Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

Draft Generic Environmental Impact Statement

Steve Levy, County Executive

Appendix E: Plan of Work

Prepared for:

Suffolk County Department of Environment and Energy
Suffolk County Department of Health Services
Suffolk County Department of Public Works
Suffolk County, New York

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SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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WORKPLAN

TECHNICAL PROJECT OVERVIEW

Cashin Associates, P.C. (CA) and Cameron Engineering & Associates, LLP (CE) together with a select group of specialist subcontractors (the CA/CE team) have submitted the attached workplan in response to the Request for Proposals for professional services associated with the development of a Vector Control and Wetlands Management Plan and its related Environmental Impact Statement for Suffolk County, and in response to followup comments from the Departments of Health Services and Public Works.

The CA/CE team will develop the Plan in accord with the following overall guidelines and principles.
Mosquito management in Suffolk County is intended to address two broad public concerns:

- Health risks associated with disease transmission, West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) primarily
- Mosquito impacts that curtail outdoor quality of life for County residents and visitors

Each concern needs to be addressed by a hierarchy of control methodologies.

In addition, there is an overriding public interest in minimizing environmental impacts from mosquito control. It is commonly believed that current control methods have negative effects on human health, wetlands ecology and environments, lobsters and other marine life, and terrestrial life (especially birds and amphibians). All mosquito management means must address these public concerns (which, in some cases, are well-grounded, and in other cases are the result of misinformation).

The mosquito program is generically understood to be composed of several distinct but interlinked parts. These include surveillance (information collection), source control, active management of the populations, and public education on all aspects of vector control activities.

In order to address mosquito problems, mosquito populations and their habitats must be well understood. An essential part of the project will be to assemble available information on the presence and propagation of local mosquitoes, and the construction of a detailed Geographic Information System (GIS) database for mosquito management purposes. It is anticipated that it will be necessary to augment currently available information through project field programs to generate a sufficiently rich data set.

When it is understood where mosquitoes are and where they are breeding, it becomes possible to implement the preferred control methodology: source control, or minimization of mosquito propagation. Since mosquitoes require stagnant or slow-moving water – either naturally-occurring, or created by human actions (such as containers, tires, storm sewers, etc.) -- for eggs to develop, removal of these breeding grounds can control populations. This requires public education to remove such sites in the immediate vicinity of homes; it also means that stormwater and wetlands management are integral in creating efficient source-control strategies.

However, it is impossible and undesirable to eliminate all mosquito habitats in the County. For instance, the slow-moving waters of salt marshes serve as vital nurseries for commercially- and recreationally-important finfish and crustaceans; slow-draining or continuously wet recharge basins are now viewed as important wildlife habitat in

suburban neighborhoods; and current stormwater regulations promote water retention to improve water quality in receiving waters. However, other areas of the country have begun to implement habitat management programs that may address these environmental concerns.

Natural mosquito predators may also be efficient enough to provide the desired decrease in mosquito populations. Augmenting existing populations (either by increasing habitat for insectivorous fish through water management, or by providing shelters such as bird or bat houses) will be investigated to determine if significant mosquito management benefits can be accrued.

Active measures will also be part of the mosquito control program. The active measures will be based on the principles of Integrated Mosquito Management (IMM). In accord with IMM:

- actions will be taken only when a need has been demonstrated (through surveillance and monitoring);
- control measures will be proportional to the infestation; and,
- early, natural, biological, and limited responses will be preferred over later, artificial, chemical, and broadcast applications.

Precise and accurate delivery systems for all controls are required, and appropriate training programs for applicators need to be prepared.

Developing trapping practices will also be assessed. It is clear that trapping adult mosquitoes can only be effective where a great deal of effort has been applied in surveillance; therefore, this requirement strengthens the need for a large effort to develop a complete GIS description of mosquito habitat and life-cycle areas.

Management of mosquitoes to minimize health risks and mosquito control aimed at enhancing quality of life might have some different aspects because each program will need to mitigate potential environmental impacts. Although specific health and environmental risk evaluations have not yet been conducted, it is likely that greater potential environmental impacts will be tolerated with regard to prevention and control of disease transmission as compared to management efforts which allow for outside activities. In actuality, these problems are not distinct, as all mosquitoes in Suffolk County that bite people are potential disease vectors, so that the control of populations that are not currently carrying disease may be still classified as a public health benefit. The perception remains that the County mosquito control program is primarily intended to reduce nuisance impacts, however, as the geographical extent of infected mosquito populations is almost always less than the populations that generate quality of life complaints.

In brief, the control program for mosquitoes impacting quality of life will be shaped by:

- the assessment of potential impacts from changing wetland environments to minimize mosquito propagation versus the public benefits that may accrue from these changes;
- definitions of appropriate larvicidal steps when propagation control efforts are insufficient;
- assessments of the practicalities of augmenting mosquito predator populations to impact mosquito numbers;
- the development of surveillance programs to determine if, when, and where adulticide efforts should be made;
- a demonstration of the latent disease risks posed by mosquitoes as compared to risks associated with each control measure; and,
- the practicalities and economics associated with nascent trapping technologies.

The disease prevention and control effort will require:

- continuing efforts (including public education) to minimize mosquito propagation in the near-vicinity of housing and widely-used public recreational areas;
- surveillance efforts to identify the specific parts of the County where disease transmission may be increasing; and,
- a clearly outlined active control element, appropriate to the risk presented by the disease threat.

Both programs will be need to be carefully assessed in light of recent County legislation that may restrict responses under some conditions, and in terms of the latest scientific information concerning:

- the value of wetland environments;
- what aspects of wetlands create these environmental values;
- the best long-term management means for different wetland types to maximize positive wetland functions;
- environmental and public health effects associated with pesticide application drift; and,
- other pertinent information regarding impacts of control measures (the potential for developing control effort-resistant mosquito populations, costs and other practicalities associated with different control strategies).

Overall Project Management

Technical management of subconsultants to meet particular Task demands and goals will be derived by the project management approach discussed below. There is a strong chain of command, with identified members of both CA and CE acting as direct supervisors over each subconsultant. The members of CA and CE with supervisory responsibilities will be in constant contact with the subconsultants by phone and e-mail. In addition, the two key non-local subconsultants (CPF and Dr. Parsons) expect to travel often to Long Island for meetings and (especially for Dr. Parsons) to interface with key County personnel and personally observe particular sites of interest. Frequent communication between the supervisors and the subconsultants will be demanded by the project supervisors (Messrs. Ellsworth and Pascucci).

First in the hierarchy of administrative supervision is the assignment of a principal of both CA and CE to the project. Messrs. Marletti and Cameron will play proactive roles on the project. Each will continually available to County representatives and the project team. One of their major tasks will be to ensure that corporate resources are always available to the project team to keep the project moving forward. They will also closely monitor products for quality and compliance with contract terms, especially those relating to budget and schedule, and to meet County expectations. All work products will be reviewed for completeness, responsiveness, and coherence. Additionally, Mr. Mayer, Esq. (CA corporate counsel and former Town of Oyster Bay attorney), will monitor the Team legal consultant (Jonathan Sinnreich, of Sinnreich and Safar) and will be in frequent contact with that firm.

To ensure a high level of quality control throughout the research, design, and project documentation process, experienced CA/CE staff will provide project coordination and quality assurance. CA/CE each have Comprehensive Quality Assurance Plans, developed, in part, to aid in reducing Professional Liability Insurance premiums. Specific management tools include preparation of coordination checklists for project documents and a pending or outstanding items list to track decisions, responsibilities, and resolution deadlines. CA/CE each typically appoint a senior technical staff person as Quality Control Specialist, who is responsible for quality control reviews and coordination of the work. CA/CE planners, scientists, and engineers utilize these methods to assure that project reports and designs are accurate, defensible, and read well. The Project Director guides and coordinates the project to ensure that proper staffing is in place to meet deadlines and that all work is conducted within budget. In addition, CA/CE senior staff will hold regular Total Quality Management meetings to review project quality and progress. Additionally, weekly coordination meetings will be scheduled with the Project Team to plan the project's tasks for the week and determine the assignments for each of the project team members.

To assist the CA/CE principals, further administrative supervision of the subconsultants will be in part established through Lawrence Britt, who will act as a project Contract Manager. Mr. Britt is well-qualified for to provide this supervision of a wide range of experts, as he served in a similar role for the LILCO Nuclear Power Station at Shoreham. His role will be to manage the development of each Task (in concert with the Project Managers) through Microsoft Scheduler software, identifying due dates for particular elements of the tasks and maintaining awareness of ball-in-court status. Mr. Britt will also manage the subconsultants through payment-for-product. Strong control of purse strings, and independent, redundant oversight of the production of work product should help ensure that the many members of the CA/CE team stay on schedule.

Mr. Gregory Greene will serve as Principal-in-Charge for the combined CA/CE Team. Mr. Greene will use his extensive experience with large, complex projects for municipal clients to ensure that all aspects of the project are properly completed in accord with the contract between CA and the County. Mr. Greene will have the day-to-day

supervisory lead on the project; he will maintain intimate knowledge of all aspects of the diverse project through the project managers. He will also be responsible for subconsultant compliance with Mr. Britt's directives, and maintain fiscal control of the overall project.

The County can expect to become very familiar with several of the subconsultants. Drs. Goodbred, Crans, and Parson will require site-specific knowledge in order to complete their work; Drs. Crans and Parsons, in addition, expect to become intimately familiar with County mosquito management procedures (and, to some degree, personnel and equipment). Mr. Sinnreich and Dr. Balfour will have more public roles. Mr. Sinnreich will attend many public meetings and play a vital role in determining legal procedures to be followed in addressing SEQRA requirements. Dr. Balfour will be pivotal in the development of public outreach and presentation materials. Dr. Lwiza and Dr. Fagan and his staff at Bowne will have a good deal of contact with the County in order to access data sets for the GIS and remote sensing activities.

Drs. Spielman, Pollack, James-Pirri, and McElroy, and Mr. Skipka will work more with members of CA/CE and other subconsultants than with the County. Their work will be more involved in research and review processes. Dr. Brownawell will serve both as a project reviewer and as a laboratory director. He, Drs. McElroy and Goodbred, and Ms. Durda (CPF) have had public roles in the Scoping process, and may also be called upon to assist at any SEQRA hearings that may ensue from the project.

Many of these esteemed experts will play important roles in the Quality Assurance program devised by CA/CE for this project. Explicitly, Drs. Crans and Spielman have been asked to review mosquito program work of Dr. Parsons; Mr. Pascucci (former manager of the Nassau County Vector Control program) will also assist in this technical review. Drs. McElroy and Brownawell will supplement the CPF internal QA with regard to ecological impacts; Drs. Spielman, Pollack, and Teitelbaum will supplement the CPF human health internal QA (while CPF will review these individuals' work, as well). The legal judgements of Mr. Sinnreich will be reviewed by many of the members of the CA/CE team with EIS experience (including Messrs. Marletti, Cameron, and Mayer). Dr. Teitelbaum's work will be subject to review by CPF. Bowne Management Systems explicitly described the QA steps it envisions as part of the GIS development in the original project proposal. The CA/CE staff contains four members with advanced degrees in coastal oceanography, including coastal geologists, and so all aspects of marsh management, whether developed by Dr. James-Pirri and reviewed by Dr. Goodbred and his laboratory, or vice versa, will be adequately reviewed internally.

The risk assessment work by CPF will use data from many different sources in numerous mathematical equations. In fact, multiple-chemical, multiple-pathway risk assessments often include tens of thousands of individual calculations using dozens of input parameters. Therefore, CPF has in place a rigorous QA program for all risk work that will be utilized in this effort. The QA program is implemented throughout the risk assessment process. Initially, the principal scientist conducting the risk analysis will evaluate all input data for accuracy and relevance to the task at hand. This will be especially important in this effort since previous environmental impact assessments are expected to provide a large amount of the data to be used in the risk analysis. Therefore, the initial QA review of these data will ensure that only accurate data relevant to the Suffolk County Assessment are utilized. After the analyses are conducted, all fate and transport modeling, risk calculations, and any toxicological extrapolations are independently quality assured by trained scientists who did not perform the initial analysis. CPF maintains files of all the data and risk calculations, and documentation of the results of the QA review and any corrections made as a result of the review.

Sampling will be subject to a project-specific Sampling and Analysis Plan, with will include discussions of sampling and analysis QA/QC procedures and data usability goals. Action projects will be developed with explicit workplans that will undergo rigorous in-house review prior to County review.

All reports will also be subject to the usual internal review processes adopted by both CA and CE to ensure texts are readable, audience-appropriate, and produced in a format consistent with other project documents.

Task 2: Laws/Regulations/Management Programs

CA/CE will undertake a comprehensive evaluation of the laws, regulations, standards, and management plans that affect (or might affect) the County mosquito control and marsh management programs. CA/CE will be assisted in this task by its legal subconsultant, Sinnreich & Safar, LLP.

The task will be divided into two parts:

- Review and descriptions of laws and regulations that affect mosquito management directly; and,
- Review and descriptions of laws and regulations pertaining to wetlands management.

Particular laws that will be assessed include:

- Federal statutes including the Clean Water Act, the Federal Insecticide, Fungicide, and Rodenticide Act, Coastal Zone Management Act, the National Estuaries Program Act, and the Fishing and Wildlife Coordination Act (including rules and regulations specific to the National Seashores and Wildlife Refuges found in the County);
- State laws with associated regulations, including SEQRA, Coastal Zone Management Act, New York State Public Health Law Article 15, and regulation sets including NYCRR Parts 190, 325, 329, 661, and 663; and,
- Local laws, especially the set of County Laws passed in 2000 allowing residents to avoid ground-spraying in the vicinity of their homes, and, if a sufficient density of residents of a neighborhood opts out, to avoid aerial applications as well.

It is clear that an assessment of how the work products of this effort can meet the requirements of the National Environmental Protection Act (NEPA) also needs to be made, given the apparent changes to be implemented at the Fire Island National Seashore (FINS). This Task will therefore require research into the potential for GEIS findings to address NEPA strictures, and to determine what other additional work may be necessary for the County to obtain NEPA approvals.

To meet these Task requirements, Mr. Sinnreich will conduct a review of the large body of legal literature, including law review articles and other legal texts and journals, which should provide helpful input into the evaluation of pertinent requirements. Mr. Sinnreich's role is expected to be two-fold:

1) he will, as required by the RFP and detailed in CA/CE's original proposal, play a central role in developing the description of legal and regulatory controls on marsh and mosquito management. This will include a discussion of relevant case law, as well as explicit discussions of relevant State regulations and underlying State and federal legislation. The local laws controlling the dispensing of pesticides (due to property owners seeking exemptions) will also be extensively discussed. Mr. Sinnreich will assist CA/CE personnel in developing `descriptions of how the regulations and restrictions are actually implemented.

2) he will also play an important role in advising the County on procedural and regulatory matters relating to SEQRA. It is often the case that procedural due process issues drive litigation in SEQRA challenges. Therefore, Mr. Sinnreich's guidance will be key in determining the process that is followed in implementing the plan for Vector Control and its associated EIS analysis. This will enable the procedure associated with the generation of the document, as well as its technical substance, to withstand to the greatest practicable extent the anticipated legal challenges.

In furtherance of these goals, Mr. Sinnreich will also review and comment on the Task reports for Tasks 3 and 8. Furthermore, he will participate in the review of current County Vector Control operations (Task 4).

Appropriate enforcement personnel (such as USEPA regulators, NYSDEC Conservation Police and Region I legal staff, and the County District Attorney) will be contacted to review current enforcement efforts and concerns. The State Pesticide regulation effort, for example, is very proactive in its efforts to educate pesticide applicators on appropriate regulations and use restrictions. Environmental organizations which have either sued or are threatening to sue the County concerning the mosquito control program will be contacted to determine the legal basis for their claims.

Planning and management efforts that will be reviewed include:

- Federal initiatives such as the Long Island Sound Study (LISS) and Peconic Estuary Program (PEP);
- State programs such as the NYSDOS Coastal Zone Management Program, the Natural Heritage Program, Significant Habitat Program, and the South Shore Estuary Reserve program (SSER);
- Local efforts including the Local Waterfront Redevelopment Programs for communities such as Huntington and Sag Harbor, the No Discharge Zone designations for the Peconic Bay System and Huntington Harbor, and Harbor Management Plans developed for Port Jefferson, and the Oyster Bay/Cold Spring Harbor Complex; ,
- Private conservation efforts such as the Long Island Soundkeeper, the Peconic Baykeeper, and the Nature Conservancy's Last Great Places on Earth designation of the East End of Long Island; and,
- The Long Island Wetlands Initiative.

Programs that are similar in scope and intent to the above that have been implemented elsewhere that may be relevant to this effort include the New York Harbor Estuary Plan and the Chesapeake Bay Program.

All of the programs mentioned above contain extensive public outreach and/or education components. LISS, over the dozen or so years of its existence, has published thousands of pages on Long Island Sound and its tributary regions. It is likely, therefore, that the greatest challenge for this task will be to limit the extent of the report to only the most pertinent material, rather than to seek and then compile all the information on the subject. It is expected that copious amounts of material will be available, either in published form or on websites.

Thirty (30) copies of a draft report will be produced. It is estimated that this report will be available in December 2002.

Task 3: Literature Evaluation & Early Action Recommendations

A. Literature Review

In order to develop the best Long-Term Management Plan, it is essential to review the collective experience of vector control experts and researchers in related environmental and human health disciplines. CA/CE have included the following practicing experts as part of the Team:

- Dr. Parsons from Harris County (Texas) Mosquito Control;
- Dr. Goodbred, Dr. Brownawell, and Dr. McElroy from Marine Sciences Research Center;
- the Human Health and Ecological Risk Assessment firm of CPF from Maryland; and,
- epidemiological experts from the Harvard School of Public Health (Drs. Spielman and Pollack) and the Mt. Sinai Department of Community Medicine (Dr. Teitelbaum).
- Dr. Crans from Rutgers University
- Dr. James-Pirri from the University of Rhode Island

These experts, along with the professionals from CA/CE, will perform detailed searches of the scientific, medical, and public health literature. Major databases such as MedLine and ToxLine as well as scientific databases available through the SUNY Stony Brook library will be used to find the most recent publications relevant to this project. MedLine includes major medical publications such as JAMA, NEJM, CDC publications, Environmental Health Perspectives, Environmental Research, American Journal of Epidemiology, and the Journal of Occupational and Environmental Health. ToxLine covers toxicology literature including various national and international guidance documents and conference proceedings. Federal government documents accessible through the National Technical Information Service will be searched, including those of the U.S. Environmental Protection Agency (USEPA) and the Centers for Disease Control (CDC). Current information on vector biology and management strategies will be gleaned from scientific articles published in journals such as the: Journal of Medical Entomology, Medical and Veterinary Entomology, Journal of the American Mosquito Control Association, Journal of Vector Ecology, Journal of the American Society of Tropical Medicine and Hygiene.

The Team will evaluate peer-reviewed and gray literature and other materials including theses, agency and non-governmental organization reports, and information available from identifiable agencies and organizations over the Internet. Detailed interviews will be conducted with Suffolk County Vector Control, as well as with their counterparts in Nassau County, New York City, and Westchester. Dr. Parsons will also gather information from vector control agencies in the southeastern United States (especially Florida and Texas), and will be assisted by Dr. Crans in the assessment of more local efforts. Environmental, health, and resource management agencies would also be contacted. The Team will also develop specific information regarding mosquito surveillance from publications released by CDC[1], the New York Academy of Science, and from the experience of the mosquito professionals contacted.

Larval and Adult Mosquito Population Surveillance

Suffolk County is home to approximately 42 species of mosquitoes. Of those, approximately 20 species have the ability to impact the quality of life and/or the health of County residents. CA/CE will provide information about these species. Each description would incorporate a discussion of life cycles, including larval and adult habitats, human

[1] *Epidemic/Epizootic West Nile Virus in the United States: Revised Guidelines for Surveillance, Prevention, and Control.* From a 1/31-2/4/2001 Workshop. Centers for Disease Control and Prevention, Division of Vector-Borne Infectious Diseases, Ft. Collins, Colorado. April 2001

biting tendencies, potential for disease transmission, and susceptibilities to control techniques. The Team would also investigate the spatial and seasonal distribution of those species where such information is available from County records. Long-term trends in population abundance will be documented from County records. Target species would include *Culiseta melanura*, associated with the transmission of Eastern Equine Encephalitis (EEE), *Culex spp*. (especially *Culex pipiens)*, associated with West Nile virus (WNV), and the bridge vector and quality of life impairment species *Ochlerotatus (Aedes) sollicitans* (salt marsh mosquito).

CA/CE will report on the techniques used by others for measuring larval and adult mosquito abundance, their experience with data collection, data entry and management, and correlations they may have made between various control techniques, mosquito populations, and disease prevalence. The Team recognizes the critical importance of accurate vector population surveillance techniques for targeted control that can reduce the quantity of pesticide applications. Accurate before and after surveys are also essential in determining the efficacy of various control techniques.

The diversity and abundance of mosquitoes in a site is correlated to the type of wetland environment, the salinity, and quality of water contained there, the extent and frequency of flooding, and the diversity and density of certain wetland flora. If the correlation is used as a predictive tool, more efficient targeting of mosquito surveys may be possible by first mapping the plant species (see Early Action Recommendations).

Arbovirus surveillance in mosquitoes is essential toward assessing the threat of human disease transmission. Monitoring the population dynamics and prevalence of infection of the enzootic vectors of EEE and WNV will provide the basis to target early interventions that are least environmentally burdensome. Although Suffolk County has sent samples of trapped mosquitoes to the NY State Laboratory in Albany to be assayed for arbovirus, it intends to assay such samples within the County. The Team will review the strategies and techniques used by the County to trap and process mosquitoes, with particular attention to the selection of traps and sites, the frequency of trapping, and the manner and expediency of sample processing and testing. Techniques, equipment, and sampling methods used by other regional vector control agencies and those reported in the literature will be investigated.

The County has monitored bird deaths, particularly corvids (crows and jays), as a means of detecting the temporal and spatial dynamics of WNV transmission. The program, although fairly standard, is of limited effectiveness for early detection. Since these birds are mobile, the site of their death may be far from the site where they acquired infection. Alternatively, to monitor local transmission of arboviruses, it has been proposed to array flocks of sentinel animals (mainly chickens). These birds are penned in a manner that permits free access to feeding vectors, and blood samples are drawn and sera tested weekly to detect anti-arboviral antibodies. Suffolk County's experience with this technique has not been favorable, to date. CDC and certain vector control projects may also deploy nets and traps to sample wild birds locally, and test sera from these birds for exposure to viruses. CA/CE will review the County's current program, those of other vector control (VC) agencies, and the recommendations of the CDC.

