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**The PMI Africa IRS (AIRS) Project**

Indoor Residual Spraying (IRS) 2

Task Order Six

# TANZANIA SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR INDOOR RESIDUAL SPRAYING FOR MALARIA CONTROL 2015 – 2020

## A NATIONWIDE SEA FOR IRS USING PYRETHROIDS, CARBAMATES, ORGANOPHOSPHATES, AND CHLORFENAPYR

AUGUST 2015

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**Submitted to**: The United States Agency for International Development/President's Malaria Initiative

*The views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.*

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# TANZANIA

# SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR INDOOR RESIDUAL SPRAYING FOR MALARIA CONTROL

# 2015-2020

August 2015

Peter Chandonait

Abt Associates, Inc.

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# ACRONYMS

| | |
|---|---|
| **ACTs** | Artemisinin-based Combination Therapies |
| **AIRS** | Africa Indoor Residual Spraying project |
| **CDC** | Centers for Disease Control and Prevention |
| **CFR** | Code of Federal Regulations |
| **COP** | Chief of Party |
| **COR** | Contracting Officer's Representative |
| **DECS** | Director of Environmental Compliance and Safety |
| **DMO** | District Medical Officer |
| **ECO** | Environmental Compliance Officer |
| **EIA** | Environmental Impact Assessment |
| **EOSR** | End of Spray Report |
| **GoT** | Government of the United Republic of Tanzania |
| **IEC** | Information Education Communication |
| **IP** | Implementing Partner |
| **IPTp** | Intermittent preventive treatment of malaria for pregnant women |
| **IRS** | Indoor Residual Spraying |
| **ITNs** | Insecticide Treated Nets |
| **IVM** | Integrated Vector Management |
| **LGA** | Local Government Authority |
| **LLIN** | Long-lasting insecticide-treated nets |
| **M&E** | Monitoring and Evaluation |
| **MOHSW** | Ministry of Health and Social Welfare |
| **MOP** | Malaria Operational Plan |
| **MSP** | Mobile Soak Pit |
| **NEMC** | National Environment Management Council |
| **NMCP** | National Malaria Control Program |
| **NMRI** | National Medical Research Institute |
| **PMI** | President's Malaria Initiative |
| **PPE** | Personal Protective Equipment |
| **PSECA** | Pre-Spray Environmental Compliance Assessment |

| | |
|---|---|
| **RLGA** | Regional Administration and Local Government |
| **RMO** | Regional Medical Officer |
| **SEA** | Supplemental Environmental Assessment |
| **SOP** | Spray Operator |
| **SUAP** | Safer Use Action Plan |
| **TDE** | Tanzania Division of the Environment |
| **TPRI** | Tropical Pesticide Research Institute |
| **USAID** | United States Agency for International Development |
| **USEPA** | United States Environmental Protection Authority |
| **USG** | United States Government |
| **URT** | United Republic of Tanzania |
| **WHO** | World Health Organization |
| **WHOPES** | World Health Organization Pesticide Evaluation Scheme |
| **WMA** | Wildlife management areas (WMA) |
| **ZAMEP** | Zanzibar Malaria Elimination Program |
| **ZEMA** | Zanzibar Environment Management Authority |

# EXECUTIVE SUMMARY

This document has been prepared to serve as a Supplemental Environmental Assessment (SEA) for Indoor Residual Spraying (IRS) in Tanzania for the period 2015-2020. Previous environmental documentation for PMI-supported IRS in Tanzania authorized the use of the pyrethroid, carbamate and organophosphate classes of the WHOPES-recommended pesticides in the Lake Zone (Kagera, Mwanza, Mara) regions of Tanzania from 2010-15, 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 3 classes of WHOPES-recommended insecticides, and to expand the authorization to include the use of chlorfenapyr (when recommended by WHOPES). This SEA also seeks to expand the geographic coverage of authorized PMI-supported IRS to the entire country, and requests authorization of small-scale, closely-supervised hut trials using new IRS insecticides, such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation and country-level required documentation has been submitted.

In June 2005, the USG selected the United Republic of Tanzania (URT) (including the Mainland and Zanzibar) as one of the first of three countries to be included in PMI. For the past nine years, PMI supported IRS in Tanzania through a bilateral cooperative agreement. In 2015, PMI Tanzania's IRS operations have been transferred to the TO6 PMI AIRS project contractual mechanism.

The FY 2015 Malaria Operational Plan presents a detailed implementation plan for Tanzania, based on the USG malaria strategy and the National Malaria Control Program's (NMCP, Mainland) and the Zanzibar Malaria Elimination Program's (ZAMEP) strategy. It was developed in consultation with the NMCP and ZAMEP, and with the participation of national and international partners involved in malaria prevention and control in the country. The activities that PMI is proposing to support fit in well with the National Malaria Control Strategy and Plan and build on investments made by PMI and other partners to improve and expand malaria-related services.

Malaria is a major public health problem in Tanzania. Although dramatic progress in malaria control has been made in recent years with the scale-up of malaria prevention and treatment interventions, nearly all 42 million residents on the Mainland and all 1.3 million persons in Zanzibar are still at risk of infection.

Changing or rotating insecticides of different classes over time and space is a leading way to manage vector resistance. In Tanzania, entomological monitoring has demonstrated that local mosquitoes have developed some level of resistance to the pyrethroid, carbamate and organochlorine (DDT) class of insecticides, but have full susceptibility to the organophosphate, pirimiphos methyl, which is currently being used for IRS.

The proposal to include chlorfenapyr is prompted by the need to increase the options of recommended insecticides available for spray activities. Chlorfenapyr, an active ingredient (AI) in the pyrrole chemical class is under WHOPES review, and if recommended for use will offer an additional option for insecticide rotation.

This SEA for IRS in Tanzania outlines the monitoring and mitigation measures that will be employed by PMI Implementing Partner (IP) to minimize or reduce any 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 Tanzania 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 (cholinesterase depression) require increased emphasis and training on the ability and responsibility of team leaders and senior personnel to constantly monitor the appearance and behavior of their team members, and to recognize the symptoms of organophosphate exposure, in order to implement response protocols. However, biomonitoring is not required for the use of pirimiphos methyl formulations for IRS at the present time.
2. Pirimiphos-methyl formulations are supplied in plastic bottles, which if not controlled carefully may be used inappropriately after being emptied of the 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 pesticide make-up procedure, whereby the pesticide 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 pesticide 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 pesticide residue in the container is essentially eliminated; however, the following procedures are also followed.
    b. Containers are punctured multiple times to eliminate the ability to reuse the containers, and,
    c. Recycling programs have been established to turn the plastic into usable products. As long as a suitable recycling program is available, through close supervision and chain of custody, and in partnership with the Tanzania National Environmental Management Council (NEMC) and the Zanzibar Department of Environment (ZDE), 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 NEMC, ZAMEP, MOHSW, and the 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 spray operation. The District Coordinators will monitor environmental compliance during the IRS campaign. The IP will complete the annual EMMR Form in Annex C, and submit it to USAID along with the annual end of spray report.

On an annual basis, a letter report will be submitted to the 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 the environmental monitoring and how the program will improve any areas of deficiency.

The following assessment draws heavily on the Programmatic Environmental Assessment (PEA) for Integrated Vector Management, approved in November 2012, and many other reference documents, as noted throughout this document.

# PRINCIPAL PROPOSALS & CLEARANCE

1. The Tanzania Supplemental Environmental Assessment (SEA) (2009), as amended in 2010 (amendment #1) was valid for implementing PMI-supported IRS in selected regions in the Lake Zone of Tanzania, using all WHO-recommended pesticides in the pyrethroid, carbamate and organophosphate classes for the period 2010-2015.
2. In order to continue with PMI IRS, PMI is seeking approval for a new SEA for a further 5 years (2015-2020) and for the SEA to be nationwide in scope.
3. It is proposed in this SEA to expand the permissible insecticide options to include chlorfenapyr, when recommended by WHOPES, in addition to carbamates, pyrethroids, and organophosphates.
4. It is further proposed to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation, and country-level required documentation has been submitted. 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).
5. 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.
6. The Safer Use Action Plan in Chapter 6 provides detailed guidance on the performance of all activities associated with IRS. The attached, updated Environmental Mitigation and Monitoring Plan (EMMP) (Annex A) summarizes the key required mitigation measures, as well as the monitoring and reporting requirements and schedule.
7. The preparation of this SEA renders the preparation of a Letter Report unnecessary for 2016. In subsequent years, provided there are no changes to the program outside the scope of this SEA, a Letter Report will be submitted to USAID annually that will discuss significant changes in the IRS program for that particular year's spray campaign.
8. It is PMI policy that the first use of organophosphates in a given country requires the signature of the Africa Bureau and Global Health BEOs on the annual Letter Report. Use of organophosphates in subsequent years does not require BEO signatures. As organophosphates have been used in Tanzania since 2013, BEO signatures are not required on the annual Letter Reports.
9. This SEA contains an updated Pesticides Procedures section, which, together with the Safer Use Action Plan, constitute the elements of a PERSUAP.

## APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED 2015-2020 SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR PRESIDENT'S MALARIA INITIAVE- INDOOR RESIDUAL SPRAYING (IRS) FOR MALARIA CONTROL IN TANZANIA

The United States Agency for International Development, Global Health Bureau has determined that the proposed IRS effort, as described in the 2015-2020 Supplemental Environmental Assessment: Indoor Residual Spraying for malaria control in Tanzania responds to the needs of the community and country as it relates to managing malaria in Tanzania, 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 Programmatic Environmental Assessment for PMI IVM (2012), is consistent with the Government of Tanzania's and USAID's goal of reducing malaria incidence in Tanzania while minimizing negative impact to the environment and to human health.

The proposed actions recommended for approval in this 2015 SEA are:

1. The continuation of IRS implementation using pyrethroids, carbamates, organophosphates, and/or chlorfenapyr when recommended by WHOPES, 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 extend coverage to all geographical areas in Tanzania where IRS may be implemented or where national or regional level support may be provided by PMI as decided by the National Malaria Control Program and PMI for the 5-year period from 2015 to 2020.
3. This SEA authorizes small, closely supervised studies or Hut Trials to study new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES 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 using the strict protocols and procedures contained in the PMI Best Management Practices (BMP) manual, and observing all precautions and prescriptions in this SEA.

The Safer Use Action Plan (Section 6) and the updated Environmental Mitigation and Monitoring Plan (EMMP) for Tanzania (Annex A) provides 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.

**CLEARANCE:**

Acting Mission Director: _____ Date: 11/2/15
USAID/Tanzania Daniel Moore

**CONCURRENCE:**

Bureau Environmental _____ Date: _____
Officer/GH: Rachel Dagovitz

**ADDITIONAL CLEARANCES:** (Type Name under Signature Line)

Bureau Environmental _____ Date: _____
Officer/AFR: Brian Hirsch

PMI Advisor: _____ Date: 11/2/15
PMI/Tanzania George Greer

Mission Environmental Officer: _____ Date: 10/27/2015
USAID/Tanzania Gabriel Batulaine

Regional Environmental Advisor: cleared by email Date: October 27, 2015
USAID/East Africa David Kinyua

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**Gabriel Batulaine <gbatulaine@usaid.gov>**

# Re: Tanzania Supplemental Environmental Assessment (SEA)

1 message

**David Kinyua** <dkinyua@usaid.gov> Tue, Oct 27, 2015 at 4:12 PM
To: Gabriel Batulaine <gbatulaine@usaid.gov>
Cc: Naomi Kaspar <nkaspar@usaid.gov>, George Greer <ggreer@usaid.gov>, "Kajuna, Gilbert(Tanzania/NRM/EG)" <gkajuna@usaid.gov>, Robert Layng <rlayng@usaid.gov>, Kitty Andang <kandang@usaid.gov>

Naomi and Gabriel,
Sorry I did not track this action properly and then last week I was out on leave. It is a solid standard document with all the necessary provisions.

Normally I would not hold this kind of standard SEA since the practice is well established.

I have cleared and attached the signature page.

Regards,

David

On Tue, Oct 27, 2015 at 1:59 PM, Gabriel Batulaine <gbatulaine@usaid.gov> wrote:
Hi Naomi,

Thanks for your email. I hope the REO (cc'd) will soon update us on the SEA under review. I re-call you underlined the time-frame of the SEA for the implementation/spray in early December. I hope we will be able to send it to the BEO for final review and approval by the end of October or early November.

Thanks.

On Mon, Oct 26, 2015 at 11:56 AM, Naomi Kaspar <nkaspar@usaid.gov> wrote:
Dear Gabriel

Have we received any feedback on the SEA??

