CERP GUIDANCE MEMORANDUM

SOUTH FLORIDA WATER MANAGEMENT DISTRICT – JACKSONVILLE DISTRICT, U.S. ARMY CORPS OF ENGINEERS

CGM NUMBER-REVISION: 056.00
EFFECTIVE DATE: **08-Feb-2011**

CATEGORY: Adaptive Management

SUBJECT:

Guidance for Integration of Adaptive Management (AM) into Comprehensive Everglades Restoration Plan (CERP) Program and Project Management

DESCRIPTION:

This CERP Guidance Memorandum (CGM) provides guidance for CERP Project Delivery Teams (PDTs) to develop project plans that integrate AM principles as defined in the CERP AM Integration Guide (AMIG) (USACE and SFWMD, 2010). This guidance supplements the Planning Guidance Notebook (Engineering Regulation [ER] 1105-2-100) (USACE, 2000), the Planning Manual (Institute for Water Resources [IWR] Report 96-R-21) (Yoe and Orth, 1996), and recent U.S. Army Corps of Engineers (USACE) guidance on ecosystem restoration planning (USACE, 2009a).

In the Water Resources Development Act (WRDA) of 2000, Congress authorized AM as a desired management approach for implementing the CERP. Implementation guidance for Section 2039 of WRDA 2007 on Monitoring Ecosystem Restoration, Section 3(d) requires that all ecosystem restoration projects (including CERP projects) develop an AM Plan (USACE, 2009a).

PURPOSE:

The purpose of AM activities in the life-cycle of the project is to address unanswered questions and other uncertainties that could prevent a project from moving forward and to set the stage for decisions and activities based on monitoring results and other new information. This CGM provides guidance on incorporating the principles of AM into CERP Program and Project Management, specifically the Project Implementation Report (PIR) process, by focusing on the places where guidance in the CERP Six-Step Planning Process, the AMIG, the Planning Manual, engineering circulars and regulations, and USACE Headquarters (HQUSACE) guidance memoranda intersect. This is the first document to merge these guidelines and procedures into a single document. This CGM will also provide guidance on incorporating the principles of AM into the post-PIR and system-level processes as soon as such guidance is developed.

GUIDANCE:

Appendix A presents the guidance for PDTs that allows for integration of AM activities into the CERP PIR process. The AM activities identified in the AMIG have been integrated into the tasks performed during the project management plan (PMP) phase and during the CERP Six-Step Planning Process. PDTs will develop and refine their AM plan, presenting concluding results and recommendations for future management options in an appendix to the PIR.

Appendix B (to be developed) will present the details of post-PIR AM activities.

Appendix C (to be developed) will present the details of system level AM activities.

APPLICATION:

Effective the date of this memorandum, the provisions of this CGM establish AM as an integral part of the CERP PIR process.

APPROVAL:

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his document provides working level guidance to assist Project Delivery Teams in the implementation of the Comprehensive Everglades Restoration Plan (CERP) program executed between the South Florida Water Management District and the U.S. Army Corps of Engineers. The guidance does not constitute policy for either agency nor does it create authority beyond that granted to any agency member carrying out their duties. Guidance reflecting agency policy on subjects listed in the guidance memoranda section of the programmatic regulations for CERP will be issued when the final programmatic regulations are adopted, using the process stated in the regulations.

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Appendix A

GUIDANCE FOR INTEGRATION OF ADAPTIVE MANAGEMENT INTO COMPREHENSIVE EVERGLADES RESTORATION PLAN PROJECT IMPLEMENTATION REPORTS

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Acronyms

A

AFB	Alternative Formulation Briefing
AM	Adaptive Management
AMIG	Adaptive Management Integration Guide
ASR	Aquifer Storage and Recovery

B

BBCW	Biscayne Bay Coastal Wetlands project
BMP	Best Management Practice

C

C-111 SC	C-111 Spreader Canal Project
C&SF	Central and Southern Florida Project
CE/ICA	Cost Effective/Incremental Cost Analysis
CEM	Conceptual Ecological Model
CERP	Comprehensive Everglades Restoration Plan
cfs	cubic feet per second
CGM	Comprehensive Everglades Restoration Plan (CERP) Guidance Memorandum

D

DCT	Design Coordination Team
DCU	Decision-Critical Uncertainty
Decomp	Water Conservation Area 3A Decompartmentalization and Sheetflow Enhancement project

E

EAB	Environmental Advisory Board
ER	Engineering Regulation
ETL	Engineering Technical Lead

F

FACA	Federal Advisory Committee Act
FAST	Functional Analysis of Systems Technique
FSM	Feasibility Scoping Meeting

H

HQUSACE	U.S. Army Corps of Engineers Headquarters

I

IWR	Institute for Water Resources

M

MAP	Monitoring and Assessment Plan
mg/L	milligrams per liter

N

NAI	Next Added Increment
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NOAA	National Oceanic and Atmospheric Administration

P

PDT	Project Delivery Team
PIR	Project Implementation Report
PMP	Project Management Plan
PRB	Project Review Board
psu	practical salinity units
PTL	Planning Technical Lead

Q

QA/QC	Quality Assurance/Quality Control
QRB	Quality Review Board

R

RECOVER	Restoration Coordination and Verification
Restudy	C&SF Comprehensive Review Study
RLG	RECOVER Leadership Group

S

SFWMD	South Florida Water Management District
SOM	System Operating Manual
S/T	Scientific/Technical
STA	Stormwater Treatment Area

T

TN	Total Nitrogen
TP	Total Phosphorus
TSP	Tentatively Selected Plan

U

USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency

W

WCA	Water Conservation Area

WRDA	Water Resources Development Act

I. BACKGROUND

Adaptive Management (AM) is a structured, iterative process of optimal decision making in the face of uncertainties, with an aim of reducing uncertainties over time via system monitoring. In this way, decision making simultaneously maximizes one or more resource objectives and accrues information needed to improve future management. AM is often characterized as "learning by doing." It is a formal process for continually improving management policies and practices by learning from their outcomes (Taylor et al., 1997). In the context of Everglades restoration, Comprehensive Everglades Restoration Plan (CERP) AM is a structured management approach for addressing uncertainties by testing hypotheses, linking science to decision making, and adjusting implementation as necessary to improve the probability of restoration success. For a more detailed definition, see the CERP Adaptive Management Integration Guide (AMIG).

Several federal agencies, including the Department of Interior (USDOI), Environmental Protection Agency (USEPA), United States Geological Survey and the National Oceanic and Atmospheric Administration (NOAA) have produced conceptual and guidance documents supporting the use of AM in ecosystem restoration efforts in Glen Canyon, Chesapeake Bay, San Francisco Bay Delta, Louisiana Coastal Area, and the Missouri River. AM has been a part of the Central and Southern Florida (C&SF) Project since the early 1990s when members of the C&SF Comprehensive Review Study (Restudy) team considered AM concepts to be essential to achieving long-term restoration success. The Water Resources Development Act (WRDA) of 2000 authorized AM as a desired management approach for implementing the CERP and in 2009 AM plans were required nationwide for all ecosystem restoration projects, including CERP projects, by Section 2039 of WRDA 2007 (USACE, 2009a). An interagency team has produced the AMIG, the comprehensive guidance manual for AM in CERP. This CERP Guidance Memorandum (CGM) is the decision document that implements many of the recommendations proposed by the AMIG to integrate AM into the U.S. Army Corps of Engineers (USACE) planning process used by CERP.

AM programs nationwide have many common elements that have been incorporated into this CGM, all of which are consistent with smart planning. They include inclusion of stakeholders in the early identification of uncertainties, a consistent, concerted approach for plan refinement and resolution of uncertainties, and an emphasis on collaborative planning. The establishment of an AM plan acknowledges uncertainties and ensures continued collaboration that withstands challenges and issues that may arise during the project implementation report (PIR) process. In addition to encouraging increased effectiveness in planning and efficient identification of uncertainties and their resolution, AM supports more cohesive and collaborative partnerships.

The CERP AM approach offers the following for the planning process:

- A formal procedure to identify and address uncertainties that either prevent a project from moving forward and/or reduce the likelihood of achieving intended outcomes. A way to determine which uncertainties are pivotal to the success and/or forward motion of a project.
- An AM plan that provides the framework for decision making under uncertain conditions and a process for project refinement based on monitoring results and new information.
- Ways to resolve questions and test hypotheses using rational approaches to gain additional information needed to determine the best course of action.
- Ways to apply new information, answers, and findings to the planning process to produce implementable plans.
- A way to obtain early management involvement in the resolution of uncertainties.

- Promotes flexible and robust designs that, based on monitoring feedback, allow for adjustments to projects to achieve restoration.

Since ecosystem restoration became a USACE mission in the 1990s, there has been a great deal of learning and appreciation of the complex interdependencies associated with ecosystem restoration as well as the limits of current Civil Works decision making processes to support this mission. It has become apparent that ecosystem restoration projects present new and different challenges. Ecological outcomes are often less predictable than engineering outcomes. This is partly the result of ecosystem restoration being a relatively young category of civil works projects compared to flood protection or navigation, and partly the result of working in a system that can be dynamic and constantly adapting to changes from many different stressors. Often, questions that arise in ecosystem restoration projects have no precedent. In addition to the technical challenges, there can be equally complex management, legal, and policy concerns from a large number of stakeholders. The first decade of CERP could be characterized as a concerted group effort to adaptively manage existing processes to fit the scope and complexity of this vast ecosystem restoration program. The concept of AM works with processes and with projects. The purpose of this Appendix is to adapt the CERP planning process slightly to include AM so that projects will be designed to be adaptively managed. The steps do not need to be elaborate or duplicative or to require a sub-team or great expense. Adaptive Management is smart planning. The steps are meant to enhance the activities that already take place.

This Appendix explains how AM activities fit into the CERP Six-Step Planning process. Some of the activities will seem familiar to the project delivery teams (PDTs); other activities will be new. The more familiar tasks differ in that they will be performed earlier in the planning process and proceed more formally. The purpose of formalizing the process is to keep attention focused on the most critical issues, to increase scientific credibility, to get and keep approval of management at key points, and to help keep projects on schedule and costs down. Resolving key uncertainties and using that information both to enhance project planning and to develop an integrated AM plan will ensure the success of CERP projects over the long term. PDTs will begin the AM process by including a preliminary list of key uncertainties in the project management plan (PMP).

Once the PIR is underway, the AM plan will be updated and approved by management regularly to reflect new information, including resolution of and progress on resolving uncertainties as well as any new uncertainties that might emerge. At the completion of the PIR, the AM plan will be finalized[1] as an integrated report in the PIR, including a set of post-construction recommendations to improve project performance, if needed. The AM plan and the post-PIR recommendations (the contingency plan, as required by USACE [2009a]) will be as simple or complex as needed, depending on the nature of the project.

II. INTEGRATION OF AM INTO THE PIR PROCESS

The following CERP AM activities were designed to assist the PDT in filling information gaps and using the information to make decisions. These nine activities are illustrated in Figure 1 and described in greater detail in the CERP AMIG.

The CERP AM activities are:

- Activity 1 – Stakeholder Engagement and Interagency Collaboration

[1] The AM Plan will continue to be updated and approved regularly after the PIR is completed and throughout the project life-cycle until all uncertainties are addressed, expected performance is achieved, and project operations and outputs become predictable and stable within expected ranges. “Finalized” as used here refers only to the culmination and documentation of AM activities in the PIR phase and proposed AM activities (including contingency plans) for the post-PIR phases.

