an iterative process leading to the quantification of potential risk. For the POPs project, the emphasis is on assessing health risks to humans resulting from exposure to persistent organic chemicals. The assessment looks at multiple exposure scenarios and calculates the incremental risks associated with each scenario, as well as the overall risk attributable to all the scenarios combined. Information provided by risk assessments is needed before appropriate risk management measures can be selected and implemented.

Transformer Storage Depot in Vientiane, Lao PDR
Source: Hatfield Consultants
(click to enlarge)

Risk assessments start off very simple, using a minimum of data, making simple assumptions and using simple calculations. At this initial stage, all assumptions should err on the side of caution. If the earliest iterations of the risk assessment predicts elevated risk, it doesn't necessarily mean that there is elevated risk, but additional work needs to be done to refine the risk assessment. In Canada, the earliest iteration is called a **Preliminary Quantitative Risk Assessment (PQRA)** (Health Canada 2004)**.** Subsequent refinements are often called Detailed Site-Specific Risk Assessments.

References:

Health Canada PQRA - 2004 (external link)

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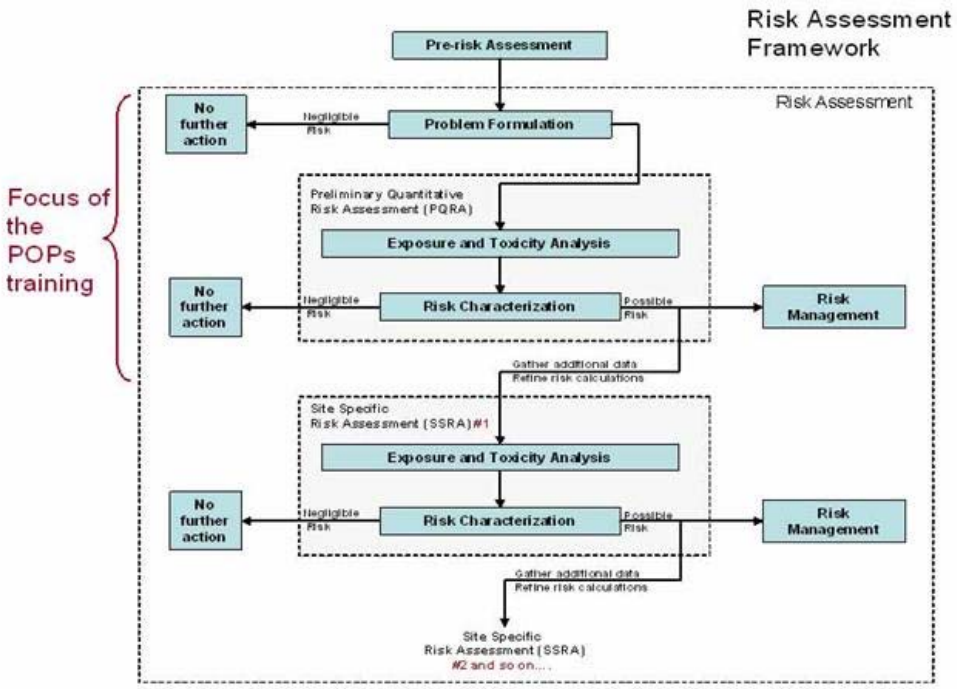
Risk Assessment Framework

Risk assessments can be broken down into several component parts. The framework utilized in the POPs project has been adopted primarily from Health Canada's **PQRA** (Preliminary Quantitative Risk Assessment) guidance for conducting human health risk assessments (Health Canada, 2004). The framework used is similar to those approaches used elsewhere in North America and in Europe.

The main components of a risk assessment are:

- **Preliminary data collection**
- **Problem formulation**
- **Exposure and toxicity analysis**
- **Risk characterization**

A PQRA will contain each of these components. More complicated risk assessments, site specific risk assessments (SSRAs), will contain additional exposure and toxicity analysis, and risk characterization.



References:

Health Canada PQRA - 2004 (external link)

Site Prioritization for Risk Assessment

Pre-Screening Tool

Site Prioritization Tool

Site Prioritization for Risk Assessment

One of the primary goals of the POPs toolkit is to provide countries with the capacity to perform simple Human Health Risk Assessments. When it comes to cleaning up multiple sites in a country the questions arise: where to begin? Which sites should be a priority for a risk assessment?

In this section, two semi-quantitative tools are presented that allow the user to determine which sites should be assessed and then to prioritize sites based on their potential for causing unacceptable risks to humans and/or the natural environment.

The purpose of the site prioritization is to classify contaminated sites based on their need for further action. Further action usually means risk assessment. The tools provided ask the user a series of questions regarding: contaminant characteristics, off-site migration potential, exposure and socio-economic factors. Then, based on the answers provided, calculates a total score for that site.

The purpose of Site Prioritization is to classify contaminated sites based on their need for further action

Source: Hatfield Consultants

(click to enlarge)

References:

The site prioritization tools are based on principals derived from the Canadian National Classification Tool for contaminated sites (CCME 2008). While the tools are applicable to any contaminated site, a greater emphasis has been put on POP's related contaminant issues.

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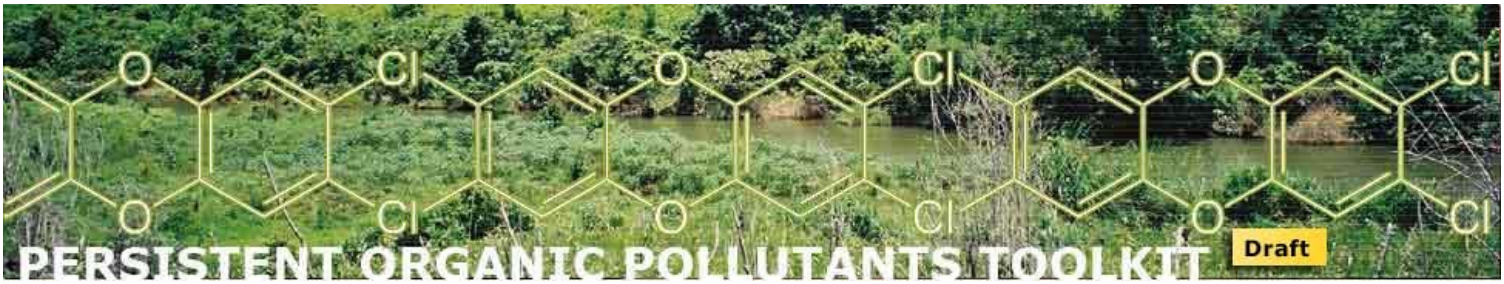

Pre-Screening Tool

The purpose of pre-screening is to identify which sites should be classified using the site prioritization tool.

Answers to the following four questions will determine whether the site:

- should be classified once a number of prescribed actions have been taken;
- will not require either classification or a risk assessment; or
- can proceed directly to classification using the site prioritization tool.

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Site Prioritization Tool

The purpose of the Site Prioritization Tool is to classify contaminated sites based on their need for a risk assessment.

The tool asks the user a series of questions regarding: contaminant characteristics, off-site migration potential, exposure and socio-economic factors. Then, based on the answers provided, calculates a total score for that site.

Using the total scores, the sites should be classified into the following categories:

- **Class 1** – High priority for risk assessment
- **Class 2** – Medium-high priority for risk assessment
- **Class 3** – Medium priority for risk assessment
- **Class 4** – Low priority for risk assessment
- **Class N** – Not a priority for risk assessment

Prioritizing a site without sufficient information

It is acknowledged that the user may not know the answer for many of the questions. Therefore, for most questions, one of the answer options is “do not know”, and an intermediate score is assigned to these questions. Once the tool has been completed, the percentage of questions answered “do not know” is calculated. If the percentage is greater than 30% of total responses, then the site is considered to have insufficient information. Additional information gathering should be conducted and the site ranked again.

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Appendix A7

Case Study of
Sok Pa Luang EDL Site

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

DRAFT RISK ASSESSMENT REPORT - A case study of Sok Pa Luang EDL Site

Presented by Mr. Khonekeo KINGKHAMBANG

National Training Workshop on Human Health Risk Assessment and Management of POPs

Vientiane, Lao PDR, January 28-31, 2009

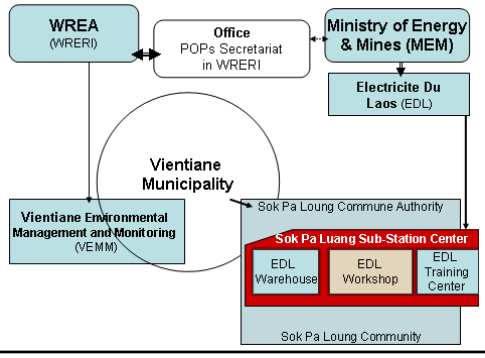
Introduction

- Electricite du Laos (EDL), Sok Pa Luang compound was selected by Laos POPs Team as a case study site.

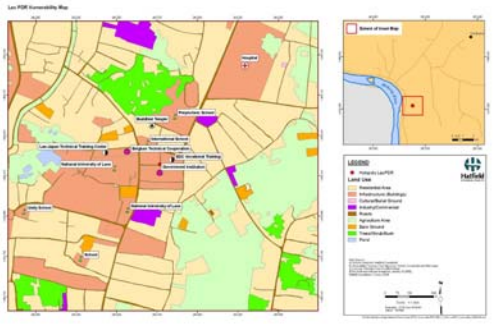
Site Management

- The EDL Compound is located centrally in Vientiane (Sok Pa Luang Road and Lao-Thai Friendship road; UTM 48Q 0248767; 1985320).
- The entire EDL compound covers an area of over 5 hectares. The repair workshop is ~30 m × 20 m.
- The Workshop has been operating since February 1, 1982.

Site Management



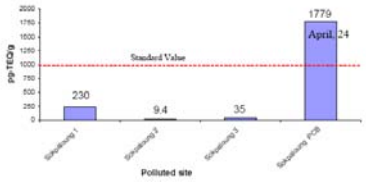
Land Use



- The major land use classes within 3 km2 are dominantly residential area (47%) and agricultural land (21%) Infrastructure (buildings) (19%) of the total land area.
- This land use is expected to further evolve towards residential and infrastructure in the next 5 years.

Suspected POPs Contaminants

- The site is used to collect, store and repair used transformers from 1982.
- Recycled oil is transferred into 45-gallon drums, and is re-used
- Previously analyzed samples from the site suggested potentially high concentrations of PCBs.

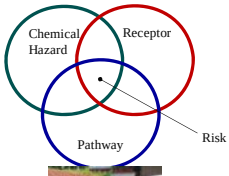


Suspected Activities Generating PCBs at SPL Site

	Activities	Status
1	Production of PCBs	
2	Production of PCBs containing fluids	
3	**Use of PCB-containing equipment and fluids**	✓
4	**Handling of PCB-containing equipment and fluids**	✓
5	**Storage of PCB containing equipment and fluids**	✓
6	**Leakage of PCB containing equipment**	✓
7	**Maintenance and Repair of PCB containing equipment**	✓
8	**Retro filling**	✓
9	Disposal of PCB containing equipment	
10	**Misuse of PCB containing fluids**	✓

Risk Assessment Objectives

- To illustrate the application of the environmental risk assessment process as applied to contaminated sites; and
- To determine if PCBs, dioxins/furans (POPs) and organo-chlorine pesticides (like POPs), and associated health risks are present.



Approach and Process

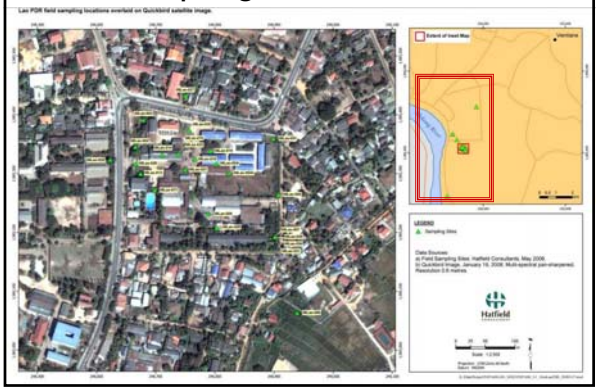
- Use Health Canada (2004) for Human Health Risk Assessment;
- Preliminary Data Collection - April-May 08;
- 1st Supplementary Field Data Collection - May 08;
- 2nd Data Collection Program (Human tissue) – August 08;
- Samples analysis by CALUX and HR GCMS – Aug – Dec, 08; and
- Risk Assessment with WREA & EDL staff – December 08.

List of Samples Collected, Sok Pa Luang, Lao PDR

Location	Site Name	May 20 - 24, 2008					August 5, 2008
		Soil/dust	Sediment	Biota	QA/QC	Interview	Blood
Vientiane, Lao PDR	Sok Pa Loung SPL Compound	19	9	3	2	16	11

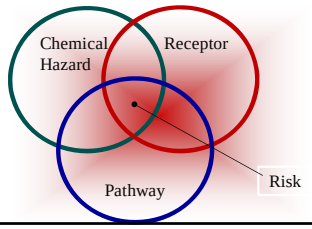
Detailed list of samples collected and analyzed is provided as **Appendix A1**. 16 potentially affected people were interviewed.

Sampling Location Sites



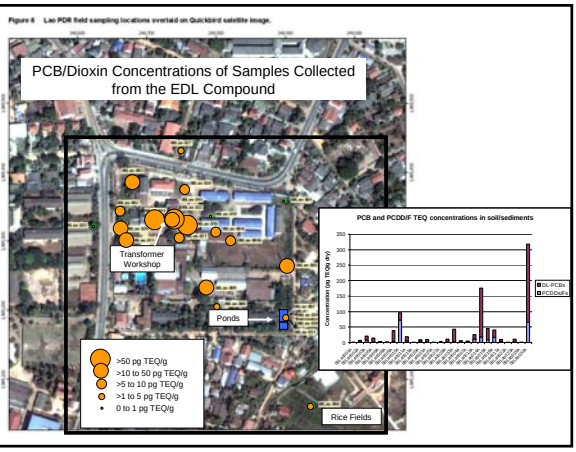
Problem Formulation

- All the components required for a human health risk were present: chemical hazards, receptors and pathways linking the hazards and receptors.



Problem Formulation – Chemical Hazards (1)

- For both soils and sediments, the maximum concentrations were 72.0 pg-TEQ/g for PCDD/Fs, and 253 pg-TEQ/g for dioxin-like PCBs (CALUX).
- Screening the maximum concentrations for PCDD/Fs and dioxin-like PCBs resulted in exceedance factors of 16.0 and 56.2, respectively (WHO 2006 TEF).
- Both PCDD/Fs and dioxin-like PCBs were considered contaminants of potential concern (COPC).
- The chlorinated pesticide – Dieldrin - analysis for the single fish tissue sample was also found to get exceedance factor of 2.6). There is no record of its use or storage at the case study site???



Problem Formulation – Receptors (2)

- Receptors are the living organisms (humans, animals and plants) that may be affected by exposure to a chemical hazard.

Potential Human receptors related to the SPL site (within 1km radius) may include:

Sok Pa Luang Site, Vientiane, Lao PDR	
Types of Potentially exposed	**Estimated numbers**
Sok Pa Luang village residents within 1 km radius	450
Full time staff of workshop	12
Full time security	4
Full time SPL compound staff	100
Students and staff of National University of Laos	2000
Students and staff of international school	200
Shift workers and visitors	60
Total	2,826

(Source: May and August 2008 field works and estimates from average population density of Vientiane Capital)

Receptors

Problem Formulation – Pathway (3)

- How a chemical ***hazard*** reaches & potentially affects a ***receptor:***
  - ***Physical Mechanisms*** – contaminant transported into environment.
  - ***Human Behavior*** –moved by people, means of transport.
  - ***Biological Mechanisms of Chemical Intake*** – dermal and/or eye contact, ingestion of contaminated food and/or soils, and inhalation of dust.

