Appendix 7B-3: Draft CERP Performance Assessment Protocol Paper

The interagency Restoration Coordination and Verification (RECOVER) team has the responsibility to develop and implement a systemwide Adaptive Management Program in support of the Comprehensive Everglades Restoration Plan (CERP). The purpose of the Adaptive Management Program is to create a set of measurable restoration objectives for CERP consistent with the plan's goals, assess how well CERP meets those objectives during and following the its implementation, and identify opportunities to improve CERP's design and operation based on assessments of its performance and on new information acquired through research and monitoring. The overall Adaptive Management Program includes a set of interconnected tasks and products that collectively give RECOVER the ability to apply the principle of adaptive management to CERP. These tasks and products include the development of conceptual ecological models of South Florida's natural systems, a set of peer-reviewed and approved systemwide performance measures and restoration objectives, a systemwide monitoring plan, a data management and quality control strategy, and a data assessment protocol. The linkages among these components of the overall Adaptive Management Program are described in sections 1 and 2 of the *First Draft CERP Monitoring and Assessment Plan* (RECOVER, 2002). The CERP performance assessment protocol presented herein describes the process RECOVER will use to assess information derived from the systemwide monitoring plan and other sources of new information. The protocol also describes how RECOVER will use these assessments to identify opportunities for improving CERP's design and operation to better meet its established goals.

The performance assessment protocol will be further revised and formalized upon the promulgation and codification of the programmatic regulations called for in the Water Resources Development Act of 2000, and will serve as a precursor to an assessment guidance memorandum identified in these programmatic regulations.

INTRODUCTION AND SUMMARY

It is imperative to be able to measure how well large, complex, regional ecosystem restoration programs are achieving their desired goals. As such, it is important for a restoration program to have a "feedback mechanism" for assessing whether the systems being restored are responding, and if so, how well they are meeting restoration expectations. Ideally, these assessments should be used to determine when and how a restoration program could be improved when expectations are not being met. An adaptive management program has been developed to meet this need throughout the implementation of the CERP. The ultimate role of adaptive management in CERP is to have an ongoing, scientifically based process for substantially increasing the probability that the plan will be successful.

Adaptive management provides necessary new information about natural and human systems by measuring how these systems respond to manipulations. This information can be used to improve the design and implementation strategy for restoration projects. Adaptive management is "learning by doing" and using new information to improve processes. Adaptive management is

the most effective means for acknowledging and minimizing great uncertainties regarding program design and system responses, uncertainties that inevitably are part of large ecosystem restoration programs.

The adaptive management program provides two opportunities during the design and implementation of CERP projects for minimizing uncertainties and improving the plan's systemwide performance. The first of these opportunities happens during the additional design work that occurs for each individual CERP project as a basis for preparing a Project Implementation Report. As part of the project planning process, the predicted performance of alternative plans for meeting the project goals and for improving the systemwide performance of the CERP will be determined through simulation modeling. The RECOVER team's evaluations of the performance of alternative plans will provide opportunities for selecting plans that maximize CERP performance.

The second opportunity for improving plan performance is through the adaptive management program (**Figure 1**). This RECOVER protocol paper focuses on how RECOVER will assess and identify opportunities to improve CERP performance based on monitoring and research data (lower set of grouped boxes, **Figure 1**). Th paper briefly summarizes and defines adaptive management as used in the context of CERP, and defines steps that are necessary to develop and implement the systemwide monitoring and assessment program. An earlier RECOVER white paper provided additional information on adaptive management's overall value and role in ecosystem restoration programs (RECOVER Adaptive Assessment Team, 2000), while the details of the CERP systemwide monitoring plan are provided in the First *Draft CERP Monitoring and Assessment Plan* (RECOVER, 2002).

