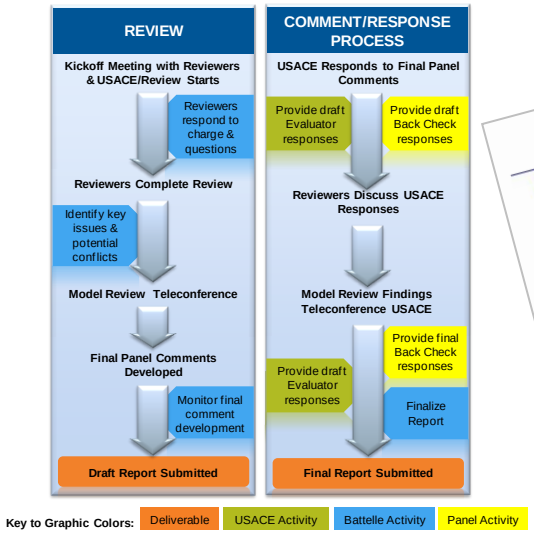
Revised Final Report
Assessment of Procedures and Results from USACE Quality Assurance Review of Environmental Planning Models Used for Ecosystem Restoration and Impact Assessment

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Headquarters and Institute for Water Resources

Contract No. W912HQ-10-D-0002
Task Order 00162
March 29, 2012



Errata

This revised final report on the assessment of procedures and results from U.S. Army Corps of Engineers (USACE) quality assurance reviews of ecosystem planning models has been submitted to correct formatting issues identified in the final report submitted on February 28, 2012. The content of the report has not changed.

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Submitted to:

Department of the Army
U.S. Army Corps of Engineers
Headquarters and Institute for Water Resources

Contract No. W912HQ-10-D-0002
Task Order 0016

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March 29, 2012

Battelle
The Business *of* Innovation

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Assessment of Procedures and Results from USACE Quality Assurance Review of Environmental Planning Models Used for Ecosystem Restoration and Impact Assessment

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models used by USACE and to make recommendations to ensure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works CW business programs."

Planning models are defined as any models and analytical tools that planners use to help define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of project alternatives and to support decision-making. USACE established policy requiring use of certified or approved models for all planning activities. Engineer Circular (EC) 1105-2-412, *Assuring Quality of Planning Models*, dated 31 March 2011, outlines the policy and procedures for review and certification/approval of planning models. This policy is applicable to all planning models currently in use, models under development, and new models. The goal of model review is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and have been reviewed in a manner compliant with the requirements of Office of Management and Budget (OMB) Final Information Quality Bulletin for Peer Review dated 16 December 2004.

Since 2005, when the policy requiring use of certified or approved models for all planning activities was first promulgated, review of 37 individual ecosystem planning models have been completed. The planning model quality assurance review process has since been refined and improved, resulting in the conduct of reviews that have satisfied USACE quality assurance needs in an effective and timely manner. The use of approved procedures and templates, development of a pool of reviewers, and conduct of planning model quality assurance reviews (referred to hereinafter as model reviews) by highly experienced technical individuals and project managers contributes to these efficiencies along with the dedicated support of subcontracted subject matter experts to meet deliverable deadlines and provide a high quality review. Based on experiences documented herein, the success of model reviews hinges on the positive team culture fostered within the review coordinators (i.e., Battelle or another USACE contractor), the Model Review Panel, and the USACE team.

The short-term value of model reviews is that they provide information that allows USACE to determine what improvements, if any, need to be made to a planning tool and whether to certify/approve the model or approach for an intended use (usually either for a single project or for a broader context-specific type of application). The long-term value of comments and recommendations generated from model reviews is that they provide a platform for continuous learning and improvement of planning tools. To ensure that the long-term value can be realized, Battelle conducted an assessment of comments, recommendations, and outcomes resulting from

completed reviews of 37 individual environmental planning models (25 completed by Battelle; 8 completed by Abt Associates; 1 completed by EA Engineering; and 3 completed internally by USACE).

Comments from reviews of 37 models were compiled in a comprehensive database and categorized according to model or approach, reviewer discipline, model assessment criteria, and significance level. Because the model reviews were executed by four different organizations and because the format in which comments are presented has changed over time, there were some differences in the metadata associated with each of the comments. Also, because individual review comments are not attributed to the individual comment authors, comments received for reviews conducted outside of Battelle usually could not be linked to expertise. Of the 418 Final Panel Comments in the database, 326 had a level of significance assigned to them, 281 were linked with the expertise of the individual developing the comment, and 105 were linked to specific model assessment criteria that relate to technical quality, system quality, and usability as defined in the *Protocols for the Certification of Planning Models* (EC 11-5-2-412). This resulted in analysis of subsets of comments in the database in some cases.

The overall number of Final Panel Comments varied by project and ranged from 3 to 55, with an average of 15 and median of 12 comments per model review. As expected, the number of comments is generally correlated with the number of model reviewers since the models are being reviewed from a variety of perspectives. The number of comments is also generally correlated with the complexity of the model, as more reviewers were typically engaged for the more complex models.

Across model reviews the greatest numbers of received comments were related to model documentation. This includes documentation of the model development, model testing and validation, data collection methods, and use of model spreadsheets/software and output. Clear documentation is critical for both users and reviewers and is particularly important to justify and support planning decisions based in part on planning model outputs.

Most model reviews also yielded comments regarding model testing and validation. Testing and validation of model performance is necessary to confirm that model outputs and resulting perceptions of differences between alternatives are credible and meaningful. Documentation of testing and validation results was frequently cited as necessary to help potential users understand the ability of models or methods to serve their intended or proposed uses.

Many model reviewers found model spreadsheets or software to be error-prone and difficult to use. The model reviews identified errors in spreadsheet/software calculations and recommended simplifying model codes, architectures, and interfaces. User documentation was also found in many cases to be lacking adequate information/guidance regarding the user-model interface, appropriate development of input data, and development/application of model outputs. To reduce the number of issues identified with model spreadsheets and software, reviewers recommended that programming/spreadsheet specialists work with model developers to: inform them of common errors; provide recommendations for ways to simplify the development, use, and maintenance of model spreadsheets/software; and perform a thorough check for errors prior to release for review by an independent Model Review Panel.

USACE has found model reviews to be of great value, resulting in identification and remedy of errors in automated computations, highlighting likely modes of misapplication/error, improving documentation practices among model developers and users, and bringing to light new information/data that could improve the credibility and quality of planning models used for planning of ecosystem restoration and preservation actions. The results of model reviews have led to the improvement of planning tools being used by USACE and either approval of models for limited or regional use, or certification of models for more widespread use across USACE projects. This ultimately has led to more credible analyses and greater confidence in USACE planning decisions regarding environmental restoration actions. Addressing issues early on in the process has resulted in decisions that are more technically defensible.

Based on findings summarized in this report, it would seem that this type of meta-analysis might be repeated periodically to ensure that lessons learned are being applied and ultimately contributing to steady improvements in the quality and efficiency of planning procedures. Likewise, it would seem that comments are bringing important issues to the attention of USACE that might inform the future improvement/development of planning tools.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AAHU	Average Annual Habitat Units
BEM	Benefit Evaluation Methodology
COI	conflict of interest
dbh	diameter at breast height
EC	Engineer Circular
ECO	Ecosystem Restoration
ECT	Electronic Calculation Template
EPW	Evaluation of Planned Wetlands
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic
HSI	Habitat Suitability Index
IEPR	Independent External Peer Review
MAV	Mississippi Alluvial Valley
NDA	Non-Disclosure Agreement
OCI	organizational conflict of interest
OMB	Office of Management and Budget
PCX	Planning Center of Expertise
PMIP	Planning Module Improvement Guide
POC	Points of Contact
QA/QC	Quality Assurance/Quality Control
RFP	request for proposal
SAM	Standard Assessment Methodology
SI	Suitability Index
SJNM	St. Johns-New Madrid
SOW	Statement of Work
UDP	Upper Des Plains
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Services
WAM	Waterfowl Assessment Methodology
WVA	Wetland Value Assessment

1 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models used by USACE and to make recommendations to ensure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for . . . USACE Civil Works business programs."

Planning models are defined as any 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. USACE established policy requiring use of certified or approved models for all planning activities in Engineer Circular (EC) 1105-2-412 *Assuring Quality of Planning Models* (which includes the *Protocols for Certification/Approval of Planning Models*), dated 31 March 2011 (USACE 2011). This document outlines the policy and procedures for review and certification/approval of planning models. The policy is applicable to all planning models currently in use, models under development, and new models.

As stipulated by USACE policy (USACE 2011), "A certified/approved model must stand the test of technical soundness and theory, computational correctness and usability and will be well documented." "The goal of model review is to establish that Corps planning products are theoretically sound, compliant with Corps policy, computationally accurate, based on reasonable assumptions regarding the availability of data, transparent, and described to address any limitations of the model or its use." The review must be conducted in a manner compliant with the requirements of Office of Management and Budget (OMB) *Final Information Quality Bulletin for Peer Review*, dated 16 December 2004 (OMB 2004).

The USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) has managed reviews of more than 36 techniques/models used for ecosystem restoration or impact analysis in USACE Civil Works Planning Studies. The March 2011 release of EC 1105-2-412 provides guidance on model certification and approval and procedures for ensuring the technical quality of USACE planning tools. USACE policy states:

> *Use of certified or approved models for all planning activities is mandatory. This policy is applicable to all planning models currently in use, models under development and new models. District commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification and approval of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products.*

USACE has indicated that reviews have significantly contributed to the improvement of tools and approaches used in the planning, design, and construction of projects. USACE intends to

use recommendations from completed model reviews to improve quality and efficiency of existing planning models and during the development of future models and approaches.

Since 2005, when the policy requiring use of certified or approved models for all planning activities was first promulgated, reviews of 37 individual ecosystem planning models have been completed. Although several organizations have conducted and contributed to the successful development and refinement of the model review process, the methods developed and used by Battelle are described and presented in the following sections. These methods may or may not be used by other organizations, and other organizations may have different but equally valuable insight into the successful conduct of model reviews.

Since 2008, Battelle has planned and conducted 11 model quality assurance reviews of 25 individual ecosystem planning models (4 projects involved the review of multiple models) to support the USACE model certification and approval process. Battelle uses established peer review protocols, as well as multiple teams of staff experienced in peer review processes, to support concurrent reviews, and incorporates all key areas of relevant technical expertise into model quality assurance reviews conducted for USACE. The success of the reviews can be attributed to the resources developed and standardized during the conduct of reviews over the past six years, including the development and application of standard operating procedures and templates related to panel recruitment, conflict of interest screening templates/practices, subcontracting practices, kick-off meetings, work plans, charge questions, reports, Final Panel Comment development/resolution practices, and findings meetings.

The quality of planning model quality assurance reviews (referred to hereinafter as model reviews) is strongly related to the level of experience of each expert on the Model Review Panels and the experience of the contractor review coordinator/manager. To ensure high quality reviews, the review coordinators seek out experts with specific expertise directly related to the purpose of the model or approach, such as planning, biology, economics, environmental science, hydrology, and engineering. Each panel member's review comments are documented, assigned a level of significance, and incorporated into the deliverable provided to USACE. When surveyed by Battelle after the completion of reviews, all panel members who responded indicated that their input to the review was well received and considered valuable. This feeling of positive contribution to USACE is critical to managing and reengaging panels of highly technical people from diverse backgrounds that have not worked together previously and in many cases may have not previously worked with/for USACE or the review coordinators.

