Cambodia: Second Health Sector Support Program –
Updated Environmental Management Plan

Prepared For
The World Bank,
Washington D.C.

Prepared By
Ministry of Health
Royal Government of Cambodia
CAMBODIA: SECOND HEALTH SECTOR SUPPORT PROGRAM

UPDATED
ENVIRONMENTAL MANAGEMENT PLAN

Prepared for
East Asia Human Development Sector Unit
The World Bank
1818 H Street N.W.
Washington, D.C., USA 20433

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MINISTRY OF HEALTH
Royal Government of Cambodia
1.0 INTRODUCTION

1. The Ministry of Health with support from the EVS Environment Consultants (EVS) undertook an environmental review (ER) of the Cambodia Health Sector Support Project (HSSP) during its preparation, which included an environment management plan (EMP). As part of the preparation of the Cambodia Second Health Sector Support Program (HSSP2), the ER was reviewed to assess its relevance, and the performance and implementation experience of implementing the EMP. The ER documents Cambodia’s environmental laws, regulations, policies and other relevant legislation to ensure that applicable environmental assessment requirements are fully addressed during project implementation.

2. This ER assesses potential environmental and human health impacts of the planned project, particularly with regard to: (a) construction and rehabilitation of health care facilities (HCF) focusing on operational health care waste management (HCWM) practices, incinerator use, arsenic in groundwater, and extraction of asbestos when present during civil works; and (b) pesticide use in malaria and dengue vector control programs. Environmental issues relevant to these HSSP2 activities are detailed in the body of the report. Recommendations are made as to appropriate mitigation measures and monitoring programs to be followed with a view to guiding project design and incorporating appropriate management plans during HSSP2 implementation.

1.1 PROGRAM DESCRIPTION

3. The World Bank support to the second phase of health sector support program (HSSP2) will contribute to the country level sector pool along with DFID, AusAID and UNFPA with the expectation of more partners joining at a later stage. The pool will also facilitate harmonized management arrangements for support by non-pooling partners through discrete accounts in the Ministry of Health.

4. HSSP2’s development objective is to support the RGC Health Strategic Plan strategies to improve access to, and utilization of effective, efficient and quality health services to improve the health status of the Cambodia population by (a) strengthening primary health care and essential referral services, (b) strengthening health financing and social protection mechanisms for the
poor; and (c) strengthening human resources and institutional capacity on the Ministry of Health.

1.2 PROGRAM COMPONENTS

5. The four program components are aligned with the HSP2 strategic areas. Activities supported under different components are subject to the Government’s 3-year and Annual Operational Planning processes.

Component A: Strengthening Health Service Delivery

6. This component will support the consolidated and integrated delivery of essential health services in health centers (Minimum Package of Activities – MPA) and referral hospitals (Comprehensive Package of Activities – CPA) through (a) the provision of Service Delivery Grants (SDGs) and (b) investments for the improvement, replacement, and extension of the health service delivery network.

Component B: Improving Health Financing

7. This component is aligned with the HSP2 health financing strategy that calls for continued policy and advocacy work, further review and development of the Strategic Framework of Health Financing 2008, and the implementation of social protection measures to protect people from catastrophic out-of-pocket health costs. This component will finance (a) Health Protection for the poor through Health Equity Fund arrangements; and (b) support the development of health financing policies and institutional reforms.

Component C: Strengthening Human Resources (HR)

8. A major bottleneck to improving service delivery outcomes in Cambodia is HR, including (a) staff shortages (e.g. midwives); (b) poor performance incentives; (c) inadequate skills and competencies; and (d) difficulties in recruiting and retaining staff in remote rural areas. Performance contracting described under Component A, improved management of user fee income, and institutional reforms driven by the Council of Administrative Reform, will support improving the incentive package at front line health facilities. This component will focus on (a) strengthening pre- and in-service training, (b) strengthening human resource management in the MOH, and (c) the Merit Based Performance Incentive scheme for health managers and key technical staff participating in the implementation of the HSP2 at central and provincial levels.

Component D: Strengthening Health System Governance
9. This component will support to the MOH shift from a hierarchical administration of health services towards a policy, regulatory and oversight institution. As the implementation of HSP2 moves forward, Program support will be available for (a) developing a priority set of policy packages identified in the HSP2; (b) strengthening the institutional arrangements at all levels of the health system – national, provincial, and operating districts, including a leadership and management training program; (c) private sector regulation and partnerships; and (d) supporting governance and stewardship functions of the national programs and centers overseeing the three HSP2 strategic programs.
2.0 ENVIRONMENTAL ASSESSMENT

2.1 CIVIL WORKS

2.1.1 Health Facility Construction and Rehabilitation

10. Similar to HSSP, civil works are expected not to cause adverse impacts to the environment and people. Most of the HCFs to be supported are health centers with support for the rehabilitation/renovation of a few hospitals. Review of the preliminary design models for referral hospitals and health centers indicates that construction and/or renovation will not trigger an environmental assessment under the Ministry of Environment EIA guidelines (new full service referral hospitals, i.e., inpatients, outpatients, surgery, x-ray, laboratory, emergency, ambulance, ward, maternity, blood bank, pharmacy, janitorial, kitchen, administration, are expected to have a total floor space of approximately 2,000 m² which is well within the 8,000 m² size threshold for new buildings requiring assessment). Building height is not expected to exceed 6 m; again well within the 12 m height threshold. Similarly, design models for health centers – both outpatients and combined outpatients and inpatients – provide for modest sized buildings with a maximum floor space of 110 m² and a height not exceeding 6 m.

11. Although environmental assessment is not required for HCF construction and rehabilitation, as was the case for HSSP, best practices will be followed to preempt any potential human health and environmental impacts. Particular attention will be given to the design of hospitals and health centers by including in the construction basic facilities such as water supply, incinerator and wastewater treatment systems. Also, particular attention will be given to the proper handling and disposal of hazardous building materials such as asbestos that may be present at facilities undergoing rehabilitation.

12. Asbestos, a fibre mined in several countries, has been widely used worldwide as a construction material and insulator because of its strength, durability and heat resistance characteristics. In recent years, evidence on the adverse health effects of exposure to asbestos has been mounting globally leading to urgent calls to cease production of the most-harmful asbestos types, limit the use of less-harmful asbestos (e.g., discontinued spraying of asbestos), and to impose strict exposure standards for workers handling raw asbestos and asbestos-containing products. Occupational exposure to asbestos by inhalation can cause asbestosis (scarring of the lung tissue), lung cancer, and mesothelioma (cancer of the lung's lining). In developed countries, occupational asbestos exposure is thought to have peaked in the 1970's but the effects of exposure continue to manifest themselves today with an
estimated 30,000 new asbestos-related cancers being diagnosed every year.