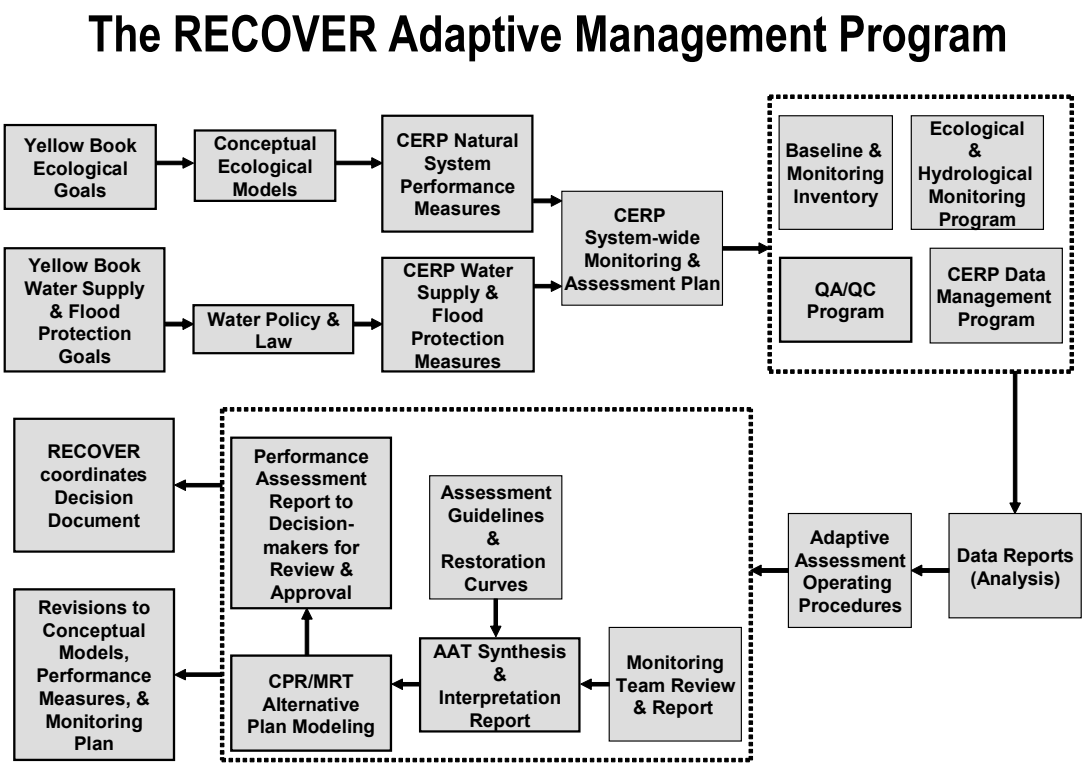

Figure 1. Overall steps in the design and implementation of an adaptive management program in support of CERP

The CERP adaptive management program includes aspects of what have been termed "active" and "passive" adaptive management strategies. Active adaptive management maximizes learning and reduces uncertainty, before the final project design is decided upon and implemented, by conducting pre-construction "experiments" designed to answer questions about how the systems will respond to specific restoration actions. These experiments can be designed to "test" the working hypotheses that form the basis for predictions of system responses. The CERP pilot projects are the primary examples of active adaptive management in the current plan.

Passive adaptive management is an iterative process conducted throughout the plan's implementation. Passive management depends on information obtained through a systemwide monitoring plan designed to measure the restoration objectives that have been defined by the set of CERP biological, hydrological, water quality and water supply performance measures. The system responses are compared to pre-CERP baseline conditions as a way of assessing the plan's impacts. Opportunities for "learning by doing" (i.e., monitoring and assessment) are limited to the period following project construction. The CERP implementation plan incorporates a passive strategy for most projects.

In the context of CERP, the overall adaptive management program includes a number of components and steps (**Figure 1**). Collectively, these components and steps are necessary to design and implement the systemwide monitoring plan, design and activate a data management and data analyses protocol, interpret and report system responses, and identify opportunities for improving the plan. To support the adaptive management program, the CERP monitoring plan is designed to:

1. Measure the status of, and trends in, the selected performance measures
2. Determine baseline (pre-project) variability for the measures' responses
3. Address uncertainties through cause-and-effect research
4. Detect unexpected and unintended system responses

Additional details on the design and implementation of the CERP Monitoring and Assessment Plan are provided in section II, below, and are more fully explained in the monitoring and assessment document.

The assessment protocol is presented in the following two sections. Section II describes how RECOVER teams will organize and interpret new information obtained from systemwide and local monitoring and research programs in ways that will detect interim and final responses brought about by CERP and other features of the Central and Southern Florida (C&SF) Project. RECOVER will determine when these responses are undesirable or unintended relative to the CERP interim and final performance measures and restoration goals, and will use modeling to identify potential solutions to performance problems. Section III proposes steps for linking science and management in a joint process for determining when and how CERP should be modified in response to RECOVER assessment reports.