Thank you
Naomi

Sent from my iPhone

> On Oct 7, 2015, at 2:02 PM, Gabriel Batulaine <gbatulaine@usaid.gov> wrote:
>
> Hi David,
>
> Please kindly review the attached SEA for Tanzania. It was sent to me while
> I was sick and unfortunately was not copied to Gilbert (my alternate). We
> have reviewed the SEA at the Mission and incorporated changes. The The
> original Programmatic Environmental Assessment (PEA) is at:
> http://www.ehproject.org/PDF/ehkm/ivm-env_assessment.pdf
>
> Thanks for your continued support.
>
>
>

**CLEARANCE:**

Mission Director: _____ Date: _____
USAID/Tanzania Susan Brems

**CONCURRENCE:**

Bureau Environmental _____ Date: _____
Officer/GH: Rachel Dagovitz

**ADDITIONAL CLEARANCES:** (Type Name under Signature Line)

Bureau Environmental _____ Date: _____
Officer/AFR: Brian Hirsch

PMI Advisor: _____ Date: _____
PMI/Tanzania George Greer

Mission Environmental Officer: _____ Date: _____
USAID/Tanzania Gabriel Batulaine

Regional Environmental Advisor: _____ Date: 10/27/2015
USAID/East Africa David Kinyua

**CLEARANCE**:

Mission Director: _____ Date: _____
USAID/Tanzania Susan Brems

**CONCURRENCE**:

Bureau Environmental Officer/GH: Email concurrence Date: 10/5/2015
Rachel Dagovitz

**ADDITIONAL CLEARANCES**: (Type Name under Signature Line)

Bureau Environmental Officer/AFR: Email clearance by Walter Knausenberger Date: 10/8/2015
Brian Hirsch

PMI Advisor: _____ Date: _____
PMI/Tanzania George Greer

Mission Environmental Officer: _____ Date: _____
USAID/Tanzania Gabriel Batulaine

Regional Environmental Advisor: _____ Date: _____
USAID/East Africa & Kenya David Kinyua

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**Kristen George <kgeorge@usaid.gov>**

# 3rd draft Tanzania SEA

**Walter Knausenberger** <wknausenberger@usaid.gov> Thu, Oct 8, 2015 at 12:37 PM
To: Rachel Dagovitz <rdagovitz@usaid.gov>
Cc: Kristen George <kgeorge@usaid.gov>, Brian Hirsch <BHirsch@usaid.gov>, Alexis Erwin <aerwin@usaid.gov>

OK, I see your point about standardizing the format. I had noticed the duplicative nature of the Principal Proposals and the Approvals language in the Zambia SEA also, but let it go. Now, with the Tanzania one, I thought rather than pointing it out, I'd try do a merger, to see how it came out. Fortunately, there really was nothing contradictory between the two sections, only duplicative. So, keeping it the way it was is fine.

And I can see why you would want to take out the DDT line, given that it is not proposed, and not likely to ever be, in the Tanzania PMI program. That is just as well, because DDT is rapidly outliving its usefulness, IMHO.

So, please consider this cleared for AFR, as you revised it.

Regards,

Walter
[Quoted text hidden]

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**Kristen George <kgeorge@usaid.gov>**

# 3rd draft Tanzania SEA

**Rachel Dagovitz** <rdagovitz@usaid.gov> Mon, Oct 5, 2015 at 1:43 PM
To: Kristen George <kgeorge@usaid.gov>
Cc: Brian Hirsch <BHirsch@usaid.gov>, Rachel Dagovitz <rdagovitz@usaid.gov>, Walter Knausenberger <wknausenberger@usaid.gov>

Hi Kristen,
Brian is out this week. I spoke with Walter and asked him to take a look at the SEA for Tanzania and hopefully he can cover Brian's clearance. I went through the SEA and feel that my comments were addressed. I can clear the SEA by email and will sign off the file when you are ready.

Thanks,

Rachel
[Quoted text hidden]
--
Rachel Dagovitz
Bureau Environmental Officer
Office of Policy, Programs and Planning
Bureau for Global Health
U.S. Agency for International Development (USAID)
2100 Crystal City Drive, Arlington , VA
Phone: 571.551.7112

**Tanzania 2015 SEA 3rd draft tracked changes and comments (2).docx**
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# 1. BACKGROUND & PURPOSE

## 1.1 PRESIDENT'S MALARIA INITIATIVE

Launched in 2005, the President's Malaria Initiative (PMI)[2] is a five-year, $1.2 billion expansion of U.S. Government efforts to reduce the intolerable burden of malaria and help relieve poverty on the African continent. The goal of PMI is to reduce malaria-related deaths by 50 percent in 19 countries in Africa that have a high burden of malaria by expanding coverage of four highly effective malaria prevention and treatment measures to the most vulnerable populations: pregnant women and children under five years of age (USAID 2005). These interventions include insecticide-treated mosquito nets (ITNs), IRS with insecticides, intermittent preventive treatment for pregnant women (IPTp), and prompt use of artemisinin-based combination therapies (ACTs) for those who have been diagnosed with malaria.

## 1.2 PROGRAM OBJECTIVES

PMI will assist Tanzania 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 a greater than 80 percent reduction from PMI's original 2000 baseline levels.
- Reduce malaria morbidity in PMI-supported districts by 40 percent from 2015 levels.

## 1.3 HISTORY AND SCOPE OF PMI-SUPPORTED IRS IN TANZANIA

In June 2005, the USG selected the United Republic of Tanzania (URT) (including the Mainland and Zanzibar) as one of the first of three countries to be included in PMI. For the past nine years, PMI supported IRS in Tanzania through a bilateral cooperative agreement. In 2015, PMI Tanzania's IRS operations were transferred to the TO6 contractual mechanism thereby becoming the newest addition to the PMI AIRS Project.

The Mainland reduced the targeted area for IRS from 659,146 structures in 2012/2013 to about 445,000 structures in 2013/2014, protecting over 2 million people (approximately 5% of Mainland's population). One factor in the reduction in the number of structures sprayed is the switch to a more expensive, but longer lasting pirimiphos-methyl CS. The switch is in keeping with the NMCP adoption of World Health Organization (WHO) guidance that calls for insecticide rotation prior to development of resistance.

In April 2014, Zanzibar used focal spraying to cover about 55,000 structures and protect about 265,000 people (approximately 25% of Zanzibar's population). Both pirimiphos-methyl CS and carbamate were used for IRS in the early 2014 spray round.

In 2015 in Zanzibar, a total of 62,391 house structures were sprayed (93.4% of those eligible) using Actellic CS, with 286,823 people protected. This includes 6,029 pregnant women and 48,182 children under the age of five (U5). In 2015 in the Mainland, IRS was implemented in seven districts of Kagera, Mara, and Mwanza regions of the Lake Zone. A total of 419,753 house structures (94.2% of those eligible) were sprayed with Actellic CS. Results showed that 2,110,198 people were protected, including 59,175 pregnant women and 431,365 children under the age of five.

With FY 2015 funding (for 2016 implementation), PMI will support targeted and focal IRS in the Lake Zone reaching approximately 400,000 structures and protecting about 2 million persons. PMI will support spraying in Geita through a public-private partnership with Geita Gold Mine. PMI will supply the insecticide and Geita Gold Mine will pay the operational costs for spraying. In Zanzibar, PMI will support focal spraying to cover about 20,000 structures and protect 100,000 people.

## TABLE 1: SPRAY PERFORMANCE IN ZANZIBAR 2006-2013

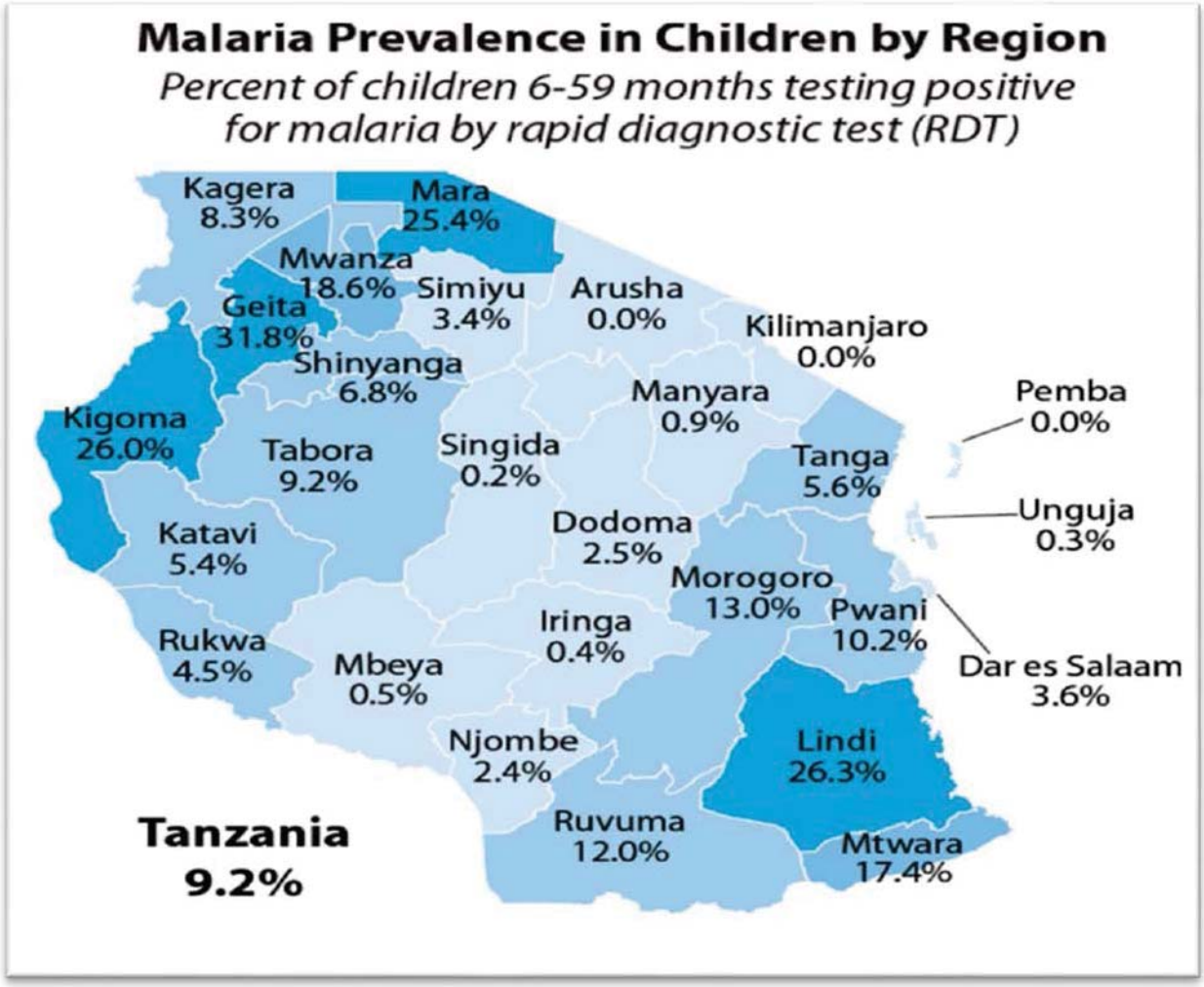
**Table 1. Spray performance in Zanzibar (structures sprayed), 2006–2013**

| Location | Round 1 | Round 2 | Round 3 | Focal Spray | Round 4 | Round 5 | Round 6 | Focal Spray | Targeted Spray | Targeted Spray | Targeted Spray | Focal Spray | Target Spray | Target Spray | Target Spray |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2007 | 2008 | 2008 | 2010 | 2011 | 2011 | 2012 | 2012 | 2013 | 2013 | 2014 | 2014 | 2015 |
| Unguja | | | | | | | | | | | | | Actellic 300CS | Bendiocarb | |
| Central | 15,167 (92%) | 15,258 (89%) | 15,737 (95%) | — | 13,897 (94%) | 15,046 (89%) | 14,883 (94%) | — | 15,392 (93%) | 4,536 (92%) | 10,171 (95%) | — | 11,138 (95%) | — | 9,399 (92%) |
| North A | 21,729 (98%) | 21,575 (96%) | 22,961 (100%) | — | 22,097 (97%) | 18,595 (88%) | 21,524 (100%) | — | 18,274 (93%) | — | 3,102 (94%) | — | 11,508 (95%) | 2,003 (96%) | 9,784 (94%) |
| North B | 11,829 (95%) | 10,819 (93%) | 11,737 (95%) | 4,797 | 10,562 (93%) | 10,397 (89%) | 11,480 (97%) | — | 11,294 (99%) | 2,653 (95%) | 8,288 (95%) | — | 9,642 (99%) | — | 11,007 (96%) |
| South | 8,036 (99%) | 8,871 (100%) | 9,167 (99%) | — | 9,417 (100%) | 8,604 (88%) | 8,472 (94%) | — | 5,644 (93%) | 1,840 (90%) | — | — | 5,460 (94%) | — | 6,321 (94%) |
| Urban | 25,670 (92%) | 23,764 (79%) | 25,828 (88%) | — | 27,464 (97%) | 22,355 (78%) | 23,127 (86.7%) | — | — | — | — | — | — | — | — |
| West | 41,182 (92%) | 37,370 (81%) | 47,739 (98%) | — | 43,053 (84%) | 40,202 (88%) | 40,422 (94.9%) | — | 24,463 (90%) | 3,065 (92%) | 4,702 (96%) | — | 8,536 (83%) | — | 15,165 (90%) |
| Pemba | | | | | | | | | | | | | Actellic 300CS | Bendiocarb | |
| Chakechake | 16,211 (99%) | 16,829 (100%) | 16,637 (99%) | — | 16,437 (96%) | 16,280 (88%) | 16,866 (94%) | — | 8,682 (98%) | 2,461 (93%) | 1,406 (95%) | — | 929 (98%) | — | 1,546 (96%) |
| Micheweni | 21,015 (100%) | 20,824 (100%) | 20,920 (100%) | — | 18,164 (97%) | 16,811 (87%) | 20,305 (96%) | 2,003 | 12,744 (98%) | 7,230 (99%) | 12,157 (99%) | 501 | 6,353 (98%) | — | 4,794 (99%) |

## 1.4 MALARIA PREVALENCE, MORBIDITY AND MORTALITY

Plasmodium falciparum accounts for 96% of malaria infection in Tanzania, with the remaining 4% due to P. malariae and P. ovale. The principal vectors of malaria in Tanzania are mosquitoes of the Anopheles gambiae complex (An. gambiae s.s and An. arabiensis). However, entomological data collected in 2013 indicate that An. funestus is prevalent on the Mainland as well, particularly in the Kagera Region. In Zanzibar, high coverage of ITNs and IRS has resulted in a shift in the malaria vector population from An. gambiae to An. arabiensis, which now represents 90% of the population in Pemba and 50% of the population in Unguja.[1]

**FIGURE 1: Malaria Prevalence in Children by Region**




Source: 2011-2012 THMIS

The 2011–2012 Tanzania HIV/AIDS Malaria Indicator Survey (THMIS) showed that 10% of Mainland children under five years of age had tested positive for malaria, down from 18% in the 2007-08 THMIS.