13. The surge of asbestos use in developing countries as they increasingly industrialize has raised concerns of a second epidemic of asbestos-related cancer deaths over the next three decades. Although the use of asbestos has fallen in developed countries, it has climbed dramatically in developing countries in the past twenty years. For example, asbestos consumption in Thailand rose from 21,271 metric tons in 1970 to 164,000 metric tons in 1994. In Thailand, asbestos is used extensively in the manufacture of construction materials such as roofing, flat sheets for wall and water pipes – these fibre cement products typically contain 13% asbestos by weight. Demand for asbestos building materials is expected to remain high in developing countries due to their low cost compared to alternatives such as polyvinyl chloride (PVC) plastics and galvanized metal.

14. Occupational health risks posed by asbestos in Cambodia are difficult to assess because of limited information concerning the use of asbestos building materials. Consultations with the SFKC, who are responsible for government civil works in Cambodia, suggest that asbestos may be present in existing building containing fibre cement products. While clay roofing tiles are the preferred roofing material used in provincial and district HCF, fibre-containing ceiling sheeting is a commonly used building material in Cambodia. Since 2000, the SFKC have specified that asbestos-fibre concrete building materials are no longer permissible – construction is closely supervised to ensure that contractors do not use cheap asbestos materials manufactured in Thailand. Recommended follow up actions detailed in the Environmental Management Plan include surveying HCF to be rehabilitated as part of the HSSP2 in order to quantify the risk posed by asbestos that may be present in existing structures and to determine appropriate occupation health and environmental mitigation measures.

15. Clearance and preparation of sites may be required since in many areas there was an existing HCF. Therefore hazardous waste from the facility may exist. This waste would have to be cleaned before the construction starts. Also appropriate disposal for this waste must be carried out.

2.1.3 Drinking Water Quality

16. Considerations relating to ensuring the supply of safe drinking water to new and rehabilitated HCF are outlined in this section. Particular attention is given to potential risks associated with arsenic in groundwater and microbial water quality.

Arsenic

17. The potential for naturally occurring arsenic to appear in groundwater
was identified as a concern in connection with provision of safe water supply to HCF. In recent years, it has become increasingly apparent that drinking water guidelines are quite frequently exceeded in available water sources worldwide. Arsenic is now recognized as one of the most serious inorganic contaminants in drinking water on a global basis (UN/WHO, 2001). The most serious groundwater problem identified to date has been in Bangladesh where very high arsenic levels in groundwater affects drinking water wells. The heavy reliance on groundwater for public drinking water supply in Bangladesh has resulted in an estimated 40 million people having been exposure to high arsenic levels. Consumption of elevated levels of arsenic in drinking water over long periods of time has been associated with a variety of human health problems including skin disorders and respiratory, cardiovascular, immune, reproductive, gastrointestinal and nervous system ailments.

18. Both surface and groundwater are used as sources of drinking water in Cambodia. Although surface water quality in generally very high and is the preferred source of drinking water, an estimated 50% of the country's population currently uses groundwater. A recently completed water quality study indicated that groundwater from certain areas of the country contains levels of arsenic that could pose problems for human health (Feldman, 2001). Arsenic levels measured are summarized by province in Table 1 (Note: Phnom Penh was not included in the study area). These values represent the highest or ‘worst case’ arsenic levels measured for individual wells in each province – spatial variability for arsenic is typically high and it is not unusual to get widely different measurements even for wells located in the same village. Study results reveal that several water sources, in both urban and rural locations, were found to contain arsenic concentrations above WHO’s recommended limit of 10 µg/l (WHO, 1993). The highest arsenic concentrations were detected in Kandal Province. Elevated levels were also detected at sampling locations in Krachey, Svay Rieng, Kampong Thom and Bat Dambang provinces.

Table 1   Overview of groundwater arsenic levels in Cambodia.

<table>
<thead>
<tr>
<th>Province</th>
<th>Arsenic Concentration (µg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banteay Mean Chey</td>
<td>10</td>
</tr>
<tr>
<td>Bat Dambang</td>
<td>50</td>
</tr>
<tr>
<td>Kampong Cham</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Kampong Chhnang</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Kampong Speue</td>
<td>10</td>
</tr>
<tr>
<td>Kampong Thom</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Kampot</td>
<td>No Data</td>
</tr>
<tr>
<td>Province</td>
<td>Arsenic Level</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Kandal</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Kaoh Kong</td>
<td>No Data</td>
</tr>
<tr>
<td>Kracheh</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Krong Kaeb</td>
<td>No Data</td>
</tr>
<tr>
<td>Krong Pailin</td>
<td>No Data</td>
</tr>
<tr>
<td>Krong Preah Sihanouk</td>
<td>No Data</td>
</tr>
<tr>
<td>Mondol Kiri</td>
<td>No Data</td>
</tr>
<tr>
<td>Otdar Mean Chey</td>
<td>No Data</td>
</tr>
<tr>
<td>Pousat</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Preah Vihear</td>
<td>No Data</td>
</tr>
<tr>
<td>Prey Veaeng</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Rotanak Kiri</td>
<td>No Data</td>
</tr>
<tr>
<td>Siem Reab</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Stueng Traeng</td>
<td>No Data</td>
</tr>
<tr>
<td>Sway Rieng</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Takaev</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

19. It is noted that monitoring of arsenic in groundwater has not yet been completed in all twelve provinces (i.e., indicated by shading in Table 1) targeted by the HSSP; no data is currently available for six of these twelve provinces. Feldman’s (2001) study covered only thirteen Cambodian provinces and municipalities due to budget and time constraints. Follow up sampling completed by the WHO and UNICEF subsequently included Stueng Traeng Province and increased the number of wells sampled – groundwater arsenic in Stueng Traeng was found to exceed 10 μg/l. JICA have also completed extensive sampling of villages in Central and Southern Cambodia. Although these studies augment the spatial coverage of groundwater arsenic surveys in Cambodia some data gaps remain in the HSSP provinces. Specifically, limited or no data is presently available for Kampot, Koah Kong, Krong Kaeb, Krong Pailin, Otdar Mean Chey, and Preah Vihear. Of these provinces, it is likely that low arsenic levels are prevalent in Kampot and Krong Keab (P. Feldman, Personal Communication). The surficial geology of Cambodia is dominated by the Mekong and Tonle Sap river systems. Study results suggest that elevated arsenic levels are closely correlated with alluvial sediments (i.e., river deposits). Lower groundwater arsenic levels have been measured in the southeastern, southwestern, and northeastern provinces where bedrock lies closer to the surface. Extrapolating from available geological and groundwater survey data suggests that groundwater arsenic may be elevated in Krong Pailin and Preah Vihear, with lower levels likely in Otdar Mean Chey (P. Feldman, Personal Communication).
20. There are currently no standards or regulations concerning drinking water quality in Cambodia; although it was learned that the Ministry of Industry, Mines and Energy (MIME) are in the process of developing guidelines. In the absence of national guidelines, WHO guidelines values can be used to evaluate the potential human health impacts of drinking water sources. It is important to note that the WHO guidelines are not intended as standards but instead as guidance values in interpreting data. In reviewing survey results, it should be recognized that the WHO's provisional guideline for arsenic of 10 µg/l may not be practical for many developing countries to achieve. For this reason, an action level of 50 µg/l has been proposed by UNICEF in Cambodia. The provisional WHO guideline of 10 µg/l is considered appropriate for a long-term goal but may be overly stringent in the near term given the difficulty of measuring trace arsenic and the expense of treatment at such low levels. Instead an interim standard of 50 µg/l is recommended – this represents the current drinking water standard in most countries. Further, a tiered-system of categorizing risk is suggested where: (i) no actions are necessary when arsenic concentrations are < 10 µg/l; (ii) arsenic concentrations of 10 – 50 µg/l are ranked as a medium priority triggering additional testing to assess the geographical extent of the problem and periodic monitoring to assess temporal changes; and (iii) arsenic concentrations > 50 µg/l are a high priority requiring treatment of affected drinking water or substitution of alternative water sources.

