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 screening level Human Health Risk Assessment for the project case study area in Cambodia – the Electricite du Cambodge (EDC) Sambour warehouse and training facility ("the SEDCW site" or "the site"), Phnom Penh, Cambodia.

Hatfield Consultants Partnership (Hatfield) was contracted by the World Bank to implement key technical activities under the POPs Project. The goal of the POPs Project is to enable officials responsible for POPs management to increase their understanding and their use of risk-based approaches for management of POPs and other chemicals, and prioritize POPs interventions to reduce local health impacts, particularly on the poor and vulnerable. Funding for the POPs Capacity Building Project is provided by the Canadian International Development Agency's POPs Fund, and is implemented by the World Bank.

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. Risk assessment reports have been prepared for each of selected study sites in Cambodia, Lao PDR, Malaysia and Thailand.

The overall Approach and Rationale for Human Health Risk Assessment (HHRA) was approved at the Launch Workshop in Luang Prabang on April 3, 2008. The detailed Approach and Rationale for HHRA was approved by the World Bank together with the Progress Report 1 in July 2008. A Canadian approach to HHRA is employed as the underlying technical basis for the POPs Project.

The draft risk assessment for the SEDCW was presented and discussed at the National Training Workshop on POPs Risk Assessment and Management which took place in Siem Reap, Cambodia from January 19th to 21st, 2009. This Final Report has been updated based on the participants' valuable comments and suggestions.

1.1 SELECTED SITE

The National Focal Point at the recommendation of the Project Team selected the EDC Sambour compound, Phnom Penh, Cambodia as an illustrative case study for a human risk assessment concerning PCBs (Figure 1.1 and Figure 1.2). The SEDCW site compound contains facilities for collection, storage and repair of electrical equipment including transformers, capacitors and their oil. The site is located next to the EDC training center and Sambour village. The primary source of PCBs is the warehouse where many old transformers are stored in both the warehouse and in the yard.

Figure 1.1 Location of the Sambour Study Site, Phnom Penh Cambodia.

The SEDCW site was opened in 1997 by combining three large warehouses that were once located in various parts of Phnom Penh. The site is situated on a plot of land of about 2 hectares in Sambour village. It is situated along the Cheung Ek Road (Road No. 303), about 9 km from Wat Phnom (point zero of Phnom Penh City) and located in Sambour village, Dangkor Commune, Dangkor District, Phnom Penh (UTM 48P 0487681 x 1272498).

The SEDCW site is the country's biggest site for storing transformers (over 300), most of which are planned for disposal. Many units were produced well before 1990; some are in poor condition, with dielectric fluid leaks on the ground. Some transformers were marked contaminated during the 2004 PCB inventory study led by the Ministry of Environment.

1.1.1 Operation and Ownership

The SEDCW site is managed and owned by the Electricite du Cambodge (EDC). It is an autonomous state-owned company under the overall jurisdiction of the Ministry of Industry, Mines and Energy (MINE, Figure 1.3).

EDC is a main electricity producer and distributer throughout Cambodia. Its General Directorate of Administration (GDA) oversees both the Sambour Warehouse and the Training Center. A deputy chief of the Warehouse and Transport Unit, GDA directly supervises the warehouse compound. Each of the warehouses (I – III) is overseen by a manager.

1.1.2 Surrounding Property and Land Use

The Sambour site is situated in Sambour village, Dangkor Commune, Khan Dangkor (Dangkor District); Khan Dangkor is a sub-urban district of Phnom Penh. The topography of the site is generally flat. A number of man-made ponds are located behind the site, which receive most of the storm water run-off from the case study site.

EDC's Training Centre and its dormitory are located just in front (east) of the site. Road access to the site is through the Training and dormitory. Table 1.1 illustrates major classes of land use in the vicinity of the site.

Figure 1.2 Location of the Sambour EDC Warehouse and Its Immediate Vicinity, Phnom Penh, Cambodia.

Cambodia field sampling locations overlaid on Quickbird satellite image.