Regional Vector Control Practices

Regional (NY, NJ, CT, RI, MA) VC, Resource Management, and Health Department agencies will be contacted to obtain copies of their vector control management plans and to consult with their specialists. Selected agencies from other communities across the country would also be queried, and the expertise of the Team itself from New Jersey, Florida and Texas will be used. They would be selected based on the recommendations of Dr, Crans and County Vector Control experts, and through Drs. Crans and Parson's extensive network of professional contacts. Published

and unpublished information would be sought and interviews conducted on vector control techniques including source reduction, biocontrols, traps, larvicides, and adulticides. Interview questions would be formulated in advance of contacting the agencies based on the key issues identified during the Scoping and subsequent formulation of the Management Plan Workplan. Some of the important issues are:

- preferences for chemical, biological, and marsh management techniques
- techniques that are not recommended
- suggestions for experimental/cutting edge control measures
- means by which the success of a control program has been measured (especially with regard to disease transmission
- response strategies to the outbreak of disease (West Nile virus).

Vector control agencies across the region and nation, because of local regulations and preferences and target species, may differ in their choice of formulations of insecticides, and the means and rates of their application to control nuisance and vector mosquitoes. The Team will search for studies that examined adulticide and larvicide application rates with reductions in adult vector populations. Particular issues of import include:

- the relationship between application rates and adult mosquito population densities
- application rate choices with regard to overall goals, product labeling, and regulations
- application rate reduction experiences, with regard to acceptable levels of efficacy at reduced cost and potential environmental impacts
- the relationship between pesticides and the development of resistance in the mosquito population
- data on long-term impacts on mosquito populations resulting from vector control programs

Other issues to be investigated will be the basis for USEPA (and NYSDEC) label restrictions, particularly with regard to setbacks from waterways and wetlands. Comments were received that suggested the basis for distances may not be well-founded (or, at least, suitable for Suffolk County conditions). A related issue is the adequacy of the current no-spray zone specified in Suffolk County law for those individuals that opt out of the County program. Finally the Team (working with Dr. Spielman) will investigate the feasibility of natural predation as a mosquito control strategy. (including augmenting predator populations through stocking, nest/box construction, and even feed programs).

Disease Control

Drs. Spielman and Pollack of the Harvard School of Public Health will discuss the means by which Suffolk County and other well-established US and overseas vector control programs attempt to control the spread of mosquito-borne diseases. They will also assist the CA/CE team in further research into more Suffolk County-oriented mosquito control assessments. Drs. Parsons and Crans will also be helpful in this assessment, as most of these publications are likely to be classified as gray literature.

In particular, Drs. Spielman and Pollack, along with Drs. Crans and Parsons, will review County programs (as described in the 2001 and 2002 EAFs and workplans, included in the RFP, and the workproduct from Task 4 as it is available) relevant to arbovirus surveillance and intervention efforts, and compare these to similar programs in neighboring counties and States. Attention will be focused on the design of the sampling strategy (type and distribution of traps, frequency of use), the timeliness and methods of processing the samples (identifying and counting mosquitoes, testing for virus), and the correlation of such results to historical and prevailing meteorological

and hydrological conditions at each site. The efficacy of adulticidal and larvicidal applications will be gauged by comparing pre- and post-intervention sampling records.

Human Health Risk Assessment

Risks to human health will be categorized as those due to exposure to infected vectors and those posed by exposure to insecticides used specifically by Suffolk County Vector Control.

Current research into the human health aspects of mosquito-borne viruses will be investigated by Drs. Pollack and Spielman. They will review current literature that addresses the prevalence and spread of mosquito-borne pathogens, and document infection rates to develop a human health risk associated with common mosquito-borne diseases (including those not yet found on Long Island, such as malaria and yellow fever). Drs. Pollack and Spielman will discuss vector abundance and distribution as it relates to the prevalence of infection in vectors and sentinel hosts. The assessment will include examining the proximity of towns and other population centers to foci of intense WNV and EEE transmission and the distribution of sampling sites and intervention activities relative to such locations. The scheduling of surveillance and interventions by Suffolk County will be considered and compared to the strategies employed in neighboring regions. Important issues to be addressed include:

- the effectiveness of monitoring in detecting early transmission events, and therefore to allow timely and environmentally-sound interventions
- identification of environmental and epidemiological triggers that should stimulate enhanced sampling and/or interventions
- the appropriateness of the current County response to outbreaks of transmission and disease

This would provide a basis for comparison for human health risk assessments for the control of mosquitoes.

The potential toxic effects of adulticides and larvicides in humans will be investigated, primarily by CPF with assistance from the Harvard team. The goal will be to assess risk posed by insecticidal applications, with regard to the choice of formulations applied, and the methods and rates of their application. This assessment would include examining the rationale and strategies for such applications, the protocols (and adherence to such protocols) for notifying the public of applications, and the monitoring and record-keeping of each application. The literature review also will investigate the toxicity of the pesticides and larvicides of interest in pregnant or nursing women and children to determine if these subgroups have a demonstrated increased sensitivity to these compounds compared to the general population. Additionally, the literature review will be used to determine if there have been reports of miscarriages associated with exposure to these compounds. The literature review will also discuss current accepted risk assessment protocols addressing issues associated with potential synergism among contaminants of concern.

The prime basis for the investigation will be toxicological information obtained through literature review and from interviews with the New York State Department of Health (NYSDOH) and other agencies. The toxicological literature included in this review will be derived largely from previous EISs conducted by New York City and Westchester County. This information will be supplemented by studies and reports that have been published since the EISs were conducted. A literature search will be conducted to identify recent relevant data from the peer-reviewed literature, government reports, dissertations, and other available sources. In addition, a literature search will be conducted to identify information on the potential human and ecological toxicity of pesticide and larvicide degradation and environmental transformation products. This information was not included in the previous EISs. The literature search will be conducted primarily using toxicological databases available through the National Library of Medicine (Medline and Toxline, as discussed previously), although other databases will be consulted as needed. The literature search will compile data for up to seven adulticides/larvicides and up to five of the most persistent and/or toxic metabolites.

The adulticides and larvicides to be the focus of the study will be selected after discussions with the County, the project Technical Advisory Committee (TAC), or others.

Representatives from NYSDOH and other agencies also will be interviewed to obtain information on documented health effects from pesticide exposure in the state. Information from the NYSDOH pesticide-poisoning registry and the on-going surveillance program of possible health effects from pesticide exposure will be particularly relevant in this regard.

This work by CPF will be supplemented by an evaluation of the potential impacts of the Suffolk County suite of pesticides on breast cancer incidence in Suffolk County. Dr. Teitelbaum (Mt. Sinai Department of Community Medicine) will review the literature for each compound (and any pertinent analogs) with regard to any role it may have in the formation or promotion of breast cancer. Dr. Teitelbaum will also provide a state-of-the art discussion of the incidence of breast cancer in Suffolk County, outlining any geographical areas that may be deserving of closer scrutiny for potential contributory impacts from mosquito control.

Furthermore, Dr. Teitelbaum will incorporate on-going research on chemical impacts on children's health, including cancer incidence and other deadly diseases, and chronic illnesses such as asthma and attention deficit disorder. Much of this research is being conducted by her peers at Mt. Sinai (although Dr. Teitelbaum's work will reference research conducted by others as well).

Ecological Toxicity

Terrestrial wildlife that is potentially impacted by adulticides includes some mammals, birds, insects, and sensitive plants. Aquatic receptors include fish, crustaceans, aquatic insect larvae, mollusks, algae, and amphibians. These organisms can be exposed directly to adulticide spraying, or from application drift transported to ponds, streams, and wetlands through the air or from runoff. Secondary exposure can also occur through terrestrial and aquatic food chains.

The toxicological literature included in this review will be derived largely from previous EISs conducted by New York City and Westchester County. This information will be supplemented by studies and reports that have been published since the EISs were conducted. Toxicity data for pets (e.g., cats, dogs) will be gathered, if available. As described above, a literature search will be conducted to identify recent relevant data from the peer-reviewed literature, government reports, dissertations, and other available sources. In addition, a literature search will be conducted to identify information on documented environmental and ecological impacts of degradation and environmental transformation products of the parent compounds. The Team will also investigate whether modern mosquito pesticides and their degradation products/metabolites bioaccumulate. The literature search will be conducted primarily using toxicological databases available through the National Library of Medicine (Medline, Toxline), although other databases will be consulted as needed. The literature search will address the same adulticides, larvicides, and degradation products considered above for the human health assessment. The search will be used to identify dose-response and hazard data in a variety of wildlife species, including non-target insects. In addition, a search will be conducted for literature on direct toxic effects of these compounds in insectivorous birds, along with a search for ecological literature examining changes in insectivorous bird population characteristics (e.g., abundance) due to changes in prey abundance or prey density following spraying. The literature search will also identify studies of the effects of these compounds in domestic household pets, primarily dogs and cats.

This will be supplemented by additional regional and county-specific impact data obtained through interviews of government agency personnel. Agencies to be contacted include the NYSDEC, the US Fish and Wildlife Service (USFWS) and FINS. These agencies have experience in assessing the hazards associated with pesticide use in natural systems. NYSDEC, for example, has prepared reports on the ecological hazards of adulticides and larvicides used for mosquito and black fly control. The USFWS has experience in applying pesticides in national wildlife refuges. FINS conducts its own extensive mosquito surveillance program, and oversight of County operations within the Seashore.

In addition to the research directed by CPF, Drs. McElroy and Brownawell (Marine Science Research Center, SUNY at Stony Brook) will provide a review of available data on the toxicity, persistence, and fate of pesticides in the coastal marine environment suitable for use in evaluating impacts of management options for mosquito control on non-target organisms. The treatments considered will include the application of specific larvicides and adulticides used by the County. Sub-lethal impacts will also be considered.

One focus will be on potential impacts to commercially-important species such as lobsters and crabs. Because of similarities in biochemical and physiological traits of this phylum (Crustacea), it has been widely hypothesized that compounds that affect mosquitoes can also impact crabs and lobsters. Drs. McElroy and Brownawell will discuss available research findings for the specific compounds and the effects they have on these marine organisms.

As part of this component of the Project, the CA/CE team will specifically discuss recent lobster and crab mortalities in the marine waters of Long Island. Drs. McElroy and Brownawell are conducting research on levels of malathion, resmethrin, and methoprene in coastal waters, and on the toxicity of these compounds to larval and juvenile lobsters. Others, such as Sylvain De Guise, Richard French, and Christopher Perkins, who are exposing lobsters to malathion, resmethrin, and methoprene, will be contacted regarding their most recent findings. Other very recent work (such as that of Michael Horst, who is studying whether methoprene could kill lobsters and cause biochemical changes in juvenile and adult lobsters) will also be assessed. Contact will also be made with the Marine Ecotoxicology Department of the National Oceanographic and Atmospheric Agency (NOAA) Center for Coastal Environmental Health and Biomolecular Research (CCEHBR). Researchers at the CCEHBR are investigating linkages between land use and the presence of chemical contaminants in the marine environment. They have assessed the relative risk to sensitive estuarine invertebrates of selected mosquito control adulticides and larvicides including those used by the County[2].

Pesticide Monitoring Protocols

The Team will build on the work in this area from the New York City and Westchester County EISs, by discussing specific information on monitoring protocols associated with pesticide use with the mosquito program experts identified above. The US Geological Survey (USGS) will be contacted regarding its developing monitoring program and innovations in sampling techniques. In general, sampling techniques would be analyzed regarding pesticide drift and deposition rates, and how they could affect concentrations measured in the water column- and sediments. Particular efforts will be made to uncover existing or proposed monitoring programs focussed on biota. Information gathered in this section would be used to formulate specific monitoring protocols for the long-term monitoring program developed in Task 6.

[2] *Selected Mosquito Control Pesticides*. Center for Coastal Environmental Health and Biomolecular Research. www.chbr.noaa.gov/public/CMPestRRA.html

An important advance in monitoring has been the use of biomarkers to determine exposures to (among other things) chemicals. The literature review, guided by Dr. McElroy, will include a discussion of this developing field, and its applicability to issues of importance to this project.

The search will also critically review the models and modeling assumptions used in the New York City and Westchester County EISs with respect to the dispersions of pesticides. Effort will also be made to research dry-deposition experiments to determine if these kinds of experiments can reliably produce usable quantifiable data.

Water Management

As many as 90% of salt marshes in the northeast U.S. were ditched in the 1920's and 1930's as part of an early water management plan for mosquito control, including those of Suffolk County. Many of these original ditches have since infilled or otherwise become ineffectual for drainage, in part prompting the development of modern management techniques around the country. Under the Clean Water Act (1972) and the increased awareness of marsh functions in the environment, newly developed management plans have sought to balance both mosquito control and the restoration/preservation of one or more marsh features, such as fish or bird habitat, plant communities, or estuarine water quality. A popular, but varied, management style since the 1980's has been Open Marsh Water Management (OMWM), which seeks to maintain mosquito control by creating habitat for natural mosquito-predatory fishes such as the banded killifish (*Fundulus diaphanus*) and mummichog (*F. heteroclitus*). OMWM is based largely on the premise that ditching has resulted in the loss of marsh-surface habitat for natural mosquito-larvae predators, and the restoration of marshes to a pre-ditch state can provide "natural" mosquito control.

However, as recognized in other areas of the US, there is generally no one-size-fits-all management strategy for coastal wetlands, whether for vector control, restoration, or preservation. Thus, the general OMWM plan has been adapted for many different coastal settings with variable success. Regionally, modified OMWM techniques have been applied to wetlands in Delaware, New Jersey, Connecticut and Massachusetts, and in some cases provide a longer-term view (longer than10 years) of outcomes and impacts from these modifications. To assess the effectiveness of OMWM projects in these areas, CA/CE in conjunction with Dr. Goodbred (Marine Sciences Research Center, SUNY at Stony Brook) will characterize the physical setting of marshes at these project sites and identify the specific goals, techniques, and outcomes of the projects.

Specifically, knowing the goals of these different OMWM applications will be important because wetlands are known to play multiple roles in the environment, and certain management strategies may enhance or limit these roles. The Team will further link the physical setting of the marshes to the techniques used and the success of the project, thus allowing us to assess suitability of the various approaches for use in Suffolk County. This latter point will be key goal of the literature review, determining if various management strategies are appropriate in the different coastal settings of Suffolk County.

Another major goal of the literature review will be to assess the broader impacts of various OMWM and related techniques. Because marshes are naturally ephemeral environments that survive at the changing interface of land and water, their lifespan is largely governed by the rate of change at this interface. And, in general, human modifications of the environmental serve to accelerate change. The Team will gather from the literature how marshes of various physical state and setting respond to OMWM modifications that may enhance or mitigate other stresses to the system. For instance, OMWM may not be appropriate for subsiding marshes or those in low tidal range settings. A further complication that will be considered during the literature review is the longer-term (more than a decade)

impacts of various marsh management approaches. Because salt marshes have both important floral, sedimentological, and hydrological controls, the effect from changes in one may be masked by the other for many years. Particularly, plants may persist under stressed conditions for some time before declining rapidly beyond a tolerance threshold (examples of such systems are Jamaica Bay and the lower Mississippi delta). Foresight of possible long-term impacts will be important in developing successful OMWM or other strategies.

In order to assess the impact of various water management regimes, it will be important to define several key concepts. These include the notion of "marsh health." Closely related to that is the determination of 'marsh ecological functions." It will be a major responsibility of Dr. Goodbred to present consensus definitions of these terms to the County (and the TAC) in order that the assessment of the water management techniques be properly conducted.

The Team, with its local expertise, will conduct the marsh water management literature review with consideration for the diversity of coastal habitats in the County. These include the glaciated embayments of the North Shore, the sheltered bays of the Peconic estuary, and the barrier lagoons of the South Shore outwash plain, as well as locally pristine, suburban, and urban settings. The bulk of literature relevant to the Suffolk marshes will be from nearby states, largely through government reports related to the Clean Water Act. There is comparatively little peer-reviewed literature on the subject, although several important papers exist (e.g., Meredith, W.H. *et al*., 1985, Guidelines for Open Marsh Water Management in Delaware's Salt Marshes: Objectives, System Designs, and Installation Procedures, published in Wetlands, **5**:119-134).

In 1985, the Connecticut Department of Environmental Protection adopted a policy of using OMWM practices in place of traditional ditch maintenance. Most projects remain only planned or early in their implementation, but the Connecticut efforts will be investigated through Dr. Goodbred's extensive professional contacts on these projects. Beyond regional efforts, various alternative practices for marsh water management will be investigated for potential use in Suffolk County (e.g., Hulsman, K. *et al*., 1989, The runnelling method of habitat modification: An environment-focused tool for salt marsh mosquito management. J. Amer. Mosquito Control Assoc., **5**:226-234).

The result of this extensive review should be an evaluation of OMWM, both as practiced here through the Wetlands Initiative, and as attempted elsewhere in the country. This will provide the necessary basis for the generation of the revised OMWM manual, sought in Task 10, and to generate alternative means of mosquito management.

The investigations into water management will also include an analysis of stormwater control structures and their potential for being mosquito breeding sites. It seems clear that in other areas of the country such structures represent significant breeding sites for mosquito species of concern. Speculations on the source of West Nile virus outbreaks in areas of Suffolk County that do not have many natural sources of standing water suggest that these kinds of structures may serve as locally-important breeding sites, too. Current preferred USEPA regulatory strategies focus on using stormwater structures to improve surface water (and, to some degree, groundwater) quality by removing solids and coliform bacteria through water detention and retention. These practices increase the amount and duration of standing water in the stormwater features, and thus improve their potential mosquito habitat value. The research questions that will be addressed include determining the potential of such structures as mosquito habitat, and searching for alternative technologies that may minimize vector production. Dr. Parsons has expertise on these issues, and will be relied upon to provide research direction (see just below).

Alternatives

The Team will utilize Dr. Parson's experience and network of professional connections to review the state-of-mosquito-management throughout the country. One particular area where some interesting approaches are appearing is Florida. There, innovative water management practices have been adopted that try to address the considerable environmental impacts associated with stormwater management while minimizing mosquito propagation. Furthermore, several private companies based in Florida have developed prototypes of physical trap systems that may be able to intercept mosquitoes moving from marshes to populated areas. In addition, compounds such as garlic oils and other materials derived from natural substances will be reviewed for evidence of their effectiveness. Finally, the potential to control mosquito populations through natural predation, in the context of the effectiveness of other methods of control, will be carefully reviewed.

CA/CE has assumed that several of these techniques may prove to be potentially effective; these are described below as Early Action Recommendations.

This literature search will be completed early in 2003; the thoroughness of the effort proposed here seems to require a little more time than proposed by the County in its schedule. CA/CE proposes that the draft report will be available (30 copies) by February, with the final (also 30 copies) produced within a month after that (assuming a quick review process).

B. Early Action Recommendations

Based on the results of the literature review of Task 3, the CA/CE team would formulate its recommendations for several early action projects. Each of the projects anticipated at this time would involve extensive field measurements, sample collection, and analyses. Several potential projects are described below:

- Determine the relationship between vegetation type and mosquito propagation. Researchers have suggested that mosquitoes prefer to breed in specific types of vegetation. If that were the case, routine mosquito surveillance and control programs could be conducted more effectively and at a lower cost by concentrating VC efforts on those areas where the identified vegetation is more prevalent. The Early Action Project would be to identify the marsh plants associated with high concentrations of adult mosquitoes. The CA/CE team would field identify and map the plants associated with specific areas identified by the County as currently supporting high concentrations of adult mosquitoes.

- Determine the relationship between OMWM, ditching, and mosquito propagation. If this effort were pursued, the CA/CE team would utilize County measurements of mosquito populations in areas with no ditches, unmodified ditches, and ditches modified in various manners as well as areas which have been subjected to other OMWM techniques. Within each area, the CA/CE team would select transects, quadrats, and permanent fixed point photo stations for detailed field measurements, evaluations, and possible future long-term monitoring. Techniques and data requirements for salt marsh monitoring will be drawn in part from the "New York State Salt Marsh Restoration and Monitoring Guidelines," published in December 2000 by NYSDEC.

- Test the efficacy of various mosquito traps. Various commercial devices have been advertised for their ability to trap mosquitoes. The CA/CE team would prepare and implement methods for testing these devices in the field under various weather conditions. The most effective traps could be used as part of other Early Action Projects.

- Examine mosquito migration paths. It has been suggested that mosquitoes follow defined migration paths from marshes to populated areas. This project would utilize a series of mosquito traps in concentric rings around marshes with high concentrations of mosquitoes to determine if migration paths exist and if so how they can be predicted. If migration paths can be documented, then mosquito traps may be used to intersect them. Marsh and weather conditions would be documented as part of the project along with counts by species of the mosquitoes captured by the devices. If migration paths are confirmed and effective traps are available, then a series of traps would be field tested as a means of intercepting the mosquitoes.

- Determine the potential impact of OMWM techniques on insectivorous fish species. Some OMWM techniques have been heralded for their ability to increase the available habitat for fish species known to consume mosquito larvae (*eg.,* mummichogs). A field test of the impact of the OMWM techniques on fish and mosquito larvae populations could be conducted. Field sites could be delineated and counts conducted under various tidal conditions.

- Examine the relationship between marsh health and OMWM. By using the standard quadrat sampling technique (as documented by the long-term investigation of potential Southwest Sewer District impacts on marshes, PINS) in a variety of settings under different tidal regimes, the CA/CE team would attempt to determine if OMWM has had any short-term impacts on marsh health in areas where it has been implemented. Standard techniques to ensure data usability (such as paired control sites, adequate sample replication, and random selection of sample locations) will be implemented under the direction of Dr. Goodbred and his laboratory. This aspect of the project will also incorporate results being generated by the USFWS in its field work, which is being led by Dr. James-Pirri.

- The CA/CE Team, with Dr. Goodbred's laboratory, will develop a new OMWM site. This site will address some of the weaknesses in the current USFWS program, and also will expand OMWM to extend the potential benefits of the technique.

  For one, this project will adequately measure pre-OMWM conditions to properly implement the BACI experimental format espoused by the USFWS. Unfortunately, none of the three Long Island sites selected by USFWS had pre-OMWM data collected. CA/CE proposes an abbreviated Fall–early Winter monitoring program, primarily implemented by the County, in order to establish some kind of baseline data set prior to the proposed manipulation of the marsh.

