

**SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT:  
DDT BASED INDOOR RESIDUAL SPRAYING FOR MALARIA  
CONTROL IN ZAMBIA**

**AMENDED FACE SHEET**

**PROGRAM/ACTIVITY DATA:**

Program/Activity Number: Zambia Supplementary Environmental Assessment  
Country/Region: Zambia/Southern Africa  
Program/Activity Title: President's Malaria Initiative  
Sub-Activity: IRS for Malaria Control in Zambia

Funding Begin: FY07 Funding End: FY09

EA Prepared By: RTI International and USAID/Zambia  
Amendment Prepared by: Tito Kodiaga, Consultant to RTI  
Current Date: July 2, 2008

IEE Amendment (Y/N): Yes

Filename & date of original EA: IRS for Malaria Control in Zambia ([36Zambia2\\_IRS\\_EA.doc](#)), June 16, 2008

**ENVIRONMENTAL ACTION RECOMMENDED:**

Categorical Exclusion: \_\_\_\_ Negative Determination: \_\_\_\_  
Positive Determination:  X  Deferral: \_\_\_\_

**ADDITIONAL ELEMENTS:**

CONDITIONS:  X  PVO/NGO: \_\_\_\_

**SUMMARY OF FINDINGS:**

The United States Agency for International Development (USAID) proposes to support Indoor Residual Spraying (IRS) in Zambia in 2008, in collaboration with other partners and funding from the Global Fund for AIDS/TB and Malaria (GFATM), the World Bank Booster Program, and the World Health Organization (WHO). Logistics and technical support (especially for environmental compliance) will be provided centrally through an agreement between USAID and Research Triangle Institute International (RTI). Country-level support, including technical, personnel and logistics, will be provided through agreements between USAID and RTI and the Health Services and Systems Program (HSSP).

The IRS implementation in Zambia forms part of an Integrated Vector Management (IVM) program involving accelerated scaling-up of the use of Insecticide Treated Nets (ITNs), supplemented with vector source reduction activities (environmental management and larviciding).

The National Malaria Control Centre (NMCC) of the Ministry of Health (MOH) intends to implement IRS in parts of 36 selected districts in 2008, covering about 1.6 million structures and providing protection for about 8 million persons against malaria. Four pesticides [alpha-cypermethrin, dichloro-diphenyl-trichloroethane (DDT), deltamethrin, and lambda-cyhalothrin] will be applied in strict compliance with environmental safeguards stipulated by the Environmental Council of Zambia (ECZ), as well as WHO guidelines and recommendations.

However, it is worth noting at this point that 100% compliance will not be achieved in terms of satisfying storage requirements. Owing to unavailability of funds from USAID, some storage facilities will not be fully environmentally compliant as recommended by the UN FAO Pesticide and Stock Control Manual. It has all the same been agreed that the NMCC will use the additional funding from the World Bank to upgrade the storage facilities. NMCC has also issued instructions to the districts to use the infrastructure budget funds at the district level to ensure that the storage facilities are upgraded to the required standard before the spraying commences. At a minimum, it is expected that NMCC should ensure that the storage facilities have the following requirements namely; ventilation, fire extinguisher, bucket of sand, warning signs, thermometer, wooden pallets and double padlocked door.

The combination of DDT and pyrethroids has proven effective for malaria control in Zambia and remains the combination preferred by the MOH. There are no plans for the MOH to introduce different pesticides in 2008 for IRS, although the Ministry is committed to evaluating options for a broader suite of pesticides for the purposes of vector resistance management. USAID support for malaria also includes provision of ITNs, malaria diagnosis and treatment and activities to reduce the burden of malaria among children and pregnant women.

This abbreviated SEA amendment is an extension of the "SEA for Indoor Residual Spraying for Malaria Control in Zambia (approved in 2007) which covered 15 districts at that time. The need for this document is warranted because (a) Use of DDT requires that every year the SEA is amended to reflect compliance concerns noted and mitigation measures recommended and or put into place.

The IRS programme in Zambia has focused spraying in the current 15 districts of Lusaka, Kafue, Chongwe, Chingola, Kabwe, Livingstone, Luanshya, Kitwe, Kalulushi, Kazangula, Solwezi, Mazabuka, Ndola, Chililabombwe and Mufulira.

According to "The Basics of Indoor Residual Spraying Environmental Health Assessments for Malaria Control" revisions or amendments to supplementary environmental assessments for IRS activities are only needed when (1) the project expansion area differs from the pilot area in environment, agriculture, and culture; (2) additional pesticide is needed (for resistance management); and (3) DDT is used and one year has elapsed since the signing of the original SEA.

This SEA amendment is thus triggered by the fact that it is one year since authorization to use DDT was provided through the SEA and now that another round of annual spray is approaching, an annual review of this SEA has thus been triggered.

### **Justification for Continued Use of DDT**

**Effectiveness:** The continued need for, and contextual use of DDT was evaluated as part of this SEA amendment in collaboration with NMCC. DDT remains an insecticide of choice for the Government of Zambia for IRS to control the mosquito vectors of malaria especially by targeting the informal settlements where it is effective. Apart from the relatively cheaper cost of the insecticide, the longer residual action of DDT of at least six months makes it particularly well suited for the length of annual malaria transmission in the country. However, the NMCC is currently developing a strategy for phasing out DDT for use in IRS and instead scaling up on pyrethroid based insecticides. The planned scale up to 21 new districts will not use DDT as the preferred insecticide but will instead use pyrethroids.

**Affordability:** The total estimated cost of the 2008-09 IRS program with continued use of the pyrethroid & DDT strategy is \$8,245,361. If the NMCC were to adopt the pyrethroid only scenario, the total estimated cost of the 2008-09 IRS program would be \$7,906,776. The estimated cost savings associated with changing from pyrethroid & DDT to pyrethroid only is \$335,585, or approximately 4.1% of estimated program costs for the current program.

**Demonstrated safe and judicious use:** Although there was no program in place to provide baseline data on environmental DDT prior to beginning the current IRS program, DDT monitoring will begin during this spray round and will be conducted in collaboration with the University of Zambia. A budget for this has been submitted to USAID and approval to commence monitoring accorded.

### **Status of National Implementation Plan (NIP) on persistent organic pollutants (POPs).**

The NIP was last reviewed in December 2007 by Ministry of Environment. The Environmental Council of Zambia (ECZ) has confirmed that as of the last update (January); there were minimal changes if any made to the document. ECZ will avail us the document.

### **Reporting requirements (full inventory of DDT imports under the Stockholm Convention on POPs)**

According to communication from Maxwell Nkoya of ECZ, Zambia in 2007 fulfilled its reporting obligation under the Article 15 of the Stockholm Convention (SC) for the period 2002-06 on DDT national consumption.

### **Rotation plan for insecticide resistance**

PMI has yet to develop a plan for rotation of insecticides to reduce vector resistance in the 2008 MOP. However according to communication between CDC, USAID and RTI there is need for such a plan to be in place and CDC has already proposed a model for designing such a plan.

The Entomology section (pg 18-21) of the 2008 NMCC Action Plan includes the following action to be taken in 2008 and the amount budgeted:

Conduct entomological surveys in 36 targeted districts - \$62,200.00  
Conduct vector susceptibility and resistance activities - \$54,000.00  
Implement insecticide resistance management - \$54,000.00

The entomology section plans from NMCC should be able to address the above concern during this year.

However, NMCC undertakes insecticide rotation among the same classes and this is currently being conducted. There has been no rotation within the same classes. The mode of action is the same and does not however, make any difference.

Currently though available information shows that there is no insecticide resistance used in IRS campaigns. NMCC is in the process of gathering more information/evidence through the Innovative Vector Control Consortium and Malaria Transmission Consortium projects as well as through the Operations research to validate this issue.

**Extent to which the proposed pesticide use is part of an IVM program**

The use of DDT for IRS in Zambia is part of the wider Integrated Vector Management (IVM) Program for malaria control. Other than pesticide application to eliminate the vector, the PMI program is involved in the accelerated scaling-up of the use of Insecticide Treated Nets (ITNs), supplemented with vector source reduction activities (environmental management and larviciding). The table below shows the other interventions pursued to ensure vector control.

