SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT
FOR NATIONWIDE IRS IN ZIMBABWE,
USING PYRETHROIDIS, CARBAMATES, ORGANOPHOSPHATES,
DDT, AND CHLORFENAPYR AND CLOTHIANIDIN (WHEN
RECOMMENDED BY WHOPES/PQ)
CALENDAR YEARS 2017-2021

APPROVED: OCTOBER 2017
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<tr>
<td>AI</td>
<td>Active ingredient</td>
</tr>
<tr>
<td>AIRS</td>
<td>Africa Indoor Residual Spraying Project</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>COR</td>
<td>Contracting Officer’s Representative</td>
</tr>
<tr>
<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
</tr>
<tr>
<td>EC</td>
<td>Environmental Compliance</td>
</tr>
<tr>
<td>ECO</td>
<td>Environmental Compliance Officer</td>
</tr>
<tr>
<td>EMA</td>
<td>Environmental Management Agency</td>
</tr>
<tr>
<td>EMMP</td>
<td>Environmental Mitigation &amp; Monitoring Plan</td>
</tr>
<tr>
<td>EMMR</td>
<td>Environmental Mitigation &amp; Monitoring Report</td>
</tr>
<tr>
<td>IP</td>
<td>Implementing Partner</td>
</tr>
<tr>
<td>IRS</td>
<td>Indoor Residual Spraying</td>
</tr>
<tr>
<td>LLIN</td>
<td>Long-lasting insecticide-treated nets</td>
</tr>
<tr>
<td>MEWC</td>
<td>Ministry of Environment, Water and Climate</td>
</tr>
<tr>
<td>MoHCC</td>
<td>Ministry of Health and Child Care</td>
</tr>
<tr>
<td>NMCP</td>
<td>National Malaria Control Program</td>
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<tr>
<td>PMI</td>
<td>President’s Malaria Initiative</td>
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<tr>
<td>PPE</td>
<td>Personal protective equipment</td>
</tr>
<tr>
<td>PQ</td>
<td>World Health Organization Prequalification Team</td>
</tr>
<tr>
<td>SEA</td>
<td>Supplemental Environmental Assessment</td>
</tr>
<tr>
<td>SOP</td>
<td>Spray Operator</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>WHOPES</td>
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EXECUTIVE SUMMARY

This document has been prepared to serve as the Supplemental Environmental Assessment (SEA) for Indoor Residual Spraying (IRS) in Zimbabwe for the calendar years 2017-2022. Previous environmental documentation for PMI-supported IRS in Zimbabwe authorized the use of the pyrethroid, carbamates and organophosphates classes of the WHOPES-recommended pesticides nationwide from 2012 to 2016, and was prepared in accordance with the provisions of USAID 22 CFR (216) regarding the use and application of pesticides. This SEA proposes to reauthorize the use of the same three classes of insecticides, and to expand the authorization to include the use of DDT, and chlorfenapyr and clothianidin (when recommended by WHOPES or listed by the WHO Prequalification Team (PQ)). This SEA also seeks to reauthorize nationwide geographical coverage of PMI-supported IRS and also requests authorization for small-scale, closely-supervised hut trials using new IRS insecticides, such as chlorfenapyr and clothianidin, once the insecticide has been submitted for Phase III WHO Prequalification review and country-level required documentation has been submitted.

PMI has supported indoor residual spraying (IRS) in Zimbabwe since August 2011. Malaria is a major public health concern in Zimbabwe with significant socio-economic impacts. In 2014, it was recorded to be the fifth highest cause of outpatient morbidity and the tenth highest cause of mortality in the country (National Health Strategy for Zimbabwe: 2016 – 2020). IRS, in combination with other malaria control strategies, has been conducted in Zimbabwe since the 1940s. Currently, IRS is conducted in all provinces in Zimbabwe, except for Bulawayo and Harare.

Changing or rotating insecticides of different classes over time is a leading way to manage insecticide resistance. In Zimbabwe, entomological monitoring has demonstrated that local mosquitoes have developed some level of resistance to various types of insecticides: including pyrethroids and (DDT in some districts). A switch of IRS insecticides to the organophosphate, pirimiphos-methyl, began in Zimbabwe starting in 2014, but DDT and pyrethroids are still used in some areas.

The proposal to include chlorfenapyr and clothianidin is prompted by the need to increase the options for recommended insecticides available for spray activities. Chlorfenapyr, an active ingredient (AI) in the pyrrole chemical class, and clothianidin of the neonicotinoid chemical class are under WHOPES/Prequalification review, and if recommended for use will offer additional options for insecticide rotation during the approved period of this SEA. USAID could not provide technical support to Zimbabwe in areas that used DDT for IRS under the previously approved SEA, as the SEA did not cover DDT. In order for USAID to provide the needed technical support to Zimbabwe, where DDT is in use for IRS, this SEA proposes to include DDT as an additional option for insecticide rotation during the approved period.

DDT is unique among other IRS insecticides, in that it is a persistent organic pollutant (POP). As stated by the Stockholm Convention, POPs such as DDT “possess toxic properties, resist degradation, bioaccumulate and are transported, through air, water, and migratory species, across international boundaries and deposited far from their place of release, where they accumulate in terrestrial and aquatic ecosystems.” Because of these characteristics, prior to the use of DDT in PMI IRS operations, a baseline environmental assessment will be conducted in all the districts considered for DDT use, to analyze the quality of both soil and vegetative matter. This baseline assessment will allow for measuring any subsequent changes in ambient DDT concentrations that may be attributable to IRS, in order to make informed decisions about its continued use.
IRS and environmental mitigation and monitoring are activities that occur simultaneously. This SEA for IRS in Zimbabwe outlines the monitoring and mitigation measures that must be employed by the PMI Implementing Partner (IP) to minimize or reduce the unintended adverse impacts of pesticide application. Those measures are found in the Safer Use Action Plan (Section 6), and summarized in the Environmental Mitigation and Monitoring Plan (EMMP) found in Annex A. All PMI IRS operations in Zimbabwe will be performed according to the protocols and procedures found therein. These procedures do not change with the use of different classes of authorized pesticides, with the following exceptions:

1. The potential cumulative effects of organophosphate exposure (e.g., cholinesterase depression) require increased emphasis and training on the ability and responsibility of team leaders and senior personnel to daily monitor the appearance and behavior of their team members, and to recognize the symptoms of organophosphate exposure, in order to implement the appropriate response protocols. Biomonitoring is not required for the use of pirimiphos-methyl formulations for IRS at the present time, but increased vigilance is essential.

2. Pirimiphos methyl formulations are supplied in plastic bottles, which if not controlled carefully may be used inappropriately once emptied of the insecticide formulation. In addition, incineration of the bottles may cause harmful emissions. Because of these potential problems, the following procedures and protocols have been established:
   a. A triple rinse for the plastic bottles has been incorporated during the insecticide make-up procedure, whereby the insecticide container is emptied into the spray tank and then three times it is partially filled with clean make-up water, capped, shaken, and emptied into the spray tank. This ensures that the insecticide is used more efficiently, the container is thoroughly rinsed of pesticide, and it is safe for handling and subsequent processing. The risk of exposure due to insecticide residue in the container is essentially eliminated; however, the following procedure is also followed.
      i. Recycling programs have been established to turn the plastic from bottles into usable products. As long as a suitable recycling program is available, through close supervision and chain of custody, and in partnership with the Zimbabwe National Malaria Control Program (NMCP), the IP will ensure that the plastic remains segregated from other materials, and is recycled appropriately.

The PMI IP will implement the EMMP in Annex A, with guidance from PMI and NMCP, and with the assistance and involvement of the local communities. All senior staff in charge of implementation of IRS will be trained to monitor operations when in the field, in order to maximize supervisory oversight and ensure effectiveness of the mitigation measures during spraying operation. District coordinators will monitor environmental compliance during the IRS campaign. The IP completes the annual EMMR Form in Annex B, and submits it to USAID along with the annual end of spray report.

On an annual basis, a letter report will be submitted to the Bureau Environmental Officer (BEO) (regional and pillar). It must contain information regarding program changes, entomological/resistance monitoring results and data, and program response to those results. It should also contain the results of environmental monitoring and a description of how the program will improve any areas of deficiency. In the year that a new SEA is prepared and approved, the Letter Report is unnecessary.

The following assessment draws heavily on the Programmatic Environmental Assessment (PEA) for Integrated Vector Management (IVM), updated in September 2012 and January 2017, and many other references, as indicated in this document.
1. The Zimbabwe Supplemental Environmental Assessment (2012), was valid for implementing PMI-supported IRS nationwide in Zimbabwe, using all WHO-recommended pesticides in the pyrethroid, carbamate and organophosphate classes for the period 2009-2016.

2. In order to continue with PMI IRS, PMI is seeking approval for a new SEA for a further five years (calendar years 2017-2022), and for the SEA scope to be maintained at nationwide.

3. It is proposed in this SEA to expand the permissible insecticide options to include DDT, and chlorfenapyr and clothianidin, the latter two when recommended by WHOPES/WHO Prequalification Team (PQ), in addition to carbamates, pyrethroids, and organophosphates.

4. It is further proposed in this SEA to conduct soil, vegetative, sediment, and other media baseline chemical sampling and analysis prior to the use of DDT in the PMI IRS program, and to perform subsequent environmental monitoring as recommended by the PMI IRS Best Management Practices (BMPs).

5. It is further proposed to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr and clothianidin, once the insecticides have been submitted for Phase III WHOPES (or PQ equivalent) evaluation, and country-level required documentation has been submitted.

6. This SEA contains the condition that spraying will not be performed by PMI IPs within 30 meters of natural water bodies, wetlands or marshes, organic farming areas, beekeeping areas or core areas within protected forests, parks or habitats.

7. The Safer Use Action Plan in Chapter 6 provides detailed guidance on the performance of all activities associated with IRS. The attached Environmental Mitigation and Monitoring Plan (EMMP) (Annex A) summarizes the key required mitigation measures, as well as the monitoring and reporting requirements and schedule.

8. The preparation of this SEA renders a Letter Report unnecessary for 2017. In subsequent years, provided there are no changes to the program outside the scope of this SEA, a Letter Report will be submitted to PMI annually that will discuss significant changes in the IRS program for that particular year’s spray campaign.

9. This SEA contains a Pesticides Procedures section, which, together with the Safer Use Action Plan, constitutes the elements of a Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP).
APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED

2017-2022 SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR PRESIDENT'S MALARIA INITIATIVE- INDOOR RESIDUAL SPRAYING (IRS) FOR MALARIA CONTROL IN ZIMBABWE

The United States Agency for International Development, Global Health Bureau has determined that the proposed IRS effort, as described in the 2017-2022 Supplemental Environmental Assessment: Indoor Residual Spraying for malaria control in Zimbabwe responds to the needs of the community and country as it relates to managing malaria in Zimbabwe, and also conforms to the requirements established in 22 CFR 216.

This document does not mandate the execution of the proposed IRS, rather, it documents the environmental planning and impact analysis executed by the IRS team in preparation for the proposed action. The design and standards of operation of the IRS program are established to avoid and reduce any potential impact. USAID has concluded that the proposed action, when executed as described in the Supplemental Environmental Assessment and the PMI Programmatic Environmental Assessment for IVM (2012 and 2017), is consistent with the Government of Zimbabwe's and PMI's goal of reducing malaria incidence in Zimbabwe while minimizing negative impact to the environment and to human health.

The proposed actions recommended for approval in this 2017 SEA are:

1. The continuation of IRS implementation using pyrethroids, carbamates, organophosphates, DDT, chlorfenapyr and/or clothianidin (the latter two when recommended by WHOPES/PQ), where appropriate, based on the evaluation of criteria such as transmission rate, vector susceptibility, residual effect, appropriate home and wall structure, economic factors, and ecological/human health impacts.

2. This SEA will have nationwide coverage where IRS may be implemented as decided by the National Malaria Control Program and PMI for the 5-year period from 2017 to 2022.

3. This SEA authorizes small, closely supervised studies or hut trials to study new IRS insecticides, such as chlorfenapyr and clothianidin, once the insecticide has been submitted for Phase III WHOPES (or PQ equivalent) evaluation and country-level required documentation has been submitted.

4. Due to the need to protect the population in buffer zones of protected areas from malaria, and given the successful record of PMI in implementing IRS in Africa without significant environmental consequences, it is proposed to allow IRS in these buffer zones, but not in any core protected areas, of protected forests, parks or habitats using the strict protocols and procedures contained in the PMI Best Management Practices (BMP) manual, and observing all precautions and prescriptions in this SEA. Core protected areas in Zimbabwe extend to 30 meters away from a protected area and IRS will not be conducted within these areas.

The Safer Use Action Plan (Section 6) and the updated Environmental Mitigation and Monitoring Plan (EMMP) for Zimbabwe (Annex A) provide detailed guidance on the performance of all activities associated with IRS. Through the use of this and other guidance, PMI has maintained an excellent record of success in executing IRS without substantial environmental or human health impact.
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USAID/Zimbabwe

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PMI Resident Advisor:
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Jeanette Normand
1. BACKGROUND & PURPOSE

1.1 PRESIDENT’S MALARIA INITIATIVE

When it was launched in 2005, the goal of the President’s Malaria Initiative (PMI) was to reduce malaria-related mortality by 50 percent across 15 high-burden countries in sub-Saharan Africa through a rapid scale-up of four proven and highly effective malaria prevention and treatment measures: insecticide-treated mosquito nets (ITNs); indoor residual spraying (IRS); accurate diagnosis and prompt treatment with artemisinin-based combination therapies; and intermittent preventive treatment of pregnant women.

With the passage of the Tom Lantos and Henry J. Hyde Global Leadership against HIV/AIDS, Tuberculosis, and Malaria Act in 2008, PMI developed a U.S. Government Malaria Strategy for 2009–2014. PMI’s Strategy for 2015-2020 takes into account the progress over the past decade and the new challenges that have arisen. Malaria prevention and control remains a major U.S. foreign assistance objective and PMI’s Strategy fully aligns with the U.S. Government’s vision of ending preventable child and maternal deaths and ending extreme poverty. It is also in line with the goals articulated in the Roll Back Malaria Partnership’s Action and Investment to Defeat Malaria 2016-2030 and World Health Organization’s Global Technical Strategy for Malaria 2016-2030. Under the PMI Strategy for 2015-2020, the U.S. Government’s goal is to work with PMI-supported countries and partners to further reduce malaria deaths and substantially decrease malaria morbidity, towards the long-term goal of elimination.

PMI will assist Zimbabwe to achieve the following targets in populations at risk for malaria by the end of 2020:

- Reduce malaria mortality by one-third from 2015 levels in PMI-supported districts, achieving an 80 percent reduction from PMI’s original 2000 baseline levels.
- Reduce malaria morbidity in PMI-supported districts by 40 percent from 2015 levels.

1.2 HISTORY AND SCOPE OF IRS IN ZIMBABWE

Malaria is a major public health concern in Zimbabwe with significant socio-economic impacts. In 2014, it was recorded to be the fifth highest cause of outpatient morbidity and the tenth highest cause of mortality in the country (National Health Strategy for Zimbabwe: 2016 – 2020). It limits productivity by affecting human resources through the loss of life and loss of productive time due to absenteeism. For children of school going age, the disease affects school attendance and cognitive development.

Zimbabwe’s commitment to combating malaria is evidenced in the National Health Strategy (NHS) 2016-2020. The NHS was developed to provide a framework for attaining health and development goals within the country. The NHS articulates three key result areas which are: to strengthen priority health

programs; to improve service delivery platforms; and to improve the enabling environment for service delivery. The priority health programs are grouped into four which are:

1. Communicable diseases-Malaria classified as a top priority;
2. Non-communicable diseases;
3. Reproductive, maternal, newborn, child health and adolescents;
4. Public health surveillance, disaster preparedness and response.

For malaria control, the Government of Zimbabwe has implemented IRS campaigns since the 1940s. Currently, IRS is conducted in all provinces in Zimbabwe, except for Bulawayo and Harare. Vector control is a central, critical component of malaria control strategies in Zimbabwe and IRS has increased immensely over the past decade as part of an effort towards universal coverage of all populations at risk of contracting the disease (Sande et al., 2016). IRS is widely accepted by Zimbabweans, and remains a key national strategic activity, in addition to other strategies, to reduce malaria incident rates nationally.

After assessing the malaria situation in all 8 regions with IRS activities in Zimbabwe using WHO (2007) guidelines, the Government of Zimbabwe designated specific provinces and district for implementation of pre-elimination activities. The first province in Zimbabwe to implement activities under malaria pre-elimination/elimination phase was Matabeleland South in 2013. Currently, Matabeleland North, Midlands and Mashonaland West Provinces have also been promoted to implement malaria pre-elimination/elimination activities in some districts with effect from 2015. The remaining four rural provinces (Masvingo, Mashonaland Central, Mashonaland West and Manicaland) are strongly expected to continue to implement activities in the control phase, but under tight surveillance for a possible move to pre-elimination and elimination (Sande, et al., 2016). Figure 1-1 presents the areas within these four provinces that are to implement pre-elimination activities.
Insecticides that have been used for IRS in Zimbabwe include pyrethroids, DDT, and organophosphates.

### 1.3 PMI IRS Country Coverage

The President’s Malaria Initiative (PMI) has supported indoor residual spraying (IRS) in Zimbabwe since August 2011, but USAID had previously provided limited malaria support, including funding and technical assistance to conduct emergency IRS in 2009, and an emergency procurement of artemisinin combination therapy (ACT) malaria medicines in 2011. PMI, through their Implementing Partner, provided IRS technical support to the Government of Zimbabwe for the first three years after 2011 in Zimbabwe. For the last three years, PMI has been wholly responsible for all spray activities in four districts in Manicaland province. Table 1-1 presents the details on the coverage of PMI has supported IRS since 2012.
### TABLE 1-1: PMI SPRAY ACTIVITY IN ZIMBABWE, 2012 - 2016

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Number of Districts¹ Sprayed</th>
<th>Insecticide Used</th>
<th>Number of Structures Sprayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>13 (3 provinces)</td>
<td>Pyrethroid</td>
<td>501,613</td>
</tr>
<tr>
<td>2013</td>
<td>25 (7 provinces)</td>
<td>Pyrethroid</td>
<td>622,300</td>
</tr>
<tr>
<td>2014</td>
<td>4 (1 province)</td>
<td>Organophosphate</td>
<td>147,949</td>
</tr>
<tr>
<td>2015</td>
<td>4 (1 province)</td>
<td>Organophosphate</td>
<td>162,127</td>
</tr>
<tr>
<td>2016*</td>
<td>4 (1 province)</td>
<td>Organophosphate</td>
<td>229,377</td>
</tr>
</tbody>
</table>

Notes:

¹ Or equivalent geographic divisions.

* Represents updated values from the 2016 IRS work plan.

Source: PRESIDENT’S MALARIA INITIATIVE Zimbabwe Malaria Operational Plan FY 2017

1.3.1 2017 CAMPAIGN SCOPE

In 2017, PMI will continue to implement IRS as a vector control strategy in Manicaland province. PMI AIRS Zimbabwe, the PMI implementer of IRS will spray four districts, namely: Chimanimani, Mutare, Mutasa, and Nyanga. PMI will continue working with provincial and district health officials in Manicaland to lead, implement, and manage the IRS campaign in the four districts. It also will continue entomological surveillance in 20 sites and providing entomological support to the NMCP, a unit of the department of Epidemiology, Disease Control and Prevention, and the National Institute of Health Research (NIHR), the research department of the Ministry of Health and Child Care (MoHCC). PMI will also collaborate with Africa University as they prepare a laboratory to process and analyze collected entomological specimens to the benefit of the MoHCC/NMCP. Moreover, PMI will provide assistance to various national-level IRS campaign issues when requested. This might include the following activities:

- Revising IRS training materials, job aids, IRS campaign monitoring and supervision checklists, and data collection/monitoring and evaluation (M&E) forms;
- Participating in malaria technical working groups and committees;
- Providing technical support to develop national insecticide resistance management plan; and
- Supporting the NMCP and its partners in IRS campaign and malaria control messaging.

Figure 1-2 presents the map of Manicaland province and the location of the four districts that will be sprayed in 2017. An organophosphate class insecticide will be used for the third consecutive year.
FIGURE 1-2: 2017 SCOPE OF PMI IRS IN ZIMBABWE

Source: Global Administrative Areas (http://www.gadm.org/country)
2. PROPOSED ACTION AND ALTERNATIVES FOR MALARIA VECTOR CONTROL

This section describes the alternatives for malaria control that were considered in the preparation of this report, including those that were accepted or rejected. Alternatives considered include the following:

1. **Preferred action**: Establish annual IRS campaigns that spray pesticides of the pyrethroid, carbamate, and organophosphate classes, DDT, and chlorfenapyr and clothianidin (when recommended by the World Health Organization Pesticide Evaluation Schemes (WHOPES/PQ)) in high-risk provinces and districts identified by the evaluation of criteria such as transmission rate, vector susceptibility, residual effect, appropriate home and wall structure, economic factors, and ecological/human health impacts.

2. **No action alternative**: This action would discontinue PMI support for IRS activities in Zimbabwe.

3. **Spraying in alternative geographic regions**: This alternative would use different criteria to select alternative provinces and districts to spray.

4. **Using alternative pesticides**: This alternative would consider pesticides other than those recommended by WHOPES/listed by PQ.

5. **Alternative technologies**: This alternative would consider methods other than IRS to achieve the stated goals of reduction in malaria mortality and morbidity.

### 2.1 DESCRIPTION OF PREFERRED ACTION

The preferred action is to implement an IRS program in selected communities, choosing among the pyrethroid, carbamate, and organophosphate classes; DDT; as well as chlorfenapyr and clothianidin, when recommended by WHOPES/PQ, considering current entomological, epidemiological, logistical, environmental, and economic conditions. The pesticide to be used will be determined by a process explained in Pesticide Procedures part b (Section 5.2).

### 2.2 NO PROJECT ALTERNATIVE

Indoor residual spraying is one of the critical interventions in the control of the spread of malaria. A no project alternative will result in rising rates of infections, transmissions, mortality and morbidity due to the increased prevalence of infected vectors. Therefore, the “no action alternative” does not meet the overall goals of the President’s Malaria Initiative and the Zimbabwe National Malaria Control Program.

### 2.3 ALTERNATIVE IRS GEOGRAPHICAL SITES CONSIDERED

In IRS implementation in Zimbabwe, areas considered as highly malarious and those areas that are included in the NMCP strategic plan are considered, while lower risk areas are not considered for IRS as an intervention. Using different criteria for selecting geographical sites would reduce the effectiveness
and impact of IRS, decreasing progress towards the goals of the PMI program and the Zimbabwe National Malaria Control Program.

2.4 USE OF ALTERNATIVE INSECTICIDE(S)

For IRS to be implemented, a pesticide recommended by the WHOPES or listed by the PQ must be selected for use. WHOPES and PQ are international institutions that analyze and recommend pesticides to be used in IRS based on their effectiveness, and toxicity to human health and the environment. The United States Environmental Protection Agency (USEPA) regulates and registers pesticide products and uses thereof in the United States, and provides guidance for foreign health interventions.

To date WHOPES has approved the use of pesticides within the following four classes of pesticides: pyrethroids, carbamates, organochlorines and organophosphates. Other alternative insecticides are not eligible for use under PMI guidelines. WHOPES is also currently considering approval for chemicals within the pyrrole and neonicotinoid classes of pesticides: chlorfenapyr and clothianidin.

PMI and their implementing partner/s will monitor WHOPES/PQ proceedings towards recommendation of new pesticides, but will seek to amend this SEA before there is any decision to use new WHOPES/PQ recommended insecticides.

It is proposed in this SEA to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr and clothianidin, once the insecticide has been submitted for Phase III WHOPES-approval or listed by the WHO Prequalification Team, and country-level required documentation is obtained. The guidelines for laboratory testing and small and large-scale field trials are provided in Test procedures for insecticide resistance monitoring in malaria vector mosquitoes (WHO, April 2013).

2.5 ALTERNATIVE TECHNOLOGIES

A full range of known, available technologies is continually considered for use by the stakeholders in malaria prevention and control efforts. It has been determined that IRS plays a significant part in malaria prevention in concert with other technologies. The specific focus of this PMI project is IRS, and the role that PMI plays in Zimbabwe includes IRS. If other, viable approaches were to arise that would replace or improve upon the role that IRS plays, PMI, the National Malaria Control Program, and its partners would evaluate them and proceed accordingly.

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4 PRESIDENT’S MALARIA INITIATIVE Zimbabwe Malaria Operational Plan FY 2017
3. AFFECTED ENVIRONMENT

This section describes the critical environment that may be adversely affected by the implementation of the IRS program (pesticide application) if adequate and necessary mitigation and monitoring measures are not put in place. The critical ecosystems or activities within Zimbabwe include surface water bodies (lakes, river, groundwater, marshlands and wetlands), air, soils, and economic and sustenance activities including agriculture, apiculture, fisheries and organic farming that might be adversely affected by the use of insecticides to non-target areas.

3.1 OVERVIEW OF COUNTRY

3.1.1 ADMINISTRATIVE AND POLITICAL UNITS

The country is administratively divided into 10 provinces: Mashonaland West; Mashonaland Central; Harare; Mashonaland East; Manicaland; Midlands; Masvingo; Matabeleland North; Bulawayo; and Matabeleland South (See Figure 3-1). Each province is subdivided into a number of districts (making a total of 63 districts) with each district subdivided into wards.

Each province is headed politically by Provincial Affairs Ministers and the heath sector is headed by a Provincial Medical Director (PMD), who reports to the Minister of Heath and Child Care through the Permanent Secretary for Health and Child Care. At Provincial Level the PMD reports politically to the Provincial Affairs Minister. Zimbabwe follows the “primary health care approach” with a primary health care strategy as the vehicle for delivering health to the populace; Zimbabwe runs a five tier health system: central level; provincial level; district level; health facility level; and community level. At the central level is the MoHCC. At the provincial and district levels, the health system is managed by the provincial health executive (PHE) and the district health executive (DHE) respectively.
Each PHE and DHE team consists of professional experts in key areas such as laboratory services, finance, administration, environmental health, pharmacy, nursing services, maternal and child health, nutrition, epidemiology and disease control, health promotion, and health information management. Each PHE is led by the Provincial Medical Director (PMD) while each DHE is led by the District Medical Officer (DMO).

National level staff are responsible for policy formulation, regulation and resource mobilization. Provincial level staff are responsible for providing technical and managerial support to district level staff including: coordination of planning; enforcement of national standards and guidelines; and financing of district program implementation, training, and operational research, monitoring and evaluation. District level staff are responsible for the secondary level of health care delivery as well as coordinating implementation of primary health care, while rural health facilities (primary level) are the first point of
contact between the community and the health sector and provides essential primary health care. Village health workers are extensions of the primary level.

