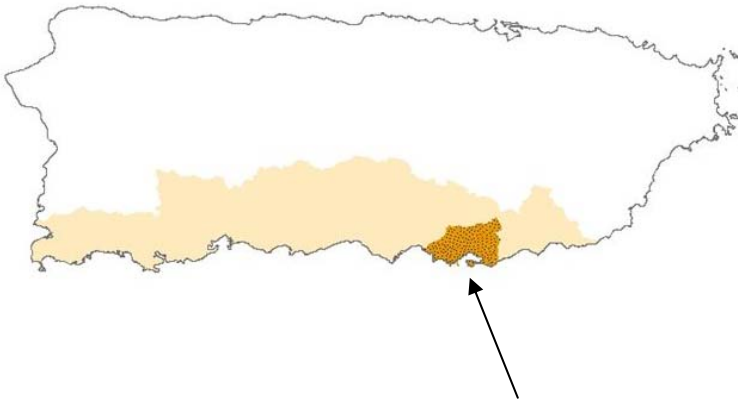
Conservation Effects Assessment Project:
Jobos Bay, Puerto Rico Special Emphasis Watershed Study

A Collaborative Effort by the
U.S. Department of Agriculture and
National Oceanic and Atmospheric Administration

Plan of Work



Jobos Bay Watershed
HUC: 21010004

May 30, 2007

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Executive Summary

The Conservation Effects Assessment Project (CEAP) began in 2003 as a multi-agency effort to quantify the environmental benefits of conservation practices used by private landowners participating in selected U.S. Department of Agriculture (USDA) conservation programs. The Jobos Bay Watershed in South-Central Puerto Rico (PR) was selected by CEAP partners as the first tropical CEAP Special Emphasis Watershed. The project originated from an ongoing collaboration between USDA and NOAA on the U.S. Coral Reef Task Force.

Water conservation and water quality concerns predominate over the entire region. In the uplands soil erosion also threatens natural resources. Improved agricultural water management consists of measures to increase or conserve present or future water supplies in rural areas, improve water quality impaired by nonpoint source pollutants, and increase the efficiency of water management for agricultural purposes.

Investigations will provide field-to-watershed scale data for evaluating and improving conservation practices and the performance of watershed assessment models. Four types of agricultural operations were selected for further study: poultry, papaya/plantain/pasture, corn for animal feed, and sorghum. The main objective of the Jobos Bay Special Emphasis Watershed Study (JBSEW) is to determine the environmental effects that agricultural conservation practices implemented by farmers on the uplands may have on coastal waters and associated habitats in tropical ecosystems, and ultimately to coral reefs.

The NRCS will serve as the lead coordinating agency for this project and conduct outreach activities with the conservation partnership. NRCS will also assist the Puerto Rico Land Authority in implementation and development of innovative conservation practices with farmers. The ARS will lead research to quantify the effects of specific conservation practices on the delivery of water and chemicals from agricultural lands to surface and shallow ground waters. NOAA will lead in defining the state of Jobos Bay water quality, benthic habitats, and living marine resources. In addition, NOAA will collaborate with the Jobos Bay National Estuarine Research Reserve to monitor changes in these ecosystem components and to assess the effects of implemented conservation practices.

During the 2007-2009 timeframe, current partners expect to complete the following products:

- ARS will evaluate suitable field and watershed models. ARS will also conduct field surveys and analyze the data to calibrate their models.
- NRCS will develop a suite of innovative conservation practices, select willing cooperator farms and generate public outreach documents.
- NOAA will complete Summit to Sea modeling and provide maps and GIS data derived from the modeling effort. In addition, NOAA will design and conduct initial water quality and sediment chemistry sampling to support development of a comprehensive water quality and biological monitoring program.

Recognizing that this watershed is a spatially complex ecosystem, all the needs for this project may not be fully met through the existing agency partnerships. Critical project needs not currently being addressed include:

- Near-shore oceanographic models,
- Deep ground water contributions to Jobos Bay,
- Urban, industrial, and other point and non-point source contributions to the bay,

- Remote sensing technologies and capabilities,
- Mangrove ecosystem interactions with the watershed.

We propose to address these needs by pursuing collaborations with additional partners including, but not limited to EPA, NASA, USGS, USDA Rural Development and academic institutions such as the University of Puerto Rico and others.

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1. Introduction

1.1. Purpose

The Conservation Effects Assessment Project (CEAP) began in 2003 as a multi agency effort to quantify the environmental benefits of conservation practices used by private landowners participating in selected U.S. Department of Agriculture (USDA) conservation programs. The project has three major, inter-related components: 1) National Assessments, 2) Watershed Assessment Studies, and 3) Bibliographies and Literature Reviews.