[1] Much of the data in this section of the SEA has been drawn from the 2015 Tanzania Malaria Operational Plan.

Prevalence varied by region, from <1% in the highlands of Arusha to 26% along the Lake Victoria shores (figure above). The same survey showed a much lower malaria prevalence of 0.2% in Zanzibar. On the Mainland, more than 40% of all outpatient visits are attributable to malaria, resulting in an estimated 10-12 million clinical malaria cases annually. The NMCP estimates that 60,000-80,000 malaria deaths occur annually in the Mainland among all age groups. Tanzania registered a 45% reduction in all-cause under-five mortality from 146/1000 live births in 1999 to the level of 81/1000 live births in 2010.

**TABLE 2: Infant and under-five Mortality rates, 1999-2010**

| *Infant and Under-five Mortality Rates for Five-year Periods Preceding Nationwide Household Surveys, Tanzania* | | | | |
|---|---|---|---|---|
| | **1999 DHS** | **2004-05 DHS** | **2007-08 THMIS** | **2009-10 DHS** |
| Infant mortality rate (95% C.I.) | 99.1 (85-113) | 68.0 (61-75) | 57.7 (50-65) | 51 (44-57) |
| Under-five mortality rate (95% C.I.) | 146.6 (128-165) | 112.0 (103-122) | 91.4 (83-100) | 81 (72-90) |

## 1.5 Health System Organization and Delivery Structure

Tanzania's health system is comprised of public, private, and donor stakeholders operating at different levels including national, regional, district, and community levels. Donor dependency for health financing typifies Tanzania's health system with the latest National Health Accounts (2009/10) showing that donors contribute a sizeable 40% of total health expenditures, followed by the private sector (largely household out-of-pocket spending) at 34%, and lastly the government at 26%. Of the total spent on health care, malaria accounts for 19% again largely financed by external funds with public financing for malaria decreasing since 2006 in absolute terms. The path towards universal health coverage is considerable; less than 15% of the population has health insurance coverage. With 1.5 health facilities per 10,000 population, Tanzania's health system has 6,734 facilities, the majority owned by the public sector (86%), 12% by faith-based organizations, and 2% by the for profit sector. While efforts have been made to ensure that there is a health facility in every village, there remains a significant deficit of skilled health staff (48% of positions are vacant) in public and faith-based facilities.

STRATEGY UPDATES

There have been two developments in Tanzania over the past year that should be noted: 1) The two malaria control programs (Mainland and Zanzibar) are finalizing new National Malaria Strategic Plans for 2014-2020 and 2013-2018 respectively. Although not yet launched, the documents have been used to guide MOP planning and strategic decisions. 2) The Zanzibar malaria program has officially changed its name to the Zanzibar Malaria Elimination Program, abbreviated ZAMEP.

The mid-term malaria strategic plans of both the NMCP and the ZAMEP ended in 2013 and 2012 respectively and both malaria programs are developing new strategic plans, with input from PMI and other partners, which will cover the time period for the FY 2015 MOP.

The NMCP strategic plan for 2014-2020 includes the following goals:

- To reduce malaria morbidity and malaria deaths by 80% from the 2012 levels by 2020.

- To reduce malaria prevalence from 10% in 2012 to 5% in 2016 and to 1% in 2020.
- To increase the proportion of women receiving two or more doses of SP during their
- pregnancy from 32% in 2012 to 80% by 2016.

The ZAMEP's 2013-2018 Strategic Plan has just been finalized (August 2015), and focuses on pre-elimination, Its vision is that by 2018 Zanzibar will have no locally-acquired malaria cases. The ZAMEP expects to achieve this by providing quality, affordable, and cost-effective antimalarial interventions and malaria curative services to all people in Zanzibar and by maintaining and expanding a well-performing epidemic detection and response system.

The operational objectives in the ZAMEP Strategic Plan are:

- To test 100% of suspected malaria cases with a parasitologic test by 2015 and to provide effective antimalarial treatment to all confirmed cases.
- To add primaquine to the treatment regimen by 2017 to reduce gametocytemia levels in the population and thereby limit transmission.
- To achieve and maintain 100% coverage with appropriate prevention measures by 2017.
- To expand malaria surveillance, conduct reactive case detection, and investigate 100% of confirmed malaria cases by 2018.
- To establish functional coordination structures for malaria elimination at national, district, and shehia (village) levels by 2018.
- To conduct relevant operational research to evaluate and optimize ongoing activities and monitor resistance to antimalarials and insecticides.

## 1.6 PARTNERS IN IRS IN TANZANIA

**Private Sector**

In FY 2012, PMI partnered with Geita Gold Mine to spray houses in two districts of Geita Region. Geita Gold Mine is providing funds to the local government for operational costs while PMI is providing the insecticide and technical expertise for microplanning, environmental compliance, data management and reporting, and final disposal of chemical waste. In 2015, the IRS partnership will expand to cover all the five districts in Geita Region.

# 2. Proposed Action and Alternatives

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 or bi-annual IRS campaigns that spray pesticides of the pyrethroid, carbamate, and organophosphate classes, as well as chlorfenapyr (when recommended by WHOPES) in high-risk districts and sectors in Tanzania 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 Tanzania.
3. **Spraying in alternative geographic regions:** This alternative would use different criteria to select alternative districts and sectors to spray.
4. **Use of alternative pesticides:** This alternative would consider pesticides other than those recommended by WHOPES.
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 Proposed Action

The preferred action is to implement an IRS program in communities selected in concert with NMCP and ZAMEP, choosing among the WHOPES-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes, and chlorfenapyr (once recommended by WHOPES), considering current entomological, epidemiological, logistical, environmental, and economic conditions. The pesticide to be used will be determined by a process fully explained in Pesticide Procedures part b (see section 4.2).

## 2.2 No Project Alternative

IRS 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 goal of the Tanzania NMCP, ZAMEP and PMI, which is to reduce malaria mortality by one-third from 2015 levels in PMI-supported countries, achieving a greater than 80 percent reduction from PMI's original 2000 baseline levels.

## 2.3 Alternative IRS Geographical Sites Considered

Although this SEA proposes to allow IRS in all provinces in Tanzania, in IRS implementation, areas considered as highly malarious and those areas that fit within the NMCP and ZAMEP strategic plan are considered. Using different criteria for selecting geographical sites would reduce the effectiveness and impact of IRS, decreasing progress towards the goals of the Tanzania NMCP, ZAMEP and PMI.

## 2.4 Use of Alternative Insecticide (s)

For IRS to be implemented with PMI support, a pesticide recommended by the World Health Organization (WHO) under the World Health Organization Pesticide Evaluation Scheme (WHOPES) must be selected for use. To date WHOPES has recommended twelve active ingredients (AI) for use in IRS for malaria control within the following four classes of pesticides: pyrethroids, carbamates, organochlorines, and organophosphates. DDT is not currently considered for use in Tanzania, and therefore approval is not requested for this pesticide. However, this SEA also requests approval for chlorfenapyr in anticipation that this new insecticide – currently under WHOPES review – will, within the time span of this SEA be fully recommended by WHOPES for IRS and be registered for public health use in Tanzania.

Currently, there are no other pesticides eligible for use in PMI-sponsored IRS, so deliberations are confined to these classes of pesticides.

## 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 those other technologies. The specific focus of this PMI effort and the role that PMI plays in Tanzania includes IRS. If other viable approaches were to arise that would replace or improve upon the role that IRS plays, the NMCP, ZAMEP, PMI and its partners would evaluate them and proceed accordingly.

# 3. Affected Environment in Tanzania

## 3.1 Overview of Tanzania

Tanzania is located in East Africa, bordering Kenya to the north; Rwanda, Burundi, and the Democratic Republic of Congo to the west; and Zambia, Malawi, and Mozambique to the south. It is the largest country in East Africa (943,000 sq km), made up of both the Mainland and the Zanzibar archipelago.

A large central plateau makes up most of the Mainland (at between 900m and 1800m). The mountain ranges of the Eastern Arc and the Southern and Northern Highlands cut across the country to form part of the Great Rift Valley.

## 3.2 Administrative and Political Units

Tanzania has a 2012 estimated population of 44,928,923 (National Bureau of Statistics, Tanzania: 2012). The country is divided into 30 regions, 25 in the mainland of Tanzania and five in Zanzibar. Within the 30 regions, areas of the country are subdivided into 169 districts, 34 of which are urban units. Urban districts have an autonomous city, town or municipal council and are subdivided into wards (*shehia*). Non-urban districts have an autonomous district council, which are subdivided into village or township councils and then into *vitongojis*, the smallest governmental unit of a village. The parliament of Tanzania consists of the president and the National Assembly and is dominated by the Chama Cha Mapinduzi party (CCM), which holds 75 percent of the seats in the assembly.

**FIGURE 2: Map of Tanzania, showing regions and districts**


## 3.3 PHYSICAL ENVIRONMENT

### 3.3.1 CLIMATE

Tanzania, located in the southern region of Africa between latitudes 1° and 11°S and 30° and 40°E has a tropical climate. In the highlands, temperatures range between 10°C and 20°C during cold and hot

seasons, respectively. The rest of the country has temperatures that never fall lower than 20°C. The hottest period spans the months from November to February (25°C–31°C), while the coldest period occurs between May and August (15°C–20°C). The average annual temperature range is 20°C. The mountainous region of Tanzania has a cool climate.

### 3.3.2 RAINFALL PATTERNS

Two types of rainfall occur in Tanzania: 1) unimodal (December–April); and 2) bimodal (October–December and March–May). The former is experienced in southern, southwestern, central, and western parts of the country, and the latter is found in the north and northern coast. The bimodal rains in March–May are referred to as "the long rains" or *masika*; the October–December rains are generally known as "short rains" or *vuli*.

Seasonal rainfall patterns are driven by the Inter-tropical Convergence Zone, which migrates south through Tanzania from October to December causing the short-period and long-period rains in the northern and eastern part of the country from October to November and March to May, respectively. The southern, western, and central parts of the country have one wet season that spans October to April or May. The amount of rain falling in the season from October to May is typically about 50-200mm per month depending on the region. In the southwestern region, the wettest region in the country, rainfall levels can reach as much as 300mm per month.

### 3.3.3 TOPOGRAPHY, GEOLOGY AND SOILS (BRIEF)

Tanzania is the largest East African country. It has a landscape of three main physiographic regions: 1) the islands and coastal plains to the east; 2) the inland plateau; and 3) the highlands. The mainland of Tanzania is generally low and flat along the coast. The Great Rift Valley runs from the northeast through central Tanzania separating the low-lying coast from the inland plateau in the central region. The inland plateau has an average elevation of about 1,220 meters.

The valley is dotted with unique lakes, including Rukwa, Tanganyika, Nyasa, Kitangiri, Eyasi, and Manyara. The uplands include the famous Kipengere, Udzungwa, Matogoro, Livingstone, and the Fipa plateau, forming the southern highlands. Usambara, Pare, Meru, Kilimanjaro, Ngorongoro Crater, and Oldonyo Lengai form the northern highlands. The volcanic Kilimanjaro is the tallest mountain in Africa at an elevation of 5,895 meters. From these highlands and the central saucer plateau flows the interior drainage system to the Indian Ocean, Atlantic Ocean, and Mediterranean Sea.