### 3.2 GEOGRAPHY

Zimbabwe is a landlocked country in southern Africa lying above the Tropic of Capricorn. It lies between latitudes 15° and 23°S, and longitudes 25° and 34°E. It straddles an extensive high inland plateau that drops northwards to the Zambezi valley towards its border with Zambia and similarly drops southwards to the Limpopo valley and its border with South Africa. Zimbabwe shares borders with Botswana 813 km, Mozambique 1,231 km, South Africa 225 km, and Zambia 797 km and meets Namibia at its westernmost point. The geographical relief of Zimbabwe consists of a north-south central plateau covering Bulawayo and Harare provinces as well as parts of Matabeleland South, Midlands, Mashonaland East and Manicaland provinces, and lying at an altitude above 1,200 meters. From this central highland, the Zimbabwe geographical relief descends gradually (over areas 900-1,200 meters; 600-900 meters; and less than 600 meters above sea level) moving away from the central highland.

### 3.3 DEMOGRAPHICS

The population of Zimbabwe in 2016 was estimated at 16.2 million based on 2012 census with a growth rate of 2.2% consisting of 49% males and 51% females; 32% urban and 68% rural dwellers; with an adult literacy rate (2015) of 87%. In 2016, the natural increase was positive, as the number of births exceeded the number of deaths by 394,264. Due to external migration, the population of Zimbabwe declined by 46,820.

According to the Zimbabwe census report of 2012, the following was the distribution of the population for the ten provinces of Zimbabwe.

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TABLE 3-1: POPULATION DISTRIBUTION IN ZIMBABWE

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Total</td>
</tr>
<tr>
<td>Bulawayo</td>
<td>304,446</td>
<td>351,229</td>
<td>655,675</td>
</tr>
<tr>
<td>Manicaland</td>
<td>831,762</td>
<td>923,238</td>
<td>1,755,000</td>
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<tr>
<td>Mashonaland Central</td>
<td>559,702</td>
<td>580,238</td>
<td>1,139,940</td>
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<tr>
<td>Mashonaland East</td>
<td>648,207</td>
<td>688,852</td>
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<tr>
<td>Mashonaland West</td>
<td>721,218</td>
<td>728,720</td>
<td>1,449,938</td>
</tr>
<tr>
<td>Matabeleland North</td>
<td>359,173</td>
<td>384,698</td>
<td>743,871</td>
</tr>
<tr>
<td>Matabeleland South</td>
<td>328,009</td>
<td>357,037</td>
<td>685,046</td>
</tr>
<tr>
<td>Midlands</td>
<td>779,233</td>
<td>843,243</td>
<td>1,622,476</td>
</tr>
<tr>
<td>Masvingo</td>
<td>691,350</td>
<td>795,254</td>
<td>1,486,604</td>
</tr>
<tr>
<td>Harare</td>
<td>1,011,831</td>
<td>1,086,368</td>
<td>2,098,199</td>
</tr>
<tr>
<td>Total</td>
<td>6,234,931</td>
<td>6,738,877</td>
<td>12,973,808</td>
</tr>
</tbody>
</table>

3.4 PHYSICAL ENVIRONMENT

3.4.1 CLIMATE

Zimbabwe, lying north of the Tropic of Capricorn, is completely within the tropics but enjoys subtropical conditions because of its high average elevation. The climate of Zimbabwe is moderated by the high altitude, proximity to maritime influence from the Mozambique Channel, influence of the mid-continental high pressure (the Botswana upper high) and the volatile, warm, moist conditions of the intertropical convergence zone. Three distinct seasons are discernible. The hot-dry season, which begins in mid-September and lasts up to January, is followed by a warm-to-hot wet season characterized by thunderstorms from the onset of the rains until March-April. The cool-to-warm dry season, marked by warm sunny days, cool nights and high evapo-transpiration, lasts from April to September. Humidity (20% in September to an uncomfortable 80% in January) depends mainly on the season and the time of day. In most places the air temperature varies within the temperate/sub-tropical range of 10° to 28°C. The climatic comfort is generally optimum in most parts of the country, except during the month of October which is extremely hot but not so in the eastern highlands. However, people living in the lowlands of the Zambezi and Limpopo valleys endure prolonged heat stress. The eastern regions consequently receive the country’s heaviest rainfall and have a more prolonged rainy season (lasting from October into April) than the rest of Zimbabwe.

June is generally the coolest month and October the warmest; temperature variations correspond closely to altitude. Nyanga, at about 5,500 feet in the eastern highlands, varies in temperature from a mean of 52° F (11° C) in July to one of 65° F (18° C) in October. Harare, at about 4,800 feet, has seasonal temperatures varying from 57° F (14° C) to 70° F (21° C), and Bulawayo, at 4,400 feet, varies from 57° F (14° C) to 70° F (21° C). Daily variations about these means are some 13° F (7° C) warmer in the afternoon and 13° F (7° C) cooler at night. Harare and Bulawayo each average about eight hours of sunshine per day, and this average does not drop below six hours during the rainy season.
3.4.2 Rainfall Patterns

Altitude and relief greatly affect both temperature and rainfall in Zimbabwe. The higher areas in the east and the highveld receive more rainfall and are cooler than the lower areas. Temperatures on the highveld vary from 12°C to 13°C (54°F to 55°F) in the winter to 24°C (75°F) during the summer. In the Lowveld, the temperatures are usually 6°C (11°F) higher, and summer temperatures in the Zambezi and Limpopo valleys average between 32°C and 38°C (90°F to 100°F). Rainfall decreases from east to west. The eastern mountains receive more than 100 cm (40 in) annually, while Harare has 81 cm (32 in) and Bulawayo 61 cm (24 in). The south and southwest receive little rainfall. Seasonal shortages of water are common within this region.

Zimbabwe experiences winter and summer in opposite times to the European and North American regions, and they correspond to the dry and wet season. The summer rainy season lasts from November to March. It is followed by a transitional season, during which both rainfall and temperatures decrease. The cool, dry season follows, lasting from mid-May to mid-August. Finally, there is the warm, dry season, which lasts until the onset of the rains.

During the wet season, from November to March, rains usually fall in heavy afternoon showers, but they can sometimes be lighter and continuous for a couple of days. The dry season, from April to October, is pretty much rain free and colder.

**FIGURE 3.2: MEAN ANNUAL RAINFALL DISTRIBUTION**

Source: Zimbabwe Meteorological Services Department
3.4.3 Topography, Geology and Soils

Zimbabwe lies almost entirely over 1,000 feet (300 meters) above sea level. Its principal physical feature is the broad ridge running 400 miles from southwest to northeast across the entire country, from Plumtree near the Botswana frontier through Gweru and Marondera to the Nyanga Mountains – which separate Zimbabwe from Mozambique. At about 50 miles wide, this ridge ranges in altitude from 4,000 to 5,000 feet, until it eventually rises to 8,504 feet (2,592 meters) at Mount Nyangani – the highest point in Zimbabwe – in the eastern highlands. This ridge is known as the Highveld and comprises about 25 percent of the country’s total area. The Middleveld, a wider plateau, lies on both sides of this central spine, sloping down northward to the Zambezi River and southward to the Limpopo River. The Middleveld is at an altitude between about 3,000 and 4,000 feet and makes up roughly 40 percent of Zimbabwe’s area. Beyond the Middleveld and mostly in the south, where the Save, Runde, and Nuanetsi rivers drain from the plateau into the Limpopo, lies the Lowveld, which constitutes approximately 23 percent of the country’s total area. The lowest point in Zimbabwe lies at an altitude of 660 feet near Dumela, where the Limpopo flows into Mozambique. There are no parts of Zimbabwe that can accurately be described as desert, although a sector northwest of Plumtree and a lengthy belt across the Lowveld in the south are severely arid.

The landscape is characterized by extensive outcroppings of Precambrian rock, which is between about 570 million and 4 billion years old. The most ancient part of this rock formation, known as the basement complex, covers the greater part of the country. About 80% of the basement complex consists of granite. Some of the hills are surmounted by formations known as balancing rocks. These formations have been eroded by wind and water along regular fault lines, leaving some blocks precariously balanced upon others. Elsewhere, innumerable small rounded granite hillocks known locally as kopjes are found. Belts of schist in the basement complex contain the veins and lodes of most of the country’s gold, silver, and other commercial minerals.

The Karoo (Karroo) System – a thick layer of sedimentary rocks consisting of shale, sandstone, and grit of Permian and Triassic age (about 200 to 300 million years old) – covers the Zambezi valley and the valleys of its tributaries from Hwange southward to Bulawayo and spreads across parts of the southern Lowveld from Tuli, near the southern border, to the Save River.

The light, sandy soils found in most parts of Zimbabwe are residual soils developed largely from the granite parent material. They are highly weathered and leached, even in the areas of lower rainfall, and do not easily retain water because of their coarse texture. Outcrops of basement schists give rise to rich red clays and loams, but their extent is limited. Since most rain occurs in heavy showers during a few months of the year, rapid runoff and high rates of erosion are common. The meagre mineral reserves in most soils imply an inherently low fertility; under cultivation, productivity drops rapidly after a few years. The difficulty of cultivating these lighter soils is greatest in the areas where population pressure no longer allows land to be temporarily abandoned to rejuvenate after cultivation.

3.4.4 Biological Environment

3.4.4.1.1. The Vegetation

Zimbabwe is predominantly savanna (tropical grassland), with a generous tree growth encouraged by the wet summers. The only true forests, however, are the evergreen forests of the eastern border and the savanna woodland, which includes teak, northwest of Bulawayo. Various species of Brachystegia (a hardwood tree up to 90 feet high with pale reddish brown wood) are dominant in the Middleveld and Highveld. Other common species include the mohobohobo (a medium-size tree with large spade-like
leaves) and the thorn tree. In the valleys of the Zambezi and Limpopo rivers, the mopane, which resembles the mohobohobo, is common, together with the stout-trunked baobab and the knobby thorn tree. Australasian eucalyptus trees have been widely introduced, predominantly on some farms, where they are used as windbreaks and for fuel. Pure grassland is uncommon but occurs particularly along the eastern border around Chimanimani.

3.4.5 National Parks and Wildlife

Cultivation of the land and the reduction of the natural vegetation have resulted in the disappearance of many forms of animal life over large areas. Hwange National Park, holding some of the densest remaining wildlife concentrations in Africa, has an area of more than 5,000 square miles and stretches from the Bulawayo to Victoria Falls railway line westward to the Botswana border. Among the flesh-eating animals found there, and occasionally elsewhere, are the lion, leopard, cheetah, serval, civet, aardvark, spotted and brown hyena, black-backed and side-striped jackal, zorille, ratel, bat-eared fox, ant bear, and scaly anteater. Elephants are found in the northern region, and giraffes in the western bushland; hippopotamuses and crocodiles live in the larger rivers. Among a great variety of hoofed and horned ruminant animals are the eland (which is immune to the deadly tsetse fly), greater kudu, blue duiker, impala, klipspringer, steenbok and grysbok, and sable and roan antelope. Snakes include mambas, boomslangs, and the black-necked cobra. Baboons, which are the bane of farmers whose crops they damage, include the Zimbabwean and yellow species, as well as the chacma, the largest known baboon species. Notable among the birdlife are the martial eagle, the bateleur eagle, and the little hammerhead, which builds enormous nests and is revered as a bird of omen.

Conservation efforts in southern Africa have been aided by the creation of trans-frontier parks and conservation areas, which link nature reserves and parks in neighboring countries to create large, international conservation areas that protect biodiversity and allow a wider range of movement for migratory animal populations. One such park is the Great Limpopo Transfrontier Park, formed in 2002, which links Zimbabwe’s Gonarezhou National Park with South Africa’s Kruger National Park and Mozambique’s Limpopo National Park.

The Wildlife Estate includes eleven national parks: the Chimanimani National Park (including the Eland Sanctuary), Chizarira National Park, Gonarezhou National Park, Hwange National Park, Kazuma Pan National Park, Mana Pools National Park, Matusadona National Park, Matobo National Park, Nyanga National Park, and Victoria Falls (Mosi-oa-Tunya) National Park and Zambezi National Parks. Some of these National Parks are presented in Figure 3-3 and these national Parks are discussed below.

Chizarira National Park

The Chizarira National Park located in northwestern Zimbabwe covers a virgin forest land of an area of 192,000 hectares (470,000 acres). It is one of the largest parks in Zimbabwe and abounds in large game fauna like elephants, lions, leopards and buffalo. Bird species to be found in the park include the African broadbill, Livingstone’s flycatcher, yellow-spotted nicator, emerald cuckoo, Angolan pitta, and Taita falcon.

Hwange National Park

The Hwange National Park (formerly Wankie) established in 1929 with an area of 14,650 km² (5,660 sq. mi) is the largest park and game reserve in Zimbabwe. It is located in the northwest corner of the country. The park lies on the main road between Bulawayo and the widely noted Victoria Falls. In the 19th century it was the hunting ground of the Ndebele warrior-king Mzilikazi and it is named after the local Nhanzwa chief. The park is close to the edge of the Kalahari Desert, a region with little water and very sparse, xerophile vegetation. While the park abounds in elephant population (one of the largest in
FIGURE 3-3: SOME MAJOR NATIONAL PARKS OF ZIMBABWE

Source: http://www.diva-gis.org/gdata

the world), it also hosts 100 mammal species, including 19 large herbivores and eight large carnivores and 400 bird species; Zimbabwe's specially protected animals are all found here. Gemsbok, brown hyena and African wild dogs occur in fairly large numbers (the population of African wild dogs is stated to be of one of the largest surviving groups in Africa now). The very large elephant population has been a matter of concern since, during drought years, they are a burden on the ecological balance of the region. Elephant culling has been done to restrict the population of elephants to 13,000 (less than 1 per km²) for the country as a whole. Conservationists covering this area have also expressed concern at the large "deforestation, poaching and unsustainable resource exploitation" that is occurring in this national park.

Kazuma Pan National Park

Kazuma Pan National Park covers an area of 31,300 hectares (77,000 acres) and is located in the northwest corner of Zimbabwe, between Kazungula and Hwange National Parks, and south-west of Victoria Falls. It was developed as a safe haven for animals during the hunting season, as it formed an extension of the Matetsi Safari Area. It has a series of depressions, which enriches the ground water which is then pumped during the dry season. It has the largest concentration of about 2,000 buffaloes
and also elephants and rhinos. Other species of wildlife seen here are lion, leopard, giraffe, zebra, gemsbok, roan antelope, sable, tsessebe, eland and reedbuck. The oribi, a small antelope, an endemic species, is rarely sighted in the depressions where a large variety of water birds such as storks, crowned cranes, stilts, cormorants, ducks and kingfishers are also seen, making it an attractive bird-watching site.

**Mana Pools National Park**

The Mana Pools National Park is a UNESCO Natural World Heritage Site that extends over an area of 2,196 km² (848 sq. mi). It is part of the 10,500 km² (4,100 sq. mi) Parks and Wildlife Estate that stretches from the Kariba Dam in the west to the Mozambique border in the east. Mana Pools National Park is in the region of the lower Zambezi River in Zimbabwe, where the flood plain turns into a broad expanse of lakes after each rainy season. As the lakes gradually dry up and recede, the region attracts many large animals in search of water, making it one of Africa’s most renowned game-viewing regions. In Shona language, ‘Mana’ means “four” referring to the four large permanent pools formed by the meandering ox-bow lakes of the middle Zambezi River. Dande Safari Area measuring 532 km² (205 sq. mi) established in 1968 and the Hurungwe Safari Area measuring 2,870 km² (1,110 sq mi) established in 1976 are contiguous to this park. The park’s habitat consists of islands, sandbanks and pools, flanked by forests of mahogany, wild figs, ebonies and baobabs. Alluvial deposits along the Zambezi have winter thorn with more diverse woodlands with species of *Kigelia africana* and *Trichelia emetica* on the top alluvial layers. The park has the country’s biggest concentration of hippopotamuses and crocodiles (Nile crocodiles in particular) and large, dry season mammal populations of elephant and buffalo. Spotted hyena, honey badger, warthog, bushpig, plains zebra and many species of antelope may also found in the park. Bird life consists of 380 species which includes Nyasa lovebird, yellow-spotted nicator, rock pratincole, banded snake-eagle and Livingstone’s flycatcher.

**Matobo National Park**

The Matobo National Park is part of the UNESCO Matobo Hills and became a national park covering an area of 44,500 hectares (110,000 acres) in 1953. It has an exclusive "Intensive Protection Zone" to protect the large population of black and white rhinoceros. The name Matobo means "bald heads" and was selected by the Matabeleland king Mzilikazi whose grave lies in the Matobo Hills close to the park.

Matobo Hills includes a range of domes, spires and balancing rock formations created by erosion and weathering within a granite plateau. It has diverse species of vegetation, including mopane, Acacia, Brachystegia, Ficus, Azanza, Ziziphus, Strychnos and Terminalia. In addition to rhinoceros, the park also supports number of other animal species, including zebra, wildebeest, giraffe, kudu, eland, sable antelope, klipspringer, leopard, hyena, cheetah, hippo, wartog, rock dassies, waterbuck, wildcat, springhare, common duiker, crocodiles, baboons and monkeys. The park is also rich in bird life, including black eagle, African fish eagle, martial eagle, secretary bird, pied crow, Egyptian goose, francolin, and weavers. Fish species in the park include bass, bottle fish, bream, and catfish and Melanochromis robustus. The park has a number of dams such as the Maleme Dam, the Mthselele Dam, the Toghwana Dam, the Mesilume Dam, which are all communal camp sites.

**Victoria Falls and Zambezi National Park**

The Victoria Falls and Zambezi National Parks, a UNESCO Natural World Heritage Site, are located on the western edge of Zimbabwe; together, the two cover an area of 56,000 hectares (140,000 acres) bounded by the Zambezi River, which borders with Zambia. The Victoria Falls and the Pa National Park are on the southern bank of the Zambezi River. The Victoria Falls, one of seven natural wonders of the world, is 1.7 kilometers (1.1 mi) wide, cascades 70–108 meters (230–354 ft) into the gorge and is formed by five different "falls": four of the five are in Zimbabwe. The catchment area of the falls is made up of rainforests with rich and unique species of flora and fauna. The flora consists of species of fig,
mahogany and date palm. An attraction is the large baobab tree near the Victoria Falls which is 16 m in diameter and 20 meters (66 ft) tall. The notable wildlife in the parks consists of elephants, lions, buffalos, leopards and white rhinoceros, with herds of sable antelope, eland, zebra, giraffe, kudu, waterbuck and impala. The Zambezi River is rich in fish fauna such as bream and fighting tiger fish.

### 3.4.6 Major Water Bodies

Zimbabwe is bordered to the north by the Zambezi River and to the south by the Limpopo River, both of which flow through Mozambique to the Indian Ocean. These major river systems form the basis for the seven rivers catchments of the country which are: Save, Runde, Mzingwane, Gwayi, Sanyati, Manyame, and Mazowe. These major rivers feed into either the Zambezi or the Limpopo.

The Zambezi River rises in northern Zambia. It is the fourth longest river in Africa with a basin of 1,390,000 square km (3,450 km long). The catchment area for the Zambezi River includes: the Gwayi River - rises from Northwest of Bulawayo and flows 400 km northwards to enter Zambezi in the Devils George before entering Zambezi River; Mazowe River - rises north of Harare and flows north then northeast, where it forms part of the border with Mozambique before entering the Zambezi River; Manyame River - rises near Wadilove, southeast of Chitungwiza, and first drains into Lake Chivero then Lake Manyame, then flows into the Carbora Basa reservoir on the Zambezi River; and Sanyati River – it rises in Mashonaland East just north of Chivhu and approximately 100 km south of Harare, runs approximately northwest for much of its length, originally formed the southern border of Mashonaland East province, and is joined by Mupfure River, beyond where the river is often referred to as Sanyati. After 500 km, the river flows into Lake Kariba making it part of the Zambezi basin.

The Limpopo River, which rises in central Southern Africa, is 1,750 km long with a drainage basin of 41,500 square km. The catchment area for the Limpopo river is formed by: the Mzingwane River, which rises near Fort Usher, Matobo district, south of Bulawayo, and flows into Limpopo River near Beitbridge, downstream from the mouth of Shashe River and upstream of the mouth of the Bubye River; Runde River - it is in southeastern Zimbabwe, a tributary of Save River and raises 60 km east of Bulawayo and flows 200 km into Limpopo river; Save River - rises 80 km south of Harare and flows 400 km from highveld to its confluence with the Odzi River, and it is joined by Runde River at the Mozambique border; and Shashe River - rises northwest of Francis Town, Botswana and flows into the Shalimpo Transfrontier conservation area, and it is a major left tributary of Limpopo River.

### 3.5 Agriculture and Organic Farming

#### 3.5.1 Agriculture

Agriculture plays an important role in Zimbabwe’s economy. Although the agricultural sector declined dramatically in the early 21st century, it is still an important productive sector of the country's economy. It regularly generates about 15% of the gross domestic product (GDP). More than one-half of the total labor force is engaged directly in agricultural activities.

The sector is divided into large-scale commercial farming, which occupies some 40 percent of the total land area, and small-scale farming, which is both commercial and subsistence in nature. Occupying about the same total area as the large-scale commercial sector, but on land that is considerably less fertile, smallholders have steadily increased their share of the country’s total agricultural output since independence, from about one-tenth in the early 1980s to about half of the total production in the early 1990s. During the 2000s, largely due to inability to maintain productivity of farms and drought conditions, the performance of the agricultural sector experienced a decline.
Crop production is well diversified. The most important food crop is corn (maize), which is grown throughout Zimbabwe, but does best in the well-watered northeast. In previous years, enough corn was usually produced so that Zimbabwe was able to meet its domestic demand and also export a sizable quantity, but, in the early 21st century, with the significant decline in agricultural productivity, the country was unable to meet domestic needs. Other food crops include wheat, millet, sorghum, barley, cassava, peanuts (groundnuts), soybeans, bananas, and oranges.

Zimbabwe is one of the largest producers of tobacco leaf in Africa and the world’s fourth-largest producer of flue-cured tobacco, after China, Brazil and the United States of America. Since cigarette production in Zimbabwe is on a small scale, the major activities in the tobacco industry are the growing, curing and subsequent handling and distribution of tobacco leaf. The country does not have a large tobacco manufacturing industry and produces only enough cigarettes to supply domestic demand and provide a relatively small volume for export. Therefore 98 percent of all tobacco production is exported.

Cotton, grown by both smallholders and large commercial farmers, was once the chief export crop and was also the foundation of a large domestic textile industry. Cotton output increased steadily from 1995 – when commercial farmers (in what was then called Rhodesia) were forced to diversify their production away from an overreliance on tobacco – but declined in the early 21st century.

Sugar is grown in the southern Lowveld. It is exported as well as used as the basis for an important fuel industry, which mixes the sugar by-product, ethanol, with gasoline to help decrease the country’s reliance on expensive imported fuels. Coffee has increased in production many times over since the early 1970s. Grown mainly in the eastern highlands between Vumba and Mount Selinda, Zimbabwe’s coffee varieties are premium mild arabicas that command a favorable price on the world market.

Cattle are the preferred livestock of the country’s farmers. Beef and dairy products, produced mainly by the commercial sector of the rural farms, are now coming up in the livestock sector, account for about a quarter of agricultural output in most years. After independence there was a growing domestic demand for beef, and, as one of the few African countries allowed to export beef to the European Community (now the European Union [EU]), Zimbabwe developed a significant export trade in beef as well. This trade has been negatively impacted by the overall decline of the agricultural sector during the early 21st century, which resulted in a lack of grain available for feed. Sheep, goats, and pigs are raised in some areas, but their importance is minor compared with cattle. Poultry are kept largely for home use.

Traditional wild fruits such as baobab fruits and masau, which is very common in low-lying hot districts such as Mbire, Mt. Darwin, Kariba, Gokwe, Binga, Chimanimani, and Beitbridge are also collected and sold domestically. Harvesting of traditional wild fruits is becoming a major income earner for the rural communities in the above mentioned areas.

3.5.2 Bee Keeping

Some communities in Zimbabwe have recognized the value of beekeeping, mostly due to the benefits of the bee products. Some of the bee products of interest include honey, which has been widely used as food and traditional medicines. Honey used to be harvested from wild hives before the communities realized the benefits of domesticating the bees through the use of traditional hives such as bark hives and clay pots. With the advent of science and technology, modern systems have been introduced. In Zimbabwe, most of the honey is produced by smallholder farmers and the apiculture sector is still at its infancy. Most of the honey production is concentrated in the Midlands, Mashonaland West and Manicaland provinces: together, accounting for about 86% of the 85,792 beehives in Zimbabwe.
4. ENVIRONMENTAL AND HEALTH IMPACTS

4.1 POTENTIAL POSITIVE EFFECTS OF THE IRS PROGRAM

4.1.1 DIRECT POSITIVE EFFECTS

The direct positive impacts of the IRS program are the reduction in child and adult malaria morbidity and mortality that will result in a reduction in human suffering. In addition, economic losses due to absenteeism or inability to work will be reduced. Other positive impacts include reduced incidence of miscarriages, low birth-weight, adverse effects on malaria-induced fetal neurodevelopment, and reduced incidence of malaria-related childhood and maternal anemia, complications, and organ failure. There is also the benefit of elimination of other household insects, as well as vermin in some cases.

4.1.2 INDIRECT POSITIVE EFFECTS

IRS will build human and institutional capacity by providing broad-based training to a large number of people associated with IRS operations. From this training, there will be an increase in knowledge and understanding of both IRS-specific and general health and environmental risks and impacts, as well as methods of mitigation of those risks. One of the goals of the IRS program is to build in-country capacity to the point where IRS can be conducted by national or local government, or by the self-organization of communities, without large-scale external assistance or intervention.

By reducing the malaria burden, the IRS program will improve the education level amongst children of school age, as a result of the reduction in the number of school days missed, and improve the productivity of the workforce as a result of the reduction in missed work days and days of reduced productivity.

The IRS program will indirectly contribute to the enhancement of the local economy in that IRS staff and workers will receive payment for their work. At least some of the money that they receive will be spent and injected into the local economy with a magnification effect, improving revenues for various businesses and per capita income.

In addition, the implementation of IRS requires certain local purchases of products and services, such as building and construction materials, rental of building space and vehicles, and hiring of local labor for the construction or renovation of storehouses and soak pits. PMI has also committed to environmentally sustainable operations, which in some cases has stimulated business activities such as recycling. Again, these recycling revenues and demonstrated demand are injected into the economy with potentially positive and significant magnification effects.

Finally, a reduction in household pests from IRS may result in a reduction in other diseases carried by the pests.

4.2 POTENTIAL ADVERSE IMPACTS

Adverse impacts of the IRS project are those unintended effects of the project that can compromise the well-being of the environment and/or human health. Potential adverse impacts are listed below.
4.2.1 DIRECT POTENTIAL ADVERSE EFFECTS

CONTAMINATION OF SURFACE WATER COURSES AND UNDERGROUND WATER

During IRS implementation, it is possible to accidentally release insecticides into water bodies during the transportation and storage of pesticides, application of insecticides to walls, and clean-up of IRS equipment and PPE. It is also possible to have a release that will affect surface or groundwater through washing in areas other than the soak pit, or improper disposal of leftover pesticide. A spill into surface water bodies is a key concern in IRS because it could lead to contamination of water routinely used for multiple domestic purposes. Fish and other aquatic organisms that are vital to a healthy ecosystem could also be wiped out.

