2.0 ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (AEAM)

2.1 AEAM Framework

Deltaic coastal ecosystems, like the Louisiana coastal area, are dynamic systems with river and marine processes integrated across global and local scales, each influenced by historical conditions. The science and technology uncertainties, outlined in Section 4.0, as well as incomplete knowledge on the effects of high-energy events such as floods and storms make response prediction within these large ecosystems inherently difficult. Integration of an AEAM process within the LCA Plan would facilitate understanding of this complex system to best achieve objectives.

AEAM prescribes a management process wherein future actions can be changed by observing the efficacy of past actions on the ecosystem. The efficacy is determined through monitoring and other means to improve the response of the system (Holling and Gunderson, 2002). The AEAM approach recognizes that uncertainty is unavoidable in managing large-scale ecological systems. If properly planned and maintained, the feedback element can be used to sequentially improve management actions so that future system conditions become more consistent with program goals and objectives than past actions. AEAM allows development of an iterative and flexible approach to management and decision-making.

The structure for an AEAM framework for coastal Louisiana would support a combination of passive and active management approaches to facilitate incorporation into existing restoration and management programs. Programs in Louisiana such as the CWPPRA already support monitoring of project-specific goals and objectives and have previously conducted passive AEAM reviews. At a project level, the Caernarvon Freshwater Diversion, which is located in southeast Louisiana, has incorporated scientific manipulations that test the assumptions of its operations. The freshwater diversion project supports an iterative approach and emphasizes that management actions can be viewed as experimental manipulations of the ecosystem. The results of the Caernarvon manipulations were monitored and studied via supporting research, and the acquired data were used to influence future management decisions. In addition, examination of historical trends provided valuable information. The effectiveness of an active AEAM approach, such as used at Caernarvon, is determined by the magnitude of system manipulations required to produce measurable changes in the selected performance measures and the ability to unequivocally attribute measured changes to the management actions.

All organizations within the LCA Management Structure have a role in implementing AEAM. The LCA S&T Office would make AEAM recommendations to the Program Management Team and the PET based on assessment of monitoring data and the development of new tools or technologies. Specifically, the Program Manager is responsible for the overall program and issuing programmatic guidance to make necessary adjustments to better meet program objectives. The PET would implement changes directed by the programmatic guidance. **Figure A-2.1** depicts this iterative process and the roles of the different groups. It is important to note that the scope of decisions presented in the "decision process" in **figure A-2.1** would differ in scale. One way of expressing this is to distinguish between strategic decision and tactical decisions. Strategic decisions comprise the decisions about the nature and timing of large projects and major policies related to the overall programmatic effort. Tactical decisions comprise those decisions about implementation and operation that are necessary for the projects and policies to succeed. The AEAM framework applies to both strategic and tactical decisions about coastal restoration. The key attribute of the decision process under AEAM is well-defined and effective communication.

The LCA Plan has benefited from a review of lessons learned over the past several years in CWPPRA, and AEAM would be more effectively implemented due to those lessons learned. CWPPRA-initiated tool development, such as the Coast-wide Reference Monitoring System (Steyer et al., 2003), would be very useful within the LCA AEAM effort.

