AGENCY TECHNICAL REVIEW GUIDE for

AQUATIC ECOSYSTEM RESTORATION STUDIES

Version 2.0

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Work Product Developed by the Ecosystem Restoration
Planning Center of Expertise (ECO-PCX)
For more information about the ECO-PCX, refer to the Knowledge Management Portal:
https://usace.dps.mil/sites/KMP-PLAN/SitePages/Ecosystem-Restoration-PCX.aspx

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I. INTRODUCTION

a. PURPOSE

The Ecosystem Restoration Planning Center of Expertise (ECO-PCX) developed this review guide for the purpose of improving the consistency and quality of reviews for aquatic ecosystem restoration (AER) studies. The intended audience for this document is anyone preparing for or conducting a technical review (e.g., ATR or DQC) for a project with a primary mission of AER. This guide may also be used as a tool by planners, biologists, and other project development team (PDT) members when developing feasibility study reports or project documents within the AER mission.

This guide summarizes key processes and policies unique to AER that reviewers should consider. This guide is organized into two sections:

1) procedural considerations for conducting AER technical reviews; and

2) technical subject matter areas unique to AER.

This guide represents advice, not guidance. It is not replacement for training and does not infer formal guidance from Corps Headquarters. It summarizes and consolidates previously issued formal guidance. **It is not intended to be comprehensive of all policy requirements or planning considerations** associated with an AER study nor intended to replace existing policy or implementation guidance. Rather, the goal of this guide is to:

- Summarize unique AER related subject matter and policy that is frequently challenging for PDTs,
- Improve quality and consistency of reviews at all levels,
- Improve overall quality of decision documents,
- Decrease the Major Subordinate Command (MSC)/Headquarters (HQ) review time by reducing the number of review comments, and
- Increase awareness of the need for quality reviews.

b. INSTRUCTIONS FOR USE

The guide has three main parts that have will have different utility depending on the purpose of the review and the information being sought. These parts are as follows:

Section II: General Procedural Requirements for Conducting ATR Reviews

This section focuses primarily on the logistical and procedural considerations typical of ATRs for AER focused projects. This section will likely be most useful for technical reviewers and review leads new to the ATR process and looking for guidance on the roles and responsibilities for ATR of AER products. It may also be useful to study teams when formulating their review plans and consider what disciplines may be necessary.

Section III: Technical Subject Matter Areas Unique to AER Studies

This section focuses on the feasibility study components that are unique to AER studies. The topics are organized sequentially to follow the USACE six-step planning process and focus on subject matter areas of common confusion. The content is intended to give a quick background of the subject areas, best-practices for review, and references to more comprehensive guidance. Users of this document may find it useful to work through this section sequentially as they review ATR products or quickly jump to certain topic areas.

Section IV: Quick Reference – Key Review Questions for AER

Lastly, this section is a compilation of key review questions for AER studies. The questions are accompanied by short responses with reference to other more comprehensive guidance. Similar to Section III, the questions are organized to follow the sequence of the USACE six-step planning process. The intent of these questions is to emphasize key areas of USACE AER policy as reviewers conduct their technical reviews of feasibility study projects. It is not intended to replace policy issue checklists, or other broader planning policy considerations. This quick reference guide may be useful to PDT members and DQC reviewers as well as to ATR reviewers for AER studies.

c. REFERENCES

Development of this ATR review guide relied primarily on the following USACE policy regulations and guidance:

1. Engineering Regulation 1105-2-103: Policy for Conducting Civil Works Planning Studies (2023).
2. Engineer Pamphlet 1105-2-70: Aquatic Ecosystem Restoration Civil Works Mission and Evaluation Procedures (2025),
3. Engineering Regulation 1165-2-217: Civil Works Review Policy (2024)
4. Engineer Circular 1105-2-412: Assuring Quality of Planning Models (2011)

Reviewers should reference the **Planning Community Toolbox** for all Planning Policies and Guidance. https://planning.erdc.dren.mil/toolbox/library.cfm?Option=Search&Sort=Default

II. General Procedural Requirements for Conducting ATR Reviews

a. Overview

This section is intended to provide a summary of the logistical and procedural considerations for conducting ATR for AER focused projects. The following provides an overview of general procedural requirements for conducting Agency Technical Reviews. See ER 1165-2-217 para 5 for detailed information on the Civil Works Review Policy as it relates to ATR.

- Agency Technical Review is undertaken to ensure the quality and credibility of USACE scientific and technical information is consistent with ER 1165-2-217 and to:
    - Assess the adequacy of DQC (NOTE: if work products are poor quality or appear to have inadequate DQC then they need to be returned prior to ATR starting),
    - Validate key PDT decisions and assess whether documentation explains the analyses and results in a reasonably clear manner for the public and decision makers; and
    - Assess analyses for being technically correct and comply with USACE criteria, guidance, procedures, and policies.
- ATR is mandatory for all draft and final decision documents and most implementation products.
    - "Early" ATR of specific elements or interim products can be beneficial to identify, avoid, and solve study problems by providing independent review of key products (See 2.e below).
    - Draft ATR includes a comprehensive review of all components.
    - Final ATR includes a targeted review, focused on work products that have been added or revised during review or preparation of the final documentation.
- ATR is conducted outside the District with an ATR Lead from outside the MSC.
- The scope of the review should be scaled to the significance of the information being reviewed, as determined by risk-informed decision-making.
- Each ATR should build upon all prior reviews for any work product and address only incremental changes and additions from prior ATR reviews, unless the ATR team determines that certain subjects warrant revisiting.

b. Role of Review Management Organization

Per 1165-2-217, the Review Management Organization (RMO) is the designated USACE organization overseeing quality review by reviewing and endorsing the Review Plan. The RMO is responsible for the overall management of the ATR effort with PDT support and is typically responsible for:

- Endorsing Review Plans
- Assigning an ATR Team Lead and ATR Team
- Preparing charge questions

- And other duties as described in 1165-2-217, Appendix B.

For General Investigation AER studies, the ECO-PCX is typically the RMO. The MSC, or in some cases the District if delegated, is typically designated as the RMO for Continuing Authority Program (CAP) studies (e.g., Sections 206 and 1135), other specifically authorized regional AER programs (e.g., Upper Mississippi River Restoration Program, etc.), implementation documents, or other post-feasibility documents with no re-formulation and no new ecological modeling (i.e., economic updates, validation studies, 902 updates). The ECO-PCX can assist PDTs as requested, even when not serving as the RMO.

c. AGENCY TECHNICAL REVIEW (ATR) LEAD

The roles and responsibilities of the ATR lead are described in ER 1165-2-217 para 5. Generally, the role of the ATR-lead is to facilitate the overall coordination of the review with the with the PDT and RMO.