**Microbial Water Quality**

21. Problems posed by bacteriological contamination of drinking water supply continues to be the most important health related concern in Cambodia's water supply sector. Feldman (2001) emphasizes that the human health threat from bacteriologically unsafe drinking water is by far the most important water quality issue in Cambodia at the present time and urges that national attention should continue to focus on this well-documented public health threat. Recognizing this threat, both the WHO and UNICEF have recommended that attention also be given to ensuring microbial water quality of drinking water supplied to HCF under the HSSP. To this end, recommendations contained in the Environmental Management Plan are intended to ensure the overall quality of drinking water utilized by hospitals and health centers.

### 2.2 Health Care Waste

22. Activities undertaken to improve health services will inevitably create waste that is potentially hazardous. Health care wastes are typically more hazardous than other types of wastes and are of concern in assessing proposed health care improvement activities. To address these concerns, it is essential to put in
place safe and reliable methods for handling and proper disposal of HCW.

23. Health care waste includes all wastes generated in the delivery of health care services. WHO (1999a) estimates that 75-90% of waste produced by HCF originates from non-risk or general sources (e.g., janitorial, kitchens, administration) and is comparable to domestic waste. The remaining 10-25% of HCW is classified as hazardous and poses a variety of potential health risks. Categories of HCW, as defined in WHO (1999a), which are considered of most concern in Cambodian HCF are summarized in Table 2.

Table 2 Health care waste characteristics and hazards profile.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Characteristics/Associated Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious</td>
<td>Comprises waste that is suspected to contain pathogens including laboratory cultures, surgery and autopsy wastes from patients with infectious diseases, bodily wastes from patients in infectious disease wards, and miscellaneous waste such as disposable gloves, tubing and towels generated during treatment of infectious patients. Pathogens from infectious waste may enter the human body through puncture of skin cuts, mucous membranes, inhalation or ingestion.</td>
</tr>
<tr>
<td>Pathological</td>
<td>Consists of tissue, organs, body parts, blood and body fluids. Pathological wastes are considered a sub-category of infectious wastes and pose the same hazards.</td>
</tr>
<tr>
<td>Sharps</td>
<td>Describes items that could cause cuts or puncture wounds, including hypodermic needles, scalpel, and broken glass. Because sharps can not only cause cuts and punctures but also infect these wounds if they are contaminated with pathogens, this sub-category of infectious wastes is considered very hazardous.</td>
</tr>
<tr>
<td>Chemical</td>
<td>Consists of discarded solid, liquid and gaseous chemicals with toxic, corrosive, flammable, reactive, and genotoxic properties. Chemicals most commonly used in HCF include formaldehyde, photographic chemicals, heavy metals such as mercury from broken clinical equipment, solvents, organic and inorganic chemicals, and expired, unused or spilt pharmaceuticals. Hazards from chemical and pharmaceutical waste include intoxication as a result of acute or chronic exposure from dermal contact, inhalation or ingestion and contact burns from corrosive or reactive chemicals.</td>
</tr>
</tbody>
</table>
Radioactive

Includes solid, liquid and gaseous materials contaminated with radio nuclides; produced as a result of procedures such as in-vitro analysis of body tissue and fluid, in-vivo organ imaging and various investigative and therapeutic practices. Because radioactive waste is genotoxic, health workers in handling active sources and contaminated surfaces must take extreme care.

24. A wide number of persons are potentially at risk from HCW, both inside and outside of HCF. Exposure to hazardous HCW can result in disease or injury to:

- Medical doctors, nurses – Occupation health risks to health care workers are numerous and varied with the greatest risk being infection (e.g., HIV/AIDS and hepatitis B and C) through injuries from contaminated sharps.

- Auxiliary and maintenance staff – Hospital workers such as janitors are at significant risk of infection or injury due to improper handling of infectious and chemical wastes at HCF.

- Patients and visitors – Although risks of exposure to hazardous waste are considered lower than for hospital staff there is a potential for accidental exposure to infectious sharps and chemical waste (e.g., children accompanying families during extended stays at HCF are particularly at risk).

- Workers at waste disposal facilities (e.g., incinerators and landfills) – Waste management workers are at significant risk of infection or injury from hazardous wastes; particularly scavengers at open landfills who are either not aware or ignore risks and often do not wear even rudimentary protective clothing.

25. Generally accepted strategies for HCWM encompass: (i) waste minimization, recycling, and reuse; (ii) proper handling, storage and transportation of HCW; and (iii) treatment of waste by safe and environmentally sound methods. These strategies are intended for tiered application – initially focusing on managing waste generation before moving on to actual disposal. Significant reductions in waste generated by HCF can be achieved through source reduction, use of recyclable products, and good management and control practices. Of these measures, waste segregation – careful sorting of waste matter into different categories – is critical to minimization of health care wastes; resulting in significant reduction of hazardous waste that needs to be handled and treated. Although safety concerns necessarily limit opportunities to reuse medical equipment (i.e., aside from items that are intended to be reusable), segregation and subsequent recycling of materials such as plastics, metal, paper and glass is often practical and can represent an income source for HCF.
26. Segregation of HCW is intended to ensure that wastes are properly identified and separated and that different waste streams are handled and disposed of correctly. It typically involves sorting different wastes into color-coded plastic bags or containers at source. Recommended handling and disposal practices for different categories of HCW will vary according to the resources available to HCF. Examples of WHO (1999a) recommended HCW handling practices appropriate for HCF that apply minimal waste management programs are:

- General HCW (in black bags or containers) should join the domestic refuse stream for disposal.
- Sharps should be collected together into puncture-proof yellow safety boxes and held for high-temperature incineration. Encapsulation and disposal to a secure landfill is a suitable alternative for sharps.
- Highly infectious waste should be sterilized by autoclaving as soon as possible. For other infectious waste, disinfection is sufficient to reduce microbial content. Treated infectious waste should then be deposited in yellow bags and containers marked with the international infectious substance symbol. Incineration is the preferred method for disposal of infectious waste although land filling is also appropriate. Blood should be disinfected before discharge to the sewer system or wastewater treatment plant, if available, or may be incinerated.
- Large quantities of chemical wastes should be packed in chemical-resistant containers and sent to specialized treatment facilities. Small quantities of chemical waste can be held in leak proof containers and enter the infectious waste stream for incineration or land filling. It is noted that incineration at low temperatures may be insufficient to destroy thermally-resistant pharmaceuticals.
- Waste containing high heavy metal concentrations should be collected separately in brown containers and sent to specialized treatment facilities.
- Low-level radioactive waste should be collected to yellow bags or containers for incineration. High-level radioactive waste must be sent to specialized disposal facilities.

