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 Malaysia – the closed Air Hitam Sanitary Landfill site (hereafter referred to as the "AHSL" site).

Hatfield Consultants Partnership (Hatfield) was contracted by the World Bank to implement key technical activities under the POPs Project. Complementary program activities will be implemented by national consultants or World Bank staff. 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 selected site in Cambodia, Lao PDR, Thailand and Malaysia.

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, and a presentation of the present POPs case study was provided during a collaborative risk assessment training workshop in Putrajaya, Malaysia on January 22 - 23, 2008. A Canadian approach to HHRA is employed as the underlying technical basis for the POPs Project.

1.1 SELECTED SITE

The Ministry of Natural Resources and Environment (NRE) as the National Focal Point for the POPs project in Malaysia in consultation with key stakeholders selected the Air Hitam Sanitary Landfill (AHSL) in the State of Selangor for the POPs HHRA case study for POPs project. While there were no existing data or known waste management practices suggesting the presence of POPs at the AHSL site, the site selection was based on speculative concern for (i) potential POPs wastes which inadvertently may have been deposited at the landfill, and (ii) the proximity of residential developments adjacent to the closed landfill.

1.2 SITE SETTING

The State of Selangor is a rapidly growing Malaysian state with population growth from 2.5 million in 1991 to 4.7 million in 2005 (Department of Statistics, 2008). Waste generation has similarly increased, in terms of both type and volume. Accordingly, Selangor State Government recognized the need and urgency to build and operate an engineered sanitary landfill in Selangor. In March 1995, Selangor State Government appointed Worldwide Sita Environmental Management to develop a sanitary landfill in Selangor.

The AHSL site is located near the Air Hitam Forest Reserve in Mukim Petaling, Daerah Petaling, Puchong, Selangor and is located at longitude 101° 39′ 55″ E and latitude 03° 0′ 10″ N. It was officially opened in November 1995 and prematurely closed in December 2006 (Worldwide Landfills, 2007). AHSL was the first engineered sanitary landfill in Malaysia, and covers an area of over 42 hectares. AHSL is equipped with a heavy-duty geotextile liner, a ground water drainage system, and a leachate collection system and treatment pond. During the operational period of AHSL (11 years), AHSL received a total of approximately 6.2 million tonnes of domestic wastes (Worldwide Landfills, 2007).

Prior to the construction of AHSL, Worldwide Landfills conducted an Environmental Impact Assessment (EIA), in compliance with the regulatory requirement of Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. The location selected for AHSL fulfilled the Guidelines for the Sitting and Zoning of Industries, which was published by the Department of Environment in 1994, which stipulated that sanitary and similar services should have a minimum of 500 meters of buffer zone from residential areas (Figure 1.1).

