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**Final Evaluation Report**

**Vector Control Project**

**USAID/Santo Domingo (517-0235)**

**February 1991**

**by**

**Samuel G. Breeland**

**VBC Report No. 81236**

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## 1. Executive Summary

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In August 1986, USAID/Santo Domingo signed a three-year, US \$1.5 million cooperative agreement with the University of South Carolina (USC) to implement Vector Control Project No. 517-0235 in the Dominican Republic (DR) to research and test a limited number of ecologically sound, low cost, effective interventions to control malaria and dengue. USC entered into subagreements with two local institutions: the Universidad Católica Madre y Maestra (UCMM) and the Servicio Nacional para la Erradicación de la Malaria (SNEM). USC provided technical assistance (TA) and training to UCMM and SNEM. In turn, UCMM conducted operational research and SNEM used data from UCMM's research to field-test vector control measures. The agreement was authorized August 22, 1986; the date of obligation was September 16, 1986. The original Project Assistance Completion Date (PACD) was to be September 11, 1989, but was extended to May 30, 1990.

This evaluation was based on 1) documents provided by USAID/Santo Domingo, SNEM and UCMM; 2) interviews with project participants; and 3) site visits.

The project had three basic components: 1) the collection and accumulation of baseline data on vectors of malaria vectors (four anopheline species, principally *An. albimanus*) and dengue vectors (*Ae. aegypti*); 2) research in control techniques developed from baseline studies, and 3) field-testing of control methodologies resulting from the research. The work was to be conducted in four phases: phase 1 - start-up, months 0-3; phase 2 - baseline data collection, months 4-9; phase 3 - operational research, months 10-30; and phase 4, field-testing for interventions, months 16-36). By the midterm evaluation (August 1988), it was evident that the phase structure was unrealistic and modifications were made to improve it.

The original A.I.D. budget of \$1.5 million was amended in November 1989 to accommodate the USC request the original and extended amounts, for extension. The funds were 95 percent expended as follows: TA, \$631,000 to \$725,373; training, \$93,000 to \$94,530; commodities, \$270,000 to \$281,432; support, \$30,000 to

\$3,805; USC overhead, \$349,000 to \$342,727; contingencies, \$77,000 to \$2,133. The entire counterpart contribution of 500,000 pesos (\$146,400) was spent on constructing, equipping and staffing a vector control laboratory at UCMM, in Santiago.

The following major outputs were planned and accomplished during the life-of-the-project (LOP): 1) in-country short courses -- 12 planned, 14 given; 2) training of people -- 200 planned, 302 trained; 3) master's degree training in vector control -- three planned, one completed; 4) short-term participant training for senior staff -- seven planned, 16 completed; 5) establishment of one laboratory and two insectaries planned -- three labs and two insectaries were constructed.

These high completion rates (100 percent or greater), except the master's degree training (33 percent), enabled the project to reach most end-of-project (EOP) objectives: 1) completion of a functioning UCMM laboratory; 2) a UCMM faculty competence in vector control research; 3) UCMM capability in providing vector control training; 4) a SNEM capacity to apply new vector control techniques; 5) a SNEM ability to apply operational research protocols; 6) a firm link between UCMM and SNEM. The seventh EOP objective of a follow-on national project was not realized, but UCMM was pursuing financing for this purpose at EOP.

Enough baseline data were collected and field research done under the project to test two interventions in malaria control: 1) truck-mounted spraying (ULV and thermal fogging) and *B.t.i.* larvicidal applications. Six interventions were tested for dengue: 1) truck-mounted ULV spraying; 2) indoor residual spraying of curtains; 3) area aerial spraying with ULV malathion; 4) use of larvivorous fish in household water-storage tanks; 5) thermal fogging and 6) a community participation project.

Sustainable benefits include the laboratory and insectary buildings; a computer capability at UCMM and SNEM (through SES-PAS); a cadre of trained people at several levels to respond to broad vector control problems; and a variety of guidelines and recommendations for routine and emergency control of malaria and dengue in the DR. The project brought the expected level of institutionalization and some commodities (microscopes, lab

equipment, computers, vehicles, insecticide application equipment, etc.) will remain useful.

Constraints plagued the project from its inception, including a project-threatening lack of collaboration between SNEM and UCMM at midterm; a difficult fiscal and personnel environment at SNEM; the poor state of repair and maintenance of SNEM-owned commodities; UCMM faculty with shared duties; a slow release of P.L. 480 funds; and long lag-times between purchasing and receiving equipment. However, such constraints were, in part, a major justification for the implementation of the project, and they were largely overcome during the LOP.

The recommendations summarized below are discussed in more detail in section 8 of this report:

- o The three major project objectives not realized at EOP should be completed to the extent possible (stratification, which was recommended by the extension assessment team; a follow-on national project; and completion of a master's program).
- o The use of temephos (Abate) for the control of *Aedes* larvae in Santo Domingo and other large urban areas should be limited to thwart further development of resistance to the compound, which would be sorely needed in emergencies (concerns expressed by project coordinator in the USC final report).
- o SNEM and UCMM should not consider USAID the only source of outside assistance.
- o USAID/Santo Domingo should consider including vector control in larger projects that might have vector-borne disease implications.
- o USAID/Santo Domingo should help maintain project gains.

## 2. Scope of Work and Supporting Documents

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### Work scope

To conduct a final evaluation of the USAID/Santo Domingo Vector Control Project (517-0235) and prepare the Project Assistance Completion Report (PACR) for the mission.

To determine whether the Vector Control Project (VCP) was implemented and conducted in accordance with the project plan (PP), and the extent to which inputs, outputs and EOPs met projected targets.