27. Incineration is a widely used treatment method for most hazardous waste generated by HCF. Incinerators can range from simply, single-chamber combustion units to sophisticated, high-temperature plants. WHO (1999a) notes that all types of incinerator, if operated properly, eliminate pathogens from waste and reduce the waste to ash. Used correctly, incineration allows for a very significant reduction of waste volume and weight and is typically selected to treat wastes that cannot be recycled, reused or safely disposed of to landfills. The key to environmentally-
safe incineration is proper segregation of waste streams within HCF – inappropriate waste types include large volumes of chemicals, photographic and radioactive wastes, PVC plastics, and waste with a high mercury or cadmium content. Incineration of these wastes causes the release of toxic emissions to the atmosphere if insufficiently high incineration temperatures are attained or in the absence of adequate emission controls.

28. Land filling of wastes that cannot be safely incinerated is regarded as an acceptable disposal option if proper precautions are taken to minimize potential exposure to infectious wastes. Disposal of HCW to open landfills is not considered acceptable. Open landfills are characterized by the uncontrolled and scattered deposit of wastes at a site which can lead to groundwater and surface water pollution and a high risk to scavengers working at the landfill. Instead, HCW should only be deposited to sanitary landfills that are designed to prevent contamination of soil, surface water, and groundwater and limit air pollution, odors and direct contact with the public. In the absence of sanitary landfills – which may not be feasible for cost and technical reasons – HCW can be safely disposed of to landfills that provide for controlled dumping; including measures to control leachate release from the site, confined disposal of wastes, and rapid burial to avoid human or animal contact.

29. Recognizing that sanitary or engineered landfills are unlikely to be available in remote locations, another option is safe burial of HCW on HCF premises. On-site disposal represents an acceptable disposal option only if certain requirements are met as follows:

- Restricted access to disposal site by authorized personnel only
- Lining of burial site with a material of low permeability such as clay to prevent groundwater pollution
- Limit use to hazardous materials which cannot safely be incinerated to maximize the lifetime of a landfill
- Proper management of landfill (i.e., layering of HCW with layers of earth) to prevent odors.

2.3 Wastewater

30. Wastewater from HCF represents a sub-category of HCW that should be addressed in planning construction and rehabilitation as part of the HSSP2. WHO (1999a) notes that although wastewater from HCF is typically of a similar quality to urban wastewater, it may also contain potentially hazardous components. Microbiological pathogens introduced into the wastewater stream by patients being treated for enteric diseases are of most concern. Lesser hazards are posed by small quantities of hazardous chemicals, pharmaceuticals, and other pollutants
commonly found in HCF wastewater. Adherence to the hazardous waste segregation practices described in the preceding section provides assurances that chemicals and pharmaceuticals are not entering the wastewater stream.

31. Typically sewage discharged from HCF is greatly diluted and as such no significant health risks should be expected if effluents are treated in municipal wastewater treatment plants (WWTP). In more remote locations where it is not feasible to connect to municipal WWTP then appropriate precautions must be taken to avoid health risks associated with untreated or inadequately treated sewage to the receiving environment (e.g., wetlands or agricultural lands immediately adjacent to a HCF). Where possible, HCF should be connected to municipal systems. Where there are no sewage systems, technically sound on-site sanitation should be provided. Recommended mitigation measures covering wastewater from HCF are elaborated in Section 5.1 – Environmental Management Plan.

2.4 Tuberculosis and HIV/AIDS

32. Health care wastes generated during treatment of patients with tuberculosis and HIV/AIDS at HCF can be considered a sub-category of HCW. Tuberculosis outpatient and hospital services to be funded under the HSSP2 are best addressed in the overall context of proper HCWM at HCF. Safeguards applicable to handling and disposal of highly infectious waste as described in the previous section are therefore applicable.

33. No specific HCWM-related environmental concerns were identified for the HIV/AIDS activity to be funded under the HSSP2. Grant funding for HIV/AIDS prevention and treatment in Cambodia will cover the cost of drugs used in sexually transmitted disease (STD) clinics for treatment of sexually transmitted infections (STI) in sex workers and operating costs of the NCHADS 100% condom use program. Drugs to be procured are Cexime, Doxycycline, Clotrimazole and Ciprofloxacin. Procurement and distribution of the drugs to STD clinics is closely supervised by NCHADS. A comprehensive manual exists for STD case management at clinics that contains guidelines on how to organize services and policies for delivery.

2.5 Malaria and Dengue Vector Control

2.5.1 Pesticide Use

34. Insecticide and larvicides intended for use in malaria and dengue vector control programs as part of the HSSP2 are summarized in Table 3. It is noted that all products have successfully passed WHO's Pesticide Evaluation Scheme (WHOPES) (see WHO, 1997 for overview). The WHOPES was set up in 1960 to promote
and coordinate the testing and evaluation of pesticides for public health. Products proposed for use are subject to a rigorous four-phase evaluation and testing program that examines the safety, efficiency and operational acceptability of public health pesticides and specifications for quality control. WHOPES reviews and recommendations are based on methodologies developed through extensive consultation with the international community and should be considered authoritative.

**Table 3 Insecticides/larvicides to be used in vector control programs.**

<table>
<thead>
<tr>
<th>Insecticide/Larvicide</th>
<th>Quantity Required (estimate/year)</th>
<th>Purpose</th>
<th>Comments on Environmental Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltamethrin (K-Othrine) 1% SC in a dose of 15 mg/m²</td>
<td>2,000 liters/year from year 2 to year 5</td>
<td>Treatment of bed nets</td>
<td>One of the products successfully passed by WHOPES</td>
</tr>
<tr>
<td>Deltamethrin (K-Othrine) specially formulated 25% water dispersible tablets providing a nominal treatment rate of 25 mg/m²</td>
<td>Quantities required will depend on actual demand created by social marketing; procurement will be undertaken by WHO</td>
<td>Treatment of hammock nets</td>
<td>Successfully passed by WHOPES</td>
</tr>
<tr>
<td>Temephos (Abate1% sand granules) applied in a dosage of 1g/10 liter</td>
<td>160 metric tons x 5</td>
<td>Larvicide of choice for <em>Aedes aegypti</em> control in portable water containers</td>
<td>Successfully passed by WHOPES</td>
</tr>
</tbody>
</table>

2.5.2 Human Health Risks

35. Chemicals currently recommended by WHOPES for use in ITN are classified as synthetic pyrethroids – considered to pose a very low risk to humans if used correctly. Potential exposure pathways to humans from ITN insecticides are through oral, dermal and inhalation routes. Exposure predominantly occurs as a result of improper handling of insecticides during regular re-impregnation of mosquito nets (e.g., splashing on the skin, into the eyes or through ingestion), accidents caused by insufficient awareness of pesticide risks and safe handling practices, and poorly or miss-labeled containers (i.e., children are particularly at risk from accidental exposure). Exposure during actual use of ITN (i.e., sleeping under the nets) can occur due to inhalation of insecticide that has volatilized from the net, dermal
contact with the net, and oral exposure from hand-to-mouth or direct contact (e.g. an infant sucking on the net) (USAID, 2002; WHO, 2001; 1999b; 1984).

