TRANSPARENCY AND ACCOUNTABILITY NETWORK

IMMC

INTEGRATED MOSQUITO AND MALARIA CONTROL

A comprehensive integrated mosquito and malaria control program to reduce the incidence of malaria, and other insect spread diseases.

BUSINESS PLAN

THE MALARIA CRISIS
HOW MODERN IMMC CAN HELP

July 2006

DRAFT – FOR DISCUSSION ONLY

For more information contact:
Peter Burgess
Tr-Ac-Net Inc. in New York
212 772 6918
peterbnyc@gmail.com

INTEGRATED MOSQUITO AND MALARIA CONTROL CONTEXT

THIS DOCUMENT IS PART OF A SERIES THAT INCLUDES THE FOLLOWING:

EXECUTIVE SUMMARY – INTERNATIONAL

EXECUTIVE SUMMARY – LIBERIA

BUSINESS PLAN – INTEGRATED MOSQUITO AND MALARIA CONTROL
COMPRISING:
A ... BP for IMMC – INTRODUCTION SECTION
B ... BP for IMMC – THE MALARIA CRISIS
C ... BP for IMMC – HISTORY OF SUCCESSES
D ... BP for IMMC – MOSQUITOES AND MALARIA
E ... BP FOR IMMC – THE IMMC STRATEGY
F ... BP for IMMC – PORTFOLIO OF IMMC INTERVENTIONS
G ... BP for IMMC – DATA AND MANAGEMENT INFORMATION

IMMC – ORGANIZATION AND MANAGEMENT
(An Excel workbook/spreadsheet)

IMMC – REFERENCES, CONTACTS, ETC.
(An Excel workbook/spreadsheet)

SIMULATION MODEL
(An Excel workbook/spreadsheet)

IMMC – BEHAVIOR OF COSTS
(An Excel workbook/spreadsheet)

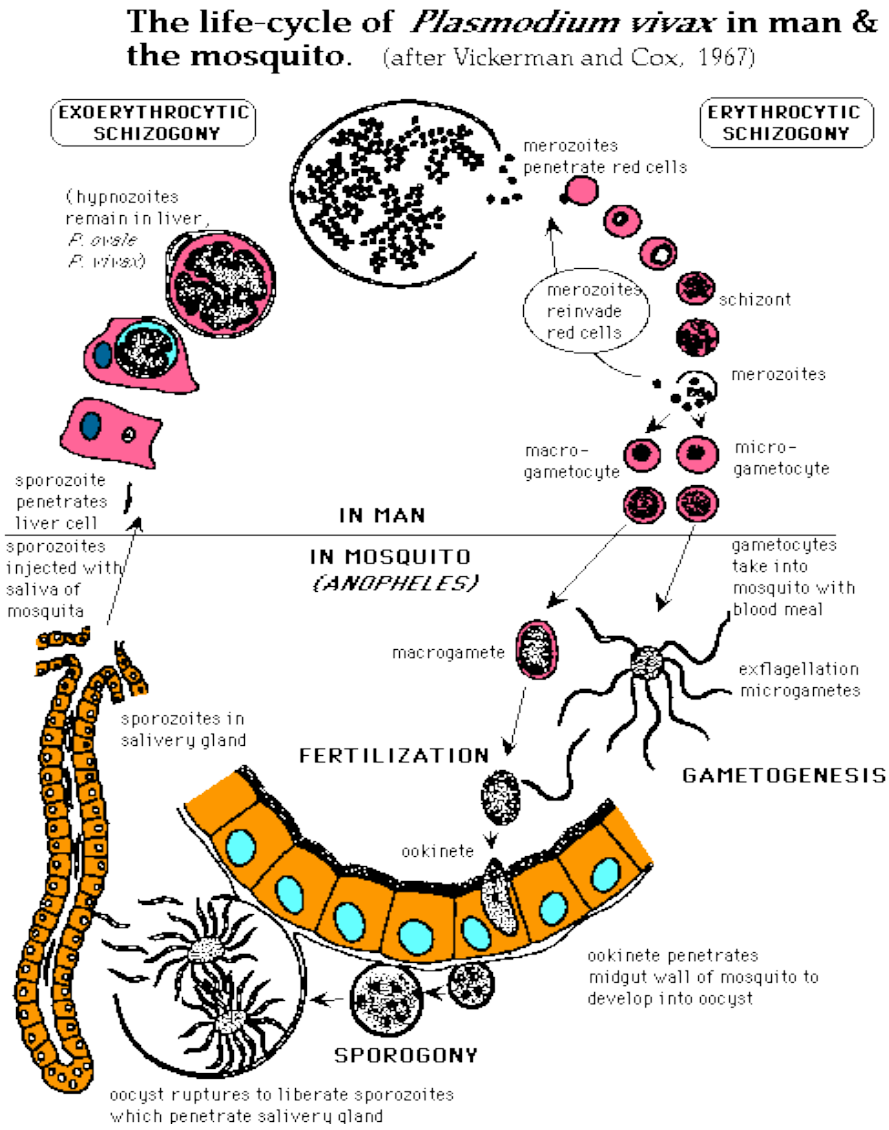
IMMC – FINANCIAL PROJECTIONS – MACRO OVERVIEW
(An Excel workbook/spreadsheet)
IMMC – FINANCIAL PROJECTIONS – COUNTRY VERSION
(An Excel workbook/spreadsheet)
IMMC – FINANCIAL PROJECTIONS – DISTRICT VERSION
(An Excel workbook/spreadsheet)

SLIDE PRESENTATIONS
Components of IMMC (21 slides)
History of Malaria Eradication (24 slides)
Economics of Malaria (17 slides)
Organization of IMMC (24 slides)

THE DYNAMICS OF THE DISEASE

Malaria

When a mosquito bites an infected person, it ingests microscopic malaria parasites found in the person's blood.



The malaria parasite must grow in the mosquito for a week or more before infection can be passed to another person. If, after a week, the mosquito then bites another person, the parasites go from the mosquito's mouth into the person's blood. The parasites then travel to the person's liver, enter the liver's cells, grow and multiply. During this time when the parasites are in the liver, the person has not yet felt sick. The parasites leave the liver and enter red blood cells; this may take as little as 8 days or as many as several months. Once inside the red blood cells, the parasites grow and multiply. The red blood cells burst,

freeing the parasites to attack other red blood cells. Toxins from the parasite are also released into the blood, making the person feel sick. If a mosquito bites this person while the parasites are in his or her blood, it will ingest the tiny parasites. After a week or more, the mosquito can infect another person.

Humans get malaria from the bite of a malaria-infected mosquito. The challenge is to stop this cycle of continuing re-infection in a cost effective way that does not have damaging side effects either in the human population or in the environment.

Over the years there has been a lot of research about mosquito behavior and its life cycle. There has also been a lot of work done to learn about the malaria parasite and its life cycle. Rather little of this research has been translated into management information that can easily be used to make planning decisions about the way in which an integrated mosquito and malaria control program should work.

Mosquitoes

The mosquito life cycle

http://www.acroloxus.com/slideshow_1.html

Email: m.jackson@acroloxus.com

The female *anopheles* mosquito carries and transmits the malarial parasite during blood feeding at the adult sexual stages. The mosquito is an uninterrupted individual feeder and is predominantly a night biting insect.

The *anopheles* mosquito lays eggs that hatch in shallow, warm, slow moving or relatively still water. Any site that holds rain water or permanent standing water for one week or more is ideally suited for breeding. Many parts of tropical Africa have a very desirable environment for the mosquito to thrive.

The gestation period is approximately twenty to twenty-one days. In dry conditions, eggs may last up to five years, waiting for water to trigger the larval and pupal stages. One report concluded that, in an area the size of a football field, over one million eggs can be found. The number of mosquitoes in relation to the number of human targets is overwhelming.

It has been reported for many years, at least since the early 1950s, that the Liberian mosquito population includes *Anopheles melas*, a salt water breeding malaria vector. This vector is present in large numbers within about 2 miles of salt water. This is especially true during the dry season. This mosquito, as well as the *An. gambaie,* is known to feed as readily outdoors as indoors. The breeding of *An. melas* in salt water makes the mangrove swamps and tidal marshes in Monrovia critical for successful mosquito and malaria control. The inaccessibility of these areas makes aerial application of larvacides indispensable in any malaria/mosquito control operations.

There are two peak seasons for the transmission of malaria for Monrovia and Liberia as a whole. One is July through August and the other October through November. The control problem is aggravated in Liberia because of the year-long tropical climate that allows different populations of mosquitoes to be in different stages of their life cycle at any and all times of the year.

Mosquito broods may peak during any season and the vector's ability to strike is continuous, chronic, and acute.

To add to the challenge, malaria can be imported into the control area. An adult mosquito riding on slight breezes can travel up to fifty miles from its point of origin. People carrying malaria can migrate into the area, bringing with them new parasites to add to the vector's source of infected hosts. The combination of many factors makes the malaria situation an epidemic by any standard, and the situation will be resolved only by all-out intervention.

It is also worth noting that the *An. melas* is an extremely efficient vector of filariasis or elephantiasis. While the goal of this project is malaria control, the control of the mosquito will certainly have a positive impact on the incidence of of filariasis which is a terrible, disfiguring disease.

One of the ways in which this IMMC initiative is different from others is that it has a focus on science, data and analysis within a management system that can access the most relevant intervention for the prevailing situation, and can change

as needed as the situation evolves.

THE MONROVIA MOSQUITO / MALARIA CONTROL PROGRAM

CONTENTS

The over-arching goals of an Integrated Mosquito and Malaria Control program are to:

1. Reduce the mortality rate of children, especially at-risk children under five years of age.
2. Reduce the morbidity rate among the population, including at-risk groups such as pregnant women.
3. Slow malaria transmission through interventions to decrease mosquito populations.
4. Reduce the malaria parasites in both mosquito and human populations to lower the risk of rapid re-infection.

Short-terms goals are to:

1. Establish the capacity to implement an efficient program for mosquito and malaria control in Monrovia.
2. Secure funding to establish the Program, and set up procedures to have ongoing funding for full implementation of the Program.
3. Set up data collection and analysis so that the Program has a baseline dataset and has ways to measure progress during implementation.

The long-term goals are:

1. First and foremost, to maintain a favorable reduction in the incidence of malaria in Monrovia on a permanent basis.
2. To build a long-run capacity to maintain an efficient program for mosquito and malaria control using the best of entomological and medical science for successful control of mosquitoes and malaria in Monrovia in perpetuity.
3. To have the understanding and capacity to replicate successful programa in other parts of Africa.

MOSQUITO / MALARIA CONTROL PROGRAM FOR MONROVIA, LIBERIA

THE BACKGROUND

Program Goals

Malaria is a critical global health issue, and nowhere it more serious than in Monrovia, Liberia. Malaria is a killer disease, especially of children. Around the world some 3,000 children die every day from this one disease. The illness is also debilitating for adults and dramatically reduces a person's ability to work productively.

Monrovia has an estimated population of more than 1,000,000 – of which about 500,000 are permanent residents; the rest are temporary residents in and just outside the city, as a result of years of insecurity and the civil war. Success in reducing the incidence of malaria in Liberia would be a major step in improving the overall economic performance of the entire country.

The Monrovia Mosquito/Malaria Control Program (the Program) is a practical and realistic initiative designed to be implemented quickly and give results that will benefit all citizens in the area. It is a very low cost project relative to the short- and long-term durable benefits that will be realized. The program costs are projected costs at $28 million over a five year period. It is expected that incidence of malaria in Monrovia will drop during this period to less than 10% of current levels.

Program Cost						
In thousand dollars ($ 000)	Year 1	Year 2	Year 3	Year 4	Year 5	5Yr total

Program Cost						
FUNDING	8,000	5,000	5,000	5,000	5,000	28,000

The mosquito control component includes steps to kill mosquitoes using aerial spraying, mechanized ground fogging, and manual spraying of environmentally safe insecticides. Simultaneously, the incidence of malaria in the population will be reduced by using appropriate medications, including ACT therapies, and ensuring less contact with the vector by reducing mosquito populations and providing additional protection including interior residual spraying (IRS) that kills and repels mosquitoes, and long lasting insecticide-treated bed nets that protect individuals in bed and protected areas. Program activities are monitored and a strong data collection component facilitates relating Program activities to results of mosquito entomological analysis and malarial health analysis. The Program also has strong accounting, financial control and transparent reporting.

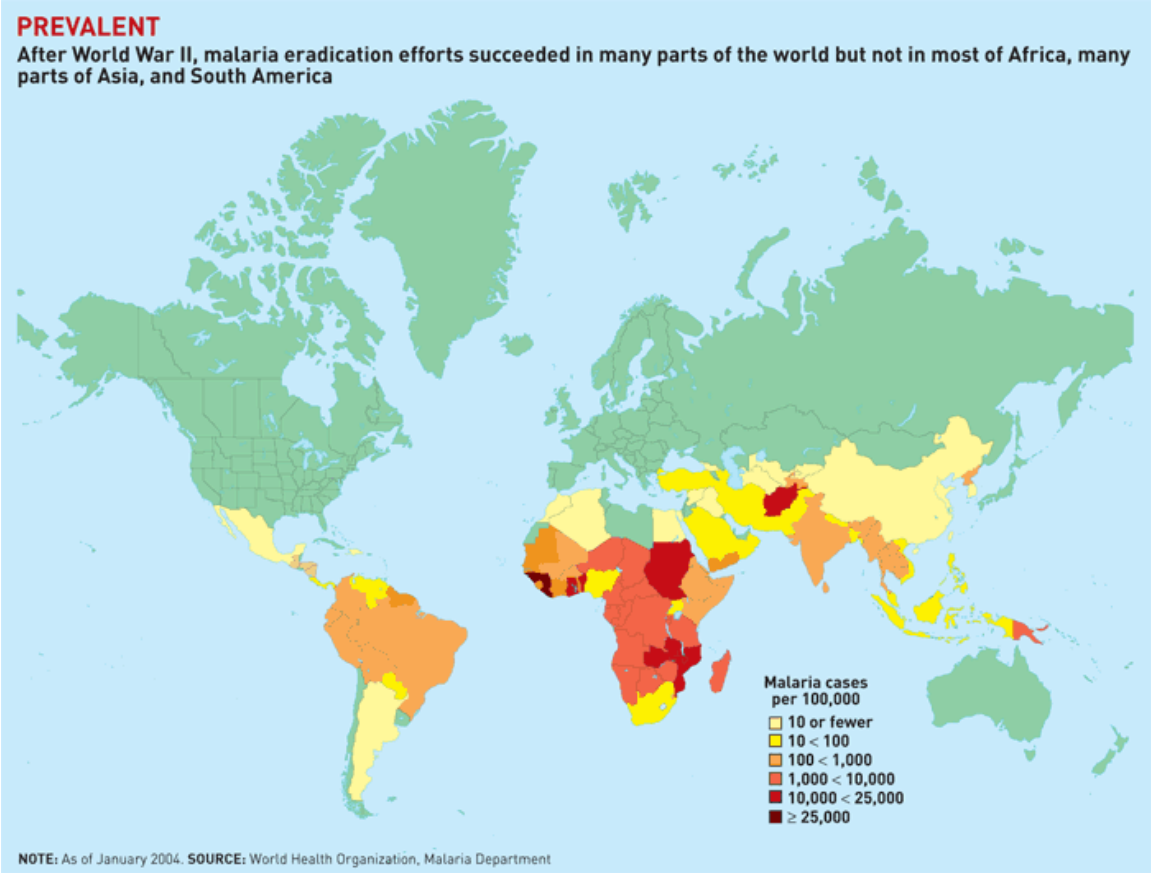
The Program will benefit about one million people directly through improvement in health and the productivity of the work force. These per capita benefits are difficult to project with any precision, but the range is from $10 to $10,000 per person, that is, from modest to huge, depending on the circumstances of the individual beneficiary. Program implementation also provides macro-economic benefit in the local economy as a result of the multiplier impact of jobs and the expenditures of the Program.

