SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR NATIONWIDE IRS IN BURKINA FASO (2018-2022)

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SEA FOR NATIONWIDE IRS IN BURKINA FASO USING CARBAMATE, ORGANOPHOSPHATE, PYRETHROID, CHLORFENAPYR, CLOTHIANIDIN, AND CLOTHIANIDIN/DELTAMETHRIN COMBINATION

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ACRONYMS

ACT	Artemisinin-based Combination Therapy
AIRS	Africa Indoor Residual Spraying Project
BMP	Best Management Practices
CDC	Centers for Disease Control and Prevention (U.S.)
CFR	Code of Federal Regulations (U.S.)
CILSS	*Comité permanent Inter-État de Lutte Contre la Sécheresse au Sahel*
CSP	*Comité Sahélien des Pesticides* (Sahelian Comity of Pesticides)
COR	Contracting Officer's Representative
DMO	District Medical Officer
ECO	Environmental Compliance Officer
FAO	Food and Agriculture Organization of the United Nations
FY	Fiscal Year
EGECC	Environment Green Economy and Climate Change
EMMP	Environmental Mitigation and Monitoring Plan
GoBF	Government of Burkina Faso
IEC	Information, Education, and Communication
IRS	Indoor Residual Spraying
IRSS	*Institut de Recherche en Science de la Santé* (Institute of Research on Health Sciences)
ITN	Insecticide-treated Net
IVM	Integrated Vector Management
MIS	Malaria Indicator Surveys
MOA	Ministry of Agriculture
MOH	Ministry of Health
MSP	Mobile Soak Pit
NBEA	National Bureau of Environmental Assessment
NMCP	National Malaria Control Program
NOAEL	No Observable Adverse Effect Level
PEA	Programmatic Environmental Assessment
PMI	President's Malaria Initiative
PPE	Personal Protective Equipment

SAPHYTO	*Societé Africaine de Produits Phytosanitaires*
SEA	Supplemental Environmental Assessment
SMC	Seasonal Malaria Chemoprevention
TPM	Technical Project Manager
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WHO PQ	World Health Organization Prequalification Team

EXECUTIVE SUMMARY

This document has been prepared to serve as a Supplemental Environmental Assessment (SEA) for indoor residual spraying (IRS) in Burkina Faso supported by the President's Malaria Initiative (PMI) for the period 2018–2022. This update was prepared in accordance with the provisions of Title 22 of the United States Code of Federal Regulations, Part 216 (22 CFR 216) regarding the use and application of pesticides. As required by the 22 CFR 216, only World Health Organization (WHO) Pre-Qualification Team (PQ)-listed pesticides are acceptable for IRS operations supported by PMI. Previous United Stated Agency for International Development (USAID) environmental documentation for IRS in Burkina Faso authorized the use of WHOPES-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes in the southwest region of Burkina Faso from 2010 to 2015. This SEA proposes to reauthorize the use of the same three classes of insecticides, and to expand the authorization to include the use of clothianidin, clothianidin/deltamethrin combination, and chlorfenapyr insecticides, when listed by WHO PQ. Additionally, the SEA seeks nationwide coverage of authorized PMI-supported IRS, and requests authorization of small-scale, closely supervised hut trials using new IRS insecticides, once the insecticide has been submitted for Phase III PQ evaluation, and country-level required documentation has been submitted and approved.

In 2009, USAID malaria funding supported an IRS pilot in Burkina Faso, but IRS was discontinued there after the 2012 campaign. IRS support will resume under the PMI VectorLink Project in 2018.

Burkina Faso's fiscal year (FY) 2017 Malaria Operational Plan includes a detailed implementation plan for Burkina Faso based on the strategies of PMI and Burkina Faso's National Malaria Control Program (NMCP). It was developed in consultation with the NMCP, and with the participation of national and international partners involved in malaria prevention and control in the country. The activities that PMI is proposing to support fit in well with the country's National Malaria Control Strategy and Plan, and build on investments made by PMI and other partners to improve and expand malaria-related services.

Malaria is a major public health problem in Burkina Faso. Although dramatic progress in malaria control has been made in recent years with the scale-up of malaria prevention and treatment interventions, many residents of Burkina Faso are still at risk of infection.

In Burkina Faso, according to 2016 statistical data of the *Système National d'Information Sanitaire* (National Health Information System), malaria is the main reason for consultation (43.4%), hospitalization (44.6%) and death (21.8%) in health facilities. Pregnant women and children under 5-years of age are the most vulnerable targets.[1]

Changing or rotating insecticides of different classes over time is a leading way to manage vector resistance. In Burkina Faso, entomological monitoring has demonstrated that local mosquitoes have developed resistance to the pyrethroid, carbamate, and organochlorine (DDT) classes of insecticides, but have full susceptibility to the organophosphate pirimiphos-methyl. Resistance-testing for the clothianidin insecticides will be performed prior to field use to confirm effectiveness.

The proposal to include new insecticides is prompted by the need to increase the available options for IRS. Clothianidin, a neonicotinoid, was listed by the WHO PQ in 2017, and is now a WHO-recommended insecticide available for use in IRS, once USAID and country-level documentation and approval processes have

[1] Per Burkina Faso's 2018 NMCP Work Plan.

been completed. Chlorfenapyr, a member of the pyrrole chemical class, and Fludora Fusion (a combination clothianidin/deltamethrin product) are currently being reviewed by WHO for pre-qualification listing; and if authorized for use in Burkina Faso will offer additional options for insecticide rotation.

This SEA for IRS in Burkina Faso outlines the monitoring and mitigation measures that the PMI Implementing Partner (IP) will use to minimize or reduce any adverse impacts of pesticide application. Those measures are found in the Safer Use Action Plan (Section 7), and summarized in the Environmental Mitigation and Monitoring Plan (EMMP), found in Annex A. All PMI IRS operations in Burkina Faso will be performed according to the protocols and procedures found therein. These procedures do not change with the use of different classes of authorized pesticides, with the following exceptions:

1. Because of the potential cumulative effects of organophosphate exposure (e.g., cholinesterase depression), team leaders and senior staff will need increased emphasis and training on their responsibility and ability to constantly monitor the appearance and behavior of their team members and to recognize the symptoms of organophosphate exposure in order to implement response protocols. Biomonitoring is not required for the use of pirimiphos-methyl formulations for IRS at the present time, but increased vigilance is essential.
2. Pirimiphos-methyl formulations are supplied in plastic bottles, which if not controlled carefully may be used inappropriately once emptied of the insecticide formulation. In addition, incineration of the bottles may cause harmful emissions. Because of these potential problems, the following procedures and protocols have been established:
    a. A triple rinse for the plastic bottles has been incorporated during the insecticide loading procedure, whereby the insecticide container is emptied into the spray tank and then three times the bottle is partly filled with clean water, capped, shaken, and emptied into the spray tank. This ensures that the insecticide is used more efficiently, and that the container is thoroughly rinsed of pesticide and therefore safe for handling and subsequent processing. The risk of exposure due to insecticide residue in the container is essentially eliminated; however, the following procedures are also followed:
        i. Containers are punctured multiple times so no one can reuse them.
        ii. Recycling programs have been established to turn the plastic into usable products. As long as a suitable recycling program is available, through close supervision and chain of custody, and in partnership with the Burkina Faso NMCP, the IP will ensure that the plastic remains segregated from other materials, and is recycled appropriately.

The PMI IP will implement the EMMP in Annex A, with guidance from PMI and the NMCP and with the assistance and involvement of the local communities. All senior staff in charge of implementation of IRS will be trained to monitor operations when in the field, in order to maximize supervisory oversight and ensure the effectiveness of the mitigation measures during spray operation. The district coordinators will also monitor environmental compliance during the IRS campaign. The IP will complete the annual Environmental Mitigation and Monitoring Report Form in Annex B and submit it to PMI along with the annual End of Spray Report.

This SEA obviates the need for a letter report in 2018, but normally a letter report will be submitted annually to the Contracting Officer's Representative (COR) and Bureau Environmental Officer (BEO). It will contain information regarding program changes, entomological resistance monitoring results, and program response to those results. It will also contain the results of the environmental monitoring and state how the program will improve in any areas of deficiency.

The following assessment draws heavily on the Programmatic Environmental Assessment (PEA) for Integrated Vector Management (IVM), updated in 2017, and many other reference documents, as noted throughout this document.

I. Principal Proposals and Clearance

1. The Burkina Faso Supplemental Environmental Assessment (2010), as amended in 2011 (amendment #1), was valid for implementing USAID-supported IRS in selected regions using all WHO-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes for the period 2010–2015.
2. In order to continue with PMI IRS, PMI is seeking approval for a new SEA effective for five years (2018–2022), and for the SEA to be nationwide in scope.
3. It is proposed in this SEA to expand the permissible insecticide options to include clothianidin, in addition to carbamates, pyrethroids, and organophosphates. The SEA also proposes the use of chlorfenapyr and Fludora Fusion (a combination clothianidin/deltamethrin product) when recommended by the WHO PQ Team.
4. It is further proposed to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr and the clothianidin/deltamethrin combination, once the insecticide has been submitted for Phase III PQ evaluation, and once the required country-level documentation has been submitted and/or registration is completed.
5. This SEA contains the condition that spraying will not be performed by PMI IPs within 30 meters of natural water bodies, wetlands or marshes, organic farming areas, beekeeping areas, or core areas within protected forests, parks or habitats.
6. The Safer Use Action Plan in Section 7 provides detailed guidance on the performance of all activities associated with IRS. The attached, updated Environmental Mitigation and Monitoring Plan (Annex A) summarizes the key required mitigation measures, as well as the monitoring and reporting requirements and schedule.
7. The preparation of this SEA renders a Letter Report unnecessary for 2018. In subsequent years, provided there are no changes to the program outside the scope of this SEA, a Letter Report will be submitted to PMI annually that will discuss significant changes in the IRS program for that particular year's spray campaign.
8. This SEA contains an updated Pesticides Procedures section, which together with the Safer Use Action Plan constitute the elements of a Pesticide Evaluation Report and Safer Use Action Plan.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED

2018–2022 SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR PRESIDENT'S MALARIA INITIATIVE- INDOOR RESIDUAL SPRAYING (IRS) FOR MALARIA CONTROL IN BURKINA FASO

The USAID Global Health Bureau has determined that the proposed IRS effort, as described in this SEA, responds to the needs of the community and country with respect to managing malaria in Burkina Faso and also conforms to the requirements established in 22 CFR 216.

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

The proposed actions recommended for approval in this 2018 SEA are:

1. Continue IRS implementation using pyrethroids, carbamates, organophosphates and neonicotinoids, and/or chlorfenapyr and the clothianidin/deltamethrin combination (when PQ-listed), where appropriate, based on criteria such as transmission rate, vector susceptibility, residual effect, appropriate home and wall structure, economic factors, and ecological/human health impacts.
2. This SEA will extend coverage to all geographical areas in Burkina Faso where IRS may be implemented or where PMI may provide national- or regional-level support as decided by the NMCP and PMI for the five-year period from 2018 to 2022.
3. This SEA authorizes small, closely supervised studies or hut trials to study new IRS insecticides such as chlorfenapyr and the clothianidin/deltamethrin combination, once the insecticide has been submitted for Phase III WHO PQ evaluation and country-level required documentation has been submitted.
4. Given the successful record of PMI in implementing IRS in Africa without significant environmental consequences, it is proposed to allow IRS in the buffer zones of environmentally protected areas, using the strict protocols and procedures contained in the PMI best management practices (BMP) manual, and observing all precautions and prescriptions in this SEA. This IRS is intended to protect people in these buffer zones from malaria.

The Safer Use Action Plan (Section 7) and the updated Environmental Mitigation and Monitoring Plan for Burkina Faso (Annex A) provide detailed guidance on the performance of all activities associated with IRS. Through the use of this and other guidance, PMI has maintained an excellent record of success in executing IRS without substantial environmental or human health impact.

CLEARANCE:

USAID/Burkina Faso Mission Representative: _____ Date: 5/7/18
Christian La Petra-Fung

CONCURRENCE:

Dennis W Durbin
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GH/Bureau Environmental Officer: _____ Date: _____
Dennis Durban (Acting)

ADDITIONAL CLEARANCES:

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

USAID/Burkina Faso/Health Office Director: _____ Date: 5/14/18
Bijou Muhura

USAID/Burkina Faso Mission Environmental Officer: _____ Date: 5/14/18
Abdourahmane N'Diaye

2. Background and Purpose

2.1. President's Malaria Initiative

When it was launched in 2005, PMI had the goal of reducing malaria-related mortality by 50% across 15 high-burden countries in sub-Saharan Africa through a rapid scale-up of four proven and highly effective malaria prevention and treatment measures: insecticide-treated nets (ITNs); IRS; accurate diagnosis and prompt treatment with artemisinin-based combination therapies (ACTs); and intermittent preventive treatment (IPT) for pregnant women. With the passage of the Tom Lantos and Henry J. Hyde Global Leadership against HIV/AIDS, Tuberculosis, and Malaria Act in 2008, PMI developed a U.S. Government Malaria Strategy for 2009–2014. In 2015, PMI launched the next six-year strategy, setting forth a bold and ambitious goal with specific objectives. The PMI Strategy for 2015-2020 takes into account the progress over the past decade and the new challenges that have arisen. PMI will assist Burkina Faso to achieve the following targets in populations at risk for malaria by the end of 2020:

- **Reduce malaria death rate by 40% in Burkina Faso from 2015 levels by 2020.**
- **Reduce malaria incidence by 40% in Burkina Faso from 2015 levels by 2020.**

According to the annual national health statistics published by the Directorate for Health Statistics of the Ministry of Health, the situation in 2017 was as follows:

- **There were 11,915,816 cases of malaria (with a reported diagnostic confirmation rate of 91.7%) compared to 8,285,251 cases in 2014 (with 82.4%confirmed cases). There were 4,144 deaths linked to malaria in 2017 compared to 5,379 deaths in 2014.**

Deaths due to malaria among children under 5-years of age had decreased slightly, with 3,135 deaths being reported compared to 4,005 in 2017. Burkina Faso was selected as a PMI focus country in FY 2017.

2.2. History and Scope of Malaria Control Efforts in Burkina Faso

The vision behind the NMCP 2011–2015 strategy was to continue to promote universal access to malaria prevention and treatment interventions by scaling up a package of interventions that would promote positive behavior change, achieve rapid and sustainable high coverage levels, and prevent and treat malaria.

In order to accommodate the Global Fund's work, parts of the 2011–2015 NMCP National Strategic Plan were revised and extended through 2017. A 2016–2020 strategy was validated on October 28, 2016, in line with the long-term vision of eliminating malaria in Burkina Faso by 2030.

Burkina Faso's National Strategy includes IRS, along with ITNs and larval source management, as vector control interventions to prevent malaria.

USAID supported a pilot IRS program in the district of Diébougou from 2010 to 2012, which covered about 35,000 structures and protected about 115,000 people annually,[2] but the Government of Burkina Faso (GoBF) has not been able to secure resources to support IRS other than that pilot. IN 2018, PMI proposes to re-start IRS in Burkina Faso in up to three high-burden districts, using effective long-lasting insecticides (pirimiphos-methyl and clothianidin), in an effort to drive down the burden of malaria.

Burkina Faso's 2016-2020 National Strategic Plan, adopted in October 2016, calls for the reintroduction of IRS in high-transmission regions of the country, which will be in addition to the universal coverage of ITNs. The NMCP objective is to cover 100% of areas that are selected for IRS with long-lasting insecticide, including using newly recommended insecticide formulations to combat the insecticide resistance that is prevalent in Burkina Faso.

The NMCP's strategic approach will continue to fall within the following major areas: prevention through malaria vector control, seasonal malaria chemoprevention (SMC) for children under 5-years of age, intermittent preventive treatment (IPT) for pregnant women, case management including diagnosis, and behavior change communication.

The malaria vector control goals are to protect individuals against infective malaria mosquito bites and reduce the intensity of malaria transmission at the community level. The key interventions in this plan include ITN distribution, IRS, and larval source control including environmental management. Burkina Faso has a robust, in-country entomological capacity to monitor the residual efficacy of IRS, so partners should be able to conduct monthly cone bioassays to monitor the duration of the intervention.

2.2.1. Indoor Residual Spraying

With FY 2018 funds, PMI plans to re-start IRS in up to three high-burden districts in Burkina Faso, as requested by the NMCP. The districts were selected by the NMCP, PMI, and relevant stakeholders after they review health management information system and entomological data. Insecticides were selected based on susceptibility data in alignment with Burkina Faso's insecticide resistance management plan, and taking into account which new WHO-recommended insecticides are on the market; pirimiphos-methyl and clothianidin will be used in 2018.