In the course of managing the model reviews, as well as more than 50 Type I Independent External Peer Reviews (IEPRs) of USACE decision documents, Battelle has refined the efficiency, timeliness, and cost-effectiveness of the review process. As organizations coordinate more model reviews, they are able to gain insight into how USACE manages projects, how best to provide input that will benefit model certification and approval through the model review process, and how to select and manage panel members to meet schedules and deliver thoughtful, focused comments. Battelle also gathers suggestions for the sole intent of improving its review process by requesting formal feedback from members of the Model Review Panel through a panel survey at the close out of each project.

The model reviews discussed in this report were conducted for regional/local ecosystem planning models and methods developed or used by district offices during planning of environmental actions. USACE uses the results of these reviews either to certify/approve the model for general application (within documented limitations) by knowledgeable trained staff or to approve the model for single-use or study-specific application.

The objectives of this report, Assessment of Procedures and Results from USACE Quality Assurance Review of Environmental Planning Models Used for Ecosystem Restoration and Impact Assessment, are to:

- Document procedures and practices associated with the model review process (Section 2)
- Provide a summary and characterize the comments from model quality assurance reviews conducted to date (Section 3)
- Describe the components that facilitate a successful review environment (Section 4).

2 PLANNING MODEL QUALITY ASSURANCE REVIEW PROCESS

The successful management of a model review demands that a defined process be established and implemented to receive and synthesize timely and useful scientific input on the model and background materials. Since 2005, Battelle has developed and refined its process for planning and conducting IEPRs successfully that meets rigorous USACE guidelines and often exacting deadlines. This process has been adapted to model reviews and can be tailored to meet the specific needs of each review, the type of model, and the characteristics of review and background materials provided. The following elements and considerations are part of Battelle's model review process:

- Identify the model review implementation team composition, duties, and qualifications, and hold internal kick-off meeting
- Schedule and conduct model review kick-off meetings
- Develop protocols to screen for conflicts of interest
- Identify and select experts for the Model Review Panel
- Confirm with USACE that the selected model review candidates do not have any real or perceived conflicts of interest (COI)
- Develop the charge and charge questions for the model reviewers, including standard charge questions
- Provide the Model Review Panel with pre-briefing about expectations and instruct them to conduct the review
- Conduct a model review meeting to discuss review comments
- Prepare the draft Model Quality Assurance Review Report
- Discuss model review findings with the Model Review Panel, USACE model proponents, and project managers
- Finalize the Model Quality Assurance Review Report
- Prepare After Action Reports and lessons learned.

Ongoing activities throughout the process include:

- Manage the scheduling and the process management
- Identify key factors influencing cost and schedule
- Set up and maintain communications between the Model Review Panel and USACE project managers and model proponents, which may include districts, major subordinate commands, USACE laboratories, model developers, and/or Headquarters
- Perform quality assurance.

Table 1 shows the general technical approach currently being used by Battelle, and possibly other contractors, for model reviews. The following sections describe the general flow of work and coordination of responsibilities during the model review process, starting with the personnel responsible for implementing the process.

Table 1. Technical Approach for Conducting Model Reviews

Model Review Panel	Battelle or Other Contractor	USACE	Business Days from Contract Award or Review Document Receipt
	Kick-off Meeting		5
	Contractor provides draft schedule to USACE		
	Contractor submits draft charge (including questions) to USACE		
	Contractor provides COI questionnaire to USACE for comment		10
Contractor identifies and recruit reviewers and potential backup reviewers			15
	Contractor submits list of potential reviewers and backups to USACE for comment		
Contractor completes subcontracts with selected model reviewers			24
Contractor convenes kick-off meeting with Model Review Panel to discuss review process			27
Contractor convenes kick-off meeting with USACE and Model Review Panel to discuss model/method and address any initial questions about the model/method			
Model reviewers complete their individual reviews and submit comments			48

Table 1. Technical Approach for Conducting Model Reviews (con't)

Model Review Panel	Battelle or Other Contractor	USACE	Business Days from Contract Award or Review Document Receipt
	Contractor collates individual comments and identifies key issues as talking points for the model review teleconference meeting		50
Contractor convenes model review teleconference with Model Review Panel to discuss key issues/concerns identified during the review			51
Contractor provides directive to the Model Review Panel to develop Final Panel Comments for the model review report			52
Model reviewers submit draft Final Panel Comments for review			58
Final Panel Comments are finalized			63
	Contractor submits draft Model Review Report to USACE		70
	USACE provides draft Evaluator Responses to Final Panel Comments and comments on draft Model Review Report		80
Model Review Panel provides draft BackCheck Responses to USACE draft Evaluator Responses			86
Contractor convenes findings meeting for discussion of Model Review Panel review findings and USACE responses			88
	USACE provides final Evaluator Responses to Final Panel Comments		93
Model Review Panel provides final BackCheck Responses to USACE final Evaluator Responses			99
	Contractor submits final Model Review Report based on comments received from USACE and including final Evaluator and BackCheck Responses		107

It is important to realize that the key to conducting a successful and useful review is proper coaching from experienced review coordinators. All members of the Model Review

Implementation Team (the team subcontracted by USACE to conduct the review) should be trained through mentoring and participating in regular meetings to discuss lessons learned and to be brought up to date on the process. Prior to initiating the model review, members of the Model Review Panel should also be trained during a kick-off meeting to discuss the model review process and specific, detailed training at the beginning of each critical step in the model review process. The elements of a good model quality assurance review should include:

(1) Assessment of the reviewers' competencies
(2) A general assessment of the overall quality of a method or model and its ability to serve its intended purpose
(3) Identification and justification of any major concerns or missing elements
(4) Identification and justification of any minor concerns or missing elements
(5) Recommendations that are reasonable and implementable for resolving any issues identified
(6) Opportunities for discussion of the issues to attempt to resolve any misconceptions or differences of opinion
(7) A positive team mentality based on mutual respect between the reviewers and the model developers.

2.1 The Model Review Implementation Team

The Model Review Implementation Team consists of highly trained review management experts who are collectively responsible for the seamless execution of a model review from start to finish. Battelle's model review management team consists of a highly qualified Program Manager and experienced management teams, a large pool of technical and support staff, and established model review processes and standard operating procedures. Table 2 shows Battelle's model review management team by labor category and responsibility. This approach has allowed Battelle to meet USACE model review needs and balances firm timeliness and rapid response, management of concurrent reviews, cost-effectiveness, assurance of objectivity and confidentiality, and maintenance of a high level of technical quality. This team composition ensures that there are no delays in on-time delivery due to sickness, vacations, or unexpected events involving project team members.

The Program Manager is responsible for oversight of Project Managers and for monitoring overall performance across all tasks. The Program Manager is also responsible for quality control of outgoing products and supervises and reviews all work plans and other deliverables for technical quality prior to submission to USACE. As the persons most familiar with the needs of specific review projects, Project Managers set performance requirements and are accountable for performance of their own tasks. Project Managers have day-to-day supervisory authority over the conduct of tasks and monitor performance of Battelle staff and model reviewers. They also alert the Program Manager to any potential project risks and possible mitigations to address those risks.

Table 2. Model Review Implementation Team

Primary Labor Category under W911NF-07-D-001 or W912HQ-10-D-002	Duties/Assignments
Program Manager	Oversees all aspects of the project/contract, reviews deliverables for consistency with contract and USACE IEPR guidance. Principal point of contact with USACE Headquarters/PCX on all project/contract management and administrative matters.
Project Manager	Provides day-to-day day management of multiple peer reviews, tracks schedule, manages deliverables, and ensures budgets are maintained. Principal point of contact with USACE Project Manager.
Project Assistant	Works under the direction of the project manager or recruitment lead. Assists with work plan development, panel recruitment, posting documents, note-taking during teleconferences.
Reviewers	Conducts technical review of decision documents, provide written comments, attend teleconferences, develop Final Panel Comments, review Final IEPR Report, and participate in comment/response process. Travel is sometimes required. Reviewers are subcontracted experts and cover disciplines such as planning, biology, economics, environment, hydrology, and engineering.
Recruitment Lead	Identifies and recruits subject matter experts for the Model Review Panel, whose expertise is in alignment with the expertise required to develop the model under review.
Quality Assurance Officer	Performs quality assurance, technical and editorial review, and provides administrative and clerical support for project management.
Administrative Support Team	Executes subcontracts, helps track budgets, and processes invoices.

Project Assistants are cross-trained individuals assigned to work on limited segments, components, or parts of model reviews, and are assigned to a specific Model Review Implementation Team in order to simultaneously conduct recruitment, work plan development, charge question development, and subcontract management activities immediately following project initiation or notice to proceed. Battelle also has a team of contracts and administration staff (Contracting Officer, Accounts Payable, etc.) who understand government procurement regulations and how they are implemented for contracts under which model review projects are conducted. This structure allows for projects to start up quickly and for various components of a

model review to be conducted simultaneously, which is especially important when under time constraints.

2.2 Planning

Battelle has developed master schedules (see Appendix) for model reviews based on a projected contract award date or the estimated review start date if the review materials are not available at the time of contract award. This schedule has been critical to successful planning and execution of the model review, and to providing the PCX realistic timeframes for review completion and final report submittal. In addition, if only a draft scope, draft review documents, or no review documents are available at the time the request for proposal (RFP) is released, potential contractors are offered an opportunity to ask questions about the panel and review requirements and may make recommendations for expertise based on previous experience recruiting panel members. Finally, contractors may ask questions about the model (including size and intricacy), the volume of review and background materials, and when they are expected to be available. These preliminary discussions allow for an expedited proposal process (i.e., no delays as a result of questions on the scope) and a quick start-up if a contract is awarded, and may prevent problems negotiating future contracts.

The first activity following receipt of a planning model review contract award is a kick-off meeting between USACE (PCX and model proponents) and the review coordinators (see Section 2.2.6). The purpose of the meeting is to review the suggested schedule (based on the master schedule), determine whether there are any client-critical deadlines to be aware of, discuss and normalize understandings of the model review process, address any questions regarding the scope (e.g., clarify expertise areas needed for panel members or the level of system quality review), and inquire whether there are any model/method-specific charge questions that will need to be addressed. Any revisions to the schedule are submitted as part of the final Work Plan. Due dates for milestones and deliverables are based on the date when the review materials are available. The schedule can be changed if there are conflicts with the selected panel's availability. If changes are necessary, the PCX is notified and a revised schedule is generated and distributed.

Working closely with the client (i.e., USACE), the review coordinators provide suggestions on the review approach that seems optimal based on the nature and complexity of the model, level of technical review needed, schedule, and resources available. The tasks defined in the USACE Statement of Work (SOW) are then incorporated into a detailed Work Plan (see Section 2.2.5) that defines the individual steps of the model review process by task, level of effort, and schedule to ensure timely review. The Work Plan also contains the number of experts and required skills for the Model Review Panel, review coordinator staff and Model Review Panel member (i.e., subcontractor) responsibilities, and lines of communication among USACE, review coordinator staff, and panel members.

One of the greatest challenges of the model review planning process (and Work Plan preparation) has been associated with attempts to account and plan for variability in access to the model and background materials. In many instances, awards for review contracts have been issued in anticipation of the final review package and, in some cases, the model itself being completed and available by the time the Model Review Panel was to be convened. While this

sort of "just-in-time" delivery of products to be reviewed can be achieved, it may also contribute to delayed initiation of reviews and contracts. Ideally, the model and background materials are available when the contract is awarded, which allows for the most efficient review. USACE review materials are made available via the USACE public file transfer protocol site or are transferred to the review coordinators using a secure file exchange server. Upon receipt, the review coordinator conducts an inventory to ensure that all documents are received, provides USACE the list of the documents received, and confirms that no review materials are missing.