The funding of the program should be a combination of international official relief and development assistance funding, international corporate and foundation philanthropy, and a local component to set the stage for permanent program continuation. The goal has been set to commence implementation as soon as an initial firm commitment of $5 million has been secured.

Malaria is a parasitic disease. The malaria parasite lives in the blood and attacks the internal organs, including the brain. The parasite moves from host to host through mosquitoes, as they feed on human blood. There are three approaches to reducing malaria: (1) reducing the mosquito population; (2) reducing human contact with the mosquito vector; and, (2) reducing the malaria parasite. The best sustainable results are achieved when all are used.

Global prevalence of malaria

The WHO map reproduced below shows the incidence of malaria around the world.



An estimated 500 million cases of acute malaria occur worldwide each year. Sub-Saharan Africa alone may incur 450 million cases annually, resulting in at least 1 million deaths, primarily among infants and young children. Worldwide, up to 3,000 children die of malaria every day.

In 2005, in an era when science and technology enables many amazing accomplishments, malaria persists as one of the world's greatest killers. Why is it that the problem of malaria has not been solved, and why is there an ongoing waste of human life? All rich countries have become malaria free and are able to maintain this status. Why not poor countries?

For decades reports have indicated that eradication of vectors and control of vector habitats can substantially reduce the incidence of malaria. Rich countries have freed themselves of the debilitating burden of malaria, while most poor tropical areas still suffer from its life threatening effects.

Malaria is endemic to all tropical areas except the tropical belt of the United States and Australia, where aggressive intervention has practically eliminated the mosquito vector from the environment and the malaria parasite from the human host. A continuing program of mosquito control ensures that the disease is not reestablished. The map shows that West Africa is the location where malaria is the worst. Of this vast area, Liberia and Guinea are particularly hard hit: there the malaria incidence exceeds 25,000 cases per 100,000 inhabitants. The efforts to control mosquitoes and malaria in Africa have not been on a significant scale for most of the last 50 years.

Strategy

Mosquito control is practiced in every tropical part of the rich developed world, with the result that mosquitoes and malaria have been brought under control and almost eliminated. Places like Florida in the United States and Darwin in Australia have effectively controlled the mosquito vector. Malaria is now rare and usually associated with visitors coming into the area. There are also reports of recent success in mosquito / malaria control in a comprehensive project in KwaZulu Natal, South Africa. The Program strategy is to reproduce this success in West Africa.

The strategy for the Program is based on experience, and lessons learned from the past. New scientific advances make it possible for some new techniques to be used to reduce the impact of malarial mosquito infestation on the population, but it is only through a comprehensive holistic plan that the most desirable results will be achieved. The program aims to include all possible interventions and stakeholders to achieve success and have a durable result.

Cooperation

To the extent possible the Program will be implemented in cooperation with the beneficiary communities and with professional individuals and organizations that have specialized knowledge and experience and can operate effectively in the Liberian context. Expatriate staff are expected to facilitate sustainability by training Liberian colleagues. An international NGO will extensive Liberian experience is being considered to supplement the medical analysis and coordination that will be available through Ministry of Health facilities. The Program's entomology analysis will be carried out in cooperation with Cuttington University science department. Data collection will be assisted through cooperation with community organizations, faith based groups and schools.

Comprehensive and holistic

Success is most likely when the program is comprehensive in nature. Neither the malaria parasite nor its mosquito vector must have a chance at winning. Partial programs that do not address both the process of infection and the treatment of the infection are much more likely to fail. A comprehensive program has a much higher potential to produce durable benefits, and thus in the long run is the most cost effective. Nothing planned for the Program is new science, but it is a complete set of holistic interventions that have proved effective in other parts of the world.

Data collection, analysis and activity planning

The Program is based on science and technology, and uses data to determine the best mix of Program activities. Rapid changes are going to take place as a result of Program activities and the Program must respond as needed to the changes that are identified. For example, mosquito populations can rapidly reestablish from old eggs and rapid response is essential to keep a new mosquito population from reestablishing itself. Data will be collected to understand the mosquito and the impact of Program activities. Data will also be collected about malaria and the malaria parasite. The Program supports treatment initiatives so that pool of infection is reduced. All performance metrics – financial, scientific and operational are used to assess Program performance and to be accountable for resource use. The metrics are all related and make up a complete system of management information that will support full transparency and accountability. Modern information technology will be used in ways that provide for the best possible management information for decision making in the Program. Critical operational data will be made available in a web accessible database so that all interested stakeholders can easily assess Program progress and performance.

Program organization and management

The program organization and management reflects the operational situation in Liberia. Key staff associated with the Program have long experience in Liberia and other similar developing countries and are committed to a high standard of Program performance in spite of physical and logistical difficulties. The Program is planned to have efficient and effective operations not only for the short term but also for a continuing period into the future. The model of California's Mosquito Abatement Districts may be used as a template for ongoing Program management into the future. The Program will be implemented in cooperation with local organizations that can be valuable to the Program and benefit from participation, such as schools, church groups, local NGOs and youth groups. Consideration will be given to cooperating with the authorities to employ demobilized soldiers in connection with mosquito / malaria control environmental cleanup.

The program organization includes units to provide data and analysis that are scientifically based, objective, independent, professional and reliable. The Program organization includes a unit to ensure financial and economic performance, cost effectiveness, and transparency and accountability. Guidance in the area of financial control and management information for Program decision making is being provided by the Transparency and Accountability Network. (Tr-Ac-Net).

Review of past costs of mosquito and malaria control interventions is difficult because of the incredible lack of useful cost information. An cost effectiveness model has been developed for this program based on relatively easily accessible information and it is clear that costs can be kept to a reasonable level if the program is cost optimized. The behavior of the mosquito and the malaria parasite to various interventions cannot be predicted with certainty, and it is absolutely clear that success will be achieved at minimum cost if interventions are initiated based feedback about current cost information, entomological data and malaria epidemiology information. All of this is included in the program plan.

Mosquito abatement

The success of mosquito abatement efforts will be assured by combining powerful mosquito eradication activities with strong scientific data collection and analysis. The technology to kill mosquitoes and disrupt their life cycle is available, has been used widely in the United States, and can be used in Liberia so that the mosquito population is significantly reduced.

The program must also address the challenge of the mosquito population getting reestablished and perhaps with resistance to some of the pesticides being used. This is best accomplished by timely, careful and continuous scientific analysis to monitor Program performance.

All forms of mosquito control will be taken into consideration continuously, and the most appropriate for each particular situation will be used. Accordingly, there will be a program capacity to do aerial spraying, mechanized ground fogging, manual ground fogging, interior residual spraying and removal of breeding places. The eradication process includes treatment to kill adult mosquitoes, as well as larvaciding to disrupt their life cycle.

The program includes capacity for data collection and analysis, so that the entomology of the mosquito is well understood at all stages, and the impact of the Program is assessed. The goal is to involve the local scientific community in this effort to the maximum possible extent, especially the existing and emerging local scientific establishment.

In addition to reducing malaria, controlling mosquitoes also helps to control other diseases that are transmitted by flies and mosquitoes such as filariasis, yellow fever, sleeping sickness, dengue fever and encephalitis. In the USA today, mosquitoes are connected to the spread of the West Nile disease, and, as a result, are being aggressively controlled using some of the techniques included in this Program.

Technical issues relating to the management of a successful mosquito abatement program are being addressed through cooperation with West Coast Aerial Applicators (WCAA) and ADAPCO, both with long experience in the use of insecticides to control insect infestation.

Malaria treatment

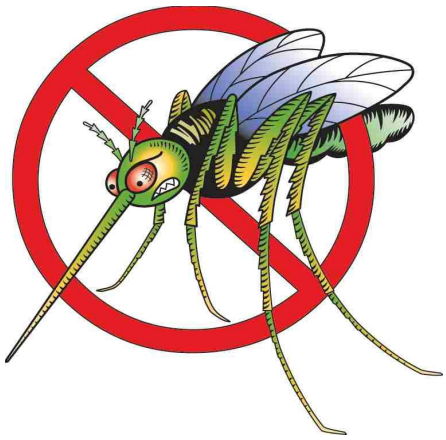
The unending cycle of infection, treatment and reinfection that prevails in most poor tropical areas is a primary reason why treatment of malaria patients by itself does not work and eventually results in the build up of resistance to medication.

However, malaria treatment plays an integral role in the long-term success of the Program. The goal is to reduce the prevalence of the malaria parasite in the human host in the region's population at large. There is a simple relationship between prevalence of the parasite and its transmission from host to host. The problem of reinfection will be addressed not only by reducing the vector, but also by reducing the number of infected people through treatment. The problem of reinfection can also be addressed by limiting the access of mosquitoes to infected persons, such as through the use of bed nets.

The Program includes data collection and analysis capacity, so that the medical issues are fully understood and the Program's progress is optimized. The goal is to involve the local medical community in this effort to the maximum possible extent, especially the existing and emerging local medical establishment, to ensure prompt and effective treatment of all patients.

Long term issues
The problem of health is a long-term issue, and the need to control mosquitoes and malaria is never-ending. The Program goal at the outset, therefore, is to reduce the incidence of malaria in the Liberian population, and then in the long term to keep the incidence of malaria very low – and to do so in an affordable, sustainable way. The long-term durable value will be achieved only if there is a sufficient success in the initial reduction phase, and ongoing work is done to maintain this situation. This ongoing work should be affordable within the context of the Liberian economy, without a requirement for permanent external subsidies.

Replication or expansion
The Program is designed to succeed, and there is a need for similar programs in many other parts of the tropical world. Some elements of this Program are suitable for replication, but local conditions must always be taken fully into consideration, because they impact program performance and the results that will be achieved. This Program aims to be transparent in all its activities, and will also be pro-active in learning about how this work can be optimized and how it might be used productively in other situations.



Success in Mosquito / Malaria Control

Malaria

USA – California

As early as 1910, California had reduced the incidence of malaria by between 80% and 90%. School absences were cut in half and medical treatment needs very much reduced. Epidemics of insect borne disease such as encephalitis, malaria and yellow fever were brought under control in most of the USA decades ago, in the first half of the last century. The Mosquito Abatement Act was passed in 1915 in California and the California Mosquito Association was created in 1930. Between 1914 and 1928, the U. S. Public Health Service reported mosquito abatement programs in no less than seventeen different states. By 1935 the American Mosquito Association was formed, and it soon boasted one hundred member countries.

USA - Minnesota

For many years, the State of Minnesota, faced with thousands of square miles of seasonally standing water and ideal mosquito breeding grounds, employs abatement and control practices that are environmentally safe and cost effective. The per capita expenditures are consistently under one dollar annually. The over-riding philosophy driving the program for decades was that, so long as public funded costs are lower than total private costs related to control, treatment, and administration, it is good public policy to conduct the program. Over the years, success rates of 87% and more in controlling the mosquito population have been the norm.

USA - Florida

Without comprehensive control programs insect borne disease would be a major problem in the United States. The State of Florida has a comprehensive program and, even though it is tropical with a lot of standing water, malaria is not any more an endemic problem. Some of the US interventions have been strengthened because of fear that the mosquito will serve as a vector to carry the West Nile virus which has appeared in recent years in parts of the USA. In the spring of 2005, the New York City health department treated many thousands of storm sewer drains with larvacide tablets to counter a potential mosquito population explosion.

USA – Gulf Coast (post Katrina and Rita hurricanes)

The programs to ensure that the mosquito population is kept under control are ongoing in the USA.. In the aftermath of Hurricanes Katrina and Rita along the Gulf Coast in the United States, the authorities arranged for many hundreds of square miles of land to be sprayed with a very low concentration of insecticide to counter a potential explosion in the insect population, including mosquitoes.

Central and South America

In the past, control of malaria was achieved in parts of South and Central America, as well as in parts of Africa and Asia.

Africa and Middle East

Egypt

As far back as 1902, Egypt's eradication program resulted in an 89% decrease in hospital cases. UNICEF had a major malaria control program in the 1960s, but it was dropped in favor of other health interventions – and no other international organization took up the challenge, even though malaria clearly remained a widespread and endemic health problem.

South Africa – Kwa Zulu Natal

Recent progress in Southern Africa in mosquito / malaria control using a comprehensive approach is encouraging. In KwaZulu Natal, insecticide use to kill mosquitoes and treatment of the infection taken together gave favorable results and the experience has been expanded in the region successfully. It is recognised that long term results are going to be achieved by regional programs that go beyond small area interventions.

The problem of sustainability

In many parts of the world there was some past success, but without continuing intervention the mosquito population has become reestablished and there is renewed widespread malaria infection of the human population. The result is that today malaria is a catastrophic health crisis in much of the world's tropical developing countries with large numbers of the population infected and affected by malaria.

Economics of Malaria

When a large percentage of the population is infected, there is a very big economic impact that affects the aggregate macro-economics of the area. Africa as a whole is seriously affected by malaria, and yet very little relief and development assistance has been used for anti-malaria programs in Africa for decades.

The justification for a reduction in the incidence of malaria in Monrovia is self-evident. Someone contracting malaria has difficulty working efficiently, or indeed in many cases working at all. Many individuals lose weeks of time every year because of malaria. Parents are unable to care for their families. Many children die, as do a good many adults. The cost of effective anti-malaria medication is going up. More and more there is resistance building up against the available medications.

Because of malaria, the Liberian economy is based on part-time work. Almost everyone must take time off when they get sick.

Education is interrupted for teachers and students. Work is interrupted when workers are absent, and the self-employed must function at reduced levels of effort. The economic and social consequence of low productivity place major constraints on socio-economic progress.

Each individual affected by malaria loses $50 to $100 a year, depending on the severity of his or her case – in countries where per capita annual incomes are often less than $750. By contrast, the cost of a comprehensive program is likely to be around $10 per person, perhaps significantly less, depending on circumstances and environmental characteristics.

In 1975, Dr. John McDougal estimated that 25% of all malaria cases affect gainfully employed workers, resulting in at least two days missed per month due to malarial illness. The situation 30 years later is worse. The opportunity cost of missing 10% of productive time by the population of Monrovia can now be estimated at as much as $20 million a year, based on a population of 1 million, losing 10% of potential work time and using a (ridiculously) low annual income of $200 per year. If Monrovia was more economically active, the economic loss would be even larger.