The ATR lead must be assigned to an appropriately certified individual from outside the MSC for the project. For large, complex AER studies, the ECO-PCX recommends that the ATR-lead have previous ATR-lead experience. The ECO-PCX recommends new ATR leads initially be assigned only to smaller studies (e.g., CAP, UMRR, etc) and new ATR leads contact the ECO-PCX for mentoring.

While it is the responsibility of the RMO to assign an ATR Lead and an ATR Team, it is common that the ATR-Lead supports the identification of ATR-team members. The necessary disciplines needed for the review team is based on project specific information provided in an approved, and RMO endorsed, review plan. Resources that are useful for identifying certified ATR reviewers eligible for participation on ATR teams is provided in that can participate on ATR teams (Table 1).

Table 1. ATR Reviewer Resources

Disciplines	ATR Reviewer Resource
Plan Formulation, Economics, Environmental Compliance, Cultural Resources, Aquatic Ecosystem Restoration	The Planner Database - https://sme.sec.usace.army.mil/auth/index.html
Engineering Disciplines	The Command Training Plan (CTP), Corps of Engineers Reviewer and Certification and Access Program (CERCAP) https://cwbi-int.sec.usace.army.mil/
Cost Engineering	Contact the Cost Engineering Mandatory Center of Expertise (MCX) directly to request reviewer assignment. See the KMP for information about the Cost MCX https://usace.dps.mil/sites/KMP-CEC/SitePages/Cost-Resources.aspx
Infrastructure and Installation Resiliency (IIR)	Contact the IIR CoP Lead directly to request reviewer assignment. See the KMP for information about the IIR CoP (https://usace.dps.mil/sites/KMP-IIR)
Real Estate	Real Estate ATR Cadre list can be provided by the Real Estate PCX (https://usace.dps.mil/sites/kmp-re)

d. TIPS FOR ATR REVIEW TEAM DISCIPLINES

The disciplines required for ATR will be documented in the project Review Plan that is endorsed by the RMO. The ATR team disciplines should generally mirror the significant disciplines involved in accomplishing the work. In addition to the project-specific disciplines, the Cost PCX and Infrastructure and Installation Resiliency disciplines are required on all projects as specified by ER 1165-2-217.

The following disciplines are certified under the Planning Community of Practice (CoP) and may have specific relevance to ATRs of AER studies.

Ecosystem Restoration – Expertise in this discipline is certified by the Environmental sub-CoP. This discipline will utilize education and experience to review the appropriateness of proposed AER measures, the suitability of and application of ecological models, the evaluation of significance of ecological outputs, the quantification of habitat units, the selection of the NER Plan, and other project components related to aquatic ecosystem restoration. This reviewer will also evaluate the cost-effectiveness/incremental cost analysis (CE/ICA) with the economics reviewer. In addition, this discipline may be asked to perform the duties of the Env. Compliance discipline for projects with an AER purpose.

Environmental Compliance – Expertise in this discipline is certified by the Environment sub-CoP. This discipline will utilize experience and expertise to review the completeness of compliance with the National Environmental Policy Act (NEPA) and other pertinent Federal statutes relating to environmental resources. As noted above, a reviewer certified for Ecosystem Restoration, may be able to cover this discipline for AER studies if they have the appropriate experience commensurate with the complexity of given study.

Plan Formulation – Expertise in this discipline is certified by the Plan Formulation sub-CoP. This discipline will utilize experience and expertise to evaluate the plan formulation components of the study considering the SMART planning study process, risk-informed decision making, and the relevant USACE planning policy.

Economics – Expertise in economics as related to AER is certified by the Economics sub-CoP specifically for the AER business line. This discipline can add valuable expertise to an AER-focused project by evaluating the CE/ICA, the justification for the selection of the NER Plan, and other potential benefit accounts (National Economic Development, Regional Economic Development, Other Social Effects). This may be particularly useful for multi-purpose studies and for validating the accuracy of comprehensive benefits accounting.

The above disciplines are only a subset of the typical review disciplines that will be required on a typical AER study. Additional disciplines will be needed as necessary to meet review requirements and review needs as defined in the approved project review plan.

e. TIPS FOR ATR KICKOFF

The ATR review period typically begins with kickoff meeting between the PDT and the ATR team. While typically organized by the PDT, the ATR-Lead and team members have an important role in this meeting in gaining alignment on the scope, schedule, and budget of the ATR review. Below are some subject matter areas that are useful to discuss during ATR kickoff.

- ATR charge,
- Documentation to be reviewed,
- Coordination between disciplines (e.g., will the economist or the AER discipline cover the CE/ICA?),
- Four-part comment structure,
- How does the PDT prefer to receive editorial comments,
- What is the status of other reviews.

f. EARLY ATR OF INTERIM PRODUCTS.

As described in the "Technical Guide for District Quality Control Reviews and Agency Technical Review Memo", dated 15 June 2022, early participation of specific elements of the ATR team presents an opportunity for study teams to identify, avoid, and solve study problems by providing independent review of key products to assure that they are technically correct and policy compliant. Most studies will benefit from an early ATR of interim products that evaluates the technical approach and supporting documentation of critical assumptions used to evaluate the final array of alternatives and the assessment of the future without project condition. By getting review team concurrence on these critical planning assumptions and approaches, the PDT can substantially reduce the risk of critically significant concerns emerging later in the study timeline.

The following AER-related items could benefit from an early focused ATR of interim products:

- Suitability of the application of selected ecological models for the generation of habitat outputs,
- plan formulation strategy,
- AER measures and array of alternatives,
- future without project description,
- approach to IIR considerations,
- resource significance,
- cost effectiveness and incremental cost analysis, and
- tradeoff analysis.

g. ATR CHARGE TO REVIEWERS.

The "Charge to Reviewers" contains the specific instructions for the ATR team in conducting their review. The ATR Charge should be developed by the RMO with support from the district PDT and MSC. Reviewers should be able to quickly focus on the details that are critical for the successful performance of the project and focus their review on the charge considerations/questions. General ATR Charge guidelines are provided in Appendix C of ER 1165-2-217.