Component	Objectives	Status	Strategies/operational design
<b>Preventive Interventions</b>			
ITNs	80% coverage in eligible areas by 2008 (3 nets/household)	72 % of households have at least one ITN	<ul style="list-style-type: none"> <li>o Regional mass distribution campaigns: free LLINs to all households</li> <li>o Free distribution to pregnant women and children under-five through ANC</li> <li>o Equity program provides free LLINs to vulnerable populations</li> <li>o Commercial distribution in urban areas</li> <li>o Treatment campaign of traditional nets</li> <li>o Eligibility: non-IRS households</li> </ul>
IRS	85% coverage of eligible households in 15 districts by 2008	80% of 700,000 households in 15 districts	<ul style="list-style-type: none"> <li>o Currently 15 of 72 district (tentative planning to increase to 36 in the near future)</li> <li>o Selection criteria: incidence level of urbanization, population density, eligible structures, health facility distribution; capacity for effective IRS campaigns</li> <li>o Annual spray campaigns/operations in all selected districts</li> </ul>
IPT (pregnant women)	80% of pregnant women access three courses, packaged with ITN and anemia reduction	72 % of mothers took at least 2 doses of IPT	<ul style="list-style-type: none"> <li>o Strengthen malaria component of ANC</li> <li>o National roll-out of focused ANC</li> </ul>

<b>Curative Interventions</b>			
Malaria Diagnosis	≥ 80% properly diagnosed	38%	<ul style="list-style-type: none"> <li>○ Expanding microscopy in all eligible clinic</li> <li>○ Introduce RDTs to all eligible facilities without microscopy</li> <li>○ Increase clinical diagnostic skills</li> </ul>
Prompt and Effective Treatment	≥ 80% of patents receiving		<ul style="list-style-type: none"> <li>○ Extend ACT (Artemether -lumefantrine) to private sector</li> <li>○ Strengthen malaria component in c-IMCI</li> <li>○ Roll-out c-IMCI</li> <li>○ Strengthen referral systems</li> </ul>

Sources: Assembled from various official documentation of MOH (2006-2010 Strategic Plan for Malaria; 2008 National Malaria Indicator Survey (preliminary results); 2007 Action Plan on Malaria)

### **Larviciding**

The 5 year strategic plan for Malaria (2006 – 2010) of the MOH indicates larviciding as a complementary intervention within an integrated vector management strategy malaria vector control. The focus will be urban, with an implementation time frame of April to early November.

### **Environmental Management**

Use of environmental management is very limited. The 5-year strategic plan envisages simple environmental modification and manipulation in urban settings as complementary interventions to the main interventions of IRS and ITNS.

### **Strategy for phasing out DDT for use in IRS**

The National Malaria Control Council has already set in motion plans to phase out the use of DDT for IRS. However the timeline or estimated timeframe is not yet determined.

### **Activities and Indicators of Previous Spray Season**

- ***Area Sprayed***

A total of 15 districts were sprayed during the year 2007 and they include; Lusaka, Kafue, Ndola Chongwe, Kitwe, Kalulushi, Chililabombwe, Mufulira, Livingstone, Luanshya, Mazabuka, Lusaka, Kazungula, Chingola and Kabwe.

- ***Number of Households Sprayed***

A total of 657,695 structures/households sprayed out of the targeted 700,000 in the targeted 15 districts

- ***Coverage Area***

The coverage was 94% which is considered as very successful in relation to the benchmark set by USAID for achieving coverage.

- ***Total Sachets Used***

A total of 65,000 sachets of DDT was procured and 65,075 ended up getting used because of DDT left over from the previous spray season.

### **Environmental Non-Compliance Issues noted during 2007**

During the 2007 spray rounds in the 15 districts using DDT, RTI Environmental Compliance Inspectors and the Environmental Council of Zambia (ECZ) conducted pre and post spray environmental compliance inspections, and noted several issues where implementation was not in compliance with the 2007 SEA (see annex section for Compliance Inspection report and recommendation for 2007).

- Inadequate disposal facilities for waste water used in rinsing of DDT; some districts lacked proper evaporation tanks and ablution blocks which are required and are a necessary infrastructure for the disposal of DDT waste water. Instead the DDT residue in some cases it was noted was being disposed in soak pits or left in barrels at the warehouses to dry up. This is a serious aspect that could lead to environmental degradation and human health impacts.
- Inadequate pesticide storage facilities; At the time of spraying in 2007, most of the districts did not have adequate pesticide storage facilities that meet the minimum requirements set forth by UN FAO which require adequate ventilation, space, security, signage etc. Storage of DDT requires stringent security measures to be in place and adequate ventilation and this was missing in many of the warehouses visited.
- Lack of DDT monitoring; there has been efforts made to initiate steps for carrying out studies aimed at monitoring the level and presence of DDT in the environment as a result of using this chemical in IRS. Communication between the NMCC, USAID, RTI and the University of Zambia (UNZA) has been on going in order to formalize the DDT monitoring process. It is proposed that experts from UNZA be incorporated in undertaking the studies. There had been a delay from RTI in submitting an official letter to USAID requesting for cooperation between UNZA, ECZ and NMCC in this study. This is a critical requirement in view of the bioaccumulation characteristics of DDT there is need to monitor its prevalence on the environment.

### **Mitigation Plans for enhancing environmental compliance for 2008**

During the year 2008, RTI in collaboration with NMCC intends to improve on the non compliance aspects that were noted in order to adhere to the mitigation measures proposed in the Environmental Monitoring Plan (EMP) that is specified in the SEA. To this end, RTI already plans to undertake the following steps namely;

- Construction of evaporation tanks and ablution blocks in all the 15 districts before the next spray round for 2008 which is expected to begin in September. There will be a separate line for disposal of pyrethroids and DDT as well as cemented washing bays and ablution blocks in all the districts. A qualified contractor will be hired to undertake the construction targeted to be complete during the 2008 spray season. RTI technical staff on the ground has already produced architectural designs and plans for the evaporation tanks and there is on going consultation between RTI, HSSP and the NMCC on identification of suitable locations to site these facilities. Expression of interest seeking qualified

contractors will be sent out in July. Training for district supervisors is already underway. It includes detailed instruction on safe disposal of DDT and pyrethroids.

- RTI plans to begin monitoring for DDT levels in the environment and will undertake this jointly with the Environmental Council of Zambia, NMCC and University of Zambia. The DDT monitoring will include collection of baseline samples prior to IRS followed by routine and evaluation monitoring through out the project. This monitoring model will be based on the on going DDT monitoring activity that is on going in Uganda at present and being carried out by RTI experts in collaboration with national experts. A formal letter was sent to USAID to review the nature of the collaboration. After the NMCC finishes reviewing and approving the letter, it will be sent to UNZA for signatures.
- RTI plans to recruit an environmental specialist to be based in Zambia and work with the IRS partners regularly to ensure compliance and monitoring is achieved especially with DDT application.

### **Status of Disposal of DDT Waste including Empty Packaging Materials**

- Disposal of DDT waste in accordance with the Basel and Rotterdam convention was one of the key compliance issues that RTI was expected to provide support in. RTI was expected to provide continued support to the ECZ in ensuring that the DDT wastes are transported and disposed in South Africa while adhering to the Basel convention on PoPs. To date all the DDT wastes have been collected and stored at a central warehouse in Lusaka. In April and May 2008, the DDT wastes were transported to South Africa via Zimbabwe for eventual incineration in compliance with the Basel Convention. Written permission was granted to ECZ to allow transport via Zimbabwe.
- A certification of successful thermal incineration has been provided by Thermopower Process Technology (PTY) Ltd which is the South African Company that was contracted to destroy the plastic sachets with DDT residue.
- Due to financial constraints it is not possible to renovate and improve the storage facilities in spite of their inadequacies. However, the NMCC is exploring ways of renovating the storage facilities by leveraging funds from the district grants.

A **Positive Determination** is recommended for this program per 22CFR216.3 (a)(ii)(3) because the pesticides proposed for use have a potential for significant impact on the environment, and per 22CFR216.3(b)(iii)(b) because the U.S. registration of one of the proposed pesticides - DDT - was canceled for use by USEPA.

The same conditions and mitigation measures specified in the SEA and “PERSUAP for Indoor Residual Spraying for Malaria Control” that was amended for 2007 and summarized in the Safer Use Action Plan and section on Required Mitigation Measures are applicable in these additional districts as well. As per ADS 204.3.4 if, during the pilot phase, the Mission Environmental Officer and/or the Regional Environmental Advisor, based at USAID/Southern Africa in Pretoria, the Health and PMI Team, CTO or Activity Manager determines that the activity is not in compliance with the Safer Use Action Plan (e.g. inappropriate use of the pesticide) or the additional conditions listed above, they must modify or end the activity.

As required by USAID's Automated Directives System (ADS) 204.5.4, the Health and PMI Team will actively monitor ongoing activities for compliance with the recommendations in this Supplemental Environmental Assessment (SEA), and modify or end activities that are not in compliance. If additional activities are added to this program that are not described in this document, an amended PERSUAP or Supplemental Environmental Assessment must be prepared and approved prior to implementation of those activities. This includes any commodities, pesticide products being considered under the program but not covered in the present SEA.



**APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:**

**CLEARANCE:**

Acting Mission Director,  
USAID/Zambia:

\_\_\_\_\_/S/\_\_\_\_\_  
Sheila Lutjens

Date: 7/9/2008

**CONCURRENCE:**

Bureau Environmental Officer,  
Global Health:

\_\_\_\_\_/S/\_\_\_\_\_  
Michael Zeilinger

Date: 6/20/2008

Bureau Environmental Officer,  
AFR/SD:

\_\_\_\_\_/S/\_\_\_\_\_  
Brian Hirsch

Date: 6/24/2008

**ADDITIONAL CLEARANCES:**

Zambia PHN Director

\_\_\_\_\_/S/\_\_\_\_\_  
Randy Kolstad

Date: 7/3/2008

Mission Environmental Officer  
USAID/Zambia:

\_\_\_\_\_/S/\_\_\_\_\_  
Mlotha Damaseke

Date: 7/3/2008

Regional Environmental Advisor  
USAID/SA

\_\_\_\_\_/S/\_\_\_\_\_  
Camilien J.W. Saint-Cyr

Date: 7/3/2008

# Trip Report

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## **Indoor Residual Spraying (IRS) Indefinite Quantity Contract (IQC)**

### **Compliance Inspection: IRS Program, Zambia**

Jacob Emmanuel Williams  
RTI International  
Washington DC, USA

**Trip dates:** 11 - 22 November 2007

**Report completion date:** 22 November 2007

## Glossary

DDS	District Director of Health
ECZ	Environmental Council of Zambia
IEC	Information, education and communication
IRS	Indoor residual spraying
ITNs	Insecticide treated nets
IVM	Integrated vector management
KAP	Knowledge, attitude and practices
MCP	Malaria Control Program
M&E	Monitoring and evaluation
MOH	Ministry of Health
NGO	Non governmental organization
NMCC	National malaria control Center
PERSUAP	Pesticide Evaluation Report and Safe Use Action Plan
PMI	United States President's Malaria Initiative
PPE	Personal protection equipment
RTI	RTI International
SEA	Supplementary environmental assessment
TOT	Training of trainers
USAID	United States Agency for International Development
WHO	World Health Organization

## Project Overview

RTI International was awarded the Indoor Residual Spraying (IRS) Indefinite Quantity Contract (IQC) in September 2006. This IQC reflects a renewed and substantial commitment from USAID to support the use of an effective malaria control intervention in countries supported by the President's Malaria Initiative (PMI). RTI is providing technical and financial support to national malaria control programs in those countries to expand the use of IRS as an intervention for malaria prevention and control.

The main objectives of the project are to:

- Introduce the appropriate, effective, and efficient use of IRS in African countries not previously using it as part of systematic control programs.
- Provide technical assistance to improve the targeting and effectiveness of IRS programs in countries that already use the method.
- Provide financial assistance and procurement support alone to countries that have an established capacity for implementing strong IRS programs, but lack the resources and mechanisms to fully cover their populations at risk for malaria.
- Develop the capacity of public health institutions, municipal and district governments, and (where appropriate) private sector companies to implement IRS programs by systematically transferring greater responsibility and authority to such institutions with each round of IRS supported under the IRS IQC, and by relying on host country staff to the maximum degree possible in each assisted country; and
- Dramatically improve the transparency and quality of current government and industry practices for procurement, technical support, safety, and environmental compliance by setting examples of excellence and establishing clear standards for participation in work under the IRS IQC.

## Trip Agenda

### Monday, November 12

08:00-11:00 Meeting with NMCC IRS Team  
11:00-12:00 Meeting with John Miller, MACEPA  
14:00-15:30 Environmental Council of Zambia (ECZ)  
16:00-17:00 Medial Stores Limited: meet Crown Agents Reps and inspect facility

### Tuesday, November 13

07:30-08:00 In-brief with USAID  
08:15 Depart Lusaka for Chongwe  
09:00-12:30 Environmental compliance monitoring (Chongwe District)  
12:45 Return to Lusaka  
14:00 Depart Lusaka for Ndola

### Wednesday, November 14

07:00 Depart Ndola for Kitwe  
07:45-16:45 Environmental compliance monitoring (Kitwe District)  
17:00 Depart Kitwe for Ndola  
14:00 Environmental compliance monitoring (Ndola District)

### Thursday, November 15

07:00-8:30 Environmental compliance monitoring (Ndola District)  
08:30 Depart Ndola for Kabwe  
10:30-13:00 Environmental compliance monitoring (Kabwe District)  
13:00 Depart Kabwe for Lusaka

### Friday, November 16

07:00 Depart Lusaka for Kafue  
07:45-11:45 Environmental compliance monitoring (Kafue District)  
12:00 Depart Kafue for Lusaka.  
13:00-14:00 Lusaka District IRS offices

### Saturday, November 17

12:00-17:30 Meeting with C. Mendis, E. Katota, S. Lizu: costing-IRS service center upgrade

### Monday, November 19

08:30-09:30 Meeting with NMCC  
10:00-11:00 Environmental Council of Zambia (ECZ)  
11:30-12:30 Meeting with Chemtalk (David out of country)  
14:00-15:00 Meeting with Dr. Sichilongo (Chemistry Department. Univ. of Zambia)

### Tuesday, November 20

11:30-12:30 Out-brief with USAID  
18:00-20:30 Meeting with C. Mendis, E. Katota, S. Lizu: costing - IRS service center upgrades

## Objectives of the Trip

The purpose of this trip was to monitor compliance of IRS implementation with the Pesticide Safe Action User Plan outlined in the environmental assessments. Specifically:

1. To determine and document whether there is full compliance with USAID requirements as included in the approved SEA;
2. Compare current compliance activities with past activities to determine whether and what kind of improvements have been made;
3. Determine immediate action to comply with the country SEA, and;
4. Determine, in consultation with RTI program and District officials; the training and other support required to improve and ensure future compliance with SEA requirements;
5. Ensure compliance with Stockholm Convention reporting requirements.

**Key People Contacted / Met with During Trip**

<b>Name</b>	<b>Organization / Affiliation</b>
Caroll Vasquez	USAID/Zambia
Mark Maire	USAID/Zambia
Oliver Lulembo, Chandana Mendis	USAID/Zambia -(also participated in field inspections) HSSP, Zambia - (also participated in field inspections)
Elizabeth Chizema	Coordinator, NMCC
Chilandu Mukuka	Deputy Coordinator, NMCC
Chadwick Sikaala	NMCC
Dayton Makusa	HSSP, Zambia
Alex Chilabi	IRS Manager, Chongwe
Chikafuna Banda	District Director of Health, Kitwe
Isao Kaonga	IRS Manager, Kitwe
Godfrey Ngoyi	Storekeeper, Kitwe
Michael Mundia	IRS Coordinator, Ndola
Dickson Shonga	IRS Supervisor, Ndola
Shazabell Dondola	Storekeeper, Ndola
Chirwa IRS coordinator	Kabwe
Chrispin Mlauzi	Storekeeper, Kabwe
David Kapindula	ECZ
Mischeck Kaoma	Crown Agent, Zambia
Kwenga Sichilongo	Chemistry Department. Univ. of Zambia
Prof. Mbewe	Chemistry Department. Univ. of Zambia
Edwin Katota	RTI Consultant
Stafford K. Lizu	Keko Construction

## Major Findings

The implementation of IRS in Zambia is guided, in part, by environmental assessments that have been developed in response to a US Government requirement for adequate safeguards on projects with potential environmental and human health impacts. The status of compliance with the pesticide safe use action plan (PERSUAP) outlined in the 2007 supplementary environmental assessment (SEA) and recommended remedial actions, are summarized in Annex 1. The following sections highlight the major findings of the compliance inspection:

### A. Assuring worker and household safety

A number of activities are carried out to equip the various categories of IRS workers:

#### Training of IRS workers

- Supervisors, team leaders, spray operators and storekeepers are all trained in accordance with standardized training and IRS operational manuals.
- Selected health workers from the 15 IRS districts were trained on poison management, with technical support of RTI. District hospitals have been designated as reference points for all poison incidents. There were no reported cases of poisoning up to the time of the present compliance visit. Incidents of allergies (mainly skin irritation) were given prompt attention and fully resolved within 24 hours.