In rural areas, badly needed agricultural products go unharvested because workers suffering from malaria are unable to do the work. This drastically reduces family income, and then reduces spending on goods and services that would employ others. It is a vicious cycle. Worse, the costs of mitigating the impact of the mosquito and the malaria a substantial, such as spending on anti-mosquito products and on medications to treat the disease. The small disposable income available to families is reduced even more.

People routinely seek chloroquine as a treatment for malaria and as a prophylactic. It has become less effective in recent years as new strains of malaria have reached West Africa. In a 1986 survey of pharmaceutical suppliers it was reported that approximately one million chloroquine tablets were dispensed monthly in Monrovia. The economic cost in a poor country is huge. Most people suffering from malaria could not even afford chloroquine treatment. Newer and more effective treatments are available but cost many times more, and are not an affordable option in the economic situation of most of West Africa including Liberia.

In order to protect from mosquitoes using personal sprays, burning coils, etc. a population of one million people would need to spend around $50 a person a year or $50 million for the whole population. Such an approach cannot work because most of the population cannot afford it. There would probably be other problems as well including environmental and health side effects, and the build up of resistance as the need for protection would be never ending.

Program support, endorsements and policy convergence.

The Monrovia Mosquito / Malaria Control Program has the support and endorsement of many affected communities and many interested international groups. The Program also reflects recent policy initiatives in the donor community, to put malaria control much more in the forefront of international relief and development efforts.

Liberian Government support
The Liberian Government at the Ministerial level has been very supportive of mosquito control and malaria prevention for a number of years. However, up to now, it has not had the funding to initiate a fully comprehensive program. The proposed Program's goals are fully consistent with the public policy of the government.

Support from the expatriate Liberian community
The international expatriate Liberian community, through LIHEDE (Liberian History, Education and Development), has been at the forefront of dialog about the need for initiatives to address the malaria crisis in Liberia, and especially Monrovia. An international conference was held at the University of North Carolina, Greensboro campus in July 2005 to explore ways to address the crisis in a tangible and effective way. The conference resolved to initiate and support a comprehensive program for mosquito/malaria control in Monrovia that included an aerial mosquito control component.

Support from the Kill Malarial Mosquitoes Now (KMMN) group organizers
The Monrovia Mosquito/Malaria Control Program also has the support of the organizers of the KMMN initiative. A declaration of KMMN to encourage a comprehensive use of insecticides including DDT to combat the lethal mosquito/malaria combination has attracted the endorsement of hundreds of people, including three Nobel Peace Laureates, prominent medical professionals and scientists, and numerous religious, business, political and public policy leaders from the United States, Africa and throughout the world. The KMMN initiative was an outgrowth of a deep concern about the failure of international aid agencies and the global community to employ or permit the best possible techniques for combating mosquitoes and malaria.

Support from African health sector professionals
Many professionals in Africa have indicated their support for a program like this. These colleagues know the cope of the health problem, understand the possibility to have a long lasting solution, but do not have access to the resources needed to make a comprehensive program that will be successful.

Support from the donor community
The donor community is very important to the future of the countries of the "South," including Liberia. Without relief and development support, and investment resources the socio-economic picture for the "South" is bleak. In recent years, the donor community has shown increasing interest in addressing the malaria health crisis. This program plan is consistent with many of the policy directions of important donors for relief and development.

Support from the Global Fund
The Global Fund for AIDS, Tuberculosis and Malaria (GFATM) has funding malaria interventions as one of its key mandates. This program plan is consistent with the goals of GFATM – as well as those of the President's Malaria Initiative.

Support from the friends of Tr-Ac-Net
The Transparency and Accountability Network (Tr-Ac-Net) has been encouraging initiatives in the global relief and development sector that provide durable value. This Program has been encouraged by friends of Tr-Ac-Net in South Asia, around Africa and Latin America.

LIBERIA COUNTRY PROGRAM

ABOUT THE PROGRAM LOCATION

Liberia

Information about Liberia can be found in the CIA World FactBook at the following URL:
https://www.cia.gov/cia/publications/factbook/print/li.html

The Republic of Liberia is located on the west coast of Africa and has an area of 43,000 square miles and a population of approximately 2.7 million. It is bounded on the north by Sierra Leone and Guinea, on the east by the Ivory Coast, and on the south and west by the Atlantic Ocean. A tropical region, it has been severely impacted by more than 20 years of strife and civil war. Along with Guinea, Liberia is the most malarial country in the world, according to WHO – with a more than 25,000 cases per 100,000 people.

The country is rich in natural resources, especially iron ore, gold, and diamonds. It is also rich in timber, and has been a major producer of rubber. But these natural resources have not resulted in a vibrant growing economy, because much of the wealth has been squandered in a long lasting civil war. In addition, the population is suffering, not only economically but because of endemic health problems, especially malaria.

The coast of Liberia is approximately 370 miles long and extends inland about fifty miles. This coastal strip is virtually the only developed region. The climate is typically equatorial, with an annual mean temperature of 82 degrees Fahrenheit, accompanied by an annual rainfall of about two hundred inches along the coastal strip and seventy inches in the interior. The rainy season occurs between April and October with drier periods from November through March.

Liberia is the oldest republic on the African continent. For more than a century, freed slaves and their descendants governed the country. They constructed and adopted a constitution in 1825, and implemented socioeconomic and political systems modeled after those of the United States. More than 90% of the population are indigenous members of sixteen different tribes. Migration from neighboring countries is a small but growing segment of the population. Approximately 40% of the population resides in urban areas, with over one half of these living in or around the capital city of Monrovia. In 1980, after a coup, government leadership passed to indigenous peoples.

The country experienced economic growth in the 1960s and the 1970s. However, the combination of political uncertainty after the 1980 coup, a worldwide decline in the commodities exported by Liberia, and the withdrawal of financial support by the World Bank, IMF and United States resulted in very difficult economic conditions. A long lasting civil war ensued, creating even worse conditions for the population. Small manufacturing activity has declined in the past 20 years and agricultural production has become the main economic activity, occupying over 70% of the population in the production of food crops like rice and cash crops like cocoa and coffee. The largest single employer is the government. The jobs crisis has been aggravated by the demobilization of the armies and militias after the civil war.

Urban areas in Liberia

The urban areas in Liberia include Monrovia, the capital city, and the cities of Robertsport, Harbel Buchanan, Greenville and Harper all along the coast and Voinjama, Foya, Gbarnga, Yakepa and Zwedru all inland.

Monrovia

Monrovia is a city with a permanent population of around 600,000. Due to the insecurity of the civil war, however, probably as many as twice that number currently reside in the urban area of Monrovia. That area is around 50,000 acres, and within it lies a mangrove swamp or wetland of some 15,000 to 20,000 acres – a nearly perfect breeding ground for mosquitoes, and malaria.

Most of Monrovia's people live close to these wetlands and the rain forests that surround the city. An additional 2,000 acres of swamp land surrounds the outlying area, with all these additional breeding grounds lying within 1.2 miles of the city, well within the flying range of the *anopheles* mosquito. It is akin to the situation in Florida, Louisiana, Mississippi and other southern US states – except that those states are no longer afflicted by malaria.

In order for human populations to live healthily in the region, it is therefore vital that mosquito and malaria abatement measures be taken and maintained. A 1975 monitoring survey counted 12.3 mosquitoes per room in a Monrovia suburb. This compares with a Nigerian standard for public health that requires spraying with a finding of one mosquito per room.

The Malaria Crisis in Monrovia

Malaria is endemic to Liberia, including the greater Monrovia district. The condition is said to be autochthonous because indigenous malaria acquired by mosquito transmission is a regular occurrence. In Monrovia, the incidence of malaria is of epidemic proportions. Some in the medical community believe malaria infects 100% of the adult population. The risk of exposure is inescapable. Between 90% and 100% of the population is exposed on a continuous basis.

The most common malaria parasite is *P. falciparum*, present in over 90% of the cases. Unfortunately, of the four species of human malaria, *P. falciparum* has the more severe symptoms and is more often fatal. It attains optimal development in the high temperatures and moist climates common to West Africa and Southeast Asia. Worse, this parasite is resistant to chloroquine, the most widely used low cost medicine for malaria treatment.

There have been many studies in Liberia since the early 1950s all showing the seriousness of the malaria crisis. Malariametric surveys since 1951 have continually shown at least mesoendemic conditions in Monrovia and hyperendemic conditions in the rest of Liberia. In 1988, research reported that one half of the population of Liberia was infected with the parasite, including one-third of all infants and over one-half of all children. Other studies have shown that, in Monrovia and its suburbs, at least one third of the population carries the disease, including one fourth of all infants and more than one third of young children. This means that even non-infected mosquitoes have a 1 in 3 chance of picking up malaria parasites and infecting the next person they bite.

A nationwide children's health survey, conducted between February and July of 1986, found that one of every two children had had fever during the four week period prior to the survey. In 67% of the cases, the child was between twelve and seventeen months old. A 1988-89 report showed that the greatest number of pediatric hospitalization cases were for malaria. In 1984 it was reported that 144 out of 1,000 infants would die before their first birthday and that 220 would die before reaching age five. That is, more than one in every five newborn children is dying before reaching age five.

Pregnant women with low levels of immunity have a higher incidence of contracting the disease, and many die. Placental parasitemia causes not only lower birth weights, but entire lives of increased susceptibility to illness.

The rate of infection in Monrovia may be even higher than for Liberia as a whole, with hospitals and clinics reporting that more than 50% of the patients are infected by malaria. Monrovia has a very high incidence of malaria because conditions are very favorable for mosquitoes to breed, there is a very high prevalence of malaria in the human population, and no efforts were undertaken to control the situation for over 20 years, because of a public finance crisis and civil war.

USING SATELLITE IMAGERY

Satellite imagery is one of the tools we have available.

The satellite image map of Monrovia shows the unusual situation of the city. The red dot to the northwest is about 10 miles from the red dot in the southeast. This area comprises about 50,000 acres, with a clearly visible swamp in the middle of the city. Coupled with a warm, wet tropical climate, this makes Monrovia one of the world's leading cities for the incidence of malaria, which accounts for well over 50% of all disease in the city. However, with available modern technologies, there is no reason that this situation needs to continue.

NOTE: The area within the yellow lines is about 50,000 acres. The dark brown area is an area of about 15,000 acres of marshland within the urban built-up area.

This image is for for Monrovia, Liberia, a location suffering from endemic malaria. The population of Monrovia was around 500,000 prior to the Liberian civil war, but since the war insecurity and an influx of displaced persons has probably expanded the population to more than 1 million people. Monrovia covers an area of around 50,000 acres, some 15,000 acres of which are marshland, a perfect breeding ground for mosquitoes, and located very close to homes. On the map , the area within the yellow lines is about 50,000 acres. The dark brown represents the marshy area of about 15,000 acres.

The majority of Monrovia's population is very poor and lives in very crowded and disorganized conditions. Perhaps half the population are now living in squatter conditions, and road access is very limited. The picture (below) of the Bushrop Island neighborhood of Monrovia is an indication of the difficulty ground operations will have to face. The yellow line represents ¼ mile. A strategy that uses ULV aerial spraying is very much suited to these areas.

The picture (below) of the Sinkor neighborhood shows a different set of physical conditions, and different issues for effective ground operations. Note in both cases how few of the buildings are road accessible and within range of effective mechanized ground fogging. Again, this area is suited to ULV aerial spraying.

The goals of the Program are set out in the first section of this paper. They bear repeating. The over-arching goals of the Monrovia Mosquito / Malaria Control plan are to:

1. Reduce the mortality rate of children, especially at-risk children under five years of age.
2. Reduce the morbidity rate among the population, including at-risk groups such as pregnant women.
3. Slow malaria transmission through interventions to decrease mosquito populations.
4. Reduce the malaria parasites in both mosquito and human populations to lower the risk of rapid re-infection.

Short-terms goals are to:

1. Establish the capacity to implement an efficient program for mosquito and malaria control in Monrovia.
2. Secure funding to establish the Program, and set up procedures to have ongoing funding for full implementation of the Program.
3. Set up data collection and analysis so that the Program has a baseline dataset and has ways to measure progress during implementation.

The long-term goals are:

1. First and foremost, to maintain a favorable reduction in the incidence of malaria in Monrovia on a permanent basis.
2. To build a long-run capacity to maintain an efficient program for mosquito and malaria control using the best of entomological and medical science for successful control of mosquitoes and malaria in Monrovia in perpetuity.
3. To have the understanding and capacity to replicate a successful Monrovia program in other parts of Liberia, and also in other parts of Africa.

The Monrovia Mosquito/Malaria Abatement Program aims to do everything that is possible to achieve success, working in a comprehensive and holistic manner.

Program costs and benefits

The aggregate program costs are projected at $28 million over a five year period.

Program Cost						
In thousand dollars ($ 000)	Year 1	Year 2	Year 3	Year 4	Year 5	5Yr total
FUNDING	8,000	5,000	5,000	5,000	5,000	28,000

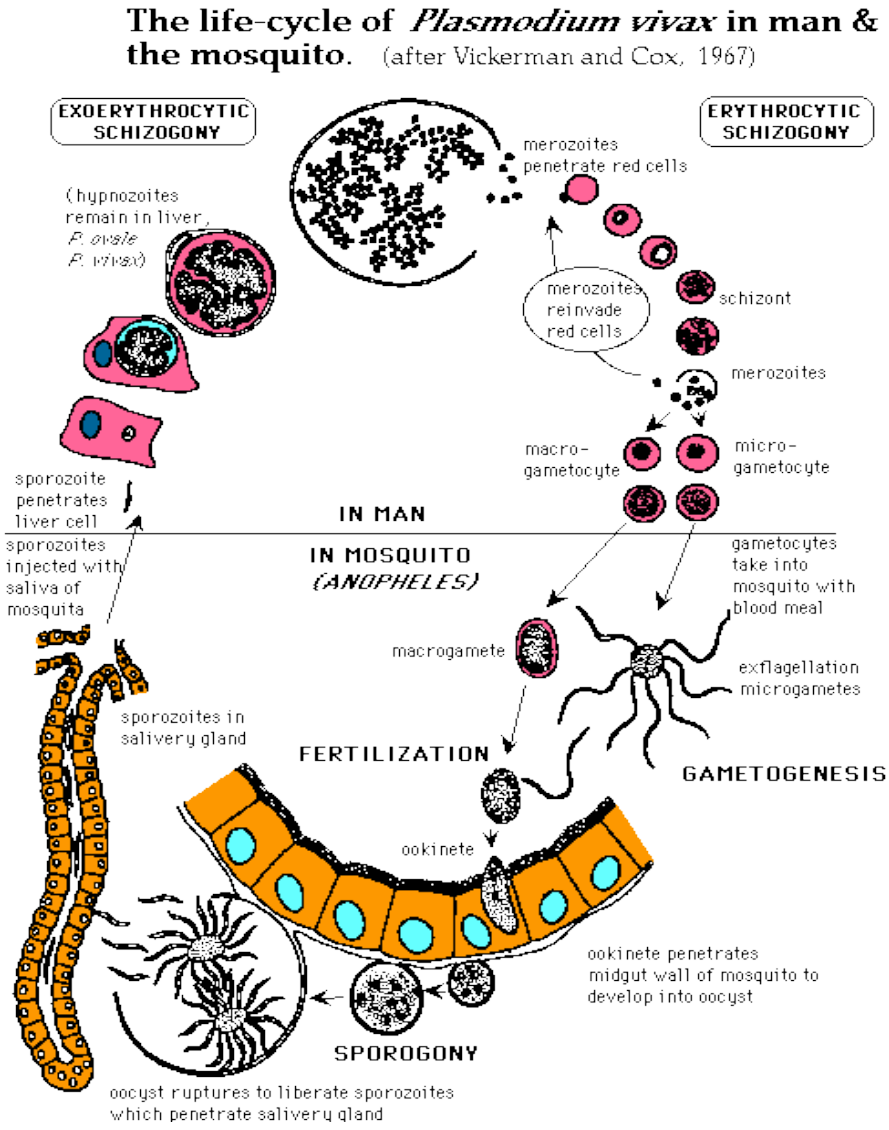
The Program aims to reduce the incidence of malaria in Monrovia during this period to less than 10% of current levels at the start of the Program. In order to measure this in an objective way the Program will establish at the outset a baseline of malaria infection data using data that are available within the units of the Liberian health sector (clinics, hospitals, etc) and will then monitor these data on an ongoing basis for the duration of the Program. Currently available data show that more than 50% of hospital patients in Liberia are infected with malaria.