To supplement these general charge guidelines, the ECO-PCX, when serving as the RMO, developed AER-specific questions that should be considered to focus reviews for AER studies:

- Does the restoration approach restore degraded ecosystem structure and function to a less degraded, more natural condition?
- Are AER related alternatives technically correct, safe, functional, constructible, economical, reasonable, and sustainable?
- Is the future without project condition of the aquatic ecosystem appropriately described and forecasted?
- Have certified/approved ecological models been applied appropriately in the generation of habitat unit outputs for the future with and without project condition?
- Are calculations and results of ecological and other analysis correct and supported by documentation of DQC?
- Are the life-cycle projects costs, including monitoring, adaptive management, and OMRR&R adequately considered during comparison of project alternatives?
- Is resource significance adequately described and considered in the identification of the NER Plan and selection of the recommended plan?
- Are real estate requirements adequately considered and described to a feasibility level-of-detail? Is it sufficiently complete to provide an adequate basis for the baseline cost estimate?
- Does the report sufficiently and correctly apply cost-effectiveness and incremental cost analysis (CEICA) to the evaluation of alternatives?
- Is the NER Plan clearly identified and is plan selection justified based on the National Objectives, evaluation criteria and USACE policy?

h. ATR DURING PED AND BEYOND

The timing of ATR during the preconstruction, engineering, and design (PED), construction, and Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) dependent on the risks and complexity of the project and must be documented in an updated review plan. For PED phase, a typical approach is to conduct ATRat various increments of the design phase such as 35%, 65%, and 95% design. The scope of the ATR should consider the unique, project-specific components associated with the project, with a focus on those with high complexities and instrumental uncertainties.

i. ATR FOR CAP AND OTHER AUTHORITIES

The requirements for ATR may vary depending on authorities (see ER 1165-2-217 and EP 1105-2-58). For CAP, these differences include:

- CAP projects are encouraged to use a Programmatic Review Plan,
- the RMO is the MSC, or can be delegated to the district, unless the project requires Independent External Peer Review (IEPR) or Safety Assurance Review (SAR),
- the approval of planning models is not required for CAP projects, but planners are encouraged to utilize certified models if they are available. Model usage will be reviewed during ATR (see Section III.c.iv) and will typically consider:
    - Appropriate computer models and methods of analysis were used, and basic assumptions are valid and used for the intended purpose,
    - The models are theoretically sound, computationally accurate, and transparent,
- CAP studies that do not include an EIS may be exempted from IEPR (Independent External Peer Review); however, SAR is required where life safety risks are significant.

III. Technical Subject Matter Areas Unique to AER

a. General

This section focuses on the feasibility study components that are unique to AER studies. The topics are organized sequentially to follow the USACE six-step planning process and focus on subject matter areas of common confusion. The content is intended to give a background of the subject areas, best-practices for review, and references to more comprehensive guidance. Users of this document may find it useful to work through this section sequentially as they review ATR products or quickly jump to certain topic areas.

The basic policy guidance for AER studies is provided in Chapter 6 of ER 1105-2-103: Policy for Conducting Civil Works Planning Studies and supplemented by EP 1105-2-70: Aquatic Ecosystem Restoration Civil Works Mission and Evaluation Procedures. The over-arching basis for justifying ecosystem restoration projects is the significance of the environmental resources. Given that some resources are more significant than others and that there will never be adequate funding to address all environmental resource problems and opportunities, it is critical that reports address significance in terms of outputs.

b. Feasibility Study Scoping

i) Problems, Opportunities, Objectives, and Constraints

As with all planning studies, development of well-defined problems, opportunities, objectives, and constraints are critical to the successful planning of AER studies seeking to restore ecosystem structure, function, and dynamic processes. Therefore, ATR reviewers should consider evaluating the problems, opportunities, objectives, and constraints with consideration of the following:

- Are impairments to ecosystem function, structure, and dynamic processes clearly defined?
- Are target habitats adequately identified, described, and specific enough to inform development of effective project measures?
- Are there specific life histories or stages of individual species that should be considered (i.e., refugia for juvenile fish)?
- Are the problems/opportunities/objectives overly vague and general (e.g., “improve the environment”)?
- Are objectives developed focused on restoring the aquatic ecosystem structure function? (i.e., do not emphasize improving water quality for humans).
- Are the objectives overly prescriptive (i.e., not sufficiently flexible) and not reflective of the impaired ecosystem function and structure? Avoid objectives like:
    - “Remove three low-head dams”, or
    - “Install locked logs at five sites”

ii) Reasonableness of the future with- and without-project assumptions

Due to the dynamic nature of natural habitats, confirming the reasonableness of the future with and without project condition is of particularly importance to AER reviews. Reviewers should consider the validity of the underlying assumptions related to the following:

- Future without project condition (FWOP) – how will ecological stressors and ecological drivers affect the existing habitat over the period of analysis? Is existing habitat anticipated to improve or degrade if no action is taken? Are these assumptions supported and documented in the report?
- Future "with-project" conditions – The assumptions related to the "with project" conditions should be a focus of technical review. In particular, how the project components are assumed to improve ecological condition ("ecological lift") and the resilience of the proposed habitat improvements to physical, chemical, and biological processes at the site. Reviewers should consider if the assumptions used in the calculation and annualization of habitat units sufficiently consider the ecological factors that may influence these outputs over the period of analysis.
- Are the impacts of future meteorological and hydrogeomorphic scenarios incorporated into these assumptions?
- Are uncertainties associated with future with and without- project assumptions characterized?

iii) Conceptual Ecological Models

Aquatic ecosystem restoration studies must include a conceptual ecological model (CEM) to represent ecosystem processes and characteristics such as the structure, functions, and services anticipated to be produced by the restoration project (See EP 1105-2-70, Chapter 4-3). A CEM can also be especially useful for visually representing the connection between ecosystem drivers, project measures, and potential benefits. One study can have multiple CEMs based on the need of the audience(s). A CEM is a simplified description of a system or sub-system that serves as a basis for intellectual organization. CEMs describe general functional relationships among essential ecosystem components and tell the story of "how the system works". CEMs are used to:

- develop a shared understanding of a complex system,
- set the stage for numerical models,
- inform restoration decisions, and
- form the basis for monitoring and adaptive management.

Conceptual ecological models are simplified depictions of complex physical, chemical, and ecological processes. They are not comprehensive – they focus only on parts of the ecosystem that are deemed to be relevant; and they are not a static final depiction – they should be flexible and able to evolve. During ATR, consider the following when reviewing the CEM:

- Is a CEM included?
- Is the CEM depicted clearly and understandable enough for the reader to follow the relationships?

- Does the CEM relate physical, chemical, biological, and ecological processes to the measures being considered?

C. PLAN FORMULATION AND EVALUATION

i) Plan Formulation Strategies

The dynamic nature of ecosystems often requires unique approaches to measure development and plan formulation. Therefore, technical review of AER studies should include evaluation of the plan formulation strategies. The IWR Planning Manual Part II: Risk informed Planning (2017-5-03) Section 8.5 defines formulation strategies as a disciplined way to produce one or more specific plans. A strategy usually consists of a set of tactics or conditional decisions that shape and guide the development of plans; thus, strategies structure the how-to of plan formulation.