The Jobos Bay Watershed in South-Central Puerto Rico (PR) was selected by CEAP partners as the first tropical CEAP Special Emphasis Watershed. Investigations will provide field-to-watershed scale data for evaluating and improving conservation practices and the performance of watershed assessment models. The project originated from an ongoing collaboration between USDA and NOAA on the U.S. Coral Reef Task Force. Preliminary discussions started in 2006 with a teleconference that identified two potential watersheds in PR for study. The Jobos Bay watershed was chosen because it is adjacent to a NOAA National Estuarine Research Reserve (NERR) and has a larger percentage of agricultural land use than the other candidate watershed (La Parguera). A site visit to Jobos Bay was conducted in January 2007. Four types of agricultural operations were examined and selected for further study: poultry, papaya/plantain/pasture, corn for animal feed, and sorghum. An important objective is to identify innovative conservation practices and irrigation management that maintain and/or enhance crop production and protect water quality in shallow groundwater and the adjacent NERR.

The Coral Reef Conservation Program (CRCP) within NOAA provides funding to the Center for Coastal Monitoring Assessment (CCMA) which conducts and manages monitoring of the biological, physical, and chemical characteristics of US tropical marine ecosystems. Characterization, habitat mapping, monitoring, and assessment of coral reef ecosystems by NOAA and its partners are conducted via the CRCP National Coral Reef Ecosystem Monitoring and Coral Ecosystem Mapping Programs. The national objective of the CRCP is to define the state of the Nation's coral reef ecosystems and track changes overtime to assess the effects of management actions and/or natural events modifying the water quality, benthic habitats, and associated living marine resources found in coral reef ecosystems.

In 2002, the U.S. Coral Reef Task Force identified the need for action at the local level to reduce key threats to coral reefs in each of the seven states and territories which possess significant coral reef resources. Local Action Strategies (LAS) were developed by Puerto Rico's local and federal agency representatives in 2003. The proposed work seeks to address a LAS goal related to land-based sources of pollution by "reducing loss of live coral reef cover through the promotion and implementation of integrated watershed and land use management practices."

1.2. Scope

At the national level, CEAP is assessing environmental effects and benefits of conservation practices associated with the following USDA conservation programs: Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), Conservation Security Program (CSP), Wetland Reserve Program (WRP), Wildlife Habitat Incentives Program (WHIP), NRCS Conservation Technical Assistance Program, and Grassland Reserve Program (GRP). Conservation practices that will be assessed by CEAP include conservation buffers; erosion control; wetlands conservation and restoration; establishment of wildlife habitat; and management of grazing land, tillage, irrigation water, nutrients, and pests.

Within CEAP, Special Emphasis Watersheds are identified. They are strategically located to quantify and demonstrate water quality and other environmental effects/benefits of conservation programs and to fill gaps in the existing CEAP--Watershed Studies Assessment program. The Special Emphasis Watersheds have ongoing research and demonstration efforts.

The principal objectives of the Special Emphasis Watersheds Assessment studies are:

1. Develop quantitative databases describing soil, water, and air quality, soil and water conservation practices, and wetlands and wildlife habitat in agricultural watersheds. The resulting databases will be used to evaluate and improve the computer models applied to the Watershed and National Assessments.
2. Conduct assessments of water quality and water conservation, soil and air quality, and/or wildlife effects/benefits of conservation practices at the watershed scale. The assessments will provide information to examine the accuracy of the National Assessments. A watershed study will focus primarily on one or two specific resource concerns.
3. Build on previous investments in watershed studies by federal agencies and others.
4. Develop indicators or performance measures for documenting and quantifying the benefits of conservation practices.

1.3. Goals and Objectives

The main objective of the Jobos Bay Special Emphasis Watershed Study is to determine the environmental effects that agricultural conservation practices implemented by farmers on the uplands may have on coastal waters and associated habitats in tropical ecosystems, and ultimately, to coral reefs.

Specific goals of the Jobos Bay Special Emphasis Watershed Study currently include:

1.3.1. Estimate benefits of conservation practices currently present on the landscape.

1.3.2. Estimate effects of conservation practices on terrestrial and aquatic species and habitat.

1.3.3. Quantify changes in water quality, sediment chemistry and coral ecosystem response from implementation of conservation management practices.

1.3.4. Estimate the need for additional conservation practices and the benefits that could be realized if appropriate conservation practices were implemented on all cropland and poultry farms.