Out of a population of 1 million, perhaps as many as 4,000 children a year die before age 5, many of the deaths associated with malaria. The Program will reduce these deaths by as much as a half. Morbidity in the general adult population will be reduced. All these health benefits have a major impact on Monrovia's potential for economic progress. The value is substantial, albeit difficult to quantify.

It is difficult to project the progress of the Program because of the many variables involved. The aggregate goal of reducing the incidence of malaria by 90% is entirely possible with a comprehensive approach over a long time.

The Malaria life cycle

When a mosquito bites an infected person, it ingests microscopic malaria parasites found in the person's blood.



The malaria parasite must grow in the mosquito for a week or more before infection can be passed to another person. If, after a week, the mosquito then bites another person, the parasites go from the mosquito's mouth into the person's blood. The parasites then travel to the person's liver, enter the liver's cells, grow and multiply. During this time when the parasites are in the liver, the person has not yet felt sick. The parasites leave the liver and enter red blood cells; this may take as little as 8 days or as many as several months. Once inside the red blood cells, the parasites grow and multiply. The red blood cells burst, freeing the parasites to attack other red blood cells. Toxins from the parasite are

also released into the blood, making the person feel sick. If a mosquito bites this person while the parasites are in his or her blood, it will ingest the tiny parasites. After a week or more, the mosquito can infect another person.

Humans get malaria from the bite of a malaria-infected mosquito. The challenge is to stop this cycle of continuing re-infection in a cost effective way that does not have damaging side effects either in the human population or in the environment.

Over the years there has been a lot of research about mosquito behavior and its life cycle. There has also been a lot of work done to learn about the malaria parasite and its life cycle. Rather little of this research has been translated into management information that can easily be used to make planning decisions about the way in which an integrated mosquito and malaria control program should work.

One of the ways in which this IMMC initiative is different from others is that it has a focus on science, data and analysis within a management system that can access the most relevant intervention for the prevailing situation, and can change as needed as the situation evolves.

INTEGRATED MOSQUITO AND MALARIA CONTROL (IMMC) ELEMENTS OF IMMC

IMMC elements or interventions

IMMC elements or interventions include the following: (1) Collecting data and the analysis and interpretation of the data; (2) management information, organizing for optimum performance; (3) malaria awareness and neighborhood cleanup to reduce mosquito breeding places; (4) interior residual spraying (IRS); (5) ultra low volume (ULV) adulticide spraying to kill flying mosquitoes; (6) larvaciding to kill larvae and stop mosquito recruitment into the population; and, (7) personal use of insecticide treated bednets (ITN). The manner in which these various IMMC interventions are implemented is determined by the facts about program performance and the changes taking place.

Collecting data and the interpretation and analysis of the data

The starting point for the IMMC program is to collect and organize existing data so that it is easier to understand and to have a baseline and starting point. A lot of data are already available, and these data should be supplemented and updated as needed. There are several sets of data that are needed: (1) entomological data concerning the mosquito population and its breeding locations; (2) geographical or spatial information about the community ... population, buildings, water, etc; (3) medical information about malaria in the community and how cases are being treated (if at all); (4) the actual IMMC interventions that have taken place and where; and, (5) updates of all the information so that results can be compared to activities.

The collection of data and its organization so that it is easily available for analysis and planning can be done now using a combination of low cost local data collectors and the low cost and power of modern information and communications technology (ICT). The IMMC program pulls together a lot of data that have been collected in the past, as well as current data to provide a starting point for planning. The IMMC process then continues data collection, analysis and planning to ensure that IMMC interventions are as effective as they can be and low cost.

Data collection incorporates information flows that relate to the physical situation and spatial information for the area, entomological information about the mosquito, medical information about the human population and medical information about the malaria parasite. Data is needed to measure results and also to alert the program managers to side effects like resistance or environmental risks that need to be minimized.

Management information, organizing for optimum performance

Organization is very important. Good performance results from management information that uses data and an appropriate analysis process, and organization that converts ideas and plans into action, and measures the results.

A planning model is being developed so that critical variables that affect the dynamic of the mosquito and malaria can be studied with easy to understand

“what if?” simulations. The model attempts to relate cost with result, on top of calculations that reflect the underlying science.

Available data are being organized and used in financial and cost analysis spreadsheets. The aim is to understand the costs and the behavior of all of the possible interventions and how these costs are related to performance in different combinations of interventions. The spreadsheets help to make cost projections for a successful IMMC program in any district or community and to understand the costs and results that can be expected based on an operational model.

One of the critical parameters that emerges from these data is that time and scale are the two very critical variables. What the operating model shows is that timing makes a big difference and fast response to changing situations is very valuable. It is also apparent that spatial information can be very valuable in helping to design interventions that improve the results and reduce costs.

Spatial information is very valuable. Spatial information is needed about the physical characteristics of the area, how mosquitoes behave in the area and the prevalence of malaria in the population. It is also needed to show how various IMMC interventions have been deployed. Spatial information gives a way to relate activity to the area as a whole, and to focus effort where it has the most impact. The following is a satellite image of Monrovia, Liberia. The area within the yellow line is 50,000 acres, and the dark brown area is a tidal marsh where mosquitoes breed prolifically. The marsh area is around 15,000 acres.

Data related to spatial distribution of malaria cases may be particularly useful, because it may be possible to focus effort in ways that reduce costs and increase results significantly. The following image shows a built up area, and helps to show visually how much work needs to be done. Where there is a population of 1 million people, there are perhaps 400,000 rooms that need to be sprayed to get complete coverage, and many of these rooms are in houses that do not have easy vehicular access.

In Darwin, Northern Territories, Australia, which is now malaria free, all malaria cases are reported and a range of control measures are immediately implemented. These include quarantining the patient, killing all mosquitoes near where the case was reported and intensive monitoring of people in the area. As a result Darwin has had no cases of local transmission of malaria since 1962. All the reported cases have been associated with visitors and travel from malaria affected areas.

Malaria awareness and neighborhood clean up

The community is where success is best measured, and it is community people that will benefit the most from success. Everyone from an early age needs to be made aware of malaria, and how it can be controlled. A lot of what is needed to have success depends on the community. There are many ways that local organizations, schools, churches, etc can be engaged in the IMMC program.

Schools should be making children aware about mosquitoes and malaria, and adult organizations like churches should do the same for adults. Some people in a community can help with data collection about mosquitoes and malaria.

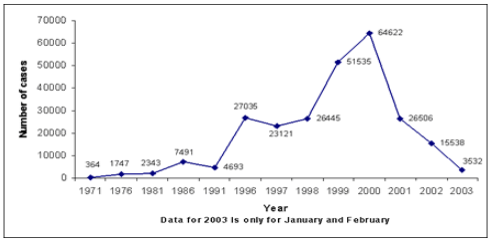
Reducing mosquito breeding places is a simple way to start getting control of the mosquito population. If the community is organized to help with clean up, and to remove places where mosquitoes can breed, they also learn about other aspects of the malaria problem.

Interior residual spraying (IRS)

The female *anopheles* mosquito carries and transmits the malarial parasite during blood feeding at the adult sexual stages. The mosquito is an uninterrupted individual feeder and is predominantly a night biting insect. This suggests that substantial protection against the mosquito and malaria can be obtained by use of interventions that focus on the house and sleeping arrangements. Interior residual spraying (IRS) using, for example, DDT, has the benefit of killing mosquitoes and serving as a repellent and reduce the impact of the vector in the house environment.

The use of interior residual spraying (IRS) has been successful in many different settings, from South America to South Asia, in the Mediterranean region and in South Africa. IRS requires workers to enter houses and do the spraying according to a protocol that is safe for residents and the spray teams.

IRS is most effective when DDT is used as the pesticide, but DDT use is controversial. The graphic below shows what happened In Kwa Zulu Natal, South Africa, when IRS with DDT was stopped. Malaria cases increased dramatically, but cases were brought under control again when IRS with DDT was once more used. More than 40,000 cases in 2000 reduced to around 1,500 three years later Similar results were obtained in neighboring Swaziland and in the south of Mozambique.



IRS works through three mechanisms: (1) there is a repellent action that keeps mosquitoes out of the house; (2) there is an irritant action that makes a mosquito leave a house quickly after entering; and, (3) a toxic action that kills the mosquito if it chooses to rest in the house. Broadly speaking, the size of the mosquito population is not affected by an IRS intervention, but behavior is modified so that there is less human blood meal taking by the mosquitoes. In an area where there is a substantial IRS intervention, the mosquito population moves outside, where it can be effectively subject to adulticide control.

The use of DDT for IRS has been controversial since the 1970s when the US Environmental Protection Agency banned DDT use in the United States. This

was mainly a result of excessive use of DDT in US agriculture and concern about the persistence of DDT in the food chain. Other countries followed the US lead and use of DDT for any purpose was banned in a number of countries around the world including Canada and several countries in Europe including Norway and Sweden.

The ban on DDT use has been a significant factor in the failure to control malaria. It has increased the cost of IRS by a factor of around 4, and other chemicals were not as effective. IRS still works, but is much less effective when DDT is not used ... perhaps 10 times less effective. In practical terms Africa has had to stop doing malaria control because of cost and budget constraints, and no countervailing initiatives from the donor community to make malaria control a priority.

Ultra low volume (ULV) adulticide spraying.

The purpose of adulticide spraying is to kill adult mosquitoes. The ULV approach kills mosquitoes mainly when they are flying, and the micron sized droplets attach to the mosquitoes legs.

All pesticide use must be done under controlled conditions with strong safety protocols in place. Used in the manner intended, the pesticides and biological agents used are highly toxic to mosquitoes, but safe for humans, animals and the environment. Compared to many of the chemicals used in treatment of malaria and other human diseases, the pesticides have low human toxicity.

Adulticiding can be done using vehicle mounted equipment or from the air. It is a safe way of reducing the mosquito population and used regularly around the world under protocols that ensure safety for people, animals and the environment.

The following are typical aircraft used for ULV spraying. They are very maneuverable, and suited to flying with very precise positioning and they are also equipped with spray equipment that enables them to generate very small spray droplets just microns in size.

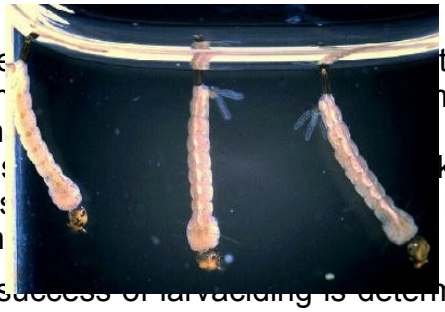
Hand carried spray equipment can also be used:

Adulticide treatment is commonly used where public health authorities are concerned about the possibility of insect borne disease. In the USA, large areas

where sprayed in the aftermath of Hurricane Katrina, and similar interventions have been used after other devastating hurricanes in the USA. Spraying is widely used when West Nile Virus is detected in US communities. Spraying has a role in getting control of mosquito vectors in malaria endemic areas.

Larvaciding and environmental control

Mosquito population control is best when mosquitoes are never recruited into the flying adult population. Mosquitoes lay eggs in stagnant water, and in a matter of days eggs become larvae, become pupae and then adult flying mosquitoes. The picture below shows what larvae look like, and how they attach themselves to the surface of the water. The examples hanging vertically are probably Culex larvae. The Anopheles larvae attaches itself horizontally to the surface of the water as shown in the right hand image.



There the stages between egg and adult mosquito, and r mented by larvacide control measures to stop all th body. For larvaciding to be effective, there needs knowledge about the water bodies and the status interventions to control the larvae need to be scien

The success of larvaciding is determined in large part by the entomological data that is collected and the analysis of this data to design effective interventions. Data has various dimensions, including a spatial dimension, a time and multiple elements of information about the mosquito life cycle and its interaction with the malaria parasite.

The success of larvaciding has been demonstrated over and over again, but it requires a lot of organization. Precise data are needed, timely intervention and well trained staff.

Some bodies of water are difficult to access, and larvaciding can be done by air. In some places helicopters are used for very precise delivery of treatment.

The environment makes a big difference to the recruitment of mosquitoes into the population. The data seem to suggest that man-made construction has a big role in creating the sort of environment that encourages mosquito breeding. Natural water is often associated with natural vegetation that seems to inhibit mosquito breeding. While the mechanism is not known, the idea that mosquito breeding varies spatially argues for precise information about the spatial entomological situation, and the precise interventions for each place.

Community level efforts to reduce mosquito breeding places is valuable. These can be organized through schools, churches, women's groups either as independent efforts or as part of a comprehensive set of activities.

Malaria case management

There are many millions of malaria cases in Africa every year. Many Africans get malaria several times a year. Only relatively few of the malaria cases in Africa get any form of professional treatment. Data that only comes from clinics is a subset of data that is not representative of the population as a whole. With 400 million at risk, it is difficult to comprehend that each case has a human face. This child got to a clinic, but the clinic had no medicine. The child died.

Quinine was found to be a useful treatment for malaria in the 19th century and was used as part of the Panama Canal anti-malaria campaign in the early 1900s. In the post WWII years Chloroquine became the most widespread malaria treatment, both as a prophylactic and for treatment, but many malaria strains have now become resistance to Chloroquine.

Other treatments have been developed. Fansidar is now widely used but it has significant side effects, and resistance has emerged.

Artemesin based combination therapies have been developed, but cost a lot more than earlier treatments, and supplies are limited from available natural artemesin sources.