II. RECOVER ADAPTIVE ASSESSMENT PROCESS

RECOVER teams will use information collected and analyzed through the CERP Monitoring and Assessment Plan as a basis for conducting five basic assessment tasks (**Figure 2**). The RECOVER Adaptive Assessment Team has primary responsibility for four of these tasks; the

RECOVER Comprehensive Plan Refinement Team is responsible for the fifth task (see below). Additional project-level monitoring and research conducted outside of CERP may also be used in the assessment process.

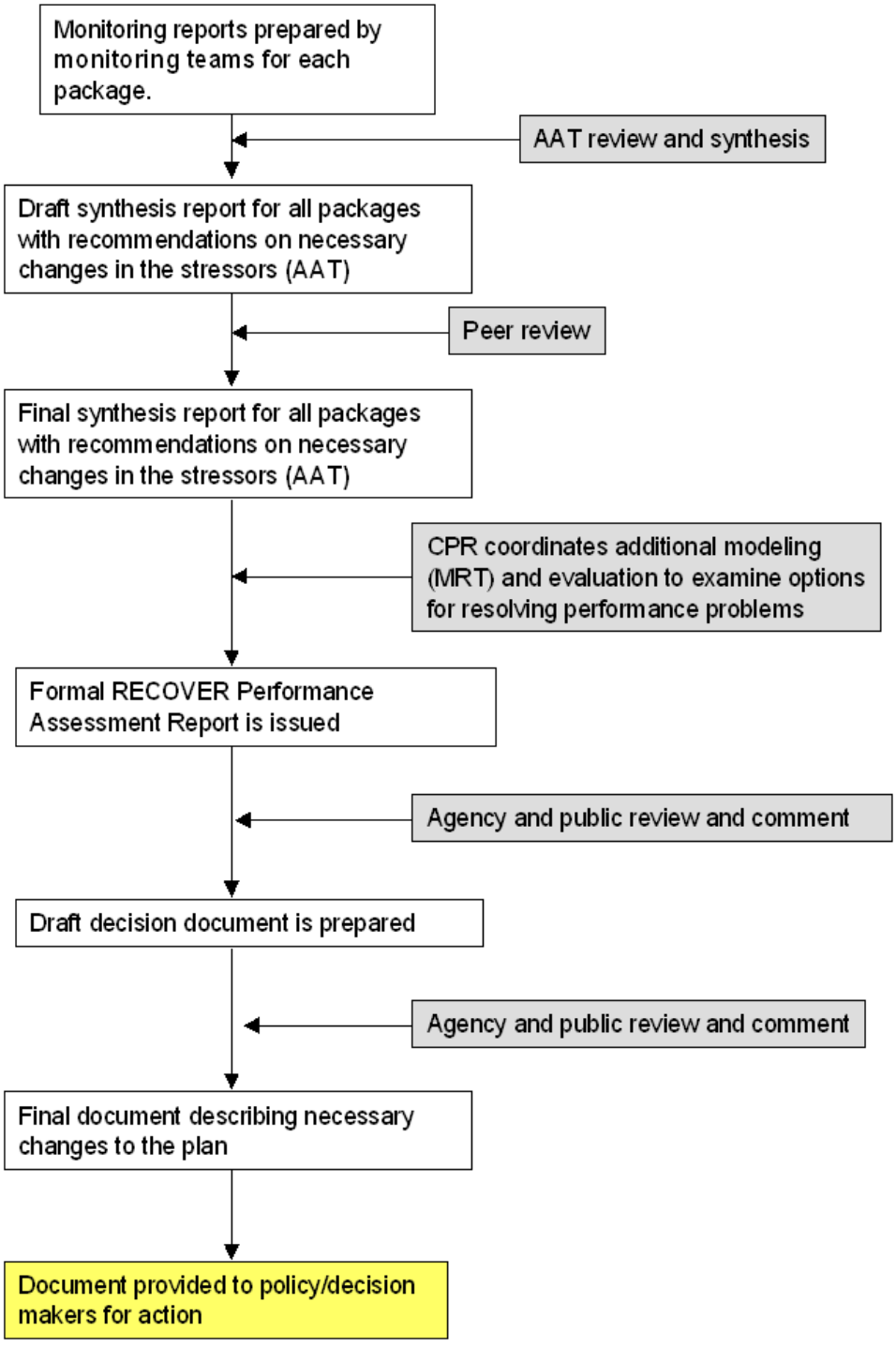

Figure 2. Sequence of reports and actions for Performance Assessment

The RECOVER Adaptive Assessment Team, in collaboration with the Water Quality and Regional Evaluation teams, will be responsible for the following:

- Determining when responses by CERP performance measures are different from natural variability and baseline conditions
- Determining if the observed responses are linked to CERP
- Comparing the responses to the interim and final objectives and determining if the responses are undesirable (e.g., they are moving away from expectations and restoration goals and/or are not meeting the interim goals) and at what point corrective action should be considered (e.g., how many performance measures or what magnitude of an undesirable change warrants concern)
- Identifying what corrections in the stressors are necessary for the performance measures to respond as desired

The Adaptive Assessment Team will prepare an assessment report synthesizing the above information for consideration by RECOVER (specifically, the Comprehensive Plan Refinement and Model Refinement teams; see below).

The RECOVER Comprehensive Plan Refinement, in collaboration with both the Model Refinement and Operations Planning teams, will do the following:

- Coordinate a modeling exercise as a basis for identifying one or several potential refinements in CERP design and operations needed to resolve the performance problems identified in the Adaptive Assessment Team report. The Comprehensive Plan Refinement Team will prepare a report describing the alternative plans that are modeled, and the performance benefits and potential consequences associated with each of the alternative plans.

The combined reports from the Adaptive Assessment Team and Comprehensive Plan Refinement Team will be jointly issued as RECOVER adaptive management reports. These reports will be reviewed and approved by decision makers in the United States Army Corps of Engineers (USACE) and the South Florida Water Management District (District or SFWMD), or another local sponsor, where appropriate, as a precursor to the development of the appropriate decision document under RECOVER's coordination. (**Figure 1**; also see Section III).

DESIGN OF THE CERP MONITORING AND ASSESSMENT PLAN

The CERP Monitoring and Assessment Plan was derived from the minimal set of performance measures that the RECOVER teams considered to be necessary for understanding system responses to CERP. The CERP Monitoring and Assessment Plan arranges these measures into monitoring modules, organized in broad functional or physiographic groupings. Each module describes the performance measures and restoration objectives, identifies a specific set of questions the module is designed to answer, and recommends an integrated monitoring protocol for the combination of measures and questions contained in that module. Additionally, each module identifies the key uncertainties in system responses associated with that set of performance measures and the research questions that must be answered to better predict and interpret system responses in the context of CERP. The research questions focus on what are thought to be the important, yet poorly understood, causal relationships. A better understanding of these relationships will be essential for improving the accuracy of the predictive models and the systemwide assessments.

It is proposed that a multiagency and multi-institutional monitoring team will coordinate implementation of the monitoring program described in each module. Each monitoring team should include representatives from the Adaptive Assessment, Water Quality and Regional Evaluation teams to ensure the necessary expertise for providing oversight for the monitoring and research needs outlined for that module.

Information collected through monitoring and assessment will provide baseline data, status and trends for each measure systemwide, as well as provide information on the causal relationships that underlie these trends. Additional project-level monitoring will be necessary to evaluate individual projects and provide information that can be used to improve each project's performance. The monitoring and assessment results also will be used to revise performance measures and restoration goals, where needed (i.e., reevaluate working hypotheses and the organization of the conceptual ecological models).

In addition to designing and implementing the CERP Monitoring and Assessment Plan and a data management strategy (**Figure 1**), a number of additional tasks must be completed for the Adaptive Assessment Team to be prepared to analyze and report on system responses to CERP. These tasks are described herein.

DETERMINE NATURAL VARIABILITY AND APPROPRIATE TEMPORAL AND SPATIAL SCALES FOR ASSESSING PERFORMANCE MEASURES

The variability of each performance measure and its context within each monitoring module will be established using a combination of historic and current preproject baseline data. Some CERP performance measures do not currently have appropriate baselines and should not be used in the assessment process for a number of years because there is no way to detect differences between "true changes" in system responses and background variability at this time. The concept of "true change" versus background variability is a challenge, and for many of the measures could require years of baseline data. For example, total phosphorus (TP) in Lake Okeechobee displays: (1) seasonal variation due to wind, (2) year-to-year variation due to variation in loading and lake level, and (3) drought-related decadal variation.