2.2.1 Period of Performance

USACE provides a draft timeline for the schedule in the scope of work. Schedules in proposals are often tentative because they are based on anticipated contract award date, projected availabilities of the Model Review Panel and USACE model proponents, and other variables affecting timeframes for completing activities and submitting the final report. Battelle's proposals therefore include a statement that the scheduled initiation of actual review activities will be revised as needed to reflect the actual contract award date or date when the model review materials become available. To expedite revisions without compromising the quality of the model review process, Battelle relies on a master schedule template that gives detailed "days to complete" for each activity (see Appendix). Schedule revisions are influenced by the following considerations: contract award date, expected or actual date of availability of the model and background materials, and any critical USACE deadlines that affect the timing of the model review.

The model review process can take from 11 to 16 weeks (i.e., 55–80 working days) from contract award and receipt of model and background materials to delivery of the draft Planning Model Quality Assurance Review Report. The amount of time to conduct a model review varies depending on the amount of review materials and whether there are any critical deadlines that need to be met. Occasionally, a model review is constrained by a fixed deadline. If the model and background materials are not available when necessary to deliver the draft Planning Model Quality Assurance Review Report on time, the number of days to complete each task in the master schedule is examined and the time to complete each task to meet the deadline is adjusted. The benefits of a review are maximized when model reviewers have more time to review the materials provided (i.e., 21 working days instead of 15).

The timeline associated with development and delivery of USACE responses to reviewer comments and submission of the final report takes an additional 3 to 7 weeks (i.e., 15–35 working days), depending on what is expected of the final deliverable. Typically, the comment-response process takes approximately 3 weeks; the final report contains the Final Panel Comments in their original form, and the outcome of model review findings discussions (discussion and reconciliation of review comments and USACE responses) are provided as teleconference notes. Under the new process, the findings discussions are formally documented in the final report, which requires a longer period of time (see Section 2.6).

To ensure that the period of performance is sufficient to meet the review deadline, Battelle defines the period of performance end date as two to three months beyond the delivery of the final Planning Model Quality Assurance Review Report (based on the master schedule). This

approach benefits the model review process by allowing sufficient time to allow potential schedule delays caused by the following examples:

- Delayed availability of model and background materials
- Negotiating subcontracts with members of the Model Review Panel
- Contract modifications (for the review coordinators and the members) to extend the period of performance, which may interrupt the model reviewers' work
- Revisions to the model or background materials being reviewed
- Delayed feedback on the COI criteria and the recommended panel
- Rejection of a model reviewer due to additional COI identified by USACE after panel selection
- Panel requests for additional information during the review
- Difficulties in coordination of the panel and USACE schedules for teleconferences
- Delays in model proponent responses to Final Panel Comments provided in the draft Planning Model Quality Assurance Review Report
- Panel member conflicts with revised schedules
- A need for additional teleconferences
- Unforeseen circumstances (e.g., natural disasters, illness, and bereavement leave).

2.2.2 Charge to the Model Review Panel

The review coordinators work with the PCX to develop the charge to the Model Review Panel to conduct the review, which includes charge guidance and questions that focus the model review. The charge questions were historically developed by Battelle based on the assessment criteria in the *Protocols for the Certification of Planning Models* (USACE 2011), Section 3, Model Certification and Approval, and submitted to the ECO-PCX for comment/approval. After the first few reviews, the ECO-PCX developed a generic list of charge questions (Figure 1) based on the assessment criteria in the updated EC 1105-2-412 (USACE 2011); these generic charge questions are used to develop draft and final project-specific charge questions and guidance for conducting the model review. The charge to the model reviewers defines the objectives of the model review and provides instructions on the specific input sought. Figure 2 gives an example of the general charge guidance provided to the model reviewers. The actual number of charge questions included in the charge to the model reviewers varies between reviews depending on the scope of review, type of model to be reviewed, and the review materials provided.

General Questions

1. Are the model's design objectives and intended uses clearly communicated?
2. To what extent does the model meet the expressed design objectives?
3. To what extent is the model suitable for the expressed intended uses?

Technical Quality

4. Comment on the quality of the model's technical documentation.
5. Comment on the technical quality of the model relative to its expressed design objectives.
6. Comment on the temporal and spatial granularity with which the model is designed to be applied.
7. Comment on the geographic range/applicability of the model.
8. Comment on the degree to which the assumptions and limitations of the model are clearly communicated.
    a. Comment on the degree to which apparent limitations impact the ability of the model to be used for characterization of system/habitat resources.
    b. Comment on the degree to which apparent limitations impact the ability of the model to be used for planning and forecasting of project-related impacts.
    c. Please provide recommendations for resolving or overcoming identified limitations.
9. Is the model based on well-established contemporary theory?
10. Does the model adequately emulate or otherwise address the suite of critical ecosystem attributes necessary to characterize system/habitat resources?
11. Does the model effectively allow for reasonable variation of variables critical to the intended uses (i.e., application of the model during planning of water resource and restoration activities)?
12. Comment on the precision and accuracy of the model outputs and identify which variables/factors have the greatest impact on model precision and accuracy.
13. Comment on sensitivities of the model and identify the variables/factors to which the model is most sensitive.
14. Are the input requirements of the model evident to the user (i.e., types as well as accuracy and precision)?
15. Is it evident to the user how the inputs are used by the model?
16. Are assumptions critical to valid application clearly identified and characterized such that violation of a critical assumption would become apparent?
17. Comment on the degree to which model assumptions might invalidate the model's use for specific applications.
18. Comment on the degree to which the model facilitates/accommodates uncertainty and risk analyses.
19. Comment on the degree to which the model can be used as a tool to forecast conditions anticipated to occur during the design lifecycle of a water resource and restoration activities project (i.e., from 1 to 50 years).
20. Comment on the degree to which the model delivers information adequate for the purpose of supporting determinations of compensatory mitigation.
21. Are the formulas used in the model(s) correct?
    a. Are model computations adequately documented?
    b. Are model computations correct throughout the document?
    c. Are model computations (mathematical logic) appropriate?
22. Comment on the degree to which the model is inconsistent with USACE policies and accepted procedures.
23. Comment on the degree to which the model is configured to accept modified assumptions and inputs regarding future global events such as, but not limited to, global climate change.

System Quality

24. Comment on the degree to which the model has been tested for errors.
25. Comment on the capacity of the model to inform users of erroneous or inappropriate inputs.
26. Is the rationale for the selection of the supporting software tool/programming language and hardware platform adequately described?
27. Is the supporting software tool/programming language appropriate for the model?
28. Can data be readily imported from/into other software analysis tools?
29. Are error checks built into the model?
30. Does the model work using both sensible and non-sensible data?
31. Comment on the degree to which post-audits of model applications are documented (i.e., documentation of a validation process whereby statistical comparisons of conditions resulting from a planned action/project are made to model outputs produced during the planning of the action/project)? If so:
    a. do results of the validation process indicate the model's tendency to reasonably characterize existing conditions;
    b. do results of the validation process indicate the model's tendency to reasonably forecast future conditions; and
    c. what model outputs were found to most greatly deviate from actual conditions (please comment on the likely cause of the deviation if possible)?

Usability

32. Comment on the model's ease of use.
33. Comment on the model's practicality and application/input requirements.
34. Comment on the availability of the data required by the model.
35. Comment on the understandability of model output(s).
36. Comment on the transparency of model output(s).
37. Comment on how useful the model is for characterization of near-term conditions.
38. Comment on how useful the model is for characterization of future conditions.
39. Comment on the usability of the model for selecting the best course/plan of action.
40. Is user documentation user friendly and complete?
41. Are the models transparent and do they allow for easy verification of calculations and outputs?

Figure 1. Generic Model Review Charge Questions

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview assessment of the model focusing on your areas of expertise and technical knowledge. Use the Charge Response Form provided when answering the questions.
2. Evaluate the soundness of the model as applicable and relevant to your area of expertise. Comment on whether the model effectively represents the system being modeled and how the model will be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to perform as intended.
5. Offer suggestions for future improvements that could be considered by USACE but are not necessary for certification at this time.
6. Panel members may contact each other or the USACE model proponents during the review with questions and information requests. However, the Battelle Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org), and Program Manager, Karen Johnson-Young (johnson-youngk@battelle.org), should be copied on all correspondence.
7. In case of media contact, notify the Battelle Program Manager, Karen Johnson-Young (johnson-youngk@battelle.org), immediately.

Your name will appear as one of the members Model Review Panel. Your comments will be included in the final Planning Model Quality Assurance Review Report, but will remain unattributed. The final Planning Model Quality Assurance Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) no later than *December 2, 2011*.

Figure 2. Example of Charge Guidance Provided to the Model Review Panel

2.2.2.1 Prepare and Finalize Charge to Model Reviewers

The review coordinators prepare and finalize the charge to the Model Review Panel based on technical direction received from USACE and guidance provided on the process and evaluation criteria for model reviews in EC 1105-2-412 (USACE 2011). This may include any or all of the following steps:

1. Model reviewers determine whether model purpose/objectives are clearly identified and whether the model described is meeting its intended purpose/objectives.
2. Based on their review of model documentation, reviewers evaluate the technical quality of the models:
    a. Is the model based on well-established contemporary theory?
    b. Is the model a realistic representation of the actual system?
    c. Are the analytical requirements of the model properly identified and does the model address and properly incorporate these analytical requirements?
    d. Are assumptions clearly identified, valid, and support the analytical requirements?
    e. Are USACE policies and procedures related to the model clearly identified, and does the model properly incorporate USACE policies and accepted procedures?
    f. Are the formulas used in the model correct, and are the model computations appropriate and done correctly?
3. Model reviewers evaluate system quality (e.g., by running test data sets or reviewing the results of beta tests) to determine:
    a. Is the rationale for selection of supporting software tool/programming language and hardware platform adequately described, and is the supporting software tool/programming language appropriate for the model?
    b. Are the supporting software and hardware readily available?
    c. Was the programming done correctly?
    d. Has the model been tested and validated, and have all critical errors been corrected?
    e. If applicable, can the data be readily imported from/into other software analysis tools?
4. Model reviewers evaluate the usability of the model to:
    a. Examine the data required by the model and determine the availability of the required data
    b. Examine how easily model results are understood
    c. Evaluate how useful the information in the results is for supporting project objectives
    d. Evaluate the ability to export results into project reports
    e. Determine whether training is readily available
    f. Determine whether user documentation is available, user friendly, and complete
    g. Determine whether adequate technical support is available for the model
    h. Determine whether the software/hardware platform is available to all or most users
    i. Determine whether the model is easily accessible

j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

Once the draft charge to the Model Review Panel has been developed, it is submitted to USACE for review and finalized based on technical direction received from USACE. Each model reviewer receives a charge to guide his or her review of the model documentation and software (if software is provided). The charge includes an assessment of any of the criteria listed above that are relevant to the review. Model reviewers are asked to respond to specific charge questions or directives regarding the assessment criteria that are critical for planning model certification or approval as described in EC 1105-2-412 (USACE 2011).

2.2.3 Conflict of Interest Protocols

It is critical that both the organization conducting the model review and the subject matter experts participating in the review be free from conflicts of interest to ensure the objectivity and integrity of the results of the model review. Candidates for the Model Review Panel are screened for COI based on relevant policy and guidance from the National Academies (May 2003) and OMB (December 2004).

2.2.3.1 Conflict of Interest

In order to provide an objective and independent model review, the organization responsible for conducting a model review must be free from both perceived and actual COI, including any past, current, or future financial interests or involvement in the subject project. These qualifications are critical for the results of the model review to withstand scrutiny. Therefore, for each model review, the review coordinator must actively demonstrate that his or her organization is free of organizational conflict of interest (OCI).

