PMI | Africa IRS (AIRS) Project

Indoor Residual Spraying (IRS 2) Task Order Four

PMI/ETHIOPIA INDOOR RESIDUAL SPRAYING SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT 2013-2017

OROMIA REGION, USING PYRETHROIDS, CARBAMATES, AND ORGANOPHOSPHATES

AUGUST 2013

Recommended Citation: Anderson, Susan and Chandonait, Peter. June 2013. *PMI/Ethiopia. Indoor Residual Spraying. Supplemental Environmental Assessment 2013-2017.Oromia Region, Using Pyrethroids, Carbmates, and Organophosphates* Bethesda, MD. AIRS Project, Abt Associates Inc.

Contract: GHN-I-00-09-00013-00

Task Order: AID-OAA-TO-11-00039

Submitted to: United States Agency for International Development/PMI

Submitted: June 15, 2013

Re-submitted: August 6, 2013

Final submitted: August 7, 2013

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PMI/ETHIOPIA
INDOOR RESIDUAL SPRAYING SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT, 2013-2017

OROMIA REGION, USING PYRETHROIDS, CARBAMATES, AND ORGANOPHOSPHATES

AUGUST 2013

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ACRONYMS

ACTs	Artemisinin-based combination therapies
AIRS	Africa Indoor Residual Spraying
BEO	Bureau Environmental Officer
BMP	Best Management Practices Manual
CB IRS	Community-based IRS
CFR	U.S. Code of Federal Regulations
CJTF-HOA	US Department's of Defense Combined Joint Task Force-Horn of Africa
CS	capsule suspension
CSA	Central Statistical Agency
DDT	dichloro-diphenyl-trichloroethane
DHO	District Health Office
DHS	Demographic and Health Survey
EC	emulsifiable concentrate
EMMP	Environmental Mitigation and Monitoring Plan
EPA	Environmental Protection Agency
EOSR	End-of-spray Report
FAO	Food and Agriculture Organization of the United Nations
FMHACA	Food, Medicine and Health Care Administration and Control Authority
FMOH	Federal Ministry of Health
FY	Fiscal Year
GFATM	Global Fund for AIDS, Malaria and Tuberculosis
GHI	Global Health Initiative
GoE	Government of Ethiopia
HEW	Health Extension Worker
HSDP	Health Sector Development Plan
IEC	Information, Education, and Communication
IMF	International Monetary Fund
IPM	Integrated Pest Management
ITN	insecticide-treated net
IVM	Integrated Vector Management
LLIN	long-lasting insecticidal net
M&E	Monitoring and Evaluation
MARD	Ministry of Agriculture and Rural Development
MCST	Malaria Control Support Team
MFP	Malaria Focal Person
MIS	Malaria Indicator Survey
MOP	PMI's Malaria Operational Plan
MPR	Malaria Program Review

MSDS	material safety data sheet
NGO	nongovernmental organization
NSP	GoE's National Strategic Plan for Malaria
OPs	organophosphates
ORHB	Oromia Regional Health Bureau
PEA	Programmatic Environmental Assessment
PEPFAR	Presidents Emergency Program for AIDS Relief
PMI	President's Malaria Initiative
PPE	personal protective equipment
RBM	Roll Back Malaria
SBCC	social behavior change communication
SEA	Supplemental Environmental Assessment
SOP	Spray Operator
SUFI	Scaling up for Impact
TOT	Training of Trainers
UNEP	United Nations Environment Program
UNFCC	United Nations Framework Convention on Climate Change
USAID	U.S. Agency for International Development
USEPA	U.S. Environmental Protection Agency
USG	U.S. Government
WHO	World Health Organization
WHOPES	WHO Pesticide Evaluation Scheme

ACKNOWLEDGMENTS

The authors of this report gratefully acknowledge the support given to this activity by the staff of Abt Associates who are involved in the project in Ethiopia. Specific acknowledgement is given to Dr. Yemane Ye-ebiyo Yihdego and Mr. Wondimu Tesgera for their guidance and assistance.

1. SUMMARY OF FINDINGS

1.1 MALARIA BURDEN IN ETHIOPIA

Malaria is ranked as the leading communicable disease in Ethiopia, accounting for about 30% of the overall Disability Adjusted Life Years lost. Approximately 68% of the total population of 84.3 million lives in areas at risk of malaria. According to the Federal Ministry of Health (FMOH), in 2009/2010, malaria was the leading cause of outpatient visits, accounting for 14% of all visits, and health facility admissions, with 9% of all admissions. Malaria is one of the top ten causes of inpatient deaths among children less than five years of age.

The FMOH estimates that there are between 5–10 million clinical malaria cases each year. However, only about one million malaria cases are officially reported. Just 462,623 (55.84%) of all suspected cases were tested and 256,487 (23.68%) confirmed positive by a diagnostic test, according to the 2009/2010 Health and Health Indicators Report. (MOP 2013) Ethiopia reported 936 malaria deaths in 2011 according to the 2012 World Malaria Report[1].

Historically, there have been an estimated 10 million clinical malaria cases annually. Since 2006, however, cases have reduced substantially. On average, 60%-70% of malaria cases have been due to P. falciparum, with the remainder caused by P. vivax. Anopheles arabiensis is the main malaria vector; An. pharoensis, An. funestus and An. nili play a role as secondary vectors.

The malaria transmission pattern in Ethiopia is seasonal and unstable often characterized by focal and large-scale cyclic epidemics. A relatively longer transmission season exists in western lowland areas, river basins, and valleys. Due to the unstable and seasonal transmission of malaria, protective immunity is generally low and all age groups of the population are at risk of the disease. The central highlands, which are >2,500m above sea level, are generally free of malaria. Areas between 2,000m and 2,500m are affected by infrequent malaria epidemics; Malaria Indicator Survey (MIS) 2011 resources were used to determine the level of malaria transmission in these areas and its programmatic importance in malaria prevention and control. Due to the altitude and rainfall, Ethiopia has a varied pattern of malaria transmission, with a transmission season ranging from less than three months to more than six months duration. In most of the country, the peak period of malaria incidence occurs from September to December, following the main rainy seasons (June-September), and from March to May, during and after the small rainy seasons (February-March). Historically, the unstable nature of malaria transmission has been characterized by frequent focal and cyclical epidemics, which reach national scale at irregular intervals of 5–8 years. In the most recent malaria epidemic (during 2003/2004), more than 2 million cases and over 3,600 deaths were recorded in 211 epidemic-affected districts.

Since 2005, Ethiopia has scaled-up one of the largest and most ambitious malaria control programs in Africa, designed to support the country's Health Sector Development Plan (HSDP), the National Strategic Plan for Malaria Prevention and Control (2011 – 2015) (NSP) and the national child survival strategy, in order to reduce under-five mortality rates by two thirds by 2015. This Scaling up for Impact (SUFI) phase has been possible as a result of substantial increases in resources from various funding sources and the commitment of the Government of Ethiopia (GoE). These resources have enabled an

[1] www.who.int/malaria/publications/world_malaria_report_2012/

unprecedented scale-up of malaria control interventions: prompt and effective treatment; case management through rolling-out of the highly efficacious anti-malaria drugs (i.e. artemisinin-based combination therapies (ACTs); selective vector control, with a special emphasis on increasing coverage and use of insecticide-treated nets (ITNs); and targeted and timely application of IRS *(National Malaria Control Guidelines 2012).*

All WHO Pesticide Evaluation Scheme (WHOPES) -approved insecticides are considered for use in Ethiopia. Currently the malaria vector control program is using carbamates, (bendiocarb - PMI, and propoxur - FMOH), due to resistance issues with pyrethoids and DDT. As new entomology studies are completed the program may need the flexibility to use pyrethoids, carbamates and organophosphates (OP) as appropriate in future campaigns. DDT is still considered for use in the FMOH IRS program, but it is not included in this SEA assessment due to resistance issues into the foreseeable future.

This SEA addresses changes in the IRS program and updates the information that was provided in previous SEAs. As per the 2009 SEA Amendment, this document also considers and proposes the use of three classes of WHO-approved pesticides - pyrethroids, carbamates, and OPs - for IRS activities in the Oromia region of Ethiopia, and will be valid for a period of five years from 2013-2017.

1.2 PMI SUPPORT IN ETHIOPIA

The President's Malaria Initiative (PMI) was launched in June 2005 as a 5-year, $1.2 billion inter-agency initiative to rapidly scale up malaria prevention and treatment interventions and to reduce malaria-related mortality by 50% in 15 high-burden countries in sub-Saharan Africa. The U.S. Government (USG) announced Ethiopia as a PMI focus country in 2007, supported by $20 million PMI funding beginning in fiscal year (FY) 2008. PMI support was initially targeted to malaria control activities in the Oromia Regional State, which has about one-third of Ethiopia's malaria burden, population, and land area. With both Global Fund for AIDS, Malaria and Tuberculosis (GFATM) and PMI support and that of other donors, the FMOH has been able to dramatically scale-up its efforts in malaria prevention and control.

PMI's support strategy for Ethiopia has evolved since PMI began its activities in FY 2008. Since 2011, PMI has expanded its support in a number of areas beyond Oromia, providing technical assistance to national structures, and technical and programmatic support and commodities to other Regional States.

Support activities continued to be focused on scaling up long-lasting insecticidal nets (LLINs), IRS, and improved case management, along with supportive activities such as social behavior change communication (SBCC), strengthening supply chain management and strategic information (i.e., surveillance, epidemic detection, and commodities micro-planning).

PMI's support to Ethiopia is in-line with GoE's HSDP (2011-2015) and the NSP. Funding is targeted to fill gaps in activities that are not already supported by the FMOH, Global Fund, or other donors. PMI support also has been targeted to translating best practices to areas and activities currently supported by other funding agencies. (MOP 2013)

In 2012 USAID prepared the *Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (PEA) that provides a broad view of the human health and environmental impacts that could result from implementation of malaria vector control interventions. Supplemental Environmental Assessments (SEAs) must be developed to describe in-country impacts of interventions and describe country-specific activities to minimize those impacts. Under the previous PEA, Ethiopia had a three-year SEA approved in 2008 and amended in 2009. A new SEA was prepared in 2011 but was never officially approved by the USAID/GH BEO. In 2012, a Letter Report was prepared to meet the needs of the

ongoing PMI IRS spray campaign. This five-year SEA (FY 2013-2018) addresses changes in the IRS program and updates the information that was provided in previous SEAs.

1.3 Adverse Health and Environmental Impacts from IRS and Mitigation Measures

Based on U.S. Agency's for International Development (USAID) experience with implementation of IRS in 17 other sub-Saharan African countries under the PMI, the most likely potential adverse health impact of the IRS intervention is unintentional pesticide exposure, leading to acute but mostly transitory health impacts on beneficiaries and spray operators. However, the health effects from exposure to OPs may not be transitory, and so exposure should be guarded against with greater vigilance. If the use of OPs is planned in Ethiopia's IRS program, additional efforts must be made to train and sensitize all IRS personnel to the risks involved, the symptoms of OP toxicity, and the medical treatment protocol. It may also be necessary to develop a cholinesterase-monitoring program for operators and others in potential close contact with these pesticides. Potential negative impacts are discussed in the Environmental Impact section and addressed in the EMMP in Annex A of this SEA, The EMMP includes mitigation strategies for each of the risks, including biomonitoring. Exposure treatment for carbamates, pyrethroids, and OP-based pesticides are detailed in Annexes B and C.

To mitigate risks of exposure, all individuals involved in the implementation of spraying – from spray operators to washpersons to storekeepers –will be provided with appropriate and adequate personal protective equipment (PPE), and will be trained in the best management practices contained in the PMI IRS Best Management Practices Manual (BMP)[2]. Community members will be informed on how to minimize direct and indirect exposure to insecticides (e.g., removing furniture and food from houses prior to spraying, keeping animals away, staying out of houses sprayed for two hours, sweeping dead bugs and properly disposing of them in pits or latrines, etc.).

Since all the WHO IRS insecticides except for malathion are hazardous for aquatic life, the highest risk to the environment is likely contamination to water resources, with subsequent die-off of fish and other aquatic life. The risk to bees, which are extremely sensitive to all WHO-recommended pesticides for malaria control, is also a consideration. Houses found within 30 meters of sensitive areas, including water bodies and bee-keeping activities, should be noted by mobilizers, marked (physically, as well as by the use of GPS if available), and not sprayed.

The BMP specifies that all washing areas and soak pits must be constructed according to specific guidance in order to protect human and animal health as well as prevent environmental damage. Additional mitigation measures include utilization of PPE, best practices in pesticide storage and management, re-use/disposal of contaminated water from operations, and strong supervision and oversight at all levels.

As required by USAID's Automated Directives System 204.5.4, USAID will actively monitor ongoing activities for compliance with the recommendations in this Supplemental Environmental Assessment (SEA), and modify or end activities that are not in compliance.

[2] http://www.pmi.gov/technical/pest/bmp_manual_aug10.pdf

1.4 SAFER USE ACTION PLAN

During implementation, USAID/PMI/Ethiopia and its PMI IRS implementing partners will adhere to the conditions detailed in this SEA, which are summarized below, and in more detail in the Environmental Monitoring and Mitigation Plan (EMMP), Annex A of this report. The EMMP Annual Reporting Form and Certification, also included in Annex A, will be submitted to the COR/AOR as part of the annual report.

General implementation conditions: Project-level implementation procedures

The following project-level implementation procedures are recommended as a general condition for approval of this SEA. Contingent upon such approval, their implementation will therefore be mandatory. They are intended to assure that the SEA findings and conditions are implemented in project work plans, monitoring and reporting requirements:

USAID/Ethiopia PMI IRS team shall undertake the following for implementation of IRS in Ethiopia:

1. The prime contractor for the project ("the contractor", or "the PMI IRS implementing partner") or his designee will develop this SEA that specifies the conditions under which IRS may be implemented.
2. The PMI IRS implementing partner(s) will follow the prescriptions of the EMMP contained herein, including monitoring to assure appropriate implementation and the sufficiency of environmental compliance measures.
3. The PMI IRS implementing partner(s) shall integrate these environmental compliance measures into the project work plan and report on them in the normal basis of project reporting, including the EMMP Annual Reporting Form and Certification, which will be included in the end-of-spray report (EOSR). The PMI IRS team shall assure that this integration occurs.
4. The PMI IRS implementing partner(s) will ensure that training is provided to all IRS staff and workers as prescribed by the EMMP and USAID's Automated Directives System (ADS) 204.5.4.
5. The PMI IRS implementing partner(s) will notify PMI/IRS of any work plan activities outside the scope of the SEA, and the PMI unit will independently audit the work plan against the requirements of the SEA.
6. Any activities not addressed within the SEA must be addressed with an SEA amendment that must be approved by the Global Health and Africa Bureau Environmental Officers (BEO) before the activities in question can go forward.
7. The PMI IRS team shall ensure that the contractor's or PMI IRS implementing partner's responsibilities with respect to environmental mitigation and monitoring will be incorporated into contracts, grants or any other sub-agreement and scopes of work.
8. For projects currently in implementation, PMI/Ethiopia, with the assistance of the Mission Environmental Officer and/or the Regional Environmental Advisor as necessary, will discuss SEA conditions with the contractor; and where necessary, come to appropriate agreement regarding the process for implementing these conditions as a mid-project adjustment.
9. As devising and implementing environmental compliance approaches should be an integral part of work plan development, these procedures place this responsibility principally on prime contractors. PMI IRS team's primary role is thus to review and monitor, as with the execution of any other part of the work plan. Where such review and monitoring indicates unforeseen environmental impacts or that mitigation and control measures are insufficient, the PMI IRS unit will consult promptly with the Regional Environmental Advisor, to revise and adapt the environmental mitigation measures as necessary.

Policy, Planning and Institutional Requirements

- Prohibit IRS in sensitive ecosystems; IRS uses insecticides that could negatively impact such sites (i.e. 30 meters from flood zones, wetlands, National Parks, biodiversity preserves, rivers, dams, lakes, fish farms, beekeeping areas, etc.). In line with the established best practices for IRS, and relevant national and USAID policies, the PMI IRS implementing partner will establish and implement mitigation measures to assure adequate protection of these sensitive ecosystems.
- Develop and implement a vector resistance management plan. Appropriate measures will be undertaken to prevent/manage resistance and to ensure the continued effectiveness of insecticides used for IRS.
- Promote inter-sectoral collaboration frameworks and institutional arrangements to facilitate a comprehensive approach to vector control and associated pesticides management. Coordination between the Federal Ministry of Health and major stakeholders will be strengthened. This will include collaboration with:
    - Ministry of Agriculture and Rural Development (MARD) – Crop Protection Department is responsible for regulating the importation and use of pesticides. It issues permits for the importation of pesticides and implements international conventions governing such pesticides.
    - The Ethiopia Environmental Protection Agency is the principle authority for implementing the national environmental policy and sustainable management law for the protection of natural resources in Ethiopia.
    - The Federal Ministry of Health (FMOH) is responsible for activities pertaining to the protection and improvement of public health and social welfare. The FMOH and Oromia Regional Health Bureau (ORHB) have the mandate to plan, implement and coordinate malaria control activities in Ethiopia and Oromia respectively. The District Health Teams deal with all diseases including malaria at the district level.

Operational Requirements

PMI and the PMI IRS implementing partner will work closely with FMOH, ORHB and District Health Offices (DHOs) to access relevant country level authorization and support needed for successful IRS implementation:

- Quality assurance for commodity procurement and IRS operations, to minimize risks to human health and the environment. This will include ensuring legitimate procurement sources, verifiable chain of custody of commodities, and representative sampling and analysis of pesticide, as well as effective quality compliance inspections of IRS activities in the field.
- Ensure compliance with national regulations on pesticides and this SEA EMMP for registering, importing, transporting, labeling, handling, use, storage, and disposal of pesticides. If there is a conflict, this SEA's EMMP has precedence as it is based on the USAID BMP that was prepared specifically for PMI IRS programs and includes international regulations. USAID compliance requirements are usually more strict than country requirements, therefore they take precedence.
- Train relevant categories of workers involved in IRS operations (e.g. district program managers/coordinators, team leaders, spray operators, porters, storekeepers, pesticide transporters/drivers, washpersons, and guards) on best practices in accordance with national pesticides regulations and this SEA (which includes recommendations/guidelines of World Health Organization (WHO). Criteria for reprimanding non-observance of best practices by these workers will be established.

- Ensure use of appropriate PPE and best practices, including effective field supervision of spray operations, for adequate protection of spray operators and other handlers of pesticides or pesticide-contaminated waste.
- Train health workers in the management of insecticide poisoning. This will include pesticide-specific guidelines on poison treatment; designation of district hospitals or health centers within the target areas for appropriate treatment of insecticide poisoning; training of IRS workers to recognize early danger signs of poisoning and taking appropriate action.
- Enforce protection of fetuses and suckling children against exposure in spray operations. Exclude pregnant women and breast-feeding mothers from direct handling of pesticides (e.g. washers). Before each spray season, and every thirty days thereafter during operations, pregnancy testing will be established for potential female handlers of pesticides.
- Work with health extension workers (HEWs) to carry out Information, Education, and Communication (IEC) activities for targeted communities and households to reduce exposure. Provide information on the removal of food, cooking and water utensils, covering of unmovable furniture with impermeable plastic prior to spraying; exclusion of spraying homes inhabitated by pregnant women or sick individuals who are unable to leave the structure to be sprayed; preventing the reentry of sprayed rooms for at least two hours after spraying; sweeping of floor residues before reentry of children or animals and disposal cleaning wastes including dead insects in pits or latrines.
- Establish strict practices to reduce environmental contamination from pesticides used in this program. This will include comprehensive pesticide chain of custody, auditing of pesticide stocks and pesticide usage, as well as enforcing best practices related to the handling, washing and disposal of containers; progressive use of waste/wash water and ablution blocks, and training on proper maintenance of spray pumps to prevent leakages.
- Establish best practice for the transport of spray operators. This includes providing trucks with benches for transport of spray operators, and ensuring that insecticides are not transported in the same compartment as spray operators. Contract specific insurance for covering spray operators during spray operation. Strengthen training of drivers to limit risk of traffic accidents.
- Provide IRS Training of Trainers (TOT) and training of spray operators on potential negative impacts of environmental contamination and the appropriate IRS BMPs to avoid or minimize these impacts.
- Provide training support, as necessary, to strengthen the supervisory capacity of Environment Protection Agency at Federal, State and District level for day-to-day monitoring environmental compliance of IRS activities.

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

1.5 APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:

The United States Agency for International Development's Global Health Bureau has determined that the proposed indoor residual spraying effort for the President's Malaria Initiative in Ethiopia, as described in the Supplemental Environmental Assessment 2013-2017, responds to the needs of the community and country as it relates to managing malaria in Ethiopia, as well as conforms to the requirements established in 22 CFR 216.

This document does not mandate the execution of the proposed IRS, rather, 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 umbrella Programmatic Environmental Assessment (2012), is consistent with USAID's goal of reducing malaria incidence in Ethiopia while minimizing negative impact to environmental and human health.

CLEARANCE:
Mission Director, USAID/ Ethiopia _____ Date: Aug 15, 2013
Dennis Weller

CONCURRENCE:
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Michael Zeilinger

ADDITIONAL CLEARANCES:

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Gunawardena Dissanayake

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David Kinyua

Environmental Officer
Africa Bureau: _____ Date: _____
Brian Hirsch

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Regional Environmental Advisor, USAID/Eastern Africa:

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Edwin Brown

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2. PURPOSE OF THIS DOCUMENT

Under the U.S. Code of Federal Regulations (22 CFR §216), malaria vector control activities supported or planned by USAID must undergo environmental examination. To assist USAID missions in planning malaria vector control interventions, USAID in 2012 prepared the *Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (PEA) that provides a broad view of the human health and environmental impacts that could result from implementation of malaria vector control interventions. However, the PEA cannot account for inter-country and interregional variation regarding issues such as the capacity to manage pesticides used for vector control and the environment likely to be impacted. For this reason, Supplemental Environmental Assessments (SEAs) must be developed to describe in-country impacts of interventions and describe country-specific activities to minimize those impacts.

Whenever an in-country malaria vector control activity involves "assistance for the procurement or use, or both, of pesticides," SEAs supplementing the PEA must address the pesticide procedures found in 22 CFR 216.3(b). The pesticide procedures list 12 factors to address in SEAs and are described in the Pesticide Procedures section of this document.

In sum, the SEA should be looked upon as the overall representation of the country with regard to IRS. The SEA should address the human health and environmental impacts that may occur as a result of USAID support of malaria vector control activities.

The purpose of a malaria program is to save lives and reduce illness and suffering. The purpose of the SEA is to optimize these goals by ensuring malaria control programs use only safe and efficacious pesticides and use them in the way that will minimize inadvertent poisonings and intoxications; by ensuring the natural resources on which people depend for their daily food production and nutrition are not damaged; by ensuring that long term development is promoted by avoiding disruption of agricultural exports due to misuse of malaria pesticides on agricultural crops; and, by participating in international environmental agreements such as the Stockholm Convention on Persistent Organic Pollutants, among others.

An initial SEA for the Ethiopia IRS program was prepared and approved in March 2008 and provided an assessment of two of the WHO-approved IRS insecticides for use in the Ethiopia Malaria Control Program, DDT and Malathion. Based on the results of the 2008 entomological study, which showed a high degree of vector resistance to DDT, an SEA Amendment was prepared in November of 2009. This Amendment provided the assessment of WHO-approved pyrethoids, OPs and carbamates, in order to offer flexibility in pesticide choice based on future entomological studies and FMOH pesticide selection decisions.

In June of 2011 an SEA was prepared in response to the expiration of the 2009 SEA Amendment, which was to be valid for three years. The 2011 SEA was never officially approved by the USAID/GH BEO, and instead a Letter Report was prepared to meet the needs of the ongoing PMI IRS spray campaign. USAID includes support for the "expansion of the SEA and improved pesticide management within the current IRS operations" in the Malaria Operational Plan 2013 for IRS activities. **This SEA addresses changes in the IRS program and updates the information that was provided in previous SEAs. As did the 2009 SEA Amendment, this document also considers and proposes the use of three classes of WHO-approved pesticides - pyrethroids, carbamates, and OPs - for IRS activities in the Oromia region of Ethiopia, and will be valid for a period of five years from 2013-2017.**

Upon approval of this SEA, a Letter Report will be submitted to USAID annually that will discuss the IRS program in detail for that particular year's spray campaign. If the use of organophosphates is anticipated in the given year, the Letter Report must be signed by the Africa Bureau and Global Health Bureau Environmental Officers. If pyrethroids or carbamates are used, the Letter Report is for informational purposes only and does not require signature. The preparation of this SEA update renders the preparation of a Letter Report unnecessary for 2013.

3. BACKGROUND

3.1 BACKGROUND TO THE PROPOSED ACTION

The PMI was launched in June 2005 as a 5-year, $1.2 billion inter-agency initiative to rapidly scale up malaria prevention and treatment interventions and to reduce malaria-related mortality by 50% in 15 high-burden countries in sub-Saharan Africa. The USG announced Ethiopia as a PMI focus country in 2007, supported by $20 million PMI funding beginning in FY 2008. PMI support was initially targeted to malaria control activities in the Oromia Regional State, which has about one-third of Ethiopia's malaria burden, population, and land area. With both GFATM and PMI support and that of other donors, the FMOH has been able to dramatically scale-up its efforts in malaria prevention and control.

The 2008 Lantos-Hyde Act extended PMI program funding through FY 2014. In May 2009, President Barack Obama announced the Global Health Initiative (GHI), a multi-year, comprehensive USG effort to reduce the burden of disease and promote healthy communities and families around the world. Through the GHI, the USG provides assistance to partner countries improve health outcomes, with a particular focus on improving the health of women, newborns, and children. PMI immediately became a core component of the GHI, along with the USG's global health programs for HIV/AIDS (the President's Emergency Program for AIDS Relief, PEPFAR) and tuberculosis and, included the USG's support for GFATM. The USG closely aligned its support for PMI, PEPFAR, and GFATM through various steering and oversight committees with funding processes within the GHI framework.

Programming of PMI activities has been aligned to follow the core principles of GHI: encouraging country ownership and investing in country-led plans and health systems; increasing impact and efficiency through strategic coordination and programmatic integration; strengthening and leveraging key partnerships, multilateral organizations, and private contributions; implementing a woman- and girl-centered approach; improving monitoring and evaluation (M&E); and promoting research and innovation. In June 2010, the USG selected Ethiopia as one of the first eight 'GHI Plus' countries, involving comprehensive, multi-sectorial approaches to USG global health development including PMI's support for malaria control and prevention. Since 2011, PMI annual budgets for Ethiopia increased sufficiently (up to $43 million annually) to allow more support for malaria activities beyond the borders of Oromia Regional State.

3.2 MALARIA BURDEN IN ETHIOPIA

Malaria is ranked as the leading communicable disease in Ethiopia, accounting for about 30% of the overall Disability Adjusted Life Years lost. Approximately 68% of the total population of 84.3 million lives in areas at risk of malaria. According to the FMOH, in 2009/2010, malaria was the leading cause of outpatient visits, accounting for 14% of all visits, and health facility admissions, with 9% of all admissions. Malaria is one of the top ten causes of inpatient deaths among children less than five years of age.

The FMOH estimates that there are between 5–10 million clinical malaria cases each year. However, only about one million malaria cases are officially reported. Just 462,623 (55.84%) of all suspected cases were tested and 256,487 (23.68%) confirmed positive by a diagnostic test, according to in the 2009/2010

Health and Health Indicators Report. Ethiopia reported 936 malaria deaths in 2011 according to the 2012 World Malaria Report.

Historically, there have been an estimated 10 million clinical malaria cases annually. Since 2006, however, cases have reduced substantially. On average, 60%-70% of malaria cases have been due to P. falciparum, with the remainder caused by P. vivax. Anopheles arabiensis is the main malaria vector; An. pharoensis, An. funestus and An. nili play a role as secondary vectors.

The malaria transmission pattern in Ethiopia is seasonal and unstable, often characterized by focal and large-scale cyclic epidemics. A relatively longer transmission season exists in western lowland areas, river basins, and valleys. Due to the unstable and seasonal transmission of malaria, protective immunity is generally low and all age groups of the population are at risk of the disease. The central highlands, which are >2,500m above sea level, are generally free of malaria. Areas between 2,000m and 2,500m are affected by infrequent malaria epidemics. MIS 2011 resources were used to determine the level of malaria transmission in these areas and its programmatic importance in malaria prevention and control. Due to the altitude and rainfall, Ethiopia has a varied pattern of malaria transmission, with transmission season ranging from less than three months to more than six months duration. In most of the country, the peak periods of malaria incidence occurs from September to December, following the main rainy seasons (June-September), and from March to May, during and after the small rainy seasons (February-March). Historically, the unstable nature of malaria transmission has been characterized by frequent focal and cyclical epidemics, which reach national scale at irregular intervals of 5–8 years. In the most recent malaria epidemic (during 2003/2004), more than 2 million cases and over 3,600 deaths were recorded in 211 epidemic-affected districts.