- Activity 2 – Establish/Refine Restoration Goals and Objectives
- Activity 3 – Identify and Prioritize Uncertainties
- Activity 4 – Apply Conceptual Models and Develop Hypotheses and Performance Measures
- Activity 5 –Alternative Plan Development and Implementation
- Activity 6 – Monitoring
- Activity 7 – Assessment
- Activity 8 – Feedback to Decision Making
- Activity 9 – Adjustment

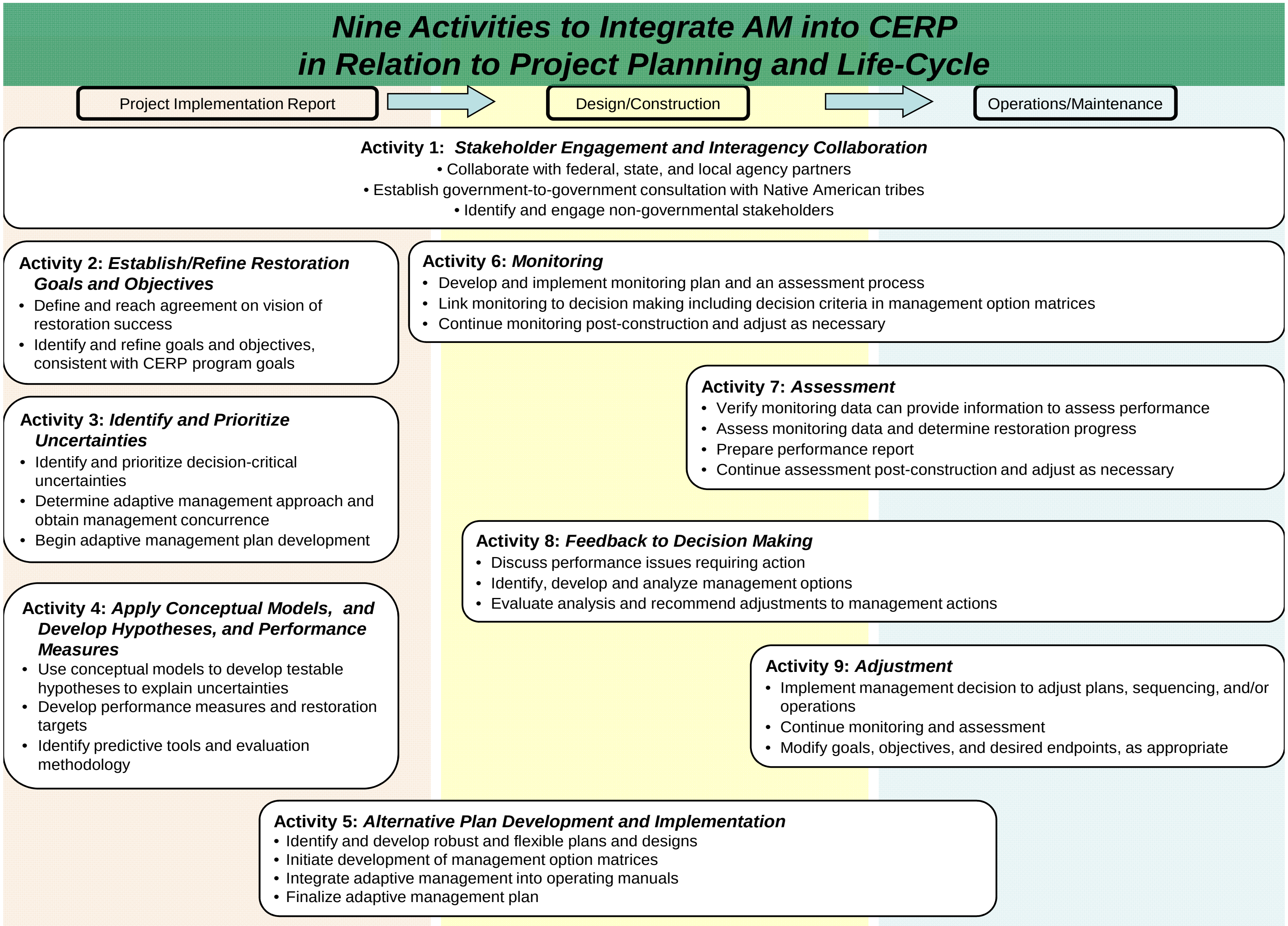

FIGURE 1. NINE ACTIVITIES TO INTEGRATE AM INTO THE CERP

This Appendix focuses on the PIR process where the emphasis is on AM Activities 1-5. AM activities begin during development of the PMP, are integrated into the Six-Step planning process, and are documented along the way, culminating in an AM plan that is integrated into the PIR. During every step of the planning process, PDTs proactively identify, screen, and prioritize uncertainties associated with achieving goals and objectives. Some uncertainties will not be able to be resolved during the PIR process but can be addressed during design, construction, or operations and maintenance phases of the project. Post-construction monitoring will be used in this resolution process. Highest priority uncertainties will be given the designation of decision-critical uncertainties (DCUs), which are those that threaten forward progress of the project. DCUs are further described in Section C.i.b. DCU designation must be approved by management. If uncertainties are considered to be DCUs, strategies will be developed, scheduled, and funded to ensure resolution as early as possible in order to support timely decisions. If a proposed uncertainty is denied confirmation by management, the rationale for this determination will be documented to eliminate future work associated with this uncertainty since it was addressed and a definitive resolution was reached. Resolution of confirmed but non-critical uncertainties (non-DCUs) can be addressed in order of importance and urgency as time and resources permit. The list of uncertainties, their priority, those designated as DCUs, and a summary of the strategies to address them during planning or post-construction will be consolidated in the Plan Formulation chapter of the PIR. Any potential post-construction management actions and their costs will be documented in the renamed Monitoring and AM Appendix to allow for future adjustments, if needed, based on monitoring results. By having a formal process and resolving issues early, new information can influence every stage of the planning process and result in projects that can succeed under a wide range of conditions, can be adjusted if necessary, and are designed to achieve CERP and project goals and objectives.

A. The Beginning - PMP

The PMP includes tasks that correspond to three CERP AM activities:

- Activity 1 – Stakeholder Engagement and Interagency Collaboration
- Activity 2 – Establish/Refine Restoration Goals and Objectives
- Activity 3 – Identify and Prioritize Uncertainties

The identification of uncertainties begins during the PMP phase. During development of the PMP, the PDT will create a preliminary list of uncertainties grouped by functional areas (e.g., hydrology, environmental, plan formulation, engineering, real estate). Project teams are encouraged to listen to stakeholders and to share their lists with agency partners and tribes to make these lists as complete as possible. The uncertainties will be prioritized and the team will determine which, if any, issues deserve DCU status. This preliminary uncertainty list will be sent to management to determine which uncertainties merit further attention. The project team may also wish to consult with the Design Coordination Team (DCT), REstoration, COordination and VERification (RECOVER), and others for ideas and guidance on uncertainties, strategies to resolve them and the relevance and criticality of the uncertainties. The PDT will outline strategies to resolve DCUs and other high-priority uncertainties that are approved for further attention. Examples of strategies are: sensitivity analysis, model evaluations, physical models, robust/flexible features and designs, multiple PIRs, operational tests, and/or construction phasing. The list of uncertainties, management determinations of priority and DCUs, strategies and the schedules and budgets for resolving uncertainties will be included in the PMP and managed as part of normal project management process. This information is preliminary and will have much less detail than the AM Plan that will be integrated into the PIR.

B. Project-Level AM Activities and Associated PIR Tasks

The following table (Table 1) shows how the CERP AM activities relate to the CERP Six-Step Planning Process (USACE, 2000) and the CERP PIR activities as identified in the Guidance Memorandum 1 on PIRs (USACE and SFWMD, 2007). CERP AM Activities parallel the CERP Six-Step Planning Process and Project Life-Cycle. As mentioned earlier, during planning the emphasis is on the first five CERP AM Activities. CERP AM Activities are asterisked (*) if they are already part of the PIR process. Activities that are new to the process are italicized. The AM activities that are already familiar to PDTs are listed because they begin earlier than the standard CERP Six-Step Process suggests and because they will be part of a more formal process to identify, prioritize, and resolve uncertainties. The integrated AM plan will consist of sections that will be written and updated throughout the PIR process to document both the AM process and the information gained by it, including a section that describes how the information was used during the PIR process. Sections in the Monitoring and AM Appendix will describe the AM plans for the project in the future. This table or the condensed version in Annex A may be used as a checklist to ensure that CERP AM Activities are completed.

TABLE 1. CERP 6-STEP PLANNING PROCESS, PIR ACTIVITIES AND PROJECT-LEVEL AM ACTIVITIES AND ASSOCIATED PIR TASKS

CERP 6-Step Planning Process[2]	**PIR Activity**[3]	**AM Activity**[4] **and Associated PIR Tasks** ***= already part of PIR process** ***italicized*** **= new activity**
Project Initiation: PMP	Develop PMP	• Develop stakeholder list, communication plan, initiate stakeholder engagement * • Identify project goals and objectives* • Identify/*prioritize key list of uncertainties and obtain management approval*
Initiate Plan Formulation Phase **Step 1 – Identify Problems and Opportunities,** **Step 2 – Inventory and Forecast Conditions**	Conduct National Environmental Policy Act (NEPA) Scoping Activities	• Stakeholder engagement* • Identify uncertainties associated with project problems and opportunities*
	Identify Planning Objectives and Constraints	• Establish/refine restoration goals and objectives* • Use conceptual ecological models (CEMs) to identify problems and opportunities; compare to Yellow Book; refine as needed.* *May develop and use conceptual model of the system from the project's perspective*. • RECOVER consistency review of project and system goals/objectives* • Identify stakeholder concerns; develop additional objectives or constraints*
	Inventory and Forecast Resources	
	Initiate Data Collection	• Coordinate with agencies and stakeholders on needed biological, ecological, and socio-economic information; develop list of uncertainties* • Distinguish between uncertainties: scientific/technical (S/T) or policy/management; do they limit future decision making?* • *Prioritize Decision-Critical Uncertainties and characterize risk** • *Determine AM approach*
	Develop Existing and Without Project Conditions	• Project PDT and RECOVER coordinate to develop existing and without project conditions
	Develop Simulation Models (Hydrological, Ecological, Water Quality)	• *Identify testable hypotheses to address Decision-Critical S/T Uncertainties* • *Identify which hypotheses can be tested by project* • *Develop strategies for resolving DCUs* • Identify predictive tools and models; begin development*

[2] Planning Guidance Notebook Engineering Regulation (ER)1105-2-100 (USACE, 2000)
[3] Program Guidance Memorandum 1 (USACE and SFWMD, 2007)
[4] AMIG (USACE and SFWMD, 2010)

CERP 6-Step Planning Process[2]	**PIR Activity**[3]	**AM Activity**[4] **and Associated PIR Tasks** ***= already part of PIR process *italicized* = new activity**
	Develop Project Performance Measures	• RECOVER consistency review of PDT performance measures* • Determine whether performance measures are supported by the Monitoring and Assessment Plan (MAP) or are project specific*
Step 3 – Formulating Alternative Plans, **Step 4 – Evaluating Alternative Plans,** **Step 5 – Comparing Plan Alternatives**	Define Management Measures	• *Identify alternative plans to test hypotheses*; link performance measures to alternative plans* • Identify potential project interdependencies* • *Develop preliminary AM plan sections* • *Present uncertainty and management measures to implementing agency management for approval*
	Feasibility Scoping Meeting (FSM)	• *Present preliminary AM plan that includes: decision-critical uncertainties*; *need for project-level AM and potential for shared AM monitoring costs*
	Develop and Screen Initial Plans	• *Use AM principles in development of alternative plans and screening*
	Formulate and Evaluate Alternative Plans	• *Relate project alternative to AM plan and develop management options matrices* • RECOVER Regional Evaluation of alternative plans*
	Develop Preliminary Design for Alternatives	• *Incorporate flexibility and robustness into the design*
	Develop Cost Estimates	• *Incorporate costs of doing AM*
	Conduct Cost Effectiveness / Incremental Cost Analysis	• *Include costs and benefits of doing AM in alternative plan evaluation* • *Consider flexibility and robustness; justify important AM features to avoid having them cut in favor of least-cost logic*
	Conduct Economic Analyses	• Account for benefits directly associated with the project as well as benefits that accrue to the program*
	Compare Alternative Plans	
	Alternative Formulation Briefing (AFB)	• AFB package*: Include scope and scale of AM plan*, risks and uncertainties to be addressed and benefits*
Step 6: Selecting Alternative Plan	Identify Tentatively Selected Plan	• *Update and complete for the PIR Phase the Integrated AM plan for inclusion in the PIR*

C. PIR

i. CERP Planning Step 1 – Identify Problems and Opportunities and Step 2 – Inventory and Forecast Conditions

Step 1 and Step 2 of the planning process include tasks that correspond to the following CERP AM Activities:

- CERP AM Activity 1 – Stakeholder Engagement and Interagency Collaboration
- CERP AM Activity 2 – Establish/Refine Restoration Goals and Objectives
- CERP AM Activity 3 – Identify and Prioritize Uncertainties
- CERP AM Activity 4 – Apply Conceptual Models and Develop Hypotheses and Performance Measures

a. Stakeholder Engagement and Interagency Collaboration

While stakeholder involvement and collaboration is not new to the planning process, it is a fundamental element of the AM and planning processes and therefore is highlighted here.