Implementation will include procurement of insecticide and personal protective equipment (PPE), training, operations, environmental compliance and mitigation, and social behavior change communication and mobilization activities in IRS areas, and overall monitoring.

2.2.2. ITNs

Burkina Faso has benefitted from three mass ITN distribution campaigns in 2010, 2013, and 2016.

The 2010 demographic and health survey showed that 44% of pregnant women and 45% of children under five years of age had slept under an ITN the night prior to the survey. Data from the MIS conducted in 2014 show that 77% of pregnant women and 75% of children under five years of age had slept under an ITN the night prior to the survey—both significant increases from the 2010 demographic and health survey.

Burkina Faso conducted its first nationwide universal-coverage ITN campaign in 2010. Approximately 7.5 million ITNs were distributed, which was about 600,000 less than the projected need. The next universal-coverage campaign was carried out from July through early November 2013. As in the 2010 campaign, multiple donors contributed, including the Global Fund, USAID, and the GoBF. In total, 9,267,584 nets were

[2] Per the PMI MOP, Burkina Faso, 2017.

distributed, covering 95% of all households that had been identified during the pre-campaign census. The reason that the remaining 5% of households were not reached is that they did not come to collect their nets on the designated distribution day. The most recent universal-coverage campaign was carried out in 2016; almost 11 million nets were purchased and distributed, with Global Fund resources covering most of the costs. USAID contributed 400,000 nets to the 2016 campaign. The estimates for the nets needed for the campaign were based on a population estimate of 19 million, but the pre-campaign census estimated the population at 22 million, meaning that universal coverage was not fully achieved.

2.2.3. Major Partners in Malaria Control

The Global Fund was the main contributor to the 2016 ITN mass distribution campaign, procuring more than 10 million nets. The Global Fund grant started on October 1, 2015 and ended on December 31, 2016. The public sector and civil society components of the grant were both awarded to the *Programme D'appui au Développement Sanitaire,* with two secondary recipients, one being the NMCP. Total funding was about $65 million USD. Major areas of intervention include ITNs both for the mass distribution campaigns and for routine distribution; severe malaria case management; pharmaceutical management; and malaria treatment at the community level.

The recent recruitment by the Ministry of Health of 17,000 new community health care workers – two per village – was supported through the Global Fund's health system strengthening grant. The Global Fund's support for community health care workers includes an integrated training package: prevention, diagnostics, and treatment of malaria, pneumonia, and diarrhea. The Global Fund will finance a quarter of the $34 per month stipend for community health care workers, while the GoBF will pay the remaining amount. The Global Fund, through its civil society malaria grant, is also providing nationwide coverage to support 252 community-based organizations promoting sensitization of communities on malaria prevention and treatment through group discussions, theatre, and videos.

UNICEF provides technical support, including hiring consultants, through their country health team. UNICEF provided technical assistance to the NMCP during the creation of the Global Fund malaria concept note, and has also provided limited financial assistance for the routine procurement of ITNs, for SMC, and for campaign implementation.

WHO provides technical assistance in setting standards and norms, and supports studies on vector resistance to insecticides and on therapeutic efficacy. WHO's support also includes limited resources for social behavior change, in particular for the celebration of World Malaria Day, monitoring and evaluation, program management, and operational research. WHO has also provided assistance for the evaluation and the development of the NMCP's 2016–2020 National Strategic Plan, through technical assistance provided by malaria advisors and the recruitment of a consultant for the 2011–2015 malaria program review.

The World Bank is providing financial assistance to the Government of Burkina Faso through a $37 million loan that supports Neglected Tropical Diseases, including malaria. The project started in January 2015 and will end in December 2019. Malaria resources have been focused on SMC interventions in 22 health districts located on the borders with Niger and Mali. Other types of support include financial resources provided for the procurement of ACTs to fill gaps; social behavior change; program management; and technical assistance.

The Malaria Consortium provides support for commodities procurement and the implementation of SMC campaigns; program management; and technical assistance. With funding from UNITAID, the consortium provided financial and technical assistance for the procurement of SMC commodities and campaign implementation in 11 health districts in 2015, with an expansion to 31 health districts in 2016, and a likely reduction of health districts in 2017.

Coopération Italienne, through their malaria training and research program, provides support for monitoring and evaluation, program management, operational research, and technical assistance. The estimated total budget for this three-year project is over $5 million.

Terre des Hommes, a Switzerland-based nongovernmental organization, provides support for SMC, purchase of ACTs, and social behavior change, as part of the integrated case management of child illnesses at health facility levels.

The GoBF provides support through the procurement of sulfadoxine-pyrimethamine for IPT for pregnant women, ACTs, and microscopy tests; malaria case management at the community level; pharmaceutical management; severe malaria case management; social behavior change communication; and program management. However, the government commitment is not easy to track or monitor, with shifting priorities and commitments.

Institut de Recherche en Science de la Santé (IRSS; Institute of Research on Health Sciences): The PMI VectorLink project will collaborate with the IRSS, which will manage entomological monitoring activities.

Table 1: Major Malaria Control Partners [3]

PARTNERS	INTERVENTION AREAS														
	Insecticide-Treated Nets	LAL	Intermittent Preventive Treatment	Seasonal Malaria Chemoprevention	Rapid Diagnostic Test	Goutte épaisse	Artemisinin-based combination therapy	Indoor Residual Spraying	PG	Gestion des achats et des stocks	IEC/CCC	Monitoring & Evaluation M&E	Project Management	Operational Research	Technical Assistance
WHO											X	X	X	X	X
UNICEF	X			X							X		X	X	X
Word Bank				X			X				X	X	X	X	X
Global Fund	X			X	X		X		X	X	X	X	X	X	X
RBM Partnership													X		X
PMI	X		X	X	X		X	X	X	X	X	X	X	X	X
Plan Burkina											X		X		
ALIMA				X							X		X		
Croix Rouge											X				
Terre des hommes				X			X				X		X		
Malaria Consortium				X							X		X		X
Rotary											X				
UNFPA			X												
Centres de recherche														X	X
Coopération Italienne													X	X	X
Panier commun du Programme D'appui au Développement Sanitaire					X		X				X	X	X	X	X
ETAT	X		X		X	X	X	X	X	X	X		X	X	X

[3] Per the NMCP's 2016-2020 National Strategic Plan.

3. Proposed Action and Alternatives

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

3.1. Description of Proposed Action

The preferred action is to implement an IRS program in selected communities, choosing among the pyrethroid, carbamate, organophosphate, and neonicotinoid classes, as well as chlorfenapyr and the clothianidin/deltamethrin combination when PQ-listed, considering current entomological, epidemiological, logistical, environmental, and economic conditions. The pesticide to be used in 2018, pirimiphos-methyl and clothianidin, was determined by a process explained in Pesticide Procedures (Section 6).

3.2. No-Project Alternative

IRS is one of the critical interventions in the control of the spread of malaria. A no-project alternative will result in rising rates of infections, transmissions, mortality, and morbidity, due to the increased prevalence of infected vectors. Therefore, the no-action alternative does not meet the overall goals of Burkina Faso's NMCP, the Global Fund's Technical Strategy, or PMI's Strategy for 2015–2020.

3.3. Alternative IRS Geographical Sites Considered

In IRS implementation, areas considered highly malarious and those areas that fit within the NMCP strategic plan were considered, while lower-risk areas were not considered for IRS as an intervention. Using different criteria for selecting geographical sites would reduce the effectiveness and impact of IRS, decreasing progress towards the goals of the Burkina Faso NMCP and the PMI program.

3.4. Use of Alternative Insecticide(s)

For IRS to be implemented, a pesticide listed by the WHO PQ Team, must be selected for use. The WHO PQ is an international institution that analyzes and recommends pesticides to be used in IRS based on their effectiveness, cost, and toxicity to human health and the environment.

To date, the WHO PQ has recommended the use of pesticides within the following five classes of pesticides: pyrethroids, carbamates, organochlorines, organophosphates, and neonicotinoids. The proposed action for Burkina Faso includes the use for IRS of these approved formulations including clothianidin, and chlorfenapyr or the clothianidin/deltamethrin combination (when recommended by the WHO PQ), with the exception of organochlorines (DDT).

PMI and their IPs will monitor WHO PQ proceedings towards recommendation of new pesticides, but will seek to amend this SEA before there is any decision to use new WHO PQ recommendations, other than chlorfenapyr and the clothianidin/deltamethrin combination.

3.5. ALTERNATIVE TECHNOLOGIES

A full range of known, available technologies are continually considered for use by the stakeholders in malaria prevention and control efforts. It has been determined that IRS plays a significant part in malaria prevention, in concert with other technologies.[4] The specific focus of this PMI project is IRS, and the role that PMI plays in Burkina Faso includes IRS. If other, viable approaches were to arise that would replace or improve upon the role that IRS plays, the NMCP, PMI, and its partners would evaluate them and proceed accordingly.

[4] Per the PMI MOP, Burkina Faso, 2017.

4. AFFECTED ENVIRONMENT

4.1. OVERVIEW OF COUNTRY

Burkina Faso is a landlocked Sahel country located in the center of West Africa, and covers an area of approximately 272,960 km². It is bordered by six countries: Mali to the north; Niger to the east; Benin to the southeast; Togo and Ghana to the south; and Côte d'Ivoire to the southwest. Its capital is Ouagadougou. In 2016, the population of Burkina Faso was estimated, using figures from the 2006 census, to be 19,034,000, with a natural growth rate of 3.1%. Twenty percent of the population lives in urban areas. Women represent 51.8% of the population, and children under 5 years of age represent 18.1%.[5]

In 2016 the pre-campaign ITNs census estimated the population at 22 million (see Section 2.2.2), not the 19 million figure cited above.

Burkina Faso is a francophone country, with French as the official language of government and business.

Geographic and environmental causes play a significant role in contributing to Burkina Faso's issue of food insecurity. As the country is situated in the Sahel region, Burkina Faso experiences some of the most radical climatic variation in the world, ranging from severe flooding to extreme drought. Unpredictable climatic shocks make it very hard for the people to rely on their harvests, either for subsistence or to accumulate wealth through agricultural means. Burkina Faso's climate also renders its crops vulnerable to attacks from locusts, crickets, and other insects, which destroy crops and further inhibit food production. Nonetheless, most of the population depends on agriculture as a source of income and in order to feed themselves – although, due to the vulnerability of agriculture, more and more families are having to look for other sources of non-farm income, and often have to travel outside of their regional zone to find work.

The country is divided under three bio-climatic zones. The Sahelian Zone covers 25% of the area of the northern part of the country, which is subdivided under the Sahelian and sub-Sahelian sectors. In the Sahelian sector, where the rainfall is only of the order of 400 millimeters (16 in), the vegetation is mostly shrubs and wooded grassland or steppe. The sub-Sahelian sector represents the transition zone: it receives an average annual rainfall of 400–600 millimeters (16–24 in). This sector has moist Sudan savanna vegetation in the river valleys, while the western half is largely inhabited by humans. Most of the large trees that were formerly in the northern half of the sector are reported to have vanished due to climate change.

The Sudan Zone receives higher rainfall, in the range of 600-1,000 millimeters (24–39 in), and is subdivided into three sectors: the central plateau sector, the Mouhoun sector, and the Pendjari-Mékrou sector. The three sectors have widely varying vegetation depending on the degree of human occupation, which brings with it agriculture; their natural vegetation is predominantly wooded savanna. The Pendjari-Mékrou sector, with its flood plains and many ephemeral rivers, is less populated by humans, but has the largest population of other mammals in the country: vultures and raptors are also reported.

The Sudano-Guinean Zone, in the southwest corner of the country, is humid, with an annual rainfall in the range of 1,000–1,200 millimeters (39–47 in). It is heavily wooded, with wooded savannas and gallery forests; it has the ambiance of a park, with its forests of *Khaya senegalensis, Daniellia oliveri* and *Isoberlin,* though tall grasses

[5] Per the PMI MOP, Burkina Faso, 2017.

and savanna vegetation also feature prominently. It has a small human population, but the second largest population of wildlife in the country.

4.2. Administrative and Political Units

Formerly called the Republic of Upper Volta, the country was renamed Burkina Faso on August 4, 1984 by then-President Thomas Sankara.

Since June 1991, Burkina Faso has had a constitution that enshrines multiparty politics and the separation of powers. The country is trying to promote the rule of law and the principles of good governance. The national territory is divided into 13 regions, 45 provinces (see Figure 2), and 351 municipalities, including 49 urban *communes,* and 8,895 villages.[6] The national health system is structured at three levels:

- **The central level, organized around the Minister's Office and the General Secretariat, defines the orientation of health policy and ensures the coordination of its implementation.**
- **The intermediate level includes 13 *Directions Régionales de la Santé* (Regional Health Directorates), whose mission is to implement the national health policy at the regional level.**
- **The peripheral level is represented by 70 *Districts Sanitaires* (Health Districts), which is the operational entity of the national health system, responsible for planning and implementing health programs.**

[6] Per Burkina Faso's 2016–2020 NMCP National Strategic Plan.

Figure 1: Burkina Faso Provinces

4.3. Physical Environment

Burkina Faso lies mostly between latitudes 9° and 15°N (a small area is north of 15°N), and longitudes 6°W and 3°E.

It is made up of two major types of countryside. The larger part of the country is covered by a peneplain, which forms a gently undulating landscape, with a few isolated hills in some areas, and the last vestiges of a Precambrian massif. The southwest of the country forms a sandstone massif, where the highest peak, Téna Kourou, reaches an elevation of 749 meters (2,457 feet). The massif is bordered by sheer cliffs up to 150 meters (490 feet) high. The average altitude of Burkina Faso is 400 meters (1,300 feet), and the difference between the highest and lowest terrain is no greater than 600 meters (2,000 feet). Burkina Faso is therefore a relatively flat country. Its elevation extremes are a lowest point at the Mouhoun (Black Volta) River (200 m) and highest point at the top of Tena Kourou (749 m).

In 2018, the Burkina Faso VectorLink project will focus on three intervention districts: Kampti (province of Poni), Solenzo (province of Banwa), and Kongoussi (province of Bam). The three districts are located across

the three ecological zones of Burkina Faso: Sudano-Guinean (west), Sudan (center-west), and Sahelian (north) ecological zones:

- **Kampti is in the Sudano-Guinean Zone.**
- **Solenzo is in the Sudan zone.**
- **Kongoussi is in the Sahelian zone.**

4.3.1. Climate

Burkina Faso can be divided into three climate zones, with rainfall decreasing from south to north. There is a distinct dry season during winter months, and a wet season during summer months.

Burkina Faso has a primarily tropical climate with two very distinct seasons. In the rainy season, the country receives between 60 and 90 cm (23.6 and 35.4 in) of rainfall; in the dry season, the *harmattan* – a hot, dry wind from the Sahara – blows. The rainy season lasts approximately four months, May/June through September, and is shorter in the north of the country. The Sahel in the north typically receives less than 60 cm (23.6 in) of rainfall per year. Its temperatures range between 5 and 47 °C (41 and 117 °F).

A relatively dry tropical savanna, the Sahel extends beyond the borders of Burkina Faso, from the Horn of Africa to the Atlantic Ocean, and borders the Sahara to its north and the fertile region of the Sudan to the south. The Sudan-Sahel region is a transitional zone with regards to rainfall and temperature. Further to the south, the Sudan-Guinea zone receives more than 90 cm (35.4 in) of rain each year and has cooler average temperatures.

Burkina Faso's natural resources include gold, manganese, limestone, marble, phosphates, pumice, and salt.

4.3.2. Rainfall patterns

The rainy season is when mosquito population density, and hence malaria incidence are the highest. The rainy season (June to September) is one of two seasons in Burkina Faso. The rainy season is when the shrubs and stunted trees flourish in the savanna in the northern region, where rainfall incidence is about 10 inches; the rivers are full, and dense vegetation grows in the southern region of the country when the rainfall incidence is as high as 40 inches (1,000 mm).

The varying duration of the rainy season across the country helps create corresponding variance in seasonal malaria transmission based on geographic zones. In the north, the rainy season is short (up to three months), in the central zone it lasts up to six months, and in the south, it can last up to nine months.

Districts targeted for malaria prevention interventions are located in three eco-climatic zones (Sudanian, Sudano-Sahelian, and Sahelian).

In the area of Kampti the climate is sub-Sudanian, with annual mean rainfalls reaching 1000 mm. The average annual temperatures are between 17 °C and 36 °C.

In area of Solenzo, rainfall varies from 700 to 1000 mm/year.

Kongoussi has an annual rainfall of between 400 and 600 mm, over a period of three to four months.