The diverse ecology of the country supports a wide range of transmission intensities, ranging from low-hypo-endemic transmission in the highlands and semi-arid regions to high-endemic perennial transmission in the lowland regions and valley floors. The levels of malaria risk and transmission intensity within these geographical ranges, however, show marked seasonal, inter-annual and spatial variability because of large differences in climate (temperature, rainfall and relative humidity), topography (altitude, surface hydrology, land cover and land use, etc.) and human settlement patterns.

3.3 History of Malaria Control in Ethiopia

Malaria vector control in Ethiopia goes back over four decades to a pilot control project in the 1950s. The national eradication campaign was later launched in the 1960s as part of the WHO-supported global malaria eradication efforts, under the Malaria Eradication Services. The campaign subsequently evolved into a malaria control program in the early 1970s and subsequently led to the establishment of the National Organization for the Control of Malaria and Other Vector-borne Diseases in 1985. Since June 1993, under the general policy of decentralization and democratization of the administration based on the federal system of administration in the country, malaria control became an integral part of the basic health service and the responsibility of managing malaria prevention and control activities has been vested to Regional Health Bureaus.[3]

Cognizant of the health and socio-economic problems the disease causes, the FMOH, Regional Health Bureaus and partners have been working jointly to strengthen malaria prevention and control activities in the country. To support implementation of the malaria prevention and control strategies, the FMOH developed several guiding documents. These included the first five year strategic plan (2001 – 2005),

[3] FMOH National Five-Year Strategic Plan for Malaria Prevention and Control in Ethiopia 2006-2010

which provided technical guidance on malaria case management, scaling-up of selective control with special emphasis on Insecticide Treated Nets (ITNs) and Indoor Residual Spraying (IRS), and prevention and control of epidemics.

The following National Five-Year Strategic Plan for 2006 – 2010 focused on scaling-up of malaria control activities in the context of the Accelerated Expansion of Primary Health Care Coverage in Ethiopia with special focus on maximizing the role of Health Extension Workers in malaria prevention and control. This effort was also hastened by strengthening partners and community participation and ownership of the program and the joint effort will be geared towards contributing to the achievement of the Millennium Development Goal targets of reducing the burden of malaria and to eventually halt transmission of the disease by 2015.

The 2011-2015 NSP builds on the achievements of 2006-2010 strategic plan, and through sustained control, will move towards malaria elimination through an integrated community health approach. This will be achieved through continued provision of malaria prevention methods (LLINs and IRS), increased diagnosis and case detection, and increased access to treatment. The achievement of these objectives will only be possible as part of a community mobilization effort.

The specific goals of the NSP are:

- By 2015, achieve malaria elimination within specific geographical areas with historically low malaria transmission
- By 2015, achieve near zero malaria death in all malarious areas of the country

The two major malaria prevention services implemented in Ethiopia are targeted IRS of houses with insecticides and distribution of LLINs. The objective of the Ethiopian vector control program is to maintain universal coverage with either LLINs or IRS. There will be a minimum overlap of these interventions when and wherever they are required at the same time and place.

Indoor spray of houses with residual insecticides has been the main vector control tool in Ethiopia for the last five decades. It also remains to be important in specific epidemiological situations. In the context of SUFI, IRS of households using DDT has been scaled up dramatically, from 700 tons in 2005 to 1700 tons in 2008. In 2008, 3.79 million unit structures were sprayed, protecting 11.9 million people. However, studies in 2008 and 2009 showed that the level of DDT resistance by the main malaria vector in Ethiopia in some selected sites was high. The immediate action of the FMOH was to replace DDT with deltamethrin as an interim solution until further studies are conducted and consultations undertaken to select an insecticide that is appropriate for the IRS program in Ethiopia.

2012 PMI-funded IRS Activities

In 2012, PMI supported Ethiopia's long- standing and extensive IRS program through a comprehensive range of activities, including improved targeting and enumeration of areas for IRS operations, improved IRS commodity and insecticide procurement, distribution and storage systems, training and supervision of spray personnel and appropriate pesticide management, entomological monitoring, and environmental compliance.

PMI's IRS operations in Ethiopia were implemented in two rounds using two different insecticides. During the first round from June 15 to August 2, 2012, the spraying was performed in 19 districts using deltamethrin from the pyrethroid class of insecticides. The second round of IRS, using bendiocarb, an insecticide from the carbamate class in 17 districts was implemented from August 15 to October 7, 2012. In FY 2012, the project also provided limited IRS support to 24 districts graduated from PMI support in 2011 and conducted a post-spray evaluation of the districts. A total of 974,880 structures were covered by PMI-supported IRS with 98% coverage of a total population of 2,940,085.

LLINs

A cornerstone for malaria disease prevention in Ethiopia is the use of LLINs. The key strategy used by the country is a rolling periodic (every three years) free distribution of LLINs to all population groups living in endemic, high and moderate malaria risk areas of Ethiopia. Two LLINs per household was used as a strategy until 2011 when it was replaced by one net per 1.8 people from that point onwards. Ethiopia has distributed about 40 million LLINs since 2005. The recent MIS showed significant improvements in LLIN ownership in malaria risk areas from 3.4% in 2005 according to 2005 Demographic and Health Survey (DHS) to 65% in 2007 and 55% in 2011 (MIS 2007, 2011). The proportion of children less than five years old and living below 2,000 meters who used an LLIN, increased from 1.6% in 2005 according to 2005 DHS to 42% in 2007 and 38% in 2011.

In collaboration with the US Department's of Defense Combined Joint Task Force-Horn of Africa (CJTF-HOA), LLIN hang-up campaigns were executed in seven districts, and as of 2013, they have hung a total of more than 225,000 LLINs. A post-campaign assessment, undertaken in Dolo Mena woreda a year after the distribution, showed that this low- cost, high-impact intervention which was supplemented by provision of SBCC materials and training, increased ownership and use of LLINs from 5% to 99% and 3.2% to 33%, respectively. In July 2010 and in March, 2012, PMI helped distribute and hang nets in two districts in the midst of focal malaria epidemics, and in both cases, the malaria emergencies resolved promptly.

3.4 USAID STRATEGIC APPROACH

PMI's support strategy for Ethiopia has evolved since PMI began its activities in FY 2008. Originally, support was focused primarily on Oromia Regional State. Since 2011, PMI has expanded its support in a number of areas beyond Oromia, providing technical assistance to national structures, and technical and programmatic support and commodities to other Regional States.

Support activities continue to be focused on scaling up LLINs, IRS, and improved case management, along with supportive activities such as SBCC, strengthening supply chain management and strategic information (i.e., surveillance, epidemic detection, and commodities micro-planning).

PMI's support to Ethiopia is inline with GoE's 2011-2015 HSDP and the 2011-2015 NSP. Funding is targeted to fill gaps in activities that are not already supported by the FMOH, Global Fund, or other donors. PMI support also has been targeted to translating best practices to areas and activities currently supported by other funding agencies.

3.5 PROGRAM OBJECTIVES

Under the GHI, the goal of PMI is to reduce the burden of malaria (morbidity and mortality) by 70% compared to 2006/2007 levels in the initial PMI countries. By 2015, PMI will have assisted the Oromia Regional State of Ethiopia to achieve the following targets in populations at risk for malaria and targeted by activities supported by PMI:

- >90% of households with a pregnant woman and/or children <5 years of age will own at least one ITN;
- 85% of children <5 years of age will have slept under an ITN the previous night;
- 85% of pregnant women will have slept under an ITN the previous night;
- 85% of houses in geographic areas targeted for IRS will have been sprayed;

- 85% of pregnant women and children <5 years of age will have slept under an ITN the previous night or in a house that has been sprayed with IRS in the last 12 months (note, because of the highly seasonal transmission of malaria in Ethiopia, one spray round per year is thought to be enough to protect the community); and
- 85% of government health facilities have ACTs available for treatment of uncomplicated malaria.

3.6 INSTITUTIONAL FRAMEWORK FOR MALARIA CONTROL

3.6.1 FEDERAL MINISTRY OF HEALTH MALARIA PROGRAM

The Malaria Program operates within the regular framework of government structure and procedures. The program functions in line with the National Health Policy of 1993, the Health Sector Strategy of 1995 and 2011-2015 HSDP IV. The health sector in Ethiopia is guided by a twenty-year health sector development program that was first launched in 1997.

Full implementation of the NSP requires active involvement and participation of all partners from central to community level. The health care system of Ethiopia follows the federal structure, with the Federal Ministry of Health at the apex. The FMOH, in collaboration with the Malaria Control Support Team, conducts annual review meetings of the Malaria Prevention and Control program and Malaria Program Review (MPR) was conducted in collaboration with local and global partners. These reviews/consultations involved both international and local partners.

Community Level: The active involvement of the community in planning and implementing all control activities has been a crucial component of the malaria strategy and will be strengthened going forward. In this process, community health workers, traditional birth attendants, opinion and religious leaders, agricultural development worker, teachers, women and youth associations, and community development organizations will all be involved in the provision of basic malaria prevention and control packages, under the leadership of HEWs and elected community (*Kebele*) leaders.

Health Facilities (Hospitals, Health Centres and Health Posts): According to the National Health Sector Strategy, all vertical program of the past have been integrated into the general health services. No specialized program functions in a vertical manner. All roles including disease management, epidemic monitoring and control, IEC, LLINs, and other vector control measures will be implemented by all health facilities and health extension workers.

District (Woreda) Level: The *Woreda* Health office is responsible for planning, monitoring and evaluating all health priorities in the *Woreda* including malaria. The main tasks relating to malaria are stratification of *Kebeles*, providing resources, and guiding and monitoring activities. In emergencies the *Woreda* health office may collaborate with the *Woreda* council and other sector offices. Other roles such as disease management, epidemic monitoring and control, IEC, LLINs, and other vector control measures will be implemented by all health facilities.

Zonal Level: The main responsibility of the zonal health office is to ensure the continuous availability of adequate essential supplies required for the different strategic approaches to malaria control. Other responsibilities include stratification of the zone into eco-epidemiological areas for better targeting of vector control interventions. The zonal health office also ensures the availability of manpower and equipment in districts, and coordinates resources of the different partners mainly during epidemic control. The zonal health office is also responsible for ensuring timely compilation, reporting, analysis of data and feedback to lower levels, as well as use of information for decision-making and quick action.

Regional Level: Regional staff supports the *Woredas* in providing overall technical support, planning, resource mobilization and allocation, and M&E of malaria control activities.

Central (Federal) Level: At the Federal Ministry of Health level, the main responsibilities for malaria control include co-coordinating and capacity building, formulating and disseminating malaria policy, producing undated technical guidelines, strategic planning (disease management selective vector control, epidemic prevention and control), overseeing policy implementation, M&E of impact, and advocate for malaria as a priority disease.

3.6.2 COORDINATION WITH PARTNERS

The Malaria Control Support Team (MCST) provides coordinated malaria technical support to the national and regional programs and is comprised by members of the FMOH, donor and international organizations, governmental and non-governmental organizations, and academia. The primary task of the MCST is to support the FMOH and regional health bureaus through ongoing technical assistance, resource mobilization, and support to epidemic preparedness and response. The MCST provides a common forum to share duties and responsibilities, avoid duplication and discuss priorities. PMI has been a member of the MCST since 2008.

Part of the MCST is the Technical Advisory Committee, which includes the main malaria stakeholders in the country, i.e., FMOH, Carter Center, Center for National Health Development in Ethiopia, Malaria Control and Evaluation Partnership in Africa, Malaria Consortium, PMI, United Nations International Children's Emergency Fund, and WHO. PMI is also a member of the Technical Advisory Committee representing a technical core of the MCST, which advises the FMOH on policy and program implementation issues, providing technical assistance on an *ad hoc* basis, and assisting with malaria program integration issues.

Ethiopia's Roll Back Malaria Partnership

The philosophy of Roll Back Malaria (RBM) is based on coordinated action and partnership. Therefore, establishment of effective partnerships has been and will continue to be essential to the success of the RBM program objectives. The MCST was established in 1998 to respond to the then on-going epidemics. After initiation of the global RBM partnership, the MCST was retained as the central level RBM task force. The MCST ensures that all partners buy into the NSP. This avoids duplication of activities, and has greatly contributed to the success of the malaria control program in Ethiopia.

Cross-Sectoral Partnerships

As this Strategic Plan seeks to move beyond sustained control and toward elimination, the involvement of other sectors will become increasingly important given the degree of collaboration required.

Specific activities will include the following:

- MARD: to mobilize extension workers involved in community based agricultural activities who in turn can mobilize communities for malaria prevention and control.
- Ministry of Finance and Economic Development: tax reduction on LLINs, to promote advocacy opportunities to mobilize increased malaria program resources and to ensure program costs are in line with policies of the ministry, IMF, etc.
- Ministry of Water Resources and Development: incorporation of malaria preventive measures in water development projects.
- Meteorological Service Agency: epidemic forecasting and early warning.
- Ministry of Education: incorporation of malaria prevention and control in school curricula and malariology courses in the curriculum of pre-service health training institutes; case management of malaria cases in teaching hospitals
- Ministry of Information: IEC.

- Research Institutions and Universities (including Ethiopian Health and Research Institute): operational research
- Investment Office, Environmental Protection: incorporation of malaria preventive measures in construction activities and environmental development projects.
- Disaster Prevention and Preparedness: information on natural disasters, mass population movement.
- FMHACA (Food, Medicine and Health Care Administration and Control Authority): involved in the registration and approval of anti-malarial supplies. Within the new BPR structure (see below), FMHACA's regulatory mandate has increased to health professionals and health facilities.

Public-Private partnerships

Private Sector: Partnership with the private sector will be further promoted. The private sector can particularly be involved in disease management, distribution of LLINs, and other operational activities. Close working relationships will be created with the private sector to involve them in the implementation and support of malaria control programs.

International nongovernmental organizations (NGOs): The MCST includes a number of international NGOs who support the Government in coordination and implementation of activities to support malaria control efforts.

Local NGOs and religious groups: A major focus of the National Strategy is to achieve sustained control towards elimination through community mass movement mobilization. Local NGOs and religious groups will be crucial partners with the HEWs. [4]

3.6.3 ETHIOPIAN ENVIRONMENTAL REGULATIONS

Ethiopia Environmental Protection Authority is responsible for implementing environmental policies. The goal of the Environmental Policy states: "The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs." The document includes policies for the Control of Hazardous Materials and Pollution from Industrial Wastes, Atmospheric Pollution and Climate Change and Environmental Impact Assessments.

Environmental Standards for Industrial Pollution Control in Ethiopia includes specific limit values for emissions to the atmosphere, emissions to water and noise for various industrial sectors including the manufacture and formulation of chemical products including pesticides.

Environmental Pollution Control Proclamation includes management of hazardous wastes. The generation, keeping, storage, transportation and treatment or disposal of hazardous wastes is subject to a permit from the Authority, or relevant regional environmental agency. Solid Waste Management Proclamation includes policies for the transportation and disposal of solid wastes.

3.6.4 PESTICIDE REGULATIONS AND CONTROL

The MARD's Crop Protection Department is responsible for the registration, control and management of agricultural pesticides in the country. MARD has strict pesticide registration requirements. The Pesticide Registration and Control Proclamation includes registration requirements; packaging, labeling,

[4] National Strategy Plan For Malari Prevention and Control and Elimination in Ethiopia 2011-2015

advertising, transport and disposal of pesticides; and safety measures. The MARD does not currently have the funding or staff to enforce the pesticide policies.

However, the FMOH is not required to meet the insecticide registration requirements of the MARD, and uses non-registered pesticides in the health program.

3.6.5 International Conventions

The following are the Multilateral Environmental Agreements to which Ethiopia is a party:

- Convention on Biological Diversity
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity
- Convention to Combat Desertification
- International Treaty on plant genetic resources for food and agriculture
- Vienna Convention for the Protection of the Ozone Layer
- Montreal Protocol on Ozone Depleting Substances
- UN Framework Convention on Climate Change (UNFCCC)
- Kyoto Protocol to the UNFCCC
- Stockholm Convention on Persistent Organic Substances
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- Basel Convention on the Trans boundary Movement of Hazardous Wastes and their Disposal
- Basel Ban Amendment
- Protocol on Liability and Compensation for Damages Resulting from Trans boundary Movements of Hazardous Wastes and Their Disposal
- Bamako Convention on the ban of Import into Africa and the Control of Trans boundary Movement and Management of Hazardous Wastes within Africa
- Convention on International Trade in Endangered Species of Wild Fauna and Flora.

3.7 Malaria Vector Control Activities in Ethiopia

Ethiopia is one of the most malaria epidemic-prone countries in Africa. Rates of morbidity and mortality increase dramatically (i.e. 3-5 fold) during epidemics. Since 2005, Ethiopia has scaled-up one of the largest and most ambitious malaria control programs in Africa, designed to support the country's HSDP, the NSP and the national child survival strategy, in order to reduce under-five mortality rates by two thirds by 2015. This SUFI phase has been possible as a result of substantial increases in resources from various funding sources and the commitment of the GoE. These resources have enabled an unprecedented scale-up of malaria control interventions: prompt and effective treatment, case management through rolling-out of the highly efficacious anti-malaria drugs (i.e. ACTs), and selective vector control, with a special emphasis on increasing coverage and use of ITNs, and targeted and timely application of IRS of households with insecticide. (National Malaria Control Guidelines 2012)

The two major malaria prevention services implemented in Ethiopia are targeted household IRS and distribution of LLINs. The objective of the Ethiopian vector control program is to maintain universal

coverage with either LLINs or IRS. There will be a minimum overlap of these interventions when and wherever they are required at the same time and place. Other vector control activities, mainly larval control through environmental management and chemical larviciding, are also practiced in areas where such interventions are expected to have significant impact (FMOH 2011-2015 Strategic Plan for Malaria).

This Section discusses malaria vector control prevention activities for all of Ethiopia, in which PMI is involved. The following discussions on LLINs, IRS and Larviciding are from the NSP.

3.7.1 LLINs

All residents at risk of malaria are encouraged to protect themselves with LLINs. While the Ethiopian malaria program aims to provide LLINs free of charge in areas where they are most needed, people living in malaria risk areas and not covered by the free distribution program are encouraged to use LLINs for malaria protection using their own resources. It is also essential to maximize use of LLINs for sustained malaria prevention, as Ethiopia moves to elimination by 2015 in targeted areas.

The following are the NSP LLIN policies and guidelines:

- Increase ownership and utilization of LLINs through demand creation, and improved knowledge.
- Demand creation is a fundamental component for going to scale with LLINs. The government, in collaboration with partners (including the private sector), will support generic promotion of LLINs. A variety of approaches can be used, including:
    - Mass media, including national, local and community radio, newspapers, leaflets, posters and television.
    - Interpersonal communication, social mobilization, and drama.
    - Participatory communication at community level, making use of the social communication package through Health Extension Program, model families and other community volunteers.
    - Faith-based Organizations, civil society and other traditional channels of communication, including schools, women's groups and community gatherings.
    - Commercial advertising and marketing techniques.
- Support creation of a favorable economic, fiscal and regulatory environment to encourage the expansion and utilization of LLINs
    - The government will support the development of a favorable LLINs distribution system through effective public-private partnership including local production of LLINs and insecticides.
    - Registration of all products that meet WHO standards to encourage competition and wider consumer choice.
    - Encourage provision and use of LLINs in collective residential/recreational sites (resort areas, hotels, schools, farming and other development projects).
    - All nets and insecticides supplied in Ethiopia must meet minimum standards, as determined by WHO.
    - WHOPES-approved LLINs are the most appropriate for Ethiopia.

Objectives of the NSP

- 100% of households in LLIN targeted areas own one LLIN per two persons.

- At least 80% of people owning LLINs use LLINs properly and regularly.

Targets of the NSP

- Provide sufficient LLINs to reach and maintain 100% ownership of LLINs in LLIN target areas (with one LLIN per two persons).
- Achieve and maintain levels of use above 80% by all age and biological groups up to 2015.
- Encourage local production of at least 3 million LLINs per year.
- Create effective partnerships with the public sector, NGOs, civil society and the private sector.

3.7.2 INDOOR RESIDUAL SPRAYING

Indoor spray of houses with residual insecticides has been the main vector control tool in Ethiopia for the last five decades. During that time DDT was the insecticide of choice. Studies in 2008 and 2009 by showed a high level of DDT resistance by the main malaria vector in Ethiopia in some selected sites. The immediate action of the FMOH was to replace DDT with deltamethrin. Since then a number of insecticide monitoring studies confirmed that the main malaria vector *An. arabiensis* has developed high level of resistance to DDT in a number of sites; similar trends were observed to deltamethrin and some other pyrethroids. These results were not unexpected given that the vector control program in Ethiopia used DDT for the last five decades and scientific evidences show that the modes of action of these two families of insecticides (deltamethrin which belongs to the pyrethroid family and DDT which belongs to the organochlorine family) are similar and cross resistance is common.

Taking into consideration that:

1. Studies have shown that DDT resistance by the vector is widespread.
2. Recent reports also show pyrethroid resistance in a number of sites, possibly due to cross-resistance with DDT.
3. The current global recommendation is not to use pyrethroid chemicals for IRS, as the same chemicals are also used in bed net programs.

The national program has now decided against using deltamethrin in its IRS program. Moreover, it also decided against the use of only one insecticide for IRS. Instead the program will use more than one type/family of insecticide for the IRS program in Ethiopia to delay the evolution and spread of insecticide resistance by the malaria vectors. The two alternative families of insecticides that are available for IRS programs are insecticides belonging to the carbamate and organophosphate families. Under those two families of insecticides, bendiocarb, propoxur, pirimiphos methyl and malathion will be considered as alternatives for rotation spray. Cost, efficacy, safety, resistance, acceptability, ease of handling etc. will be routinely monitored to drop out or add into the insecticides on the rotation schedule.

Considering the rapidly spreading insecticide resistance by the vector in the country and the very limited choices of insecticides the program has, it becomes critically important that the country implements procedures for rational use of insecticides and puts in place an insecticide management strategy. The first measure for rational use is targeting IRS to specific areas in need and avoiding overlap with LLIN. IRS will be targeted to the relatively low risk high land fringe areas where malaria is highly seasonal and unstable. The second important action adopted as an insecticide management strategy is rotation spray of two or preferably more insecticide classes with different modes of action at different spray cycles. Mosaic spray, which is using different chemicals in different places at the same time, will also be considered where and when it is applicable.

In addition the following IRS-related activities will be conducted:

- Regular monitoring of insecticide resistance will be conducted in selected sentinel sites throughout the country to develop mechanisms for insecticide resistance management.
- Local production of alternative insecticides by the public/private sector will be encouraged and technically supported, as long as they can meet the technical and packaging standards for PMI.
- Development projects, both public/and private, and Refugee Affairs are also encouraged and technically supported to develop the capacity to perform integrated vector control activities to protect the communities under their jurisdiction.
- Quality control based on WHO standards for quality of inputs and operations for vector control will be institutionalized, maintained and updated through time.
- Procedures for safe handling and disposal of public health insecticides including insecticide treated or contaminated materials will be institutionalized in accordance with the Ethiopia's Environmental Protection Authority and WHO global regulations.
- New population settlement, tourism and temporary camps should also exercise precautionary measures in the selection of settlement sites, types of houses to be constructed and screening of houses and should involve health personnel in the design.

Objectives of the NSP

- Increase and maintain IRS coverage to 90% of households in IRS-targeted areas.

Targets of the NSP

- Achieve and sustain at least 90% coverage of IRS targeted districts and Kebeles
- Maintain more 90% coverage of households sprayed in targeted districts and Kebeles.

3.7.3 LARVAL CONTROL

In the larval control program, health workers at the village and district level mobilize communities for environmental management activities aimed to reducing the larva sources near human residential areas. These activities are mainly undertaken during the peak mosquito population or malaria transmission season, which comes during or after the rainy seasons. Anti-larval interventions using chemicals are also part of the vector control program in specific areas and the insecticide of choice is Temephos; an OP chemical recommended by WHO to be sprayed in water sources used for human and animal consumption.

Larval control methods involving both physical and chemical methods should be applied singly or in combination with other vector control methods (LLINs, IRS) to reduce transmission in all malaria risk areas except in those stable year-round transmission settings.

- Limited areas and defined areas
- Regular monitoring of important breeding sites and test for anopheles larvae will be conducted in targeted malaria risk communities.
- Geo-reference coordinates of breeding habitats identified and those tested will be recorded and mapped for guiding effective implementation of larval control methods and for M&E.

Activities

- Source reduction through environmental activities will be implemented, in areas where breeding sites can be defined and manageable in size.
- Larviciding will be undertaken using temephos and the bacterial toxin Bti_{14} and other will be applied

every week till the transmission period is over.

- To effectively implement this, the HEWs and development armies in the target communities will be trained on larval control methods according to the national guideline. [5]

Objectives of the NSP

- 100% of identified important larval breeding habitats in targeted malaria risk areas will be reduced through the application of the larval control methods

Targets of the NSP

- 100% of the breeding sites will be identified by HEWs and development army in the target communities
- At least 80% of the total identified breeding habitats will be eliminated or controlled through the larval control methods.

3.7.4 District-based and Community-based IRS Models

Traditionally, IRS in Ethiopia has been planned and implemented by the district health office with technical and operational inputs from regional, zonal, and central health offices. Each district on average includes two operation sites with a soak pit, washing, bathing, and camping area, where the spray team stays for the duration of the IRS campaign. The spray team is comprised of a team leader, up to four squad leaders and porters, and 16-20 spray operators (SOPs). The number of spray teams depends on the number of structures targeted for spraying in the district. District health staff train temporary-hire SOPs, who are recruited from towns in the same district. The SOPs are stationed in a temporary camp, usually set up near a health center or a school for the duration of the spray campaign. From there, SOPs travel to the villages to conduct the spraying on a daily basis. Moving the spray teams from the district operation sites to the villages requires vehicles. For camping accommodations, tents, mattresses, and other items are required. In most cases, the SOPs are not familiar with the village and are often not trusted by the community making implementating more difficult.

Community-based IRS (CB IRS) is a new model to organize IRS operations with mini operational sites established in each kebele. HEWs serve as IRS squad leaders and assume responsibility for managing storerooms, washers, operators, and the data collection and reporting processes. SOPs are hired from the same communities and do not require transport and camping facilities. Instead, they go home at the end of each spray day.

The FMOH has planned to shift implementation of IRS to CB IRS by incorporating the planning and execution of the operation into the Health Extension Program. The main reasons for this shift in IRS were to:

- Increase community participation and acceptance;
- Reduce cost and make it more sustainable; and
- Increase structure coverage.

[5] National Strategic Plan for Malaria Prevention, Control and Elimination in Ethiopia 2011-2015 Draft

3.7.5 ENTOMOLOGICAL MONITORING

Entomological monitoring activities to study mosquito behavior and their susceptibility to insecticides were originally performed decades ago to inform IRS operations, but were discontinued due to insufficient funding and lack of trained manpower. PMI recently reintroduced entomological monitoring activities as part of its support for IRS operations in Ethiopia.[6] With support from PMI, Ethiopia has greatly expanded its capacity for entomological monitoring, including testing for insecticide resistance in anopheline mosquitoes. PMI IRS entomological monitoring activities are implemented in collaboration with the ORHB, the FMOH, and Jimma and Addis Ababa Universities. Most of the entomological monitoring activities have being carried out by the PMI IRS implementing partner entomology team. The major activities accomplished in 2012 include efficacy and residual life of different insecticides on sprayed walls, monitoring vector behavior and density, insecticide susceptibility tests, and other relevant entomological studies. The following are the results of the 2012 PMI entomology study.

Insectary

PMI supports a well-functioning insectary in Nazareth owned by the ORHB. The insectary is a reliable source of susceptible mosquitoes for all entomological monitoring activities undertaken by PMI. The insectary also serves as a learning center for a number of local and international trainings on entomology.

Insecticide Residual Life

Cone/wall bioassay tests have been undertaken to assess the residual life of a number of potential alternative insecticides, which include long-lasting capsule suspension (CS) formulation of pirimiphos methyl, deltamethrin, and propoxur. The results of the study (Tables 1 and 2) showed that the residual life of two insecticides (pirimiphos methyl and deltamethrin) was more than six months. Mortality rate of laboratory-reared susceptible *An. arabiensis* was 100 percent after six months of spray.