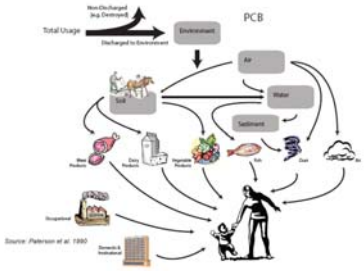


Pathway

- There are several potential exposure pathways:
  - On-site: inhalation, accidental ingestion and dermal contact of soils/dust;
  - Off-Site: wind erosion and surface water transport of exposed soils ➔ inhalation, accidental ingestion and dermal contact;
  - Transportation of soils/sediments off site either on tires of trucks, dirty clothes/boots;
  - Transportation of transformer oils off site for use as cooking fuel ➔ inhalation, accidental ingestion and dermal contact; and
  - Ingestion of potentially contaminated fish and wildlife.

Pathway

From human exposure survey in May 2008, the pathway was further confirmed



Risk Characterization

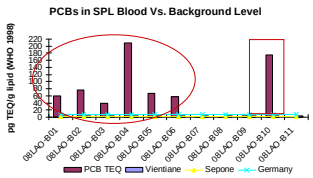
- Potential human health risk associated with PCBs & dioxin/furans is present.
- The PCB exposure was confirmed by measured concentrations of PCBs in the blood of some workers/staff.

Risk Estimates

- Based on the results of the model, there may be a potential human health risk associated with workers, workers family members and local residents being exposed to PCBs and dioxins/furans.
- Hazard quotients were as high as 62.6, several fold higher than the 0.2 threshold.
- The greatest exposure, and greatest contributor to potential risk, is the ingestion of fish and dermal contact with contaminated oils/soils.

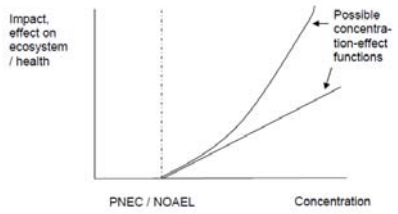
Blood Result

- Measured PCB blood concentrations of workshop workers is significantly (>25 times) higher than the average background concentrations of PCBs in blood in Lao PDR and Germany.
- However, health implications at the SPL case study site are yet unclear.




Health Implication

- Predicting effects is difficult due to uncertainty in the relationship between blood levels, duration of exposure and observed effects.
- American Chemistry Council (ACC 2003): estimate of an acceptable blood concentration ranged from 10 to 30 pg TEQ/g lipid in blood.



Path Forward to Risk Management

- From the risk assessment, the SPL site can be placed into one of five categories of risk management priority, namely:
  - Level A – action is required;
  - Level B - action likely required;
  - Level C - action may potentially be required;
  - Level N - remedial action not needed; and
  - Level I - insufficient data.

Human Health Risk & Other Concerns

- The potential risks to human health and ecology (from the results of the risk assessment);
- Responsibility/liability that it may pose to:
  - the owners (e.g. cost of remediation, reputation and relation), and
  - affected parties – workers/staff, nearby property owners.
- Currently no specific measures to mitigate the potential PCBs exposures

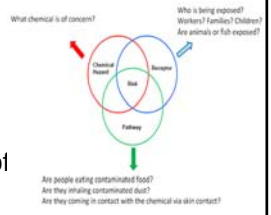
Setting Risk Reduction Strategy for the Site

- Goals, Objectives and Indicators:

➔ contribute to broader national development strategy and poverty eradication.

➔ address components of risk:

- Receptors;
- Pathway; and
- Chemical hazards.



Proposed Goals, Sub-goals and Indicators (1)

Goal 1	Sub goals	Indicator
To reduce health risks to sensitive groups of people arising from PCB contamination	1.1. To minimize health risks of residents living adjacent to the SPL compound	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).
	1.2. To minimize health risks of workers and trainers working in the SPL compound.	By year 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).
	1.3. To minimize health risk of workers working in the SPL workshop	By 2015, reduce daily exposure to PCBs to the lowest acceptable level (i.e., HQ<0.2) or monitor success of implementing specific risk management approaches (to be determined).

Proposed Goals, Sub-goals and Indicators (2)

Goal 2	Sub goals	Indicator
To avoid or, when avoidance is not feasible, minimize uncontrolled releases of PCB hazardous materials or accidents (including explosion and fire) during their handling, storage and use.	2.1. To establish hazardous materials management action plans to address potential chemical hazards, exposure pathways and potential receptors identified through human health risk assessment.	By year 2015, the national hazardous materials management priorities plan is in place and effectively enforced.
	2.2. Where practicable, to avoid or minimize the use of hazardous materials (for example, replacing PCBs in electrical equipment by non-PCB substitutes).	By year 2015, PCB oil or PCB contaminated oils are no longer in use in all transformers and capacitors.
	2.3. To prevent uncontrolled releases of PCBs and other hazardous chemicals to the environment or uncontrolled reactions that might result in fire or explosion.	By 2015, proper containment facilities are in place and properly operated and maintained.
	2.4 To Implement management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been (or cannot be) prevented or controlled through appropriate risk management measures.	By 2015, management control activities – procedures, inspections, communication, training and drills – are conducted regularly.

Proposed Management Measures

- Numerous technical approaches and other instruments.
- Combination of various measures ➔ more effective outcomes in risk reduction.
- Identified/pre-screened options/measures were further screened against balancing factors: i) effectiveness ii) Long-term reliability iii) Implementability iv) Implementation risk; v) cost (construction, operation & maintenance).

Recommended RA Options: 1) Measures for Controlling PCB Hazard

- Containment facility;
- Test-based inventory of contaminated equipment;
- Store contaminated equipment in containment facility;
- Area signage and enforce access restriction;
- Label equipment, containers and piping systems.

Recommended RA Options: 2) Spill Control, Prevention & Mitigation

- Spill Control & Countermeasure Plan and SOPs;
- Engineering measures to control release;
- Training staff on release prevention and mitigation;
- Monitoring and Inspection Program;
- Enforce use of Personal Protection Equipment (PPE).

Recommended RA Options: 3) Excavating & Capping of Hot Spot.

- Excavating and recapping critical area promptly;
- Cleaning up of potentially contaminated channels and ditches;
- Capturing sediments from run-off from site during rain; and
- Preventing contaminated soil removed by truck or wind.

Recommended RA Options: 4) Occupational Health & Safety Plan at Work Place

- Job safety analysis;
- Prevention and protective measures:
  - Remove high exposure activities from work process;
  - Minimize hazards through institutional, administrative & engineering controls; and
  - Enforce use of protection equipment.

4) Occupational Health & Safety Plan at Work Place (2)

- Integrity of workplace facilities/structure:
  - Surface, structures and installations should be easy to clean, and maintain, and not allow for accumulating hazardous compounds;
  - Facilities for showering and changing into and out of street and work clothes;
  - Providing specific personal protection equipment (PPE), first aid and sanitary facilities in workplace; and
  - Providing clean eating areas.

Recommended RA Options: Control site Access & change in human behavior

5. Define & enforce “restricted entry” without proper personal protection equipment;
6. Control on consumption of contaminated foods – discourage or educate on safe eating of suspected contaminated food.
7. Stop workers/staff from bringing contaminated oil and products home
8. Monitor & verify effectiveness of RA plan;
9. Risk Communication & Training; and
10. Labeling

III. Health and Safety Plan (HSP) – Workplace Hazardous Materials Information System (WHMIS) (3)

Labels –

- All controlled products must be labeled.
- Other means, such as warning signs or color codes.
- Labels alert workers to hazards and safe handling instructions, and MSDS for a product.
- Label information:

Product name	First aid measures
Hazard symbols	Supplier identifier
Risk phrases	Reference to MSDS
Precautionary measures	

Next Steps

- Risk Communication:
  - Community concerned; and
  - Decision makers.
- Sensitizing/channeling POPs RA/RM into decision/policy agenda ➔ commitment.
- Implementation Plan/Program and Support.

Conclusion

- All three element of risk are presents.
- PCBs concentration in environment and blood samples are many times higher than background level.
- Ingestion of contaminated food and dermal contact are the predominant route of exposure.

Conclusion (2)

- Potential human health risk associated with PCBs exposure & dioxin/furans.
- SPL site is categorized as Level A– actions are required now.
- There is neither past nor existing mitigation plan in place.
- Short-list of cost-effective RA options are proposed to address: 1) hazard; 2) pathway; and 3) receptors.
- Risk communication, implementation plan, and monitoring and evaluation measures are important for the success in risk reduction.

Thank You

For further information contact:

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- Thomas Bovin,

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Appendix A8

Risk Assessment Process

Preliminary Data Collection

Before conducting a risk assessment a number of preparatory steps are required. Two of the most important steps are:

- **To choose data quality objectives**
- **To gather data**

Soil Sampling in Vientiane, Lao PDR
Source: Hatfield Consultants
(click to enlarge)

Data Quality Objectives (DQO)

Data Quality Objectives provide criteria for developing a data collection design that includes: when to collect samples, where to collect samples, the maximum allowable error for the study, and how many samples to collect. Using the DQO process will help ensure that the type, quantity, and quality of environmental data used in the risk assessment and/or risk management is appropriate. In addition, the DQO process will help prevent the collection of unnecessary data (USDOE 2008). For more information on DQO's please visit: the US Department of Energy's Data Quality Objectives website.

Data Gathering

Before staring the risk assessment process, certain types of data will be required. Common tasks are as follows:

Collection of pre-existing data - if previous investigations have been done at the site, some of the required data may be available as printed material. Other information, such as former site use may be available in the historical literature.

Conduct a site investigation - In addition to printed material, a site investigation is always recommended (Environment Canada 2003, USEPA 2008). By visiting the site, the Risk Assessor can collect current information which may not be available in the printed literature. A site investigation provides the risk assessor with data necessary to carry out a risk assessment. Information can include:

1) Visual Observations – i.e., What might be the contaminant of concern? What organisms might be exposed? How might organisms be exposed? Are there areas where soils appear to be darker or oily, or of a different color?

2) Collection Of Samples For Analysis – i.e., What are the average and maximum concentrations of contaminants in exposure media (i.e., soils, sediments, water or tissue etc.)? Are there unexpected contaminants of concern? What is the spatial distribution of contaminants?

Collect Ancilliary Data - Ancilliary data includes data that can be used for the risk assessment, but is generally not collected during the site investigation. Ancilliary data can include the results of interviews of people on site - i.e., What are the human behaviors at the site which might result in exposure? Have effects been observed? What is the duration or frequency of exposure?

More information will be provided regarding data in the next sections.

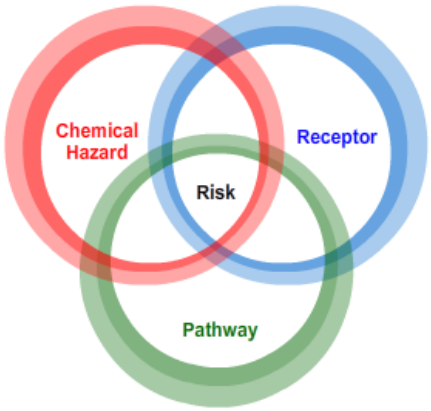
Human Health Risk Assessment

Problem Formulation

The very first step in the risk assessment is problem formulation which defines the problem. This process explicitly identifies the **components** and sets the stage for the Risk Assessment (Environment Canada 2003, Health Canada 2004). All three components are essential in order for a contaminant-based health risk to exist. Absence of any one will remove the possibility of an unacceptable health risk.

Components of Risk

(click on a component of risk to see questions raised by that component)



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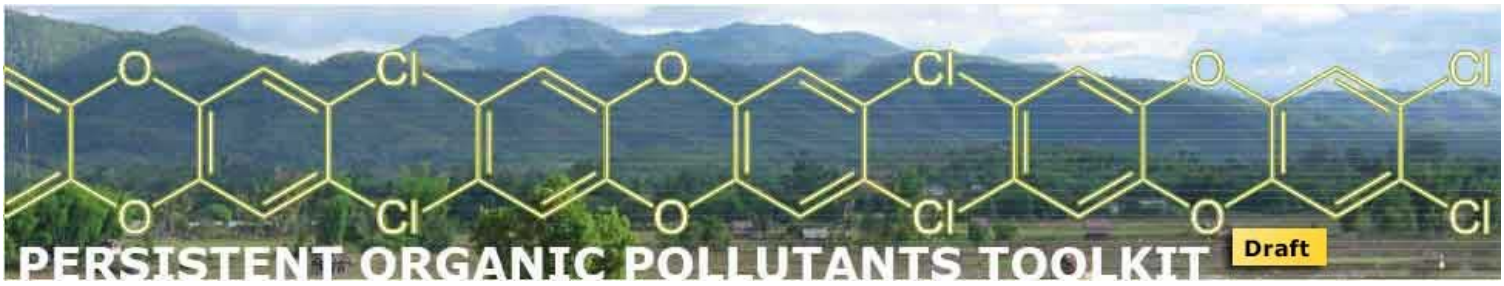

Risk Assessment Problem Formulation Worksheet Tool

The purpose of this worksheet is to help the risk assessor identify the components of the risk assessment. Use this worksheet to think through all parts of the problem formulation (see the problem formulation training module). A filled-in version of this worksheet should be included in your Risk Assessment report.

Potential land uses of the site

In this section, briefly describe the past, current and planned future land use of the site. Several categories are provided because some sites may have had more than one land use. Having this background information will help identify the types of chemical hazards possibly present at the site, the potential receptors and the pathways linking the chemical hazards with the receptors.

	Potential?	*Explanation*
Agricultural		
Residential/urban parkland		
Commercial		
Industrial - indoors		
Industrial - outdoors		
Recreational		
Other		

Humans receptors and pathways

Use this section to identify and describe the receptors (human and non-human) and pathways possibly present at the site.

Human receptor group

	On Site?	*Explanation*
General public or resident		
Employees		
School Children		
Other		

Human receptor ages

	On Site?	*Explanation*
Infant		

Toddler		
Child		
Teen		
Adult		
Other		

Human exposure pathways

	On Site?	*Explanation*
Accidental ingestion of soil		
Inhalation of soil particles		
Inhalation of indoor contaminant vapours		
Inhalation of outdoor contaminant vapours		
Ingestion of drinking water		
Dermal contact with soil		
Dermal contact with water		
Ingestion of contaminated food		

Non-human receptors and pathways

Non-human receptors

	On Site?	*Explanation*
Aquatic Animals		
Terrestrial Animals		
Plants		

Non-human exposure pathways

	On Site?	*Explanation*
Aquatic organism exposed via water		
Aquatic organism exposed via food		
Aquatic organism exposed via sediments		

	On Site?	*Explanation*
Terrestrial organism exposed via water		
Terrestrial organism exposed via food		
Terrestrial organism exposed via soil		

	On Site?	Explanation
Plants exposed via surface water or groundwater		
Plants exposed via soils		

Contaminant concentrations (highest measured concentrations)

To fill-in this section:

- *replace the column header "Chemical A, Chemical B, Chemical C..etc.", with a chemical contaminant name.*
- *enter the maximum concentration of that contaminant measured in the applicable row. Note that the concentration units of the concentration entered must match those shown in the first column.*
- *The maximum contaminant concentration can then be compared to environmental quality guidelines. If the measured maximum concentration exceeds the guidelines, then the contaminant is a Contaminant of Concern.*

add column

	Chemical A	Chemical B	Chemical C	Chemical D
Soil (*mg/kg*)				
Groundwater - source (*mg/L*)				
Drinking water (*mg/L*)				
Bathing/swimming water (*mg/L*)				
Outdoor air - particulate (mg/m^3)				
Root vegetables (*mg/kg wet weight*)				
Other vegetables (*mg/kg wet weight*)				
Fish (*mg/kg wet weight*)				
Wild game (*mg/kg wet weight*)				

Print this worksheet

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Chemical Hazards

To determine if a Chemical Hazard exists, site chemical data are **screened** against **environmental quality guidelines** (e.g., the CCME Environmental Quality Guidelines (external link) and Health Canada Drinking Water Guidelines (external link)). Concentration data is first summarized by calculating the mean, 95% upper confidence limit of the mean (UCLM), 95th percentile and maximum concentration.The summary statistics are then screened against the environmental quality guidelines. In addition to statistical summaries of concentrations, other information may need to be collected (e.g., for soil data).