36. Risks to humans from ITN insecticides will vary depending on actual exposure. Occupational risks resulting from frequent exposure to low concentrations of pyrethroids are considered to be very low if proper precautions are taken (e.g., use of protective gloves and face shields). An additional safety factor can be achieved by persons involved in re-impregnation of ITN through use of the lowest-toxicity products and avoiding exposure as much as possible using proper protective equipment (gloves, mask and goggles). Of the WHOPES recommended pyrethroids, Deltamethrin is considered one of the least toxic and highly unlikely to cause adverse effects in normal use. Results of human health risk assessments indicate that exposure to this insecticide during actual use of ITN poses little or no hazard. Worst-care risk calculations indicate a high margin of safety for adults and children at estimated exposure via inhalation, skin contact and oral exposure while sleeping under an ITN. The larvicide Temephos (commonly known by the trade name Abate® in Cambodia) to be used in dengue vector control is classed as an organophosphate. This pesticide has a very low toxicity to humans as it is used at a very low concentration (1%). Potential exposure routes are ingestion, inhalation of dust and to some extent dermal contact (i.e., skin contact is considered insignificant because absorption is inherently slow). The Temephos formulation to be used in HSSP1 and 2 (i.e., 1% sand granules) is thought to present minimal risk to humans — no adverse effects have been observed during occupational handling or in the general population using treated water over extended periods. Similarly, no poisoning in humans as a result of accidental exposure has been documented (WHO, 2001; 1999b; 1975).

37. The protection and safety requirements while handling these pesticides has been outlined in the table which is a part of the Pesticide Management and Monitoring Plan.

2.5.3 Environmental Risks

38. The toxicity of the pesticides intended for use in malaria and dengue vector control programs in Cambodia to non-target species varies widely. Laboratory and field tests indicate that Deltamethrin is only slightly toxic to birds but is moderately to very highly toxic to fish. Temephos has been shown to be highly toxic to some bird species but moderately toxic to others. It is considered highly toxic to bees and moderately to highly toxic to fish. Both Deltamethrin and Temephos have been shown to be very highly toxic to aquatic invertebrates (WHO, 1999b; 1984;1975).

39. Environmental risks to non-target species, particularly aquatic organisms, can result from the unintentional release of these pesticides through improper handling or disposal. Although Deltamethrin and Temephos are highly toxic to aquatic
organisms, under normal circumstances negligible quantities are likely to be released into ponds, streams and rivers. In assessing potential toxicity to nontarget organisms it is important therefore to recognize that risk is a product of toxicity and exposure (i.e., there is little or no risk even at high concentrations if no exposure actually occurs). Exposure, if any, is likely to be short-term because: (i) these pesticides break down rapidly to products that are non toxic to aquatic organisms; (ii) rapid dilution will occur in flowing waters; and (iii) products typically are rapidly adsorbed to suspended solids and bottom sediments. Malaria and dengue vector control experts from the CNM and WHO interviewed in completing this ER advised that the potential for unintentional release of pesticides to the natural environment is very limited. Of the two pesticides currently being used in vector control programs, Deltamethrin is most likely to enter the receiving environment as a result of washing of ITN in streams and ponds. Loss of pesticides from ITN during washing is estimated at 50% for the initial wash and 2-20% for subsequent washes until ITN re-impregnation is necessary – re-impregnation typically occurs annually in Cambodia although more frequently impregnation is desirable to maintain the effectiveness of the nets. At these loss rates, risk to aquatic organisms from washing of ITN is considered minimum if only a few nets are washed in a pond, stream or river at any one time. However, if a sufficiently large number of nets are washed at the same time, then there is a slightly higher potential to cause short-term acute toxicity to aquatic organisms. Similarly, improper disposal of excess net treatment solutions could cause rapid fish kills and other adverse impacts especially in small ponds and streams with limited assimilative capacity. No scenarios were identified where Temephos might be released unintentionally to the receiving environment. Appropriate management and safety needs for the use and application of the pesticides is give in the Pesticide Management and Monitoring Plan.

2.5.4 PESTICIDE MANAGEMENT AND MONITORING PLAN

40. The intent of this Pesticide Management and Monitoring Plan (PMMP) is to summarize mitigation measures and best management practices with a view to minimizing or avoiding any potential adverse human health or environmental effects that have been identified for malaria and dengue vector control programs to be funded under the HSSP2. Recognizing that all pesticides are toxic to some degree, it is paramount to ensure that proper care and handling practices form an integral part of any program involving their use. In formulating management practices, it is necessary to take into account both the nature of the pesticides being used (i.e., their formulation and the proposed methods of application) and any existing safeguards that have been incorporated into programs to address potential occupational safety and environmental concerns. Guidelines and training materials have already been developed for both malaria and dengue programs in Cambodia and few improvements are considered necessary to ensure the continued safety of these activities. Existing best management practices and recommended enhancements are detailed in the following sections by activity.
2.5.6 Malaria

41. Distribution and re-impregnation of ITN in Cambodia as part of malaria vector control programs was previously undertaken directly by the CNM and NGOs working in various parts of the country. Current practice has decentralized the responsibility for program implementation to provinces and OD with all activities now being undertaken by local health workers.

42. Existing guidelines provide that pesticides used in malaria programs be procured by CNM directly from manufacturers to ensure that they conform to WHOPES quality specifications. Guidelines do not presently cover the safe transport of pesticides to the provinces and secure storage of pesticide concentrates by PHD. Although no problems have been reported to date (e.g., loss during transport, theft, access by children to storage facilities) it is recommended that provisions be added to the guidelines to strengthen health safeguards during transportation and storage. Guidelines do cover distribution of pesticides as a precaution against misuse; specifying that all empty containers be returned to the PHD for inventory before being transported back to Phnom Penh for proper disposal.

43. Strict safeguards have been put in place by the CNM to minimize the potential for accidental exposure of both villagers and health workers to pesticides during actual field activities. Written guidelines have been distributed to all PHD and OD to raise awareness of safe handling practices and regular training is provided to health workers involved in the ITN program. An important safeguard is the provision that no pesticides can be distributed directly to villagers. Instead re-impregnation of nets is undertaken by PHD and OD workers in the presence of villagers – previously washed nets are dipped in a prepared solution and then returned in individual plastic bags with instructions to allow proper drying of the net prior to use. These precautions effectively remove the risk of pesticide exposure among villagers. Although well considered, it is recommended that the distribution safeguards be further strengthened to address remaining concerns regarding occupational exposure among health workers. Additional training would also be beneficial to ensure that health workers fully understand safety guidelines and spot checks be completed to gauge compliance. Guidelines should be revised to specify that needed safety supplies (e.g., rubber gloves to be worn while handling pesticides to avoid dermal contact) be issued to health workers and a provision made for procurement and distribution of safety supplies along with pesticides.