1.3.5. Simulate alternative options for implementing conservation programs on croplands and poultry farms in the future.

Current partners in the CEAP Jobos Bay SEW include USDA's Agricultural Research Service (ARS) and the Natural Resources Conservation Service (NRCS), National Oceanic and Atmospheric Administration (NOAA) and the Government of Puerto Rico. Initial funds to support the proposed work will come from multiple sources including USDA-NRCS, ARS, and NOAA. We plan to seek additional funding from future project partners and other interested institutions and organizations.

For the USDA-led CEAP partnership at Jobos Bay, NOAA plans to expand coral reef ecosystem monitoring studies to the Bay and modify the existing suite of monitored parameters to better evaluate changes in water quality (e.g., nutrients and pesticides), habitats (e.g., seagrass), and marine animals (e.g., fishes, shellfish) due to changes in conservation practices.

1.4. Measurement of Progress (Benchmarks)

Progress towards improved environmental stewardship within the study area can be estimated by providing benchmarks that quantify various environmental conditions at specified time intervals. Benchmarks are quantitative variables which can be periodically measured to determine spatial and temporal responses in critical natural resource conditions. An example of a benchmark would be improvements in water quality resulting from reductions in nitrogen loadings.

1.4.1. Short-term (3 years) measures of progress

1.4.1.1. Existing conservation practices and upland conservation plans are documented.

1.4.1.2. Field research, monitoring and modeling activities are implemented to address priority resource concerns.

1.4.1.3. Additional conservation practices, research, monitoring and modeling activities are identified to address resource concerns for unfunded priorities.

1.4.1.4. Management decisions are informed by focused scientific research, monitoring and modeling.

1.4.1.5. Achievements and lessons learned are documented and an active public outreach program with field demonstrations is conducted.

1.4.2. Long-term (+10 years) measures of progress

1.4.2.1. Pollutant loads to coastal waters have decreased.

1.4.2.2. Reductions in impacts to reef ecosystems were demonstrated by multiple indicators (e.g., reduced algal cover, increased living coral cover, reproduction).

1.4.2.3. Innovative conservation practices and watershed-based conservation plans were developed and implemented at other suitable locations within the Caribbean Area.

1.5. Study Area Description

The 10,210 ha (25,219 acre) Jobos Bay watershed is located on the south-central coast of PR. The 8-digit Hydrologic Unit Code (HUC) is 21010004. There are two municipalities within the watershed, Guayama and Salinas, with a total population of about 73,000 persons. The predominant land use is agriculture, including diversified production of agricultural commodities such as plantains, bananas, papayas and hayland, and animal operations with poultry and some beef cattle.

The watershed is located within the Subtropical Dry Forest Zone. Puerto Ricos' Central Ridge Mountains serve as a barrier to the moisture-laden northeast trade winds. Orographic factors give rise to a zone of low precipitation throughout the entire length of the southern coast of Puerto Rico. Mean annual rainfall is 1,129 mm (44 inches). The monthly average for the 30-year period (1960-90) at the Aguirre Station rain gauge, located within the watershed, showed October to be the wettest month, with average rainfall of 228.6 mm (9 inches), and March the driest, with average rainfall of 25.4 mm (1 inch).

Temperature shows little seasonal fluctuation. The mean annual temperature is 26.55^{o} C, with a maximum of 27.4^{o} C during August and a minimum of 24.77^{o} C during February (National Weather Service, 1959, 1965, and 1970). Winds averaging six to seven knots blow regularly from the east.

1.6. Watershed Resource Concerns

Human activity is commonly identified as a major contributor to the observed deterioration of coral reef ecosystem health. The global threat to coral reef ecosystems from coastal pollution is surpassed in severity only by coral bleaching from increasing water temperatures and fishing impacts. Water conservation and water quality concerns related to agricultural practices are important in the Jobos Bay watershed. Preliminary studies reported that pesticides and fertilizers applied in agricultural fields were being transported to the Bay.

Increasing industrial and commercial growth in the watershed has also been recognized as a major concern for coral reef ecosystem health. An initial evaluation of thermal effluent from the Aguirre Power Plant on Jobos Bay revealed significant impacts upon mangrove root and seagrass communities in the vicinity of the thermal discharge. In addition, the regional BFI landfill is located on the northern boundary of the watershed and is expected to broaden to twice the size of its original plans. Other major industries such as Chevron Phillips Core, Ayers-Wyeth, IPR Pharmaceuticals, Colgate-Palmolive and ProChem maintain operations in the watershed.

Water conservation and water quality concerns predominate over the watershed. In the uplands soil erosion also threatens natural resources. Improved agricultural water management consists of measures to increase or conserve present or future water supplies in rural areas, improve water quality impaired by nonpoint source pollutants, and increase the efficiency of water management for agricultural purposes.