#### Personal protection of spray operators

- All spray operators are equipped with a full compliment of PPE. Satisfactory use of PPEs was confirmed by extensive field observation. Signs and reminders on pesticide handling and personal protection are placed at vantage points within the IRS service points to reinforce best practices. The author however came across a spray operator without his gloves, although he had been supplied with gloves at the start of the day's operation. The operator indicated that he had inadvertently left the gloves in the last house he sprayed, as he quickly moved to the next. He was advised to use his gloves at all times and the incident was brought to the attention of the field supervisor for follow up.
- Direct field observation of spray-operator activities (Fig. 1) indicates generally good practices, especially with regards to quality and compliance with the spraying of households



**Fig. 1:** Spray operator with full compliment of PPE, readying to spray a house in Kitwe District.

### Limiting females to pyrethroid spray teams

- The 2007 SEA proposes the re-assignment of pregnant women and breast-feeding mothers to non-spraying IRS activities, as well as reasonable efforts to assure that women do not serve as spray operators on teams using DDT for IRS. Where the complete exclusion of women from DDT spray teams is not feasible because it would unduly disrupt operations, the presence of women on these teams should still be reduced as much as possible.

In response, the program has shown very commendable efforts in adhering to this requirement although the SEA was approved after planning, training and other preparations for this year's IRS operations had already been completed.

- MOH issued a formal letter of to USAID stating its agreement to the re-assignment of females to pyrethroid teams. Coordinator, NMCC, also verbally confirmed the implementation of the policy to this author.
- Lusaka district restricts it full force of 136 female spray operators to pyrethroids; Kabwe district has all of its 26 women on pryrethroids, while Kafue district also has all its females re-assigned to pyrethroid teams.

Significant reductions in female involvement in DDT teams are also observed in rural districts (Fig. 2), where the impact of the exclusion of females from DDT teams is highest. For example, Kitwe district has reduced its female force to 4 women; Ndola district demonstrate a reduction of about 80%. Chongwe had 3 out of its 9 women spray operators on DDT teams. These districts further indicate that relevant adjustment will be made in the number of male operators next year, to ensure full exclusion of females in DDT teams.

- Pregnant women and lactating mothers are not engaged as spray operators. Pregnancy tests are conducted before spray operations begin. Female spray operators are also cautioned on the potential dangers of pesticides to the fetus.



*Fig. 2: Author posing with female operators upon a chance meeting in the field & interviewing to verify reassignment to pyrethroid lines.*

### Educating households and minimizing household exposure

- Good IEC efforts are made through mass media campaigns, community meetings, public address systems, and by direct communication by spray operators. However, a common theme from spray operators, team leaders and supervisors, in all the districts visited was a need for enhanced sensitization of households and to address some misconceptions (e.g. “IRS results in increased bugs”, “why IRS is not adequately targeting cockroaches”). Significant spray time is lost from operator engagement of households (including coaxing for entrance in some localities). RTI has very effectively utilized community workers specifically trained on IEC/IRS in other PMI countries. This category of workers forms an integral part of the districts IRS teams and work in close coordination with the spray teams to adequately prepare households and address any queries.

## **B. Assuring environmental safety**

### Supervision and monitoring

A hierarchy of supervision and monitoring of field operations is implemented to promote compliance and environmental safety. It involves the following:

- Squads from the central level (NMCC) made up of senior personnel conduct regular rounds (about 3-4 visits during spray season of about 60 days) with technical support from HSSP
- Unannounced field inspections by ECZ
- Periodic joint compliance inspections by USAID and RTI
- Team leaders, supervisors and district coordinators direct the day-to-day spray-operator action. Supervision of the daily post-spray activities (washing, equipment rinsing etc.) at the service points should be improved to enable more efficient water management, rinse/water reuse and reduce potential for spillage.

### Improving daily post-spray activities at the IRS service points

- There is a need for significant improvement on post spray practices at the IRS service points, especially with regards to wastewater minimization. Team leaders, supervisors and district coordinators need to increase vigilance. Equipment cleaning and related activities tend to be disorganized. While this situation is largely because of the inadequate on-site facilities supporting large numbers of operators, the current system where each spray operator has to wash his/her coverall and clean the PPE components in addition to cleaning his/her spray pump, result in an overuse of water and a less than desirable attention to spillage within the wash area. As a result there are leftovers and in some cases, an accumulation of rinse water, as not everything is consumed via the rinse-water reuse the next morning (Fig 3).

Remedial actions to minimize wastewater discharge may include the engagement of 2-4 wash persons at each service point, who will have specific responsibility for washing the coveralls and cleaning other PPEs components, and preparing the service points for



pump rinsing activities by the spray operators. Dedicated wash persons have been used by RTI in other PMI countries and have proved to be very effective (Fig. 4).

In addition, the spray operators should strictly adhere to instructions on the amount of water that is used to rinse the pump at each stop of the triple-rinse sequence: (i.e. between  $\frac{1}{4}$  and  $\frac{1}{3}$  of the pump volume). This ensures that when they fill their pumps the next day with rinse water from the drums, each spray operator takes back all, or more than, the rinse water he/she generated from the previous day's cleaning activities.



**Fig 3.** Rinse water not completely utilized/recycled the next day. Some stations experiencing gradual accumulation of such leftovers



**Fig. 4.** Use of dedicated wash persons by RTI (seen here in yellow overalls), has proven effective in organizing daily post-spray activities (pictures from Rwanda IRS/PMI operations).

- Urgent support is needed to upgrade facilities at the IRS service points (e.g. soak pits for pyrethroids lines, evaporation tanks and cemented wash bays for DDT lines, ablution blocks and toilets). The decision by USAID/Zambia to support such upgrades (re: Annex 1 on *IRS service center upgrades*) is timely and most welcome.
- There is strict accounting of each sachet of pesticide used for the IRS. Temporary field supply/refilling stations are established (Fig 5). This means instead of receiving the daily documented amount of 5-6 sachets at the start of the day, spray operators return to these refilling stations to receive and recharge their spray-pump with the next sachet. While this method may potentially present an additional burden for the spray operator, because of the extra walking distance imposed, the program indicates it is a better way of assuring that each sachet is actually mixed in the pump and used for the intended purpose.



**Fig 5.** Pesticide recharge field stations have been set up to assure accountability

### Management of empty DDT sachets

- The management of empty DDT sachets is further improved: All empty sachets from the districts are accounted for, and per 2007 SEA, are now retrieved to a central location on the premises of CHEMTALK (the local representative of pesticide supplier AVIMA) in Lusaka. In addition, AVIMA also provides specially designed bags for temporary storage of the empty sachet at the district during the spray season (Fig. 6), which facilitates secure transportation of the empty sachets.



*Fig. 6. Specially designed bags provided by AVIMA to retrieve empty DDT sachets from the 15 districts*

### Environmental monitoring of DDT

Discussions have been held with representatives of the Chemistry department, University of Zambia, ECZ and NMCC on the engagement of the chemistry department to undertake environmental monitoring of DDT. The department has the basic equipment needed for the evaluation (Fig. 7). It has requested a formal letter by MOH to the Vice Chancellor of the University, to enable the conclusion of partnership arrangements. The letter is being drafted and will be discussed by USAID and NMCC in the coming weeks. It is expected that environmental monitoring of DDT will be initiated by March 2008. It will involve the selection of sampling sites in areas where DDT is being used for IRS, and it will also include sampling of soil (including sediments of water bodies), selected agriculture produce, as well as food produce that is stored in the households among subsistent farmer communities.



*Fig. 7. Gas chromatography/mass spectrometry equipment in the chemistry department, Univ. of Zambia*

### **C. Fulfilling Stockholm Convention requirements**

The Stockholm Convention stipulates compliance with recommendations and guidelines of WHO on the use of DDT - from importation through to end use and disposal. Hence the above situation analysis also reflects the level of compliance with the Convention. The proposed support by USAID to upgrade facilities at the IRS service centers [*Annex I*] will immensely contribute to achieving full compliance with the 2007 SEA and relevant WHO recommendations/guidelines. The status on the previously outstanding issues specific to the Convention is as follows:

- Zambia, a Party to the Convention, has duly informed the Secretariat of the Convention on the use of DDT for indoor residual spraying.
- NMCC indicates it will fulfill the country-reporting obligation under the Convention when the next reporting is due. As guided by the Decision of the Third Conference of Parties (COP-3) in May 2007, the next reporting cycle is in 2008. Zambia was unable to fulfill its reporting obligation during the last reporting cycle in 2006, these was largely because of the inability of the program to assemble the very detailed technical information required, as well as the less than ideal coordination between the NMCC and ECZ, which hosts the national focal point to the convention. The reporting forms were extensively simplified during COP-3, resulting in less stringent/detailed technical information requirement. The changes should now facilitate reporting by Zambia. Coordination between NMCC and ECZ should however be improved to enable timely submission of the country report.