Identification of the appropriate spatial and temporal scale for assessment will be critical for determining how each performance measure fits into each monitoring module and how it will be used in the assessment process. For example, data for some performance measures may be collected each year, but due to variability the response time could be five or 10 years. Because of changes in response time for each measure, different measures might be used in the assessment each year. The determination of which measures will be used in each year will be identified in the monitoring network design. It will be important to identify short-, medium- and long-term measures for the assessment process and to remember that just because a measure will not be used in the assessment for 10 years, the data still need to be collected each year (**Figure 3**). While responses by the final endpoint shown in this figure may not be expected except on long time scales, responses that fit a predicted trend at intermediate (interim) points would provide an early indication that the restoration plan is headed in the proper direction.

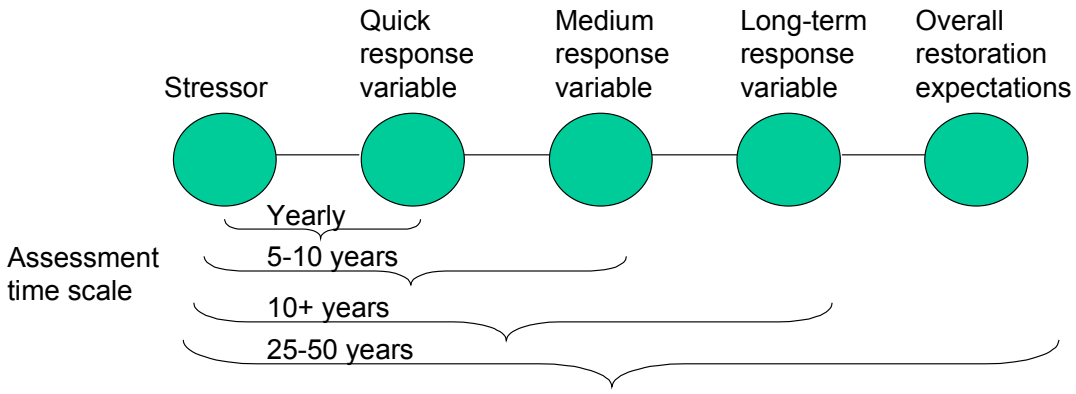

Figure 3. Illustration of temporal scales of measurement and assessment

DEVELOP RESPONSE CURVES AND CONFIDENCE ENVELOPES FOR THESE CURVES

A question that will need to be addressed for each performance measure is that of how measures taken in the field could be expected to change given the changes in CERP. One way to address this is by using the output from hydrologic, water quality and ecosystem landscape models to show the predicted rates of stressor and biological responses, and then developing response curves with appropriate confidence envelopes for each measure or set of measures. The concepts of response curves and confidence envelopes are used here in the broadest sense and may range from detailed quantitative statistical relationships to qualitative best professional judgments. Each response curve will provide a prediction of the rate and magnitude of responses by a performance measure or set of measures during and following CERP implementation. The refinement of these curves will be dependent on the data collected through the monitoring and research program.

As a means for developing the response curves, the Adaptive Assessment Team will use hydrologic modeling to predict future systemwide hydrological patterns based on the rate and sequence of project implementation proposed by the current CERP Master Implementation Schedule. This modeling could be designed to show predicted hydrological patterns at five-year intervals during CERP implementation and as a basis for predicting interim goals during these same time intervals.

Expected responses of the performance measures can then be developed based on the hydrologic predictions. Existing tools (ATLSS, ELM, etc.) can be used to aid in the development of response curves. Ideally, these response curves will take into account natural variability. Areas where the improvement or development of new tools could assist with the development of response curves should be identified. Responses that fall outside of the predicted response envelopes could result in recommendations for improvements in the plan.

The criteria for developing the confidence envelopes around the responses need to be developed. Questions such as what constitutes “real” change will depend on natural variability, the monitoring network design, and the desired level of confidence. It will be necessary to

consider the power of the analyses (the chance of reliably identifying a change), as well as the significance values used to determine change.