Table 1. Watershed Resource Concerns

Water Quality	Loading of nutrients, pesticides and other contaminants (e.g., arsenic, copper) to surface and groundwaters Transport to surface water of pollutants adsorbed to soil particles
Water Quantity	Inefficient water use on irrigated land Competition for available fresh water Concentrated water runoff on cropland Reduced capacity of irrigation conveyance system by sediment deposition
Soil Quality	Organic matter depletion on intensively cultivated cropland Salinity in drip irrigated cropland Phosphorus accumulation on cropland
Soil Erosion	Soil erosion on irrigated cropland Soil erosion on steeply sloping lands
Plant Condition	Diminished productivity, health and vigor on croplands
	Decline in fish and shellfish in the bay
Fish and Wildlife	Habitat degradation and loss
Ecosystems	Fragmentation and mangrove mortality
	Diminished ecosystem services associated with the bay, including declines in seagrass beds and coral reefs

2. Methods

2.1. Watershed Assessment Activities

2.1.1. Description of ongoing conservation work

The most common conservation practices and the number that have been applied in the last 10 years are listed in the following table:

Resource	Conservation Practice	Practice Code	Number of Practices Installed Since 1996
Cropland	Irrigation Water Management	449	21
	Irrigation System, Microirrigation	441	5
	Irrigation System, Sprinkler	442	--
	Irrigation Storage Reservoir	436	2

Resource	Conservation Practice	Practice Code	Number of Practices Installed Since 1996
Cropland	Pumping Plant	533	1
	Nutrient Management	590	45
	Pest Management	595	45
	Conservation Crop Rotation	328	45
	Residue Management Mulch Till	345	45
	Residue Management, Seasonal	344	45
	Row Arrangement	557	--
Poultry Ranch	Manure Transfer	634	10
	Waste Store Structure	313	10
	Nutrient Management	590	10
	Waste Utilization	633	10

2.2. Proposed Conservation Technologies

One goal of the project will be to identify new and innovative approaches for the implementation of conservation practices that address the specific problems identified in the watershed. This activity will include innovative implementation strategies for conservation practices currently in use as well as the identification of new conservation practices that might be implemented in the watershed.

For example, water quality and quantity, soil quality and soil erosion have been identified as resource concerns in the watershed. Current management practices and the warm climate tend to destroy or accelerate the decomposition of crop residues worsening these resource issues. One possible innovative approach to these problems is a residue management system that is customized to the tropical climate and the crops grown in the watershed. This residue management system may involve changes in planting and tillage practices and new strategies to control pests, apply nutrients and to manage irrigation water. In steep upland areas residue management will need to be coupled with an emphasis on contouring practices and in some cases structural practices to control erosion and runoff problems.

2.3. Water Quality and Sediment Analysis

2.3.1. Description of current monitoring efforts

The Jobos Bay National Estuarine Research Reserve, as part of the NERRS System-Wide Monitoring Program (SWMP), routinely monitors of a uniform suite of water quality and weather data that serve as important indicators of change (e.g., dissolved oxygen). Automatic sondes measure basic water quality parameters, and a weather station registers basic climatic data. This monitoring effort began in 1996 and is ongoing in Jobos Bay.

2.3.2. Planned water quality analyses

NOAA will conduct estuarine surface water quality sampling for nutrients, pesticides and metals of concern (e.g., As and Cu). The estuarine surface water sampling will occur after rain events to maximize the likelihood of detecting representative agriculture-related contaminants. Additionally, NOAA will conduct a baseline assessment of sediment contaminant concentrations for historically used pesticides, and metals (As and Cu will be of agricultural interest). The sediment analyses will consist of a one-time sampling of 7-10 sediment sites in Jobos Bay.

2.4. NRCS Activities and Deliverables

The NRCS will serve as the lead coordinating agency for this project and conduct outreach activities with the conservation partnership. NRCS will also assist the Puerto Rico Land Authority in implementation and development of innovative conservation practices with farmers. In conjunction with the development of a tropical CEAP Special Emphasis Watershed Study, the primary responsibility of NRCS is to provide assistance in various ways that will facilitate the implementation of the project within the overall CEAP effort. This assistance will require bringing together partners at the local level to identify current soils, water quality/quantity, land use and other databases available for use by ARS and NOAA. It will include providing land users within the watershed with timely information regarding the project and promoting the testing and application of new and innovative conservation practices based on field research and analysis. The NRCS will also assist in the development of baseline conditions for which future analyses can be compared.

2.5. ARS Activities and Deliverables

The ARS will lead research to quantify the effects of specific conservation practices on the delivery of water and chemicals from agricultural lands to surface and shallow ground waters.