At Battelle, after a new scope is received from USACE, it is entered into Battelle's project/proposal management system and a request for an OCI analysis is submitted by the Battelle Project Manager to the Corporate Scope Clearance Office. This office conducts an electronic search of Battelle's database for similar activities (projects, proposals, etc.) based on the new scope description, specific key words, site information, type of work being performed, and other client information. If a previously cleared scope is changed, (i.e., RFP scope of work changes), it is cleared again as a new scope. The Corporate Scope Clearance Office sends the results of the analysis to the Project Manager to review and respond. A formal response is required that indicates "there are no conflicts with the proposed project" or if a potential conflict is identified, the Corporate Scope Clearance Office notifies the business unit whose activities appear to potentially conflict and assists in the analysis and resolution of potential conflicts.

In addition to the scope system, for any specific model review project, all Battelle staff members identified to work on the project are obligated to indicate if they may have a conflict. As an additional safeguard, each staff member signs an employment agreement that obligates him or her to protect information received from third parties during and after the staff member's employment with Battelle.

2.2.3.2 Subcontractor Conflicts of Interest

Experts selected to serve on a Model Review Panel must sign a COI Inquiry Form as part of their subcontract agreement. They must either confirm that they have no known existing or potential conflicts of interest associated with the task, or disclose in writing all known existing or potential conflicts of interest associated with the task.

Under Battelle's model review management approach, all model reviewer subcontracts include a Non-Disclosure Agreement (NDA). Furthermore, reviewers are instructed on how to characterize their participation in the model review in their résumés and what to do in the event of a media inquiry.

Per guidance from the *Civil Works Review Policy* (USACE 2010), the NDA clause specifies:

> *This information is distributed solely for the purpose of pre-dissemination review under applicable information quality guidelines. It has not been formally disseminated by USACE. It does not represent and should not be construed to represent any agency determination of policy.*

Furthermore, the Terms and Conditions of each subcontract agreement states:

> *Subcontractor further agrees not to disclose, without Battelle's prior written approval, any such information or data. Such data and information shall be the sole property of Battelle.*

On the advice of USACE Headquarters, the review coordinators recommend that panel members include text similar to the following in their résumés:

> *[Name] was selected to participate in the model review panel to review the [Name of Model] for the USACE [Name of PCX] Planning Center of Expertise as a subcontractor to [Name of Review Coordinator]*.

During the Battelle kick-off meeting, model reviewers are instructed that if they are contacted by the media, they are required to inform Battelle at once, and Battelle then immediately notifies USACE via e-mail and follows up with a telephone call.

At the request of the PCX or model proponents, for models that are highly controversial and visible, panel members are required to sign both project-specific and subcontract agreement NDAs.

2.2.4 Model Reviewer Panel Recruitment

The process for selecting panel members is very labor intensive, requires significant experience in knowing where to search for panel members and how to screen them, and must be done quickly to meet the rigorous deadlines of the model review process. The panel recruitment process consists of:

- Developing technical criteria for selecting the candidate model reviewers and COI criteria to screen for potential or actual conflicts

- Searching for candidates using standard sources (business referrals, previous reviewers, advertisements in professional publications, and targeted Internet searches; Battelle also uses a database of experts developed for conducting model reviews and IEPRs)
- Identifying additional sources if needed
- Contacting the candidates via e-mail to conduct a preliminary screening on interest, technical qualifications, and availability
- Requesting that candidates complete the detailed technical screening form and COI form
- Evaluating the submitted technical and COI screening forms for technical qualifications, potential COI, and availability.

For each model review, the review coordinator recruits a panel of experts who meet the technical and professional requirements described in the SOW provided by USACE. Recruitment is conducted following procedures described in ECEC 1165-2-209 (USACE 2010) and in accordance with OMB (2004). Supplemental guidance on evaluation for conflicts of interest is obtained from the *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports* (The National Academies, 2003).

2.2.4.1 Selection Criteria and COI Screening

The intended application of the model to be reviewed forms the basis for defining the criteria for selecting candidate panel members. Battelle contacts candidates to evaluate their technical skills, potential COIs, availability, and hourly rates before selecting the project-specific number of experts to serve on the Model Review Panel. Selection criteria are clarified and revised in consultation with USACE. The selection criteria used to identify candidate panel members are documented in an appendix to the Work Plan.

Battelle also includes a detailed COI screening questionnaire in recruiting documents. USACE reviews, provides input to, suggests changes to (if needed), and approves the COI list before it is sent to the candidate panel members. COI questions provide a means of disclosure, and help better characterize a potential candidate's employment history and background. Providing a positive response to a COI screening question does not automatically preclude a candidate from serving on the panel. For example, a question always listed on the COI screening questionnaire is participation in previous USACE technical peer review committees and other technical review panel experience. A positive response to this question could be considered a benefit.

The National Academies (May 2003) states that "The term COI means something more than individual bias. There must be an interest, ordinarily financial, that could be directly affected by the work of the committee." The National Academies emphasizes that COI applies only to current interests and not to past or future possible interests. However, the COI questionnaire that Battelle sends to candidate panel members includes questions about past involvement in the subject project or related projects, in addition to questions regarding current interests. Review coordinators and USACE are both very aware that public perception and perceived COI are important, particularly because planning decisions for projects that are highly visible or sensitive in nature are based in part on planning model outputs. Battelle also inquires about potential future COI, because it is important to know if a particular firm or individual intends on bidding

on a future project whose implementation may depend, at least partially, on the results of the model review.

Candidates must also disclose their travel and vacation schedules during the period of the review process. Dates when they will be completely unreachable or out of town, but available by phone and e-mail during specific hours, are compared to the review schedule to ensure that deliverable and teleconference meeting dates are not affected. If a candidate has a scheduling conflict with a deliverable or teleconference meeting date, Battelle confirms whether the candidate will be able to meet the deliverable date or participate in the meeting before eliminating him or her from consideration for the model review.

2.2.4.2 Identifying Candidate Model Reviewers

Once technical requirements are defined, Battelle uses several reliable and successful methods to quickly identify candidate model reviewers: recommendations from business colleagues, previous reviewers, advertisements in professional publications (such as the American Society of Civil Engineers monthly magazine, *Civil Engineering*), targeted Internet searches (e.g., professional society websites), and a Battelle database. The Battelle database contains contact information on hundreds of technical experts in nearly 30 disciplines, and is continuously being updated with each IEPR and model review project. Battelle typically identifies the majority of candidate model review experts through referrals from experts with whom relationships have been developed over the years.

Ideally, for the recruitment process to be most efficient, the model and background materials should be available when the contract is awarded. Sometimes this is not the case and recruitment uses a projected date for model availability. The benefits of having the model and background materials available prior to beginning recruitment include the ability to:

- Efficiently coordinate the review schedule with model reviewer availability
- Refine technical qualifications based on the model and background materials
- Develop COI screening criteria based on the model and background materials
- Minimize the need to replace model reviewers due to availability conflicts that arise when schedules are revised as a consequence of delayed model and background material availability.

The panel recruited for each model review generally has three or four subject matter experts, but may have as many as six, depending on the technical needs of the review. Three or four reviewers are optimal for coordination. Battelle typically identifies up to twice as many qualified experts as are needed on the panel: one primary expert in each required subject area, and one backup expert. Primary and backup experts are identified for as many disciplines as possible; ideally, the backup expert is as qualified and available as the primary expert.

Backups are important because they allow the review coordinator to quickly secure a replacement if the selected expert cannot serve on the Model Review Panel because of schedule conflicts due to a change in the availability of review documents, illness, an undisclosed COI, or failure to negotiate a subcontract. There is a nominal additional cost for recruiting backup

reviewers, but this is a worthwhile investment because it ensures that there are no delays in the schedule.

Identifying both primary and backup experts is a quality control function that has proven valuable when the primary expert has needed to be replaced. When this has occurred, Battelle has been able to quickly move the backup expert into the primary role with no impact on the review schedule. As a recent example, one panel member had to have emergency cancer surgery after he had started the review. Battelle contacted the backup reviewer, initiated a subcontract as expeditiously as possible, and brought the reviewer up to speed so that the schedule would not be compromised.

When selecting the final Model Review Panel, Battelle ensures that no more than 50 percent of the panel consists of previous USACE employees, with a minimum five-year separation from their employment with USACE. A minimum two-year separation from USACE is followed for economists or plan formulators because of the specific requirements for these two categories.

2.2.4.3 Selecting Panel Members

USACE reviews the credentials, technical expertise relative to the model, and brief biographies of the primary and backup candidates selected by review coordinators for the Model Review Panel. The USACE review allows the model proponents to make the review coordinators aware of any problems (focused exclusively on COI) with a specific reviewer that may affect the final selection for the Model Review Panel. For example, USACE may be aware that an individual or his or her firm has a COI that was not identified during the COI screening process. Perceived or potential bias should not be considered a reason for eliminating an expert from being selected. Potential sources of bias are not necessarily disqualifying for purposes of committee service. Bias is taken seriously and there must be documented evidence (e.g., public statements) to remove someone from a panel because of bias.

Once USACE confirms that no proposed reviewer has an identifiable COI, the final selection is made for the subject matter experts that will serve on the Model Review Panel from the candidate group of qualified primary and backup reviewers whose expertise and experience best match the selection criteria described in the Work Plan.

2.2.4.4 Panel Subcontracts

Battelle sends each primary panel member a scope of work that includes activities for the project, a request for quotation, and a COI inquiry form. Upon receipt of the panel members' written quotations indicating willingness to participate and the absence of a COI, Battelle establishes a contract with each panel member at agreed-upon rates and hours to secure participation.

The scope of work for each panel member consists of:

- Participation in a Battelle kick-off teleconference meeting
- Participation in a USACE kick-off teleconference meeting with the model proponents and Battelle
- Review and assessment of the technical quality, system quality, and usability of the model and preparation of individual written comments

- Participation in a model review teleconference to discuss findings and agree on a list of key topics/issues that will form the model review Final Panel Comments and be presented in the draft Planning Model Quality Assurance Review Report
- Preparation of the model review Final Panel Comments
- Review of the draft Planning Model Quality Assurance Review Report before it is submitted to USACE
- Review of USACE draft Evaluator Responses to Final Panel Comments provided in the draft Planning Model Quality Assurance Review Report
- Participation in a teleconference with USACE to discuss model review findings and recommendations for resolution
- Preparation of final Back Check Responses to USACE final Evaluator Responses to Final Panel Comments for inclusion in the final Planning Model Quality Assurance Review Report (this task has been added recently and is being used for current model reviews)
- Review of the final Planning Model Quality Assurance Review Report before it is submitted to USACE
- Provision of additional technical support as directed.

The level of effort for each model reviewer to complete a review is approximately 80–120 hours to complete all tasks from the kick-off meeting to the finalization of the Planning Model Quality Assurance Review Report. On average, the time required for most model reviewers to complete a review is approximately 95 hours, but may vary depending on the size and complexity of the model and the volume of background materials provided for the review. Most reviews require approximately 60 hours for model review and charge question response, 3 hours for the kick-off meetings, and 30 hours for teleconferences, preparation of Final Panel Comments, report reviews, and the conduct of other activities as listed above. In some cases the exact number of pages for model documentation and background materials is not available before Battelle's proposal is developed; therefore, a standard number of hours must be used to calculate the total number of hours needed by the panel to conduct the review. Model reviews involving a review of spreadsheets or software typically require a greater level of effort for the spreadsheet auditor or software programmer.

In general, it is preferable to use "new" reviewers to avoid any public perception of bias from reviewers who have participated in multiple USACE reviews. However, in Battelle's experience, having one expert with previous review experience on each Model Review Panel can help educate the other panel members on the process, resulting in a smoother review. Also, on projects that have very tight schedules, the most reliable way to meet such schedules is to use a panel that includes experienced reviewers who have worked with Battelle and are familiar with the model review process.