  Secondly, the CA/CE Team suggests that a site with *phragmites* infestation be considered as the project locale. It is possible that the standing water and potentially higher pore-water salinities associated with OMWM could impact *phragmites*. If part of the *phragmites* could be eradicated to create a panne-environment, the edge-type ecosystem (with *phragmites* serving as cover and habitat, and the panne creating forage areas) could create a more dynamic wetlands ecology, especially as compared to a monospecific *phragmites* marsh (CA/CE assumes that the County recognizes the difficulty in replacing *phragmites* with *Spartina spp*., and so assumes that the wetlands plant will remain *phragmites*, at least over the short-term). This approach may have dual benefits by improving habitat in *phragmites* marshes and also reducing what is presumed to be significant mosquito propagation in the dense cover found in reed stands. CA/CE believes that this kind of new concept for OMWM may loosen regulatory strictures that face any project of this kind.

Finally, CA/CE believes that the project might best be sited on the Carmans River near to where the USFWS research is being undertaken. This will strengthen the research by:

- Taking advantage of earlier Goodbred and USFWS characterization studies in this marsh system;
- Allowing for more direct comparisons of USFWS OMWM projects and the County variation;
- Creating the possibility that the differing assessment means can be used cooperatively to benefit both projects.

It also allows the considerable *phragmites* problem in the Carmans River system to be addressed. Finally, using a Federal site (assuming USFWS compliance and cooperation) may defuse State permit issues to some degree.

Dr. Goodbred and the CA/CE Team are hopeful they could informally assist the County in choosing the experimental sites for such a project, and discuss the kinds of monitoring that would be most appropriate to conduct prior to beginning OMWM at the Impact site.

- Map and then examine at least one pilot area to determine if stormwater structures serve as important breeding sites for mosquitoes. This project would utilize various treatment techniques available for stormwater structures to control mosquito populations.

- Design, in conjunction with current County efforts, a series of dry-deposition experiments for vector control chemicals which can be used to field-verify the modeled deposition rates to be conducted as part of Task 8. This project would be based on the literature search to determine the general reliablity and credibility of dry deposition experiments.

- Conduct a caged fish experiment, modified from the NYSDEC design presented during Scoping, to determine the acute toxicity of ambient applications of aerial mosquitocides. Dr. McElroy has already prepared (and submitted) a detailed outline of such a series of tests.

- Test, using the state-of the art County instrumentation, for the possibility that groundwater represents a significant pathway for the introduction of Vector Control pesticides to the estuaries. Suffolk County has developed and field tested a meter that can measure and collect groundwater seepage into salt water bodies. This device could be used to collect concurrent samples for analysis in conjunction with dry deposition, ambient surface water, and, potentially, biotic sampling as part of a mass-balance experiment regarding fate-and-transport of the chemicals of interest. Data from such samples would also be useful in the determination of background impacts from non-Vector Control pesticides.

- Potentially, a biomarker assay may be useful in determining the exposure of organisms to Vector Control chemicals. The results of the literature search will determine if such a project can be conducted in a timely and cost-effective manner to assist the development of a management plan.

Each of the proposed Early Action projects will be presented to the County and the TAC for review and comment. It is likely that other topics suitable or experimentation will be uncovered through the course of Task 3, as well.

Task 4: Suffolk County Vector Control's Existing Operations

Under this Task, the Team would develop a comprehensive overview and detailed description of operations of Suffolk County Vector Control. Information supplied by the County would be utilized including annual reports and historical files. The resultant report will be a compendium of historical and current mosquito control practices.

The report would describe the impetus for the development of the Vector Control program in the early 1930's as a response to the hundreds of cases of malaria that occurred each year on Long Island. The development and evolution of mosquito control techniques would be detailed, and their relationship to disease-causing and nuisance mosquitoes that affect the quality of life for Suffolk County residents. The report would include the discovery of endemic viruses causing EEE and WNV. The report will discuss the construction of mosquito control ditches, and the waxing and waning of maintenance programs for these structures. Changes in pesticide use will be documented, from DDT to the current mixture of modern larvicides and adulticides. The growing use of surveillance throughout the County, both to detect disease-bearing mosquitoes and to better target control efforts, will be discussed. Public outreach efforts will be reported. Finally, the report will include a section on changes in the regulatory and legal environments associated with the County program, including actions such as the County No-spray Law, the banning of DDT, and the increasing concern over chemical inputs to shoreline ecosystems.

Suffolk County is the home of approximately 42 species of mosquitoes. Of those, approximately 20 species have the ability to impact the quality of life and/or the health of County residents. The Team will provide information about the mosquito species targeted by the Vector Control. Each description would incorporate a discussion of the species' life cycle including larval and adult habitats, human biting tendencies, its potential for disease transmission, and its susceptibility to control techniques. The Team would also investigate the spatial and seasonal distribution of those species where such information is available from County records. Long-term trends in population abundance would be documented from County records. Target species would include *Culiseta melanura*, associated with the transmission of EEE, *Culex spp.* (especially *C. pipiens*), associated with WNV, and bridge vector species such as the salt marsh mosquito *Ochlerotatus (Aedes) sollicitans*.

Comprehensive surveillance programs that target pest and vector species and justify the need for control are a necessity in IMM. Thorough surveillance can reduce the use of pesticides, reducing potential risks to humans and non-target species. The County currently analyzes approximately 12,000 larval and adult mosquito surveys each year. The use of New Jersey light traps and CDC live traps will be presented along with a comparison to trapping techniques used elsewhere. The possible role of certain wetland vegetation as a tool for identifying likely breeding areas will be discussed. The County's ability to monitor for the presence of the exotic Asian tiger mosquito, *Aedes albopictus,* would be evaluated in light of the fact that this species colonizes areas outside the usual surveillance program of the County (tree holes and containers).

The report will include a discussion of the County's strategies for responding to outbreaks of WNV, as developed in accordance with Federal and State Response Plans.

Current public notification procedures as they relate to the timing of notifications for pesticide applications, and the adequacy of warnings given with respect to potential health risks will also be evaluated. It has been suggested that early notification might be possible. Also, some jurisdictions seem to believe that greater precautions are in order when Vector Control pesticides are applied, as compared to the warnings issues by SCDHS.

The County's criteria for selection of suitable locations for CDC light traps and gravid traps for viral surveillance would be documented along with the dead bird surveillance program and use of sentinel species.

Current County water management practices will be discussed. Accounting for approximately 70% of the Division's total operation, water management involves maintaining the existing system of ditches, culverts, and other drainage structures that drain surface water or allow access to breeding sites by predatory fish. The Team will report on the County's methods for assigning management priority to different wetlands. Vector Control's ditching operations will be discussed along with its justification.

The County program includes a stocking program for biological control of mosquitoes, which will be documented. The County's participation in OMWM efforts will also be reported. Dr. Goodbred is currently assessing the responses of Long Island salt marshes to environmental forcings such as sea-level rise, land use, coastal alterations, and physical setting (over the past one hundred years). By first understanding these governing factors on marsh behavior, the Team will be better able to assess possible influences from previous and ongoing management techniques.

Approximately 25% of Vector Control operations involve larviciding, which are usually assessed as the most efficient and effective method of managing mosquitoes. The Team will document the County's use of chemical agents such as Altosid (methoprene), and biological (bacteriological) agents such as *Bacillus thuringiensis* var. *israelensis* (Bti) and the newer *Bacillus sphaericus* (the active ingredient of Vectolex). Specific habitat targets and application regimens will be reported.

Adulticiding accounts for approximately 5% of the Vector Control operations, and is conducted only when it has been established through complaints and Division surveillance that a substantial infestation exists or there is a threat of mosquito-borne disease. The Team will describe the County's use of adult control chemicals including Resmethrin (Scourge), Sumithrin (Anvil) and Malathion (Fyfanon) and their application rates and techniques (hand or truck mounted sprayers, aerial spraying).

It will be important to describe current methods used to ensure that applications occur in the targeted areas, and that required buffers are adhered to. In addition, Vector Control training and continuing education efforts will be described and compared to the practices of other jurisdictions.

CA/CE notes that one of Vector Control's long-term goals is to "combine surveillance, larval control, and targeted use of adulticides to focus control on high-risk areas…to limit pesticide use while still protecting the public." As evidence of its success in targeting their applications, the County reports a 74% reduction in adulticide applications from 68,496 acres in 2000 to 18,400 acres in 2001. Vector Control may be eligible to become a 'Partner' in the USEPA Pesticide Environmental Stewardship Program, which includes 110 members (as of May 2002) to develop environmental stewardship strategies and implement specific pest management practices designed for pesticide use/risk reduction.[3] CA/CE could assist the County in the preparation of an application for membership, as such documentation flowed out of other activities associated with the project.

The report will include a discussion of selected regional surveillance and control techniques and compare them to the techniques used by Vector Control. The local programs that will be assessed will be New York City, Nassau,

[3] *USEPA Pesticide Environmental Stewardship Program*. http://es.epa.gov/partners/pest/pest.html; June 2002

Westchester, and Onondaga Counties, Monmouth, Middlesex, and Ocean Counties in New Jersey, and Connecticut. In order for this review to be effective, Drs. Crans and Parsons will become intimately familiar with County practices. In addition, some regional innovations from Florida and Texas will be reported on by Dr. Parsons.

Bowne Management Systems will load Suffolk County Vector Control's existing GIS and operations data. This data will be loaded according to the GIS Database Design approved by Suffolk County during Task 1.
Bowne will load the existing Suffolk County Vector Control point coverages. These are:

- Major Mosquito Breeding Sites
- Areas Subject to Adulticiding (1999-2002)
- Surveillance Sites

Following the loading of this data a quality control review will be performed.

Bowne will also load the existing Suffolk County Vector Control digital operations data. These are:

- Pesticide Application Records (1997-2002)
- Adult Mosquito Population Data (1977-2002)
- No Spray Address List

The following assumptions have been made regarding these data:

- These records can be related to GIS point coverages by site id, site name or other unique key field.
- There are approximately 400 to 500 No Spray Address records that can be georeferenced by a Property Section, Block and Lot (SBL) Identifier.

Following the loading of this data a quality control review will be performed.

Bowne will perform data entry for the mosquito breeding records. Data entry of mosquito breeding records will consist of approximately 16,000 records, with 17 fields each, to Access or Excel format. Following data entry, a quality control review will be preformed.

However, it is assumed that if the 1940s-present Annual Report data, pesticide use records and application records, and historical and recent data on mosquito-borne disease in Suffolk County are also to be included in the GIS, the County will provide Bowne with electronic versions of the appropriate portions of the data sets.

Bowne will georeference the mosquito breeding records based on site name or street address. It is anticipated that 20% of the 16,000 records entered in the previous subtask will need to be georeferenced. In addition, 20,000 records that have already entered by Suffolk County will need to be georeferenced, bringing the total to approximately 23,500 records. Any records that do not have a site name or street address, have missing or incomplete data, or that have data fields that are illegible will be returned to Suffolk County Vector Control for clarification. After georeferencing the records, Bowne will perform a quality control review.

Bowne and the CA/CE team will create GIS polygon (area) layers depicting Major Mosquito Breeding Sites, Areas Subject to Adulticiding, Surveillance Sites, Water Management Structures (Culverts and Ditches), and County Vector Control Management Areas.The polygon areas will be compiled from the GIS Point Coverages loaded earlier for

areas that are greater than 1/2 acre in size. For this subtask, it is assumed that approximately 2000 primary breeding sites have been georeferenced in the point coverages.

Suffolk County aerial photography and other references will be used to compile the polygon areas. It is assumed that Suffolk County Vector Control will work with the Team by providing site characteristic analysis and support during the delineation of these polygons. After all layers have been digitized, Bowne will perform a quality control review.

A methodology for compiling and creating the polygon areas is summarized below.

1. Overlay Point Coverages (Major Mosquito Breeding Sites, Areas Subject to Adulticiding, Surveillance Sites) with wetland layers (loaded in Task 5).
2. Select all wetland polygons that contain points and that are greater than ½ acre in size.
3. Extract polygons to target coverage and classify polygons based on type of points contained in the polygon.
4. Repeat steps 1, 2 and 3 for other existing polygon layers.
5. Determine points not yet assigned a polygon.
6. Overlay points on digital orthophotography or other suitable reference layers.
7. Delineate and digitize polygon boundaries based on point locations and site characteristics.

As described below in Task 5, Bowne will create thematic display and map templates that can be used to view a Major Mosquito Species Layer and display:

- Abundance and Distribution
- Population Changes over Time

Bowne will prepare 10 CD-ROMS containing all data developed during this task. GIS data deliverables will be in ESRI Shapefile format.

The report on the existing program (draft, 30 copies; final, 30 copies) should be produced before the New Year, 2003. The loading of data may require a considerably longer time frame, depending on how easily the material can be delivered (and its exact state). The Team proposes completing the GIS data collection by mid-Spring, 2003.

Task 5: Data Compilation – Physical Setting (Status and Trends)

This task is an extensive mapping and data compilation effort to expand the County's GIS to include most of the study information.

A. Data

CA/CE will collect general environmental data that defines Suffolk County and its shoreline including:

1) Watershed Delineations

The Nassau-Suffolk Planning Board 208 Study, development of the groundwater model for SCDHS, the current Source Water Assessment Program, LISS, PEP, SSER, and various USGS surface water and groundwater studies have helped define watersheds and groundwater catchment areas for the County. CA/CE will compile this information and incorporate it into the GIS system.

2) Status and Trends Analysis of the Area's Wetlands

NYSDEC and the US Army Corps of Engineers have each developed maps of the County's wetlands. Many of the Towns within the County have further refined these mappings, adding wetlands too small to have been considered under either the State or Federal mapping effort. NYSDEC has quantified broad trends for Long Island, including some Suffolk County wetlands. New York State Department of State (NYSDOS) has also made efforts in this regard (such as identifying signature examples of various kinds of habitats, including marshes), including significant work quantifying changes in marsh areas. Habitat Workgroup studies for the PEP, SSER, and LISS have tried to develop reasonable assessments of existing wetlands, and to compare current conditions with historical conditions. The USFWS has also developed some historical trends for certain Suffolk County areas. CA and Sidney Bowne, as part of work on the DGEIS for the County's maintenance dredging program, mapped habitat areas over much of the County's shoreline. Particular marsh areas have been the subjects of academic study (Dr. Goodbred working in Carmans River and Nissequogue River; other MSRC work in Stony Brook Harbor), including tracking historic changes in marsh vegetation (a thesis by Emilie Cademartori in 1999) or marsh extent (a thesis by Gregg Cademartori in 2001) over several decades. Municipal governments often have a great deal of information on local systems (the Town of Huntington, for example, has compiled extensive amounts of data and many reports on the Crabmeadow and Twin Ponds systems). NYSDEC has additionally mapped riparian and other fresh water systems.

Aerial photographs may be difficult to use to accurately track changes in vegetation types, as ground-truthing of the historical photos is impossible. Thus, changes in high marsh-low marsh areas, or the spread of *phragmites*, may not be possible to determine for most wetlands in the County. It is more likely that the CA/CE team will be able to identify broader measures, such as overall marsh extent, areas of emergent vegetation, and areas of channels, from historical aerials.

Habitat mapping is an expensive task and using remote sensing to complement field surveys is the most cost-effective means of obtaining products that are useful for management purposes. Remote sensing tools that are appropriate for habitat monitoring range from digital airborne scanners to color aerial photographs to satellite-borne sensors. The choice of which tool to use is determined by size of study area, required resolution, and cost.

The availability of historical aerial photographs may allow for trend analyses of broad wetland characteristics in some of the systems. Some work recently accomplished at SUNY Stony Brook suggests that it is very labor-intensive to try

to closely interpret old aerial photographs for fine vegetation details (such as high marsh-low-marsh-phragmites distinctions); nonetheless, it should be possible to estimate generic wetland acreage for specific sites from the historical aerials, and so determine broad trends in wetland migration and losses of acreage.

The CA/CE team has investigated the potential of using remote sensing (satellite images) to establish a more sophisticated trend analysis program for the County. The largest wetland in Suffolk County does not exceed two square kilometers (~500 acres). Therefore the required sensor should be able to detect changes within such a small space. Satellite sensors aboard LANDSAT (Thematic Mapper) and SPOT (SPOT XS), which have traditionally been used for habitat mapping cannot work in this case because their resolution is greater than 20 meters. However, the IKONOS satellite, which was launched in 1999, provides the highest spatial resolution available on civilian satellites.

IKONOS imagery allows for 1-meter resolution for visible light (black-and-white and color imagery). However, resolution for multispectral data for the same series of images is limited to what is specified as 4-meter resolution (which is 5- to 6-meter resolution in practice). The data will be pan-sharpened, that is, a resolution merge of the panchromatic and multispectral data will be conducted so as to produce 1-meter multispectral images. This process of resolution merging can be applied to other less expensive satellite data or aerial photographs, as well, improving their definition. The high tidal ranges on the North Shore of the County, and moderate ranges through the Peconic system, may create enough elevation-related definition in the marshes that this resolution limitation may still allow for good separation of important vegetation types (CA/CE envisions creating the ability to map high marsh, low marsh, and phragmites through remote sensing). However, the patchiness of basic marsh archetypes associated with smaller tidal ranges along the South Shore may mean the available resolution is inadequate for careful mapping. However, in the next two years the resolution of IKONOS imagery is expected to improve to 0.5 meter.

Whether or not the mapping will meet project (and County) needs to cannot be determined, however, until it is attempted. Dr. Kamazima Lwiza (MSRC, SUNY at Stony Brook), will lead an effort to create appropriate algorithms to allow for mapping and quantification of these basic wetland types. The CA/CE team envisions two iterations at the shoreline Tier I marshes (see Task 7). The general procedure requires field mapping of the appropriate vegetation distinctions, identification of the signature spectral patterns in the satellite imagery, creation of an algorithm to account for geographical and reflective distortions due to satellite picture angles, and then execution of the algorithm (and QC of the vegetation assignments). The general algorithm would be verified through repetition at a later season; this repetition would also allow the County to receive training in algorithm adjustments. Because of this training, if the assignment process proves to be accurate and precise enough, the County might be able to complete a baseline mapping of all of the County's wetlands, and to monitor changes in vegetation extents over the ensuing years, using in-house staff.

Extension of this concept, as currently being developed in research projects (by USGS, University of Texas, and University of California at Davis) may allow for measures of the relative health of marshes, as well (as measured by chlorophyll content of the plants, shoot thickness, and shoot densities).

There are two major drawbacks associated with IKONOS. The first drawback is that the data is expensive compared to other types of satellite data. A 1-meter and 4-meter combination photograph series, if the image is in archive, is $50.00 per square kilometer; the minimum order is 100 square kilometers ($5,000). However, the ability to quantify, delineate, and identify wetland and/or vegetation types with a small error is likely to be worth the initial cost. The second drawback is that IKONOS has a long repeat cycle (144 days between available photographs) and it does not

take images continuously. This means that there will be instances where it will be necessary to special-order images (an additional $3000 fee plus a 20% surcharge on the entire order). To keep costs down, CA/CE proposes to request three orders of 100 square kilometers each for each system, making certain that the Tier 1 marshes are included in the selections.

General concerns over remote sensing include the inability to control when photos are taken (leading to differences of tidal cycles; this problem with aerial photos has caused great controversy for NYSDEC with regard to its evaluation of Jamaica Bay wetlands, for example). Additionally, very robust computer systems are required to support the data sets generated. Finally, if the skills required to adjust the algorithms are not practiced, they may not be useful. Therefore, the County may need to continually hire outside expertise to enable each interpretation of the photo sets.

Traditionally, to determine vegetative change a Normalized Difference Vegetation Index (NDVI) would be computed on two satellite data sets. NDVI is related to the proportion of photosynthetically absorbed radiation, and is calculated from atmospherically corrected reflectances from the visible and near infrared channels of a satellite borne sensor:

$$\frac{NearInfrared - Visible}{Near\text{-}Infrared + Visible}$$

where *Visible* is the reflectance in the visible wavelengths and *NearInfrared* is the reflectance in the reflective infrared wavelengths.

The principle behind this is that the visible part of the spectrum is where chlorophyll causes considerable absorption of incoming radiation, and the near infrared is a spectral region where spongy mesophyll leaf structure leads to considerable reflectance. A 256-class difference image will be created by subtracting the first NDVI image from the last NDVI image. The difference will be recoded into categories representing high, medium, and low biomass change. Although NDVI provides a rough idea as to where and how much change has occurred between two multispectral satellite images, it cannot determine changes between a digital vector image and a raster one.

Hence, it will be necessary for Dr. Lwiza to develop a robust change detection algorithm that can detect changes between a vector product (such as the National Wetland Inventory) and a raster product (satellite image), or between two raster products. The technique of choice will be Cross-Correlation Analysis (CCA) because most other techniques that have been developed failed to adequately identify small-scale wetland changes. CCA was successfully tested by USFWS on a study site in eastern Maryland and by USEPA in conjunction with USFWS and the Natural Resource Conservation Service on a study site in eastern North Carolina. Dr. Lwiza intends that the CCA algorithm will differentiate between seasonal changes and human and/or environmental impacts.

Ancillary data layers such as the National Wetland Inventory (NWI), Digital Ortho-photo Quarter Quadrangles (DOQQ's), Soils, LANDSAT TM and/or ASTER satellite imagery, will be used to assist in the mapping/identification process. Additional fieldwork may be necessary to provide accurate wetland delineation and vegetation identification information across the study area.

Classification accuracy will be determined by comparisons with existing wetland database information and field surveys specified for the project. The target is 85% for each class mapped.

DELIVERABLES

1. A land use/land cover map of the study area. This will be provided to the Data manager in digital form in ERDAS Imagine and ArcInfo GRID format in a NAD83 State Plane Coordinate Projection. The map will also be provided in the form of color plots with format and content consistent with the County's needs and standards.

2. A change detection map of the study area both Seasonal and Annual in a in a NAD83 State Plane Coordinate Projection. The map will also be provided in the form of color plots with format and content consistent with the County's needs and standards.

3. IKONOS raw satellite imagery will be provided. Imagery will be clipped to the County's boundaries where applicable and will be provided in a UTM, NAD 83 projection.

4. Summary statistics on total acres within each study area.

5. Land cover change analysis comparing year 1 land cover classification with year 2 land cover classification

6. A report of the methods and algorithms used in the development of the products and statistics. This will include documentation on the map accuracy and assessment.