Due to the variety of measures and multiple scales often associated with ecosystem restoration plans, reviews of AER studies should confirm that decision documents have clearly described the plan formulation strategies in a manner that provides consistency and transparency into the planning process. Numerous strategies for formulation of measures and alternatives are relevant to AER projects (IWR Planning Manual Part II and See EP 1105-2-70, 4-6 g. (2)). It is at the discretion of the PDT to apply the most appropriate formulation strategies to the particular project; however, it is important for the reviewer to assess whether the plan formulation strategies applied by the PDT is described consistently, transparently, and logically in the planning process.

The following are examples of plan formulation strategies that may be relevant to AER studies:

- *Theme Based (Outcome Based)* - Alternatives have been formulated to achieve specific focal areas such as "maximize environmental benefits," "minimize operation and maintenance," "life safety," "sponsor preferred," "economics," etc. This is an ECO-PCX preferred method.
- *Incremental Approach* - Alternatives have been formulated by starting with the critical measures and adding additional measures to maximize benefits**.**
- *Experts and Experience Approach* - Elicit input from experts both within and external to the team to guide the formulation of alternatives**.**
- *All Possible Combinations* - This approach involves mechanistically combining compatible measures to create all possible alternatives. While this may provide the most comprehensive approach to plan formulation, it omits critical thinking in the planning process, leads to the most unwieldy analysis, and risks overlooking important nuances of individual plans. This approach is not preferred by the ECO-PCX, should only be considered if there are few and completely independent measures, and the PDT desires to look at all possible combinations. This strategy may be least useful for AER studies that have complex arrays of measures with subtle, but ecologically important differences. In addition, looking at all possible combinations could potentially lead to thousands, even millions, of alternatives, making the analysis overly complex and cumbersome. Furthermore, this strategy should be avoided especially if ecological model outputs do not have the precision needed to calculate benefits at a given individual measure scale. Typically, ecological modeling outputs are not precise/sensitive enough for this level of detail. Rather, ecological models are better for evaluating a holistic solution due to the synergies of components working together. See "Lessons Learned and Best Practices: Recent

Experiences with Cost Effectiveness and Incremental Cost Analyses (CE/ICA) for Ecosystem Restoration Projects" (Skaggs, 2016) for additional discussion on this topic.

- *Required Plans* - Engineering Regulation 1105-2-103 identifies several plans that must be included in the array of alternatives for evaluation. A given alternative may meet multiple of the below. These include:
    - No Action Alternative,
    - **National Economic Development** (NED) plan (not required for AER projects),
    - **National Ecosystem Restoration** (NER) plan,
    - **Total Net Benefits Plan** - A plan that reasonably maximizes total net benefits including monetized and non-monetized benefits,
    - **Total Net Benefits By Study Purpose –** A plan that reasonably maximizes net benefits including monetized and non-monetized benefits consistent with the study purpose only,
    - **The least environmentally damaging practicable alternative** (LEDPA), as required by the Clean Water Act 404,
    - A **non-structural plan** for studies with FRM components,
    - A **Locally Preferred Plan (LPP)** if requested by the non-federal partner, and
    - A **nature-based solution** (see ASA-CW Memo, April 2024)

Additional information on formulation strategies can be found in the 14 September 2023 webinar "Planning Fundamentals: Plan Formulation Strategies and Required Plans" via the Planning Library.

ii) Other Plan Formulation Considerations

Ecosystems are inherently dynamic and therefore the scope of alternatives evaluated will depend on the study purpose, study area, and objectives. Reviews of AER studies should consider the following when evaluating the formulation of alternative plans:

- **Description of Alternative Plans –** Alternative plans should be uniquely different and described in sufficient detail to describe the measures proposed for implementation. Descriptions of alternative plans should clearly describe the size, scale, and materials of each component and also the associated benefits to ecosystem structure and function.
- **Sustainability of Project Features –** Description of alternative plans should consider the sustainability of project features in terms of to what degree they will be self-sustaining or reliant on future management to achieve their proposed benefits. For instance, will plans that rely heavily on plantings to establish habitat be successful if the fundamental geomorphic process are not modified as part of the plan? Will structural habitat measures require frequent maintenance/replacement in order to deliver its proposed benefits?
- **Innovative Alternatives -** Innovation may be evaluated in terms of ability to achieve success, non-structural measures, cost reduction, schedule reduction, etc. Particularly for ecosystem

restoration projects, innovation should also focus on sustainability and low O&M, and may need robust adaptive management to address identified uncertainty.

- **Array of Alternatives** – The range of alternatives considered should be broad enough to allow for effective consideration of project effects and incremental cost analysis. However, this will also be determined by the project authority (i.e., CAP projects likely to be smaller scale than GI studies) and site-specific conditions.
- **Alternative Screening -** Justifications for excluding measures/alternatives should be clearly described. These may include failure to meet minimum standards for the four P&G evaluation criteria - completeness, effectiveness, efficiency, and acceptability. The IWR Planning Manual (pp. 155-159) provides advice regarding use of the four P&G criteria for screening. Alternatives may be eliminated in the initial screening process before in-depth evaluations are performed, but the reasons for elimination should be presented in the report and should be adequate to support the planning and evaluation process.

iii) Feasibility-Level Restoration Concepts (Level of Detail)

The level of detail associated with aquatic ecosystem restoration concepts may vary between projects under different authorities, project types, and target ecosystems. A reviewer should consider if adequate detail has been provided in the decision document to ensure delivery of proposed benefits if the recommended plan is approved. The reviewer should also assess whether there is sufficient support for the benefit calculations, significance determinations, environmental impact analysis, and cost estimation. Some items for consideration are provided below:

- **Risk and Uncertainties** - Have the risks and uncertainty associated with projected restoration alternative outputs been evaluated, discussed, and included as part of the Monitoring and Adaptive Management Plan? It is essential that the risk and uncertainty associated with the function and sustainability of a given measure be described during the plan evaluation. There may be uncertainty in the ability of an alternative to achieve the desired restoration target which, if significant enough, might drive the PDT to select a different alternative with less risk of failure. Timing implications may introduce elements of risk, particularly if the resource is in such a degraded state that failure to restore it in the near term may preclude future restoration success.
- **Planting Plans** – Projects where establishment of native plant communities are an integral component of the recommended alternative should include a planting plan that lays out the materials, budget, schedule, and operation and maintenance to a level of detail appropriate for the feasibility phase. Reviewers should consider the appropriateness of the proposed planting plan as well as if risks to plant establishment are adequately described and accounted for.
- **Invasive Species Treatment Plans** – Often this may be included as a component of the planting plan. Similar level of detail should be provided for invasive species treatment plans, as is described for planting plans above. The reviewer should consider if the appropriateness of the treatment schedule and methods being proposed will be sufficient for the proposed effect (i.e., prevention or management).
- **Monitoring and Adaptive Management Plans** – Monitoring plans should include sufficient detail to ensure the establishment trajectory of proposed AER components, and also to allow for sufficient cost estimation. Monitoring is discussed in more detail in subsequent sections.