The soils of Tanzania vary by region. Light sandy soils predominate in the coastal areas, whereas volcanic soils are prevalent in the northeast and southwest highlands areas. Red soils occupy most of central plateau, ironstone soils are found in the far west region and granite soils are found in the mid-west region in the Mwanza and Tabora region. Tanzania is also home to the mbuga black vertisols, which are widespread and an important source of dry season grazing. Tanzania is currently dealing with environmental issues of soil degradation, deforestation, desertification, destruction of their coral reefs, and drought.

## 3.4 BIOLOGICAL ENVIRONMENT

### 3.4.1 PLANT LIFE

As a result of Tanzania's tropical climate and varied geography, Tanzania's plant life contains representatives of all the plant formations found in Africa's main ecological zones. The main vegetation

types, are woodland, wooded/bush grassland, grassland and dwarf shrub grassland, bushland and shrub thicket, and forest. Forests cover 37 percent of the country's land area, about 33.5 million hectares. Tanzania is among the 12 most biodiverse countries in the world with over 10,000 plant species, the second most of any country in Africa.

On the eastern side of the country, in the Eastern Arc mountain range, there are patches of tropical rainforest with a wide assortment of plant species, many of which are only found in Tanzania. These include the Usambara or African violet (Saintpaulia) and Impatiens. South and west of the Eastern Arc range are areas of baobab. In the flat regions of the country, much of the land is covered by miombo ('moist' woodland), where the main vegetation is various types of Brachystegia tree. Tanzani's central plateau is covered with savanna, bushland and thickets, while grasslands cover the Serengeti plain and other areas that lack good drainage.

### 3.4.2 Animal Life

Tanzania is home to many species of diverse wildlife. The country has the largest number of mammals in Africa and contains roughly 20 percent of the species of Africa's large mammal population. These animals are can be found in Tanzania's game management reserves, conservation areas, marine parks, and 17 national parks. Tanzania also has the third largest number of bird species, the fourth largest number of amphibian species, and the fourth largest number of reptile species in the continent of Africa.

Wildlife conservation has been a priority in the Tanzanian government for decades, and as a result, there are major restrictions on the use of wildlife resources by the local communities. These policies have caused harm to impoverished rural communities and have resulted in poaching by these areas. The Tanzania National Parks Authority (TANAPA) has now been working to involve local communities in conservation efforts and has allowed more equitable sharing of wildlife resources.

Wildlife resources have been an important part of Tanzania's economy, providing an annual income of US$30 million to the national revenue, and illegal hunting is estimated to be worth US$ 50 million. In the 1990s, exports of 1.68 million birds, 523,000 reptiles, 12,000 mammals and 148,000 amphibians occurred, and wildlife related tourism increased by about 30%. Fishery resource exports contribute US$145 million in 2005.

## 3.5 Major water bodies

The major water basins in Tanzania are the Lake Victoria, Pangani River, Rufuji River, Wami-Ruvu, Lake Nyasa, Lake Rukwa, Lake Eyasi and Manyara, Lake Tanganyika, and Ruvuma River/Southern Coast basin. The Lake Victoria basin is a part of the Nile River basin, draining to the Mediterranean Sea. The Pangani River basin, Wami-Ruvu, Rufiki River, Ruvuma River/Southern Coast, and Lake Nyasa basin all drain to the Indian Ocean. The Lake Tanganyika basin is part of the Congo River basin and drains to the Atlantic Ocean.

### 3.5.1 Lakes

Three major lakes are located on the borders of Tanzania. Lake Victoria, the largest waterbody in Africa covering a total area of 68,800 km$^2$, is located on the northern border and is shared by Uganda and Kenya with Tanzania holding 51 percent of the lake's area. Lake Tanganyika lies on the western border and is shared with Burundi, the Democratic Republic of Congo and Zambia. The total area of the lake is 32,900 km$^2$, of which 41 percent belongs to Tanzania. Lake Nyasa, sometimes referred to as Lake Malawi, is part of the Zambezi River basin and is shared with Malawi and Mozambique on Tanzania's

southwestern border. Lake Nyasa has an area of 30,800 km$^2$ and 18 percent of the lake lies in Tanzania. Other smaller lakes include Lake Rukwa, Lake Eyasi, Lake Manyara, Lake Natron, Lake Balangida.

### 3.5.2 Rivers

The majority of Tanzania's rivers drain to the eastern coast of Africa into the Indian Ocean. This includes Tanzania's longest river, the Ruvuma River, which originates east of Lake Nyasa and runs 704 km before emptying into the Indian Ocean. Several rivers drain to Lake Victoria in the Nile River basin, the Congo River basin, and the Endorheic basin, which lies in the Great Rift Valley and is home to many small lakes.

### 3.5.3 Wetlands

Tanzania is rich in wetland resources, which support an extensive trading and transport system, fishing areas, and agricultural and pastoral activities. These areas have also been utilized for irrigation and hydroelectric power. These wetlands are located throughout Tanzania on the Indian Ocean coast, the shorelines of Tanzania's three major lakes, and in some riverine environments in the central region of the country. Wetlands make up roughly 10% of the country's land area. There are approximately 2.7 million hectares of area covered by permanent or seasonal freshwater swamps and seasonal floodplains. The main wetland systems are the Western and Eastern Rift Valley lakes, Lake Victoria, minor lakes, riverine floodplains and swamps, and coastal mangrove systems with intertidal mudflats.

## 3.6 Protected Areas

Tanzania has a total 646 protected areas in the form of national parks, game reserves, marine parks, and forest reserves. Altogether, these areas cover 28 percent of the country and some marine areas. Tanzania has 17 wildlife management areas (WMA) that cover roughly 42,000 km$^2$ of land. The 17 WMAs represent 18 wildlife protected areas, consisting of eight national parks (NPs), eight game reserve areas, one conservation area, and one game controlled area, and 16 forest reserves. The WMAs are managed by the Authorized Association, which is a community-based organization that represents participating villages members that form the WMA. There are currently 22 other WMAs in various stages of development in Tanzania. The national parks have a separate authority, TANAPA. Three of the largest and most famous Tanzanian NPs, Serengeti, Ruaha and Kilimanjaro, are detailed below.

The PMI IRS IP will not perform IRS within Tanzania's core protected areas. Protected areas in Tanzania have a core protected area, with stringent regulations restricting uses, entry, and activities, and buffer areas referred to as WMAs with less stringent protection. In general, the WMAs are designed to protect the environment while allowing sustainable use of resources. PMI will only perform IRS within buffer areas of Tanzania's protected areas, as allowed by national and local regulation, if needed and required by the NMCP to protect the population in these areas from malaria, using the strict protocols and procedures contained in the PMI Best Management Practices (BMP) manual, and observing all precautions and prescriptions in this Supplemental Environmental Assessment (SEA). PMI-sponsored IRS will not be performed within 30 meters of the core protected areas. Operations sites for storing pesticide and performing clean-up activities will not be allowed in the buffer or core areas.

### 3.6.1 Serengeti National Park

The Serengeti National Park is Tanzania's most famous national park and became a world heritage site in 1951. The park spans 14,750 km$^2$ on the northwestern border of Tanzania. The park is contiguous with

the Maasai Mara National Reserve and is shared with Kenya. The park is surrounded by game reserves, conservation areas, and game control areas. The park covers grassland plains, savannah, riverine forest, and woodlands. The park is known for its large population of wildlife, specifically the "big five". Prominent wildlife species include lions, African leopards, African elephants, black rhinoceros, African buffalo, and Tanzanian cheetah. Smaller animals in the park include gazelles, topi, elands, waterbucks, hyenas, baboons, impalas, African wild dogs, giraffes and about 500 bird species.

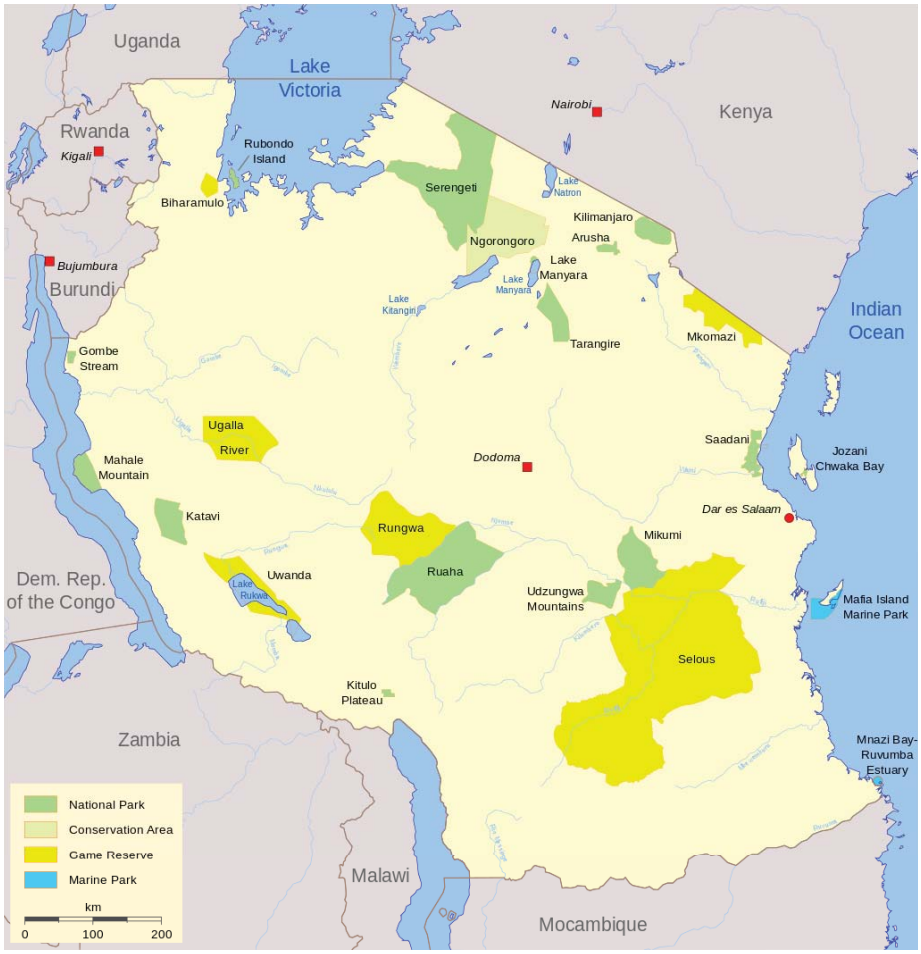
### 3.6.2 Ruaha National Park

Ruaha National Park is the largest national park in Tanzania and one of the largest national parks in Africa. In 2008, the park was expanded to 20,226 $km^2$ by incorporating the Usangu Game Reserve and wetland areas. The park is located in central Tanzania, covering part of the Rungwa-Kizigo-Muhesi ecosystem and some of Tanzania's game reserves, WMAs, and other protected areas. The national park has a large population of elephants, African wild dogs, antelopes, and bird species. Rhinoceros formerly lived in this area but are now extinct due to poaching. The park is currently dealing with a large environmental problem due to drought and dry seasons. The Great Ruaha River runs through the park and has been progressively drying up due to irrigation and drought in the area.

### 3.6.3 Kilimanjaro National Park

Kilimanjaro National Park is located near the city of Moshi and covers the area of Mount Kilimanjaro above the tree line and the surrounding montane forest belt above 1,820 meters. The total area of the park is 1,688 $km^2$. The park is home to unique wildlife. Above the timberline, the Kilimanjaro tree hyrax, the grey duiker, rodents, bushbucks and red duiker can be found. Cape buffalo, blue monkey, western black and white colobus, bushbaby, and leopards are found in the montane forest. Elephants can also be found between the Namwai and Tarakia rivers and sometimes occur at higher elevations.

**FIGURE 3: Protected Areas in Tanzania**




## 3.7 AGRICULTURE AND ORGANIC FARMING

The agriculture sector in Tanzania is large, providing 43.4 percent of Tanzania's US$9.9 billion GDP and employing roughly 80 percent of the population. Small-scale farms represent more than 90 percent of the farming population, and 54 percent of agricultural workers are women. The main food crops are maize, paddy rice, sorghum, millet, wheat and sweet potato. In 2002, paddy rice and maize represented 48 and 31 percent of the irrigated crop areas, respectively. Today, maize is the dominant crop with over 1.5 million hectares, while paddy is planted over 0.5 million hectares. The main agricultural exports in 2011 were green coffee, tobacco, cashew nuts, sesame seed, and cotton lint (FAO, 2015). Pesticides have been used in agriculture since the 1980s. All pesticides used are imported into the country from where they are formulated. Between 1989 and 1992, Tanzania imported an average of 14,000 tons of pesticides per year. Insecticides, herbicides and fungicides account for over 90 percent of all pesticides used in the country, mainly on cotton, coffee, maize, and paddy (Kishimba et al, 2004)

### BEE KEEPING

Beekeeping contributes substantially to the foreign exchange earnings of the country. The Miombo woodlands offer a huge potential for the beekeeping industry, but deforestation is undermining development opportunities. Over 75% of beekeeping activities in Mwanza Region are carried out in

Geita District, followed by Kwimba and Sengerema districts. The beekeepers almost all use traditional beehives.