Recreational Fishing at Xuan Lake, Viet Nam
Source: Hatfield Consultants
(click to enlarge)

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Screening of Chemical Hazards

Chemicals found at a site must be screened against environmental guidelines. To do this screening, the chemical measurement is compared against the **CCME Environmental Quality Guidelines** for protection of human health should be used. Where CCME human health guidelines are not available, other human health-based guidelines from reliable sources may be used. One source is the U.S. Environmental Protection Agency's (US EPA) preliminary remediation goals (**PRGs**). Another is US EPA risk based concentrations (**RBCs**). When compared against guidelines, Contaminants of Potential Concern (COPC) are identified.

Adjusting US EPA risk based concentrations

For non-carcinogens, PRG's or RBC's must be adjusted to reflect 20% of the US EPA toxicological reference value (TRV). A TRV is the maximum safe dose a human can be exposed to each day over a life time (mg/kg body weight/day). 20% of the TRV is taken to allow for exposure from other media and pathways.

Screening when a guideline is not available

In the event that a contaminant has no corresponding health-based soil quality guideline, the contaminant should be included as a Chemical of Potential Concern (COPC) for further risk assessment, unless the measured concentrations are consistent with natural or background concentrations.

Background Concentrations

Before a site is considered contaminated, concentrations of contaminants at the site, particularly natural elements (e.g., metals), should also be compared to background soil and groundwater concentrations (and surface water concentrations, if relevant), if data are available. If it is found that concentrations of contaminants at the site are representative of background levels, then the site may not be contaminated even though measured concentrations are greater than the guidelines. A further discussion of background levels is provided in Appendix A (external link) of the **PQRA guidance** document (Health Canada 2004).

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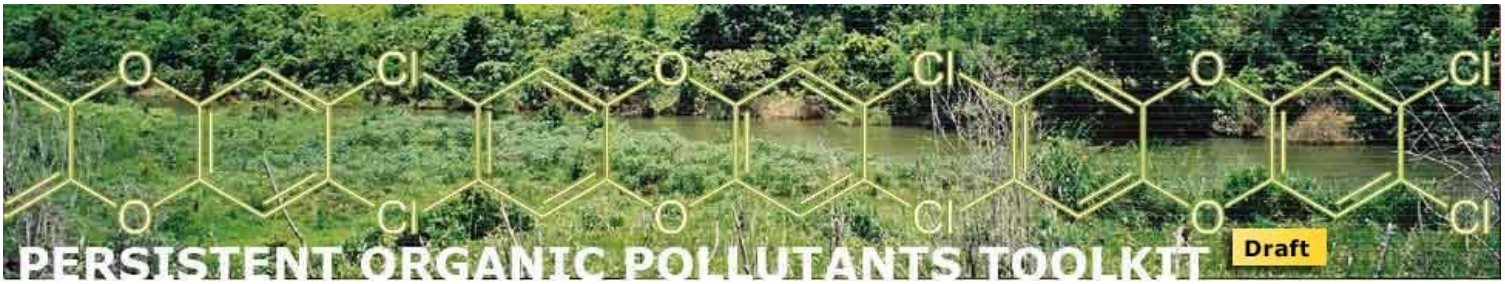


Environmental Quality Guidelines

Environmental Quality Guidelines are concentration limits for contaminants or environmental quality characteristics (such as dissolved oxygen or pH) that if exceeded, may affect humans or the environment (CCME 2006). For the POPs program, the CCME Environmental Quality Guidelines for the protection of human health have been recommended as the principle guidelines for ***screening*** purposes.

Collected Biological Samples
Source: Hatfield Consultants
(click to enlarge)

Like many environmental quality guidelines, the CCME Guidelines are generally based on scientific studies in which animals were exposed to the contaminant in question at various concentrations until a toxic effect was observed. If an animal study is used to represent potential effects to humans, a scaling factor accounting for difference in body weight is used. In addition, safety factors are applied to account for uncertainty, such as the relative sensitivity of animals and humans to a contaminant (CCME 2006).

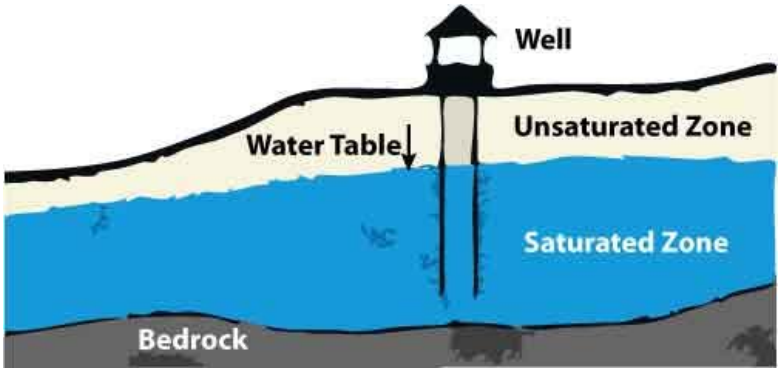
In the case of guidelines protective of human health, once scaling and safety factors have been taken into consideration, the guideline is calculated from **the toxicological reference value** (**TRV**). This is the highest total daily dose or concentration of a given chemical that is considered to not cause a toxic effect in humans when exposed over a lifetime. Guidelines are back calculated from the TRV, by making a number of assumptions about possible exposure scenarios and uptake efficiencies (CCME 2006).

The CCME guidelines provide guidelines addressing most potential exposure scenarios. However CCME does not provide guidelines specific to potential contaminated ***groundwater exposure***.

Groundwater

For contaminants in groundwater, the following screening approaches are recommended, depending on the potential exposure route:

- If the groundwater may be used for drinking water purposes, the Health Canada Guidelines for Canadian Drinking Water Quality (http://www.hc-sc.gc.ca/hecs-sesc/water/index.htm) should be used for screening of COPCs.
- If the groundwater is not used for drinking but may be used for other purposes, then the CCME water quality guidelines that best matches the intended purpose (e.g., livestock watering or to protect aquatic life etc.) should be used (Water Quality Guidelines CCME 2006).
- If the groundwater flows into a stream, lake or pond, it is often assumed that the groundwater will undergo a 10x dilution before discharging. Therefore for screening purposes, it is reasonable to screen groundwater concentrations in this scenario against CCME water quality criteria (for the protection of aquatic life) which have been multiplied by 10.



Additional Documentation and Data

For soil samples, the depth at which samples were collected should be indicated. A map of sampling locations is often helpful to determine if the collected samples reflect the distribution of contaminants across the entire property or just specific areas (Health Canada 2004).

For groundwater, the depth of the water table, flow direction, and travel time are useful data to document.

Receptors

Receptors are the living organisms (humans, animals and plants) that may be affected by exposure to a chemical hazard. Receptors are unique for a given contaminated site and exposure scenario. It is the receptor that is affected by the risk that is being assessed.

Receptors are the living organisms that may be affected by exposure to chemical hazards
Source: Hatfield Consultants
(click to enlarge)

Humans as Receptors

Humans are often subdivided on the basis of age group (Health Canada 2004). Typical age groups are as follows:

- infants (0 to 6 months),
- toddlers (7 months to 4 years),
- child (5 years to 11 years),
- teen (12 – 19 years) and
- adults (20+ years).

Age groups are assessed separately because many of the factors determining the degree of exposure are different. In addition, certain age groups are more susceptible to chemically mediated effects (i.e., infants, toddlers and pregnant woman are often the most sensitive to chemical exposure)(Health Canada 2004).

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Exposure Pathways

An exposure pathway is the route a chemical ***hazard*** takes to reach (and potentially affect) a ***receptor*** (Environment Canada 2003, Health Canada 2004). Exposure pathways include:

- ***Physical Mechanisms*** – e.g. contaminated soil being washed into a nearby creek and potentially affecting sediment dwelling organisms.
- ***Human Behavior*** – e.g. contaminated material moved by people from one location to another; contaminated soil on a truck's tires or people bring PCB containing oils home to be burned in cooking fires.
- ***Biological Mechanisms*** – e.g. dermal contact with contaminated soil, ingestion of contaminated food, inhalation of dust, etc.

An exposure pathway is the route a chemical hazard takes to reach a receptor
Source: Hatfield Consultants
(click to enlarge)

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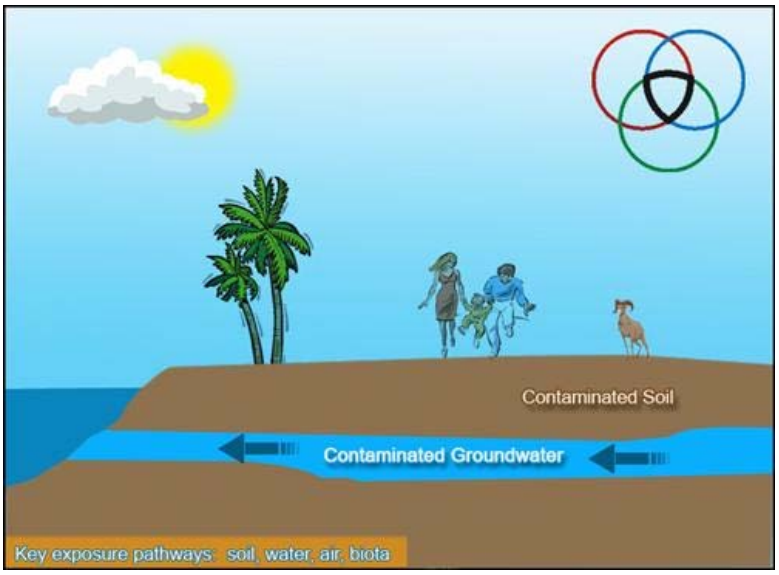
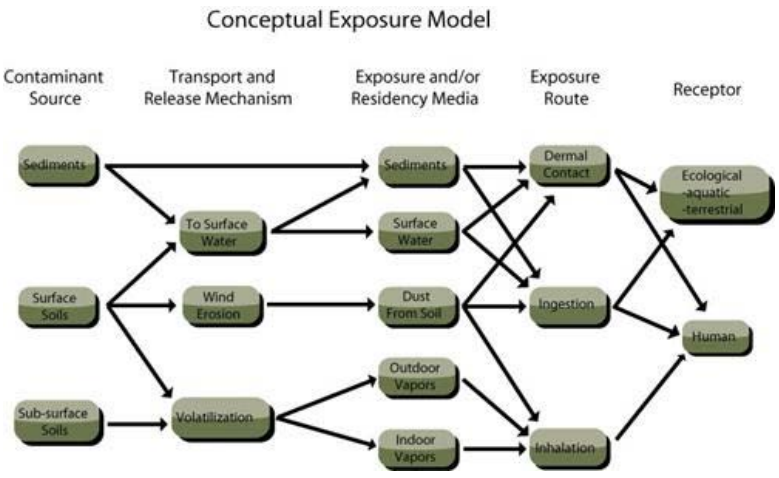
Conceptual Site Exposure Model

A conceptual site exposure model should be created to illustrate and explain how the contaminant sources, exposure pathways and receptors are linked together to form the potential for health risk. This step should involve a simple diagram and short description of these interrelationships. The conceptual exposure model provides the basis for developing the mathematical exposure model and estimation of health risks.

Example 1: schematic picture of conceptual exposure model.



Example 2: schematic flow diagram of conceptual exposure model.



Exposure Analysis

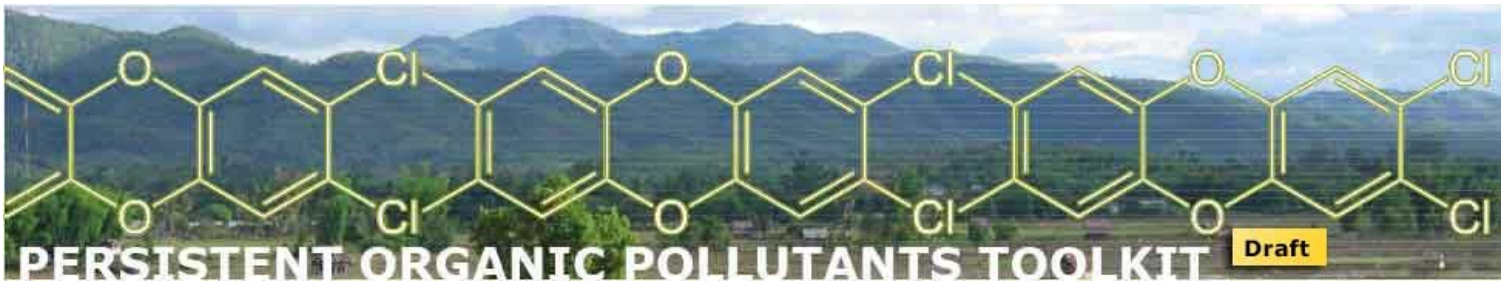
The exposure assessment attempts to quantify the contaminant intake rate for a given pathway. The intake of a contaminant via individual pathways can then be summed to estimate the total daily intake (Health Canada 2004).

Exposure via individual exposure pathways can be calculated by considering contaminant concentrations in **environmental samples**, human behavior information from **exposure surveys** and **standard exposure parameters**.

Alternatively, total exposure (for POPs) can be estimated by collecting **human tissue samples** for direct chemical analysis (i.e., blood and breast milk samples).

Health Canada's Preliminary Quantitative Risk Assessment (**PQRA**) guidance, provides an Excel spreadsheet-based **model** which calculates the total daily intake (Health Canada 2004). A simpler model has been incorporated into the POPs Toolkit (view the Problem Formulation Tool). The equations used to calculate exposure are provided and discussed later in this module.

Cocunut husks soaked in transformer oil for domestic use
Source: Hatfield Consultants
(click to enlarge)



Standard Exposure Parameters

Calculating exposure requires information about several exposure variables. Some of these variables can be derived from the human exposure survey; however, many may not be easily available. Health Canada (2004) provides a **table of standard exposure values** that can be used in the absence of information collected at the site, but they may not be representative of the area being surveyed because they reflect Canadian conditions/characteristics. Risk assessors are encouraged, as much as possible, to use values that are reflective of their country (i.e., average body weight, average lifetime etc.).

The Health Canada standard exposure values can be viewed online here (pdf file).

Other sources of Standard Exposure Parameters include: Richardson (1997) and U.S. EPA Exposure Factors Manual (U.S. EPA, 1997).

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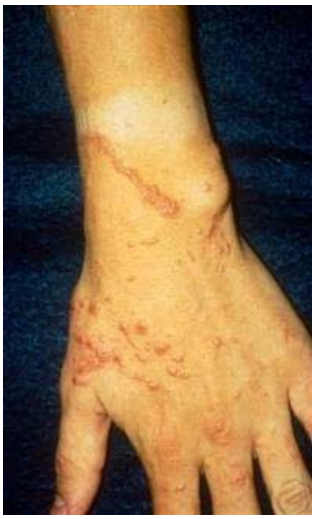
Exposure Equations

For each human exposure pathway, there exists a unique equation for calculating the total daily intake of contaminants. These equations include:

- Accidental ingestion of contaminated soils;
- Inhalation of contaminated soil particles (dust);
- Ingestion of contaminated drinking water;
- Dermal contact with contaminated soil; and
- Ingestion of contaminated vegetables, fruit or meat.