Contamination of underground water resources is possible through improper disposal of leftover pesticide on the ground, especially if there is a high water table. However, the impacts of this risk are likely to be insignificant, primarily because pesticide disposal is strictly controlled and supervised, and the sites for soak pits are carefully chosen according to the criteria in the PMI BMPs. Secondarily, most formulations of pyrethroids, OPs, carbamates and chlorfenapyr move slowly through soil, and degrade quickly when exposed to sunlight, hydrolysis, or microbial action in the soil. Clothianidin is expected to have high mobility in soil but degrade quickly when exposed to light. If wash areas and soak pits are properly constructed and employed, liquid pesticide traces will be captured in the charcoal layer of the soak pit or organic matter in soil, and held until degradation by natural processes. With regards to DDT, soak pits will not be used to dispose of waste water from wash areas. Rather, either evaporation tanks will be used to hold the waste water until the water evaporates or a system of trapping the waste chemical in the granulated activated carbon of a mobile soak pit will be employed to manage all liquid waste from wash areas. The system to be used for MSPs for handling DDT-contaminated waste is outlined in section 6.2.4.4 of this SEA.

POTENTIAL IMPACTS TO NON-TARGET ORGANISMS FROM PESTICIDES

The degree of toxicity of the four WHOPES-recommended pesticide classes, chlorfenapyr, and clothianidin to birdlife, aquatic life and insects, as well as pesticide persistence and bio-accumulation potential is documented in Table 5-3 in Section 5.5.1 of this SEA.

DDT is persistent in the environment, and as much as 50% can remain in the soil 10-15 years after application. It is also bio-accumulative, and is believed to have effects on many different species in the environment. ([http://people.chem.duke.edu/~jds/cruise_chem/pest/effects.html](http://people.chem.duke.edu/~jds/cruise_chem/pest/effects.html)) There has been much concern over chronic exposure of bird species to DDT and its effects on reproduction, especially eggshell thinning and embryo deaths. Due to these characteristics and impacts, when using DDT for IRS activities, all best management practices must be strictly adhered to, to ensure DDT is contained and does not contaminate the environment.

SPECIAL NOTE: IMPACTS ON BEES

Spraying in areas near beehives can lead to the death of the bees, which are vulnerable to all WHO-recommended pesticides. In addition, spraying near hives can lead to contamination of edible honey. These risks must be mitigated at all times. Bee keeping in Zimbabwe is mainly conducted away from the household. The project will identify locations where beehives are kept, and observe a 30 meter no-spray buffer zone around them. Bee-hive owners will be advised accordingly. In communities where the beehives are kept close to the home, AIRS Zimbabwe will advise all homeowners with hives close to the home to relocate them at least 30 meters away from homes before the home is sprayed.
4.2.2 INDIRECT ADVERSE EFFECTS

Upon termination of the IRS program, PMI will properly dispose of the IRS equipment and will no longer supervise its use. IRS equipment that may be disposed of includes spray tanks, used or clean boots, wash basins, progressive rinse barrels, etc. that are still in operable condition. Improper use of this equipment could lead to contamination of the environment or adverse health effects as noted.

In general, if PMI supports the procurement of insecticide or disposition of unused insecticide to the Government of Zimbabwe, this activity is required to be mentioned in the annual Letter Report, in addition to this SEA. This type of support requires annual environmental compliance monitoring by PMI and/or the IP, requires that PMI and/or the PMI IP provide environmental training in the PMI IRS BMPs, and language must be inserted into the government to government agreement that PMI must provide technical assistance for insecticide selection to ensure quality/appropriateness of the product. Similarly, if PMI supports the procurement, loan, or disposition of spray pumps or personal protective equipment to the Government of Zimbabwe, these activities must be mentioned in the annual Letter Report, in addition to this SEA. These activities do not require environmental compliance monitoring; however, PMI and/or the PMI IP must provide environmental training in the PMI IRS BMPs. These requirements only relate to the use of non-DDT insecticides by the Government of Zimbabwe. The conduct of IRS by the MoHCC with communities, using properly working equipment left behind by PMI may temporarily, and in a minor way increase the total pesticide load on the environment. However, since the IRS equipment will be in operable conditions and capacity will have been built among the District Medical Officers, it is expected that spray operations will be according to BMPs, and the total pesticide load on the environment is expected to be less compared with if the donation were not made.

4.3 HUMAN EXPOSURE RISKS/IMPACTS

4.3.1 WORKER AND RESIDENT EXPOSURE PATHWAYS

During the IRS spraying process, spray personnel are at risk of unintentional or deliberate exposure through accidents or poor and improper handling of the spray chemical. Worker exposure to the chemical could arise during the pre-spraying, spraying and post-spraying phase of the IRS operations. A risk calculation evaluating incidental soil ingestion, soil dermal absorption, inhalation, and vegetable and chicken ingestion pathways indicates that potential DDT exposures by chicken ingestion are by far the most significant and may result in a lifetime cancer risk. Beneficiaries can also be exposed during each of these phases, and additionally over the life of the pesticide on the wall. Exposure risks of all WHO-recommended pesticides in relation to cancer and non-cancer endpoints are presented in the 2012 and 2017 IVM PEAs. The exposure risk for cancer and non-cancer endpoints is presented at different stages of the pesticide application including mixing, spraying, post spraying, dermal risk, etc.

The short-term acute effects of DDT on humans are limited, but long-term exposures have been associated with chronic health effects. DDT has been detected in breast milk, raising serious concerns about infant health. Due to these potential impacts, when using DDT for IRS activities, all best management practices (see the 2015 PMI IRS BMP manual) must be strictly adhered to, to ensure DDT is contained and that females employed by this project don’t have any contact with the pesticide.

4.3.2 PRE SPRAYING EXPOSURE PATHWAY

Preparing pesticide solutions during the IRS requires pouring the pesticide in the spray pump and agitating it to ensure ample mixing with the water. The process of mixing the pesticide can lead to exposures via inhalation, dermal contact, and incidental ingestion, from releases of pesticide vapors and liquids. Vapor releases can occur when liquid concentrated emulsions are diluted. Workers or residents
can inhale the vapors or the particulates or be exposed through dermal contact. Spills could also pose significant risk, especially for children who ingest the resulting residues that are left on surfaces such as food, floors, soil, as well as absorbing additional doses from eating plants and animals contaminated during the preparation for spraying.

**4.3.3 EXPOSURE DURING SPRAYING**

Inhalation of aerosol droplets during spraying is the main process for worker exposure during IRS, however, dermal exposure through spills or absorption onto cotton overalls is also a significant risk. Especially in the case of organophosphates, the dermal hazard is significant, and can cause cholinesterase depression. Residents are mainly exposed through dermal contact with sprayed surfaces and incidental ingestion of insecticide after their houses have been sprayed, especially when food or drink are left in the house during spraying. Leaky equipment can also lead to insecticide exposure through dermal contact with the floors and incidental ingestion by children who may come in contact with the spills before they are cleaned up.

**4.3.4 EXPOSURE DURING DISPOSAL (INCLUDING PROGRESSIVE RINSING)**

Disposal is a key issue with IRS intervention that utilizes pesticides especially during the decontamination process and disposal of the liquid effluent that will arise from washing and progressive rinse. Both burying and dumping can lead to dermal exposure of residents who come in contact with the soil or water in which the pesticide was disposed. Once the pesticide gets into the soil, it can migrate to groundwater, which may be used as a water supply via household wells. In this manner, ingestion exposure can occur from drinking contaminated surface water. Residents may also be exposed to this contaminated water by dermal contact when it is used for cleaning or cooking purposes.

**4.3.5 OCCUPANT LONG-TERM EXPOSURE FROM RESIDUE**

Residents of sprayed structures, especially crawling babies and children, will have a finite exposure risk due to physical contact with sprayed surfaces, as well as small amounts released from substrate walls, ceilings, and eaves, due to physical surface breakdown.

**4.4 PESTICIDE- AND PROCESS-SPECIFIC POTENTIAL HEALTH IMPACTS**

**4.4.1 INHALATION EXPOSURE AND RISK DURING MIXING**

Of the proposed pesticides, only etofenprox (pyrethroid) and propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

**4.4.2 DERMAL EXPOSURE AND RISK DURING MIXING**

On the WHOPES list of insecticides to be used in IRS only three (DDT, etofenprox (pyrethroid) and propoxur (carbamate)) have been determined to be carcinogenic at dermal exposure levels of 8E-07 mg/kg-day for etofenprox and 4E-06 mg/kg-day for propoxur.

**4.4.3 INHALATION EXPOSURE AND RISK DURING SPRAYING**

Of the proposed pesticides, only etofenprox (pyrethroid) and propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

**4.4.4 DERMAL EXPOSURE AND RISK DURING SPRAYING**

Of the proposed pesticides, fenitrothion and pirimiphos-methyl have non-cancer risks (cholinesterase depression) due to dermal exposure.
4.4.5 **Resident Dermal Exposure and Ingestion Risk After Spraying**

The only concerns are to adults when using cyfluthrin and etofenprox (pyrethroids) and propoxur (carbamate). The risk is however very low.

4.4.6 **Resident Exposure and Risk Due to Chronic Ingestion After Spraying**

There are four insecticides with potential impact due to chronic ingestion by drinking insecticide contaminated water. These are Cyfluthrin, Permethrin and Etofenprox (pyrethroids) and propoxur (carbamate). Best management practices are recommended.

4.4.7 **Resident Dermal Exposure and Risk Due to Bathing Using Contaminated Groundwater**

Cyfluthrin and etofenprox (pyrethroids) have potential impact for dermal exposure using contaminated groundwater. When best management practices are applied in IRS, this risk is significantly reduced.

4.4.8 **Resident Exposure and Risk Due to Reuse of Pesticide Containers**

Only deltamethrin is considered to have potential for acute ingestion hazard from using pesticide containers. However, residents will have no access to pesticide containers used in IRS. The pesticide containers are carefully inventoried and stored in IRS storage facilities which are securely double locked. When an appropriate recycling system is available, they will be disposed by recycling into non-consumer products. Otherwise they will be landfilled after washing and puncturing, or as a last resort, incinerated.

4.4.9 **Worker Exposure and Risk Due to Inhalation During Spillage**

According to information presented in the IVM PEA, etofenprox and propoxur have potential to impact workers through inhalation during spillage. The workers are trained on how to handle spillage and must be equipped with appropriate PPE.

4.5 **Cumulative Impact**

Because DDT is persistent and has the potential for bio-accumulation, there is a risk of a cumulative impact from long-term use. To mitigate this risk, PMI uses evaporation tanks or other treatment devices to capture and properly dispose of DDT wastes. Organophosphates are the pesticides with the next highest potential for cumulative impacts. Pyrethroids, carbamates, and most organophosphate formulations break down readily in the environment, limiting the risk of cumulative environmental impact, especially if disposal sites are well-chosen and PMI BMPs are followed.

However, repeated exposures to organophosphates result in cumulative cholinesterase depression, with increasingly severe effects. For this reason it is exceptionally important that PPE is worn properly and at all times when pesticide contact is possible. It is also incumbent upon team leaders to monitor the health of their spray operators on a daily basis, and to look for any signs of cholinesterase depression. Formulations of the organophosphate pirimiphos-methyl have been used for several years and in several countries without any report of observed symptoms of cholinesterase depression.

Additionally, there are indications that the capsule suspension form of Actellic® is more resistant to environmental degradation than either Actellic® EC, or the other WHOPES/PQ-recommended pesticides. This may result in a temporary build-up of concentration within the soak pit prior to degradation.

Due to the persistence of DDT and its potential for bio-accumulation, there is a risk of a cumulative impact from long-term use. If PMI agrees to use DDT in its IRS program, the IP will arrange to monitor
this risk by performing baseline and ongoing sampling and testing of DDT residues in soil and plants near the IRS operations sites, where the risk of release and build-up is greatest. If analysis should indicate that ambient DDT levels are increasing, the IP will identify and eliminate any PMI-related source of releases.
Title 22 of the United States Code of Federal Regulations, Part 216 (22 CFR 216) mandates the consideration of twelve factors when a project includes “assistance for the procurement or use, or both, of pesticides”. As the PMI IRS Zimbabwe program includes assistance in both of these aspects, it is subject to this regulation. This section therefore addresses each of the twelve factors for the IRS Malaria Control Program in Zimbabwe.

5. PESTICIDE PROCEDURES

5.1 THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY’S REGISTRATION STATUS OF THE REQUESTED PESTICIDE

Pesticides registered for IRS or a similar use in the United States and the host country government will be preferred in this IRS project. Some of the pesticides on the WHOPES list are not registered with the USEPA for economic, technical, or regulatory reasons. There is a very limited market in the US for IRS, and as a result, registrations for this use of these pesticides have been voluntarily withdrawn, or never filed. However, US 22 CFR 216.3(b)(1)(iii) allows for the use of pesticides not registered for the same or similar use by USEPA, provided that:

1. The proper assessments are performed,
2. The assessments include an evaluation of the factors in Sections 5.1-5.12 of this document, and
3. Notification is provided to, and authorization received from the host country government for the use of the pesticide in-country.

PMI works closely with host country governments, with full and clear disclosure, and provides any necessary assistance in the mitigation of risk from the use of these WHOPES pesticides. The SEA, supported by the PMI IVM PEA, and distributed to the NMCP and Environmental Management Agency (EMA), provides the assessment, notification and mitigation requirements of US regulations. USAID/PMI is therefore empowered, upon acceptance of this document and the receipt of formal authorization from a competent Zimbabwean authority, to use in all Zimbabwe WHOPES/PQ-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes; DDT; and chlorfenapyr and clothianidin when recommended by WHOPES/PQ.

5.2 THE BASIS FOR SELECTION OF THE REQUESTED PESTICIDES

In addition to the above criteria, insecticide selection for any PMI supported program is subject to the following considerations.

5.2.1 PRIMARY CRITERIA FOR CHOOSING PESTICIDES

Approval by the World Health Organization Pesticide Evaluation Scheme: Only insecticides recommended by WHOPES/PQ can be used in IRS. Certain pesticides in the organophosphate, carbamate, pyrethroid and organochlorine classes are WHOPES-recommended for use in IRS. Table 5-1 shows the list of WHO-recommended pesticides. Chlorfenapyr and clothianidin are not yet recommended by WHOPES/PQ, but authorization is requested in this SEA to use them for hut trials and for IRS when and if they receive a WHOPES recommendation/PQ listing.
### TABLE 5-1: WHOPES RECOMMENDED PESTICIDES WITH EFFECTIVE DURATION

Updated: 2 March 2015

**WHO recommended insecticides for indoor residual spraying against malaria vectors**

<table>
<thead>
<tr>
<th>Insecticide compounds and formulations¹</th>
<th>Class¹ group²</th>
<th>Dosage (g a.i./m²)</th>
<th>Mode of action</th>
<th>Duration of effective action (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDT WP</td>
<td>OC</td>
<td>1-2</td>
<td>contact</td>
<td>&gt;6</td>
</tr>
<tr>
<td>Malathion WP</td>
<td>OP</td>
<td>2</td>
<td>contact</td>
<td>2-3</td>
</tr>
<tr>
<td>Fenitrothion WP</td>
<td>OP</td>
<td>2</td>
<td>contact &amp; airborne</td>
<td>3-6</td>
</tr>
<tr>
<td>Pirimiphos-methyl WP, EC</td>
<td>OP</td>
<td>1-2</td>
<td>contact &amp; airborne</td>
<td>2-3</td>
</tr>
<tr>
<td>Pirimiphos-methyl CS</td>
<td>OP</td>
<td>1</td>
<td>contact &amp; airborne</td>
<td>4-6</td>
</tr>
<tr>
<td>Bendiocarb WP, WP-SB</td>
<td>C</td>
<td>0.1–0.4</td>
<td>contact &amp; airborne</td>
<td>2-6</td>
</tr>
<tr>
<td>Propoxur WP</td>
<td>C</td>
<td>1–2</td>
<td>contact &amp; airborne</td>
<td>3-6</td>
</tr>
<tr>
<td>Alpha-cypermethrin WP, SC</td>
<td>PY</td>
<td>0.02–0.03</td>
<td>contact</td>
<td>4-6</td>
</tr>
<tr>
<td>Alpha-cypermethrin WG-SB</td>
<td>PY</td>
<td>0.02–0.03</td>
<td>contact</td>
<td>up to 4</td>
</tr>
<tr>
<td>Bifenthrin WP</td>
<td>PY</td>
<td>0.025–0.05</td>
<td>contact</td>
<td>3-6</td>
</tr>
<tr>
<td>Cyfluthrin WP</td>
<td>PY</td>
<td>0.02–0.05</td>
<td>contact</td>
<td>3-6</td>
</tr>
<tr>
<td>Deltamethrin SC-PE</td>
<td>PY</td>
<td>0.02–0.025</td>
<td>contact</td>
<td>6</td>
</tr>
<tr>
<td>Deltamethrin WP, WG, WG-SB</td>
<td>PY</td>
<td>0.02–0.025</td>
<td>contact</td>
<td>3-6</td>
</tr>
<tr>
<td>Etofenprox WP</td>
<td>PY</td>
<td>0.1–0.3</td>
<td>contact</td>
<td>3-6</td>
</tr>
<tr>
<td>Lambda-cyhalothrin WP, CS</td>
<td>PY</td>
<td>0.02–0.03</td>
<td>contact</td>
<td>3-6</td>
</tr>
</tbody>
</table>

**Chlorfenapyr 240 SC:** The current assessments of Chlorfenapyr SC (class group: pyrrole) are available in the report of the 16th WHOPES Working Group meeting, 22–30 July 2013 and the report of the 17th WHOPES Working Group meeting, 15–19 September 2014 (both reports available at: [http://who.int/whopes/resources/en/](http://who.int/whopes/resources/en/)).

**Note:** WHO recommendations on the use of pesticides in public health are valid ONLY if linked to WHO specifications for their quality control. WHO specifications for public health pesticides are available on the WHO homepage on the Internet at [http://www.who.int/whopes/quality/en/](http://www.who.int/whopes/quality/en/).

¹CS = capsule suspension; EC = emulsifiable concentrate; SC = suspension concentrate; SC-PE = polymer enhanced suspension concentrate; WG = water dispersible granules; WG-SB = water dispersible granules in sealed water soluble bags; WP = wettable powder; WP-SB = wettable powder in sealed water soluble bags.

²OC = organochlorines; OP = organophosphates; C = carbamates; PY = pyrethroids.

**Note:** Chlorfenapyr and clothianidin are still undergoing testing so are not included in this table.

**Registration for use in Zimbabwe:** In the case where the insecticide proposed for use in IRS is not registered in Zimbabwe, PMI will work with manufacturers and distributors, as well as the NMCP, the MoHCC, and other regulatory bodies to obtain special authorization for the use of the pesticide, where possible.

**Residual effect for a period longer than, or at least equal to, the average duration of the malaria transmission season in the area:** As seen in the table above, all pyrethroids, carbamates, and organophosphates are expected to stay active and effective for 3 to 6 months and DDT for more than 6 months after application; however, the effective duration varies under different climatic conditions.
conditions and other factors. Three pyrethroids, known as longer-lasting pyrethroids, can last up to eleven months based on various field trials. For this reason, pyrethroids have traditionally made the best choice for extended seasons. However, in order to manage vector resistance, it has proven to be necessary to periodically switch the class of pesticides used in IRS.

**Pesticide must be appropriate for use on the wall surfaces of the selected location:** Various types of materials are used for inner walls of residential structures in Zimbabwe. The 3 main types are mud; burnt bricks; and cement bricks. Structures in the IRS targeted areas are mostly from mud walls or burnt bricks. Near major towns and commercial centers, cement and brick walled houses are predominant. Pyrethroids, carbamates, organophosphates, and DDT are known to function well on mud and cement walled houses and are therefore appropriate. Some other temporary structures are made of materials (for example, corrugated iron sheets, tin, or sticks) and constitute non-sprayable structures for IRS.

**Local vector susceptibility to the insecticide:** The primary malaria vector in Zimbabwe is *Anopheles arabiensis*, which is widely distributed in 8 rural provinces. In 2013, *An. funestus* was also detected in Mutasa and Mutare districts in Manicaland province. This is an efficient vector that is resistant to pyrethroids and carbamates. *An. funestus* has also been detected in Karoi in Mashonaland West and possibly has a wider distribution within the country.  

*An. gambiae* s.s., another efficient malaria vector, has limited distribution, with the last record made in Kanyemba in the Zambezi Valley in 2002. A minor vector, *An. merus*, a saltwater breeder belonging to the *An. gambiae* s.l. complex, has patchy but widespread distribution in Zimbabwe. Most often the vectors are found in sympathy with the non-vector *An. quadriannulatus*, and current data from entomological surveillance suggests that there is a significant decline in the vector, relative to the non-vector.

Resistance to insecticide develops when a hereditary feature is selected in an insect population that reduces the population’s sensitivity to a given insecticide. In Zimbabwe, vector resistance to various insecticides has been recorded in different areas. As a result, three insecticides (including, a pyrethroid, DDT, and an organophosphate) are currently used for IRS. Results of insecticide resistance testing in 2015 and 2016, with *An. gambiae* s.l., in seven of the 10 provinces are presented in Table 5-2.

**TABLE 5-2: INSECTICIDE RESISTANCE TESTS WITH AN. GAMBAE S.L., 2015 -2016 (% MORTALITY)**

<table>
<thead>
<tr>
<th>Province</th>
<th>Lambdacyhalothrin</th>
<th>DDT</th>
<th>Bendiocarb</th>
<th>Pirimiphos methyl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># tested</td>
<td>% mortality</td>
<td># tested</td>
<td>% mortality</td>
</tr>
<tr>
<td>Matebeleland North</td>
<td>100</td>
<td>93</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Matebeleland South</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>85.3</td>
</tr>
<tr>
<td>Mashonaland East</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Mashonaland West</td>
<td>100</td>
<td>83</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Mashonaland Central</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Midlands</td>
<td>100</td>
<td>92P</td>
<td>100</td>
<td>87.5</td>
</tr>
<tr>
<td>Manicaland</td>
<td>50</td>
<td>100</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: 2017 Zimbabwe Malaria Operational Plan

* Further entomological surveillance is needed to confirm this suspicion.
Zimbabwe has developed an IRS Insecticide Resistance Management plan to guide IRS activities in the country. To support these vector control objectives, the National Institute of Health Research (NIHR), with support from partners and other institutions, will take a leading role in conducting national vector mapping, resistance monitoring and regular entomological surveys. The NMCP in collaboration with research institutions and partners will consolidate and maintain an entomological database.

PMI has supported the NMCP in various ways with entomological monitoring. Working with the NMCP, PMI will continue to provide support for entomological surveillance and monitoring, laboratory capacity building for entomological surveillance, procurement of entomological supplies, and technical assistance to PMI IRS activities in 2017.

**Ecological impact:** It is extremely important that IRS does not in any way diminish the biodiversity of Zimbabwe. The ecological impact of the WHOPES pesticides is well-documented, recently in the 2012 and 2017 PMI IVM Program Environmental Assessment (IVM PEA). However, if BMPs for IRS are strictly followed, the release to the environment, and therefore the impact to the environment, should be negligible. More information on ecological impact of the proposed pesticides is found in sections 5.5 and 5.7, as well as other sections of this document.

**Human health impact:** The 2012 and 2017 IVM PEA assessed cancer and non-cancer risks associated with all WHOPES-recommended insecticides by process (e.g., mixing insecticide, spraying, residing in sprayed house, etc.) and pathway (e.g. inhalation, dermal, ingestion, etc.), and cancer risks by process and pathway where available. In general, pyrethroids, carbamates, chlorfenapyr, and clothianidin pose less non-cancer risks via any pathway than organophosphates when risks are assessed, but the risks of organophosphates can be managed by following standard PMI IRS procedures and protocols (BMPs).

### 5.2.2 Secondary Selection Criteria:

- Appropriate packaging for safety and standard delivery tools
- Unit cost of insecticide
- Timely delivery of the insecticide to the preferred point of delivery
- Local representation of supplier in host country
- Technical assistance with training and troubleshooting by supplier

### 5.3 The Extent to Which the Proposed Pesticide Use Is Part of an Integrated Pest Management (IPM) Program

IPM is defined as “an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials (pesticides) are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.”

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7 [http://www.ipm.ucdavis.edu/IPM PROJECT/about.html](http://www.ipm.ucdavis.edu/IPM PROJECT/about.html)
IPM is often used in an agricultural context, but similar in nature is the concept of Integrated Vector Management (IVM).

The major characteristics of IVM include:

- Methods based on knowledge of factors influencing local vector biology, disease transmission, and morbidity;
- Use of a range of interventions, often in combination and synergistically;
- Collaboration within the health sector and with other public and private sectors that impact vectors;
- A public health regulatory and legislative framework.

Use of IVM for the control of the malaria vector population is practiced using two primary interventions, insecticide-treated nets, and indoor residual spray. Environmental management for malaria control is limited to some common sense safeguards, such as limiting standing water, which can serve as a breeding ground for mosquitoes. USAID/PMI does not support environmental management as a vector control method. Because of the life-cycle requirements and the adaptability shown by malaria vectors, these practices have not demonstrated large-scale effectiveness.

PMI strategy has been that IRS will be implemented as a component of IVM for malaria control. PMI supports an evidence-based approach and will continue to review health management information systems and entomologic data to determine where best to deploy IRS.

5.4 THE PROPOSED METHOD OR METHODS OF APPLICATION, INCLUDING AVAILABILITY OF APPROPRIATE APPLICATION AND SAFETY EQUIPMENT

IRS involves spraying an insecticide with long-lasting residual activity on indoor wall and ceiling surfaces where mosquitoes usually rest. The pesticide then dries up and leaves a crystalline deposit on the sprayed surface. A lethal dose of the insecticide is absorbed when the mosquito rests on the surface, which kills the mosquito.

Pesticide will only be applied using pressurized spray equipment approved for the pesticide in use, and by trained spray operators wearing gloves, overalls, hard hats with face shields, neck shields, and boots. All necessary PPE for this activity is supplied by PMI, and its use is supervised and enforced throughout the course of the campaign. Spray operators are trained in and use spray patterns that have proven effective for providing long-lasting toxicity toward the malaria vector mosquito.

The spray operators who implement IRS use compression sprayers to apply a measured amount of insecticide on the interior walls of houses and structures. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the sprayer is pressurized, and the material is then applied. After the day’s spraying is complete, spray operators reserve in a collection drum any pesticide left in the spray pump, clean the sprayer following PMI BMPs to maintain proper functioning of the pump and to guard against release of and/or exposure to pesticides, and reuse leftover pesticide on the following day. They also follow the pump manufacturer’s recommendations to ensure their proper operation and calibration.
### 5.5 Acute and Long-Term Toxicological Hazards Associated with the Proposed Use and Measures Available to Minimize Such Hazards

The IVM PEA assessed the toxicity of WHO-recommended IRS insecticides to non-target organisms, including mammals, birds, fish, bees, and other aquatic organisms. Table 5-3 provides graphic information on the toxicity and some of the other characteristics of the WHOPES pesticides. In general, most of them are toxic to bees, fish, and other aquatic organisms, and less so to mammals and birds.