7. Metadata for any layers delivered will be provided in a format consistent with the County's needs and standards.

CA/CE, with assistance from Dr. Goodbred, will prepare an assessment of marsh health throughout the County. Important indicators of marsh health include the presence of indicator plants, sedimentation as a response to rising sea level, and bank or interior erosion. A determination of County-wide historic trends in these parameters may be difficult or impossible, although a trends analysis for particular marshes may be possible if sufficient historic data exists. The CA/CE effort will address the existing efforts by various local, State and Federal agencies, and reconcile differences among the various trends approaches. A "best available methodology" will be developed, most probably in accord with Dr. Lwiza's work, that will allow the County to track wetland trends .

3) Water and Sediment Quality of the Estuaries

The CA/CE Team will access monitoring data collected by SCDHS as part of its participation in the three estuary programs. This includes water quality and nutrient concentration data from 46 stations in North Shore harbors (Mattituck, Mount Sinai, Port Jefferson, Stony Brook, Nissequogue River and the Huntington Bay complex), which are monitored biweekly on both incoming and outgoing tides, 30 stations in the Peconic Bay complex, monitored biweekly (some stations are also monitored for Brown Tide concentrations), and 12 stations in each of Great South Bay (expanded at some times to as many as 21 stations), Moriches Bay, and Shinnecock Bay, which are also monitored biweekly. Major rivers in the County (such as the Carmans, Peconic, Nissequogue, and Connetquot Rivers) are monitored at least quarterly (the frequency may be greater because of County implementation of USGS sampling programs), and several hundred groundwater samples are usually collected as part of the SCDHS groundwater monitoring program and cooperative efforts with other agencies such as NYSDEC and USGS. All stream and groundwater samples are analyzed for basic water quality and nutrient parameters, as with the estuary surface water

samples, but also most are routinely analyzed for a suite of metals, volatile organic compounds, and pesticides (including the pesticides used in the mosquito control program). This suite of parameters is also analyzed for in special sampling of North Fork creeks in the Peconic Estuary Program. Six creeks, from the Peconic River in the west to Narrow Creek in Orient are sampled at 4-5 stations each for the complete County water parameter list. These samples are taken monthly in the winter into Spring, and thereafter on a schedule dictated by resource availability.

Much of the data is available in databases for trend analyses, although certain data sets (primarily those from 1998 and later) may require input. It is significant, however, that this routine monitoring has not yet detected any mosquito program pesticides in any environmental sample.

Furthermore, the County groundwater model has facilitated the definition of groundwater and surface water contribution watersheds. This will allow for determinations of the surface water and groundwater sources for the estuarine wetland systems, and so will be effective in assessing inadvertent pesticide input potentials. The watershed concept is also an efficient means of sub-categorizing much of the GIS data, and making the vector control program system consonant with other data systems the County is developing. The overall notion of coordinating environmental analyses through watershed definitions is receiving much attention nationwide, and has been strongly supported by many USEPA programs.

These water quality data, in conjunction with project specific on-going monitoring efforts and use of the sub-aqueous discharge flowmeter, may support fate and transport calculations for potential overland and groundwater transport of applied VC chemicals to coastal environments.

The USEPA Coastal 2000 program (administered by NYSDEC) has collected sediment and water quality samples throughout the north shore bays, the Peconic system, and the South Shore Estuary. The NYSDEC takes many bacterial samples as part of their shellfish certification program. These data are likely to be of use in connection with the mosquito control effort. Some historical assessments of coastal water quality have been attempted, notably in connection with the 208 Study.

Other existing data sets include an MSRC study of north shore bays in the 1970s, an MSRC study of Great South Bay from the late 1970s, student work in Stony Brook Harbor and Port Jefferson Harbor in the 1980s and 1990s, metals sampling in Great South Bay in the late 1990s, a Planning Board study of south shore creeks in the 1980s, and data compilations associated with various Harbor Management Plans and LWRPs.

4) Hydrology of the Study Area

Suffolk County hydrology has been well documented by the 208 Study, USGS efforts, and SCDHS monitoring and modeling. Although the general discharge characteristics of local aquifers have been determined, the processes involved at the fresh water-salt water interface are still the subject of basic research (an international effort to standardize the measurement of near-shore groundwater discharges is underway, with a local component of this research recently having been conducted in West Neck Harbor, Shelter Island, in the spring of 2002). The project will incorporate many of those findings and technologies, as it uses the County interface meter to track the transport of program pesticides to the estuaries via groundwater pathways.

CA/CE would draw a large-scale picture of water flows and budgets, but important micro-scale phenomena will require further research (using, for example, the subaqueous discharge meter) if modeling exercises were to be undertaken on such a small scale. In general, sufficient information is available pertaining to County hydrology to support the required analyses. CA/CE will prepare a discussion of groundwater flow patterns and how they could affect the fate and transport of potential subsurface contaminants. Due to the importance subaqueous discharge concerns, near-shore groundwater quality will be carefully tracked and assessed as part of this project (see Task 3b, Early Action Projects, and Task 6, below).

5) Stormwater Flows and Control Structures

It is clear that upland stormwater control structures represent potentially important disease vector habitats. Because of this, the project will address these structures through several tasks.

Bowne Management System has estimated that data collection and mapping of the stormwater structures associated with over 7,000 linear miles of Suffolk County roadways could cost $500,000. As part of Task 5, CA/CE in consultation with the County will select several pilot areas for study (three one-square mile areas may suffice). It may be best to choose representative regions of the County, or it may be preferred to select areas in terms of West Nile virus-related issues. For example, West Nile virus has made people in Dix Hills ill, although there are not many fresh water ponds to serve as mosquito habitat. This is in contrast to Babylon, where West Nile was also detected in mosquito pools, and where surface waters are more common. These two areas may be appropriate to provide pilot study sites (a third area might be drawn from a part of the County where no West Nile virus was detected in 2002). CA/CE will identify and locate all of the stormwater structures within the pilot areas, using existing State, County and local data as it already exists, and Bowne will incorporate them into the project GIS (see Task 4 and just below). CA/CE will then determine the potential for these structures to serve as mosquito breeding sites, and determine the feasibility of altering them to lessen this potential.

This limited effort will be used as a basis for determining true costs (and potential benefits) of mapping the remainder of the County. As part of that effort, Bowne Management Systems will determine how much of the County-wide stormwater infrastructure is already mapped and available on GIS. If substantial areas are already so mapped, and it is feasible to do so, then Bowne will import them into the project GIS. If not, Bowne will estimate the percentage of coverage, and, together with CA/CE, provide the County with an estimate of the cost of completing the coverage.

A report on the physical setting of the project will be generated for use in the EIS. The County has not requested any copies of this report, however.

B. Maps

During this task, the mapping and data subconsultant, Bowne Management, will create a GIS data repository, in accord with a GIS Database Design developed in Task 1. A preliminary list of this data is included in Table 1; a recent compendium of Peconic Estuary GIS data sets compiled by the Nature Conservancy will be accessed. This data will be integrated with the data sets developed during Task 4.

Table 1
GIS Coverages to be Loaded During Task 5

Comparison of Task 5 Requirements and Data Set Availability

Task 5 Requirements	**From RFP Attachment 4** **Data to be Provided by Suffolk County**
The consultant will develop and digitize the study area map for the SCVC wetlands management long term plan including all inland pond wetlands and the wetlands of the Peconic Estuary, South Shore Estuary, and the Long Island Sound Study Areas in Suffolk County. Other maps to be compiled and/or developed and digitized by the consultant include, but are not limited to the following:	Wetlands mappings as currently available (from the County and other sources)
Study Area	
Overall study area map (watershed delineations for estuary program)	
Land Use and Demographics	
Land use data	Planning Department Information – Land use data prepared for PEP east end towns only (1999-2000). They are currently working on the north shore groundwater contributing areas to the Long Island Sound, which should be complete in the next few months. Landuse Coverage – BT Camp
Population data status and trends	Planning Department Information – Excel file for Population by Town, includes Nassau and Suffolk Counties. Saturation population analysis (east end) is available on their web page.
Environmental	
Wetlands (NYSDEC, ACOE, USFWS)	USFW NWI Wetlands data 1980 USFW NWI Wetlands data 1994 NWI 1980-1994 Suffolk County Freshwater Wetlands Town GIS data (if available)
Water and Sediment Quality (e.g. NYSDEC Shellfish Sanitation Data, SCDHS Water Quality Monitoring – see Attachment I. of RFP	Shellfish Closure Areas for 1996 Uncertified Shellfishing Areas
Submerged Aquatic Vegetation (Estuary Program & USACOE)	Eelgrass
Hydrology and Groundwater Quality Monitoring (SCDHS) and Subwatersheds (Estuary Programs)	LI Hydrology – linework including polygon outlines
The Long Island Wetlands Initiative candidate site map for wetlands restoration	
The Peconic Estuary Program's Critical Natural Resource Area designations	Critical Habitats in the Peconics
Rare, Threatened and Endangered Species (NYSDEC, NY Heritage)	Natural Heritage Data (will be encrypted or other access-restricted)
NYSDEC Shellfish Sanitation shoreline survey	
Finfish data (NYSDEC) (NOAA, including fishery areas)	Important fin and shellfish areas
NYSDOS Significant Coastal Fish and Wildlife Habitats	
Shoreline Hardening (PEP)	
Stormwater Runoff Mapping (various sources)	
Land Cover (DOS)	
Land Use (1995 PEP detailed data set; all of Suffolk to be provided via merging Suffolk County Tax Map Number (SCTRM) with assessor code from SC Planning Dept)	Planning Department Information – Land use data prepared for PEP east end towns only (1999-2000). They are currently working on west end, which should be complete in the next few months. Excel file for Population by Town, includes Nassau and Suffolk Counties. Saturation population analysis (east end) is available on their web page.

The following will be achieved to create this data repository:

1) The GIS data repository will be constructed. This repository will contain all of the data indicated in the GIS Database Design developed in Task 1. The work activities will include:

- Load acquired data from the source media.
- Perform format conversion or translation, as necessary.
- Transform the data to the required coordinate system (projection and units). No rubbersheeting or positional fit improvements will be made.
- Establish links to related attribute data tables, as necessary.
- Perform a quality control and assurance review on the loaded data.

2) An ArcView Project will be created for the Suffolk County Vector Control GIS data repository. This project will be used by the project team and will serve as the standard application program interface (API) for the work to be performed by team members in the later project tasks. The Bowne Internet FTP site will serve as the central point for the project team to access the most current data. Bowne will also establish a version control, and temporal data access methodology for use by the project team. Special ArcView scripts will be developed for this purpose.

3) In addition, scripts will be developed to prepare data for data modeling and the production of map and data products. These include scripts for:

- Thematic display
- Spatial overlay
- Geographic (proximity) searching
- Database queries

The remote sensing data sets will also be incorporated into the overall project GIS. The project will contain a customized map production template that will be used to produce the map and data products produced by the team. This ArcView Project will be a deliverable at the conclusion of the project.

At the conclusion of this task, Bowne will conduct a workshop with Suffolk County to demonstrate the GIS data repository and analysis tools that will be available for the remaining project tasks.

Bowne will make the GIS data and analysis tools available to the project team, train as necessary, and support team members as needed during the remaining project tasks. Deliverables for this task will include all GIS Data Sets on CD-ROM (10 copies provided). GIS data deliverables will be in ESRI Shapefile format. The Team anticipates completing this task early in the summer 2003, before the active mosquito control program begins (estimated to be June).

Task 6: Monitoring Program

The Team will design and implement a physical, biological, and chemical sampling program. Both a short-term characterization study and long-term trends monitoring program will be designed. It is intended that the monitoring program will determine concentrations of Vector Control chemicals in surface waters, sediments, and organisms following application. Long-term goals include:

- Determine the concentrations at which Vector Control chemicals reach surface waters and sediments following spray events.
- Determine the degradation and dispersal of those chemicals.
- Determine the concentrations of Vector Control chemicals in biota.

At this time, analytical capability limits the accurate determination of the degradation products of commonly applied pesticides. Current instrumentation and a lack of published analytical procedures mean these compounds cannot be determined in natural settings. Although such capabilities will be sought for the Long Term Monitoring Program, Phase I and Phase II monitoring will necessarily be limited to the parent pesticide compounds, and detection limit realities and rapid degradation of these compounds may result in predominantly non-detections of the compounds of interest.

During the summer of 2002, the SCDHS and SCDPW conducted field spray trials, and collected depositional samples, and water and sediment samples (Phase I monitoring). The County will further document and evaluate the performance of their field spray equipment by collecting samples at set distances from a controlled spray event to be conducted in 2003. They will examine the resmethrin/PBO sample collection techniques and analytical methods used. Deposition sample collection devices will be deployed, prior to spraying, at set distances from the spray route and at near water locations to determine whether Vector Control chemicals are reaching surface waters, and at what concentrations. Water and sediment samples will be collected to evaluate actual ambient levels of Vector Control chemicals. Support will be provided by the USGS. CA/CE will evaluate the monitoring results, in conjunction with County personnel. The report on the initial results of this effort should be available by the New Year, 2003. This will be a limited distribution report (10 copies of the draft and final).

The evaluation will be used to design an expanded monitoring program to be conducted in 2003. (Phase II Monitoring). Collection techniques and analytical methods from Phase I will be evaluated by the Team as part of the design of the Phase II sampling program.

As part of this effort, Dr. Brownawell will provide analytical services for up to 72 samples (although no sooner than June 2003) of biological tissues for the determination of pesticides concentrations for those compounds currently being applied by the County. Drs. McElroy and Brownawell will also assist CA/CE and the County in determining which fish or other organism may be most appropriate for pesticide monitoring. For example, filter-feeding, sessile organisms such as mussels, which are usually found in salt marshes, or can be easily caged or tethered in the water column if appropriate substrate is not available, may be a better choice than free-swimming fish where exposure to the release is not as certain. It should be noted that NOAA already has a nationwide monitoring program to test for estuarine contaminant trends (metals and organic compounds) using blue mussels or other analogous organisms.

Dr. Brownawell has indicated that his laboratory expects to be able to analyze mosquito pesticides using equipment that may be unmatched in the country (except, perhaps, for USGS in Denver and the SCDHS laboratory itself) by the New Year. The work is being funded by Sea Grant as part of his investigatory work into the lobster die-off in Long

Island Sound. Therefore, the County will benefit from the extensive methodological preparation that was paid for through another funding source.

As indicated just above, both Drs. Brownawell and McElroy were funded through the special grant competition of the NY Sea Grant to study the 1999 Long Island Sound lobster die-off. Dr. Brownawell was also an invitee to the Lobster Summit hosted by litigators in the winter of 1999, and has publicly commented on aspects of studies purporting to explain the die-off. Dr. McElroy has long specialized in contaminant impacts on marine benthic organisms (such as crabs, although much of her work has been with more sessile organisms such as worms), and expects to work closely with Dr. Brownawell to formulate a discussion of the potential for impacts on marine benthos generally. This will include those species of economic importance (such as mussels, oysters, clams, crabs and lobsters) but others where the explicit impact potential is more ecological than economic.

Assistance will be sought from the Marine Ecotoxicology Department of NOAA's Center for Coastal Environmental Health and Biomolecular Research (CCEHBR). Researchers at the CCEHBR have sampled for the presence of selected mosquito control adulticides and larvicides, including those used by Vector Control, in sensitive estuarine invertebrates.

The County has suggested that a semi-permeable membrane device (SPMD) will be used to determine what levels of Vector Control chemicals aquatic life may be exposed to over time, with assistance from USGS which is developing this monitoring technique. The cutting edge results produced by these devices may be usable as surrogates for organism exposure to Vector Control pesticides. Additionally, USGS will continue its County-sponsored monitoring program, expanding its scope to include sampling through the water column, and some sediment quality work.

The County will augment these efforts with its own additional work. The sub-aqueous discharge meter will be used to collect samples of water discharging from and entering into the sediments; the meter will also be used to measure the flux of water along these paths.

These data may allow for a wider exploration of potential fate and transport pathways followed by VC chemicals and their metabolites, beyond those currently described in the literature.

Bioindicators continue to receive great attention as potential monitoring tools. USEPA espouses a four-part method for bioindicators:

- identify an indicator that has conceptual relevance;
- determine the feasibility of implementation of monitoring the indicator;
- assess the response variability in light of the variability of the conditions being monitored; and,
- interpret and use the data produced by the program.

The simplicity of the list belies the great difficulties associated with each step. Nonetheless, making direct measurements of impacts on sensitive or ecological keystone species or assemblages makes a great deal of sense. Examples of successful implementations remain rare, although New York programs using bioindicators include USACOE dredge spoil toxicity determinations, USEPA R-EMAP New York Harbor monitoring, and the NYSDEC freshwater stream RIBS program.

Biomonitoring is especially attractive in its potential to make environmental linkages apparent. For example, it has been hypothesized that changes to small creekside marsh systems are reflected in impacts in the wider Peconic Bay system. If appropriate organisms can be identified, then trends in both populations and individual organism health may be useful in signaling greater effects from such subtle signals as the small creekside marsh changes.

One barrier to implementation of biomonitoring along Suffolk County shorelines is the distinct ecological differences between the three major systems (South Shore, Peconic Bays, and North Shore interior harbors) that may preclude a single organism or suite of organisms covering all three. The nature of estuarine systems is that they are populated by organisms accustomed to adapting to major natural environmental changes such as floods, droughts, major coastal storms, as well as anthropogenically-driven events (hypoxia and eutrophication-derived phytoplankton blooms, sewage releases, etc.). This often results in ecological systems that are exceedingly hardy, and not easily insulted by changes to the system. This can mean that near-catastrophic changes to water quality may result in little impacts to the organisms (or impacts that are quickly overcome). Broader measures of ecosystem quality, as used by R-EMAP in New York Harbor, have been criticized as losing the immediate linkage between environmental stressors and the indicator index, because in order to measure effects throughout New York Harbor (also a diverse set of water bodies) the indicator needed to be site-unspecific (and so it is not exactly certain whether the indicator measures changes in water quality or changes in the water body type).

Nonetheless, the monitoring community still is desirous of greater implementations of ecological indicators since they are direct measures of impacts. Water quality data requires interpretation to determine potential impacts, and so is a less direct means of monitoring the ecological health of the system of interest. Therefore, the CA/CE team will include careful evaluations of proven biomonitoring means. Further, should no appropriate biomonitoring tools be available, the report will discuss ways that the County may be able to foster the development of Suffolk County-appropriate biomonitoring.

Finally, CA/CE will review the appropriateness of bioassays to determine impacts from pesticide(s), as discussed in Task 3. At this juncture, it is not clear if the data that might be generated would generate significantly different information than has been generated through regulatory processes such as pesticide registration. It may be that site-specific aspects of potential impacts in Suffolk County make these kinds of experiments extremely valuable, however.

CA/CE will provide the County with a Sampling and Analysis Plan (late Spring, 2003; limited distribution report) that will describe the sampling locations, techniques, and proposed analyses. It will also detail QA/QC procedures to ensure all data are accurate and reliable.

The Team will be responsible for the full implementation of the Phase II monitoring program as detailed in the Sampling and Analysis Plan including all sample collection and the arranging for analysis of samples other than those from the water column or sediments. The Team notes that the County can obtain significant cost savings for USGS assistance through its cooperative program, and therefore the Team has not made any allowance for arranging for USGS help directly. It is understood that the County, through the Suffolk County Public and Environmental Health Laboratory, will provide conventional water quality and sediment analysis services. All sample locations and conditions will be accurately documented and the sample collection information inserted into the GIS maps.

At this time, it is expected that Phase II work will be centered on the Tier I wetlands (defined in Table 1). It is likely that at least two samples will be taken at these locations. Most will be intended to measure impacts from spraying,

compared to pre-application results. In addition, sampling results may prove to be useful in verifying air modeling data.

The report on the Phase II monitoring should be released near the New Year, 2004. It will also be a limited distribution report.

A long-term Phase III Monitoring Program will be designed by the Team with the cooperation of the County. It will be based on the experience gained from Phase I and Phase II sampling. The Long Term Monitoring Plan will address the need for accurate measurements of the applied compounds, and daughter compounds, and have an emphasis on determining uptake by significant elements of the food chain. The Plan will include estimates of the time and money necessary to expand the current analytical program and the County's future sampling needs. The Monitoring Plan will develop data sets from which quantitative ecological risk assessments can be developed, and meaningful discussions of the impact of pesticide applications can be extracted. Its overall structure will be based upon the development of minimal, extensive, and optimal plans of work, and will estimate the annual costs associated with these three, prioritized levels of effort. Additionally, the monitoring plan will outline a systematic plan for academic research needed to augment existing knowledge and monitoring capabilities to meet potential County needs. Drs. McElroy and Brownawell and CPF will play important advisory roles in setting the framework for this major effort.

Among the options to be considered, the CA/CE team will discuss alternatives to more traditional monitoring programs, including remote sensing. It is unclear if all of the County's needs can be met with the current satellite imagery resolution. Uncertainties regarding continuing costs for this technology should be recognized as significant when evaluating the benefits of remote sensing. However, there is no doubt that remote sensing does offer the County a potential means for monitoring wetlands far beyond its current capabilities (given staffing realities). Dr. Goodbred will assist CA/CE in establishing a long-term wetlands monitoring program for the County that is feasible given technological and funding realities.

The report for this part of the project would be completed in January, 2004, as part of the Management Plan (see Task 10).

Task 7: Field Assessment and Mapping: Study Area Refinement

A. Classification Model

CA/CE, working closely with Dr. Goodbred and the TAC, will develop a conceptual classification method for coastal wetlands and certain stormwater control structures (especially recharge basins). The classification scheme will identify a set of wetlands (Primary Study Areas, also known as Tier 1 wetlands) that will be subject to site-specific and detailed review with regard to marsh management and mosquito control. The Primary Study Sites will also serve as candidates for potential demonstration projects, including OMWM or other restoration efforts. These wetlands will be chosen because of their exceptional environmental qualities or for their value as archetypes for other sites in the County. Their value in guiding the selection of a preferred mosquito management program will also be a criterion of selection. Tier 2 wetlands will not receive the same level of review. Rather, they will be addressed in terms of program elements developed for the Tier 1 sites and generic program evaluations.