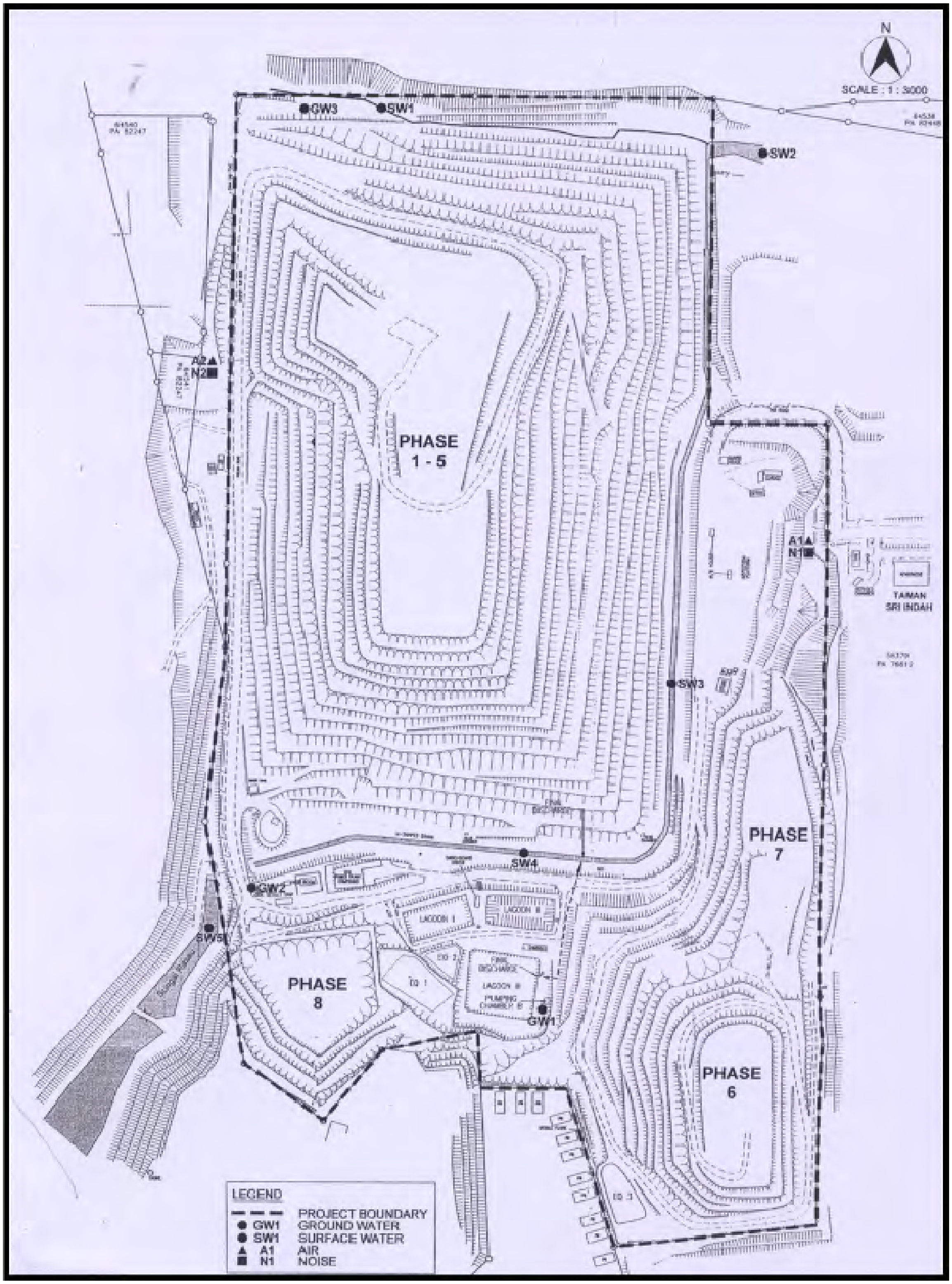
1.2.1 Operation and Ownership

The Selangor State Government Council Meeting on 22 March 1995 approved Worldwide Sita Environmental Management to develop a sanitary landfill in Selangor. The AHSL was initially managed by the Worldwide Holdings Berhad and SITA Group JV; but since 2000, AHSL was under the sole management of Worldwide Landfills Sdn Bhd (WLSB).

Worldwide Landfills obtained a concession contract for 20 years which included a 5 year landfill closure maintenance plan (for the AHSL). However, after the first residential area was built in year 2000, residents started to complain about the operation of AHSL, particularly odors emitted or released from AHSL. The AHSL was officially closed on 31 December 2006 (premature to contracted date, i.e. 2015) and the 5-year Landfill Closure and Post Closure Maintenance Plan (LCPCMP) is in place (2007-2011).

The primary regulatory ministry for landfills is the **Ministry of Housing and Local Government** (**MHLG)** and the **National Solid Waste Management Department**. Other agencies responsible for the approval and monitoring landfills are the Department of Environment, Municipal Council of Subang Jaya (MPSJ), and the Public Works Department.

Figure 1.1 AHSL Landfill Lay-out and phases, Selangor, Malaysia (LESTARI, 2008).



1.2.2 Surrounding Property

The State of Selangor is one of the most rapidly growing states in Malaysia. Infrastructure including houses and apartments has been built to accommodate the increasing population, and by 2000 this had extended into areas surrounding AHSL. The area has experienced further rapid development in the last several years resulting in encroachment into the buffer zone area (e.g. a school is being built next to the site). Residential areas in the vicinity of AHSL include (Worldwide Landfills 2007, Mazrura 2009):

- Taman Lestari Putra;
- Taman Lestari Perdana;
- Taman Equine; and
- Taman Sri Indah.