iv) Model Usage and Review

Aquatic Ecosystem Restoration projects typically rely on various ecological models for the quantification of ecological outputs and habitat units. Per EC 1105-2-412, and subsequent memos, the use of certified or approved models for all planning activities is mandatory. Some specific authorities, such as CAP, are not required to use approved/certified planning models; however, use of certified models should be used if available (EP 1105-2-58). Model certification and approval needs should be identified, scheduled, and budgeted in the project review plan, adequately coordinated with the appropriate PCX (ECO-PCX for AER models), and comply with the 28 July 2023 CECW-P memo, *Model Coordination for Civil Works Planning Studies.*

Model considerations during various review periods are as follows:

- *During Review Plan review*: Reviewers should consider if appropriate models have been proposed and if they are appropriate to capture the effects (benefits and impacts) to the target aquatic ecosystems. Reviewers should also confirm the model certification status, the need for model certification, and compliance with CECW-P memo (28 July 2023). The use of "Model Coordination and Questionnaire" is required when ECO-PCX is the RMO, which is found the ECO-PCX KMP site (https://usace.dps.mil/:f:/r/sites/KMP-PLAN/Shared%20Documents/EcoPCX/Model%20Coordination%20for%20Civil%20Works%20Planning%20Studies?csf=1&web=1&e=2sBb8P).
- *DQC*: Ensure the appropriateness of selected models and confirm that the model formulas have been applied appropriately and accurately. This should include quality control and quality assurance review of model outputs. Per ER 1165-2-217, all computations will undergo a rigorous, independent check during DQC.
- *ATR*: It is the intent of ATR to ensure the overall technical analysis and approaches are correct and compliant with all pertinent USACE guidance. The role of ATR is to assess the adequacy of DQC, validate key PDT decisions, and identify important concerns and lessons learned. As it relates to the use of ecological models, the ATR reviewer should consider:
    - If the models used are appropriate for the specific study and sensitive to capture the proposed ecological effects (benefits or impacts),
    - are the models used clearly described and supported by justification of the appropriateness of their use,
    - does the documentation explain how data to support the model was acquired (field data, modelling, professional judgment, etc.),
    - have the model results been applied appropriately to the plan evaluation, comparison, and selection of the recommended plan,
    - have the model outputs been annualized over the period of analysis and do they accurately represent the anticipated trajectory of ecosystem outputs under the “with” and “without” project condition, and
    - has DQC of the models been completed appropriately.

v. Environmental Consequences of AER Projects

Within the environmental impacts analysis (i.e., Environmental Assessment or Environmental Impact Statement), the beneficial effects of the AER alternatives should be discussed along with any environmental commitments required (e.g., monitoring, best management practices, conservation measures, avoidance measures). During the alternatives’ effects analysis, PDTs should describe the impacts and benefits to all relevant resources for each alternative in the final array. Care should be given to accurately describe the long-term benefits to wetland/aquatic resources and not describe

impacts to these specific resources as adverse. Recommended alternatives should not conflict with the purpose of national ecosystem restoration. Additionally, any efforts to minimize or avoid potential impacts should be described as such and use of the word "mitigation" for wetland/aquatic resources should be avoided. Furthermore, projects implemented using ecosystem restoration authorities may not be used as wetland banks or mitigation credit for other entities (EP 1105-2-70).

vi) Consideration of Invasive Species Prevention and Control

Invasive species policy, as set forth in a Memo from the ASA(CW) February 2023 SUBJECT: U.S. Army Corps of Engineers Invasive Species Policy, states that measures to either prevent or reduce establishment of invasive or non-native species will be a component of all USACE Civil Works projects and will be applied to invasive species issues in the execution of all Civil Works programs. Reviewers should consider this policy when reviewing the appropriateness for AER alternatives. Reviewers should also consider how proposed alternatives will prevent or manage the spread of invasive species in alignment with the referenced memo. Additional consideration of invasive species treatment plans is discussed above in the "Feasibility Level Restoration Concepts" sub-section.

vii) Monitoring and Adaptive Management Plans

The authority to perform monitoring and adaptive management must be expressly stated in the authorizing legislation or in the authorizing document for the project. Costs should be shown in the 06 Fish and Wildlife Facilities feature cost. Monitoring and adaptive management plans (also called a contingency plans) are used to determine success of restoration efforts (*see ER 1105-2-103 Chapter 6-8 e*.) and to guide necessary corrective actions. The monitoring and adaptive management plan should consider long-term ecological need and include:

- Clear success criteria for restoration based on the planning objectives that comply with Corps guidance on what cannot be used to determine project success (see ER 1105-2-103 and EP 1105-2-70).
- duration of monitoring (up to 10 years may be cost-shared),
- monitoring needs, including schedule and budget,
- description of adaptive management corrective actions, and explicit triggers for when corrective actions will be taken based on the monitoring data; and
- identification of non-fed partner responsibilities

For additional detail on monitoring plans see ER 1105-2-103 Chapter 6-8, e. and Memorandum CECW: Subject Implementation Guidance for Section 1161 of the WRDA Act of 2016, Completion of Ecosystem Restoration Project 2017. For adaptive management guidance, see the technical guide "A Systems Approach to Ecosystem Adaptive Management – ERDC/EL SR-19-p".

viii) Operations, Maintenance, Repair, Replacement, and Rehabilitation

The decision document should include a description of the features that are considered non-mechanical and non-structural. It should describe the non-federal responsibility to conduct OMRR&R and describe when the responsibility for OMRR&R of non-structural/non-mechanical components will cease. Risks associated with OMRR&R should also be characterized in plan comparison and in the description of the recommended plan.

d. PLAN COMPARISON AND SELECTION

i) Comprehensive Benefits Accounting

The requirements and procedures for evaluating AER policies are provided in ER 1105-2-103 Chapter 6-5. A brief summary of key considerations are provided below:

- *Comprehensive Benefits Accounting:* Decision documents should include a comprehensive accounting of monetary and non-monetary benefits and costs. Economic, social, and environmental benefits, impacts and costs are to be identified measured, and/or qualitatively characterized using the four P&G accounts.
    - NED – PDTs should evaluate the incidental economic benefits produced by AER using methods and procedures for the type of benefit produced (e.g. flood-risk management or recreation benefits associated with riverine wetland creation).
    - RED – AER alternative evaluation must include an assessment of the construction impacts and the contribution of the project to regional economies.
    - EQ – AER outputs and other environmental benefits and impacts should be included in the Environmental Quality account. This account will include the NER benefits as measured in Average Annual Habitat Units. It should also include any effects (positive or negative) to cultural resources and/or aesthetics.
    - OSE – AER projects are likely to have other various benefits such as access to green space or improved aesthetics that may be considered in the other social effects (OSE) account
    - Ecosystem Goods and Services should be considered for inclusion in any of the four-accounts where most appropriate.