Engagement with stakeholders throughout a project's planning and implementation is critical to the development and maintenance of common understandings of goals and objectives, expectations of results; and potential commitment of resources. PDTs and stakeholders can jointly benefit from the gained insights and mutual attention. Such interaction helps all to interpret events and to appreciate the time and patience it requires to fully realize the benefits of restoration projects and to manage expectations that might go unmet for reasons yet unknown. Without this interaction, the tendency is for people to react to what they may perceive as failure due to the lack of immediate or readily apparent results. CERP PDTs regularly include representatives of federal, tribal, state, and local agencies during project planning efforts. However, while publicly noticed workshops and meetings provide an avenue for broadcasting information and receiving public comment, at this time, there are more limited means for non-governmental stakeholders to engage PDTs in collaborative discussion. Additional information about techniques, tools, and training that PDTs might use to initiate and engage in effective collaboration can be found online at the Corps's Collaborative Planning Toolkit website[5].

The effectiveness of AM plans can be increased by the degree to which interests, perceptions, observations, and knowledge are shared between action agencies (e.g., USACE and local sponsors), Native American Tribes in Florida[6], resource agencies (e.g., USDOI, USEPA, state and local regulatory agencies), and other stakeholders who may have been underrepresented in the past. Opportunities to facilitate exchange of information and enhance communication should be pursued throughout the life-cycle of every project. In fact, they will be critical to the success of every AM plan. The following are suggestions that might help PDTs systematically identify and take advantage of all possible avenues to engage in exchange of information.

PDTs should continually seek to identify organizations (governmental and non-governmental) who might affect, be affected by, and/or be able to contribute knowledge, data, and/or resources to project-related activities (e.g., planning, design, implementation, and monitoring). For example:

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[5] http://www.sharedvisionplanning.us/CPToolkit/TOC.asp
[6] Miccosukee Tribe of Indians of Florida and Seminole Tribe of Florida

- Which individuals or groups have sought information about the project and/or potentially affected interests/resources from the Corps, local sponsors, or regulatory agencies, and what has been their inspiration?
- Which individuals or groups have commented about the project and/or potentially affected resources in the media, discussion groups, and/or other chat forums and what has been their inspiration?
- Which individuals or groups have traditionally expressed interest in the project and/or potentially affected resources and what has been their inspiration?
- Which individuals or groups reside, work, or recreate near the project site or potentially affected resources?
- Which individuals or groups have traditionally been underrepresented during public processes and/or disproportionately by public decisions?
- What research projects/scopes have been or are being pursued by others (agencies, universities, groups) near the project site or on potentially affected resources? In addition to identifying potential resources that can contribute to improving the effectiveness of AM planning and execution, the response to this question might help teams anticipate issues that could prompt interest or inquiries from others.

PDTs should continually seek to reveal, understand, and prioritize uncertainties relative to their potential influence on project/program related decisions (i.e., what phase of a project's life-cycle is likely to be influenced), project goals, programmatic goals, and interests of other agencies and stakeholders. Not all uncertainties are created equal and some interested parties may not fully understand how or where the uncertainties are likely to affect project outcomes, where or when concerns are most effectively and constructively communicated, and where or when sharing of knowledge is most likely to beneficially affect project outcomes.

PDTs should continually seek opportunities to exchange information with others throughout the life-cycle of AM activities and help stakeholders understand when input would be most useful to AM efforts. The following are periods during a PIR's development where input from stakeholders is particularly relevant:

(1) PMP Development and NEPA Scoping;
(2) Development or updating of program/project goals and objectives (Planning Step 1 – Identification of problems and opportunities, specification of objectives and constraints);
(3) Identification and prioritization of program/project uncertainties (Planning Step 1 – Input to information gathering process, determination of uncertainties);
(4) Application of conceptual models and development of hypotheses and performance measures (Planning Step 3 - Input to alternative plan formulation; Planning Step 4 - Appraisal of plan's effects);
(5) Design of project alternatives;
(6) Development of the AM plan (Planning Step 5 - Input on comparison of alternative plans; Planning Step 6 - Input on selection of plan);
(7) Development of the management option matrix; and
(8) Development of the monitoring plan.

PDTs may consider innovative tools to assist with elicitation of meaningful information and to help develop common understandings among agencies and stakeholders. The Shared Vision Planning website of the USACE (http://www.sharedvisionplanning.us/) includes references to case studies, tools techniques/training, and contacts that might be able to quickly help teams address specific challenges. Techniques such as Vision to Action Multi-Vision Integration Workshops (http://www.nwbrownfields-update.com/2009/06/have-you-heard-of-vision-to-action/) can provide powerful shared visioning environments. Initially developed for use with stakeholders in the southeastern US, but now used nationwide by the USACE and USEPA in the brownfields program, the technique provides a forum where stakeholders develop and express their visions of problems, opportunities, and successful/sustainable outcomes, developing mutual understandings in the process (and providing meaningful insights to PDTs). Developed by James Waddell, USACE, this approach to sustainable redevelopment allows participants to "see" what others want, relies less on consensus, inspires hope and grassroots actions and leads to synergistic connections. For more information visit on the following website: http://www.epa.gov/ciconference/previous/2007/2007_presentations/wednesday/1245pm/v_to_a_for_epa_jacksonville.pdf. The value of holding visioning workshops goes beyond the obvious benefit of developing a shared vision of restoration; these workshops also yield information on uncertainties, emerging issues, misunderstandings, and conflicts of interest.

PDTs should also consider developing mechanisms to highlight an emerging need for a briefing or workshop. For example:

- Web-based platforms could provide stakeholders with a means of expressing concerns or other public comments, and provide USACE and SFWMD staff with an understanding of emerging issues to help with the scheduling and development of public workshop/meeting schedules;
- The local sponsor, other government agencies, and/or other officially-recognized organizations convened by government agencies/organizations could be invited to request periodic briefings from PDTs on the status of projects, monitoring activities, and implementation of AM strategies.

When presenting information, receiving comments, and/or otherwise engaging with the public, PDTs and stakeholders should be reminded that the manner in which information is presented, the timing of public comments, and the overall general context in which information and comments are expressed (even when limited to presentation-comment formats) can yield insights critical to successful assimilation of new information and implementation of AM strategies. Many times, misinterpretation of comments or consideration of those comments outside of the context in which they are made can nullify any benefits that the information might have otherwise provided. To the extent possible PDTs should strive to encapsulate presented material such that public comment can be assessed within the context of the specifically-targeted issues followed, of course, by a comment period to accommodate more generalized comments.

PDTs and RECOVER teams who wish to use these forums for engaging with non-governmental stakeholders should coordinate with designated points of contact and agency managers. PDTs needing guidance on which forums to use should consult with the DCT; RECOVER should consult with the RECOVER Leadership Group (RLG).

b. Identify and Prioritize Uncertainties and Identify Associated Risks

During development of the PMP, a preliminary integrated AM plan was written based on the best available information. During CERP Planning Steps 1 and 2 and throughout the planning process, the list of uncertainties will be expanded and prioritized, strategies will be devised to resolve them, and each strategy will be approved by management and given a schedule and budget.

Some of the more obvious uncertainties will be identified during stakeholder involvement and during the process of defining project goals and objectives. The next step involves uncovering the questions that lie beneath these uncertainties. This deeper step is an important aspect of AM because following the threads of the underlying questions often makes it possible to use a single strategy to address multiple uncertainties in parallel rather than addressing each in series as they are discovered. To uncover questions that underlie uncertainties, PDTs could use diagramming techniques such as the Functional Analysis of Systems Technique (FAST) (see Annex B), or “Why” diagramming to map the “what, how, and why” of an AM program. The map of the activities, information needed and decisions to be affected can be used to create an AM Relationship Tree as described in Annex C.

Uncertainties need to be prioritized as they are identified. Prioritization prevents the team from spending scarce resources on too many avenues of study and focuses the team’s attention on uncertainties associated with the greatest risks. The most critical uncertainties will be designated DCUs. DCUs are defined as uncertainties that may impair decision making during CERP planning and implementation and increase the risk that the program or project will not meet its restoration goals and objectives. Two DCUs from the Water Conservation Area (WCA) 3A Decompartmentalization and Sheetflow Enhancement (Decomp) project are:

- How to minimize adverse nutrient loading (soil and water), while maximizing sheetflow restoration?
- What is the best structural/operational design to meet the goals of restoring sheetflow across the Miami Canal in WCA 3A? Will a configuration of earthen plugs provide the same hydrologic effects south of the canal as complete backfill of the canal?

Once the PDT prepares a list of uncertainties and determines which are DCUs, it would request DCT approval of the designated DCUs, other priority uncertainties, and uncertainties the team has decided it will no longer pursue. At appropriate intervals during the planning process as new uncertainties arise or priorities change, updated lists will need to be resubmitted for approval.

To help prioritize uncertainties and decide which should be considered DCUs, the PDT may wish to ask the following questions about achieving project goals and objectives:

- Which habitat variables have associated uncertainties that are most likely to affect planning decision processes?
- Which parameter is likely to overwhelmingly affect the planning outcome or the plan selection/course of action?
- Are any variable(s) potentially capable of affecting the choice of actions?

If the answer to any of these questions is “yes”, or if the variable(s) have uncertainties associated with them, they are likely candidates for DCU designation (Yoe and Skaggs, 1997). Three other criteria may help determine DCUs:

- What is most important to stakeholders?
- What variables have the most influence in the models or other analytical tools being used?
- What variables can the project affect?

While not necessarily considered decision critical, higher priority should be given to resolving uncertainties that can provide important information to later phases of a project or to other projects. At the program level, efforts to sequence projects should consider which projects may be the good candidates to answer broader, program level questions that could benefit other CERP projects. At the project level, if a project should be phased, early phases could be designed to answer questions that would reduce risks and uncertainties of later phases of the project.

In addition to the above considerations, prioritizing and sequencing how uncertainties are addressed may involve two additional factors. First are *management directives* that may come during the approval process. These directives may integrate the perception of risks, availability of resources, and the importance of the project and/or the uncertainty with respect to the program as a whole. Second are the *project management scheduling and budgeting processes*. Strategies to address uncertainties may have their own schedules and budgets and activities that need to be coordinated with other project activities. When uncertainties common to more than one project are considered by AM advisors, DCT and Quality Review Board (QRB), decisions would be made as to how and when the uncertainty would be resolved. Its resolution may be assigned to the project that identifies it, a different project that lies at a different point on the program-wide schedule, or to a CERP programmatic effort such as RECOVER or through a program-level pilot study.