During 2007, ARS proposes to conduct an initial assessment and evaluation of the Jobos Bay Special Emphasis Watershed based on the following tasks: participate in interagency planning efforts in Puerto Rico and D.C.; collect, edit and summarize existing GIS layers and data sets; conduct initial survey of groundwater and soil quality within the watershed; complete initial evaluation of potentially suitable models (e.g., RZWQM, PRZM, SWAT and AnnAGNPS); identify variables needed for model inputs and validation; conduct an initial survey of farm management practices within the watershed; identify probable linkages between agriculture and water quality concerns; identify priority suite(s) of conservation practices for implementation and evaluation; identify growers/crops to collaborate in conservation practice implementation and evaluation; identify sites for establishment of alternative conservation practices; and prepare an annual report.

Table 2. Major Activities and Tasks by Fiscal Year

OBJECTIVE 1. Watershed Inventory & Assessment

Task ID	Task Name	Start	End	Lead Agency	Assisting Agency	% Completed	Comments
1.1	Initial visit to the area to observe field conditions.	01/07	03/07	NRCS		100	Trip made to JW by NRCS, ARS, NOAA, UPR, USGS, F&WS. PR Land Authority, DNER. Core group visited to the Jobos Bay watershed to observe field conditions on agricultural lands.
1.2	Coordinate with collaborating agencies to collect all existing pertinent data & studies on Jobos Bay Watershed related to hydrology, soils, vegetation, landuse, socio-economics & water quality.	03/07	07/07	NRCS	JOBANERR	10	
1.3	Translate Conservation Plans in the baseline selected area.	05/07	08/07	NRCS	ARS DNER PRLA AES-UPR	10	
1.4	Integrate the Jobos Bay Area Wide Conservation Plan approach into CEAP.	02/07	04/07	NRCS		100	
1.5	Conduct an inventory of conservation practices applied.	04/07	05/07	NRCS	ARS	25	
1.6	Synthesize descriptions of historical and current monitoring efforts in Jobos Bay	02/07	09/07	NOAA	JOBANEER	10	

OBJECTIVE 2. Develop a comprehensive communications plan that educates and communicates the conservation watershed approach.

Task ID	Task Name	Start	End	Lead Agency	Assisting Agency	% Completed	Comments
2.1	Provide agencies with a promotional CEAP package in Spanish and English to conduct an active outreach program.	04/07	09/07	NRCS-Sea Grant	JOBANERR	10	
2.1.1	Develop brochure about CEAP objectives.	04/07	09/07	NRCS	JOBANERR-Sea Grant	20	Sea Grant will print.
2.1.2	Develop and set forth news release in local press media Jobos Watershed.	05/07	12/09	NRCS	JOBANERR		
2.2	Develop a PowerPoint presentation about CEAP in Jobos Watershed.	05/07	07/07	NRCS	NRCS	5	
2.3	Conduct informational meeting in JW CEAP.	05/07	06/07	NRCS	ARS PRLA Sea Grant		
2.4	Inform stakeholders and conservation partners of the CEAP approach.	05/07	08/07	NRCS		5	
2.5	Participate in the JOBANERR scientific technical committee.	05/07	09.09	NRCS			
2.6	Prepare a CEAP marketing document regarding potential effects of conservation practices in the marine environment.	07/07	01/08	NOAA	NRCS		
2.7	Develop a technical note of BMP's practices implemented.	01/08	09/09	NRCS			
2.8	Develop and distribute a case study of CEAP.	02/09	09/09	ARS	NRCS		

OBJECTIVE 3. Data Collection and Analysis

Task ID	Task Name	Start	End	Lead Agency	Assisting Agency	% Completed	Comments
3.1	Analyze data to determine baseline conditions.	06/07	09/09	ARS	NOAA NRCS		
3.1.1	Perform site specific soil descriptions on monitoring sites in uplands and wetlands.	10/07	04/08	NRCS	ARS		
3.1.2	Assist with collection and development of baseline data from early 1980's to present.	05/07	02/08	NRCS	DNER USGS NOAA		
3.2	Select farm-sites to establish monitoring stations of current/new or modified conservation practices or management activities.	08/07	02/08	ARS	NRCS		
3.2.1	Design and selection of monitoring protocols.	06/07	05/08	ARS	NRCS		
3.3	Select willing cooperator farmers to establish monitoring stations.	10/07	12/07	ARS	NRCS		
3.4	Install field monitoring equipment on selected farms.	01/08	08/08	ARS	NRCS		
3.4.1	Collect field data from monitoring stations.	01/08	05/10	ARS	NRCS NOAA		
3.5	Complete analysis of all field specific monitoring and prepare findings report.	05/10	09/10	ARS			
3.6	Calibrate and verify models based on baseline information and field monitoring data.	06/08	12/08	ARS	NRCS		
3.7	Develop Technical Notes on potentially new conservation practices. (English & Spanish).	04/09	09/09	NRCS			
3.8	Assist landusers in the implementation of conservation practices in conjunction with PRLA, landusers and ARS modeling.	09/09	09/10	NRCS	PRLA ARS		
3.9	Compile a GIS database to support Summit to Sea analysis	02/07	09/07	NOAA		50	
3.10	Develop GIS data and maps describing erosion potential and sediment delivery to outflows and bay	02/07	09/07	NOAA	ARS	50	
3.11	Design a monitoring approach to assess changes from implementation of	02/07	11/07	NOAA	JOBANEER	0	

