CRC Infrastructure Sub-Committee

Project Identification Template and Instructions

Project Identification Template

Instructions: Please complete all of the information requested with the best information you have available. Limited attachments are acceptable if necessary to adequately describe the project but the **total length should be limited to 6 pages** one-sided (including attachments). This Identification Template is intended as a preliminary mechanism by which proposals and projects to improve the resiliency of Coastal Alabama are solicited and captured with some consistency of format, scope definition, and project benefits and impact. **This is only a first step: proposals and projects will not be funded based upon this submittal. Further information and details will be solicited at such time as the screening and funding process is more fully defined.**

Responses should be received by November 26, 2010, to be included in the appendix the Coastal Recovery Commission Report to the Governor to be submitted December 15, 2010. Submittals after that date will be accepted for consideration but will not be included in the Project Appendix.

Completed Templates may be submitted:

- **Electronically (.pdf preferred) to: crcalabama.templateresponse.com.**
- **By US mail to: Coastal Recovery Commission.**

  P.O. Box 881, Mobile, AL 36601-0881

I. What – Project Information/Basic Facts

1. Project Scope **Assessment of Groundwater Availability and Vulnerability in Coastal Areas of Mobile and Baldwin Counties, Alabama**
2. Project duration or schedule by phase and status of any work in progress. Please refer to attached proposal. Duration of project is estimate at 3 ½ years.

   2.1. Conceptual and Feasibility Planning, Engineering, Construction ________________

3. Estimated Cost (plus or minus 30%) Project is estimated at $689,000.00

    3.1. Indicate level of confidence in accuracy of these estimates ____________________

II. Why – Project Description relative to Impact and Criteria

1. Identify what need, threat or opportunity that this project, study, or recommendation will address Please refer to attached proposal.

2. How does this project or recommendation address and impact the recommended evaluation criteria:

    2.1.1. Coastal Recovery ____________________

    2.1.2. Resiliency ____________________

    2.1.3. Transformational ____________________

    2.1.4. Regionalism ____________________

    2.1.5. Economic Diversification ____________________

3. Project Economics ____________________

4. Identify Direct Project benefits to Coastal Alabama, including avoided costs, consequence of "No Build" alternative. ____________________

    4.1. Impact on employment, job training and development, both short term and permanent ____________________

    4.2. Oil spill mitigation outside of claims process ____________________

5. Identify Indirect benefits and costs

    5.1. Collateral Benefits to the objectives of Healthy Environment, Healthy Economy and Healthy Society (subjective responses allowed) ____________________

    5.2. Collateral Costs or impacts to the objectives of Healthy Environment, Healthy Economy and Healthy Society (subjective responses allowed) ____________________

    5.3. Connectivity and Linkage to other projects or initiatives: Does this project complement or compete with other projects? What other projects would be precluded if this project is funded? ____________________

III. Who/How – General Information

1. Name and contact information for Entity, Collaboration or Person submitting project or recommendation nomination. Bruce Campbell and Jim Landmeyer, U.S. Geological Survey, 720 Gracern Road, Suite 129, Columbia, SC 29210. Telephone number 803-750-6161

   1.1. Entities and communities sharing a common threat or need are encouraged to collaborate for a joint/combined project submittal to raise the profile of the issue and solution to be addressed. Also please indicate the level of community support or resistance and hurdles to collaboration.

2. Identify Sponsoring Entity for oversight and accountability if different from above.

   2.1. Existing or to be created? Existing

   2.1.1. If to be created, what parties or interests must be involved and what level of effort is required to do so? ______________________________

   2.2. Describe governance, organizational capacity, availability of skills, experience of sponsoring entity to implement the Project U.S. Geological Survey

   2.3. Project complexity: Hurdles and barriers to project implementation, completion and sustainability. Identify regulatory issues. No issues identified.

3. Identify any known or anticipated administrative, regulatory, or legislative action that would be required at either the local, state, or federal governmental level. No known or anticipated issues.