The evaluation is based on a detailed review and analysis of documents produced by participating institutions (A.I.D., GODR/SNEM, USC and UCMM); discussions with project participants from the respective institutions; and site visits.

### Supporting documents

The basic documents used for this evaluation are listed below.

Vector Control Project Paper, Dominican Republic (Project No. 517-0235) 36 pp 11 annexes (USAID, August 1986).

Midterm Evaluation Report, Vector Control Project, 30 pp, (MSCI, August 1988).

Assessment of Vector Control Project, 27 pp. (LAC/W, VBC, May 1989).

Annual Reports, Vector Control Project: September 11, 1986 - September 30, 1987; October 1, 1987 - September 30, 1988 (USC).

Final Report, Vector Control Project, October 1, 1989, through May 31, 1990, 18 pp., 14 app. (USC).

All project-related documents in the Mission files were made available and were reviewed to see if they were applicable. Documents used for this evaluation are referenced in Annex C.

### 3. Description of Project

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In September 1986, USAID/Santo Domingo signed a three-year, US \$1.5 million cooperative agreement with the University of South Carolina (USC) to conduct a vector control project in the Dominican Republic. Scheduled to end in 1989, the project was extended to May 30, 1990.

#### **Project purpose**

To establish an institutional capacity in the DR to research and test a few ecologically sound, low-cost, effective interventions to control malaria and dengue.

#### **Implementing institutions**

To conduct the project, USC entered into subagreements with two local institutions -- the Universidad Católica Madre y Maestra (UCMM) and the Servicio Nacional para la Erradicación de la Malaria (SNEM). UCMM was to conduct operational research to identify applicable vector control methods and SNEM was to field-test alternative techniques. USC, with A.I.D. guidance and support, was to provide technical assistance and training to UCMM and SNEM.

#### **Project components**

The three basic components were 1) the collection of baseline data on both malaria dengue and their vectors; 2) research in control techniques indicated by baseline studies 3) pilot field tests of selected alternative control methodologies by SNEM (with USC/UCMM guidance) to determine their feasibility on a larger scale in the DR.

## **Project phases**

The project paper (PP) called for the work to be done in four phases (project start-up, months 0-3; baseline data collection, months 4-9; operational research, months 10-30; and field testing of interventions, months 16-36). The phase structure proved unrealistic, however, and the structure was modified to a more realistic plan during the project.

## **Project inputs**

Project financing called for technical assistance, \$631,000 (A.I.D.); training, \$197,000 (A.I.D., \$93,000, DR, \$104,000); commodities, \$285,000 (A.I.D., \$270,000, DR, \$15,000); support costs - \$351,000 (A.I.D. - \$30,000, DR, \$ 321,000); construction/land, \$60,000 (DR); evaluation, \$50,000 (A.I.D.); USC overhead, \$349,000 (A.I.D.); contingencies, \$72,000 (A.I.D.).

## **Project objectives**

1. Provide in-country vector control training courses.
2. Provide in-country training.
3. Provide master's degree training in vector control (three people).
4. Provide short-term participant training in vector control.
5. Field-test three dengue interventions through vector control.
6. Field-test three malaria interventions through vector control.

## **8**

7. Set up laboratories (vector research).
8. Build insectaries (vector rearing facilities).

### **Expected EOP status**

1. The UCMM medical entomology laboratory will be able to perform basic operations research in vector control for malaria and dengue.
2. The UCMM faculty will be able to design, implement and evaluate at least three different interventions.
3. UCMM will be able to provide training sessions or seminars on vector control problems for personnel in private agriculture and tourism.
4. SNEM staff will have the capacity to apply new vector control techniques that proved successful during the field trials.
5. SNEM will be able to apply operations research protocols.
6. A permanent national link will have been established between UCMM and SNEM for conducting vector control research.
7. Recommendations for a follow-on national program will have been developed.

#### 4. Previous Evaluations

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A midterm external evaluation was conducted in August 1988 by two consultants from Medical Service Corporation International (MSCI). The evaluations assessed 1) progress in technical areas (such as facilities development, baseline data collection, field and laboratory research, field-testing of interventions and training) and 2) institutional functions and support related to the project. The major recommendation requiring A.I.D. action was to enhance institutional cooperation between USC/UCMM and SNEM. USAID/Santo Domingo responded by promoting an operational-level committee with representatives from SNEM, USC, UCMM and USAID meeting monthly and by encouraging SNEM to appoint a staff member to work closely with a UCMM counterpart on the project.

An extended assessment was made in May 1989 by Patricia Moser (LAC/W) and Andrew Arata (VBC) in response to a request from the project's grantee, USC, to approve a no-cost, one-year extension to the PACD, scheduled for September 11, 1989. The assessment weighed achievable outputs within the original PACD against those that could be expected with an extension. After a thorough evaluation, the team recommended a six-month extension until March 11, 1990, subject to an acceptable institutionalization plan being submitted to A.I.D. by June 16, 1989. USC submitted a plan and USAID/Santo Domingo granted a nine-month extension of the PACD, to May 30, 1990. I address the results of the extension assessment, where appropriate, in this evaluation.