	conservation practices on coral reef ecosystem						
3.12	Conduct water quality monitoring and sediment contaminant assessment in Jobos Bay estuarine system	TBD	Start+18 months	NOAA	JOBANEER ARS	0	

OBJECTIVE 4. Efficient and Effective Implementation of Conservation Programs Addressing Priority Resource Concerns in Tropical Areas

Task ID	Task Name	Start	End	Lead Agency	Assisting Agency	% Completed	Comments
4.1	Encourage implementation of innovative conservation approaches.	09/09	09/10	NRCS			
4.2	Use CEAP findings to review CB FOTG's and make updates as necessary.	09/09	09/10	NRCS			
4.3	Write a final report on the JW CEAP project including conclusions and recommendations that can be drawn from existing data.	09/09	02/10	ARS	NRCS NOAA		
4.4	Make recommendations on needs for further assessments, evaluations and monitoring.	10/09	04/10	NRCS			

Based upon reconnaissance work conducted in 2007, ARS proposes in 2008 to establish field conservation test/validation plots on high priority farm(s) and begin field research. Proposed components of field research include use of: suction lysimeters and groundwater wells; an atmospheric deposition sampler; weather/climate stations; soil moisture probes; and model calibration with data sets for water, nutrient and pesticide use and export. Preliminary investigations will investigate the need for surface runoff and erosion measurements. Once research sites are identified, conservation practices will be implemented and comparisons made with conventional agricultural systems.. Comparisons will be based upon water samples analyzed for selected nutrients and pesticides. Data will be collected to evaluate water balances at the irrigated and non-irrigated sites. Soils will be sampled and analyzed for selected nutrient and pesticide concentrations. As data are developed a pesticide risk assessment will be conducted for the watershed following the NRCS-NAPRA model. An annual report will be submitted for 2008.

In 2009, ARS proposes to quantify site-specific conservation practice effects for the first year and complete the following tasks: implement conservation practice suites on selected crop(s); obtain and analyze water samples for selected nutrients and pesticides; collect and analyze plot water balance data and climate data; obtain and analyze soil samples for nutrients and pesticides; conduct sensitivity analysis of model(s); identify variables affecting soil and water quality parameters from agricultural fields; quantify uncertainty of model predictions for base (no conservation practices) case; prepare the annual report, publications and the final report.

If additional funding is available, the following research activities are proposed: replicate individual field test blocks or alternate practice suite evaluations; quantifying changes in potentials for soil carbon sequestration, plant-available nitrogen, and pesticide degradation; conduct rainfall simulation studies to characterize the potential for surface runoff and erosion, contaminant transport, and to determine soil hydraulic properties; stem flow collars and thermal imagery remote sensing to quantify actual crop water use/demand change effects of conservation practices; add groundwater well network transecting agricultural lands and evaluate subsurface contributions from agricultural areas; and evaluations in riparian systems buffering agricultural lands from mangrove swamps and Bay such as REMM modeling.

2.6. NOAA Activities and Deliverables

NOAA will lead in defining the state of Jobos Bay water quality, benthic habitats, and living marine resources. In addition, NOAA will collaborate with the Jobos Bay National Estuarine Research Reserve to monitor changes in these ecosystem components and to assess the effects of implemented conservation practices.

During 2007, NOAA proposes to complete the following three tasks:

Task 1: In consultation with partners develop two CEAP-Jobos documents to describe and implement the study. One document will be this Plan of Work (POW) for the entire CEAP-Jobos study and a second document will be derived from the POW. It will be a 1-2 page overview of the project that will serve as the primary communication document to USDA and NOAA leadership and interested partners and the public.

Task 2: NOAA will build on its evolving "Summit to Sea" project for the characterization of coastal watersheds and apply its approach to the Jobos Bay watershed to support the CEAP-Jobos Bay study. The objective of Task 2 will be to develop a simple GIS-based tool for the Jobos Bay watershed and the bay using satellite imagery and other data to characterize the land-based sources of pollution and the level of threat to the shallow-water coral reef ecosystem (e.g., mangroves, seagrass, corals) found in and adjacent to the boundaries of the Jobos Bay National Estuarine Research Reserve.