The criteria developed to screen the wetlands are likely to be similar to the following list:

- Size (in acres);
- Tidal regime (mean tidal range, in ft);
- Presence of tidal restrictions;
- Percent high marsh (acres of *Spartina patens*);
- Percent low marsh (acres of *Spartina alterniflora*);
- Percent invasive species (acres of *Phragmites australis*);
- Presence of endangered/threatened species;
- Presence of locally-significant resource species;
- Ratio of natural channels to ditches (linear feet);
- Erosive rate (percent, as measured in acres);
- Presence of freshwater tributary;
- Presence of barrier beach;
- Presence of major tidal creek;
- Classification as open fringing, sheltered fringing, island, or overwash marsh.
- Percent developed upland fringe (linear feet)
- Perpetually wet (>80% of the year)
- Rarely contains water (<20% of the year)
- Often contains standing water (>20% but <80%)
- Adjacent upland is sloped (bluffs, moraine) or low-gradient (outwash, barrier)
- Urban, developed, or pristine upland catchment
- Former duck farm site

Please note some criteria are only applicable to salt marshes, others to recharge basins. Particular to recharge basins are the following classifications:

- Maintained (cleaned in last five years)
- Grassy slopes (trees/shrubs < 25%)
- Forested slopes (trees > 50%)

The criteria listed here are subject to change with further project input (especially with regard to marsh classification work undertaken by the NYSDEC and NYSDOS recently, especially in other areas of the State).

The valuation of the functionality of each marsh will be based on a combination of field assessment and the GIS that was developed in Task 4 and Task 5. Many of the criteria are likely to be quantifiable by GIS analysis; some of the criteria will require ground-truthing prior to finalization of the evaluation. Some criteria may be determined through literature review (*e.g.* the Natural Heritage program) whereas other criteria may require field assessment to be quantified. Again, recent work on marsh classifications by State agencies will readily be incorporated into this effort.

Based on evaluations of historical aerial photographs and current conditions, all marshes will be categorized as either damaged or functioning wetlands. Functioning wetlands will be further evaluated as impaired, adequate, or pristine. A damaged wetland is one that appears to be losing major functionalities and/or suffering from measurable erosion. Impaired wetlands are those with invasive plant species, or anthropogenic effects that limit water flows or native species (i.e., dredge spoil placement or the presence of dams/culverts). Adequate wetlands are those with obvious human influences (mosquito ditching or status as a recharge basin) that appear to have little present-day impacts on wetland functions. Pristine wetlands are those that do not appear to have been altered by human actions.

The classification scheme will serve as the basis for a matrix that will be used to evaluate all County marshes. The largest marshes will automatically receive special consideration for Primary Study Area status. Other marshes will also be considered for Primary Study Area status including pristine, adequate, impaired, and damaged wetlands. It is hoped that the selection of Primary Study Areas will allow for some of the Tier 1 marshes to also act as archetypes for Tier 2 marshes. In this way, a sufficient variety of settings will be evaluated, with some of the Tier 1 marshes serving as archetypes for Tier 2 sites. This should simplify the transfer of information from the Primary Study Areas (the Tier 1 marshes) to Tier 2 marshes.

The selection of Primary Study Areas will be finalized only after complete and thorough consultation and comment from the TAC.

B. Characteristics of the Primary Study Areas

Based on the evaluation matrix established in Part A of this task, primary study areas will be either large, important wetlands, or archetypes of particular kinds of marshes that are common in the County. Each Primary Study Area will be important to the Vector Control program in some way, either as a known mosquito breeding area, a site managed by the Division of Vector Control, or a control site for the purposes of this project. Identification of exemplary marshes, such as has been done by the New York Heritage Program, will facilitate the use of information collected on the primary study areas at the Tier 2 sites. The report by the Heritage Program, "Identification of Reference Wetlands on Long Island, New York" (D. MacDonald and G. Edinger under funding from USEPA) will provide a foundation upon which to develop this study's wetland classification scheme, and provide a template for the transfer of information from Tier 1 to Tier 2 sites.

These marshes will be ground-truthed after selection by the model, in order to ensure that the data provided by the GIS is accurate for the purposes of the study. As part of ground-truthing, relevant data to complement the existing GIS data will be collected. These data will be collected using standardized collection means (quadrats along transects). The particular characterization data to be collected will be determined through Task 3, Task 5, and earlier Task 7 work (primarily through Dr. Goodbred, in conjunction with Dr. James-Pirri). These data will complete the descriptions generated from the initial screening criteria from above, and as loaded into the GIS in Task 5.

Field visits to document these conditions would involve general observations across a majority of each of the wetlands as well as detailed measurements of selected quadrats and transects within each of the wetlands over different tidal cycles and seasons. The anticipated work effort is large to properly assess conditions in the wetlands in order to then use them as a basis for evaluating the potential impacts of marsh management and other mosquito control techniques. Approximately 500 hours of effort (exclusive of management effort, but inclusive of associated report generation) are anticipated (approximately 20-30 man-hours per marsh) for the field effort.

CA/CE believes that between 15 and 25 primary study areas will be sufficient even though each wetland in the County has certain aspects that differentiate it from all other wetlands. Nonetheless, there are sufficient characteristics common to most marshes for the CA/CE team to create a useful classification scheme.

This task will be addressed throughout the spring and summer of 2003, although CA/CE is hopeful that preliminary results may be available earlier in the summer to assist in the definition of the early action projects (Task 3).

The report will be issued in both draft and final forms (30 copies each), on both the Wetland Classification Model and the characteristics of the Primary Study Areas.

Task 8: Impact Assessment

An impact assessment will be conducted under the direction of CPF to evaluate the potential human health and ecological effects associated with pesticide use (adulticides and larvicides) and water management for mosquito control in Suffolk County. The overall conceptual approach will be modeled after the impact assessment evaluations conducted as part of the Westchester County and New York City EISs; however, this evaluation will include a water management component that will be unique to this project.

Three types of impacts will be assessed for both human and ecological receptors.

- Risk of mosquito borne disease;
- Risk associated with pesticide use; and,
- Risk associated with water management.

For each of these, risks will first be evaluated for a baseline condition, assuming no active mosquito management program. Then, risks will be evaluated assuming that a mosquito management program is implemented. Although the finalized mosquito management program will not have yet been developed prior to this analysis, CA/CE and CPF will work with the Steering Committee and TAC to construct a "most likely" management plan for detailed analysis in the impact assessment. This hypothetical plan (hereinafter referred to as the evaluation management plan) will include the pesticide application and water management options that have been initially evaluated through preliminary analyses in earlier tasks to best balance public health and environmental benefits and impacts. The overall benefits or impacts of mosquito control will then be evaluated by comparing predicted risks under the evaluation management plan to baseline conditions.

Alternative pesticide application and water management options will then be considered. The alternatives evaluated will be those identified by CA/CE, and the Steering Committee and TAC, to be potentially viable management options. The Alternatives analysis will focus primarily on the populations, exposure pathways, and endpoints that were associated with the greatest risks in the evaluation management plan assessment. One of the "alternative" scenarios to be evaluated during this analysis will be the County's current West Nile Response Plan.

The results of the baseline, evaluation management plan, and alternatives analyses will then be summarized and compared. This information can then be used to support risk-based decisions for the design of a final mosquito management plan that maximizes public health and environmental benefit.

CONCEPTUAL FRAMEWORK FOR THE ANALYSES

The analytic framework for the impact assessment will be fashioned largely around the risk assessment paradigm developed initially by the National Academy of Sciences (NAS) in 1983[4]. In this context, risk assessment can be defined as the process of assigning magnitudes and probabilities to the adverse effects of human activities. This process involves identifying hazards, such as the release of a pesticide or the presence of mosquito-borne disease, and using measurement, testing, and mathematical or statistical models to quantify the relationship between the initiating event and the effects. This overall analytical framework will be the basis for the mosquito control program impact evaluation.

[4] National Academy of Sciences. 1983. Risk Assessment in the Federal Government: Managing the Process. National Academy of Sciences. Washington, DC

The NAS paradigm divides risk assessment into four major steps:

- hazard identification
- dose-response assessment
- exposure assessment
- risk characterization (including an analysis of uncertainties)

The general approach for each of these steps in the mosquito control program impact assessment is discussed below. More detailed discussions of the particular approaches to be used to characterize disease, pesticide, and water management impacts are discussed in subsequent sections of the technical scope.

Hazard Identification

Hazard identification is the process of determining whether exposure to a stressor can cause an increase in the incidence of a health consequence. The mosquito control program impact assessment will need to evaluate three distinct types of stressors:

- biological (*i.e.,* mosquito-borne disease)
- chemical (*i.e.,* adulticides and larvicides)
- physical (*i.e.,* wetland water management)

Thus, the risk assessment paradigm provides an ideal framework with which to conduct a comparative analysis of diverse environmental stressors.

For both the human health and ecological impact evaluations, the first step of the hazard identification will be the development of a conceptual model to characterize the potential relationships between the three stressors of interest and effects. The conceptual models will be developed from information about the stressors, the potentially affected populations (both human and ecological), and potential exposures, and will be used to focus the impact analysis on a defined set of stressors, receptors, exposure pathways, and health and ecological endpoints.

Information compiled as part of previous tasks will be used to support conceptual model development. For example, data on land use, ecology, and population compiled during Task 5 will be used to define the general types of human and ecological populations that could be exposed. More specific information on study area characteristics, including ecological characteristics and human use, gathered during Task 7 will be used to further refine the conceptual model. Information on the Suffolk County mosquito control program collected during Task 4 will be used to identify the mosquito target species and the pesticides of concern.

After the conceptual model has been developed, additional qualitative data will be gathered to describe the relationship between the stressors (i.e., mosquito-borne disease, pesticide use, and wetlands water management) and health and ecological effects. The data to support this effort will be derived largely from the published literature. Information to be included in the hazard assessment includes information on:

- mosquito-borne disease etiology and transmission;
- human and ecological laboratory toxicology studies of adulticides and larvicides, and,
- impacts and benefits of wetlands management.

In addition, human epidemiology data of disease occurrence, particularly from recent outbreaks in New York and the mid-Atlantic and northeast, also will be summarized. Empirical data on ecological effects from pesticide use at other

locations also will be included. The literature review conducted under Task 3 will provide the input to this step of the evaluation process.

Dose-Response Assessment

Dose-response assessment is the process of characterizing the relationship between exposure and the incidence of an adverse health or ecological effect in the exposed human or ecological population. Dose-response assessment takes into account:

- exposure intensity (how much)
- frequency (how often)
- duration (how long)
- susceptibility characteristics of the exposed population (e.g., age, sex, lifestyle)

The types of dose-response data to be used in the assessment will be unique to each of the three stressors being evaluated. For mosquito-borne disease, information on disease transmission and infection rates will be used, again relying importantly on information from recent outbreaks in New York and the mid-Atlantic and northeast. For pesticides, dose-response information for both acute and longer-term exposure will be compiled. Dose-response data for pesticides will be based on:

- application rate (e.g., pounds of active ingredient per acre);
- intake (e.g., mg pesticide per kg of body weight of exposed individual); or,
- environmental concentration (e.g., mg/m^3 of air).

Synergism will be addressed as an additive impact.

Quantitative exposure-response data for wetlands water management might be lacking but could include information on plant stem density, growth height, seed production and above-ground biomass as a function of altered hydrologic conditions (see the discussion in the August Addendum). Again, the literature review conducted under Task 3 and any data gathered during demonstration or monitoring projects will provide the input to this step of the evaluation process.

The output of the dose-response assessment will be an identification of numerical criteria to be used to support the impact assessment. In might not be possible to develop quantitative dose-response criteria for each of the stressors. In these cases, dose-response will be addressed qualitatively.

Exposure Assessment

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of exposure to a stressor. The exposure assessment for the analysis of mosquito-borne disease will use information on the prevalence of infected mosquitoes derived from Suffolk County and/or New York State surveillance programs, or other sources for diseases that may not yet be present in the County or State. The exposure analysis for the pesticide risk assessment will assess chemical release, transport, and degradation/transformation, and the rate and magnitude of contact by humans or ecological receptors. The exposure assessment for the wetlands water management might be based on factors such as the amount of time a wetland is dry or otherwise subject to non-baseline hydrological conditions.

Data from the literature and modeling will be used to assess exposure. In addition, data collected as part of early action projects initiated under Task 3 and monitoring programs under Task 6 will be used to the extent feasible, especially with regard to model verification. The data being collected by the County during the summer of 2002 under the Phase I monitoring program might be especially useful in characterizing pesticide environmental transport and fate, or for characterizing exposure in certain settings and calibrating the models used to predict pesticide

dispersion, deposition, partitioning, and bioaccumulation. This is especially true of the dry deposition studies proposed for that time period, and potential dry deposition work as proposed by the project air modeler, RTP.

Risk Characterization

Risk characterization is the process of estimating the incidence of a health or ecological effect under the various conditions of exposure described in the assessment. It is performed by combining the exposure and dose-response assessments. The uncertainties of the risk estimates are also fully explored in this step.

To the extent possible, a variety of both qualitative and quantitative information will be used to assess potential impacts. This type of weight-of-evidence analysis generally adds strength to the conclusions that can be drawn from the risk analysis, and reduces the impact of uncertainties on the ability to make management decisions.

GENERAL METHODS PROPOSED FOR THIS STUDY

Within the risk assessment framework, three general methods will be used to examine the potential for adverse health and ecological effects:

- literature review
- predictive modeling
- epidemiology and attributable risk analyses.

These three methods also were used to assess impacts under the Westchester County and New York City EISs.

Literature Review

The literature review conducted as part of Task 3 will provide the data to support the literature-based impact assessment. Literature summarized as part of the Westchester County and New York City EISs will be important sources of information on mosquito-borne diseases, as will the research conducted by Team members (such as Dr. Pollack). The EISs will be important sources of information on the health effects of pesticides, as well. This will be supplemented by database searches for information published since these EISs were prepared. Much of the analysis of the risks of mosquito borne disease will be based on the literature review. However, work accomplished specifically for this study by Drs. Spielman and Pollack will also be of great utility.

Predictive Modeling

Modeling (in conjunction with the other methods) will be used to assess the risks of pesticide exposures in humans and ecological receptors. Risk assessment guidance published by the USEPA will be used along with applicable guidance from other agencies and organizations. Guidance to be considered includes the following:

- USEPA Risk Assessment Guidance for Superfund -- Parts A, B, C;
- USEPA Guidance for Risk Characterization and Risk Management
- USEPA Exposure Factors Handbook
- USEPA Framework for Ecological Risk assessment
- USEPA Office of Pesticide Programs (OPP) ecological risk assessment guidance
- USEPA air modeling guidance

This list should not be regarded as comprehensive.

The modeling approach also will consider environmental transformation and degradation of parent compounds (active ingredients, synergists, and inerts, as applicable). Transformation/degradation products will be identified during the literature search conducted during Task 3.

Much of the modeling may be fashioned after the methods used to assess pesticide transport, exposures, and risks in the Westchester County and New York City EISs. Toxicological data to be used in the predictive assessments will be derived from these EISs and supplemented, as needed by other toxicity data sources including data from USEPA's Reregistration Eligibility Documents (REDs), the OPP pesticide ecotoxicity database, and other OPP data sources. Relevant fate and effects information from USEPA's ongoing cumulative risk assessment of organophosphate pesticides also will be considered. Exposure equations, intake assumptions (e.g., contact frequency, and age-specific inhalation, soil, and produce ingestion rates, body surface area, body weight), and risk equations will be taken largely from previous EISs, although these will need to be tailored to reflect conditions unique to Suffolk County human populations and ecological systems. It is assumed that the electronic spreadsheets (in Excel or compatible format) used to support the previous EIS efforts can be obtained by Suffolk County and used by the CA/CE team to conduct the risk assessment.

Epidemiology and Attributable Risk Analysis

Epidemiological and attributable risk analyses will be conducted to support the impact evaluation to the extent that appropriate and sufficient data exist to support these types of evaluations. At a minimum, the information presented in the New York City EIS will be considered and included in the assessment to the extent applicable.

PUBLIC HEALTH ASSESSMENT – TECHNICAL APPROACH

The public health impact assessment will address public health effects and benefits of the mosquito management plan. Risks from the transmission of mosquito-borne disease, pesticide use, and water management and other non-chemical means of controlling mosquitoes will be considered.

Assessment of the Public Health Risks of Mosquito-borne Disease

Much of the information to assess the risks of mosquito-borne disease without implementation of the mosquito control (baseline conditions) and with implementation of the mosquito management plan will derived from previous EISs. This information will be tailored to address conditions unique to Suffolk County.

The conceptual model for this evaluation will begin with a characterization of mosquito population dynamics and transmission of viral infections, largely derived from previous EISs and updated to reflect new information and conditions unique to Suffolk County. Information from Suffolk County's mosquito surveillance programs will be used here, along with information from the New York statewide West Nile virus surveillance programs, regional surveillance programs, and those maintained by the CDC. Areas potentially susceptible to mosquito outbreaks due to particular land-use and habitat characteristics (*e.g.,* related to vegetative and hydrologic conditions) will be identified to the extent possible. Early action surveillance project data will be utilized, assuming that it is available in a timely fashion.

The hazard assessment will characterize the types of health effects that might occur from transmission of mosquito-borne disease. The focus will be on West Nile virus, but other diseases, as warranted, will be discussed. Health effects from West Nile virus include fever, headache, neck stiffness, stupor, skin rash, and swollen lymph glands, and

more severe illness such as meningitis, encephalitis, and mortality[5]. The data collected by Drs. Spielman and Pollack will be extremely valuable for this portion of the work.

Once the conceptual model is developed and the hazard assessment is completed, the risks of health effects under baseline (no-action) and mosquito management plan implementation conditions will be assessed.

Impacts associated with a no-action alternative will be assessed using epidemiological data on the estimated rates of infection, illness, hospitalizations, and death from previous mosquito-borne disease outbreaks to project future conditions. This data will come from previous EISs as supplemented by more recent or additional data compiled during Task 3, including the results of research on whether mosquito control efforts increase or reduce the risk of disease transmission.

Suffolk County-specific infection and disease information will be used (from State Department of Health annual reports), and future conditions will be projected to be within the range of infection and illness rates identified by previous EISs, other regional data, and the CDC. Population data from Suffolk County will be used to project the number of infections, illnesses, and deaths county-wide, and potentially for individual primary study areas, if the potential for disease occurrence and transmission is deemed to be variable across the County.

Reductions in infections, illness and deaths will be projected using information on disease control as a result of the use of pesticides and water management measures. The literature collected during Task 3 will be used to support these analyses. If quantitative data are available on disease control effectiveness, numerical estimates of the reduction in infection, illness and deaths will be calculated using Suffolk County population data. It is possible that few data will be available to quantitatively estimate the disease control effectiveness of the different management options. If so, this impact assessment will be semi-quantitative or qualitative and provide general numerical ranges of the decreased incidence of disease.

Assessment of Public Health Risks from Pesticide Exposure

The assessment of risks from pesticide use will rely principally upon predictive toxicity and exposure modeling. However, epidemiological and attributable risk data will be used, as available, to provide a more comprehensive, weight-of-evidence risk evaluation.

The conceptual model for this evaluation will begin with an identification of the adulticides and larvicides used for mosquito control, an identification of active ingredients, synergists, inert components of these products (as is possible, given trade-secret restrictions), as well as a discussion of the environmental transformation/degradation products resulting from the parent compounds, as identified in Task 3. Degradation and transformation products were not considered in previous EISs. However, these compounds can be as toxic or more toxic than the parent compound. For example, malaoxon is a metabolite of malathion that can be particularly toxic to humans. Isomalathion, which is an impurity of malathion that increases in concentration with improper storage at high temperatures, can also cause adverse health effects.

The health effects and environmental persistence of all potential compounds identified during Task 3 will be considered, and a final list of compounds will be selected for more detailed evaluation in the risk assessment. It is likely that some compounds will not be quantitatively evaluated in subsequent analyses because they are not

[5] Center for Disease Control West Nile Virus website.

especially toxic or persistent, or because the method of application renders them less likely to come in contact with human populations. For example, larvicides were not quantitatively evaluated in the public health assessment in the Westchester County EIS because of their low to non-existent toxicity to humans, and the expected low environmental concentrations. They will not be quantitatively evaluated in the human health portion of Suffolk County mosquito management plan impact assessment.

Once the final list of compounds has been selected, their source characteristics will be characterized to provide perspective on the way these compounds can enter and move in the environment. Factors considered will include the method of application, application rates, and application frequency. Fate and transport characteristics including physical-chemical properties of the compounds, meteorological conditions, and hydrologic conditions in potentially receiving water bodies will be considered. This information will be used to identify the media (surface water, sediments, air, soils) to be included in the risk assessment, and the potential timeframe for exposure analyses (acute, subchronic, and chronic). Particular areas of the county that might be susceptible to higher chemical concentrations (e.g., due to prevailing winds, low surface-water flow, poor flushing) also might be identified based on this analysis. Previous EISs will provide some of the information relevant to this analysis, but Suffolk County characteristics will be key to finalizing the conceptual approach to the fate and transport analysis. If appropriate, particular Primary Study Area characteristics will be used to guide these analyses. Based on this analysis, up to five target areas will be selected for quantitative evaluation in the risk assessment. Comparisons between other environments will be made qualitatively.

Next, information on land-use and population distributions gathered during Task 5 will be used to identify potentially exposed human populations and the pathways by which they might be exposed. Information on the likely frequency and magnitude of contact with pesticides will be used to identify exposure pathways for detailed analysis. Pathways to be considered include inhalation of dusts and aerosols, direct contact with skin, and ingestion of food, water and contaminated soil/dust.

Also, segments of the population that are potentially more sensitive to pesticide toxic effects, such as the young, elderly, or pregnant or nursing women , or more susceptible to exposure, such gardeners, anglers, or pesticide applicators and public works employees frequenting treated areas, will be identified. It is likely that only a subset of all potential pathways will be applicable for any one of the target areas. A subset of potential pathways for representative target areas will be selected for evaluation that will represent maximum exposure conditions throughout the County. Under this approach, exposure and risks in other target areas are assumed to be less. The results of the Westchester and New York City EISs will be used to identify those pathways that are associated with the greatest risk. The final pathways for quantitative evaluation will then be selected from this set of risk-driving pathways. Justification for all selections will be presented during the conceptual model development.

The final step of the hazard identification will be an assessment of the types of health effects potentially caused by the pesticides to be evaluated in the risk assessment, including potential sub-lethal effects. Again, information from previous EISs will be the primary source of this data, though new information published since the earlier EISs will be considered. In addition, the potential health effects of environmental transformation products will be assessed. The Westchester and New York City EISs did not include an evaluation of environmental degradation products. Therefore, this evaluation will be unique to the Suffolk County mosquito management program impact assessment. Based on a review of the available literature for degradation products, it is anticipated the evaluation will contain no more than five degradation products.