The design of these beehives consists of two semi-cylindrical pieces of tree bark or dugout wood tied together and hung in a tree. The hive is left there until a wild bee swarm takes up residence. After a hive has been occupied and a breeding colony is well established, the bees are then smoked out and the honey and wax removed. The limited data available suggests that a traditional beehive's average annual honey yield is 12.5kg. It is suggested that under favorable weather conditions, production can go up to 20kg of honey annually.

As PMI operations and support for IRS by the Geita Gold Mine are widespread in Geita, precautions must be taken to protect beekeeping endeavors.

## 3.8 ENVIRONMENTAL ISSUES[2]

### 3.8.1 ILLEGAL AND UNSUSTAINABLE DEFORESTATION

A majority of Tanzanians rely on wood and agricultural residues for their energy needs, causing deforestation and environmental degradation. Deforested areas no longer provide a home for wildlife - leading to biodiversity loss - and are also susceptible to soil erosion. In 2007, TRAFFIC showed that organized illegal timber crime is causing millions of dollars of timber revenue to be lost each year in Tanzania

### 3.8.2 OVERGRAZING AND UNSUSTAINABLE RANGE MANAGEMENT

Large cattle size and many goats may be an economic boon for farmers, but when their numbers exceed the area's natural carrying capacity, this can turn to a serious disadvantage. When vegetation disappears, the ground becomes exposed to soil erosion, which greatly reduces its ability to grow new plants. Eroded soil also runs into rivers and out at sea, where it smothers sensitive corals.

### 3.8.3 POLLUTION

In Tanzania's major towns and cities, solid and liquid wastes are left untreated. As a result, air and water are contaminated with pollutants, a major health hazard for those who live in under-privileged areas. In Dar es Salaam for example, a major city in Tanzania, few people are connected to a sewage system. The few sewage systems that exist discharge directly into the ocean, affecting marine habitats and the species that live there.

### 3.8.4 ILLEGAL AND UNSUSTAINABLE WILDLIFE EXPLOITATION

In village areas, people often resort to poaching. Sometimes, this happens in retaliation to wildlife attacks which destroy crops, and hence livelihoods. Such conflicts between humans and wildlife are also straining relations between wildlife authorities and local people.

[2] http://wwf.panda.org/who_we_are/wwf_offices/tanzania/environmental_problems__in_tanzania/, accessed on line on 7/29/15, Sources Mniwasa E., Shauri V. 2001. Review of the Decentralization process and its' impact on environmental and natural resources management in Tanzania.

## 3.9 SUMMARY

Tanzania still has high prevalence and transmission rates of malaria and IRS has been demonstrated to help reduce these rates in the areas where it has been employed. Tanzania also has a rich and diverse natural environment that needs to be preserved for future generations. The people are part of this environment, and they must be cared for as well. PMI has a strong record of IRS execution without environmental degradation, and it is highly likely that with continued adherence to the environmental mitigation and monitoring plan, which is key to this history of success, that implementing contractors will continue to deliver life-saving IRS with insignificant environmental impact. Therefore, it is recommended that IRS be permitted to continue in the areas identified by the NMCP, including in the buffer areas of the above-mentioned protected areas.

# 4. PESTICIDE PROCEDURES

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 Tanzania IRS 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 Tanzania.

## 4.1 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. However, some of the pesticides on the WHOPES list are not registered with the USEPA, for economic reasons rather than technical ones. Because this is an economic issue rather than a technical one, US regulations permit the use of these insecticides, conditioned on the performance of the proper environmental assessments, as well as notification to and authorization from the host country government. There is widespread acceptance and use of these chemicals around the world, with a good database attesting to the safety of the chemicals when used as directed. PMI/USAID works closely with host country governments, with full and clear disclosure, as well as providing any necessary assistance in the mitigation of risk from the use of these WHOPES pesticides.

This SEA, supported by the PMI IVM PEA, and distributed to Tanzania Division of the Environment (TDE), Zanzibar Environmental Management Authority (ZEMA), Tropical Pesticide Research Institute (TPRI), MOHSW and ZAMEP, provide the notification and mitigation requirements of US regulations. PMI/USAID is therefore empowered, upon acceptance of this document and the receipt of formal authorization from a competent Tanzanian authority, to allow the use of all WHOPES-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes, and chlorfenapyr when recommended by WHOPES.

## 4.2 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.

### 4.2.1 PRIMARY CRITERIA FOR CHOOSING PESTICIDES

**Approval by the World Health Organization Pesticide Evaluation Scheme:** Only insecticides recommended by WHOPES or by USAID/USEPA can be used in IRS. Certain pesticides in the organophosphate, carbamate, pyrethroid and organochlorine classes are WHOPES-recommended for use in IRS. Table 3 shows the list of WHO-recommended pesticides. Chlorfenapyr is not yet recommended by WHOPES, but authorization is requested in this SEA to use it for hut trials, and for IRS when and if it receives WHOPES-recommendation.

## TABLE 3: WHOPES Recommended Pesticides With Effective Duration

Updated: 2 March 2015

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

| *Insecticide compounds and formulations*[1] | *Class group*[2] | *Dosage (g a.i./m²)* | *Mode of action* | *Duration of effective action (months)* |
|---|---|---|---|---|
| ***DDT WP*** | OC | 1-2 | contact | >6 |
| ***Malathion WP*** | OP | 2 | contact | 2–3 |
| ***Fenitrothion WP*** | OP | 2 | contact & airborne | 3–6 |
| ***Pirimiphos-methyl WP, EC*** | OP | 1-2 | contact & airborne | 2–3 |
| ***Pirimiphos-methyl CS*** | OP | 1 | contact & airborne | 4–6 |
| ***Bendiocarb WP, WP-SB*** | C | 0.1–0.4 | contact & airborne | 2–6 |
| ***Propoxur WP*** | C | 1–2 | contact & airborne | 3–6 |
| ***Alpha-cypermethrin WP, SC*** | PY | 0.02–0.03 | contact | 4–6 |
| ***Alpha-cypermethrin WG-SB*** | PY | 0.02–0.03 | contact | up to 4 |
| ***Bifenthrin WP*** | PY | 0.025–0.05 | contact | 3–6 |
| ***Cyfluthrin WP*** | PY | 0.02–0.05 | contact | 3–6 |
| ***Deltamethrin SC-PE*** | PY | 0.02–0.025 | contact | 6 |
| ***Deltamethrin WP, WG, WG-SB*** | PY | 0.02–0.025 | contact | 3–6 |
| ***Etofenprox WP*** | PY | 0.1–0.3 | contact | 3–6 |
| ***Lambda-cyhalothrin WP, CS*** | PY | 0.02–0.03 | contact | 3–6 |

**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/).

**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/.

[1] CS = 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.

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

**Registration for use in Tanzania:** In the case where the insecticide proposed for use in IRS is not registered in Tanzania, PMI will work with manufacturers and distributors, as well as the NEMC, TPRI, MOHSW and ZEMA to obtain special authorization for the use of the pesticide.

**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 after application; however, the effective duration varies under different climatic 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. Cone bioassays to test the longevity of Actellic 300CS on various wall surfaces in Zanzibar in 2015 show that the sprayed surfaces remain highly efficacious for over eight months post-spray, eliciting over 80% mortality against a susceptible strain of *Anopheles gambiae*. In the mainland, a total of five sentinel sites were established to monitor insecticide effectiveness on the various wall surfaces sprayed with pirimiphos-methyl (in Ngara, Chato, Magu, Rorya, Missungwi, Muleba and Biharamulo). Up to two months after the last spray round, Actellic 300CS elicited 100% mortality on all surfaces. Data is continuing to be collected for the subsequent months to determine the full range of residual efficacy. The duration of effectiveness on the primary wall surface types will continue to be researched and considered when selecting insecticide class and active ingredient.

**Pesticide must be appropriate for use on the wall surfaces of the selected location**: In Zanzibar, the majority of Pemba Island wall surfaces are made up of limestone bricks and in Unguja Island it is concrete blocks. As for the Tanzanian mainland (lake zone) the majority of the houses in rural settings are still made up of mud wall surfaces, mud bricks and burnt bricks. Pyrethroids, carbamates, and organophosphates are known to function well on these surfaces, and are therefore appropriate for use.

**Local vector susceptibility to the insecticide:** 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 Tanzania, vector susceptibility studies have confirmed the effectiveness of pirimiphos methyl in all these districts, it is now being used for IRS in the current spray districts to manage resistance and to take advantage of the long residual effect.

**Monitoring Vector Susceptibility to Insecticides in Tanzania Mainland (2014)**[3]

(Lake Zone included)

NIMR-Amani has a total of 22 sentinel sites for insecticide resistance monitoring. In 2014, the national insecticide resistance monitoring program carried out insecticide resistance testing in 18 of the 22 sites using the WHO standard assay for permethrin, deltamethrin, bendiocarb and lambdacyhalothrin at all 18 sites.

[3] PMI FY2016 Malaria Operational Plan

Results are presented for all sites with a lower than 98% mortality. Permethrin resistance, ranging from 10% to 55% was detected in 3 of the 18 sites. Two sites indicated possible permethrin resistance, between 6.7 and 7.5%. Lambdacyhalothrin resistance was more widespread and was found in 11 of the sites (11% - 62%) and one site indicated possible lambdacyhalothrin resistance at 6.7%. Deltamethrin resistance was detected in 6 sentinel sites (14.4% - 41%) and possible resistance in 5 sites (2.2% - 8%). Resistance to at least two of the pyrethroids was detected in 9 of the 18 sites. Bendiocarb resistance was detected in 1 of the 18 sites (41.8%) and possible resistance in two other sites (6.7% and 7.5%). In PMI IRS regions, the insecticide sentinel sites were the districts of Geita, Magu, Musoma and Ngara. In Magu and Ngara lambdacyhalothrin resistance was detected at 23.7% and 16.7% respectively. In Geita reduced susceptibility was detected for deltamethrin and lambdacyhalothrin (resistance at 3.3% and 6.7%). In Musoma there was also reduced susceptibility to permethrin, resistance was at 5%. There was no bendiocarb resistance in any of the PMI IRS regions.

In addition, the latest vector susceptibility data from 2014 indicates that there is DDT resistance in one site (Kindoni), and suspected resistance in 3 additional sites. There is 100% organophosphate susceptibility in all tested sites, with the exception of Kyela, however, pirimiphos-methyl was not tested.

**Monitoring Vector Susceptibility to Insecticides in Zanzibar (2014)**[4]

In 2014, two rounds of WHO insecticide resistance testing was carried out in Zanzibar, the first between April-June and the second between October-December. Insecticide resistance testing was performed at a total of nine sites on Pemba for permethrin, deltamethrin, lambdacyhalothrin, alpha-cypermethrin, bendiocarb and pirimiphos-methyl CS. Insecticide resistance testing was carried out at three sites in Unguja for the same insecticides except that deltamethrin and lambdacyhalothrin were not tested in Unguja.

In Pemba, resistance was detected for all five sites monitored for lambdacyhalothrin (23% - 66%), for six sites monitored for permethrin (25% - 51%), for two sites for deltamethrin (51%-57%) and three sites for alpha-cypermethrin (60% - 67%). No resistance was detected for bendiocarb or pirimiphos-methyl CS. In Unguja, resistance was detected at one site tested for alpha-cypermethrin (12%), and in one site for permethrin (61%). There was no insecticide resistance detected for bendiocarb or pirimiphos-methyl CS.

**Ecological impact:** Tanzania boasts of a diverse wildlife throughout the country, but especially in the national parks and protected areas, and it is extremely important that IRS does not in any way diminish this biodiversity. The ecological impact of the WHOPES pesticides is well-documented, recently in the 2012 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 4.5 and 4.7 below, as well as other sections of this document.

[4] PMI FY2016 Malaria Operational Plan

**Human health impact:** The 2012 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 (mainly for DDT and select pyrethroids). In general, pyrethroids and carbamates 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). The results of a bio-monitoring pilot conducted in 2015 may contribute to a needs assessment and guidelines for PMI spray operations.

### 4.2.2 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

## 4.3 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."[5]

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 four primary interventions, insecticide-treated nets, indoor residual spray, artemisinin-based combination therapies

[5] [5] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html

(ACT), and intermittent preventive treatment for pregnant women (IPTp). 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. PMI does not support environmental management as a vector control method. Because of the life-cycle requirements and the adaptability shown by IRS 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.

## 4.4 The Proposed Method or Methods of Application, Including Availability of Appropriate Application and Safety Equipment

IRS involves spraying a liquid 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, 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 backpack 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 clean the sprayer following PMI BMPs to maintain proper functioning of the pump, reuse leftover pesticide on the following day, and to guard against release of and/or exposure to pesticides. They also follow the manufacturer's recommendations to ensure their proper operation and calibration.

## 4.5 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. The table below 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.

"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 IVM PEA, and to Chapter 5 of this SEA for greater detail about pesticide toxicity.