4. Requested funding from Coastal Recovery Fund (CRF) $689,000.00

5. Identified potential funding sources other than the CRF ______________________

   5.1. Leverage or multiplier on CRF investment: matching funds, public or private Matching

   5.2. Public Private Opportunities, user fees, Federal funds, private foundation grants, bonding capacity, etc. ______________________________

6. Forecast of ongoing maintenance or operating costs and source of funding if not self sustaining ______________________________

Proposal

for

Assessment of Groundwater Availability and Vulnerability in Coastal Areas of Mobile and Baldwin Counties, Alabama

Submitted to

Alabama Coastal Recovery Commission (CRC)
Infrastructure Sub-Committee

prepared by

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Proposal SC-11a

BACKGROUND

The coastal counties of Baldwin and Mobile, Alabama (fig. 1) are underlain by aquifers composed of several hundred feet of Holocene, Pliocene and Miocene aged unconsolidated sediments. These aquifers provide 89% of the water supply for all non-drinking-water uses in Baldwin County and 24% of all non-thermoelectric uses in Mobile County (Hutson, 2009). These aquifers provide 100% of the public drinking water supply in Baldwin County and 15% in Mobile County.

The aquifers underlying southern Baldwin County have been divided into three aquifer units: A_1, A_2, and A_3 (Chandler, 1996). Aquifer unit A_1 is generally the upper unconfined water-table aquifer in the upper parts of the Holocene-aged sediments. Aquifer unit A_2 underlies aquifer unit A_1 and is composed of 200 to 250 feet of Pliocene-Miocene age sand and gravel forming a semi confined aquifer. The aquifer unit A_3 underlies unit A_2 and is composed of Miocene-aged sediments forming a semi confined to confined aquifer system. Development of groundwater has resulted in significant saltwater encroachment in southern Baldwin County in aquifer unit A_1 and minor encroachment in aquifer unit A_2 (Murgulet, 2008).

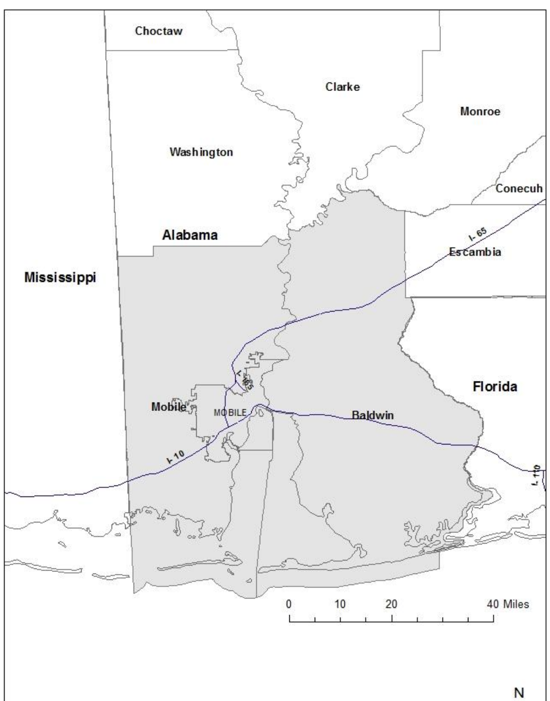

Figure 1. Location map of proposed study area

Aquifers underlying southern Mobile County consist of Pliocene-Miocene aged unconsolidated sediments forming unconfined to confined aquifers (Mooty, 1988). Detailed groundwater studies have not been conducted in southern Mobile County so the extent of saltwater intrusion is unknown.

PROBLEM

The coastal location of Baldwin and Mobile Counties provides a contrasting scenario of the potential for rapid growth through the development of the groundwater resource but also the potential for increased vulnerability from threats to groundwater quality, especillay from saltwater encroachment. Moreover, the recent release of oil from the BP well offshore and its negative impact to these coastal counties impresses upon water managers the need to manage coastal groundwater sources with state-of-the-art approaches and methods.