2.2.5 Work Plan

Several years ago Battelle recommended that USACE include work plans as part of the scope of work for IEPRs and model reviews. Work plans, required by Battelle's Quality Assurance Unit for all Battelle projects, provide specific details associated with the project scope of work to guide the Model Review Implementation Team and ensure that the project is executed according

to the scope, within budget, and on an approved schedule. Work plans have become standard for all model reviews conducted by Battelle, and require approval by USACE. The model review Work Plan consists of:

- Background, objectives, and scope of work
- Methods and technical approach
- Quality assurance/quality control (QA/QC) procedures
- Reporting
- Schedule
- Project organization
- Communication
- Staffing plan
- Revised schedule based on the contract award date
- Appendices: technical and professional requirements for the Model Review Panel, the potential exclusion criteria for COI, and the charge to the Model Review Panel.

USACE provides comments on the draft Work Plan submitted by the review coordinator, including the draft charge questions in the Work Plan appendix. Most USACE SOWs reference a teleconference with the USACE Project Manager to discuss comments on the Work Plan; however, this teleconference has only been requested once. Comments on the Work Plan are received in track changes to the draft Work Plan, all comments are addressed, and a final Work Plan is submitted. This Work Plan is not revised unless there is a contract modification affecting the scope of work, or there are significant changes to the schedule that would necessitate submission of a revised final Work Plan. Changes to the schedule are discussed with the PCX and model proponents and documented in a new schedule that is typically distributed via e-mail.

2.2.6 Kick-off Meetings

Communication is key to successfully conducting time-critical model review projects. Battelle schedules and facilitates four kick-off teleconferences to ensure that all parties—Battelle, USACE, and the Model Review Panel—understand the project, are familiar with the model review process, and are prepared to meet the model review schedule. The first kick-off meeting is held with the Battelle staff who will work on a given project to review staffing, budget, and schedule. A project kick-off meeting with the key Battelle staff (Program Manager, Project Manager, and Recruitment Lead) and USACE is also held to allow Battelle to ask questions about the project prior to developing the Work Plan and charge to the model reviewers. This meeting is critical to USACE and Battelle for developing a mutual understanding of the process, deadlines that must be met, and model details. The project teams for both USACE and Battelle are introduced, the model review process is explained in detail, the availability of the model and background materials is discussed, the panel requirements and level of effort are reviewed, and the schedule is discussed in detail.

Once the Model Review Panel has been selected and is under contract, Battelle holds a kick-off teleconference with the panel to discuss the model review process and schedule and to review the expectations of the panel, including non-disclosure of the project during the review. The Model

Review Panel is also informed that results of the review may be used by USACE to determine whether the model will be certified for widespread use or approved limited use on a specific project or set of projects. Finally, the Model Review Panel and Battelle participate in a meeting with USACE staff, including the Project Manager and the PCX representative, and the model proponents, who provide a description of the model and any challenges of which the Model Review Panel should be aware. This meeting also allows time for the Model Review Panel to ask any preliminary questions they may have about the model. This meeting represents one of the few occasions when the Model Review Panel and the model proponents communicate directly with one another; direct communication between the Model Review Panel and any USACE staff occurs only with Battelle facilitation to ensure that the independence of the panel from the agency is not compromised.

2.3 Conduct Model Review

The model review process begins with the kick-off teleconference with review coordinators and the model reviewers to discuss the review process, schedule, and communications. Prior to the meeting, the members of the Model Review Panel receive copies of the model software (if software has been developed), model documentation, background materials (if provided), and EC 1105-2-412, *Assuring Quality of Planning Models* (USACE 2011). Battelle sends these materials electronically. USACE provides these documents to the review coordinators either via its file exchange site or the review coordinator's secure file transfer site. Battelle also sends the panel members the charge guidance and questions, instructing them to undertake the review and outlining the steps and deadlines. Working with USACE, the review coordinator responds to any of the model reviewers' questions or information requests during the review process.

The charge to the model reviewers is generally the same (with the possible exception of some minor differences in the charge questions) regardless of whether the model being reviewed is a limited use model or is being certified by USACE for widespread use. The difference between the two types of reviews is in how the model reviewers evaluate the usability of the model and model documentation. General assumptions are made about the user and reviewer audience regarding familiarity with the model. Reviews of limited use models are more focused on the technical quality of the model and usability of results, and it is typically assumed that they will only be used by the USACE model development/project team. It must be assumed that a model being distributed for widespread use will have a more diverse user/reviewer audience that is less familiar with the model and requires more detailed model documentation to ensure that it is properly applied and understood. These assumptions may affect the level of significance of the key issues identified during the review, and the same comment from the review of a limited use model may have lower significance than if the issue were identified for a model to be made available to a broader user audience if it affects the understanding of how the model should be applied. It is assumed that limited use models will be used by the model development/ project team or someone who is working very closely with the team, and the potential for misuse is lower.

A mid-review teleconference is held with USACE, the model proponents, and the Model Review Panel to provide the model reviewers an opportunity to ask questions that can clarify issues that arise during their review of the model software (if provided) and documentation. Providing the model reviewers an opportunity to ask clarifying questions has been found to reduce the number

of comments made based on insufficient or incorrect understanding of the model and makes for an easier, more efficient review.

The model reviewers complete their reviews individually and send their comments to the review coordinator. Battelle merges all the comments into one document and sends it back to the model reviewers to allow them to see the responses of the other Model Review Panel members to the charge questions. In addition, Battelle carefully reviews the comments and identifies key issues related to the technical quality, system quality (as appropriate), and usability of the model, as well as the model description and model testing. The key issues identified in the merged individual comments are listed in an Agenda and Talking Points memo, developed by Battelle, which is distributed to the model reviewers for discussion during a model review teleconference. The Agenda and Talking Points memo ensures that all key issues are discussed during the teleconference and helps focus discussions to reach agreement on the key issues that will be presented to USACE as efficiently as possible.

The teleconference allows the model reviewers, many of whom are from diverse scientific backgrounds, to exchange technical information about the key issues specifically associated with the model review assessment criteria, discuss potentially conflicting comments, and reach agreement on the concerns identified with the model during the review. The outcome of these discussions is a list of key findings that the Model Review Panel agrees should be presented to USACE in the draft Planning Model Quality Assurance Review Report as Final Panel Comments. The model review teleconference typically lasts approximately four hours, but varies depending on the number of key issues identified and the amount of discussion. The Battelle Project Manager facilitates the discussions, helps keep the discussions focused for reaching agreement on the key issues effectively and efficiently, and takes notes on the discussions.

During the teleconference, the specific wording for each Final Panel Comment statement is agreed upon by all panel members, and Final Panel Comments are assigned high, medium, or low significance based on the following definitions:

- High: Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose.
- Medium: Affects the completeness or understanding of the model, usability of the model, or the level of performance of the model.
- Low**:** Affects the technical quality of the model documentation but will not affect the performance of the model.

The model reviewers are directed to prepare Final Panel Comments, each of which includes: (1) a clear statement of the comment; (2) a list of the model assessment criteria to which the comment is related; (3) the basis for the comment (e.g. the causes of the issue, likelihood of occurrence/exploitation, and potential consequences on the credibility of results generated); (4) the significance of the comment (high, medium, or low); and (5) recommendations for resolution. Figure 3 shows the guidance provided to help the model reviewers with the development of Final Panel Comments.

Battelle prepares a directive to the Model Review Panel for the development of Final Panel Comments that includes the comment statements discussed during the model review teleconference, their assigned significance level and lead authors for developing each comment, notes from the call to help develop the basis for the comment, and guidance on what type of information should be presented in the comment. Throughout the development of Final Panel Comments, direction and coaching are also provided to ensure clarity of content, consistency with the review materials, and that significance statements and recommendations are reasonable and appropriate.

For projects involving reviews of multiple models, reviews should be staggered if the model review schedule allows (i.e., there are no critical deadlines that need to be met), and the same subject matter experts used across all of the reviews that have similar expertise requirements. This approach is more cost-effective because there are fewer individuals to brief on the model and model review process for a kick-off call and the total project level of effort is reduced. Having fewer Model Review Panel members also makes it easier to coordinate schedules for teleconferences.

Comment #:

The comment statement is 1-2 sentences that when reviewed without the rest of the comment can clearly describe the issue.

Relevant Model Assessment Criteria:

Select the model assessment criteria to which the comment is related. Delete criteria to which the comment is not relevant.

Review of:

- Theory
- Representation of the System
- Analytical Requirement
- Model Assumptions
- Ability to Evaluate Risk and Uncertainty
- Ability to Calculate Benefits for Total Project Life
- Model Calculations/Formulas
- Supporting Software
- Programming Accuracy
- Model Testing and Validation
- Data Availability
- Results
- Model Documentation

Basis for Comment:

Purpose of this section is for the panel to convince USACE that this is an issue that needs to be addressed.

- *State the issue in more detail than in the comment statement, citing sections of the report if appropriate. Do not repeat the comment statement.*
- *What is the impact of the incorrect/missing/??? data or information identified in the comment statement?*
- *What led you to determine that this is an issue? Reference review document sections/page numbers, figures/table*
- *State what has been done on other projects that has not been considered here. Reference literature, other studies and your experience*
- *Summarize the benefits of addressing this issue*
- *Do not lecture or include more detail than is needed to describe the issue (e.g., the process of determining benefit cost ratios should not be included)*
- *Do not include questions to USACE*

Significance – High:

The purpose of this section is to justify the significance rating. High ratings are reserved for those things that could be considered "fatal flaws"

- *Clearly state why this issue as presented in the comment statement affects the project justification (e.g., benefit/cost ratio may not meet project requirements); completeness/understanding of the report (e.g., something is missing – data, analyses); technical quality (e.g., figures and tables don't match text; appendices and main document have conflicting information).*
- *This should be 1 sentence; no more than two*
- *Do not repeat the final panel comment statement*

Recommendations for Resolution:

Purpose of this section is to provide USACE with implementable recommendations to address the issues describe in the Basis for Comment.

1. *List the recommendations by number (follow format).*
2. *Each number should be a single action.*
3. *The recommendation should be stated such that USACE can decide to "adopt" or "not adop,"*
4. *Be specific in the recommendations – where in the report, what is needed (e.g., analysis, references, recalculations)*
5. *Statements should be worded to follow the opening statement (e.g., . . . to include an analysis, detail on*

Figure 3. Guidance for Developing Five-Part Final Panel Comments for Model Reviews

2.4 Draft Planning Model Quality Assurance Review Report

The review coordinators and model reviewers prepare the draft Planning Model Quality Assurance Review Report and the review coordinator submits the report to USACE. The report presents the panel members and their qualifications; the methods used to conduct the model review; an assessment of the degree to which the model meets the technical quality, system quality, and usability criteria outlined in EC 1105-2-412 (USACE 2011); specific issues identified with the models during the reviews; recommendations for resolving the issues identified; and the Final Panel Comments. The draft Planning Model Quality Assurance Review Report uses the following outline:

1.0 Introduction
- 1.1. Model Purpose
- 1.2. Model Summary
- 1.3. Report Organization

2.0 Model Evaluation Assessment Criteria and Approach

3.0 Technical Quality Assessment
- 3.1. Review of Theory and External Model Components
- 3.2. Review of Representation of the System
- 3.3. Review of Analytical Requirement
- 3.4. Review of Model Assumptions
- 3.5. Review Ability to Evaluate Risk and Uncertainty
- 3.6. Review of Model Calculations/Formulas

4.0 System Quality Assessment
- 4.1. Review of supporting software
- 4.2. Review of programming accuracy
- 4.3. Review of model testing and validation

5.0 Usability Assessment
- 5.1. Review of Data Availability
- 5.2. Review of Results
- 5.3. Review of Model Documentation

6.0 Model Assessment Summary

7.0 Conclusions

8.0 List of Preparers

9.0 References

Appendix with Final Panel Comment Forms

Sections 1.0 and 2.0 of the report provide basic background information on the model and the review approach. Sections 3.0 through 5.0 contain the key findings of the model review as Final Panel Comment statements that relate to the model assessment criteria that are the focus of each individual report section. If there are no comments for a given assessment criterion, it is stated as such. Sections 6.0 and 7.0 summarize the key concerns identified during the model review and the conclusions and recommendations for resolution, respectively. The full five-part Final

Panel Comments are provided as an appendix to the report. Comments from individual reviews are not included in the draft Planning Model Quality Assurance Review Report.