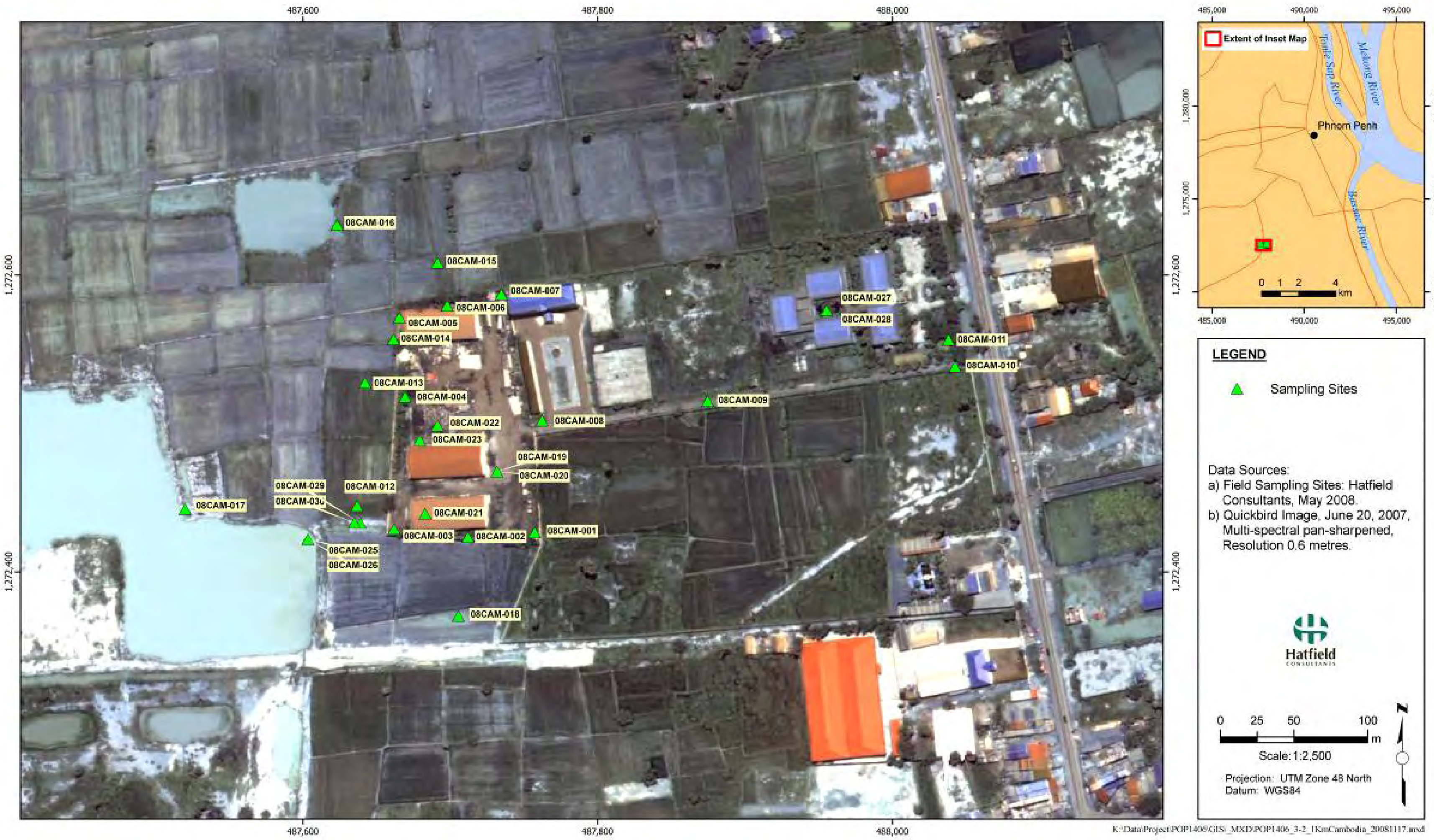


Figure 1.3 Management structure of Sambour EDC Warehouse, Phnom Penh.