DEVELOP CRITERIA FOR INTERPRETING INDIVIDUAL AND COLLECTIVE RESPONSES OF PERFORMANCE MEASURES

Assessments will be integrated across the system. The set of monitoring modules provides the framework for this integration. The monitoring modules have been designed to address not only individual performance measure responses, but also the factors that are causing change. Within each module the assessment process will ask the following questions of each performance measure:

- Has the measure changed from the base condition?
- Is this a change in the desired direction?
- Is the change occurring within the expected/desired values as described by the hydrologic modeling and response curves?
- Are the changes linked to CERP (specific projects or components)?

Using the assessment process, the stressors will be examined. If no changes in the stressors are found, then it should be deduced that any detected changes among the attributes could be due to natural variability or other causal factors. The Monitoring and Assessment Plan will provide information that will allow the Adaptive Assessment Team, with assistance from the Water Quality and Regional Evaluation teams, to make this assessment. Each attribute will be examined using the same set of questions. Responses will be examined in the context of each monitoring module to determine progress toward restoration expectations.

The monitoring team responsible for implementing each module will prepare a brief, annual report for review by the Adaptive Assessment Team. The report will present the current status of each measure in the context of the monitoring module, summarize progress made in addressing key uncertainties, and provide a discussion on the cause and direction of changes. In addition, the report will include a section highlighting measures outside the confidence envelopes and a discussion of necessary stressor changes aimed at improving the response. Guidelines will be developed to help the monitoring teams decide when the number and magnitude of "wrong" responses is great enough to trigger a review of alternative plans for improving CERP performance.

The Adaptive Assessment Team will evaluate the monitoring teams' reports and develop a summary report that synthesizes the information and analyzes any performance problems in the natural and human systems. As a general guideline for deciding the levels of CERP-influenced responses in the natural and human systems that will be considered undesirable, thereby triggering a review of potential solutions, the predicted performance of the initial CERP (D13R and OPEs) is considered to be the minimal acceptable performance of CERP during implementation. The overall goal is to improve the performance described by D13R and OPEs, especially in those regions where the initial CERP performance was predicted to achieve only a "yellow" or "red" performance level. Any system response that is less than the predicted performance for the initial CERP at any point during implementation, or that does not improve on "yellow" or "red" performance predictions will be considered potentially inadequate for meeting the plan's restoration goals. While other levels of response or other information can lead to RECOVER actions, this initial CERP performance threshold will automatically trigger the review

protocol described in this section. RECOVER uses a similar performance threshold for evaluating the modeled predictions of systemwide performance by CERP projects during the development of project implementation reports.

DETERMINE THE APPROPRIATE FREQUENCY OF RECOVER ADAPTIVE ASSESSMENT REPORTS

RECOVER will decide how often to conduct formal assessments of system performance and will issue performance assessment reports. While the monitoring program and the monitoring module teams are organized to annually collect and review, respectively, monitoring data, responses by most performance measures to the effects of CERP may not be detectable during one-year time frames. The high level of interannual variability in rainfall and the influences of other major climatological events (freezes, hurricanes, etc.), coupled with the expected slow response times for many ecological features of the Everglades system, suggest that formal assessment reports will not be needed annually. Additionally, the pace of CERP project implementation is such that major physical and operational changes in the system generally will occur at multiyear scales rather than within-year time scales. Consideration should be given to multiyear intervals between formal assessments. Two-year intervals might be appropriate to coincide with the expected intervals for Water Resource Development Act legislation. Three-year intervals might be best for detecting and interpreting many of the expected responses in the natural system. Five-year intervals would coincide with required reporting times to the U.S. Congress and would serve as the maximum time period between the issuance of assessment reports.

MODIFICATIONS TO THE COMPREHENSIVE EVERGLADES RESTORATION PLAN

The recommended steps in the process of resolving system-level performance problems and improving the systemwide performance of CERP are represented in **Figure 1**. Successful application of the adaptive management program will require the interagency RECOVER team, policy and decision makers, and the public to interact in addressing the opportunities identified by the performance assessment protocol. The assessment reports will lay the groundwork for both resolving performance problems and for improving the plan's overall performance.