## 5. Sustainable Benefits

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1. The UCMM laboratory, which was established by the project, has the capacity to investigate interventions to prevent and control malaria and dengue. Sustainability will depend upon the continuing involvement of faculty members trained by the project, or those who might be trained by them.
2. UCMM and SNEM together have the insectaries and facilities needed to determine the vector status of mosquito populations as well as their susceptibility to insecticides. These entities can be sustained as long as they are used.
3. UCMM and SNEM (through SESPAS) both have the computer equipment to store and retrieve a broad spectrum of data essential to developing sound vector control interventions. The computer intended for SNEM, however, was taken over by SESPAS because SESPAS has an air-conditioned facility and computer staff, so SNEM's access is somewhat limited.
4. UCMM has the capacity to train people in the basics of intervention design, implementation, operation and evaluation. In conjunction with SNEM, it can train field workers from SNEM as well as from agricultural and tourist interests.
5. UCMM can offer health education and encourage community participation. It has an appropriate faculty trained in vector control.
6. SNEM has three staff members trained in designing, managing and evaluating field trials and in training field staff. Thus, it can implement and evaluate operational research for field application.
7. Reference documents are available on emergency control of dengue, operational control of dengue and malaria, and criteria for stratification of both diseases.

8. Mechanisms for continued monitoring of vector populations and disease incidence are in place.
9. At EOP, there is a cooperative agreement between SNEM and UCMM and evidence of a cordial link. Their continued collaboration will help assure sustainability of project gains.

### **Comments**

The tangible commodities procured for the project are ephemeral. The project is over. The vehicles and spray equipment will soon wear out; the microscopes will lose parts and disappear. The laboratories and insectaries will endure only as long as they are staffed. The knowledge and ability of the people who used these commodities, however, can be sustained. Properly supported and inspired, they will find ways to replace expendables and to recognize and address vector control needs in the DR.

## 6. Evaluation Results

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### Administration and management

#### 1. Training

The PP projected four major outputs in vector control training aimed at developing the technical and manpower capabilities of SNEM and UCMM. The outputs, with project expectations and EOP realizations, are:

- o In-country short courses -- 12 planned, 14 accomplished (> 100 percent completion).
- o In-country training of people -- 285 trainees planned, 302 trained (> 100 percent completion).
- o Out-of-country master's degree training in vector control -  
- three planned and identified, one completed (Zaglul, USC), one partial completion by EOP, one left SNEM before commencing training (33 percent completion).
- o Short-term participant (on-the-job) training of senior staff in vector control -- seven planned, 16 completed (> 100 percent).

Thus, with one exception (one of three master's degrees), training outputs met or exceeded EOP targets. More than 300 participants received in-country, training 14 courses were conducted, and 16 participants completed out-of-country short courses.

Course offerings were well-balanced, as was the institutional distribution of the students who took them. In country, four short courses dealt with specific topics in the broad areas of vector bionomics, taxonomy or biological control; four with the safe and efficacious use and application of insecticides; three

with health education and community participation; two with dengue and its vector, *Aedes aegypti*; and one with sophisticated laboratory procedures in vector research. Recipients of in-country short-course training were a good mix of SNEM field workers, UCMM students and staff, and military, medical and other health professionals.

Out-of-country short courses (USC, McClellanville) included mosquito taxonomy, epidemiology and control of malaria and other vector-borne diseases, and the use of computers in vector control research and program management. These courses were attended by senior professionals from SNEM, UCMM and SESPAS. Among the participants were a SNEM director and a chief of operations.

The vector control training should contribute significantly toward sustaining institutional capacity in the DR well beyond the LOP.

A detailed tabulation of project training activities, including dates, specific topics and attendees by name, appears in Appendix 14 of the USC Final Report.

## **2. Technical assistance**

The project allocated \$631,000 in USAID funding to cover long and short-term TA. The budget amendment of November 22, 1989, increased the amount to \$725,373 to reflect needs posed by the expansion of the PACD from November 11, 1989, to May 30, 1990, which required more time and effort from various USC components to complete project commitments.

The PP provided for 20 person/months (ca. 600 consultant days) of short-term TA (operations research, epidemiology, ULV operations, malariology and vector control -- 8 p/m; entomology -- 7 p/m; computerized data management -- 2 p/m; training and health education -- 1 p/m; and management improvement assistance -- 2 p/m).

At the time of the extension assessment in May 1989, approximately 86 percent of TA consultant funds had been expended, and most needs from outside sources, other than USC, had been met. While short-term TA had been judiciously used in entomological surveys, control methodology and health education, needed assistance had not been provided as planned in data management and epidemiology. Needs identified by the extension assessment resulted in a total of 675 personnel days of TA for the LOP. The extra TA during the extension period answered the concerns of the extension assessment team, principally in the areas of data management and epidemiology.

A review of the project coordinator's final report and the USC extension implementation plan shows that activities the PP stressed for technical assistance were conducted adequately, and the grantee (USC) made every effort to comply with earlier evaluation and assessment recommendations by fully using TA to complete projects within the revised budget.

### **3. Infrastructure development**

SNEM has provided and equipped laboratory and insectary facilities both at headquarters in Santo Domingo and at a field site in the Province of Dajabón. A well-equipped vector control laboratory at UCMM, financed with P.L. 480 funds, was inaugurated on May 23, 1989. Before occupying the laboratory, UCMM had provided interim space on campus. By the midterm evaluation (August 1988), the permanent lab was functional.

Together, the laboratories and insectaries of SNEM and UCMM are equipped and staffed to conduct studies essential to sound vector control in both malaria and dengue.

Early delays in laboratory construction caused by the slow release of PL 480 funds were mitigated by innovative use of the temporary facilities provided by UCMM. Well before the EOP, all required construction and space renovation had been completed, and projected P.L. 480 funds for construction committed or expended.

#### 4. Commodities

Notwithstanding an unexpected lag (up to seven months) between purchasing and the delivery to the DR, all commodities had been acquired and put into use by May 1989 (extension assessment). This action was well within the time projected in the project paper, which had scheduled three major procurements to coincide with project phases: three months into the project (phase 1, \$227,900); early 1987, months 4-9 (phase 2, \$31,400); months 10-30 (phase 3, \$25,700), for a total of \$285,000.