One approach to assess the groundwater availability of Baldwin and Mobile Counties by development and application of simulation–optimization modeling of the groundwater resources. The use of combined simulation-optimization models greatly enhances the utility of simulation models by directly incorporating management goals and constraints into the modeling process (fig. 2). In the simulation-optimization approach, the modeler specifies the desired attributes of the hydrologic and water-resource management systems (such as maximum groundwater flow gradients or maximum allowed groundwater-level declines) and the model determines, from a set of several possible strategies, a single management strategy that best meets the desired attributes. In some cases, however, the model may determine that none of the possible strategies are able to meet the specific set of management goals and constraints. Such outcomes, while often not desirable, can be useful for identifying the hydrologic, hydrogeologic, and management variables that limit water-resource development and management options.

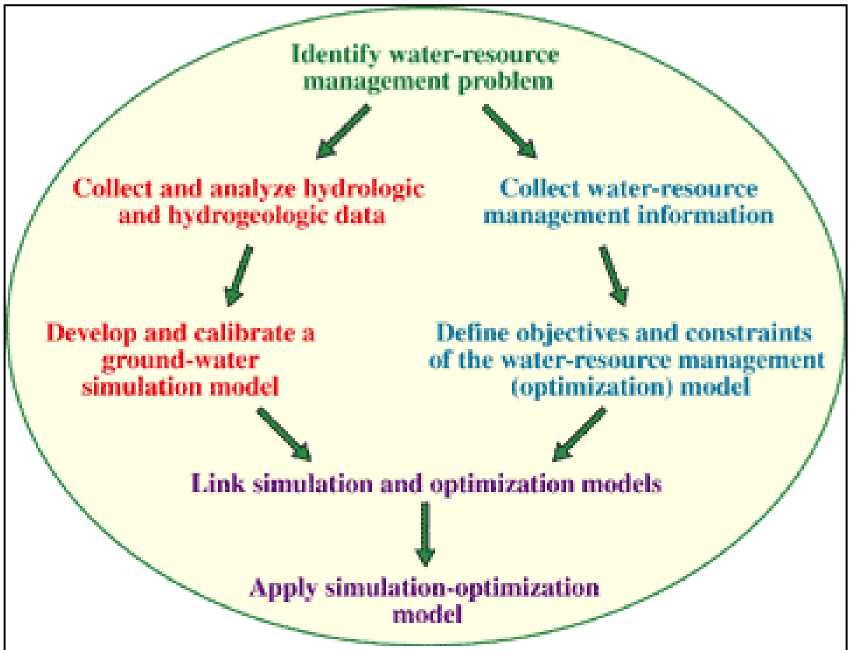

Figure 2. Principal steps in the development and application of a ground-water simulation-optimization model (From Barlow, 2005).

Applying groundwater optimization techniques requires that a management problem be formulated in terms of an objective or objectives, decision variables, and constraints. An objective in the coastal Alabama area might be to maximize the amount of ground water that can be pumped from the Pliocene–Miocene aquifer or to minimize the amount of treated surface water purchased. Decision variables include the distribution, rates, and timing of groundwater pumping. The constraints are, in essence, the factors that limit meeting the objective. In the coastal Alabama area, a likely constraint would be limits on allowable groundwater level declines, especially the areas at along the shoreline. There also may be constraints on the decision variables, for example limits on maximum pumping rates from certain wells. A valuable use of optimization models is evaluating the relation between the constraints and the objective. This allows decision makers to understand exactly how changing the constraints (making them either more or less stringent) will affect the difficulty of meeting the objective(s). Optimization techniques have been successfully applied to groundwater management problems elsewhere in the United States (see Barlow and Dickerman, 2001; Czarnecki, Clark, and Reed, 2003; Czarnecki, Clark, and Stanton, 2003, Reichard and others, 2003).