Because of these complexities, the problems of scale, competing issues, time constraints, and resource limitations, an uncertainty could meet the requirements of a DCU yet remain unresolved during the PIR phase. Documenting these considerations, anticipated impacts, and recommendations for future actions could be very useful. The annotated list of uncertainties, their history, prioritization, and disposition is an important archive. As PDT members, agency staff, management, and stakeholders come and go, many uncertainties will resurface. This list will eliminate future work associated with uncertainties that have already been addressed.

c. Identify Risk Associated with Uncertainties

Another source of information about uncertainties can be found in the different types of risks encountered in the planning process. There are potential risks to the process and to the success of the project. Much has been studied about risks to understand their effects and manage them. The risks associated with environmental restoration projects are not particularly different than risks that other water resource projects encounter, though how they may be best addressed could be different. AM provides a framework for analyzing and managing risks that are common in ecosystem restoration projects. It is important to determine the type of risk each uncertainty comprises. Generally, these risks would fall into one of the following categories:

- Risk of Not Meeting Goals: This involves uncertainty about how the ecosystem works, restoration endpoints, and the best design to meet those restoration endpoints. For example, when CERP was authorized there was uncertainty about whether new technologies (Aquifer Storage and Recovery [ASR] wells) would work to address water storage requirements identified in the CERP. Given the importance of ASR technology to the CERP, addressing this risk resulted in the authorization of several pilot projects to address uncertainties.

- Risk of Negative Impact (violating constraints): This involves uncertainties that pose risks related to potential negative impacts identified as constraints in the planning process. This type of uncertainty would likely require more detailed strategies to address. For example, on the Decomp project, recreational access concerns combined with uncertainty about restoration targets for flow and the best project design led to the development of the Decomp Physical Model. On the C-111 Spreader Canal Project (C-111 SC), potential risks of flooding agricultural lands combined with endangered species concerns and the best operational criteria to achieve ecosystem restoration performance goals led to the proposal for operational tests associated with C-111 SC Western PIR.

- Risk of Falsely Attributing Negative Impact to CERP: As noted earlier, ecosystems are unpredictable insofar as they are sensitive to numerous stressors, some of which are beyond the direct influence of the CERP; such as climate change and sea level rise.

- Risk of Falsely Attributing Benefits to CERP: Benefits that are actually caused by other influences could be falsely attributed to a project. This risk could occur as a result of misconceptions about ecosystem cause-and-effect relationships and may result in unnecessary or misdirected funding.

Depending on the type of risks and uncertainty, the means of analyzing and managing the risks can vary. The strategies employed to resolve uncertainties also should be commensurate with the type and degree of risks and should be customized to fit each specific uncertainty.

Specific tools and techniques for analyzing and managing risk can be applied at various stages during project planning and implementation to minimize the potential for uncertainty-induced gridlock. For purposes of managing uncertainty-based risks during planning efforts, the following four questions are useful:

- Are there uncertainties that affect justification of the plan formulation effort? This question would be typical of one asked during specification of problems and opportunities, or during development of inventories and forecasts of study area conditions. Answering this question could help a team understand the degree to which interest in the project (and/or perception of project need) could be brought into question.

- Are there uncertainties that affect the scope and/or magnitude of plan formulation efforts? This question would be typical of one asked during development of inventories and forecasts of study area conditions, formulation of alternatives, and evaluation of effects of the alternative plans. Answering this question could help a team understand the degree to which it has adequately identified/characterized the magnitude of the study area and the scope of issues to be considered.

- Can uncertainties be effectively managed and associated risks be minimized during plan formulation? This question would be typical of one asked during development of inventories and forecasts of study area conditions, formulation of alternatives, and evaluation of effects of the alternative plans. Answering this question could help a team understand its capacity to effectively manage some risks and reduce the likelihood of unplanned outcomes.

- Are there other uncertainties that affect planning decisions? This question would be typical of one asked during evaluation of effects of the alternative plans, and comparison of alternative plans. Answering this question could help a team understand the degree to which its decisions are robust, and the degree to which each alternative can be expected to result in desirable impacts across a range of conditions.

Ultimately, analyzing and managing risks means that the joint Project Review Board (PRB), DCT and QRB must be able to discern when enough is known to proceed. This means that they perceive the risks of negative outcomes, either their probability of occurrence or their magnitude of negativity, or both are small enough that they are outweighed by the potential benefits of moving ahead. While this can be stated simply and succinctly, in practice it is much harder. Like the analytical methods described above, there are quantitative and qualitative methods available to determine when enough is known to "sufficiently resolve an uncertainty." Sufficiently resolving an uncertainty implies that there may not be absolute resolution of uncertainty. In fact, this is usually the case.

d. Develop Strategies for Resolving Uncertainties

Strategies are coordinated sets of actions designed to resolve one or more DCUs and priority uncertainties as time and resources permit. Examples of strategies may include:

- sensitivity analyses
- modeling tests
- legal/policy opinions
- data mining
- incorporation of robust and flexible plans and designs
- pilot projects or physical models (field tests)
- operational tests
- phased construction or multiple PIRs

Some scientific/technical uncertainties may be resolved by transferring knowledge from other studies and projects. Others may require modeling and other analyses comparing alternatives based on different hypotheses, selecting alternatives that perform well over a range of conditions/targets (robust design), designing flexible plans capable of being adjusted to meet changing needs, developing pilot tests or studies, and/or examining performance through directed monitoring/assessment. On a larger scale, phases of projects or projects themselves could be strategies if they are designed to answer questions that reduce risks associated with implementing the project and/or multiple projects. Policy/management uncertainties may be resolved by obtaining additional scientific, engineering, or socio-economic information, but often to be fully resolved, would likely require collaboration and/or conflict resolution to develop a resolution that meets the needs of the project.

In devising strategies to resolve uncertainties, PDTs should consider "what specific tasks must be performed" and "how will they be performed?" While the PDT is asking, "What could be accomplished ecologically and what are the constraints?" they must also ask, "What is required and what must be known to move this project forward?"

At every scale, the steps to develop strategies that address uncertainties are the same:

1) identify a DCU,
2) define testable hypotheses about what the outcome should be,
3) devise a way to test the hypotheses,
4) select appropriate performance measures (i.e., decision criteria needed to evaluate results) and targets
5) test the hypotheses (e.g., spreadsheet or model analysis, or through monitoring and assessment),
6) determine the results,
7) decide from the results if the hypotheses were correct, and
8) use new information to make decisions that ensure the project meets its objectives.

All strategies would include a scope, budget, and schedule for completion during planning or as part of post-PIR construction. The priority DCUs and associated strategies to resolve them would be presented to the DCT for concurrence or elevation to Joint PRB (Executive Level), prior to assigning resources to execute along with the other tasks associated with the completion of a PIR. The following subsection describes different strategies to resolve uncertainties.

e. Qualitative and Quantitative Tools

Strategies to resolve uncertainties can often involve reliance on qualitative and quantitative tools. A growing number of these tools are now available that show the cause-and-effect relationships of actions on natural systems. PDTs are encouraged to use conceptual models; however, PDTs need to be conservative in the use of complex models that require more time and resources.

Qualitative tools include conceptual models that show the relationships between stressors on a system and the effect they have on different parts of the ecosystem, flood control, water supply, or other socioeconomic services. In 2006, the USACE Chief of Engineers Environmental Advisory Board (EAB, 2006) encouraged the explicit use of conceptual models to guide Corps ecosystem restoration planning and implementation. In their recommendations:

"Conceptual models should be required as a first step in the planning process, as they provide a key link between early planning (e.g., an effective statement of problem, need, opportunity, and constraint) and later evaluation and implementation."

The EAB describes conceptual models as a conceptualization of how the system works and how activities that restore hydrologic and geomorphic processes can result in ecosystem change. They are the fundamental framework for ecosystem restoration planning and should be used by all CERP projects. Essentially, conceptual models should include:

- Those physical, chemical and biological attributes of the system that determine its dynamics.
- The ways in which ecosystem drivers, both internal (e.g., flow rates) and external (e.g., climate) cause change with particular emphasis on those aspects of the system where the Corps can effect change.
- Critical thresholds of ecological processes and environmental conditions.
- Assumptions and gaps in the state of knowledge, especially those that limit the predictability of restoration outcomes.
- Current characteristics of the system that may limit the achievement of management outcomes.

They advise that models should include narrative and references at a minimum and may be summarized in simple graphics to facilitate communications of key cause-effect relationships.

Conceptual models, according to the EAB, do not, in and of themselves, allow prediction of restoration outcomes. However, as they summarize current understanding of how the ecosystem works and they can provide a key foundation for the development of benefits metrics, monitoring plans, and performance measures. Due to the long life-cycle of many CERP projects, it will be necessary to routinely revisit and revise conceptual models as new information is developed. This is crucial to the success of ecosystem restoration in the long-term and a key element of effective adaptive management.

Several conceptual ecological models (CEMs) for south Florida have been published (RECOVER, 2004; Wetlands, 2005; RECOVER, 2006). CEMs describe the stressors that led to a loss of the natural ecological characteristics of the south Florida and Everglades ecosystem, the processes that occurred and the attributes that were affected. The underlying hypotheses in the CEMs are useful in developing additional hypotheses for newly identified uncertainties. FAST diagrams (see Annex B) are another type of conceptual model and can be described as conceptual models of projects. The PDT would review the CEMs to develop a list of hypotheses specific to the project's effect on the natural system while analyzing alternative plans and management measures and their expected outcomes during Step 3 of the CERP Six-Step Planning Process - Formulation of Alternative Plans, for example. PDTs may also choose to use the Conceptual Ecological Model Construction Assistance Toolbox developed by USACE Engineering Research and Development Center (USACE, 2009b) to develop conceptual models for projects. Conceptual models are powerful communication tools. Conceptual models can be as simple or complex as needed, and can be used to build consensus in groups.

CEMs in the region where a project is being considered may help a project team document and effectively communicate linkages between national planning objectives, project design goals and objectives, and measures used to evaluate (during planning) and assess (during implementation) performance of considered and implemented alternatives respectively. These larger system or region conceptual models could reveal insights concerning critical dependencies and linkages to other efforts, help illuminate potential influences of study area boundary definitions and planning assumptions on planning outcomes, and reveal insights about these types of uncertainties and their potential impacts on a project from planning through operation.

Qualitative methods include stakeholder input which sometimes offers sufficient information to management/leadership to allow for determinations to be made as to whether sufficient resolution of uncertainties has been reached. This method should not be discounted as stakeholder input can result in a synthesis of many views and insights that project teams should seek out as valued contributions to the planning effort. Care should be employed to ensure that stakeholders are realistic, accepting of new information and other opinions/views, and committed to fair and honest dialogue (i.e., sharing in a sense of accountability for the planning effort). Formal methods for tradeoff analysis, consensus building and negotiation are useful and can be applied to facilitate honest dialogue and partnering, thereby reducing overall study costs and impacts. Achieving consensus on the scope, magnitude, and significance of an uncertainty can assist in expeditious resolution of otherwise paralyzing issues.

Quantitative tools include analytical techniques and numerical modeling which may be applied during plan formulation to help develop and solidify common understanding of the relationship between risks, DCUs, and potential project outcomes. These tools may also be applied during plan evaluation to identify the best plan or design, but also to help determine the sensitivity of a plan's performance when restoration endpoints are uncertain. Careful consideration and use of alternative planning assumptions could yield insights about the feasibility of formulated alternatives and the degree to which formulated alternatives are robust enough to tolerate (or be adapted to operate under, or in response to) a variety of conditions.

Quantitative methods to assess the value and adequacy of information include application of the scientific method to experimentally test hypotheses. Additionally, quantitative risk analysis methods may be used at the beginning of the uncertainty resolution process and at subsequent points along the path to resolution. When there is enough reduction in quantifiable risks and/or risks fall below an accepted threshold, it may mean that enough is known to proceed and the uncertainty has been sufficiently resolved.