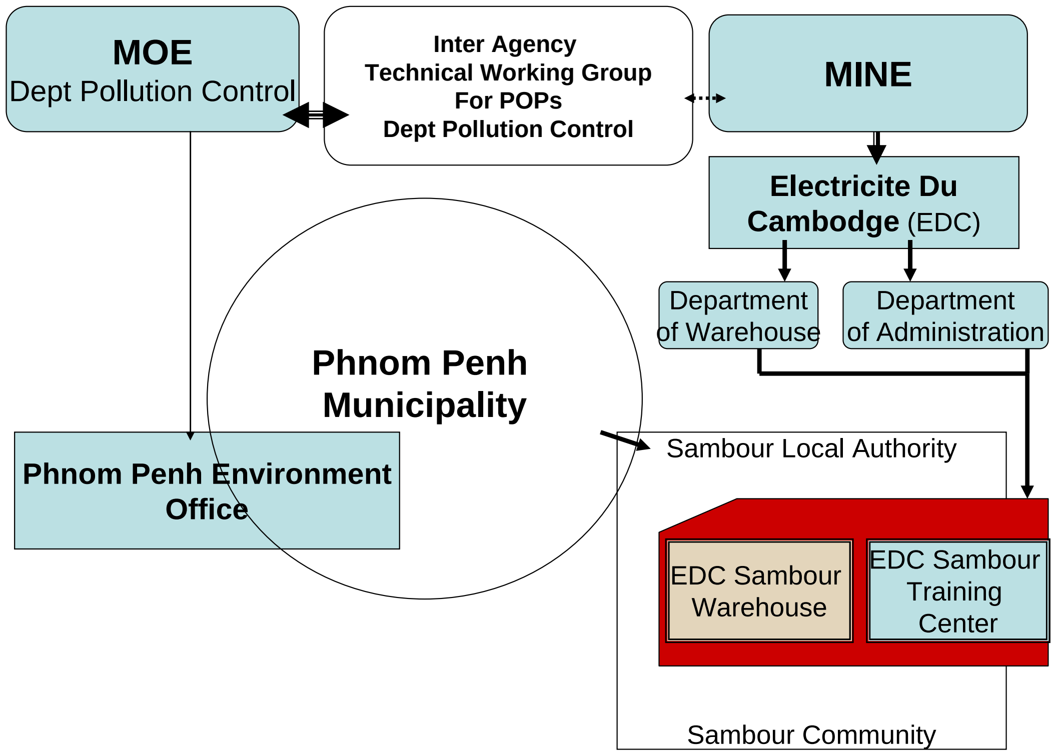


Table 1.1 Major land use classes [1] within 1 km radius from the SEDCW Site in Sambour, Phnom Penh.

Land Use	Area (Ha)	Area (Percentage)
Agriculture Area	187.9	59.8%
Bare Ground	18.9	6.0%
Cultural	0.6	0.2%
Industry/Commercial	21.9	7.0%
Roads	7.5	2.4%
Infrastructure (Buildings)	6.3	2.0%
Residential Area	40.7	13.0%
Trees/Shrub/Bush	8.1	2.6%
Water Body (Pond/River/Canal)	22.3	7.1%
TOTAL	314.1	100%

[1] Quickbird high resolution satellite imageries (0.6 meter resolution) covering an area of 25 km^2 were used as data input for land-cover delineation over the selected study sites in Cambodia, Lao PDR, Thailand and Malaysia. Projection: UTM 48N WGS1984 (Cambodia and Lao PDR); UTM 47N WGS1984 (Thailand and Malaysia). Imaging Dates - Cambodia: 20 June 2007; Lao PDR:19 January 2008; Thailand: 10 January 2005; and Malaysia: 07 May 2007. The project team applied 'heads-up' digitizing approach (manual on-screen classification) for extracting land cover classes from satellite imagery, based on the general land cover types observed over the study sites.

The major land use classes within 3 km^2 of the site are predominantly residential and agricultural (13% and 60%, respectively). This land use is expected to change in favor of residential area and industrial/commercial use in the near future as the area has experienced rapid residential development during the last five years. The construction of a large scale multi-unit condominium over an area of more than 3 hectares immediately east of the SEDCW site is nearly completed for the prospective owners to occupy in 2010.

1.1.3 Climate

The climate is dominated by two monsoons from the southwest (rainy season) and northeast (dry season). The southwest monsoon from May to October brings heavy and frequent rains and high humidity. The northeast monsoon from November to April brings very limited precipitation or considered as no rainfall and low humidity. The average monthly maximum temperatures range from 28 to 35^{o}C. March and April are the hottest months. During the dry season months of October to February, the wind is predominantly from the North and North East. The wind speed in November and December ranges from 6 – 10 m/s. The dry season account for about 6 months long or about 180 days.