Presenting each of the issues identified in separate Final Panel Comment forms as an appendix to the report allows (1) each issue to be presented clearly, (2) specific recommendations to be made to address each individual issue, and (3) individual issues to be separated and addressed by the appropriate model proponent.

The draft Planning Model Quality Assurance Review Report is submitted electronically to USACE for review both as read-only (i.e., pdf) and for editing to allow comments to be made in track changes. The ECO-PCX and model proponents review the report and provide review comments on the draft report. Comments and proposed revisions are only considered in the context of the main body of the report, as the Final Panel Comments represent the objective, independent viewpoint of the Model Review Panel and are not subject to influence beyond that of the review panel itself.

The report is the same for all model reviews, whether the model is being reviewed for limited use for a single project or set of projects, or for USACE certification for widespread use on multiple current and future projects. However, the number and nature of the review comments may differ, and there may be more comments on a model that is slated for widespread use by a more diverse user audience.

2.5 Discussion of Review Findings

A copy of the report appendix with the Final Panel Comment forms is provided to USACE with the draft report. Two sections are added to each Final Panel Comment form for responses from the USACE model developers, called Evaluator Responses, and counter responses from the Model Review Panel, called BackCheck Responses, to document the final exchange between USACE and the Model Review Panel on whether they agree with the review findings and recommendations. Prior to discussing the review findings, the USACE model developers provide draft Evaluator Responses to the Final Panel Comments in the form of "concur" or "non-concur". They will generally either agree or disagree with the comment statement, and must explain why if they disagree. For each of the recommendations in the Final Panel Comments, the USACE model developers provide a response of "adopt" or "not adopt", either specifically describing what will be done if a recommendation is adopted or explaining the reason for not adopting a recommended action. Battelle reviews the draft Evaluator Responses to ensure that they are in the correct format so that the model reviewers can efficiently develop an appropriate response. If the draft Evaluator Responses are not in the correct format, Battelle requests that USACE revise the response as needed.

The draft Evaluator Responses are provided to the Model Review Panel for review, and the model reviewers are asked to provide draft BackCheck Responses of "concur" or "non-concur" to the draft Evaluator Responses, explaining any instances of "non-concur." Battelle convenes a teleconference with the Model Review Panel to discuss the panel's draft BackCheck Responses and how to approach discussions with USACE during a findings teleconference.

The review coordinator convenes a teleconference with the Model Review Panel, USACE Project Manager, model proponents, and a representative from the ECO-PCX to discuss the review findings and USACE's draft Evaluator Responses. At Battelle, the teleconference facilitator (usually the Project Manager) reads each comment statement, its level of significance, and whether USACE concurs with the statement. If USACE concurs, no additional discussion is necessary. If USACE does not concur, a discussion is opened between the Model Review Panel and model proponents to clarify any issues identified, develop a common understanding of observations and perspectives, and try to reach concurrence on as many of the issues as possible. Although most discussions on comment resolution to date have resulted in concurrence, there are occasions when the model reviewers and model proponents agree to disagree. The findings teleconference can last up to four hours.

2.6 Final Planning Model Quality Assurance Review Report

Following the findings teleconference, USACE prepares the final Evaluator Responses. The Model Review Panel reviews the final Evaluator Responses and provides final BackCheck Responses. Battelle then prepares the final Planning Model Quality Assurance Review Report based on the comments on the main body of the report and includes the amended Final Panel Comment forms with the final Evaluator and BackCheck Responses. The Model Review Panel is given an opportunity to review the final Planning Model Quality Assurance Review Report before the report is submitted to USACE. The comment-response sequence is presented Figure 4.

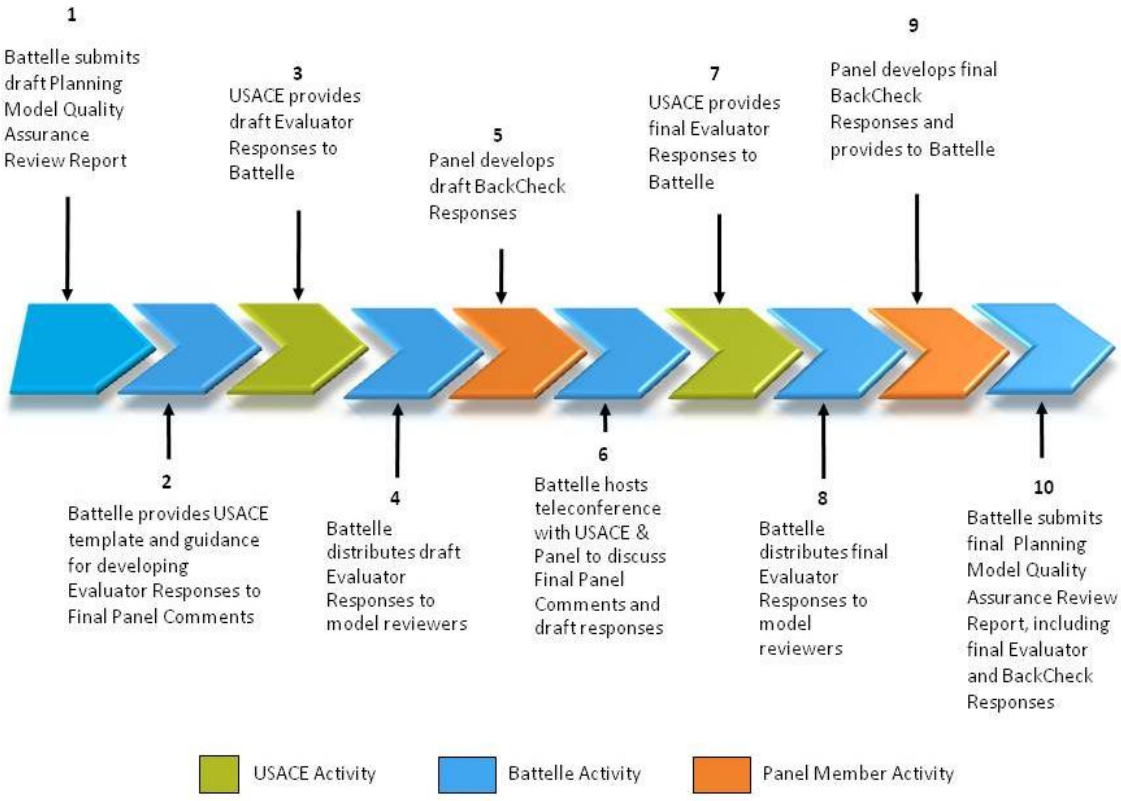


Figure 4. Comment/Response Process

This approach of formally documenting the comment-response process, similar to that used for IEPRs, is being implemented for the first time for model reviews currently being conducted. Previously, the only documentation of the comments response process was in less formal notes from the findings teleconference.

2.7 Project Closeout

The final stage of the project is the closeout, which is a series of activities that Battelle and the panel members must complete to document the model review prior to the end of the period of performance. As part of closeout, Battelle conducts separate model reviewer and client surveys to gather specific input that can be used to improve the process.

2.7.1 Battelle Closeout

Battelle closeout consists of the following activities:

- Provide a closeout directive to the Model Review Panel in an e-mail that includes a formal survey asking for suggestions to improve the model review process and instructions for submitting final invoices, referencing the work that was conducted in their resumes, and how to proceed in the event of media contact
- Receive final invoices from the Model Review Panel and close out subcontracts before the end of the model review period of performance
- Archive project files, including communications, notes, and deliverables
- Conduct and document After Action Review/Lessons Learned discussions
- Send a Battelle Corporate client survey to USACE
- Update model review procedure based on experience with the project, as needed.

Battelle policy requires that records, including data generated during the course of a project, must be capable of withstanding challenges to their validity, accuracy, and legibility. Controls are established to permit authorized access to project files, and to prevent unauthorized access to software systems and to data files. Project files are retained for ten years.

These document management controls for electronic files ensure that the final documents and associated files are traceable throughout the model review process and are maintained in such a way that they are identifiable and retrievable. Once the document review process is complete, the technical records and project management files are archived by Battelle's Records Management Office in a secure, protected, limited access facility for at least 10 years after contract expiration (deliverables are archived for 20 years). The complete project file contains the following documents, only some of which are deliverables:

- Draft model review schedule and draft charge questions
- Final schedule and charge included in the final Work Plan
- Final list of selected members of the Model Review Panel
- Draft Planning Model Quality Assurance Review Report
- Teleconference meeting notes from all meetings

- Final Planning Model Quality Assurance Review Report.

Documented protocols describe full weekly and daily differential backup procedures for network servers, personal computer security via unique usernames and passwords, and the use of password-protected screen savers. The QA Officer conducts an annual review of randomly selected project files to ensure that they are complete and traceable.

2.7.2 Panel Closeout

Once the project is complete, the Project Manager sends an informative message to the Model Review Panel concerning invoicing and other contractual reminders. Officially, closeout procedures are initiated when the final invoice is received from the subcontractor. A member of the Administrative Support Team authorizes the subcontracting office to begin closeout procedures, which require having the subcontractor complete closeout documentation and paying the final invoice once the paperwork is in order.

Battelle also sends the members of the Model Review Panel a survey to solicit process feedback (Figure 5). The responses from panel members are used to validate the process and to implement continuous improvements based on the recommendations provided. Panel members can also indicate whether they would like to serve on future panels (a majority of those who complete the survey), and recommend colleagues to be added to the Battelle database for future projects. In addition, Battelle asks USACE and the model reviewers to provide informal feedback and comments at the end of the findings teleconference. The Battelle Project Manager follows up on any negative responses personally to discuss the comments.

2.8 Quality Control

Quality control procedures are implemented throughout the model review process. There are numerous instances when QA/QC practices are implemented to ensure products of the highest quality are being provided to USACE. These QA/QC practices are described below.

2.8.1 Deliverable Review

It is Battelle policy that every deliverable be independently reviewed to ensure that it is accurate and technically sound; has objective interpretation, solid conclusions, and satisfying presentation; and meets or exceeds client expectations. The review may include a technical, editorial, and/or QA component, depending on the document and project requirements. The Project Manager determines the type(s) of review appropriate for each deliverable. In addition, following Battelle policy, all deliverables have a one-over-one review and approval by the appropriate Resource Manager prior to external distribution. All reviews are documented in the project files.

Model Review Panel Survey

Your input has been critical to us during many aspects of this model review project. We are constantly striving to improve the model review process for future reviews. As part the closeout process, we invite you to take a moment to answer the following 10 questions.

Please email responses directly to Karen Johnson-Young at johnson-youngk@battelle.org and Amanda Maxemchuk MaxemchukA@battelle.org. Thank you.

1. Were the objectives/your role clearly stated when you were initially contacted? How could they be improved?
2. Were the charge questions appropriate to focus your review on potential issues associated with the project?
3. Were your opinion and/or comments valued and accurately reflected in the deliverables or in the final comments?
4. Do you believe that your contribution was equally valued and added to the improvement of the project?
5. Comment on Battelle's process for conducting the model review. What areas can be improved?
6. Did you have a sufficient number of hours and calendar time to complete your review?
7. Would you be willing to serve on future review panels managed by Battelle?
8. Overall how would you rate your experience serving as a model review panel member? – *Excellent, Good, or Poor* (Or add other comment)
9. Please provide any additional comments regarding your experience as a panel member.