Major acquisitions under the procurement plan (PP, Annex H) were vehicles (three vans, five motorcycles), microscopes (seven compound, seven dissecting), spray equipment (two Leco, 12 Lecon, seven portable foggers, six hand compression); two computers, insecticides, and a variety of laboratory, office and training equipment.

The original commodity budget of \$285,000 (including \$15,000 DR) was increased to \$296,432 in November 1989 to cover the project extension.

The EOP commodity distribution left UCMM with two vehicles, 10 microscopes, a computer system, and a variety of laboratory furniture, equipment and supplies. SNEM received one van, two stereoscopic microscopes, a variety of insecticide application equipment, a copier and computer system with associated components and furniture. As a result of A.I.D. concerns (USC Final Report, App. 10), however, the computer system intended for SNEM was housed in SESPAS, with a written agreement outlining responsibilities and use between SNEM and SESPAS.

#### 5. Financial resources

USC, under the cooperative agreement, managed all the finances except to pay for the evaluation (\$50,000), which A.I.D. conducted.

Financial data given in the USAID/DR Project Status Report for the six-month period ending March 31, 1990, showed that \$1,401,906 of the \$1,500,000 (95 percent) original grant had been used, with no further commitments. The document showed that DR \$146,400 (100 percent) had been expended. It further showed that the projected time for the project had elapsed.

The USC Final Report (May 31, 1990) shows a total expenditure through June 27, 1990, of \$1,373,453.33 for the LOP. In-kind contributions for the LOP were USC, \$150,551; UCMM, \$146,400 pesos; SNEM, \$49,69. Major P.L. 480 spending was for constructing, equipping and staffing the vector control laboratory. The report stated that a final budget statement was pending.

Financial resources appear to have been prudently and expeditiously used with only a single revision during LOP: that of November 1989, resulting from the USC request for an extension. Budget amendments to cover the extension period, by category, are detailed in Section III (Project Description) of this report.

## 6. Institutionalization

The impact of this project presupposes the long-term institutionalization of the skills used in selecting, developing, assessing and implementing cost-effective vector control measures that fit the malaria and dengue risk in the DR. Indeed, institutionalization is the stated purpose of the project: "to establish an institutional capacity in the DR specifically for malaria and dengue."

The project named UCMM and SNEM as the DR institutions through which development would be focused under the cooperative agreement between USAID/Santo Domingo and the University of South Carolina (USC). USC's responsibilities were to provide technical assistance and training to UCMM and SNEM. In turn, UCMM was to conduct operational research and SNEM was to field-test vector control interventions jointly developed.

Planned EOP outputs aimed at institutionalization were Specific and are listed under Section III (Project Description) of this report. A summary with the EOP status is given below:

<u>Planned EOP Objectives</u>	<u>EOP Status</u>
1. A functional vector control laboratory at UCMM	Completed
2. UCMM faculty capacity in vector control	Accomplished (3 faculty trained -- 1 master's completed and 1 faculty member completed course work at USC)
3. UCMM capacity to train agriculture and tourism personnel	Completed
4. SNEM capacity to apply new vector control techniques	Completed (one UCMM faculty employed by SNEM)
5. SNEM capacity to apply operational protocols	Completed
6. A permanent link between UCMM and SNEM for vector-control research	Completed (as institutional plan signed between UCMM and SNEM)
7. Recommendations for a follow-on national project.	UCMM seeking funding

At EOP, UCMM has a well-functioning laboratory that can conduct malaria vectorability studies. The UCMM laboratory also has a computer. SNEM can conduct malaria and dengue surveillance and control activities -- singly or in collaboration with UCMM, and has limited access to a computer capability

through SESPAS. Collaboration between UCMM and SNEM appears to be close and effective. At midterm, the relationship was in a project-threatening state.

Documents provided by USC should promote institutional capacity in the DR after the PACD. Appendices to the USC Final Report include a dengue stratification plan (methods to determine and define control targets by priority); a dengue research matrix (guideline for decision making); a malaria stratification plan; and a malaria research matrix.

Although no specific document has recommendations for a follow-on national project, the USC Final Report does refer to the "new cooperative agreement between SNEM and UCMM" and provides recommendations for malaria control in the DR (App. 13), as well as a document on the emergency management of dengue in the DR (App. 7).

A review of institutional responsibilities and contributions under the institutionalization plan for the project indicates that the respective entities -- USC, UCMM and SNEM--adhered closely to the plan's provisions. In spite of delays, setbacks and a slow start-up in some areas and an early lack of harmony between UCMM and SNEM, project participants seemed to have done "what they could, when they could and how they could" to get the job done.

Expected EOP outputs reflected an overall high level of compliance with the institutionalization plan.

## **7. Constraints**

From the start, the project was plagued by constraints. However, goal-impeding hindrances during LOP should have been expected. Indeed, predictable constraints were a major reason for the project. The early pages of the PP are replete with statements of GODR/SNEM inadequacies in vector control, from administration to the spray tank -- statements crafted to justify the project in the DR.

Thus, the project was implemented in an atmosphere of constraints, resulting in unrealistic assumptions.

It was unrealistic to impose rigid deadline on elucidation of biological phenomena; to require that a set number of interventions be developed and tested; to promise a major reduction in malaria and dengue incidence through a research project, and to require that dengue and malaria investigations be conducted in the same locale. It was also unrealistic to expect smooth management, a stable or rising budget, timely release of funds, expeditious purchasing, shipping and delivery of commodities, and expert maintenance. Yet the project operated under all of these expectations.