**TABLE 5-3: PESTICIDE TOXICITY TO NON-TARGET SPECIES**

<table>
<thead>
<tr>
<th>IRS Insecticide</th>
<th>Mammal</th>
<th>Bird</th>
<th>Fish</th>
<th>Other Aquatic</th>
<th>Bee</th>
<th>Persistence</th>
<th>Bioaccumulate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-cypermethrin (P)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Bendiocarb (C)</td>
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<tr>
<td>Bifenthrin (P)</td>
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<tr>
<td>Cyfluthrin (P)</td>
<td></td>
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<tr>
<td>DDT (OC)</td>
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<tr>
<td>Deltamethrin (P)</td>
<td></td>
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<tr>
<td>Etofenprox (P)</td>
<td></td>
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<tr>
<td>Fenitrothion (OP)</td>
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<tr>
<td>Lambda-cyhalothrin (P)</td>
<td></td>
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<tr>
<td>Malathion (OP)</td>
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<tr>
<td>Pirimiphos-methyl (OP)</td>
<td></td>
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<tr>
<td>Propoxur (C)</td>
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<td></td>
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<tr>
<td>Chlorfenapyr (PR)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Clothianidin (N)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: IVM PEA 2012 and 2017

**Key**

- High Toxicity
- Medium to High Toxicity
- Medium Toxicity
- Low to Medium Toxicity
- Low Toxicity
- Data Not Found
“Indoor” being an important operative word in IRS, the risks to biodiversity from spray operations are minimal if PMI BMPS are followed. The BMPs have been designed to prevent any significant release to the environment, and a strong, automated, smart-phone-based supervisory system ensures that BMPs are followed or non-compliance is immediately corrected. The reader is referred to Annex E of the 2012 and 2017 IVM PEA for greater detail about pesticide toxicity.

5.5.1 HAZARDS

The two broad categories of hazard are release and exposure to humans and domestic animals, and releases causing environmental damage. Release and exposure may occur at any point, from the production or importation of the pesticide through transportation, storage, distribution, pesticide make-up, spray application, clean-up, and final disposal, as well as post-spray due to improper spray deposition on household articles, or improper behavior of beneficiaries regarding sprayed surfaces.

In humans, both organophosphates and carbamates can produce cholinesterase depression if the proper protective measures are not utilized and exposure results. Cholinesterase inhibition results in overstimulation of the nervous system, with symptoms that include nausea, dizziness, confusion, and respiratory paralysis and death at very high exposures (U.S. EPA, 2000). The two classes of insecticides differ in their impact on human health in that with carbamates, the cholinesterase inhibition is temporary, and may dissipate in as little as 2-3 hours, providing the exposure is eliminated. With organophosphates, the inhibition is longer-lasting and cumulative, and thus more dangerous.

DDT acts by impairing the conduction of nerve impulses. Symptoms of acute exposure to high levels of DDT by any route include mild altered sensations, tremors, convulsions, and respiratory depression. Additional effects observed in humans after acute DDT exposure include headaches; nausea and vomiting; diarrhea; numbness; paresthesia (a burning, tingling, or stinging of the skin); increased liver enzyme activity; irritation of the eyes, nose, or throat; altered gait; and malaise or excitability. In addition to potential acute effects, DDT is a liver toxicant, and is associated with various reproductive and developmental effects. Recent data indicate that exposure to DDT in amounts necessary for malaria control may cause preterm birth, decreased birth weight, early weaning, and pregnancy loss (PMI IVM PEA, 2012).

5.6 THE EFFECTIVENESS OF THE REQUESTED PESTICIDE FOR THE PROPOSED USE

Pesticides are selected for IRS based on technical efficacy and economic efficiency in the intended use, along with other extrinsic variables. Complete selection criteria can be found in Section 5.2 of this PERSAUP. Knowledge of vector susceptibility is critical to planning and evaluating the effectiveness of the IRS program. It enables timely forward planning to (i) manage the development of the resistance and (ii) evaluate new or alternative insecticides for possible future introduction should a change of pesticide be required. Resistance testing is done to (i) establish a baseline susceptibility of the local vectors for future reference, (ii) monitor changes that occur as time progresses, (iii) identify the mechanisms of resistance and cross-resistance to inform the resistance management strategy that will be adopted, and (iv) evaluate the susceptibility of the local vectors to potential alternative insecticides, should there be a need to change pesticide.

Prior to each campaign, it is necessary to measure vector resistance in the target areas, to ensure that acceptable kill levels will be achieved. A resistance monitoring program has been established by the NMCP in collaboration with PMI, and the results from this ongoing program are the primary determinants of the choice of pesticide and other supplementary actions.
Pesticide efficacy is also affected by vector behavior, insecticide quality, and the residual action of the pesticide. The probability of vector-pesticide contact depends on whether the targeted vector feeds indoors (endophagic) and rests indoors (endophilic), as this increases the likelihood of the vector resting on the sprayed wall. The efficacy of the pesticide to kill may be compromised if the vector exits after feeding without resting on the wall, or if the vector feeds outdoors (exophagic) and rests outdoors (exophilic). The two major malaria vectors in Zimbabwe, An. gambiae s.s. and An. funestus, are mainly endophagic and endophilic. This makes them suitable targets for IRS.

Vector resistance may differ in origin, intensity, type, and significance for vector/disease control in a given population. The evaluation of the significance of resistance to vector control should therefore consider the biochemical and genetic characteristics of the resistance, as well as the eco-epidemiology of the disease and operational characteristics. Resistance also tends to be highly focal (i.e., limited to a definite area). It is therefore important to ascertain the spatial distribution of the observed resistance to better inform the resistance management strategy to be employed and the geographical extent to which it will apply (e.g., what geographical area a possible change in pesticides for IRS should cover).

The residual efficacy of the pesticide being used for IRS is crucial to evaluating the overall effectiveness of IRS. The wall surface to which the pesticide is applied is a factor affecting residual efficacy, and must be taken into account. It is important that bioassays on various wall surfaces be carried out at specified intervals after the IRS operation in order to determine the period and level of residual activity in a given locality and on a given sprayed surface.

A third major factor affecting the effectiveness of the pesticides is their quality (specification). If the active ingredient, for example, is not up to the recommended specification and concentration, it may lead to under-dosage of deposited pesticide, which then contributes to intervention failure. Storage of pesticide for too long a time, or in extremely hot warehouses can lead to breakdown of the active ingredient. Poor pesticide quality may present additional risks to the pesticide handlers and spray operators who may be exposed. For this reason, samples of the pesticide will be taken prior to shipment to Zimbabwe, and analyzed for the concentration of the active ingredient. In all PMI IRS warehouses the temperature is monitored and controlled as much as possible to avoid temperatures that could alter the chemistry or the characteristics of the pesticide.

### 5.7 Compatibility of the Proposed Pesticide with Target and Non-Target Ecosystems

The pesticides are compatible with the target environment (walls, ceilings, eaves) in that they dry on these surfaces, and are not released to receptors or the general environment to any great extent. The dried pesticide remains on the sprayed surfaces, and performs as designed, killing vector mosquitoes that rest on them, and the exposure to non-target organisms and ecosystems is very limited.

The WHOPES recommended pesticides are incompatible with the non-target ecosystems (humans, animals, and the environment), in that, if they are released to the environment in large quantities, they would have negative effects on land and water based flora and fauna (See Table 5-3). However, the IRS implementation process is designed to ensure that, to the maximum extent possible, pesticides are deliberately and carefully applied to the walls and ceilings of dwellings, and do not come in contact with humans, animals, or the environment. IRS implementation is also planned to minimize and responsibly manage liquid wastes through the reuse of leftover pesticides, the triple rinsing of equipment, and the daily washing of PPE (except in DDT operations where PPE is washed after two days of use) with rinse water treatment to remove trace pesticide. Wherever possible, recycling is incorporated into the waste
management plan, particularly in the case of plastic bottles used for pesticide containers. Where it is not feasible to recycle materials, they are either washed thoroughly and disposed of in a landfill, or contaminated solid wastes are incinerated in an approved incinerator that will destroy the pesticide and prevent environmental contamination (see section 6.1.13). The Environmental Mitigation and Monitoring Plan details the measures that have been and will be enacted to prevent contamination of ecosystems. In addition, there are solid and liquid waste management plans contained in the Safer Use Action Plan of this PERSUAP (Chapter 6).

5.8 THE CONDITIONS UNDER WHICH THE PESTICIDE IS TO BE USED

IRS is scheduled to be performed prior to the rainy season in each location to maximize the effectiveness of IRS, and to avoid logistical complications from the degradation of transportation infrastructure due to flooding and washout.

During IRS, particular attention will be paid to any identified sensitive areas, including water bodies, schools, hospitals, any area where organic farming is practiced, where bee-keeping or natural bee habitats are established, etc. In addition, bird-nesting habitats will be protected, and all insecticides will be kept away from all water habitats and resources. Prior to spraying, geographical reconnaissance will include identification of households in sensitive areas, and the PMI implementing partner (IP) will train sprayers to identify houses that should not be sprayed. IRS will be prohibited within 30 meters of sensitive ecosystems.8 If pesticide drift is observed, spraying will be halted until the cause has been determined. Drift could be a result of spraying an inappropriate surface with gaps that allow pesticide to escape, so the wall surface must be evaluated for fitness for spraying, and the structure potentially disqualified. Alternately, if drift is caused by excessive wind (especially if spraying eaves outdoors) operators must wait until wind conditions subside. The IP will consult with competent services of the EMA regarding the application of pesticides in or near ecologically sensitive areas, such as wetlands, lake shore, river edge and protected areas and follow their policies and guidelines, unless the conditions prescribed herein are more strict, in which case the SEA will have precedence. Strict supervisory control will also be established to prevent contamination of agricultural products.

5.9 THE AVAILABILITY AND EFFECTIVENESS OF OTHER PESTICIDES OR NON-CHEMICAL CONTROL METHODS

In Zimbabwe, as in many countries, a full range of malaria control methods are employed, and in some circumstances, one method may be favored over another. However, PMI has determined that IRS is part of the overall effort to decrease malaria morbidity and mortality in Zimbabwe and in many other countries.

This IRS program is limited to using those pesticides that are on the WHOPES/PQ list of recommended pesticides. WHO currently recommends 15 formulations from four chemical classes for IRS, each with a specific dosage regime, duration of effectiveness, and safety rating. Each of these agents has been evaluated for effectiveness within the program, and continued monitoring for resistance and susceptibility will be employed to allow up-to-date decisions prior to each spray campaign. One goal of this SEA is to broaden the options for pesticide use to six recommended pesticide classes (including chlorfenapyr in the pyrrole class and clothianidin in the neonicotinoid, if and when they are recommended by WHOPES/PQ), to combat periodic resistance development.

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8 In Zimbabwe, the core zones of protected areas extend 30 meters around the protected area. Some areas outside of the core zones may be designated as buffer zones. PMI will only conduct IRS within the buffer zones upon written authorization from the Government of Zimbabwe.
Non-chemical means of malaria vector control are examined and discussed briefly under section 5.3, Integrated Pesticide/Vector Management (IPM/IVM), but are generally not effective on a large scale for malaria vector control. For example, while elimination of standing water breeding habitats is a logical and sensible concept, the malaria mosquitoes only need the smallest of aquatic habitats to successfully reproduce, and it is nearly impossible to eliminate all of these minute breeding habitats (e.g., hoof prints or tire ruts).

5.10 THE REQUESTING COUNTRY’S CAPACITY TO REGULATE AND CONTROL PESTICIDES DISTRIBUTION, STORAGE AND USE OF THE REQUESTED PESTICIDES

There are a number of laws and institutions significant to the implementation of this IRS program, as discussed below.

5.10.1 RELEVANT INSTITUTIONS

Management of insecticides for indoor residual spraying is undertaken by various agencies in Zimbabwe: the Pesticide Registration Department of Ministry of Agriculture; Environmental Management Agency (EMA) under Ministry of Environment and Climate; National Institute of Health Research; and Environmental Health Departments under the Ministry of Health and Child Care. The National Malaria Control Programme (NMCP) is overall responsible for the conduct of the IRS and storage of insecticides.

The Pesticide Registration Department is responsible for the registration of all pesticides before their importation and use in Zimbabwe. The Pesticide Registration Department only operates from a centralized location in Harare.

EMA has a department responsible for management of hazardous substances and has officers at the National, Provincial, and District levels. EMA is mainly responsible for controlling the sale, handling, transportation, storage of pesticides, and hazardous waste management in Zimbabwe.

The National Institute of Health Research (NIHR) is responsible for conducting field trials of WHOPES/PQ approved insecticides in Zimbabwe, before their registration and use in IRS operations. NIHR has two laboratories in Zimbabwe (Harare and De Beers Research Laboratory in Chiredzi, Masvingo Province) and they are manned by qualified entomologists and technicians.

The Environmental Health Department, headed by a directorate, has a three tier system which involves the National, Provincial and District levels. The National level tier works closely with the National Malaria Control Programme to coordinate the implementation of IRS in Zimbabwe. At the Provincial level, there is a Provincial Environmental Health Officer (PEHO) who works closely with the NMCP Vector Control Officer (VCO) on implementation of IRS operations. At the District level, the District Environmental Health Officer (DEHO) is responsible for coordination of IRS operations at implementation level. The DEHO supervises a team of Environmental Health Technicians and spray operators, who are responsible for day to day IRS operations. The Environmental Health Department has the following key roles in managing IRS insecticides:

- Setting minimum health requirements for all IRS storerooms
- Inspecting insecticide storage facilities in collaboration with EMA and NMCP
- Controlling the importation of insecticides in Zimbabwe through inspections at ports of entry and pre-shipment at country of origin where needed
- Training of spray teams on proper use and handling of insecticides, and disposal of waste
• Supervising IRS teams for compliance to regulations related to the proper, safe handling of insecticides and disposal of generated waste
• Conducting safety education to spray operators and the beneficiary community on identifying adverse health effects of IRS insecticides

The NMCP is responsible for coordinating all IRS insecticide management activities, including logistics related to procurement, warehousing, distribution of insecticides to provincial and district warehouses, training of spray teams in the use of IRS insecticides, and management of waste from IRS operations. Management of IRS insecticides at NMCP level is coordinated by the VCO assisted by the Assistant VCO.

The private sector also has a role to play in the management of insecticides earmarked for use in IRS. The registered entities provide local support services (warehousing and distribution of insecticides to provinces) through competitive bidding processes. The contracted agents also handle solid waste transportation from districts to the final disposal sites. In addition to the local support services, the private sector provides stewardship on the product they are contracted to handle on behalf of the supplier.

In view of the above arrangements, the country has the capacity to regulate, handle, store, distribute and use all the classes of requested insecticides covered under this SEA.

5.10.2 LAWS AND REGULATIONS

A. International Conventions Governing IRS Operations in Zimbabwe

The sustainable management of natural resources, protection of the environment and prevention of pollution and environmental degradation is governed by the provisions of the Environmental Management Act and its subsidiary instruments. The legislations outline the requirements for registration of pesticides in Zimbabwe as well as the appropriate packaging and labelling.

Zimbabwe is signatory to Multilateral Environmental Agreements (MEAs) that governs pesticide management in member states. Some of the MEAs include:

• The Montreal Protocol on Substances that Deplete the Ozone Layer, 1987
• The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1992
• The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, 2004
• The Stockholm Convention on Persistent Organic Pollutants (POPs), 2004

The Stockholm Convention initially targets 12 particularly toxic POPs for reduction and eventual elimination, while setting up a system for tackling other chemicals identified as unacceptably hazardous. Nine of these POPs are pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, and toxaphene), two are industrial chemicals (hexachlorobenzene and PCBs/PCTs) and two are unintentional byproducts of various industrial activities (dioxins and furans). In order to phase out these chemicals (and others that may be listed in future), the Convention sets in place bans and/or limits on their production and use.

The conventions limits the production and use of DDT to controlling disease vectors such as malarial mosquitoes, or as use as an intermediate in the production of the pesticide dicofol in those countries that have registered for this exemption.
B. Pesticide Registration Laws as Administered by Ministry of Agriculture of Zimbabwe

In Zimbabwe, all pesticides for public health and agricultural usage are supposed to be registered in accordance with the provisions of The Fertilizers, Farm Feeds, and Remedies Act Chapter 18:12; and Statutory Instrument 144 of 2012 Pesticide Regulations before being marketed for use.

No pesticide may be sold in Zimbabwe unless it is registered in terms of above mentioned regulations. These regulations govern all pesticide related activities, including all pesticide registrations, pest control operators, and pesticide distributors and retailers. This includes imports, export, use, distribution, transport, disposal, advertising and packaging.

Pesticides intended for public health usage will be evaluated and approved for the purpose by the WHOPES/PQ. The applicant for registration of the concerned pesticide is responsible for ensuring the products concerned have gone through successful local field trials through the relevant ministries and institutions to the satisfaction of the registration board. Upon registration, the product can then be imported for use in the country.

C. Insecticide Registration Process in Zimbabwe

Registration is done by the pesticide registration office of the Ministry of Agriculture. A standard process is specified for the registration of pesticides. The requirements for registration include random sampling of the chemical, inspection of field test results, and proof of registration in the country of manufacture. Importers’ warehousing facilities have to be inspected by the Pesticide Registration Office and the Ministry of Health and Child Care before the chemical is imported. Standards for the warehousing of chemicals include:

- Fire Extinguishers
- Septic Tank
- Adequate Ventilation
- Good Drainage System
- Saw Dust in case of spillages
- Located away from Residential Areas and Central Business District (C.B.D)

2. Controlling of pesticide use, handing and waste disposal as administered by the Environmental Management Agency

According to the Environmental Management Act Cap 20:27, Any person who intends to manufacture, import or process a new pesticide or toxic substance or who intends to reprocess an existing pesticide or toxic substance must apply to the Environmental Management Board in the prescribed manner for the registration of the pesticide or toxic substance, before importing, manufacturing, processing, or reprocessing such pesticides or toxic substance (1).

The application referred to in (1) shall include the name, trade mark, and the molecular structure, proposed categories of use, estimate quantity of the pesticides or toxic substances and any data related to health and other environmental effects that the Environmental Management Board may require.

The Environmental Management Board may, upon application in terms of above stated sections, register a pesticide or toxic substance subject to such conditions as may be prescribed or as the Board may determine. Every pesticides or toxic substance shall be registered for a period of ten years unless some other period is prescribed or specified by the Environmental Management Board. The registration may be renewed for a further period of ten years at a time or such other period as may be prescribed or specified by the Environmental Management Board.
refuses to register any pesticide or toxic substance, the notice of refusal shall state the reasons for such refusal.

The Environmental Management Act CAP 20:27, enacted in 2006, was crafted to provide for the sustainable management of natural resources and protection of the environment. It also provides the prevention of pollution and environmental degradation; the preparation of a National Environmental Plan and other plans for the management and protection of the environment. All other environmental management statutory instruments were derived from the EM Act.

The following regulations support the enforcement of Environmental Management Act Cap 20:27;

EMA is responsible for enforcement of the Environmental Management Act and Regulations i.e.

- S 1 77 of 2009 Environmental Management (Importation and transmit of Hazardous substances regulations), 2009.
- S 1 10 of  2007 Environmental Management (Hazardous waste management regulations), 2007
- S 1 12 of 2007 Environmental Management (Hazardous Substances, Pesticides and other toxic substances) regulations, 2007.
- S 1 129 of 2011 Environmental Management (Hazardous Substances, Pesticides and other toxic substances) amendment regulations, 2011 no 3. Prohibition of storage of Hazardous substances without license.
- S 1 5 of 2011 Environmental Management (Hazardous Substances, Pesticides and other toxic substances) amendment regulations, 2011 no 2. (Registration of Pesticide Transporters).

In Zimbabwe the following are punishable offences

- Discharge of any type of waste directly into a water body
- Discharge of hazardous waste on any other part of the environment without a license from the Agency.
- Transportation of hazardous waste without a license issued by EMA
- Storage of insecticides without a license issued by EMA

Environmental Health Department MoHCC

The Environmental Health Department of the Ministry of Health and Child Care is responsible for the enforcement of the Public Health Act Cap 15:09. The purpose of the Public Health Act is to protect the health of human beings from any environmental factors that are injurious or offensive to health.

Public Health Act CAP 15:09 section 85 (e) and (n) define what constitutes a nuisance as “any accumulation or deposit of refuse, offal, manure or other matter whatsoever which is offensive or which is injurious or dangerous to health.

The Department also enforces the provisions of The Public Health (Port Health) Regulations 200 of 1995, which controls the importation of Hazardous substances at all ports of entry, in liaison with the Environmental Management Agency

5.11 The Provisions Made for Training of Users and Applicators

The effectiveness of the IRS program depends on the availability of adequately trained spraying personnel, well-maintained equipment, and competent supervision, as well as end-user acceptability and compliance. PMI has developed guidelines for IRS operations (“Best Management Practices (BMP) for Indoor Residual Spraying in Vector Control Interventions”, updated 2015), and provides a training manual “Spray Operator Pocket Guide” (A. Were, (2014)). Other resources include the Manual on
Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning, USAID PMI’s IVM PEA (USAID, 2012 and 2017), as well as this SEA, all of which provide precautions and recommendations on many aspects of IRS operations. The IRS BMP manual and the PMI IVM PEA requirements are the primary references and have precedence, but the other documents may be used as a reference. It is not incumbent upon the IP to comply with non-PMI documentation except where required by law. However, PMI/USAID requirements are usually stricter than others’, so there should not be a conflict.

PMI will support the training of spray operators and supervisors, and provide overall guidance and logistical support to the IRS operations in Zimbabwe. The contractor will continue to provide technical support for environmental compliance, with a medium-term goal of building national capacity to progressively transfer responsibilities. Preparations will include the following:

- A training of trainers program, in which potential supervisors, storekeepers and team leaders are trained on all aspects of IRS operation. Areas of training shall include planning of IRS, household preparations, record keeping, community mobilization, rational/judicious use of insecticides including sprayer and PPE cleaning, personnel management, environmental aspects of IRS – including geographical reconnaissance, and data recording and analysis.
- The training of temporary workers recruited from local areas and trained as spray team members (operators, team leaders, and wash persons). New operators will receive five to seven days of training prior to the spray operations.

5.12 THE PROVISIONS MADE FOR MONITORING THE USE AND EFFECTIVENESS OF THE PESTICIDE

Two kinds of measurements are needed to provide a complete understanding of the effectiveness of pesticide that is being used for IRS. Direct methods measure the efficacy of the pesticide, that is, the degree to which the pesticide is able to kill the targeted mosquito vectors. These methods rely on entomological evaluations of pesticide contact bioassays and related pesticide resistance methodologies as recommended by WHO. The second broad level of measuring the effectiveness of the pesticides relates to the primary goal of reducing the local disease burden. These efforts will require specialized entomological and epidemiological skills and the assessment of the impact of vector control operations, and possibly the assignment of the contributory impact of the IRS operations. This latter measurement is usually done through a combination of methodologies such as measuring the changes in parasite inoculation rates, passive case detection at health centers, and periodic community fever and parasite surveys (active case detection).

Another key characteristic of pesticide effectiveness is the longevity of the treatment. This characteristic has important economic and health implications: the program must adjust its spray schedule to make sure that there is active pesticide on the walls of homes during critical breeding periods. Unfortunately, the guidance that is provided with regard to effective period for each pesticide is very broad (e.g. 3-6 months), and the effective period is probably subject to complex environmental factors such as heat, humidity, and substrate (wall, ceiling) composition.

However, pesticide manufacturers are well aware of the need for duration of effectiveness, and in some cases are reworking their formulations to provide greater longevity. This is the case for pirimiphos-methyl (organophosphate), which has been formulated as a capsule suspension (CS) that may extend the effectiveness of the application out to six months. Because of the length of the malaria season in
Zimbabwe, this characteristic may be critical to the success of IRS. Therefore pirimiphos-methyl in the CS formulation will be used for PMI spraying in the selected districts in 2017.
6. SAFER USE ACTION PLAN

This section outlines the safer use action plan proposed for the potential adverse impacts outlined above. The primary mitigation measures include delivery of a mix of IEC approaches targeting the residents and spray operators and all IRS personnel, training of spray operators and strengthening supervision and monitoring, and provision of appropriate PPE. The mitigation measures, along with monitoring and reporting information, are compiled in the EMMP found in Annex A.

6.1 IMPLEMENTATION CONDITIONS

During implementation, USAID/PMI/Zimbabwe and its PMI IRS IPs will adhere to the conditions detailed in this Safer Use Action Plan, and in the Environmental Monitoring and Mitigation Plan (EMMP), Annex A of this report.

6.1.1 PREPARATION FOR SPRAY

Prior to spraying, the contractor or implementing partner will:

- Conduct a preliminary logistical assessment to quantify eligible house structures, target population, spray equipment, insecticide, and spray teams and identify suitable sites and facilities for pesticide storage and disposal of effluent waste.
- Develop selected sites for year-round and temporary storage of IRS equipment and insecticide, and construct effluent waste disposal facilities as necessary.
- Identify sensitive areas (water bodies, protected habitat, aquaculture activities, etc.) to avoid during IRS.
- Promote acceptance of IRS in the targeted communities through information, education and communication (IEC) activities. Households have the opportunity to “opt-out” of participation in IRS after hearing the IEC messages on benefits and risks.
- Train spray teams in a variety of positions, including site managers, team leaders, spray operators, overalls washers, site attendants, security guards, and water fetchers.
- Procure, transport, and store all necessary spray and personnel protective equipment (PPE), insecticides, and consumables, and
- Implement this Safer Use Action Plan and the Environmental Mitigation and Monitoring Plan (EMMP) in Annex A of this SEA throughout all processes.

6.1.2 IMPLEMENTING PARTNER REQUIREMENT

1. The prime contractor for the project (“the contractor”, or “the PMI IRS implementing partner”) or his designee will develop this SEA that specifies the conditions under which IRS may be implemented.
2. The PMI IRS implementing partner(s) will follow the prescriptions of the EMMP contained herein, including monitoring and reporting to assure appropriate implementation and the sufficiency of environmental compliance measures.
3. The PMI IRS implementing partner(s) shall integrate these environmental compliance measures into the project work plan and report on them in the normal basis of project reporting,
including the EMMR Annual Reporting Form, which will be included in the end of spray report (EOSR). The PMI IRS team shall assure that this integration occurs.

4. The PMI IRS implementing partner(s) will ensure that training is provided to all IRS staff and workers as prescribed by the EMMP and USAID’s Automated Directives System (ADS) 204.5.4.

5. The PMI IRS implementing partner(s) will notify PMI/IRS of any work plan activities outside the scope of the SEA, and the PMI unit will independently audit the work plan against the requirements of the SEA.

6. Any activities not addressed within the SEA must be addressed with an SEA amendment that must be approved by the Global Health and Africa Bureau Environmental Officers (BEO) before the activities in question can go forward.