➪ These equations can be found in the risk calculation tool of this website.

Additional equations may also be necessary in cases where a pathway is not sufficiently described by one of the above equations.



Dermal exposures are generally added to the ingested dose, once adjustments are made accounting for differences in absorption
Source: Hatfield Consultants
(click to enlarge)

Inhalation of Dust

The inhalation of dust is usually insignificant relative to direct ingestion of soil and water, and to dermal absorption. However, in some cases the inhalation pathway can become important.

In most cases, the concentration of a contaminant in the respirable airborne dust can be assumed to be equal to the concentration in surface soil (maximum or average). The average airborne concentration of respirable (≤ 10 µm aerodynamic diameter) particulate matter can be assumed to be 0.76 µg/m3 (based on U.S. EPA, 1992).

For situations where vehicle traffic on contaminated unpaved roads can be a significant concern, a reasonable dust level created by vehicle traffic on unpaved roads is 250 µg/m3 (down-wind side of the road; Claiborn et al., 1995).

Dermal Exposure

Toxicological reference values (**TRVs**) for the dermal exposure pathway are not commonly available. Therefore, dermal exposures are generally added to the ingested dose, once adjustments are made accounting for differences in absorption (see Relative Absorption Factors below).

Exposure via Multiple Pathways

In many cases the intake rates for oral, dermal and inhalation exposures are combined and a single TRV is used to evaluate the risks. For example, in cases where only an oral TRV is available, exposures by all routes (oral, dermal, inhalation) should be summed for comparison to the oral TRV.

In cases where TRVs for oral and inhalation exposures are intake rates, calculations for these pathways should be calculated separately.

Relative Absorption Factors (RAFs)

For more refined risk estimates it is desirable to apply **relative absorption factors (RAFs)** in exposure calculations. For PQRAs, oral exposures are typically assumed to have a relative absorption of 100% (RAF = 1); but if evidence suggests a lower bioavailability, this may be modified with justification. Where inhalation exposures are being summed with oral exposures, the inhalation RAF will generally default to 1 unless there is a

good reason for respiratory absorption to be significantly less that 100%.

Where dermal exposures are being summed with oral exposures, the RAF values presented in Relative Absorption Factors and Exposure via Multiple Pathways table (Excel file) should be applied.

Other sources of RAF values include

- **the Risk Assessment Information System** (RAIS - external link),
- Toxicological Profiles published by **the Agency for Toxic Substances and Disease Registry** (ASTDR - external link)

Toxicity Analysis

The toxicity assessment quantifies the sensitivity of the receptor to the chemical hazard. In a Preliminary Quantitative Risk Assessment, the toxicity assessment typically consists of choosing the correct toxicity reference value (**TRV**) for a given contaminant and exposure uptake route. TRVs generally can be used for multiple routes of exposure (i.e., dietary, inhalation or dermal contact), but for some contaminants, separate TRVs are provided specifically for ingestion and inhalation pathways.

Reference Files:

- Health Canada TRVs (Excel file)
- US EPA RBCs (Excel file)

Toxicity assessments consider the mode of action of the contaminant, the toxic potency as observed in scientific studies, and physiological/biochemical factors which might modify the toxic potency.

Generally, chemicals are considered to have either a **threshold** or **non-threshold** dose or concentration where toxic effects may begin to occur. Each is assessed differently in a human health risk assessment (Health Canada 1994).

The toxicity assessment quantifies the sensitivity of the receptor to the chemical hazard
Source: Hatfield Consultants
(click to enlarge)

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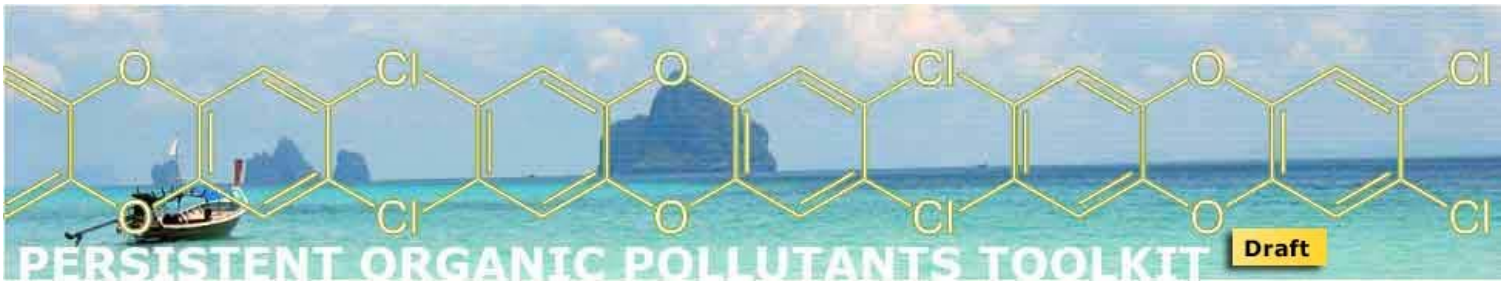


Toxicity Reference Values (TRVs)

Health Canada toxicity reference values (TRVs) may be applied where available (Health Canada, 2004). These are referred to as tolerable daily intake (TDI) or reference dose values for non-carcinogens, and slope factors (SF) for carcinogens.

Data without Health Canada TRVs

For substances with no Health Canada TRVs, Reference Doses (**RfD**s), Reference Concentrations (**RfC**s), Acceptable Daily Intakes (**ADI**s), Minimum Risk Levels (**MRL**s) or Cancer Slope Factors (**CSF**s) should be obtained from the following agencies, in order of preference (Health Canada 2004):

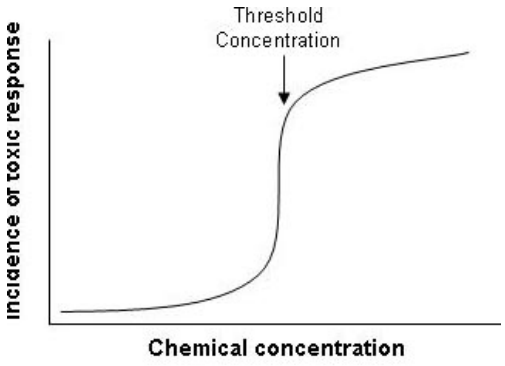
- **U.S. EPA Integrated Risk Information System** (IRIS):
- **World Health Organization** (WHO)
- **Netherlands National Institute of Public Health and the Environment** (RIVM):
- **Agency for Toxic Substances and Disease Registry** (ATSDR) (U.S.);

Reference Files:

- Health Canada TRVs (Excel file)
- US EPA RBCs (Excel file)

Threshold Contaminants

A threshold response is characterized by a toxic effect occurring above an exposure concentration. Most environmental contaminants are threshold contaminants.



The maximum allowable exposure concentrations, called the **Exposure Limits** (or Toxicity Reference Values) are based on the threshold determined from toxicity experiments. Usually the Exposure Limit incorporates an Uncertainty Factor (or Safety Factor) to account for uncertainties in the estimate. The Exposure Limit for a Threshold Contaminant is generally presented as a Tolerable Daily Intake value (TDI; mg chemical/kg body weight/day) (Health Canada 1994) or a Reference Dose (RfD; US EPA).

You can calculate Hazard Qutotient for a threshold contaminant using the Risk Calculation Tools of the toolkit.

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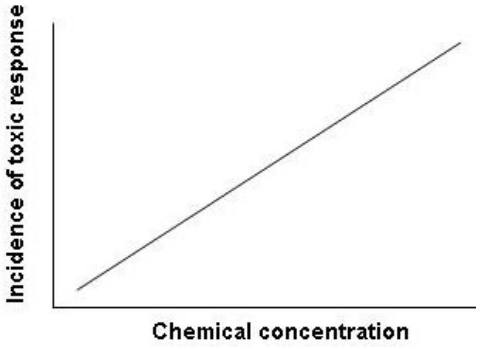
Non-Threshold Contaminants

Non-threshold acting contaminants exhibit affects at virtually all levels of exposure (i.e., any exposure results in some level of risk). Most, but not all carcinogens are generally regarded as non-threshold acting contaminants.



Risk estimation for non-threshold substances is computed differently than for threshold contaminants. The risk estimation is presented as the Incremental Life-time Cancer Risk (ILCR). This is the incremental probability of acquiring cancer over and above the background probability.

The ILCR is calculated by multiplying a chemical concentration by a Slope Factor (SF). In Canada, an acceptable ILCR is generally considered to be 1 in 100,000 (0.00001).

You can calculate an ILCR values using the Risk Calculation Tools.

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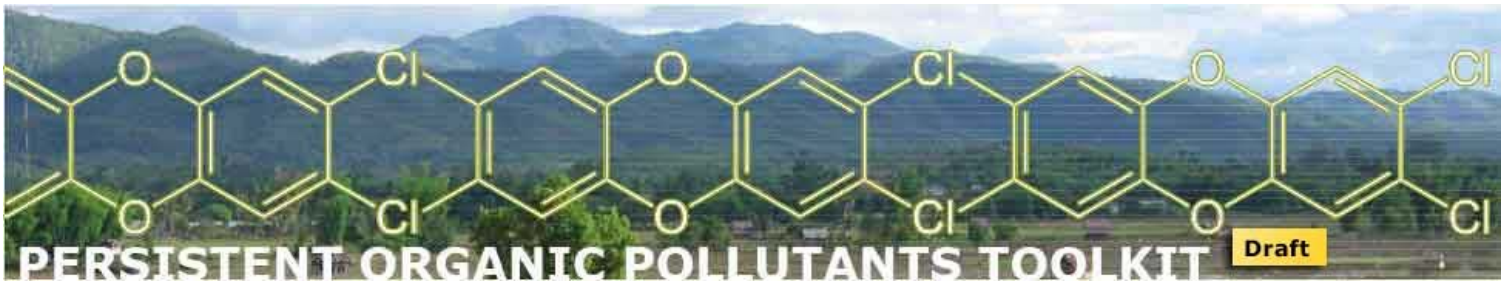

Risk Characterization

The final component of the risk assessment is the risk characterization. The risk characterization integrates the information from the exposure and toxicity analysis to derive a quantitative estimate of human health risk.

This is normally accomplished by calculating an exposure ratio called a **Hazard Quotient (HQ)** for threshold contaminants or an **Incremental Life-time Cancer Risk (ILCR)** for non-threshold contaminants.

If risks are predicted at the risk characterization stage, the risk assessment process is repeated using additional data, refined assumptions and more complex equations and/or risk management measures are taken.

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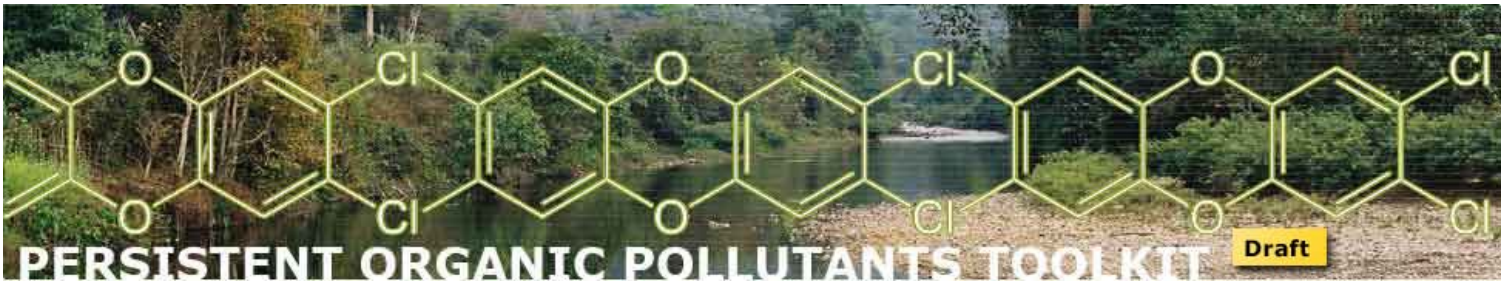

Hazard Quotient

For threshold contaminants, the risk to a human receptor from being exposed to a chemical via a single pathway can be expressed as an Exposure Ratio, commonly called a Hazard Quotient (HQ).

$$HQ = \frac{\text{Dose Rate}}{\text{Reference Dose}} = \frac{\text{Exposure Concentration}}{\text{Reference Concentration}}$$

The reference dose is interpreted as the Tolerable Daily Intake (**TDI**; mg/kg/day).

A Hazard Index (**HI**) is the sum of HQ's for all pathways and similar toxic effects. A HQ of <0.2 for any given pathway is often considered acceptable; while an HI of <1.0 is considered acceptable (Health Canada 2004).

Non-carcinogens: Single-Substance Exposures

For substances presenting risks other than cancer, a Hazard Quotient (HQ; also called an exposure ratio and hazard ratio) will be derived as the ratio of the estimated exposure (for each critical receptor) to the tolerable daily intake (TDI) or tolerable concentration (TC), as follows:

$$\textit{Hazard Quotient} = \frac{\textit{Estimated Dose (µg/kg/day)}}{\textit{Tolerable Daily Intake (µg/kg/day)}}$$

For purposes of preliminary quantitative risk assessment, exposures associated with a HQ = 0.2 will be deemed negligible. This is consistent with the CCME (1996) and the OMEE (1996a), and has become accepted as common practice (Health Canada 2004). If the HQ is greater than 0.2, or the HI is greater than 1, the risk assessment should either be refined and/or risk management measures should be taken.

Online Tool

You can calculate a Hazard Quotient using the Risk Calculation Tools.

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Incremental Lifetime Cancer Risk

For carcinogens, the estimated exposure will be multiplied by the appropriate *Cancer Slope Factor* or *Unit Risk* to derive an estimate of the potential Incremental Lifetime Cancer Risk (ILCR) associated with that exposure (Health Canada 2004). The ILCR is derived as:

ILCR = Exposure (µg/kg/d) x Cancer Slope Factor (µg/kg/day)$^{-1}$

Where pathway-specific slope factors or unit risks exist, the risks via inhalation and the risks via oral + dermal exposure should be estimated separately. In other cases, the cancer risks posed by simultaneous inhalation/dermal/oral exposure will be estimated.

Cancer risks will be considered “essentially negligible” where the estimated ILCR is 1-in-100,000 (≤ 1 x 10^{-5}) (Health Canada 2004).

If the ILCR is greater than 1 x 10^{-5}, the risk assessment should either be refined and/or risk management measures should be taken.

Online Tool

You can calculate an ILCR value using the Risk Calculation Tools.