Based on your experience would you recommend others to serve on a model panel? If yes, please recommend a couple of colleagues that may be interested in participating in future USACE peer reviews; please list those recommendations (i.e., name, phone, email).

Figure 5. Panel Survey Following Completion of Model Review

2.8.2 Model Review Panel Recruitment

As an unbiased panel is critical to the successful completion of the model review process, Battelle is meticulous in recruiting the Model Review Panel. The first step in the process is the preparation of a COI screening questionnaire, which initially includes a list of potential COI issues common to all model reviews. At a minimum, Battelle then uses the project review documents and pertinent supplemental information to identify potential COI issues specific to each project. In addition, USACE provides information on any other project-specific COI issues that they have identified. USACE approves the final list of potential COI issues before the questionnaire is distributed to potential panel members.

Each candidate panel member undergoes a detailed review of qualifications and potential COI issues. The Battelle recruitment team presents each candidate reviewer's technical qualifications and COI screening responses to the Program Manager and Project Manager. The candidate's

qualifications are compared to the scope of work and to the pool of potential candidates. If there are any outstanding questions regarding the candidates' responses to the COI screening, the candidate is contacted and the questions resolved prior to submitting the candidate's name to USACE. As part of the subcontracting process, each potential panel member completes and signs the COI inquiry form.

2.8.3 Teleconferences

Teleconferences are an important component of conducting a model review. They are critical for communicating the process and specific information for the review, developing the Final Panel Comments, and discussing the Final Panel Comments with USACE. It is important that any presentation materials developed for teleconferences are accurate and complete. Therefore, all presentation slides are reviewed by the Program Manager. Accurate recording of action items, resolutions, and other information discussed during these teleconferences is critical to the process. To ensure that important information is not missed or overlooked, Battelle provides at least two note-takers for all teleconferences and kick-off meetings with USACE and/or the model reviewers. All sets of notes taken by Battelle staff are compared and consolidated after each teleconference to provide one set of official notes. These notes are retained in the project files.

2.8.4 Development of Talking Points for Panel Review Teleconference

After reviewing the model reviewers' responses to charge questions on the review documents, the Project Manager develops a talking points memorandum prior to the model review teleconference. This document guides the teleconference and includes the key themes identified from the model reviewers' individual comments, areas where all panel members agree, and specific issues where the panel members may have disagreed with one another. Prior to submission to the panel members, the talking points memorandum is reviewed by the Program Manager for consistency with the overall charge question responses.

2.8.5 Documented Procedures

Battelle provides detailed written briefing materials that guide panel members throughout the review process. The procedures are reviewed during the panel kick-off teleconference so that all members understand the process and procedures. In addition, during each phase of the model review, the panel receives specific guidance. The Kick-off Teleconference PowerPoint presentation covers:

- Introductions
- Model review objective and background
- Battelle's role
- Panel member role and guidance (including the model review process and level of effort)
- Review, supporting, and reference documents
- Non-disclosure Agreement reminder
- Communications
- Schedule

- Invoicing.

Reference documents are provided:

- U.S. Army Corps of Engineers, Water Resources Policies and Authorities' *Civil Works Review Policy* (EC 1165-2-209), dated January 31, 2010
- Office of Management and Budget, *Final Information Quality Bulletin for Peer Review*, released December 16, 2004
- Department of the Army, U.S. Army Corps of Engineers, *Assuring Quality of Planning Models* (EC 1105-2-412), dated March 31, 2011.

Standard templates are provided:

- Table template for responding to charge questions
- Templates for Final Panel Comments (high, medium, low).
- Process Guidance provided via e-mail, including formal (written) directives/guidance
- Charge Guidance and Questions, including a file with a written directive
- Directive to Panel for Preparation of Final Panel Comments, including a file with a written directive
- Guidance for panel response to USACE Evaluator responses to Final Panel Comments
- Project Close-Out.

Tutorials are offered as appropriate:

- Habitat Evaluation Procedures (HEP) and Plan Formulation for model certification reviews
- The USACE Six-Step Planning Process
- Review-specific tutorials for the use of model software, if requested.

A key to the management of concurrent, complex model review assignments is Battelle's internal tracking and monitoring system using Microsoft SharePoint on Battelle's internal servers. The SharePoint folders provide a secure location for all project files that is only accessible to Model Review Implementation Team members, allows project files to be quickly and easily accessed by team members, and provides an effective means of updating project information and document version control. The SharePoint includes the following elements, among others:

- Proposal and project start-up documents
- A schedule showing status of deliverable milestones
- Detailed information on each model review subcontract
- A repository for summaries of lessons learned for all reviews discussed during monthly meetings
- Sharing and storing project meeting presentations and notes, review documents, review comments, and deliverables
- Sharing of files for review during the development of Final Panel Comments.

There are no monthly reporting requirements for model reviews.

2.9 Positive Team Culture

A high level of independence is maintained on reviews to avoid the appearance of collaboration between the USACE model proponents and review panels. Because of this separation, it is sometimes difficult to develop and maintain a team ethic/mentality throughout the duration of the review (which in essence is an internal attempt to improve the quality and credibility of USACE and its deliverables, as is typically highlighted during kick-off meetings). Interactions between USACE model proponents and Model Review Panels have the potential to become contentious if comments provided are perceived as critical or USACE decides not to adopt recommendations provided by the review panel.

In order to maintain a positive team culture, the Project Manager takes the following approach:

- During the kick-off meeting, the model reviewers are invited to introduce themselves, allowing them to express themselves as individuals. Occasionally, members of a Model Review Panel reconnect with "long lost" colleagues.
- Also during the kick-off meeting, the stage for a positive team culture is set by informing the model reviewers that the purpose of the review is to provide productive comments that will help ensure that USACE is using the best planning tools possible. It is not the intent of the review to necessarily find fault with the materials being reviewed. Participants are encouraged to engage in the review as members of a team seeking to improve the quality and credibility of analyses and products of the USACE. Reviewers are reminded that this is an opportunity to make a beneficial difference as a participant of an internal USACE quality assurance effort. The model proponents are reminded that the reviewers are offering the potential to improve the quality of USACE's analytical tools, the reliability of USACE's findings, and ultimately contributing to the fortification of USACE's credibility.
- During the development of Final Panel Comments, the model reviewers are asked to avoid language that sounds critical or confrontational. Words like "fatal flaw" and "insufficient" convey that there is a critical issue but do not provide any useful information. Model reviewers are told to be very specific about the nature of the issue, why it is an issue, and the manner in which it is likely to affect the quality of information generated by the model or method, and to provide reasonable implementable recommendations for resolution.
- After receiving USACE draft Evaluator responses and prior to the model review findings teleconference with USACE, the model reviewers are reminded that it is ultimately USACE's decision whether to adopt any recommendations for resolution proposed by the Model Review Panel. In some cases USACE may not concur with a comment because either the model reviewers did not fully understand the model or USACE misunderstood the comment. The findings teleconference is held to resolve such issues. The model reviewers are reminded that often USACE is working with a very limited budget or a tight schedule and is unable to adopt all recommendations immediately. The model developers will often choose to address the issues that are critical to the performance of the model and necessary for approval of the model for limited use. They will then

address additional recommendations as time and budget allows. A model is not certified for widespread use until it is assured that it can be applied by a broader user audience without a high potential for critical errors or misapplication.

- At the beginning of the model review findings teleconference with the Model Review Panel and USACE, everyone on the phone is reminded that we are all part of the same team, and are all seeking to improve the quality and credibility of USACE analyses and products. The purpose of the call is to discuss any comments for which there is non-concurrence, with the objective of reaching agreement on as many issues and recommendations as possible. The discussions are intended to be informative and help USACE develop a planning tool that will meet the needs of projects effectively and without error. Everyone is reminded that it is counterproductive to become critical or defensive during these discussions.

USACE has indicated that similar measures are taken by the ECO-PCX Project Manager with the Model Development Team in order to maintain a team ethic/mentality during discussions with the Model Review Panel.

3 META-ANALYSIS OF MODEL REVIEW RESULTS

For the meta-analysis of the results of model reviews, Battelle entered 418 comments from 16 reviews into a Microsoft Access comment database along with the model name, expertise/ discipline of the model reviewer who made the comment, the significance level of the comment (high, medium, or low), the basis for the comment, recommendations for resolution, general type of comment (i.e., technical quality, system quality and usability), and the model assessment criteria affected. The comments came directly from 15 model quality assurance review reports prepared by Battelle and 12 reports prepared by other organizations. All were reviews of ecosystem restoration planning models performed for the USACE ECO-PCX. Table 3 lists the reports reviewed.

Table 3. Model Quality Assurance Review Reports Included in the Model Overview Assessment

No.	Report Title	Date
	Prepared by Battelle	
1	Final Model Certification Review Report for the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook	14 April 2010
2	Final Model Certification Review Report for the EnviroFish Model, Version 1.0	5 March 2010
3	Final Model Certification Review Report for the Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	15 March 2010
4	Final Model Certification Review Report for the Waterfowl Assessment Methodology	18 Feb. 2010
5	Final Model Review Report for the Western C-111 Spreader Canal (C111SC) Benefit Evaluation Methodology	6 Nov. 2009
6	Final Model Certification Report for Tamiami Trail Limited Reevaluation Report Ecosystem Output Model	6 June 2008
7	Final Report for the Independent External Peer Review of the Clear Creek Floodplain Forest and Wet Coastal Prairie Community Index Models (2 models)	29 Oct. 2009
8	Review of Modified Charleston Method, W-14 Project	2 July 2010
9	Final Model Quality Assurance Review Report for A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin	6 Dec. 2010
10	Final Model Review Report for the Community Models for the Upper Des Plaines River Watershed in Illinois and Wisconsin (3 models)	28 July 2010
11	Draft Planning Model Quality Assurance Review Report for the Sacramento River Bank Protection Project Standard Assessment Methodology (SAM) and SAM Electronic Calculation Template (ECT)	17 Nov. 2010
12	Final Planning Model Quality Assurance Review Report for the Evaluation of Planned Wetlands Model	29 Oct. 2010
13	Final Model Review Report for the Wetland Value Assessment Models (8 models)	31 Aug. 2010
14	Summary of Comments from the Chatfield Ecological Functions Approach Review	23 Oct. 2009
15	Final Planning Model Quality Assurance Review Report for the Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)	18 May 2011
	Prepared by USACE	
16	Summary of Model Review of the Island Community Units Model for Middle Chesapeake Bay Islands Restoration Project	5 May 2008
17	DRAFT Planning Model Quality Assurance Review Comments On: A Planning-based Wetlands Functional Assessment Model for Southern	9 Nov. 2010

	Arizona's Arid Riverine Systems and Their Associated Riparian Habitats	
18	Review Comments Fish Passage Connectivity Index Model	4 Dec. 2008
	Prepared by EA Engineering, Science, and Technology, Inc.	
19	Certification Review Criteria Based Ecological Evaluation Matrix (CBEEM) Biscayne Bay Coastal Wetlands Project	6 May 2009

Table 3. Model Quality Assurance Review Reports Included in the Model Overview Assessment (con't)

No.	Report Title	Date
	Prepared by Abt Associates Inc.	
20	Final Model Review Report: Wildlife Habitat Appraisal Guide (WHAG) Model	14 April 2011
21	Final Model Review Report: A Shorebird Migration Model for Portions of the Northern Plains /Prairie Pothole Region of the USA	5 May 2011
22	Final Model Review Report: A Dabbling Duck Migration Model for the Upper Mississippi River	19 April 2011
23	Final Model Review Report: Modified Bluegill Habitat Suitability Index Model for Winter Conditions for Upper Mississippi River Backwater Habitats	14 April 2011
24	Final Model Review Report: Aquatic Habitat Appraisal Guide (AHAG) Model	12 May 2011
25	Final Model Review Report: Smallmouth Bass Habitat Suitability Index Model	17 Feb. 2011
26	Final Model Review Report: Modified Mink HSI Model	11 March 2011
27	Final Model Review Report: Migratory Habitat Model for Diving Ducks Using the Upper Mississippi River	16 March 2011

All final panel comments were put into an Excel matrix to identify trends observed in the comments. The number of comments was evaluated by review, discipline, significance, general type of comment, and model assessment criteria affected. Common and uncommon but significant comments were identified. Battelle analyzed:

- Stats (minimum, maximum, mean, and median) on the number of comments per review, by subject matter expert discipline, by the model assessment criteria to which individual comments relate, and significance level.
- Reviewers disciplines
    - By review
    - Across all reviews
- Comments by expertise/discipline of the lead comment author
- Comments at each significance level
    - By review
    - Across all reviews
    - By general type of comment (technical quality, system quality, and usability)
- Comments for each of the general comment types (technical quality, system quality, and usability)
- Comments relating to each of the following assessment criteria:
    - Theory

- Representation of the System
- Analytical Requirement
- Model Assumptions
- Ability to Evaluate Risk and Uncertainty
- Ability to Calculate Benefits for Total Project Life
- Model Calculations/Formulas
- Supporting Software
- Programming Accuracy
- Model Testing and Validation
- Data Availability
- Results
- Model Documentation.