7. The PMI IRS team shall ensure that the contractor’s or PMI IRS implementing partner’s responsibilities with respect to environmental mitigation and monitoring will be incorporated into contracts, grants or any other sub-agreement and scopes of work.

8. For projects currently in implementation, PMI/Zimbabwe, with the assistance of the Mission Environmental Officer (MEO) and/or the Regional Environmental Advisor (REA) as necessary, will discuss SEA conditions with the contractor, and where necessary, come to appropriate agreement regarding the process for implementing these conditions as a mid-project adjustment.

9. As devising and implementing environmental compliance approaches should be an integral part of work plan development, these procedures place this responsibility principally on prime contractors. PMI IRS team’s primary role is thus to review and monitor, as with the execution of any other part of the work plan. Where such review and monitoring indicates unforeseen environmental impacts or that mitigation and control measures are insufficient, the PMI IRS unit will consult promptly with the REA, to revise and adapt the environmental mitigation measures as necessary.

### 6.1.3 Policy Planning and Institutional Requirements

- **Prohibit IRS in sensitive ecosystems** (i.e. within 30 meters of the core zone of protected areas (National Parks, National Reserves, etc.), flood zones, wetlands, rivers, dams, lakes, fish farms, beekeeping areas, etc.); IRS uses insecticides that could negatively impact such sites. In line with the established best practices for IRS, and relevant national and USAID policies, the PMI IRS implementing partner will establish and implement mitigation measures to assure adequate protection of these sensitive ecosystems.

- **Develop and implement a vector resistance management plan.** Appropriate measures will be undertaken to prevent/manage resistance and to ensure the continued effectiveness of insecticides used for IRS.

- **Promote inter-sectoral collaboration frameworks and institutional arrangements to facilitate a comprehensive approach to vector control and associated pesticides management.** Coordination between the Ministry of Health and Child Care and major stakeholders will be strengthened. This will include collaboration with:
  - **MoHCC** is responsible for planning, health policy guidelines, surveillance, monitoring and evaluation, allocating funds, and sourcing key health inputs including drugs and equipment for service delivery.
  - **Ministry of Environment, Water and Climate (MEWC)** is the principle authority for policy formulation on land, environment, natural resources and pollution control. The MEWC co-ordinates, monitors and evaluates the operations of the executive agencies that have been created to implement policies on behalf of the government. EMA is responsible for implementing the Environmental Management Act which provides a legal
framework for the use and correct management of the environment and its components and to assure the sustainable development of Zimbabwe. EMA under PTS regulation is responsible for regulating the importation and use of pesticides as well as implementing international conventions governing such pesticides. It issues permits for the importation, distribution and storage of pesticides.

- DDT is currently used by the Government of Zimbabwe for IRS operations and is registered for Public Health use. PMI and does not use DDT and does not expect to use DDT in its IRS program in Zimbabwe. DDT is categorized as a persistent organic pollutant (POP); therefore, its management needs to be in accordance to the Stockholm Convention on Persistent Organic Pollutants. Other conventions that regulate DDT management and use include the Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and Their Disposal, and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. The use of DDT for IRS must be closely monitored and reported to WHO and to the Secretariat of the Stockholm Convention. PMI IP Zimbabwe will assist the Government of Zimbabwe as necessary with Stockholm Convention reporting requirements.

- DDT should be used under strict control and only for the intended purpose. Using it in any other way would have important consequences, such as violation of international conventions, and the possible contamination of food and agricultural products, including export goods, with a potential impact on international trade.

- The need for DDT should be evaluated regularly by the parties to the Stockholm Convention. The results from these evaluations will depend, among other things, on: insecticide resistance status of local vectors; availability of alternative insecticides; control methods and strategies; and level of funding allocated to malaria vector control.

6.1.4 OPERATIONAL REQUIREMENTS

PMI and the PMI IRS implementing partner will work with EMA, NMCP and MoHCC to access relevant country level authorization and support needed for successful IRS implementation. PMI IRS implementing partner will work closely with the NMCP, MoHCC and the PMDs to coordinate and implement the IRS program at the field level. PMI will work with all government partners in the following areas:

- Ensure quality assurance for commodity procurement and IRS operations to minimize risks to human health and the environment. This will include ensuring legitimate procurement sources, verifiable chain of custody of commodities, and representative sampling and analysis of pesticide, as well as effective quality compliance inspections of IRS activities in the field.

- Ensure compliance with national regulations on pesticides and this SEA EMMP for registering, importing, transporting, labeling, handling, use, storage, and disposal of pesticides. If there is a conflict, this SEA’s EMMP normally has precedence, as it is based on the USAID PMI IRS BMP that was prepared specifically for PMI IRS programs and includes international regulations. USAID compliance requirements are usually stricter than country requirements; however, if country requirements are stricter, they must take precedence.

- Train relevant categories of workers involved in IRS operations (e.g. district program managers/coordinators, team leaders, spray operators, porters, storekeepers, pesticide transporters/drivers, washpersons, and guards) on best practices in accordance with national pesticides regulations and this SEA (which includes recommendations/guidelines of World Health Organization (WHO). Criteria for reprimanding or punishing nonobservance of best practices by these workers will be established.
• Ensure use of appropriate PPE and best practices, including effective field supervision of spray operations, for adequate protection of spray operators and other handlers of pesticides or pesticide-contaminated waste.

• To avoid undue exposure of householders and spray operators to DDT, standard operating procedures and national guidelines should be in place and strictly followed. Appropriate management of DDT also entails adoption and enforcement of stringent rules and regulations to avoid leakage (e.g., into agricultural use) and misuse (e.g., when used in domestic hygiene). This includes the possibility of appropriate legal measures in the event that individuals or entities do not comply with this condition.

• Train health workers in the management of insecticide poisoning. This will include pesticide-specific guidelines on poison treatment; designation of district hospitals or health centers within the target areas for appropriate treatment of insecticide poisoning; training of IRS workers to recognize early danger signs of poisoning and taking appropriate action.

• Enforce protection of fetuses and suckling children against exposure in spray operations. Exclude pregnant women and breastfeeding mothers from direct handling of pesticides (e.g. spray operators or washers, entry into pesticide storage areas, etc.). Before each spray season, and every thirty days thereafter during operations, pregnancy testing will be established for potential female handlers of pesticides.

• Work with NMCP to carry out Information, Education, and Communication (IEC) activities for targeted communities and households to reduce exposure. Provide information on the removal of food, cooking and water utensils, covering of unmovable furniture with impermeable plastic prior to spraying; exclusion of spraying homes inhabited by pregnant women or sick individuals who are unable to leave the structure to be sprayed; preventing the reentry to sprayed rooms for at least two hours after spraying, then airing sprayed rooms at least ½ hour via open windows and doors; sweeping of floor residues before reentry of children or animals and disposal cleaning wastes including dead insects in pits or latrines.

• Establish strict practices to reduce environmental contamination from pesticides used in this program. This will include comprehensive pesticide chain of custody, auditing of pesticide stocks and pesticide usage, as well as enforcing best practices related to the handling, washing and disposal of containers; Progressive use of waste/wash water and ablution blocks, and training on proper maintenance of spray pumps to prevent leakages.

• Establish best practice for the transport of spray operators. This includes providing trucks with benches for transport of spray operators, and ensuring that bulk insecticides are not transported in the same compartment as spray operators. Contract specific insurance for covering spray operators during spray operation. Strengthen training of drivers to limit risk of traffic accidents.

• Provide IRS Training of Trainers (TOT) and training of spray operators on potential negative impacts of environmental contamination and the appropriate PMI IRS BMPs to avoid or minimize these impacts.

• Provide training support, as necessary, to strengthen the supervisory capacity of EMA and MoHCC at National, Provincial, and District level for day-to-day monitoring environmental compliance of IRS activities.

6.1.4.1 Supervisory Structure

In coordination with the PMI IRS contractor, EMA with the NMCP/MoHCC will carry out routine compliance inspections of all IRS districts, including unannounced spot inspections, to verify compliance
with all relevant national regulations. The PMI IRS contractor will also conduct inspections, including unannounced spot inspections, of IRS activities and facilities in the IRS districts.

The District Health Executive (DHE) is composed of the District Medical Officer (DMO), Health Services Administrator, District Nursing Officer, Public Health Officer, the District Environmental Health Officer (IRS Managers), and other health personnel. The DHE has a strong supervisory role throughout the duration of the spray round. Each DMO supervises the field activities in his/her district to help ensure quality and performance of the spray teams.

AIRS Zimbabwe in collaboration with NMCP will take the lead on implementation of IRS activities in the spray districts while the NMCP will lead IEC efforts, or BCC efforts, in all districts that will receive direct funding from PMI. In addition, the NMCP will lead the national planning meeting, national evaluation meeting, TOTs, and IEC trainings in all districts. The PMI Zimbabwe IP will work together with the NMCP and DHE to ensure supervision of spray performance during the campaign.

The District Coordinator (DC) will ensure the quality of the spray operations and administrative duties. He/she also works in close collaboration with the District IRS Manager to manage the planning and coordination of IRS activities. The DC supervises all logistical operations such as store keeping and transportation. And he/she ensures all risk preventions and environmental compliance measures are fully implemented. The District Coordinator and the IRS Manager will coordinate all IRS activities. An operational spray plan (progress calendar), produced during the microplanning and validated by the DHEs, indicating all communities to be sprayed during the spray operations will be maintained by the DC. The District Coordinators will hold weekly meetings with the DHE to discuss operational issues and their solutions. During these meetings, the partners will assess the progress of spray operations, ensure that the planned work schedule is strictly adhered to, and make recommendations as necessary to the IRS project or IEC implementers.

The IRS coordinators at camp level evaluate the work of the spray teams and IEC activities in the field. He/she also inspects structures that have been sprayed to check quality of spraying and that proper protocols have been fully followed. IRS coordinators mostly EHTs, monitor the effectiveness on beneficiary populations of IEC campaigns by visiting sprayed houses to discuss beneficiary impressions, and visiting unsprayed houses to discuss with heads of families why spraying is important. Regarding spray technique and spray operator discipline, monitoring will involve visiting the sprayed compounds and interviewing beneficiaries to ensure that spray operators respect household members, spray all eligible rooms, record the essential data in the relevant form, mix and apply insecticides at the right dosage, and pass the relevant health information to the household. IRS coordinators will provide oversight to ensure the goal of day-to-day achievement of environmental compliance. At the end of each day, team leaders at each operational site will meet with the team leaders to discuss the day’s events, challenges faced, and recommendations for resolving problems.

The Team Leaders oversee spray operators to ensure spraying occurs according to best practices. They will also ensure sprayer equipment and PPE are properly cleaned daily, as well as review data collection for accuracy. They are also responsible for tracking insecticide sachets.

The Environmental Compliance Officer will visit each IRS campsite during the spray operations and complete the Environmental Compliance Checklists. The Environmental Compliance Checklists are versions of those found in the PMI IRS BMP Manual (2015) for use in the field. The checklists ensure that all best management practices are being implemented and are effective, or that immediate action is taken to correct non-compliances.
The PMI IRS implementing partner will maintain records of program performance reports which will be able to demonstrate adherence to PMI IRS BMP, quality of training and supervision, procurement activities, and environmental compliance. Such reports include the pre- and mid-spray environmental compliance reports (checklists), reports on core IRS indicators and end-of-spray evaluation reports.

Good supervision will also require observing each spray team during implementation to ensure best practices for insecticide storage and solid waste management. Since the reports of the operators are the basis for all reporting and data collection, supervisors will ensure that they are completed accurately and promptly at the end of the spraying day.

The districts are divided into IRS campsites to facilitate operation and implementation. IRS campsites develop their operational plans with support from the DCs and IRS Managers. To ensure that IRS operations are running smoothly, in each district, AIRS Zimbabwe will have a district operations team made up of:

- District coordinator (full-time);
- Stores Officer/Logistics assistants (Seasonal)
- Data entry clerks (seasonal);
- M&E assistants (seasonal);
- A team of SOPs with one Field Supervisor per 3-5 SOPs; and
- One Team Leader per 15 SOPs

In an effort to transfer more responsibilities to the NMCP and Provincial Medical Directorates (PMD) and government entities, the team will continue to work with the DHE. However, the AIRS Zimbabwe Environmental Compliance Officer (ECO) will remain responsible for the pre-spray assessments of every operations site (storeroom and wash areas) two months before spraying.

Prior to spray operations, the district teams will develop spray progress plans, in collaboration with health posts, health committee chairs, and other local officials who have greater knowledge of the villages and settlements targeted for spraying. To quantify the number of structures to be sprayed in 2017 (or any upcoming year), the project will use 2016 (the previous year’s) data for structures/rooms found by SOPs (spray operators).

Each site will have two to five teams, each comprised of up to 15 SOPs and other staff as listed below:

- District Coordinators;
- EHT supervising spray techniques in each site;
- Team leaders (one for each team);
- Field Supervisors for every 3-5 Spray Operators
- SOPs (15 in each spray team);
- Warners (IEC community mobilizers);
- Storekeepers;
- Drivers;
- Washers;
- Guards;
Data Managers; and
M&E Assistants

The SOPs will work seven days per week with average hours of operation from 6AM to 5PM for two periods of 15 days each, separated by a 7-day break. The project will ensure SOPs transportation to and from spray villages with traditional vehicle transportation while exploring new ways to reduce higher operational cost and increased environmental risk. Examples include: organizing camp sites to reduce considerable transportation costs in remote areas. Every morning, spray personnel will receive PPE, insecticide for the day, spray pumps, and data collection materials.

To track daily results and promote competitive performance, the districts will be using the spray performance tracking sheet that was successfully introduced in 2013 as well as the mobile phone-based performance tracker (PMT) introduced in 2014. Additionally, the PMI AIRS Project will utilize a simple SMS platform to send helpful job reminders to hired seasonal workers. The objective of these job-aid text messages is to reinforce key behaviors for high-quality and environmentally sound spray implementation (i.e. proper use of PPE, proper data collection tips, etc.).

The AIRS Zimbabwe operations manager will review the performance tracking sheet weekly (at least) for all operations sites. Spray teams’ performance will be shared periodically with DMOs, MoHCC and the NMCP. The use of the PMT will allow the DMO, DHE, NMCP, and PMI to have daily access to spray data (including number of structures sprayed, number of people protected, insecticide use, and SOP attendance).

District storekeepers/Logistics assistants will be responsible for regular supervision of secondary site stores to ensure appropriate stock and waste recordkeeping.

The AIRS PMI project will continue enhancing efforts to increase women’s participation in IRS operations. Specifically, AIRS Zimbabwe will use planning meetings and meetings with local leaders as a venue to advocate for recruitment of women as SOPs, team leaders, store keepers, data entry clerks and M&E assistants. The project will also work with existing female SOPs and community-based organizations including women and youth associations to promote this job to other women. AIRS Zimbabwe will work with the DHE/PHEs to ensure the IRS program creates a safe working environment for female workers in securing toilet and dressing rooms for them. The project will review conditions of camps sites for operators to ensure the safety and protection of women. The project will also plan to advocate communities’ participation for free sites. AIRS Zimbabwe will offer SOPs tarpaulins or mattresses for better sleeping conditions in camping sites.

### 6.1.4.2 Insecticide Selection

The insecticide selection and the timing of the spray cycle are generally dictated by MoHCC and are based on the results of annual entomological studies. The insecticide will normally be procured by PMI/USAID program.

### 6.1.4.3 Quantification of Pesticide Requirements

PMI IRS IP will conduct an annual logistics assessment for all targeted districts for planning and procurement of the correct quantity of materials, including insecticides. Purchase of insufficient pesticide will lead to shortages, delays, and possibly the inability to spray all targeted areas. Purchase of too much pesticide may lead to expiration of the pesticide before it can be used up, which creates serious storage and disposal problems.
6.1.4.4 **PESTICIDE QUALITY ASSURANCE**

The procurement and use of pesticides that do not meet the necessary quality assurance standards can compromise the overall spray quality and desired vector action while at the same time could expose the residents and spray operators to hazards related to altered toxicological characteristics.

USAID PMI program will procure the insecticide from a reputable supplier. Pesticide batches will be analyzed for the concentration of the active ingredient prior to shipment to Zimbabwe. Additional sampling and testing may be performed upon arrival. Delivery of all insecticide to the central warehouse in Mutare will be supervised by PMI and NMCP before being dispatched to the districts where spray operations will be concentrated.

6.1.4.5 **QUALIFICATION OF WAREHOUSES (STORAGE FACILITIES)**

IRS pesticides can cause adverse impacts to human health, animals, and the natural environment if not properly stored according to PMI BMPs. Before insecticides are procured or transported to the spray areas, suitable warehouse(s) must be assessed to ensure that they can meet BMP standards. During the geographical reconnaissance and logistics assessments, the need for new or rehabilitation of previously used district warehouses to meet PMI IRS BMP standards for pesticide storage will be assessed. The standards include:

- Located as far as feasible from: flood plains, wetlands and water bodies, markets, schools, residential, beehives, and protected areas
- Spacious enough to store insecticides in bulk and to store other IRS commodities separately
- A separate space for the storekeeper’s office.
- Well ventilated and allowing for air circulation and better temperature control
- Built of concrete or other solid material
- Impervious flooring, or floor must be completely covered by a tarpaulin
- Watertight roofing
- Barred and screened windows
- Preferably 2 exits from the pesticide storage area for emergency purposes

In addition to the above, all facilities used for storage, distribution, and transportation of insecticide products should comply with relevant requirements of Zimbabwean pesticide regulation. During the logistical needs assessment, the PMI IRS IP will identify warehouses at the district level that can meet these requirements. PMI cannot provide funds for the construction of new buildings, but can assist in the modification or renovation of existing facilities. In Zimbabwe, IRS is implemented in partnership with the MoHCC/NMCP, therefore, some warehouses are located on District Health Office property for logistic and security purposes.

6.1.4.6 **QUALIFICATION OF LIQUID WASTE DISPOSAL FACILITIES (WASH AREAS, SOAK PITS AND EVAPORATION TANKS)**

Pyrethroids, OPs and carbamates degrade quickly when exposed to environmental action such as photolysis, hydrolysis, and bacterial action. If wash areas and soak pits are properly constructed in appropriate locations and used according to BMPs, liquid pesticide waste will be captured in the charcoal layer of the soak pit and held until it breaks down by these natural processes.

Cleanup from spray operations using DDT will be performed in a wash area that drains to an evaporation tank or other capture/treatment device, in order to prevent a gradual build-up of DDT
concentrations near wash areas. At the end of the season, the evaporation tank dries up, and the solid residue is carefully collected for proper disposal in an approved incinerator.

Site considerations for locating IRS cleaning and waste facilities (progressive rinse, wash areas, soak pits, and tanks) include soil type, topography, vertical distance to ground water, and proximity to schools, lakes, streams, and other sensitive areas. Ideally, disposal facilities should be located adjacent to the storage facilities, where they can be more easily protected and monitored. However, the setting or the function of buildings provided for storage are not always appropriate for siting a wash area, so it may need to be placed some distance away. Due to access limitations and distance to some spray sites, it may be more feasible to locate a small wash facility in an appropriate area near the spray site.

Soak pits and evaporation tanks must be located at least 30 meters from any sensitive areas such as water bodies, flood plains, habitat, schools and other public buildings, areas protected by regulations, and areas of high groundwater. They should be located on relatively high ground to increase the vertical distance to groundwater. The general area should be level, but the wash area must be constructed to slope gently toward the soak pit or toward the collection point that is piped to the soak pit/evaporation tank.

Soil characteristics affect how pesticides move through the soil, and how they break down by environmental or micro-biological degradation. Clay soils have a high capacity to absorb many pesticides, but if hard-packed, may have limited percolation abilities. Sandy soils have a much lower capacity to absorb pesticides, but liquids percolate rapidly. Where possible, locate facilities on fine textured soils with organic content and good absorptive properties. Hard packed clay or rocky soils are not appropriate.

Pesticides may move in water runoff as compounds dissolve in water or attach to soil particles. Facilities should be located on high, level ground to minimize exposure to runoff. Avoid steep slopes or natural runoff flow lines. Where necessary, curbs or berms will be constructed around wash areas to divert storm water runoff away from the soak pit/evaporation tank, and to contain any spills or overflows. In very rainy areas or seasons, it may be necessary to cover the soak pit/evaporation tank and wash area when not in use with a tarpaulin, to prevent flooding of the soak pit and subsequent runoff of pesticide-contaminated water.

6.1.4.7 Supply Chain and Disposal Options

The PMI IRS implementing partner will work with the relevant authorities and will employ the pesticide chain management as shown in Figure 6-1 in its Zimbabwe IRS program to ensure control. The chain of custody procedures are based on PMI IRS BMPs (and as previously mentioned, these BMPs include WHO, FAO and other international guidelines).
### FIGURE 6-1: PESTICIDE CHAIN OF CUSTODY AND MANAGEMENT

<table>
<thead>
<tr>
<th><strong>Manufacture</strong>: PMI IRS implementing partner supplements pesticides for PMI program as needed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality Control</strong>: Pesticide samples will be tested for chemical properties and efficacy internationally.</td>
</tr>
<tr>
<td><strong>Port of entry</strong>: Pesticides will be collected by PMI AIRS staff and NMCP representative</td>
</tr>
<tr>
<td><strong>Transportation</strong>: All drivers must be trained in proper pesticide handling and transportation safety measures as per the PMI IRS BMP. All vehicles must meet BMPs requirements. A PMI AIRS and MoHCC representative will escort the insecticides to the central storage facility and, where possible, EMA officials will be included to escort the insecticide to the central storage.</td>
</tr>
<tr>
<td><strong>Central Storage</strong>: Pesticide will be stored in warehouses that meet the specifications detail in the BMP manual for storage and transport of pesticides</td>
</tr>
<tr>
<td><strong>Spray Operators</strong> must sign out all pesticides received daily and return empty sachets or bottles at the end of the day as per the Insecticide Distribution Section below</td>
</tr>
<tr>
<td><strong>District Storage</strong>: Empty containers will be stored in warehouses that meet the specification detailed in the BMP manual for storage and transport of pesticides</td>
</tr>
<tr>
<td><strong>Disposal</strong>: All empty pesticide sachets will be incinerated in an approved incinerator. All plastic containers will be triple washed and recycled at an approved facility.</td>
</tr>
</tbody>
</table>

### 6.1.4.8 PESTICIDE TRANSPORT

After the receipt of insecticide at the central warehouse, insecticides are transported to the district warehouses by road. During transportation, there is a risk of vehicle accidents and consequent insecticide spillage. It is essential that the vehicle type and speed of transport be matched to the conditions. Drivers must take no chances.

A lockable box truck is the preferred vehicle to transport insecticides from central to district stores. All vehicles must be in good condition and pass the Pre-Contract Vehicle Inspection performed by the Environmental Compliance Officer or their qualified designate, using a smart phone. If during transport, the pesticides are to be left unattended for any period of time, including lunch breaks or overnight stops, a lockable box truck is essential.

Prior to long-distance transport of the insecticide from the customs warehouse or PMI Zimbabwe central storage facility, drivers will be informed about general issues surrounding the insecticide and how to handle emergency situations such as accidents or spillage. Training for long-distance transport will include the following information:
• Purpose of the insecticide (indoor usage for malaria protection, not for agricultural or any other outdoor use)
• Toxicity of the insecticide
• Security issues, including implications of the insecticide getting into public access.
• Hazardous places along the routes to be taken, and mitigation measures.
• Steps to take in case of an accident or emergency (according to BMP standards)
• Combustibility and toxicity of the combustion byproducts of insecticide

Drivers hired for intra-district transport of insecticide and spray team members during the spray campaign will receive training in:

• Operator transportation best practices and vehicle requirements from PMI IRS BMP #2, Worker and Resident Health and Safety.
• Health and safety as provided to spray operators, with the exception of sprayer operation and spray practice.
• Handling an accident or emergency according to BMP standards.
• Handling vehicle contamination.
• Vehicle decontamination procedures

Figure 6-2 below provides a list of key responses to mitigate the impact of the insecticide spills.

**FIGURE 6-2: EMERGENCY RESPONSE TO A SPILL**

**IN CASE OF INSECTICIDE SPILLS**

1. Control, contain and clean up the spill
2. Protective clothing should be donned prior to attempting to clean the spills.
3. It is imperative to avoid fire as a result of the accident and a fire extinguisher should be deployed just in case. The engine should be shut off and smoking in the area strictly prohibited.
4. Onlookers and bystanders should be cautioned against approaching the accident site.
5. If the crew has come in contact with the pesticides, they should remove contaminated clothing immediately and wash the pesticide off their skin.
6. For major spills send for help immediately; drivers must have cell phones and an emergency number for use in such cases.
7. People should be kept away and the spill covered with earth, sand, etc.; no attempt should be made to wash away the spill with water or other substances.
8. Vehicles that are used for transporting large quantities of pesticides should be equipped with a bucket of sand, sawdust or soil, a shovel, and fire extinguisher.
Because vehicles used for insecticides transportation can be used for the transport of other goods, including food, it is important to ensure that vehicles are decontaminated. The drivers will be responsible for cleaning and decontaminating the interior of the vehicle and exterior bed at the end of the spray campaign. Drivers will be provided with gloves, overalls, and rubber boots to wear for cleaning the vehicle. All cloths used in wiping down the interior and bed of the vehicle will be washed with soap and water.

If pesticide is transported over water, BMP #10, Water Transport (PMI IRS BMP Manual, 2015) must be followed in every detail.

6.1.4.9 Health and Safety in the Warehouse

The following measures are required in all warehouses in order to reduce cases of pilferage, exposure through leakages and theft, and to ensure the health and safety of those accessing these facilities:

- Guarded 24 hrs./day
- Warehouse must be double-padlocked.
- All the storage facilities must have thermometers installed for daily temperature recording.
- Soap and clean water for washing must be available at all times.
- Trained storekeepers must be present and wear appropriate PPE when in the pesticide area of storage.
- Pallets are available for proper storage of insecticides and must be used
- Pesticide stacking position and height in the warehouses must not be above 2 meters in height unless placed on sturdy shelves.
- Fire extinguishers must be available in the storage facilities and all workers trained on how to use them.
- Hazard warning notices must be placed in the outside of the store in pictorial form (skull and crossbones).
- First aid kits must be fully stocked and available in all the central warehouses and secondary stores. Security and inventory management of first aid supplies is mandatory.

Inhalation of toxic fumes in the event of a storehouse fire is a major risk of IRS. The risk can be minimized, however, by following BMPs for storage, including prohibiting lighted materials in or near the warehouse or in the vicinity of pesticides during transport to/from vehicles, providing fire extinguishers, and proper ventilation of storerooms.

6.1.5 Fetal Exposure (Pregnancy Testing)

All female candidates for spray teams will be tested for pregnancy before being recruited into the spray operations and every thirty days until operations end. Females found to be pregnant will be re-assigned to positions that do not have the potential for exposure to insecticides. Women who are breastfeeding cannot have any contact with pesticides, and are thus prohibited from spraying of pesticide or washing contaminated items. Due to the possible bioaccumulation and teratogenic effects of DDT, women will not be exposed to this pesticide through duties such as spray operations or monitoring, overall washing, or pesticide storekeeping.