Task 3: Working with project partners, NOAA will design monitoring approaches to measure effects from changes in conservation practices under the direction of the CEAP-Jobos Bay project team. For year one of the study several partner institutions and their scientists (e.g., University of Puerto Rico, Jobos Bay NEER, ARL) will be coordinated by NOAA to design a sampling approach and associated metrics that have the best potential for quantifying changes in Jobos Bay water quality, benthic habitats, and biota due to implementation of innovative conservation practices. This will include a baseline assessment conducted by NOAA's Coastal Oceanographic Assessment, Status and Trends (COAST) Team prior to changing conservation practices in the watershed and subsequent monitoring to assess responses to change. COAST will conduct estuarine surface water quality sampling for nutrients, pesticides and metals of concern following rain events to maximize the likelihood of contaminant detection. In addition, a one-time sampling event of 7-10 sediment sites in Jobos Bay will be analyzed for pesticides and metals of agricultural interest.

During 2008, NOAA proposes to integrate the completed models and final Summit to Sea assessment report including the digital GIS base layers into the overall CEAP-Jobos Bay data base management system. This activity will facilitate analyses and integration of multiple data sets from the land-based studies with the in-water chemical and biological monitoring data. In year two of the study the biological, chemical, and physical studies would be implemented within and adjacent to the Jobos Bay NEER. This proposed work would include biogeochemical sampling, characterization of mangrove communities, mapping of benthic habitats and characterization of associated fish and macro-invertebrate fauna within and adjacent to the Bay. The nutrient biogeochemistry of the Jobos Bay NEER would also be studied.

During 2009, NOAA proposes to continue monitoring the water quality, benthic habitats, biota, and biogeochemistry of Jobos Bay to assess whether effects from conservation practices can be determined based on monitoring key Bay ecosystem components (e.g., seagrass communities). It is anticipated that relatively short term changes would be measured in water quality and microbes, while long-term changes in higher trophic levels, such as fishes, may take much longer to see any potential biological responses. Additional activities proposed for 2009 include development of a final report, digital data, and maps to facilitate integration into the comprehensive CEAP-Jobos Bay study report for years 1-3. The NOAA report would be developed in consultation with project partners so the NOAA component can be easily incorporated into the CEAP final report. In addition, all digital data and associated metadata will be delivered to CEAP and the Jobos Bay NEER. The project summary 2 pager will be revised with key results from years 2 and 3 and will include a section on the next directions for out year monitoring.

2.7. Summary of Activities

During the 2007-2009 timeframe, current partners expect to complete the following products:

ARS will evaluate suitable field and watershed models. ARS will also conduct field surveys and analyze the data to calibrate their models.

NRCS will develop a suite of innovative conservation practices, select willing cooperator farms and generate public outreach documents.

NOAA will complete Summit to Sea modeling and provide maps and GIS data derived from the modeling effort. In addition, NOAA will design and conduct initial water quality and sediment chemistry sampling to support development of a comprehensive water quality and biological monitoring program.

3. Project Collaboration Opportunities

3.1. Critical Project Needs Not Currently Addressed

Recognizing that this is a spatially complex ecosystem, all the needs for this project may not be fully met through the existing agency partnerships. The following areas were identified as critical project needs not currently being addressed by this plan of work:

- **3.1.1.** Near-shore oceanographic models
- **3.1.2.** Deep ground water contributions to the bay
- **3.1.3.** Urban, industrial, and other point and non-point source contributions
- **3.1.4.** Remote sensing technologies and capabilities
- **3.1.5.** Mangrove ecosystem interactions with the watershed.

3.2. Potential Additional Partnerships

We propose to address these unfulfilled critical project needs by collaborating with additional partners such as, but not limited to:

- **3.2.1.** USGS
- **3.2.2.** EPA
- **3.2.3.** USDA Rural Development
- **3.2.4.** NASA
- **3.2.5.** University of Puerto Rico and
- **3.2.6.** Other academic institutions

3.3. Local Agency Partnerships

The Agricultural Extension Service in Puerto Rico has offered to help with a) transferring information related to CEAP, and b) making logistical arrangement with local farmers and others for stakeholder meetings.

Sea Grant at UPRM is providing technical expertise in scientific and popular writing and will lead printing of brochures and other miscellaneous information related to Jobos CEAP.

The Environmental Quality Board (EQB) will provide information related to air quality (e.g., PM2.5 and PM 10 data), and other natural resources such as water quality from monitoring stations in the Jobos Bay. They will also provide information about the management and monitoring of the local landfill.