Other constraints were more specifically identified and discussed in earlier reports and evaluations:

- o There was a project-threatening lack of collaboration at midterm between SNEM and USC/UCMM. At EOP, this situation seems to have been corrected.
- o The extension assessment team recognized a difficult fiscal and personnel environment at SNEM engendered by staff turnover and declining funding. Progress had been made in personnel at EOP, but lack of adequate funding and the eroding value of local currency continues to plague SNEM.
- o The assessment team also noted that SNEM-owned commodities were poorly maintained. The USC Final Report indicated that SNEM vehicle and equipment problems were directly responsible for two projects not being completed (evaluation of local fogging for malaria reduction and the determination of optimal insecticide rates for dengue control). That these problems occurred late in the project suggests that they persist at EOP.

- o The extension assessment team noted that UCMM input was hindered by the shared-duty nature of university staff. This problem would have affected project operations more than institutional capacity. At EOP the resource is there.

In spite of the many constraints, the project has met most of its stated outputs and EOP objectives. Postproject activities or follow-on projects are not likely to be immune to constraints experienced during LOP.

## **Technical**

### **1. Background**

The project plan listed three basic components to meet technical objectives: 1) the collection of baseline data on malaria and dengue vectors, 2) research in control techniques and 3) field-testing and evaluation of six control interventions, three each in malaria and dengue. Although projected for specific periods, or phases, in actual practice, these activities overlapped.

### **2. Baseline data and research**

Essential baseline data had to be collected before developing and testing interventions. Basic research, therefore, had to be done during the LOP. Activities included the delineation of vector densities and distribution; elucidation of larval habitats, adult resting, biting and flight habits, and the propensity of vectors for human contact; and insecticide susceptibility/-resistance determinations. Although most baseline studies were programmed for the first year of the project, data were accumulated throughout the LOP.

Enough baseline data were generated to do the laboratory and field research necessary to select, test and evaluate several interventions against malaria or dengue.

### **3. Field-testing of interventions**

Two malaria control interventions (larviciding with *B.t.i.* and thermal fogging) were tested and evaluated. Tests using other methodology, which are not considered interventions in the strict sense (for example, insecticide resistance testing), were completed.

For dengue, six clear-cut interventions were tested: truck-mounted ULV spraying, thermal fog spraying, residual spraying of curtains in domiciles, aerial spraying, predatory fish, and community participation in source reduction.

### **4. Project results**

EOP projections were generally met, or exceeded, in technical areas. The lack of stratification (vector control targeting by priority) of the DR might be considered a project shortcoming. However, this objective was probably unrealistic for the LOP and its incompleteness is largely mitigated by the presence of stratification documents in the USC Final Report (dengue, App. 2; malaria, App. 11). These guidelines should permit SNEM to do stratification in the future.

Project activities in the technical area (baseline data collection, research and field testing) for both malaria and dengue are tabulated and summarized, with comments in Table 1.

Table 1. USAID Vector Control Project Research Activities, Malaria, EOP

Activity	EOP Status	Comments
<b>Baseline Data Collection</b>		
Anophelism determined by species for two areas -- Dajabon and Barahona.	Overall, <i>An. albimanus</i> -- 98.2 percent <i>An. vestitipennis</i> -- 10.1 percent, <i>An. crucians</i> -- 1.5 percent <i>An. grabhamii</i> -- 0.1 percent.	Concentration on <i>An. albimanus</i> indicated, monitor others; in Barahona, <i>An. crucians</i> is more prevalent than <i>An. vestitipennis</i> , showing the importance of studies by locale.
<i>Anopheles</i> breeding places defined.	Dajabon -- mainly in rice fields and animal watering holes; in Barahona - sugar cane irrigation canals.	Differing breeding places strengthen need for studies by locale, necessary for stratification.
Indoor/outdoor resting and biting habits of females	Outdoor resting and feeding.	Outdoor habits diminish the effect of indoor spraying.
24-hour (diel) resting and biting habits defined, established.	Main biting activity is outdoors from evening to about 11 pm, with a peak from 8 to 10 pm. <i>An. vestitipennis</i> less attracted to light than <i>An. albimanus</i> .	Defines optimum time for adulticiding with ULV and fogging; information contributes to malaria transmission pattern and selection of control strategies.

**Activity****EOP Status****Comments****Baseline Data Collection:**

Vectorability and malarionetric data obtained.

Gonotrophic cycles, parity rates, anthropophilic indices, infectivity rates and so forth were determined.

Data useful for stratification.

Insecticide susceptibility rates determined.

*An. albimanus* resistant to DDT (WHO method), but susceptible to some OP and carbamate compounds.

Essential information for the selection of insecticides.

Stratification effort.

Stratification was not achieved; however, with the computer data system and stratification guidelines (App. 11, USC Final Report), SNEM has the means to complete it.

A computer-based data recording and a processing system was developed and instituted to improve and replace the manual system at SNEM (through SESPAS).

Activity	EOP Status	Comments
<b>Research, Testing and Evaluation of Interventions:</b>		
Source reduction.	None planned.	
Limited testing of biological control agent ( <i>B.t.i.</i> ) against anopheline larvae.	Effective against anophelines, but with short residual action.	Short activity period would require frequent applications, but still might be indicated in environmentally sensitive situations.
Peridomicilliary thermal fogging tests completed (Barahona).	Malathion sprayings had immediate impact on anophelines.	Method employs a "safe" insecticide with spatio-temporal efficacy.
Malaria control recommendations.	Recommendations for malaria control made on the basis of baseline data and control research.	Recommendations minimize the importance of indoor spraying, maximizes alternative methodology, an important step toward a horizontal program. Recommendations are detailed in Appendix 13 of the USC final report.