6.1.6 Spray Operator Exposure

The individuals recruited for IRS campaigns will receive intensive training on INSECTICIDE DISTRIBUTION AND MANAGEMENT PROCESS AT DISTRICT AND COMMUNITY LEVELS.
The PMI IRS implementing partner will use, or develop if necessary, standard requisition, tracking, and monitoring forms to be used for inventory, and record and track all the insecticides distributed and returned. These forms will be used in the program at all levels, and the store managers will receive training on how to use these forms. The steps below highlight the insecticide distribution process proposed including recording and tracking methods:

- Upon reception of the pesticide at the central warehouse (the import company is responsible to deliver the pesticide to a determined location) lot numbers and quantities of insecticide are registered on shelf inventory card by the PMI IRS implementing partner storekeeper. All copies are kept at the warehouse.
- District requisitions are approved at the PMI IRS implementing partner program office, where copies are maintained.
- Requisition then proceeds to district warehouses where distribution takes place. All pesticide inventories are signed for based on sachet numbers. Insecticides are distributed on a “first-expired, first-out” system, so that the insecticide with the earliest expiration date is distributed first. This avoids accumulation of expired stock.
- All sachets or bottles are counted and stamped with the relevant stamp and registered on a stock card. Boxes are then resealed with the correct original quantity of sachets inside until the sachets are issued.
- Every morning before the spray operations begin, store managers distribute only enough sachets or bottles for the day’s work to the team operators. The team operator must sign for all pesticides received daily in a logbook.
- At the end of the day, empty and full sachets or bottles are returned and numbers checked against what was signed out. Returned empty and full sachets or bottles are logged into the logbook by the storekeeper or supervisor.
- Supervisor and team leaders examine spray operators’ performance by comparing number of structures sprayed to bottle (or sachets) used to determine whether there is an over or under application.
- Storekeeper must submit the following to the program office for data entry on a daily basis: 1) insecticide stock balances; 2) sign-in/sign-out results; and 3) structures sprayed per spray operator.
- The next day, all previously signed for but unused bottles (or sachets) are reissued and signed for by the relevant spray operator.
- At the end of each day and at the end of the spray round, stock remaining must equal the stock at start of the day minus the number of bottle (or sachets) distributed. Number of bottles (or sachets) distributed should be equal to number of bottles (or sachets) used if there is no returned full bottle (or sachet).

6.1.6.1 PERSONAL PROTECTIVE EQUIPMENT

In accordance with PMI IRS BMP, all persons working on IRS must be adequately protected against potential harm due to exposure from pesticides. All persons with potential direct contact or exposure to pesticides during handling, transportation, storage, use and cleaning of pesticides or pesticide contaminated materials must wear appropriate personal protective clothing in accordance with the safety instructions on the pesticide label or material safety data sheet (MSDS). At a minimum, those handling pesticide will wear a dust mask, overalls, gloves, and rubber boots.

Each team leader, field supervisor, spray operator, and washer will be provided with the following safety equipment to be used during the spraying, in accordance with the PMI IRS BMPs specifications:
- Broad-brimmed hat/helmet
- Face shield or goggles (face shield preferable)
- Dust mask or filtered mask
- Two or more cotton overalls per spray operator (appropriately sized)
- Nitrile rubber, neoprene, or butyl rubber gloves, without inside lining, and long enough to cover the forearm
- Rubber boots
- Cloth to protect the neck.
- Flashlights

For spray operators, safety precautions will depend on the proper use of PPE, and personal hygiene, including washing and daily changing of spray clothes. A schedule for carrying out and supervising personal hygiene, regular washing of protective clothes and cleaning of equipment will be organized along the following lines:
- Spraying staff will be provided with at least two uniforms to allow for frequent changes.
- Washing facilities with sufficient water and soap will be made available in the field at appropriate locations.
- All working clothes must be removed at the end of each day’s operations and a shower or bath taken—in circumstances where a full-body shower or bath is not feasible, face/neck and hands must be washed with soap and water.
- Working clothes will be washed daily by the washpersons hired by the project.
- Particular attention will be paid to washing gloves, helmets, face shields, and boots, and to avoiding contamination of the inside of these items.
- Spray operators will wash before eating, drinking or smoking at the end of the daily spray operation.
- Eating, drinking and smoking during work will be strictly forbidden at all times during operations. If spray operators need to drink water in between spraying structures, they must receive assistance from the homeowner, such that they do not need to handle water containers with gloves or other PPE that has been exposed to pesticides during spray or mixing activities. Because in the field there are no proper disposal facilities for water contaminated by washing gloves and hands, it is recommended that homeowners assist the operator if hydration is needed (for example, holding a cup and straw for the operator).

6.1.6.2 PROCUREMENT OF OTHER IRS EQUIPMENT

The following IRS equipment will be procured alongside with the insecticides and PPEs including:
- Spray Nozzles. The program in Zimbabwe will procure 8002E nozzles for the spray pumps, which are the standard size recommended by WHO for mud and brick walls.
- Spray pumps. Spray operators use Hudson XPERT and Goizper compression sprayers and with shoulder-suspended tanks to apply a measured amount of insecticide on the interior walls of houses and structures. Insecticide is added to the sprayer according to the instructions in the spray operator’s pocket guide for the pesticide in use, the sprayer is agitated and pressurized, and the material is then applied to the interior walls of targeted house (structure). For liquid pesticide formulations, the container must be triple-rinsed during pesticide make-up. After the day’s spraying is complete, spray operators must clean the sprayer following the manufacturer’s recommendations to ensure their proper operation and calibration.
The objective of the trainings is to provide the knowledge and skills to the spray and supervisory teams, and to build the capacity of the host government at the national and district levels to implement, monitor and evaluate a well-organized IRS program.

Training in IRS implementation will be a key element of the PMI IRS program. The planning process for trainings will be carried out in coordination with the NMCP, and the Environmental Health Department (of the MoHCC) and EMA will be actively engaged from inception. The recruitment and training of spray operators are key elements in this process, and require vigorous involvement of implementing partner staff to ensure that when these activities are transferred to NMCP/ DHEs, there will be sufficient local capacity to continue IRS activities.

Drivers:
Drivers are recruited by the transport vendor hired to offer transport services during IRS implementation. Drivers that will transport insecticide will be trained on methods and protocol for safe driving, handling insecticides, and what to do in an emergency situation when transporting insecticides. Drivers will also be trained on insecticide-related security issues, handling vehicle contamination, methods for cleaning vehicles after transporting insecticide, and handling insecticide runoff. They will also be provided with emergency contact cards in the case of an accident.

TOT Training for IRS supervisors:
Participants include representatives from Environmental Health Department, MoHCC, NMCP, and former trainers from past spray campaigns. Key topics that will be covered include the following:

- Malaria epidemiology
- IRS
- Storage of IRS commodities
- Environmental and safety issues concerning IRS campaigns
- IEC
- Spray pump use and maintenance
- Spray technique
- Data management and quality (correct use of forms)
- Basic entomological information
- Supervision, performance monitoring and auditing of spray activities

Graduates of the TOT training for supervisors then conduct the spray operator training with the support of the PMI IRS implementing partner. The training has both theoretical and practical sessions. Training in IRS implementation and supervision is crucial to the overall capacity building strategy of the IRS program. In order to reduce training costs and reduce the facilitator trainee ratio, AIRS Zimbabwe will work with NMCP and MoHCC to conduct TOT trainings in provinces. With support from the PMI Zimbabwe IP, NMCP will be responsible for organizing and coordinating trainings on IEC. In addition, NMCP/MoHCC will organize the trainings on IRS supervision with AIRS Zimbabwe’s support.

Training for District Staff on Environmental Compliance:
Participants will include district health staff identified by the District Coordinator, District Environmental Health Officer (DEHO) who is the District IRS Manager and the Environmental Compliance Officer (ECO). District health staff will be trained on measures taken during IRS operations to meet environmental compliance rules and regulations, based on the EMMP (Annex A). This will include best practices in Environmental Compliance, including pre- and post-spray assessments, inspections, and
reporting. They will also receive training to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training is conducted in accordance with PMI IRS BMP manual (2015).

**Training spray operators, team leaders and base supervisors:**

Participants include spray operators, team leaders and field supervisors identified by the local communities at the health post level. PMI AIRS staff will supervise the trainings sessions. Spray operators will initially be chosen based on their completion of primary school and must pass written and practical tests of their ability to read, write and record critical spray information, and make calculations. They will then undergo medical exams to determine their physical capability for providing appropriate application of the insecticide. All female workers will be tested for pregnancy before training and recruitment as spray operators or washers. Pregnancy tests will then be conducted every 30 days during IRS operations. It is incumbent on the implementing partner to protect female spray operators’ privacy concerning pregnancy testing.

The training includes:

- Insecticide application technique
- Handling a spray pump
- Communication strategies in the field
- Spray operation organization
- Completing Daily Spray Operator forms for accuracy
- Team Leader protocols for checking Spray Operator data (physical and mathematical checks)
- Use of PPE to prevent toxic exposure, environmental compliance and avoidance of spraying in environmentally-sensitive areas

Following the training, a post-training exam is given, and only candidates that receive high scores will qualify as spray operators. The District Coordinator and Team Leaders will identify outstanding trainees and designate them as Field Supervisors to supervise a number of operators.

**Storekeepers:**

Participants will include storekeepers. Training for all storekeepers includes IRS logistics and supply chain management, insecticide storage and security, inventory tracking (stock card use), spill control and management, and IRS waste storage and management. Following the training, an exam will be given, and only those who achieve a high enough score will qualify as storekeepers for the IRS spray campaign. The AIRS Zimbabwe Logistician will work with the ECO to train storekeepers to manage stock and IRS waste effectively.

**Pump technicians:**

Technicians for each operations site will be trained on technical maintenance and repair of the spray pumps and progressive rinsing systems.

**Washers:**

AIRS Zimbabwe staff will lead training for washers on how to wash coveralls and other PPE to protect themselves, and prevent contamination.

**Data Clerks and District Data Manager:**
Data clerks will be trained in IRS data entry; using the IRS database; and methods for reviewing data and assuring data accuracy and quality. The M&E Coordinators and Database Manager will complete the trainings.

**TOT for IEC Coordinators:**

Participants will include IRS managers, DCs, warners, and IEC Coordinators. Training will include modules on the IEC communication protocol, and messaging for the IEC/BCC campaign. The PMI IRS implementing partner with the NMCP IEC department will complete the training.

The main purpose of mobilization is to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles, responsibilities, and behaviors before, during, and after spray operations. Mobilizers are trained to conduct house-to-house mobilization during the first cycle of each IRS campaign. Once the risks and benefits of IRS have been explained, households have the option of declining to participate. Door-to-door communication is the main strategy used for community outreach. PMI IRS implementing partner develops, prints, and distributes household IRS cards as well as IRS fliers and brochures with key IRS messages.

In 2016, PMI continued to support communication activities in areas targeted for IRS to inform potential beneficiaries about the timing of spray activities, what they can expect, the precautions they need to take, and the health benefits of IRS. Finally, tools to collect data on communications activities were revised and materials to support BCC activities (posters, training guides, and manuals) were produced.

**Health Workers in Poison Management:**

Participants include health facility staff identified by the District Coordinator and the DMO. The AIRS Zimbabwe Operations Manager will conduct the trainings. Health facility staff will be trained and prepared for handling insecticide poisonings, skin irritations, and other potential IRS spray campaign injuries. General poison control guidance will be provided. When new pesticides will be used, additional training specific to the symptoms and treatment for that chemical will be provided. Acute exposure can occur through dermal contact, which could lead to absorption into the blood stream as well as skin and eye irritation, inhalation or ingestion. The DMO will be in charge of certifying intoxication cases reported in the field.
### TABLE 6-1: TREATMENT MEDICINES FOR WHO-RECOMMENDED PESTICIDES

<table>
<thead>
<tr>
<th>Pesticide Class</th>
<th>Treatment Medicine(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organochlorine (DDT):</td>
<td>Activated Charcoal (priority)</td>
</tr>
<tr>
<td></td>
<td>Diazepam or Lorazepam (for seizure)</td>
</tr>
<tr>
<td></td>
<td>Phenobarbital</td>
</tr>
<tr>
<td></td>
<td>Cholesteryamine resin</td>
</tr>
<tr>
<td>Organophosphates:</td>
<td>Atropine sulfate or Glycopyrolate (priority treatment)</td>
</tr>
<tr>
<td></td>
<td>Furosemide (less critical)</td>
</tr>
<tr>
<td></td>
<td>Diazepam or Lorazepam (for seizure)</td>
</tr>
<tr>
<td>Carbamates:</td>
<td>Cholestryamine Atropine (priority)</td>
</tr>
<tr>
<td></td>
<td>Furosemide (less critical)</td>
</tr>
<tr>
<td></td>
<td>Diazepam (for seizure)</td>
</tr>
<tr>
<td>Pyrethroids:</td>
<td>Promethazine</td>
</tr>
<tr>
<td></td>
<td>Panadol</td>
</tr>
<tr>
<td></td>
<td>Diazepam</td>
</tr>
<tr>
<td></td>
<td>Lorazepam</td>
</tr>
<tr>
<td></td>
<td>Calamine cream</td>
</tr>
<tr>
<td></td>
<td>Vitamin E</td>
</tr>
<tr>
<td></td>
<td>Hydrocortisone cream</td>
</tr>
<tr>
<td></td>
<td>Salbutamol</td>
</tr>
<tr>
<td></td>
<td>Activated charcoal</td>
</tr>
<tr>
<td>Chlorfenapyr:</td>
<td>Activated charcoal</td>
</tr>
<tr>
<td></td>
<td>Benzodiazepine (seizures)</td>
</tr>
</tbody>
</table>

**Accidental Warehouse Fires**

Human inhalation of toxic fumes in the event of a storehouse fire is also a risk for which storekeepers and site supervisors must be prepared. The risk can be minimized, however, by following PMI IRS BMPs for storage, including prohibiting lighted materials in the warehouse and in the vicinity of pesticides, providing proper ventilation, etc.

Information on the combustion of byproducts of pyrethroids can be found in Table 6-2 below, and the 2012 PEA. Firefighting instructions can be found in the Material Safety Data Sheet (MSDS) for the pesticide(s) in storage.
<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Combustion Byproduct</th>
<th>Extinguishing Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-cypermethrine</td>
<td>Open burning of lambda-cyhalothrin creates nitrogen oxides, hydrogen chloride, and hydrogen fluoride (WHO, 1997)</td>
<td>Extinguishing media: For small fires use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. For large fires, use Alcohol-resistant foam. Water spray Extinguishing media, which must not be used for safety reasons: Do not use solid water stream as it may scatter and spread fire. Specific hazards during firefighting: As the product contains combustible organic components, fire will produce dense black smoke containing hazardous products of combustion. Exposure to decomposition products may be a hazard to health. Special protective equipment for firefighters: Wear full protective clothing and self-contained breathing apparatus. Further information: Do not allow run-off from fire-fighting to enter drains or watercourses. Cool closed containers exposed to fire with water spray.</td>
</tr>
<tr>
<td>Bendiocarb</td>
<td>Fine dust may form explosive mixtures in air. The product is not flammable, but when heated above 125º C will evolve toxic fumes of methyl isocyanate. Water is the preferred extinguishing medium as it decomposes any methyl isocyanate.</td>
<td>Water fog or fine spray, carbon dioxide, dry chemical, foam. Fire fighters should wear full protective gear, including self-contained breathing apparatus (AS/NZS 1715/1716). Keep unnecessary people away and move all other personnel to windward side of fire. Bund area with sand or earth to prevent contamination of drains or waterways. Dispose of fire control water or other extinguishing agent and spillage safely later.</td>
</tr>
<tr>
<td>Deltamethrine</td>
<td>Combustion and/or pyrolysis of deltamethrin can lead potentially to the production of compounds such as formaldehyde, acrolein, hydrogen cyanide, and hydrogen bromide (UK PID, 2006).</td>
<td>Suitable extinguishing media: Water spray jet, carbon dioxide (CO2), dry powder, foam. Extinguishing media which should Product itself is noncombustible not be used for safety reasons: Fire extinguishing measures to suit surroundings.</td>
</tr>
<tr>
<td>Bifenthrin</td>
<td>Not available</td>
<td>Suitable extinguishing media: Carbon dioxide (CO2), Foam; Powders Not suitable extinguishing media: Water (the product is hazardous for the environment - do not dilute it). Specific fire-fighting methods: Isolate fire area. Evacuate downwind. Contain the extinguishing fluids by bunding (the product is hazardous for the environment). Do not attempt to fight the fire without suitable protective equipment. Do not breathe fumes Protection of firefighters: Self-contained breathing apparatus and complete protective clothing.</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>Combustion and/or pyrolysis of cyfluthrin can lead potentially to the production of compounds such as formaldehyde, acrolein, hydrogen cyanide, hydrogen chloride, and hydrogen fluoride (UK PID, 2006).</td>
<td>Not available to-date.</td>
</tr>
</tbody>
</table>
6.1.6.4  **Prevention of Residential Exposure**

NMCP, MoHCC, EMA, and the PMI IRS implementing partner and other partners will work with relevant institutions at all levels to carry out an IEC campaign/BCC to sensitize residents to IRS activities, in accordance with WHO guidelines and also Zimbabwe National Malaria Strategic Plan and PMI Malaria Operational Plans. The IEC campaign (as well as IRS project supervisors and health workers who will also instruct residents on best practices prior to spraying) should focus on the following elements of residential safety during an IRS program:

- Clear homes of mats or rugs, furniture, cooking implements and foodstuffs prior to spraying; if furniture cannot be moved out of the home, then move it to the center of the room and covered with impermeable material.
- Stay outside the home during spraying for two hours after spraying.
- Homes inhabited by pregnant women or sick individuals who are unable to leave the structure to be sprayed will not be sprayed.
- Move and keep all animals at least 10 meters from the home during spraying, and for two hours after spraying.
- After two hours, open all windows and doors and air the house out for ½ hour before allowing reentry by children and animals.
- Sweep up any insects killed from the spraying and drop them in latrine pits.
- Sweep floors free of any residual insecticide that may remain from the spraying and dispose of in pits or latrines.
- Do not replaster, wash, or paint over the sprayed walls after spraying.
- Keep using bed nets for protection against malaria.
- If skin itches after reentrance into home, wash with soap and water; for eye irritation, flush eyes with water; for respiratory irritation, leave the home for fresh air; for ingestion, if soap and water are unavailable, or if symptoms persist, contact program staff or go to nearest health facility which has the appropriate medical intervention.

If spraying during the rainy season, the teams should follow the following Contingency Plan which will minimize exposure of household effects.

**During the rainy season:**

- Each spray operator must be given adequate covering material (3m by 3m minimum), which should be used to cover household effects moved to the center of the room (only if necessitated by rain, etc.) More than one sheet may be required, depending on the size of structures and the amount of belongings.
- Materials can also be moved into structures that are not targeted to be sprayed, e.g., an isolated kitchen or other domestic animal shelter.
- Move the household effects to one room which will not be sprayed on that particular day, but the next day.
- The spray teams should pay close attention to any signs of potential rains so that they prepare the communities accordingly.

**When it rains in the mid of spraying:**

- Stop the spraying activities. After the rains stop and the weather is considered good spraying can continue.
Cover the household effects with an impermeable material. These materials should have already been procured by the program and given to each operator.

6.1.7  SPECIAL HEALTH AND SAFETY CONSIDERATIONS WHEN USING DDT

6.1.7.1  WORKER HEALTH AND SAFETY

PPE used for DDT IRS activities should be washed every other day (to minimize contaminated effluent) in a cemented bay that is adjacent to and drains into a storage tank or collected for recycling with the appropriate filtration procedure.

6.1.7.2  PESTICIDE EXPOSURE AND TREATMENT

Early symptoms may include paresthesia (tingling) of the tongue, lips and parts of the face, which in severe cases extends to the extremities. The patient may have a sense of apprehension and disturbance of equilibrium, dizziness, confusion, and a characteristic tremor. Remove contaminated clothing and wash the affected skin with clean water and soap, and flush the affected area with large quantities of clean water. Keep the patient calm and in quiet, shaded conditions and seek medical attention.

Medicines to be Administered by a Professional at the Hospital in Case of DDT Poisoning:

- Activated Charcoal (priority): Phenobarbital.
- Diazepam or Lorazepam (for seizure): Cholesteryamine resin.

6.1.7.3  SAFETY OF WOMEN SPRAY PERSONNEL

When using pyrethroids, carbamates, and organophosphates, PMI’s policy is to test all women for pregnancy, and if a woman is found to be pregnant, to only offer positions that do not entail any contact with pesticides. For spray campaigns lasting longer than 30 days, the pregnancy tests must be repeated once every month during the campaign, and to reassign any women found to be pregnant to a position that does not involve potential contact with pesticide. As there is some evidence that DDT is bioaccumulative, and may have an impact on fetal development, it is especially important for countries using DDT to ensure that women are not exposed to DDT. Therefore, if DDT is to be used, women may not occupy positions such as spray operator, washperson, or storekeeper, who have potential contact with DDT.

6.1.7.4  PESTICIDE STORAGE AND STOCK CONTROL

It is of increased importance that PMI BMPs regarding pesticide storage and stock control be implemented when using DDT. Strict mechanisms for retrieving empty sachets of DDT from the districts should be established and auditing should be frequent. Once retrieved, the empty sachets will be kept in a secured designated location until transported to a certified incinerator (see solid waste disposal). Punitive measures against pilferage and unauthorized use of DDT should be enforced.
6.2 PREVENTING ENVIRONMENTAL CONTAMINATION FROM END OF THE DAY CLEANUP

6.2.1 TRIPLE RINSE AND REUSE OF LEFTOVER PESTICIDE

USAID’s PMI IRS BMP Manual recommends that any remaining pesticide, as well as the water used to rinse out spray pumps at the end of each day must be re-used at the beginning of the next day’s work to save water, reduce the load on soak pits/evaporation tanks (for DDT only), and reduce the potential for pollution from leftover pesticide or contaminated rinse-water. This contaminated material should be considered as make-up water rather than pesticide, as it has degraded with exposure to air and sunlight, and so it must be mixed with new insecticide accordingly. This best practice for spray pump cleaning is called “progressive rinse.” As shown in Figure 6-3, seven barrels/drums/containers of approximately 200-liters each are placed in a line. Every other container is filled with water (e.g. the first container is empty, the second is filled with water, the third is empty, fourth is filled with water, fifth is empty, sixth is filled with water and the seventh container is empty). During the end-of-day cleanup, the remnants of the insecticide prepared in the field and remaining in the pump are emptied into the first container. This will be a limited volume, which should be much less than half of this container, as most sprayers should be returned empty from the field. It is important to train operators to manage this goal of minimizing leftover at the end of the day. The spray operator will then add two liters of water from the second container, close and shake the sprayer, and dump the rinse water into the third container.

The spray operator will repeat those steps with the fourth and fifth containers, then with the sixth and seventh containers. The spray operator then washes the outside of the sprayer using water from the sixth container on the impermeable wash area that drains to a soak pit. The following day, the spray pumps are filled with liquid from containers in the same sequential order: container one, then container three, then container five, and finally seven.
FIGURE 6-3: THE SEVEN BARREL TRIPLE RINSE SYSTEM

At the beginning of wash operations

<table>
<thead>
<tr>
<th>Barrel #1</th>
<th>Barrel #2</th>
<th>Barrel #3</th>
<th>Barrel #4</th>
<th>Barrel #5</th>
<th>Barrel #4</th>
<th>Barrel #7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty</td>
<td>Rinse water</td>
<td>Empty</td>
<td>Rinse water</td>
<td>Empty</td>
<td>Rinse water</td>
<td>Empty</td>
</tr>
</tbody>
</table>

Wash Operation Sequence


Note: After this operation is complete, the outside of the pump is washed, along with the spray operators’ helmet, face shield, gloves, boots, and neck protection, in the central wash area, with the wash water directed to the soak pit.
6.2.2 EFFLUENT DISPOSAL FACILITIES

6.2.2.1 WASH AREAS AND SOAK PITS (PYRETHROIDS, CARBAMATES, OPS AND CHLORFENAPYR)

Spray operators must completely wash their pumps, most of their PPE, and themselves after triple-rinsing their pumps. Overalls are washed separately by wash-persons provided with protective gear. In order to minimize possible ground contamination from washing spray equipment and PPE, wash operations are conducted on an impervious (plastic or concrete) wash area that continuously slopes to a soak pit. A soak pit is an in-ground filter that contains a layer of charcoal that adsorbs the insecticide from wash water.

Spray operators should never wash themselves, their overalls, or their PPE in any water bodies, or delay washing until they are home. Washing must be performed at designated sites, and all wash-water must be disposed of in a soak pit. Where necessary, construction of infrastructure for proper disposal of contaminated water will be financed by PMI. The site for the soak pits will be selected jointly with the implementing partner’s Operations Manager, Environmental Compliance Officer, District Coordinator and the representative of the District Health Office according to the criteria in section 1.1.4. The soak pit site must be away from water bodies, bore holes, schools, and other sensitive areas.

The size of the soak pit depends on the number of spray operators that the soak pit supports. According to the USAID PMI IRS BMP Manual, to serve about 30 operators the soak pits should be 2 meters by 1 meter, excavated to a depth of one meter. The bottom of the pit is packed with sawdust followed by hard coal or charcoal, stone aggregates and gravels as shown in Figure 6-4. The entire soak pit area is fenced complete with a lockable access door to prevent unauthorized entry by children or animals. Soak pits are built by DHE with funding from PMI. New soak pits are constructed before spray operations commence. Existing soak pits are evaluated by the PMI IRS implementing partner and DHE annually and are renovated as needed before spray operations begin.

The PMI IRS BMP standards for constructing soak pits are based on WHO guidelines. The soak pit as described can be used for pyrethroids, carbamates, organophosphates and chlorfenapyr. The principle of the soak pit, sometimes referred to as a bio-bed, is to absorb the toxic chemicals in the pesticide through a carbon filtration process, so that the water that finally exits the bottom of the soak pit has been purified and no longer contains the chemical components in any significant concentration. The gravel and stone layers work to exclude large particulates such as leaves and sticks that may eventually clog the soak pit, and they also help to distribute the influent across the soak pit bed so that it is not concentrated in one spot. As the wash-water flows through the charcoal layer, the organic chemical contaminants (pesticides) are adsorbed onto and held by the charcoal, where they are eventually degraded by environmental forces, including hydrolysis and microbial action. The sawdust at the bottom helps to regulate the flow rate so that there is enough contact time between the contaminated water and the coal. Research has shown that pesticides on the coal are degraded within three months in the soak pit. Unless the soak pit becomes clogged with foreign matter and will not drain, the soak pit should remain effective for three years, at which time it can be excavated so that the sawdust and coal can be replaced. As long as the foreign matter can be separated from the stone, the three stone layers can be reconstituted using the same material.
FIGURE 6-4: SOAK PIT LAYERS

Cross section: Soak Pit for Pyrethroids
Showing Filling materials

Gravels
Size about that for road construction

Courser gravels/smaller stones

Stone
Size about average half cement blocks and smaller

Charcoal
Quantity - about 1.5 - 2.0 maxi-bags

Wood shavings/saw-dust
Quantity - about 1 - 1.5 maxi-bags
6.2.3 MOBILE SOAK PITS (MSP)

To reach certain targeted spray areas, operators must travel a great distance, and they may not be able to return at the end of the day to a centralized wash area for clean-up. Sometimes the operators will spend several days in the field, finding lodging and food in the villages where they finish their work for the day. The next day, they either continue to work at the same village, or travel on to the next nearby targeted spray area. Working this way can reduce transportation requirements, shorten the working day, and result in greater productivity. However, operators need a different system for clean-up at the end of the day.