The Puerto Rico Land Authority (agency of the Local Department of Agriculture) will provide detailed land use information, and will develop agreements to establish new conservation practices with local farmers using government property land.

The Puerto Dept. of Natural and Environmental Resources is providing in-kind staff support, coordination, and access to DNER historical and current data for the Jobos Bay region.

The Jobos Bay National Estuarine Research Reserve is providing in-kind staff support, local logistical support, data collection, and access to historical and current Jobos Bay project data.

The UPR-Department of Marine Sciences is providing coordination with UPR scientists, and historical and current data for the Jobos Bay region.

3.4. CEAP Interagency Activities Matrix

Appendix B is a proposed matrix of CEAP Interagency Activities which subdivides the study area into environmental compartments or areas of concern. The environmental compartments are based on three sectors of human activity (agriculture, municipal and corporate) and associated sub-sectors.

Each participating agency is requested to populate the matrix with current monitoring and assessment activities in the watershed. Also, future activities and research projects proposed for implementation should be documented.

If adequate funding was available, an interactive GIS map could be developed showing informational markers with pop-up bubbles containing active web links to each participating agency conducting the assessment or research.

4. Tropical CEAP Collaboration

This Plan of Work will help guide NOAA, USDA and other federal, state, local and academic partners in establishing complementary CEAP Special Emphasis Watersheds in other tropical and sub-tropical environments. The long-term goal is the development of coordinated watershed and coral reef management and conservation options for tropical and sub-tropical ecosystems.

5. Annual Budgets by Agency

The FY2008 and FY2009 projected funding was estimated by each Lead Agency with funding sources and actual amounts to be determined.

Agency	Fiscal Year 2007 (Actual)	Fiscal Year 2008 (Proposed/Requested)	Fiscal Year 2009 (Proposed/Requested)
ARS	**$60,000**	**$190,000**	**$190,000**
NOAA	**$50,000**	**$200,000**	**$200,000**
NRCS	**$115,000**	**$200,000**	**$200,000**

6. References

NOAA Biogeography Branch
http://ccma.nos.noaa.gov/about/biogeography/

NOAA Coral Reef “Summit to Sea” Project
http//ccmaserver.nos.noaa.gov/ecosystems/coralreef/summit_sea.html

NOAA Coastal Oceanographic Assessment, Status and Trends Team
http://ccmaserver.nos.noaa.gov/about/coast/welcome.html

NOAA National Status and Trends Program (NS&T)
http://ccma.nos.noaa.gov/stressors/pollution/nsandt/welcome.html

NOAA Jobos Bay National Estuarine Research Reserve
http://nerrs.noaa.gov/JobosBay/

USDA-ARS National Program - Soil Resource Management
http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=202

USDA-NRCS Conservation Effects Assessment Project
http://www.nrcs.usda.gov/technical/NRI/ceap/

Appendix A. List of Abbreviations

AES - Agricultural Extension Service
ARS – Agricultural Research Service
CEAP – Conservation Effects Assessment Project
DNER - Puerto Rico Department of Natural and Environmental Resources
FWS - Fish and Wildlife Service
JOBANERR – Jobos Bay National Estuary Research Reserve
JW - Jobos Watershed
NOAA - National Oceanic and Atmospheric Administration
NRCS - Natural Resources Conservation Service
PRLA - Puerto Rico Land Authority
UPR – University of Puerto Rico
USDA – United States Department of Agriculture
USGS – United States Geological Survey

Appendix B. Puerto Rico CEAP Interagency Activities Matrix

Each participating agency is requested to populate the matrix with current monitoring and assessment activities in the Jobos Bay watershed as well as future activities and research projects proposed for implementation.

Sector → / Sub-sector → / Ecological Compartment/ Concern ↓	Agriculture				Municipal					Corporate				
	Row Crops	Papaya/ Plantain	Poultry	Dairy	Sewage	Solid Waste	Roads	Home Const.	Parks/ Reserves	Power	Pharmaceutical	Chemical	Textiles	Food Processing
Soil Map Units	Texture, depth, organic matter, moisture capacity, nutrients, hydraulic conductivity, pest density, pesticide degradation rate, etc.				Nutrients, pathogens, volume, erodibility, toxins, etc.									
Geologic Units	Geology, porosity, fractures, etc.													
Groundwater - Shallow - Deep	Depth, connectivity, flow direction and rate, N, P, salinity, pesticides, endocrine-active compounds, etc.													
Surface Water - Lakes - Streams	Volume, evaporation, evapotranspiration, flow, N, P, Pesticides, Endocrine-active compounds, etc.													
Estuarine - Canals - Mangroves - Bay Margin														
Coral/Ocean Air/Deposition														
Water Consumption	Source and quantity													