The specific qualitative or quantitative modeling or analytical technique applied would depend greatly on the questions posed by and the tools available to the planning team. Different approaches include:

- simple consideration of alternative planning assumptions (e.g., assumptions about voluntary water conservation),
- testing the degree to which planning decisions and cost-efficiency of alternatives might be affected by ranges in potential outcomes (e.g., Institute for Water Resources [IWR] Planning Suite Cost Effectiveness and Incremental Cost Analysis Sensitivity Assessment Utilities),
- testing of sensitivity of evaluation metrics and ecological output models (e.g., evaluation of performance measure sensitivities),
- analyses of project performance under alternative sea level rise and climate change scenarios using a variety of numerical models (e.g., alternative hydrology and hydraulics model boundary conditions and inputs)
- multi-criteria decision making analysis to integrate risk, uncertainties, and values to support decision making about the best plan and design

The scope, complexity, and time dedicated to these analyses should be linked to DCUs and be commensurate with level of risk and certainty desired by project leadership.

f. Performance Measures

The EAB also discussed the importance of project scale performance measures to AM (EAB, 2006). Performance measures are defined as standards or indicators used to evaluate the outcome of management actions. They are *indicators* of progress toward a *goal*, *objective*, or *target*. All performance measures need to be measurable in the landscape with a high degree of certainty (high signal-to-noise ratio). Selection of performance measures for any project should be based on the goals and objectives and the understanding of system dynamics articulated in the conceptual model. Even when a goal is clearly defined, it is necessary to define whether a performance measure *evaluates (predicts) change* or *assesses goal attainment*. They must also reflect the different spatial and temporal scales at which Corps actions affect ecosystem response. Within the context of ecosystem restoration, performance measures are usually addressing the question “Was the action successful?” Note that this is not the question “Did the action make a difference?” Performance measures are specifically related to the expectation of the action (as defined during the planning process in the conceptual model).

According to the recommendations of the EAB, defining and measuring performance measures are a crucial component of adaptive management. In most AM frameworks the performance measures are the mechanism by which the outcomes are compared to the expectations of a project, and modifications are made to seek an improved measure of performance. However, whether the action made a difference may be dependent upon other aspects of system dynamics beyond the control of the Corps. The conceptual model allows the identification of such potential externalities, provides a context for monitoring or tracking them as funds permit, and is thus crucial to the identification of effective performance measures.

For the Corps, the EAB continues, recognizing that most projects manipulate or manage only the hydrogeomorphic aspects of the ecosystem, therefore performance measures should be defined in hydrogeomorphic terms. Whether species or habitat outcomes are achieved as a result of the hydrogeomorphic changes effected by the project may depend on a number of external factors. For example, the CERP may have a primary interest in securing desired wading bird numbers and species composition at a certain location. However, the ability to predict changes in species numbers and composition is complicated by multiple relevant stressors, natural variability, and model limitations. It is more appropriate to predict, during planning, the hydrologic and landscape conditions that would result from an action and that would tend to favor these species, rather than a metric about the state of the species themselves. Thus performance measures should not be restricted to wading birds numbers and species composition, but rather should focus on the hydrologic and landscape conditions achieved by CERP actions.

Importantly, performance measures must be measurable in the field at a temporal and spatial scale relevant to project objectives. When National Ecosystem Restoration (NER) projects include funds for monitoring or adaptive management, the identification of effective, measurable performance measures is essential to justify the expenditure. Such performance measures must acknowledge the facets of ecosystem dynamics that the project can and cannot influence and be structured to elicit both whether hydrogeomorphic outcomes were achieved and whether the expected ecological consequences were realized.

ii. CERP Planning Step 3 – Formulating Alternative Plans and Step 4 – Evaluating Alternative Plans

- CERP AM Activity 1 – Stakeholder Engagement and Interagency Collaboration
- CERP AM Activity 2 – Establish/Refine Restoration Goals and Objectives
- CERP AM Activity 3 – Identify and Prioritize Uncertainties
- CERP AM Activity 4 – Apply Conceptual Models and Develop Hypotheses and Performance Measures
- CERP AM Activity 5 –Alternative Plan Development and Implementation

Strategies to address uncertainty and risk during CERP Planning steps 3 and 4 involve developing robust and flexible plans and/or designs, and evaluating model runs.

a. Robust and Flexible Alternatives and Plans

Incorporating the AM principle of robust and flexible plans/designs into planning, engineering, design, construction, operations, and maintenance as a strategy to address uncertainties would help projects anticipate future uncertainties and changing conditions, such as climate change, and design alternatives so that they can function effectively over a wide range of potential future conditions.

Robust plans or alternatives are designed to perform well structurally or operationally under a variety of future scenarios, and are developed when future conditions are highly uncertain. Robust alternative plans retain their intended functions over a broad range of potential future conditions. Robustness may be achieved by designing plan alternatives that have limited consequences if they fail, are reversible, or have the capability to ensure that project sequencing, operations, and design could be changed in the future. In CERP AM, the chances of failure or costly setbacks may be greatly reduced by designing plans or alternatives that incorporate robustness. For example, if a project is being planned to store and distribute water, alternatives should be designed to operate under an acceptable range of conditions given the uncertainty in characterizations of climate and weather conditions. This may entail purchase of land/easements to provide for additional water storage during flood conditions. It could entail designing a weir to be both a permanent structure if performing well, but also allow for future adjustments to height without major retrofitting or removal of the previous base structure.

Flexibility refers to plans or alternatives that have the structural and/or operational capacity to change in response to new conditions, as indicated through monitoring. Flexibility within a project may include the addition of three 250 cubic-feet per second (cfs) pumps in different locations to provide more options for moving water out of an area and/or to another area in order to meet a range of targets, as opposed to a single 750 cfs pump in a single location. Multiple PIR projects could be designed in increments (or phased) to allow for mid-course corrections or operational adjustments when new/updated information (e.g., new scientific information, updated modeling) is learned. The more uncertain a project design, the greater the need to incorporate robustness and flexibility.

b. Incorporating AM into Benefits Quantification

At the project level, environmental benefits and economic cost quantification would be performed in a manner consistent with current practices, while also performing and documenting:

- analyses of relationships between identified uncertainties, features of alternative plans (particularly those features that give an alternative a competitive edge during cost-effectiveness and incremental cost analyses) (to illustrate first-order stochastic dominance among alternatives), and ranges in consequences that one might anticipate possible (to illustrate second-order stochastic dominance among alternatives resulting from lower ranges in uncertain benefits/costs); and
- analyses of immediate (near-term) benefits to be caused by the project, and future (long-term) benefits that might be caused in collaboration with other CERP projects.

This discussion may include how readily and easily a project might be altered over time to work in conjunction not only with currently approved projects (Next Added Increment [NAI]) but also with the full complement of CERP projects in a manner that better illustrates the project's contribution to programmatic attainment of desired benefits. The analysis can refer to the management options matrices (see next section) and other decision support tools, such as decision trees, that explicitly show each set of options, their potential outcomes, and associated decision points/criteria that will be used to determine the need to implement the AM options.

Additional potential economic costs and environmental benefits associated with each of the features described above should be calculated and/or estimated to the extent practicable. Cost effective/ incremental cost analysis (CE/ICA) could then be carried out and reported for each alternative plan to disclose potential ranges in costs and benefits associated with each alternative to help manage expectations. To the extent possible, the probability of each AM option becoming a reality should be estimated (in the absence of general consensus, equal probabilities could be assigned to each AM option as a placeholder for future modification). These probabilities could then be used to heighten awareness of the more probable outcomes and costs, and to potentially assign weights to the costs and benefits of each AM option when deriving aggregated estimates of benefit and cost for each alternative.

One approach would be the ability to look at the management actions that would be taken if a project did not meet its performance targets and the costs of those actions and compare them between alternative plans. PDTs are not asked to complete a management options matrix, discussed in further detail in the next section, for every alternative, just the tentatively selected plan (TSP), but there should be sufficient management actions and costs available for each alternative plan to make fair comparisons. Because features and options might differ between alternative plans it is recognized that the number of possible outcomes might be too large to make the individual calculation of each benefit and cost practicable. Under such circumstances, techniques such as Monte Carlo methods may be used to estimate and display potential distributions of benefits and economic costs associated with implementing the different options for each alternative (preferably using commercial off-the-shelf or agency-developed software such as @RISK, Crystal Ball, and IWR Planning Suite, among other software).

iii. CERP Planning Step 5 - Comparing Plan Alternatives

- CERP AM Activity 5 – Integrate AM into Alternative Development and Implementation

In order to integrate AM into the comparison of plan alternatives, PDTs would place emphasis on elements of flexibility, robustness and sustainability that make plans more likely to succeed in the long term even if the initial costs may be slightly higher. The management options matrix is part of this process. Plans that are more likely to succeed are more likely to produce ecological outputs on time, within budget, have lower contingency costs, and therefore be more cost effective in the long run. Current USACE guidance supports favoring plans that produce greater ecological output even if they are slightly more expensive:

The Planning Guidance Notebook states, "When identifying the National Ecosystem Restoration plan the associated risk and uncertainty of achieving the proposed level of outputs must be considered. For example, if two plans have similar outputs but one plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it might be possible that, due to uncertainties beyond the control or knowledge of the planning team, the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs, that plan would have been excluded from further consideration" (Appendix E, pg. E-163 Paragraph E-39 of USACE, 2000).

The management options matrix links monitoring to the management actions that will be considered in the future if a project does not meet its goals and objectives as defined by performance measure targets. Project NEPA documents will consider the range of subsequent consequences from the potential actions identified in the management options matrix.

A management options matrix for the Biscayne Bay Coastal Wetlands Project is presented below (Table 2) as an example. While it is possible to include every individual performance measure in the management options matrix, the PDT may choose to limit it to a set of key performance measures that indicate overall project performance.

TABLE 2. HYPOTHETICAL MANAGEMENT OPTIONS MATRIX FOR BISCAYNE BAY COASTAL WETLANDS PROJECT

Hypothetical Management Options Matrix for Biscayne Bay Coastal Wetlands Project				
Stressor/Attribute Metric	**Target (Timeframe)**	**Management Action Option 1**	**Management Action Option 2**	**Management Action Option 3**
Salinity (operational tests may be required to achieve balance between multiple project objectives, e.g., seagrass, oysters, water quality)	• 10–25 practical salinity units (psu) range from shoreline to 100 meters offshore • 20 psu average monthly bottom target in zone 250 and 500 meters from shore during dry and wet seasons respectively (1-2 years)	Change operations (more pumping) to meet flow requirements to achieve salinity range and zones	Increase flow from North to Biscayne Bay Basin	Evaluate additional factors affecting flow
Water Quality Sedimentation	No increase or reduced sedimentation (2-3 years)	Dredge muck	Adjust flows to minimize increases in sedimentation	
Water Quality Nitrogen/Phosphorus	No increase or reduced total nitrogen (TN) and total phosphorus (TP) concentrations of 0.005 and 0.8 milligrams per liter (mg/L) respectively (2-3 years)	Decrease flow rates through coastal wetlands	Implement best management practices (BMPs)	Increase stormwater treatment area (STA) acreage in Biscayne Bay Coastal Wetlands (BBCW) PIR 2
Seagrass	Increase biomass and range of *Halodule* seagrass (2-5 years)	If water quality targets have not been met, address first	If desired salinity range is met, change operations to adjust flows based on new hypothesis	Implement seagrass plantings in coordination with state, USDOI and NOAA
Fish and Macro-Invertebrates	Increase abundance and diversity of fish and macro-invertebrates (5-10 years)	If *Halodule* seagrass biomass and range has not increased, focus on operations to support seagrass growth	If *Halodule* seagrass has increased, but oyster reefs have not, focus on operations and oyster restoration activities.	If *Halodule* seagrass and oyster reefs have increased, but fish have not, reevaluate hypotheses, consider other factors such as fishing pressure

iv. CERP Planning Step 6 - Selecting an Alternative Plan: Completing the Integrated Adaptive Management Plan

- CERP AM Activity 5 - Alternative Plan Development and Implementation

In Planning Step 6, information learned from the AM activities will be used to select and justify the choice of the TSP and the management options matrix will be finalized including costs (project fund code 06) to be authorized with the final PIR contingent on actual monitoring results. Monitoring needs would be identified for the engineering, design, implementation, operations, and maintenance phases of the project. The PDT would also finalize the documentation of the AM activities by completing the Integrated AM plan.