TABLE 1. WALL BIOASSAY RESULTS OF TESTING DELTAMETHRIN 2.5% WDP (2012)

House No.	Percent Mortality						
	After 24 hrs.	After 1 month	After 2 months	After 3 months	After 4 months	After 5 months	After 6 months Feb
1	100	100	100	100	100	100	100
2	100	100	100	100	100	100	100
3	100	100	100	100	100	100	100
4	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100
average	100	100	100	100	100	100	100
control	4.0	8.0	4.0	6.0	2.0	2.6	14.7

[6] ightingmalaria.gov/news/voices/ethiopia_intervention.html

TABLE 2. WALL BIOASSAY RESULTS OF TESTING PIRIMIPHOS METHYL 30% SUSPENSION

House No.	Percent Mortality						
	After 24 hrs month (October 2011)	After one months (November 2011)	After 2 months (December 2011)	After 3 months (January 2012)	After 4 months (February 2012)	After 5 Months (March 2012)	After 6 Months (April 2012)
1 (Experimental hut)	100	100	100	94.85	100	100	100
2(Experimental hut)	100	100	100	92.2	100	100	100
3	100	100	100	100	100	100	100
4	100	100	100	92.2	95.6	95.3	100
5	100	100	100	74.2	95.6	92.3	100
average	100	100	100	90.6	98.1	97.7	100
control	6.0	6.0	4.0	14.6	6.7	5.3	4.0

pH Impact on Insecticide Residual Life

Many pesticides, particularly commonly used OPs and carbamate insecticides, are known to undergo a chemical reaction in the presence of alkaline water that reduces their effectiveness. The more alkaline the water, the more rapidly the pesticide breaks down. PMI is conducting cone bioassay tests to determine the residual efficacy of carbamates (propoxur and bendiocarb) at different pH levels of spray water and types of wall surface.

The study so far has shown that:

- Adjusting the pH level of spray water had no effect on efficacy and residual life of these insecticides;
- Bendiocarb and propoxur sprayed on dung-coated walls performed better than when sprayed on mud walls; the reason is not yet known;
- pH of the two plaster materials (mud and dung) did not differ;
- Propoxur showed longer residual life than bendiocarb.

Quality of Spraying and Persistence

This activity was performed 1–3 days after the spraying began in Gobu-Seyo district, East Wollega zone. Susceptible and wild species of *An. gambiae s.l* were exposed to deltamethrin 2.5 percent water dispersible powder sprayed walls in 10 houses. The overall mortality rate of wild mosquitoes exposed to deltamethrin-sprayed walls 1–3 days after the spray was 25.8 percent. In a bioassay test with susceptible mosquitoes, mortality was 100 percent. One month after spray, mortality of wild mosquitoes was 8 percent and mortality of susceptible was 100 percent. Two months after spray, mortality of susceptible *An. gambiae s.l* was 98.6 percent; there was no point in continuing the test with wild mosquitoes as it had been confirmed that wild mosquitoes are highly resistant to deltamethrin. The results indicated that the spray quality was adequate but the vector in the operation area was resistant to deltamethrin as shown in the table below.

TABLE 3. BIOASSAY RESULTS OF SPRAYED SURFACES EXPOSED TO DELTAMETHRIN

Mosquito Type	Exposure	# of Mosquitoes Exposed	# of Mosquitoes Killed after 24hr	% Mortality	Corrected Mortality (%)
Susceptible (lab reared) mosquitoes	Test mosquitoes	405	405	100	100
	Control mosquitoes	135	13	9.6	9.6
Wild (field collected) mosquitoes	Test mosquitoes	450	116	25.8	25.8
	Control mosquitoes	150	0	0	0

Insecticide Susceptibility

More than 20 insecticide susceptibility tests were undertaken between June and August 2012; vector resistance to deltamethrin was detected in a number of sites and the vector was susceptible to bendiocarb, propoxur, and fenitrothion in the tested areas.

The susceptibility level of *Anopheles gambiae* complex, the major vector of malaria in Ethiopia, to 0.05 percent deltamethrin, 0.1 percent bendiocarb, 1.0 percent fenitrothion, and 0.1 percent propoxur was tested in five selected sites in the Oromia project districts in July 2012. The tests were conducted on 2–3-day-old female mosquitoes reared from larvae. The test results showed 8 to 61 percent susceptibility of *An. gambiae* to deltamethrin, indicating a high level of resistance of the vector to this insecticide. The susceptibility to bendiocarb in Asendabo and Bako sites was 95 to 100 percent. Susceptibility of the vector to fenitrothion was 98 percent in one site and 100 percent for propoxur in three sites.

Similar studies by other partners between 2010 and 2011 also showed that the vector is susceptible to bendiocarb, propoxur, and fenitrothion. The selection of bendiocarb for IRS in the PMI project districts and the FMOH's decision to use both types of carbamates in all areas sprayed by the national IRS program were based on these data. The data on deltamethrin resistance were mixed. Deltamethrin killed more than 80 percent of the vector in 15 of the 28 sampled sites; mortality was less than 80 percent in 13 localities. The FMOH decided to spray deltamethrin in all areas where the resistance level was low and/or in the areas where data on deltamethrin resistance was not available in 2012.

Other reasons for the FMOH's decision of spraying deltamethrin in June-July 2012 included: (i) The FMOH was getting reports of case increases in May and a large number of districts needed spray with a long-lasting insecticide in June; the only insecticide available in stores at the time was deltamethrin. (ii) The FMOH decided to spray all deltamethrin accumulated in stores, which otherwise expire in 2013. FMOH believed that this would avoid keeping another obsolete chemical in district and regional stores. Due to these reasons, PMI complied with the FMOH's decision to spray deltamethrin in districts where the vector was known to be susceptible to deltamethrin or there were no data regarding resistance to deltamethrin. Out of 36 districts, 19 met the criteria of either reported susceptibility to deltamethrin or no report of resistance.

TABLE 4. RESULTS OF PMI SUSCEPTIBILITY TESTS, 2012

Insecticide	Area	% Mortality
Bendiocarb	Nazareth Lab Colony	100
	AAU Lab Colony	100
	Gobu Sayo project district (wild)	100
	Ilu Gelan project district (wild)	97.3
	Asendabo project district (wild)	95
Deltamethrin	Gutin project district (wild)	42
	Njeo project district (wild)	61
	Omo Nada	8
Propoxur	Gutin project district (wild)	100
	Dale Sedi	100
	Omo Nada	100
Fenitrothion	Dale Sedi	98

3.7.6 DDT Stock Pile

Ethiopia has been using DDT and other public health pesticides for malaria control for the last four decades. The on-going PMI supported IRS program in Oromia region used DDT in 2008 and 2009. Since the end of 2009, DDT was the primary choice of insecticide in Ethiopia for IRS operations, with malathion as a secondary option. However, after PMI support was initiated for IRS operations in Oromia region, malaria vector monitoring, especially susceptibility status of the main vector for DDT and other insecticides was introduced as part of the program component. Based on PMI insecticide susceptibility study results published in 2010 and direction from the FMOH, the use of DDT was discontinued and deltamethrin was used for spraying activities in 2010.

In December 2010 an inventory was conducted by PMI IRS implementing partner of obsolete pesticides in the IRS districts in the country (including both PMI and non PMI districts within Oromia region). The data collected included the following;

- Location of the obsolete pesticides and contaminated wastes (by district)
- Quantities of expired pesticides and contaminated wastes in each store
- Quantities of contaminated wastes in each store
- Type of expired pesticides in each store (commercial name, date of manufacture, name of manufacturer, date of expiry
- Physical form of the pesticide (granules, liquid) including active ingredient
- Condition and type of the packaging material of the expired pesticides (drums, sachets, boxes)
- The condition of the warehouse in terms of safeguarding the pesticides before a disposal option is identified (floor type, roof type).

In 2012 USAID PMI requested the PMI IRS implementing partner conduct an updated inventory of the DDT stock in the 60 projects districts in Oromia. To conduct the survey, a protocol and checklist for the assessment was developed before staff was dispatched to the field. The survey was conducted in each of the 60 districts in 10 zones of Oromia region where the staff collected data and took photographs in order to characterize the amounts and storage conditions of these stocks. Specific

locations for the stock were noted using GPS to better estimate the logistics that will be required to consolidate the pesticides at a central, secure storage location.

Since PMI began providing support to the Oromia region, all the DDT wastes from the PMI supported districts have been safely stored in the Adama central warehouse, pending determination of an environmentally sound disposal method. According to FMOH, there is no stockpile of PMI-owned DDT in Oromia, and all the existing stock is FMOH property.

March 2011 DDT Stock Assessment (Oromia and nation wide):

- DDT - (technical grade 100%) - 2,588.6 Kgs of obsolete DDT was found in 190 storage facilities in Oromia region. For the entire country the total quantity of DDT inventoried under this assessment is 3439.49 Kgs.
- DDT – (technical grade 75%) - 248,742.29 Kgs of obsolete DDT was found in 190 storage facilities in Oromia region, For the entire country the total quantity of DDT inventoried under this assessment is 871,860.889 Kgs.[7]

Note: The empty sachets of DDT and those containing expired DDT insecticides lacked labeling requirements necessary when pesticides are manufactured, especially the date of manufacture and expiration

February 2013 DDT Stock Assessment (Oromia region only):

- DDT (technical grade 100 %) – 2,599.3 Kgs in 123 boxes were found in 60 storage facilities in Oromia. Formulation and expiration dates were not found on the packaging, however it has accumulated over years, and is assumed to be past the expiration date.
- DDT (technical grade 75%) - 76,725.95 Kgs in 3620 boxes were found in 60 storage facilities in Oromia. However, the assessment team did not identify the formulation or expiration dates of the chemicals.[8]

Upon completion of the inventory, PMI and FMOH have been working on an action plan to safeguard all stocks of DDT in Ethiopia, ultimately leading to their environmentally sound disposal. The safeguarding phase will include stock repackaging, transport and interim storage.

Currently, the obsolete DDT is contained in cardboard boxes that are broken or damaged, and in some cases this has made quantification difficult. All existing DDT boxes will require repacking before they can be safely transported to a secure storage facility.

The consolidation of stocks from outlying stores to one secure location has been identified as the first step to safeguarding the stockpile of obsolete pesticides. Currently 440,000 Kgs of the DDT from nationwide stock is stored at a warehouse at the Adami Tulu pesticide plant, which has filled the warehouse to capacity. The status and condition of this stock could not be confirmed. An addition to the warehouse will need to be constructed if the stocks from other regions (from Oromia and potentially other locations as well) are consolidated at this site. Adami Tulu has expressed interest in receiving the obsolete DDT due to the potential for the plant to repurpose it.

The transportation of pesticides and obsolete pesticide containers requires great care. Road transport from stores to collection centers is one of the most hazardous phases of a pesticide safeguarding and disposal, and will need to comply with the environmental best management practices for pesticide transportation.

[7] Obsolete Pesticides and Contaminated Waste Disposal Options Report 2011, RTI
[8] AIRS Ethiopia Assessment of Obsolete Insecticide Wastes in 60 Supported Districts, Febuary 2013

Re-certification

It is not always easy to establish whether old stocks have deteriorated to a level at which they have become unusable. If not stated otherwise on the label, products normally have a shelf life of two years from the date of release, during which the manufacturer guarantees the quality of the product provided that it is stored according to instructions stated on the label. Such instructions usually refer to temperature, humidity, light, and exposure to direct sunlight.

Storage periods beyond two years or beyond the shelf life indicated on the label do not automatically imply that such products have degraded beyond usability. Pesticides can be analyzed in laboratories to determine if the product is still viable. Once it has been determined viable, then a certificate is issued and permission to use the pesticide is granted. Any action of recertification that Ethiopia proposes to do with the DDT stock must be in accordance to Annex B of the Stockhom Convention for Persistant Organic Pollutants and WHO.

Currently there are few laboratories in Africa that are able to conduct the analysis leading to recertification. Also, WHO procedures for re-certification are detailed and extremely costly. Given the large amount of expired DDT stock in Ethiopia, this option may not be viable (RTI 2011). No re-certification of the DDT is anticipated under this SEA. If re-certification of the obsolete DDT is proposed with PMI funding during the period covered by this SEA, an amended SEA will be prepared to cover all activities associated with repackaging, testing, transporting, and re-use of DDT.

Disposal

The pesticide manufacturing industry conducted a number of research and demonstration studies to identify the best disposal options for pesticides and pesticides wastes. Combustion was soon considered to be the best method and several key research projects confirmed this in pilot and commercial available incinerators (Ferguson and Wilkinson, 1984).

Hazardous waste incinerators have a main chamber for burning wastes and an afterburner to achieve maximum destruction of hazardous organic byproducts, by holding combustion gases at the appropriate temperature (over 1,100 deg. C) for at least two seconds (residence time). The technical specifications of the Basel Convention indicate that 850 deg. C is sufficient for destruction of wastes containing less than 1% chlorine, which includes many of the WHO-recommended pesticides for malaria vector control, other than DDT.

Since gas-cleaning equipment cannot work at the high temperature of the gases leaving the furnace, the gases in the stack are cooled to temperatures of approximately 200 deg. C.

Properly managed incineration can, in principle, destroy pesticide wastes with a Destruction and Removal Efficiency (DRE) rate of 99.99 percent or higher. However, the effectiveness of incineration depends on many factors, such as: design; process control and maintenance of the correct residence time, temperature and turbulence; type of products incinerated; and capacity and effectiveness of air pollution control devices. Inappropriate use of incinerators can create hazardous solid and airborne by-products that pose a severe threat to the environment and public health. Of particular concern is the formation of dioxins and furans, if the waste being destroyed contains more than 1% chlorine. The risk of formation of dioxins and furans can be reduced by an incinerator design in which stack gases are cooled very quickly (quenching) past the temperature interval at which dioxins and furans are formed (250 deg. C to 350 deg. C), and which has a scrubber to bind halogens (e.g. a wet scrubber using a sodium hydroxide solution). In addition, emissions of dioxins and furans can be reduced by special filter systems.

Food and Agricultural Organization (FAO) and World Health Organization (WHO) approve incineration of pesticides and pesticide wastes in incinerators with combustion temperatures of over 1100-1300 degrees Celsius and a residence cooling of 2 seconds (RTI 2011). PMI IRS BMP includes best practices for incinerating IRS wastes. These practices are included in the EMMP of this SEA.

Incineration in South Africa

The only known incinerator that meets the specifications for burning DDT wastes in Africa is in South Africa. The export of such hazardous substances are governed by strict legal provisions of the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*, which require the formal consent of both importing and exporting countries. Depending on the mode of transportation to be used, this requirement can add considerably to the planning requirements of shipping DDT, as well as the cost.

Incineration in Ethiopian cement kilns

PMI contracted a study of two existing cement kiln installations in Addis Ababa, Ethiopia (Derba Midroc Cement Factory and Mugher Cement Factory) to determine if cement kilns would be a feasible option for safe disposal for the obsolete DDT. The contractor was instructed to develop a proposal and budget for the destruction of solid DDT wastes in these facilities while meeting the technical guidelines of the Basel Convention, Stockholm Convention, US EPA regulations, and local Ethiopian regulations. The contractor conducted a preliminary investigation of several options for feeding the solid waste into the existing cement kilns and recommended feeding the waste into the kiln riser duct above the feed shelf. This was proposed to be implemented through the installation of a feed chute, double gate airlock valve, and refractory lined transition duct/chute. The estimated budget for installation of a waste receiving and storage enclosure, modifications necessary to incorporate kiln riser waste feed system, and permitting is US $674,000 at each site.

4. Description of Proposed and Alternative Actions

This section describes the alternatives that were considered in the preparation of the report including those that were accepted or rejected. The section begins with the preferred proposed intervention, and the key components of this option, before discussing other alternative interventions that were considered alongside the IRS intervention and subsequently rejected. Alternative spray sites and alternative insecticide classes are also discussed in this section.

The SEA does not address the malaria treatment options that are part of the Malaria Control program, only the vector control actions.

4.1 Proposed Vector Control Actions

4.1.1 Distribution of Long Lasting Insecticidal Nets

The PMI supports the FMOH policy and distribution of LLINs to most needy communities in the Oromia regional state. In addition to the LLIN procurement and distribution, PMI in collaboration with FMOH and other in-country stakeholders are currently developing an LLIN replacement strategy for the country.

In FY 2013, 2.5 million PMI LLINs will be delivered through ORHB channels and distributed mainly through community based distribution channels. LLIN distribution will be complemented by comprehensive SBCC efforts, as well as targeted hang-up campaigns to ensure that LLIN use by the population is maximized. PMI will also provide support for national net coverage efforts by building on and strengthening routine distribution systems and support to national malaria commodity micro-planning activities, which estimate district and community-level LLIN needs and gaps.

Currently, Ethiopia aims to achieve universal coverage by distributing 1 LLIN per 1.8 persons (sleeping space) through mass, free campaigns at the community level through the HEWs and/ or health facilities. (MOP FY 2013)

The PMI supports the FMOH policy and distribution of LLINs to most needy communities in the Oromia regional state. In addition to the LLIN procurement and distribution, PMI in collaboration with FMOH and other in-country stakeholders are currently developing an LLIN replacement strategy for the country.

Proposed Activities for FY 2013

(PMI identifies the proposed activities for the Malaria Control Program annually; activities for subsequent yearly programs may vary).

- **Procurement and distribution of LLINs:** Due to the pressing need in covering the LLIN gap, PMI will increase its support for procurement and distribution to 2.5 million LLINs. The LLINs will be distributed free to communities mainly through health facilities, HEWs, and in some occasions through NGOs.
- **Hang-up campaigns:** In FY 2013, PMI will continue to support LLIN hang-up campaigns in

selected districts; districts will be selected following discussions with the ORHB and CJTF-HOA. Similar to previous LLIN hang-up campaigns, all households within a district's malaria-endemic kebeles will be targeted and hang-up activities will include comprehensive SBCC messaging. All activities will be coordinated with local authorities in order to ensure that engagement of targeted districts is maximized.

Note: The focus of this SEA is to provide an Environmental Assessment on IRS activities, and does not address LLINs. LLINs are only discussed in this SEA as they are part of the PMI malaria control program and are included in the PEA. However, the PMI IRS implementing partner is only required to provide an SEA on IRS, as they are not actively implementing the LLIN program under IRS2.

4.1.2 INDOOR RESIDUAL SPRAYING

In the 2011- 2015 NSP, IRS is given high priority as a main component of vector control. The FMOH's IRS objective is "to increase and maintain IRS coverage to 90% of households in IRS-targeted areas." The targeted areas include high malaria burden areas, epidemic-prone areas, development projects, and malaria-affected communities with low access to the health care system. Specific IRS-targeted communities (kebeles) are selected based on historical malaria case loads, altitude, presence of nearby anopheline breeding sites, agriculture and water development practices, epidemic records, and other economic or social factors (settlements, etc.). The selection of communities for IRS is refined every year and the same communities are often repeatedly selected for IRS because of continued high numbers of suspected malaria cases or other factors conducive to high malaria transmission. Malaria transmission in Ethiopia is seasonal, lasting for about three months, mostly peaking after the main rainy season. Depending on the residual life of the insecticide used and timing of spray operations, one spray round per year could give the required protection against malaria.

PMI will maintain the FY 2012 level of IRS support in 2013 by working closely with the FMOH, ORHB and other partners. With FY 2013 funding, approximately 500,000 structures will be sprayed with full support from PMI in 36 districts, protecting a population of approximately 1.5 million people. Figure 1 demonstrates locations of the 36 districts sprayed in two rounds in 2012. In 2013, the same districts will be sprayed in one IRS campaign round due to use of only one type of insecticide. In addition PMI will provide minimal support for IRS operations in the 24 graduated districts. PMI will continue to focus on high malaria burden districts in Oromia and support environmental compliance activities, entomological monitoring in sentinel sites and insecticide resistance or susceptibility tests in selected sites.

PMI's comprehensive support for IRS targeted districts in Oromia includes insecticide, operational funds, transportation, rehabilitation of district storage facilities, soak pits, PPE, environmental compliance, IEC and social mobilization, training on IRS techniques, and use and maintenance of spray pumps.

Proposed activities for FY 2013 from the PMI Malaria Operational Plan (MOP)

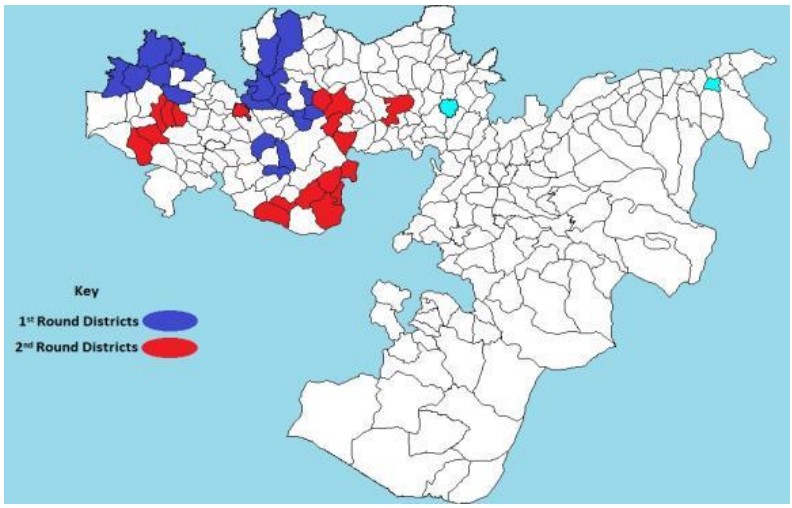
(PMI identifies activities for the Malaria Control Program annually; activities for subsequent yearly programs may vary).

- **Procurement of insecticide:** The exact allocations and specifications of insecticides will be adjusted upon completion and review of the 2012 IRS activities and the insecticide policy decision of FMOH.
- **IRS operations**: PMI will continue to support the ORHB in planning, implementation and evaluation of IRS in Oromia. With FY 2013 funding, PMI will provide full support for approximately 500,000 structures sprayed in 36 districts, protecting a population of approximately 1.5 million people, roughly the same as in 2012. In addition, PMI will provide minimal support for IRS operations in the 24 "graduated" districts, that is, those that have assumed a greater degree of responsibility for managing their IRS activities. Based on the evaluation of 2012 operations and how effective the graduation approach is, the number of structures to be sprayed may be adjusted.

Traditionally, IRS is planned and implemented by district health offices. Community-based IRS is a new model to organize IRS operations at the kebele level to increase community participation, reduce costs and increase structure coverage. PMI wil continue to support district-based IRS in 30 districts in Oromia in FY 2013, and will also support pilot community programs in six Oromia districts. The number of districts under PMI support that will implement community-based programs may increase in following years. (AIRS 2013)

- **Indoor residual spray training**: PMI will support in-service training at federal and regional levels to increase the FMOH's and ORHB's capacity in planning and management of IRS operations, environmental compliance and poison control.
- **Entomological capacity-building and monitoring services**: Resistance monitoring will be carried out in 15 sites in different ecological zones of the country. This represents an increase of 10 sites from those included in entomological resistance monitoring in prior years. The rationale for this expansion being that these activities now represent one of PMI's national-level activities rather than just being restricted to Oromia. Technical support will be provided to coordinate entomological monitoring activities implemented by the FMOH in sites outside of Oromia. Behavioral monitoring will be conducted to assess if vector behaviors change, especially early outdoor biting, in response to the changes in the insecticide used for IRS. Insecticide residual life monitoring to obtain evidence for the selection of best alternative insecticide also continues to be a priority activity.
- **Pesticide management**: PMI will support pesticide management of PMI- supported IRS operations in Oromia, and also pesticide management at the national level. Continued support will be provided for by expansion of this SEA to include DDT management activities, and improved pesticide management within the current IRS operations. Until an approach for final DDT insecticide disposal is chosen, PMI will support the collection of insecticides from districts, zones and regional states and will support their storage at a central location. However, the FMOH insists on having the final disposal mechanism in place before the obsolete insecticides are collected and stored centrally. Finding solutions for the disposal of the accumulated DDT stock is in the PMI 2013 Work Plan.
- **Environmental compliance monitoring**: An external environmental compliance assessment of Ethiopia's IRS activities will be performed annually. Insecticide distribution, use, storage and disposal as well as insecticide tracking systems and/or tools will be monitored by the PMI IRS implanting partner. Monitoring will be conducted through pesticide chain of custody and management procedures that are integrated into the implementation program.

FIGURE 1. MAP OF PMI FULLY SUPPORTED DISTRICTS



Insecticide Selection

The selection of type of insecticides that will be used for each IRS campaign is decided annually by the FMOH based on the results of the annual entomology studies by PMI, WHO, FMOH and Jimma, Mekelle, Dilla and Addis Ababa Universities.

Insecticides for each year's spray campaign for the FMOH malaria program may be obtained from unexpired supplies managed by the regional health bureaus, locally produced at the Adami Tulu government-owned pesticide mixing plant, or procured through international companies. However, all pesticides purchased by the PMI funded programs are procured from certified, international companies. Insecticide selection for any PMI supported program is subject to international procurement requirements of the US Federal laws. Requisitions for public health insecticides used in IRS must be initiated at class level, rather than for a particular insecticide formulation or active ingredient. The selection of insecticide class for use in IRS is based on a number of considerations.

Primary Selection Criteria:

- Must be WHOPES approved
- Should be registered for IRS use in the country if such a registration process exists
- Should have a residual efficacy pertinent to transmission pattern
- Should be suited to the main type of wall surface
- Local vectors must show high susceptibility
- Must be able to manage and minimize environmental impacts

Should the economic and resistance criteria between formulations be similar (that is to say similar cost and similar vector susceptibility), then lower toxicity formulations should be favored when making procurement decisions.

Secondary Selection Criteria:

Once FMOH selects the pesticides to be used, PMI initiates the procurement process in accordance with international open competitive procurement rules. Once there are responses to the call for bids, the resulting proposals are subjected to secondary criteria including:

- Appropriate packaging for safety when using 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

Alternatives Considered and Insecticide Classes Selected

For IRS to be implemented, a pesticide approved by WHOPES must be selected for use. The PMI program does not allow for procurement of pesticides that are not approved for IRS by WHO and the host government. WHOPES is the institution that analyzes and recommends the pesticides that should be used in IRS based on their residual effectiveness, toxicity to human health and the environment.

To date WHOPES has approved the use of pesticides within the following four classes: pyrethroids, carbamates, organochlorines and OPs. Table 5 below highlights the recommended insecticides for IRS in vector control. The proposed action includes the use of carbamates, pyrethroid and OP formulations.

Due to resistance issues the organochlorine, DDT (dichlorodiphenyl- trichloroethane) is not currently proposed for use in Ethiopia.

TABLE 5: WHO RECOMMENDED PESTICIDES

Insecticide compounds and formulations(1)	Classgroup (2)	Dosage ($gai./m^2$)	Mode of action	Duration of effective action (months)
DDTWP	OC	1-2	contact	>6
MalathionWP	OP	2	contact	2-3
FenitrothionWP	OP	2	contact&airborne	3-6
Pirimiphos-methylWP&EC	OP	1-2	contact&airborne	2-3
BendiocarbWP	C	0.1-0.4	contact&airborne	2-6
PropoxurWP	C	1-2	contact&airborne	3-6
Alpha-cypermethrin WP&SC	PY	0.02-0.03	contact	4-6
BifenthrinWP	PY	0.025-0.05	contact	3-6
CyfluthrinWP	PY	0.02-0.05	contact	3-6
DeltamethrinWP,WG	PY	0.02-0.025	contact	3-6
EtofenproxWP	PY	0.1-0.3	contact	3-6
Lambda-cyhalothrin WP,CS	PY	0.02-0.03	contact	3-6

(1)CS:capsule suspension;EC=emulsifiableconcentrate;SC=suspensionconcentrate;WG=waterdispersiblegranule; WP=wettablepowder.
(2)OC=Organochlorines;OP=Organophosphates;C=Carbamates;PY=Pyrethroids.

Preferred Insecticide Classes

Due to the issues of resistance in Ethiopia, preferred insecticides will change in response to the results of the annual enthomology reports. Generally, pyrethroids have been the preferred insecticide of choice for PMI programs, but due to increase of resistance to pyrethroids, carbamates (specifically bendiocarb) are now the preferred insecticide class for the PMI IRS program. OPs may be selected for future use in Ethiopia in order to manage vector resistance on an ongoing basis, but are the least preferred due to costs and the possible need to biomonitor workers who will come into contact with the insecticide.