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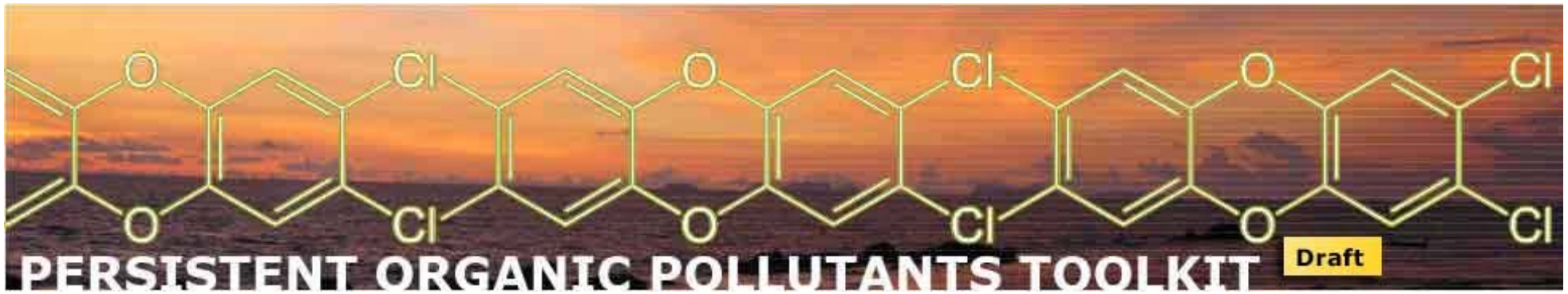
Appendix A9

Risk Calculation Tools



Risk Calculation Tools

Several risk tools that use a simple model, have been provided to estimate Human Health Risks. The tool calculates exposure (i.e., dose) via ingestion, inhalation and dermal contact. Calculated doses are then used to calculate expressions of human health risk:

- Hazard Quotients (HQs) for non-carcinogens
- Incremental Lifetime Cancer Risk (ILCRs) for carcinogens

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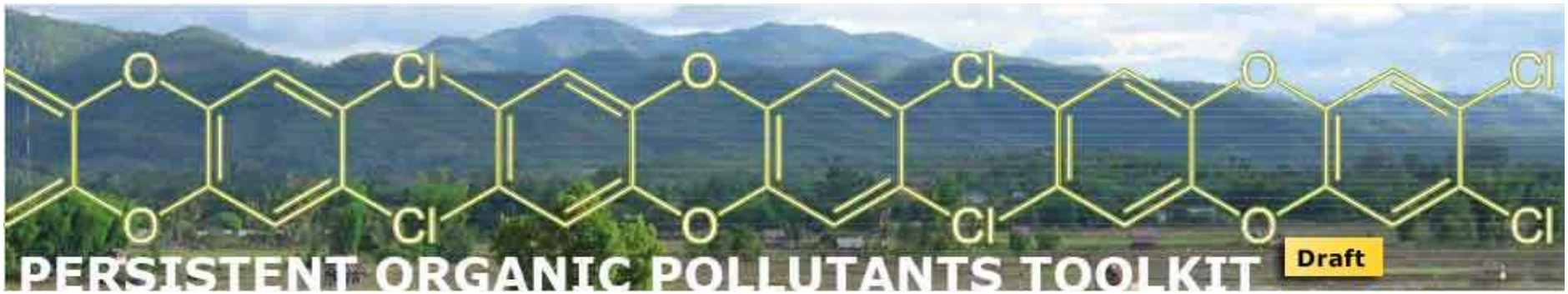


Risk Calculation Tool for a Non-Carcinogen (Threshold) Contaminant

Use this tool to calculate the Hazard Quotient (HQ) for a threshold contaminant (see training material for more information).
If a Hazard Quotient greater than 0.2 is calculated, a risk to human health potentially exists.

Accidental Soil Ingestion Dose Calculation (hide)

$$Dose_{SoilIngestion} = \frac{(C_S \times IR_S \times AF_{GIT} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 16 \times 365 \times LE} =$$

C_S =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_S =		kg/day	Accidental soil ingestion rate for adult (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours	Hours per-day with exposure (0 - 16) *(16 is the maximum assumed awake hours per day)*
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)

BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: dusts can be trapped by the nose and later ingested, soils can also be ingested from hands if hands are not regulary washed or if dusts deposit on foods eaten at the site.

Water Ingestion Dose Calculation (hide)

$$Dose_{WaterIngestion} = \frac{(C_W \times IR_W \times AF_{GIT} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_W =		mg/kg	Concentration of contaminant in drinking water, usually 90th percentile or maximum.
IR_W =		L/day	Water ingestion rate for adult (see Table: Receptor Characteristics - adapted from Health Canada, 2004)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1 for a preliminary risk assessment** (as recommended by Health Canada, 2004)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Food Ingestion Dose Calculation (hide)

$$Dose_{FoodIngestion} = \frac{(C_{food} \times IR_{food} \times AF_{GIT} \times D_{Days} \times D_{Years})}{BW \times 365 \times LE} =$$

C_{food} =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_{food} =		kg/day	Food ingestion rate (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1 for a preliminary risk assessment** (as recommended by Health Canada, 2004)
D_{Days} =		# of days in a year food item is ingested	Number of days in a year food from the site is ingested (0 - 365)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)

LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: If multiple animals are consumed from the site (i.e., crabs, chickens, snakes, snails etc.), the dose from eating these items should be calculated separately using the same formula.

Inhalation of contaminated particles Dose Calculation (hide)

$$Dose_{ParticleInhalation} = \frac{(C_s \times P_{Air} \times IR_A \times AF_{Inh} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE \times 10e^{-9}} =$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
P_{Air} =		µg/m^3	Concentration of particles in the air. **Use 0.76µg/m^3** for typical conditions as per USEPA (1992)
IR_A =		m^3/hour	Inhalation rate (see Table: Receptor Characteristics)
AF_{Inh} =		(unitless)	Absorption Factor for the lungs. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours in a day	Hours of a day with exposure (0 - 24)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: the concentration of respirable dust may be much higher in certain circumstances. Examples would include locations next to dirt roads and inside workshops or storage facilities.

Dermal contact with contaminated soil Dose Calculation (hide)

$$Dose_{DermalContact} = \frac{(C_s \times SA_H \times SL_H \times AF_{Skin} \times EF \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
SA_H =		cm^2	Surface area of hands (assumes only hands are exposed, see Table: Receptor Characteristics)

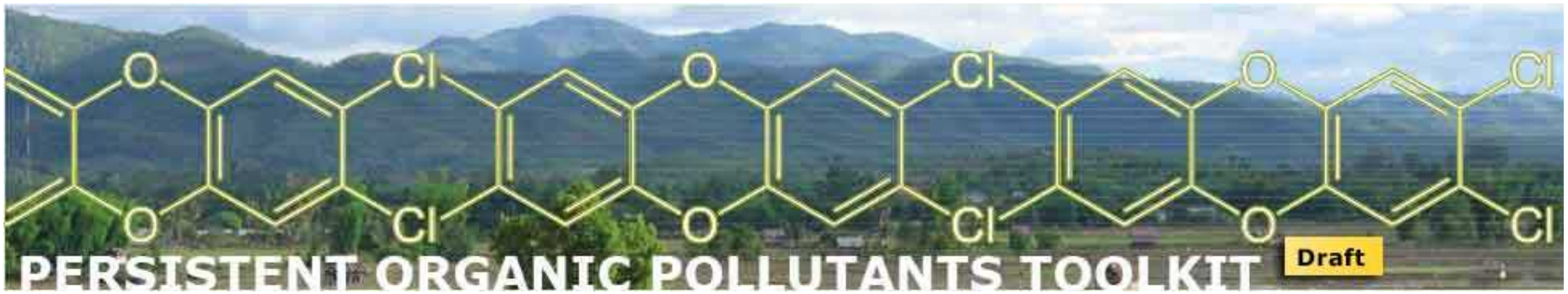
SL_H =		kg/cm^2 - event	Soil loading to exposed skin (see Table: Receptor Characteristics). For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered portions of the body.
AF_{Skin} =		(unitless)	Absorption Factor for the skin (see Table: Relative Dermal Absorption Factors)
EF =		events/day	number of dermal exposures per day
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =	N/A	years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =	N/A	years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered partions of the body. Please refer to Exposure Table.

Calculation of Hazard Quotient:

$$HQ = \frac{(Dose_{SoilIngestion} + Dose_{WaterIngestion} + Dose_{FoodIngestion} + Dose_{ParticleInhalation} + Dose_{DermalContact})}{TDI} =$$

TDI =		mg/kg - day	Tolerable daily intake (TDI) (see Table: Health Canada's TDIs, or US EPA's TDIs).
$Dose_{SoilIngestion}$ =		mg/kg - day	
$Dose_{WaterIngestion}$ =		mg/kg - day	
$Dose_{FoodIngestion}$ =		mg/kg - day	
$Dose_{ParticleInhalation}$ =		mg/kg - day	
$Dose_{DermalContact}$ =		mg/kg - day	
Total Dose =		mg/kg - day	



Risk Calculation Tool for a Carcinogen (Non-Threshold) Contaminant

Use this tool to calculate the Incremental Lifetime Cancer Risk (ILCR) for a non-threshold contaminant (see training material for more information).

If an Incremental Lifetime Cancer Risk greater than 1 x 10^{-5} is calculated, a cancer risk potentially exists.

Accidental Soil Ingestion Dose Calculation (hide)

$$Dose_{SoilIngestion} = \frac{(C_s \times IR_s \times AF_{GIT} \times D_{Hours} \times D_{Days} \times D_{weeks} \times D_{Years})}{BW \times 16 \times 365 \times LE} =$$

C_s =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_s =		kg/day	Accidental soil ingestion rate for adult (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours	Hours per-day with exposure (0 - 16) *(16 is the maximum assumed awake hours per day)*
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =		years	Number of years of exposure

BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics - adapted from Health Canada, 2004)
LE =		years	Life expectancy. The number of year that the person is likely to live.

Note: dusts can be trapped by the nose and later ingested, soils can also be ingested from hands if hands are not regulary washed or if dusts deposit on foods eaten at the site.

Water Ingestion Dose Calculation (hide)

$$Dose_{WaterIngestion} = \frac{(C_W \times IR_W \times AF_{GIT} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_W =		mg/kg	Concentration of contaminant in drinking water, usually 90th percentile or maximum.
IR_W =		L/day	Water ingestion rate for adult (see Table: Receptor Characteristics - adapted from Health Canada, 2004)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =		years	Number of years of exposure
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =		years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Food Ingestion Dose Calculation (hide)

$$Dose_{FoodIngestion} = \frac{(C_{food} \times IR_{food} \times AF_{GIT} \times D_{Days} \times D_{Years})}{BW \times 365 \times LE} =$$

C_{food} =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
IR_{food} =		kg/day	Food ingestion rate (see Table: Receptor Characteristics)
AF_{GIT} =		(unitless)	Absorption Factor for the gastrointestinal tract. **Use a value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Days} =		# of days **in a year** food item is ingested	Number of days in a year food from the site is ingested (0 - 365)
D_{Years} =		years	Number of years of exposure (not used for non-carcinogens)
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics - adapted from Health Canada, 2004)

LE =		years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: If multiple animals are consumed from the site (i.e., crabs, chickens, snakes, snails etc.), the dose from eating these items should be calculated separately using the same formula.

Inhalation of contaminated particles Dose Calculation (hide)

$$Dose_{ParticleInhalation} = \frac{(C_S \times P_{Air} \times IR_A \times AF_{Inh} \times D_{Hours} \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE \times 10e^{-9}} =$$

C_S =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
P_{Air} =		$\mu g/m^3$	Concentration of particles in the air. **Use 0.76µg/m^3** for typical conditions as per USEPA (1992)
IR_A =		m^3/hour	Inhalation rate (see Table: Receptor Characteristics)
AF_{Inh} =		(unitless)	Absorption Factor for the lungs. **Use value of 1** for a preliminary risk assessment (as recommended by Health Canada, 2004)
D_{Hours} =		# of hours in a day	Hours of a day with exposure (0 - 24)
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =		years	Number of years of exposure
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =		years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: the concentration of respirable dust may be much higher in certain circumstances. Examples would include locations next to dirt roads and inside workshops or storage facilities.

Dermal contact with contaminated soil Dose Calculation (hide)

$$Dose_{DermalContact} = \frac{(C_S \times SA_H \times SL_H \times AF_{Skin} \times EF \times D_{Days} \times D_{Weeks} \times D_{Years})}{BW \times 365 \times LE} =$$

C_S =		mg/kg	Concentration of contaminant in soils, usually 90th percentile or maximum.
SA_H =		cm^2	Surface area of hands (assumes only hands are exposed, see Table: Receptor Characteristics)
SL_H =		kg/cm^2 - event	Soil loading to exposed skin (see Table: Receptor Characteristics). For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other

			parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered portions of the body.
AF_{Skin} =		(unitless)	Absorption Factor for the skin (see Table: Relative Dermal Absorption Factors)
EF =		events/day	number of dermal exposures per day
D_{Days} =		# of days in a week	Days in a week with exposure (0 - 7)
D_{Weeks} =		# of weeks in a year	Weeks in a year with exposure (0 - 52)
D_{Years} =		years	Number of years of exposure
BW =		kg	Body Weight of Receptor (see Table: Receptor Characteristics)
LE =		years	Life expectancy. The number of year that the person is likely to live. Not used for non-carcinogens.

Note: For a given area of skin, hands will be exposed to a greater mass of contaminated soil than skin on other parts of the body. Health Canada (2004) give hands a 10x greater loading (SLH) than other skin covered partions of the body. Please refer to Exposure Table.

Total Calculation of Incremental Lifetime Cancer Risk:

$$ILCR = ((Dose_{SoilIngestion} + Dose_{WaterIngestion} + Dose_{FoodIngestion}) \times SF_{Oral}) + (Dose_{ParticleInhalation} \times SF_{Inhalation}) + (Dose_{DermalContact} \times SF_{Dermal}) =$$

SF_{Oral} =		mg/kg - day	Oral slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors).
$SF_{Inhalation}$ =		mg/kg - day	Oral slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors).
SF_{Dermal} =		mg/kg - day	Dermal slope factor for contaminant (see Table: Health Canada's Slope Factors, or US EPA's Slope Factors). **Where SF_{Dermal} is not available, use the SF_{Oral} value**.
$Dose_{SoilIngestion}$ =		mg/kg - day	
$Dose_{WaterIngestion}$ =		mg/kg - day	
$Dose_{FoodIngestion}$ =		mg/kg - day	
$Dose_{ParticleInhalation}$ =		mg/kg - day	
$Dose_{DermalContact}$ =		mg/kg - day	
Total Dose =		mg/kg - day	

Appendix A10

Economic Valuation of POPs Impacts

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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 3/5/2009 SLIDE 1

Economic Valuation of Health Impacts from POPs

by Thomas Boivin

Hatfield Consultants Partnership

Hatfield CONSULTANTS

 3/5/2009 SLIDE 2

Why Conduct An Economic Valuation of POPs Impacts? (1)

- Understanding economic costs of POPs is important *for convincing policymakers of the impacts of POPs;*
- However, there are not enough **resources** - financial, human, or technical to deal with these problems;
- Countries need to **prioritize** to make better use of limited resources
- We need to be **strategic** to maximize the use of limited funds;

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 3/5/2009 SLIDE 3

Why Conduct An Economic Valuation of POPs Impacts? (2)

- An economic valuation is not commonly done in countries where strong regulations and enforcement are in place;
- If a site is contaminated, then the government or developer is responsible to clean it up to avoid human health or ecological impacts;
- "Polluter Pays Principle" is common in western countries, but is often not enforced in SE Asian countries;
- Risk Assessment requires a good understanding of the economic costs of different management options;

 3/5/2009 SLIDE 4

Overview of Economic Valuation of Health Impacts from POPs

- Preliminary methodology has been developed for discussion;
- Economic costs will be calculated from the case study sites, and these will be compared with different risk management or remediation measures;
- Limited data exists on the economic costs of POPs in the 4 countries;
- Any estimates of economic impacts from POPs can be modified in future as additional data becomes available.

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Overview of Economic Valuation of Health Impacts from POPs (2)

- The objectives of the economic valuation of health risk portion of the project are:
  - a) To estimate (in *quantitative* terms) the dollar value of the human health impact of POPs contamination at a designated 'hot spot';
  - b) to compare the estimate with the cost of remediation measures; and
  - c) to describe (in *qualitative* terms) the values of POPs impacts in direct human health and other unquantified costs.