4.3.3. Topography, Geology, and Soils

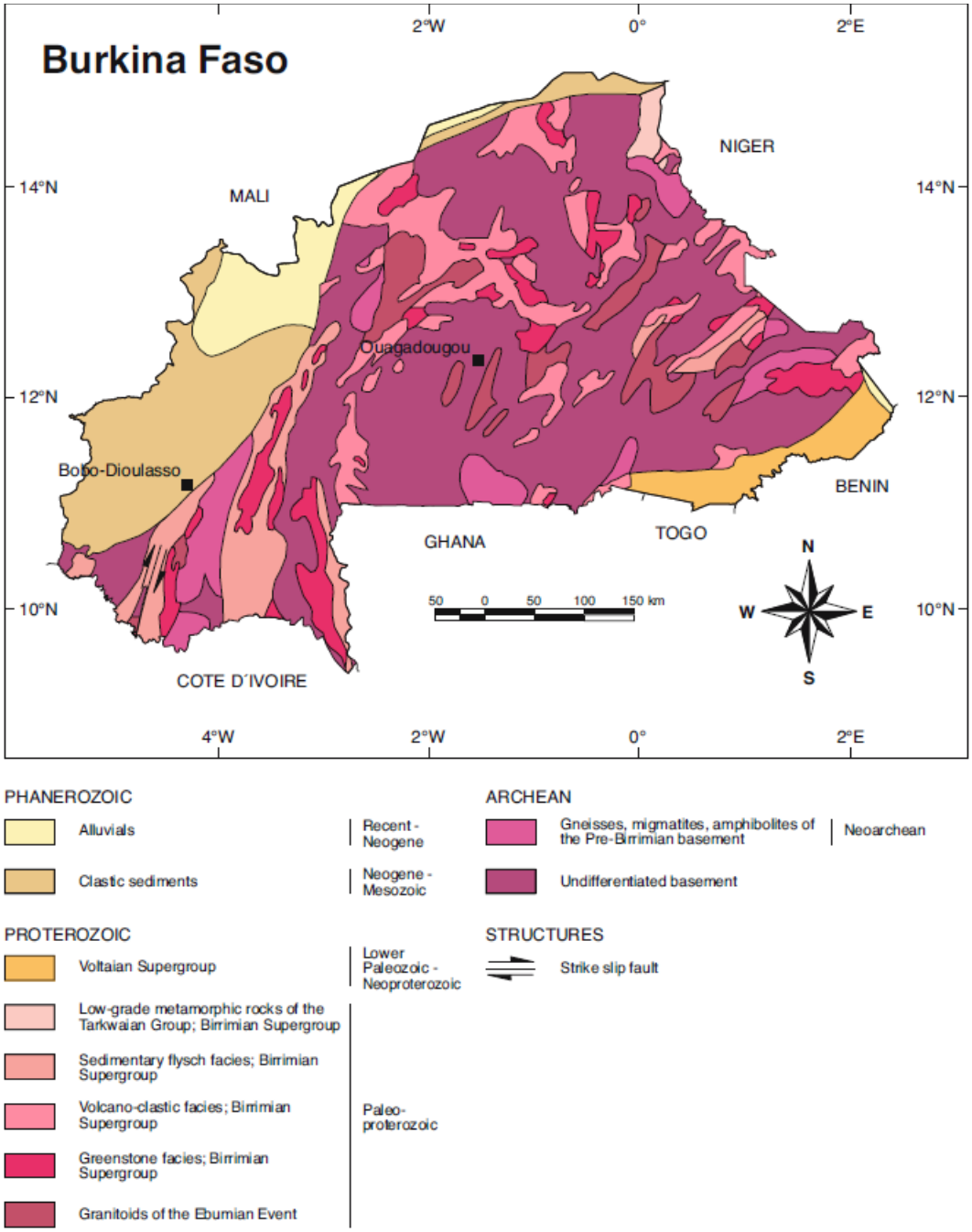
Burkina Faso is predominantly underlain by rock of the Guinea Rise, which borders the Gulf of Guinea and extends from Sierra Leone in the west and to Ghana in the east. The rise is generally characterized by granitic gneisses, and north to northeasterly trending belts of metasediments and metavolcanics.

The oldest rocks in Burkina Faso are pre-Birimian migmatites, gneisses, and amphibolites underlying the Birimian deposits, which can often be divided, similarly as in neighboring Ghana, between predominantly clastic (flysch) formations and volcano-clastic formation. The clastic sequence consist of intensely deformed pelitic and psammitic metasediments. There are three major Birimian greenstone belts in the south and the west of the country, in which volcano-sedimentary sequences are dominant, a fourth in the central and northeastern regions, besides numerous other smaller greenstone belts, which are found throughout the country. Granites and granodiorites occupy the spaces in the between the greenstone belts. Proterozoic conglomerates and sandstones of the Tarkwaian Group rest on Birimian rocks around Essakane in the northeast of Burkina Faso. The margins of a large sedimentary basin of Neoproterozoic to Ordovician age emerge at the western border of Burkina Faso. These rocks consist of basal sandstones with overlying shales and dolomites, sometimes carrying bauxite mineralization.

Gold occurrences are widespread and found throughout the Birimian formations as mineralization related to quartz veins and stock work, disseminations, and the alluvial concentrations in Quaternary or recent river gravels. Gold occurrences have been described from seven districts:

Alluvial diamonds have been found, but so far no major discoveries have been made. Besides gold, the country's most significant mineral resources are the Perkoa zinc deposits (about 120 km west of Ouagadougou) and the Tambao manganese deposits, about 300 km northeast of Ouagadougou. Three low-grade copper deposits have been investigated, but none is presently mined. Numerous small deposits of bauxite have been discovered, but none has been mined to date. There are several phosphate deposits in the southeast of Burkina Faso, concentrated in the Pendjari Series of sedimentary rocks. Reserves are believed to be on the order of 30 megatons of ore.

Figure 2 : Geological overview of Burkina Faso[7]



[7] 2008 Geological Atlas of Africa: With Notes on Stratigraphy, Tectonics, Economic Geology, Geohazards, Geosites and Geoscientific Education of Each Country, by Thomas Schlüter with contributions by Martin H Trauth.

Burkina Faso's industries include mining of copper, iron, manganese, gold, cassiterite (tin ore), and phosphates. These operations provide employment and generate international investment. Gold production increased 32% in 2011 at six gold mine sites, making Burkina Faso the fourth-largest gold producer in Africa, after South Africa, Mali, and Ghana.

4.3.4. Biological Environment

Burkina Faso is largely wild bush country with a mixture of grass and small trees in varying proportions. The savanna region is mainly grassland in the rainy season and semi-desert during the *harmattan* period. Fauna, one of the most diverse in West Africa, includes the elephant, hippopotamus, buffalo, monkey, lions, crocodile, giraffe, various types of antelope, and a vast variety of bird and insect life. The country has 147 mammal species, 330 aquatic species including 121 species of fish, and 2,067 different plant species. Of the plant species, the dominant endemic species are the baobab, and the shea tree *(Butyrospermum parkii),* which has immense economic value to the country. Fauna conservation areas were first established in 1926, and included five *"parcs de refuge"* that covered 536,700 hectares.

The Global Environment Facility in its report to the World Bank reported that the biodiversity species profile of Burkina Faso contains "655 wildlife species (mammals and birds); 330 aquatic species (includes 121 fish species), and 1054 plant species (751 grass, 304 tree and brush species)," based on meager data. It was also noted that the natural habitats were found in parks, reserves and gazetted forests, and agricultural operations dominate the scene in 70% of the country. The oryx, cheetah, and giraffe are reported to be totally extinct, as is probably the Burkina redneck ostrich. The species nearing extinction were reported to be black and white colobus, dama gazelle, leopard, and topi. This alarming loss of biodiversity resulted in creation of national operational strategies not only for rural development in 2001 but also, earlier, for reforms in the wildlife and protected area sector in 1995. In 1996 a Forestry Code was introduced defining the National Forestry Policy and establishing 12 Wildlife Conservation Units covering the entire country. This was followed by a Biodiversity Strategy and Action Plan in 2000, with the stated objective being to "ensure responsible management of biological diversity by the populations by 2025."

4.3.5. Eco-Regions

The large northern ecoregions, Liptako Sahel, Gondo-Mondoro, and Gourma Malien, belong to the Sahelian Region and are dominated by shrub savanna and steppe. Moving south, the Plateaus of Samo, Gourmantché, and the Nord Plateau Mossi (North Mossi Plateau) dominate the north central part of the country, where population density is high. The southern ecoregions, from the Pendjari plains in the east to the Bwa Plateau and Comoé Poni Basin in the southwest, cover a wide bioclimatic gradient. With rainfall varying from 650 mm to over 1,000 mm, they extend over the more humid Sudanian Region. The more favorable climate and permanent rivers make them quite suitable to agriculture, with cash crops becoming increasingly important. The village of Oursi, on the edge of the Mare d'Oursi, is a wetland of international importance for Palearctic bird migrations.

4.3.6. Major Water Bodies

The country owes its former name of Upper Volta to three rivers that cross it: the Black Volta (or Mouhoun), the White Volta (Nakambé), and the Red Volta (Nazinon). The Black Volta is one of the country's only two rivers that flow year-round, the other being the Komoé, which flows to the southwest. The basin of the Niger River also drains 27% of the country's surface.

The Niger's tributaries – the Béli, the Gorouol, the Goudébo, and the Dargol – are seasonal streams, and flow for only four to six months a year. They still, however, can cause large floods. The country also contains numerous lakes – the principal ones are Tingrela, Bam, and Dem. The country contains large ponds, as well,

such as Oursi, Béli, Yomboli, and Markoye. Water shortages are often a problem, especially in the north of the country.

Surface water

The center, south, and west of Burkina Faso are drained by tributaries of the Volta system, including the Nakambe, Mouhoun, and Comoé rivers. The north and east are drained by rivers of the Niger basin. Many of the smaller rivers are ephemeral, drying during the dry season. There are a number of natural lakes. Many valleys are dammed to store wet season rainfall: in 2001 there were approximately 2,000 reservoirs with a total storage volume estimated at 2.66 billion cubic meters.[8]

Fishing activities are practiced along the rivers. The main fish species are *Glacias* (silure), *Alestes* (sardines), *Hydrocion (poisson chien:* dogfish), *Disticodice* (*faux capitaine:* false captain), *Malopterus (poisson électrique:* electric fish), and *Lates niloticus* (*le capitaine*: captain). Fishing is not for export but mainly for local consumption.

Groundwater

Average recharge rates are estimated at 5 mm/year in the drier north and 50 mm/year in the south, but local estimates range up to 250 mm/year.[9]

Generally, groundwater in Burkina Faso is of suitable quality for drinking water, although there are local problems. Naturally occurring arsenic has been identified as a problem in some areas, particularly associated with zones of gold mineralization in Birimian (Lower Proterozoic) volcano-sedimentary rocks.[10] Pollution from nitrate is thought to be common in shallow groundwater sources, derived from domestic waste as well as agricultural sources, often highest in areas of high housing density. Groundwater in some areas of northwest Burkina Faso has high salinity.[11]

4.3.7. HYDROLOGY

Several rivers cross Burkina Faso; all are tributaries of one of three major rivers: the Volta, the Comoé, and the Niger. The basins of these three rivers drain about 8 billion m^3 of water per year. Two major constraints seem to limit the mobilization and the development of water resources:

- **The environment (rainfall and hydrogeology), which imposes a relatively low estimated at 9 billion m3 or 0.1 to 10% of the annual rainfall**
- **Limited performance of water mobilization infrastructure**

Burkina Faso currently has more than 33,000 wells and boreholes intended primarily for human food, and 2,000 surface water reservoirs, including 380 permanent reservoirs. These reservoirs have a storage capacity of 6 billion m3, or 75% of the annual contributions of the three river basins. This water is used for irrigation, city supply, and electricity generation (with two dams). To achieve this level of service, the water management policy has evolved since the colonial period, owing to:

- **The development of legal frameworks**
- **Technological innovation, which has resulted in the use of modified manual pumps as well as solar-powered pumps**

[8] Obuobie and Barry, 2012
[9] Obuobie and Barry, 2012
[10] Smedley et al. 2007
[11] BGS, 2002

- **Participation of private operators in the field of irrigation and management of small drinking water distribution networks**

4.3.8. Special Conditions

The Volta River Basin in West Africa has a surface area of approximately 400,000 km2 across six countries: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, and Togo. It is the ninth largest river basin in sub-Saharan Africa. About 85% of the Volta basin is located in Burkina Faso and Ghana, while Togo, Benin, Côte d'Ivoire and Mali share the remaining 15%.

The basin is divided into four major sub-basins: the Black Volta, the White Volta, the Oti, and the Lower Volta. The Volta Basin is home to nearly 19 million people who depend directly or indirectly on the resources of the river. Therefore the Volta Basin is an important asset for the development of the riparian countries.

In order to manage water resources across national boundaries, a management tool was needed that could clarify the roles and responsibilities of different actors. This would enable conflict resolution and build a collective understanding of how to manage water resources and respond to environmental problems. A Code of Conduct for the Volta Basin was therefore required to enable various stakeholders to come together to create a common goal founded on accepted knowledge and information. Burkina Faso and Ghana agreed to develop such a code between their two countries.

In the Volta basin, the Water and Nature Initiative and partners have worked with riparian states to improve water governance and water management practices. This has resulted in multi-scale participatory governance frameworks for joint management of water resources and improvement of livelihoods through riverbank protection schemes. These governance frameworks have complemented and helped to facilitate large-scale government and donor initiatives that have supported the establishment the Volta Basin Authority. The Volta Basin now has a number of legal tools, and knowledge and capacity, to sustainably manage its shared water resources at local to transboundary levels.

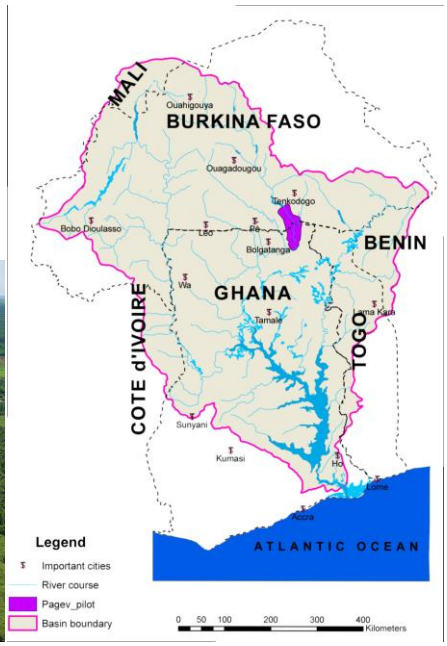


Figure 3: The Volta River and its catchment area. (Source: Final evaluation, The Volta Water Governance Project (PAGEV), International Union for Conservation of Nature)

4.4. PROTECTED AREAS

To ensure conservation and preservation of the wildlife of Burkina Faso, two national parks have been established. The forests, fauna, and fish have been declared part of the national estate of Burkina Faso.

Detailed parks, reserves, and other protected areas are[12],[13]

- **National Parks: Kabore-Tambi, W du Burkina Faso**
- **Partial Wildlife Reserves: Arly, Bontioli, Kourtiagou, Nabéré, Pama**
- **Wildlife Reserves: Arly, Bontioli, Madjoari, Singou**
- **Classified Forests transformed into Wildlife Reserves: Deux Balé, Dibon, Dida, Diéfoula, Koflandé, Laba, la Mou, Logoniégué**
- **Protection/Protected Zone: *Ranch de Gibier de Nazinga***
- **Bird Sanctuaries: *Beli, Mare d'Oursi***
- **Other Protected Areas: Parco Urbain Bangr-Weoogo, Riserve des Cascades de Banfora**
- **Wetlands of International Importance (Ramsar): *La Mare aux Hippopotames, La Mare d'Oursi, Parc* National du W**
- **UNESCO- Man and the Biosphere Programme Biosphere Reserves : La mare aux hippopotames, Region "W" du Burkina Faso**

Burkina Faso has a larger number of elephants than many countries in West Africa. Lions, leopards, and buffalo can also be found here, including the dwarf or red buffalo, a smaller reddish-brown animal which looks like a fierce kind of short-legged cow. Other large predators live in Burkina Faso, such as the cheetah, the caracal or African lynx, the spotted hyena and the African wild dog, one of the continent's most endangered species.

Burkina Faso's fauna and flora are protected several reserves and national parks:

- **The W National Park in the east which encompasses parts of Burkina Faso, Benin, and Niger**
- **The Arly Wildlife Reserve (Arly National Park in the east)**
- **The Léraba-Comoé Classified Forest and Partial Reserve of Wildlife in the west**
- **The Mare aux Hippopotames in the west**

[12] Site Officiel du Premier Ministère du Burkina Faso, http://www.primature.gov.bf/
[13] Ministère de l'Environnent et du Cadre de Vie du Burkina Faso, http://www.environnement.gov.bf/

A complex of four protected areas in Benin and Burkina Faso are proposed as a 1.5-million-hectare extension to Niger's W National Park, listed as a World Heritage site since 1996[14]. The area is a refuge for fauna that has either disappeared or is highly threatened elsewhere in West Africa, such as cheetahs and lions.