The intersection of the knowledge and views of these three groups should indicate where the restoration plan has the highest probability of being successful (**Figure 4**). RECOVER scientists and resource specialists provide updated information on the ecological and water supply goals and on potential actions designed to resolve performance problems and provide opportunities for enhanced performance within the context of CERP. Management and policy makers provide agency perspectives and represent what is possible and practical with CERP implementation and redesign. The public provides independent review and a regional stakeholder perspective. Incorporating these groups' views into the decision making process for CERP alterations will be critical to the restoration program's long-term success.

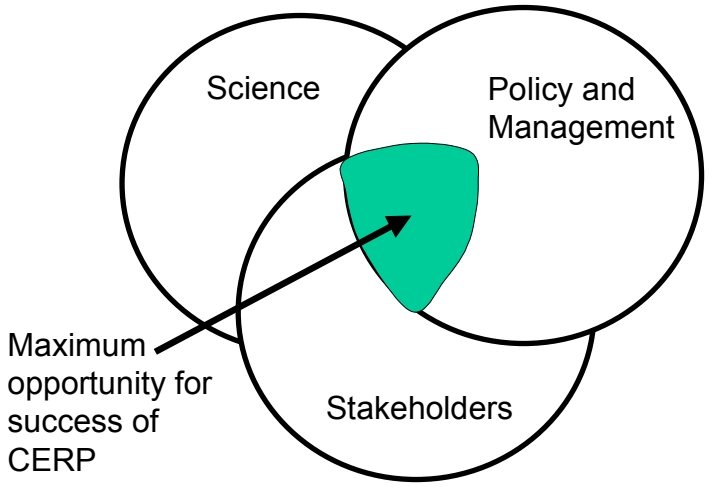

Figure 4. Integrating the inputs of science, policy/management and stakeholders as a way to successfully meet the goals and objectives of the Comprehensive Everglades Restoration Plan

As summarized above, the formal performance assessment reports issued at two- to five-year intervals by RECOVER will: (1) report the natural and human systems' responses to CERP implementation, (2) identify any performance problems attributable to CERP, and (3) identify potential options for resolving undesirable performance or for improving CERP performance based on new monitoring and research information. When the USACE and the SFWMD (or other local sponsor) agree that performance problems or other opportunities for improved performance should be addressed, RECOVER will assist in the development of a Comprehensive Plan Modification Report or other appropriate decision document. The report/document will detail recommendations for the plan's reformulation and/or describe any necessary operational changes needed for resolving performance problems or making improvements based on new monitoring and research information.

The suggested steps in this process are:

1. The RECOVER Adaptive Assessment Team identifies any system-level performance problem or new information that can lead to an improvement in plan performance.

2. RECOVER Program Managers (USACE and SFWMD) informally consult with senior management in their respective agencies regarding performance problems or new opportunities to improve plan performance. These consultations should produce agreement on an initial set of alternative solutions for addressing problems and opportunities.

3. The RECOVER Comprehensive Plan Refinement and Model Refinement teams coordinate modeling to better define the range of alternative solutions for improving plan performance.

4. The Adaptive Assessment and Comprehensive Plan Refinement teams prepare a formal performance assessment report that not only fully defines the performance issues and opportunities, but also documents the alternative solutions that were

modeled. This assessment report is much like a mini-reconnaissance study in that it describes the problem(s) and opportunities and identifies a range of potential actions.

5. The RECOVER performance assessment report goes through agency and public review and may be reviewed by the South Florida Ecosystem Restoration Task Force.

6. In response to agency and public review and comment, the Comprehensive Plan Refinement Team assists in the drafting of a Comprehensive Plan Modification Report or other appropriate decision document. The Modification Report (or other decision document) can be likened to a mini-feasibility study in that it includes a full analysis of costs, benefits and improvements in plan performance and identifies a preferred plan.

7. The Comprehensive Plan Modification Report (or other appropriate decision document) goes through agency and public review.