**USAID Vector Control Project Research Activities, Dengue, EOP**

Activity	EOP Status	Comments
<b>Baseline Data Collection:</b>		
Defined populations and breeding sites in 3 study areas in Santo Domingo.	Concrete-lined, 55-gallon drums dominant breeding sites in most areas.	Without piped water, drums as water containers are essential to populace.
Defined mosquito densities.	Average of 800 larvae/drum; one drum estimated to produce 60-plus larvae/day/premise (80 percent from drums) = 10 mosquitoes/person/day.	Correlation between high numbers and dengue transmission is unknown. Extension assessment noted that analysis combined with serological studies would be useful, Data correlating larval and adult densities is lacking.
Stratification.	Stratification not accomplished, because of lack of correlation between larval and adult densities, serological data and so forth.	Though not accomplished, the USC final report gives a guide to stratification (App. 2) and a dengue research matrix (App. 3).

Activity	EOP Status	Comments
<b>Baseline Data Collection:</b>		
Insecticide susceptibility tests conducted.	Larvae resistant to temephos (Abate), but not to malathion; adults highly resistant to DDT, with relatively high rates to other candidate compounds.	Resistance to Abate poses a serious problem because of its extreme safety and efficacy -- continued use could increase resistance that might render it useless in emergencies. Susceptibility results are in Appendix 4 of the USC Final Report.
Recommendations indicated by baseline data.	Factors portend future serious dengue epidemics, without appropriate interventions. The USC final report warns that insecticide use should be careful and limited to peri-focal treatment of dengue-positive houses/premises, or to epidemics.	Baseline data are excellent, and given the level of resistance, the recommendations fostered by them should be taken seriously.

**Activity****EOP Status****Comments**

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**Research, Testing and  
Evaluation of Interventions:**

Testing of vehicle-mounted  
ULV and thermal fog space  
spraying.

Results of 30 applications:  
female mosquito mortality as  
high as 95 percent with 3  
successive applications of  
malathion at ULV rates;  
mortality as high as 81 per-  
cent in bioassay cages  
under beds.

Method offers promise in conjunction with  
larviciding for localized control. Results  
are detailed in the USC Final Report  
(App. 5).

Aerial spraying for the  
emergency control of dengue.

Less than 50 percent mosquito  
mortality; compares  
unfavorably with ground  
applications in coverage,  
penetration and mortality.

Low mortalities might have been due to  
low rates of insecticide. Might be a  
necessary intervention in epidemics  
(with possible higher rates). Results  
are detailed in the USC Final Report  
(App. 6).

Activity	EOP Status	Comments
<b>Baseline Data Collection:</b>		
Pilot community participation program was conducted using larvivorous fish and cloth drum covers.	One-time project.	Mainly served to educate householders on origin of mosquitoes and to test the effectiveness of community participation. Use of fish and drum covers offers an ideal community participation project.
Two species of predatory fish were introduced to water storage drums.	Difficult to maintain the fish in drums, multiple reasons; a third (bottom-dwelling) species was more persistent.	Probably an effective intervention potential with good coverage and community participation.
Use of nylon sacking material as drum covers.	When conscientiously employed, an effective tool.	Cloth covers have a cost advantage over heavier types, but any type will require substantial education.
Use of a fungal agent against larvae in drums.	Results erratic, from 100 percent infection rates, in some drums, to 0 in others.	Opposed by local health authorities, development and testing hindered.

**Activity****EOP Status****Comments**

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**Baseline Data Collection:**

Use of permethrin-treated curtains.

Ineffective.

Probably should be re-evaluated by SNEM.

Emergency control of dengue.

Document completed.

A contingency plan for the emergency control of dengue is given in the USC Final Report (App. 7).

## 5. Applicable Interventions

The project was to test, under operational conditions, six methods of vector control during the EOP -- three against the anopheline vectors of malaria and three against the *Aedes* vectors of dengue. Several test areas were to be selected on the basis of disease endemicity, potential for outbreaks and the diversity of ecological conditions and vector populations.

For malaria tests, the district of Dajabon (in the Province of Dajabon) on the northwest frontier of Haiti was selected for the following reasons: it was identified by SNEM as an area least responsive to malaria control efforts; it offered a diversity of ecological habitats; and it had a history of insecticide resistance among the *Anopheles* populations. Some additional work was done in Barahona, in southwestern DR, as well as in Elias Piña, Haina and Santiago.

Dengue study sites were selected on the basis of available records from SNEM and preliminary surveys conducted by project staff. The principal study sites were Ensanche Espaillat (in Santo Domingo), which was representative of many older middle-class communities of the city. A second site, Mejoramiento Social, with similar characteristics, was chosen to compare *Ae. aegypti* indices and control interventions. A third, poorer barrio, Gualey, contiguous with E. Espaillat, was also selected for comparative studies.

Among the various tests conducted (Table 1), the following appeared to offer the most promise for further testing and future applicability to SNEM vector control operations.

**Malaria.** Applying *B.t.i.* granules to ditches containing *Anopheles* larvae reduced larval populations. Newly hatched larvae were noted within 48 hours, however, indicating the need for frequent treatments at recommended rates. The non-chemical nature (produced from bacteria) of *B.t.i.* -- with its characteristics of target specificity, safety and absence of resistance -- might dictate its future operational use.