The public health impact assessment will include an assessment of risks from baseline exposure to pesticides that exists without implementation of the mosquito management program. Information to support this analysis will be derived from the New York City EIS and from other data specific to pesticide exposures in Suffolk County (including SCDHS and USGS groundwater studies, NYSDEC registration data, and, potentially agricultural and consumer sales data). This evaluation is anticipated to be largely qualitative and will focus on information related to the degree of current exposure resulting from pesticide use in Suffolk County unrelated to mosquito control, and from exposure to pesticides in foods and other consumer products from non-County sources. Information from the NYSDOH pesticide-poisoning registry and its surveillance of possible health effects from pesticide exposure also will be consulted. To support the baseline evaluation, data will also be compiled on the amount of pesticides that are applied annually in Suffolk County by agricultural and other users (to the extent that these data are available) along with human health toxicity developed by the USEPA for these non-vector control pesticides. This usage and toxicity information will be compared to that available for vector control pesticides applied in previous years. This will be used to provide a qualitative, relative risk evaluation of non-vector control pesticides compared to vector control pesticides.

As part of this baseline analysis, Dr. Teitelbaum of the Mt. Sinai Department of Community Medicine, will explore the incidence of breast cancer in Suffolk County and review the published and gray literature on breast cancer and pesticide exposure. Working with CPF, Dr. Teitelbaum will discuss possible breast cancer risks associated with Vector Control chemicals. Dr. Teitelbaum will also incorporate Mt. Sinai research on the impacts of chemicals on children's diseases and illnesses into the analysis.

Potential public health impacts from pesticide use will be assessed using predictive modeling supplemented by relevant epidemiological data.

Dose-Response Assessment

A toxicological assessment will be conducted to identify quantitative toxicological criteria for assessing health risks. The toxicity analysis and criteria used for the Westchester and New York City EISs will be used to quantify dose response, unless errors are discovered or they are determined to be no longer up-to-date. Carcinogenic and non-carcinogenic criteria will be identified to address risks from acute and longer-term (chronic and subchronic) exposures. In addition, toxicity criteria will be developed for any degradation/transformation products that are selected for evaluation. Standard methods employed in regulatory toxicology, such as those used by the USEPA to derive toxicity criteria in its integrated risk information system (IRIS) database, will be used if no regulatory toxicity criteria have yet been developed. The project team has substantial experience in developing toxicological criteria for evaluation of public health risks.

Exposure Assessment.

The first step in the exposure analysis will be to estimate pesticide intake in people directly contacting the compounds via inhalation of spray drift or indirectly via contact with pesticides that have deposited on soils, surface waters, sediments, food (e.g., produce), and interior surfaces that are contacted by people, or have accumulated in locally-harvested fish and shellfish.

The exposure analysis will consist of three principal parts. First, aerial transport and pesticide deposition following application will be estimated. Then persistence and/or accumulation in other exposure media will be estimated. Finally, intake in exposed persons will be calculated. In all cases, the models, algorithms and assumptions used as

part of the Westchester and New York City EISs will provide the foundation for the analysis. These will then be modified to account for conditions unique to Suffolk County and its mosquito management program.

Aerial transport and pesticide deposition will be estimated using air dispersion models developed by the USEPA by RTP Environmental. The AgDRIFT model, which was developed in cooperation with several federal agencies, including the USEPA and a consortium of agricultural chemical registrants, will be used to model the spray drift for application of the pesticide, along with model runs from the ISCST3 model. It is hoped that the results of this modeling exercise can be verified using data generated in field deposition experiments, conducted specifically for this project (see Task 3 and Task 12).

Persistence and accumulation in other media will be estimated using a variety of fate and transport models based on a tiered approach that begins with simple worst-case models and progresses to more refined models as needed to refine the risk estimates. The proposed modeling approach for this assessment is to initially conduct simple, worst-case exposure modeling and then evaluate risks. If risks under these first stage analyses are unacceptable, more refined analyses will be conducted. It is proposed to use a one-in-a-million cancer risk and a noncancer hazard index of one as the general criteria for defining unacceptable risks. These criteria are standard for risk-management decisions by regulatory agencies. Risks higher than these levels will be considered unacceptable and will be subject to refined fate and transport modeling.

All models will be predicated on a mass balance approach; however, simplifying assumptions will be made for the initial evaluation. For example, all material that lands on soil could be assumed to runoff into the nearest surface water body in order to provide a worst-case estimate of exposure point concentrations. More refined models would employ equilibrium partitioning to distribute the deposited material within the receiving media according to its physicochemical properties. A more refined analysis of the previous example would use the solubility and organic carbon partition coefficient to determine the fraction of deposited material that would bind to the soil and the fraction that could be carried off in solution via runoff. In addition, first-order loss mechanisms such as volatilization and degradation will be evaluated based on a review of the physical and toxicological characteristics of the pesticide being evaluated. Degradation products of toxicological importance will be modeled employing the same tiered approach. In general, the modeling will be conducted assuming steady-state conditions; however, time dependent models would be employed as needed to simulate acute exposures that could occur prior to reaching steady state, or for transient conditions that could significantly alter the exposure point concentrations. The simple screening-level models and many of the more refined techniques will be published algorithms from USEPA or from recognized published literature. Computer models available from the USEPA, such as the Pesticide Root Zone Model (PRZM) and the Exposure Analysis Modeling System (EXAMS), could also be used for more refined modeling applications. Results in this section may be modified based on data generated by USGS and/or County monitoring.

Indoor air exposure also will be assessed using applicable models (CPF developed the indoor air model of shower exposures that was used in the Westchester and New York City EISs). The updated and refined CPF model[6,7] will be used in the Suffolk County impact assessment, if this is determined to be an important pathway.

[6] Chrostowski, P., and Foster, S. 2001. Model Validation of Indoor Exposure to Volatile Organic Compounds from Showering. Presented at the Air & Waste Management Association 94th Annual Conference, Orlando, Florida. June.

[7] Chrostowski, P., Foster, S. and Lape, J. 1999. Integrated Multipathway Exposure Model for Volatile Organic Compounds. Presented at the Society For Risk Analysis Annual Meeting, Atlanta, Georgia., December.

Assumptions regarding human intake used in previous EISs will be reviewed too and modified as necessary to assess exposures. Both acute and longer-term exposures will be assessed. Variations in averaging time will be incorporated to address carcinogenic and non-carcinogenic risks. It is assumed that the working spreadsheets used during either the Westchester County or New York City EISs can be obtained to support the exposure analysis.

Risk Characterization

The risk characterization will be conducted by combining estimates of exposure with dose-response information to predict cancer and non-cancer risks associated with pesticide use. Acute and longer-term exposures will be calculated separately. In addition, epidemiology or surveillance data on the health effects of mosquito control pesticide use will be considered to provide a weight-of-evidence evaluation of potential impacts. The uncertainties in the risk results also will be explored qualitatively or by sensitivity analyses examining the impact of varying assumptions on risk.

Comments received during the public Scoping period highlighted a concern for potential health effects in consumers of locally grown produce or locally produced wine. Therefore, the risk evaluation will include a quantitative assessment of these pathways even if the previous analyses have not identified them as the pathways associated with the greatest risk. The detailed quantitative analysis will evaluate consumption risks for one target application area located in or near a farm and vineyards. Fate, transport and exposure modeling and the dose-response assessment will be conducted using the general methods outlined above.

Additionally, some effort will be made to determine if particular micro-environments (houses with synthetic carpets or air-conditioner filters, for example) represent risk characterizations to their occupants that vary from the standard models addressed here.

ASSESSMENT OF PUBLIC HEALTH RISKS OF WETLAND WATER MANAGEMENT

The primary anticipated public health impacts (changes in mosquito populations) of wetland water management (and, potentially, other non-chemical means of mosquito control) will have been evaluated using the procedures detailed above. Any other potential public health impacts or benefits of the proposed wetlands water management that were identified during the Task 3 literature review will be addressed in this section. Potential beneficial effects include change in the incidence of other insect-borne diseases and reductions in populations of other nuisance insects. Potential short-term adverse impacts include increased odors caused by more anaerobic wetland sediments being exposed to air, or, potentially, an increase in mosquito populations and therefore increased risk of disease. In addition, a reduction in stormwater control could lead to increased loading of coliform bacteria, nutrients, and other contaminants due to increased surface run-off. Further, alteration of the hydrologic regime in existing wetlands would result in changes to the chemical environment. This could result in increased mobility and release of heavy metals as the sediment-bound metals are oxidized to more volatile and soluble forms. This type of effect has been observed in the Everglades, for example, where mercury releases were substantially increased in drained wetlands. This evaluation is anticipated to be qualitative and literature-based.

An effort will be made, in particular, to assess any potential changes in stormwater management. As current stormwater management regulations are intended to reduce coliform concentrations (for example) in surface waters, changes in these management methodologies may have the potential for public health impacts.

ECOLOGICAL ASSESSMENT – TECHNICAL APPROACH

The ecological assessment will address ecological effects and benefits of the mosquito management program. As was the case for the public health assessment, risks from the transmission of mosquito-borne disease, pesticide use, and water management (and other non-chemical means of mosquito management) will be considered.

Assessment of Ecological Risks of Mosquito-borne Disease

Similar to the human health risk assessment, this part of the analysis will focus largely on the disease risks associated with West Nile virus (unless the disease risk analysis has indicated that other diseases need to be considered as well).

As is the case with humans, wildlife can become infected with West Nile virus through mosquito bites. CDC surveillance data document infection in a variety of wildlife species, including birds, bats, chipmunks, skunks, squirrels, and domestic rabbits. Birds, by far, appear to be the wildlife group most affected and serve as reservoir hosts for virus transmission. The ecological consequences of these infections are not yet known. Although birds, particularly crows and jays, infected with West Nile virus can die or become ill, most infected birds do survive. No cases of death in other wildlife species have been documented, suggesting that these species are not susceptible to the adverse effects of the virus. The baseline ecological assessment will include and evaluation of the potential population-level risks in birds exposed to West Nile virus. The evaluation will consider disease incidence based on Suffolk County and NYSDOH surveillance data, and mortality rates published in the literature. The potential population-level consequences of this will be explored. It is anticipated that this evaluation will be largely qualitative, as no models have yet been developed to look at population-level impacts in bird species from West Nile exposure. Data from countywide or local breeding bird or other surveys might be considered to support evaluations of baseline avian population risks in the County, to the extent that these data are available.

It is not clear if West Nile virus causes extensive illness in dogs or cats. More information has been appearing that expands on the single published report of West Nile virus isolated from a dog in southern Africa in 1982, and West Nile virus was isolated from a single dead cat in 1999. A sero-survey in New York City of dogs in the 1999 epidemic area indicated that dogs are frequently infected.

Cases of West Nile virus disease in horses have been widely documented, however[8]. Because approximately 40% of equine West Nile virus cases results in the death of the horse[9], this is potentially a significant impact associated with the transmission of mosquito-borne disease. It is anticipated that infection risks in horses will be an important focus of the evaluation of the risks of viral transmission in non-human receptors.

Few data are likely available to assess virus transmission and disease occurrence in horses. Therefore, the assessment of baseline (no action) risks will be largely qualitative. As part of the assessment, stables or farms with horses in the study area will be identified, and the total horse population estimated. Infection rates without mosquito management will be qualitatively assessed using disease prevalence data compiled from surveillance data summarized as part of the public health assessment, and potentially using data from the dog sero-survey conducted in New York City in 1999. The potential number of deaths will be estimated. Similar approaches will be used if other wildlife species are identified during the Task 3 literature review as being at risk from mosquito-borne disease.

[8] CDC. http://www.cdc.gov/ncidod/dvbid/westnile/birds&mammals.htm

[9] Ibid.

Reductions in infections and deaths will be projected using information on disease control as a result of the use of pesticides and water management measures. The literature collected during Task 3 and incorporated in the public health assessment will be used to support these analyses. It is expected that this analysis will be largely qualitative.

Assessment of Ecological Risks from Pesticide Exposure

The assessment of risks from pesticide use will rely principally upon predictive toxicity and exposure modeling. However, empirical data from field studies in which pesticides have been applied also will used, as available and as generated as [part of Task 3b (Early Action Projects) and Task 6 (Monitoring), to provide a more comprehensive, weight-of-evidence risk evaluation. Special consideration will also be given to potential impacts from larvicides.

The conceptual model for the ecological evaluation will be identical to that developed for the public health pesticide evaluation with respect to the target application areas and pesticides evaluated, the sources characteristics, and fate and transport. However, larvicides will likely receive more detailed evaluation in the ecological assessment because of a greater toxicity and exposure potential in ecological receptors compared to humans. The NYSDEC ecological toxicity evaluations on the relative toxicity of larvicides and adulticides to a variety of ecological receptors[10] will be used during conceptual model development.

A key component of the conceptual model for the ecological assessment will be identification and characterization of potentially affected habitats and selection of the species, pathways, and endpoints to be the focus of the evaluation. Information on the ecological characteristics of the Primary Study Area habitats compiled as part of Task 7 will be used. Examples of sources for species and habitat information include:

- USFW – Ecological Services, Long Island Field Office
- USGS – Biological Resources Office, New York Information
- USGS – Butterflies of Suffolk County
- Department of Biology, Hofstra University in Hempstead, New York - Amphibian and Reptiles of Long Island, Species Accounts and Distributions
- New York State Museum – New York State Biological Survey
- NYSDEC – Division of Fish, Wildlife and Marine Resources
- NYSDEC – Bureau of Wildlife
- NYSDEC – Bureau of Fisheries
- NYSDEC – Bureau of Marine Resources
- NYSDEC – Bureau of Habitat
- NYSDEC – Endangered and Threatened Species
- NYSDEC - New York State Amphibian and Reptile Atlas Project, Species Listings and Distributions
- NYSDEC – New York State Breeding Bird Atlas
- NYSDEC – New York Natural Heritage Program, Species Listings
- NYSDEC – New York State Wildlife Publications (Species Accounts for Birds, Mammals, Reptile & Amphibians, and Insects, Mollusks and Other Invertebrates
- NYSDEC – Region 1 (Nassau and Suffolk Counties) Office
- New York Turtle and Tortoise Society (NYTTS)

[10] NYSDEC. 2000. Fish and Wildlife Related Impacts of Pesticides Used for the Control of Mosquitos and Black Flies. http://www.dec.state.ny.us/website/dfwmr/habitat/insectrisk2000.pdf

Overall, the ecological assessment will focus on sensitive ecological receptors, including those that are endangered or of economic and recreational importance to Suffolk County. A matrix of criteria for receptor selection will be developed. Factors to be considered include:

- **Habitat associations and distribution**. Receptors will be selected based on their known or expected use of each of the study area's habitats.
- **Taxa.** Representatives of major taxa (e.g., birds, mammals, reptiles, plants, insects) will be considered.
- **Population status.** Endangered, threatened, and special concern (ETSC) species are more susceptible to chemical impacts given the already stressed condition of their populations. Abundance will be considered for non-ETSC species; species that are abundant in the study area have a potential for greater exposures and impacts given that these species have a demonstrated preference for study area habitats.
- **Ecological significance.** The overall role of the species in the habitat ecology will be considered. For example, the role of non-target insects in the local ecology and as an important prey source for insectivorous birds will be considered.
- **Exposure potential.** Species exposure potential also will be considered. Position in the food web, foraging method and residency during the spraying will be considered.
- **Toxicant sensitivity.** Species that are known or suspected to have a higher toxicant sensitivity will be considered as candidate receptors.
- **Societal value.** Economically and recreationally important species and species otherwise valued by the local or regional populations will be candidate receptor species. For example, important shellfish (*e.g.,* lobster) and recreational fish species will likely be included in the ecological assessment. Similarly, public comments received during the scooping process identified insectivorous birds and pets as important, non-human receptors. Each of these species groups will be considered during the receptor assessment.

Species that were selected as part of the Westchester County and New York City EISs will be selected to the extent that they are deemed to be appropriate ecological receptors for the Suffolk County mosquito management plan ecological assessment. Use of these species will reduce assessment costs because previously compiled data can be used in the ecological risk assessment. However, there are a variety of habitat types and conditions particular to Suffolk County that will likely result in a unique set of receptors for this ecological evaluation. At a minimum, however, the results of the previous EISs will be used to focus the assessment on those receptor-pathway combinations that are most likely to result in the maximum ecological impacts.

The final step of hazard identification will be an assessment of the types of ecological effects potentially caused by the pesticides to be evaluated in the risk assessment. Information from previous EISs will be the primary source of this data, though new information published since the earlier EISs will be considered. In addition, ecotoxicity data on the degradation/transformation products will be summarized.

Drs. McElroy and Brownawell will assist CPF by qualitatively evaluating risks associated with non-target marine species, with special attention being paid to saltwater marsh ecosystems, and to economically-valued crustaceans such as crabs and lobsters. The intent of this portion of the study will be to find which species may be most at risk from various considered pesticides.

The ecological impact assessment will include an assessment of risks from baseline exposure to pesticides that exists without implementation of the mosquito management program. Information to support this analysis will be derived from national and regional databases on the levels and effects of pesticide residues in wildlife. Potential

information sources include the USGS National Contaminant Biomonitoring Program, the US Army Corps of Engineers Residue Effects database, and the NOAA Status and Trends program. This evaluation is anticipated to be largely qualitative, though some of the available data might support quantitative risk analyses. In addition, baseline information on non-vector control pesticide usage rates in the County and the relative ecological toxicity of vector control and non-vector control agents will be used to provide a qualitative, relative risk evaluation of non-vector control pesticides compared to vector control pesticides under baseline conditions.

Potential ecological impacts from pesticide use will be assessed using predictive modeling supplemented by relevant empirical data from field studies. In addition, data collected as part of early demonstration projects and project monitoring efforts will be used to refine estimates of toxicity, exposure, and risk.

A tiered ecological risk assessment approach will be used. Initially, simplifying assumptions will be made to provide worst-case estimates of risk. Receptors and pathways not associated with significant risks under this tier will not be evaluated further. More refined analyses that better represent exposure conditions and/or toxicity will be conducted under the more detailed assessment. The tiered risk assessment approach is consistent with USEPA guidance for ecological risk assessment and was used to evaluate ecological risks in the Westchester and New York City EISs.

Dose-Response Assessment.

A toxicological assessment will be conducted to identify quantitative ecotoxicological criteria for assessing ecological risks. The toxicity analysis and criteria used for the Westchester and New York City EISs will be used to quantify dose response, unless errors are discovered or they are determined to be no longer up-to-date. Risks from acute and longer-term exposures will be considered. In addition, toxicity criteria will be developed for any degradation/transformation products that are selected for evaluation. Standard methods employed in ecotoxicology will be used to derive toxicity criteria, if published criteria do not exist. Members of the project have developed peer-reviewed and accepted procedures related to the derivation of ecotoxicological benchmarks.[11]

Exposure Assessment.

The fate and transport modeling conducted as part of the public health assessment will be used to predict the concentrations of pesticides in air, water, soil, sediment, and wildlife food (these data will be verified based on project monitoring results, where appropriate). Then, data on the rate, frequency, magnitude, and duration of receptor contact with the pesticide will be used to estimate dose. The exposure assumptions will be derived from standard ecological risk guidance documents available in the technical and peer-reviewed literature. Exposure models and assumptions developed by USEPA, including the Office of Pesticide Programs, will be used. The models and assumptions used in previous EISs will be reviewed to determine applicability to the Suffolk County Mosquito Management Program impact assessment, and modified as necessary to assess exposures. Both acute and longer-term exposures will be assessed, as applicable. Again, it is assumed that the working spreadsheets from the previous EISs will be obtained to inform the exposure analysis.

Exposure assessment data collected as part of early demonstration projects and during the Phase I monitoring program being conducted by the SCDHS during the summer of 2002 also will be used, as available. For example, if the SPMD study is conducted under the Phase I monitoring, it will be potentially useful in characterizing pesticide

[11] Durda, J. and Preziosi, D. 2000. Data quality evaluation of toxicological studies used to derive ecotoxicological benchmarks. Human and Ecological Risk Assessment. 6(5):747-765.

partitioning and accumulation in aquatic organisms. Similarly, underflow quantification and pesticides concentrations derived from the subaqueous discharge meter program will also be helpful.

Risk Characterization.

The risk characterization will be conducted by combining estimates of exposure with dose-response information. A hazard quotient approach will be used. A hazard quotient (HQ) is the ratio of the predicted exposure to the toxicity criterion. HQs less than one are interpreted as indicating no adverse ecological effect. HQs greater than one suggest an impact is possible. In these situations, other data will be used to interpret the significance of the predicted risks. This will include the consideration of empirical data from pesticide field studies. The uncertainties in the risk results also will be explored qualitatively or quantitatively by sensitivity analyses examining the impact of varying assumptions on risk estimates.

Comments received during the public Scoping period highlighted a concern regarding the health effects of pesticides on human pets. Therefore, the quantitative ecological risk assessment will include an evaluation of the potential pesticide exposures and risks in pets. We anticipate evaluating risks in dogs and cats, because the data necessary to characterize potential exposures and toxicity are more likely to be available for these animals than for other domestic pets. The primary pathways likely to be evaluated include inhalation, ingestion while grooming, and incidental ingestion of soil. The degree to which any pathway can be quantitatively evaluated will be largely dictated by the availability of quantitative exposure and toxicity data.

Comments received during the public Scoping period also highlighted a concern for potential impacts in insectivorous birds directly from exposure to pesticides in the diet and environment, and indirectly as a result of pesticide-induced alterations in insect prey density or abundance following spraying. Therefore, the impact assessment will include an evaluation of potential impacts on insectivorous birds from these direct and indirect effects. This will be approached by evaluating the dietary exposure risks for insectivorous birds in the target application area predicted to have the highest environmental residues and highest food-chain bioaccumulation. This evaluation will likely be quantitative and will be conducted for a representative insectivorous species that occurs in the County. The impact assessment also will include an evaluation of the potential indirect effects as a result of pesticide-induced prey reductions. As part of this assessment, the potential for significant reductions in the non-target insect abundance following spraying will be evaluated, and, if so, the potential magnitude of that decrease. If significant reductions are expected to occur, available ornithological literature will be reviewed to identify data that characterize changes in population size or decreased reproductive success in insectivorous birds as a result of changes in prey density or availability. A quantitative or qualitative estimate of population-level impacts will be provided, depending upon the quality of the data available to support such estimates.

Assessment of the Ecological Impacts of Wetland Water Management

The literature review and evaluation conducted during Task 3 will provide the data to assess ecological impacts and benefits of proposed wetlands water management alternatives. A conceptual model will be developed to explain the hypothesized relationship between different wetland management techniques and ecological response. Potential benefits to be assessed include increased fish and wildlife habitat. Potential impacts include decreased fish and wildlife habitat and increased contaminant loading to nearby waterbodies. The ecological consequences of these actions will be discussed.