**TABLE 4: Pesticide Toxicity**

| IRS Insecticide | Mammal | Bird | Fish | Other Aquatic | Bee | Persistence | Bioaccumulate |
|---|---|---|---|---|---|---|---|
| Alpha-cypermethrin (P) | | | | | | | |
| Bendiocarb ( C) | | | | | | | |
| Bifenthrin (P) | | | | | | | |
| Cyfluthrin (P) | | | | | | | |
| DDT (OC) | | | | | | | |
| Deltamethrin (P) | | | | | | | |
| Etofenprox (P) | | | | | | | |
| Fenitrothion (OP) | | | | | | | |
| Lambda-cyhalothrin (P) | | | | | | | |
| Malathion (OP) | | | | | | | |
| Pirimiphos-methyl (OP) | | | | | | | |
| Propoxur ( C) | | | | | | | |
| Chlorfenapyr (PR) | | | | | | | |

Source: IVM PEA 2012

Key

| | |
|---|---|
| High Toxicity | |
| Medium to High | |
| Medium Toxicity | |
| Low to Medium | |
| Low Toxicity | |
| Data Not Found | |

### 4.5.1 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, 2000b). 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.

## 4.6 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 4.2 of this SEA. 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 NMRI in collaboration with the PMI supported AIRS Tanzania project, 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 principal vectors of malaria in Tanzania are mosquitoes of the Anopheles gambiae complex (An. gambiae s.s and An. arabiensis). However, entomological data collected in 2013 indicate that An. funestus is prevalent on the Mainland as well, particularly in the Kagera Region. In Zanzibar, high coverage of ITNs and IRS has resulted in a shift in the malaria vector population from An. gambiae to An. arabiensis, which now represents 90% of the population in Pemba and 50% of the population in Unguja. 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 implication of vector resistance. 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 the 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 Tanzania, and analyzed for the concentration of the active ingredient. If feasible, susceptibility testing should also be performed, but seasonal dips in vector population usually limit this activity. In all PMI AIRS 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.

## 4.7 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 4). 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 the liquid wastes through the reuse of leftover pesticides, the triple rinsing of equipment, and the daily washing of PPE with rinsewater 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 6.1.11). The Environmental Mitigation and Monitoring Plan in Annex A 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 SEA (Chapter 6).

## 4.8 The Conditions under Which the Pesticide is to be Used

Chapter 3 of this document provides a detailed account of the environmental conditions in Tanzania 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 sensitive areas identified in Chapter 3, 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 habitat 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 IP will train sprayers to identify houses that should not be sprayed. IRS will be prohibited within 30 meters of sensitive ecosystems. 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 NEMC and ZEMA 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.

## 4.9 The Availability and Effectiveness of Other Pesticides or Non-Chemical Control Methods

In Tanzania, 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 Tanzania and in many other countries.

This IRS program is limited to using those pesticides that are on the WHOPES 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.[6,7] Each of these agents has been evaluated for effectiveness within the program, and continuing 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 five recommended pesticide classes (including chlorfenapyr in the pyrrole class, if and when it is recommended by WHOPES), to combat periodic resistance development.

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 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.

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[6] Najera JA, Zaim M (2002). Malaria vector control – Decision-making criteria and procedures for judicious use of insecticides. WHO, Geneva, WHO/CDS/ WHOPES/2002.5. (Document available at: www.who.int/ctd/whopes/docs/JudiciousUseRev.pdf)

[7] Chlorfenapyr is currently under consideration to be included. The 17th WHOPES Working Group (2014) recommended that, considering the potential efficacy of chlorfenapyr to kill pyrethroid-resistant Anopheles, further evidence be gathered in Phase II to assess the efficacy of indoor residual application of chlorfenapyr 240 SC against malaria vectors, following the WHO guidelines for IRS. It is recommended that the trials should be conducted at a minimum of three study sites, the applied doses should comply with target doses, the vectors are susceptible to chlorfenapyr, and use should be made of appropriate positive controls (i.e. WHO-recommended insecticides for IRS) to which local vectors are susceptible (control 1) and resistant (control 2). If, in a specific situation, local vectors are not susceptible to the positive controls, in at least the two other study sites the local vectors should be susceptible to the positive controls.

## 4.10 THE REQUESTING COUNTRY'S ABILITY TO REGULATE OR CONTROL THE DISTRIBUTION, STORAGE, USE, AND DISPOSAL OF THE REQUESTED PESTICIDE

### ENVIRONMENTAL LAWS AND REGULATIONS

There are a number of laws and regulations that demonstrate Tanzania's ability to regulate and control pesticides, and are significant for the implementation of this IRS program. This section of the SEA outlines and reviews the existing laws and regulations, and identifies requirements to guide the project's development in compliance with the national laws applicable to the IRS program.

These laws and regulations include the following:

# Tanzania

### 4.10.1 NATIONAL ENVIRONMENT MANAGEMENT ACT, 2004

Under the National Environmental Management Act, the NEMC was created to advise government on all environmental matters, formulate environmental policies, coordinate institutions, and evaluate proposed policies and environmental standards. According to the National Environment Management Act, conducting an Environmental Impact Assessment (EIA) is a mandatory requirement when implementing certain categories of projects in which large scale pesticide application and use are inherent. This SEA has thus been prepared and will be modified in order to meet the requirements of this act. As modified into a Tanzanian Environmental Impact Assessment, it will be submitted to the NEMC for review and approval.

### 4.10.2 ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS (2005)

This regulation describes the required structure and content of EIAs.

### 4.10.3 PLANT PROTECTION ACT (1997)

The Plant Protection Act's purpose was to institutionalize a system for both research and regulation of pesticides in use in Tanzania. The Act mandates the creation of the TPRI, which has responsibilities to supervise and regulate the manufacture, importation, distribution, sale, and use of pesticides in Tanzania, and to administer the regulations made under the Act.

The Act gives TPRI the authority to create the Pesticides Approval and Registration Technical Committee. The committee's responsibilities are to: 1) advise the council on pesticides regulations, control, and registration; 2) draw short- and long-term pesticides registration programs; and 3) review and formulate registration approval programs consistent with the country's needs. Part V of this Act establishes the system of pesticide registration.

Labeling requirements are also specified in Section 20 of the Act and include: 1) name; 2) percentage of active ingredients in proportion to weight; 3) descriptions of precautions to be used; 3) approval stamp from TPRI; and 4) name and address of person responsible for producing or manufacturing. Section 5 also provides generally for enforcement and legal proceedings, including a provision of corporate liability for violations of the Act.

In implementing this program, the IP will ensure that its partners and suppliers of the pesticides, as well as program staff, comply with the above regulations. During the bidding and procurement, the standards for packaging, labeling, and transportation will be adhered to.

### 4.10.4 FOREST ACT

The most significant changes are concerned with biodiversity conservation and community forest

management. EIAs are required in forested areas and watersheds for certain developments. National forest reserves may be declared to maintain and enhance biodiversity and genetic resources. Outside the reserves, conservation of trees include both protection of natural water supplies and biodiversity. Provisions are made for protection of wild plants and animals listed in the government gazette. There will be no IRS activities undertaken in forest areas where IRS would be prohibited under this Act.

### 4.10.5 Fisheries Act (2003)

The Fisheries Acts, 2003, provides laws on sustainable development, protection, conservation, aquaculture development, regulation and control of fish, fish products, aquatic flora, and it products and for related matters. IRS implementation in the mentioned regions will observe this Act and will institute the necessary safeguards to ensure aquaculture is not impacted through the chemical applications.

### 4.10.6 Wildlife Act (2009)

The Wildlife Conservation Act, 2009, section 74 puts restrictions on human activities etc in wildlife protected areas borderline. Bearing in mind the fact that Mara is close to Serengeti National Parks so, this Act is of great relevance because of the potential use of pesticides as a poison against all protected species within the park.

### 4.10.7 National Water Policy (2002)

The National Water Policy, 2002; this falls under the Ministry of Water. One of the objectives of the Water Policy, 2002, under "Water and the Environment" is the need to protect water-associated environments.

### 4.10.8 The Water Utilization (Control & Regulation) Act

The Water Utilization (Control & Regulation) Act, 1974 as amended in 1997 describes acts and omissions, which constitute offences in relation to pollution of water in any river, stream or water course or any water body to such extent as to likely cause injury, directly or indirectly to public health, to livestock or fish, to crops, orchards or gardens, which are irrigated by such water or to any products in the process of which such water is used.

## Zanzibar

### 4.10.9 Zanzibar Environmental Management Act, (Revolutionary Government of Zanzibar, 2015)

The Act covers environmental and social impact assessment, coastal zone management, pollution prevention and waste management, conservation of biodiversity, management of water, administration and institutions, emergency management, and offenses and penalties.

### 4.10.10 Zanzibar Environmental Policy, Zanzibar Department of the Environment, 2013 )

The policy addresses fundamental environmental issues which include Environmental and Climate change Governance; Terrestrial and Marine Resources and Biodiversity; Forest Conservation; Renewable and Efficient Energy; Environmental Pollution; Waste management; Integrated Water Resources Management; Development of Environmental Quality Standards, Environmental and Social Impact Assessment; Environmental Information Systems and Awareness, Climate Change Adaptation and Mitigation, Sustainable Tourism; Gender, HIV/AIDS and Public Health.

### 4.10.11 Procedure for Certification of Consultants for Environmental Impact Assessment

Self-explanatory

### 4.10.12 Procedures for Conducting Environmental Impact Assessment and Environmental Audit in Zanzibar, (Zanzibar Department of the Environment, undated)

Self-explanatory

**TABLE 5: SUMMARY OF ENVIRONMENTAL LAWS AND REGULATIONS**

| Law or Regulation | Date Enacted | Impact on IRS |
|---|---|---|
| National Environmental Management Act (Mainland) | 2004 | Requires preparation of an EIA |
| Environmental Impact Assessment Regulations | 2005 | Describes the required structure and content of EIAs. |
| Plant Protection Act | 1997 | Created TPRI, regulates the use of pesticides |
| Forest Act | 2002 | Regulation of activities within designated preserves and forests |
| Fisheries Act | 2003 | Regulates aquaculture and preservation of water habitats |
| Wildlife Act | 2009 | Restricts human activities within designated wildlife habitats |
| National Water Policy | 2002 | Protection of water resources, restrictions on activities |
| The Water Utilization Act | Amended 1997 | Restrictions on pollution of water resources, including habitat and other water uses. |
| Zanzibar Environmental Management Act | 2015 | Requires preparation of an EIA |
| Zanzibar Environmental Policy | 2013 | Wide-ranging policies on environmental pollution; waste management; integrated water resources management; Development of environmental quality standards, Environmental and Social Impact Assessment |
| Procedure for Certification of Consultants for Environmental | undated | Details requirements for certification to prepare EIAs |

| Law or Regulation | Date Enacted | Impact on IRS |
|---|---|---|
| Impact Assessment | | |
| Procedures For Conducting Environmental Impact Assessment And Environmental Audit In Zanzibar | undated | Details requirements of the EIA |

## 4.11 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. USAID 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,*[8], USAID PMI's IVM PEA (USAID, 2012 Update), 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 Tanzania. 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[9], 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..

[8] WHO-UNEP Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning: A Resource Tool. World Health Organization, Geneva. 332 Pages. Document also accessible at: http://www.who.int/whopes/recommendations/IPCSPesticide_ok.pdf

[9] These are usually health-related government staff within the targeted district (health assistants/educators/ inspectors, nursing assistants, and community development assistants).

## 4.12 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, and involve entomological evaluations on 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 Tanzania, this characteristic may be critical to the success of IRS. Therefore pirimiphos-methyl in the CS formulation has been used for PMI spraying in the Northern Region of Tanzania since 2013, and will continue to be used in 2015 in both the Lake Zone and Zanzibar.

# 5. Environmental & Health Impacts

## 5.1 Potential Positive Effects of the IRS Program

### 5.1.1 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.

### 5.1.2 Indirect Positive Effects

IRS will build human and institutional capacity building 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 going 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. Again, these revenues 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.

## 5.2 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. Table 4 in section 4.5 provides a graphic representation of the potential impacts on various receptors, as well as certain physical and chemical properties of the WHOPES pesticides.

### 5.2.1 Direct Potential Adverse Effects

#### *Contamination Of Surface Watercourses And Underground Water*

During IRS implementation, it is possible to accidently 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, and carbamates move slowly through soil, and degrade quickly when exposed to sunlight, hydrolysis, or microbial action in the soil. 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.

#### *Potential Impacts To Non-Target Organisms From Pesticides*

The degree of toxicity of the four WHOPES-recommended pesticide classes and chlorfenapyr to birdlife, aquatic life and insects, as well as pesticide persistence and bio-accumulation potential is documented in Table 4 in Section 4.5 of this SEA.

#### *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 Tanzania is mainly conducted away from the household and the sale of honey provides significant income to the residents, particularly in Geita. 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.