44. Environmental risks associated with ITN programs are addressed in part by existing CNM guidelines that provide for education of villagers in the proper use and handling of ITN. This training focuses primarily on storage procedures and washing frequency for nets to extend their effectiveness although some mention is made regarding environmental safeguards (e.g., ITN should not washed in streams
and ponds). It is recommended that education materials be revised to deal more explicitly with potential environmental concerns – they might provide additional explanation of environmental risks posed by ITN pesticides and safeguards to be taken by villagers to minimize or avoid environmental harm.

### 2.5.7 Dengue

45. Larviciding programs inherently pose fewer occupational health and environmental risks due to the pesticide formulations used, their controlled application, and the lower potential for exposure of health care workers involved in program implementation. Notwithstanding these factors, extensive safeguards have been developed by the CNM and WHO to minimize or avoid potential human health and environmental problems.

46. Dengue programs undertaken in Cambodia are scheduled to coincide with the peak transmission period occurring during the rainy season. Two applications of Temephos are made each year in targeted provinces; in May-June and repeated in July-August. In preparation for field distribution, approximately 160 metric tons of Temephos is procured annually by the MOH for use in dengue programs. Purchased Temephos is securely stored in a government warehouse until immediately prior to program implementation at which time casual workers are employed to pre-package the granular product into 20g satchels. Pre-packaging is intended to facilitate field activities (i.e., addition of a 20g satchel of Temephos to a standard 200 liter water jar or two satchels to the alternative 400 liter container size provides the required dosage) and increase the efficacy of the chemical when placed in water containers. Although some safety precautions (e.g. children are not allowed to be involved or present) are taken in the packaging of Temephos, it is recommended that these safeguards be strengthened to address potential occupational health concerns. Specifically, strict precautions should be taken in handling the chemical such as: ensuring adequate building ventilation; wearing protective gloves to avoid dermal contact; wearing protective masks to avoid inhalation of chemical dust; and washing of hands after handling.

47. Comprehensive guidelines have been developed by the CNM for Temephos larviciding programs to address potential human health and environmental concerns during field operations. Safeguards include:

- Tiered supervision by CNM, provincial and district health departments to closely track all aspects of inventory and distribution of stocks.
- Daily supervision of all field activities to ensure proper handling and household coverage.
- Water containers that are used frequently and those holding fish and other aquatic life are not treated.

20
Households are educated on proper procedures for care and handling of water containers to which Temephos has been added (e.g., remove Temephos before washing containers).

First aid procedures are explained for use if Temephos is accidentally ingested.

48. Safeguards developed by the CNM for dengue programs in Cambodia are considered to represent best available practices. With the exception of the need to strengthen occupational health practices during pre-packaging of Temephos into satchels, available guidelines are comprehensive and inclusive. Provision should be made for: (i) regular delivery of training to PHD and OD staff involved in program implementation to ensure that each person knows precisely what their responsibilities are; and (ii) ongoing monitoring and evaluation to ensure compliance with safeguards.

49. One of the objectives of the PMP is identify the pesticide use, storage, waste management, leftover stocks and empty containers. It would be useful to include those in this PMP document. The section below outlines the management and safety needs while handling these pesticides.
Management of Pesticides used for the Vector Control Programme

<table>
<thead>
<tr>
<th>Pesticide Name</th>
<th>Use</th>
<th>Protective measures</th>
<th>Management needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltamethrin</td>
<td>Treatment of bed nets and hammock nets</td>
<td>• Can cause skin rashes, irritation, headache, dizziness, nausea, diarrhea etc.</td>
<td>Transportation: In rigid and leak proof containers and kept away from food and drinks. All containers should be well labeled. Other than tin and aluminum no other metal should be brought in contact with the pesticide. Usage: Appropriate washing and cleaning facilities should be available for those handling the chemicals. The facilities should be away from eateries etc. Appropriate protective gear must be worn during usage. Storage: This should be according to the instructions on the pesticide containers and should be away from food and water. Hygiene: Proper washing facilities should be available and they should be used. After using the chemicals the workers must clean themselves properly. Specific gear must be earmarked to wear while handling the chemicals. In case disposal gear is used it should be disposed with the toxic waste of the hospital. Other gear must be disinfected after use. Worker Protection: The management must ensure that appropriate gear is available for the workers; they know how to use it and are using it. Instructions on the use of all gear, the storage and management of the chemicals must be clearly posted on the store wall or notice board so that the workers can remember what requires to be done. Container disposal: Ideally the containers should be returned to the pesticide manufacturers. In the absence of such a mechanism the containers should be decontaminated and destroyed along with the HCF's hazardous waste. While disposing the containers and other paraphernalia used for the pesticide care should be taken to ensure that surface and ground water systems are not polluted. Spillage: In case there is pesticide spillage decontamination and clean up should be done immediately and according to the instructions for the chemical.</td>
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<tr>
<td></td>
<td></td>
<td>• Protective gear must be worn while applying the pesticide</td>
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<tr>
<td></td>
<td></td>
<td>• In case of any or the symptoms during and after using the pesticide the victim must be report to the doctor and appropriate medication and antidotes should be administered</td>
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<tr>
<td></td>
<td></td>
<td>• All workers handling the chemicals must undergo periodic health checks</td>
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<td></td>
<td></td>
<td>• Those suffering from allergies, cardiovascular and respiratory diseases should not handle the chemicals</td>
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<tr>
<td></td>
<td></td>
<td>• The pesticide can be absorbed through inhalation though it is primarily absorbed through the gastrointestinal tract. Therefore appropriate protective gear must be worn when handling the chemical. This should include a face mask and eye protection, gloves and long sleeves garments and full length trousers and shoes to reduce chance of absorption</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• All workers must also be trained in handling, the appropriate quantities and dilutions to be used and use of the pesticide</td>
<td></td>
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<tr>
<td>Temephos</td>
<td>Larvicide to be used in water to control mosquitoes</td>
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<td>----------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low toxicity and no clinical symptoms of poisoning for humans observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low toxicity observed in some non-mammalian species like birds and fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• All workers using the chemicals or handling them must undergo a periodic health check</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Workers suffering from hepatic or renal diseases should not handle the chemicals</td>
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</tr>
<tr>
<td></td>
<td>• All workers must be trained on the use, the appropriate quantities and dilutions to be used and management of the chemicals</td>
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</tr>
<tr>
<td></td>
<td>• Although low toxicity and slow absorption it can be absorbed through inhalation and the mouth. To some extent may also be absorbed through intact skin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Protective gear must include a face mask and eyes protection, gloves and long sleeves garments and full length trousers and shoes to reduce chance of absorption</td>
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<tr>
<td></td>
<td>• Public awareness programmes may also be undertaken in areas where the chemical is used and posters on the use, management and risks of the pesticide should be put up at the HCF.</td>
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</tr>
</tbody>
</table>

Transportation: Chemicals should be transported in leak proof containers and kept away from food and drinks. Containers should be well labeled.