1.1.4 Suspected Contaminants

The site has been used to collect, and store used transformers since 1997. The PCB inventory (2004), through density tests and screening tests (using test kits), confirmed that a number of transformers contained PCBs dielectric fluid. Open/uncontrolled burning of waste was carried out regularly on the site. Accordingly, PCBs, coplanar (dioxin-like) PCBs, and dioxins/furans are contaminants of concern for the site.

There were no environmental data available regarding concentrations of contaminants in soil, sediment or animal tissues. Other information, such as socio-economic data, environmental data, health issues and other related issues, was largely unavailable.

The scope of the risk assessment was limited to PCBs, dioxins/furans and organo-chlorinated pesticides. Consistent with the objectives (noted below) no other potential contaminants (e.g., metals, hydrocarbons or solvents) were evaluated.

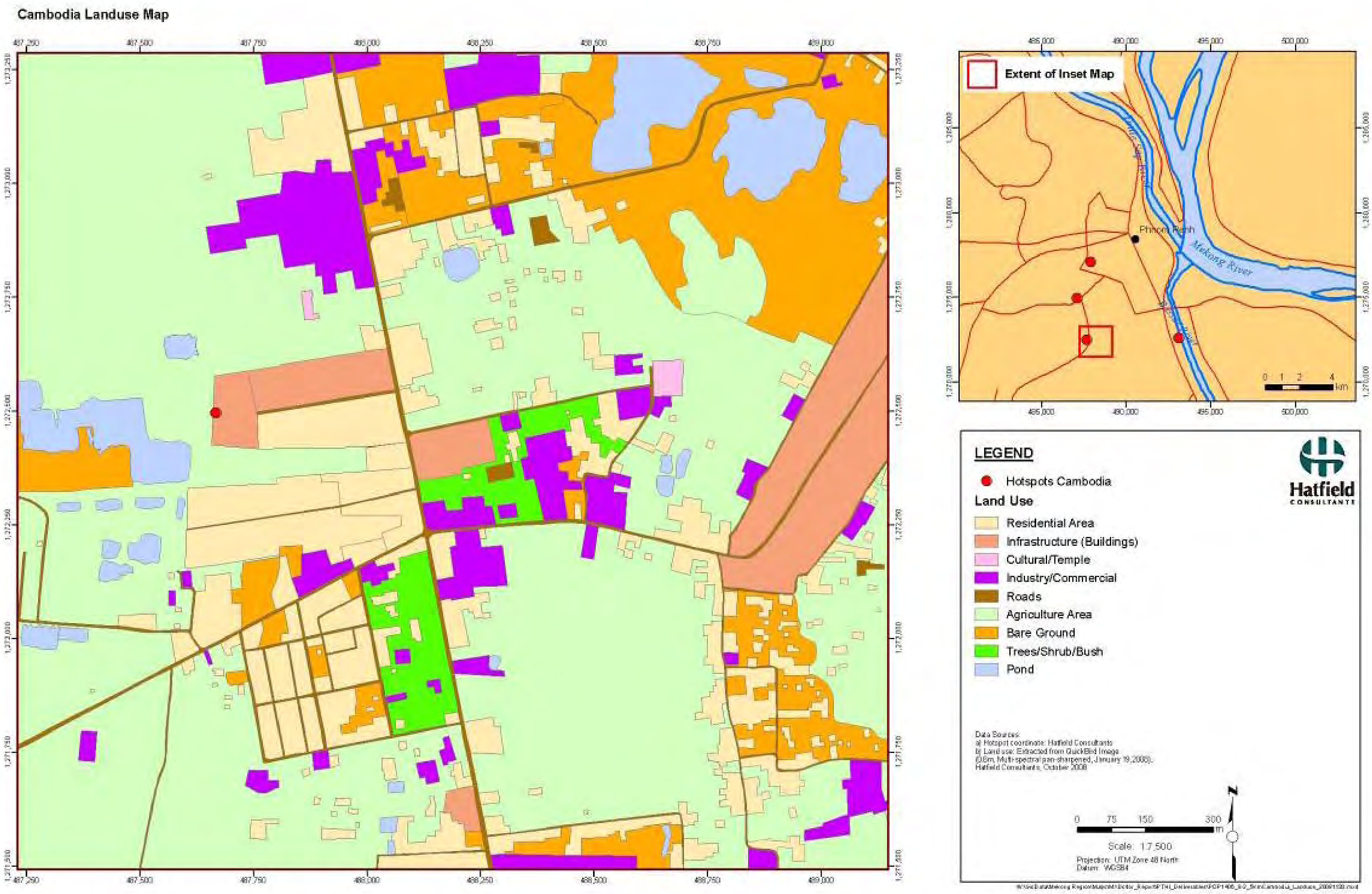
1.2 RISK ASSESSMENT OBJECTIVES

The objectives of the present study were:

1. to illustrate, using the SEDCW Case Study Site, the application of the environmental risk assessment process as applied to contaminated sites; and

2. to determine if PCBs, dioxins/furans and organo-chlorine pesticides, (and associated health risks) are present in the vicinity of SEDCW, based on existing and supplementary data.

Figure 1.4 Land Use Map of the Study Site, in Sambour, Phnom Penh, Cambodia.



The analysis focused on POPs as the key contaminants of interest for training purposes; the site sampling, chemical analyses and risk assessment provide preliminary insight to assess need for potential management interventions respecting POPs. However, it should be recognized that while the case study provides new insights to the SEDCW site, its primary purpose is for capacity building. Accordingly, other potential contaminant classes not investigated presently (e.g., metals, solvents, petroleum hydrocarbons etc.), and their relevance to both human and ecological risks, may need to be considered beyond the present assessment before a final risk management position may be formulated for the site.

The Canadian approach to HHRA (Health Canada 2004) was applied and adjusted to allow for meaningful quantification or comparison of health risks while relying to the extent possible on available country data about POPs, the study site, and potentially exposed populations.

The project team, together with the key national stakeholders, defined the appropriate type of investigation and analyses that should be undertaken for the selected site.

1.3 APPROACH

The study design covers four main stages as shown in Table 1.2 below.

Table 1.2 Risk Assessment Design for the SEDCW Case Study, Cambodia.

Stage	Definition	Key Questions	Methods
Problem Formulation	Defining contaminant sources, concentrations, transport pathways and potential receptors	What hazards (POPs contaminants) are present? What are their properties? What ecological receptors or groups of people may be exposed? What pathways exist linking the chemical hazard and potential receptors?	Reviewing existing data and supplementary field data
Toxicity (Effects) Assessment	Determine consequences of hazard exposure, including identifying dose-response relationships	What types of health effects are possible? What is the contaminant toxic potency (i.e., toxicity reference value)?	Review of existing international agency toxicity databases
Exposure assessment	Evaluate plausibility of the hazardous chemical coming into contact with receptor, estimate the probability, magnitude and duration of contaminant intake rates from exposure	How might the receptors become exposed to the hazards? What is the probability and rate of exposure?	Use numerical exposure equations to estimate chemical intake rate via different environmental media and exposure routes
Risk estimation	Quantify consequences of exposure with reference to effects and dose - probability of hazardous effects; and, expressed over a range of spatial and temporal scenarios	What is the probability and scale of harm or effect?	Calculate risk estimates in the form of exposure ratios (hazard quotients) or incremental lifetime cancer risks

The team reviewed available information collected through a site reconnaissance and reports submitted by the Cambodian National Consultants to: i) determine basic site characteristics; ii) identify potential exposure pathways and exposure points; and, iii) help determine data needs (including modeling needs). Site information was obtained through: i) scoping information in the National Implementation Plan (NIP), POPs inventory reports, National Profile on Chemicals Management in Cambodia, and other official literature; ii) site inspection data (site reconnaissance visit and field observation notes); iii) photographs and remote sensing data; iv) records on site management; and v) information on amounts of hazardous substances disposed (e.g., from site records).

To fill data gaps and augment existing site data respecting potential presence of POPs and releases from the site to the environment, supplemental investigations and environmental transport modeling activities were undertaken. The field program was designed to gather enough contaminant information to assess human health risks within project budget constraints.

The Project Team worked closely with key national stakeholders during the risk assessment process. This included sampling design, sample collection and analysis, quality control, and use of the results for developing case studies. Collected data were then integrated into a quantitative statement of human health risk at the site. Computer-simulated exposure modeling was used to predict risks to human health.