The FMOH program used deltamethrin during the 2012 spray campaigns and may continue to do so in regions that continue to meet susceptibility standards, though they are also using bendiocarb and propoxur in regions that show resistance.

Rejected Insecticide Classes

All of the WHO approved insecticides for IRS will be considered for use on the PMI IRS program. No insecticides have been eliminated from consideration by the PMI Mission in Ethiopia, including DDT. However, due to the probability that the resistance to DDT will be an issue for a considerable amount of time, there is a minimum possibility that it will be selected for use during the life of this SEA, therefore DDT is not evaluated in this report. If DDT is proposed by the FMOH and PMI decides to use DDT in their IRS program, an SEA amendment will be prepared to cover procurement, use, storage and disposal of DDT. DDT is listed in Annex B of the Stockholm Convention on Persistent Organic Pollutants. Parties must register with the Secretariat to use DDT for disease vector control and comply with information collection requirements on production and use of DDT. DDT can be used for IRS

where it is deemed appropriate based on country-level decision making, provided that stringent measures are taken to avoid its misuse and leakage outside public health.

Quantification of Pesticide Requirements

PMI IRS implementing partner will conduct an annual geographical reconnaissance and logistics assessment for planning and procurement of materials (insecticides, pumps, PPE, etc. including all Districts that have been selected by the ORHB and DHOs.

USAID PMI program will procure the insecticide from a reputable supplier, and it will be shipped to Addis Ababa. Delivery of the insecticide to the central warehouse will be supervised by PMI, before being dispatched to the districts where spray operations will be concentrated. Transportation of insecticides will be done in compliance with program and national environmental compliance requirements.

Qualification of Warehouses (Storage Facilities)

During the geographical reconnaissance and logistics assessments, the need for rehabilitation of principal warehouses at district level to meet PMI BMP requirements for pesticide storage will be assessed. Existing storage facilities meet PMI BMP requirements, but will be re-evaluated between spray campaigns.

The procured pesticides are categorized as hazardous and toxic and can potentially cause adverse impacts to human health, animals, and the natural environment if not properly stored according to the EMMP in this SEA (which is based on PMIIRS BMPs (2011)) for storing insecticides. Before insecticides are procured or transported to the spray areas, suitable warehouse(s) must be assessed to ensure that they meet EMMP standards in this SEA. The standards include among others:

- Spacious enough to store insecticides in bulk and to store other materials separately
- Located as far as possible from; flood plains, wetlands, markets, schools and residential areas
- Well ventilated and allowing for air circulation
- Built of concrete or other solid material
- Adequate roofing that is not susceptible to leaks
- Adequately secured
- At least 2 exits for emergency purposes

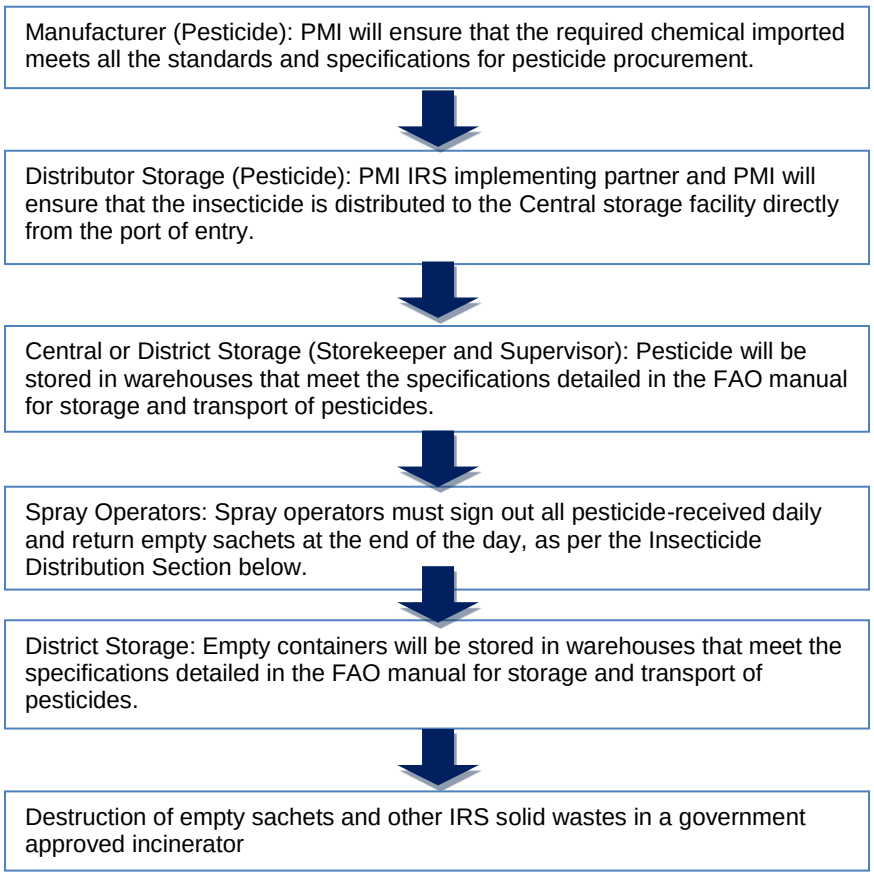
During the logistical needs assessment, the PMI IRS implementing partner working with District Health Team will identify appropriate warehouses at the districts level that meet the above-mentioned requirements. New facilities may be constructed by district health teams as needed with funding from PMI. PMI cannot provide funds for the construction of new buildings, but can assist in the modification or renovation of existing facilities. In Ethiopia IRS is implemented and managed by the DHO, therefore, all warehouses are located on Health Department property for logistic and security purposes.

All facilities used for storage, distribution, and transportation of insecticide products should comply with relevant requirements of the Ethiopia EPA and MARD, and any other relevant Ethiopia standards on pesticides use and management. To that end, the following section and the EMMP describe the program requirements for storage, distribution, and transportation.

Supply Chain and Disposal Options

The PMI IRS implementing partner will work with the relevant authorities and will employ the pesticide chain management as shown in Figure 2 in its Ethiopia IRS programs to ensure control. The chain of custody proceedures are based on PMI IRS BMPs (and as previously mentioned, these BMPs include WHO, FAO and other international guidelines).

FIGURE 2: PESTICIDE CHAIN OF CUSTODY AND MANAGEMENT



Health and Safety in the Warehouse

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

- Guarded 24 hrs/day
- Warehouse must be double-padlocked.
- All the storage facilities must have thermometers installed for temperature recording.
- Soap and clean water for washing must be available at all times.
- Trained storekeepers must be present and wear appropriate PPE when in the pesticide area of storage.
- Pallets are available for proper storage of insecticides
- Pesticide stacking position and height in the warehouses must not be above 2 meters in height.

- Fire extinguishers must be available in the storage facilities and all workers trained on how to use them.
- Hazard warning notices must be placed in the outside of the store in pictorial form (skull and crossbones).
- First-aid kits must be available in all the central warehouses and secondary stores

Insecticide Distribution and Management Process at District and Community Levels

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

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

Personal Protective Equipment

The district-based spray team comprises a team leader, up to four squad leaders and porters, and 16-20 SOPs. The number of spray teams depends on the number of structures targeted for spraying in the district. The community-based spray team comprises of an HEW acting as a squad leader, four spray

operators and one porter selected from the community and who are responsible for planning and implementing IRS in their kebele. One to two washers will be assigned to each soak pit. Each team leader, spray operator, porter and washer for both the district based and community based implementation models will be provided with the following safety equipment to be used during the spraying, in accordance with the PMI BMPs specifications:

- Broad-rimmed hat/helmet
- Face shield or goggles (face shield preferable)
- Dust mask or filtered mask
- Two or more cotton overalls per spray operator (appropriately sized)
- Nitrile rubber, neoprene, or butyl rubber gloves, without inside lining, and long enough to cover the forearm
- Rubber boots
- Cloth to protect the neck.

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

For spray operators, safety precautions will depend on the proper use of PPE, and personal hygiene, including washing and daily changing of spray clothes. A schedule for carrying out and supervising personal hygiene, regular washing of protective clothes and cleaning of equipment will be organized along the following lines:

- Spraying staff will be provided with at least two uniforms to allow for frequent changes.
- Washing facilities with sufficient water and soap will be made available in the field at appropriate locations.
- All working clothes must be removed at the end of each day's operations and a shower or bath taken—in circumstances where a full-body shower or bath is not feasible, face/neck and hands must be washed with soap and water.
- Working clothes will be washed daily by the wash-person hired by the project.
- Particular attention will be paid to washing gloves, helmets, face-shields, and boots, and to avoiding contamination of the inside of these items.
- Spray operators will wash before eating, drinking or smoking at the end of the daily spray operation.
- Eating, drinking and smoking during work will be strictly forbidden at all times during operations. If spray operators need to drink water in the course of the operation, they must receive assistance from the homeowner, such that they do not need to handle water containers with gloves or other PPE that has been exposed to pesticides during spray or mixing activities. Because in the field there are no proper disposal facilities for water contaminated by washing gloves and hands, it is recommended that homeowners assist the operator if hydration is needed.

Procurement of Other IRS Equipment

The following IRS equipment will be procured alongside with the insecticides and PPEs including:

- Spray Nozzles. The program in Ethiopia will procure 8002E nozzles for the spray pumps, which are the standard size recommended by WHO for mud walls.
- Spray pumps. Spray operators use Hudson X-PERT compression sprayers with shoulder-suspended tanks 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 to the interior walls of targeted house (Structure). After the day's spraying is complete, spray operators must clean the sprayer following the manufacturer's recommendations to ensure their proper operation and calibration.

Training

The objective of the trainings is to build the capacity of the host government at the national and district levels to implement, monitor and evaluate a well-organized IRS program. Training is organized in three levels, National training, Regional training and the training of spray operators and community mobilizers.

National Trainings:

National level training extends beyond Oromia regional state and covers all nine regional states of Ethiopia. It includes two Training of Trainer (TOT) events: 1) comprehensive IRS program for MFPs from regional or zonal health departments that are recruited by the Regional Health Bureaus; and 2) insecticide poison management for physicians from regional or zonal hospitals and health centers. Training on spray pumps maintenance and entomological monitoring for health workers from all regions in the country are also given at the national level. Selection, invitation and tutoring of trainees are done in collaboration with the FMOH.

Regional Training:

Regional comprehensive TOTs are given to staff in the project zones and districts of Oromia region Training includes both theoretical and practical sessions. Topics include introduction to IRS; spray pump handling, use, assembly and maintenance; insecticide use, handling, and safety; and environmental compliance.

During the regional training, MFP are oriented on how the train HEWs to serve as squad leaders and assist in the selection of Spray Operators from targeted kebeles for the community-based IRS implementation model. A five-day training is provided on key IRs implementation strategies, spraypump maintenance, communication skills and data recording and reporting.

Training of Spray Operators, including Reserve Operators (Porters) and Squad Leaders:

Spray operators will initially be chosen based on their completion of primary school and must pass written and practical tests of their ability to read, write and record critical spray information, and make calculations. They will then undergo medical exams to determine their physical capability for providing appropriate application of the insecticide. All female workers will be subjected to a mandatory pregnancy test before training and recruitment as washers (no females are recruited as spray operators). Every month until the operations are concluded, a pregnancy test must be obtained from the female candidates selected.

Graduates of the regional TOT training then conduct the spray operator training with the support of the PMI IRS PMI implementing partner. The training has both theoretical and practical sessions.

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps, including practical exercises during a 5-day period prior to the beginning of the spraying campaign. They will also receive training to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training is conducted in accordance with PMI IRS BMP (which includes WHO IRS guidelines).

Regional TOT participants will then give trainings to washers, storekeeper assistants and guards on issues related to spray operation, mobilization, and enumeration, as well as on environmental compliance.

For the community-based IRS implementation model, HEWs are responsible for training SOPs selected from the community.

IEC Mobilizer Training:

HEWs, the frontline health workers in each kebele, and other kebele-based government staff, are recruited and trained to be the mobilizers. The main purpose of mobilization is to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles and behaviors before, during, and after spray operations. Mobilizers are trained to conduct house-to-house mobilization during the first cycle of each IRS campaign. Once the risks and benefits of IRS have been explained, households have the option of declining to participate.

The PMI IRS implementing partner will also collaborate with other USAID-funded projects and FMOH at all levels to mobilize communities. Door-to-door communication is the main strategy used for community outreach. District Malaria focal persons[9] (MFPs) work in close contact with the SBCC team leaders to inform the population about the spraying schedule. PMI IRS implementing partner develops, prints, and distributes household IRS cards as well as IRS fliers and brochures with key IRS messages.

Clinician Training:

The professionals in the district health center facilities will be given refresher courses on how to handle acute exposure incidents that may occur when using pesticides. When new pesticides will be used, additional training specific to the symptoms and treatment for that chemical will be provided. Acute exposure can occur through dermal contact, which could lead to absorption into the blood stream as well as skin and eye irritation, inhalation or ingestion, which could also lead to poisoning. The health facilities must have relevant anti-dotes for poisoning incidences in their store (see Table 6, 7 and 8).

TABLE 6: DRUGS RECOMMENDED FOR TREATMENT OF PYRETHROID EXPOSURE

Name of drug	Active ingredients
Promethazine	Promethazine Hydrocloride
Panadol	Paracetamol
Diazepam	Benzodiazapine/Diazapam
Lorazepam	Lorazepam
Calamine cream	Calamine, zinc oxide, glycerol, phenol, purified water, sodium citrate, betonite,
Vit E	Tocopherol, fragrance, mineral oil, deionized water, sodium hydroxide, stearic acid
Hydrocortisone cream	1% hydrocortisone
Salbutamol	Salbutamol 100 mcg, suspended inert aerosol
Salbutamol tablets	Salbutamol sulphate 4 mg
Activated Charcoal	Activated Charcoal

[9] Malaria focal person – a public health officer in charge of malaria component at a district or zonal health office

TABLE 7: DRUGS RECOMMENDED FOR TREATMENT OF CARBAMATE EXPOSURE

Name of drug
Atropine Sulfate
Activated Charcoal
Pralidoxime
Furosemide
Diazepam

TABLE 8: DRUGS RECOMMENDED FOR TREATMENT OF ORGANOPHOSPHATE EXPOSURE

Name of drug
Atropine Sulfate
Obidoxime choride
Pralidoxime

Driver Training

All the drivers recruited for the operations will also receive training on safe transport of pesticides, use of PPE, and steps to respond to spills or accidents.

Supervisory Actions during IRS

The spray team comprises a team leader (supervisor), up to four squad leaders and porters, and 16-20 SOPs for the district-based IRS implementation model. For the community-based model, the spray team is comprised of the HEW acting as the squad leader, four spray operators and one porter

Team Leaders will observe spray teams to ensure spraying occurs according to best practices. They will travel between squads and will observe spray operators and pesticide preparation, spray technique, and sprayer and PPE clean-up during the IRS campaign, as well as compile all data collected by their respective teams. District teams will provide oversight to ensure the goal of day-to-day achievement of environmental compliance.

In general, IRS activities will be centralized in each district health center and will include a storage facility, soak pit and washing bays in an appropriate fenced area. All IRS facilities will be located separately from the health facilities.

At District level, activities are coordinated by the Malaria Focal Person (MFP), who is part of the District Health Office (DHO). The MFP will maintain an operational spray plan (progress calendar), produced during the micro-planning and validated by the health team at the district level, indicating all communities to be sprayed during the spray operations.

At the community level, the head of the DHO, malaria focal person and Envrionmental Health Officer from each district will supervise the operation and provide technical back-up when required.

At the end of each day, team leaders at each operational site will meet with the MFP to discuss the day's events, challenges faced, and recommendations for resolving problems. The PMI IRS implementing

partner will hold weekly meetings with the district MFP and the Environmental Health Officer within the DHO to discuss operational issues and their solutions. During these meetings, the partners will assess the progress of spray operations, ensure that the planned work schedule is strictly adhered to, and make recommendations as necessary to the IRS project or IEC implementers.

The PMI IRS implementing partner will maintain records of program performance reports which will be able to demonstrate adherence to PMI IRS BMP, quality of training and supervision, procurement activities, and environmental compliance. Such reports include the pre- and mid-spray environmental compliance report (checklist), reports on core IRS indicators and end-of-spray evaluation reports.

Team Leaders will monitor the effectiveness on beneficiary populations of IEC campaigns by visiting sprayed houses to discuss beneficiary impressions, and visiting unsprayed houses to discuss with heads of families why spraying is important. Regarding spray technique and spray operator discipline, monitoring will involve visiting the sprayed compounds and interviewing beneficiaries to ensure that spray operators respect household members, spray all eligible rooms, record the essential data in the relevant form, mix and apply insecticides at the right dosage, and pass the relevant health information to the household.

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

The District Environmental Health Officer will visit each Kebele during the spray operations and complete the Environmental Compliance Checklists provided by the PMI IRS implementing partner. The Environmental Compliance Checklists are simplified versions of those found in the PMI BMP Manual for use in the field. The checklists ensure that all best management practices are being implemented and are effective.

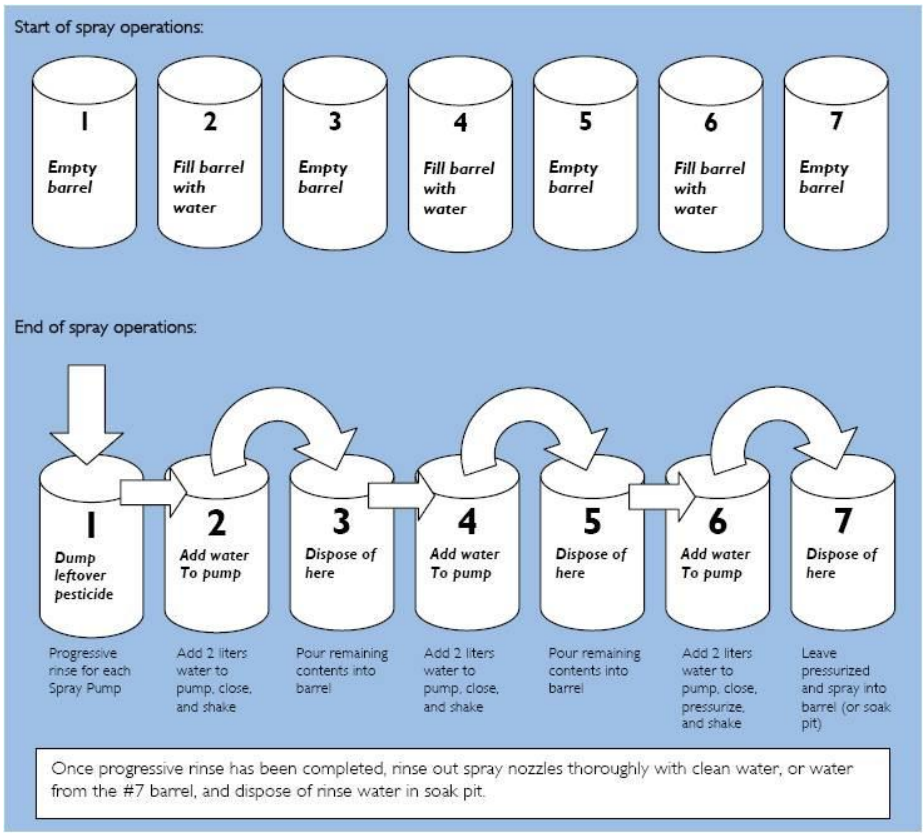
Equipment for decontamination

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

The spray operator will repeat those steps with the fourth and fifth containers, then with the sixth and seventh containers, making sure to rinse the outside of the sprayer only at the sixth container (although not in the sixth container). The following day, spray pumps are filled with liquid from containers in the same sequential order: container one, then container three, then container five, and finally seven.

Currently, best management practices recommend re-using the liquid that is contaminated with pesticide from container one, three and five, to limit the amount of pesticide disposed of in the soak pit.

FIGURE 3: PROGRESSIVE RINSING (BMP MANUAL)



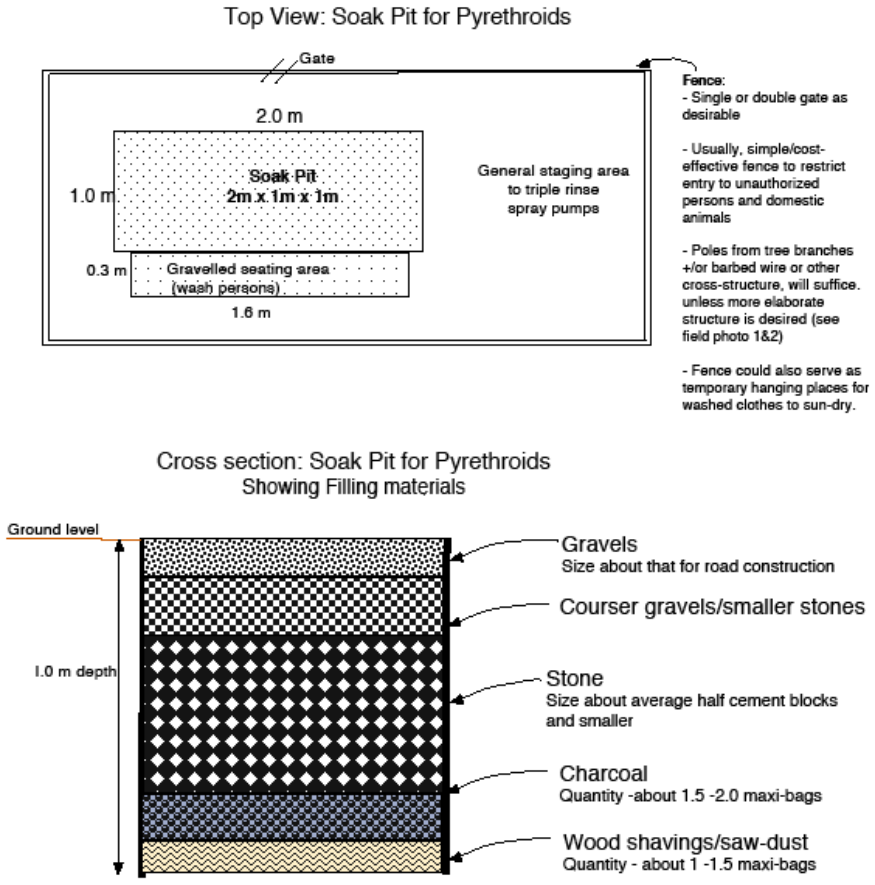
Effluent disposal facility: soak pits and washing areas

The site for the soak pits in each storage facility will be selected jointly with the implementing partner's representative and the representative of the District Health Office. The soak pit site must be away from water bodies, bore holes and schools wherever possible. The size of the soak pit depends on the number of spray operators that the soak pit supports. On average, and according to the USAID/BMP Manual, the soak pits are 2 meters by 1 meter, excavated to a depth of one meter. The bottom of the pit is packed with sawdust followed by hard coal or charcoal, stone aggregates and gravels as demonstrated in Figure 4. The entire soak pit area is fenced complete with a lockable access door to prevent unauthorized entry by children or animals. Soak pits are built by DHO with funding from PMI. New soak pits are constructed before spray operations commence. Existing soak pits are evaluated by the PMI IRS implementing partner and DHO annually and renovated as needed before spray operations begin.

The soak pit as described can be used for all three classes of proposed pesticides, but it is not appropriate for DDT. The overall principle of the soak pit, also referred to as a bio-bed, is to absorb the toxic chemicals in the pesticide through a carbon filtration process so that the water that finally exits the bottom of the soak pit has been purified and no longer contains the chemical components in any significant concentration. The gravel and stone layers work to exclude large particulates such as leaves and sticks that may eventually clog the soak pit, and they also help to distribute the influent across the soak pit bed so that it is not concentrated in one spot. As the organic chemical contaminants

(pesticides) flow through the coal layer, they are adsorbed onto and held by the charcoal, where they are acted upon by environmental forces, including bacterial action. The sawdust at the bottom helps to regulate the flow rate so that there is enough contact time between the contaminated water and the coal. Research has shown that pesticides on the coal are degraded within three months in the soak pit. Unless the soak pit becomes clogged with foreign matter and will not drain, the soak pit should remain effective for three years, at which time it can be excavated so that the sawdust and coal can be replaced. As long as the foreign matter can be separated from the stone, the three stone layers can be reconstituted using the same material.

FIGURE 4: SOAK PIT (BMP MANUAL)



In order to minimize possible ground contamination from washing spray equipment and PPE, all staging areas are required to have an impervious wash area that continuously slopes to the soak pit. This will ensure that all contaminated wash water drains to and is properly treated in the soak pit.

Wash-persons will be hired and provided with protective gear. Wash-persons will wash overalls at a central location in tubs used exclusively for overall washing. Spray operators must completely wash themselves after each day's operations using washbasins or shower areas constructed near the soak pits. Spray operators should never wash themselves, their overalls, or their PPE in any water bodies, or delay washing until they are home. Washing must be performed at designated sites, and all wash-water must be disposed of in a soak pit. Where necessary, construction of infrastructure for proper disposal of contaminated water will be financed by PMI.

IRS Solid Wastes Disposal

IRS solid wastes, which include empty insecticide sachets, masks and torn gloves and boots, will be temporarily stored in the District warehouse. At the end of the spray campaign, the material will be relocated to the storage facility adjacent to the two PMI-procured incinerators located at the Guije Health Center in Burayu town, Oromia State about 30 Km from Addis Ababa. All contaminated material will require disposal in an environmentally and internationally accepted manner as prescribed by the PMI IRS BMPs.

Incineration under specific conditions is highly recommended by the United Nations Environment Program (UNEP) and WHO/FAO for mask and sachet disposal. Incineration is not recommended for polyvinyl chloride or other chlorinated wastes such as gloves and boots. Gloves and boots can be easily decontaminated with soap and water and disposed of as normal non-hazardous waste.

Generally, according to WHO/FAO[10], incinerators recommended for disposal of non-DDT wastes meet the following key requirements:

- The recommended combustion temperature is between 1,100°C and 1,300°C.
- An after-burner is required, with a residence time of at least two seconds.
- The incinerator should have emission control, including particulate matter filters.
- Ash and slag produced by high-temperature incineration of pesticides are, in principle, considered inert, unless determined otherwise, and can be disposed as normal waste, preferably in a dug out pit.

PMI procured two mobile incinerators (INCINER 8) in 2011 for the disposal of all wastes contaminated with non-DDT insecticides. The vendor of the incinerators gave a two-day practical training course to PMI partners and PMI IRS implementing partner staff. The incinerators have been located in permanent, shelters at the Guije Health Center and approval to proceed with incineration has been provided by the ORHB, FMOH and Ethiopia EPA. Empty sachets, used respiratory masks, and other insecticide-contaminated wastes from IRS that do not contain chlorinated materials are currently being incinerated at this facility. Sachets of expired pesticide may not be incinerated in these incinerators.

DDT Disposal

The PMI IRS implementing partner will collaborate with FMOH and PMI to prepare a strategic plan for addressing the DDT issues. The following are potential areas to be addressed:

- Identify an appropriate central storage location large enough to contain the amount of waste expected. Storage locations must be secure and meet the BMP specifications.
- Perform any necessary modifications so that the storage building meets PMI and FAO standards. These standards are provided in the PMI IRS BMP. Any building renovation will also need to meet environmental compliance best management practices for construction projects. Please refer to USAID Asia and Near East Environmental Guidelines for Small-scale Construction.
- Engage a professional environmental training firm to conduct hazardous waste operations (HAZWOPER) training for district level environmental officers (10 hours) and the workers who will perform DDT repackaging and clean-up activities (40 hours). In the US, HAZWOPER training is a formal 40-hour program overseen by the Occupational Safety and Health Administration, which results in the certification necessary to perform hazardous waste operations. In Ethiopia, the training will qualify the officers to supervise and the workers to perform the pesticide collection,

[10] Food and Agriculture Organization of the United Nations (2008). International Code of Conduct on the Distribution and Use of Pesticides: Guidelines on Management Options for Empty Pesticide Containers. Rome: FAO. Accessed June 2, 2008 http:www.who.int/whopes/recommendations/Management_options_empty_pesticide_containers.pdf

repackaging, and shipping operations, as well as the final cleaning operations for the former storage sites, so that they can be turned over for other uses.