In conservation and sustainable resources management efforts, the Important Bird and Biodiversity Area Local Conservation Group, with help from BirdLife Partners around the world, has set up "Site Support Groups" in Burkina Faso, which initially began in 1959 to count birds. This resulted in training of local volunteers as ornithologists. In 2009, Vogelwacht Utrecht, a Dutch regional volunteer birding group, supported efforts to conserve migratory birds. Cambridgeshire Bird Club in the UK has also pitched in with support. However, all these efforts are concentrated at Lake Oursi (included in the List of Ramsar wetlands of international importance), and are yet to permeate to a national scale.

Burkina Faso has designated *La Zone de confluence Mouhoun-Sourou* as a Wetland of International Importance.[15] The country now has 19 Ramsar Sites covering over 700,000 hectares. The *Zone de confluence* (Ramsar Site no. 2292) is at the confluence of the Mouhoun and Sourou rivers in the *Boucle du Mouhoun* region. The larger Mouhoun River forms, with its tributary the Sourou, a complex with a particular hydrological regime.

4.5. Agriculture and Organic Farming

Burkina Faso has good agricultural potential. Crops grown there include maize and rain-fed rice, plus the main industrial and cash crops of sugar cane, cotton, yams, sorghum, millet, maize, rice as cereal crops, groundnut, sesame, soybeans, nuts cowpea, and sweet potato.

Crops are farmed for subsistence, and agriculture is dominated by food crops that coexist with other crops that are in constant evolution. The global food crisis of 2007–2008 created a drastic surge in food prices that led to high rates of hunger, malnutrition, and political and economic instability in nations across the globe. This strongly affected Burkina Faso because around 80% of Burkina's population is rural, relying on subsistence farming to make a living.

Burkina Faso is a fast-growing country with an annual population growth rate of more than 3%. This trend has consequences for food security, since agricultural productivity is still on a comparatively low level in Burkina Faso. In order to compensate for the low productivity, the agricultural areas are expanding quickly.

Subsistence agriculture is a self-sufficiency farming system in which the farmers focus on growing enough food to feed themselves and their families. The output is mostly for local requirements with little or no surplus trade. The typical subsistence farm has a range of crops and animals needed by the family to feed and clothe themselves during the year. Planting decisions are made principally with an eye toward what the family will need during the coming year, and secondarily toward market prices.

However, despite the primacy of self-sufficiency in subsistence farming, today most subsistence farmers also participate in trade to some degree; though usually it is for goods that are not necessary for survival, and may include sugar, iron roofing sheets, bicycles, used clothing, and so forth.

Burkina Faso has a potential comparative advantage in several non-traditional cash crops, such as fruit (especially mangoes) and vegetables (such as onions, tomatoes, potatoes, and beans), both for West Africa's coastal countries and for European countries, where demand is high, particularly demand for organic products.

[14] IUCN World Heritage Evaluations 2017 – IUCN. Evaluations of nominations of natural and mixed properties to the World Heritage List.
[15] https://www.ramsar.org/news/nineteenth-ramsar-site-for-burkina-faso

Burkina Faso has generated impressive economic growth over the past couple of decades (Figure 5). Gross domestic product has expanded at an average growth rate of 10.4% per year since 1994, rivaling the earlier economic performance of the Asian Tigers in the 1960s and 1970s and more recent developments in economic powerhouses like China, Brazil, and India. Burkina Faso's economic growth has been inclusive by sub-Saharan African standards, having been accompanied by a marked improvement in social welfare measures. Based on the United Nations Human Development Index, Burkina Faso's development has advanced as rapidly as any country over the past 15 years. Although Burkina Faso remains near the bottom of the global rankings, the country's Human Development Index scores have steadily improved, from an average of 0.21 in the 1980s to a value of 0.38 in 2010–13, an increase of 80.1%.[16]

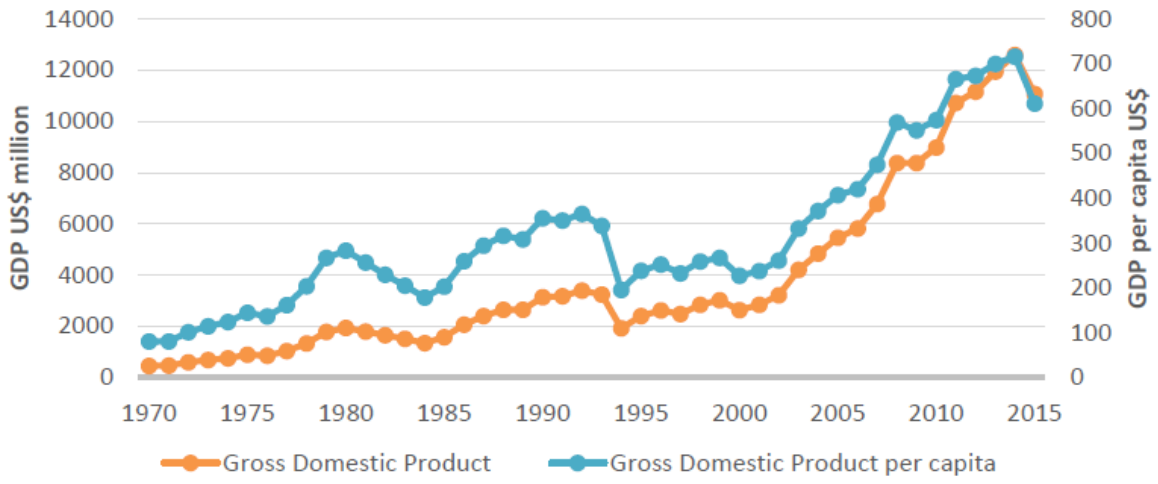


Figure 4: Evolution of Gross Domestic Product in Burkina Faso (1970–2015). Source: Food and Agriculture Organization of the United Nations (FAO).

Shifting Agriculture

In this type of agriculture, a patch of forest land is cleared by a combination of felling and burning, and crops are grown. After 2-3 years the fertility of the soil begins to decline, the land is abandoned, and the farmer moves to clear a fresh piece of land elsewhere in the forest as the process continues. While the land is left fallow the forest regrows in the cleared area and soil fertility and biomass are restored. After a decade or more, the farmer may return to the first piece of land. This form of agriculture is sustainable at low population densities, but higher population loads require more-frequent clearing, which prevents soil fertility from recovering, opens up more of the forest canopy, and encourages scrub at the expense of large trees, eventually resulting in deforestation and land erosion.

In Burkina Faso some fields are left fallow to regain soil fertility, but this practice is increasingly rare, as the high population density forces people to cultivate every hectare of land available. In most villages you eventually walk through a lower-lying area that gets temporarily flooded in the rainy season. The fringes of these depressions have richer soils, and the yields there are often higher than from other fields.

[16] Economic importance of cotton in Burkina Faso. Background paper to the UNCTAD-FAO Commodities and Development Report 2017: Commodity markets, economic growth and development http://www.fao.org/3/i8492en/I8492EN.pdf

Primitive Agriculture

While this slash-and-burn technique may describe the method for opening new land, commonly the farmers in question have in existence at the same time smaller fields, sometimes merely gardens, near the homestead. There they practice intensive "non-shifting" techniques. Such gardens nearer the homestead often regularly receive household refuse, the manure of any household chickens or goats, and compost piles. Farmers often recognize the value of such compost, and apply it regularly to their smaller fields. They also may irrigate part of these smaller fields if they are near a source of water.

Nomadic Herding

In this type of farming people migrate along with their animals from one place to another in search of fodder for their animals. Generally they rear cattle, sheep, goats, camels and/or yaks for milk, skin, meat, and wool. This way of life is common in parts of central and western Asia, India, east and southwest Africa and northern Eurasia. In Burkina Faso the herding territory is mainly composed of the following elements: the attachment territory (the main residence and adjacent fields), the peripheral territory (rangelands grazed by herds on a daily basis, the area grazed changing with the seasons and forage availability), and territories at a distance from the residential area.[17]

Intensive Subsistence Farming

In intensive subsistence agriculture, the farmer cultivates a small plot of land using simple tools and more labor. Large number of days with sunshine, and fertile soils, enable farmers to grow more than one crop annually on the same plot. Farmers use their small land holdings to produce enough for their local consumption, while remaining produce is used for exchange against other goods. In the most intensive situation, farmers may even create terraces along steep hillsides to cultivate rice paddies. They may also use manure and other animal waste as fertilizer, and artificially irrigate their land. Africa has seen sharp declines in rice yield after a few years of intensive cultivation in the irrigated perimeters of Tanzania (Duwayri et al., 1999), Burkina Faso, Cameroon, and Nigeria (Fagade and Nguyen, 2000).

[17] Herding territories in Northern Cameroon and Western Burkina Faso: spatial arrangements and herd management. https://link.springer.com/content/pdf/10.1186%2F2041-7136-2-26.pdf

5. Environmental and Health Impacts

5.1. Potential Positive Effects of the IRS Program

5.1.1. Direct Positive Effects

The direct positive impacts of the IRS program are the reductions in child and adult malaria morbidity and mortality, which 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: miscarriage; low birth weight; adverse effects on fetal neurodevelopment as a result of exposure to malaria; and 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.

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

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

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

In addition, the implementation of IRS requires certain local purchases of products and services, such as building and construction materials, rental of building space and vehicles, and hiring of local labor for the construction or renovation of storehouses and soak pits. Again, these revenues are injected into the economy with potentially positive and significant magnification effects.

The Burkina Faso PMI VectorLink project views gender equality and female empowerment as development goals in their own right, as well as approaches that accelerate vector control. VectorLink Burkina Faso will mainstream gender across its operations, in line with the project's gender strategy, with an emphasis on women's economic empowerment through employment in its IRS and entomology operations. To achieve this goal, the project will implement policies that promote the hiring of female seasonal workers and ensure a safe and respectful workplace for all.

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

5.2. Potential Adverse Impacts

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

5.2.1. Direct Potential Adverse Effects

Contamination of Surface Watercourses and Underground Water

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

Contamination of underground water resources is possible through improper disposal of leftover pesticide on the ground, especially if there is a high water table. However, the impacts of this risk are likely to be insignificant, primarily because pesticide disposal is strictly controlled and supervised, and the sites for soak pits are carefully chosen according to the criteria in the PMI BMPs. Secondarily, most formulations of pyrethroids, organophosphates, and carbamates move slowly through soil, and degrade quickly when exposed to sunlight, hydrolysis, or microbial action in the soil. If wash areas and soak pits are properly constructed and employed, liquid pesticide traces will be captured in the charcoal layer of the soak pit or organic matter in soil, and held until degradation by natural processes.

Potential Impacts to Non-Target Organisms from Pesticides

Table 3 in Section 6.5 of this SEA documents the degree of toxicity of the five WHO PQ-recommended pesticide classes, to birdlife, aquatic life, and insects, as well as pesticide persistence and bio-accumulation potential.

Special Note: Impacts On Bees

Spraying in areas near beehives can lead to the death of the bees, which are vulnerable to all WHO-recommended pesticides. In addition, spraying near hives can lead to contamination of edible honey. These risks must be mitigated at all times. Modern methods of beekeeping in Burkina Faso have developed throughout the country, as evidenced by the creation of many beekeeping centers offering various services (training in modern apicultural techniques, production and sale of honey, supervision of groups and/or apicultural associations, etc.) The project will identify locations where beehives are kept, and observe a 30- meter no-spray buffer zone around them. Bee-hive owners will be advised accordingly.

5.2.2. Indirect Adverse Effects

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

In general, if PMI supports the procurement of insecticide or disposition of unused insecticide to the Government of Burkina Faso (GoBF), this activity is required to be mentioned in the annual Letter Report, in addition to this SEA. This type of support requires annual environmental compliance monitoring by PMI and/or the IP, requires that PMI and/or the PMI IP provide environmental training to the GoBF in the PMI IRS BMPs, and technical assistance for insecticide selection to ensure quality/appropriateness of the product.

If PMI supports the procurement, loan, or disposition of spray pumps or personal protective equipment to the GoBF, these activities must be mentioned in the annual Letter Report, in addition to this SEA. These activities do not require environmental compliance monitoring, however, PMI and/or the PMI IP must provide environmental training in the PMI IRS BMPs. These requirements relate to the use of non-DDT insecticides by the GoBF.

The conduct of IRS by District Medical Officers with communities, using properly working equipment left behind by PMI may temporarily, and in a minor way increase the total pesticide load on the environment. However, since the IRS equipment will be in operable condition and capacity has been built among the District Medical Officers, it is expected that spray operations will be according to BMPs, and the total pesticide load on the environment is expected to be less than if the donation is not made.

5.3. Human Exposure Risks/Impacts

Worker and Resident Exposure Pathways

During the IRS spraying process, spray personnel are at risk of un-intentional or deliberate exposure through accidents or poor and improper handling of the spray chemical. Worker exposure to the chemical could arise during the pre-spraying, spraying and post-spraying phase of the IRS operations. Beneficiaries can also be exposed during each of these phases, and additionally over the life of the pesticide on the wall. Exposure risks of all WHO-recommended pesticides in relation to cancer and non-cancer endpoints are presented in IVM updated PEA 2017. 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.

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

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

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

water. Residents may also be exposed to this contaminated water by dermal contact when it is used for cleaning or cooking purposes.

5.3.4. Occupant Long-Term Exposure From Residue

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

5.4. Pesticide- and Process-specific Potential Health Impacts

The potential health impacts of the insecticide products that can be used for IRS are described in detail in the PMI Programmatic Environmental Assessment for Integrated Vector Management Programs for Malaria Vector Control (2012 and 2017 Updates). A summary of these effects is given in Annex E of this SEA.

5.5. Cumulative Impact

Organophosphates are the pesticides with the highest potential for cumulative impacts. Pyrethroids, carbamates, and most organophosphate formulations break down readily in the environment, limiting the risk of cumulative environmental impact, especially if disposal sites are well chosen and BMPs are followed.

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

There are indications that the Capsule Suspension form of Actellic is more resistant to environmental degradation than either Actellic Emulsifiable Concentrate or the other WHO PQ-recommended pesticides. This may result in a temporary build-up of concentration within the soak pit prior to degradation.[18]

[18] Mitchell, David, et al, (2015).

6. PESTICIDE PROCEDURES

Title 22 CFR 216 mandates the consideration of 12 factors when a project includes "assistance for the procurement or use, or both, of pesticides." As the PMI Burkina Faso IRS program includes assistance in both of these aspects, it is subject to this regulation. This section therefore addresses each of the 12 factors for the IRS Malaria Control Program in Burkina Faso.

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

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

1. The proper assessments are performed.
2. The assessments include an evaluation of the factors in Sections 7.1–7.12 of this document.
3. Notification is provided to, and authorization received from, the host country government for the use of the pesticide in country.

PMI works closely with host country governments, with full and clear disclosure, as well as providing any necessary assistance in the mitigation of risk from the use of these WHO PQ pesticides. This SEA, supported by the PMI IVM PEA, and distributed to Ministries of Health, Environment, and Agriculture, provides the assessment, notification, and mitigation requirements of U.S. regulations. PMI is therefore empowered, upon acceptance of this document and the receipt of formal authorization from a competent Burkina Faso authority, to use in Burkina Faso all WHO PQ-recommended pesticides in the pyrethroid, carbamate, organophosphate and nicotinoid classes; as well as chlorfenapyr and the clothianidin/deltamethrin combination when recommended by the WHO PQ.

Clothianidin and deltamethrin are currently registered with United States Environmental Protection Agency (USEPA).

Pirimiphos Methyl had an Interim Reregistration Eligibility Decision since 2006, and was reviewed in 2009.

6.2. THE BASIS FOR SELECTION OF THE REQUESTED PESTICIDES

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

6.2.1. PRIMARY CRITERIA FOR CHOOSING PESTICIDES

Approval by the WHO: Only insecticides recommended by the WHO PQ or by USEPA can be used in IRS. Certain pesticides in the organophosphate, carbamate, pyrethroid, neonicotinoid and organochlorine classes are WHO PQ-recommended for use in IRS. Chlorfenapyr and the clothianidin/deltamethrin combination are

not yet recommended by WHO, but authorization is requested in this SEA to use them for hut trials, and for IRS when and if they receive a WHO PQ listing[19].

Registered for use in Burkina Faso: In the case where the insecticide proposed for use in IRS is not registered in Burkina Faso, PMI will work with manufacturers and distributors, as well as the Ministry of Health and the *Comité Permanent Inter-État de Lutte Contre la Sécheresse au Sahel* (CILSS; Permanent Interstate Committee for Drought Control in the Sahel) to obtain special authorization for the use of the pesticide. Both pirimiphos methyl and clothianidin are registered in Burkina Faso by the competent authority.