A second approach is to assess the vulnerability of groundwater to known and unknown threats to water quality, such as saltwater encroachment or oil-leaks and spills, respectively. The vulnerability of groundwater can be defined as the length of time between the arrival of contamination, either from the subsurface (saltwater encroachment) or land surface (oil spill) and the detection of the threat in wells. Fortunately, the vulnerability of groundwater can be estimated prior to contamination by the quantification of groundwater geochemistry and the age of groundwater since recharge. Moreover, these data can be used as part of the assessment of groundwater availability with model development described above.

OBJECTIVES

The objective of the proposed investigation is to assess groundwater availability and vulnerability of Baldwin and Mobile Counties. The objective will be met by

(1) the development and application of a groundwater-flow model with a groundwater management model, and
(2) the determination of groundwater geochemistry and age and the levels of contaminants that indicate vulnerability

The model and groundwater assessment will enable coastal Alabama water-resource managers to:

(1) determine groundwater flow rates within aquifers and drawdown effects from current pumping centers.
(2) test possible scenarios for future groundwater withdrawals from the various Pliocene–Miocene age aquifers and the effects of these withdrawals on existing wells.
(3) optimize future groundwater withdrawals to meet current and projected future demands and while not exceeding constraints such as impacts on nearby users, overall groundwater level declines, and the groundwater flow gradients in areas of lateral salt-water encroachment or potential contamination from surficial sources.

SCOPE

The scope of these assessments will include the Coastal Plain aquifers underlying coastal Alabama and the immediate vicinity. However, the model will be extended to the areas to the east and west. The simulation period of the model will be from about 1900 (predevelopment) to 2011. Scenarios of possible future groundwater management strategies along with the impacts of the proposed withdrawals will be evaluated. Existing wells will be sampled to the extent practicable. All groundwater samples will be analyzed by the USGS at the National Water-Quality Laboratory. The results of the investigation will be documented in a USGS Scientific Investigations Report.

APPROACH

The approach for each task of the proposed study is presented below.

Task 1: Assemble pertinent hydrogeologic, geologic data, and groundwater vulnerability data

Sub-Task 1(a) - Compile existing hydrostratigraphic data

The purpose of this task is to gather the data necessary to update the regional USGS hydrogeologic framework to a more detailed scale. Existing geologic reports and maps, subsurface data and hydrogeologic information will be assembled to refine the current hydrostratigraphy. Project personnel will work closely with scientists from the USGS Florida and Mississippi Water Science Centers, along with any state or local experts who are involved in the same area.

Sub-Task 1(b) - Compile existing historic and current water-use data

There are water-use data available for the coastal Alabama area that has previously been gathered. This modeling effort will compile recent (1997-present) monthly water-use data from the project partners and state agencies to account for any seasonal variations.

Sub-Task 1(c) - Compile and interpret existing aquifer-test data

Aquifer-test data is available from several sources in the region. Data from the USGS, state agencies, and the project partners will be collected and interpreted to fill in areas with little or no data.

Sub-Task 1(d) - Compile existing water-level data

There are several sources of groundwater level data in the region. Existing reports, the USGS database, state partners, and data from local entities will be the primary sources of historic groundwater-level data collected in the area.

Sub-Task 1(e) – Complete synoptic water-level data collection

A synoptic water-level data collection will occur early in the project to create updated potentiometric surface maps of the Pliocene–Miocene aquifers underlying the coastal Alabama area. Wells measured will include the project partner's production and observation wells and other available wells in the study area.

Sub-Task 1(f) – Collect and compile all available groundwater contamination analytical data and potential sources

Groundwater contaminant data for salt, volatile organic compounds (VOCs), and others that have been previously detected in wells and surface water in the immediate area will be compiled.

Task 2: MODFLOW model development:

The USGS will develop a groundwater-flow model using MODFLOW-2005 (Harbaugh and others, 2005) and will use a commercial graphical user interface to enhance pre- and post-processing tasks, as well as to allow for visualization, ease of use, and updating. This modeling effort will include all of the Pliocene–Miocene aquifers in the study area.

Sub-Task 2(a) - Refine the existing regional hydrogeologic framework to incorporate local-scale data.