- Create awareness of environmental concerns and personnel safety among all actors. Strictly follow guidance on the use of PPE while packing, loading and unloading obsolete wastes, and while performing a final cleaning of the former storage sites.
- Obtain and use appropriate materials for re-packaging pesticides before transporting, and use care when packing, loading, cleaning up spills, transporting, and unloading pesticides. Strict adherence to proper BMPs must be adhered to during all handling of DDT, including the use of proper PPE. Any additional procedures for HAZWOPER activities must also be followed.
- Provide information to the zones and districts to coordinate the repackaging and transportation processes with environmental health inspectors and MFPs in each location.
- Provide training to the workers who will be responsible for on-going care-taking of the centralized wastes until disposal, so that they will maintain safe and environmentally secure storage based on PMI IRS BMPs.
- Continue investigation of appropriate incineration options.

Alternative IRS Geographical Sites Considered

The current targeted areas for PMI IRS activities include high malaria burden areas, epidemic-prone areas, development projects, and malaria-affected communities with low access to the health care system. Specific IRS-targeted communities (kebeles) are selected based on historical malaria case loads, altitude, presence of nearby anopheline breeding sites, agriculture and water development practices, epidemic records, and other economic or social factors (settlements, etc.). The selection of communities for IRS is refined every year and the same communities are often re-selected for IRS because of continued high numbers of suspected malaria cases or other factors conducive to high malaria transmission. Malaria transmission in Ethiopia is seasonal, lasting for about three months, mostly peaking after the main rainy season. Depending on the residual life of the insecticide used and timing of spray operations, one spray round per year could give the required protection against malaria.

PMI commodity and operations support from FY 2013 funding will continue to concentrate primarily in Oromia. PMI and the ORHB conducted a series of consultative meetings discussing the incidence of malaria, history of spray, altitude, and other epidemiological factors to make an informed decision about the districts that required full IRS support for 2012. As a result, PMI and ORHB selected 36 districts, 26 of which have already received PMI assistance over the past two years, and 10 new districts.

Unauthorized areas, however, including all special habitats such as wetlands, within 30 m of water bodies, and areas of sensitive habitats such as bee keeping areas, national forests, parks and other all protected habitats, may not be sprayed.

4.2 POTENTIAL OTHER VECTOR MANAGEMENT STRATEGIES

Other vector-control activities, mainly larval control through environmental management and chemical larviciding, are currently being implemented by the FMOH in areas where such interventions are expected to have significant impact and to address IRS gaps.

Larval control through physical, chemical and biological methods are among the main malaria vector control measures used to suppress malaria transmission in targeted risk areas since the early 1980s. In Ethiopia, the main malaria vector, *An. arabiensis*, prefers to breed in temporary sunlit clear/turbid water bodies, primarily associated with rainfall. Hence, larval density shows strong seasonal fluctuations within a given location due to variations in rainfall and its interaction with landscape and soil type. Not all water bodies are equally important breeding habitats. Most productive breeding sites such as borrow pits,

puddles, etc. are often found around dwellings. Thus, identification of those important breeding habitats, testing for the presence of larvae, and sketch mapping of these habitats are important activities prior to the application of any of the three larval control methods.

In Ethiopia, source reduction through environmental management activities such as draining, filling, flushing have been applied on a weekly basis in urban areas, resettlement sites, irrigation sites, and other areas that have defined and manageable breeding habitats, with the involvement of the community. Larvicides such as Temephos (Abate emulsifiable concentrate), used motor oil (only in contained sites), and Bti_{14}, have also been used in those habitats that are positive for larvae. PMI funds will not be used to support larval control.

4.3 No Action Alternative

A no action scenario would mean the cessation of PMI support to malaria control in Ethiopia, and the potential to return to the number of malaria cases that were prevalent 5 years ago before PMI began implementation of IRS. IRS is a critical intervention in the control of malaria because it attacks the indoor resting malaria vector and drastically reduces the vector population. As a result, it prevents or reduces transmission, hence minimizing morbidity that would need to be addressed through a curative approach, as well as reducing mortality. Indoor spray of houses with residual insecticides has been the main vector control tool in Ethiopia for the last five decades.

Approximately 52 million people (68%) live in malaria risk areas in Ethiopia, primarily at altitudes below 2,000 meters. Historically, there have been an estimated 10 million clinical malaria cases annually. Since 2006, however, cases (and mortality) have reduced substantially.

5. AFFECTED ENVIRONMENT

5.1 COUNTRY OVERVIEW

Ethiopia is 435,071 square miles (1,126,829 km2) and lies between latitudes 3° and 15°N, and longitudes 33° and 48°E. The major portion of Ethiopia lies on the Horn of Africa, which is the easternmost part of the African landmass. Bordering Ethiopia are Sudan and South Sudan to the west, Djibouti and Eritrea to the north, Somalia to the east and Kenya to the south. Within Ethiopia is a vast highland complex of mountains and dissected plateaus divided by the Great Rift Valley, which runs generally southwest to northeast and is surrounded by lowlands, steppes, or semi-desert. The great diversity of terrain determines wide variations in climate, soils, natural vegetation, and settlement patterns.

Ethiopia is an ecologically diverse country, ranging from the deserts along the eastern border to the tropical forests in the south to extensive Afromontane in the northern and southwestern parts. Lake Tana in the north is the source of the Blue Nile. It also has a large number of endemic species, notably the Gelada Baboon, the Walia Ibex and the Ethiopian wolf (or Simien fox). The wide range of altitude has given the country a variety of ecologically distinct areas, and this has helped to encourage the evolution of endemic species in ecological isolation.

Since 1996, Ethiopia has been divided into nine ethnically based and politically autonomous regional states (kililoch) as shown in Figure 5: Affar, Amhar, Benishangul-Gumez, Gambella, Harair, Oromia, Somali, and Tigry and two chartered cities, Addis Ababa and Dire Dawa.

FIGURE 5: MAP OF ETHIOPIA

5.2 FOCUS REGION - OROMIA

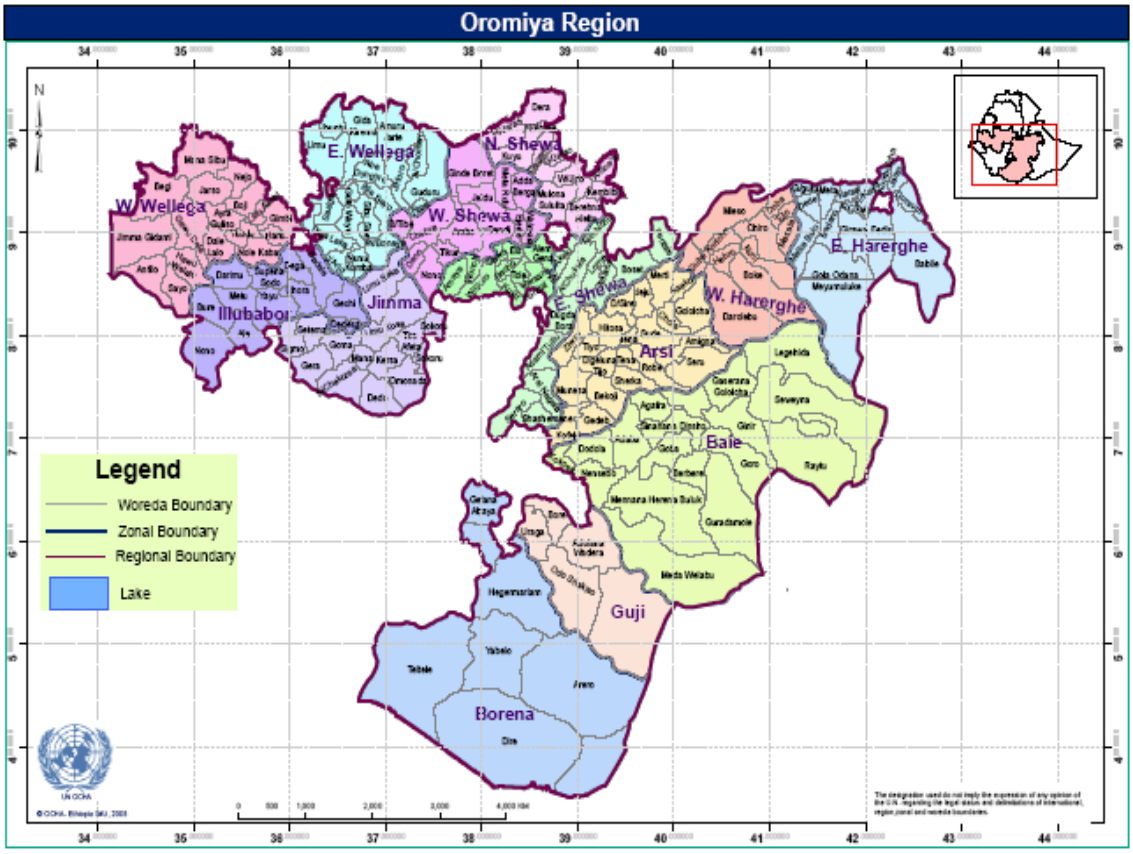
PMI in Ethiopia has primarily focused on Oromia region during the first three years of the initiative. Oromia is both the largest and, by many health indicators, the most underserved regional state in Ethiopia. As of the writing of this report in mid-2013, PMI commodity and operations support funding for IRS will continue to concentrate primarily in the State of Oromia.

The State of Oromia borders Afar, Amhara and the State of Benshangul/Gumuz in the north, Kenya in the south, The State of Somali in the east, the Republic of the Sudan and the state of Benishangul/gumuz in the west, the State of Southern Nations, Nationalities and Peoples' and the state of Gambella in the south. It has an annual rainfall that ranges between 3448mm to 200mm and temperature of 4°c to 35°c annually. Its altitude also ranges from 500m to 4377m above sea level, with a vegetation of dominantly alpine, canopies of forests in the high lands, wood lands, savannah bush land and shrubs in the low land.

5.2.1 ADMINISTRATIVE AND POLITICAL UNITS

The administrative structure of the Oromia Regional State consists of the Regional Government, zones, aanaas (woredas) and gandaas (kebeles). Presently, the region is divided into fourteen zones, which are further subdivided into 199 aanaas (Figure 6). Organs of the Regional State comprise the 'Caffee' or parliament, which is vested with the legislative power and is the supreme organ; the Administrative Council, in which the executive power is vested and is accountable to the 'Caffee' and the Court, in which the judicial power is vested.

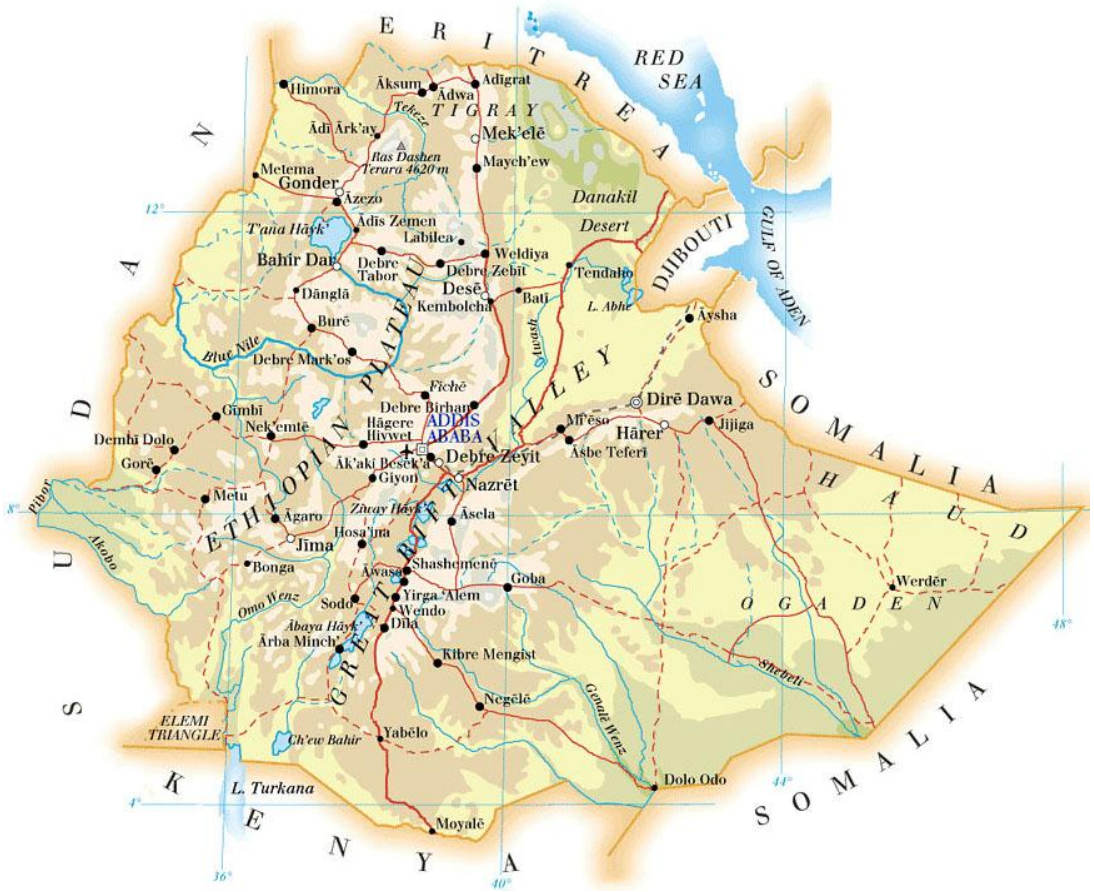
FIGURE 6: MAP OF OROMIA



5.2.2 PHYSICAL ENVIRONMENT

Physical geography of Ethiopia presented in Figure 7. Oromia is one of the nine regional states that constitute the Federal Democratic Republic of Ethiopia. It extends from 30 40'N to 10035'N and from 34005'E to43011'E. Thus it is located in tropical zone, though subject to modification by variation in altitude. On the basis of the current border delineation, the land area of the region is estimated at 359,619.8 square kilometers. The region occupies over 30 percent of the country's total area and is contiguous with all but one regional state - Tigray. The region can be categorized into three distinct geographical areas: the western highlands and associated lowlands, the eastern highlands and associated lowlands and the Rift Valley. Generally, the elevation varies from less than 500 meters to 4,000 meters above sea level.

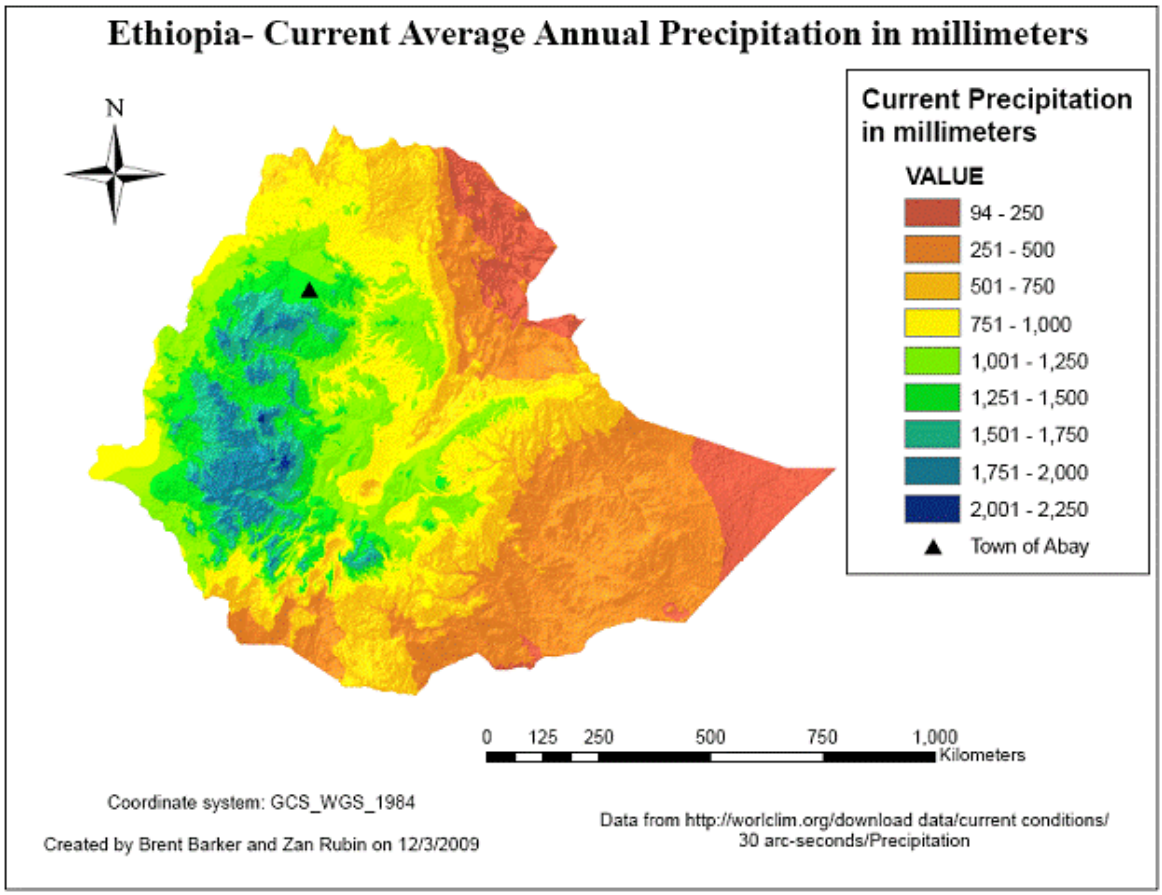
FIGURE 7: MAP OF ETHIOPIA GEOGRAPHICAL AREAS



5.2.3 CLIMATE

The climate of Oromia is affected significantly by variation in altitude, its latitudinal position, prevailing winds and air pressure and circulation and its proximity to the sea. In general, about 30 percent of the lowlands of eastern sub-region have arid climate as demonstrated in Figure 8. Over 35 percent of the intermediate highlands of central and western Oromia have hot tropical rainy climate, while the highlands have warm temperate rainy, tropical rainy and arid climate. The mean annual temperature of Oromia is about 19.3 deg. C with a range of mean maximum over 30.0 deg C in lowland areas. The rainfall pattern of the region is bimodal, receiving the greatest share of rainfall in summer and the smallest portion in spring. The distribution of mean annual rainfall varies from place to place and from year to year, decreasing in all directions from the western highlands (1600-2400mm) towards the eastern and southeastern arid lowlands (less than 400mm).

FIGURE 8: MAP OF ETHIOPIA ANNUAL PRECIPITATION



Oromia has a wide range of climatologically and physiographic conditions that give rise to vast water resource potential. The seven river basins, with 63 major rivers and 688 tributaries, that drain the region, yield an estimated annual average total runoff of 58 billion cubic meters. Apart from this, the annual replenishable groundwater recharge of the region is estimated at 23.5 billion cubic meters, of which about 2.58 billion cubic meters is considered technically useable.

5.2.4 GEOLOGY AND SOILS

Soils of Oromia are diversified due to variations in parent material hypsography, climate and vegetation in the various agro-ecological zones of the region. There are 14 major soil units and 31 sub units in the region. The major soil types in the region include vertisols, nitrosols, cambisols. Vertisols occur throughout the sub-tropical and temperate highlands of the regions such as central shewa, Arsi, Bale and slopes of Hararghe plateau. Nitrosols mainly occur in humid west and parts of Highland of Borena. Cambisols mainly occur in central and western Bale, Southwest hararghe and Arsi. Most soils of Oromia have good agricultural potential. The highland part of the region is dominated by fertile soils of volcanic origin. The dominant soils are: nitrosols on flat to sloping terrain in high rainfall areas; vertisols in flat water logged areas; cambisols on slopes of Bale, south west of West Hararghe and Arsi; luvisols and acrisols mostly on sloppy terrains.

Oromia is endowed with a variety of mineral resources. Mineral deposits known to exist in the region include construction minerals such as limestone, gypsum, silica sand, soda ash, quartz, diatomite, marble, asbestos, feldspa/mica, graphite, energy minerals such as lignite/coal, oil shale, and geothermal resources and agro minerals such as phosphate. Gold and tantalite are the most important metallic minerals under exploitation. The mineral sector remains the most insignificant part of the economy of the region and contributes only about one percent of the regional gross domestic product.

Land Resources

Though information on land use is varied and inconsistent, the Economic Study of Oromia has indicated that the total land area of the region is about 359,619.8 km2. Extensive plain, mountains, and plateaus constitute the land mass of the region, of which about 3.8 million hectares (CSA) are being cultivated land comprising about 3.7 million hectare of rain fed and 84,000 hectares irrigated land. However, the Economic Study of Oromia puts the size of cultivated land in the region in the order of 5 million hectares comprising 4.9 million hectares of rain-fed agriculture and 92,000 hectares of irrigated agriculture As per the same source, mountains, water bodies, waste land and land used for other purposes cover about 5.9 million hectares.

Moreover, the region's about 1.7 million hectares of land has also been used for settlement and infrastructure while still there is estimated 3.1 million hectares of land which could be used for cultivation. Due to rapid population growth, absence of land use policy and strategy (until recent time) the farm land has continued to be fragmented considerably affecting the size of land holding, production and productivity of agriculture.

5.2.5 BIOLOGICAL ENVIRONMENT

Fauna

There are around 800 bird species and more than 100 wild animals in the region. Endemic wild animals such as the mountain Nyala, the Semien Red Fox and Menelik Bushbuck inhabit the Bale mountains national park. The Awash National Park, the oldest and most developed game reserve of its kind in Ethiopia, consists most of the East African plain game except Giraffe and Buffalo. It is home to the Oryx, Kudu, Caracal, Aardvark, Colobus Monkey, Green Monkeys, Baboons, and leopard, Klipspringer, Hippo, Seemering's Gazelle, Grevy's Zebra and Cheetah.

The Awash National Park is also a natural sanctuary of numerous bird-species, some of which include Limburger, Wattle Crane, Angur Buzzard, Verreaux Eagle and long eared owls. Water Fowl, Shore Birds and the colorful Ruddy Shelled Duck as well as the endemic Blue-winged Goose are common in the marshy areas of the park.

Rivers and Lakes

Oromia is endowed with high water potential, abounding with many rivers and lakes. The region has an estimated surface water potential of 58 billion m3 and renewable groundwater potentials of 23.5 billion m3. Oromia is drained by seven major river basins whose headwaters for most part are in Oromia, which includes Abbay, Awash, Baro, Ganale-Dawa, Omo-Ghibe, Wabeshaballe and the Rift Valley lakes.

River Awash, which is the longest river inside Ethiopia, is a source of great agroindustrial and hydroelectric power. The crator lakes Green Lake (true to its name), Bishoftu, Kuriftu, Bishoftu-Gudo, Hora-Kilole, Horsa Arsedi, and the rift-valley lakes Ziway, Abiyata, Shala, and Langano are found in this region. They have immense potential for recreation and fishery development.

The region's water resources potential could be developed and used for the provision of water supply and irrigation. Moreover, hydropower could be generated to supply clean energy for domestic and industrial consumption thereby conserving forest resources and minimizing environmental degradation.

Forest Resources

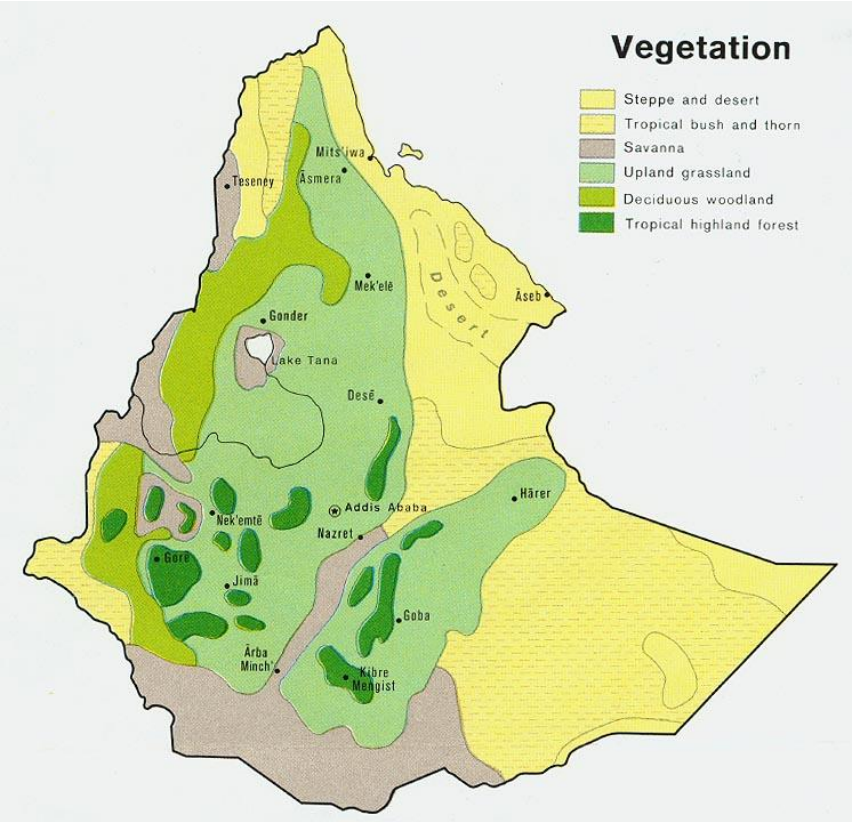
Forest resources cover an estimated 3.1 million hectares of land in Oromia, of which 692,000 hectares are closed and 2,408,000 hectares are classified as open tree formation. This covers about 8% of the region's land surface and accounts for about 75% of the country's forest resources (Oromia Economic Study, 1999). Figure 9 presents a vegetation map of Ethiopia withl information on types ground cover exist in the country.

However, due to rapid population growth and the demand for more farmland and fuel wood, shifting cultivation, growing food insecurity, forest fires, urbanization etc., the forest cover of the region has been dwindling at an average of about 75,000 hectares annually. As some studies indicate, the region will lose all its forest resources approximately in 32 years unless proper conservation and development measures are taken. Indeed, there are some ongoing reforestation and afforestation endeavors (11,395 ha being covered by forest each year) that attempt to offset this loss by approximately 14.67% of the annual deforestation, which is extremely small and worrisome in the face of encroaching desertification.

Lack of land use policy and absence of effective forest and land management systems are among major factors contributing to the significant loss of forest resource and thereby resulting in poor conservation of soils, water resource and wildlife.

Over the last seven years about 881.8 million seedlings were raised and planted on 91,162.04 ha of land at an annual average of 11,395 hectares.

FIGURE 9: MAP OF ETHIOPIA VEGETATION



5.2.6 SOCIOECONOMIC ENVIRONMENT

Demography

Oromia is the most populous regional state in the country. According to the 2007 population and housing census report of Central Statistical Agency (CSA), the total population of Oromia National Regional State is 27,158,471, which accounted for 36.7% of the total country's population. Out of the population of the region about 12.8 percent is estimated to dwell in urban areas, whereas the remaining 87.2% resides in rural. Generally the level of urbanization is very low.

The population of the region is characterized by high population growth, increasing at a rate of 2.9 percent annually. The region's population is expected to reach 33,649,000 by the year 2015. The age structure of the region shows that over 45 percent of the population is under 15 years of age, while the economically active age group is about 50 percent. The dependency ratio of the region is about 100, implying that for every 100 persons in the productive age group, there are 100 dependents (both young and old ages) to be supported.

Agriculture

Agriculture is the foundation of the economy of Oromia. It provides employment for an estimated 89 percent of the population and accounts for about 65 percent of the region's gross domestic product. Exports of agricultural products originating in Oromia, such as coffee, hides and skins, pulses and oil seeds make up the lion's share of the country's exchange earnings. However, increases in agricultural

output and productivity are constrained by several factors including traditional farming methods, natural resources degradation and limited use of modern technologies. Furthermore, rapid growth of population has resulted in fragmentation and reduction of farm sizes, negatively impacting on the production and productivity of food crops. The main agricultural crops include maize, teff, wheat, barly, peas, bean and various types of oil seeds. Coffee is the main cash crop in the region. Oromia accounts for 51.2% of the crop production, 45.1% of the area under temporary crops and 44% of the total livestock population of Ethiopia.

As per the available data on peasant holdings, the total area under cultivation in 1994 E.C. (2001 A.D.) is estimated at 3735.6 thousands of hectares (CSA) which is a 6.8% increase from 1987 E.C (1994 A.D.). Total area under major crops has grown at an average rate of 1.1%. Similarly, area under cereals has increased by 1%, under pulses 2% and under oil crops by 0.9%. According to the classification of the agricultural holdings at national level, 78.6% of peasant holders exercise mixed farming, 18.8% is only crop producers and 2.6% are livestock holders in Oromia. In 1987 about 78% of the households have landholding less than 2 hectares, which has increased to 83.2% in 1992, exhibiting further intensive fragmentation of peasant land holding due to accelerated population growth in the region.