### **Conclusions and Recommendations**

The IRS program's demonstration of good faith efforts to comply with the SEA requirements is commendable. Full compliance in some aspects is however constrained by inadequate technical and financial resources, as well as some weaknesses in field supervision. The absence of adequate numbers of soak pits (for pyrethroid lines) and evaporation tanks (for DDT), for example, constrains waste water minimization and presents a potential risk for environmental release. The following recommendations are

made, all of which have been discussed at various stages with both USAID/Zambia and NMCC.

1. USAID to support rehabilitation of district IRS service centers focusing on urgent environmental and human safety needs. [re. *Annex I*]
2. NMCC to enhance IEC efforts by deploying IEC field workers that are specifically trained by the IRS program, to better address queries and enhance community sensitization. Opportunities for closer collaboration between IRS program and HCP should be explored, particularly on mass media communication.
3. IRS program should further enhance field supervision to improve water management and waste water minimization
4. NMCC should make additional investment to improve entomological and eco-epidemiological functions of the program. Ongoing USAID support to the establishment of a functional entomological laboratory at the NMCC, is very commendable and should be continued as much as feasible.
5. Efforts to further expand IRS to additional districts should be contingent on adequate preparation and fulfilling pre-requisite requirements, such as adequate facilities at the IRS service points in the proposed new districts (e.g. evaporation tanks, wash bays, soak pits, secure and adequate storage). The constraints faced by the program in the current 15 districts denote a need for carefully considered decisions on future program expansion.

## Annex 2: District IRS Service Point Upgrade [Phase 1]

The 2007 SEA and previous compliance evaluations, highlighted the need for improving on the storage and other facilities in the IRS service points, to enhance human health and environmental safety linked to IRS implementation, and to achieve full compliance with SEA requirements. With the concurrence of USAID/Zambia, an assessment was undertaken and needs prioritized. Urgent remedial action related to environmental and worker safety is proposed as a phase 1 support.

A basic minimum upgrade is determined that will make it possible for each of the 15 districts (plus additional service point in Lusaka district) to improve compliance with relevant parts of the SUAP/SEA with some reasonable efforts, on their part, to realign current field operations.

### Estimated cost per service point

[There is one service point per district 15 districts, plus one additional point in Lusaka district]

Item	Details	Component Cost			
		Material	Labour	Total ZMK	Total US\$
A	Washing Bay	9,000,000	2,250,000	11,250,000	2,960.53
B	Evaporation Tank - DDT line [2.5m x 1.5m x 1m] x 2	13,000,000	3,250,000	16,250,000	4,276.32
C	Soak Pit - pyrethroid line [1.5m x 1.5m x 1m]	900,000	225,000	1,125,000	296.05
D	6 toilets (3 each Male and Female)	14,500,000	3,625,000	18,125,000	4,769.74
E	10 Showers (5 each Male & Female)	14,400,000	3,600,000	18,000,000	4,736.84
<b>SUB TOTAL</b>		51,800,000	12,950,000	64,750,000	17,039.47
Transport & Contingencies Average for Phase 1 (9% of subtotal)				5,827,500	1,533.55
<b>TOTAL PER DISTRICT</b>				<b>70,577,500</b>	<b>18,573.03</b>
<b>TOTAL FOR 16 SERVICE POINTS</b>				<b>1,129,240,000</b>	<b>297,168.42</b>

Exchange rate ZMK 3,800.00 = US\$1.00

### Additional Note

For 8 districts, the need for change rooms for spray operators is considered critical. It is envisaged that an amount of \$6000.00 (six thousand dollars) will be needed to erect a "two room" structure at each service center [i.e. an additional amount of \$48,000 (Forty eight thousand dollars)]. The total cost, accounting for this variation, will be three hundred and forty five thousand, one hundred and sixty eight dollars [US\$345,168.42]. The above estimates do not include any overhead/administrative costs for USAID or RTI.

Details for a possible phase 2, which will cover pesticide storage rehabilitation, is not included in the present estimates. Phase 2 will be approached as a cost sharing effort with MOH and the districts, and may be best assessed following the completion of Phase 1 activities.

**Annex 3: Status of compliance and remedial action**

<b>Compliance Areas</b>	<b>Status of Compliance</b>	<b>Remedial Actions Recommended</b>
<i>Follow Pesticides &amp; Toxic Substances Regulations, and ECZ and MOH guidelines</i>	<ul style="list-style-type: none"> <li>• In compliance, as far as possible. Satisfactory overall</li> </ul>	<ul style="list-style-type: none"> <li>• Continued vigilance required</li> </ul>
<i>Quality assurance for procured commodities</i>	<p>Compliant:</p> <ul style="list-style-type: none"> <li>• Commodities procured from internationally recognized manufacturers (e.g. Syngenta) and supplier (AVIMA - a certified agent of Syngenta) by Crown Agents, which also maintains chain of custody up to the central storage.</li> </ul>	<ul style="list-style-type: none"> <li>• No action required</li> </ul>
<i>Train relevant categories of workers involved in IRS operations on best practices</i>	<p>Compliance satisfactory.</p> <ul style="list-style-type: none"> <li>• Training conducted for supervisors, team leaders, spray operators and storekeepers.</li> </ul>	<ul style="list-style-type: none"> <li>• Training of dedicated IEC field staff to work closely with spray operators in preparing and addressing specific queries from households/community.</li> </ul>
<i>Train health workers in the management of insecticide poisoning.</i>	<p>Compliant: District health hospitals designated as reference points for poisoning. Incidents of allergies promptly attended to within 24 hours.</p>	<ul style="list-style-type: none"> <li>• No action required</li> </ul>
<i>Ensure adequate protection of spray operators through the use of PPEs and best practices during spray operations</i>	<p>Largely compliant, but with room for improvement:</p> <ul style="list-style-type: none"> <li>• Full compliment of PPEs supplied and used.</li> <li>• Equipment cleaning and related activities following daily spray operations need improvement.</li> </ul>	<ul style="list-style-type: none"> <li>• Improved water management needed to minimize discharge and enhance rinse/water reuse: <ul style="list-style-type: none"> <li>- Especially in relation to spray-operator rinsing of spray pumps:</li> <li>- Engage dedicated wash person at each service point to wash spay operator coveralls and clean other PPE components</li> </ul> </li> </ul>
<p><i>Ensure effective supervision of spray operations and other operations to promote compliance.</i></p> <p><i>Reduce environmental contamination</i> through strict auditing, handling washing and disposal practices</p>	<p>Compliance satisfactory. However, room for improvement in certain areas.</p> <ul style="list-style-type: none"> <li>• Various levels of inspections undertaken as per SEA.</li> <li>• Each DDT sachet accounted for through daily spray sheets and pesticides recharge field stations.</li> <li>• Kabwe service points equipped</li> </ul>	<ul style="list-style-type: none"> <li>• Planned USAID support to upgrade IRS service point facilities, focusing on worker and environmental safety to be implemented as soon as possible.</li> <li>• Opportunities for supplier to return empty sachets/packaging cartons to South Africa being supported by ECZ.</li> </ul>

<b>Compliance Areas</b>	<b>Status of Compliance</b>	<b>Remedial Actions Recommended</b>
<i>Return empty DDT sachets to the supplier for disposal.</i>	with evaporation tanks. Lusaka obtains new facilities. Less-resourced district still using open drums as evaporation tanks increased risk for spillage. Ablution facilities in almost all service points need upgrading. <ul style="list-style-type: none"> <li>• Empty DDT sachets retrieved for central storage. Pesticide supplier provides bags. Long-term final disposal scheme yet to be found.</li> </ul>	<ul style="list-style-type: none"> <li>• District IRS Coordinators and Team Supervisors should enhance their supervision of the daily post-spray activities (washing, equipment rinsing etc.) at the IRS service points, to enable more efficient water management, rinse/water reuse and reduce potential for spillage.</li> </ul>
<i>Minimizing risks in pesticide transport</i>	Compliance satisfactory <ul style="list-style-type: none"> <li>• Transport has been procured under a World Bank grant for malaria control. This is used to distribute commodities from central stores to the districts.</li> </ul>	<ul style="list-style-type: none"> <li>• No action needed</li> </ul>
<i>Storage facilities</i>	<ul style="list-style-type: none"> <li>• Facilities stretched in some districts (limiting space, structural limitations)</li> </ul>	<ul style="list-style-type: none"> <li>• Support for storage facility rehabilitation on a cost-sharing basis with MOH and Districts to be explored by USAID/Zambia.</li> </ul>
<i>Reduce household exposure and educate target communities through an IEC campaigns</i>	<ul style="list-style-type: none"> <li>• Use of formal public address systems, community meetings, direct home visits by spray operators prior to spray operations.</li> <li>• Household education and compliance can be improved.</li> </ul>	<ul style="list-style-type: none"> <li>• Use of IEC field workers, specifically trained by the IRS program, to better address queries and enhance community sensitization.</li> </ul>
<i>Initiate monitoring of pesticides used in IRS to the extent feasible and relevant.</i>	<ul style="list-style-type: none"> <li>• Environmental monitoring (sampling) expected to be initiated in March 2008. Ongoing discussions with University of Zambia to formalize engagement.</li> </ul>	<ul style="list-style-type: none"> <li>• Formal letter from MOH to Vice Chancellor, University of Zambia, on the proposed collaboration.</li> </ul>
<b>POLICY REQUIREMENT</b>		
<i>Re-examination of the need for DDT based upon the best available information and to identify the best choice for IRS chemicals</i>	<ul style="list-style-type: none"> <li>• A small entomological laboratory has been established at NMCC with support from USAID. Some basic equipment provided.</li> <li>• Need to strengthen core vector control functions on eco-epidemiological evaluation:</li> </ul>	<ul style="list-style-type: none"> <li>• NMCP indicates evaluation of new pesticides/ larvicides needed and planned for 2007/8</li> <li>• Continued USAID/partner technical support to be provided as needed to further enhance eco-epidemiological evaluations to</li> </ul>