ii) Cost Effectiveness and Incremental Cost Analysis (CE/ICA):

Cost effectiveness and incremental cost analysis must be performed at an appropriate level of detail for each study to identify the most cost-effective plan within the identified constraints. The use of IWR Planning Suite software (IWR Planning Suite (army.mil)) is recommended for use to conduct CE/ICA. Most importantly, CE/ICA results inform decision-making regarding plan selection and/or the NER plan identification; they do not, in isolation, constitute a decision. In other words, PDTs must consider all four planning criteria (Completeness, Effectiveness, Efficiency, Acceptability) when identifying the NER Plan and selecting a recommended plan. CE/ICA typically provides information for the “Efficiency” criteria and helps inform the decision - it does not give you the "right answer".

The EP 1105-2-70 Aquatic Ecosystem Restoration Civil Works provides a detailed discussion on conducing CE/ICA, and reviewers should reference that information when conducting their technical reviews. In summary, CE/ICA will typically be supported by a narrative, tabular information and figures. The figures typically used are the “All Plans” graph of costs per outputs (Figure 1), and the incremental cost per incremental output box-chart (Figure 2). Tables showing the associated data should also be provided. These tables should include plans organized in order of increasing output/benefit and include alternative name, output/benefit, cost, incremental output/benefit, incremental cost, and incremental cost per unit of output/benefit.

For more discussion on using CE/ICA, see EP 1105-2-70 Aquatic Ecosystem Restoration Civil Works Mission and Evaluation Procedures and "Lessons Learned and Best Practices: Recent Experiences with Cost Effectiveness and Incremental Cost Analyses (CE/ICA) for Ecosystem Restoration Projects" (Skaggs, 2016).

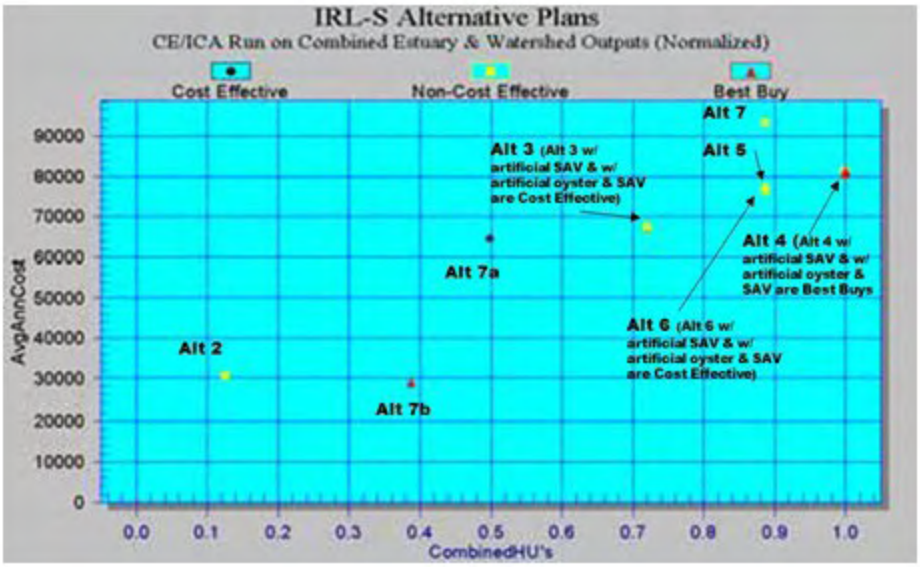

Figure 1. Example "All Plans" graph from IWR Planning Suite

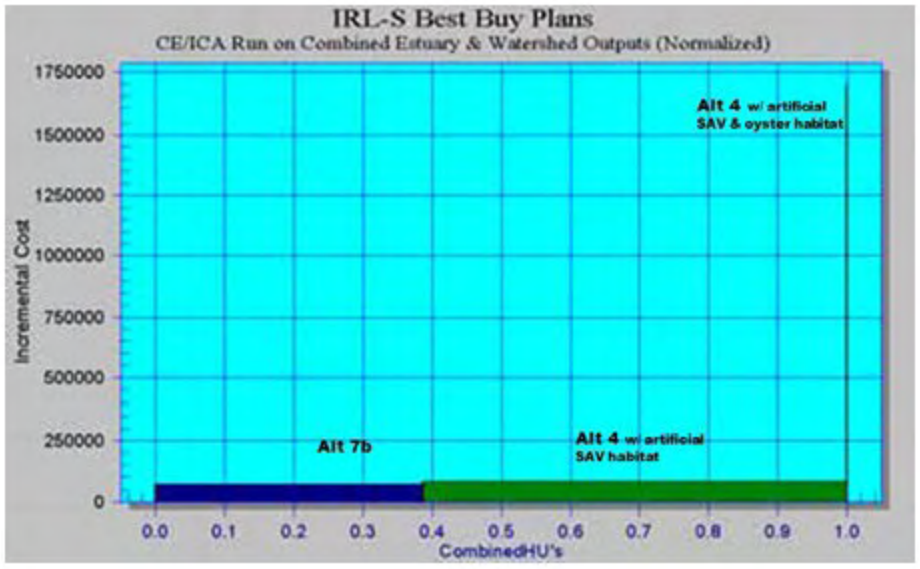

Figure 2. Example "Incremental Cost/Benefit" of Best Buy Plans graph from IWR Planning Suite

iii) Consideration of Significance

For AER projects, a federal interest determination is supported by consideration of resource significance and national significance (ER 1105-2-103 Chapter 6-1 c.). Significance should be addressed at each step of the planning process (see IWR Report 97-R-4 "Resource Significance for Environmental Project Planning"). The concept of significance of outputs also plays an important role in the evaluation ecosystem restoration alternatives. Along with CE/ICA and the planning criteria, the significance of

ecosystem outputs will help determine whether the proposed investment is worth its cost and whether a particular alternative should be recommended (EP 1105-2-70).

Therefore, AER projects should be discussed in terms of the three types of significance: institutional, public, and technical recognition. While not every element is required to establish the significance of an individual project or when evaluating alternatives, discussion of technical recognition should consider:

- Scarcity,
- representativeness,
- status and trends,
- connectivity,
- critical habitat, and
- biodiversity.