Generally, by virtue of relatively abundant rainfall, suitable soils and other agricultural characteristics, Oromia remains the major crop-producing region in the country. Accordingly, Oromia has accounted for 49% of major food crops production, 50.8% of cereals, 37% of pulses and 43.56% of oil crops production of total peasant holdings of the country in 1994 E.C. production year (CSA, 1994 E.C).

Livestock contributes about 30-35% of agricultural gross domestic and more than 85% of farm cash income. It also contributes about 13-16% to total GDP of the country. Likewise, livestock plays a significant role in the economy of the Oromia region. The livestock population of Oromia is estimated at 23.7 million heads of cattle, 10 million poultry and 1.5 million beehives under private holdings (CSA, 1992). According to this source, Oromia accounts for about 44% of cattle, 39.5% of sheep and 30.5% of goats stock and 47.6% of beehives of the country, implying the existence of high potential in the region, which should be exploited effectively and efficiently.

With regard to fishery development, although Oromia has a large number of water bodies containing fish resources, commensurate developmental activity has not been undertaken so far. According to the Oromia Economic Study (1999), it should be possible to harvest 17,500 tons of fish per annum from the water resources, although the current actual yield is only 4700 tons, which is only 27% of the potential resource. Fish stocks in most of the lakes in Oromia are generally under-exploited and virtually untapped, despite the region's location advantage to access most of bigger urban centers. On the other hand, very little effort has been made so far to increase production of fisheries by adding 459.6 thousand of fish chicks into water bodies, distributing 164 boats, 855 nets and 50868 hooks for fish catchers/producers in the region over the five years (1988 – 1992).

Despite the fact that the region possesses a high raw material potential for industrial development, the sector is at an infant level due to backward technological use. Consequently, the share of industrial production remains low, contributing a mere 11.9 percent of the regional GDP in1998/99 and employing only 20551 persons. Owing to its large demand potential as the result of huge population and presence of various industrial, social, and economic establishments, Oromia provides favorable environment for the development of trade and commerce.

Education

Education plays a crucial role in the process of social and economic transformation of any country. The panacea for attaining sustainable long-term development lies in making an effective use of its abundant human and material resources, through expanding education and skill trainings. In the last decade, encouraging strides have been made in the region to expand educational opportunities to hitherto

unaddressed sections of the population. As a result of this, students' gross enrollment ratio of the region both at primary and secondary levels goes on increasing every year. Although, the extant achievement is remarkably high so far, a considerable number of children in the region nonetheless lack the opportunity to go to school. Generally, despite the concerted efforts that have been made in the region to expand education, the rate of literacy is still alarmingly low. The literacy rate is found to be even lower among females.

Health

Provision of health services is one of the preconditions for human resource development. Relative to the size of its population, Oromia has a limited number of health facilities and personnel. The ratios both of health professionals and health institutions to the population are far below those recommended by the WHO. The coverage of health services in the region is extremely low even by the standards of Sub-Saharan Africa. A large proportion of the population has neither access to safe water nor sanitation facilities, and as the result, is severely afflicted by water borne diseases. The major causes of morbidity are malaria, respiratory infections, HIV/AIDS, skin infections diarrhea diseases and intestinal parasitic infections. The prevalence of such diseases is due mainly to poverty and economic backwardness.

In Oromia region there were 21 governmental and 4 non-governmental hospitals in 2003 G.C. There were also 4 other governmental (other than Ethiopian government) hospitals that make 29 the total number of hospitals in the region. According to the information obtained from Oromia Health Bureau, there were 153 governmental, 2 non-governmental and 20 governmental other than Ethiopian government health centers in 2003G.C. in Oromia State. Hence, the total number of health centers in the region is 175 in 2003/4.

Oromia has 306 districts divided into 18 zones and 9 'special towns'. According to 2010/2011 ORHB data, there are 36 hospitals, 1,157 health centers, 656 health stations and 5,929 functional health posts operated by the GoE. In addition, there are 4 hospitals, 2 health centers, 80 health stations and 5 health posts operated by NGOs. There are also 4 hospitals, 3 health centers and 115 health stations under other governmental organizations (e.g., teaching or armed services hospitals). Oromia's health professional to population ratio is very low with one physician serving 107,602 people (WHO standard is 1:10,000), and one nurse serving 9,309 people (WHO standard is 1:5,000). The available hospital beds (GoE 2,867 and NGO 340 hospital beds) total 3,207 with a bed- to-population ratio of 1:9,153 (WHO standard 1:3,000). The health service coverage in Oromia is lower than in most of the other regional states in Ethiopia, which has contributed to low coverage in vital indicators such as vaccination and family planning.

Transport and Infrastructure

Transport and communications constitute an integral part of the social and economic development of a region or a country as provider of services to other sectors of the economy. Hence it would be impossible to conceive of social and economic development in the absence of adequate transport and communications infrastructure and services. In Oromia, as in the rest of the country, road transport is the leading mode of modern transport. Therefore a maximum effort will be exerted to expand road transport in the region in the years to come. About 247 km of the Ethio - Djibouti Railway line stretches with in Oromia region.

Oromia is endowed with rich and diverse tourist resources, which, much like other resources, remain poorly tapped. The region abounds with natural lakes, hot springs and curative spas, numerous valleys, gorges, mountain peaks and meadows of scenic beauty, national parks and wildlife sanctuaries, which are home for several endemic wildlife resources. Compared to many other regions of the country, the bio-diversity in general is extremely rich. Its advantage in location and relatively better availability of various economic infrastructures provide Oromia with huge opportunity for private investment.

6. PESTICIDE PROCEDURES

Regulation 22 CFR 216.3(b) mandates the consideration of twelve factors when a project includes "assistance for the procurement or use, or both, of pesticides". This section addresses each of those twelve factors for the Malaria Control Program in Ethiopia.

6.1 THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S REGISTRATION STATUS OF THE REQUESTED PESTICIDE

Pesticides registered for IRS in Ethiopia and the United States, and recommended by WHO, will be preferred for use in this IRS project. However, some of the pesticides on the WHOPES list are not registered with the U.S. Environmental Protection Agency (USEPA), for economic reasons rather than health and safety or technical ones. Because this is an economic issue rather than a technical one, and because there is widespread use of these chemicals around the world, with a good database attesting to the safety of the chemicals, USAID and USEPA has chosen to allow the use of all WHO-recommended pesticides under the Africa IRS program.

The agricultural pesticide regulating body in Ethiopia is the MARD's Crop Protection Department. Currently, only deltamethrin, lambda-cyhalothrin and alpha-cypermethrin are registered by the MARD for use in IRS. However, the FMOH is not required to register health pesticides with MARD, therefore country registration is not a limiting factor in deciding which pesticides may be used in the program. All of the WHOPES-approved pesticides for IRS are included in this SEA, except DDT. All applicable Ethiopian laws and regulations regarding the public health use of the WHOPES-recommended pesticides will be followed.

6.2 THE BASIS FOR SELECTION OF THE REQUESTED PESTICIDES

Insecticide selection for any PMI supported program is subject to international procurement requirements of the US Federal laws. Requests to purchase public health insecticides used in IRS must be initiated at class level, rather than for a particular insecticide (compound). The insecticide class to be used in IRS is selected for each campaign based on a number of considerations.

Primary Criteria for choosing pesticides:

a. **Approval by the World Health Organization Pesticide Evaluation Scheme:** Only insecticides approved by WHO can be used in IRS. OPs, carbamates, and pyrethroids are WHOPES approved classes of pesticides for use in IRS and thus any can be chosen for use based on entomological data and host country registration status.

b. **Registration for use in the country:** The FMOH is not required to conform to the pesticide registration requirements developed by the MARD, therefore the insecticides identified by the FMOH for use in health programs may or may not be registered for use by the MARD.

c. **Residual effect for a period longer than, or at least equal to, the average duration of the malaria transmission season in the area:** According to WHO, all pyrethroids, carbamates, and OPs are expected to have duration of 3 to 6 months in terms of effectiveness; however, the duration of effectiveness varies under different climatic conditions. In most of the country, the peak periods of malaria incidence occurs from September to December, following the main rainy seasons

(June-September), and from March to May, during and after the small rainy seasons (February-March). Three pyrethroids, known as longer-lasting pyrethroids, can last up to eleven months based on various field trials. From this perspective, and for economic reasons, pyrethroids are normally the most effective choice of insecticide. The results of a study conducted on 15 sprayed houses in Adama area showed that the residual life of two insecticides (pirimiphos methyl and deltamethrin) was more than six months. Due to resistance to pyrethroids it is currently not the best choice in Ethiopia and carbamates are being used instead. Due to the shorter effective duration of carbamates, FMOH is implementing either two spray campaigns in regions where the malaria is prevalent during the short rain season, or other stopgap measures are being employed (larviciding). Technical information on duration of effectiveness on the primary wall surface types will continue to be considered when selecting insecticide class(es).

d. **Pesticide must be appropriate for use on the wall surfaces of the selected location**: The majority of the structures in the targeted regions are made of thatch/wood covered with a mud plaster. Some homes may be only thatch, while others may have a commercial plaster surface. Structures made of corrugated metal are not sprayed as the pesticides do not adhere sufficiently to the surface to be effective. In Ethiopia ceilings and eves are also sprayed. These are usually constructed out of thatch. Corrugated metal roofing is not sprayed.

   Cone bioassay tests were conducted to determine the residual efficacy of carbamates (propoxur and bendiocarb) at different pH levels of spray water and types of wall surface.

   The study so far showed that:

   - Adjusting the pH level of spray water had no effect on efficacy and residual life of these insecticides;
   - Bendiocarb and propoxur sprayed on dung-coated walls performed better than when sprayed on mud walls; the reason is not yet known;
   - pH of the two plaster materials (mud and dung) did not differ;
   - Propoxur showed longer residual life than bendiocarb.

   Overall human landing catch collection results showed that vector biting was consistently lower indoors than outdoors, indicating a tendency of exophagic habits. To further elaborate on these findings, the data indicates that the vector has both options but it prefers biting people sitting outdoors than those sitting indoors. However, because people spend more time indoor than outdoor, a mosquito has to go inside to bite, which means people can still be protected by IRS and bed nets; both will remain effective.

e. **Local vector susceptibility to the insecticide:** One of the major concerns when implementing IRS campaign is to prevent resistance to insecticide among vectors. Resistance to insecticide develops when a hereditary feature is selected in an insect population that reduces the population's sensitiveness to a given insecticide. Entomological monitoring activities will be implemented in collaboration with the ORHB, FMOH and Jimma and Addis Ababa Universities. The susceptibility level of *Anopheles gambiae* complex, the major vector of malaria in Ethiopia, to 0.05 percent deltamethrin, 0.1 percent bendiocarb, 1.0 percent fenitrothion, and 0.1 percent propoxur was tested in five selected sites in the Oromia project districts in July 2012. The tests were conducted on 2–3-day-old female mosquitoes reared from larvae. The test results showed 8–61 percent susceptibility of *An. gambiae* to deltamethrin, indicating a high level of resistance of the vector to this insecticide. The susceptibility to bendiocarb in Asendabo and Bako sites was 95–100 percent. Susceptibility of the vector to fenitrothion was 98 percent in one site and 100 percent for propoxur in three sites.

Recent studies indicated that resistance to pyrethroids is spreading. Based on this evidence, the National IRS Technical Working Group recommended that the FMOH switch insecticides from pyrethroids to either carbamates or OPs, or use a rotation spray approach with the two classes of insecticides. The FMOH has made the following decisions with regard to the insecticides to be used in IRS:

1. After the 2012 malaria transmission season, PMI and FMOH will stop using pyrethroids for IRS.
2. Starting in 2013 PMI will spray carbamate class of insecticides in all project districts; the FMOH will use the carbamates bendiocarb and propoxur in all other malaria-risk districts.
3. The PMI and the FMOH will continue monitoring vector response, and discussions on resistance management and proper targeting for IRS operations.

f. **Ecological impact:** The 2012 PEA for Integrated Vector Management (IVM) assessed the toxicity of IRS insecticides to non-target organisms, including mammals, birds, fish, bees, and 'other aquatic' organisms. In summary, pyrethroids and carbamates are similar in toxicity to non-target organisms as shown in Table 9. Apart from propoxur, the rest of the insecticides are all highly toxic to fish and other aquatic organisms. Similarly all the insecticides from the approved classes are highly toxic to bees, apart from pirimiphos methyl. In mammals, all the insecticides approved by WHO for IRS carry low-to medium toxicity, with the exception of lambda cyhalothrin and propoxur, which are categorized as highly toxic to mammals. In avi-fauna, only propoxur is categorized as highly toxic with the rest categorized as low/medium in toxicity.

TABLE 9: 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)							

Source: IVM PEA

Key	
High Toxicity	
Medium to High Toxicity	
Medium Toxicity	
Low to Medium Toxicity	
Low Toxicity	
Data Not Found	

g. **Human health impact:** The 2012 PEA for IVM also assessed cancer and non-cancer risks associated with all WHOPES-approved 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 than OPs when risks are assessed via any pathway. If OPs are used, then decisions on insecticide type should be informed in part by the human health toxicity and risk associated with each compound and formulation. For malathion and fenitrothion, it will 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 cholinesterases and urinary excretion of chemical biomarkers. PMI will evaluate various approaches for monitoring sprayer exposure to OPs, and will develop protocols based on these evaluations. PMI will use these protocols to guide the implementation of any OP monitoring program. An investigation will need to be conducted to determine if Ethiopia has the capability to conduct biomonitoring and what level of capacity building would be required. All of the IRS facilities are located at district health centers; therefore, biomonitoring could be completed at these centers.

Secondary Selection Criteria:

Once the FMOH and PMI approve the analysis of these factors, then the criteria is updated to include international procurement language in which the criteria is clearly stipulated and then tendered out in accordance with international open competitive procurement rules. Once there are responses to the call for bids, the resulting proposals are subjected to secondary criteria including:

- 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

PMI/USAID procures the insecticide for the Ethiopia PMI IRS program without the involvement of the PMI IRS implementing partner.

6.3 The Extent to Which the Proposed Pesticide Use Is Part of an Integrated Pest Management Program

Integrated Pest Management (IPM) is defined[11] 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 [agricultural products]. 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."

The FMOH Malaria Control Guidelines include environmental management and larviciding. Environmental management for vector control has been implemented in urban and semi-urban areas,

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

refugee camps, development projects, water harvesting ponds, and irrigation scheme areas. In areas where breeding sites are few, accessible, and manageable, communities are encouraged to participate in environmental management activities under the direction of HEWs. Larvicides can be used to address collected water that cannot be managed through environmental control measures. Similar to environmental control measures, the success of larvicides depends on the identification of all mosquito breeding sites and their distribution in the entire target area, followed by sustained weekly spraying of chemicals. Larvicide control measures should be applied in conjunction with environmental control measures. The most common water-soluble chemical used to kill mosquito larvae in Ethiopia is temephos (Abate®). The application of temephos must be carried out on larvae-positive sites through the guidance of HEWs in areas where breeding sites are easily identifiable.

IPM is often used in an agricultural context, but similar in nature is the concept of 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.

USAID strategy has been that IRS will be implemented as a component of IVM for malaria control, along with LLINs, larviciding and environmental management. These other interventions are described in a preceding section on *Proposed Action and Alternatives*.

6.4 PROPOSED METHODS OF APPLICATION

IRS involves spraying a liquid insecticide with long lasting residual activity on the indoor wall 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, and the mosquito is killed.

Pesticide will only be applied using pressurized spray equipment approved for the pesticide in use, by trained spray operators wearing full PPE (face mask, gloves, overalls, hard hats with face shields, boots, neck protection and goggles). Experienced program operators will train spray operators in the correct spray procedures per PMI BMPs. These procedures have been proven to be effective for providing long-lasting effectiveness toward controlling the malaria vector mosquito.

The following IRS equipment will be used:

- **Spray Nozzles**

  The program in Ethiopia will procure 8002E nozzles for the spray pumps, which are the standard size recommended by WHO for mud wall.

- **Spray pumps**

  The spray operators who implement IRS use HUDSON X-PERT or Goizper 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 to the interior walls of targeted house (structure). After the day's spraying is complete, spray operators must clean the sprayer following the manufacturer's recommendations to ensure their proper operation and calibration.

6.5 ACUTE AND LONG-TERM TOXICOLOGICAL HAZARDS AND MEASURES TO MINIMIZE THEM

The two broad categories of hazard are exposure to humans and domestic animals, and release into the environment causing environmental damage. These may occur at any point, from the production or importation of the pesticide through transportation, storage, distribution, pesticide preparation, spray application, cleanup, and final disposal. Post-spray activity may cause exposure as well through improper behavior of beneficiaries regarding sprayed surfaces and cleanup and disposal of residue and any insects killed with the insecticides from the household after spraying. Hazards are discussed in the Environmental Impact section and addressed in the EMMP in Annex A. The EMMP includes mitigation strategies for each of the risks. The consequences of release and exposure are found in Table 9. The acute and long-term toxicological hazards of pyrethroids, carbamate and OP-based pesticides are detailed in Annex E: Pesticide Profiles of the PMI IVM PEA.

Major hazards include exposure during handling (transporting or spraying), environmental release through vehicular accidents during transportation, and widespread airborne release of pesticide combuston byproducts in the event of a fire at the storage facility or in transport. Although the PMI BMP manual is the operative document, the *Pesticide Storage and Stock Control* by FAO provides detailed guidance on proper storage management practices, as well as remedial measures in case of spillage and incidents brought on by natural disasters including flooding. These guidelines therefore provide a sound basis for minimizing the risk of human, animal, or environmental exposure. It is not incumbent on the PMI Ethiopia implementing partner to observe all recommendations from the FAO manual.

Exposure treatment for carbamates, pyrethroids, and OP-based pesticides are detailed in Table 6, 7 and 8, and Annexes B and C. Training for supervisors, spray team leaders, spray operators, washpersons, storeroom managers, and health officials include recognition of the symptoms of poisoning, incident response elevation protocol, and, for the medical professionals, the treatment protocols for each pesticide.

Specific measures to mitigate transportation-related exposure will include:

- Training drivers before they transport insecticides from the customs warehouse or central storage facility to the local storage facility.
- Ensuring that drivers are thoroughly knowledgeable about the toxicity of insecticides, and that training includes opportunities for drivers to respond to scenarios related to the transport of specified insecticides, and
- Knowing the routes that must be negotiated to transport the pesticide to its destination, and the hazards that exist along those routes. The drivers will also be trained on mitigation of those hazards.

Drivers must remove any pesticide contamination in vehicles rented for the project in order to avoid negative consequences when the vehicles are used for other purposes, such as food transport. To prevent pesticide runoff from vehicle washing, drivers are responsible for wiping the vehicle bed with a damp cloth before washing the exterior of the vehicle.

Other than transporters, storage area personnel, and spray teams, the people at risk of exposure are primarily the beneficiary population in the targeted communities. Acceptance of the pesticide and IRS intervention among the targeted households are primary external factors critical for compliance. The IEC program is of critical importance toward gaining beneficiary acceptance. It is important that the targeted community and households are adequately educated on safety, including procedures for removing personal belongings prior to spraying, observing the required exclusion period, and avoiding contact with sprayed surfaces on an indefinite basis.

IEC programs, also referred as SBCC programs, are currently being implemented in targeted communities under the ongoing IRS operation.

The main purpose of mobilization is to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles and responsibilities before, during, and after spray operations in the elimination or mitigation of any possible negative impacts.

The PMI IRS implementing partner collaborates with FMOH at all levels to mobilize communities. HEWs, the frontline health workers in each kebele, and other kebele-based government staff, are recruited and trained to be the mobilizers. MFPs, SBCC team leaders and mobilizers take part in the mobilization campaigns in both rounds of spraying. Door-to-door communication is the main strategy used for community outreach. District MFPs work in close contact with the SBCC team leaders to inform the population about the spraying schedule. The project develops, prints, and distributes household IRS cards as well as IRS fliers, brochures and posters with key IRS messages.

6.6 THE EFFECTIVENESS OF THE REQUESTED PESTICIDE FOR THE PROPOSED USE

Pesticides are selected for IRS based on efficacy in the intended use, and other extrinsic variables. Selection criteria have been expounded in the Description of Alternative and Proposed Actions section, and in Section 6.2 of this Pesticide Procedures section.

Once the program is established, it is necessary to monitor vector resistance prior to the initiation of spray activities, to ensure that acceptable kill levels will be achieved. A resistance monitoring program has been established and is operating, and the results from this ongoing program will be a primary determinant 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 either compromised if the vector exits after feeding without resting on the wall, or absent if the vector feeds outdoors (exophagic) and rests outdoors (exophilic). Overall human landing catch collection results showed that vector biting was consistently lower indoors than outdoors, indicating a tendency of exophagic habits. This is characteristic of *Anopheles arabiensis*, which is the dominant vector in Ethiopia. To further elaborate on these findings, the data indicates that the vector has both options but it prefers biting people sitting outdoors than those sitting indoors. However, because people spend more time indoors during the mosquito's preferred biting time (night time), a mosquito more often has to go inside to bite, which means people can still be protected by IRS.

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. The operational criterion for vector resistance is having 20% or more survival rate in the number of mosquitos tested using standardized methods of the WHO.[12]

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.[13, 14] 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 will cover).

Irrespective of the pesticides used for IRS, national capacity is being strengthened to enable systematic evaluation of the mechanisms for resistance development and the gene frequencies among the local malaria vector populations. There is also a need to evaluate other pesticides and non-chemical alternatives to facilitate the evolution of a full-fledged IVM for malaria.

The residual efficacy of the pesticide being used for IRS is crucial to evaluating the implication of vector resistance. Generally, a positive correlation between observed vector resistance and a decline in pesticide efficacy is an important criterion in determining the need for a change of the pesticide in a local area. It is important that wall bioassays 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.

The third major factor affecting the effectiveness of the pesticides is their quality (strength and other factors). 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 should be taken prior to use, and analyzed for the concentration of the active ingredient.

6.7 Compatibility of the Proposed Pesticide with Target and Non-Target Ecosystems

The WHOPES recommended pesticides are compatible with the target environment (walls, ceilings, eaves, etc.) in that they dry on these surfaces, and are not released to any great extent. The dried pesticide remains on the sprayed surfaces, and performs as designed, killing vector mosquitos that rest on those surfaces. In fact, there is a high potential for a positive impact on the target environment because of corollary reduction of other household pests.

The proposed pesticides are incompatible with the non-target ecosystems (humans, animals, and the environment), in that if they are released to the non-target environment in large quantities, they would have negative effects on humans, as well as land and water based flora and fauna.

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[12] WHO (1998). *Test procedures for insecticide resistance monitoring in malaria vectors, bio-efficacy and persistence of insecticides on treated surfaces.* World Health Organization, Geneva, WHO/CDS/CPC/MAL/98.12

[13] WHO (1986) Resistance of vectors and reservoirs of disease to pesticides: tenth report of the WHO Expert Committee on Vector Biology and Control. World Health Organization, Geneva.

[14] Brogdon, W.G. and McAllister, J.C. (1998). Insecticide Resistance and Vector Control *Emerging Infectious Diseases* 4(4): 605-613.

The IRS implementation process is carefully designed to ensure that pesticides are deliberately and carefully applied via strict protocols to the interior surfaces of dwellings, and do not come in significant contact with humans, animals, or the environment. IRS implementation protocols minimize and responsibly manage IRS liquid wastes, through the next-day reuse of mixed but unused pesticides drained from operators' spray tanks at the end of the day, and the triple rinsing process. At the end of the spray season, contaminated solid wastes are incinerated in approved incinerators that destroy the pesticide and prevent environmental contamination. The EMMP in Annex A details the steps and measures that will be taken to prevent negative impacts on the non-target ecosystems.

6.8 THE CONDITIONS UNDER WHICH THE PESTICIDE IS TO BE USED

Chapter 5, Affected Environment of this SEA discusses in detail the environmental background conditions that exist in Ethiopia relative to the implementation of IRS. Ethiopia in general and Oromia in particular exhibit the environmental conditions that promote malaria transmission.

In general, carbamates, pyrethroids and OPs have the potential to cause harm to bees, birds, fish, and other aquatic organisms. As noted in Chapter 5, it is estimated that 1.5 million bee-hives are tended in Oromia region. Due to the established toxicity of the WHO pesticides to bees, as well as the potential for contamination of edible honey, structures with attached or free-standing bee-hives within 30 m will not receive IRS. Prior to spraying, IEC and reconnaissance personnel will work to identify areas where bee-keeping or natural bee habitats are established, and explain to the households that bee-hives should be temporarily moved before spraying to a safe location at least 30 m from any habitation.

Oromia contains a rich network of rivers and water bodies, and established National Parks. The PMI IRS implementing partner will consult with the EPA regarding the application of pesticides near ecologically sensitive areas, such as wetlands, lakeshores, river edges, protected areas and National Parks, and follow their policies and guidelines. At a minimum, no IRS activities will take place within 30 meters of any sensitive sites

The PMI IRS implementing partner will identify households within sensitive areas, and train sprayers to also identify houses that should not be sprayed. In addition to spraying precautions, pesticide storage areas may be bermed if necessary to contain any spills and provide an extra layer of protection for downgradient natural or developed resources.

Strict supervisory control will be established to prevent contamination of Ethiopia's economic resources, such as agricultural, aquacultural, horticultural, or apiary production, due to authorized or unauthorized outdoor spraying, or disposal of wastes.

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

This IRS program is limited to using those pesticides that WHO currently recommends, comprising twelve insecticides from four chemical groups, each with a specific dosage regime, duration of effectiveness, and safety rating.[15]. Each of these agents has been evaluated for effectiveness within the

[15] 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)

program, and continued monitoring for resistance and susceptibility will be employed to allow up-to-date decisions prior to each spray campaign. The goal of this SEA is to broaden the options for pesticide use to combat periodic resistance development. Due primarily to monitoring that has confirmed vector resistance to it, DDT is the only WHO-recommended pesticide that will not be considered for PMI-sponsored IRS at this time.

Non-chemical control methods include behavior modification and use of untreated bednets. While the IEC program includes certain types of behavior modification to avoid or reduce the probability of beneficiaries contracting malaria, untreated nets are not used, in favor of treated nets. Luring and trapping of vector mosquitos remains a possibility, but in general, luring is accomplished by the use of some type of chemical, which may or may not have toxicity characteristics. The PMI IRS implementing partner will remain alert to the possibilities for other non-chemical control methods, and will continuously evaluate the utility and practicality of these methods.

6.10 The Requesting Country's Ability to Regulate or Control the Distribution, Storage, Use, and Disposal of the Requested Pesticide

The MARD, Crop Protection Department is responsible for regulating the registration, importation and use of agricultural pesticides. Due to limited funding and staff, MARD has a limited capacity to enforce the pesticide regulations. Health pesticides used by FMOH are not required to be registered by the MARD, and therefore are often not officially registered for use in Ethiopia.

Ethiopia's Environmental Protection Agency is the principal authority for the management of environmental issues. The EPA sets national environmental policy and enforces environmental regulations at the federal level, while the Regional States administer environmental regulations and policies at the regional level.

The quality of the pesticide used can have a large impact on the effectiveness of the IRS undertaking. There is no scientific testing facility in country to provide pesticide quality control functions. Pesticides manufactured at the Adami Tulu plant are sent to a certified laboratory in Belgium for quality testing. Pesticides that PMI imports for use in IRS are tested prior to delivery at WHO certified laboratories in South Africa or Germany.

Ethiopia has significant capacity to produce pesticides, and unfortunately has done so with little regard to demand or to disposal issues. Regulation and control have been lacking. PMI is currently involved in a project to collect scattered DDT stores from around the country, and to centrally store them. This situation is evidence of the lack of management capacity and control, and it is suspected that pilferage is occurring at these unmonitored storage locations.

6.11 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 (*"PMI IRS Best Management Practices"*), and WHO provides a training manual *Manual for Indoor Residual Spraying*[16]. Although PMI-produced

[16] WHO. 2002. Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control (WHO/CDS/WHOPES/GCDPP/2000.3).

documentation has precedence over other guidance, information from other sources may be useful and may be followed if the recommendations do not conflict with PMI sources. Other resources include the *WHO-UNEP Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning,*[17] the 2012 PEA and this SEA, all of which provide precise precautions and recommendations on many aspects of IRS operations.