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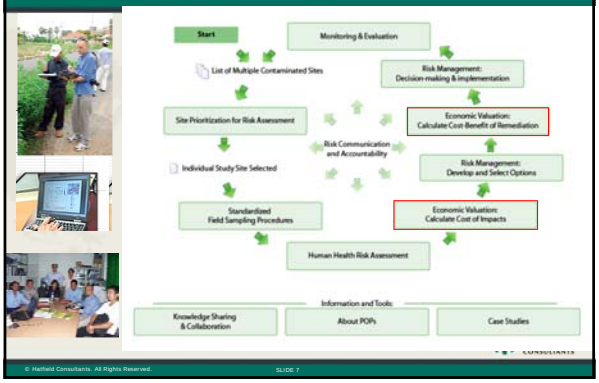
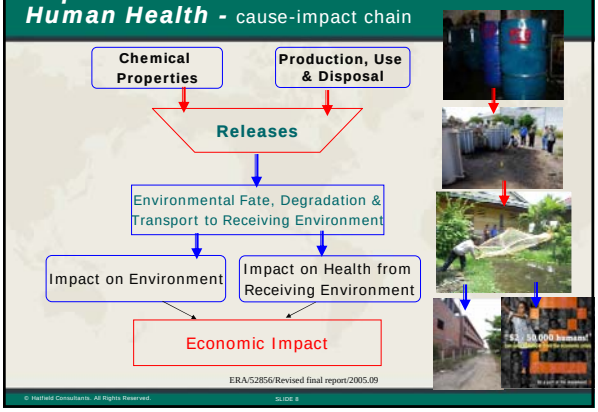
 SLIDE 6

Economic Valuation Within Overall Risk Governance Framework



Impact of Chemicals On Environment And Human Health - cause-impact chain

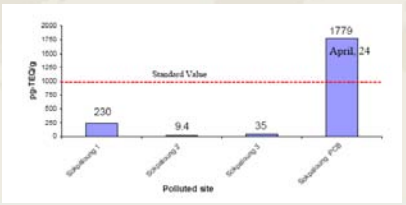


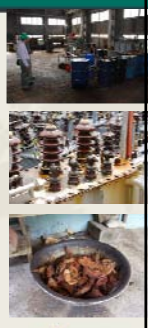
ERA/52856/Revised final report/2005.09

Land Use for SPL Site

Suspected POPs Contaminants

- The site is used to collect, store and repair used transformers from 1982.
- Recycled oil is transferred into 45-gallon drums, and is re-used
- Previously analyzed samples from the site suggested potentially high concentrations of PCBs.





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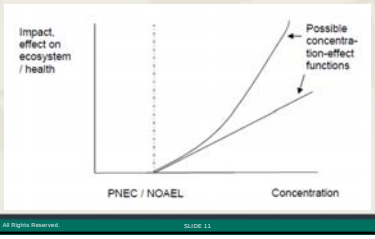
Valuation of Health Risk

- Valuation of human health risks is the most significant and also the most controversial parameter.
- In many cases, we can define the effect concentration, but a dose-response relationship has not been defined to show how types of morbidity and premature mortality respond to the exceedance of the no-effect level.



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The Ideal Approach

- The ideal measurement of economic impacts involves four 'end points':
  - **(a) Health effects from exposure to ambient environmental concentrations;**
  - **(b) Health effects from chemicals accumulated in food and water;**
  - **(c) Health effects from exposure to chemicals in the workplace; and**
  - **(d) Loss of ecosystem functioning.**
- **Difficulties in establishing relationships between ecological or health effects and economic costs:**
  - **Limited health dose-response information exists;**
  - **Effects are not known with any precision; and**
  - **Resources are required to conduct "willingness to pay" (WTP) studies and collect other important information.**

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Possible Economic Valuation Approaches

- There are several methodologies for establishing a dollar value for adverse human health impacts;
- Each approach requires significant data collection to ensure accuracy of the results.

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 SLIDE 13

Disability Adjusted Life Years (DALY) Approach to Economic Valuation

- DALY is originally developed by WHO to quantify the impact of premature death (mortality) and disability (morbidity) on a population by combining them into a common metric.
- One DALY can be thought of as one lost year of "healthy" life.
- DALYs show the relative importance of health problems and can be combined with other data to establish which public health interventions would be most cost-effective.
- For example, 3,300 DALYs would equal 100 infant deaths or 5,500 people aged 50 living one year with blindness. These comparisons are helpful in setting national and global health priorities.

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 SLIDE 14

Why the DALY Approach Was Selected

- Given limitations of time and resources, the DALY approach to estimating the physical component of human health impact is judged the best approach because:
  - *Conceptual simplicity*: DALY covers both mortality and morbidity in one number. The equations are straightforward with 5 elements in 2 equations;
  - *Data availability*: WHO has estimated DALY rates per 100,000 population for all countries, not just the four of the POPs study;
  - *Ethically Acceptable*: The DALY approach does not place a value on a human life; rather is places a value on the risk shared by members of an exposed population.

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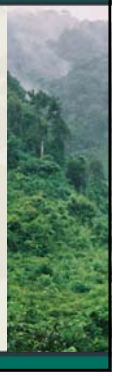
 SLIDE 15

Approach – Limitations of the Analysis

- Human health impacts are not the only impacts at a POPs contaminated site;
- Non-human health impacts such as environmental impacts, decreased land values, and ecological impacts may also be significant;
- However, non-human health impacts can be *qualified* (e.g., described in words).



 SLIDE 16

Key Steps in Economic Valuation using DALY

- **Step 1 - Obtain DALY**
- **Step 2 - Scale DALY to Local Site**
- **Step 3 - Calculate Unit Price per DALY**

Calculate Cost of Impacts

- **Step 4 - Estimate Site Remediation Costs**
- **Step 5 - Estimate Benefit of Remediation (#DALYs saved per year)**
- **Step 6 - Calculate Cost-Effectiveness of Remediation**

Calculate Cost of RM Options => Cost-Effective

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 SLIDE 17

Step 1 - Obtain DALY

- **Step 1 - Obtain DALY**
- These estimates are found at the WHO website:
  - Go to WHO website http://www.who.int/en/
  - Click on "Data & Statistics" http://www.who.int/research/en/
  - Scroll down to "Data by Categories"
  - Under "Mortality & Health Status", select: ***Causes of Death [xls 3.03 MB]***
  - Download the file. Filename = **bodgbddeathdalyestimates**

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 SLIDE 18

DALYs / 100,000 population, 2002. 4 POPs countries

DALYs per 100,000 of population	Cambodia	Lao People's Democratic Republic	Malaysia	Thailand
Population ('000) (e)	13,810	5,529	23,965	62,193
All Causes	**38,451**	**40,324**	**14,626**	**20,508**
I. Communicable, maternal, perinatal and n	23,975	24,340	2,906	6,111
A. Infectious and parasitic diseases	16,191	10,740	1,604	4,563
1. Tuberculosis	1,904	643	281	320
2. STDs excluding HIV	154	417	146	155
3. HIV/AIDS	3,180	28	320	2,221
4. Diarrhoeal diseases	2,801	3,181	117	297
5. Childhood-cluster diseases	1,124	994	68	51
6. Meningitis	1,573	422	70	156
7. Hepatitis B (g)	182	106	48	135
8. Malaria	884	832	28	259
9. Tropical-cluster diseases	85	360	84	84
10. Leprosy	6	9	12	11
11. Dengue	44	112	17	111
12. Japanese encephalitis	32	84	9	8
13. Trachoma	18	17	0	0
14. Intestinal nematode infections	357	317	92	96
B. Respiratory infections	1,799	3,660	357	532
C. Maternal conditions	864	1,371	146	162
D. Perinatal conditions (h)	3,324	6,663	358	463
E. Nutritional deficiencies	1,797	1,906	441	390

 SLIDE 19

DALYs / 100,000 population, 2002. 4 POPs countries

DALYs per 100,000 of population (continued)	Cambodia	Lao People's Democratic Republic	Malaysia	Thailand
II. Noncommunicable diseases	11,847	11,257	10,180	11,673
A. **Malignant neoplasms**	1,125	932	955	1,157
B. Other neoplasms	17	24	11	12
C. Diabetes mellitus	254	157	394	421
D. Endocrine disorders	358	95	113	218
E. Neuropsychiatric conditions	2,968	3,183	2,874	3,222
F. Sense organ diseases	764	795	1,888	2,236
G. Cardiovascular diseases	2,362	2,315	1,545	1,568
H. Respiratory diseases	837	933	649	728
I. Digestive diseases	888	1,093	522	592
J. Genitourinary diseases	440	212	260	330
K. Skin diseases	88	50	104	122
L. Musculoskeletal diseases	429	409	502	575
M. Congenital anomalies	1,171	913	200	310
N. Oral conditions	147	144	164	181
III. Injuries	2,628	4,727	1,540	2,724
A. Unintentional injuries	1,923	3,849	1,071	2,032
2. Poisonings	22	137	15	19
B. Intentional injuries	705	878	469	692

 SLIDE 20

Step 2 - Calculate Unit Price per DALY

- To calculate the dollar value (unit cost) of a DALY, the benefits transfer method is used.
- *Value of 1 DALY*: Using benefit transfer, the calculation of the 2007 US$ value of 1 DALY in **Laos** is made as follows:
  - Start with the value of a DALY in the United Kingdom used in the 2003 "The Social Cost of Chemicals" study: **€ 94,936**;
  - Convert this 2003 Euro value to a 2007 US$ value using historical data on the Euro – US$ exchange rate[1] and UK inflation from 2004 – 2007.[2] That yields a 2007 US$ value of 1 DALY in the UK of **$118,401**;
  - Adjust the UK DALY to local conditions by the ratio of per capita income of the two countries.[3] GNI/capita in the UK is 17.4 times that of Laos in 2007. Divide the UK value of a DALY by that multiple to yield a 2007 US$ value of 1 DALY in Laos of **$6,796**

[1] The average exchange rate for 2003 was US$1.1321 = €1.00. www.oanda.com
[2] Annual inflation in the UK was: 2.6% (2004), 2.2% (2005), 2.4% (2006) & 2.6% (2007). World Bank.
[3] Gross National Income per capita, PPP method: $33,800 (UK); $13,570 (Laos). UK / Laos = 17.4

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Step 3 - Estimate Site Remediation Costs

- Cost estimates for different remediation options can be developed;
- Issues which need to be considered, including:
  - Remediation method to be used (e.g., Capping? Incineration?);
  - Costs are site-specific, depending on type of contamination and extent of the problem;
  - Simple solutions can significantly reduce risk, and may be preferable to more costly, high-tech solutions;
  - Social/cultural acceptance of remediation method used; and
  - Government and local priorities.

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 SLIDE 22

Step 4 - Calculate Cost-Effectiveness of Remediation

- The economic analysis must include an estimation of benefit over time, and needs to consider the following questions:
  - How much money can we save in future by investing in environmental protection today?
  - How much money would we lose (or how many people will be impacted) if we do **not** invest in environmental protection, and end up with a bigger problem in the future?

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Step 5 - Relate Site Remediation Costs to Number of DALYs Saved

Therefore:

$$\text{\# DALYs Saved Per Year} = \frac{\text{Site Remediation Costs Over Time}}{\text{Average Price Per DALY}}$$

- The above simple calculation can be used to compare the #DALYs saved as part of decision-making process;
- For example:
  - Site remediation costs (Option A) = $100,000;
  - Average price per DALY (Laos) = $6,796
  - Therefore: #DALYs Saved Per Year = $100,000/$6,976
    = 14.7 DALYs/Year

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 SLIDE 24

Conclusions (1)

- Understanding economic costs of POPs is important *for convincing policymakers of the impacts of POPs;*
- Helps to **prioritize sites** which may require remediation;
- Can also prioritize across different sectors/investments (e.g., how does the costs of a clean-up project compare to the investment required for other civil projects (clean water project, etc.?);
- In most developed countries, there is a well developed legislative framework, strict enforcement and sanctions against violators. As such, an economic valuation is not normally performed.

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 SLIDE 25

Conclusions (2)

Key Questions and Assumptions:

- How do we place a value on health impacts, and how do we link health problems to POPs?
- Use of the DALY approach requires certain assumptions and professional judgment to be applied, and accordingly may generate uncertainties in final economic estimates.
- Costing remediation measures also requires a number of assumptions, as these vary between different sites and between countries.

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 SLIDE 26

Conclusions (3)

- The POPs Project Economic Analysis will develop a simple method which can help prioritize risk management and remediation activities;
- Methodology developed is still a draft for discussion;
- Comments from workshop participants, local public health officials and economists would be appreciated;
- Risk Management Discussion session will include discussion of costs for remediation at the Case Study Site;
- Final draft reports for review– early March 2009.

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Please Send Your Comments to World Bank and Hatfield!

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 3/5/2009 SLIDE 28

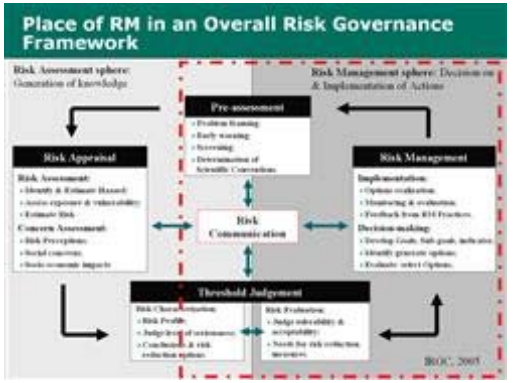
Appendix A11

Risk Management Toolkit

Introduction to Risk Management

Risk Assessment results feed directly into the Risk Management phase. Risk Assessments evaluate the probability and magnitude of contaminant-related effects, while Risk Management is a process used to:

- Decide whether a level of risk is acceptable in a larger context (socially, economically and politically); and/or,
- Select risk reduction options (i.e., either technical or policy-based solutions), and assess cost-benefit of the options.



Place of Risk Management in Overall Risk Governance Framework
Source: Hatfield Consultants
(click to enlarge)

Characteristics of Effective Risk Management Strategies

Experience from industrialized countries show that certain characteristics are likely to promote an effective and successful risk management decision-making process:

***Current**:* Risk reduction strategies need to remain up to date with evolving national policies and priorities, new scientific findings or technological developments, and they need to take into account the effectiveness of existing strategies.

***Participatory**:* Numerous stakeholders play a role in the development of an effective Risk Management strategy. Consequently, effective risk communication and dialogue must be apparent in all Risk Management activities.

***Informed**:* Risk management decision-making requires various types of information such as statistical data, probability studies, information about local customs and practices, knowledge about the nature of past and present exposure, economic analyses, information about regulatory and other control options, etc.

***Contextual**:* Risk reduction strategies should be adapted to the political, cultural and socio-economic context as well as local realities.

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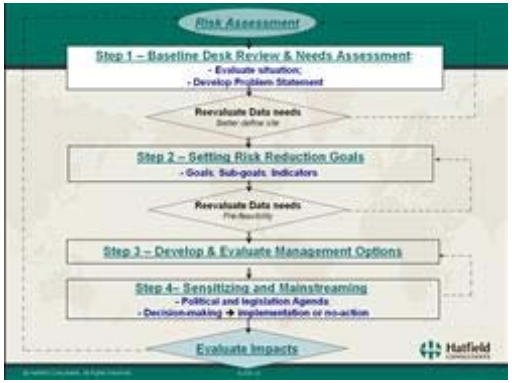
funded by the Canadian POPs Trust Fund through the Canadian International Development Agency / Agence canadienne de développement International

Five Step Process for Risk Management

The Five Step Risk Management Process used in the POPs Toolkit can be used for planning risk management activities on either a site-specific or a nation-wide basis.

The Risk Management process must be carried out within the context of the unique institutional mechanisms and circumstances of each country. Therefore, the guidance and broad suggestions presented in this module should be used and applied in a flexible manner.



The Five Step Process for Risk Management
Source: Hatfield Consultants
(click to enlarge)

Step 1 - Baseline Review

The Baseline Review provides the framework for the Risk Management process. It defines and describes the following:

- The exposure scenarios resulting in risks that need to be managed;
- The types of economic information needed to estimate the costs related to chemical contamination (i.e., health care, lost wages, reduction in property value, loss of property usage);
- Information related to local and national conditions;
- Communications strategy and approach; and
- The basis for the collaborative development of national priorities for health risk management.