Some of the residential areas are adjacent to the AHSL including Taman Lestari Perdana and Taman Lestari Putra (Figure 1.2); residents have complained about the operation of AHSL, particularly related to odors and issues of hygiene.

1.2.3 Land Use Adjacent to AHSL Site

Table 1.1 and Figure 1.2 below show major classes of land use in the vicinity of the AHSL site:

Table 1.1 Major land use classes within 1 km radius from the AHSL site[1].

Land Use	Area (Ha)	Area (Percentage)
Bare Ground	92.43	29%
Forest	24.59	7.8%
Industry/Commercial	2.34	0.74%
Roads	44.47	14%
Infrastructure (Buildings)	0.23	0.07%
Residential Area	81.85	26%
Pond	1.35	0.43%
Trees/Shrub/Bush	65.74	21%
River/Canals	1.11	0.35%
TOTAL	**314.12**	**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.

Figure 1.2 Land-use Map of AHSL Site (LESTARI, 2008).

Abbr	Land use types	Abbr	Land use types
SM	Secondary School (under construction)	KT	Reservoir
PLR	Sewage treatment plant	M	Mosque
S	Muslim place of worship	PPU	Main Electrical Supply Centre
TDK	Kindergarten	TA	Water Tank
SB	Integrated School (under construction)	DS	Multipurpose hall
KYS	Selangor Foundation Club (under construction)		

Source: MPSJ 2008

The predominant land use classes within 3 km^2 are residential and bare ground – 26% and 29% respectively. The proportion of bare ground is expected to decrease quickly if the high development rates seen during the last eight years continue. Some of this land is within the minimum 500 meters buffer zone required by the Guidelines for the Sitting and Zoning of Industries, 1994.

1.2.4 Climate

The areas in the vicinity of AHSL receive average 2,600mm of rainfall, and average 163 raining days annually. The temperatures are high, on average between 23-33°C with a relative humidity of around 77%. The average annual proportion of days with precipitation is 0.45 (i.e., 0.55 for days without precipitation) and annual evaporation for the areas in the vicinity of AHSL is 4.0 mm (Malaysia Meteorological Department, 2008).

1.2.5 Suspected Contaminants

As part of the AHSL closure plan Worldwide Landfills monitors pollution levels for non-POPs contaminants, particularly in surface and ground water, air quality, and leachate discharge (Worldwide Landfills, 2007). Due to the lack of POPs data from the site, it is a challenge to specify if and what POPs may be present in the AHSL. The sanitary landfill was designated for disposing non-scheduled waste, including: domestic/household waste, commercial and light industrial waste, market waste, street cleaning waste, construction waste and food waste.

POPs pesticides might be present in AHSL, since several POPs pesticides were historically registered in Malaysia (e.g. DDT was registered for 19 years in the country). Some domestic wastes might also contain PCBs and other POPs-like contaminants.

1.3 SCOPE OF RISK ASSESSMENT AND GOALS

The objectives of the present study are:

1. To illustrate, using the AHSL case study example, the application of the environmental risk assessment process as applied to contaminated sites; and

2. To determine if POPs and associated health risks are present in the vicinity of AHSL in Selangor, based on existing and supplementary data.

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 AHSL 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 Hatfield Project Team, together with the key national stakeholders, defined the appropriate type of investigation and analyses that should be undertaken for the selected site.

1.4 APPROACH

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

Table 1.2 Risk Assessment Design for the AHSL Case Study, Malaysia.

Stage	Definition	Key Questions	Methods
Problem Formulation	Define 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?	Review 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 in to contact with receptor, esitmate 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, express 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 Malaysian National Consultants (Lestari 2008, Mazrura 2009) 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 also obtained through: i) scoping information in the National Implementation Plan (NIP) for the Management of Persistent Organic Pollutants (POPs) in Malaysia, 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 waste 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.