<b>Compliance Areas</b>	<b>Status of Compliance</b>	<b>Remedial Actions Recommended</b>
<i>Enhance institutional capacity to improve core vector control functions for better targeting of IRS and judicious use of public health pesticides.</i>	<ul style="list-style-type: none"> <li>- Routine evaluation of vector susceptibility/resistance levels and pesticide wall bioassay not done.</li> <li>- Vector density studies initiated in some districts. Need for a functional vector surveillance system.</li> </ul>	better evaluate impact and progress of IRS. 2008 PMI MOP indicates support to these areas.
<i>Develop and implement vector resistance management</i>		
<i>Regular assessment of the effectiveness of the safeguards and compliance on the restricted use of DDT</i>	<ul style="list-style-type: none"> <li>• Compliance satisfactory: compliance inspection regimes established under the 2007 SEA being implemented satisfactorily</li> </ul>	<ul style="list-style-type: none"> <li>• Continued vigilance required</li> </ul>
<i>Prohibiting IRS in sensitive areas and voiding DDT use where possible, particularly in communities focused on export agriculture.</i>	<ul style="list-style-type: none"> <li>• Compliance satisfactory</li> </ul>	<ul style="list-style-type: none"> <li>• Vigilance required as national IRS program expands to new districts.</li> </ul>



## Annex 4: Required Mitigation activities for IRS Program

Culled from 2007 SEA

Before Spray Operations	During Spray operations	Post-Spray Operations
<p><b>Ensure compliance with national regulations on pesticide and MOH guidelines on IRS and vector control.</b> The legislation details procedures for registering, pesticides and importing, and outlines requirements for transporting, labeling, handling, use, storage, and disposal of pesticides.</p>	<p><b>Follow guidelines for malaria vector control and Pesticide registration and MOH guidelines on IRS and vector control.</b> These provide adequate information on appropriate handling for all stages of the pesticides lifecycle.</p>	<p><b>Ensure compliance with national regulations on pesticide and MOH guidelines.</b> Ensure that unused pesticides are properly stored and secure until the next spraying season</p>
<p><b>Ensure effective quality assurance/control procedures during procurement of commodities (pesticides, equipments and PPEs) and during spray operations.</b></p>	<p><b>Reduce household exposure:</b> cover furniture that cannot be moved with cloths prior to spraying, and prohibit spraying in rooms where sick persons or pregnant women are living and cannot stay outside the home during and one hour after spraying</p>	<p><b>Retrieve and store empty DDT sachets</b> in a designated and secure place until a final decision on disposal is reached by the country.</p>
<p><b>Train spray operators, team leaders, and supervisors, store operators and transporters</b> according to best practices, as outlined by the World Health Organization (WHO), the MOH guidelines on IRS and this EA.</p>	<p><b>Ensure adequate protection of spray operators</b> through the use of appropriate personal protection equipment.</p>	
<p><b>Train health workers</b> in insecticide poisoning treatment and ensure availability of treatment medicines in districts targeted for IRS.</p>	<p><b>Reduce environmental contamination</b> through strict auditing, handling, washing and disposal practices. Each insecticide sachet will be strictly accounted for; contaminated waste-water/rinse-water will be re-used in subsequent days of spraying (progressive rinsing); and use of ablution blocks and evaporation tanks for other contaminated waters from clean-up will reduce environmental contamination.</p>	
<p><b>Educate target communities and households</b> through an Information, Education, and Communication (IEC) campaign – emphasize issues relating to minimizing exposure risks (removal of all food, water and utensils from house before spraying; moving furniture to the center of the room or outside; prevent re-entry of sprayed house for at least 1 hour and sweep floor of residues before allowing children or animals in the house.</p>	<p><b>Initiate Monitoring of Pesticides used in IRS to the extent feasible and relevant with technical support from</b></p>	

## Required Mitigation Activities for IRS Program (cont'd)

Before Spray Operations	During Spray Operations	Post-Spray Operations
<p><i>Inform fire brigades</i> of the location and contents of storage facilities.</p>		
<p><i>Implement environmental assessment plan, including monitoring of pesticides used for IRS and impacts on environment</i>, to the extent feasible and relevant, with technical support from EPA and USAID as needed.</p> <p>Conduct compliance inspections on preparatory activities.</p> <p>Undertaking sampling of soil and food products in selected districts.</p>	<p><i>Continue implementation of environmental assessment plan:</i></p> <p>Conduct compliance inspections by technical partners and NMCC</p>	<p><i>Continue implementation of environmental assessment plan, including monitoring of pesticides used for IRS and impacts on environment as per agreed protocol.</i></p> <p>Undertake post-operation compliance evaluations.</p> <p>Undertake environmental sampling.</p> <p>Conduct joint meeting to evaluate findings, identify lessons and devise remedial measures as needed.</p>
<p><i>USAID will discuss importance of an environmental assessment</i> for any pesticides used in IRS. Will be discussed with MOH and MOE staff-- online resource for conducting assessments will be provided</p>		

## Annex 5: Comparative Cost Analysis Regarding the Use of DDT for Indoor Residual Spraying in Zambia

### *Context of the Analysis*

As part of the President's Malaria Initiative (PMI), the U.S. Agency for International Development (USAID) is supporting the use of indoor residual spraying (IRS) for Zambia's national malaria control strategy. The National Malaria Control Centre (NMCC), part of the Ministry of Health, provides direction and management of Zambia's malaria control program. District health management teams (DHMT's) are responsible for implementing IRS and other malaria control interventions within their district.

Zambia restarted its IRS program in 2003 after a 30-year hiatus and has increased its coverage targets in each subsequent year. For the 2008-09 transmission cycle, the NMCC will implement IRS in 15 districts with a total coverage target of 900,000 households. The 15 districts are clustered in three IRS operational areas in the south, central, and north sections of the country (see Figure 1).

Most of Zambia's IRS program is focused in urban and peri-urban areas that constitute the country's main population centers. The program uses pyrethroid insecticides and dichloro-diphenyl-trichloroethane (DDT) in combination, applying pyrethroids in "modern" houses with plastered walls and DDT in "traditional" houses with mud walls and thatch. This strategy has been used consistently since 2003.

All of the areas in which IRS is being used experience a seasonal pattern of malaria transmission lasting 4 to 6 months. Figure 2 shows that the climatic conditions necessary for vector mosquito populations are generally present from December through March in the southern and central areas, and from November through April in the north where there is greater average rainfall (1,200 mm/year vs. 500 mm/year).

### *Scope of the Analysis*

USAID is supporting Zambia's IRS program by providing technical and financial assistance, including purchase of insecticides and support to improve insecticide storage, waste disposal, and other aspects of environmental compliance. USAID's environmental regulations (22 CFR 216) require that the cost implications of alternative strategies be evaluated as part of an environmental assessment. The purpose of this analysis is to determine whether Zambia's use of DDT in combination with pyrethroids results in a cost savings or additional costs, when compared to hypothetical program employing only pyrethroids. The analysis is specifically for the size and scope of the NMCC's current IRS program as proposed for 2008-09.

### *Key Assumptions*

- One round of spraying per year with either DDT or a pyrethroid will be sufficient to substantially reduce the anopheline vector population and malaria transmission in the

treated areas. When applied at its recommended dose of 1-2 g/m<sup>2</sup>, DDT is effective for at least 6 months. A 6-month duration of effect can also be achieved using WHOPEs-certified pyrethroid insecticides if they are applied at the upper limit of the recommended dose range.