PMI will support the training of spray operators and supervisors, and provide overall guidance and logistical support to the IRS operations in Ethiopia. The PMI IRS implementing partner 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 TOT program in which potential supervisors[18] and team leaders are trained on all aspects of IRS operation in collaboration with the FMOH, ORHB and the DHOs. 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 identification of temporary workers recruited from local areas and trained as spray operators and wash persons. New operators will receive five to seven days of training prior to the spray operations. Priority areas of training will include:
    - How to properly mix the wettable powder or liquid pesticides, and filling of the sprayer. If liquid pesticides are used, the sprayers will be trained to triple-rinse containers during the filling of the sprayer.
    - Correct spraying (maintaining 35-55 psi pressure, spray nozzle at 45 cm from the sprayable surface, swath overlap, etc.).
    - The correct use of protective materials and related safety precautions.
    - Support to households on safety issues.
    - Personal safety relating to the different pesticides used for IRS (carbamate and OP-based pesticides, as well as the pyrethroids, which are currently in use).
    - Environmental safety in relation to pesticides, including management of the empty pesticide sachets.
    - The use of daily spray cards and data entry.
- An additional training is planned in connection with the effort to consolidate DDT wastes from storehouses throughout Oromia. This training will provide supervisory capacity to district environmental health officials for the clean-up effort, as well as operational capacity to technicians who will be chosen to execute the consolidation. The latter will include storeroom workers from the Adama Tulu warehouse and manufacturing facility so that they will be qualified to provide ongoing care for the stored DDT.

[17] WHO. 2007. *WHO-UNEP Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning: A Resource Tool*. World Health Organization, Geneva. 332 Pages. (Document also accessible at. www.who.int/ipcs/en/a)
[18] These are usually health-related government staff within the targeted district (health assistants/educators/ inspectors, nursing assistants, and community development assistants).

6.12 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. The immediate (output) level relates to the efficacy of the pesticide, that is, the degree to which the pesticide is able to kill the targeted mosquito vectors, and involves direct entomological evaluations on pesticide contact bioassays and related pesticide resistance methodologies as recommended by WHO.[19] The second broad level of measuring the effectiveness of the pesticides relates to the general goal of reducing the local disease burden. This 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) composition.

The PMI IRS implementing partner manages a number of entomological monitoring activities in collaboration with the ORHB, the FMOH, and Jimma and Addis Ababa Universities. The major activities include efficacy and residual life of different insecticides on sprayed walls, monitoring vector behavior and density, insecticide susceptibility tests, and other relevant entomological studies. Cone/wall bioassay tests have been undertaken to assess the residual life of a number of potential alternative insecticides, which include long-lasting (CS) formulation of pirimiphos methyl, deltamethrin, and propoxur. PMI IRS implementing partner is conducting cone bioassay tests to determine the residual efficacy of carbamates (propoxur and bendiocarb) at different pH levels of spray water and types of wall surface. Overall human landing catch collection results showed that vector biting was consistently lower indoors than outdoors, indicating a tendency of exophagic habits.

[19] WHO (1998). Test procedures for insecticide resistance monitoring in malaria vectors, bio-efficacy and persistence of insecticides on treated surfaces WHO/HQ, Geneva, World Health Organization, WHO/CDS/CPC/MAL/98.12

7. Environmental Impacts and Mitigation and Monitoring Plan

This section addresses the potential direct and indirect impacts of the IRS program in Ethiopia, and also discusses mitigation and monitoring measures. The EMMP, in Annex A, presents the best management practices and mitigation measures identified for the project, responsibilities for the implementation of the Plan, and monitoring and reporting measures. This EMMP is the guiding document for IRS management team in Ethiopia, and will be used as the tool for ensuring environment compliance for the program. The EMMP Annual Reporting Form and Certification will be completed and submitted to the COR/AOR as part of the annual end-of-spray report (EOSR).

The EMMP in Annex A presents a program by which the PMI IRS implementing partner, FMOH, ORHB and DHOs will assure initial and ongoing compliance with environmental requirements and guidelines. The plan also includes descriptions of activities proposed for mitigating environmental and social impacts, indicators, methods and frequency of monitoring, and identifies responsible parties for monitoring.

7.1 Potential Positive Effects of the IRS Program

Direct Positive Effects

The direct positive impacts of the IRS program are generally 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.

Indirect Positive Effects

The IRS program will also indirectly contribute in the enhancement of the local economy in the following indirect ways: spray operators, washers, mobilizers, supervisors will all receive a daily payment for their work. There will also be human and institutional capacity building in the form of training of a large number of people in IRS operations. A reduction in household pests may result in a reduction in other diseases carried by the pests.

7.2 Potential Adverse Impacts

Adverse impacts of IRS project are those unintended effects of the project that can compromise the well-being of the environment and/or human health.

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 deliberate 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 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 because pyrethroids, OPs and carbamates degrade very quickly when exposed to sunlight and in the soil. If wash areas and soak pits are properly constructed and used, liquid pesticide waste will be captured in the charcoal layer of the soak pit and held until it breaks down by natural processes.

Impacts to Birds, Fishes, and other organisms from pesticides

The degree of toxicity of the four WHO approved pesticide classes to birdlife, aquatic life and insects especially bees including the degree of persistence and bio-accumulation is well-documented and very important to remember. See Table 6 for details.

Impacts on Bees

Bee keeping is done at a household level and the sale of honey provides some income to the residents. 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. The project will make conscientious efforts to identify locations where beehives are kept, and observe a 30 meter no-spray buffer zone around them.

Indirect Adverse Effects

When the PMI IRS program is discontinued, USAID will leave remaining IRS equipment in the hands of the DHOs and with the communities (community based programs); and will no longer supervise its use. IRS equipment left to district health officials includes backpack compression sprayers, unexpired unused chemicals, and used, clean boots that are still in operable condition. The action of leaving behind IRS equipment may temporarily, and in a minor way increase the total pesticide load on the environment.

Summary of Toxicity of pesticides to Avifauna, Aquatic life, Mammals and Insects by Class

Pyrethroids:

- All pyrethroids are highly toxic to bees and highly toxic to fish and other aquatic organisms except Deltamethrin, which has low toxicity to other aquatic organisms[20].
- Birds, if exposed, are most affected by bifenthrin (low to medium toxicity). All other pyrethroids have very low toxicity to birds.
- In the pyrethroid class, only lambda cyhalothrin is highly toxic to mammals. Alpha-cypermethrin and etofenprox have very low toxicity to mammals while bifenthrin, cyfluthrin and deltamethrin have low to medium toxicity.
- In terms of persistency in the environment, only cyfluthrin is considered persistent. The rest of the pyrethroids have low to medium persistence.

[20] USAID's IVM PEA

- Bifenthrin does not accumulate in the environment. Potential for bio-accumulation in aquatic organisms for deltamethrin and cyfluthrin is relatively low while lambda-cyhalothrin is medium and alpha-cypermethrin is high.

Carbamates (Bendiocarb and Propoxur)

- Carbamates are highly toxic to bees, and have the potential to cause cholinesterase depression in humans. Care must be taken to avoid skin contact with carbamates, especially by spray operators. All spray personnel should be trained to recognize the symptoms of cholinesterase depression, and know the protocol for obtaining medical assistance.
- In addition to other aquatic organisms propoxur is also highly toxic to mammals and birds. Acute symptoms of propoxur poisoning in birds include eye tearing, salivation, muscle incoordination, diarrhea, and trembling. Depending on the type of bird, poisoning signs can appear within 5 minutes of exposure, with deaths occurring between 5 and 45 minutes, or overnight. On the other hand this insecticide has very low toxic properties on fish.
- Bendiocarb has low to medium toxicity on mammals and birds.
- In general both carbamates have low to medium indications for persistency in the environment and bioaccumulation in organisms

OPs

- OPs have different characteristics and impacts on different organisms depending on the type of insecticide. However, all three WHO-approved OPs have the potential to cause cholinesterase depression in humans and other organisms, and *skin contact with these pesticides must be strictly avoided, especially by spray personnel*. All spray personnel should be trained to recognize the symptoms of cholinesterase depression, and know the protocol for obtaining medical assistance.
- Fenitrothion has low toxicity on mammals and fish and is not persistent in the environment. However it is highly toxic to bees, birds and other aquatic organisms, like crustaceans and aquatic insects and has a medium toxicity to aquatic worms. It has moderate to medium potential to bioaccumulate in organisms.
- Malathion is only highly toxic to bees. It has very low impacts on fish and other aquatic organisms, and has a very low potential to bioaccumulate in organisms or persist in the environment. Its toxicity on mammals and birds is low to medium.
- Pirimiphos-methyl is highly toxic to fish and other aquatic organisms and has a high potential to persist in the environment. It has low to medium toxic effects on mammals and bees. It does not bioaccumulate in organisms.
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7.3 HUMAN EXPOSURE RISKS/IMPACTS

Exposure risks of all WHO approved pesticides in relation to cancer and non-cancer endpoints, and with respect to exposure dosage, Hazard Quotient and the Life Time Average Daily Dose are presented in 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.

Inhalation exposure and risk during mixing

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

Dermal exposure and risk during mixing

- From the WHOPES approved 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.

Inhalation exposure and risk during spraying

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

Dermal exposure and risk during spraying

- Of the proposed pesticides, fenitrothion and pirimiphos-methyl have non-cancer risks due to dermal exposure.

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.

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.

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.

Resident exposure and risk due to reuse of pesticide containers

- Only deltamethrin is registered to have potential for acute ingestion from using pesticide containers. However, residents will have no access to pesticide containers used in IRS. The pesticide containers are only available in IRS storage facilities which are securely double locked and must be disposed by incineration at high temperature.

Worker exposure and risk due to inhalation during spillage

- According to information presented in the 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.

Worker and Resident Exposure Pathway

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.

a. Pre Spraying Exposure Pathway

   Preparing pesticide solutions during the IRS requires pouring the pesticide in the spray pump to ensure ample mix with the water. The process of mixing the pesticide can lead to exposures via inhalation, dermal contact, and incidental ingestion, mostly from releases of pesticide vapors, and solutions. 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.

b. Exposure during Spraying

Inhalation of aerosol vapors 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.

c. 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. Ingestion exposure can occur from drinking contaminated surface water. Once the excess formulation gets into the soil, the pesticide can reach the groundwater, which may be used as a water supply via household wells. Residents may then be exposed to this contaminated water by ingestion or by dermal contact when it is used for cleaning or drinking purposes.

d. 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.

7.4 CUMULATIVE IMPACT

The combined, incremental effects of human activity, referred to as cumulative impacts, pose a serious threat to the environment. Cumulative impacts develop over time, from one or more sources, and can result in the degradation of important resources.

The critical resources or ecosystems that can be affected by the IRS program over a period of time especially with regards to pesticide application include water supply, food supply, waste assimilation/disposal capacity, river, lake, and stream quality, agriculture, aquaculture, apiculture, human and animal health, biodiversity resources, environmental services, and others. Pesticide run-off and accumulation in the rivers, streams and other water bodies, can lead to the progressive contamination of the water resources and reduction of aquatic biodiversity. However, implementing the EMMPs provided in this SEA reduces the likelihood of releases, and the chances of a series of releases within the pesticides half-life are extremely unlikely, except in the case of willful malfeasance.

Continuous human exposure to pesticides over time can lead to health risks or complications, especially among spray operators and others in close contact with pesticides. This is particularly true in the case of OPs. However, the risk assessment performed in the PEA indicates minimal exposure with the use of proper technique and appropriate PPE, i.e. dust masks, helmet, face shield, gloves, overalls and boots that minimize exposure by dermal absorption or inhalation, and a great reduction in the potential for harm.

The sprayed pesticides solidify on the walls, ceilings, and eaves of the structures, and become largely immobile and significantly less harmful. Exposure to the occupants will be further reduced by the procedures and safety measures described in the EMMP.

Pyrethroids, OPs and carbamates degrade very quickly when exposed to light and to the external environment, thus the cumulative and residual adverse impacts of their use will be insignificant. The soak pits used for waste disposal are designed to break down influent pesticides wastes within about three months, while the pesticides are held by the charcoal used in pit construction.

The long-term use of any pesticide could lead to insecticide resistance. To minimize this cumulative impact, insecticide resistance is actively monitored. The proposed action is designed with the concept of vector monitoring, insecticide rotation and mosaicking which will reduce the future incidence of vector resistance.

7.5 MITIGATION MEASURES

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

Residential Exposure

District Malaria Focal Person, Health Extension Workers, PMI IRS implementing partner and other partners will work with relevant institutions at all levels to carry out an IEC campaign to sensitize residents to IRS activities, in accordance with WHO guidelines and also Ethiopia National Malaria Strategy Plan 2011-2015 and PMI Malaria Operational Plan. The IEC campaign (as well as IRS Project team leaders and Health Extension Workers who will also instruct residents on best practices prior to spraying) should focus on the following elements of residential safety during an IRS program:

- Clear homes of mats or rugs, furniture, cooking implements and foodstuffs prior to spraying; if furniture cannot be moved out of the home, then move it to the center of the room and covered with impermeable material.
- Stay outside the home during spraying for two hours after spraying.
- Move and keep all animals outside 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.
- Sweep floors free of any residual insecticide that may remain from the spraying and dispose of in pits or latrines.
- Do not re-plaster or paint over the sprayed walls after spraying.
- Keep using bed-nets for 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 not removed from the houses.
- Adopt a system of moving household effects to the center of the room and covering them with impermeable material before spraying.
- Materials can also be moved into structures that are not targeted to be sprayed, e.g., an isolated kitchen or other domestic animal shelter.
- Move the household effects to one room which will not be sprayed on that particular day, but the next day.
- The spray teams should pay close attention to any signs of potential rains so that they prepare the communities accordingly.

When it rains in the mid of spraying:

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

Pesticide Transport

After the procurement of the insecticides for use during the current IRS campaign, insecticides are expected to move to the district warehouses by road. During transportation, there is a risk of vehicle accidents and consequently insecticide spillage. The transport must comply with environment management regulation, statutory instrument 12 of 2007 section 14, regarding hazardous substances, pesticides and other toxic substances and the guidelines of NEMA on transport of pesticides.

Prior to long-distance transport of the insecticide from the customs warehouse/central storage facility of the supplier, drivers will be informed about general issues surrounding the insecticide and how to handle emergency situations (e.g. road accidents). Training for long-distance transport will include the following information:

- Purpose of the insecticide.
- Toxicity of the insecticide.
- Security issues, including implications of the insecticide getting into the public.
- Hazardous places along the routes to be taken, and mitigation measures.
- Steps to take in case of an accident or emergency (according to FAO standards).
- Combustibility and toxicity of the combustion byproducts of insecticide.

Drivers hired specifically for the spray campaign period will receive:

- Training in operator transportation best practices and vehicle requirements from PMI BMP #2, Worker and Resident Health and Safety.
- Training provided to spray operators (with the exception of sprayer operation and spray practice).
- Handling an accident or emergency (according to FAO standards).

- Handling vehicle contamination.

The vehicles to transport insecticides must be in good condition and preferably a lockable box truck. If the pesticides are to be left unattended for any period of time, including lunch breaks or overnight stops, a lockable box truck is essential. Figure 10 below provides a lis of key responses to mitigate the impact of the insecticide spills.

FIGURE 10: EMERGENCY RESPONSE TO INSECTICIDE SPILLS

1. Control, contain and clean up the spill
2. Protective clothing should be donned prior to attempting to clean the spills.
3. It is imperative to avoid fire as a result of the accident and a fire extinguisher should be deployed just in case. The engine should be shut off and smoking in the area strictly prohibited.
4. Onlookers and bystanders should be cautioned against approaching the accident site.
5. If the crew has come in contact with the pesticides, they should remove contaminated clothing immediately and wash the pesticide off their skin.
6. For major spills send for help immediately; drivers should have cell phones and an emergency number for use in such cases.
7. People should be kept away and the spill covered with earth, sand, etc.; no attempt should be made to wash away the spill with water or other substances.
8. Vehicles that are used for transporting large quantities of pesticides should be equipped with a bucket of sand, sawdust or soil, a shovel, and fire extinguisher.

Because vehicles used for insecticides transportation can be used for the transport of other goods, including food, it is important to ensure that vehicles are decontaminated. The drivers will be responsible for cleaning and decontaminating the interior of the vehicle and exterior bed at the end of the spray campaign. Drivers will be provided with gloves, overalls, and rubber boots to wear for cleaning the vehicle. All cloths used in wiping down the interior and bed of the vehicle will be washed with soap.

Accidental Warehouse Fires

Human inhalation of toxic fumes in the event of a storehouse fire is also an unavoidable risk. The risk can be minimized, however, by following BMPs for storage, including prohibiting lighted materials in the warehouse and in the vicinity of pesticides, providing proper ventilation, etc.

Information on the combustion byproducts of pyrethroids can be found in Table 10 (taken from PEA 2012 and fire-fighting instructions from MSDSs).

TABLE 10: INSECTICIDE, COMBUSTION BYPRODUCT, AND EXTINGUISHING INSTRUCTIONS

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

(Source: IVM PEA, USAID, Jan 2007)

Fetal Exposure (Pregnancy Testing)

All female candidates for washers will be tested for pregnancy before being recruited into the spray operations and every thirty days thereafter until operations end. Females found to be pregnant will be re-assigned to positions that do not have the potential for exposure to insecticides. Women who are breastfeeding cannot have any contact with pesticides, and are thus prohibited from spraying of pesticide or washing contaminated items. In addition to PMI guidelines, Ethiopian law does not allow females to work as spray operators.

Spray Operator Exposure

Each spray operator will be provided with safety equipment in accordance with WHO and FAO specifications.

Workers will be closely monitored for acute symptoms, because there will always be some level of exposure. In addition, workday duration should be monitored to limit exposure as required by safety recommendations.

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 PMI IRS implementing partner Operations Director.

Similarly, residential exposure will 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 exposure incidents.

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps and practical exercises during a five-days training period prior to the beginning of the spraying campaign. They will also receive training to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training will be conducted in accordance with 2002 WHO's *Manual for Indoor Residual Spraying* and the BMP. Potential spray operators must also pass written and practical tests at the end of training.

For malathion and fenitrothion OPs, it will 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 cholinesterases and urinary excretion of chemical biomarkers. PMI will evaluate various approaches for monitoring sprayer exposure to OPs, and will develop protocols based on these evaluations. PMI will use these protocols to guide the implementation of the OP monitoring program.

Pesticide Exposure and Treatment

The following drugs in Table 11 are recommended for use in case of exposure to the insecticides. The project will ensure that all the health facilities around the spray sites have in their store these recommended drugs and that all the staff responsible receives appropriate training on administering emergency treatment to pesticide exposure. Annexes B and C provide additional information on symptoms and treatment protocols.

TABLE 11: ANTIDOTES FOR PESTICIDE CLASSES

Organochlorine (DDT):	Activated Charcoal (priority) Diazepam or Lorazepam (for seizure) Phenobarbital Cholestryamine resin	
Organophosphates:	Atropine sulfate or Glycopyrolate (priority treatment) Furosemide (less critical) Diazepam or Lorazepam (for seizure)	
Carbamates:	Cholestryamine Atropine (priority) Furosemide (less critical) Diazepam (for seizure)	
Pyrethroids:	*Name of Drug*	*Active Ingredient(s)*
	Promethazine	Promethazine Hydrocloride
	Panadol	Paracetamol
	Diazepam	Benzodiazapine/Diazapam
	Lorazepam	Lorazepam
	Calamine cream	Calamine, zinc oxide, glycerol, phenol, purified water, sodium citrate, betonite,
	Vit E	Tocopherol, fragrance, mineral oil, deionized water, sodium hydroxide, stearic acid
	Hydrocortisone cream	1% hydrocortisone
	Salbutamol	Salbutamol 100 mcg, suspended inert aerosol
	Salbutamol tablets	Salbutamol sulphate 4 mg
	Activated Charcoal	Activated Charcoal

All the 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, eye or dermal contact with the chemical. This training will be conducted by the district malaria focal person and will include drills to test knowledge of the operators. However, most interventions will have to be provided by medical professionals at the nearest health clinic.

Warehouse/Storage Risks

In order to mitigate risks associated with pesticide storage, the following key points will serve as key mitigation steps:

- All primary pesticide storage facilities will be double-padlocked and guarded on a 24 hour basis.
- All the storage facilities will be located away from nearby watercourses, domestic wells, markets, schools, hospitals, etc.
- Soap and clean water will be available at all times in all the facilities.
- A trained storekeeper will be hired to manage each facility.
- Recommended pesticide stacking position and height in the warehouse as provided in the FAO Storage and Stock Control Manual will be followed.
- All the warehouses will have at least two exit access routes in case of fire outbreak.
- A fire extinguisher will be available in the storage facilities and all workers will be trained on how to use this device.
- Warning notices will be placed outside of the store with skull and crossbones and the local language (Ndebele and Shona).
- All pesticides waiting to be used and any remnants will be stored under lock and key until the next rounds of spraying.

Solid and Liquid Contaminated Wastes

Mitigation measures are described in the solid waste management section and in the EMMP in Annex A.

7.6 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. Ethiopia does not currently have a certified laboratory to do quality assurance tests. It is assumed that all pesticides procured from reputable manufactures are of good quality and testing in country is not required. Pesticides that are manufactured at the Adami Tulu plant are sent to a certified laboratory in Belgium for quality testing.

7.7 CONCLUSION

Table 12 below is a decision criteria matrix showing that if all the factors are considered in combination i.e. (diseases management effect, environmental effect, health risk and cost effectiveness etc.), pyrethroids are the most cost effective, have beneficiary and government preference, and are considered less detrimental to human health and the environment, though studies show an increase in mosquito resistance. OPs have the disadvantage of higher human health risk and higher cost, with lower beneficiary preference, and will probably require urine or blood biomonitoring. At the same time, it is important to note that all three pesticide classes, when used with all the compliance and mitigation measures, have acceptable risk to human health and the environment and therefore are considered part of the proposed action.

TABLE 12. DECISION CRITERIA MATRIX

Criteria	Pesticide Choice	Susceptibility	Socio-economic Impact	Cost	Country Preferences	Human and ecological impacts	Total
IRS in Ethiopia							
	Pyrethroids	--	+++	+++	+++	-	7
	Carbamates	+++	+++	++	++	-	9
	Organo Phosphates	+++	+++	+	+	--	6
No Action		0	---	--	---	0	-8

Key/Legend

0= net zero effect
-=net negative effect
--=moderate negative effect
---=significant negative effect
+=positive effect
++=moderate positive effect
+++=significant positive effect

8. EMMP IMPLEMENTATION

The District Environmental Health Officers, with the support from the PMI IRS implementing partner, FMOH and ORHB, will be responsible for implementation of the EMMP. The staff in charge of implementation of EMMP will be trained to ensure effectiveness of the mitigation measures during spray operation. The District Environmental Health Officers will monitor environmental compliance during the IRS campaign.

The PMI IRS implementing partner will work closely with District Environmental Health Officers throughout the spray campaign. The PMI IRS implementing partner's Environmental Compliance Officer will conduct environmental compliance inspections during pre-spray activities, during mid-spray operations and at the completion of the spray campaign. These inspections will endeavor to ensure that all the mitigation measures in the EMMP are being implemented and propose measures for improvement for the next IRS campaign. These compliance inspections achieve the following objectives:

- Create a baseline of current compliance activities for the purpose of evaluating improvement in future IRS programs.
- Observe IRS activities in progress to determine and document whether the intervention is in full compliance with USAID requirements as included in the approved SEA.
- Determine, in consultation with EPA officials, the training and support required to improve and ensure future compliance with the SEA.
- Ensure adherence to relevant international rules and regulations, including USA regulations.
- Ensure accurate record keeping and daily collection of empty sachets.
- Ensure that progressive rinsing methods are used in all spray sites and ensure that leftover insecticide solution is re-used for spraying the next day to prevent environmental contamination.
- Ensure that SOPs, washers, team leaders and supervisors are knowledgeable of the correct way to handle and apply insecticides.
- Ensure that all persons in potential contact with pesticides use PPE at all times.

In addition, PMI has annually-programed funds to conduct an independent environment compliance audit to ensure that all the mitigation measures are implemented during the spray campaign.

9. PUBLIC CONSULTATIONS

During the preparation of this SEA, consultations with the various implementing governmental agencies including the FMOH, ORMB, EPA and the MARD, the USAID Mission PMI staff, and also with District Health Workers in the field (MFP, District Health Office Head, and Environmental Health Officer) were undertaken to ensure the information provided in this document was accurate and met the needs of the malaria control program. The SEA also sets out to meet the needs of the Ethiopian EPA and their Environmental Impact Assessment requirements based on the Environmental Assessment Guidelines.

Door-to-door communication is the main strategy used for community outreach. District MFPs work in close contact with the Social Behavior Change Communication (SBCC) team leaders to inform the population about the spraying schedule. PMI IRS implementing partner develops, prints, and distributes household IRS cards as well as IRS fliers and brochures with key IRS messages. The HEWs carry out Information, Education, and Communication (IEC) activities for targeted communities and households to remind beneficiaries about the positive benefits of IRS in controlling and preventing malaria and malaria-related deaths, and to remind them of their roles and behaviors before, during, and after spray operations. House-to-house mobilization is conducted during the first cycle of each IRS campaign.

Overall, all stakeholders are actively involved in the management and implementation of the IRS program, and the program is well received in the field. FMOH determines what insecticides to be used, selecting from the WHO approved pesticides list, and ORMB and DHOs determine geographic coverage where there is high burden of malaria.

PMI Ethiopia will distribute a draft version of the SEA to the malaria control partners in Ethiopia for review.