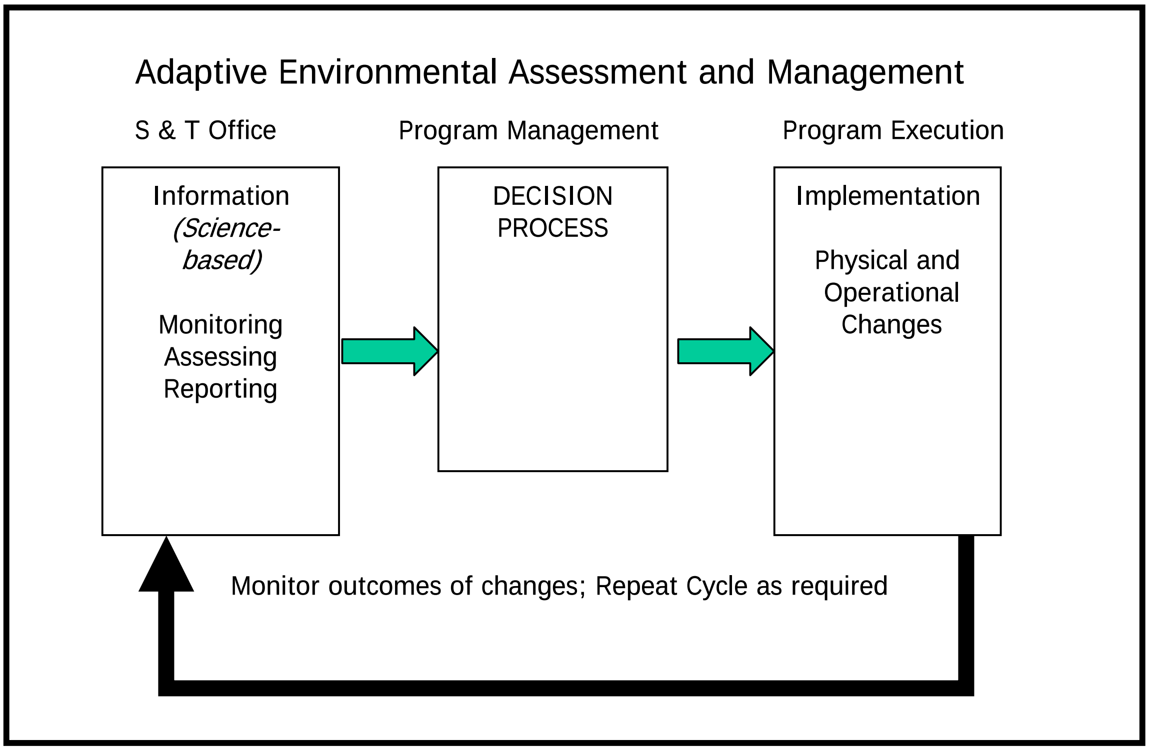

Figure A-2.1. Adaptive Environmental Assessment and Management. Different roles of the organizations and iterative steps are depicted here to illustrate implementation of an effective AEAM process.

The structures and general process outlined in the LCA S&T Program provide the basic elements of an AEAM program. To make the AEAM effort most effective, it would be important to view the restoration effort as a learning process, with adaptation as required. Timely and effective communication of information to all participants would be instrumental in effectively implementing the AEAM process and to further attain program objectives. Examples of communication tools are project-specific assessment reports (report cards), annual programmatic AEAM report, and science symposia convened on an annual or biennial basis.

An AEAM framework would be used to help guide restoration actions toward a sustainable condition. Several components within an AEAM framework include: goals and objectives, conceptual models, performance measures, role of targets, project and basin-level assessments, monitoring, modeling and research, information and communication frameworks, and decision-making approaches. A summary of some of the important AEAM elements is discussed below.

2.1.1 AEAM Elements

2.1.1.1 Goals and objectives

Goals and objectives for restoration in coastal Louisiana can be developed at a number of scales and are essential at all scales. At the programmatic scale, a coast wide vision for the future and a benchmark for progress can be formulated. At the project scale, goals and objectives are critical in design and evaluation. However, they may be used slightly differently at each of these levels. At both scales, the LCA Plan would improve current efforts to refine quantitative and measurable objectives.

The LCA Plan goal is to "Reverse the current trend of degradation of the coastal ecosystem." The objectives would present the approaches and actions to be undertaken, and if successfully completed, they would show progress towards achieving the goal. Progress towards a sustainable ecosystem would support nationally significant living resources, provide a diverse array of fish and wildlife habitats, and reduce nitrogen delivery to offshore gulf waters. Planned features that maintain the structural integrity of the coastal ecosystem, or that promote the distribution of riverine freshwater, nutrients, and sediments, using natural processes and ensuring the structural integrity of the estuarine basins, would accomplish these objectives.

2.1.1.2 Increase understanding using models

Models are useful in identifying attributes that provide a measure of the behavior of a broad suite of ecosystem properties and allow the selection of alternative courses of action during the rehabilitation project (Lee and Gosselink, 1988; Mitsch, 1994; Lee, 1993). In addition, models represent an important "cross-fertilization" (Shugart, 1989) between long-term monitoring and modeling. The S&T Program would develop interactive, spatially explicit models that allow the evaluation of simulated results of proposed management alternatives across the landscape as recommended by Meyer and Swank (1996). Capitalizing on differing areas of expertise, the S&T Office and the PET would collaborate on the execution of models developed by the S&T Program. The suitability of those models to meet program goals would be conveyed back to the S&T Program for review, analysis, and subsequent refinement of the models. The introduction of a modeling component to a restoration program can help forecast the trajectories of success criteria in terms of hydrology, geomorphic features, ecological structure, ecosystem function, and landscape sustainability. Modeling plays a crucial role in AEAM to modify or adjust restoration programs or actions, and to provide analysis and guidelines as to the efficiency of different rehabilitation strategies (**figure A-2.2**). Modeling methods that were employed to guide the early LCA Plan formulation are described in detail in Appendix C, HYDRODYNAMIC AND ECOLOGICAL MODELING. AEAM relies extensively on the use of models to articulate understanding and forecast the effects of alternative management actions. Estimating the effects of a particular restoration action requires projections of the future outcome (i.e., system state) of a decision within the dynamic behavior typical of estuarine systems.