- The regulatory systems currently in place in Zambia for registration and regulation of DDT are adequate. This analysis does not include any costs that might be associated with reform of the regulatory scheme or strengthening of the regulatory institutions.<sup>1</sup>
- The bilateral agreement between Zambia and South Africa, under which insecticide-contaminated waste generated in Zambia may be transported to and disposed of in South Africa, will remain in force. This agreement was established in 2007, consistent with the requirements of the Basel Convention. It is an important achievement, allowing for the first time the legal export and destruction of DDT-contaminated waste generated by IRS operations in Zambia.

### *Methodology*

The analysis employs an ingredients approach, listing each type of cost anticipated, estimating the number of units required, and determining costs by using unit costs derived from recently completed IRS programs or procurement data obtained during such programs.

### *Analysis*

1. Estimated cost of the Zambia IRS program in 2008-09, excluding purchase of insecticides and environmental compliance costs uniquely attributable to the use of DDT.
  - *Estimated base cost of the 2006-07 IRS program.* RTI obtained an estimated budget for the 2006 IRS program from Dr. Michael Macdonald, who served as Boston University's Resident Advisor for Malaria in Zambia from 2003 to 2006, with funding support from USAID and the US Centers for Disease Control and Prevention/Schools of Public Health Grant program. The cost of Zambia's IRS program for 2006-07 was estimated at \$4,856,908.<sup>2</sup> This estimate included \$1,957,532 for insecticide purchase and \$210,482 for fuel and transport; the base cost of the IRS program, exclusive of insecticide and transport, was \$2,688,894. The 2006 program treated 592,346 households. Costs were calculated originally in Zambian kwacha and converted to US dollars at an exchange rate of 3200 ZKW per \$1US. This cost was used as a starting point for estimating the cost of the program for 2008-09.

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<sup>1</sup> USAID has supported training for environmental inspectors and the operational cost of inspections conducted by field staff of the Environmental Council of Zambia; these inspections are equally necessary for pyrethroids and DDT and the use of DDT does not result in any additional inspection costs.

<sup>2</sup> This was the estimated cost that would be incurred by the government for its operational program. The program also received technical assistance and general program support from USAID's Health Sector Support Program; these resources are not considered in the analysis.

- *Estimated base cost of the 2008-09 IRS program.* The IRS program for 2008 will treat approximately 900,000 households, representing an increase of 51.9% compared to 2006. The cost of fuel has also increased substantially; fuel in 2006 was estimated using a unit cost of 5000 ZKW per liter, compared to today's market rate of 8355 ZKW per liter. The foreign exchange rate has also moved from 3200 to 3250 ZKW per \$1US. Adjusting for these factors, we estimate the base cost of the 2008-09 IRS program in Zambia at \$5,945,205. This is the estimated cost of treating 900,000 households using an IRS program structured and implemented in the same manner as the program in 2006-07, excluding the cost of insecticide and environmental monitoring and compliance costs uniquely associated with use of DDT.

2. Estimated cost of insecticide for the 2008 IRS program, including shipping and disposal.

*Cost of Insecticide*

- Table 1 presents the estimated cost of insecticide for 2008-09 for three scenarios: pyrethroid only, pyrethroid & DDT, and DDT Only. The table replicates the standard calculation of the amount of insecticide required for four pyrethroid insecticides (lambda-cyhalothrin, alpha-cypermethrin, deltamethrin, and bifenthrin) and for DDT, as follows.
- The target coverage for 2008 is 900,000 households. 56% of the households are expected to be of the "western" or modern style, which are larger houses with 180m<sup>2</sup> of plastered walls; 44% are expected to be traditional houses with 90 m<sup>2</sup> of mud walls. The percentages and wall area are based on assumptions used in the 2006 IRS budget.
- The calculation for PYR2 for the "pyrethroid only" scenario is illustrative of all calculations in Table 1.<sup>3</sup> The total wall area to be treated is 126,360,000 m<sup>2</sup>. WHO recommends that PYR2 be applied at a dose of 0.02 to 0.03 g/m<sup>2</sup> to achieve effective action against anopheline mosquitoes for 4-6 months; this analysis assumes the higher dose will be required to meet the Zambia program's requirement for 6 months protection. The commercial product for PYR2 is a 5% formulation; each sachet weighs 150 g and contains 7.5 g of active ingredient. Each sachet contains sufficient insecticide to cover 250 m<sup>2</sup> ( $7.5/0.03 = 250$ ). Thus, the Zambia program would require  $126,360,000/250 = 505,440$  sachets of PYR2 to meet its full needs. At a cost of \$3.60 per sachet, the estimated cost of meeting the full program needs using PYR2 would be \$1,819,584.
- The estimated cost of insecticide sufficient to support the 2008 program ranges from \$1,819,584 to \$4,245,696 for the pyrethroid Only scenario, depending on the insecticide selected. The cost range for the combined pyrethroid & DDT scenario is from \$1,817,031 to \$3,558,855, representing a

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<sup>3</sup> Estimated prices for each insecticide are based on quotes received as part of competitive bidding conducted in 2007.

cost reduction of only \$2,553 when comparing the lowest-cost options of the two scenarios. The cost reduction ranges up to \$686,841 for comparisons between pyrethroid only and pyrethroid & DDT at the upper end of the cost range.

- The DDT Only scenario offers an additional cost saving of \$6,499 compared to the lowest cost option for pyrethroid & DDT. This scenario is included only for illustrative purposes; it is not a realistic option, since many of the residents of western houses would object to the use of DDT in their homes because it leaves a white powdery residue noticeable on plastered walls.

#### *Shipping and Storage*

- Because the volume of DDT required to treat a given wall area is much greater than the volume of pyrethroid required, the shipping costs associated with use of DDT will also be greater, assuming both insecticides originate from the same location and are shipped by the same mode of transport (road, sea or air freight). Using data from procurement conducted for Zambia in 2007, which included quotations for pyrethroids and DDT shipped from the same location, illustrative shipping costs were estimated as \$94,443 for PYR2, and \$153,212 for PYR2 plus DDT. These estimates include adjustments for changes in exchange rates and fuel costs. The additional cost of shipping associated with use of DDT is \$58,768.
- Storage costs for DDT are also generally greater than those for pyrethroids, since the volume of insecticide required is greater. Storage costs have been excluded from this analysis, however, since no investments are planned in 2008-09 for increasing the capacity of existing storage facilities. Such investments are being considered for future years and will need to take into account the government's plans regarding continued use of DDT.

#### *Recovery and disposal of insecticide packaging*

- Based on a 2007 price quotation from a DDT vendor, the cost of disposing DDT-contaminated packaging and associated waste is estimated at \$0.23 per sachet. This estimate was based on shipping waste out of Zambia for incineration in South Africa.<sup>4</sup> As the USAID IRS program evolves, it may also become necessary to collect and incinerate pyrethroid-contaminated waste in all countries. For purposes of this analysis, we have assumed it will be feasible to collect and incinerate pyrethroid-contaminated waste in-country at a cost of \$0.10 per sachet. Using these assumptions, the waste disposal cost associated with the pyrethroid & DDT scenario is \$68,914, compared to \$50,544 for PYR2 only. This results in an additional cost of \$18,370 associated with use of DDT.

### 3. Estimated 2008 IRS program cost including operations and insecticide.

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<sup>4</sup> The quoted price included transportation at 2007 rates; the cost for 2008 will likely be higher because of higher fuel costs. This potential increase has not been included in the analysis because it was not clear from records what proportion of the quoted price was attributable to transport.

For purposes of further analysis, we assume that the Zambia NMCC would select the lowest-cost options among those presented.

- For pyrethroid & DDT, the estimated cost of the program includes the following, plus additional costs unique to DDT as described in the next section.