Residual effect for a period longer than, or at least equal to, the average duration of the malaria transmission season in the area: All pyrethroids, carbamates, and organophosphates are expected to stay active and effective for 3 to 6 months after application; however, the effective duration varies under different climatic conditions and other factors. Three pyrethroids, known as longer-lasting pyrethroids, can last up to 11 months, based on various field trials. For this reason, pyrethroids have traditionally made the best choice for extended seasons. However, in order to manage vector resistance, it has proven to be necessary to switch the class of pesticides used in IRS.

The duration of effectiveness of each insecticide formulation on the primary wall surface types will continue to be researched and considered when selecting insecticide class and active ingredient.

Appropriate for use on the wall surfaces of the selected location: In Burkina Faso the majority of the houses in rural settings are still made up of mud wall surfaces, mud bricks, and burnt bricks; the remainder, found largely in urban areas, are made with cement . Pyrethroids, carbamates, and organophosphates are known to function well on these surfaces, and are therefore appropriate for use.

Figure 5: Structures in Burkina Faso (source: SEA preparation trip in Burkina Faso by Sana Diop – Nov 2017)

[19] http://www.who.int/pq-vector-control/prequalified-lists/en/

Local vector susceptibility to the insecticide: Resistance to insecticide develops when a hereditary feature is selected in an insect population that reduces the population's sensitivity to a given insecticide. In Burkina Faso, vector susceptibility studies have confirmed the susceptibility of pirimiphos-methyl and clothianidin in most districts.

Monitoring Vector Susceptibility to Insecticides in Burkina Faso (2017)[20]: The PMI VectorLink Project will work in collaboration with the IRSS, the NMCP, the Centers for Disease Control and Prevention (CDC), the National Center of Research On Malaria, and other in-country organizations to implement entomological monitoring activities. VectorLink Burkina Faso will subcontract the field and laboratory activities to IRSS. The project will be responsible for entomology items that require international procurement, provision of technical assistance, and ensuring the quality of work. The IRSS will be responsible for field and laboratory activities, including local procurement of materials and supplies, on-the-ground supervision, and writing reports in English to provide the VectorLink Burkina Faso deliverables set forth in the subcontract.

The project will:

1. Determine the susceptibility level of the main malaria vectors, *Anopheles gambiae* s.l. and *An. funestus* s.l. (where found in sufficient densities), to five insecticides recommended by WHO PQ in selected sentinel sites. Baseline susceptibility testing will also be conducted in various sentinel sites for two new insecticides, chlorfenapyr and clothianidin. The project will also determine the intensity of insecticide resistance to pyrethroids using the CDC bottle assay in seven sites.
2. Collect detailed baseline information on mosquito biting rates, indoor resting densities, seasonality, biting times, and parity rates of malaria vectors in longitudinal selected sentinel sites.
3. Conduct laboratory analysis of mosquito samples to determine species composition, presence of resistance mechanisms of the voltage gated sodium channel and Ace-1, blood-meal source, and infectivity with *P. falciparum* sporozoites.
4. Provide technical assistance to the NMCP in the development of its national resistance monitoring plan.

Ecological impact: Burkina Faso boasts of a diverse wildlife throughout the country, but especially in the national parks and protected areas, and it is extremely important that IRS does not in any way diminish this biodiversity. The ecological impact of the WHO PQ pesticides is well documented, recently in the 2017 PMI IVM PEA. However, if BMPs for IRS are strictly followed, the release to the environment, and therefore the impact to the environment, should be negligible. More information on ecological impact of the proposed pesticides is found in Section 6 as well as other sections of this document.

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

[20] 2017 Burkina Faso Entomology Progress Report.

6.2.2. Secondary selection criteria

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

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

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

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**

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

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

6.4. The Proposed Method or Methods of Application, Including Availability of Appropriate Application and Safety Equipment

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

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

The spray operators who implement IRS use backpack compression sprayers to apply a measured amount of insecticide on the interior walls of houses and structures. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the sprayer is pressurized, and the material is then applied. After the day's spraying is complete, spray operators clean the sprayer following PMI BMPs to maintain proper functioning of the pump, reuse leftover pesticide on the following day, and guard against release of and/or exposure to pesticides. They also follow the manufacturer's recommendations to ensure their proper operation and calibration.

6.5. Acute and Long-Term Toxicological Hazards Associated with the Proposed Use, and Measures Available to Minimize Such Hazards

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

"Indoor" being an important operative word in IRS, the risks to biodiversity from spray operations are minimal if PMI BMPS are followed. The BMPs have been designed to prevent any significant release to the environment, and a strong, automated, smart-phone-based supervisory system ensures that BMPs are followed or non-compliance is immediately corrected. The reader is referred to Annex E of the 2017 IVM PEA, and to Chapter 5 of this SEA for greater detail about pesticide toxicity.

Table 2: The degree of toxicity of the IRS WHO PQ-recommended pesticide

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

Source: IVM PEA 2012 and 2017

Key

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

Note: Toxicity of Clothianidin[21,22]

Clothianidin is moderately toxic in the short-term to mammals that eat it, and long-term ingestion may result in reproductive and/or developmental effects. Using laboratory test animals as surrogates for humans and dosages much higher than are expected from exposure related to actual use, testers found low short-term oral, dermal, and inhalation toxicity to clothianidin among rats. For mice, acute oral toxicity was moderate to high. Rabbits showed little to no skin or eye irritation when exposed to clothianidin, and the skin of guinea pigs was not sensitized by it. When extrapolated to humans, these results suggest that clothianidin is moderately toxic through oral exposure, but toxicity is low through skin contact or inhalation. While clothianidin may cause slight eye irritation, it is not expected to be a skin sensitizer or irritant. Clothianidin does not damage genetic material nor is there evidence that it causes cancer in rats or mice; it is unlikely to be a human carcinogen.

Permissible amounts of clothianidin residue on food and animal feed vary from crop to crop and nation to nation. However, regulatory authorities around the globe emphasize that when the insecticide is used according to the label instructions, clothianidin residues on food are not expected to exceed safe levels (as defined by each nation's laws and regulations).

Subchronic: The No Observable Adverse Effect Level (NOAEL) in a three-month rat feeding study with clothianidin was 27.9 mg/kg/day (male) and 34.0 mg/kg/day (female).

The NOAEL in a 90-day dog feeding study was 19.3 mg/kg/day (male) and 21.2 mg/kg/day (female). In a subchronic dermal study with rats, the NOAEL is > 1,000 mg/kg/day**.**

Chronic/Carcinogenicity: The clothianidin NOAEL for a two-year rat study was 9.7 mg/kg/day (female); for an 18-month mouse study it was 47.2 mg/kg/day (male) and for a 12-month dog study it was 7.8 mg/kg/day (male). The principal target organs were the glandular stomach, kidney, ovary, and liver. No oncogenic effects were observed in the two-year rat or 18-month mouse feeding studies.

Developmental Toxicity: Transient developmental effects (delayed ossification) were observed in rabbits at maternally toxic doses (100 mg/kg/d). The technical material is feto-toxic in animal studies at maternally toxic doses.

No teratogenic effects on rats or rabbits were observed.

Reproduction: No reproductive effects were observed in rats at the highest dose tested (2,500 ppm).

Mutagenicity: In vivo tests have demonstrated that the technical material is not mutagenic. Some in vitro tests were positive for mutagenicity. The observed effects in vitro were due to cytotoxic effects. The weight-of-evidence from the in vivo whole animal tests suggests that this product does not present a mutagenic hazard.

Specific Target Organ: Single exposure: rat neurotoxicity study (oral), nervous system. Repeated exposure: rat two-year chronic toxicity study (diet), blood and ovaries; dog 90-day repeated dose toxicity study (diet), blood; and dog one-year chronic toxicity study (diet), blood.

Avian Toxicity: The following results were obtained from studies with clothianidin:

LD 50 Japanese quail: = 430 mg/kg

LD 50 northern bobwhite: > 2000 mg/kg

LC 50 northern bobwhite: > 5200 ppm

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[21] http://www.who.int/whopes/quality/Clothianidin_spec_eval_WHO_September_2017.pdf
[22] Sumishield 50 WG MSDS Feb 2016.

LC 50 mallard duck: > 5200 ppm

Aquatic Organism Toxicity: This product is toxic to aquatic invertebrates.

Other Non-Target Organism Toxicity:

Honeybee 48-hour oral LD 50: = 0.0037ug (microgram)/bee

Honeybee 48-hour contact LD 50: = 0.044 ug (microgram)/bee

Earthworm 7-day LC 50: = 19 mg/kg dry soil

Note Toxicity of Deltamethrin:

Deltamethrin: The risk results for the clothianidin/deltamethrin combination are based on the same study on clothianidin and, for deltamethrin, an acute study on neurological effects in rats (used for oral and inhalation), and an acute dermal contact study on rats that observed local effects on the skin. The USEPA determined that there was no apparent increase in hazard with repeated or chronic exposures, so the benchmarks derived from the acute studies were used directly as benchmarks for intermediate and chronic exposures (USEPA 2004). All derived RfDs were based on a UF of 100 that represented differences in intra-species sensitivity (10), and the lack of human exposure studies (10). Based on the risk screening results, adverse health effects for workers or residents are not expected.

- **Acute oral LD50: LD50 in rates is 9.36 mg/kg**
- **Inhalation LC50 (2h): for rats is 785 mg/L**
- **Dermal LD50: LD50 in rabbits is 2,000 mg/kg**

Deltamethrin is of moderate toxicity to mammals as it is rapidly metabolized and does not accumulate. Deltamethrin exhibits its toxic effects by affecting the way the nerves and brain normally function by interfering with the sodium channels of nerve cells. Typical symptoms of acute exposure are irritation of skin and eyes and neurological effects such as severe headaches, dizziness, nausea, anorexia, vomiting, diarrhea, excessive salivation, and fatigue. Tremors and convulsions have been reported in severe poisonings. Dermal exposure to deltamethrin has been shown to cause reversible cutaneous paresthesia (a burning, tingling, or stinging of the skin). Limited data exist for humans following chronic exposures. Chronic occupational exposure to deltamethrin has resulted in skin and eye irritation. Long-term animal studies have not shown reproductive or mutagenic effects. IARC has classified deltamethrin as "not classifiable as to its carcinogenicity in humans."

In one study, the aquatic half-life of deltamethrin ranged from 8-48 hours. Variations of the half-life were due to the method of application. Other reported aquatic half-lives range from one to four hours. Deltamethrin was stable to hydrolysis in solutions of pH 5 and 7. In a pH 9 solution, the average half-life was 2.5 days. Deltamethrin was stable to direct aqueous photolysis in a 30 day study. Due to its Henry's law constant (1.2 x 10-4 atm·m3/mol at 25 °C), deltamethrin has a higher potential to volatilize from water compared with other pyrethroids

The clothianidin/deltamethrin combination will not be stored within 30 meters of water bodies, and any transport over water will be according to PMI BMPs.

HAZARDS

The two broad categories of hazard are release and exposure to humans and domestic animals, and releases causing environmental damage. Release and exposure may occur at any point, from the production or importation of the pesticide through transportation, storage, distribution, pesticide loading into tanks, spray

application, clean-up, and final disposal, as well as after spraying due to improper spray deposition on household articles, or improper behavior of beneficiaries regarding sprayed surfaces.

In humans, both organophosphates and carbamates can produce cholinesterase depression if the proper protective measures are not used and exposure results. Cholinesterase inhibition results in overstimulation of the nervous system, with symptoms that include nausea, dizziness, confusion, and at very high exposures respiratory paralysis and death (U.S. EPA, 2000b). The two classes of insecticides differ in their impacts on human health in that with carbamates the cholinesterase inhibition is temporary, and may dissipate in as little as 2-3 hours, providing the exposure is eliminated. With organophosphates, the inhibition is longer-lasting and cumulative, and thus more dangerous. However all potential environmental threats are noted and monitored along with planned mitigations measures for the safe use of pesticides. Details of specific environmental threats and activities needing precaution are listed with mitigation measures in Section 7 and Annex A.

6.6. The Effectiveness of the Requested Pesticide for the Proposed Use

Pesticides are selected for IRS based on technical efficacy and economic efficiency in the intended use, along with other extrinsic variables. Complete selection criteria can be found in Section 6.2 of this SEA. Knowledge of vector susceptibility is critical to planning and evaluating the effectiveness of the IRS program. It enables timely forward planning to (i) manage the development of vector 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.

6.6.1. Vector Resistance

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

Prior to each campaign, it is necessary to measure vector resistance in the target areas, to ensure that acceptable kill levels will be achieved. A resistance monitoring program has been established by the IRSS in collaboration with the PMI-supported VectorLink Burkina Faso project, and the results from this ongoing program are the primary determinants of the choice of pesticide and other supplementary actions.

All pyrethroids, carbamates, and organophosphates are expected to stay active and effective for 3 to 6 months after application; however, the effective duration varies under different climatic conditions and other factors. Three pyrethroids, known as longer-lasting pyrethroids, can last up to 11 months, based on various field trials. For this reason, pyrethroids have traditionally made the best choice for extended seasons. However, in order to manage vector resistance, it has proven to be necessary to switch the class of pesticides used in IRS.

In Burkina Faso, Malaria vectors in the eight sites demonstrated a high resistance to all pyrethroids tested but moderate resistance for bendiocarb. Two rounds of testing provided strong evidence of resistance to

pirimiphos-methyl in some sites designated for IRS in 2018. A repeat third round with new insecticide papers confirmed this trend in the Western and Southwestern regions.

Due to the detection of resistance to pirimiphos-methyl, bendiocarb and pyrethroids it was necessary to plan for the use of alternative insecticides for IRS and LLINs. Therefore, an alternative insecticide, Sumishield 50WG is to be sprayed in 2018 in Kampti due to the higher frequency of pirimiphos-methyl resistance. It will be important to gather more data on the resistance intensity and whether synergists such as piperonyl butoxide are effective in restoring control of pyrethroid-resistant malaria vectors.

To determine the status and intensity of insecticide resistance, larvae will be collected from 21 sentinel sites. An. gambiae s.l. and An. funestus s.l. (if this species is present in the area) larvae will be collected from larval habitats in all sentinel sites and reared in larval trays either in the insectary at IRSS in Bobo-Dioulasso or in a field rearing room, depending on location. WHO susceptibility tests will be conducted with diagnostic dosages of the following insecticides in 2018:

1. Clothianidin (dose to be confirmed)
2. Chlorfenapyr (dose to be confirmed)
3. Pirimiphos methyl 0.25%
4. Permethrin 0.75%
5. Deltemethrin 0.05%

WHO susceptibility tests will be conducted using 100 An. gambiae s.l. per insecticide (4 replicates of 25). Therefore, each site will test 500 An. gambiae s.l. in WHO cylinder susceptibility tests, with a total of 10,500 An. gambiae s.l. females for all 21sites.

Resistance intensity assays will be conducted by IRSS involving exposure of An. gambiae s.l. to 1x, 5x and 10x the diagnostic dose of deltamethrin and pirimiphos methyl using the WHO intensity test. Four replicates of 25 mosquitoes will be tested per dose. Intensity testing will only be conducted in eight selected sites including the former selected for treatment and their control sites and Diebougou. The number of sites will be extended to 16 with the co-funding plan of NMCP.

Table 3. Mortality rates obtained with CDC bottle tests (30mn after exposure)

Locality		1X	2X	5X	10X
Kongoussi		100	100	100	100
Kampti		66.5	100	96.3	100
Solenzo		100	100	100	100

Source: 2017 Burkina Faso Entomology Progress Report.

Pesticide efficacy is also affected by vector behavior, insecticide quality, and the residual action of the pesticide. The probability of vector-pesticide contact depends on whether the targeted vector feeds indoors (endophagic) and rests indoors (endophilic), as this increases the likelihood of the vector resting on the sprayed wall. The efficacy of the pesticide to kill may be compromised if the vector exits after feeding without resting on the wall, or if the vector feeds outdoors (exophagic) and rests outdoors (exophilic).

In Burkina Faso biting patterns are generally quite similar. The biting rates showed similar seasonality, with most peaks in August and/or September. The variation between some sites may be partly due to the variation in rainfall patterns. Meteorological data is being collected to confirm this. Biting patterns outdoors were around the same intensity and timing as indoors, suggesting that malaria transmission can occur both indoors and outdoors if people are exposed.

6.6.2. Vector Behavior

An. gambiae s.l. remains the main malaria vector in Burkina Faso in all regions sampled. Molecular analysis revealed that *An. gambiae* and *An. coluzzi* occur in sympatry in western areas. Surprisingly, the central and northern areas were dominated by *An. coluzzii,* with few *An. arabiensis* detected. The next surveys will definitively clarify the species dispersion. Furthermore, HLC and PSC collections indicated that few *An. gambiae* s.l. were collected in early June except in areas with more permanent water sources, such as Kongoussi, Seguenega and Tiefora. As the rainy season progressed, vector densities increased greatly, generally peaking in August or September depending on the climatic zone. The role of other vectors was trivial for the past four months, but *An. funestus* can appear towards the end of the rainy season according to its bioecology.