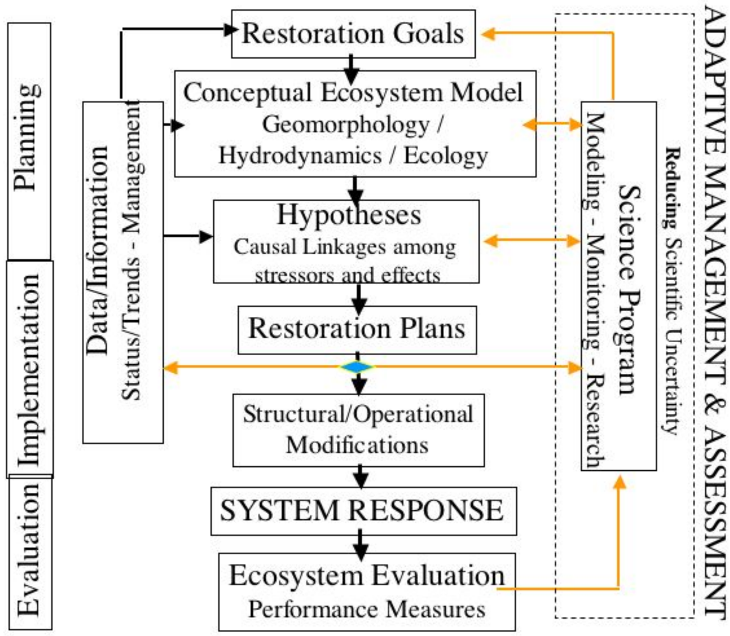

Figure A-2.2. Adaptive Environmental Assessment and Management. This figure presents the S&T Program Approach proposed for developing comprehensive ecosystem restoration plans for the LCA Plan.

Standard methods of model calibration and verification would be used to ensure that algorithms for critical processes are sufficiently robust to accurately portray processes in reference, forecasted, and existing settings. Standard methods of error and uncertainty analysis can estimate the robustness that managers can expect of model forecasts. After this step, the algorithm can then be applied to guide restoration with confidence that it can simulate not only the impacted condition but also the local reference condition. Post-construction assessments of the models are critical to determining the effectiveness of the models in predicting future outcomes. These assessments should identify hypothesis-driven research and data needed to support model refinement. The models provide assurance that the functions are accurately described and objectively simulated.

AEAM would not be conducted independent of other coastal activities; therefore, modeling efforts would integrate existing projects and permitted activities. Cumulative assessments of human induced and natural factors would be integrated into predictive tools. For example, Corps of Engineers water resource projects and regulatory activities (Section 404 permits) would be integrated into the hydrologic unit/watershed scale restoration plans.

2.1.1.3 Supporting research

An important element of any AEAM strategy is carefully planned and focused research. Testing underlying hypotheses of system behavior and model assumptions are integral components of supporting research. Research for the LCA Plan would be process oriented and focus initially on testing critical hypotheses developed from previous modeling efforts identified during the early LCA Plan formulation process (See Appendix C). It would also be necessary to build on lessons learned from other studies along the coast such as prior investigations at Caernarvon that suggest the potential benefits of periodically pulsing waters through that diversion. Numerous other hypotheses have been developed from lessons learned in previous studies during implementation of the early LCA Plan formulation effort. However, research would not be conducted solely to feed the needs of the models. Supporting research would be directed at reducing scientific uncertainty to improve confidence in modeling and monitoring tools and ultimately management actions. Research would also undergo regular intense peer review to maintain the highest level of integrity.

2.1.1.4 Monitoring and evaluation

Scientifically defensible monitoring programs are critical to AEAM. Monitoring provides feedback between decision-making and system response relative to management goals and objectives. Monitoring characterizes actual system response to management actions whereas models forecast probable future system states. Feedback from monitoring and decision-makers into program goals, objectives and system understanding provides the information for "assessment" that enables the "adaptive" component of AEAM.

Informative monitoring programs would identify what is to be monitored to appropriately describe system state, in relation to management goals and objectives (Steyer and Llewellyn, 2000), and the questions that are important to management (Lee 1993). Monitoring program designs would be sensitive to tradeoffs in accounting for temporal and spatial variability, which may hinder traditional statistical and experimental design approaches (Underwood, 1994). Flexibility, therefore, would be incorporated into monitoring approaches to account for uncertainties in addressing system variability.

Monitoring also provides information for building effective models. Monitoring provides data for estimating initial conditions and parameter values of models used in support of AEAM. Monitoring results would also be used to describe and decipher differences between forecast and measured system response to management actions.

2.1.1.5 Data management

Management of data collected prior to the S&T Program as well as data collected during implementation of the S&T Program is critical to ensure establishment of "institutional memory" within the S&T Program. The LCA Plan is proposed to cover an extensive period, and therefore, makes it imperative that data are managed in such a manner that the S&T Program can build upon prior efforts. This requires that the process be transparent, i.e., open and available for public scrutiny, and that the data be available in a form accessible with limited but necessary controls.

2.1.1.6 Decision-making approach

The AEAM framework would be invaluable in assisting the LCA Program Manager to arrive at informed decisions that continuously seek to improve program performance. The process of making a decision largely consists of the gathering and analysis of information to support the choice of one among a number of possible alternative actions. The annual AEAM Program report prepared by the S&T Office for Program Management Team, and the PET would serve to continuously update these forecasts and evaluations, facilitating sound adjustments to program and project-level efforts.

2.1.1.7 Learning and adaptation

Learning and adaptation are elements of AEAM that close the feedback loop and initialize the next cycle of iterative management actions. Information from monitoring, results of experimental manipulations, model forecasts, and supporting research are combined to yield either confirmations of existing beliefs or new explanations of the factors that control the system. This vital information should be "learned" by all stakeholders. Over multiple iterations of the AEAM process, new understanding of how the system operates should result in the re-formulation of goals and objectives.