Estimated operational cost other than insecticide	\$5,945,205
Insecticide purchase	\$1,817,031
Shipping and storage	\$ 153,212
Waste disposal	<u>\$ 68,914</u>
Subtotal, pyrethroid & DDT	\$7,984,361

- For pyrethroid Only, the estimated cost of the program is as follows:

Estimated operational cost other than insecticide	\$5,945,205
Insecticide purchase	\$1,819,584
Shipping and storage	\$ 94,443
Waste disposal	<u>\$ 50,544</u>
Total, pyrethroid only	\$7,909,776

4. Cost of additional measures specific to the use of DDT.

- *Evaporation tanks.* Rinse water containing DDT cannot be disposed in a pit latrine; rather, it must be placed in an evaporation tank, from which solid phase DDT can be collected after the water has evaporated. One tank is required at each IRS operational site at which compression sprayers are stored and from which spray operators deploy each day. In Zambia, a storage and wash facility is being built in each of the 15 districts. These facilities include water supply, wash stations, and a water trough that can be directed either to a soak pit (for pyrethroids) or an evaporation tank (for DDT). The evaporation tank is the only part of the facility that is a unique requirement associated with use of DDT. The additional cost of the evaporation tank is estimated at \$4,000 per location, for a total of \$60,000 for the program. These facilities should be useful for many years if maintained. For purposes of this analysis, we assume a 10 year life span and a pro-rata allocation of the capital cost, resulting in an increase of \$6,000 for the 2008 IRS program.
- *Environmental Monitoring.* RTI is preparing an environmental monitoring plan specific to the use of DDT in Zambia. Based on recent discussions with the USAID Cognizant Technical Officer, RTI will include baseline sampling to estimate existing concentrations of DDT in soil, sediment, selected biota, and crops being grown for local consumption. Additional samples will be taken after the 2008-09 spray round to determine whether use of DDT in the IRS program has resulted in any increase compared to background levels of DDT in the areas

and media sampled. The anticipated cost of the environmental monitoring program is \$390,000, of which \$150,000 is for baseline sampling and analysis. The baseline study will provide data that are useful as a point of comparison for many years; we have pro-rated these costs over a 10 year period. Thus, the estimated cost of environmental monitoring allocable to the 2008 IRS program is  $(\$150,000 * .10) + \$240,000 = \$255,000$ .

- *Total estimated cost for additional measures specific to the use of DDT*

Evaporation Tanks (2008 allocation)	\$ 6,000
Environmental Monitoring (2008 allocation)	<u>\$255,000</u>
TOTAL	\$261,000

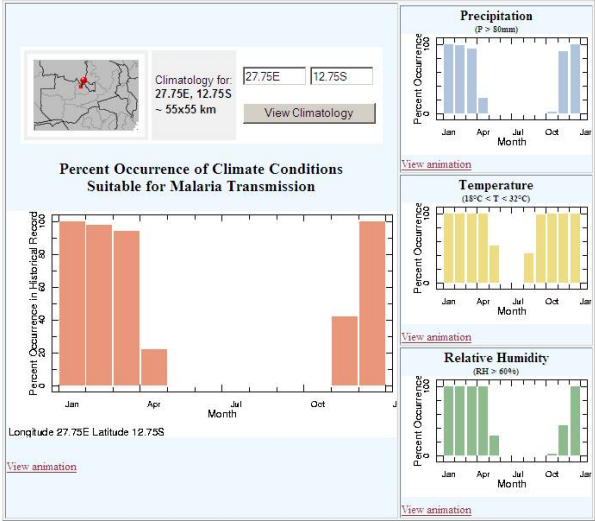
5. Cost Comparison: IRS using pyrethroids Only vs. pyrethroids & DDT

- The total estimated cost of the 2008-09 IRS program with continued use of the pyrethroid & DDT strategy is  $\$7984,361 + \$261,000 = \$8,245,361$ .
- If the NMCC were to adopt the pyrethroid only scenario, the total estimated cost of the 2008-09 IRS program would be \$7,906,776.
- The estimated cost savings associated with changing from pyrethroid & DDT to pyrethroid only is \$335,585, or approximately 4.1% of estimated program costs for the current program.

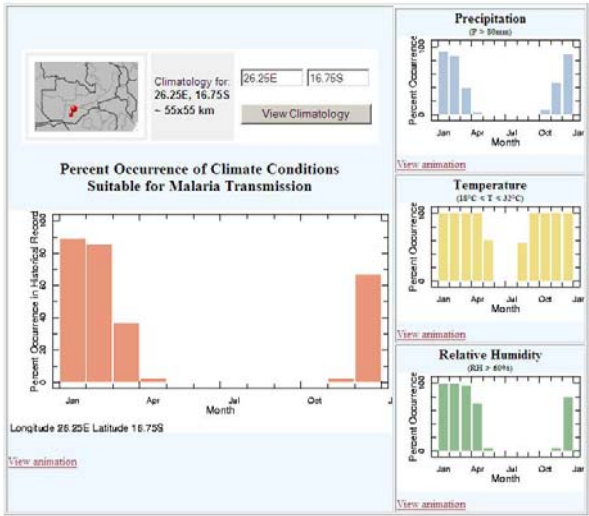




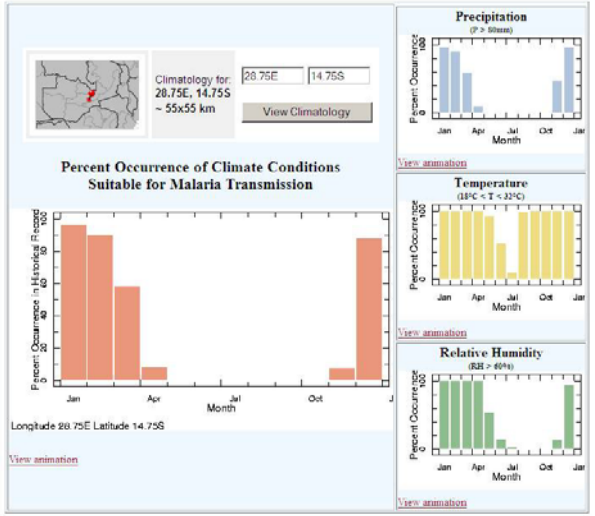
Figure 2. Seasonal Pattern of Climatic Conditions Suitable for Malaria Transmission in Zambia



Northern Area



Southern Area



Central Area

Table 1. Estimated Cost of Insecticides for Use in 2008 IRS Program, Zambia

<b>Pyrethroid Only</b>	PYR 1	PYR2	PYR3	PYR4	
#IH Total	900,000	900,000	900,000	900,000	
#IH Western 180m2 (56%)	504,000	504,000	504,000	504,000	
#IH Traditional 90m2 (44%)	396,000	396,000	396,000	396,000	
Wall area Western HHs (m2)	90,720,000	90,720,000	90,720,000	90,720,000	
Wall area Traditional HHs (m2)	35,640,000	35,640,000	35,640,000	35,640,000	
Wall area Total (m2)	126,360,000	126,360,000	126,360,000	126,360,000	
Mass a.i. per sachet (g)	6.25	7.5	4	6.25	
Dose for 6 mo's effect (g/m2)	0.03	0.03	0.025	0.05	
Coverage/sachet (m2)	208.3	250.0	160.0	125.0	
# sachets required	606,528	505,440	789,750	1,010,880	
Cost per sachet (\$)	4.63	3.6	2.85	4.2	
Estimated cost of insecticide (\$)	<b>2,808,225</b>	<b>1,819,584</b>	<b>2,250,788</b>	<b>4,245,696</b>	
<b>Pyrethroid &amp; DDT</b>	PYR 1	PYR2	PYR3	PYR4	DDT
#IH Total	900,000	900,000	900,000	900,000	900,000
#IH Western 180m2 (56%)	504,000	504,000	504,000	504,000	
#IH Traditional 90m2 (44%)					396,000
Wall area Western HH (180m2)	90,720,000	90,720,000	90,720,000	90,720,000	
Wall area Traditional HH (90m2)					35,640,000
Wall area Total (m2)	90,720,000	90,720,000	90,720,000	90,720,000	35,640,000
Mass a.i. per sachet (g)	6.25	7.5	4	6.25	502.5
Dose for 6 mo's effect (g/m2)	0.03	0.03	0.025	0.05	2
Coverage/sachet (m2)	208.3	250.0	160.0	125.0	251.3
# sachets required	435,456	362,880	567,000	725,760	141,851
Cost per sachet (\$)	4.63	3.6	2.85	4.2	3.6
Estimated cost of insecticide (\$)	2,016,161	1,306,368	1,615,950	3,048,192	510,663
Total est'd cost pyr & DDT	<b>2,526,824</b>	<b>1,817,031</b>	<b>2,126,613</b>	<b>3,558,855</b>	
<b>DDT Only</b>	DDT				
#IH Total	900,000				
#IH Western 180m2 (56%)	504,000				
#IH Traditional 90m2 (44%)	396,000				
Wall area Western HH (180m2)	90,720,000				
Wall area Traditional HH (90m2)	35,640,000				
Wall area Total (m2)	126,360,000				
Mass a.i. per sachet (g)	502.5				
Dose for 6 mo's effect (g/m2)	2				
Coverage/sachet (m2)	251.3				
# sachets required	502,925				
Cost per sachet (\$)	3.6				
Estimated cost of insecticide (\$)	<b>1,810,531</b>				