Usage: Appropriate washing facility should be provided for those handling the chemicals. When the chemical is being sprayed no food or drinks should be around the chemicals or area where the pesticide is applied.

Storage: This should be according to the instructions on the chemical container. It should be kept away from food and water.

Hygiene: After handling or use of chemicals the staff must wash properly. It may also be advisable to have specific gear worn (including protective masks and gloves which are discarded) during the spraying activity. This gear may be cleared or disposed as is considered most appropriate.

Worker Protection: Protective gear must be provided and the management must ensure that it is being used properly and is also in good shape.

Instructions on the use of all gear, the storage and management of the chemicals must be clearly pasted on the store wall or notice board so that the workers can remember what requires to be done.

Container disposal: Ideally all containers should be returned to the manufacturers. However if not possible then they should be decontaminated and disposed with the hazardous waste of the HCF.

Emptying of containers, decontamination or burying containers should be away from waterbodies and not in areas of high aquifers or prone to flooding.

Spillage: In case of spillage the area should be decontaminated according to instructions on the container.

Reference:
http://www.inchem.org/documents/pds/
http://www.pesticideinfo.org/
3.0 ENVIRONMENTAL MITIGATION MEASURES

3.1 ENVIRONMENTAL MANAGEMENT PLAN

50. The intent of an EMP is to recommend feasible and cost-effective measures to prevent or reduce significant adverse impacts to acceptable levels. For purposes of the HSSP2 for which environmental impacts are expected to be limited gauging from the HSSP experience, particular attention is given to outlining best management practices and design measures which should be put in place to ensure that environmental impacts are minimized during civil works activity and that human health and environmental concerns are fully addressed on an ongoing basis during project implementation. Best management practices and mitigation measures are detailed by activity in the following sections.

3.1.1 Health Care Facility Construction and Rehabilitation

51. Although HCF construction and rehabilitation to be undertaken as part of the HSSP2 does not require environmental assessment, best practices will still be followed to avoid potential adverse environmental impacts. Environmental checklists developed by the SFKC and the Ministry of Environment provide a comprehensive basis for identifying any environmental impacts of civil works projects. The SFKC’s Checklist of Likely Environmental Impacts Arising From School and Health Care Projects be used/adopted during the design stage for each referral hospital and health center planned under the HSSP2. The checklist covers:

- Environmental effects related to project location and design including natural habitat and wildlife, land use and settlement, drainage, water quality, traffic congestion, noise, and health and safety.

- Environmental effects related to project construction/operation including natural vegetation, land use and settlement, health and safety, drainage pattern, water quality, noise and dust, and traffic congestion.

52. Available preventive and mitigation measures for potential negligible and moderate impacts include:

- Design consideration in health centers and hospitals to ensure that adequate water system, incineration and wastewater treatment system are included in the design and construction package. This approach has been found and proven to be effective under the first phase and therefore should be continued in the second phase.

- Consultation with the local community regarding site selection

- Design specifications that provide for minimization of
disruption of natural vegetation and terrestrial and aquatic habitats

- Design modifications for flood prone areas
- Supervision and monitoring of construction (e.g., restricting work to daylight hours, limiting noise and dust emissions, safe traffic control, occupational health and safety).
- In areas where old and derelict buildings or existing HCF are being removed for the new construction or refurbished the site should be cleaned and decontaminate before any construction starts.
- Appropriate waste disposal plan should be identified and implemented where hospital or hazardous waste exists.
- In case required appropriate protective gear should be provided for the construction workers to ensure their health and safety while working at the HCF construction. This may specially be an issue of relevance for areas where the new construction or refurbishing is to take place in old and derelict HCF sites or within the compound of an exist HCF.
- In areas where construction is to take place within an existing health centre or hospital compound appropriate measures must take place to ensure minimum disturbance and impact to the hospital. This could be in the form of enclosures for the construction site, low noise, vibration and smoke producing machines. The construction plan should also be discussed with the HCF management to ensure minimum disturbance.

3.1.2 Asbestos

53. Potential risks associated with fibre-concrete building materials containing asbestos must be considered in planning HCF rehabilitation. Recommended mitigation measures to avoid or minimize occupational health risks associated with asbestos exposure are:

- Survey of all building structures (i.e., both existing HCF and buildings to be demolished before construction of the new NLDQC) by qualified and experienced building inspectors to determine whether asbestos is present in structures.
- Adherence to best practices to ensure construction worker protection during renovation and demolition activities. Occupational exposure can be avoided by controlling dust emissions and through use of effective respiratory protective equipment.
- Workers involved in asbestos removal should be properly trained.
- Ensuring that demolition waste is disposed of at secure landfills or handled by a reputable hazardous waste management facility.
- Prohibit procurement of asbestos-containing building materials.
- Close supervision and monitoring of all demolition and construction activities.
3.1.3 Drinking Water Quality

54. Ensuring the safe supply of water to HCF as part of the HSSP2 is of paramount concern. Microbial water quality represents the most serious human health threat in Cambodia with infectious diseases caused by pathogenic bacteria, viruses and protozoa or by parasites representing a common and widespread health risk associated with drinking water. Microbial water quality is of most concern for untreated surface waters and shallow groundwater obtained from open wells – handpump wells commonly used to tap aquifers at depths of greater than 15 m are generally considered to provide water that is safe from a biological perspective if the wells are properly drilled and maintained.

55. Available water quality data indicates that chemical water quality, particularly for surface waters, is generally very good in Cambodia but that groundwater in certain areas of the country contains levels of chemicals that could pose problems for human health. The most important of these chemicals is arsenic which has been found to exceed the WHO’s recommended limit of 10 µg/l in some HSSP2 provinces – most notably Kampong Thum and Kracheh. Although water chemistry sampling has yet to be undertaken in all HSSP2 provinces, elevated arsenic levels are predicted for Krong Pailin and Preah Vihear based on geological evidence.

56. Based on available information on groundwater arsenic levels in HSSP2 provinces, it is recommended that a water quality monitoring program be included as part of project implementation to confirm that water supply to HCF will meet WHO guideline values – particularly for microbial quality and arsenic content. Although data exist for some of the rural communities to be served by the HCF, the high spatial variability of groundwater arsenic necessitates that drinking water supply be tested at all existing and planned HCF as the only certain way of determining its potability. Routine follow up monitoring of water supply should also be undertaken to ensure that water continues to meet drinking water guidelines. Provision of simple testing kits and delivery of basic training to MOH and PHD staff would enable their involvement in monitoring of water quality on an ongoing basis.

57. Available mitigation and remedial measures to ensure microbial quality of surface waters include (WHO, 1993):

- Pre-treatment of surface waters through impoundment in reservoirs. Microbial quality can be improved considerably as a result of sedimentation and the effect of ultraviolet content of sunlight.