Concern over the development of resistance and side effects from anti-malaria treatments are valid, and as long as endemic malaria in the environment prevails, there will have to be ongoing leap-frogging of medical science and resistance development. This of course, argues for an anti-malaria strategy that addresses the environment and the endemic malaria.

A malaria vaccine has not yet been developed. Malaria is not an easy disease to control with a vaccine, but it is scientifically possible. Whether there is an enabling economic environment for vaccine development and deployment is questionable, and needed political support is also problematic. For the purposes of this IMMC program a malaria vaccine is “in the future”. However, the understanding of the parasite may help in accelerating treatment so that the environment can be improved by more rapid treatment to minimize parasite prevalence.

Bednets and insecticide treated textiles

Bednets, insecticide treated nets (ITN), are another intervention that should be part of a comprehensive anti-malaria campaign. The model being used for IMMC planning has not been able to demonstrate that bednets on their own are as cost effective as other IMMC interventions, but they do have a favorable impact for the people who choose to use bednets.

The model suggests that bednets in fact have a potential value to help reduce the transmission of malaria from infected humans to others, and could be used to facilitate a form of quarantine for infected patients.

Long lasting insecticide treated bednets have been introduced in Africa since around 2003. These nets retain their effectiveness for about 5 years. The bednet shown below is being used in Uganda.

Data regarding the effectiveness of bednets seems to show that a bednet reduces the risk of malaria infection for the users of the bednets, but has no appreciable impact on the community as a whole that does not have bednets. This is in contrast to IRS, where the community at large seems to benefit from an IRS program, even where less than all the houses are sprayed.

Insecticide treated textiles can be used to manufacture clothes. The technology has been used already for military uniforms for soldiers being deployed in malaria endemic areas. The approach might be used in an IMMC program for uniforms for “Malaria Control Teams” as well as for the various uniformed services of countries in malaria endemic areas.

MOSQUITO CONTROL

Program overview

The starting point for an effective campaign against malaria is the initiation of a quality mosquito abatement and control program.

Destroying the vector can be achieved through aerial spraying of approved chemicals, urban fogging, water drain and sewer clean-outs, periodic changes in chemical use, indoor residual spraying, and the application of emerging new methods of eradication. Over the years, many alternative methods for mosquito eradication have been studied, including physical controls such as source eradication involving nationwide clean-up projects and improved drainage systems. Other methods that can be employed include Indoor Residual Spraying (IRS), ground hot fogging

and ultra low volume (ULV) spraying. A continual search for the best combination of methods will be an ongoing Program priority.

The Program plans to use modern mosquito control techniques that make use of insecticides and a variety of delivery systems, depending on the terrain and local circumstances. There are several systems that may be used, including aerial spraying, ground fogging from vehicles, hand spraying in confined areas and interior residual spraying. The most efficient system for the conditions will always be employed in determining which insecticides and methods to use. Cost analysis and projections for the Program suggest that a combination of methods will be the most cost effective depending on both the physical structures and terrain and the response to interventions by both mosquitoes as the vector and the malaria parasite within the human host.

The effectiveness of spraying depends on many variables, but it can be anticipated that there will be over 80% kill of mosquitoes in the first weeks of operation. While this is very important, it is not sufficient for enduring success. A mosquito population will reestablish itself very quickly, if the environmental conditions are favorable, and the malaria vector will return to a dangerous status very rapidly unless the program addresses all the relevant issues.

Specially designed aircraft that are able to fly safely at low altitudes will be used. Several hundred of these aircraft are routinely used in the United States for crop spraying and insect control. They will be equipped for the Monrovia work with modern spray systems that make it possible to use an especially low spray density with ultra fine droplets (about 50 micron) that are highly effective against airborne mosquitoes.

Community involvement in the program can be very valuable, both for doing the work associated with insecticide spraying and in helping to eliminate breeding places for mosquitoes. This is a useful part of a comprehensive effective program. Breeding places can also be treated with larvacides to kill the larvae before they grow into adult mosquitoes.

The project will have the capacity to employ various forms of ground spraying using methods. There will be exterior spraying as well as interior residual spraying (IRS).

The method chosen will always be the one that is most suited to the conditions. For example, while mosquitoes in the mangrove swamp will be killed through aerial spraying, ground fogging from vehicles will be used along urban roads.

Hand carried spray units will be deployed in areas not accessible by vehicle.

Mosquitoes have the ability to reestablish themselves very quickly. Therefore, ongoing operations are needed to kill any remaining mosquitoes and reduce the mosquito vector to insignificance, and then keep it under control at a very low level. Fast data analysis is critical, with action interventions modified to get maximum impact under rapidly changing conditions. For example: though mosquitoes are totally eliminated for a time, there is the potential for a rapid reemergence of the mosquito population because eggs that are in the environment can emerge in the future to become a new vector threat, unless they too are eliminated. The goal of the Program must be to maintain an unfavorable environment for the mosquito throughout its life cycle and in perpetuity. This is a challenge in Monrovia, where very favorable mosquito breeding grounds are everywhere, unless there is ongoing aggressive intervention.

The Program's performance will depend on carrying out all the operations needed and in the manner required. Ongoing analysis of the entomological situation will be conducted, so that the operations are scientifically sound and as cost-effective as possible. Care must be taken to avoid building insecticide resistance; this can be done by using a range of chemicals, rather than a single one.

Chemicals: toxicity and environmental considerations
Chemicals and methods used in this project will be very low in mammalian toxicity and environmentally safe. The chemicals will be alternated, to safeguard against the possibility of resistance build-up. A list of possible chemicals to be used is in the appendix.

Ultra low volume (ULV) insecticide application methods pose no environmental hazard. The concentrations of insecticide that are used to kill the mosquitoes are NOT toxic to either humans or animals. The concentration of chemicals used for mosquito control is vastly lower than what is needed for effective use of chemicals in agriculture. The spray is very fine and a small amount of insecticide treats a very large area. In the case of aerial spraying for mosquito control, the spray path may be 1,000 feet wide compared to perhaps only 60 feet in a typical agricultural crop spraying program.

The ULV insecticide application to control mosquitoes should not be confused by use of chemicals to control some major agricultural pests in the past that resulted in build up of pesticide in the environment.

The abatement process will start with the application of an ultra low volume adulticide (such as Dibrom) at a rate of ¾ ounce per acre, to knock adult mosquitoes out of the air and dramatically reduce their populations. This spraying will be repeated as necessary, with chemical strength and frequency of application determined by the entomologists. The spraying will take between two and four days for each application, depending on the conditions.

Mosquito control will include, in addition to the adulticide applications, the use of a larvacide (such as *Bacillus thuringiensis*) to eradicate the upcoming broods before they hatch. The need for and quantity of additional spraying will be determined analyzing entomological data about the impact of the program and the status of the mosquito population. Concurrent with aerial spraying schedules, a ground fogging process will be initiated. This is most appropriate in built-up urban

areas where there is vehicle access. A standard pick-up truck equipped with modern spraying equipment will be used to fog urban areas with a suitable adulticide, as needed.

Also concurrently, the program will spray city storm drains, sewer pipes and water storage areas to eliminate breeding adults and larvae.

Indoor residual spraying (IRS) will be conducted in areas considered most susceptible to intense mosquito attacks. Experts will determine which insecticide should be used on the basis of wall surface types (such as cinderblock, painted wood, etc.) and other considerations. It is hoped that DDT will be allowed for IRS application since it is very efficient, and in this use, very safe both for humans, mammals and the environment.

Field test information will be gathered and the collected data analyzed on a continuing basis. The feedback about entomological data is a critical dimension of the Program. Data about the mosquito population, as well as the malaria/parasite/human host, will be collected. Monthly review will correlate results with application rates and methods. The entomologist will confirm larval and mosquito counts, insecticide effectiveness, and environmental impact data regarding the abatement program.

Biological controls, especially aquatic and water fowl, are in accord with and aligned with long-term ecological and environmental philosophies. Introduction of fish that eat mosquito larvae (guppies) into the Monrovia swamps would be redundant, as they are already abundant in the area. However, studies should be made as to the enhancement of these existing fish populations, and they must be protected during the subsequent mosquito control project.

With an epidemic state of malaria and a very large expanse of swamp area and no easy surface accessibility to prime breeding sites, it is best to attack the mosquito vector by aerial spraying with insecticides. A powerful knockdown strike can be executed at the onset of the program and it is expected that there will be an immediate kill in excess of 80%. But it is also likely that the population will quickly rebuild and ongoing strikes will be needed to achieve a sustained reduced mosquito population.

MALARIA PARASITE CONTROL

Program overview

The reduction in mosquito population is only one step in the process of stopping malaria. The long term success of the program depends on control of both the mosquito and the parasite. If there is a small population of mosquitoes and a strong population of parasites in the host bloodstreams, then the malaria crisis will be unending, but if there can be both a low population of mosquitoes and a low population of infected hosts, then a low incidence of malaria can be achieved and sustained.

Reducing the malaria parasite population

A malaria-infected human population is a vast reservoir for malaria parasites, and these have to be systematically eliminated. The process of removing the parasite from the human population is long, but important. If the parasite exists in the human host, the mosquito will find it and act as a vector to move it to others. The challenge is to remove the vector and the parasite, so that the population does not easily become reinfected. Mosquitoes that feed off humans with no malaria parasites do not transfer malaria to the next person, but if there is a large parasite-infected host population, any mosquitoes that exist will rapidly reinfect the population.

Reduction in the incidence of malaria will take time. A lot of progress can be made if a comprehensive program is implemented for several years. However, malaria will return rapidly when mosquito control stops and the mosquito population gets reestablished, such as when the medical profession stops addressing the need for medication to control the parasite. There must therefore be a long-term program to ensure that the benefits are ongoing.

Of course, one of those benefits will be healthy students, who can attend school and learn to become highly productive members of society. Another is families that no longer have to spend disproportionate parts of their income on treating diseases – and a healthy workforce that is able to work to the full extent of its ability, earning wages, buying goods and services, and paying

taxes, to build an ever-stronger community and nation. That, in turn, will bring about modern housing, with window screens and other features that will further prevent malaria.

The Monrovia project will thus also help with ensuring affordable access to medication required to reduce the prevalence of the malaria parasite in the population. It will also encourage the use of long lasting insecticide impregnated bed-nets, at least as an interim measure while mosquitoes and malaria remain endemic.

Anti-malarial interventions

There has to be aggressive use of effective anti-malarial medications as well as vector control. Reduction of the malaria parasite in the human host is a key to long term success. When the malaria parasite is under control, the biting of mosquitoes becomes an irritant, but not as much a danger. The program initiatives to reduce the mosquito as a vector helps to control reinfection until such time as the parasite is brought under control. The assumption is that mosquito population can be rapidly reduced, but that it will rapidly reemerge ... while the parasite will take much longer to disappear from the host, but then can be kept very much under control. The program aims to be effective in both areas of intervention.

Use of long lasting impregnated bed-nets

Use of long lasting impregnated bed nets may be very helpful in reducing the transmission of malaria for two reasons: (1) in the first case merely to reduce the incidence of mosquito bites and the associated transmission of disease; and, (2) to help keep mosquitoes away from people with the malaria infection. They cost around $8 to manufacture, and with delivery and storage the delivered cost will be around $10 each (assuming local and national governments do not impose duties or taxes on the import and purchase of the nets).

PROGRAM IMPLEMENTATION

Overview

The implementation naturally falls into three phases: (1) a start up and mobilization phase that should be completed within one year; (2) an operational phase that lasts for the balance of five years; and (3) a post Program phase that needs to be ongoing in perpetuity, as in the US. Each phase is important in itself, but it also sets up the work to be successful in the next phase.

Arrangement of financing

Before anything of significance can be done there must be financing commitments for the first phase, and indications that there will be ongoing financing available for the subsequent activities. The source of financing planned is a mix of official relief and development assistance funding from donor organizations and funding from corporate and private philanthropy and foundations.

Start up and mobilization

Start up and mobilization includes the recruitment of staff, the procurement of equipment and supplies and the establishment of an operational base in Liberia. It is expected that start up and mobilization will take up to six months. It cannot start until the program has secure funding commitments, a broad commitment from Liberian leadership and the community to support it, and cooperation by all relevant parties to make the program successful.

Staff recruitment and training
The personnel selected must possess a high degree of specialized expertise, combined with a thorough knowledge of the pesticides used, insects to be controlled, and the many factors affecting the efficiency of the applications.

Pilots chosen should have completed at least 6,000 hours of low-level flying, with one half of the hours concentrated in agricultural flying. The professionalism of these individuals cannot be overemphasized. Aerial application is a profession more pest-control oriented than aviation oriented, and pilots must be highly skilled to do the job properly, while avoiding accidents.

A highly qualified entomologist is a key person on the team, to ensure that the work is not only done, but the results needed are achieved. Similarly expertise in medical matters will be part of the team, so that malaria reduction goals are achieved.

Equipment
The program advisers will select and procure aircraft, spraying equipment, mixing equipment, cold fogging equipment, qualified personnel, monitoring systems, and maintenance and logistics management.

The aircraft used in this operation will be imported from the United States. These aircraft are production spraying aircraft specifically equipped for this work. Two aircraft will give needed flexibility, especially during the start-up phase in Monrovia, but as the process expands additional aircraft will be needed. The contractor will select, purchase and maintain the aircraft.

Operational base
An efficient operational base is important. There is a need for offices and secure storage facilities for the chemicals and operational equipment, including the aircraft. Monrovia is fortunate to have Spriggs Payne Airport close to the center of Monrovia. This is an airport designed for very small aircraft and general aviation, with a physical infrastructure that is very suitable for both the aerial operations and all on-the-ground operations being planned. The facilities will need some upgrading to provide suitable space for the staff and secure storage for supplies and equipment.

Data collection and analysis
Entomological surveys will be used right at the start of the program to establish which breeding areas in the Monrovian swamps are being used by the various malaria vectors, so that the best control methods are applied. This is critical because the Monrovian swamps are fed by fresh ground waters in the more inland areas and by the sea closer to the Atlantic. The estuary areas present an especially complex situation as far as the breeding grounds are concerned. This will be carried out by insect trapping and identification in the affected areas. .

Available information about malaria and the human population must also be surveyed, to establish a base for programming interventions that will reduce the existence of the parasite.

Data collection and analysis is the key to success of the total program. The science of the mosquito and the malaria parasite needs to be respected and data used continuously, so that program activities produce useful results.

Existing Liberian organizations will be asked to cooperate on this, including clinics and hospitals, schools and universities, and laboratories such as the Red Cross Blood Bank and Liberian Institute of Research.

Cooperation with the government
There will cooperation with the government at many levels. Some of the government entities concerned include:

1. (primarily) the Ministry of Health and Social Welfare, Central Directorate, Communicable Disease Control Division,
2. with coordination involving the Ministries responsible for Education, Agriculture, Water and Sewer Corporation, Lands and Mines, Ministry of Planning, and the Civil Aviation Administration of the Ministry of Transportation,
3. expert guidance by the Director of the Malaria Control Division of the Ministry of Health and Social Welfare, and
4. entities of the public health service, who will monitor program progress

Program Activities

The program will operate as an integrated whole, with each department working to the best of its ability within its realm of expertise, but in cooperation with all departments so that the outcome is the best possible.