Peridomiciliary thermal fogging tests in Barahona using malathion immediately reduced adult anopheline populations. Because project studies show that malaria transmission is largely outdoors in the early evening hours, and available candidate compounds (malathion and carbamates) have shown no resistance problems, the methodology is promising for future operations. This method would be an exceptionally useful approach during epidemics or during periods of high endemicity at the community level.

**Dengue.** Results of vehicle-mounted ULV (ultra-low-volume) and thermal fog space-spraying (aerosols) at a maximum rate of 8 oz per acre were impressive, with reductions of anopheline populations up to 95 percent. This technique, together with larviciding, holds promise for localized dengue control, but, as with all candidate methods, efficacy must be determined for each target locality.

Preliminary aerial spray trails using ULV malathion were less impressive (<50 percent mortality) than those obtained when the same chemicals and rates were applied by ground equipment. However, given the absence of a continuing *Ae. aegypti* control program in the DR, aerial spraying would probably be employed in emergency situations requiring rapid action over large areas with dense populations.

A pilot community participation study was conducted to help educate residents to increase awareness that the community produces, and might develop the capacity to control, its own *Aedes* populations. In essence, residents were taught to place predatory fish in water-storage tanks, which produce 80 percent of the *Ae. aegypti* in some barrios, and to cover the tanks with project-issued cloth sacks. With proper organization, education and participation, this intervention could have a high impact.

Aside from the community participation trials, which included the use of fish and nylon sacking, these methods were tried in separate tests. Both interventions might find use in future operations, especially in conjunction with other methodology. Again, effectiveness depends on community cooperation.

During the time that this project was operational the Vector Biology and Control Project (MSCI)/USAID prepared a contingency plan for the emergency control of dengue in the DR, at the request of the mission. This timely document is available in both English and Spanish (see Annex C).

## 7. End-of-Project Status

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### Realizations

The project, aimed at the institutionalization of UCMM and SNEM, expended 100 percent of planned financial input from the host country and 95 percent of A.I.D. allocations. Most of the planned EOPs were reached 1) establishing a vector control research facility at UCMM, 2) developing a faculty capability at UCMM to conduct vector control research germane to malaria and dengue interventions, 3) developing a UCMM capability to provide vector control training, 4) developing a SNEM capability to apply new vector control techniques, 5) developing an ability at SNEM to apply operational research protocols, and 6) encouraging the development of an institutional plan, signed by both institutions, to establish a lasting link between UCMM and SNEM. A final EOP objective, not realized because of lack of funding, was the development of a follow-on national project. UCMM, however, has taken the lead in seeking funds for that purpose.

EOP realizations were accomplished through 1) the provision of 14 in-country short courses, 2) the in-country training of 302 people, 3) completion of a master's degree for one UCMM faculty member and partial completion for one SNEM vector control specialist, 4) the out-of-country participation training of 16 professional staff members of UCMM and SNEM, 6) the construction and equipping of the UCMM laboratory with PL 480 funds and the establishment of insectaries at both UCMM and SNEM.

The USC Final Report contains a number of project-developed guidelines and vector control strategies as appendices. These documents will be useful to SNEM in developing future protocols and responding to both routine and emergency vector control needs. Principal documents are referenced in appropriate sections of this evaluation report.

## Outlook

SNEM employs the services of a vector control specialist, Lic. Carlos Peña, who participated in many of the project activities, interspersed with resident training toward a master's degree at USC. He was a UCMM employee working very closely with the project coordinator until the EOP and during the extension period. His presence in SNEM bodes well for the future. However, it is important that he complete the training planned under the project.

SNEM seems to have the capacity and willingness to do its job well, as well as the legal mandate and responsibility to conduct vector control activities in the DR, but fiscal problems and being given low priority are likely to remain as major constraints.

The UCMM faculty and administration seem determined to maintain their gains under the project. Although the project ended in May 1990, project-trained faculty conducted extensive insecticidal tests in the fall of 1990, and an agenda has been developed for January - May 1991. The plans include seminars, course offerings, printing and distribution of pertinent documents, maintenance of the insectary colony of *Ae. aegypti*, cooperative work with "The Wedge" (USC), additional insecticide evaluations and promotion of vector control topics among medical students at UCMM. These activities, and the issuance of a quarterly report for the period ending in December 1990, indicate ongoing activity at UCMM.

The postproject outlook must consider the premise that UCMM's vector control development under the project represents a voluntary involvement that, if not internally fostered and externally supported, could end. SNEM, on the other hand, will continue to be the DR institution with the mandate and responsibility for preventing and controlling vector-borne diseases in the country. Thus, it is important that SNEM be able to function singly -- as it can at EOP -- or in collaboration with UCMM, as it does at EOP.

According to the USC Final Report, a cooperative agreement was prepared and signed by both SNEM and UCMM to assure their postproject coordination in operational research. Evidence indicates that a relatively good relationship exists between the two institutional beneficiaries of the project.

The project has contributed research facilities, provided a cadre of people trained in vector control and developed some applicable malaria and dengue interventions, but it was a research project and it has ended. Meanwhile, the vector control component of SNEM continues to be plagued by the same fiscal, operational and maintenance constraints that existed before the project. The new knowledge and methodology will not be translated into action without purpose and resources to employ the gains. What is different at EOP is a state of awareness and capacity, which was not there before, to recognize vector control needs in disease control and respond with appropriate interventions. Postproject support will be needed mainly in commodities. Technical assistance and training residuals from the project should endure for the foreseeable future.