Biting patterns were generally quite similar, except in Kampti and Mangodara, at the beginning of the rainy season, with low densities. For other sites the biting rates showed similar seasonality, with most peaks in August and/or September. The variation between some sites may be partly due to the variation in rainfall patterns. Meteorological data is being collected to confirm this. Biting patterns outdoors were around the same intensity and timing as indoors, suggesting that malaria transmission can occur both indoors and outdoors if people are exposed. Malaria sporozoite rates were highest in the west and southwest areas of Burkina Faso, and were detected from June, with high values in August and September among both indoor- and outdoor-collected females. Additionally, the parity rates were higher than in central and northern sites. The high biting rates coupled with high parity and sporozoite rates give an indication that malaria transmission will be most intense and sustained for a longer period of time in this region, rather than in the north.

6.6.3. Residual Efficacy

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

In Burkina Faso, cone bioassay for quality assurance will be conducted in at least 10 houses per district within 1 week of the start of IRS in the three IRS districts of Kampti, Kongoussi and Solenzo. The same houses will be used for subsequent monthly cone bioassay. For each house, 10 females will be introduced in 3 cones placed on the wall at heights of 0.5m, 1m and 2m. One control test will be conducted for each house by using a portable wall substrate (e.g. concrete block). The control test should be conducted outside to avoid possible fumigant mortality. Therefore, at least 400 An. gambiae Kisumu and wild An. gambiae s.l. will be tested monthly in each district. Female mosquitoes will be taken to the insectary for delayed mortality at 80 ± 10% relative humidity and 27 ± 2°C temperature. Mortality for houses sprayed with Actellic 300CS will be recorded after 24h. For houses sprayed with Sumishield 50WG mortality will be recorded every 24h for 5 days. Tests will be performed monthly until mortality is <80% for two consecutive months.

6.6.4. Pesticide Quality

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

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

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

The WHO PQ recommended pesticides are incompatible with the non-target ecosystems (humans, animals, and the environment), in that, if released to the environment in large quantities, they would have negative effects on land and water based flora and fauna (See Table 3). However, the IRS implementation process is designed to ensure that to the maximum extent possible, pesticides are deliberately and carefully applied to the walls and ceilings of dwellings, and do not come in contact with humans, animals, or the environment. IRS implementation is also planned to minimize and responsibly manage liquid wastes through the reuse of leftover pesticides, the triple rinsing of equipment, and the daily washing of PPE to remove trace pesticide. Wherever possible, recycling is incorporated into the waste management plan, particularly in the case of plastic bottles used for pesticide containers. Where it is not feasible to recycle materials, they are washed thoroughly and either given away or disposed of in a landfill, or contaminated solid wastes are incinerated in an approved incinerator that will destroy the pesticide and prevent environmental contamination (see Section 7.1.11). The Environmental Mitigation and Monitoring Plan in Annex A details the measures that have been and will be enacted to prevent contamination of ecosystems. In addition, there are solid and liquid waste management plans contained in the Safer Use Action Plan of this SEA (Chapter 7).

6.8. The Conditions under Which the Pesticide Is To Be Used

Chapter 4 of this document provides a detailed account of the environmental conditions in Burkina Faso under which the pesticide is to be used. IRS is scheduled to be performed prior to the rainy season in each location to maximize the effectiveness of IRS, and to avoid logistical complications from the degradation of transportation infrastructure due to flooding and washout.

During IRS, particular attention will be paid to any sensitive areas identified in Chapter 4, including water bodies, schools, hospitals, any area where organic farming is practiced or where bee-keeping or natural bee habitats are established, etc. In addition, bird-nesting habitat will be protected, and all insecticides will be kept away from all water habitats and resources. Prior to spraying, geographical reconnaissance will include identification of households in sensitive areas, and the IP will train sprayers to identify houses that should not be sprayed. IRS will be prohibited within 30 meters of sensitive ecosystems. If pesticide drift is observed, spraying will be halted until the cause has been determined. Drift could be a result of spraying an inappropriate surface with gaps that allow pesticide to escape, so the wall surface must be evaluated for fitness for spraying, and the structure potentially disqualified. Alternatively, if drift is caused by excessive wind (especially from spraying eaves outdoors) operators must wait until wind conditions subside. The IP will consult with the IRSS, the NMCP, the *Centre National de Recherche et de Formation sur le Paludisme* (National Center of Research and Training on Malaria), and other in-country organizations to implement entomological monitoring activities regarding the application of pesticides in or near ecologically sensitive areas, such as wetlands, lake shore, river edge, and protected areas, and follow their policies and guidelines – unless the conditions prescribed herein are more strict, in which case the SEA will have precedence. Strict supervisory control will also be established to prevent contamination of agricultural products.

6.9. The Availability and Effectiveness of Other Pesticides or Non-Chemical Control Methods

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

This IRS program is limited to using those pesticides that are on the WHO PQ list of recommended pesticides. WHO currently recommends 16 formulations from five chemical classes for IRS, each with a specific dosage regime, duration of effectiveness, and safety rating.[23,24,25] Each of these agents has been evaluated for effectiveness within the program, and continuing monitoring for resistance and susceptibility will be employed to allow up-to-date decisions prior to each spray campaign. One goal of this SEA is to broaden the options for pesticide use to six recommended pesticide classes (including chlorfenapyr in the pyrrole class, and the clothianidin/deltamethrin combination, if and when it is recommended by WHO PQ), to combat periodic resistance development.

Nonchemical means of malaria vector control are examined and discussed briefly under Section 6.3, Integrated Pesticide/Vector Management (IPM/IVM), but are generally not effective on a large scale for malaria vector control. For example, while elimination of standing water breeding habitats is a logical and sensible concept, the malaria mosquitoes only need the smallest of aquatic habitats to successfully reproduce, and it is nearly impossible to eliminate all of these minute breeding habitats (e.g., hoof prints or tire ruts).

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

[24] Chlorfenapyr is currently under consideration to be included. The 17th WHOPES PQ Working Group (2014) recommended that, considering the potential efficacy of chlorfenapyr to kill pyrethroid-resistant *Anopheles,* further evidence be gathered in Phase II to assess the efficacy of indoor residual application of chlorfenapyr 240 SC against malaria vectors, following the WHO guidelines for IRS.

[25] http://www.who.int/pq-vector-control/prequalified-lists/en/

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

6.10.1. Relevant Institutions

The CILSS was created in 1973, following the extreme droughts that occurred in the Sahelian region at the beginning of the 1970s. It is composed of 13 member states located in the Sahelian zone (Benin, Côte d'Ivoire, Burkina Faso, Cape Verde, Gambia, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Senegal, Togo, and Chad). The general objective of the committee is to organize and support research for food security and the fight against the effects of drought and desertification to ensure resilience and ecological equilibrium. Since 1992, the CILSS has also been responsible for the regulation of the pesticide homologation in the member states. The objective of this regional regulation was to bring together the expertise and resources in order to improve environmental and human health protection.

The *Comité Sahélien des Pesticides* (CSP; Sahelian Comity of Pesticides) commenced operations in 1994 as the executive body of this regional policy. The CSP provides two lists of pesticides. The first lists the trade names of the authorized formulations in agriculture (general list), and the second lists the formulations authorized for gardening. Since the creation of the CSP, member states have not been allowed to have an autonomous regulatory body in the field of pesticide homologation.

In 2000 Burkina Faso created the *Commission Nationale de Contrôle des Pesticides* (CNCP; National Commission on Pesticides Control), in charge of the application of the CSP directives in the country. This commission (with representation from the Ministry of Agriculture (MOA), Water Resources, Sanitation and Food Security; Ministry of Environment and Fishery Resources; Ministry of Health; Ministry of Economy and Finance, etc.) was placed under the authority of the MOA and became operational in 2007. The CCNP is responsible for pesticide management (procurement, handling, transport, storage, distribution, use, and waste management). Agriculture technicians, called brigadiers, are trained in outdoor pesticide spraying methods and not for IRS. These technicians are used as volunteers, at the village level, to assist in spraying the villages for the culture's protection.

A Toxicovigilance Committee is active, composed of relevant actors like the environment and health ministries, and companies (cottons, chemicals units) who have a responsibility for pesticide management. The objective of the committee is to have a framework for identifying and evaluating the toxic risks existing in a community, and consider the impact of chemical products.

Management of obsolete pesticide stocks represents a large burden in developing countries. The lack of resources and infrastructure for collection and treatment often leads to potentially harmful waste disposal. In the absence of national management, only large companies collect, store, and try to eliminate their waste.

The *Societé Africaine de Produits Phytosanitaires* (SAPHYTO) is the lone official company producing pesticides in Burkina Faso. It imports active ingredients, and fabricates products and commercializes them. This company, located in the industrial area of Bobo-Dioulasso, is active in agriculture, animal husbandry (veterinary practice), and public health (vector-borne diseases control). For waste management, SAPHYTO conducts incineration and recycling of most of the waste in Burkina Faso. It has an agreed-upon protocol with the regional directorates of agriculture.

6.10.2. Laws and Regulations

Burkina Faso is party to the following international environmental agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Marine Life Conservation, Ozone Layer Protection, Wetlands. It has signed, but not ratified, the Law of the Sea and the Nuclear Test Ban.

Environnemental Law of Burkina Faso: Loi n°006-2013/AN *portant Code de l'Environnement du Burkina Faso*

This law is the overarching legal framework responsible for management of the environment in Burkina Faso. Article 9 of the Environment Code mandates maintenance of the quality of the environment, its restoration, and the enhancement of natural resources in general.

A specific section of this law demands that all projects and programs must be subjected to a mandatory environmental impact assessment, which is eventually reviewed by the Ministry of Environment, before approval is provided.

The implication of this law for the IRS program is that before the start of the pilot IRS program, an environmental impact assessment report will have to be presented to the ministry in order to fulfill the host government regulations, or, the Ministry of Health can write to the Ministry of the Environment to request a derogation to start the activities, while making the commitment to submit the PMI SEA when completed..

Chapter II of this environmental law specifically provides guidance on the use of pesticides and fertilizers with respect to environmental protections.

Common regulation for the registration of pesticides in CILSS Member States

Under the umbrella of the Committee on Drought Control in the Sahel, the member states (Burkina Faso, Cape Verde, Chad, Guinea Bissau, The Gambia, Mali, Mauritania, Niger, and Senegal) established a Common Regulation for Pesticide Registration. The main objective of this Common Regulation is to combine the expertise on pesticide evaluation and management of all CILSS member states for pesticides registration. The CSP, the common pesticide registration body, became operational in 1994. It assesses registration dossiers submitted by the agrochemical industry and grants sales permits valid for all its member states. The MOA will submit to the SPC a registration dossier requesting registration of carbamates and organophosphates in Burkina for use in public health regulation.

The Ministry of Environment is charged with the responsibility for designing the conditions for the transportation, storage, and use of insecticides to prevent risks to the public health and the environment.

These conditions are mainly borrowed from the FAO/WHO guidelines for pesticide storage and transportation. All IRS activities supported by USAID base best practices on the guidelines set forth by these two institutions in terms of pesticide storage and transport.

Decree n°98-48 1/PRES/PM/CMCIA/AGRI of 9th December 1998 for conditions of importation, commercial, storage, distribution of pesticides.

The law gives responsibility to the MOA for authorization for pesticides importation. However, the certificate is issued by CSP, and, as discussed under the Environmental Law, an application for registration will be made to the SPC for registration of carbamates and organophosphates.

A new pesticide management control: *Loi* N°026-2017/*AN Portant Contrôle de la Gestion des Pesticides au Burkina Faso*

The purpose of the import control is to ensure that pesticides admitted for use in Burkina Faso comply with the regulations in force and with the technical specifications defined. Import control includes documentary control, inspection, and the analysis of the quality of pesticides.[26]

[26] Loi N°026-2017/An Portant Controle de la Gestion des Pesticides au Burkina Faso. http://www.assembleenationale.bf/IMG/pdf/loi_026-2017_portant_pesticide.pdf

Every importer of pesticides holds the following documents:

- **A valid import license issued by the Minister responsible for trade;**
- **A prior order authorization issued by the Pesticide Control Station;**
- **A valid prior import declaration issued by the Minister in charge of trade;**
- **Aa certificate of physicochemical analysis of pesticides issued by a mandated laboratory other than that of the formulator;**
- **A National Certificate of Conformity (CNC) issued by the Minister in charge of trade; and**
- **A purchase invoice issued by the supplier.**

However, the importation of pesticides as a donation is the subject of a declaration by the beneficiary and authorization by the government after advice from the National Pesticide Management Committee. Pending the operationalization of the law, the CSP remains the only structure responsible for the approval of pesticides.

Forest Law, 1997

Chapter IV of this law specifically mentions the need to protect water bodies and catchment areas against pollution, and calls for project implementers to take necessary measures to avoid pollution of water or otherwise face fines and other restrictions. This law is significant to the VectorLink program, which will use insecticides that could potentially pollute the natural and artificial water bodies found in the southwestern region, especially the rivers described in Section 5. However, the IRS activities will not be undertaken in the areas classified as protected under the Forest Law. As shown previously above, forests and conservation areas referred to as classified are under the protection of the state and no settlement or anthropogenic activities are allowed. Since the IRS targets households, and humans do not live in these classified forests, no IRS activities will occur in these zones.

6.10.3. Strength and Ability of Enforcement

Enforcement in Burkina Faso is a responsibility primarily shared by the *gendarmerie* and the police. The environmental police are empowered by territorially competent authorities to ensure public tranquility, safety and security without prejudice.[27]

Said agents are bound by professional secrecy. They must carry a professional card indicating their authority during their mission.

For pesticide management, all state members of the CILSS that have ratified the Common Regulation are mandated to adopt legislation that lays out financial and/or criminal sanctions for offenders in case of non-compliance with the regulation. The CSP is charged with preparing a list of pesticides whose use is banned or severely restricted in the CILSS member states. Member states' regulations must enforce the conditions required by the Common Regulation, notably:

- **The quality of formulations placed on the market**
- **The authorized areas of use and the restrictions as specified on the provisional registrations and registrations**
- **The standards and use indications shown on the labels**

[27] Loi n°006-2013/AN portant Code de l'Environnement du Burkina Faso.

- **The use of the commercialized pesticides according to the indications as specified on the labels**
- **The effects of the pesticides on the environment**

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. PMI has developed guidelines for IRS operations ("Best Management Practices (BMP) for Indoor Residual Spraying in Vector Control Interventions," updated 2015), and provides a training manual, the Spray Operator Pocket Guide (Were, 2014). Other resources include the *Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning,*[28] USAID PMI's IVM PEA (USAID, 2017 Update), as well as this SEA, all of which provide precautions and recommendations on many aspects of IRS operations. The IRS BMP manual and the PMI IVM PEA requirements are the primary references and have precedence, but the other documents may be used as a reference. It is not incumbent upon the IP to comply with non-PMI documentation except where required by law. However, PMI/USAID requirements are usually stricter than others, so there should not be a conflict.

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

- **A training of trainers program, in which potential supervisors,[29] storekeepers, and team leaders are trained on all aspects of IRS operation. Areas of training will include planning of IRS, household preparations, recordkeeping, community mobilization, rational/judicious use of insecticides including sprayer and PPE cleaning, personnel management, and environmental aspects of IRS – including geographical reconnaissance, and data recording and analysis.**

- **The training of temporary workers recruited from local areas and trained as spray team members (operators, team leaders, and wash persons). New operators will receive five to seven days of training prior to the spray operations.**

More information on the training that will be provided is in Section 7, the Safer Use Action Plan.

6.12. THE PROVISIONS MADE FOR MONITORING THE USE AND EFFECTIVENESS OF THE PESTICIDE

Entomological monitoring is firmly established in the PMI Burkina Faso Work Plan, and is used for insecticide decision-making, as well as monitoring the effectiveness of applied insecticides. The elements of this monitoring have been laid out in previous sections.

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

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

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

Another key characteristic of pesticide effectiveness is the longevity of the treatment. This characteristic has important economic and health implications: the program must adjust its spray schedule to make sure that there is active pesticide on the walls of homes during critical breeding periods. Unfortunately, the guidance that is provided with regard to effective period for each pesticide is very broad (e.g. 3-6 months), and the effective period is probably subject to complex environmental factors such as heat, humidity, and substrate (wall, ceiling) composition. The insecticides tests' efficacy is detailed in Section 7.6.