ANNEX A: ENVIRONMENTAL MITIGATION AND MONITORING PLAN

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
Driver and/or community exposure, or environmental contamination due to improper transport of pesticide	• Driver training according to FAO recommendations • Provision of appropriate equipment (reliable vehicle with side walls capable of negotiating rugged roads, tie-downs, packing materials, tarps, spill clean-up kit) • Cautious driving while transporting chemicals • Checking for and repairing leaks from spray equipment prior to transport • In case of accident, completion of accident and corrective action report	Once prior to campaign, reinforcement as needed Continuous	Observation Environmental Compliance Checklists Accident reports	• Procedures being followed • Demonstrated knowledge • Existence of training materials • Absence of vehicle accidents • Vehicle condition • Absence of spills during insecticide transport	Drivers, PMI IRS implementing partners, Pesticide distributors, spray team leaders
Environmental contamination due to improper siting or construction of storage and wash facilities	• Use site qualification checklist. Locate storage and wash facilities on high ground, above floodplains, away from sensitive receptors (water bodies, birds, bees, fish, children, etc.). Provide berms around pesticide storage if necessary. • Use appropriate construction materials as specified in FAO recommendations	Once prior to campaign	Observation Environmental Compliance Checklist	• Storage and wash facilities outside of floodplain and away from sensitive receptors (birds, bees, fish, children, etc.) • Constructed of suitable material • Adequately ventilated • Adequate storage space	District Environmental Officers, PMI IRS implementing partner

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
Storekeeper and/or community exposure or environmental contamination due to improper storage or pilferage Storekeeper and/or community exposure or environmental contamination due to improper storage or pilferage	• Provision of secure storage facilities • Training of storekeepers, team leaders and supervisors according to FAO recommendations • Daily tracking of insecticide sachets issued, used, and returned • Storage procedures according to PMI BMPs • Storekeepers trained to not issue pesticides for agricultural or any other unauthorized use	Once prior to campaign Continuous Continuous	Observation Environmental compliance checklists Chain of custody records for insecticides	• Dedicated and trained storekeeper who demonstrates knowledge and uses correct procedures • Stock records up-to-date • Stocks orderly, rotation system in place • Expiration dates observed • Empty sachets collected, counted and reconciled with amounts issued • Ratio of structures sprayed to sachets issued • Storehouse temperature measured and recorded • No leaks or spills evident • Insecticides not stored in same room with food, or medicine, or in inhabited spaces • Facility physically secure, padlocked and guarded when not in use • No fire, flame, smoking or eating allowed in storage areas	Storekeeper, spray team supervisors, spray team leaders, PMI IRS implementing partners
Personnel handling OPs or carbamates experience cholinesterase inhibition (CI) due to exposure. (Symptoms include tiredness, weakness, dizziness, nausea and blurred	• For all pesticides, all storage, spray, and wash (SSW) personnel receive training in recognizing effects of pesticide poisoning, remain alert to symptoms amongst their co-workers and respond appropriately.	Training: Included in pre-campaign orientation, and in training for new	Discussions with Spray team Visits to health faciltiies	• Demonstrated knowledge of symptoms of poisoning, emergency treatment, and referral protocol by supervisors, team leaders, SSW personnel	FMOH, District Malaria Focal Person PMI IRS implementing partners

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
vision, headache, sweating, tearing, drooling, vomiting, tunnel vision, and twitching, abdominal cramps, muscular tremors, staggering gait)	• PMI will evaluate various approaches to monitoring sprayer exposure to OP pesticides and will develop protocols, based on these evaluations, for a biomonitoring program.	personnel. PMI will use the protocols developed to inform the implementation of PMI program monitoring for OP pesticides.	Environmental compliance checklist	• Antidotes available at health facilities	
Acute effects of pesticide toxicity go untreated (Symptoms include tiredness, weakness, dizziness, nausea, blurred vision, headache, sweating, tearing, drooling, vomiting, tunnel vision, twitching, abdominal cramps, muscular tremors, staggering gait)	• Employ CI testing as needed • Team leaders, storekeepers trained to recognize symptoms and enforce treatment protocols. (e.g., medical referral) • Ensure treatment medicines are available at District health centers. • 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, or if symptoms persist, contact program staff or go to nearest health facility.	Training on symptoms and responses prior to each campaign Continuous observation, reinforcement and enforcement of treatment protocols	Discussions with Spray team Visits to health faciltiies Environmental compliance checklist Biomonitoring	• Demonstrated knowledge of signs and symptoms of poisoning, emergency treatment, and referral protocol by SSW personnel, and residents • CI test results • Antidotes and treatment medicines available at health facilities	Spray team supervisors, spray team leaders. District health officials, and PMI IRS implementing partners
Exposure of SSW personnel and/or community during spray operations due to improper spray procedures Failure to realize/receive the benefits of IRS due to improper spray procedures	• Training of SSW personnel and health workers according to MOH and WHOPES recommendations • Proper assembly and calibration of spray equipment • Proper spray patterns • Proper cleanup and equipment storage	Once prior to campaign	Observation Environmental Compliance Checklist	• SSW personnel and health workers display knowledge by following procedures at all times • Frequently agitate spray can • Hold pump such that	Spray team supervisors, spray team leaders, PMI IRS implementing partners

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
	procedures • Discipline SSW personnel who do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)	Continuous		compression gage can be seen • Stands parallel to wall being sprayed • Stands 45 cm from wall • 1m/2.5 sec spray rate • 75 cm swatch width and 5 cm overlap • All eaves and interior surfaces sprayed except dedicated kitchens	
SSW member or community exposure, or environmental contamination due to equipment or PPE issues	• Use of sprayers manufactured and maintained according to WHOPES specifications • Proper assembly and calibration of spray equipment • Procurement and proper use of PPE by all persons in contact with pesticides	Continuous	Observation Environmental Compliance Checklists Biomonitoring	• All PPE as specified in WHOPES recommendations in good condition and worn by all personnel in contact with pesticides • Condition of spray equipment • Spray nozzle not dripping during spraying or transportation • CI levels	Spray team supervisors, spray team leaders, PMI IRS implementing partners
• Residential Exposure from contaminated household goods	• Training of spray operators to refuse to spray houses that are not properly prepared • IEC Campaign, instruct residents to: • 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	Training and communication program prior to campaign, Spray operators require household goods removal prior to	HEW interview with households Observation Environmental Compliance Checklists	• IEC materials developed and include specific instructions • IEC materials delivered in appropriate fashion • Residents outside house during spraying • Food and goods outside house during spraying	District Health Office, NEMA, EPA, PMI IRS implementing partners, USAID

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
	the room and cover with drop cloth • Stay outside the home during spraying and for two to four hours after spraying • Move and keep (tie-up or cage) all animals outside the home during spraying, and for four hours after spraying • Sweep up any insects killed from the spraying or any residual insecticide and drop waste in latrine pits	spraying domicile		• Furniture covered during spraying • Residents stay outside for four hours after spraying • Residents sweep floor and dispose of waste properly • Occurrence of skin/eye/throat irritation • Houses not sprayed for lack of preparation	
• Failure to realize benefits of spraying due to post-spray behavior change	• Train residents to continue using bed nets for protection against malaria, and to refrain from re-plastering or painting over the sprayed walls after spraying, re-plaster prior to spraying if necessary	Prior to each campaign	HEW observations	• Continued bed net use • Walls not plastered after spraying	Village and district leaders
• Staff and community exposure in vehicle used to transport spray team and/or pesticides	• Frequent washing interior and exterior of program vehicles after pesticide transport using soap and water and PPE	Continuous	Environmental Compliance Checklist	• Vehicle condition	Spray team supervisors, spray team leaders, PMI IRS implementing partners
• SSW personnel exposure due to poor personal hygiene	• Training and enforcement in good personal hygiene, daily washing of protective clothes and cleaning of equipment • Prohibition of eating, drinking and smoking during travel, work or before decontamination • Discipline SSW personnel that do not follow proper procedures in all aspects of operations (handling, spraying, hygiene, cleanup)	Training once prior to campaign, continuous reinforcement and enforcement of good personal hygiene	Environmental Compliance Checklists	• Two uniforms and PPE issued to each spray operator and one set cleaned each day • No eating, drinking or smoking witnessed during operations or prior to washing • Adequate numbers of shower/bathing facilities available • Shower or bath taken,	Spray team supervisors, spray team leaders, PMI IRS implementing partners

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
				face/neck and hands washed with soap and water.	
• SSW personnel and/or community exposure due to poor waste management procedures	• Procurement of barrels for progressive rinse, and wash-tubs for personal hygiene; close supervision of triple rinse and wash procedures: equipment labeled as District Health Office property to deter sale and domestic use in event of pilferage • Collection, counting, and comparing number of empty sachets to disbursement records, collection of worn/torn gloves and masks • Shipment of all wastes to authorized incinerator, destruction witnessed by PMI IRS implementing partner and Ministry of Health official	Once prior to campaign Continuous	Review of records	• Purchase records, inspection reports, waste disposal records from incinerator	District health officials, PMI IRS implementing partners
• Exposure of residents needing physical assistance during spray operations	• Communities establish system to assist the elderly and disabled in removing self and goods from the household. • Spray operators enforce removal of household goods	Train operators once prior to campaign Continuous enforcement	Observation Discussion with Communities/ HEW	• IEC campaign adequately addresses issues surrounding the elderly and disabled	District, County, Parish, and Village leaders
• Fetal/Infant Exposure due to maternal exposure on spray team • Fetal Exposure – Pregnant women in contact with pesticides • Note: Ethiopian law prohibits women from spraying pesticide.	• Training of SSW teams. • Pregnancy tests as eligibility criteria for SSW teams; • Prohibition of breastfeeding women on SSW teams; • Education of women regarding risks of exposure • Completion of consent forms	Once prior to campaign, during campaign as necessary	Review of records	• Pregnancy test results • Written confirmation from all female SSW workers that they are not breastfeeding • Signed consent forms from all female SSW workers • Number of females	Spray team supervisors, spray team leaders, District heath officials, PMI IRS implementing partners

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
	• Assign pregnant women to tasks that have no occupational exposure to insecticides.			reassigned	
• Exposure of aged, infirm, pregnant women or fetus, due to inability to leave the home during spraying	• Prohibition of spraying in homes where seriously infirm or immobile persons, or pregnant women are living who cannot move outside the home and stay outside the home during, and 4 hours after spraying	Continuous	Observation Environmental Compliance Checklists	• Residents outside house during spraying • Residents stay outside for four hours after spraying Number of houses not sprayed due to resident immobility	Spray team leaders and supervisors, residents, spray personnel
• Pesticide contamination of water resources, (groundwater, rivers, streams, lakes)	• Do not store pesticides within 100 meters of water resources. Do not spray any residences or establish triple rinse/wash facilities within 30 meters of water resources (other interventions should be implemented such as LLINs or wall lining) • Do not dispose of any pesticides anywhere other than IRS triple rinse wash system	Continuous	Discussion with Communities/ HEW	• Evidence/absence of environmental contamination (fish, bird, or bee kills), discoloration or turbidity of water	Spray team leaders, supervisors, district environmental officers, PMI IRS implementing partner's ECO
• Loss of biodiversity due to pesticide contamination	• Do not store pesticide within 100 m, nor spray or wash within 30 m sensitive areas or critical habitat (sensitive areas and critical habitats must be identified before activities commence)	Continuous	Health facility reports	• Individual organism fatalities or impairment	Spray team leaders, supervisors, district environmental officers, PMI IRS implementing partner's ECO

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
• Farm, aquaculture or apiary contamination	• Train farmers, fish farmers and beekeepers in target areas to guard against contamination of agri/aquaculture or apiary equipment, and to ensure sweeping and disposal of floor residue and dead after IRS in pit latrines prior to storing equipment in home. • Train SSW workers on the dangers of pesticides to food, fish, birds, and bees	Once prior to campaign	HEW interviews with community	• Number of post-spraying complaints from agri-aquaculture or apiary practitioners in target area • Reports of fish or bee kills	Spray team leaders and supervisors, spray personnel, PMI IRS implementing partners
• Spray operations have no/reduced impact on vector due to pesticide quality	• Collect insecticide samples and test to ensure quality control • Supervise and monitor pesticide make-up procedures	Periodic spot sampling Continuous monitoring by spray team leaders and supervisors	Chain of custody reporting	• Pesticide meets specifications • Spray operator usage reports reflect proper house/sachet ratio	PMI IRS implementing partners, team leaders and supervisors
• Loss of efficacy of pesticides due to continuous or inappropriate use	• Use pesticide rotation or mosaicing protocol to minimize development of resistance to insecticides. Avoid agricultural use of health-based pesticides.	Continuously re-assess pesticide to be used based on entomological monitoring	Supervision Entomological study Community complaints/HEW	• Protocol developed	PMI IRS implementing partners.
• Vector develops resistance to insecticide used	• Change pesticide used	Monitoring resistance before, during, and after each campaign.	Entomological Study	• Monitoring results presented in end-of-round report	PMI IRS implementing partners
• SSW worker or community exposure,	• Take disciplinary action against SSW workers that do not follow proper	Continuous monitoring	Supervision Observation	• Good hiring and management practices	Spray team supervisors, spray team leaders, PMI IRS

Potential Negative Impact	Mitigation Activities	Monitoring Frequency	Monitoring Method	Monitoring Indicators	Implementation Responsibility
or environmental contamination due to negligence	procedure in all aspects of operations (handling, spraying, hygiene, cleanup) up to and including discharge from duties	throughout campaign, immediate action upon discovery of non-conformance with procedures	Reports	• Adequate supervisor to team leader to spray operator ratio • Number and severity of incidents reported	implementing partners, District Officials
• Community exposure, or environmental contamination post-campaign due to inadequate de-mobilization	• Pesticide storage areas, spray equipment, overalls, PPE, wash equipment, etc. are cleaned with soap and water at end of campaign and are securely stored • Transfer any unused pesticide to district secured warehouse for disposal if expired, or use in subsequent spray round(s).	Once at end of campaign	End of spray Environmental Compliance Checklists	• Presence of adequate facilities for end of campaign cleaning and storage • Visual observance of proper de-mobilization • All equipment cleaned and properly stored	District health teams, PMI IRS implementing partners
• Community exposure due to residuals in vehicles used for pesticide transport	• End-of-program cleaning/decontamination of interior and exterior of vehicles	Once after campaign	End of spray checklist	• Interiors and exteriors of vehicles cleaned	Drivers/Rental company

USAID/Ethiopia PMI IRS

Environmental Mitigation and Monitoring Plan

Annual Reporting Form and Certification

Implementing Organization:

Geographic location of USAID-funded activities:

Period covered by this Reporting Form and Certification:

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
Driver and/or community exposure, or environmental contamination due to improper transport of pesticide	• Driver training according to FAO recommendations • Provision of appropriate equipment (reliable vehicle with side walls capable of negotiating rugged roads, tie-downs, packing materials, tarps, spill clean-up kit) • Cautious driving while transporting chemicals • Checking for and repairing leaks from spray equipment prior to transport • In case of accident, completion of accident and corrective action report	•	
Environmental contamination due to improper siting or construction of storage and wash facilities	• Use site qualification checklist. Locate storage and wash facilities on high ground, above floodplains, away from sensitive receptors (water bodies, birds, bees, fish, children, etc.). Provide berms around pesticide storage if necessary. • Use appropriate construction materials	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
	as specified in FAO recommendations		
Storekeeper and/or community exposure or environmental contamination due to improper storage or pilferage Storekeeper and/or community exposure or environmental contamination due to improper storage or pilferage	• Provision of secure storage facilities • Training of storekeepers, team leaders and supervisors according to FAO recommendations • Daily tracking of insecticide sachets issued, used, and returned • Storage procedures according to PMI BMPs • Storekeepers trained to not issue pesticides for agricultural or any other unauthorized use	•	
Personnel handling OPs or carbamates experience cholinesterase inhibition (CI) due to exposure. (Symptoms include tiredness, weakness, dizziness, nausea and blurred vision, headache, sweating, tearing, drooling, vomiting, tunnel vision, and twitching, abdominal cramps, muscular tremors, staggering gait)	• For all pesticides, all storage, spray, and wash (SSW) personnel receive training in recognizing effects of pesticide poisoning, remain alert to symptoms amongst their co-workers and respond appropriately. • PMI will evaluate various approaches to monitoring sprayer exposure to OP pesticides and will develop protocols, based on these evaluations, for a monitoring program.	•	
Acute effects of pesticide toxicity go untreated (Symptoms include tiredness, weakness,	• Employ CI testing as needed • Team leaders, storekeepers trained to recognize symptoms and enforce treatment protocols. (e.g., medical	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
dizziness, nausea, blurred vision, headache, sweating, tearing, drooling, vomiting, tunnel vision, twitching, abdominal cramps, muscular tremors, staggering gait)	referral) • Ensure treatment medicines are available at District health centers. • 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, or if symptoms persist, contact program staff or go to nearest health facility.		
Exposure of SSW personnel and/or community during spray operations due to improper spray procedures Failure to realize/receive the benefits of IRS due to improper spray procedures	• Training of SSW personnel and health workers according to MOH and WHOPES recommendations • Proper assembly and calibration of spray equipment • Proper spray patterns • Proper cleanup and equipment storage procedures • Discipline SSW personnel who do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)	•	
SSW member or community exposure, or environmental contamination due to equipment or PPE issues	• Use of sprayers manufactured and maintained according to WHOPES specifications • Proper assembly and calibration of spray equipment • Procurement and proper use of PPE by all persons in contact with pesticides	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
• Residential Exposure from contaminated household goods	• Training of spray operators to refuse to spray houses that are not properly prepared • IEC Campaign, instruct residents to: • 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 cover with drop cloth • Stay outside the home during spraying and for two to four hours after spraying • Move and keep (tie-up or cage) all animals outside the home during spraying, and for four hours after spraying • Sweep up any insects killed from the spraying or any residual insecticide and drop waste in latrine pits	•	
• Failure to realize benefits of spraying due to post-spray behavior change	• Train residents to continue using bed nets for protection against malaria, and to refrain from re-plastering or painting over the sprayed walls after spraying, re-plaster prior to spraying if necessary	•	
• Staff and community exposure in vehicle used to transport spray team and/or pesticides	• Frequent washing interior and exterior of program vehicles after pesticide transport using soap and water and PPE	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
• SSW personnel exposure due to poor personal hygiene	• Training and enforcement in good personal hygiene, daily washing of protective clothes and cleaning of equipment • Prohibition of eating, drinking and smoking during travel, work or before decontamination • Discipline SSW personnel that do not follow proper procedures in all aspects of operations (handling, spraying, hygiene, cleanup)	•	
• SSW personnel and/or community exposure due to poor waste management procedures	• Procurement of barrels for progressive rinse, and wash-tubs for personal hygiene; close supervision of triple rinse and wash procedures: equipment labeled as District Health Office property to deter sale and domestic use in event of pilferage • Collection, counting, and comparing number of empty sachets to disbursement records, collection of worn/torn gloves and masks • Shipment of all wastes to authorized incinerator, destruction witnessed by PMI IRS implementing partner and Ministry of Health official	•	
• Exposure of residents needing physical assistance during spray operations	• Communities establish system to assist the elderly and disabled in removing self and goods from the household. • Spray operators enforce removal of household goods	•	
• Fetal/Infant Exposure due to maternal	• Training of SSW teams. • Pregnancy tests as eligibility criteria for	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
exposure on spray team • Fetal Exposure – Pregnant women in contact with pesticides • Note: Ethiopian law prohibits women from spraying pesticide.	SSW teams; • Prohibition of breastfeeding women on SSW teams; • Education of women regarding risks of exposure • Completion of consent forms • Assign pregnant women to tasks that have no occupational exposure to insecticides.		
• Exposure of aged, infirm, pregnant women or fetus, due to inability to leave the home during spraying	• Prohibition of spraying in homes where seriously infirm or immobile persons, or pregnant women are living who cannot move outside the home and stay outside the home during, and 4 hours after spraying	•	
• Pesticide contamination of water resources, (groundwater, rivers, streams, lakes)	• Do not store pesticides within 100 meters of water resources. Do not spray any residences or establish triple rinse/wash facilities within 30 meters of water resources (other interventions should be implemented such as LLINs or wall lining) • Do not dispose of any pesticides anywhere other than IRS triple rinse wash system	•	
• Loss of biodiversity due to pesticide contamination	• Do not store pesticide within 100 m, nor spray or wash within 30 m sensitive areas or critical habitat (sensitive areas and critical habitats must be identified before activities commence)	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
• Farm, aquaculture or apiary contamination	• Train farmers, fish farmers and beekeepers in target areas to guard against contamination of agri/aquaculture or apiary equipment, and to ensure sweeping and disposal of floor residue and dead after IRS in pit latrines prior to storing equipment in home. • Train SSW workers on the dangers of pesticides to food, fish, birds, and bees	•	
• Spray operations have no/reduced impact on vector due to pesticide quality	• Collect insecticide samples and test to ensure quality control • Supervise and monitor pesticide make-up procedures	•	
• Loss of efficacy of pesticides due to continuous or inappropriate use	• Use pesticide rotation or mosaicing protocol to minimize development of resistance to insecticides. Avoid agricultural use of health-based pesticides.	•	
• Vector develops resistance to insecticide used	• Change pesticide used	•	
• SSW worker or community exposure, or environmental contamination due to negligence	• Take disciplinary action against SSW workers that do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup) up to and including discharge from duties	•	

Potential Negative Impact	Mitigation Activities	Status of Mitigation Activity	List any Outstanding Issues related to Mitigation
• Community exposure, or environmental contamination post-campaign due to inadequate de-mobilization	• Pesticide storage areas, spray equipment, overalls, PPE, wash equipment, etc. are cleaned with soap and water at end of campaign and are securely stored • Transfer any unused pesticide to district secured warehouse for disposal if expired, or use in subsequent spray round(s).	•	
• Community exposure due to residuals in vehicles used for pesticide transport	• End-of-program cleaning/decontamination of interior and exterior of vehicles	•	

USAID/Ethiopia PMI IRS
ENVIRONMENTAL MITIGATION AND MONITORING PLAN
REPORTING FORM AND CERTIFICATION

Certification

I certify the completeness and the accuracy of the Environmental Mitigation and Monitoring Plan Reporting Form for activities funded by USAID/Ethiopia as described above and covered by PMI IRS SEA 2013-2017 for which I am responsible:

_____ _____
Signature Date

_____
Print Name

_____
Organization

BELOW THIS LINE FOR USAID USE ONLY

USAID/Ethiopia Mission Clearance of EMMP Reporting Form and Certification:

Agreement Officer's Technical Representative:_____ Date:_____

Mission Environmental Officer:_____ Date: _____

ANNEX B: GENERAL PRINCIPLES IN THE MANAGEMENT OF ACUTE POISONING

Skin Decontamination

Decontamination must proceed concurrently with whatever resuscitative and antidotal measures are necessary to preserve life. Shower patient with soap and water, and shampoo hair to remove chemicals from skin and hair. If there are any indications of weakness, ataxia, or other neurologic impairment, remove the victim's clothing, have the victim lie down, and give the victim a complete bath and shampoo using copious amounts of soap and water. Check for pesticide sequestered under fingernails or in skin folds and wash these areas.

Flush contaminating chemicals from eyes with copious amounts of clean water for 10-15 minutes. If eye irritation is present after decontamination, ophthalmologic consultation is appropriate.

Persons attending the victim should avoid direct contact with heavily contaminated clothing and vomitus. Contaminated clothing should be promptly removed, bagged, and laundered before returning to the patient. Shoes and other leather items cannot usually be decontaminated and should be discarded. Note that pesticides can contaminate the inside surfaces of gloves, boots, and headgear. Decontamination should especially be considered for emergency personnel (such as ambulance drivers) at the site of a spill or contamination. Wear rubber gloves while washing pesticide from skin and hair of patient. Latex and other surgical or precautionary gloves usually do not provide adequate protection from pesticide contamination.

Airway Protection

Ensure that a clear airway exists. Suction any oral secretions using a large bore suction device if necessary. Intubate the trachea if the patient has respiratory depression or if the patient appears obtunded or otherwise neurologically impaired. Administer oxygen as necessary to maintain adequate tissue oxygenation. In severe poisonings, mechanically supporting pulmonary ventilation for several days may be necessary.

Note on Specific Pesticides: There are several special considerations with regard to certain pesticides. In **OP** and **carbamate** poisoning, adequate tissue oxygenation is essential prior to administering atropine.

Gastrointestinal Decontamination

A joint position statement has recently been released by the American Academy of Clinical Toxicology and the European Association of Poisons Centres and Clinical Toxicologists on various methods of gastrointestinal decontamination. A summary of the position statement accompanies the description of each procedure.

1. **Gastric Lavage.** If the patient presents within 60 minutes of ingestion, lavage may be **considered**. Insert an orogastric tube and follow with fluid, usually normal saline. Aspirate back the fluid in an attempt to remove any toxicant. If the patient is neurologically impaired, airway protection with a cuffed endotracheal tube is indicated prior to gastric lavage. Lavage performed more than 60 minutes after ingestion has not proven to be beneficial and runs the risk of

inducing bleeding, perforation, or scarring due to additional trauma to already traumatized tissues. It is almost always necessary first to control seizures before attempting gastric lavage or any other method of GI decontamination. Studies of poison recovery have been performed mainly with solid material such as pills. There are no controlled studies of pesticide recovery by these methods. Reported recovery of material at 60 minutes in several studies was 8 percent to 32 percent. There is further evidence that lavage may propel the material into the small bowel, thus increasing absorption.

Note on Specific Pesticides: Lavage is contraindicated in hydrocarbon ingestion, a common vehicle in many pesticide formulations.

Position Statement: Gastric lavage should not be routinely used in the management of poisons. Lavage is indicated only when a patient has ingested a potentially life-threatening amount of poison and the procedure can be done within 60 minutes of ingestion. Even then, clinical benefit has not been confirmed in controlled studies.

2. **Activated Charcoal Adsorption**. Activated charcoal is an effective absorbent for many poisonings. Volunteer studies suggest that it will reduce the amount of poison absorbed if given within 60 minutes. There are insufficient data to support or exclude its use if time from ingestion is prolonged, although some poisons that are less soluble may be absorbed beyond 60 minutes. Clinical trials with charcoal have been done with poisons other than pesticides. There is some evidence that paraquat is well absorbed by activated charcoal. Charcoal has been anecdotally successful with other pesticides.

DOSAGE OF ACTIVATED CHARCOAL:

- Adults and children over 12 years: 25-100 g in 300-800 mL water.
- Children under 12 years: 25-50 g per dose.
- Infants and toddlers under 20 kg: 1 g per kg body weight.

Many activated charcoal formulations come premixed with sorbitol. Avoid giving more than one dose of sorbitol as a cathartic in infants and children due to the risk of rapid shifts of intravascular fluid. Encourage the victim to swallow the adsorbent even though spontaneous vomiting continues. Antiemetic therapy may help control vomiting in adults or older children. As an alternative, activated charcoal may be administered through an orogastric tube or diluted with water and administered slowly through a nasogastric tube. Repeated administration of charcoal or other absorbent every 2-4 hours may be beneficial in both children and adults, but use of a cathartic such as sorbitol should be avoided after the first dose. Repeated doses of activated charcoal should not be administered if the gut is atonic. The use of charcoal without airway protection is contraindicated in the neurologically impaired patient.

Note on Specific Pesticides: The use of charcoal without airway protection should be used with caution in poisons such as OPs, carbamates, and organochlorines if they are prepared in a hydrocarbon solution.

Position Statement: Single-dose activated charcoal should not be used routinely in the management of poisoned patients. Charcoal appears to be most effective within 60 minutes of ingestion and may be considered for use for this time period. Although it may be considered 60 minutes after ingestion, there is insufficient evidence to support or deny its use for this time period. Despite improved binding of poisons within 60 minutes, only one study suggests that there is improved clinical outcome. Activated charcoal is contraindicated in an unprotected airway, a GI tract not anatomically intact, and when charcoal therapy may increase the risk of **aspiration** of a hydrocarbon-based pesticide.

Seizures: Lorazepam is increasingly being recognized as the drug of choice for status epilepticus, although there are few reports of its use with certain pesticides. Emergency personnel must be prepared to assist ventilation with lorazepam and any other medication used to control seizures. See dosage table below. For organochlorine compounds, use of lorazepam has not been reported in the literature. Diazepam is often used for this, and is still used in other pesticide poisonings.

DOSAGE OF DIAZEPAM:

- *Adults*: 5-10 mg IV and repeat every 5-10 minutes to maximum of 30 mg.
- *Children*: 0.2 to 0.5 mg/kg every 5 minutes to maximum of 10 mg in children over 5 years, and maximum of 5 mg in children under 5 years.

DOSAGE OF LORAZEPAM:

- Adults: 2-4 mg/dose given IV over 2-5 minutes. Repeat if necessary to a maximum of 8 mg in a 12 hour period.
- Adolescents: Same as adult dose, except maximum dose is 4 mg.
- Children under 12 years: 0.05-0.10 mg/kg IV over 2-5 minutes. Repeat if necessary .05 mg/kg 10-15 minutes after first dose, with a maximum dose of 4 mg.

Caution: Be prepared to assist pulmonary ventilation mechanically if respiration is depressed, to intubate the trachea if laryngospasm occurs, and to counteract hypotensive reactions.

Phenobarbital is an additional treatment option for seizure control. Dosage for **infants, children, and adults** is 15-20 mg/kg as an IV loading dose. An additional 5 mg/kg IV may be given every 15-30 minutes to a maximum of 30 mg/kg. The drug should be pushed no faster than 1 mg/kg/minute.

For seizure management, most patients respond well to usual management consisting of benzodiazepines, or phenytoin and phenobarbital.

ANNEX C: SUMMARY OF ACUTE EXPOSURE SYMPTOMS AND TREATMENT OF WHO PESTICIDES

Summary of Acute Exposure Symptoms and Treatment of WHO-recommended Carbamates

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-phosphates	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 in the blood and brain. 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). 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 approved for residual house spraying, and has a relatively low margin of safety. Absorbed through the gastrointestinal tract as well as through intact skin and by inhalation. It is also a cholinesterase inhibitor.	Dermal exposure to fenitrothion should be treated by removing contaminated clothing, rinsing the skin with water, washing the exposed areas with soap and water, then seeking medical attention. If fenitrothion gets into the eyes, they should be rinsed with water for several minutes. Contact lenses should be removed if possible and medical attention should be sought. Ingestion of fenitrothion should be treated by rinsing the mouth and inducing vomiting if the person is conscious. Inhalation exposures require removal to fresh air and rest in a half-upright position. Artificial respiration should be administered if indicated and medical attention should be sought.

Organo-phosphates	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. The affected person should stop work immediately, remove any contaminated clothing, wash the affected skin with soap and clean water and flush the skin with large quantities of clean water. Care must be taken not to contaminate others, including medical or paramedical workers. Automatic injectors loaded with atropine sulfate and obidoxime chloride can be made available in the field whenever relatively toxic OP insecticides are used in areas without easy access to medical care. Atropine sulfate. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible. Glycopyrolate has been studied as an alternative to atropine and found to have similar outcomes using continuous infusion.

Summary of Acute Exposure Symptoms and Treatment for Pyrethroids

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. No skin inflammation or irritation observed; however can cause a reversible tingling sensation. Incoordination, irritability to sound and touch, tremors, salivation, diarrhea, and vomiting have been caused by high doses.	Depends on the symptoms of the exposed person. Casual exposures require decontamination and supportive care. Wash affected skin areas promptly with soap and warm water. Medical attention should be sought if irritation or paresthesia occurs. Eye exposures should be treated by rinsing with copious amounts of water or saline.
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. 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.
Lambda-Cyhalothrin	Skin exposure leads to transient skin sensations such as periorbital facial tingling and burning. Can irritate the eyes, skin, and upper respiratory tract. Oral exposure can cause neurological effects, including tremors and convulsions. Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis.	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. 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. 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. 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.

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