Reviewers should ensure that significance is sufficiently discussed within the decision documents and considered as part of plan comparison and selection. Local communities and Indigenous Knowledge should be considered as a source for information pertaining to significance along with reports, academic research, and action plans.

iv) Identification of the NER Plan

For AER projects, the plan that reasonably maximizes AER benefits compared to costs, consistent with the Federal Objectives and Guiding Principles, and has been shown to be cost effective to achieve the desired level of output, is the NER Plan (ER 1105-2-103). As described in a previous section, a common mistake of PDTs is to only consider CE/ICA when identifying the NER Plan. The CE/ICA should not be the sole basis for the identification of the NER Plan. Rather, identification of the NER plan should consider the planning criteria (completeness, acceptability, efficiency, effectiveness), reasonableness of costs, resource significance, and risk and uncertainty, In practice the PDT will perform CE/ICA on the plans that have already been determined to be "complete" and "acceptable", and will use the outputs of CE/ICA to characterize "effectiveness" and "efficiency".

The key quantitative metric that should be discussed is the "Incremental Cost per Average Annual Habitat Unit (AAHU)". The identification of the NER Plan should include various "Is it worth it?" assessments comparing the Incremental Cost per AAHU against the significance of an AAHU (of the specific type of habitat being restored) in contributing to the USACE AER Mission. If an increment is determined to be "worth it," the argument for its significance should be commensurate with the cost. For example, the significance needed to justify a cost of $50,000/yr per AAHU would be double the significance needed to justify a cost of $25,000/yr per AAHU.

It should not be assumed that all studies will have an action alternative identified as the NER Plan. If none of the action alternatives produce habitat with significance that is commensurate with their *Incremental Cost per AAHU*, then the No Action alternative should be identified as the NER Plan.

Identification of the NER plan should be deliberate and clearly documented with discussion of how the plan meets the four planning criteria, the Federal Objectives, and the Guiding Principles. A common

mistake PDTs make is to muddle the identification of the NER Plan and the selection of a recommended plan. While the recommended plan may often be the NER plan, the identification of these plans should occur sequentially, and be clearly described.

Per 1105-2-103, the total net benefits plan must also be identified. The total net-benefits plan must also be incrementally justified.

v) Plan Selection and Tradeoff Analysis

A tradeoff analysis must be used to document the selection of the recommended plan (ER 1105-2-103, Chapter 6-6.). It should consider cost effectiveness and incremental cost, degree of achieving the planning objectives, significance and magnitude of ecological benefits, reasonableness of cost, and other pertinent decision factors. Incremental cost analysis assists in this trade-off analysis but does not drive that process.

vi) Determination of the Recommended Plan

The determination of the recommended plan is often focused on the cost-effectiveness of the plan in delivering all benefits, consistent with protecting the environment and achieving the planning objectives. The criteria for determining the recommended plan may vary between studies but should be based on criteria developed by the PDT and agreed to by the vertical team. Determination of the recommended plan is based on a collaborative process between the planning team, non-federal partner, stakeholders, and the public. Determination of the recommended plan should also consider a discussion of tradeoffs between the various goals of the project. If the district recommends a plan other than the NER plan, an exception request must be prepared and submitted to the ASA (CW) for approval.

IV. Quick Reference: Key Review Questions for AER Review

Scoping:

Are the ecosystem restoration components of this study part of a larger multi- purpose or watershed study?

Reports should identify upfront if the study has multiple purposes (i.e., Ecosystem Restoration with Flood Risk Management, Water Supply, Hydropower, etc.). For multi-purpose studies, it should be clearly stated if the ecosystem output benefits are in addition to the other benefit categories, and not used to mitigate or offset project impacts.

Does the report provide concise statements of specific problems and opportunities?

The IWR Planning Manual (pp. 70-75) provides examples of concise problem statements. Problem statements should not include the suggestion of a specific solution. There is no need to restate problems as opportunities.

Are planning objectives clearly stated?

The objectives of the study should be determined early in the study process and presented early in the report so that information can be evaluated in light of the study objectives. Various alternatives should be evaluated/compared in how effective they are in meeting the objectives. It is important to recognize that objectives should not be measures or alternatives. Objectives must be clearly defined and provide information on the effect desired, the subject of the objective, the location where the expected result will occur, the timing of the effect and the duration of the effect. Objectives should also be sufficiently flexible such that they do not unduly constrain the plan formulation.

Are the planning objectives consistent with the purpose of Civil Works aquatic ecosystem restoration activities?

The purpose of Civil Works aquatic ecosystem restoration is to restore significant aquatic ecosystem function, structure, and dynamic processes that have been degraded. Ecosystem restoration projects attempt to return natural areas or ecosystems to less degraded, more natural conditions. In most cases, a return to pre-disturbance conditions will not be feasible, but partial restoration may be possible. While ecosystem restoration is not limited to the replication of historic conditions, enhancement of artificial environments (e.g., reservoirs or landscaped parks) or non-native species (e.g., naturalized game fish) should not be an objective of the NER plan.

Are the planning constraints consistent with Corps policies?

The planning constraints presented in the report should be supported by applicable Corps policies or other requirements of federal law. Stakeholder preferences that are not supported by Corps policy should not be identified as planning constraints for the NER plan. For example, complying with state or local law is not always a federal constraint. Generally, state and local laws are compatible with federal law and policy. However, there may be instances where state

and/or local laws are more restrictive than Corps policy or federal law. Where this is the case, constraints based on these laws should be clearly identified and may result in a locally preferred plan.

Are the assumptions and rationale for the future without-project conditions explicitly stated and are they reasonable?

These assumptions include changes to the hydrologic regime, development pressures, land use changes, sedimentation, water quality, hydrogeomorphic, or meteorological conditions. Since the future without project condition is what each alternative is measured against, it is very important to document the assumptions and rationale. Scenario-based evaluation of future without project conditions may be required when projected changes to the environment are difficult to predict and vary widely based on small differences in environmental parameters.

Does the report include a Conceptual Ecological Model (CEM)?

The CEM should be included with the report to provide a simplified representation of the ecosystem processes that the study will address. It should support the development of effective measures, alternative plan formulation, and monitoring/adaptive management.

Plan Formulation:

Has an adequate range of uniquely different alternatives been provided (small to large scale) and have the plan formulation strategies been clearly described?

The scale of alternatives should cover a broad range to allow for effective consideration of project effects and incremental benefits analysis. However, this will also be determined by the project authority (i.e., CAP projects likely to be smaller scale than GI studies) and site-specific conditions.

The alternative formulation strategies used should be described clearly and transparently.

Has an adequate justification been provided for measure/alternative screening?