For Risk Management programs addressing human health risks on a country-wide basis and/or site specific, it is helpful to divide the Baseline Review into a Situation Statement and a Problem Statement.

Baseline Desk Review & Needs Assessment follows directly from Risk Assessment data and results

Source: Hatfield Consultants

(click to enlarge)

Step 2 - Setting Risk Reduction Goals

The process of setting risk reduction goals involves clearly defining the goals for the protection of human health and the environment from POPs-related risks. These goals provide the framework for developing and evaluating Risk Management Options in Step 3.

The expected output from this step is a concise statement and table of the main risk reduction goals which includes goal setting for the overall goals, sub-goals and indicators.

Step 2 follows from Baseline Desk Review & Needs Assessment phase
Source: Hatfield Consultants
(click to enlarge)

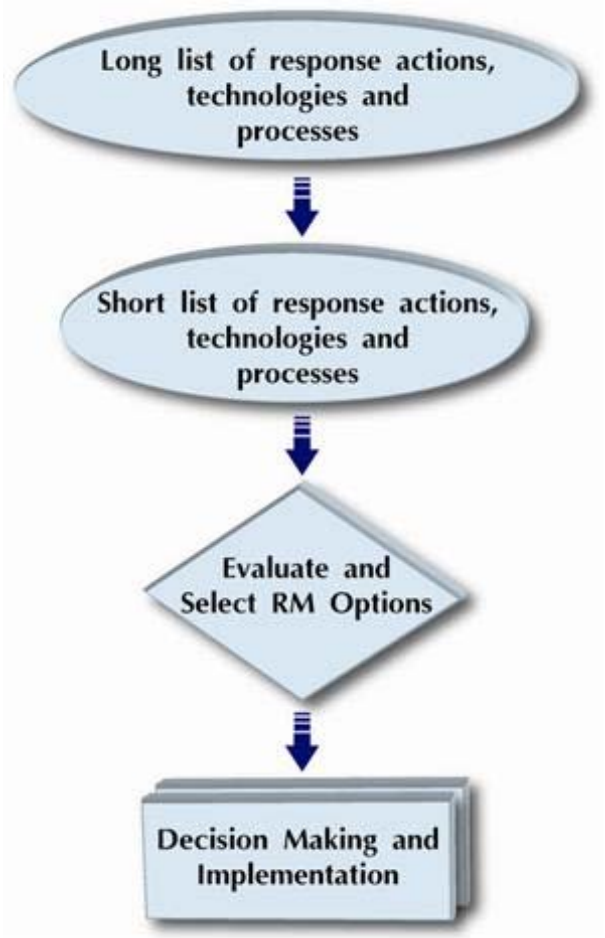
Step 3 - Developing and Evaluating Management Options

Step 3 builds upon the results from Step 1 (Baseline Review), and Step 2 (Goal Setting). The development and evaluation of risk management options can be accomplished by:

- Developing a list of possible response actions, technologies and process;
- Preliminary screening of the list;
- Qualitative screening of the list; and
- Semi-quantitative evaluation of selected approaches on the list.

The suggested output is an evaluation of the advantages and drawbacks of possible risk reduction options that could be used to prevent, or reduce, the risk of concern. The last step (iv) ties into the policy making process.

Clearning up a contaminated storage building
Source: FAO
(click to enlarge)



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General Risk Reduction Considerations

Use a Multi-pronged Approach

In most cases, there will be more than one way to achieve a particular risk reduction goal. A combination of regulatory and voluntary risk management approaches should be considered when dealing with unacceptable risks at contaminated sites.

Conducting a multi-pronged approach requires a large amount of communication (Thailand)
Source: Hatfield Consultants
(click to enlarge)

Communication

The development of risk management options requires communication and participation between government agencies and other stakeholder groups to focus on:

- Existing national and local risk management approaches;
- Lesson learned from other countries that have risk managed POPs contaminated sites;
- New and innovative risk management measures; and
- Resources available.

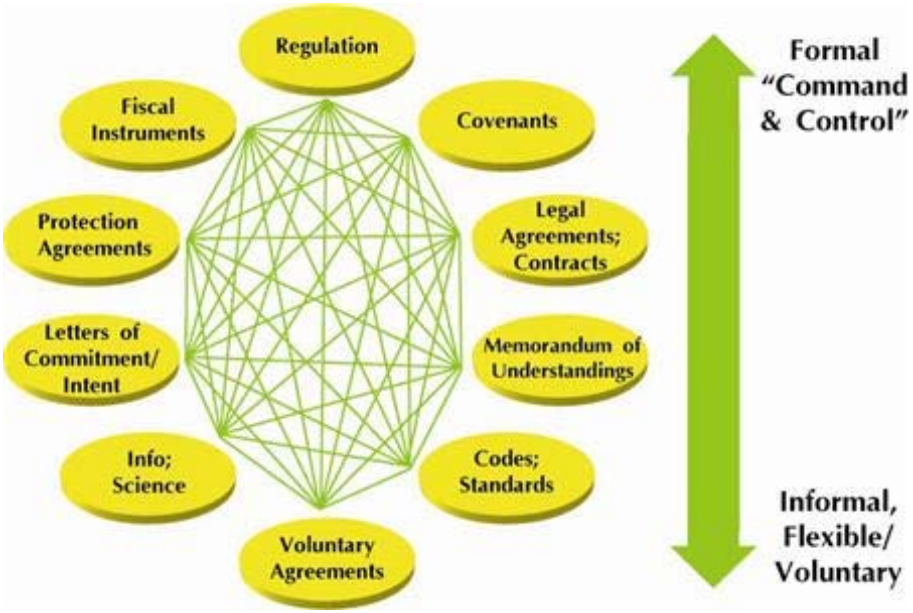
Use Existing Tools

When considering possible actions, it may also be useful to consider how *existing* tools and measures can be made more effective. For example, a lack

of active enforcement of existing regulations, or lack of awareness, may be contributing to observed risks.

Continuum of Risk Management Approaches

Each category of risk reduction measures can be placed in a range of flexibility, between formal command and control measures to informal, voluntary measures. The figure below shows the categories of risk reduction on this range.



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Example Risk Management Options

This page provides a list of risk management approaches. Most were presented in National Implementation Plans (NIPs); however, some additional approaches are also provided.

A GeoMembrane Cap in Vancouver, BC
Source: Mike Rankin
(click to enlarge)

Chemical Hazard:

Risk management approaches addressing the chemical hazard usually involve the removal of the contaminants from soil, sediments or groundwater.

Example approaches include:

- Excavation of contaminated soils followed by off-site disposal,
- Solidification or stabilization,
- Removal (excavation),
- Disposal (off-site),
- Removal of contamination by treating soils with microbes,
- Phytoremediation ,
- Chemical degradation,
- Proper segregation,
- Research and development.,
- Mandatory screening for POPs contamination,
- Cap contaminated soils,

- Establish guidelines and limits for acceptable values of residual chemical products or equipment,
- Redesign process, change substance/material used,
- Include BAT in relevant industrial activities related to waste incineration and disposal, metallurgical industry, chemical industry and transportation sector,
- Natural attenuation, or
- Volatalization.

Pathway:

Risk Management approaches addressing the pathway usually involve placing a barrier between the contamination and the receptor.

Example approaches include:

- The use of personal protective equipment,
- Local bans on hunting/fishing,
- Limit occupation & accidental exposure,
- Drainage and dust erosion controls,
- Loading and unloading control (transport),
- Access restriction,
- Activity restriction,
- Compulsory use of personal protection equipment,
- Public awareness information and education - school curriculum,
- Monitoring & maintenance of equipment,
- Biological and medical monitoring of workers,
- Awareness of the value of protective equipment and going home from work with clean clothes/hands/shoes,
- Rules and enforced demobilization and decontamination after work,
- Sanitation and cleanliness,
- Capping or covering contaminated soils with clean soils, asphalt etc., or
- Using vegetation, wind fences and dust suppressants to control dust levels.

Receptor:

Risk Management approaches addressing the receptor usually involve restricting receptor access to the site.

Example approaches include:

- Use of walls or fences to keep people out of the contaminated area,
- Containment,
- Control on storage,
- Develop national guidelines (inventory and identification /labeling contaminated equipment),
- Land use restrictions,
- Provide free alternatives to behaviours resulting in risk,
- Public awareness information and education - school curriculum,
- Warning signs and labels, and
- Land use restrictions on contaminated sites.

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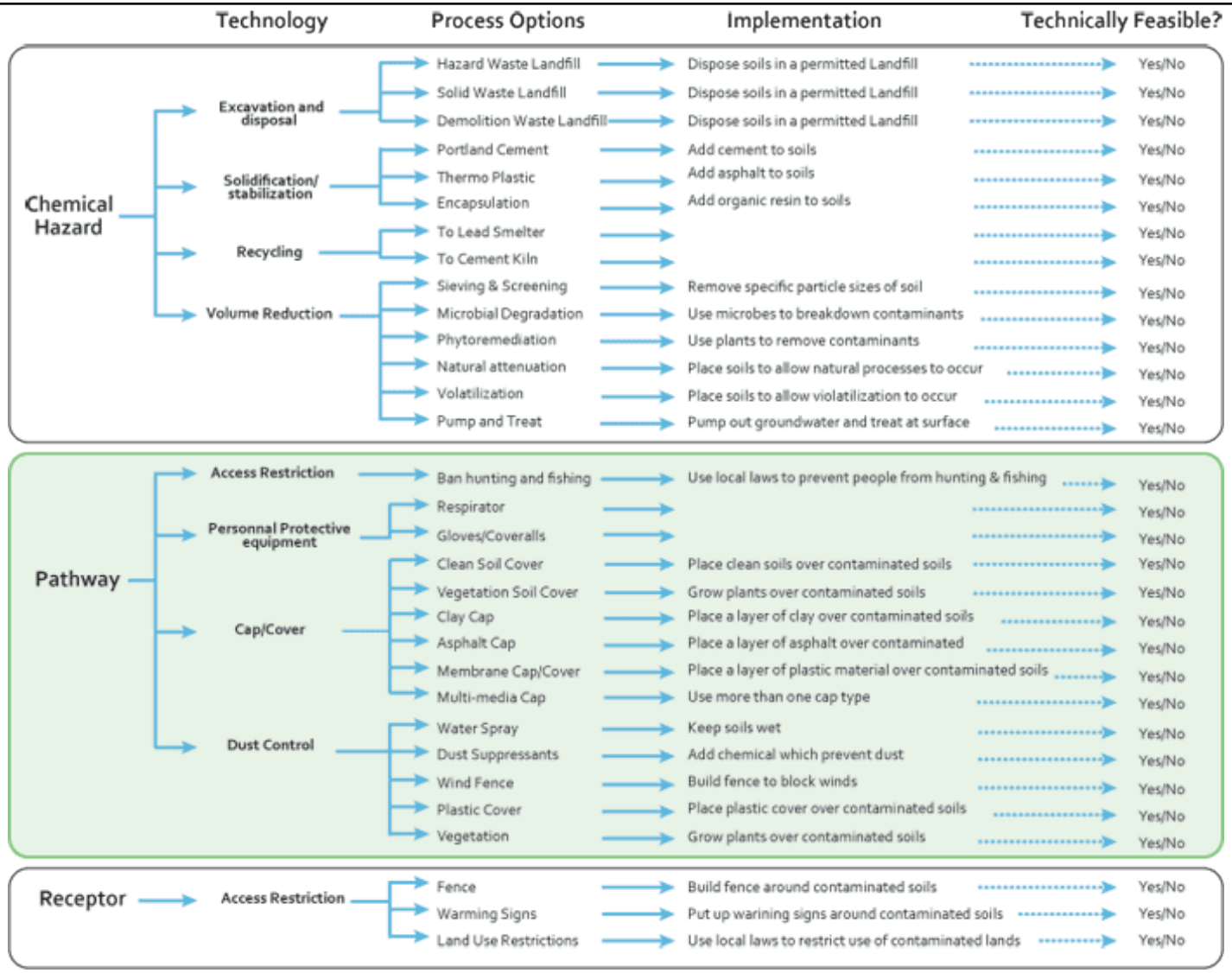
Preliminary Screening

The preliminary screening step can be simplified by expanding general approaches ("response actions") into Technologies and Process Options. This is best done using either a table or a flow diagram (as shown below). Reviewing this table/flow diagram, it assists with the selection of approaches which are unlikely to be effective.

The table/flow diagram is developed from the long list of potential risk management options and is therefore site-specific. Consequently, a new table/flow diagram will have to be created for each new site.



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Qualitative Screening

Risk Management Options retained from the preliminary screening are evaluated in the qualitative screening.

Balancing Factors

During the qualitative screening, each management option is weighed against various **balancing factors**. Balancing factors may include:

- Effectiveness
- Long term Reliability
- Ease of Implementation
- Implementation risk
- Cost:
  - cost for implementation
  - cost for operation and maintenance

Risk management options should be weighed against each other using balancing factors

Source: Araleya

(click to enlarge)

Recommending Management Alternatives

Once all technologies and implementation options have been weighed, the concerned officials will recommend risk management alternatives from those developed and evaluated in the risk management decision process.

Recommending management options is a balancing act
Source: Hatfield Consultants
(click to enlarge)

Criteria for Recommendations

The person who proposes **a list of recommended management alternatives** is responsible for demonstrating to decision-makers that the recommended actions **meet the following criteria**:

- They are protective of present and future public health, safety and welfare and of the environment;
- Are based on balancing different key factors;
- Treat hot spots of contamination to the extent feasible; and
- Take into consideration the concerns of stakeholders.

As a rule, **the least expensive, more protective alternative is preferred**, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the weighting factors.

Implementation Planning

The detailed Risk Management action plan must include implementation plans by addressing:

- **How** – under what legal mandate will the activity(ies) be undertaken and with what resources?
- **When** – realistic timeframe for the actions; and key milestones?
- **By whom** – ministry, agency, or stakeholder groups to be involved?

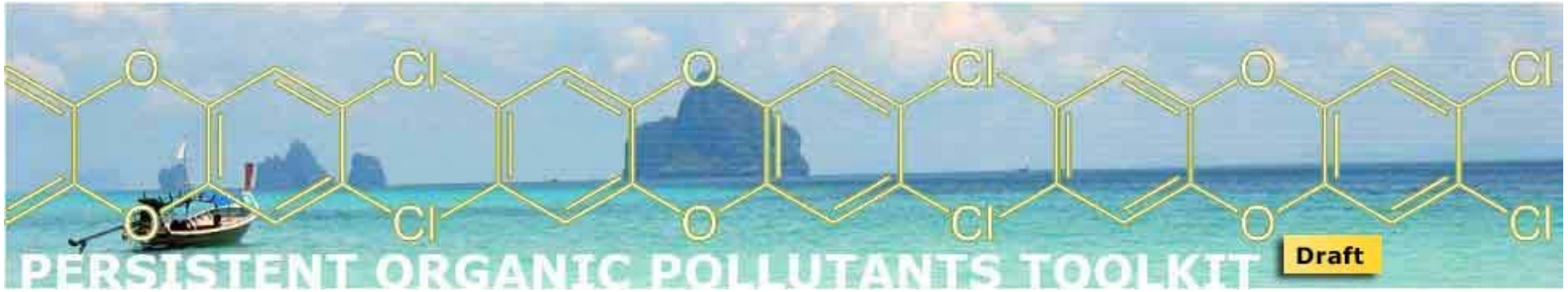
For more discussion on stakeholder identification and planing, please read here.

Stakeholders should be consulted in implementation planning
Source: Hatfield Consultants
(click to enlarge)

Assigning Responsibilities

Risk management responsibilities may be shared between different ministries depending upon the complexity of the risk situation – multi-media, multi-source, or multi-chemical in context.