Flight operations
Flight operations is concerned with everything to do with aerial dimensions of the work, including performance and safety. Safety not only relates to flying, but also to the use of chemicals and the impact on the environment and the human population.

Mechanized ground operations
Mechanized operations is concerned with everything to do with the mechanical delivery of insecticide and vector control.

Maintenance and inventory control
Support for operations is provided by a skilled maintenance team and an inventory and logistics team that is responsible for provisioning the program.

Manual application teams
A program unit is responsible for all the work associated with the recruitment, training and operational supervision of people undertaking manual applications. Manual applications includes the use of Interior Residual Spraying (IRS). This work will include cooperation with local groups that are interested in and capable of taking responsibility for local area activities.

Data collection
A data collection unit is responsible for activities associated with both entomological and medical data needed to measure Program progress. The unit will coordinate with existing organizations that are already collecting and using the needed data, as well as organizing to collect additional data that will be required. The unit will also ensure that the data are reliable and can be used responsibly by the Program.

Data analysis
A data analysis unit is responsible for the analysis of data and the drawing of conclusions needed to operate the program in the most effective way. The unit has a very important responsibility and will draw on expertise not only within the program team, but also within the professional community and the research and academic institutions in Liberia, as well as internationally.

Feedback and operational planning
Feedback and operational planning is the key to ongoing program optimization. Things that work

will be replicated, and things that do not work changed. The results of data analysis will drive the planning, so that ongoing results are good.

Financial control, monitoring and evaluation
From the start, the Program will implement a strong framework for financial management and control, to maintain focus on proper use of funds and value derived from the program activities.

Training
Training is going to be a very high priority for the program. Initially the training will focus on staff needed for the immediate program activities. It will subsequently move more and more to establishing a complete cadre of well trained staff, to continue operations in perpetuity.

Public relations and communications
The program will establish a public presence as fast as possible, so that the population and leadership of the country and communities know what the program is trying to do and how they can help. The program will encourage active feedback from the community about the program and its performance.

Security
It is hoped that personal security will not be a serious issue, but to the extent that it becomes an issue, the program will take aggressive measures to ensure that the program staff are safe.

Financial control, data analysis and management

The need for excellent financial control, data analysis and management is recognized as a Program imperative. This will be achieved by the application of basic principles and procedures for accounting, and the use of both financial and operational data for timely, almost real-time, performance analysis. Data collection is a substantial component of the Program efforts, since both the mosquito and the malaria parasite are complex organisms that require the application of good science if success is to be achieved. Excellence in management will be achieved using qualified and experienced staff who have a commitment to the success of the Program.

Public information and communications

The program will engage in a broad-based education and information campaign regarding all aspects of the program and the malaria problem. This will include education about source eradication and personal precautions and prevention techniques. Of particular value will be the program advisers' working knowledge of chemicals being used in the program. The public needs to have good information regarding the chemicals being used, the precautions being taken to avoid undesirable side effects, and the results being achieved through use of these chemicals.

The program will support a range of monitoring activities to ensure successful program performance and public safety.

The success of a field testing and assessment activity depends to a large extent on the people doing the work, and it is planned that the Program advisers will train local workers to do the needed work, including sample extraction and chemical handling.

The public information and communications program will involve all segments of Monrovia society, including the government and civil society organizations. All media dimensions will be used including local radio, newspapers, magazines and television, to communicate the purpose of the program and what individual citizens, parents, school children, teachers and public officials can do to help make the program successful.

The public information and communication messages will encourage the following:

- Cleaning up neighborhoods, so that there are no breeding places for mosquitoes,
- Cooperation with the program personnel to facilitate their work,
- Getting medical attention,
- Living in mosquito-free, well-screened areas,
- Sleeping with the protection of mosquito netting,
- Wearing appropriate clothing during night hours,
- Applying insect repellent on the body, and
- Correct spraying of insect pesticides in living and working areas.

Training

A fundamental objective of the Monrovia Mosquito/Malaria Control Program in Liberia is for it to be sustainable in the long run. One part of this is to "Liberianize" the work and workforce. This requires very specific training, which will be done in cooperation with the educational and training establishments of the Liberian community, including the government authorities and educational institutions.

The training and qualifying of Liberians will be necessary to convert the national project to a self-sustaining, internalized, long-lasting program. All types of training should be possible, depending on the people involved and the aim of the training. The goal is to have local people do as much as possible and at the same time maintain the very highest standards in all dimensions, including scientifically, socially and operationally.

Local labor

There are many challenges in the labor and employment sector, arising from years of civil war and a deterioration of the economy and the educational system. There is a high rate of unemployment and a low level of education. In addition there are many young people who have been dismissed from military units and are in need of work and training.

The Monrovia Mosquito/Malaria Abatement Program should be used to help address these problems in the most efficient way possible. The training of youth – so that they become engaged in the process of cleaning up the environment and eliminating mosquito breeding places – is one area of useful activity. Many can also be trained to carry out other important functions in a productive organization.

Scientific, medical and other professionals

The effectiveness of the program depends on the decisions that are made on a continuing basis about operations. Many scientific, medical and operational matters require a full and practical understanding of the issues involved and how they interact. The success of the program depends on having a cadre of professionals that can help with making the best possible decisions.

The professional staff should be as good as it can be, and initially this will be a mix of Liberian and international personnel. The goal is to maintain excellence and build to a fully Liberian team. This requires training and the opportunity to gain experience and responsibility. It applies to all areas of operations of the program.

It includes, *inter alia*, the air operations. At least two Liberian pilots, as well as some key Liberian managers, will need to attend an aerial application school in the United States. This training will provide instruction on flight techniques, pesticide use and safety, toxicology, insect identification, and operational management.

Government training programs

The government has a challenge to educate Liberians at all levels of the education system. The program will cooperate with the government in this area, and especially in helping to build bridges between education and productive, valuable employment. The program for mosquito/malaria abatement has major social value, which also must translate into economic progress.

Post Program Activities

The success of the Monrovia Mosquito/Malaria Control Program will be best assessed in twenty years. No matter how many mosquitoes are killed during the 5 year program period, and no matter how many people are treated and improve their health during this time, the enduring value will have been wasted if in twenty years there is little or nothing to show for the effort.

All the available information shows that a successful outcome from Mosquito/Malaria control requires ongoing monitoring and timely continuing interventions. Accordingly, it is very important that there are structures in place in perpetuity, so that this monitoring is done and the intervention capacity is available.

Part of the program activity is designed to help set up the institutional structures and systems, so that everything needed for ongoing success is in place, including arrangements to ensure that there will be ongoing funding.

Constraints and Possible Problems

Low level of education in the country

As far back as 1980, the National Socioeconomic Development Plan set goals in its compulsory education system for universal education by the year 2000. The educational levels consist of primary, secondary and adult post-secondary. Unfortunately, only 46% of the total Liberian school age population attends: 57% of school age males and 34% of the females. Obviously, the goals will not be attained even at the primary level. It is estimated that only 34% of the males and 17% of the females over the age of ten in Liberia are literate in English, the official national language.

The low level of education is a major national problem in Liberia, and will be addressed by the new administration to the extent possible with available funding. The economic value of education is enhanced when the children are healthy and full of energy. The Monrovia Mosquito/Malaria Control Program is central to making children more healthy.

Lack of jobs

The economy of Liberia is floundering as a result of more than 20 years of stagnation and civil war. The country has rich resources, but has not had much benefit from these resources for a long time. The country needs a lot of economic initiatives in order to change the prevailing economic situation and create jobs.

Malaria is a powerful disincentive to investment and to development success. The story of the building of the Panama Canal is an example from history. There were at least three unsuccessful attempts to build the Panama Canal before it was eventually built. Tropical diseases, mainly malaria, were the critical problem that made initial construction impossible.

Investment in the Monrovia Mosquito/Malaria Control Project is a creator of jobs, as well a creator of important socio-economic value. That, in turn, will improve the productivity of the labor force and the economy as a whole.

Lack of money

Money is a problem, but money should not be a problem. The financial and economic value of the Monrovia Mosquito/Malaria Control Program justifies the allocation of financial resources to make it successful. Furthermore, the ongoing importance of maintaining a low level of malaria incidence in the country should make ongoing support for the program an imperative of the government, the society and the financial decision makers.

Lack of government commitment

A lack of government commitment would be a constraint, but the socio-economic and political benefits to be derived from a successful implementation of this project are significant. Under the new administration in Liberia, it is anticipated that there will, in fact, be a very high degree of support and commitment. It is recognized, however, that the government has many major priorities and will have limited resources to satisfy all the demands it is faced with.

Lack of community interest and participation

A lack of community interest and participation is to be expected initially. There have been decades of ineffective governance and development assistance, and the population has reason to be skeptical. Accordingly the Monrovia Mosquito/Malaria Control Program will need to undertake a major public awareness initiative and prove itself by good performance and results.

In addition, the program has been designed so that well respected institutions in the community are involved with the program, including the churches, the clinics, and the schools and universities.

ORGANIZATION AND FINANCE

ORGANIZATION AND MANAGEMENT

Organization

The program will be implemented by an organization that is legally established in Liberia. The form of organization will be similar to a not-for-profit corporation and will be authorized to engage in a public-private partnership to arrange financing and carry out the program. Arrangements can be made so that the program is organized in ways that satisfy any special requirements of various funding organizations.

The project will be implemented in a manner that integrates knowledge of the mosquito population and the community's health status with the day-to-day operational program. The program organization reflects this need. The program organization will be structured so that there are clear lines of responsibility and functional departments to provide all the services needed for success. These include an operations unit, an entomological unit, a medical unit and a financial controllership unit.

The operations unit will be responsible for all equipment, all aerial operations, all ground application of chemicals, all storage of equipment and supplies, and all logistics. It will also facilitate practical training, so that a productive Liberian staffed operations unit will emerge for long term sustainability.

An entomological unit will be responsible for all aspects of the scientific analysis of the mosquito in the context of the program's operational needs, and to satisfy program goals. This department will coordinate with outside organizations as needed, including the scientific community in Liberia, and especially the experts at Cuttington College.

A medical unit will address all the issues of malaria, including assessing the program's performance and progress in reducing the incidence of malaria. This will be done in cooperation with units of the Ministry of Health, including local health clinics and hospitals where many morbidity statistics originate.

A financial controllership unit will also be established, so that the financial affairs of the program are well managed and there is performance accountability and good stewardship of Program resources. The program will measure progress in both operational and financial terms, and relate this to the economic benefit being derived in the local economy as a result of the improved health environment.

Management

General management

A strong general management team needs to be in charge of and responsible for all aspects of the program. The team must have expertise in all the functional areas that impact Program outcomes, including technical operations (both ground and air), entomology, medical science, training and management accountancy. The key positions are:

- General Manager
- Financial controller
- Manager – Air operations
- Manager – Ground operations
- Manager – Engineering and maintenance
- Manager – Entomological science
- Manager – Medical science
- Manager – Training
- Manager – Community Programs
- Manager – Promotion and Public Relations

A strategy of training professional Liberians to take on all the senior management responsibilities will be implemented from the start of the Program. The training will be practical and oriented to building a competent effective team to run the Program successfully into the future. The changes

in the staffing structure are reflected in the staffing tables in the Attachments.

The organization of the Program reflects the need for management expertise and management responsibility. The management information (see below) used by the Program is organized in part to provide for routine reports according to the principles of responsibility accounting.

Functional areas
The Program is organized into functional areas which need to have qualified and experienced professionals who are fully capable of doing the work that needs to be done and also to train local staff to take critical responsibility. The staff within a functional unit have clear responsibility for the activities within the function. Each member of the team must good at his or her own work, but also needs to integrate that work with that of the other functional departments. The success of the program depends on all the functions doing the work that is needed. Feedback between the departments is critical.

Liberianization
The Program is deeply and broadly committed to "Liberianization" and Program sustainability. This will be actively supported through training and development of staff at all levels.

Using management information for decision making and control

The Program will make extensive use of management information for decision making and control. Management information has characteristics that are different from simple accounting or economic data; it is information that is the most suited to optimizing the decisions that need to be made for day to day operations and the long term.

Operational cost effectiveness modelling
The cost effectiveness of the Program depends on making good operational decisions on a continuing basis. This requires cost information and results information to be collected and used in an operational modelling framework. This was done as part of the initial Program design, but without very good information. Though malaria control programs have been implemented for many years, there is almost no accessible cost and management information about these programmes and what is the relationship between the costs and the results.

The cost effectiveness modelling suggests that ULV aerial spraying is the lowest cost way of reducing the mosquito population, that DDT and Interior Residual Spraying (IRS) is the lowest cost way of reducing mosquito bites inside a residence and that a prevalence level of the malaria parasite in host population blood is another critical factor for sustained success.

The cost of chemicals and salary costs are the two biggest cost elements. Larvaciding is the most expensive chemical treatment, and DDT perhaps the most cost effective. The banning of DDT by the Environmental Protection Agency in the USA in he 1970s may, in retrospect, be one of the most costly decisions ever in terms of human life and the cost effectiveness of malaria control. Salary costs will be high as long as the program needs many international staff, and other professional staff that command international scale salaries.

Data collection and analysis
Teams of local staff will collect data about mosquito populations and the response of those populations to various treatment regimes. These data will be analyzed on a continuous basis, so as to feed into the spray campaign planning. Teams of local staff will also collect data concerning the prevalence of the mosquito parasite in the human population. This will be done mainly at hospitals and clinics, but it will also be done by sampling people who are not currently going to either the hospitals or clinics.

Transparency and accountability
The program will have excellence in accountancy as the foundation for transparency and accountability. Critical data that are used for operational decisions will be made available in a web accessible database so that progress of the Program can be easily monitored by all interested stakeholders and performance objectively assessed. Modern information technology will be used with content optimized for management and oversight purposes. Monitoring and evaluation will be done as an integrated part of the operational and management processes, so that costs can be related to results. Every month, managers and staff will provide internal management information that relates entomological and medical data with the operational activities and operational costs. This will be an ongoing process that, *inter alia*, aims to get the best results from scarce funding

resources.

Monitoring and evaluation
The Program is open to independent professional monitoring and evaluation by concerned stakeholders. This external monitoring and evaluation is transparency in practice. It does not form a part of the internal Program management information system used for Program decision making and control.

Internal assessment of performance
The success of the program will be assessed internally on a continuous basis and the results will be easily accessible by stakeholders. The impact of all the operations are measured in a very timely way so that critical decisions about ongoing operations can be made based on feedback from very recent activities and their latest impact.

For the mosquito control activities, the Program managers need to know almost in real time how the population of mosquitoes is responding to various spray interventions. Mosquito population information needs to be collected from many locations, recorded in a suitable information system, and tracked to understand cause and effect, and the next decisions that need to be made. This is part entomology and part operations research or management science.

A different set of information is needed for the management of an Interior Residual Spraying (IRS) activity. An inventory of buildings is needed, together with a record of the activities undertaken in connection with the building and the impact of the interventions on the mosquitoes and the building occupants. This information needs to be at the right level of detail and easy to manage and use.