The Integrated AM Plan would document the identification and prioritization of the uncertainties associated with a project (Section C.i.b), describe the resolution of the DCUs (Section C.i.d), discuss how this new information affected plan formulation, plan selection, and plan evaluation (e.g., robust/flexible plans, phased implementation) (Section C.ii.a), and summarize in a management options matrix (Section C.iii) the future actions to be taken in the event the project does not meet its goals and objectives (contingency plan, as required by USACE 2009). Suggestions as to where in the PIR and exactly what to include are described below but the actual contents of the integrated AM Plan for each project are left to the discretion of the PDT. The preliminary AM plan would have been drafted during the PMP phase and approved as part of the PMP. During the PIR process, the following sections would have been written, reviewed and updated as new uncertainties were identified, as DCUs were approved, as strategies were devised by the PDT to resolve them, and as issues were resolved. The Integrated AM plan will document how the AM activities added value to the planning process and would continue to add value beyond the planning phase. The contents of the AM plan may be simple or complex depending on the scope and complexity of the project and the range of AM activities. Suggested topics and location in the PIR are listed below. Most sections would be included in either the Plan Formulation chapter or the Monitoring and Adaptive Management Appendix (formerly named the Monitoring Appendix).

a. Stakeholder Engagement

In the Plan Formulation chapter of the PIR, describe how stakeholders were involved in AM Activities. In the Monitoring and AM Appendix, identify the list of stakeholders, level of engagement needed and key points in order to know when to engage the stakeholders during the post-PIR AM process (e.g., review and input on assessment results). Identify the venue(s) for undertaking stakeholder engagement (Federal Advisory Committee Act [FACA] compliant) and for documenting stakeholder concerns identified during project planning, design, construction, operations, and assessment (Section C.i.a).

b. Reference Project Goals and Objectives

In the Plan Formulation chapter, reference project goals and objectives and identify how AM supports reducing risk and uncertainty associated with achieving those goals and objectives.

c. Identification and Prioritization of Uncertainties

In the Plan Formulation Chapter, describe how uncertainties were identified and prioritized relative to achieving project goals and objectives. What were significant stakeholder contributions? Include descriptions of conceptual models (e.g., FAST) if used. List significant uncertainties and groups of uncertainties if they were related or resolved together. Document when an uncertainty was determined to be a DCU and when that decision was made. Document when and why the PDT decided not to continue to pursue an uncertainty (Section C.i.b).

d. Scope of AM Plan

In the Plan Formulation chapter, describe the strategy used to resolve each DCU and priority uncertainty approved for resolution . Describe the testable hypotheses and show the AM Relationship Tree (if used). Examples of strategies used to test hypotheses include: scenario planning and sensitivity analysis, model evaluations and performance-measures used, physical models, operational tests, robust/flexible features and designs, multiple PIR, construction phasing, and performance measures used during post-construction monitoring/assessment. Summarize the results of the uncertainties that were resolved during planning. If DCUs remain unresolved, describe steps to be taken post-PIR (Section C.i.d) in the Monitoring and AM Plan Appendix.

In the Plan Formulation chapter, describe the benefits of reducing the risks or increased likelihood of achieving restoration goals and objectives associated with the selected plan by including features conducive to AM (i.e. flexible, resilient, robust features) (Sections C.i.c and C.ii.a). Compare the costs of the features with the benefits of reducing the risks of failing to meet restoration targets and the potential for long-term cost savings with decreased likelihood of needing to add new projects or retrofit the constructed project (Section C.ii.b). Describe any benefits of new information to the planning and design of future projects.

e. Contributions to the TSP

In the description of the TSP, describe how the results of AM activities, particularly the results of the hypothesis testing of the DCUs, were used in plan formulation, plan evaluation and in the selection of the TSP to reduce risk and uncertainty associated with achieving goals and objectives. The process may have resulted in a more robust or flexible plan or the need for post-construction management options (Section C.ii.a)

f. Post-PIR Management Options Matrix

Post-PIR recommendations, including the management options matrix and the cost of each option implemented under the AM plan, will be documented in the Monitoring and AM Appendix. The management options matrix should identify the performance measures (targets and timeframes for desired outcomes) to be used in identifying restoration success or performance issues (Section C.iii).

g. Reference Monitoring Plan and Decision Making Process

The Monitoring and AM Appendix will describe the monitoring parameters as part of the management options matrix. This appendix will also include the process for reporting success or performance issues to management and reference the decision-making process found in the AMIG to describe how new monitoring information would be brought to CERP management to identify post-construction options or changes to the project operating manual to improve restoration performance.

h. Reference Operating Manual

If one of the strategies to address uncertainties is operational flexibility, the project operating manual and the Monitoring and AM Appendix will include the details of how operations can be adjusted and what criteria are used to determine those changes.

III. POST-PIR ACTIVITIES

Post-PIR tasks may involve all of the CERP AM Activities, but focus on the following:

- CERP AM Activity 6 – Monitoring
- CERP AM Activity 7 – Assessment
- CERP AM Activity 8 – Feedback to Decision Making
- CERP AM Activity 9 – Adjustment

In order to insure delivery of intended benefits and avoid unintended negative impacts, AM activities will continue after completion of the PIR and for the entire project life-cycle, including the monitoring, engineering, design, construction, operations, and maintenance components. This Appendix does not address post-PIR activities beyond those included in the PIR, but recognizes that AM must be integrated throughout the post-PIR phases.

Project monitoring plans describe the data management, quality assurance/quality control (QA/QC), and data synthesis process that provide the new information for post-PIR decision making. The information generated by the monitoring plan will be used by the USACE Jacksonville District and the SFWMD in consultation with the Tribes, USDOI, other state resource agencies and the USACE South Atlantic Division to guide decisions on operational or structural changes that may be needed to ensure that the ecosystem restoration project meets the success criteria. If the results of the monitoring program support the need for physical modifications to the project, the cost of the changes will be cost shared with the non-federal sponsor who must agree with the changes. The USACE Headquarters (HQUSACE) Regional Integration Team will be advised at such time that it is determined a modification to a project is required. Any changes to the AM plan approved in the decision document must be coordinated with HQUSACE at the earliest possible opportunity. If a needed change is not part of the approved AM plan and is determined by HQUSACE to require a post-authorization change or related action, the annual budget guidance to initiate a study for such corrections should be followed. Significant changes to the project that are required to achieve ecological success and which cannot be appropriately addressed through operational changes or through the approved AM plan may need to be examined at the CERP program-level (i.e., through adjustments to other CERP projects, the integrated delivery schedule, system operating manual [SOM], or through a comprehensive plan modification).

The Programmatic Regulations require that CERP develop a SOM and individual CERP project operating manuals. Together, these documents provide the potential operational flexibility (through the application of AM) within the constraints (i.e., flood control and water supply) identified for CERP. The SOM allows for adjustments to operations of multiple projects within the system or at the regional level, within the limits of the approved NEPA document(s). This flexibility may allow for any management actions identified within the management option matrix to be subsequently incorporated into the SOM (and subsequently the project operating manuals), within the limits of the approved NEPA document(s). The SOM supports authorized water supply and flood protection aspects as well as other water-related needs of the region (e.g. improving timing and distribution of water in the system's network of WCAs, rivers, canals, levees, pump stations, water control structures, and areas of restored sheetflow). Additionally, existing or proposed water control operations can be tested and refined, as needed as part of an AM strategy, with built-in flexibility for adjusting operating criteria. For example, the C-111 SC Project includes operating criteria to incrementally increase stages in the Aerojet Canal to better achieve restoration goals without impacting agriculture lands (USACE and SFWMD, 2009). Operational flexibility would be analyzed at both project and system-wide levels as part of the existing PIR NEPA process for SOMs and project operating manuals.

IV. UPDATES AND DIALOGUES WITH PDT STAFF

To ensure that AM is properly integrated into the planning process, the Planning Division Management and CERP Program Management will provide project and program level staff (e.g., planning technical leads [PTLs], environmental technical leads [ETLs], engineers, engineering operations staff, and other PDT members involved in the Post-PIR phase) with an introduction to this appendix at the beginning of the planning process for new projects and routinely during the PIR development process. This update will include AM updates, dialogues and support from AM expert advisors. These updates and dialogues will provide interactions between RECOVER teams and RLG members as well.

V. ROLES AND RESPONSIBILITIES

It is not necessary that project managers, PTLs and ETLs become AM experts but they need to understand AM and AM methods and practices and to be key players in the integration of AM into planning. To accomplish this, they will:

- lead the discovery of uncertainties
- lead the engagement of stakeholders
- consult with CERP program management and the AM advisory group on the vetting and confirmation or dispensing of uncertainties
- develop and execute strategies for resolving each uncertainty
- develop, review, and update as necessary the AM plan

Most of the focus of the PDTs will be on developing and executing the AM plan. While doing this, PDTs will:

- maintain program and project perspectives
- coordinate with RECOVER
- cooperate in efforts to account program benefits
- develop an interdisciplinary approach to integrating AM
  - AM efforts should be inclusive of a number of disciplines, including planning, to ensure that broad perspectives are included from the start and through all phases of project planning

RECOVER will assist PDTs where possible including:

- reviewing AM plans developed by PDTs and consulting with PDTs to improve and execute the AM plan
- advising PDTs on strategies to resolve program level uncertainties and activities that may help PDTs develop and execute the AM plan

USACE Planning Division Management and CERP Program Management will support the integration of AM into the planning process by:

- establishing AM as part of the overall interagency interdisciplinary PDT process
- establishing a senior-level AM advisory group to assist PDTs in integrating AM into the planning process and developing AM plans

For more detail on roles and responsibilities and decision making see Appendix D of the AMIG.

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VII. GLOSSARY

Adaptive Management: A formal process for continually improving management policies and practices by learning from their outcomes. For Comprehensive Everglades Restoration Plan (CERP), adaptive management is a structured management approach for addressing uncertainty by testing hypotheses and linking science to decision making to adjust implementation, if necessary, to improve the probability of restoration success.

Active Adaptive Management: An adaptive management approach in which multiple designs or operational criteria (e.g., field tests) are implemented to test competing hypotheses about specific uncertainties regarding hydrological, ecological, or water quality responses to management actions.

Adaptive Management Plan (Contingency Plan): A plan that outlines management/restoration goals, objectives, uncertainties, and strategies for reducing uncertainty associated with the set of management actions in order to achieve desired goals and objectives. The plan should: describe how hypotheses will be tested to help determine the best management action(s) and address uncertainty; link monitoring plan results to restoration targets; and include decision criteria to measure project success or to identify performance issues that may need to be addressed through potential management actions and identified in the plan (i.e., management options matrix). Adaptive management plans are required for USACE ecosystem restoration projects, and can also be developed for restoration programs.

Adjust: Changing program/project implementation to address performance issues or opportunities by implementing management action(s) identified in a management option matrix. These changes may include adjustments to sequencing, operations, or structural features. Adjustments may be identified as part of an authorized project, or could involve changes that require additional authorization/revised decision documents. See Management Actions and Management Options Matrix.

Alternative Plan (see also Robust Alternative): A system of structural or nonstructural measures, strategies, or programs formulated to alleviate specific problems or use opportunities associated with water and related land resources during planning. In an adaptive management context, project alternatives that are designed to anticipate future uncertainties and changing conditions, such as changes in hydrology and climate, are intended to reduce project-level and system-wide uncertainty and facilitate project restoration success. Alternatives should be designed to address various ecological stressors and integrate contingencies into plan formulation to address key uncertainties.

Assessment: The process of interpreting ecosystem responses to management actions by synthesizing monitoring data of observed natural system changes at different temporal/spatial scales and comparing them to performance measures to determine how well restoration goals and objectives are being achieved.

Attribute: Biological or ecological elements that are key indicators of responses in the natural systems to measure effects of stressors.

CERP Regions: Four physiographic regions outlined in the CERP Monitoring and Assessment Plan including Northern Estuaries, Greater Everglades, Southern Coastal Systems, and Lake Okeechobee. System-wide refers to the sum of these regions.

Conceptual Model: A qualitative understanding (set of hypotheses) of how a system works and how its parts interact based on the best available science. Conceptual models are used as planning tools to identify major human actions and natural drivers that shape and stress the natural and human systems, the ecological or socioeconomic effects of the stress, and the key biological or socioeconomic attributes or indicators of these effects.

Constraint: A restriction that limits the planning process, such as resource, legal, or policy constraint (e.g., water quality, or presence of threatened and endangered species).