Determination of ecological impacts from choices in marsh management is not a simple task. It is difficult to identify key parameters that directly indicate impacts. However, if the marsh itself is maintaining its health, in the broadest sense, then it would seem that overall environmental and ecological impacts on the system have been minimal.

Thus, marsh management scenarios require well-designed, forward-thinking plans that consider the broader context of wetlands. Because recreated wetlands continue to have a high failure rate, it is necessary to carefully evaluate any marsh restoration and modification projects. It may be impossible to return a modified system back to some pre-modification state; thus, all changes need to be viewed in terms of the precautionary principle.

One mechanism for understanding the health of a marsh is a careful and diverse monitoring program. The physical, chemical, and biological dynamics of a marsh system are centered on the plants in the marsh. Because salt marsh grasses are perennials, reproducing their above-ground stems and leaves each year, they can reveal an annual response to changing environmental conditions. The kinds of data that should be evaluated include biseasonal measurements of:

- plant stem density
- growth height
- above-ground biomass
- fall seed production

Because it is not known how plants might respond to environmental modifications (given many other controlling factors), these diverse but simple measures provide a cross-section of floral biology, from growth rate, to robustness, to reproductive strategies (i.e., sexual [seeds] vs. asexual [rhyzomal cloning]). To account for natural environmental variability, these parameters will also be measured at undisturbed control sites. Typically, such measurements are made through randomly-selected, areal assessments (quadrats).

Two other simple parameters that need to be evaluated are near-surface porewater salinity and short-term sedimentation rates. These two parameters are probably the best early indicators of potential marsh stresses, and represent both chemical and physical causes. The shallow porewater salinity values can reflect changes in the hydrological system that inundates the surface and feeds sediment and nutrients to the marsh. Assuming a constancy of tidal regimes, decreasing salinity indicates either an increase in freshwater inputs to the system or a decrease in salt-water advection onto the marsh. Either change may be harmful; decreases in pore-water salinity are often associated in the literature with phragmites invasions (although some local research indicates this may not be the variable that controls phragmites spread). Changes in pore-water salinity generally act as a surrogate for larger water movement changes. Since the movement of water controls movement of sediments, this parameter might be used to forecast sedimentation rate changes (which take a longer time frame to become apparent).

Changes in sedimentation rates themselves, however, are vital to understand the long-term future of any marsh today. Due to sea level rise (the local change in sea-level in the 20th Century was documented as 2.4 mm per year; it is projected that the rate will increase due to global warming in the 21st Century), all local marshes need to either accrete sediments or retreat shoreward in order to maintain their areal extent. In nearly all Long Island environs, urban development (or steep slopes) preclude shoreward migration. This means that Long Island wetlands must accrete sediments equivalent to sea-level rise in order to maintain themselves. It is possible to measure short-term sediment accumulation by placing textured plates on the marsh surface and examining the sediment that collects on

them over one or more tidal cycles; further analysis of the sediments allows for determination of the source and composition of the material, and therefore a determination of its long-term value (and availability) to the system..

Because of the paucity of County-wide data on these important parameters, the CA/CE Team has included the development of a short-term monitoring program in the Tier 1 marshes as a means of creating some baseline data sets to evaluate marsh health. These data can be compared to the few long-term marsh measurement data sets such as the FANS project to determine if there may be impacts from some of the proposed marsh modifications.

The objectives of the three year USFWS study being directed by Dr. James-Pirri are to compare parallel-ditched salt marshes with OMWM marshes. Specifically, this study is designed to evaluate the effects of OMWM and/or ditch plugging on marsh hydrology (marsh water table levels, soil salinity, and extent of surface water flooding), sedimentation and marsh development processes, vegetation patterns, utilization by nekton (fish and decapod crustaceans) and birds, and mosquito control. This study employs a BACI study design (Before, After, Control, Impact). At each study Refuge pairs of marshes have been selected that include a ditched (treatment) marsh and a control marsh. The ditched marsh and control marsh are sampled for one year prior to any OMWM activities (Before). Then in year two, OMWM is performed on the ditched marsh and sampling proceeds (After). In the BACI design, the practice of OMWM is the Impact and the undisturbed marsh is the Control. With this kind of study design it is possible to evaluate, with a degree of statistical certainty, the initial response of the marsh to OMWM. Study sites have been established at Prime Hook NWR (Delaware Bay), Edwin B. Forsythe NWR (Atlantic Coast of NJ), three different sites in the Long Island NWR Complex (Wertheim NWR, Sayville, and Flanders), Steward B. McKinney NWR (Long Island Sound, CT shoreline), Parker River NWR (northeastern MA shoreline), and Rachel Carson NWR (southern ME).

The National Park Service's Northeast Coastal Barrier Network has indicated interest in a similar study at National Park Service sites from Maine to Virginia.

The on-going USFWS study of OMWM will have some data that appear to be pertinent to the above concerns. However, the USFWS study is concentrating on water budget and biota effects (including determinations of presence/absence for plants, rather than quantitative determinations of biomass change) as measures of marsh variations in response to OMWM treatments. The CA/CE Team finds the USFWS approach interesting, but believes the County may wish to monitor the parameters noted above to additionally assess marsh well-being.

In any case, because one or two years of data collection (or even the three years of data that may be available from USFWS by 2004) will not address long-term marsh dynamics, out-of-County analogs will be presented as projections of potential impacts. Areas that may serve as reasonable analogs to address County marsh management concerns include Jamaica Bay and Louisiana for negative examples of marsh management, and Connecticut and New Jersey where management efforts have been much more benign. More locally, although somewhat tangential because of many of the systems are freshwater, the marshes of the Hudson River north of New York City offer some examples of more managed environments that nonetheless have remained robust ecosystems (despite insults from invasive species along with anthropogenic effects).

The Team will carefully review these examples in order to extract benefits realized elsewhere, while hopefully excising the aspects of other projects that led to marsh ill-health or demise. Through this exercise, the CA/CE Team

will develop a knowledge base sufficient to generate a useful Marsh Management Handbook, and establish the proper role for OMWM in optimal mosquito control for the County.

ALTERNATIVES ANALYSIS

Once the risks associated with the evaluation management plan have been characterized, alternative pesticide application and marsh management options will then be considered. The Alternatives analysis will be streamlined, primarily focusing on the populations, exposure pathways, and endpoints that were associated with the greatest risks in the evaluation management plan assessment. It is anticipated that a portion of this analysis will be largely qualitative, by comparing relative potencies or fate characteristics of the alternatives compared to those in the evaluation management plan.

The alternatives analysis will include a quantitative risk evaluation of the 2002 West Nile Response Plan used by the County, focusing on the identified risk driving scenarios. The alternatives analysis also will evaluate the relative risks of aerial, truck, and hand application methods, using qualitative information from the literature and the results of air dispersion and deposition modeling for these different application scenarios. In considering ecological impacts of alternative application means, special impacts that may be associated with aerial applications over wetlands (with regard to avian species) will be considered.

RECOMMENDATIONS

The results of the baseline, evaluation management plan, and alternatives analyses will then be summarized and compared. This information can then be used to support risk-based decisions for the design of a final mosquito management plan that maximizes public health and minimizes environmental impact.

The Task 8 draft report is anticipated to be completed in the late Fall (November, 2003; 30 copies will be produced). The final report (30 copies) should be available before the New Year, 2004, assuming a brisk review process.

Task 9: Management Alternatives

After a thorough review of the County's existing Vector Control program and examination of control programs in other jurisdictions, the CA/CE team would investigate alternatives to the current management approach by the County. The advisability of pursuing any particular alternative will be determined according to its:

- Environmental advantages/disadvantages;
- Implementation feasibility;
- Public/environmental health implications;
- Cost/benefit implications;
- Financial implications;
- Long-term institutional coordination and oversight options;
- Long-term monitoring plan.

If promising alternatives were uncovered, they will be evaluated for potential use in the Primary Study Areas identified in Task 7. Selected management alternatives would be further scrutinized in terms of the following criteria.

Minimization of Human Health Impacts.

Selected management alternatives would be examined in terms of potential changes to rates of disease transmission. The CA/CE team, working closely with Drs. Spielman and Pollack, will assess potential changes in the risks of acquiring endemic-to-Long-Island diseases such as EEE and WNV, as well as potential future threats from other mosquito-borne diseases including malaria and yellow fever. The relationship between various sentinel monitoring results and precise, local human health risks, insofar as they can be determined at this time, will be discussed and quantified. Changes in the perception of risk as different organisms present as carriers will be included, as these changing risks may affect the control of pest mosquitoes such as the salt marsh species.

The human health risk assessment would focus primarily on risks associated with exposure to mosquito-control pesticides such as the pyrethroids (*e.g.*, Anvil) and organophosphates (*e.g.*, malathion). Various air, water, and ingestion exposure pathways associated with various application technologies would be investigated. Much of this data is available from sources such as the New York City and Westchester County EISs, but certain application modes may not have been adequately treated there or elsewhere. The CA/CE team will include this information as part of a Suffolk County-focused investigation, using the expertise of CPF (human health risk modelers and analysts) and RTP Environmental (air modelers). First-order estimates of risk can be used to prioritize alternative treatments. Those that appear to be effective and have the least risk can be investigated in depth. Surface water and air dispersion modeling will determine the potential exposure for various at-risk populations and quantify the risk posed by particular pesticides at a various application rates and means. The models could be used to theoretically vary pesticide application rates and techniques in order to predict change in public health risks.

The risks associated with pesticide applications would be compared to the risks associated with diseases, to ensure that the health risks from mosquito control are less than the risk to human health posed by the mosquitoes.

Considerable attention has been focused on the association between exposure to pesticides and the risk of acquiring breast cancer. Alternatives that include pesticide treatments will be assessed by Dr. Teitelbaum for breast cancer concerns, as well as special concerns that may be associated with childhood disease/illness incidence and exposure to chemicals such as pesticides. This portion of the study will attempt to refine understanding of the role played by mosquito-related pesticides in these problems.

The human health considerations may vary depending upon population densities associated with surrounding land uses, but are unlikely to be dependent upon marsh classifications (as developed in Task 7). Therefore, the human health risk assessments are likely to be made on a County-wide basis rather than in terms of the Primary Study Areas.

The overall human health risk analysis will also address the potential for differential risks for sub-populations – as some believe children may be more at-risk from chemical exposures but older adults may be more at-risk from West Nile virus. Thus, the potential exists that the selected management plan may shift risks from one population to another, while reducing overall human health risks. This issue will be thoroughly explored.

Minimization of Environmental Impacts

The discussion of environmental impacts would be framed almost entirely in terms of the Primary Study Areas.

There are generally fewer environmental impacts from early intervention with natural and biological controls as compared to later, artificial, chemical, and more widespread techniques. Therefore, the selection of alternatives would emphasize source-reduction programs that reduce mosquito propagation and programs with a strong surveillance component. These alternatives enable targeted, minimized control.

Surveillance alternatives will be strongly influenced by the Early Action program results (see Task 3). The Team anticipates that a concerted surveillance and mosquito monitoring effort will reap many dividends. Knowledge of where mosquitoes propagate and how they migrate to populated areas will strongly influence treatment options.

Temporal and spatial sampling intensity will be dependent on the intended mosquito program function. Disease-risk surveillance efforts will be different from responses to nuisance complaints, or more general mosquito population surveys.

Proper surveillance is essential to optimal placement of mosquito traps and to identifying zones where larviciding would be initiated. The effectiveness of surveillance may be increased if wetland plant species can be identified that are associated with mosquito propagation (see Task 3 early action proposals). Mapping the location of the plants would then be a means of predicting the location of mosquito breeding areas.

Source reduction -- or the elimination of breeding habitat (primarily standing water into which mosquitoes lay their eggs) -- can have a significant impact on mosquito populations. The CA/CE team would reinforce the County's public education effort to reduce unnatural habitats such as stagnant birdbaths, discarded tires, and other unintentional or unmanaged rainwater catchments. The CA/CE effort will include a review of Highway Department maintenance procedures for storm sewers and catch basins to ensure that best mosquito management control procedures are in place. The CA/CE team will also investigate new approaches to the management of recharge basins. Many mosquito control agencies in Florida, for example, have had good results controlling mosquitoes associated with stormwater impoundments with minimal or no adverse environmental impacts. The CA/CE team would investigate whether those techniques could be adapted to Suffolk County recharge basins, and what the potential adverse environmental impacts might be.

An important focus of the source control effort would be a review of water management in salt water wetlands. The Long Island Wetlands Initiative has proposed using OMWM to increase habitat for mummichogs and other insectivorous fishes as a means of controlling mosquito populations. The CA/CE team would examine the thesis that OMWM, by altering, removing, or undoing mosquito control ditches, can return wetlands to a more natural condition that reduces standing water, reduces mosquito breeding habitat, increases fish habitat, and generally decreases adult mosquito populations. Ducks Unlimited has provided most of the funding to support OMWM efforts locally, and, in concert with Dr. Pirri-James and USFWS, has been the major investigator of OMWM effects to date. CA/CE proposes to independently verify much of that information.

The CA/CE team is fortunate to include Dr. Goodbred, as he has been evaluating the effects of ditch plugging in the Carmans River-Wertheim National Wildlife Refuge area. He also has a research interest in the various factors that impact Long Island marshes, both in terms of growth and areal reduction, and has looked at many of these effects under different tidal regimes. The CA/CE team, with direction from Dr. Goodbred, would evaluate the short-term and long-term effects of OMWM on saltwater Primary Study Areas. A major concern of the CA/CE team would be to ensure that proposed actions do not decrease wetland functionality. Therefore, those marshes deemed highly functional as part of the Task 7 evaluation would be more strictly assessed than those wetlands assessed as damaged or impaired (*per* the definitions in Task 7).

The team would compare mosquito propagation rates in marshes with ditches to marshes that have already been subjected to OMWM, such as the Carmans River area. It is proposed to operate a controlled experiment to compare ditched and unditched wetlands (or sections within particular wetlands), perhaps expanding the effort to include pairs in each of the tidal regimes by 2004. Initial results would be incorporated into the EIS, supplementing the literature search conducted in Task 3. Results of the study could have an immediate impact on the County's mosquito control management plan.

The effectiveness of stocking insectivorous fish (mummichogs and mosquito fish) in controlling mosquito populations will be assessed. The Team would provide estimated stocking costs and would evaluate whether the fish would be self-sustaining in various Primary Study Areas (including recharge basins). The Team will also assess the fish in terms of more active management regimes (including various restocking scenarios). The CA/CE team would determine whether changes would be required in recharge basin water management to promote habitat for mosquito fish. An important conclusion to be reached concerns the potential benefits of fish stocking in recharge basins as compared to additional management costs and the potential for creating more mosquito-breeding habitat. An additional factor is the added value of inland habitat (even if not natural) on Long Island if it contains permanent water. The study would also examine which other mosquito consumers might be appropriate and effective in reducing mosquito populations. The CA/CE team would review the effectiveness of bats, dragonflies, and certain birds that have received attention as mosquito predators, and would evaluate the efficacy of increasing their present-day numbers substantially to reduce adult mosquito populations.

Larviciding has always played an important role in mosquito management. Applications of DDT and surface oils have been phased out in favor of more environmentally-friendly pesticides. At this time, the County uses combinations of Bti, Altosid and Vectolex. However, it is not clear if it is possible to increase larval deaths sufficiently to influence adult mosquito populations. Mosquitoes are typical *r*-species insects that are characterized by large numbers of offspring, few of which survive to adulthood. If 99% of all mosquito larvae usually die from natural causes, then a larvicide with 99% effectiveness may not significantly change the absolute numbers of adult mosquitoes. Therefore,

it is appropriate to test the effectiveness of various larvicidal applications in comparison to control sites for their impact on adult populations.

Additionally, pesticide applications always run the risk of generating resistant populations. Dr. Parsons and Dr. Crans are very familiar with this problem and would guide the CA/CE team in devising optimal treatment patterns to reduce resistance rates in Suffolk County.

The intent of examining these options is to determine the most effective means of larvicidal use for Tier 1 wetlands. Additionally, CA/CE would determine the optimal rotation of larvicides to reduce resistance and their potential impacts on non-target species.

The use of pesticides to control adult mosquito populations may be one of the public's greatest environmental concerns. Although the County has reduced adulticide applications, the CA/CE team would determine if further reductions are possible to minimize potential impacts.

As one means of assessing the environmental impact of spraying, the CA/CE team would take aqueous and sediment samples following near-marsh applications to measure unintended drift. The Brownawell laboratory may develop a biotic monitoring component (potentially utilizing blue mussels as the organism of choice). Monitoring at a variety of Tier 1 saltwater wetlands would help resolve how different geographic and/or marsh characteristics affect drift distances and directions. This would allow the Team to develop practical buffer zones to prevent pesticide contamination of wetlands.

Worst-case ecological risk assessments would be conducted primarily by CPF (see Task 8). These would be augmented by literature work on non-target marine species impacts by Drs. Brownawell and McElroy. They will focus on commercially important species such as crabs and lobsters, but would also include work on a variety of wetland invertebrates that could be exposed to the compounds of concern.

Research in Florida has made it clear that under certain circumstances physical traps may be extremely effective in controlling mosquito impacts on communities. It is necessary to develop a clear picture of where mosquitoes are propagating and the defined migration pathways they follow from the wetlands to the community. The CA/CE Team believes that this depth of knowledge can be obtained for some of the Tier 1 marshes and their immediate environs through careful and detailed surveillance work. Then, it may be possible to determine, given data on the effectiveness of various traps (physical baffles and/or contact pesticides), whether a string of traps could curtail adult infestations of residential areas as effectively as adulticide applications. It may be that, given restrictions on adulticide use, in certain locations the physical traps would be more effective than pesticides. CA/CE expects that the results from its limited experiment on this process will adequately test this theoretical means of adult mosquito control.

The work in the Tier 1 wetlands would then be evaluated with regard to its application in Tier 2 settings. Potential environmental impacts would be extrapolated from those identified in Tier 1 sites and from the literature and the experiences of team members such as Dr. Parsons. The environmental impact assessment would play an important role in ultimately determining the vector control long-term management plan fashioned by the CA/CE team.

Legal Controls

Marsh management and mosquito control are heavily regulated. All management options would be carefully considered in light of wetland and pesticide use regulations. The CA/CE team includes an environmental lawyer (Mr. Sinnreich) to ensure that all recommendations meet regulatory and legal requirements.

The CA/CE team would also review the "Do not spray" list maintained by the County pursuant to County law. The Team would identify areas where the pesticide avoidance list is sufficiently dense to trigger bans on aerial spraying. Bowne Management Systems will prepare GIS maps of these addresses to help make those determinations.

Enforcement staff associated with the relevant laws and regulations would be solicited to determine the potential impacts of existing and proposed mosquito control options on regulatory efforts. One important consideration may be the difficulty in obtaining "other than non-detection" analytical results from environmental samples.

Programmatic Implications

The CA/CE team would consider the potential impact of proposed management alternatives on SCDPW staffing and budgets. Dr. Parsons, who manages a mosquito control program in Houston, Texas, that is similar in size and scope to the current County program, would help assist in analyzing these potential impacts.

The team would be sensitive to those elements of the proposed management plan that could require specialized personnel or additional training for current personnel. All cost estimates would be apportioned between operating and capital expenses. The CA/CE team would also differentiate between one-time charges and on-going expenses. Efforts would be made to determine both short-term and long-term costs for major elements for each alternative. Since Dr. Parsons has nearly 30 years experience with public mosquito control programs, he would be extremely valuable in determining the practicality of options as they are identified.

One institutional issue that would be discussed is the division of responsibilities for mosquito control between SCDPW and SCDHS. This is not standard in other areas of the country. Options to be discussed would include the creation of a separate organization with vector control responsibilities, re-organization of vector control entirely within one department or the other, and a no-action alternative. It will be essential that responsible parties be clearly identified, however, no matter which institutional model is selected. Factors discussed elsewhere that may influence this report include the importance of monitoring and surveillance to the selected program, and options selected with regard to marsh management (especially the amount of physical marsh alterations that are projected to be necessary).

Finally, it will be important to document the on-going nature of the program. The management plan approach used to derive the vector control program espouses an adaptive management paradigm. The selected plan will be subject to revision, as the oversight groups (especially the Steering Committee, but potentially the TAC and CAC) reconvene to review the results generated by the continuing monitoring and research programs. Especially because the wetlands research and monitoring may not produce essential results for years after the conclusion of the initial effort associated with the program, it is necessary to understand that elements of the program maybe subject to substantial changes after the completion of the Tasks outlined in this proposal.

SELECTION OF THE PREFERRED MANAGEMENT PLAN

The preferred management plan would be that plan that minimizes human health and environmental impacts, at the least cost, while eliminating nuisance impacts as well, all without violating federal, state and local regulation and without causing major institutional changes.

Since no one option is likely to meet all those criteria, the CA/CE team would attempt to reduce the number of alternatives (and options within the alternatives) to a manageable number as a first cut. These Potential Program Alternatives would be presented to the Steering Committee, with follow-up presentations to the TAC and CAC as requested. Steering Committee feedback would allow further refinement of the plans to two Preferred Program Alternatives (with a minimal number of options within each alternative). The Team would then present its Preferred Mosquito Management Plans to the Steering Committee for its input. The TAC and CAC would also be solicited, as requested. This would allow CA/CE to finalize the Proposed Plan.

There are many means used to determine a preferred option from a set of alternatives. The choices available increase with the complexity of the problem. The kinds of decision tools can be described as either quantitative or qualitative.

Quantitative tools are often preferred because they (notionally) have less bias than qualitative decision-making. The development of a numerical ranking has the appearance of being an operator-free process. Therefore, the use of decision matrices based on the assignment of either rankings or relative, weighted scores is often used for decisions where controversy may be expected.

However, the determination of variables, the weighting of scores and the determination of scores and/or rankings is far from bias-free. Very often, quantitative matrices of these kinds merely make the analyst's qualitative or selective choices invisible to the audience, and create a veneer of value-free decision-making. This is often a criticism of risk assessments, for example.

The CA/CE team believes that the County's decision-making process for this program must be as transparent as possible. It is possible to develop a consensus on rankings through various facilitative meeting/decision-making techniques, although when differences in background biases are too great these techniques often do not reach successful completion. However, the best implementation of these consensus-building techniques require fairly long periods of time (in land use planning, for example, several months to a year may be consumed in determining the parameters to be used to address community concerns).