### 5.2.2 Indirect Adverse Effects

Upon termination of the IRS program, USAID will properly dispose of the IRS equipment and will no longer supervise its use. IRS equipment that may be disposed of to district health officials includes backpack compression sprayers, 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 GoT, 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 USAID and/or the USAID IP, requires that USAID and/or the USAID IP provide environmental training to the GoT 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. If PMI supports the procurement, loan, or disposition of spray pumps or personal protective equipment to

the GoT these activities must be mentioned in the annual Letter Report, in addition to this SEA. These activities do not require environmental compliance monitoring, however, USAID and/or the USAID IP must provide environmental training in the PMI IRS BMPs. These requirements relate to the use of non-DDT insecticides by the GoT. The conduct of IRS by District Medical Officers with communities, using properly working equipment left behind by USAID 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 has 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 than if the donation is not made.

## 5.3 Human Exposure Risks/Impacts

### Worker and Resident Exposure Pathways

During the IRS spraying process, spray personnel are at risk of un-intentional 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. 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 IVM PEA 2012. 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.

### 5.3.1 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.

### 5.3.2 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 OPs, 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.

### 5.3.3 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 to 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.

### 5.3.4 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.

## 5.4 Pesticide- and Process-specific Potential Health Impacts

### 5.4.1 Inhalation exposure and risk during mixing

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

### 5.4.2 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

### 5.4.3 Inhalation exposure and risk during spraying

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

### 5.4.4 Dermal exposure and risk during spraying

- Of the proposed pesticides, fenitrothion and pirimiphos-methyl have non-cancer risks (cholinesterase depression) due to dermal exposure

### 5.4.5 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.

### 5.4.6 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.

### 5.4.7 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.

### 5.4.8 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 recycle 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.

### 5.4.9 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.

## 5.5 CUMULATIVE IMPACT

Organophosphates are the pesticides with the 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 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. 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. At the present time, PMI is conducting evaluations to determine the need for closer scrutiny or monitoring.

Additionally, there are indications[10] that the capsule suspension form of Actellic is more resistant to environmental degradation than either Actellic EC, or the other WHOPES-recommended pesticides.

[10] Mitchell, David, and Chandonait, Peter (2015)

# 6. Safer Use Action Plan

This section outlines the safer use action plan proposed for the potential adverse impacts outlined in Section 5. 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 and facilities for the storage and disposal of pesticides and contaminated waste. 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/Tanzania 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 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.

### 6.1.2 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 Tanzania. Additional sampling and testing may be performed upon arrival. Delivery of all insecticide to the central warehouse in Dar es Salaam will be supervised by PMI and NMCP before being dispatched to the districts where spray operations will be concentrated.

### 6.1.3 Pesticide Transport

After the receipt of insecticide at the central warehouse, insecticides are transported to the district warehouses by road, and in some areas, over water in boats. 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 required vehicle to transport insecticides from central to district stores. If box trucks are not available, the IP will notify the Contract Officer Representative (COR). 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 AIRS Tanzania 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 5 below provides a list of key responses to mitigate the impact of the insecticide spills.

**FIGURE 4: EMERGENCY RESPONSE TO A SPILL**

**IN CASE OF INSECTICIDE SPILLS**

1. Control, contain and clean up the spill
2. Don protective clothing 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 must be shut off and smoking in the area strictly prohibited.
4. Onlookers and bystanders must be cautioned against approaching the accident site.
5. If the crew has come in contact with the pesticides, they must 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 must 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 are required to 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 after use. 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 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 at least 30 meters from flood plains, wetlands and water bodies, markets, schools, dwellings, beehives, and protected areas. Warehouses may not be located in the buffer zones of protected areas, or in schools.

- 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
- Built of concrete or other solid material
- Impervious flooring, or floor must be completely covered by a leak-free 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 Tanzanian pesticide regulations. 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 Tanzania, IRS is implemented in partnership with the MoHSW/NMCP, therefore, some warehouses are located on District Medical Office property for logistic and security purposes.

### 6.1.5 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.

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.

Although the soak pit captures the majority of pesticide from washwaters, small amounts may pass through and enter the soil below. Soil characteristics affect how pesticides move through the soil, and how they break down by environmental or microbiological 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 to capture and degrade trace amounts of pesticide. 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 stormwater 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.

### 6.1.6 Warehouse/Storage Risk Management

In order to mitigate risks associated with pesticide storage, the following will serve as warehouse/storage best management practices:

- A trained storekeeper will manage each facility and will wear gloves, mask, overalls, and boots when in the pesticide area of storage.
- No smoking or eating will be allowed within 30 meters of the pesticide storeroom.
- Pesticide storage facilities must have thermometers installed for daily temperature recording.
- Soap and clean water will be available at all times in all the facilities. Recommended pesticide stacking position and height in the warehouse as provided in the FAO Storage and Stock Control Manual will be followed.
- A fire extinguisher will be available in the storage facilities and all site workers will be trained on how to use this device.
- Warning notices will be placed outside of the store with skull and crossbones pictogram, and warnings in the local language
- Insecticides must be lifted off of the floor via pallets or shelves.
- 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.

#### *Accidental Warehouse Fires*

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.

### 6.1.7 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. Provided their work history has been acceptable, females who have been hired and later 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.

### 6.1.8 Spray Operator Exposure

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps, including hands-on exercises prior to the beginning of the spraying campaign. They will also be trained 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 will be conducted in accordance with the IRS Training Guide for Spray Operations (USAID,

2009) and the 2015 IRS BMP manual. Potential spray operators must also pass written and practical tests at the end of training.

Training for monitoring spray operators for symptoms of pesticide exposure will be mandatory for team leaders and supervisors, as well as for storekeepers and other senior personnel. Any case of an operator or beneficiary displaying symptoms of exposure will require the immediate completion of a standard Incident Report Form by the district coordinator, who will forward the report to the country Operations Manager and Chief of Party, who will forward it to IP's Director of Environmental Compliance and Safety (DECS) and Technical Project Manager (TPM) within 24 hours. The DECS will then forward it to the PMI (COR) Team and the PMI IRS Activity Manager in Tanzania upon receipt.

For malathion and fenitrothion OPs, it may be necessary to monitor the level of acetyl cholinesterase in any worker who may have been exposed to contamination. Occupational exposures to OP insecticides are measurable using blood cholinesterase and urinary excretion of chemical biomarkers. PMI has evaluated various approaches for monitoring sprayer exposure to OPs, and is developing protocols based on these evaluations. However, the WHOPES Working Group recommendations stated that, "provided that operational guidelines are followed, routine cholinesterase monitoring of spray men during IRS programs is not required" for Actellic CS.

### 6.1.9 Beneficiary Exposure

Residential exposure will also be monitored. During the IEC campaign, residents are made aware of the steps to take if exposed, and, especially if acute symptoms are encountered, the advice is to report to the nearest health facility. Thus reported cases at health facilities or by IEC mobilizers will serve as the principal monitoring strategy for beneficiary exposure incidents.

NMCP, DMOs, and the PMI IRS IP 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 Tanzania National Malaria Strategic Plan 2014-2020 and PMI Malaria Operational Plans. The IEC campaign (as well as IRS project leaders and MOHSW/NMCP Officers) 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 at least 10 meters from the home during spraying, and for two hours after spraying.
- 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.
- Sweep up any insects killed from the spraying and drop them in latrine pits before allowing re-entry by children and animals.
- Do not re-plaster or paint over the sprayed walls after spraying.
- Keep using bed-nets for additional protection against malaria.
- If skin itches after re-entrance 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 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 middle of spraying:

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

### 6.1.10 Pesticide Exposure and Treatment

All spray operators, team leaders, and supervisors will receive detailed training on the emergency steps to take if accidental exposure of the chemical occurs including ingestion, inhalation, eye or dermal contact with the chemical. This training will be conducted by the District and Sector Coordinators and will include drills to test knowledge of the operators. However, most interventions for acute exposure will have to be provided by medical professionals at the nearest health clinic, so transporting the exposed person to the health clinic will be the priority.

PMI AIRS will confirm that all the health facilities around the spray sites have in their store the recommended treatment drugs, and that all the staff responsible for administering emergency treatment to pesticide exposure receive appropriate training. Annex B provides additional information on symptoms and treatment protocols.

### 6.1.11 Solid and Liquid Contaminated Waste Management

Non-contaminated wastes, or those that can be cleaned thoroughly with soap and water will be recycled whenever possible, or disposed of in a municipal landfill if there is no appropriate recycling outlet.

Liquid contaminated wastes will be disposed of on a daily basis in soak pits that are carefully sited and designed according to the criteria in this SUAP and the PMI BMP manual. The soak pit is designed so that pesticides are adsorbed by the charcoal layer, and held until environmental processes result in the

degradation of the pesticide. Thus, there should be no contaminated liquid waste to deal with at the end of the spray season.

Contaminated solid wastes are incinerated in incinerators that are capable of destroying the pesticide and preventing environmental contamination.

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.

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 Tanzania, as solid wastes are incinerated in a PMI-owned incinerator, ash and slag will be incorporated into cement blocks and buried.

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 Tanzania, 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 non-hazardous 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 non-hazardous wastes. In Tanzania, the incineration will take place at the provincial medical hospitals in respective regional capitals. The EMMP in Annex A gives details on the steps and measures that will be taken to prevent negative impacts on the non-target ecosystems from liquid and solid IRS waste materials and disposal practices.

# 7. Public Consultation & Preparation Methodology

This SEA was prepared by the AIRS DECS, Peter Chandonait. A short-term technical assistance trip was made to Tanzania, in order to meet with major stakeholders and gather the information necessary for the SEA preparation. The DECS first attended meetings with the MoHSW, NEMC, NMCP and the Vice President's Office of Pollution Control in Dar es Salaam, where he discussed the need for the SEA to meet US regulatory requirements, and the parallel Tanzanian requirement and then traveled to several regions to meet with regional and district health officers. These visits enabled them to evaluate the past performance of IRS and identify sensitive areas and resources, and to determine needed improvements, areas of special concern, and how best to protect sensitive areas while conducting IRS in an environmentally sound manner.

In all the regions visited, meetings were first held with the Regional Medical Office (RMO) at the regional level and the District Medical Office at district level. In these meetings in the Lake Zone, malaria came out to be the number one disease with high disease burden in all the districts visited. As such, all the RMOs and DMOs welcomed IRS.

Several medical officers and others commented that a frequently heard complaint from beneficiaries was the emergence of bedbugs after spraying, which was attributed to pesticide. These officers indicated that the phenomena is probably due to sub-optimal household practices, such as failure to occasionally bring mattresses outdoors and leave them in the sun, which disperses the bedbugs. There were no other issues mentioned by beneficiaries relating to the performance of IRS.

After these consultations, in most cases, these officials arranged for and accompanied the DECS on visits to storerooms and soak pits to observe the conditions and status.

After visiting the Lake Zones, the DECS proceeded to the islands of Zanzibar, and met with officials of ZAMEP and ZEMA, and learned that a separate EIA is required by the government of Zanzibar. The DECS then visited some representative storerooms and soak pits, as well as the PMI-owned incinerator.

After the field trips, the DECS prepared the first draft of this SEA, which was submitted to PMI. Comments and edits were received and incorporated into the final draft, which was submitted for all appropriate approvals.

The table in Annex D comprises the names of the people who were interviewed during the preparation of the SEA.