Pesticide manufacturers are well aware that duration of effectiveness is important, and in some cases they are reworking their formulations to provide greater longevity. This is the case for pirimiphos-methyl (organophosphate), which has been formulated as a capsule suspension (CS) that may extend the effectiveness of the application out to six months. Because of the length of the malaria season in Burkina Faso, this characteristic may be critical to the success of IRS, and this insecticide will be used in 2018, along with the new clothianidin insecticide.

7. SAFER USE ACTION PLAN

This section outlines the safer use action plan proposed for the potential adverse impacts outlined in Section 6. The primary mitigation measures include delivery of a mix of IEC approaches targeting the residents and spray operators and all IRS personnel, training of spray operators and strengthening supervision and monitoring, and provision of appropriate PPE and facilities for the storage and disposal of pesticides and contaminated waste. The mitigation measures, along with monitoring and reporting information, are compiled in the EMMP found in Annex A.

7.1. IMPLEMENTATION CONDITIONS

During implementation, PMI/Burkina Faso and its PMI IRS IPs will adhere to the conditions detailed in this Safer Use Action Plan, and in the EMMP, Annex A of this report.

7.1.1. QUANTIFICATION OF PESTICIDE REQUIREMENTS

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

7.1.2. PESTICIDE QUALITY ASSURANCE

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

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

7.1.3. PESTICIDE TRANSPORT

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

A lockable box truck is the expected vehicle to transport insecticides over land from central to district stores. If box trucks are not available, the IP will notify the COR to receive instructions for an alternative security mechanism. (If during transport the pesticides are to be left unattended for any period of time, including lunch breaks or overnight stops, a lockable box truck is *required*.) All vehicles must be in good condition and pass the Pre-Contract Vehicle Inspection performed by the Environmental Compliance Officer (ECO) or a qualified designate, using a smart phone.

Prior to long-distance transport of the insecticide from the customs warehouse or VectorLink Burkina Faso central storage facility, drivers will be trained on general issues surrounding the insecticide and how to handle

emergency situations such as accidents or spillage. Training for long-distance transport will include the following information:

- **Purpose of the insecticide (indoor use for malaria protection, not for agricultural or any other outdoor use)**
- **Toxicity of the insecticide**
- **Security issues, including implications of unauthorized access to or use of the insecticide**
- **Hazardous places along the routes to be taken, and mitigation measures**
- **Steps to take in case of an accident, spill, or emergency (according to BMP standards)**
- **Combustibility, and toxicity of the combustion byproducts of insecticide**

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

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

Figure 7 below provides a list of key responses to mitigate the impact of an insecticide spill.

IN CASE OF INSECTICIDE SPILLS

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

Figure 6: Emergency Response to a Spill

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

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

7.1.4. Qualification of Warehouses (Storage Facilities)

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

- **Located at least 30 meters from flood plains, wetlands and water bodies, markets, schools, dwellings, beehives, and protected areas. Warehouses may not be located in the buffer zones of protected areas, or in schools.**
- **Spacious enough to store insecticides in bulk and to store other IRS commodities**

separately

- **Providing a separate space for the storekeeper's office**
- **Well ventilated and allowing for air circulation**
- **Built of concrete or other solid material**
- **Impervious flooring, or floor must be completely covered by a leak-free tarpaulin**
- **Watertight roofing**
- **Barred and screened windows**
- **Preferably two exits from the pesticide storage area for emergency purposes**
- **A fire extinguisher**

In addition to the above, all facilities used for storage, distribution, and transportation of insecticide products should comply with relevant requirements of Burkina Faso pesticide regulations. During the logistical needs assessment, the PMI IRS IP will identify warehouses at the district level that can meet these requirements. PMI cannot provide funds for the construction of new buildings, but can assist in the modification or renovation of existing facilities. In Burkina Faso, IRS is implemented in partnership with the Ministry of Health/NMCP; therefore, some warehouses are located on District Medical Office property for logistic and security purposes. There is also the possibility of using the warehouses of departmental services of the MOA. This would meet the eligibility criteria of the project requirements.

7.1.5. Qualification of Liquid Waste Disposal Facilities (Wash Areas, Soak Pits, and Evaporation Tanks)

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

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

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

Although the soak pit captures the majority of pesticide from wash waters, small amounts may pass through and enter the soil below. Soil characteristics affect how pesticides move through the soil, and how they break down by environmental or microbiological degradation. Clay soils have a high capacity to absorb many pesticides, but if hard-packed may have limited percolation abilities. Sandy soils have a much lower capacity to absorb pesticides, but liquids percolate rapidly. Where possible, locate facilities on fine textured soils with

organic content and good absorptive properties to capture and degrade trace amounts of pesticide. Hard-packed clay or rocky soils are not appropriate.

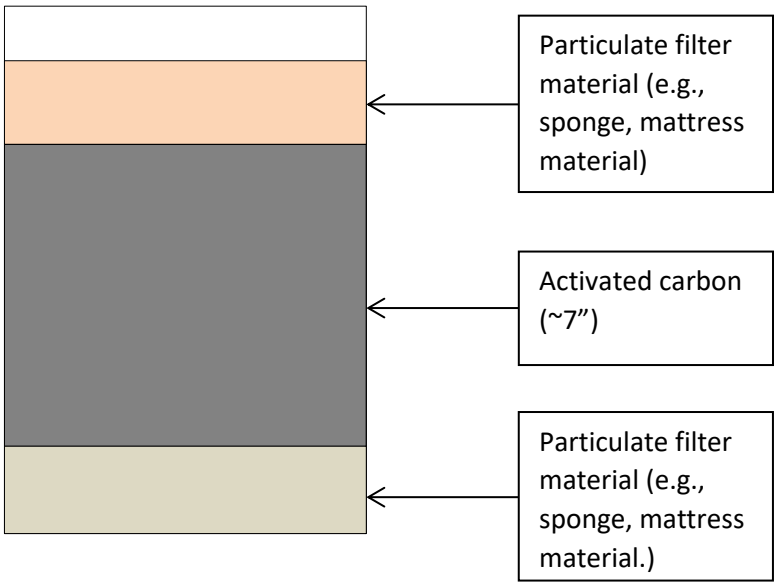
Pesticides may move in water runoff as compounds dissolve in water or attach to soil particles. Facilities should be located on high, level ground to minimize exposure to runoff. Avoid steep slopes or natural runoff flow lines. Where necessary, curbs or berms will be constructed around wash areas to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

Mobile Soak Pit (MSP)

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

Figure 7: Mobile Soak Pit Layers

Designed and drawn by Peter Chandonait, Abt Associates, Inc.



In this situation, the operators carry a MSP filter, wash barrels, and a tarpaulin with them, and construct a temporary wash facility at a suitable site within the village where they will stay. The MSP filter is a 20-25 L bucket with highly adsorbent activated carbon that removes pesticide contamination from the wash water, so that the water that exits to the ground is purified. For more information on the mobile soak pit, please see the PMI BMP manual.[30]

7.1.6. Warehouse/Storage Risk Management

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

- **A trained storekeeper will manage each facility and will wear gloves, a mask, overalls, and boots when in the pesticide area of storage.**

[30] Chandonait, Peter. February 2015. *President's Malaria Initiative BMP Manual Best Management Practices (BMP) For Indoor Residual Spraying (IRS) In Vector Control Interventions.* Bethesda, MD. PMI | Africa IRS (AIRS) Project, Abt Associates.

- **No smoking or eating will be allowed within 30 meters of the pesticide storeroom.**
- **Pesticide storage facilities must have thermometers installed for daily temperature recording.**
- **Basins, soap and clean water will be available at all times in all the facilities.**
- **Recommended pesticide stacking position and height in the warehouse as provided in the FAO Storage and Stock Control Manual will be followed.**
- **A fire extinguisher will be available in the storage facilities and all site workers will be trained on how to use this device.**
- **Warning notices will be placed outside of the store with a skull and crossbones pictogram and warnings in the local language.**
- **Insecticides must be lifted off of the floor via pallets or shelves, and separated from the walls of the storeroom by 9-12 inches.**
- **First-aid kits must be fully stocked and available in all the central warehouses and secondary stores. Security and inventory management of first aid supplies is mandatory.**

Accidental Warehouse Fires

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

7.1.7. Fetal Exposure (Pregnancy Testing)

All female candidates for spray teams will be tested for pregnancy before being recruited into the spray operations, and every 30 days until operations end. Provided their work history has been acceptable, females who have been hired and later found to be pregnant will be reassigned 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.

7.1.8. Spray Operator Exposure

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps, including hands-on exercises prior to the beginning of the spraying campaign. They will also be trained to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training will be conducted in accordance with the IRS Training Guide for Spray Operations (USAID, 2009) and the 2015 IRS BMP manual. Potential spray operators must also pass written and practical tests at the end of training.

Training for monitoring spray operators for symptoms of pesticide exposure will be mandatory for team leaders and supervisors, as well as for storekeepers and other senior personnel. Any case of an operator or beneficiary displaying symptoms of exposure will require the immediate completion of a standard Incident Report Form by the district coordinator, who will forward the report to the IP's headquarters within 24 hours. The incident report must be received from the IP's Technical Project Manager (TPM) by PMI COR within 48 hours.

For malathion and fenitrothion organophosphates, it may be necessary to monitor the level of acetyl cholinesterase in any worker who may have been exposed to contamination. Occupational exposures to

organophosphate insecticides are measurable using blood cholinesterase testing and urinary excretion of chemical biomarkers. PMI has evaluated various approaches for monitoring sprayer exposure to organophosphates, and has determined that biomonitoring is not required when using pirimiphos-methyl. Moreover, the WHO PQ Working Group recommendations stated that "provided that operational guidelines are followed, routine cholinesterase monitoring of spray men during IRS programs is not required" for Actellic CS.

7.1.9. Beneficiary Exposure

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

NMCP, DMOs, and the PMI IRS IP and other partners will work with relevant institutions at all levels to carry out an IEC/BCC campaign to sensitize residents to IRS activities, in accordance with WHO guidelines and also the Burkina Faso National Malaria Strategic Plan 2014-2020 and PMI Malaria Operational Plans. The IEC campaign (as well as IRS project leaders and Ministry of Health/NMCP Officers) should focus on the following elements of residential safety during an IRS program:

- **Clear homes of mats or rugs, furniture, cooking implements and foodstuffs prior to spraying; If furniture cannot be moved out of the home, then move it to the center of the room and cover with impermeable material.**
- **Residents must stay at least 10 meters from the home during spraying, and for two hours after spraying.**
- **Move and keep all animals at least 10 meters from the home during spraying, and for two hours after spraying.**
- **After two hours, open all windows and doors and air the house out for ½ hour.**
- **Sweep up any insects killed from the spraying and drop them in latrine pits before allowing re-entry by children and animals.**
- **Do not relater or paint over the sprayed walls after spraying.**
- **Keep using bed nets for additional protection against malaria.**
- **If skin itches after re-entrance into home, wash with soap and water; For eye irritation, flush eyes with water. For respiratory irritation, leave the home for fresh air; For ingestion, or if symptoms of other types of exposure persist, contact program staff or go to nearest health facility that has the appropriate medical intervention.**

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

- **Each spray operator must be given adequate covering material (3m by 3m minimum), which should then be used to cover household effects that have been moved to the center of the room (rather than outdoors) because it has started to rain. More than one sheet may be required, depending on the size of structures and the amount of belongings.**
- **Household effects can also be moved into structures that are not targeted to be sprayed, e.g., an isolated kitchen or domestic animal shelter.**

- **Household effects can alternatively be moved to one room that will not be sprayed on that particular day, but on the next day.**
- **The spray teams should pay close attention to any signs of potential rains so that they prepare the communities accordingly.**
- **When it rains in the middle of spraying, stop the spraying activities; resume when the rain stops and the skies clear.**

7.1.10. Pesticide Exposure and Treatment

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

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

7.1.11. Solid and Liquid Contaminated Waste Management

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

Liquid contaminated wastes will be disposed of on a daily basis in soak pits that are carefully sited and designed according to the criteria in this Safer Use Action Plan and the PMI BMP manual. The soak pit is designed so that pesticides are adsorbed by the charcoal layer and held until environmental processes result in the degradation of the pesticide. Thus, there should be no contaminated liquid waste to deal with at the end of the spray season.

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

Incinerators recommended for disposal of contaminated wastes fall into two categories:

- **Basel Convention technical standards, for all insecticides that do not contain greater than 1% chlorine**
- **WHO/FAO standards, which apply if using DDT or insecticides that contain >1% chlorine**

For wastes containing less than 1% chlorine:

- **The recommended combustion temperature is >850 °C.**
- **An after-burner is required, with a residence time of at least two seconds.**
- **The incinerator must have emission control, including particulate matter filters.**
- **Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location. In Burkina Faso, as solid wastes are incinerated in a PMI-owned incinerator, ash and slag will be incorporated**

into cement blocks and buried.

For wastes containing greater than 1% chlorine:

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

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

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

Cardboard boxes previously containing intact insecticide sachets or bottles are not considered contaminated waste. In many cases uncontaminated boxes can be recycled, or can also be disposed of as normal non-hazardous wastes. Incineration is not recommended for cardboard boxes unless they have been contaminated by pesticide leakage or used for the storage of other contaminated wastes. In Burkina Faso, the incineration of contaminated wastes will take place at the provincial medical hospitals in respective regional capitals, or by SAPHYTO. SAPHYTO is the lone official company producing pesticides in Burkina Faso. It imports active ingredients, and fabricates products and commercializes them. Created in 1989, this company, located in the industrial area of Bobo-Dioulasso, is active in agriculture, animal husbandry (veterinary practice), and public health (vector-borne diseases control) (MECV, 2005a).

The EMMP in Annex A gives further details on the steps and measures that will be taken to prevent negative impacts on the non-target ecosystems from liquid and solid IRS waste materials and disposal practices.

Annex A: Environmental mitigation and Monitoring Plan

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
1. Education, Technical Assistance Training	Activities involving studies, education, technical assistance, training, of information transfer, except to the extent they directly affect the environment (such as construction of facilities), are recommended for categorical exclusion.	N/A Categorical Exclusion	N/A	N/A	N/A	N/A
2. Research and Development	Entomological surveillance and vector control research use laboratory equipment, chemical reagents, insecticides, and entomological surveillance supplies that have the potential to cause adverse health and environmental impacts if not properly managed. These materials require special care and management to minimize	• Implement laboratory environmental, health, and safety (EHS) manuals with standard operating procedures (SOPs), or use existing SOPs, for laboratory operations in accordance with country-specific compliance mechanisms. • Implement SOPs for the safe storage, transport, and use of equipment, chemical reagents, insecticides, and supplies in conformance with international best practices (e.g., WHO, FAO) and host country requirements. • Provide training to workers on the approved SOPs or Waste Management Plan	Laboratory personnel within the respective country, with oversight provided by Abt Associates technical experts.	a. EHS manual/Standard operating procedures (SOPs) implemented per PMI and country-specific requirements. b. Training of staff in activities related to the laboratory EHS manual/SOPs	• Review of EHS manual/SOPs to ensure it is appropriate, and complies with PMI, WHO and country-specific recommendation for safety, use of protective equipment (if needed), spill prevention, and training.	• Routine site visits, as needed, to ensure accordance with operating plan

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
	their expiration and/or damage.	(WMP) developed for properly handling and disposing of wastes.			• Review training materials and logs to verify trainings were conducted. • Confirm during routine visits that SOPs are being effectively implemented and that workers are reporting EHS incidents • Include date of visits, findings and non-compliance issues in annual EMMR • Include photographs from site visits.	
3. Public Health Commodities	N/A	N/A	N/A	N/A	N/A	N/A
4. Small-Scale Construction or Rehabilitation-on	No construction will take place under this contract. Rehabilitation or cosmetic improvements may lead to adverse environmental and health impacts if hazardous materials are present, or if rehabilitation activities are not properly managed. Exposure to certain building materials during rehabilitation activities can result in health impacts to workers.	• Implement rehabilitation activities in conformance with USAID best practices and host country laws and regulations. Refer to the "Small-Scale Construction" chapter of the USAID Sector Environmental Guidelines (www.usaidgems.org/sectorGuidelines.htm) • Only non-hazardous materials may be used for rehabilitation of facilities. In particular, asbestos and/or lead-based paint or plumbing will not be used, even if allowed by host country. • If existing hazardous materials are identified during planning or rehabilitation, implementing partners will cease rehabilitation activities until all such materials have been removed by other	USAID Missions personnel		.	• Final report upon completion of rehabilitation.