The current hydrogeologic framework for the proposed study area will be refined, were needed, using currently available stratigraphic and hydrogeologic data. The refined framework would use existing wells that have the required data available (geophysical logs and drill cuttings descriptions).

Sub-task 2(b) - Define boundary condition(s) of the model

Boundary conditions will be defined to best simulate natural conditions within the aquifers. The boundary conditions from previous modeling efforts will be re-evaluated and modified as appropriate to best represent the natural hydrologic conditions.

Sub-task 2(c) – Model calibration to predevelopment and 2011 conditions

Test initial model parameters and model sensitivity, and perform a steady-state calibration to ground-water measurements and any appropriate surface-water flow observations. In subsequent applications, the steady-state model will be used to refine a transient-model calibration. The transient-model will simulate groundwater conditions over time (1900-2011) that generally result from groundwater withdrawals. Calibration criteria will be determined based on the degree of accuracy of the model data.

Task 3: Simulate Management Scenarios:

After calibration, the transient groundwater-flow model will be applied to simulate possible future withdrawal scenarios by using the GroundWater Management (GWM) package for MODFLOW (Ahlfeld and others, 2005). The GWM package is a tool that allows the flow-model to be enhanced by incorporating management goals and constraints such as minimizing drawdowns or maximizing groundwater production while minimizing objectives such as flow gradients or costs. Some combinations of objectives and constraints may lead to infeasible solutions which can still provide useful information on the management of the coastal Alabama ground-water resources. Groundwater users and other stakeholders will be involved in developing management scenarios to be tested.

Task 4: Groundwater contaminant data collection and interpretation:

<u>Sub-Task 4(a) – Determine potential contaminant sources</u>

The source or contributing area of groundwater derived from selected public supply and domestic wells will be determined from advective transport or particle-tracking techniques using the groundwater flow model. This is applicable without needing to use more sophisticated and time intensive solute transport models because many contaminants behave as particles of water in aquifers.

<u>Sub-Task 4(b)-Collect groundwater samples and redox geochemistry</u>

The redox geochemistry of groundwater will be assessed during contaminant sampling. Delineation of the prevailing redox status is important in understanding the long-term fate of many contaminants. Parameters such as dissolved oxygen, iron, sulfate, sulfide, methane, manganese, etc., will be analyzed, using in-field methods when applicable. The groundwater temperature and other parameters such as specific conductance also will be measured, in an attempt to further delineate the source of the contaminants.

Sub-Task 4(c)-Age Dating of Shallow Groundwater Using CFCs

The man-made compounds CFC-11, CFC-12 (the "Freon™" used in older car air conditioners), and CFC-113 were manufactured, leaked to the atmosphere, and dissolved in rainwater in overlapping cycles between the 1940's and their ban in 1990. The detection of these chlorofluorocarbons (CFCs) in groundwater indicate recharge by water that has been in contact with the atmosphere since the 1940's, and absolute-CFC concentrations can indicate the age of groundwater. Detection of CFCs in groundwater in the coastal counties of Baldwin and Mobile will help determine the age of the groundwater and, therefore, the extent of groundwater vulnerability to contamination; younger groundwater is more susceptible to contamination than older, more isolated, groundwater.

Task 5: Publications:

A USGS Scientific Investigations Report will be published to document the model and to summarize the results of the simulations.

Task	Description	FY11		FY12				FY13				FY14	
		3	4	1	2	3	4	1	2	3	4	1	2
1	**DATA COLLECTION**												
	Compile relevant existing hydrogeologic data for the coastal Alabama area ground-water system.												
	Compile historic and current ground-water use data												
	Compile and analyze existing aquifer-test data												
	Compile existing ground-water-level data.												
	Complete synoptic ground-water												

	level data collection												
2	**GROUND-WATER FLOW MODEL DEVELOPMENT**												
	Refine the regional hydrogeologic framework to incorporate local-scale data												
	Refine the model grid												
	Define boundary condition(s) of the model												
	Model calibration to predevelopment and 2011conditions												
3	**MANAGEMENT SCENARIOS**												
	Develop management model and simulate management scenarios.												
4	**GROUNDWATER CONTAMINANT DELINEATION**												
	Determine probability of potential contaminant source area(s)												
	Collect groundwater redox geochemistry												
	Age Dating of Shallow Groundwater Using CFCs												
5	**PUBLICATIONS**												
	Prepare a USGS Scientific Investigations Report to document and publish the results of the study.												