Decision Criteria (Performance Measures and Targets): A reference point or group of points (i.e., performance measures and targets), supported by observations and data collection, that act as the basis for setting in motion an action or set of actions to make an adjustment to resolve an issue. In addition, time thresholds of when enough information has been gathered to reduce uncertainty associated with monitoring measurements and when a particular measure of success should be achieved are factored into what is being measured and should be achieved.

Decision-Critical Uncertainties: A subset of uncertainties that, if not addressed, may impair decision making during CERP planning and implementation and increase the risk that the program/project will not meet its restoration goals and objectives. Examples of decision-critical uncertainties include questions about ecological response to management alternatives, whether funding and authority exists to implement a particular management alternative, the criteria/standards to be met, regulations, or stakeholder collaboration.

Evaluation: The process of forecasting the performance of plans and the designs relative to desired objectives by using predictive modeling and other tools. Forecasted results are compared to actual monitoring results verified through assessment to reduce uncertainty.

Federal Advisory Committee Act (FACA): Federal legislation enacted in 1972 to ensure that advice by the various advisory committees formed over the years is objective and accessible to the public.

Field Test (also known as Physical Model): An experiment undertaken as part of active adaptive management to address decision-critical uncertainties and test hypotheses to develop new information for planning and design prior to project construction.

Flexibility: The structural and/or operational capacity to adjust if monitoring indicates the need. Flexibility can be incorporated into an alternative as a design parameter to make it robust with respect to uncertain future conditions. Flexibility within a project may include the addition of three 250 cubic-feet per second (cfs) pumps in different locations to provide more options for moving water instead of a large 500 cfs pump in a single location even though this may not be the least cost pump configuration.

Goals: Goals are given to CERP planning teams. The teams then develop objectives that support achievement of the goals. In the case of CERP adaptive management, the restoration goals are articulated in the Yellow Book. Goals can be both program- or project-level.

Hypothesis: A tentative explanation for an observation or scientific problem that can be tested by further investigation. In Everglades restoration planning, a hypothesis projects how the system is anticipated to respond to a management actions. An alternative plan hypothesizes which actions will achieve project goals and objectives and system-wide restoration.

Incremental Adaptive Restoration: An alternative framework outlined by the National Research Council (2007) for advancing CERP progress, which aims to resolve scientific/technical decision-critical uncertainties and address project sequencing constraints to improve the pace of restoration.

This is done by making investments in restoration project increments that are large enough to secure significant environmental benefits, while testing hypotheses selected to resolve key uncertainties about the system's response to management actions. For CERP adaptive management, elements of incremental adaptive restoration are incorporated at the project-level through phased implementation.

Interim Goals: A subset of system-wide performance measures selected as indicators to assess CERP performance in five-year increments through implementation. Interim goals are intended to evaluate CERP progress toward regional hydrologic performance targets, improvements in water quality, and anticipated ecological responses.

Interim Targets: A subset of system-wide performance measures selected as indicators to assess CERP progress towards the other water-related needs of the region, including water supply and flood protection, throughout implementation.

Management Actions: Structural and operational alternatives undertaken as part of resource management. In the CERP planning process, management actions are grouped into alternative plans. Adaptive management plans contain potential management actions that may be taken to improve performance if project/program goals and objectives are not met.

Management Options Matrix: A decision support tool that links monitoring to potential management actions to be considered if monitoring indicates that a program/project is not meeting its goals and objectives, as determined by decision criteria. Management options matrices are developed for a set of key performance measures/targets that measure overall program/project performance link to potential management actions to adjust.

Monitoring: The process of measuring natural system conditions (e.g., stage, flow, water quality, habitat growth, species numbers or fitness) and the system's responses to management actions. In CERP, monitoring provides feedback to test hypothesized outcomes of management actions. Project-level monitoring plans are developed for each project, and system-wide monitoring is conducted as part of the Monitoring and Assessment Plan.

Monitoring and Assessment Plan (MAP): The primary tool used by RECOVER to continually assess CERP's performance. MAP provides a single integrated, system-wide monitoring and assessment plan for all participating agencies to track and measure the status of the Everglades ecosystem.

National Environmental Policy Act (NEPA): Enacted in 1969, a federal law that establishes a national policy on promoting the enhancement of the environment. This requires agencies to consider environmental impacts of their proposed actions and reasonable alternatives to those actions as part of the decision-making process.

New Information (also known as Learning): New information to inform uncertainties is gained through the science-based adaptive management process from the testing of hypotheses. This new information is fed into decision-making and used to better inform and refine, if necessary, planning, design/engineering, construction, operations, and maintenance.

Objectives: The CERP Six-Step planning process defines an objective as a"… statement of the intended purposes of the planning process; it is a statement of what an alternative plan should try to achieve."

Opportunities: Future desired conditions that may be achieved through the goals and objectives of Everglades restoration.

Passive Adaptive Management: An adaptive management approach in which a single design or operational plan is implemented and monitored to test hypotheses about the hydrological, ecological, or water quality responses to management actions in order to address uncertainty.

Performance Issue: An unanticipated, undesired result from restoration efforts; this is determined by comparing monitoring data results to predicted performance measures and desired targets.

Performance Measures: Performance measures are planning tools used to both design the restoration program, as part of the CERP Six-Step Planning Process, and to assess the response of the natural system during and after project implementation, through monitoring. Quantitative performance measures allow project planners to determine the degree to which proposed alternative plans are likely to meet restoration objectives, and to compare projected benefits among alternative plans. Performance measures and their targets are additionally used to define the content of monitoring plans designed to assess project or program performance or to indicate the need for adjustments to improve success.

Problems: Problems are existing, undesirable conditions. Problems are the reasons for planning. In the CERP Six-Step Planning Process these are stated succinctly in a *problem statement* and described in detail in a *problem definition.*

Program-Level Adaptive Management: Scale of adaptive management applied for the entire CERP program including all project components and operations.

Project-Level Adaptive Management: Scale of adaptive management applied for a CERP project that includes all project phases (i.e., planning, design/engineering, construction, operations, and maintenance).

Restoration Targets: CERP system-wide performance measures that provide quantifiable restoration metrics used to assess CERP performance and progress toward program/project restoration goals and objectives using hypotheses.

Restoration Vision: A common vision of what constitutes restoration success for a particular project or program as a whole.

Robust Alternative: A plan or alternative that is designed to perform well structurally and/or operationally under a variety of future scenarios, and is developed when future conditions are highly uncertain. Robust alternative plans retain their intended functions over a broad range of potential future conditions. Robustness can be achieved by designing plan alternatives that have limited consequences if they fail, are reversible, or have the capability to ensure that project sequencing, operations, and design can be changed in the future. In CERP adaptive management, the chances of failure or costly setbacks can be greatly reduced by designing plans or alternatives that incorporate robustness.

Stakeholders: Individuals or groups that may be affected by a proposed management action. For CERP, stakeholders include, but are not limited to: governmental organizations (federal, state and local); Native American tribes; the private sector (agriculture, utilities, and other businesses); non-governmental organizations (environmental and conservation groups), and citizens and residents of south Florida within affected project areas, as well as within the nation, that support restoration of the Everglades and south Florida ecosystem.

Stressors: Known or potential causes of ecological impacts in the landscape, such as water management practices, nutrient surpluses or deficits, and invasive species.

System-Wide Monitoring: Monitoring conducted under the CERP Monitoring and Assessment Plan.

Thresholds: Ecological thresholds are often characterized to represent a point, range, or distribution beyond which an important change occurs in an ecosystem condition, such as a state, pattern, or process (Bennetts et al., 2007)

Uncertainty: Lack of knowledge or disagreement about how the ecosystem functions, the outcome of a restoration design (management actions), or restoration endpoints. For CERP adaptive management, uncertainties are categorized into two groups: scientific/technical uncertainties (technical issues related to achieving ecological goals and objectives), or policy/management uncertainties (values, legal and budget issues).

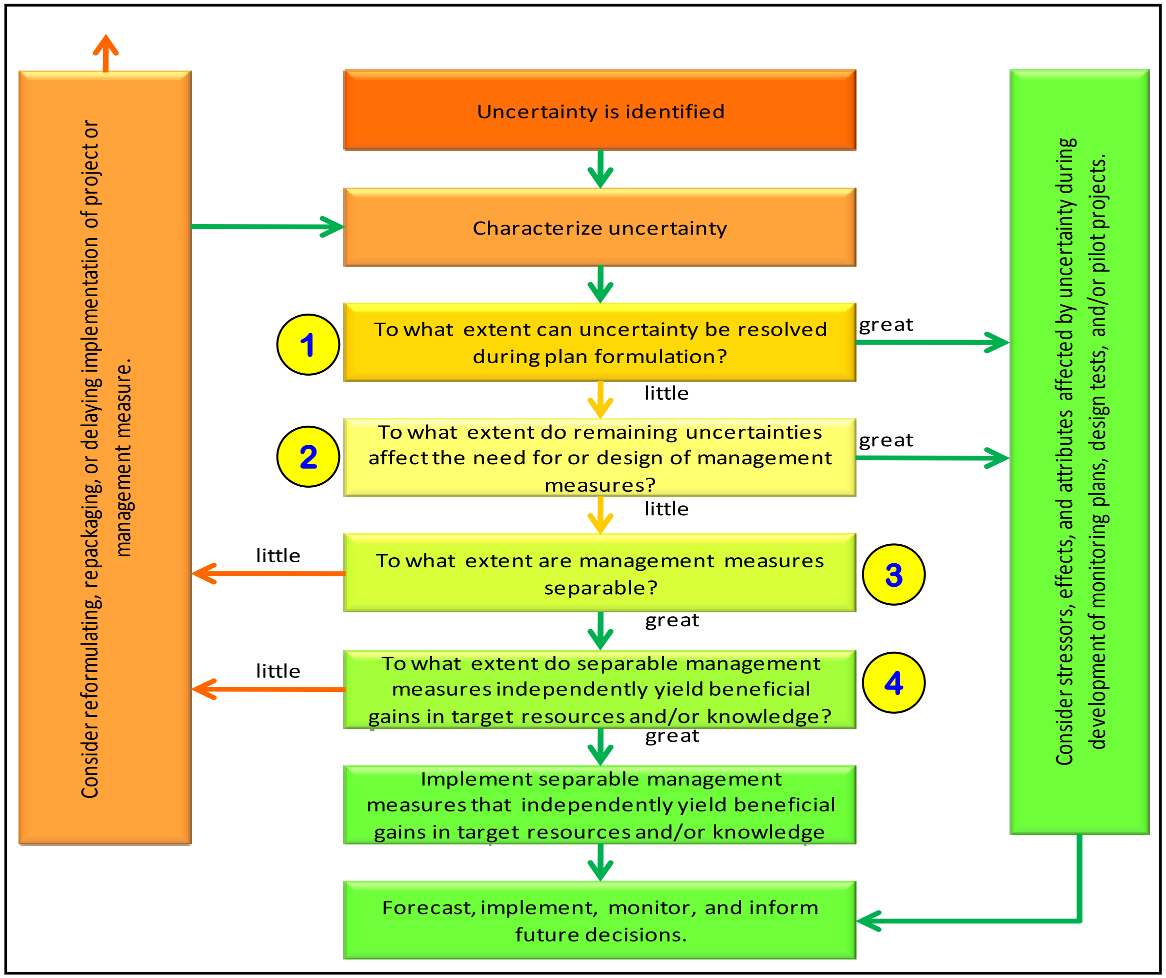
ANNEX A. CONDENSED TABLE OF CERP 6-STEP PLANNING PROCESS, PIR AND AM ACTIVITIES AND ASSOCIATED PIR TASKS

CERP 6-Step Planning Process	PIR Activity	AM Activity and Associated PIR Tasks
Step 1 – Identify Problems and Opportunities, Step 2 – Inventory and Forecast Conditions	Conduct NEPA Scoping Activities Identify Planning Objectives and Constraints Inventory and Forecast Resources Initiate Data Collection Develop Existing and Without Project Conditions Develop Simulation Models (Hydrological, Ecological, Water Quality) Develop Project Performance Measures	Activity 1: Stakeholder Engagement and Interagency Collaboration Activity 2: Establish/Refine Restoration Goals and Objectives Activity 3: Identify and Prioritize Uncertainties Activity 4: Apply Conceptual Models, Develop Hypotheses and Performance Measures
Step 3 – Formulating Alternative Plans Step 4 – Evaluating Alternative Plans Step 5 – Comparing Plan Alternatives	Define Management Measures FSMDevelop and Screen Initial Plans Formulate and Evaluate Alternative Plans Develop Preliminary Design for Alternatives Develop Cost Estimates Conduct Cost Effectiveness / Incremental Cost Analysis Conduct Economic Analyses Compare Alternative Plans Alternative Formulation Briefing	Activity 5: Integrate AM Principles into Alternative Plan Development and Implementation
Step 6: Selecting Alternative Plan	Identify TSP	

ANNEX B. FUNCTIONAL ANALYSIS OF SYSTEMS TECHNIQUE

The ability of a PDT to effectively manage and address uncertainties during the planning and implementation of a project is greatly affected by the degree to which each of its members has developed and maintained a common understanding of the uncertainties, and the decision context in which the uncertainties are likely to be influential on project designs and/or outcomes. The process and techniques for developing common understandings need not be complicated or time-consuming, and should not be dismissive or antagonistic, but rather should be as simple as necessary to develop a common picture of potentially influential uncertainties and their decision context.