Potential justifications for excluding measures/alternatives include: failure to meet minimum standards for the four P&G evaluation criteria - completeness, effectiveness, efficiency, and acceptability. The IWR Planning Manual (pp. 155-159) provides advice regarding use of the four P&G criteria for screening. Alternatives may be eliminated in the initial screening process before in-depth evaluations are performed, but the reasons for elimination should be presented in the report and should be adequate to support the planning and evaluation process.

Have the alternatives been described in sufficient detail?

Alternative plans should be described in sufficient detail to describe the measures proposed for implementation. Descriptions of alternative plans should clearly describe the size, scale, and materials of each component and also the associated benefits to ecosystem structure and function.

Plan Evaluation and Comparison:

Do the models used in the study meet the definition of planning models, as defined in EC 1105-2-412?

Per the EC, the definition of a Planning model is "models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision-making."

Have the models used in the study been certified/approved for use by the Ecosystem Restoration Planning Center of Expertise (ECO-PCX)

If not, request that the PDT coordinate with the ECO-PCX to initiate the certification process on models that have not been certified. Details on the model certification process are provided in EC 1105-2-412, and in the Delegation of Model Certification (2018) and Modification of the Model Certification Process and Delegation of Model Approval For Use (2017) memorandums. Note that project completed under the CAP authority do not require certified models to be used, although they are recommended.

Were the models used appropriately to calculate habitat units, and were the units annualized?

Habitat units should be calculated using an appropriate model and annualized over the period of analysis. The annualization should reflect the anticipated trajectory in the condition of the "with" and "without" project condition.

Were costs annualized appropriately?

Costs should be annualized using the appropriate interest rate and period of evaluation. The reviewer should also confirm that the average annual costs used in the CE/ICA include interest during construction, OMRR&R, monitoring and adaptive management, and Lands, Easements, Rights of Way, Relocations, Disposal Areas (LERRDs), as well as "Associated Costs" and "Other Direct Costs," consistent with the "NED Evaluation Procedures" outlined in Appendix D of ER 1105-2-100.

Are the costs of OMRR&R considered during plan evaluation comparison?

Do the cost of plans differ significantly in cost over time (first cost vs. O&M)? These differences should be clearly presented for use in the plan selection.

Are military and civilian airports within 10 miles of the project area identified and has appropriate coordination with the Federal Aviation Administration occurred?

Per 1105-2-70, 3-15, the PDT should all military and civilian airports within 10 miles of the project area and coordinate with the Federal Aviation Administration in order to avoid significant increase in wildlife risks to aviation and human safety.

Plan Selection

Is the NER Plan clearly identified?

For AER projects, the plan that reasonably maximizes AER benefits compared to costs, consistent with the Federal Objectives and Guiding Principles, and has been shown to be cost effective to achieve the desired level of output, is the NER Plan. The NER plan should be clearly identified in the report.

Is the recommended plan sufficiently described?

Description of the recommended plan should fully describe all features, costs, construction methods, environmental commitments, LERRDs, maintenance requirements, residual risk and uncertainty, and associated monitoring and adaptive management requirements.

Are the benefits of the recommended plan clearly described?

Are the benefits associated with the recommended plan adequately described including concise statements of significance, ecological model outputs, number of acres protected/restored, description of ecosystem changes. Be sure to include a clear justification statement.

Are the estimated costs and durations of monitoring and adaptive management in accordance with Corps guidance?

Monitoring begins upon completion of construction of a project, or a separable element of a project; and continues until success criteria are met. Within a period of ten years from completion of construction, monitoring may be cost-shared. Any additional monitoring required beyond ten years will be a non-federal responsibility. The ten years of cost-shared monitoring may be applied separately for separable elements of the project that are completed at different times (ER 1105-2-103 Chapter 6-8, e).

Is each separable feature of the NER Plan incrementally justified?

There is no Federal interest in cost sharing project segments or features that are not incrementally justified. Even though the benefits for the overall plan may exceed the costs, it is still necessary to demonstrate that each major segment or feature contributes net benefits to the overall restoration plan.

Does the NER plan primarily produce aquatic ecosystem restoration benefits?

The NER plan should primarily produce AER benefits as opposed to benefits from recreation, aesthetics, cultural resources, or hazardous and toxic waste clean-up (ER 1105-2-103, Chapter 6-8 b). Aquatic ecosystem restoration projects may include terrestrial buffer areas of limited width if supported by the specific project objective (1105-2-70, para 2-2 g.).

Does the report demonstrate that the project would provide restoration benefits to the general public rather than a few landowners?

For projects where the land on which the majority of the physical ecosystem restoration will occur is in the ownership of a single firm, individual, club, or association with restrictive membership requirements, it must be demonstrated clearly that the restoration benefits are in the overall public interest and that the benefits do not accrue primarily to the property owner (EP 1105-2-70 para 3-5)

Is there sufficient rationale for any recommended departure from the NER plan and has any deviation from the NER plan been identified for approval by ASA (CW)?

Typically if the district recommends a plan other than the NER Plan for aquatic ecosystem restoration, an exception request must be prepared and submitted to the ASA(CW) for approval (ER 1105-2-103 para 2-4. f. (5)(d)).

Are any proposed recreation features appropriate in type/scale relative to the ecosystem restoration purpose? Will recreation activities diminish the ecosystem restoration outputs?

Proposed recreation features must be adequately justified and consistent with guidance limiting the types of recreation features that may be cost-shared (EP 1105-2-70). Recreation development must be *ancillary* to the primary purpose, appropriate in scope and scale, and *must not diminish the ecosystem restoration outputs*. Recreation features must not increase the federal cost of the AER project by more than 10 percent without the approval of the ASA(CW). Recreation features are most appropriate when placed in areas used for construction staging, access, or along "edge habitats".

Is the real estate to be acquired consistent with the area required to protect the anticipated ecosystem restoration benefits, including consideration of potential future land use changes?

Aquatic ecosystem restoration projects will emphasize improving degraded ecosystem function and structure through engineering, as opposed to projects that rely on acquisition and protection to achieve project benefits. Project proposals that consist primarily of land acquisition are not appropriate. In general, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this level are not likely to be given high priority for budgetary purposes (EP 11-5-2-70, para 3-6.). If LEERD values exceed 25%, non-federal sponsor may need to voluntarily waive the LERRD costs.

V. REFERENCES

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CECW-P Memorandum, Subject: Modification of the Model Certification process and Delegation of Model Approval for Use.

CECW-P Memorandum, Subject: Model Coordination for Civil Works Planning Studies, 28 July 2023.

Engineer Circular 1105-2-412, Assuring the Quality of Planning Models

Engineer Regulation 1165-2-217, Civil Works Review Policy

Engineer Regulation 1105-2-103, Policy for Conducting Civil Works Planning Studies

Engineer Pamphlet 1105-2-70, Aquatic Ecosystem Restoration Civil Works Mission and Evaluation Procedures

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