The CA/CE Team proposes to seek a less numerically-driven determination of the preferred alternative. It has been our experience in complicated matters such as this, a rational consensus of qualified experts results in superior decisions. Such a process is well-suited to the EIS process, because the explicit discussion of the relevant issues often lends itself to the development of the impact statement itself.

CA/CE does not propose to make this determination based solely on its own set of experts. The County, the TAC, and the CAC will be expected to substantively participate in the process, and, in fact, largely drive the process. It is expected that many aspects of the project will resemble the formal elements of Task 1. The consultant will develop a first approach to the task, including a slate of alternatives for the County, TAC and CAC to consider. It is likely that the CA/CE Team will advise these groups that one (or more, in some instances) of the alternatives are more

favorably perceived by CA/CE, initially. However, the Team expects substantial feedback from the County, TAC, and CAC, and this iterative process may very well lead to the selection of another alternative, or substantial modifications to the initial choices.

This process will occur through a combination of formal presentations and more intimate participation – such as small group settings, or through invited commentaries on selected written drafts.

Ultimately, the County will need to approve of the decision that will be presented. The CA/CE team will have a distinct focus to determine the preferred alternative of the consensus of the County; much of the process may be driven by adjustments to meet objections, recommendations, queries, and comments from these sources.

Throughout the process, the intent of the decision-making will be to identify options that minimize risks to the health of County residents (from actual mosquito control as balanced by disease risks), minimizes short-term and especially long-term environmental impacts (especially with regard to the long-term health of the County marshes, as can best be projected), is feasible given County resources and personnel commitments, and minimizes financial impacts on the County and its taxpayers.

A draft report on management alternatives would be disseminated. After comments are received, a final report would be issued. The usual thirty copy distribution would be followed.

The CA/CE team would have a goal to finish this task by the new year, 2004. However, this section is one of the most sensitive portions of the study, and it may be that additional time will be necessary to address all concerns put forth by the various oversight groups.

Task 10: Management Plan Report

When the management planning process discussed in Section 9 has been completed, the CA/CE Team will produce a draft Management Plan Report. This report would contain the following elements:

Overview of the Plan

This will be a general discussion of the intent of the program, the identified benefits to the approach chosen, and the potential environmental and human health impacts associated with its implementation. This will serve as the Executive Summary of the report.

General implementation elements

This section will be a more detailed discussion of the issues addressed by the program and its overall structure. This will serve as the Introduction of the report.

Implementation at Tier 1 (primary study) sites

This section will detail the specific program elements suggested for implementation at the Tier 1 sites.

Implementations at Tier 2 sites.

Tier 2 sites fall into two categories: those with an analog in the Tier 1 sites; and those that would strictly be addressed by the more generic aspects of the Plan. In either case, those aspects of the Tier 1 site discussion that are applicable to Tier 2 sites would be presented in a format suitable for implementation.

Implementation Timeliness

A schedule would be prepared for adapting the current County control plan to the proposed plan. Some aspects may be implemented immediately, while others (dependent on permit or equipment acquisition, or further information gathering) might require a longer time horizon.

Expected Benefits

This section would establish the goals of the program in terms of reduced mosquito populations, disease transmission, and quality of life problems. All discussions of benefits will be balanced by a thorough discussion of costs (financial and otherwise).

Plan Management Structure

This section would detail the division of responsibilities in the County for implementation and operation of the program. Responsible entities will be clearly identified, along with their associated pertinent tasks and management concerns.

Cost Estimates and Innovative Financing Methods

The CA/CE team would estimate the capital and operational cost of the program over an appropriate time scale. The Team would also endeavor to find grants and other mechanisms for reducing costs to County taxpayers.

Monitoring Program

The long-range monitoring program would be detailed in this section to provide management information to help guide the County operation and review of the Plan. As discussed under Task 6, the discussion will be presented with at least three levels of prioritized effort (and costs), along with recommendations for on-going research initiatives.

Acceptable Alternatives

It is quite probable that some of the alternatives reviewed in the course of developing the Plan would meet County goals. Alternatives whose implementation might generate similar benefits (for similar costs – both financial and otherwise) – would be detailed in this section.

Plan Evaluation Metrics (Quantifiable Goals)

The report would close with this section, which would develop quantifiable goals for the program. It is expected that the monitoring program will produce the necessary data to test these goals. Examples of the kinds of metrics are: cases of mosquito-borne disease; numbers of citizen quality of life complaints; acres of reclaimed wetlands; miles of ditches maintained; mean concentrations of certain target compounds; examples of biota displaying impacts from the program; etc.

Appendices:

- Best Management Practices Manual

This manual would detail the practices required to implement the proposed program with minimal impacts to human health and the environment.

- Local implementation of NYSDEC OMWM manual

This manual would adapt the existing NYSDEC guidance manual for the classified Tier 1 and Tier 2 sites.

- Finalized task reports

The draft report would be submitted to the Steering Committee for review and comments, and then would be finalized. One hundred copies of the final report would be produced, along with 500 copies on CD-ROMs.

If the process of completing Task 9 has proceeded smoothly, the draft report will be submitted in January of 2004, with the final produced by the end of February-early March, 2004. As discussed in Task 9, however, there is a possibility that this schedule may be difficult to maintain.

The CA/CE Team, especially Bowne Management Systems, will work with the staff of Vector Control to broaden the Division's existing web site. The Executive Summary of the Environmental Impact Statement (EIS) will be posted to the web site along with a table of contents, similar to the New York City and Westchester EISs, with individual chapters available for download in PDF format. The results of the EIS Scoping session will be similarly posted to the site along with public presentation and meeting notices. The Draft Suffolk County Vector Control and Wetlands Management Long-Term Plan will be posted for download and public comment. The Final Long-Term Plan will be available for download from the web site.

Contact information for the CAC, Steering Committee, TAC, and others will also be available. The existing Vector Control site is good, but would be reformatted to make it more readable and more easily navigated. All of the links should work, and more detail could be added to some of the features. The new site would serve as an expanded public information clearinghouse with static maps, graphics, and interpretive materials designed to provide both background and up-to-date information. Additional background information would be provided on mosquito biology, species, natural history and habitats, mosquito-borne diseases, and methods of control taken from the report. Detailed information about the County's Vector Control program from the report would include surveillance

techniques, on-site inspections, larval and adult control agents (their effectiveness and safety), when and where the County sprays, where and when they don't spray.

The Santa Clara County Vector Control site is a good municipal mosquito control site (http://www.sccvector.org/). Other well-constructed and informative county sites are:

- Leon County Florida: http://www.co.leon.fl.us/mosquito/mcserv/default.htm
- Manatee County Mosquito Control District, Florida: http://www.manateemosquito.com/
- Marin/Sonoma County Vector Control District, California: http://www.msmosquito.com/
- Saginaw County Mosquito Abatement Commission, Michigan: http://www.scmac.org/

The web site will not be fully implemented until the DEIS is released. CA/CE expects that many aspects of the site can be installed much earlier than that. The web site would be preferentially sited on the County server, but the CA/CE Team will find an alternate server if that is not feasible.

Task 11: Peer Review and Meetings

At four junctures in the program, peer review comments will be solicited by SCDHS and SCDPW on the program. Input will likely be sought on the following:

- Final Scope of Work and the proposed Monitoring Plan (Phases II and III)
- Results of the data compilation (Tasks 2-5)
- Proposed approach for analytical tasks (Tasks 6 through 8)
- Results of the study area refinement, impact assessment, and management alternatives (Tasks 6 through 8)
- Recommended management plan and draft final report

The Team would reply to the peer review comments and modify the work project accordingly as appropriate.

Representatives of the Team would attend the initial Scoping meetings as described in Task 1 as well as the following meetings:

- Twelve Technical Advisory Committee Meetings
- Six Steering Committee meetings
- Two public information meetings
- Six presentations to the Suffolk County Legislature
- Two presentations to the Suffolk County Supervisors Association
- Two presentations to the Suffolk County Village Officials Association
- Working meetings with SCDHS and SCDPW

At each meeting, CA/CE will be prepared to provide a status report on the project (if requested).

In addition, CA/CE will send a monitor to the monthly CAC meetings to ensure it is informed regarding activities of that group.

The Team, working through Balfour Technologies, would prepare presentation materials for all the meetings that would include large format color maps, photographs, and charts. Handouts would be prepared with summary information appropriate to the target audience. Balfour Technologies will prepare PowerPoint and/or fourDviz presentations for larger audiences. Arcview 8.2 GIS software would be utilized for most geo-referenced presentation material.

Meeting summaries would be prepared by the Team that would include a summary of the types of presentations made at each meeting/presentation and all substantive comments, questions, and testimony. Where approved by the County, summaries would be posted on the Project Website.

Task 12: Demonstration Projects

In Task 3B, a set of potential demonstration projects will be created. For Task 12, CA/CE will select projects to execute from that list. Some possibilities were listed in the narrative associated with Task 3B.

Each project will have a detailed workplan (including appropriate monitoring protocols). CA/CE will obtain the necessary permits and permissions for the project. CA/CE is also responsible for implementing the project. After the project is complete, the Team will produce a project report, including a narrative, maps, pictures, and monitoring results, describing its success or failure and its impact on the potential management plan. Thirty copies of a draft report will be produced for each demonstration project, and, following comments, 30 copies of the final will be produced.

Task 13: Public Education, Outreach, and Involvement

Citizen understanding has been described as an "essential component to the successful development and implementation of the Vector Control Wetlands Management Long-Term Plan." It is also critical to public acceptance of all the components of the County's mosquito control program. Lack of adequate information helps create public misconceptions. It can also interfere with the County's ability to properly perform vector control functions that have been sanctioned by knowledgeable professionals and well-informed citizens.

The CA/CE team has designed a public outreach program to include two components:
1) information outreach on project progress, findings, mosquitoes and mosquito control techniques, and marsh management, and,
2) participation in a citizen monitoring and restoration program.

It is vital to the success of the project to keep the public informed as the project moves forward toward the Final Environmental Impact Statement. The Team will be sensitive top the information that is presented, and will spend great time and effort to insure that the information is accurate and presented in a clear and understandable manner.

Information Outreach and Education includes the flow of information to the general public, and responses to public inquiries and concerns. CA/CE expects to address these needs through the following components:

- Mr. John Pascucci, PE, will supervise this effort. While Deputy Commissioner of Nassau County DPW, he served as the senior liaison to all citizen committees involved with County water pollution control efforts. He acted in this capacity on at least 15 major projects over a five-year period. Under the direct supervision of Mr. Pascucci, a senior staff member will serve as the Information Outreach Officer to interact with agencies, organizations, the media, and the public. That person would have a counterpart at the County that would authorize all information releases by the CA/CE Information Officer.

- The final Scoping documents will be made available to the public, with appropriate press releases to assist in media coverage. The general broad magnitude of the program, and selected components of the project will be stressed (these components will be determined in conjunction with the County).

- All project findings will be made available through the Project Web Site. Executive summaries of all project progress will be posted directly on the web site, for example; full text versions of all reports will be available for download.

- A general information email address would be established to which questions by the public will be received. Answers to these questions would be posted in a Frequently Asked Questions (FAQ) section of the web site, following standard Q&A formatting. The FAQ's would be updated regularly as questions were received.

- The CA/CE team will establish an email listserv to disseminate information to subscribers. It is not intended that the listserv be a venue for two-way communication, however; questions from the subscribers will be sent to the FAQ section of the website. However, the Team will carefully consider any posted questions from listserv members as indicative of topics of interest/controversy to the more interested sections of the general population.

- Fact Sheets will be produced to address general topics of interest. Many of these can be developed from Task 3 activities. It is assumed that these bi-fold documents, containing three pages of information and graphics with the fourth page reserved for mailing purposes and contact information, will address topics such as:
    mosquito biology and ecology
    mosquito-borne diseases
    mosquito control techniques
    marsh management
    wetlands of Suffolk County
    risk assessment principles
    estuarine monitoring techniques

The Fact Sheets will be available at all public forums. They will be mailed to all County libraries, distributed in bulk to the Towns, and released to the press. The Fact Sheets will also be posted on the web site. They will also serve as a primary outreach tool to the general population through response mailings.

- A project update mailing/newsletter will also be produced and disseminated similarly to the fact sheets. The newsletter will have its own title (distinct from the fact sheet series). It will be published so as to coincide with and report on the completion of various project milestones. A distribution list of interested parties (drawn from scoping, and expanded through requests) will be maintained.

The dynamic and real-time graphics firm 4D-Viz will be used to establish an overall, consistent presentation package for the project. Its particular graphics package will be of great use for displaying trend data at public events in a manner comprehensible to the general public, and even for analysis of some of the more complex data sets. Individual frames from the dynamic presentations will also be used as the basis for print and still-frame presentations.

However, its primary role will be to generate an overall project look that will enable mosquito management outreach tools to be instantly identifiable. The Long Island Sound Study has had success with this approach, and this general notion has recently been adopted by the Hudson River Estuary Program as well, to help combat what was perceived as the lack of a defined program identity. This is especially important for this project, with its multitude of topics and tasks, and the many players that will ultimately have important roles in addressing the problem.

As an auxiliary function to the overall mosquito management plan development, and as a logical extension of the marsh management component of the project, the CA/CE team will help establish a Citizen Monitoring and Restoration Program. This program, once established, would be autonomous from the mosquito management program. The CA/CE Team envisions that the Monitoring and Restoration Program will have a Steering Committee with appropriate representation by the County (among others) to guide the overall progress of this Program. The Team assumes that the Program will initially serve as an outgrowth of some of the monitoring and marsh program activities associated with the mosquito management program. As such, it is probable that many results will be reported on (and incorporated into the mosquito management task reports) by CA/CE. However, the Team also envisions that this Program will continue beyond the limited timeline for the mosquito management plan project.

Lead in the Citizens Monitoring and Restoration Program would be most appropriately taken by local environmentally-concerned organizations and their volunteers (such as Audubon chapters), high school environmental clubs, and undergraduate environmental science programs at colleges such as Dowling, St. Joseph's, Suffolk Community

College, and SUNY at Stony Brook. The function would be to establish local monitoring components, and to identify opportunities for marsh restoration projects that are in tune with the prospective Marsh Management Manual to be produced by the mosquito management project. These groups would also serve as a source for volunteer labor for the restoration projects they identify.

One of the more popular and useful means of involving the public is by participating in the National Volunteer Water Quality Monitoring program. The USEPA Office of Water sets standards for water quality monitoring and has extensive technical and organizational resources available for the program. The Office has fact sheets that describe:

- the role and activities of volunteer monitors;
- USEPA's support for volunteer monitoring;
- how to start in volunteer monitoring;
- National Volunteer Monitoring Conference proceedings; and
- Methods Manuals for estuarine, lake, and stream monitoring techniques and quality assurance guidelines.

It may be valuable to engage citizens in monitoring those aquatic systems that support large mosquito populations to document their water quality.

As part of the project, the Team may be successful in documenting a relationship between certain wetland plant species and mosquito population density. If so, citizens could also help by documenting the presence or absence of those plant species. There may also be opportunities for volunteers to quantify the presence of mosquito fish in different wetland environments, before and after implementing various OMWM techniques.

Task 14: Draft and Final Environmental Impact Statements

The CA/CE team carefully considered the proposed outline for the Draft Environmental Impact Statement (DEIS) presented as Appendix K of the RFP. The Team prefers an alternative structure for the document that may be more flexible in terms of incorporating the task reports into the DEIS. This would decrease the effort required and costs associated with producing the DEIS.

The CA/CE team suggests the following overall chapter structure be adopted:

GLOSSARY OF KEY TERMS

1. EXECUTIVE SUMMARY

2. DESCRIPTION OF THE ACTION

3. HUMAN HEALTH SETTING

- 3.1. **Demographics**
- 3.2. **Distribution of vectors**
- **3.3. Distribution of mosquito-borne disease infections, hospitalizations, and deaths**

4. ENVIRONMENTAL SETTING

- 4.1. **Land Uses**
- 4.2. **Geology**
- 4.3. **Water Resources**
- 4.4. **Air Resources**
- **4.5. Ecological Resources**
  - 4.5.1. Mosquitoes
  - 4.5.2. Mosquito habitats (distributions, inhabitants, historic trends)
  - 4.5.3. Mosquito predators (species, life histories, distribution)
  - 4.5.4. Rare and Endangered Plants and Animals
- 4.6. **Community and Emergency Services**
- 4.7. **Aesthetics & Cultural Resources**

5. LEGAL AND REGULATORY SETTING

6. POTENTIAL ENVIRONMENTAL IMPACTS

- **6.1. Potential Human Health Impacts**
- **6.2. Potential Environmental Impacts**

7. MITIGATION MEASURES

8. UNAVOIDABLE ADVERSE IMPACTS

- **8.1. Impact on non-target organisms**
- **8.2. Impact of pesticide residuals on soils and water**
- **8.3. Impact of pesticide residuals on human health**

9. ALTERNATIVES & THEIR IMPACTS

- **9.1. No action alternative – VC discontinued, no marsh management**
- **9.2. Current County program continued**
- **9.3. No pesticide alternative – active marsh management**
- **9.4. Alternative application rates of existing VC chemicals**
- **9.5. Alternative application techniques for existing VC chemicals**
- **9.6. Alternative VC chemicals/substances**
- **9.7. Alternative marsh management techniques**

10. CUMULATIVE IMPACTS

10.1. County-wide general pesticide use

10.2. Regional wetland initiatives, trends, and impacts

10.3. Regional stormwater policies

10.4 "Mosquito monitoring" program in context of other County (etc.) efforts

11. IRRETRIEVABLE AND IRREVERSIBLE COMMITMENT OF RESOURCES

12. **GROWTH-INDUCING ASPECTS**

The work products for each of the Work Plan tasks could easily be drafted so that they could later be incorporated with little modification into the DEIS. For example, the Description of the Action (Chapter 2) would be drawn largely from the Final Task Report for Task 10. Chapter 5, Legal and Regulatory Setting, could largely consist of the Task 2 report. Chapter 4, the Environmental Setting, would be drawn from the Task 5 and Task 7 reports. Much of the DEIS would be written from the work completed under the earlier tasks, while at the same time completely satisfying the requirements for a complete review of the environmental consequences of the action, *per* SEQRA. The CA/CE team, which has extensive experience with SEQRA, would also utilize the services of an experienced environmental lawyer (Mr. Sinnreich) to assist in managing all aspects of the SEQRA process. This legal expertise will ensure that the County meets all legal requirements, and avails itself of all protections offered by its dual role in the process (applicant and Lead Agency).

The CA/CE team would prepare and disseminate the DEIS to all official interested parties and to at least 25 libraries and other public repositories following comments by the County departments. The distribution would be such that all residents of the County would be afforded access to the document. All formal noticing requirements of SEQRA would of course be met.

A presentation would be prepared by the Team for the anticipated public hearings. Balfour Technologies would assist the Team by providing *FourDviz* and other information presentation materials of the project results. CA/CE would supply the necessary court reporter for the session(s), transcripts, and responses to comments.

The CA/CE team would generate a draft FEIS from written and verbal submissions during the DEIS comment period for County review and comment. The revised FEIS would be submitted to the Legislature, along with draft Findings for Legislative review and amendments. If the Legislature determines a hearing is necessary at this stage, the CA/CE team and Balfour Technologies would prepare a presentation on the Plan.

Assuming an early Spring, 2004, completion of Task 10, the draft DEIS could be completed for County review by June, 2004. This would indicate a release to the public well before the end of the summer.

The proposed approach to the EIS process has the advantage of utilizing the work products, with few modifications, that generated the Mosquito Control Plan. This would reduce the costs associated with production of the EIS.

It is quite likely that public interest in this Plan would generate extensive comments, as many interest groups have already adopted positions on many aspects of the Plan and would present their positions publicly. Response to comments in the FEIS is therefore expected to be voluminous. Although many of the comments may have been addressed in the DEIS, clarification or reiteration is likely to be required to serve the public interest. The FEIS might very well be completed before the end of 2004, making conservative assumptions regarding the nature of comments

received and the additional work required to complete the process. This would be timely for a 2005 County Mosquito Management Workplan.

It is a project goal to find a means for the GEIS to be completed to meet SEQRA requirements to also serve a useful purpose under NEPA. At this time, due to schedule constraints and conflicting regulatory pathways, it appears unlikely that the documents produced through this project will be entirely suitable to meet the needs of NEPA. However, the guidance and counsel of Mr. Sinnreich may be sufficient to overcome these apparent difficulties.

Proposed Project Schedule

The general schedule was created to explicitly identify the areas that the CA/CE team believes are subject to the greatest slippage. This schedule, as presented, is possible, but also contains aggressive assumptions. In the experience of project managers, the degree of public involvement, and the required reviews of what are potentially substantial reports have the potential to delay almost all stages of this project. It should be explicitly noted that the preparation of the DEIS necessarily will occur prior to the completion of the 2004 field work; the DEIS will either be based on field work extrapolations, or some aspects of the analysis will be held until the FEIS. It is in all parties' interests to ensure that the field work is approved and underway early in the summer of 2003 to minimize this potential problem. There appears to be no current barrier to such timing; however, if Task 1 has not been completed by the New Year, then it is probable that the schedule will be entirely untenable.

Permit acquisition for OMWM projects may be difficult, and so be delayed, if there is no relaxation in current NYSDOS and NYSDEC regulatory opposition to such projects. The CA/CE Team is hopeful that a well-designed and -presented application for a demonstration project in an optimal setting will receive a more favorable review, especially if the experimental design has involved some of the pertinent regulators to address particular concerns. Nonetheless, it may be difficult to complete a major OMWM construction effort in the Spring, 2003, if current regulatory postures are not adjusted.

Selection and review of the preferred management plan, if it turns out to be much different from current practices, may require more time for acceptance by the County. Conversely, some outside commentators may require additional persuasion if the proposed management plan is extremely similar to the existing program. Thus, the potential for a long review process of Task 9 and Task 10 exists. Completion of Task 10 is necessary to substantially begin compiling the draft EIS.

The other major time sink could be the review of the draft DEIS. It will be necessary for the CA/CE team and the County to involve all appropriate individuals and agencies in Task reviews to avoid late refocusing of the proposed management plan. It may be difficult to catch all necessary parties' attention at the early phases of the project, the avoidance of long delays at later stages of the project suggest that effort early will be repaid in time savings later.

Additionally, as litigation has already been commenced on the project, it may be that public interest in the EIS portion of the project may lead to substantial delays in the issuance of Findings and the final FEIS beyond the dates suggested here (as indicated by the continuing dashed lines beyond the anticipated summer 2004 project completion date).