Figure 2 is generalized illustration of one potential chronological AM decision that a PDT might encounter or otherwise consider when attempting to identify and characterize uncertainties in specific decision-related contexts. It is intended to provide teams with an illustration of a thought process that might be employed during the project planning and implementation report preparation to help with prioritization (which, when, and how uncertainties are addressed during project planning and implementation). The purpose of the thought process is to help teams find a way to maintain forward momentum on meaningful elements of projects that might otherwise end up clouded by uncertainties associated with elements of more questionable significance, design, or benefits.



Questions to consider:

1) Is the uncertainty related to policies, assumptions, or other factors that can be resolved by leadership?

2) Is the justification for the project, or critical elements if its design sensitive to reasonable ranges in uncertain data?

3) How integrated are the management measures of the project; Are there functional groups of management measures that can stand alone or be implemented in phases?

4) Do the individual separable/functional groups of management measures deliver sought benefits and knowledge?

FIGURE 2: SAMPLE SERIES OF QUESTIONS THAT PLANNING TEAMS CAN CONSIDER DURING PREPARATION OF A PIR TO ADDRESS UNCERTAINTY

ANNEX B. FUNCTIONAL ANALYSIS OF SYSTEMS (CONT'D)

During the preparation of a PIR, it may become necessary to justify investments in monitoring and demonstrate the relevance, significance, and context/role of monitoring activities as they relate to demonstrating attainment of project objectives or influencing future project or programmatic decisions. Figure 3 is a generalized diagram that illustrates relationships between project actions and intended project outcomes. While this is very similar to the process used to develop CEMs, this diagramming exercise requires careful consideration of other resources/services of interest/relevance to the planning context, and recognizes their role in decision making processes. From top to bottom, it shows how a PDT might manipulate conditions in the field to elicit a desired ecological response. From bottom to top, it shows why the PDT believes a response would be observed. When the scope and/or magnitude of the action necessary to trigger a response is uncertain, the diagram helps illustrate how the uncertainty might affect outcomes (following the diagram from top to bottom), and how decisions concerning the scope and magnitude of future actions (following the diagram from bottom to top) might be influenced. When an action potentially influences more than one resource/service of interest/concern and uncertainties surrounding the influence or outcomes of those actions exist, PDTs might find such a diagramming exercise useful to illustrate the need for AM activities that could alter how (i.e., scope and magnitude of actions) goals of the plan are being pursued, and why those AM activities are necessary or otherwise relevant to the entire context of the planning/implementation activities.

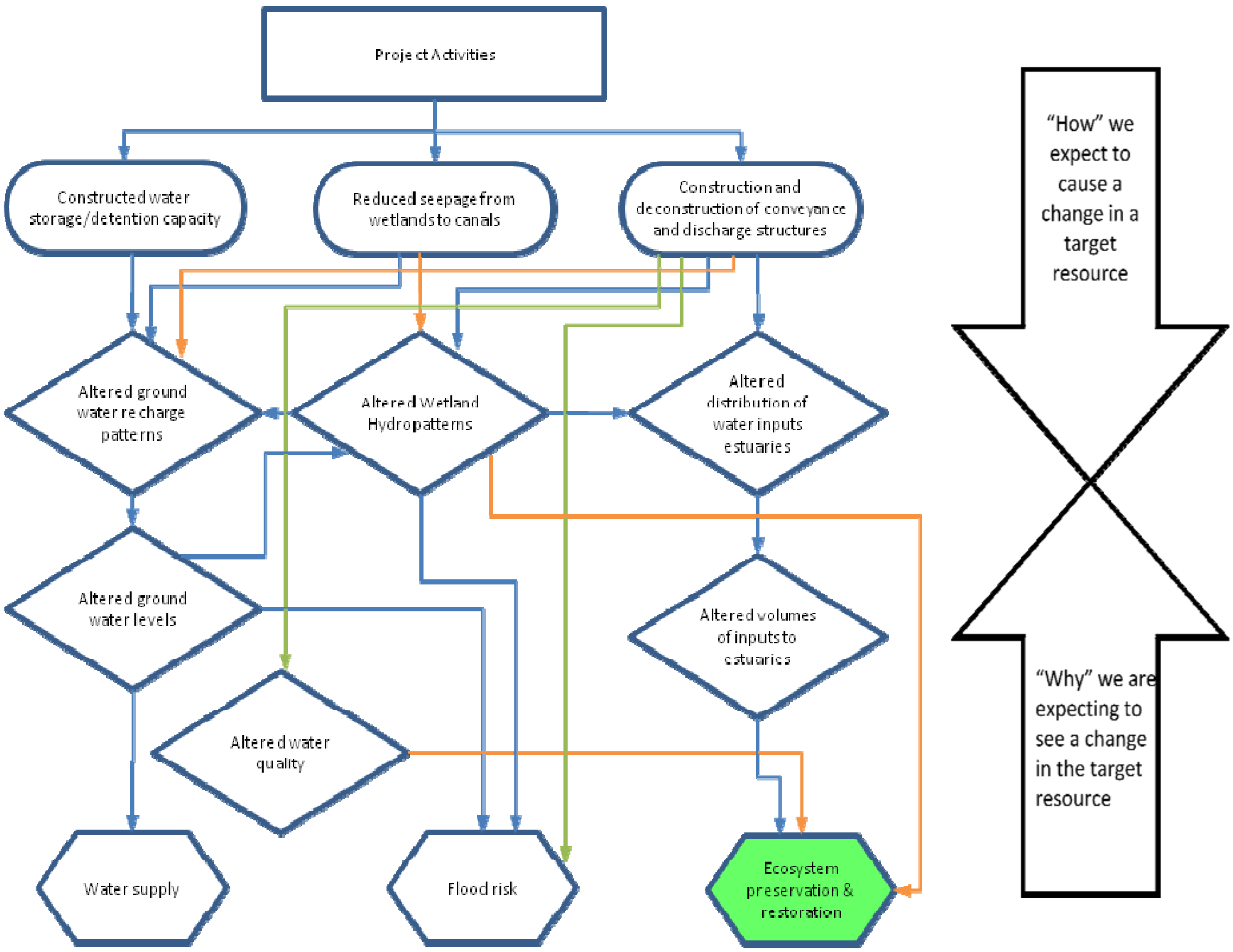


FIGURE 3. ILLUSTRATON OF RELATIONSHIPS BETWEEN PROJECT ACTIONS AND INTENDED PROJECT OUTCOMES (LINE COLORS ARE FOR EASE OF READ)

ANNEX C. AM RELATIONSHIP TREE

The AM relationship tree is a conceptual model diagram that uses lines, arrows, and text boxes, etc. to illustrate the links the project's goals and objectives, confirmed uncertainties, and the strategies designed to resolve the uncertainties.

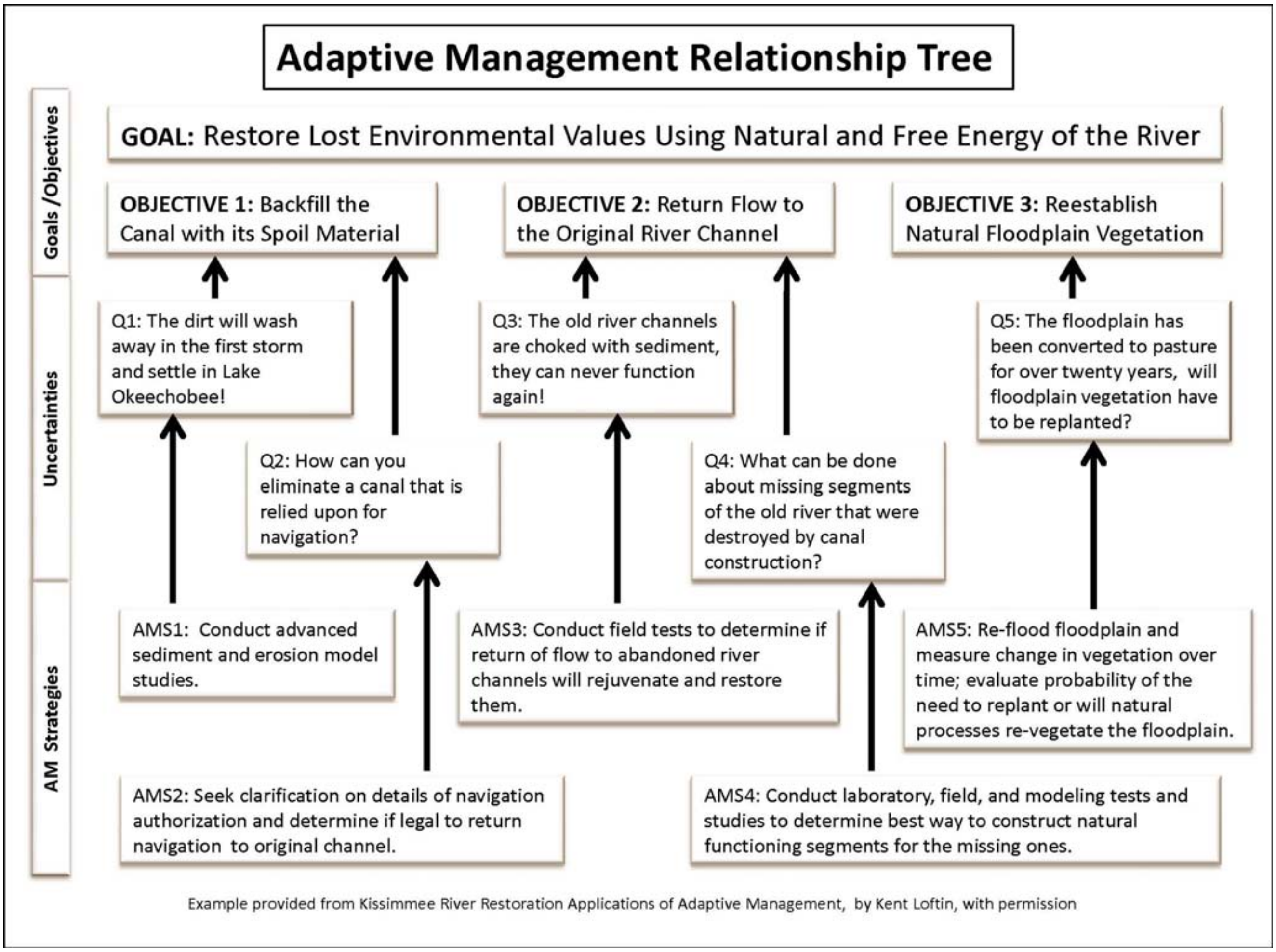


FIGURE 4. EXAMPLE AM RELATIONSHIP TREE