In this situation, the operators carry a MSP filter, wash barrels, and a tarpaulin with them, and construct a temporary wash facility at a suitable site within the village where they will stay. The mobile soak pit filter is a 20-25 L bucket with highly adsorbent activated carbon that removes pesticide contamination from the wash water, so that the water that exits to the ground is purified. In 2014-15, Abt Associates
tested the MSPs and each MSP has the capacity to filter the rinses of 5 spray operators' pumps for at least 40 days.

The MSP can use a four-barrel rinse system to minimize the number of barrels that the spray team must carry, and reduce the necessary size of the wash area constructed. The four-barrel rinse system uses three barrels for rinse water, but only one barrel to receive both the leftover pesticide, and the water from all three rinses. This system simplifies the reuse of all leftover pesticide and rinse-water the following day, as the operators draw from only one barrel, instead of four. See Figure 6-6.

**FIGURE 6-6: MOBILE SOAK PIT FILTER LAYERS**

![Diagram of mobile soak pit filter layers]

- Particulate filter material (for example, sponge, mattress material) ~5" thick
- Granular activated carbon (GAC) ~7 inches deep.
- Particulate filter material (for example, sponge, mattress material) ~3" thick
6.2.3.1 MSP LAYOUT

FIGURE 6-7: MOBILE SOAK PIT CONFIGURATION

This schematic shows a 4m x 4m (not to scale) wash area, sloping to the MSP filter at the center, and covered with a tarp. A hole is dug in the center of the area to receive the MSP filter. An X-shape is cut in the center of the tarp to allow rinse-water to drain into the MSP. There is a rectangular boot wash at the entrance to the wash area, so that mud does not drain to and clog the MSP. There are two rows of rinse barrels so that two operators can wash up at one time. The large barrel on the left receives both leftover pesticide and all rinse-water.

FIGURE 6-8: PREPARING THE SITE FOR THE MSP INSTALLATION
6.2.4 Special Considerations for the Disposal of DDT-Contaminated Liquids

6.2.4.1 Wash Water Disposal
In the implementation of IRS activities, wash water is generated on a daily basis during the cleaning processes for spray pumps, PPE (helmet, face shield, gloves, and boots), plastic sheets used to cover household good, and overalls. This wash water is contaminated with very small concentrations of DDT, but improper disposal could cause damage to human health or the environment. Because DDT is a POP (meaning that it does not decompose quickly in the environment), even small amounts of discharge could build up to harmful concentrations in the local environment. For this reason, PMI does not use soak pits for the disposal of contaminated wash water. Instead, the wash water is collected and stored for subsequent evaporation or treatment and destruction.

6.2.4.2 Storage and/or Evaporation Tank
A PMI storage or evaporation tank is designed for the storage of non-biodegradable liquid pesticide waste such as DDT. It can be designed to evaporate the water collected, leaving the solid pesticide behind, or designed to facilitate other means of pumping, capture, treatment, or destruction.

Standard Design and Construction
An IRS holding tank should hold approximately 15,750 liters or 4,100 gallons, which should be sufficient to allow disposal of effluent from 20-30 DDT spray operators during the spray season. If a larger number of operators will be using the facility, it should be designed accordingly. The tank can be designed and engineered to maximize evaporation if that is the separation mechanism, or to accommodate various forms of treatment. The tank should be constructed with an impermeable surface (e.g., concrete) and covered with a lockable wire mesh on top for physical strength, and a window screen below to exclude bees and other insects. It should be simple to connect a pump for treatment or evacuation.
FIGURE 6-9: EVAPORATION TANK AND WASH BAY FOR DDT OPERATIONS

Basic design of evaporation tank and wash bay for DDT-based IRS operations

Note: Size/volume of evapo-tank depends on # of spray persons intending to use structure.

Estimating volume/size needed: Assume 3.0 - 4.0 litres per person/day. Multiply by # of spray persons and total # of spray-days. Add 10% extra volume. The difference could be accommodated by increasing or decreasing depth of tank.

Dividing hinge to allow opening of wire mesh for cleaning

Note: Top of tank is covered with wire mesh

0.3 m of tank below ground
Natural ground level

0.5 m of tank below ground

Evaporation tank (5m x 3m x 0.8 m)

0.5 m below natural ground level
0.3m above ground level
4.0 m

Natural ground level

3.5 m
0.75 m from end

Natural ground level

0.75 m from edge of tank

Drainage holes, PVC pipes 8 cm diameter

Relative position of metal poles for cloth lines

Wash Bay
- Concrete slab (3m x 4m)
- Staining gently towards tank
- Smooth finish

Raised edges 20 cm above natural ground

The whole structure will be surrounded with a 1-meter area of gravel chips
Siting
Holding tanks should be constructed at least 100 meters away from flood prone areas, steep gradients and slopes, water sources (wells and springs), schools, habitat, protected areas under federal or local regulation. They may not be located within any buffer zone of any protected area. A berm may be required to prevent run-on of storm water into the tank. The tanks should also be located downhill from the progressive rinse area so that run-off from this facility can be directed into the tank. The wash area must be covered when not in use to prevent overflow of the tank due to collected rain flow.

Precautions
During the spray round, the evaporation tank must be covered with a tarpaulin to prevent rainwater from flooding the tank and causing overflow. If water level in the tank comes within six inches of the drainage hole, liquid should be siphoned into plastic poly tanks (around 4k L) for temporary storage, until they can be added back to the tank. Liquid wastes should be placed in double-bung plastic drums or other approved containers.

6.2.4.3 DECOMMISSIONING
After a spray round, the water is removed for treatment or induced to evaporate (while protected from rainfall influent), and all of the sand, sludge, and pesticide residue remaining in the tank is scooped out, placed into a sealed container, stored with empty sachets and other contaminated waste, and disposed of according to US, host-country, and international regulation and conventions. If evaporation is used, the dried residue is carefully collected while wearing full PPE, and is disposed of together with other DDT-contaminated waste. Airborne contamination can be generated during this final cleaning process, so it is essential that PPE is worn, including face shield, gloves, organic/particulate combination respirator, rubber boots, and overalls. This PPE should be wiped clean following use with alcohol-impregnated paper or cloth wipes (e.g., baby-wipes), which are also added to the contaminated waste.
For final decommissioning, the tank should be cleaned with a towel dampened with alcohol, which is then added to the residue container. All this hazardous waste must be disposed of according to all US and host-country regulations and international conventions regarding POPs and hazardous wastes. Concrete storage or evaporation tanks should be broken up and buried in a secure location, or used as roadbed material. The site should be restored back to its natural state as much as possible. Sampling and analysis of site soil and vegetation should be performed to ensure that DDT concentrations do not significantly exceed ambient concentrations in more distant surrounding soils.

DDT-contaminated solid waste must be sent to an incinerator that meets Basel Convention technical standards for POP destruction. See more complete instructions below. Considering the available facilities in Zimbabwe, DDT waste will likely need to be shipped to an appropriate incinerator in another country. After incineration the remaining ash residue should be handled as a dangerous material. Mixing this ash with concrete for use in construction or road building is one of the safest and most useful methods of final disposal.

All wash-persons at the evaporation tank staging area will wear gloves, boots, and coveralls, and will wash overalls at the operational site while spray operators are in the field. Spray operators must completely wash themselves after each day’s operations using washbasins or shower areas constructed near the soak pits. Spray operators should never wash themselves, their overalls, or their PPE in any water bodies, or delay washing until they are home. Washing must be performed at designated sites, and all wash-water must be disposed of in the evaporation or storage tank.

### 6.2.4.4 Alternative DDT Liquid Waste Disposal Method

The conditions for disposal of residue from and decommissioning of evaporation tanks pose a not insignificant risk of exposure. To mitigate such potential risks, where DDT is to be used for IRS, PMI AIRS has developed a system of recycling waste water from cleaning PPE (helmet, face shield, gloves, and boots), plastic sheets used to cover household goods, and overalls. Waste water from the clean-up activities is collected into drums at the wash area, then passed through a MSP three times. After the waste water has been passed through the MSP the third time, the effluent must be disposed of at a fixed soak pit (if the waste water included soap) or could be used to mix insecticide for the next day of spraying (if not waste water does not include soap).

### 6.2.5 IRS Solid Wastes Disposal

IRS solid wastes must be classified as contaminated with insecticide, or non-contaminated, according to the guidance below. Contaminated solid wastes should be stored with pesticide stocks, separated from non-contaminated wastes and IRS commodities. Empty pesticide sachets and bottles must be fully accounted for and stored in sealed containers labeled with the pesticide and item identity.

At the local site level, contaminated solid wastes are separately collected, counted, and stored in labeled and sealed boxes. Usable gloves, plastic bags, boots, and plastic sheeting are decontaminated, air-dried under the sun and packaged by washers in clean containers. All such decontaminated solid wastes are then transferred to the main provincial warehouse, where decontaminated gloves are disposed of properly as ordinary garbage. Decontaminated plastic wastes are recycled in facilities approved by EMA.

Other contaminated wastes, including empty insecticide sachets, plastic containers, and masks, will be temporarily stored in the District warehouse. At the end of the spray campaign, the material will be

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9 Where available, a system of three MSPs may be used, with the waste water sequentially passed through the system.

10 Testing conducted shows that the MSP removes more than 97% of DDT from DDT-contaminated waste water after the second pass, and more than 99% after the third pass.
relocated to the central storage facility in the provincial capital (or other district capital if PMI IRS activities expand or move to other districts). All contaminated material will require disposal in an environmentally responsible manner as prescribed by the PMI IRS BMPs.

Incinerators recommended for disposal of contaminated wastes fall into two categories, those that meet:

- Basel Convention technical standards for all insecticides that do not contain greater than 1% chlorine
- WHO/FAO standards: to be used if we're using DDT or insecticides which contain > 1% chlorine.\textsuperscript{11}

For wastes containing less than 1% chlorine:

- The recommended combustion temperature is >850 °C.
- An after-burner is required, with a residence time of at least two seconds.
- The incinerator must have emission control, including particulate matter filters.
- Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location. In Zimbabwe, as solid wastes are not incinerated in a PMI-owned incinerator and the implementing partner does not have control over the ash and slag, PMI AIRS can only recommend this disposition.

For wastes containing greater than 1% chlorine:

- The recommended combustion temperature is between 1100-1300 °C.
- An after-burner is required, with a residence time of at least two seconds.
- A quench rinse for the gas stream that causes a rapid temperature drop to below 250 °C
- The incinerator must have emission control, including particulate matter filters.
- Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location. In Zimbabwe, as solid wastes are not incinerated in a PMI-owned incinerator and the implementing partner does not have control over the ash and slag, PMI AIRS can only recommend this disposition.

Incineration is not recommended for polyvinyl chloride or other chlorinated wastes such as gloves and boots. Gloves and boots no longer usable for IRS can be easily decontaminated with soap and water and then offered to spray team members, or disposed of as normal nonhazardous waste.

Empty plastic containers should not be incinerated due to the difficulty inherent in burning them cleanly, and the nuisance and toxic emissions that may result. Once punctured to prevent reuse, plastic bottles can be triple rinsed and recycled at an appropriate facility, or landfilled.

Cardboard boxes previously containing intact insecticide sachets or bottles are not considered as contaminated waste. Incineration is not recommended for cardboard boxes unless they have been contaminated by pesticide leakage, or used for the storage of other contaminated wastes. In many cases uncontaminated boxes can be recycled, or can also be disposed of as normal nonhazardous wastes.

After the solid waste management process is completed, a notification form for contaminated solid wastes is developed according to the Basel Convention, and is jointly signed by all involved parties (producer, carrier and eliminator) and submitted for record keeping.

\textsuperscript{11} AIRS Zimbabwe will consult with the Director of Environmental Compliance and Safety for determining halogen content prior to incinerating any concentrated insecticide wastes or any plastics.
6.2.6 SPECIAL CONSIDERATION FOR DDT-CONTAMINATED SOLID WASTE DISPOSAL

DDT is included as one of the insecticides that may be considered for use in IRS operations in Zimbabwe by the NMCP so as to help manage insecticide resistance in the mosquito population. Disposal of DDT-contaminated materials or of expired DDT pesticide is subject to numerous host-country, US, and international regulations. Any disposal of DDT pesticide must be approved by the implementing partner’s HQ staff, as well as the COR and GH BEO. If the decision is made by the NMCP to use DDT for IRS, masks and empty insecticide sachets will be shipped to an approved facility for incineration, as Zimbabwe does not have an approved facility to incinerate DDT-contaminated waste.

DDT-contaminated wastes will only be disposed of under the following conditions (drawn from WHO and FAO guidelines):

1. Commercially licensed facilities accredited by the host governments to dispose of POP toxic waste. The IP or GRZ must obtain a list of the approved and licensed facilities from the EMA. If there are no appropriate in-country incinerators, the GRZ or the IP must locate and contract with an appropriate facility outside of the country.
2. Facilities must be assessed by the IP and found to satisfy PMI and international requirements for toxic waste disposal.
3. Incinerators constructed or procured by the implementing partner, that meet international standards (WHO/FAO).
4. Incinerators that consistently burn between 1100 deg. C and 1300 deg. C, with a minimum 2 second residence time in the afterburner chamber (hot zone) with excess oxygen (>11%) and with high levels of induced turbulence in the gas stream to promote complete combustion. The gas stream is then rapidly cooled to eliminate the risk of dioxin and furan formation.
5. Incinerators with air scrubbers to ensure minimal impact to air quality.
6. In some cases incineration can be negotiated with the pesticide manufacturers, who are responsible for recapturing solid wastes and then disposing of those wastes in an environmentally sound manner.
7. Alternatively, cement kilns or furnaces can also be considered for disposal in countries where cement factories or copper furnaces that meet the above criteria are available.

Wastes consisting of, containing, or contaminated with DDT should be properly packaged before storage or transport. Empty containers should be punctured to ensure that they cannot be used for other purposes, particularly the storage of food or water for human or animal consumption. Ideally suppliers are required to dispose of all DDT waste, and provide a certificate of destruction as proof that the wastes have been disposed of in a certified facility.

PMI Zimbabwe has a number of checks in place to ensure that minimal excess DDT is available after spraying. AIRS Zimbabwe will conduct post-season inventory counts and consolidate the resulting numbers with the pre-season inventory counts for the subsequent spray season. The amount of insecticides needed for the season is estimated after careful consideration during the needs quantification process. This involves taking account of the number of structures to be sprayed and the estimated number of structures sprayed with a sachet or bottle. The amount of insecticides on-hand from the previous season is noted (from pre-season and post-season inventory counts). The amount of insecticide ordered is the balance of the quantified amount needed less the amount on-hand from the previous year. During the spray campaign, the insecticide batches with earlier expiration dates are used before those batches with later expiration dates: first-expired first-out system. Leftover insecticide will be stored at the AIRS Zimbabwe central store in conditions specified by the manufacturer.
Any disposal of DDT pesticide must be approved by the implementing partner’s HQ staff, as well as the COR and GH BEO. Should DDT solid waste be disposed of in an approved incinerator, the remaining ash residue from the incineration must be treated as toxic waste and be disposed according to the requirements for disposal of toxic ash residue. Ideally this ash will be mixed with concrete and buried in a remote location.

The main concerns when handling DDT contaminated wastes are human exposure, accidental release to the environment, and contamination of other waste streams with DDT. Such wastes must be handled separately from other waste types to prevent contamination of other waste streams.

All DDT wastes are considered hazardous wastes and must be properly disposed of. DDT solid waste can be disposed of in an approved incinerator that meets DDT disposal requirements. As no such incinerator currently exists in Zimbabwe, the waste must be transported out of the country to a certified facility. This can be complicated due to inter-country transport/export/import laws, and must meet Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their disposal requirements as there are stringent requirements for notice, consent and tracking for movement of wastes across national boundaries. Once incinerated, the remaining ash residue from the must be treated as toxic waste and be disposed according to the requirements for disposal of toxic ash residue. Because of the small number of qualified incinerators worldwide, PMI AIRS will be unlikely to have control over the disposition of ash from the incineration of DDT wastes.

The use of DDT is subject to the following additional requirements:

- Notify Stockholm Secretariat and WHO of production and/or use of DDT
- Restrict production and/or use to disease vector control
- Produce and/or use DDT in accordance with WHO recommendations and guidelines
- Use DDT only when locally safe, effective, and affordable alternatives are not available
- Report on production and/or use of DDT every three years (reporting requirements found at www.pops.int).

Stockholm Convention Recommendations on DDT

The Stockholm Convention also lays out the following recommendations, “with the goal of reducing and ultimately eliminating the use of DDT”:

- Each Party using DDT should develop and implement an action plan as part of its National Implementation Plan (NIP). That action plan should include:
  a) Development of regulatory and other mechanisms to ensure that DDT use is restricted to disease vector control
  b) Implementation of suitable alternative products, methods, and strategies, including resistance management strategies to ensure the continuing effectiveness of these alternatives
  c) Measures to strengthen health care and to reduce the incidence of the disease.
- All Parties to the Stockholm Convention, within their capabilities, should promote research and development of safe alternative chemical and nonchemical products, methods, and strategies for vector control.

As a signatory to the Stockholm Convention, the U.S. Government is committed to ensuring that its support for DDT use in developing countries is consistent with Stockholm Convention requirements and recommendations, as well as NIPs prepared by the host countries. Thus, USAID will support the following planning, program, and environmental compliance activities where it supports DDT use in disease vector control:
• USAID will base its support of insecticides used in disease vector control on a rational selection process considering the insecticide’s effectiveness in reducing or repelling the vector; risk to human health, the environment, and the agricultural and trade sectors; acceptability in the host country; cost; the need for resistance management; and other considerations.

• USAID will only provide support of DDT to Parties that have notified the Stockholm Secretariat and the WHO of their production and/or use of DDT, and that restrict DDT use to disease vector control.

• All USAID support of DDT use will follow WHO recommendations and guidelines.

• USAID will assist host-country governments in re-examining the need for DDT based upon the best available information and in identifying the best choice for IRS chemicals, considering safety, effectiveness, and affordability in accordance with the Stockholm Convention. The selection of alternatives or combination of alternatives for malaria control will take into consideration human health risks and environmental implications; viable alternatives to DDT should pose less risk to human health and the environment, be suitable for disease control, and be supported with monitoring data.

• USAID will review and revise SEAs pertaining to DDT every year, to ensure that USAID support remains consistent with stipulations in the Stockholm Convention, the host-country NIP, and Stockholm Convention Party reporting requirements for DDT use.

• When local capacity is insufficient, USAID will assist host-country governments in conducting activities to fulfill Stockholm Convention reporting requirements. To receive USAID support for use of DDT in IRS, the host country must demonstrate concerted effort in developing and following a NIP as well as reporting to the Stockholm Secretariat.

• USAID will support the monitoring of DDT in the environments where it is sprayed. According to CFR Title 22 Section 216, “to the extent feasible and relevant, projects and programs for which Environmental Impact Statements or Environmental Assessments have been prepared should be designed to include measurement of any changes in environmental quality, positive or negative, during their implementation.”

• When local capacity is insufficient, USAID will facilitate appropriate disposal of DDT-contaminated waste resulting from IRS operations in accordance with the Basel Convention and other relevant regional and international treaties.

### 6.2.6.1 Conclusion

Using the foregoing Best Management Practices and procedures, IRS can be performed safely and provide substantial benefits to the beneficiaries. The EMMR Annual Reporting Form and Certification in Annex A will be submitted to the USAID as part of the annual report.
7. REFERENCES


Annex A: Environmental Mitigation & Monitoring Plan

Please See the EMMP next page
<table>
<thead>
<tr>
<th>Category of Activity</th>
<th>Describe specific environmental threats of your organization's activities</th>
<th>Description of Mitigation Measures</th>
<th>Who is responsible for monitoring</th>
<th>Monitoring Indicator</th>
<th>Monitoring Method</th>
<th>Frequency of Monitoring</th>
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</thead>
<tbody>
<tr>
<td>Use of insecticides</td>
<td>1. Occupational risks for workers involved in IRS campaigns (e.g., risks from insecticide exposure and vehicular accidents), especially women of child-bearing age</td>
<td>a. Inspect and certify vehicles used for pesticide or spray team transport prior to contract. b. Train drivers c. Provide cell phone, personal protective equipment (PPE) and spill kits during pesticide transportation. d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact. e. Health test all spray team members for duty fitness. f. Procure, distribute, and train all workers with potential pesticide contact on the use of PPE. g. Train operators on mixing pesticides and the proper use and maintenance of spray pumps. h. Provide adequate facilities and supplies for end-of-day cleanup. i. Enforce spray and clean-up procedures.</td>
<td>a-d. Environmental Compliance Officer (ECO). e-g. Operations Manager (OM). h. ECO i. Chief of Party (COP), Technical Project Managers (TPM) and headquarters environmental staff.</td>
<td>a. Transport vehicles have a valid inspection certificate on-board. b. Drivers have a certificate of training completion. c. Transport vehicles are equipped with cell phone, spill kit, and PPE. d. Storekeeper has records of pregnancy testing for all female team members. e. Storekeeper has medical exam results for all team members. f. Spray operators wear complete PPE during spraying and clean-up. g. Operators mix pesticide properly and the pump does not leak. h. All facilities are compliant, and materials required for clean-up are present. i. Inspections are performed as scheduled, corrective action is taken as needed.</td>
<td>a-c. ECO inspection of vehicles in the field. d-e. ECO inspection of health records at IRS operational sites. f-h. ECO performs pre-spray inspections of inventories and training records, and mid-spray inspections of PPE use and spray operator performance. i. Monitoring of on-line database for submission of inspection reports.</td>
<td>a-c. 2 inspections per week. d-e. One inspection per campaign, additional inspection if new hires or more than 30 spray days. f-h. ECO pre-spray inspections 2/campaign, ECO mid-spray inspections 5 times/week. i. Weekly</td>
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<td>2. Safety risks for residents of sprayed houses (e.g., risks from inhalation and ingestion of insecticides)</td>
<td>a. IEC campaigns to inform homeowners of responsibilities and precautions. b. Prohibit spraying houses that are not properly prepared. c. Two-hour exclusion from house after spraying d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside.</td>
<td>a-b. IEC officers, OM, ECO c. ECO d. Spray operators (SO) and Team Leaders (TL)</td>
<td>a. Pre-spray IEC campaigns were executed. Homeowners know responsibilities. b. All houses being sprayed are properly prepared. c. Homeowners observe 2 hour exclusion. d. Lack of incident reports, or incident reports with proper response noted.</td>
<td>a. OM- IEC work records, ECO- mid-spray inspections b-d. ECO mid-spray inspections</td>
<td>a. OM- IEC work records b-d. ECO mid-spray inspections 3/wk.</td>
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<tr>
<td>3. Ecological risk to non-target species and water bodies from use of insecticides (during mixing and spraying)</td>
<td>a. Spray indoors only. b. Train operators on proper spray technique. c. Maintain pumps. d. Conduct baseline and ongoing monitoring of DDT in in area of PMI operations. e. Implement BMPs for waterbody crossing with pesticides f. No spraying within 30 meters of sensitive areas</td>
<td>a-c. TL, District Coordinator (DC), OM, ECO</td>
<td>a. Operators spray only inside of houses. b. Operators are trained and know and use proper spray techniques. c. Pumps are maintained and operated to eliminate leaks and erratic spraying.</td>
<td>a. ECO mid-spray inspections b-c. Training records, ECO mid-spray inspections</td>
<td>a. ECO inspections 3/wk. b. ECO inspection of training records 1/campaign. b-c. ECO mid-spray inspections 5/wk.</td>
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<td>4. Environmental risk from disposal of insecticide (both liquid and solid waste)</td>
<td>a. Choose sites for disposal of liquid wastes, including mobile soak pit sites according to PMI BMPs. b. Construct fixed and mobile soak pits with charcoal to adsorb pesticide from rinse water. c. Maintain soak pits as necessary during season. d. Inspect and certify solid waste disposal sites before spray campaign. e. Monitor waste storage and management during campaign. f. Monitor disposal procedures post-campaign. g. IP control of DDT stocks at conclusion of spray season.</td>
<td>a-c. Abt OM, ECO, DC d-g. Abt ECO</td>
<td>a. Operations sites meet PMI BMPs. b. Fixed and mobile soak pits are sited and constructed according to the PMI BMP manual. c. Fixed and mobile soak pits perform properly throughout the spray season. d. Disposal sites have the capacity and policies to properly dispose of wastes. e. Solid wastes are stored and managed according to PMI BMPs. f. Waste disposal has taken place as agreed and certificates of disposal received. g. Pre- and post-spray inventory checks of insecticides</td>
<td>a-b. ECO Pre-spray inspections c-f. ECO mid- and post-spray inspections and monitoring. g. ECO pre-and post-spray inventory checks.</td>
<td>a.2/campaign b.1/campaign c. 5/week d. 1/campaign e. 3/week f. Continuous during disposal g. 1 pre-campaign and 1 post-campaign.</td>
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| 5. Risk of diversion of insecticides for unintended or uncontrolled use | a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles.  
b. Reconcile number of houses sprayed vs. number of sachets/bottles used.  
c. Examine houses sprayed to confirm spray application.  
d. Perform physical inventory counts during the spray season. | a-d. Storekeepers, District coordinators, sector managers, logistics coordinator, OM, ECO | a-d. All pesticide management records are reconciled. | a-b, d. Inspection of pesticide management records. Storekeeper performance checklists.  
c. ECO mid-spray inspections. | a-b, d. Daily monitoring by storekeeper or site supervisor. Weekly monitoring by District Coordinators  
c. 1/campaign by country headquarters.  
2/campaign by ECO | a-b, d. 2/campaign/ store-room |
Annex B: EMMR Form

Implementing Organization:

Geographic location of USAID-funded activities:

Period covered by this Reporting Form and Certification:

<table>
<thead>
<tr>
<th>Mitigation Measure</th>
<th>Status of Mitigation Measures</th>
<th>Outstanding issues relating to required conditions</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>1a. Pre-contract inspection and certification of vehicles used for pesticide or spray team transport.</td>
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<td>1b. Driver training</td>
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<td>1c. Cell phone, personal protective equipment (PPE) and spill kits on board during pesticide transportation.</td>
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<td>1d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact.</td>
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<td>1e. Health fitness testing for all operators</td>
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<td>Mitigation Measure</td>
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<td>1f. Procurement of, distribution to, and training on the use of PPE for all workers with potential pesticide contact.</td>
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<td>1g. Training on mixing pesticides and the proper use and maintenance of spray pumps.</td>
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<td>1h. Provision of adequate facilities and supplies for end-of-day cleanup,</td>
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<tr>
<td>1i. Enforce spray and cleanup procedures.</td>
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<td>2a. IEC campaigns to inform homeowners of responsibilities and precautions.</td>
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<td>2b. Prohibition of spraying houses that are not properly prepared.</td>
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<td>2c. Two-hour exclusion from house after spraying</td>
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<td>2d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside.</td>
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<td>3a. Indoor spraying only.</td>
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<td>3b. Training on proper spray technique</td>
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<td>3c. Maintenance of pumps</td>
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<td>4a. Choose sites for disposal of liquid wastes, including mobile soak pit sites, according to PMI BMPs.</td>
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<td>4b. Construct fixed and mobile soak pits with charcoal to adsorb pesticide from rinse water.</td>
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<td>4c. Maintain soak pits as necessary during season.</td>
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<tr>
<td>4d. Inspection and certification of solid waste disposal sites before spray campaign.</td>
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<td>4e. Monitoring waste storage and management during campaign.</td>
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<td>4f. Monitoring disposal procedures post-campaign.</td>
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<td>5a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles.</td>
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<td>5b. Reconciliation of number of houses sprayed vs. number of sachets/bottles used.</td>
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<td>5c. Visual examination of houses sprayed to confirm pesticide application.</td>
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<tr>
<td>5d. Perform physical inventory counts during the spray season.</td>
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</tbody>
</table>
ANNEX C: STAKEHOLDER CONSULTATIONS

PMI/USAID
- Regis Magauzi – Malaria Specialist-PMI/USAID, Zimbabwe
- Christie Billingsley – USAID Malaria Advisor- PMI/USAID, Zimbabwe

WHO
- Dr. Anderson Chimusoro – Malaria Adviser
- Jasper Pasipamire – National Professional Officer (Malaria)

National Malaria Control Program
- Dr. Joseph Mberikunashe – Programme Director
- Wilson Chauke – Vector Control Officer
- Zvoizwawaani Matiza – Assistant Vector Control Officer

Local funding Agency (for Global Fund)
- Albert Makone – M&E Consultant
- Ester Antionio – Team leader
- Godfrey Magwindiri – Finance Professional

Environmental Health Department (MoHCC)
- Victor Nyamande – Deputy Director Environmental Health
- Daison Rodrick – Deputy Director Environmental Health
- Margaret Tawodzwera – Food Safety Manager

Pesticide Registration Department (Ministry of Agriculture)
- Mr. Mushore – Pesticide Registrar

Environmental Management Agency
- Florence Matewe – Environmental Quality Manager

Provincial/District Medical Department
- Penika Kazembe – Provincial Environmental Health Officer, Mash Central, Bindura
- Dr. Tendai Kamuriwo – District Medical Officer, Shamva District
- Godfrey Dandajena – District Environmental Health Officer, Shamva District
- Patrick Marasha – IRS Coordinator, Mbire District
- Parker Muzama – Acting Provincial Environmental Health Officer, Manicaland, Mutare
• Joseph Makanda – Provincial Field Officer (Vector Control), Manicaland, Mutare
• Dr. Mafaune – Provincial Medical Director, Manicaland, Mutare
• Davis Bangira – Principal Environmental Health Technician, Manicaland, Mutare District
• Mr. Kamusikiri – Environmental Health Technician, Nyanyadzi Rural Hospital
• Elisha Murape – Principal Environmental Health Technician, Birchenough General Hospital
• Mr. Tshuro – Provincial Field Officer (Vector Control), Masvingo Province
• Dr. Shamu – Provincial Medical Director, Masvingo Province
• Lovemore Manyanye – District Environmental Health Officer, Chiredzi District
• Robert Gwitima – Provincial Environmental Health Officer, Masvingo Province
• Nelson Makuyane – Principal Environmental Health Technician, Chiredzi District
• Mrs. Judith Shayamano – Principal Environmental Health Technician, Chizvirizvi Health Center
• Mr. Chauke – Provincial Environmental Health Officer, Mashonaland West Province
• William Maigurira – Environmental Health Officer, Mashonaland West Province
• Mr. Musekiwa – District Environmental Health Officer, Makonde District
• Micheal Toma – District Environmental Health Officer, Kariba District
• Givemore Manenji – Health Services Administrator, Kariba District
• Elisha Chakwanya – Principal Environmental Health Technician, Kanyati Health Center
• Ephraim Nyoni – Registered General Nurse, Kanyati Health Center
• Formai Chiruchaumba – Senior Environmental Health Technician, Musambakaruma Rural Health Center
• Mrs. More Blessing Muromba – Registered General Nurse, Musambakaruma Rural Health Center
• Terence Machiha – Environmental Health Officer, Kadoma District
• Nziramasanga Ezwick – Environmental Health Technician, Donani Rural Health Center
• Kapenge Cleopas – Environmental Health Technician, Donani Rural Health Center
• Siamusiyi Raphael – Environmental Health Technician, Binga District
• Ashwin Maseko – Environmental Health Technician, Binga District
• Milusi Mhlanga – Environmental Health Officer, Binga District
• Reginald Gumede – Environmental Health Technician, Sinakoma Rural Health Center
• Jimmy Musaka – Nurse, Sinakoma Rural Health Center
• Ms. Otilia Musaka – Nurse, Sinakoma Rural Health Center

**Beneficiary Feedback**

Feedback gathered from beneficiaries was mainly from the NMCP, Provincial and District Environmental Health Officers. Upon arrival in Harare and during the initial meeting with Regis Magauzi (Malaria Specialist with PMI Zimbabwe), we were informed of the intent by the Global Fund (GF) to use the SEA document as guidance for IRS activities by the Government of Zimbabwe’s being funded by the GF. As a result, much of our consultations and field visits were planned to provide a more comprehensive view of all IRS activities conducted by the NMCP.

Based upon the review and field trips conducted, we arranged a final debriefing meeting with the NMCP to discuss our findings on June 2, 2017. The main gaps in environmental compliance identified with IRS activities in Zimbabwe were:
- Insecticide storage facilities and conditions
- Liquid waste management at camp sites and operations sites
- Solid waste disposal
- Training of drivers, storekeepers, and other IRS workers
- Transportation of spray operators, and
- Capacity building on environmental compliance aspects of IRS (DEHOs and EHTs).

As storage space at health centers, which are used as operations sites for IRS operations, is very limited, the program faces some challenges in providing storage space in the appropriate locations for keeping insecticides. However, some more care can be taken in the selection of storerooms to ensure that populations and the environment are not placed at risk from exposure. In addition, storerooms should have enough room to allow segregation on of insecticides from other IRS materials. The appropriate signage (danger signs, spill and emergency procedure, safety data sheets, etc.) should also be clearly displayed in the storerooms, and safety equipment, such as thermometers and fire extinguishers should be available at all stores.

Wash areas that are not used for DDT operations should be equipped with soak pits for the disposal of contaminated waste water. If soak pits cannot be provided at all camp sites, arrangements should be made to use mobile soak pits. We discussed a system of using the mobile soak pit to sequentially filter DDT-contaminated waste water, before disposing of the water in a fixed soak pit. Once the system is approved by the USAID Bureau Environmental Officer, we will suggest the use of this system for DDT operations. In the meanwhile, the use of “mobile” evaporations tanks should be closely monitored to ensure the appropriate use.

Solid waste disposal should follow the hierarchy of reuse-recycle-landfill-incineration. All solid waste materials should be evaluated and opportunities sought for disposal by the more environmental-friendly modes, and all failing disposed of at an EMA-certified incinerator.

Vehicles for the transportation of spray operators will be reviewed. If alternative vehicles to those currently be used cannot be resourced, the vehicles on hand should be retrofitted with benches and railings for worker safety. In addition, all drivers employed to transport spray operators and bulk insecticides should be provided annual training on safe driving, handling of insecticide spills and accidents, and decontamination of vehicles.

Annual training of IRS workers, such as storekeepers, is also needed to ensure the safety of all workers and to protect the environment from inappropriate contamination. In addition to the workers, district Environmental Health Officers and Technicians will benefit immensely from some environmental compliance capacity building activities. This should help them recognize potential risks when they are faced with such situations and help prevent beneficiary and environmental exposures.

**Local Funding Agency Feedback**

**LFA’s Input**

LFA conducts spot checks on GF grant implementation and IRS is another area that has generated interest of late. The NMCP has been seen to be responsive to issues raised and has shown marked improvement. Zimbabwe is one of the countries known for implementing an IRS program that demonstrates impact, as such, it is important to identify loose ends for improving operations. Reference was made to some observations during their routine spot checks which include the following key issues:
Warehousing
- Country had capacity issues for storage of insecticides both at national and subnational levels
- Lack of technical knowhow by some entities engaged for services related to storage of chemicals
- Safety and security of chemicals in warehouses/storage facilities (rodent proofing and access by unauthorized persons)
- Pre-delivery assessment of warehouses

Insecticide Management
- Roles and responsibilities of different player involved in the handling of chemicals from the border to the national warehouse and distribution to districts, including handover processes needed to be explicit.
- Accountability for downstream management of chemicals for IRS needed improvements
- Lack of guidelines for management of insecticide management
- Mode of transport for chemicals – transportation in open trucks needs improvements
- Quality Assurance and efficacy monitoring of sprayed chemicals not consistent

Licensing/permit for handling chemicals
- Transport inspections not physically done by the monitoring Agents e.g. EMA
- Delays in processing of permits, impacting on distribution timelines

Waste management (liquid and solid waste)
- Standardization of liquid waste management facilities an issue still being affected by inadequate funding
- Improving on triple-rinsing facilities – inadequate drums and supporting facilities (soak-pits, evaporation tanks, ablation facilities)
- Exportation of solid waste was not well understood in the concept of GF grant (export for income) and certification needs improvement for documentation
- Capacity for local sound handling/management of waste (final disposal of solid waste, cross border collaboration) to assist neighboring countries

Personal protective clothing (PPE)
- Quality of tents was one of the outstanding issues that triggered discussions – was it an issue of quality? Non-conformity to specifications resulting in poor quality? Old and torn tents being replaced?
- Gloves and carrier bags not conforming to specifications – PPM procured
- Policy on use of old PPE/C once used by other SOs
- SOPs for standard PPE/C requirements for spraying teams

Grants Management Compliance
- Assessment of vendors prior to engaging them for GF grants services
- Competitive bidding of vendors
- Supporting documents for any activity undertaken
- Accountability and clear flow of information and transfer of responsibilities from national to implementation level
- Worker safety and health issues, including community and environmental issues

**Documentation**
- Certification for waste disposal
- Documentation of processes for all activities undertaken
- Quantification of outputs and targets

**Procurement for IRS commodities**
- Timeliness of procurement of IRS commodities to avoid last minute rush
- Quality of product
- Compliance to specifications

**Geographical Reconnaissance**
- Method of data collection to avoid bias (geographical reconnaissance)
- Data validation
- Origin of data collectors (external versus local cadres)

**Social Behavior Change Communication (SBCC)**
- Identification and engagement of key influential people in the community not necessarily traditional leadership
- Targeted SBCC to areas with low IRS coverage and high refusal rates
- Use of diversified approaches in delivering health messages e.g. school competitions; drama etc.
- Timing of SBCC messaging

**Programme Management**
- Some camp sites and communities where IRS is implemented had water challenges
- Timely assessment of trucks and their service
- Resource mobilization for vehicle servicing and EC facilities construction
- Adequate notification by partners when pulling out of the program for smooth coordination

**Recommendations**
- The country now has an IRS management Plan. This document outlines processes that need to be followed from procurement to waste management.
- Role definitions also clearly spelt out to guide programming
- Pre-storage assessment of suitability of warehouses
- Improvement of storage facilities at operational levels (secured, inaccessible to unauthorized persons, rodent proofed etc.)
- Physical examination of trucks prior to issuance of a transportation permit
- Standardization of liquid waste management at camp sites including religious use of provided facilities
- Capacity building for local staff on safe handling and management of insecticide including waste management
- Resource mobilization for improving liquid waste management at campsites through establishment of appropriate soak-pits and evaporation tanks
- Improved supervision for quality and up to scratch EC operations at camp sites e.g. triple rinsing
- Funders to allow for program countries to procure locally part of PPE/C which they cannot secure as specified (internal tenders) to ensure safety of workers and value to money
- Policy formulation on use by another person PPE/C that was once used by another
- Provision of rehydration breaks during spraying
- Explore alternative ways of making payments for community based activities for enhance SBCC work
- Documentation of all activities/work done and provision of supporting documents where applicable
- Engagement of local personnel in the collection of geographical reconnaissance data to ensure quality, reliable and valid data for target setting
- Timely and efficient servicing of lorries for IRS management including chemical waste management
SEA discussions with LFA – PWC Offices

Date: 4th October 2017

Agenda:
1. Draw input from LFA for finalization of SEA for IRS, Zimbabwe
2. AOB

Introduction
The meeting was held on 4 October at LFA offices in Mt Pleasant and the following were in attendance:

- Wilson Chauke Vector Control officer, NMCP
- Tendayi Muchenje ECO– Abt Associates
- Albert Makone M&E consultant LFA Global Fund
- Ester Antionio- Team leader LFA Global Fund
- Godfrey Magwindiri – Finance Professional LFA Global Fund

The meeting was chaired by the Vector Control Officer (NMCP) who briefed the team on the following purposes of the meeting in liaison with the AIRS ECO:

- To solicit for LFA’s input into the draft Supplementary Environmental Assessment (SEA).
- Zimbabwe and AIRS through PMI support engaged a consultant to develop the next generation of SEA to cover the next 5 years
- Document meant to guide implementation of IRS in an environmentally sound and sustainable manner.
- Document will serve as a Standard Operating Procedure for IRS and will be used by both partners in vector control and NMCP.
- LFA thus is a key partner, in that they conduct spot checks and have valuable information that can help shape the SEA as it is being finalized.

LFA’s Input
LFA conducts spot checks on GF grant implementation and IRS is another area that has generated interest of late. The NMCP has been seen to be responsive to issues raised and has shown marked improvement. Zimbabwe is one of the countries known for implementing an IRS programme that demonstrates impact, as such identifying loose ends for improving operations becomes key. Reference was made to some observations during their routine spot checks which include the following key issues:

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- Transport inspections not physically done by the monitoring Agents e.g. EMA
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Waste management (liquid and solid waste)
- Standardization of liquid waste management facilities an issue still being affected by inadequate funding
- Improvisation on Triple rinsing facilities – inadequate drums and supporting facilities (soak-pits, evaporation tanks, ablution facilities)
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Documentation
- Certification for waste disposal
- Documentation of processes for all activities undertaken
- Quantification of outputs and targets

Procurement for IRS commodities
- Timeliness of procurement of IRS commodities to avoid last minute rash
- Quality of product
- Compliance to specifications
Geographical Reconnaissance
- Method of data collection to avoid bias (geographical reconnaissance)
- Data validation
- Origin of data collectors (external versus local cadres)

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- Timely assessment of trucks and their service
- Resource mobilization for vehicle servicing and EC facilities construction
- Adequate notification by partners when pulling out of the programme for smooth coordination

Recommendations
- The country now has an IRS management Plan. This document outlines processes that need to be followed from procurement to waste management.
- Role definitions also clearly spelt out to guide programming
- Pre-storage assessment of suitability of warehouses
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- Documentation of all activities/work done and provision of supporting documents where applicable
- Engagement of local personnel in the collection of geographical reconnaissance data to ensure quality, reliable and valid data for target setting
- Timely and efficient servicing of lorries for IRS management including chemical waste management
Reaction of Zimbabwe AIRS to LFA’s Feedback

In general, feedback provided by the LFA, with regards to environmental compliance, was very much in line with our observations during the SEA field trips. As a result, most of these issues have been addressed in the SEA or in the PMI BMP. This feedback will be incorporated with the SEA, specifically, in Annex C: Stakeholder Consultations.

Please find below, the revised Annex C of the SEA.
## Annex D: Summary of Acute Exposure Symptoms & Treatment of IRS Pesticides

### Summary of Acute Exposure Symptoms and Treatment of WHO-recommended Carbamate

<table>
<thead>
<tr>
<th>Carbamates</th>
<th>Human side effects</th>
<th>Treatment</th>
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</thead>
<tbody>
<tr>
<td>Bendiocarb</td>
<td>Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.</td>
<td>The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine.</td>
</tr>
<tr>
<td>Propoxur</td>
<td>Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.</td>
<td>The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine.</td>
</tr>
<tr>
<td>Organophosphate</td>
<td>Human side effects</td>
<td>Treatment</td>
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<td>Malathion</td>
<td>Malathion is an indirect cholinesterase inhibitor. The primary target of malathion is the nervous system; it causes neurological effects by inhibiting cholinesterase. Exposure to high levels can result in difficulty breathing, vomiting, blurred vision, increased salivation and perspiration, headaches, and dizziness. Loss of consciousness and death may follow very high exposures to malathion.</td>
<td>Oral exposure to malathion should be treated with rapid gastric lavage unless the patient is vomiting. Dermal exposures should be treated by washing the affected area with soap and water. If the eyes have been exposed to malathion, flush them with saline or water. People exposed to malathion who exhibit respiratory inefficiency with peripheral symptoms should be treated via slow intravenous injection with 2–4 mg atropine sulfate and 1,000–2,000 mg pralidoxime chloride or 250 mg toxogonin (adult dose). Exposure to high levels of malathion that result in respiratory distress, convulsions, and unconsciousness should be treated with atropine and a re-activator. Morphine, barbiturates, phenothiazine, tranquilizers, and central stimulants are all contraindicated.</td>
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<td>Fenitrothion</td>
<td>Fenitrothion is the most toxic to man of the insecticides recommended for residual house spraying, and has a relatively low margin of safety. Absorbed through the gastrointestinal tract as well as through intact skin and by inhalation. It is also a cholinesterase inhibitor.</td>
<td>Dermal exposure to fenitrothion should be treated by removing contaminated clothing, rinsing the skin with water, washing the exposed areas with soap and water, then seeking medical attention. If fenitrothion gets into the eyes, they should be rinsed with water for several minutes. Contact lenses should be removed if possible and medical attention should be sought. Ingestion of fenitrothion should be treated by rinsing the mouth and inducing vomiting if the person is conscious. Inhalation exposures require removal to fresh air and rest in a half-upright position. Artificial respiration should be administered if indicated and medical attention should be sought.</td>
</tr>
<tr>
<td>Organo-phosphate</td>
<td>Human side effects</td>
<td>Treatment</td>
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<tr>
<td>Pirimiphos-methyl</td>
<td>Pirimiphos-methyl is also a cholinesterase inhibitor. Early symptoms of poisoning may include excessive sweating, headache, weakness, giddiness, nausea, vomiting, stomach pains, blurred vision, constricted pupils, slurred speech, and muscle twitching. Later there may be convulsions, coma, loss of reflexes, and loss of sphincter control.</td>
<td>OP poisoning is a medical emergency and requires immediate treatment. All supervisors and individual spray men (in the case of dispersed operations) should be trained in first-aid and emergency treatment of OP intoxication. The affected person should stop work immediately, remove any contaminated clothing, wash the affected skin with soap and clean water and flush the skin with large quantities of clean water. Care must be taken not to contaminate others, including medical or paramedical workers. Automatic injectors loaded with atropine sulfate and obidoxime chloride can be made available in the field whenever relatively toxic OP insecticides are used in areas without easy access to medical care. Atropine sulfate is recommended. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible. Glycopyrolate has been studied as an alternative to atropine and found to have similar outcomes using continuous infusion.</td>
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## Summary of Acute Exposure Symptoms and Treatment of WHO-recommended Pyrethroids

<table>
<thead>
<tr>
<th>Pyrethroids</th>
<th>Human side effects</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Bifenthrin</td>
<td>Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness. No skin inflammation or irritation observed; however can cause a reversible tingling sensation. Incoordination, irritability to sound and touch, tremors, salivation, diarrhea, and vomiting have been caused by high doses.</td>
<td>Depends on the symptoms of the exposed person. Casual exposures require decontamination and supportive care. Wash affected skin areas promptly with soap and warm water. Medical attention should be sought if irritation or paresthesia occurs. Eye exposures should be treated by rinsing with copious amounts of water or saline.</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness.</td>
<td>If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.</td>
</tr>
<tr>
<td>Lambda-Cyhalothrin</td>
<td>Skin exposure leads to transient skin sensations such as periorbital facial tingling and burning. Can irritate the eyes, skin, and upper respiratory tract. Oral exposure can cause neurological effects, including tremors and convulsions. Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis.</td>
<td>Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest.</td>
</tr>
<tr>
<td>Pyrethroids</td>
<td>Human side effects</td>
<td>Treatment</td>
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<tr>
<td>Alpha-Cypermethrin</td>
<td>Acute exposure symptoms include skin rashes, eye irritation, itching and burning sensation on exposed skin, and paraesthesia. Acute inhalation exposures may cause upper and lower respiratory tract irritation. Ingestion of alpha-cypermethrin is also harmful</td>
<td>Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest.</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma.</td>
<td>If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.</td>
</tr>
<tr>
<td>Etofenprox</td>
<td>Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma.</td>
<td>If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.</td>
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</tbody>
</table>
### Summary of Acute Exposure Symptoms and Treatment for DDT

<table>
<thead>
<tr>
<th>Human side effects</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>DDT impairs the conduction of nerve impulses. In humans, this can cause effects</td>
<td>Exposure to DDT may be measured through laboratory tests. DDT and its metabolites (DDE and DDD)</td>
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<tr>
<td>ranging from mild altered sensations to tremors, convulsions, and respiratory</td>
<td>may be detected in the blood/plasma, semen, urine, liver, kidney, fatty tissue, skin lipids,</td>
</tr>
<tr>
<td>depression. Additional effects observed in humans following acute DDT exposure</td>
<td>breast milk, and lymphatic tissues. DDT exposure should be treated with anticonvulsants (</td>
</tr>
<tr>
<td>include headaches; nausea; vomiting; diarrhea; numbness; paresthesia; increased</td>
<td>benzodiazepines), oxygen, and cardiopulmonary monitoring. Epinephrine, other adrenergic</td>
</tr>
<tr>
<td>liver enzyme activity; irritation of the eyes, nose, or throat; altered gait; and</td>
<td>amines, atropine, and orally administered fats are all contraindicated.</td>
</tr>
<tr>
<td>malaise or excitability.</td>
<td>-----------------------------------------------------------------------------------------------------</td>
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</tbody>
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Summary of Acute Exposure Symptoms and Treatment for Chlorfenapyr

<table>
<thead>
<tr>
<th>Human side effects</th>
<th>Treatment</th>
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</thead>
<tbody>
<tr>
<td>As chlorfenapyr is a rather new product there are not many cases of poisonings where the symptoms were described. For the time being, one patient, exposed to vapors of chlorfenapyr, first exhibited general fatigue, hyper-perspiration, nausea and vomiting. He was initially diagnosed as being dehydrated. Another patient, who ingested the chemical in a suicide attempt, initially presented with hyper-perspiration, headache and cough. Symptomatic management was initiated, but after seven days she suffered neurological and respiratory deterioration, causing her death.</td>
<td>Symptoms following exposure should be observed in a controlled setting until all signs and symptoms have fully been resolved. If ingested, control any seizures first. Chlorfenapyr can produce abnormalities of the hematopoietic system, liver, and kidneys. Do not use emetics. Monitoring complete blood count, urinalysis, and liver and kidney function tests is suggested for patients with significant exposure. If respiratory tract irritation or respiratory depression is evident from inhalation, monitor arterial blood gases, chest x-ray, and pulmonary function tests. Significant esophageal or gastro-intestinal tract irritation or burns may occur following ingestion. Consider gastric lavage after ingestion of a potentially life-threatening amount of poison if it can be performed soon after ingestion (generally within 1 hour). Protect airway by placement in Trendelenburg and left lateral decubitus position or by endotracheal intubation. Activated charcoal binds most toxic agents and can decrease their systemic absorption if administered soon after ingestion. Immediate dilution with milk or water may be of benefit in caustic or irritant chemical ingestions. Rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Observe patients with ingestion carefully for the possible development of esophageal or gastrointestinal tract irritation or burns. If signs or symptoms of esophageal irritation or burns are present, consider endoscopy to determine the extent of injury. Carefully observe patients with inhalation exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary. If exposure is to the eyes, immediately irrigate exposed eyes with copious amounts of room temperature water (better with 0.9% saline) for at least 15 minutes. If irritation, pain, swelling, lacrimation, or photophobia persists, the patient should be seen in a health care facility. For dermal exposure remove contaminated clothing and wash exposed area thoroughly with soap and water. A physician may need to examine the area if irritation or pain persists.</td>
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**Summary of Acute Exposure Symptoms and Treatment for Clothianidin**

<table>
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<th>Human side effects</th>
<th>Treatment</th>
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<td>Clothianidin is a systemic insecticide belonging to the nitroguanidine subgroup of nicotinoid insecticides. It is also referred to as a chloronicotinyl or neonicotinoid. Clothianidin and other neonicotinoids act on the central nervous system of insects as an agonist of acetylcholine, the neurotransmitter that stimulates nAChR, targeting the same receptor site (AChR) and activating post-synaptic acetylcholine receptors but not inhibiting AChE. The acute health risks to humans from exposure to clothianidin are minimal due to its low mammalian toxicity. Extrapolation from test results on animals to humans suggests that clothianidin is moderately toxic through oral exposure, but toxicity is low through skin contact or inhalation. Mild to moderate poisoning can cause nausea, vomiting, diarrhea, abdominal pain, dizziness, headache, and mild sedation. While clothianidin may cause slight eye irritation, it is not expected to be a skin sensitizer or irritant. Large deliberate ingestions have caused agitation, seizures, metabolic acidosis, coma, hypothermia, pneumonitis, respiratory failure, hypotension, ventricular dysrhythmias, and death. Rare caustic injury to the esophagus has been reported. This is likely due to the solvent component (N-methyl-2-pyrrolidone (NMP)) of the insecticide as opposed to the neonicotinoid itself. Clothianidin does not damage genetic material nor is there evidence that it causes cancer in rats or mice; it is unlikely to be a human carcinogen. Submitted data also indicate that no significant adverse environmental impacts are expected to occur from the use of clothianidin.</td>
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<td><strong>MANAGEMENT OF MILD TO MODERATE TOXICITY</strong></td>
<td>- Treatment is symptomatic and supportive. Administer IV fluids for hypotension.</td>
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<tr>
<td><strong>MANAGEMENT OF SEVERE TOXICITY</strong></td>
<td>- Treatment is symptomatic and supportive. Treat hypotension with IV fluids; add vasopressors if hypotension persists. Treat dysrhythmias per ACLS guidelines. Consult a gastroenterologist for patients with pain on swallowing, drooling, or other evidence of caustic injury to evaluate for esophageal damage. Atropine should be considered if a patient is bradycardic or experiencing cholinergic symptoms because these insecticides are frequently mixed with organophosphate and carbamate pesticides.</td>
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14 [https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7281](https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7281), Accessed 7/14/17

15 Ibid


17 [https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7281](https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+7281), Accessed 7/14/17