# ANNEX A: ENVIRONMENTAL MITIGATION & MONITORING PLAN

**Please See the EMMP next page**

| Category of Activity | Describe specific environmental threats of your organization's activities | Description of Mitigation Measures | Who is responsible for monitoring | Monitoring Indicator | Monitoring Method | Frequency of Monitoring |
|---|---|---|---|---|---|---|
| **Use of insecticides** | 1. Occupational risks for workers involved in IRS campaigns (e.g., risks from insecticide exposure and vehicular accidents), especially women of child-bearing age | a. Inspect and certify vehicles used for pesticide or spray team transport prior to contract.<br><br>b. Train drivers<br><br>c. Ensure that driver has cell phone, personal protective equipment (PPE) and spill kits during pesticide transportation (Phone must be provided by rental company).<br><br>d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact.<br><br>e. Health test all spray team members for | a-d. Abt Environmental Compliance Officer (ECO).<br><br>e-g. Abt Operations Manager (OM).<br><br>h. ECO<br><br>i. Chief of Party (COP), Technical Project Managers (TPM) and headquarters environmental staff. | a. Transport vehicles have a valid inspection certificate on-board.<br><br>b. Drivers have a certificate of training completion.<br><br>c. Transport vehicles are equipped with cell phone, spill kit, and PPE.<br><br>d. Storekeeper has records of pregnancy testing for all female team members.<br><br>e. Storekeeper has medical exam results for all | a-c. ECO inspection of vehicles in the field.<br><br>d-e. ECO inspection of health records at IRS operational sites.<br><br>f-h. ECO performs pre-spray inspections of inventories and training records, and mid-spray inspections of PPE use and spray operator performance.<br><br>i. Monitoring of on-line database for submission of inspection reports. | **a-c. 2 inspections per week.**<br><br>d-e. One inspection per campaign, additional inspection if new hires or more than 30 spray days.<br><br>f-h. ECO pre-spray inspections 2/campaign, ECO mid-spray inspections 5 times/week.<br><br>i.Weekly |

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| | | duty fitness.<br><br>f. Procure, distribute, and train all workers with potential pesticide contact on the use of PPE.<br><br>g. Train operators on mixing pesticides and the proper use and maintenance of spray pumps.<br><br>h. Provide adequate facilities and supplies for end-of-day cleanup.<br><br>i. Enforce clean-up procedures. | | team members.<br><br>f. Spray operators wear complete PPE during spraying and clean-up.<br><br>g. Operators mix pesticide properly, and the pump does not leak.<br><br>h. All facilities are compliant, and materials required for clean-up are present.<br><br>i. Inspections are performed as scheduled, corrective action is taken as needed. | | |
| | 2. Safety risks for residents of sprayed houses (e.g., risks from inhalation and ingestion of | a. IEC campaigns to inform homeowners of responsibilities and precautions.<br><br>b. Prohibit spraying | a-b. IEC officers, OM, ECO<br><br>c. ECO<br><br>d. Spray | a. Pre-spray IEC campaigns were executed. Homeowners know | a. OM- IEC work records,<br><br>ECO- mid-spray inspections. | a. Inspect work records 1/campaign,<br><br>b-d. ECO mid-spray inspections |

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|---|---|---|---|---|---|---|
| | insecticides) | houses that are not properly prepared.<br><br>c. Two-hour exclusion from house after spraying<br><br>d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside. | operators (SO) and Team Leaders (TL) | responsibilities.<br><br>b. All houses being sprayed are properly prepared.<br><br>c. Homeowners observe 2 hour exclusion.<br><br>d. Lack of incident reports, or incident reports with proper response noted. | b-d. ECO mid-spray inspections | 3/wk. |
| | 3. Ecological risk to non-target species and water bodies from use of insecticides (during mixing and spraying) | a. Spray indoors only.<br><br>b. Train operators on proper spray technique.<br><br>c. Maintain pumps.<br><br>d. Monitor spraying in sensitive sites. Maintain required spray distance from bee keeping, wetlands, surface water. No spraying in forested areas per Tanzania | a-c. TL, Abt District Coordinator (DC), OM, ECO | a. Operators spray only inside of houses.<br><br>b. Operators are trained and know and use proper spray techniques.<br><br>c. Pumps are maintained and operated to eliminate leaks and erratic spraying. | a. ECO mid-spray inspections.<br><br>b-c. Training records, ECO mid-spray inspections | a. ECO inspections 3/wk.<br><br>b. ECO inspection of training records 1/campaign.<br><br>b-c. ECO mid-spray inspections 5/wk. |

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|---|---|---|---|---|---|---|
| | | Forest Act. | | | | |
| | 4. Environmental risk from disposal of insecticide (both liquid and solid waste) | a. Choose sites for disposal of liquid wastes according to PMI BMPs.<br><br>b. Construct soak pits with charcoal to adsorb pesticide from rinsewater.<br><br>c. Maintain soak pits as necessary during season.<br><br>d. Inspect and certify solid waste disposal sites before spray campaign.<br><br>e. Monitor waste storage and management during campaign.<br><br>f. Monitor disposal procedures post-campaign. | a-c. Abt OM, ECO, DC<br><br>d-f. Abt ECO | a. Operations sites meet PMI BMPs.<br><br>b. Soak pits are constructed according to the AIRS BMP manual.<br><br>c. Soak pits perform properly throughout the spray season.<br><br>d. Disposal sites have the capacity and policies to properly dispose of wastes.<br><br>e. Wastes are stored and managed according to PMI BMPs.<br><br>f. Waste disposal has taken place as agreed and certificates of | a-b. ECO Pre-spray inspections<br><br>c-f. ECO mid- and post-spray inspections and monitoring. | a.2/campaign<br><br>b.1/campaign<br><br>c. 5/week<br><br>d. 1/campaign<br><br>e. 3/week<br><br>f. Continuous during disposal |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | disposal received. | | |
| | 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.<br><br>b. Reconcile number of houses sprayed vs. number of sachets/bottles used.<br><br>c. Examine houses sprayed to confirm spray application.<br><br>d. Perform physical inventory counts during the spray season.<br><br>e. Maintain secure transport of pesticides by using a lockable box truck if available. | 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.<br><br>c. ECO mid-spray inspections. | a-b, d. Daily monitoring by storekeeper or site supervisor. Weekly monitoring by District Coordinators<br><br>c. 1/campaign by country headquarters. 2/campaign by ECO<br><br>d. 2/campaign/ store-room |

# ANNEX B: SUMMARY OF ACUTE EXPOSURE SYMPTOMS & TREATMENT OF WHOPES PESTICIDES

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

| Carbamates | Human side effects | Treatment |
|---|---|---|
| Bendiocarb | 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. | 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. |
| Propoxur | 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. | 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. |

**Summary of Acute Exposure Symptoms and Treatment of WHO-recommended organophosphates**

| Organo-phospate | Human side effects | Treatment |
|---|---|---|
| Malathion | Malathion is an indirect cholinesterase inhibitor. The primary target of malathion is the nervous system; it causes neurological effects by inhibiting cholinesterase.<br><br>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. | 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).<br><br>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, tranquillizers, and central stimulants are all contraindicated. |
| Fenitrothion | Fenitrothion is the most toxic to man of the insecticides recommended for residual house spraying, and has a relatively low margin of safety.<br><br>Absorbed through the gastrointestinal tract as well as through intact skin and by inhalation. It is also a cholinesterase inhibitor. | 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.<br><br>Contact lenses should be removed if possible and medical attention should be sought.<br><br>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. |

| Organo-phospate | Human side effects | Treatment |
|---|---|---|
| Pirimiphos-methyl | 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. | OP poisoning is a medical emergency and requires immediate treatment. All supervisors and individual spraymen (in the case of dispersed operations) should be trained in first-aid and emergency treatment of OP intoxication.<br><br>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.<br><br>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.<br><br>Atropine sulfate. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible.<br><br>Glycopyrolate has been studied as an alternative to atropine and found to have similar outcomes using continuous infusion. |

**Summary of Acute Exposure Symptoms and Treatment of WHO-recommended organophosphates**

| Pyrethroids | Human side effects | Treatment |
|---|---|---|
| Bifenthrin | 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.<br><br>No skin inflammation or irritation observed; however can cause a reversible tingling sensation.<br><br>Incoordination, irritability to sound and touch, tremors, salivation, diarrhea, and vomiting have been caused by high doses. | 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.<br><br>Medical attention should be sought if irritation or paresthesia occurs. Eye exposures should be treated by rinsing with copious amounts of water or saline. |
| Deltamethrin | 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. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br><br>Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate.<br><br>Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed. |
| Lambda-Cyhalothrin | Skin exposure leads to transient skin sensations such as periorbital facial tingling and burning.<br><br>Can irritate the eyes, skin, and upper respiratory tract. Oral exposure can cause neurological effects, including tremors and convulsions.<br><br>Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis. | 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. |

| Pyrethroids | Human side effects | Treatment |
|---|---|---|
| Alpha-Cypermethrin | Acute exposure symptoms include skin rashes, eye irritation, itching and burning sensation on exposed skin, and paraesthesia.<br><br>Acute inhalation exposures may cause upper and lower respiratory tract irritation. Ingestion of alpha-cypermethrin is also harmful | 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. |
| Cyfluthrin | 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. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br><br>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. |
| Etofenprox | 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. | If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water.<br><br>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. |

**Summary of Acute Exposure Symptoms and Treatment for Chlorfenapyr**

| Human side effects | Treatment |
|---|---|
| As chlorfenapyr is a rather new product there are not many cases of poisonings where the symptoms were described. One patient first exhibited general fatigue, hyper-perspiration, nausea and vomiting. He was initially diagnosed as being dehydrated.<br><br>Another patient 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. | 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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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 persist, the patient should be seen in a health care facility.<br><br>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. |

# ANNEX C: EMMR FORM

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 1a. Pre-contract inspection and certification of vehicles used for pesticide or spray team transport. | | | |
| 1b. Driver training | | | |
| 1c. Cell phone, personal protective equipment (PPE) and spill kits on board during pesticide transportation. | | | |
| 1d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact. | | | |
| 1e. Health fitness testing for all operators | | | |
| 1f. Procurement of, distribution to, and training on the use of PPE for all workers with potential pesticide contact. | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 1g. Training on mixing pesticides and the proper use and maintenance of spray pumps. | | | |
| 1h. Provision of adequate facilities and supplies for end-of-day cleanup, | | | |
| 1i. Enforce clean-up procedures. | | | |
| 2a. IEC campaigns to inform homeowners of responsibilities and precautions. | | | |
| 2b. Prohibition of spraying houses that are not properly prepared. | | | |
| 2c. Two-hour exclusion from house after spraying | | | |
| 2d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside. | | | |
| 3a. Indoor spraying only. | | | |
| 3b. Training on proper spray technique | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| 3c. Maintenance of pumps | | | |
| 4a. Choose sites for disposal of liquid wastes according to PMI BMPs. | | | |
| 4b. Construct soak pits with charcoal to adsorb pesticide from rinsewater. | | | |
| 4c. Maintain soak pits as necessary during season. | | | |
| 4d. Inspection and certification of solid waste disposal sites before spray campaign. | | | |
| 4e. Monitoring waste storage and management during campaign. | | | |
| 4f. Monitoring disposal procedures post-campaign. | | | |
| 5a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles. | | | |
| 5b. Reconciliation of number of houses sprayed vs. number of | | | |

| Mitigation Measure | Status of Mitigation Measures | Outstanding issues relating to required conditions | Remarks |
|---|---|---|---|
| sachets/bottles used. | | | |
| 5c. Visual examination of houses sprayed to confirm pesticide application. | | | |
| 5d. Perform physical inventory counts during the spray season. | | | |

# ANNEX D: NAMES OF PARTICIPANTS

## NAMES AND POSITIONS OF THE STAKEHOLDERS INTERVIEWED

| S# | Name | Organization | Position |
|---|---|---|---|
| 1 | Naomi Kasper | USAID | Communication Lead & PMI Program Support |
| 2 | Dr. Janet Mghamba | MOHSW | Assistant Director of Epidemiology and Disease Control |
| 3 | Jubilet Benard | MOHSW | |
| 4 | Aziz Abu | NEMC | Senior Environmental Management Officer |
| 5 | Magdalene Mtenga | Vide President's Office of Pollution Control | Assistant Director |
| 6 | Charles Dismus Mwalimu | NMCP | |
| 7 | Gaudence Juma Rutta | RTI International | Registered EIA Expert |
| 8 | Dr James Kengia | RALG | Regional Medical Officer (RMO) Mwanza |
| 9 | Dr. Saula Bench | RALG | Regional Malaria Focal Person (RMFP) |
| 10 | Mangabe Mhilago | RALG | Regional Environmental Officer (REO) |
| 11 | Richard Charles | Misungwi LGA | District Environmental Officer, Misasi |
| 12 | Gasaya Mekeya | Misungwi LGA | District Medical Officer (DMO) |
| 13 | Dr. Sospeter Ndegi | LGA | District Malaria Focal Person (DMFP), Magu |
| 14 | Charles Mkoma | LGA | DMO, Bunda |

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|---|---|---|---|
| 15 | Dr. Samson Winani | RALG | RMO, Mara |
| 16 | Phinias Nwruti | LGA | DMFP, Musoma |
| 17 | Deogratia Kayera | RALG | Regional Health Officer, Mara |
| 18 | Dr. Gideon Mkuigira | LGA | Acting DMO, Musoma |
| 19 | Alex Dnunga | LGA | DMFP, Serengeti |
| 20 | Victor Charles Rutonesha | LGA | DEO, Serengeti |
| 21 | Dr. Mathis Abuya | LGA | DMO, Roriya |
| 22 | Dr. Jongo Machage | LGA | Roriya |
| 23 | Veronica Mazigi | RALG | RMFP, Geita |
| 24 | Dr. Joseph Kisala | RALG | RMO, Geita |
| 25 | Dr. Elibarik Mollel | LGA | DMO, Geita |
| 26 | Andrew Ruba | RALG | REO, Kagera |
| 27 | Jeremiah Humphrey Ngondi | RTI International | Epidemiologist |
| 28 | Dr Abdulla Ally | ZAMEP | Program Manager |
| 29 | Juma Mcha | ZAMEP | |
| 30 | Mr. Sheha Juma | ZEMA | Director General |
| 31 | Makame Haji Makame | ZAMEP | Pemba |
| 32 | David Mkasha | ZAMEP | DMO, Mic heweni |
| 33 | Ali Rashid Said | ZAMEP | DMO representative, |
| 34 | Tanya Shaame Khanns | ZAMEP | Site Manager, Micheweni District |
| 35 | Habibu Mkalanga | TPRI | Registrar |
| 36 | Farhat Mbarouk | ZDE | Head, Environmental Impact Assessment Unit, Zanzibar |
| 37 | Dr. Jasper Juma | Nelson Mandela Africa Institute of Science and Technology | Senior Lecturer, Certified Environmental Impact Assessment Consultant |

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