The Responsibility Assignment Matrix (RAM) can be used as a tool to help organize responsibilities, organizations involved, expertise and experience; appropriate level of decision making authority, etc.



Step 4 - Risk Communication and Policy Making

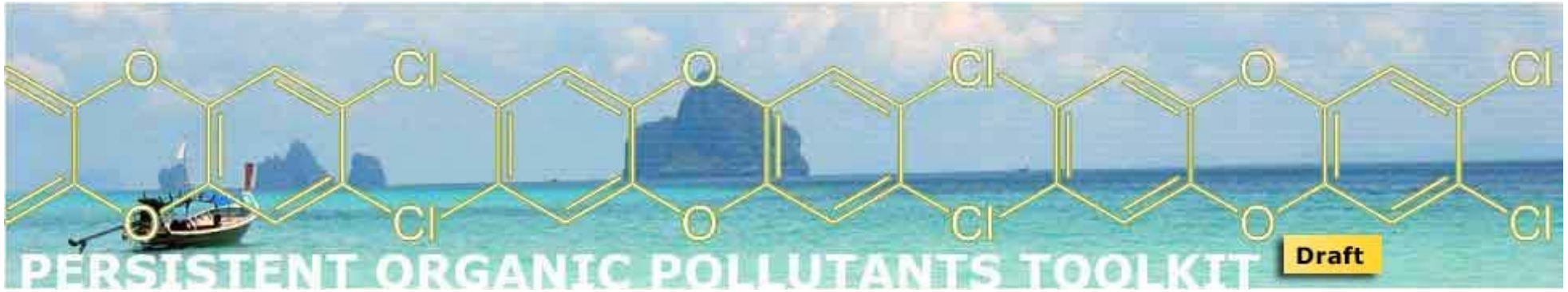
Step 4 - Risk Communication and Policy Making - focuses on:

- **Risk Communication** and creating a risk awareness culture;
- **Communicating** with decision-makers; and
- the **Policy Process**.

The main purpose of this step is to discuss Risk Management strategies and means for:

- Sensitizing and mainstreaming identified POPs health risk management (RM) options into national political agenda and national development planning;
- Fostering national political and securing financial commitments to ensure their effectiveness and sustainability.

Grand Palace, Bangkok
Source: Hatfield Consultants
(click to enlarge)



Step 5- Monitoring and Evaluation of Risk Management Programmes

Step 5 of the risk management training module will introduce you to the key steps and approaches to monitor and evaluate the adopted risk management options.

Monitoring and evaluation are integral parts of the risk management decision-making process. However, in most developing countries, it is often the weakest link in the whole risk management process.

Risk management is only as good as its weakest link – every step from risk characterization to monitoring and evaluation is important.

Monitoring and evaluation is an integral part of the risk management decision-making process
Source: Hatfield Consultants
(click to enlarge)

Objectives and Expected Outcomes of Step 5

Objective: To evaluate the progress and impact of the risk management options and determine whether adaptive action is required.

Suggested outcomes: An evaluation of the risk management effectiveness as measured against the baseline situation and in light of the risk reduction goal. Also determine whether the current options should be continued, and if not, recommendations for adaptations. Any results from monitoring and evaluation should be communicated to stakeholders as part of a public accountability process.

References:

Adapted from Monitoring & Evaluation – some Tools, Methods & Approaches, Operations Evaluation Department (pdf file) - World Bank, 2004

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Appendix A12

Group Discussion Composition

Appendix A12

Group Discussion Composition
Vientiane, January 31, 2009

Group Yellow (Question 1+)

No	Name	Organization
1	Mr. Soukvilay INPANYA	EIA
2	Dr. Somchith VONGSASITH	103 Hospital
3	Dr. Thongsavanh VONGMANY	UXO
4	Mr. Soulaphone THILAKOUNE	Luang Prabang
5	Mr. Khamngeun ONLUESAY	LuangNamtha
6	Mr. Keo udom PHANYAXAY	Bokeo
7	Mr. Phetdavong BOUNMISAVATH	Sekong
8	Mr. Sharnvansay Sengmany	Phongsaly
9	Mr. Thoumma LUEMXAY	Xiengkouang
10	Mr. Outhone SINGHADUANGPHANYA	Bolikhamsay
11	Mr. Khamphay PHENGPHEANGMOUNG	Khammouane
12	Mr. Vanhna Phanphongsa	WREA
13	Mr. Aloon PHENGMANY	Champasak
14	Mr. Chanhsamy PHOMMALA	Attapue

Group Pink (2+)

No	Name	Organization
1	Mr. Sommay VONG INH	EDL
2	Mr. Vilavong KENSOULINE	Vientiane Capital
3	Mr. Souphone SENGTHEP	EDL,Sok Praluang
4	Mr. Kongmnoun VONGSAY	Ministry of defense
5	Mr. Aloun MANOSANE	Luang Prabang
6	Mr. Onsy DUANGBOUNTHAM	Houaphan
7	Mr. Khammanh CHANTHAKEO	Bokeo
8	Mr. Amphaivanh SANiPHONH	Sekong
9	Mr. Phonesay LEX	Phongsaly
10	Mr. Vilaiphone Manivong	Xiengkouang
11	Dr. Khamphew TAYBOUAVONE	Oudomxay
12	Mr. Sinsalerm PHOMMACHANH	Sayaboury
13	Mr. Som Oula YAPHICHIT	WREA
14	Mrs. Vayouvet VISAYSOMBOUN	Savannaket

Group Green (3+)

No	Name	Organization
1	Mr. Keosangkhoum PHOMMASENG	Environment department

2	Mr. Khonekeo KINGKHAMBANG	WREA
3	Mr. Vaiyakone SYSAVATH	Industry Department
4	Mr. Bounmai KHOUNMYSAY	Vientiane province
5	Mrs. Khamfong PHOUMVONGXAY	Vientiane Capital
6	Mr. Phongsavath YINGYONG	WREA
7	Mr. Synouane SIHARATH	Savannaket
8	Mr. Bounkham PHOETHISARN	Champasak
9	Mr. Bouankeuam SIMMA	Saravan
10	Mr. Navalat NOUANTHONG	Attapue
11	Dr. Khamla PHOUMMANY	Ministry of health
11	Mr. Khamphua PHENGPHANHACK	Vientiane
12	Ms. Malaythong KEONGOTHI	WREA
13	Mrs. Johnnaly KEOBOUNPHANH	WREA

Group White (Question 2+)

No	Name	Organization
1	Mr. Keosangkhom PHOMMASENG	Environment department
2	Mr. Sivannakone MALIVARN	WREA
3	Mr. Bounthanong	Environment social impact assessment
4	Mrs. Vanh VOLASANE	EDL
5	Mr. Sylathong	Ministry of defense
6	Mrs. Khamfong PHOUMVONGXAY	Vientiane Capital
7	Mr. Phounmysay PHENGKHAMHACK	Houaphan
8	Mr. Som SYHATHEP	LuangNamtha
9	Mr. Oukham KEOVILAY	Sayaboury
10	Mrs. Phetdala PHONTHASI	Oudomxay
11	Mr. Khampasong VONGTHANA	Boilikhamsay
11	Mr. Phonevisith KHOUNBOULOM	Khammouane
12	Mr. BounEua KHAMPHILAVANH	WREA
13	Mr. Sengchan KHAMMANIVONG	Saravan

Appendix A13

Debriefing Note for Group Discussion

Regional Capacity Building Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia Program

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 3/5/2009 SLIDE 1

"Debriefing Note for Group Discussion

Session 9: Risk Management Development &Selection "

National Training Workshop

Vientiane, Lao PDR, January 30, 2009

Hatfield CONSULTANTS

 3/5/2009 SLIDE 2

PATH FORWARD TO RISK MANAGEMENT

- It is challenging to categorize a contaminated site based only on a screening level risk assessment and based on a limited number of samples.
- For training purposes, it may be reasonable to categorize the SPL Site as a Level A – actions are required immediately.
- The site is a concern because of:
  - The potential risks to human health and ecology (from the results of the risk assessment); and
  - Responsibility/liability that it may pose to the owners (e.g. cost of remediation, reputation and relation with community, and affected parties.

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 SLIDE 3

Background

- Goal - to facilitate improved communication and coordination between key Ministries in the areas of RA and RM, compliance monitoring and enforcement;
- The objective of the RM component =➔ to enhance the capacity to apply the RA results to set RM and identify priority interventions to reduce risks to an acceptable level:

(i) developing strategies for the management of these risks at the selected site; and,

(ii) Developing cost and benefits of alternatives.

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 SLIDE 4

Assignments for Group Discussion

- 3 discussion groups chaired by one designated member (selected by the group), and facilitated by the project team. The discussion group topics are:
  - Topic 1 – What are the potential risks associated with the site? How will risks evolve with time and is there a need to worry about this?
  - Topic 2 – What are the management options for the site? What are the potential costs of implementing them?
  - Topic 3 – What additional monitoring and remediation should be conducted? What are the potential costs of implementing them? Who should be reviewing the results of the monitoring and how often? Who should be notified of the results of monitoring?

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 3/5/2009 SLIDE 5

Topic 1

- Please review draft Risk Assessment Report pp. 40-43, and pay attention to Table 5.1 and Figure 5.1
- Your group has 20 minutes to work on the questions:
  - What are the potential risks associated with the site? and
  - How will risks evolve with time and is there a need to worry about this?

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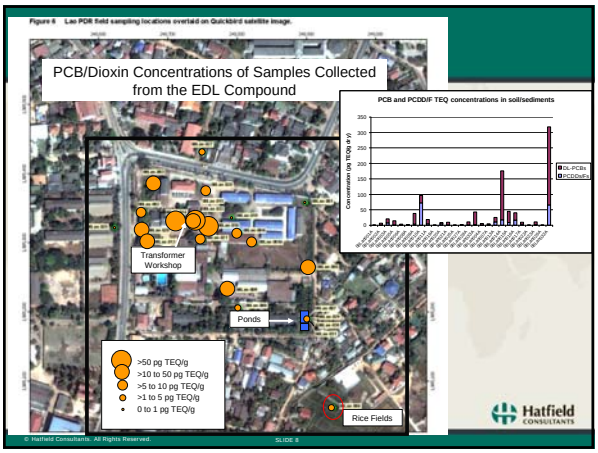
 SLIDE 6

Suspected Activities Generating PCBs at SPL Site

1	Production of PCBs	
2	Production of PCBs containing fluids	
3	**Use of PCB-containing equipment and fluids**	✓
4	**Handling of PCB-containing equipment and fluids**	✓
5	**Storage of PCB containing equipment and fluids**	✓
6	**Leakage of PCB containing equipment**	✓
7	**Maintenance and Repair of PCB containing equipment**	✓
8	**Retro filling**	✓
9	Disposal of PCB containing equipment	
10	**Misuse of PCB containing fluids**	✓



Topic 2

- Please spend 20 minutes to discuss:
  - What are the management options for the site? And
  - What are the potential costs of implementing them?

(Reference Table 6.2 pp. 48-49)

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Topic 3

- Please spend 20 minutes to discuss:
  - What additional monitoring and remediation should be conducted?
  - What are the potential costs of implementing them?
  - Who should be reviewing the results of the monitoring and how often? And
  - Who should be notified of the results of monitoring?

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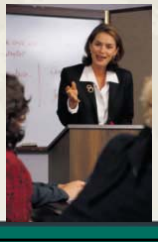
Special Notes

- Please kindly assign one team member to take notes from the discussion and present the outcomes to the plenary session.
- Hatfield and World Bank Project Team members will join the discussion groups, to provide technical support if required.



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Thank You

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 3/5/2009 SLIDE 13

Appendix A14

Presentation of Group Discussion Results

Appendix A 14

Group Discussion Notes

Setha Palace, Vientiane, January 30, 2009

Group Yellow:

Topic 1: Topic 1 – What are the potential risks associated with the site? How will risks evolve with time and is there a need to worry about this?

1.1. The following were the main risk associated with the site:

- Use, handling, storing and disposal of PCB-containing equipment and fluids;
- Maintenance, Repair of PCB containing equipment, and retro-filling of contaminated fluids;
- Leakage of the PCBs into the drainage and surrounding areas;
- Dermal contacts;
- Off-site transport of contaminants – drainage, vehicles, wind, and human behaviors.

1.2. The risk was expected to evolve with time if proper risk management actions are undertaken now. The great concern is for heath of the workers, family and ecology. The potential risk is also growing with the rapid population growth, and land use changes. The contaminated substance releases into the environment is expected to be increase, and so the level of their concentration.

Cost can be reduced by just prevention.

Additional comments from the floor on immediate follow-up:

- Specific training for the Sok Pa Luang staff for improving their understanding about the outcomes of the risk assessment and prevention/mitigation measures;
- Public awareness for the staff and community at the site; and
- Potential replication of the risk assessment and management to other sites.

Group Pink:

Topic 2 – What are the management options for the site? What are the potential costs of implementing them?

2.1. Management options for the site:

- Government Regulation controlling use of PCBs, and other dirty dozen;
- Health and Safety Plan + personal protection equipment and training + enforcement;
- Awareness raising campaign about POPs – what is POPs? Its impacts? How to prevent or mitigate them etc..? Approaches: posters; media, and public meeting.
- Control off-site transport of contaminants – engineering measures and control measures;
- Regular monitoring (environment sampling and regular health check for workers);
- Regular inspection and investigation of health and safety plan;
- Welfare for taking care of the workers at the site.

2.2. Costing: No cost estimate is provided. It depends on the actual cases of risk management options and need further market search.

Group White

Topic 2 – What are the management options for the site? What are the potential costs of implementing them?

2.1. Management options for the site:

- To relocate the site, but the cost is high for new facility, land area and clean-up of the old location (US$10 million); or
- To clean-up the existing site (improvement of the existing site to the required standards:

    - Removal of contaminants (contaminated equipment, waste, soil, sediment etc…) and disposal at proper containment facility;
    - Constructing the containment facility so that the contaminants will not be transported off-site, and the exposure to the staff at the site will be reduced.
    - Control access and transport to and from the site;
    - Public awareness about the hazard of the PCBs, control hunting and fishing at the site.
    - No more misuse of the fluids (strict regulations and enforcement); and
    - Safety and Health Plan must be in place and strictly enforced and monitored.

2.2. Potential costs of implementing then:

Need more information about the cost of the containment measures. The rough cost-estimates are 03 million $ for engineering measures + 0.5 million for other public awareness and training for a period of 05 years.

Group Green

Topic 3 – What additional monitoring and remediation should be conducted? What are the potential costs of implementing them? Who should be reviewing the results of the monitoring and how often? Who should be notified of the results of monitoring?

3.1. Additional monitoring and remediation

- Monitoring the sensitive groups – staff and immediate family members.
- Regular environmental monitoring of the site – in addition to the human health.
- More detailed risk monitoring plan: addition to blood analysis, need to assess further the health consequences. Need to add impacts on ecology and animals, such as chicken, aquatic animals etc...

3.2. Relocation of the site is needed. However, it would be very expensive. Awareness raising and other management measures leading to reduction in exposure rates are immediately required. Raise awareness among people, but be well designed and conducted to avoid panicking.

3.3. Cost of additional measures: cannot come with a rough costing, as they needed more information on the specific actions and unit costs.

3.4. Who should be reviewing the results of the monitoring and how often? Who should be notified of the results of monitoring?

Regular monitoring and reporting (accountability) should be carried out by company and responsible agency (EDL). WREA will have to verify the results of monitoring. Agencies in charge: WREA, MOH, MINE, Company (EDL).
Frequencies: 3-6 monthly - annually.

The result of the monitoring should be informed to the concerned authorities – national and local, and raising awareness of the nearby community using all appropriate media/means.

Comments: The site selection for capacity building, maybe there are other more hot sites in the country that need to study applying human health risk assessment further.