RELEVANCE AND BENEFITS

An important part of the USGS mission is to provide reliable, impartial, and timely scientific information to manage and understand the water resources of the Nation through a program of shared efforts with Federal, State, and local partners. The USGS, through these partnerships, seeks to solve real-world problems by developing tools to improve the application of hydrologic information while ensuring that its information and tools are available to all potential users (U.S. Geological Survey, 2005). The proposed ground-water flow and ground-water management model of the coastal Alabama area supports the *USGS Strategic Plan – FY 1998-2008* (U.S. Geological Survey, 2000) by expanding our understanding of environmental and natural-resource issues through integrated science on a regional scale as well as enhancing our predictive modeling capabilities for coastal Alabama. By providing water-resource managers with an improved database and better understanding of the ground-water-flow system, the model will provide a framework for facilitation of natural-resource protection and water management decision-making. Carefully considered input simplifications and output enhancements will make the model user-friendly for trained personnel, as well as ensuring that the graphics-rich output is understandable to non-scientists.

Additionally, the proposed model supports the *USGS Water Resources Discipline (WRD) Strategic Plan 1998-2008* (U.S. Geological Survey, 1999) toward WRD's increased emphasis on the effects of land use and population increases on water resources on drinking water availability and quality, and hydrologic system management. The proposed model will provide a powerful tool for water-resource managers that can be employed to optimize future development of the coastal Alabama aquifers. Simulations that incorporate optimization constraints can account for the complex physical processes of the hydrologic system and identify the best management strategy for a particular objective and set of constraints.

Benefits of this project to partners include:

- Availability of a comprehensive groundwater-resource data set for the coastal Alabama area.
- Scientifically-based groundwater flow and groundwater management models developed and documented by the USGS.
- Assessment and simulation of potential drawdown effects from pumping centers on existing groundwater users.

PRODUCTS

The planned products for this project:

- Status reports describing project progress, findings, and issues (provided quarterly).
- All model datasets and model computer files (provided upon the completion of the project).
- Project findings will be published in a USGS Scientific Investigations Report (draft copy will be provided for review; final report will be provided after final publication).

QUALITY-ASSURANCE

All projects are reviewed 4 times per year in the USGS Alabama Water Science Center for technical details and schedule and budget adherence. When completed, the new coastal Alabama area groundwater flow model and associated report will undergo colleague review and will be approved by the Director of the USGS. These reviews will ensure that the final boundary conditions, aquifer parameters, and model assumptions are reasonable and that the model is technically sound. In addition, the groundwater flow model will be documented and archived according to USGS guidelines and policies. USGS Office of Ground Water and Alabama Water Science Center Quality Assurance Plans will be followed for all field and office work relating to the project. Data compiled as part of this study will be entered into the USGS National Water Information System database and will be available to the general public after being quality assured by USGS personnel.

PERSONNEL

A senior USGS Hydrologist will serve as project chief on a part time basis to manage the project and assure completion of the project tasks. Other USGS hydrologists and hydrologic technicians will assist in data collection, model development, and report preparation. Members of the publications unit will be utilized for report review, illustration development, and publication.

FUNDING

Proposed project budget = $689,000

REFERENCES

Ahlfeld, D.P., Barlow, P.M., and Mulligan, A.E., 2005, GWM-A ground-water management process for the U.S. Geological Survey modular ground-water model (MODFLOW-2000): U.S. Geological Survey Open-File Report 2005-1072, 124 p.

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