- Use of slow sand filtration or an activated carbon system are simple and effective methods for removing pathogenic bacteria, viruses, and parasites.

- Disinfection, typically through chlorination, provides an effective barrier to transmission of waterborne bacterial and viral diseases.

58. Available mitigation and remedial measures when high arsenic levels are
found in drinking water sources include:

- Investigate possibility of digging deeper wells to access groundwater from below alluvial areas. Handpump wells are typically 30m deep compared to deep aquifers at 70-120 m depths.
- Extending water supply to HCF from proven water sources such as municipal water systems or pumping from other safe wells.
- Substitution of alternative low-arsenic sources of drinking water such as rainwater or potable surface water where available and appropriate. Alternative water supplies such as surface water should be tested to ensure compliance with drinking water guidelines (e.g., microbial water quality).
- Segregation of water use within HCF. Water containing elevated arsenic is reserved for non-drinking purposes such as laundry and sanitary uses. Water from safe wells, surface water sources or bottled water purchased from commercial suppliers is used exclusively for consumption by patients and HCF staff.
- Treatment of water supply to remove arsenic. Considered the least preferable option due to installation costs and high maintenance requirements.

3.1.5 Health Care Waste Management

59. Guidelines have been developed by the MOH for use by HCF in handling and disposal of HCW. These guidelines are intended to supplement WHO’s comprehensive HCWM guidelines (WHO, 2000; 1999a) and focus on practical aspects of safe hospital waste management, including waste minimization, collection, segregation, storage, transportation, and disposal. Additional guidelines on injection safety have also been developed by the MOH to provide specific guidance to HCF on the distribution, use, collection and safe destruction of disposable syringes and safety boxes. Feedback from WHO and UNICEF safe injection experts obtained in completing the ER indicated that the guidelines reflect best practices but that attention should be given to ensuring their proper application by HCF. Recommended follow up activities in support of HSSP2 implementation by the MOH include detailed review of both sets of guidelines to ensure that they are consistent with WHO guidelines and that additional technical content be added as required. Capacity building should also be provided to HCF staff under the HSSP2 to build awareness of occupational health and environmental risks posed by HCW and increase knowledge of best management practices.

60. Notwithstanding the availability of HCWM guidelines, it is apparent that there is considerable scope for adopting more rigorous HCWM practices in health centers and referral hospitals. Of particular concern is uneven application of guidelines regarding proper waste handling and disposal. To address this weakness it is recommended that capacity building be provided to improve site-specific waste management practices at HCF. Capacity building should comprise both training and technical support. Training in best health care handling and
disposal practices is expected to create more awareness of HCWM issues and foster responsibility among HCF staff in an effort to prevent occupational exposure to hazardous HCW. Training materials could be readily drawn from WHO's (Pruss and Townsend, 1998) Teacher's Guide on Management of Wastes from Health Care Activities and MOH's own HCWM and injection safety guidelines. Training should be provided to all HCF staff – both health care personnel and auxiliary and support staff. Recognizing that sustaining adequate waste management practices at HCF ultimately depends on auxiliary staff, it is highly recommended that waste management responsibilities be clearly defined and linked with performance based monitoring and evaluation.

61. Adequate waste handling and disposal infrastructure and management systems should be put in place at HCF. A standard HCWM package intended to improve HCW handling at HCF would encompass: (i) color-coded waste plastic bags and containers; and (ii) safety boxes for disposal of syringes. Additional assessment of available HCW disposal options is required before finalizing recommended disposal practices. Preliminary findings of the ER suggested that incineration and disposal to landfills are preferred disposal options. However, it is necessary to fully evaluate the appropriateness of all disposal strategies within the context of overall HCWM in finalizing guidance to HCF concerning best practices. The segregation of waste at source to minimize mixed waste must be practiced as it would improve the waste disposal system. Therefore an appropriate system and management should be put in place to ensure waste segregation at the point of generation itself.

62. Safe disposal practices for wastewater as specified in the MOH's Waste Management Guidelines should be followed in handling of sanitary wastes from HCF. Specific mitigation measures to ensure environmentally-safe disposal of wastewater from HCF are also described in WHO (1999a). Recommended practices include:

- Where possible, hospitals should be connected to municipal WWTP.
- Hospitals that are not connected to municipal WWTP should install compact on-site sewage treatment (i.e., primary and secondary treatment, disinfection) to ensure that wastewater discharges meet applicable permit requirements.
- HCF in remote locations should provide for minimal treatment of wastewater through affordable means such as lagooning; the system should comprise two successive lagoons to achieve an acceptable level of purification, followed by infiltration of the effluent to the land.
- Sewage from HCF should never be used for agricultural or aquacultural purposes.
- Sewage should not be discharged into or near water bodies that are used for drinking water supply or for irrigation purposes (i.e., infiltration to soil must take place outside of the catchment area of aquifers).
• Convenient washing and sanitation facilities should be available for patients and their families, and HCF staff to minimize the potential for unregulated wastewater discharge.

• Where septic tanks are used for the treatment and disposal of toilet waste it should be ensured that the septic tanks do not leak and appropriate management systems are identified for them. The septic tanks should also be of appropriate size to handle all the waste they are supposed to receive.

3.2 PESTICIDE MANAGEMENT AND MONITORING PLAN

63. The intent of this Pesticide Management and Monitoring Plan (PMMP) is to summarize mitigation measures and best management practices with a view to minimizing or avoiding any potential adverse human health or environmental effects that have been identified for malaria and dengue vector control programs to be funded under the HSSP2.

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3.2.2 Dengue

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Purchased Temperos is securely stored in a government warehouse until immediately prior to program implementation at which time casual workers are employed to pre-package the granular product into 20g satchels. Pre-packaging is intended to facilitate field activities (i.e., addition of a 20g satchel of Temperos to a standard 200 liter water jar or two satchels to the alternative 400 liter container size provides the required dosage) and increase the efficacy of the chemical when placed in water containers. Although some safety precautions (e.g. children are not allowed to be involved or present) are taken in the packaging of Temperos, it is recommended that these safeguards be strengthened to address potential occupational health concerns. Specifically, strict precautions should be taken in handling the chemical such as: ensuring adequate building ventilation; wearing protective gloves to avoid dermal contact; wearing protective masks to avoid inhalation of chemical dust; and washing of hands after handling.

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- Tiered supervision by CNM, provincial and district health departments to closely track all aspects of inventory and distribution of stocks.
- Daily supervision of all field activities to ensure proper handling and household coverage.
- Water containers that are used frequently and those holding fish and other aquatic life are not treated.
- Households are educated on proper procedures for care and handling of water containers to which Temperos has been added (e.g., remove Temperos before washing containers).
- First aid procedures are explained for use if Temperos is accidentally ingested.

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64. Information on the proper management, storage and usage of pesticides must be given to the health workers involved in the program to ensure that minimum contamination and toxicity of the environment and in the HCF. An appropriate waste disposal system should also be identified for the waste generated from the pesticide programme. This waste would largely consist of the pesticide containers and pesticide dispensers.