Any RECOVER assessment that shows that CERP performance measure responses are sufficiently undesirable, based on assessment criteria developed by the Adaptive Assessment Team (section II), should initiate the review of alternative solutions as described above. A proposed framework for organizing the review of potential alternatives for resolving performance problems or improving plan performance, and for selecting a preferred alternative, is shown in **Figure 5**. This "decision tree" suggests an organized pathway that can lead to a decision regarding the most effective and efficient action for dealing with any performance problem or performance opportunities. The decision tree leads to the following potential actions:

1. Modify current plan operations

2. Modify the design or operational plan for a plan project that is not yet implemented

3. Modify the sequence or schedule for plan implementation

4. Modify current operations of the plan

5. Add new components to the plan or delete components not yet implemented

6. Remove or modify a plan component already in place

7. Apply more than one of the above options

The preferred alternative plan identified in the Comprehensive Plan Modification Report or other decision document will go through public and agency review and will comply with the conditions of the Programmatic Regulations prior to action.

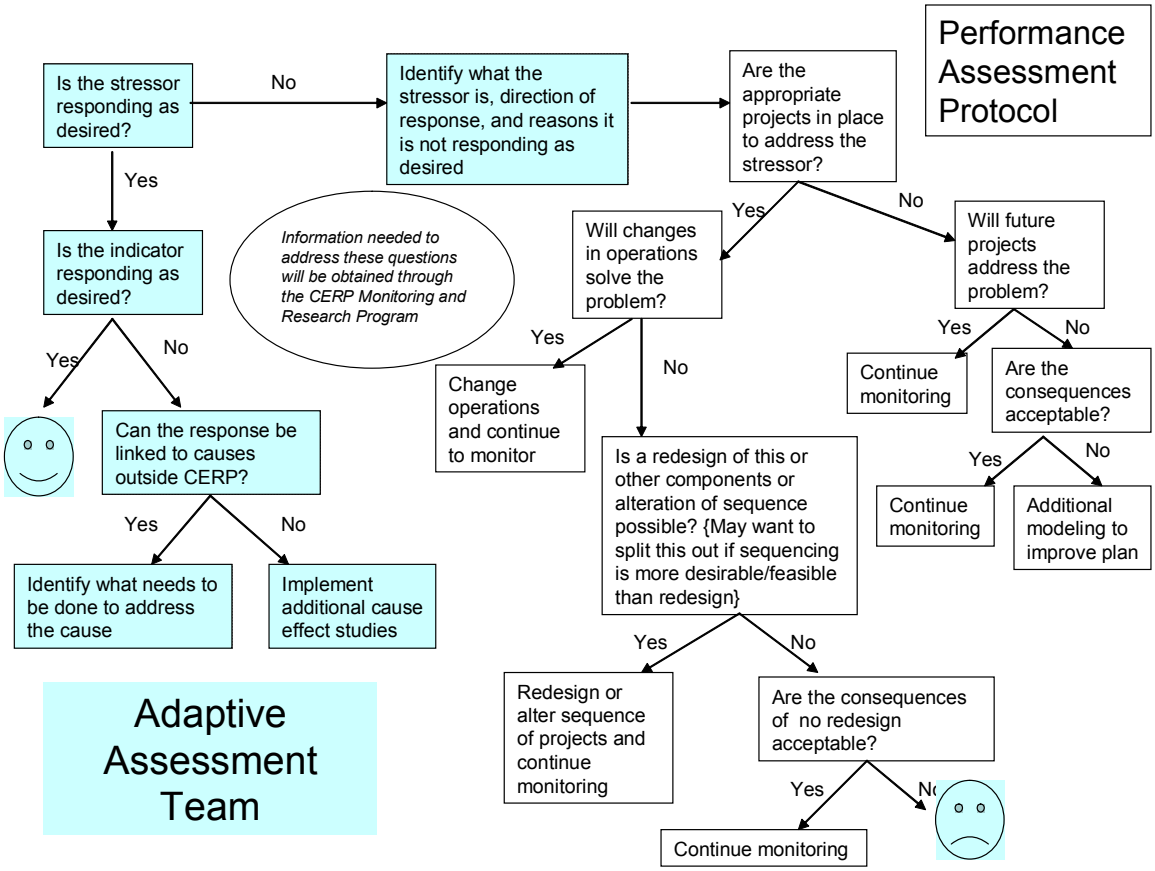

Figure 5. Decision tree for determining changes to the Comprehensive Everglades Restoration Plan

LITERATURE CITED

RECOVER Adaptive Assessment Team. 2000. *An Adaptive Assessment Strategy for the Comprehensive Everglades Restoration Plan*. West Palm Beach, FL.

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