The accounting information must also be organized for use in the management information mode. This provides both information to help with decision making about Program activities, and also feedback that ensures that fund flows are fully accounted for.

Cooperation with Tr-Ac-Net
The Transparency and Accountability Network (Tr-Ac-Net) is experienced in management science and will advise as needed to facilitate the design and implementation of suitable management information systems and processes, and will also provide a web enabled database environment for the storage and analysis of this information by all stakeholders interested in the performance of the Program.

Where Can I Get More Information About Malathion and Mosquito Control?

For more information about mosquito control in your area, contact your state or local health department. Other resources for information on public health, disease control, and mosquito control include the following:

Centers for Disease Control and Prevention (CDC)

Tel: 970-221-6400
Fax: 970-221-6476
E-mail: dvbid@cdc.gov
Web site: http://www.cdc.gov

National Pesticide Information Center (NPIC)

Tel: 1-800-858-7378
E-mail: npic@ace.orst.edu
Web site: http://npic.orst.edu/

West Nile Virus Resource Guide: http://npic.orst.edu/wnv/

American Mosquito Control Association (AMCA)

Joseph M. Conlon, Technical Advisor
Tel/Fax: (904) 215-3008
E-mail: amca@earthlink.com

From The American Mosquito Control Association (Mosquito.Org)

ABOUT

The American Mosquito Control Association, founded in 1935, is a scientific/educational, not-for-profit public service association operating under the corporation laws of the state of New Jersey. It is world-wide in scope, with members or subscribers to its publications in over 50 countries. The majority of its members are in the United States. Under its bylaws, only individuals can be "regular" members, and much of its activity is performed by volunteers, approximately 150 of these serving on Committees. It is an "open" association and anyone may join. The Board of Directors is composed of six officers, nine regional directors and an industry director, all elected by the membership.

AMCA is not governmental nor is it subject to political control, but its services are provided mainly to public agencies and their principal staff members engaged in mosquito control, mosquito research and related activities. However, services are equally available to any agency, company or individual that may request any information or services that AMCA can provide. Also, such organizations are invited to name individuals who may apply for full "regular" membership.

There are various special memberships. Corporations, agencies and individuals desiring to participate in the work of this association are urged to become

Sustaining Members. Also, U.S. income tax-deductible contributions are invited in any amount to the AMCA Foundation. Special contributions may be made in the memory of John N. Belkin, and Dan F. Boyd, or to the Student C ompetition or the Grassroots Fund.

Grants or services may be accepted by AMCA in accordance with its primary purposes. The AMCA is primarily an information gathering and exchange organization, and a major function is the publication of the Journal of the AMCA, and various special publications, including the AMCA Newsletter and WingBeats.

One annual meeting is held each year in a different part of the country, usually as a joint meeting with a state or regional mosquito control association. At these meetings, which are attended by leading mosquito workers from North America and from other countries, a great many papers are presented reporting outstanding research and operational control progress.

The AMCA recognizes individuals who have made exemplary contributions to the science of medical entomology, mosquito studies and public health; and to the development and implementation of control methods and/or equipment. Since 1937, the AMCA has awarded various types of recognition: honorary memberships, Medal of Honor, and meritorious service awards.

From The American Mosquito Control Association (Mosquito.Org)

Contact us

As a part of our mission "to provide information, and education". We can be reached at anytime by the following address and contact numbers.

American Mosquito Control Association
15000 Commerce Parkway
Suite C
Mount Laurel, NJ 08054
Phone: 856-439-9222
Fax: 856-439-0525
Email: amca@mosquito.org

Joe Conlon
Technical Advisor
Ph: 904-215-3008
Fax: 904-264-7945
Email: joec@mosquito.org

From The American Mosquito Control Association (Mosquito.Org)

The following text is from the webpage:
http://www.mosquito.org/mosquito-information/control.aspx

Mosquito Control

Mosquito control can be divided into two areas of responsibility: individual and public. Most often it's performed following the Integrated Mosquito Management (IMM) concept. IMM is based on ecological, economic and social criteria and integrates multidisciplinary methodologies into pest management strategies that are practical and effective to protect public health and the environment and improve the quality of life. IMM strategies are employed in concert with insecticide. These include source reduction, which incorporates physical control (digging ditches and ponds in the target marsh) and biological control [placing live mosquito fish (Gambusia) in the ditches and ponds to eat mosquito larvae]. Other non-chemical control methods include invertebrate predators, parasites and diseases to control mosquito larvae. Adult mosquito biological control by means of birds, bats, dragonflies and frogs has been employed by various agencies. However, supportive data is anecdotal and there is no documented study to show that bats, purple martins, or other predators consume enough adult mosquitoes to be effective control agents.

Pesticides may be applied to control larvae (larvicides) or adults (adulticides). Applications of adulticides or larvicides are made after the presence of mosquitoes has been demonstrated by surveillance procedures. Application is made by prescribed standards. All insecticides must have the name and amount of active ingredient (AI) appearing on the label; examples are DEET and pyrethroids. Check the label before buying. No pesticide is 100 percent safe and care must be exercised in the use of any pesticide. Material Safety Data Sheets (MSDS) contain basic information about a product intended to help you work safely with the material.

Larval Control

An efficient way to control mosquitoes is to find and eliminate their breeding sites. Eliminating large breeding areas (source reduction) such as swamps or sluggishly moving streams or ditches may require community-wide effort. This is usually a task for your organized mosquito control program. They might impound an area of water, establish ditches or canals or control the aquatic weeds (cattails, water lettuce, etc) on a body of water. The second method used by organized mosquito control agencies is larviciding. This utilizes the application of insecticides targeted at the immature mosquitoes - the larvae or pupae. These are applied to bodies of water harboring the larvae. However, since larvae do not usually occupy the entire body of water, larvicides are applied where the larvae are, usually the areas near the shoreline of the lake, stream or ditch. Larvicides differ from adulticides in that they are directed at a limited targeted area, i.e. the body of water and often only that area where the larvae grow and mature. Larvicides are classed as stomach toxins, contact larvicides, surface agents, natural agents and insect growth regulators (IGR). Some examples are listed in the Homeowner section that follows.

Homeowners can take the following steps to prevent mosquito breeding on their own property:

1. Destroy or dispose of tin cans, old tires, buckets, unused plastic swimming pools or other containers that collect and hold water. Do not allow water to accumulate in the saucers of flowerpots, cemetery urns or

in pet dishes for more than 2 days.
2. Clean debris from rain gutters and remove any standing water under or around structures, or on flat roofs. Check around faucets and air conditioner units and repair leaks or eliminate puddles that remain for several days.
3. Change the water in birdbaths and wading pools at least once a week and stock ornamental pools with top feeding predacious minnows. Known as mosquito fish, these minnows are about 1 - 1-1/2 inches in length and can be purchased or native fish can be seined from streams and creeks locally. Ornamental pools may be treated with biorational larvicides [Bacillus thuringiensis subsp. israelensis (Bti) or S-methoprene (IGR) containing products] under certain circumstances. Commercial products "Mosquito Dunks" and "Mosquito Bits" containing Bti can be purchased at many hardware/garden stores for homeowner use. Zodiac, a division of Wellmark International, has developed Pre-Strike Preventative Mosquito Control (PMC) product that kills developing mosquitoes using insect growth regulator (IGR) technology. Like Mosquito Dunks, Zodiac's Pre-Strike can be found at many home/garden and pet specialty stores.
4. Fill or drain puddles, ditches and swampy areas, and either remove, drain or fill tree holes and stumps with mortar. These areas may be treated with Bti or methoprene products also.
5. Eliminate seepage from cisterns, cesspools, and septic tanks.
6. Eliminate standing water around animal watering troughs. Flush livestock water troughs twice a week.
7. Check for trapped water in plastic or canvas tarps used to cover boats, pools, etc. Arrange the tarp to drain the water.
8. Check around construction sites or do-it-yourself improvements to ensure that proper backfilling and grading prevent drainage problems.
9. Irrigate lawns and gardens carefully to prevent water from standing for several days.
10. If ditches do not flow and contain stagnant water for one week or longer, they can produce large numbers of mosquitoes. Report such conditions to a Mosquito Control or Public Health Office. Do not attempt to clear these ditches because they may be protected by wetland regulations.

Recently another method of larval control has become available. The LarvaSonic is an acoustic larvicide system. Sound energy transmitted into water at the resonant frequency of the mosquito larvae air bladders instantly ruptures the internal tissue and causes death.

More information on adulticides, larvicides, MSDS's and the equipment used to disperse these mosquitocides may be found on the "links" section of this web site.

Adult Control

Mosquito Traps. Insect electrocutors (bug zappers) and mosquito trapping devices are 20 th century control measures. Manufacturers modernized 19 th century mosquito trapping devices such as the New Jersey light trap with more "bells and whistles" to improve their appeal to the public. Insect electrocuter light traps have been extensively marketed for the past several years claiming they can provide relief from the biting mosquitoes and other pests in your back yard.

Numerous devices are available for purchase that claim to attract, repel or kill outdoor infestations of mosquitoes. They should be thoroughly researched before being purchased.

Other mosquito traps are designed to mimic a mammal (horse, cattle, man and domestic pets) by emitting a plume of carbon dioxide, heat and moisture, which is often combined with an additional attractant, i.e., octenol, to create an attractant to mosquitoes, no-see-ums, biting midges and black flies. After drawing the insects to the trap, a vacuum device sucks the insects into a net or cylinder where they dehydrate and die. No electric killing grid or pesticides are used.

Scientific data relative to the effectiveness of these devices is sparse so be sure to review all the information available before purchasing one. In addition, some of the mosquito traps are quite expensive. For more information see the page on mosquito traps.

Space sprays. Mosquitoes used to be killed inside the house by using a flit gun. Household aerosol space sprays containing synergized pyrethrum or synthetic pyrethroids (allethrin, resmethrin, etc.) are available now. The major advantage of space treatment is immediate knockdown, quick application, and relatively small amounts of materials required for treatment. Space sprays are most effective indoors. Outdoors, the insecticide particles disperse rapidly and may not kill many mosquitoes. The major disadvantage of space spraying is that it will not manage insects for long periods of time.

Only insecticides labeled for flying insect management should be sprayed into the air. Best results are obtained if doors and windows are kept closed during spraying and for 5-10 minutes after spraying. Always follow directions on the label.

Outdoor Control. Homeowners, ranchers or businesses may use hand-held ULV foggers, portable or fogging attachments for tractors or lawn mowers for temporary relief from flying mosquitoes. Pyrethrins or 5% malathion can be fogged outdoors. Follow instructions on both the insecticide label and fogging attachments for application procedure.

Mechanical Barriers. Mosquitoes can be kept out of the home by keeping windows, doors and porches tightly screened (16-18 mesh). Those insects that do get into structures can be eliminated with a fly swatter or an aerosol space spray containing synergized pyrethrum.

Vegetation Management. Adult mosquitoes prefer to rest on weeds and other vegetation. Homeowners can reduce the number of areas where adult mosquitoes can find shelter by cutting down weeds adjacent to the house foundation and in their yards, and mowing the lawn regularly. To further reduce adult mosquitoes harboring in vegetation, insecticides may be applied to the lower limbs of shade trees, shrubs and other vegetation. Products containing allethrin, malathion or carbaryl have proven effective. Paying particular attention to shaded areas, apply the insecticides as coarse sprays onto vegetation, walls and other potential mosquito resting areas using a compressed air sprayer. Always read and follow label directions before using any pesticide.

Many of the mosquito problems that trouble homeowners and the general

population cannot be eliminated through individual efforts, but instead, must be managed through an organized effort. Many states have some sort of organized mosquito control, either at the State, County or city level. Florida has over 50 organized mosquito control organizations that specialize in area mosquito control. Some residential communities organize to control their mosquito problems. There has been an increase in the number of these organizations in the United States since the West Nile arbovirus outbreak in 1999. These organized management programs incorporate the IMM strategies mentioned above which include permanent and temporary measures. Permanent measures include impounding water and ditching, and draining swampy mosquito breeding areas. Temporary measures include treating breeding areas to kill larvae and aerosol spraying (ULV) by ground or aerial equipment to kill adult and larval mosquitoes. If you live within an organized mosquito management district, support it in its control efforts. Organized mosquito management can accomplish much more than individual efforts. If you are not sure about whether your community has a mosquito control district, contact the local division of health officials.

Aerial adult mosquito control using fixed-wing aircraft or helicopters and/or ground adult mosquito control using truck or boat mounted equipment are often the most visual aspects of an organized mosquito control program. This method of control is called adulticing. Although it is often expensive in terms of manpower, equipment and inventory, sometimes difficult to accomplish and more likely to affect non-target organisms if mis-handled, it is the only method to rapidly reduce infected mosquito numbers or to control pest and nuisance mosquitoes from inaccessible breeding areas that are interfering with normal outdoor activities of a community.

FINANCIAL COSTS

Overview
The financial costs projected for a 5 year program in Monrovia, Liberia are estimated at $28 million. It is projected that the costs for the program will be:

Project Costs for Five Years In thousand dollars ($ 000)						
	Year 1	Year 2	Year 3	Year 4	Year 5	5Yr total
Equipment, durable assets	3,000	500	500	500	500	5,000
Working capital						
Operating program	4,000	3,750	3,750	3,750	3,750	19,000
Community cooperation						
Management and admin.	1,000	750	750	750	750	4,000
TOTAL PROJECT COST	8,000	5,000	5,000	5,000	5,000	28,000

Start up and mobilization
The Program's first and most immediate need is for funding for the start up and mobilization process, including all the preliminary work described in the start up and mobilization section above.

Capital equipment and working capital
The Program's capital requirement includes crop spraying aircraft, pick up trucks, air spraying and ground spraying equipment, storage tanks for chemicals, storage facilities, security equipment, and office equipment. There are substantial costs associated making the equipment suitable for use in Africa and for delivery of equipment and supplies to Liberia.

In Liberia there will be a need to upgrade available space so that it is suitable for all Program activities. While space availability is not likely to be a problem, getting space that is in good condition after the civil war and economic crisis will be difficult and funds will be needed for improvements.

Operating costs
The operating costs are estimated to be $19 million over five years. Initially, the operation will include expatriate staff, but during the course of the program this group will be phased down. The budget includes funding for training so that this phase-down can be carried out effectively.

The operating costs include chemicals. The cost of chemicals will be kept under constant review and operations adjusted based on cost and performance considerations. It is to be noted that DDT, which is a low cost and high performance insecticide and spatial repellant chemical, might not be permitted because of regulatory mandates. (However, the U.S. Agency for International Development has recently revised its policies to include DDT as a vital malaria/disease control intervention; many countries – including Mozambique, South Africa, Swaziland and Zambia – are using it successfully to control malaria; and many other nations want to do likewise. We therefore expect that current regulatory restrictions will change, and will adjust accordingly.)

The issue of resistance will also be kept under review and operations adjusted to reflect the ongoing scientific analysis.