## 8. Recommendations

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Recommendations resulting from the final evaluation of this project are as follows:

1. Major project objectives, not realized at EOP, should be completed to the extent possible: a) SNEM should try to accomplish stratification (establish control priorities on the basis of disease endemicity, environmental factors and epidemic potential) of one city for dengue and one province for malaria as an exercise toward national stratification, b) UCMM should complete plans for a follow-on national project, c) SNEM should make every effort to support, or solicit support, for the completion of the master's degree requirements by Carlos Peña.
2. Given the presence of multiple dengue serotypes in Santo Domingo, the epidemic potential of the disease, economic constraints and incipient insecticide resistance, the GODR-/SNEM should seriously heed the advice of the project coordinator (USC Final Report, page 4, last paragraph) to reserve insecticide applications against *Ae. aegypti*, particularly with temephos (Abate), to the perifocal treatment of dengue-positive houses or to more extensive application in epidemic situations.
3. SNEM and UCMM should not consider A.I.D. the **only** source of outside assistance. These institutions, perhaps through SESPAS, should seek donor assistance, where appropriate, from such groups as PAHO (training and TA), regional banking institutions (for example, commodities to support vector control interests in tourist developments), and other governments, such as Japan or Israel (insecticides). This type of assistance is not without precedent in the region.

4. USAID/Santo Domingo should consider including vector control interventions as components of larger projects, especially in child survival, community health, and construction programs that result in topographic changes (reservoirs, channeling, drainage, road or airport construction) that foster vector production.
  
5. USAID/Santo Domingo, should be receptive to well-justified future DR requests for vector control assistance, especially in the area of commodities, TA and emergency assistance. TA and emergency assistance to help maintain the gains that have been made under the project would be available to the Mission through S&T/Health and the LAC Bureau.

## Annex A. Biodata of Evaluator

Samuel Breeland, born 1926; U.S. citizen; B.S. U. Georgia (Zoology 1950); M.S. N. Carolina St. (Entomology 1953); Ph.D. U. Tennessee (Entomology 1957); positions held include 1980-84 Supervisor, Mosquito Control Section, Florida Department of Health; 1979-1980, Director, Florida Medical Entomology Lab; 1973-78 Chief, Medical Entomology Branch, CDC; 1967-1972, Research Entomologist, Central American Malaria Research Station, CDC, El Salvador; 1958-1960, Medical Entomologist, Canal Zone Health Bureau, Panama; Chairman, Section D-Medical Entomology, Entomological Society of America; Consultant to PAHO and other organizations; multiple publications and monographs, mostly dealing with biology and control of *Anopheles* in the Americas, resistance to insecticides, and control of malaria. Dr. Breeland speaks Spanish.

**Annex B. Contracts and Itinerary**

Saturday, February 9	Arrival in DR
Monday, February 11	Meeting with Jack Thomas, Deputy General Development Officer, USAID/Santo Domingo; and Sara George, Project Officer, USAID/Santo Domingo.
Wednesday, February 13	Safety briefing, U.S. Embassy, with Chris Lion, Security officer.
Monday, February 18	Meetings with Dra. Jacqueline Medina, Director; and Lic. Carlos Peña, Medical Entomologist, SNEM.
Tuesday, February 19	Traveled to Santiago and returned. Meetings with Dr. Andrés Peralta, Assistant to the Rector for Institu- tional Affairs, UCMM; Dra. Rosario Granados, Director, Vector Control Research Laboratory, UCMM; and Lic. Zoila Rojas, Coordinator of Community Participation and Student Coordinator, UCM.
Wednesday, February 20	Meeting with Sara George to discuss progress work plans, USAID/Santo Domingo.

## Annex C. Referenced Documents

### USAID

Vector Control Project Paper, Dominican Republic (517-0235)  
August 1986.

Midterm Evaluation Report, Vector Control Project, August  
1988.

Assessment of Vector Control Project, May 1989.

### USAID/Santo Domingo Files

Institutional Plan	1.3.1	VC 0235
Computerization of SNEM	1.3.2	"
Project Identification Document	2.1	"
Conditions Precedent (agreements)	2.3.1	"
Project Asst. Closing Doc. (PACD)	2.3.4	"
Project Activity Log	2.4	"
Project Status Reports	2.6.2	"
USC Progress Reports	2.10	"
Midterm Evaluation	6.1	"
Moser/Arata Assessment	6.2	"

### USC

Progress Reports	October 1986 - June 1987
	October 1987 - December 1987
	January 1988 - March 1988

Annual Report	September 1987
Annual Report	September 1988
Final Report	May 1990

Educacion Sanitaria/Intervencion Comunitaria. Gordon, Rojas  
(UCMM) and Tidwell, 28 pp.

**MSCI/VBC**

Contingency Plan for Emergency Management of Dengue and Dengue Hemorrhagic Fever in the DR (Tonn and Waterman). October 1989, rev. May 1990 (VBC staff).

**SESPAS**

Plan de acción para el control del *Aedes aegypti* a corto plazo (Medina, Mercedes and Valdez).

**Annex D. Abbreviations and Acronyms**

<i>B.t.i.</i>	<i>Bacillus thuringiensis israelensis</i> , a mosquito larvicide of bacterial origin.
DR	Dominican Republic
EOP	End of Project
GODR	Government of the Dominican Republic
HC	Host Country
LOP	Life of Project
MSCI	Medical Service Corporation International, USA
PACD	Project Assistance Completion Date
PP	Vector Control Project Paper
SESPAS	Secretaria de Estado de Salud Pública y Asistencia Social
TA	Technical Assistance
UCMM	Universidad Católica Madre y Maestra
USAID/Santo Domingo	U.S. Agency for International Development Mission in the Dominican Republic
USC	The University of South Carolina
WHO	World Health Organization