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
		qualified parties in compliance with host country regulations. • Implementing partners and/or sub-contractors will provide training to workers on applicable best practices.				
	Rehabilitation of facilities may generate debris and waste that contain both non-hazardous and hazardous materials and require proper disposal. Workers and others disposing of debris and wastes may experience negative health effects if appropriate PPE is not used.	• Implementing partners and sub-contractors will follow best practices, for properly disposing of waste resulting from renovation or rehabilitation activities. Contractors will train workers on the proper use of PPE, and best practices for handling and disposing of waste. • If the presence of asbestos is suspected in a facility to be renovated, the facility must be tested for asbestos before rehabilitation works begins. Should asbestos be present, implementing partners and sub-contractors must cease work until removal is carried out by others in conformity with host country requirements. Work may not re-commence until the facility is retested to demonstrate that asbestos removal has been effective. • All results of the testing for asbestos shall be communicated to the COR.	Abt Associates EHS managers and sub-contracting supervisors.	c. Best practices implemented d. Correspondence with contractors on renovation waste disposal	e. Review of intended best practices to ensure it is adequate f. Review records to verify training/briefing were conducted g. Receive and review certificates of waste disposal.	h. At least once, and as required prior to rehabilitation i. Once post-rehabilitation but prior to final disposal of wastes.
5. Small-Scale Water and Sanitation	N/A	N/A	N/A	N/A	N/A	N/A
6. Nutrition	N/A	N/A	N/A	N/A	N/A	N/A
7. Vector Control	1. Health and environmental impacts may result due to inadequate quality control of insecticides (i.e., procuring non-approved insecticides, improper storage, or	• Insecticide selection for any USAID-supported malaria program is subjected to the criteria listed in the USAID Programmatic Environmental Assessment, country SEAs, and host country requirements. • Procurement and inventory logs must be maintained.	District Coordinator (DC), Operations Manager (OM), Abt Environmental Compliance Officer (ECO), Abt Vector Control Manager	j. PMI BMPs reviewed and implemented k. Procurement and inventory logs maintained l. Proper PPE used by workers, if needed.	o. Inspection of facilities, conditions, PPE use, and logs p. Review waste management records and storekeeper	s. Daily monitoring by storekeeper or site supervisor t. Weekly monitoring by DC

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
	poor inventory management	• Ensure storage facility and personal protective equipment (PPE) are appropriate for the active ingredient used and in accordance with approved SOPs • Distribute insecticides to facilities than can manage such commodities safely in storage, use, and disposal (i.e., in a manner generally equivalent to Implementing partner's own SOWs/WMP)/	(VCM), Storekeepers (These positions are representative of the responsibilities required, but may not reflect exact job title.)	m. Operations facilities are sited appropriately n. All insecticide management records are reviewed and maintained	performance checklists. q. Verify that inspection reports and storage records are properly maintained and document verification in the annual EMMR. r. ECO performs mid-application inspections. Verifying that inspection reports are properly maintained and document verification in the annual EMMR	u. Monthly review of procurement logs and inventories by OM
	2. Occupational risks for workers involved in IRS campaigns.	• Inspect and certify vehicles used for insecticide or team transport prior to contract. • Train drivers • Ensure availability of cell phone, personal protective equipment (PPE) and spill kits during insecticide transportation. • Initial and 30-day pregnancy testing for female candidates for jobs with potential insecticide contact. • Health test all spray team members for duty fitness. • Procure, distribute, and train all workers with potential insecticide contact on the use of PPE. • Train operators on mixing insecticides and the proper use and maintenance of application equipment. • Provide adequate facilities and supplies for end-of-day clean up.	DC, OM, ECO, Chief of Party (COP), and Abt Associates technical experts within the respective country	a. Transport vehicles have a valid inspection certificate on-board. b. Drivers have a certificate of training completion. c. Transport vehicles are equipped with cell phone, spill kit, and PPE. d. Storekeeper has records of pregnancy testing for all female team members. e. Storekeeper has medical exam results for all team members. f. Operators wear complete PPE during application and clean	a-c. ECO inspection of vehicles in the field. d-e. ECO inspection of health records at operations sites. f-h. ECO performs pre-application inspections of inventories and training records, and mid-application inspection of PPE use and operator performance. i. Monitoring of on-line database for	a-c. 2 inspections per week d-e. One inspection per campaign, additional inspection if new hires or more than 30 application days. f-h. ECO pre-application inspections 2 per campaign, ECO mid-application inspection 5 times per week. i. Weekly

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
		• Enforce application and clean-up procedures.		up, according to SOP requirements. g. Operators mix insecticide properly, and equipment does not leak. h. All facilities are compliant, and materials required for clean-up are present. i. Inspections are performed as scheduled, corrective action taken as needed.	submission of inspection reports.	
	3. Health and safety risks for residents of treated houses (e.g., risks from skin contact and/or ingestion of insecticides)	a. Implement Information, Education and Communication (IEC) campaigns to inform homeowners of responsibilities and precautions, including washing itchy skin and going to health clinic if symptoms develop and do not subside. b. Ensure health facility staff are aware of insecticide poisoning management.	IEC officers, OM, ECO, host country Ministry of Health/Environment officials.	a. Review IEC materials and records and execute pre-application IEC campaigns	a. Review IEC materials and records to verify IEC pre-application campaigns were conducted and homeowners were informed of responsibilities and precautions.	a. Review IEC materials once per campaign
	4. Nearby residents may be exposed to insecticides if insecticides are not securely stores to prevent theft and misuse incidents, including illegal resale of insecticides	• Storage facilities and transportation vehicles must be physically secured to prevent theft. • Maintain records of all insecticide receipts, issuance, and return of empty containers. • Conduct analysis comparing number of houses treated vs. number of containers used. • Examine houses treated to confirm application • Perform physical inventory counts during application season.	Storekeepers, DC, sector mangers, logistics coordinator, OM, ECO	• Storage facilities and transportation vehicle are secured • All insecticide management records reconciled	• Inspection of storage facilities and transportation vehicles. • Inspection of insecticide management records. Storekeeper performance checklists. • ECO mid-campaign inspections.	• Daily monitoring by storekeeper or site supervisor. Weekly monitoring by District Coordinator • Examine houses during campaign according to schedule in SOPs. • Physical inventory counts

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
						twice per campaign per storeroom.
	5. Ecological risk to non-target species and water bodies from use of insecticides	• For shipments of insecticide over water, sachets/bottles will be packed in 220 liter open top barrels with a water-tight top and a locking ring, or in a similar durable container. Waterproof labeling must be affixed to the barrel, with the identity of the pesticide, number of bottles inside, the weight, the type of hazard posed by the contents, and the personal protective equipment to be worn when handling the barrel. • Train applicators on SEA operational requirements, SOPs, PMI BMPs, and approved WMP, developed for the safe and effective storage, distribution, application, and disposal of insecticides • Ensure application equipment and PPE are appropriate for the active ingredient used and in accordance with approved SOPs, and maintain equipment to avoid leaks. • Maintain application equipment • No application of insecticides within 30 yards of beekeeping sites	DC, OM, ECO	• Training materials and records • Equipment is maintained and operated to eliminate leaks. • Applicators only mix and apply insecticides according to SOPs	• Review training materials and records to verify trainings were conducted • Conduct inspections during operations. • Verify that inspection and incident reports are properly maintained and document verification in the annual EMMR. Include any issues identified during inspections in annual EMMR	• Inspect work records once per campaign • Inspections during operations 3 times per week • Review training materials once per campaign
	6. Environmental risk from disposal of liquid and solid wastes	• Handling, treatment, and disposal of nonhazardous (general waste) and hazardous wastes must be in accordance with the approved WMP/SOPs and the PMI BMPs. The WMP, which outlines SOPs for managing waste processes, must be in accordance with PMI best practices and host country requirements • Choose sites for disposal of liquid wastes, including fixed and mobile soak pit sites, according to PMI BMPs	DC, OM, ECO	• WMP implemented and disposal sites inspected and certified before campaigns. • Disposal sites near operations sites are appropriate according to PMI BMPs • Soak pits are constructed according to PMI BMPs • Soak pits perform properly throughout the application season	• Review WMP/SOPs to ensure it conforms to PMI BMPs and WMP is available on site • Pre-application inspection. Verify that inspection reports are properly maintained and document verification in the annual EMMR. Include any issues	• Pre-application inspection: once per campaign • Mid- and post-application inspections: twice per campaign • Review of WMP/SOPs during campaign

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
		• Construct fixed and mobile soak pits with charcoal according to BMPs to adsorb insecticide from rinse water • Maintain soak pits as necessary during season • Monitor waste storage and management during campaign • Monitor disposal procedures post-campaign		• Wastes are stored and managed according to PMI BMPs • Waste disposal is conducted in accordance with the WMP/SOPs and records maintained	identified during inspections in the annual EMMR • Mid- and post-application inspections and monitoring. Verify disposal practices in inspection reports and document in annual EMMR. Include any issues identified during inspections in annual EMMR. • Review WMP/SOPs for effectiveness and maintain on site	
	7. Improper incineration of wastes and disposal of residual as can pose a threat to air quality, soil, and the water supply and result in environmental and public health hazards.	• Waste will only be disposed in incinerators that comply with PMI BMPs. Collect and maintain treatment and disposal documents and records on file. • Country-level USAID EC documentation must contain guidance on proper disposal of wastes	COR, Abt ECO, Abt Technical Experts	• Incinerator specifications • Maintenance of treatment and disposal records • Reg 216 documentation for incinerator procurement and management services reviewed by COR and GH BEO.	• Review incineration records and document in the annual EMMR	• Review incinerator specifications prior to disposal arrangements • Annual review of disposal records
8. Testing of Insecticide-Treated Nets	1. Risk of theft from storerooms, followed by unintended use. 2. Pollution from improper disposal of packaging. 3. Surface or groundwater pollution from improper disposal of wastewater from washing nets	1. Store nets only in storerooms secured with sturdy doors, double locks, and barred windows. 2. Dispose of waste materials according to PMI BMPs.	1 – 4. ECO, USAID Mission	1. Storerooms are built or modified to meet PMI BMPs. 2. Evidence of a compliant disposal program in place.	1. Inspection of storeroom using checklists. 2. Inspection of disposal/ destruction records	1 – 4. Once per fiscal quarter.

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
	4. Risk of the use of nets for purposes for which they are not designed or intended					
9. Emergency Response	N/A	N/A	N/A	N/A	N/A	N/A

Annex B: Environmental Mitigation and Monitoring Report Form

Vector Link Burkina Faso

ENVIRONMENTAL MITIGATION AND MONITORING REPORT (EMMR)

ANNUAL REPORTING FORM

Implementing Organization:

Geographic location of USAID-funded activities:

Period covered by this Reporting Form and Certification:

List each Mitigation Measure from column 3 in the EMMP (EMMT Part 2 of 3)	Status of Mitigation Measures	List any outstanding issues relating to required conditions	Remarks
1. Education, Technical Assistance, Training			
2. Research and Development			
3. Public Health Commodities			
4. Small-Scale Construction			
5. Small-Scale Water and Sanitation			
6. Nutrition			
7. Vector Control			
8. Emergency Response			

ANNEX C: PUBLIC CONSULTATION & PREPARATION METHODOLOGY

This SEA was prepared by the PMI VectorLink Regional Environmental Compliance Manager, Sana Diop Dieng, under the supervision of Alexis Hardie, PMI VectorLink Environmental Compliance Manager, and Peter Chandonait, PMI VectorLink Director of Environmental Compliance and Safety. A short-term technical assistance trip was made to Burkina Faso, in order to meet with major stakeholders and gather the information necessary for the SEA preparation. During the first week, Ms. Dieng and Dr. Adama Kone, also in Burkina Faso to provide technical assistance for the startup activities, conducted field visits to the three target districts, accompanied by the NMCP focal point, to collect relevant information and data related to the SEA and to determine needed improvements, areas of special concern, and how best to protect sensitive areas while conducting IRS in an environmentally sound manner. The PMI VectorLink Environmental Compliance Manager first attended meetings of the NMCP, where he discussed the need for the SEA to meet U.S. regulatory requirements and the parallel Government requirement

Field visits were conducted by the PMI VectorLink Environmental Compliance Manager and the AIRS Senegal chief of party, Adama Kone, in three districts: Kampti (southwest region), Solenzo (region of Boucle du Mouhoun), and Kongoussi (central north region). In all the regions visited, meetings were first held with the Regional Directorates of Health, Environment and Agriculture at the regional level; the District Medical Office; and provincial Directorates of Environment and Agriculture at the district level. In these meetings, malaria emerged as the number one disease, with high disease burden in all the districts visited. Consequently, all the directors and DMOs welcomed IRS.

The AIRS Senegal PMI VectorLink Environmental Compliance Manager and the AIRS Senegal chief of party met with Jennifer Somtore, the PMI resident advisor, at USAID Burkina Faso to debrief on both STTA for the new VectorLink start-up activities and SEA preparation.

Meeting at the Burkina Faso Ministry of Environment, Green Economy and Climate Change

The PMI VectorLink Environmental Compliance Manager met the Directors of Environmental Protection, the National Bureau of Environmental Assessment (NBEA) Director of Inspections and Environmental Audits, and the *National Direction de l'Autorité de Radioprotection et de Sureté Nucléaire* (radio-protection and nuclear security). In order to conform to the country regulations, it was requested that the country conduct a Strategical Environmental Assessment with an EMMP – essentially the same thing as an SEA. The NBEA is responsible for environmental studies in Burkina Faso, and the Directors of Environmental Protection have authority to inspect project operations. Recycling of electronic waste must be completed in the NBEA-approved structure named Atelier Bocab.

Meeting with agents of SAPHYTO

The PMI VectorLink Environmental Compliance Manager met the responsible party for public hygiene at SAPHYTO, called the Hygiene, Security and Environment Responsible. SAPHYTO was formerly a branch of

Arysta LifeScience, which developed a contaminated-waste management system. After the field trips, the Director of Environmental Compliance and Safety prepared the first draft of this SEA, which was submitted to PMI. Comments and edits were received and incorporated into the final draft, which was submitted for all appropriate approvals.

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

ANNEX D: NAMES OF PARTICIPANTS

NAMES AND POSITIONS OF THE STAKEHOLDERS INTERVIEWED

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ANNEX E: SUMMARY OF ACUTE EXPOSURE SYMPTOMS & TREATMENT OF IRS PESTICIDES

Summary of Acute Exposure Symptoms and Treatment of WHO-Recommended Carbamate

Carbamates	Human Side Effects	Treatment
Bendiocarb	Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.	The affected person should stop work immediately, remove any contaminated clothing, and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer atropine.
Propoxur	Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.	The affected person should stop work immediately, remove any contaminated clothing, and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer atropine.

Summary of Acute Exposure Symptoms and Treatment of WHO-Recommended Organophosphates

Organophosphate	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. 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 solution 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 nervous system stimulants are all contraindicated.
Fenitrothion	Fenitrothion is the most toxic to humans of the insecticides recommended for residual house spraying, and has a relatively low margin of safety. It is absorbed through the gastrointestinal tract as well as through intact skin and by inhalation and 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.
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	Organophosphate poisoning is a medical emergency and requires immediate treatment. All supervisors and individual spray operators (in the case of dispersed operations) should be trained in first-aid and emergency treatment of organophosphate intoxication. The affected person should stop work immediately, remove any contaminated clothing, wash the affected skin with soap and clean

Organophosphate	Human Side Effects	Treatment
	be convulsions, coma, loss of reflexes, and loss of sphincter control.	water, and flush the skin with large quantities of clean water. Care must be taken not to contaminate others, including medical or paramedical workers. 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 of WHO-Recommended 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	Deltamethrin is a powerful broad-spectrum synthetic pyrethroid. It is of moderate toxicity to mammals as it is rapidly metabolized and does not accumulate. It poses low risk to humans when used at levels recommended for its designed purpose. Deltamethrin exhibits its toxic effects by affecting the way the nerves and brain normally function by interfering with the sodium channels of nerve cells. Typical symptoms of acute exposure are irritation of skin and eyes and neurological effects such as severe headaches, dizziness, nausea, anorexia, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness. Tremors and convulsions have been reported in severe poisonings. Inhaled deltamethrin has been shown to cause reversible cutaneous paresthesia (a burning, tingling, or stinging of the skin). Limited data exist for humans following chronic exposures. However, the following effects are suspected to be a result of chronic exposures in humans: choreoathetosis, hypotension, prenatal damage, and shock. Chronic occupational exposure to deltamethrin causes skin and	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 with 4% sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.

Pyrethroids	Human Side Effects	Treatment
	eye irritation. IARC has classified deltamethrin as "not classifiable as to its carcinogenicity in humans."	
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.
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 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 with 4% 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	If exposed, immediately remove any contaminated clothing. Soak any liquid contaminant on the skin; clean affected area with soap and warm water.

Pyrethroids	Human Side Effects	Treatment
	symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular twitching, convulsions, and coma may occur.	Rinse copiously with water when eye exposures occur, or with 4% sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.

Summary of Acute Exposure Symptoms and Treatment for Chlorfenapyr

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

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

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

ANNEX F: REFERENCES

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