Aerial operations have a high aggregate cost, but in terms of cost-effectiveness, performance of air operations is extremely low based on almost all metrics, including area covered, per capita of population and mosquito kill rates. The aerial spraying project will be initiated in the Monrovia swamp areas. The annual cost of aerial spraying is estimated to be around $2.0 million based on spraying approximately 50,000 acres about twenty-four times per year. More than 50% of this annual budget is the cost of chemicals.

Organization and management
A substantial budget has been allocated to the organization and management function. This is

because the success of the project depends to a very large extent, not only on the effectiveness of the operations, but on the use of good data for professional analysis and decision making about operational aspects of the Program.

The program needs a lot of data, and the data should be good and current. Local organizations – such as hospitals, clinics, schools and universities – can all be used to help collect and analyze the data, and for this they should be paid appropriately. The payments individually should not be large, but the aggregate will be considerable, and must be provided for in the financial planning.

The program also needs strong management and control, including accountancy and financial control, together with transparency and accountability.

In addition, the Program needs to support a training component, so that local staff are able to learn what is needed to make the entire Program efficient and sustainable.

FINANCING PLAN

Financing need

The financing plan for the Monrovia Mosquito / Malaria Program is based a total 5-year financial need of $28 million, with an ongoing requirement to sustain the mosquito and malaria control estimated at $3 million a year. The funding has three components: (1) initial funding for start up, mobilization and first year operations of $8 million; (2) further funding for the operations of the program for a further four years at $5 million a year; and, (3) a funding arrangement so that the program can operate in perpetuity at an estimated $3 million a year.

The following table shows a possible mix of funding that would support the program. Multiple sources of funding is desirable, because of the scale of the Program and its to all parts of Liberian society, as well as to any international visitors to the country.

Financing Plan
In thousand dollars ($ 000)

	Year 1	Year 2	Year 3	Year 4	Year 5	Ongoing/year
Government of Liberia	500	500	500	500	500	500
Multilateral funding agencies	2,000	1,000	1,000	1,000	1,000	400
Bilateral funding agencies	5,000	2,000	2,000	2,000	2,000	400
Private philanthropic funding	1,000	800	800	800	800	1,000
Corporate support	400	500	500	500	500	500
Small private contributors	100	200	200	200	200	200
TOTAL	8,000	5,000	5,000	5,000	5,000	3,000

Many organizations have funded malaria control programs over the years. These have usually been programs with a single component, and the results have been limited. The Monrovia Mosquito/Malaria Control Program is multi-dimensional, truly integrated, and based on programs that have been successful in the past in the United States and Australia.

There has been growing interest in funding malaria control interventions since the UN highlighted the malaria crisis in the 2005 Millennium Development Goals progress report, for which Professor Jeffrey Sachs was the principal author. The US Agency for International Development has been tasked with undertaking malaria control initiatives in Africa, as well as with providing relief and development assistance to Liberia following the inauguration of Ellen Sirleaf-Johnson as President of Liberia. The Global Fund for AIDS, Tuberculosis and Malaria (GFATM) includes among its three components the financing of interventions against the malaria epidemic. WHO and UNICEF have both had major anti-malaria programs in the past, and both recognize that malaria is a crisis that must be addressed.

A number of initiatives have already been funded by private corporations in various parts of the world to combat malaria. These are usually in places where the corporation has operations, and anti-malaria programs are an important component of their community outreach programs, efforts to ensure a healthy workforce, healthcare for workers' families, corporate social responsibility programs – and ultimately their bottom lines, since healthy workers, families and communities are better educated and more productive.

African governments are using their own resources, to the extent that they are able, to fund anti-malaria programs. However, because they are generally poor, the funding is limited and the scale usually small. Faith-based support for anti-malaria programs is likewise small, but growing, as a result of being highlighted last year as one of Africa's most critical problems.

APPENDIX 1

MANAGEMENT AND STAFF BIOGRAPHIES

Biographies of Some Key Staff

The following are some of the people who are committed to the success of this initiative and will form the core of the management team

Delvin Walker
General Manager
Delvin Walker will be the overall manager of the project. He was chief of the science department at Cuttington College in Liberia prior to the outbreak of the civil war. He has extensive experience in program management and is a trained entomologist. He has worked with international relief and development assistance organizations in countries around Africa for many years. He received a master's degree from California Polytechnic and has other academic training from other universities.

William Nesler
Operations Manager and Senior Pilot
Bill Nesler is commercial aircraft pilot with over 20,000 hours of flying time, of which 15,000 hours have been in agricultural pest control operations. He has been chief pilot in charge of 8 airplanes, 9 pilots, 3 mechanics and numerous ground crews. He has been licensed and has worked in most of the agricultural states in the USA and has lived and worked in Liberia for almost 20 years. He has experience working with Liberians and an understanding and appreciation of the local traditions and customs. While living in Liberia, Mr. Nesler and his family suffered from severe attacks of malaria, giving him a personal understanding of the problem. Mr. Nesler will serve as the Program's operations manager.

Jeffrey Widmann
Training Manager and Senior Pilot
Jeffrey Widmann is an experienced aerial applicator and an active and highly regarded flight instructor, with over thirty years experience, he has provided students with the specific training necessary to operate the Grumman Agcat safely. He is a retired U.S. military officer with experience in international flight operations and training and is a Federal Aviation Administration certified aircraft mechanic. Mr. Widmann will assume the position of training manager and chief pilot to train selected Liberian pilots in the field of aerial application of pesticides. Mr. Widmann has lived and worked in Monrovia and is familiar with the customs and culture of the Liberian people. He has flown commercial flight operations in Liberia and has held a Liberian commercial pilot certification and work permits.

Peter Burgess
Controller and Management Information Services
Peter Burgess is an accountant with international corporate management experience, and a consultant for the global relief and development sector. He is the founder and CEO of Tr-Ac-Net Inc, the Transparency and Accountability Network, which maintains a universally accessible database for data related to the global relief and development sector. He was a pioneer in using available IT for management information related to corporate financial control and operations analysis and has applied it in analysis of socio-economic development performance. During his corporate career, he was CFO of Continental Seafoods, Inc, a US company that operated a successful fisheries joint venture in Liberia and around the world during the 1970s. He earned a double major in engineering and economics at Cambridge University and trained as a chartered accountant with Coopers and Lybrand in London.

Brian Cain
Chief – Aircraft Maintenance
Brian Cain is a US licensed aircraft mechanic, with an Inspectors Authorization from the FAA. He has extensive experience in the aerial application of pesticides, having been raised in a family actively involved in this work. He taught aircraft maintenance at the University of Missouri and

maintained its fleet of aircraft. Mr. Cain will supervise all aircraft and ground maintenance operations, as well as take responsibility for the training of Liberian maintenance and ground operations personnel.

Laura Aragon
Manager - International Logistics and Liaison
Laura Aragon will serve as the America-based specialist for procuring and shipping required equipment and supplies, including spare parts and chemicals and insecticides. She will be also function as liaison for communications with groups interested in the Liberian operations. She has extensive experience and understands the complexities of international logistics. While in the US Army, she was assigned to the White House as the supply and shipping specialist for Presidential, Vice Presidential, First Lady and Secret Service travel missions worldwide.

William Horton
Chief Information and Technology Officer
Bill Horton will have responsibility for developing a data management system for the program. He is trained in information technology and has experience making technology applications work in harsh environments. His background includes system development and training. He graduated from Central Texas College and has impressive credentials working with military communications and network systems.

Robert J. Novak
Entomology Adviser
Robert Novak will ensure that the Program follows rigorous scientific discipline and help to optimize the activities of the Program to ensure effective operation and good results. He is a professional scientist affiliated with the University of Illinois at Urbana-Champaign with vast experience with vector control both in the United States and overseas. He earned his Masters degree at the University of Utah and PhD at University of Illinois.

APPENDIX 1A

FRIENDS, ADVISERS AND SUPPORTERS

The following are some of the people who have shown support for this initiative and other initiatives that aim to reduce the scourge of malaria in developing countries.

The Transparency and Accountability Network

The Transparency and Accountability Network (Tr-Ac-Net) is an international organization committed to using best practice accounting and information and communications technology (ICT) to to accelerate socio-economic progress and the performance of the international relief and development sector. Tr-Ac-Net operates a globally accessible database about international relief and development fund flows and analysis of relief and development performance. Tr-Ac-Net provides assistance in planning and implementation of relief and development activities, and support for excellence in management and a framework for transparency and accountability.

Peter Burgess
Founder and CEO of the Tr-Ac-Net organization
Peter Burgess is an accountant with international corporate management experience, and a consultant for the global relief and development sector. He is the founder and CEO of Tr-Ac-Net Inc, the Transparency and Accountability Network, which maintains a universally accessible database for the global relief and development sector. His focus is on management information for financial control and operational effectiveness. During his corporate career, he was CFO of Continental Seafoods, Inc, a US company that operated a successful fisheries joint venture in Liberia and around the world during the 1970s. He did a double major in engineering and economics at Cambridge University before training as a professional accountant with Coopers and Lybrand in London.

The Kill Malarial Mosquitoes Now (KMMN) community

The Kill Malarial Mosquitoes Now (KMMN) initiative aims to draw attention of policy makers to the scourge of malaria in developing countries and the constraints being imposed on using the most effective ways of controlling the malarial mosquito vector and therefore malaria. Many experts in the field of mosquito control and malaria have endorsed the need for active intervention to change policy and implement effective control measures. (see the KMMN document). Some of the key people involved with the KMMN initiative include:

Paul Driessen
Advocate for effective malaria abatement interventions
Paul Driessen has a professional focus on health, environment, energy, economics, ethics, human rights and corporate social responsibility. He has written a book and numerous articles about these issues, and discusses them frequently on radio talk shows and college campuses, before congressional committees and at other events in the United States, Canada and Europe. His career includes tenures with the United States Senate, U.S. Department of the Interior and an energy trade association. He is a senior policy adviser with the Congress of Racial Equality and other public policy institutes. Paul received a BA in geology and field ecology from Lawrence University and a law degree from the University of Denver,

MORE TO COME

APPENDIX 2

PERFORMANCE CHARACTERISTICS OF THE EQUIPMENT

The following is a summary table of the performance characteristics of some of the equipment that is expected to be used in the program:

Types	Uses	Advantages and Limitations
Hydraulic sprayer on fixed-wing aircraft	Larviciding or adulticiding with liquids	Most economical and efficient for very large sources. Can treat areas not accessible to ground equipment. Droplet dispersal highly affected by wind drift. Operations restricted over congested areas. Requires suitable landing strip.
Hydraulic sprayer on rotary-wing aircraft (helicopter)	Larviciding or adulticiding with liquids	Can treat areas not accessible to ground equipment. More maneuverable than fixed-wing. Less restricted over congested areas. Requires only small landing pad. Droplet dispersal highly affected by wind drift. Less economical than fixed-wing (higher maintenance, lower payload)
Portable thermal aerosol	Adulticiding with Light weight generator oil solution	Limited effectiveness
Vehicle-mounted thermal aerosol generator	Adulticiding with oil solution	Produces a dense, highly visible smoke cloud. Optimum weather conditions critical Deposits little residue Uses high volume of oil.
Vehicle-mounted non-thermal aerosol generator (fogger)	Adulticiding with cold oil solution	Optimum weather conditions critical. Deposits little residue. Produces almost invisible aerosol cloud. Can use ultra low volume of formulation.
Horn seeder	Larviciding with granules	Good for small sources not accessible to vehicles. Rugged and simple to operate. Limited capacity.
Portable rotary granule applicator	Larviciding with granules	Good for small sources not accessible to vehicle. Less rugged but simple to operate. Limited capacity Shorter range.
Vehicle-mounted rotary granule applicator	Larviciding with granules	Large capacity Good for larger sources accessible to vehicles.
Vehicle-mounted (sandblaster) granule gun	Larviciding with granules	Large capacity. Good for larger sources that are accessible to vehicles. May also be operated away from vehicle with extension air hose.
Granule spreader on fixed-wing or rotary-wing aircraft	Larviciding with granules	Good for very large sources and sources not accessible to vehicle.

APPENDIX 3

REFERENCES

This is a partial list of references about malaria, mosquitoes and the background on the Monrovia Mosquito Malaria Abatement Program:

1. Africa Child Survival Initiative, United States Agency for International Development, International Health Program, Center for Disease Control. "Combating Childhood Communicable Diseases." Atlanta, Georgia, U. S. A.: 1988-89.
2. American Mosquito Association. "Medical Note on Malaria." Edition #8, February 23, 1990 and Edition #9, March 2, 1990. Boston, Massachusetts.
3. Bureau of Statistics, Ministry of Planning and Economic Affairs, Institute for Resource Development. "Demographic and Health Survey." Westinghouse, Columbia, Maryland, U. S. A.: 1986.
4. California Department of Health. "Vector Control Manual." Sacramento, California, U. S. A.: 1990.
5. California Mosquito and Vector Control Association, Northern San Joaguin Region. "Continuing Education Report." Modesto, California, U. S. A.: 1987.
6. McDougal, John, M. D. "Incidence of Malaria: A Research Report on Monrovia, Liberia." World Health Organization: 1975.
7. Metropolitan Mosquito Control District. "Options for the Control to the Year 2000," excerpt from Environmental Impact Statement. Minneapolis-St. Paul, Minnesota, U. S. A.: 1989.
8. Ministry of Health and Social Welfare. "National Malaria Control Policy." Republic of Liberia: 1988.
9. National Agricultural Aviation Association. AG Aviation. Washington, D. C., U. S. A.
10. Nesler, William. Economic Costs and Social Impact. Liberia: Schwenk, Inc., 1986
11. Henry M. Gelfand, M.D. "Anopheles gambiae giles and Anopheles melas theobald in a coastal area of Liberia, West Africa," National Institutes of Health, Laboratory of Tropical Diseases, Bethesda, Maryland.
12. Young, M.D. and Johnson, Jr., T.H. 1949. A malaria survey of Liberia. Journal of the National Malaria Society 8(4): 247-266.

From: "Dave Malone"

<dmalone@e-adapco.com>
To: "Bill Nesler"

<sdbc@hur.midco.net>

Sent: Monday, February 13, 2006 3:18 PM

Subject: RE: malaria control

Bill,

There is a possibility that when your proposal reaches the hands of the 'malaria experts' the party line of insecticide impregnated bednets and indoor residual spraying may result in your ideas of ground and aerial ULV treatments being queried.

I think there is a good case for making these applications in terms of taking out exophilic vectors, intercepting mosquitoes moving from breeding sites and to some extent killing some indoor resting mosquitoes.

A secondary benefit that is probably worth including in your proposal is that ULV treatments will generally reduce the numbers of other biting mosquitoes thus making life more bearable in reducing nuisance species.

In addition it is very likely that the city will have Culex (biting nuisance and vectors of filariasis) as well as Aedes aegypti (vector of dengue and yellow fever), species that should be impacted by the ULV spraying.

It was just a thought.

David Malone

ADAPCO Inc.

2800 South Financial Court

Sanford, Florida 32773-8118

Direct: (407) 549 5528

Toll Free: (866) 230 4376

Cell: (321) 239 8002

Fax: (866) 330 9888