Because of improvements in the model review process over time and because reviews were conducted by more than one organization, some of the queries could only be performed for a subset of model reviews because the same information was not available across all the reviews.

Table 4 is a summary of 16 reviews of 27 planning models. The number of Final Panel Comments varied greatly by project, from 3 to 55, averaging about 15 comments per review (median = 12). Figure 6 shows how the 418 comments were distributed across projects. These results are presented for illustration purposes only and do not imply that one model was better than another based on a lower number of Final Panel Comments. The Final Panel Comments specifically address the quality of the model documentation, model software or spreadsheet programming (as appropriate), and model usability.

The following discussion is organized by model complexity, model reviewer disciplines, model assessment criteria, and comment significance, and presents examples of Final Panel Comments received across reviews. In some cases, the comments have been revised to remove model-specific information. Some Final Panel Comments presented as examples could be assigned to more than one category; thus there may be some duplication in the examples. Also, because some information was not available for all model reviews (e.g. some reviews did not relate the comment to the model assessment criteria), some of the discussion is based on subsets of the data. This section concludes with recommendations for the development of future ecosystem planning models.

Table 4. Summary Data for 27 Models Reviewed

Region/Project	Review	Model or Method	# Reviewers	# Final Panel Comments[1]	Significance, #		
					High	Medium	Low
Southern Arizona Arid Riverine Systems and Associated Riparian Habitats	Planning-based Wetlands Functional Assessment Model	Arid River Model[2]	3	5	3	2	0
Jamaica Bay Habitat Restoration	Evaluation of Planned Wetlands Model	Jamaica Bay EPW[2]	4	41	21	20	0
Western C-111 Spreader Canal	Benefit Evaluation Methodology	C-111 BEM[2]	5	18	7	8	3
Tamiami Trail	Limited Reevaluation Report Ecosystem Output Model	Tamiami Trail Model	3	5	0	4	1
Biscayne Bay Coastal Wetlands Project	Criteria Based Ecological Evaluation Matrix (CBEEM)	CBEEM[2]	4	6	0	0	6
SJNM Floodway	EnviroFish Model, Version 1.0	SJNM EnviroFish Model[3]	5	32	11	11	10
St. Johns-New Madrid (SJNM) Floodway	Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook	SJNM HGM Method[2]	4	21	9	6	6
SJNM Floodway	Waterfowl Assessment Methodology	SJNM WAM	3	6	0	2	4
SJNM Floodway	Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	SJNM Shorebird Model (Rev1)	3	7	6	1	0

Table 4. Summary Data for 27 Models Reviewed (con't)

Region/Project	Review	Model or Method	# Reviewers	# Final Panel Comments[1]	Significance, #		
					High	Medium	Low
SJNM Floodway	Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins	SJNM Shorebird Model (Rev2)	4	10	3	4	3
Mid-West	Shorebird Migration Model for Portions of the Northern Plains/Prairie Pothole Region of the USA	NPPP Shorebird Model[2]	4	7	3	3	1
Mid-West	Aquatic Habitat Appraisal Guide (AHAG) Model	AHAG[2]	4	14	12	2	0
Mid-West	Wildlife Habitat Appraisal Guide (WHAG) Model	WHAG[2]	5	13	9	4	0
Mid-West	Dabbling Duck Migration Model for the Upper Mississippi River	Dabbling Duck Migration Model[2]	4	8	4	4	0
Mid-West	Migratory Habitat Model for Diving Ducks Using the Upper Mississippi River	Diving Duck Migration Model[2]	4	10	5	5	0
Mid-West	Bluegill Habitat Suitability Index Model for Winter Conditions for Upper Mississippi River Backwater Habitats	Modified Bluegill HSI Model[2]	4	7	4	3	0
Mid-West	Modified Mink HSI Model	Modified Mink HSI Model[2]	2	6	4	2	0

Table 4. Summary Data for 27 Model Reviews (con't)

Region/Project	Review	Model or Method	# Reviewers	# Final Panel Comments[1]	Significance, #		
					High	Medium	Low
Mid-West	Smallmouth Bass Habitat Suitability Index (HSI) Model	Smallmouth Bass HSI Model[2]	2	4	3	0	1
Upper Mississippi River Lock and Dam 22	Fish Passage Connectivity Index Model	Fish Passage Model[2]	4	55	not assigned	not assigned	not assigned
Sacramento River Bank Protection Project	Standard Assessment Methodology (SAM) and SAM Electronic Calculation Template	SAM and SAM ECT[2] (ECT)	6	22	9	12	1
Upper Des Plaines River Basin	Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin	UDP HGM Method	3	17	9	6	2
Upper Des Plaines River Basin	Community Models for the Upper Des Plaines River Watershed in Illinois and Wisconsin	UDP Community Models	4	15	9	4	2
Clear Creek, TX	Clear Creek Floodplain Forest and Wet Coastal Prairie Community Index Models	Clear Creek Community Models2	4	15	13	2	0

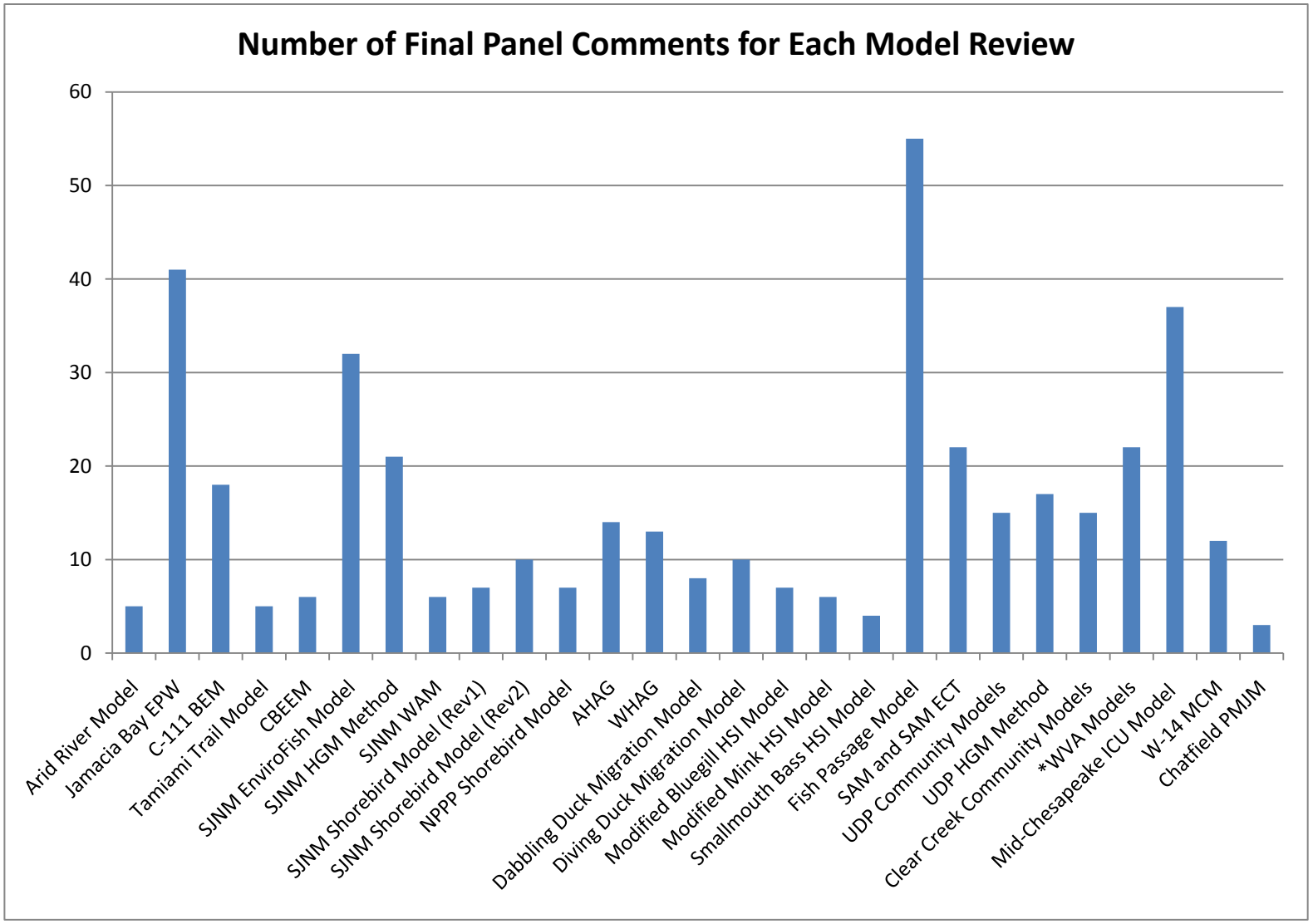
Table 4. Summary Data for 27 Models Reviewed (con't)

Region/Project	Review	Model or Method	# Reviewers	# Final Panel Comments[1]	Significance, #		
					High	Medium	Low
Louisiana and East Texas Coastal Wetlands	Wetland Value Assessment Models	WVA Models[2]	6	22	17	4	1
Middle Chesapeake Bay Islands Restoration Project	Island Community Units Model	Mid-Chesapeake ICU Model[2]	6	37	not assigned	not assigned	not assigned
W-14 Project	Modified Charleston Method	W-14 MCM[2]	3	12	8	4	0
Chatfield Reallocation Study	Summary of Comments from the Chatfield Ecological Functions Approach Review, Battelle, 23 October 2009	Chatfield PMJM	1	3	0	2	1

[1]**Note**: The number of Final Panel Comments from a review is much less that the original number of comments received upon completion of a review. The Final Panel Comments represent a summary of the key issues identified that need to be addressed to improve a method or model. Also note that for some reviews (e.g. Jamaica Bay EPW and SAM and SAM ECT), some of the Final Panel Comments had multiple parts that were each counted as an individual issue.

[2]Model spreadsheets provided for the review.

[3]Model software provided for the review.



* WVA included a review of eight very similar models.

Figure 6. Number of Final Panel Comments for Each Model Review

All of the models reviewed are ecosystem output models based on the U.S. Fish and Wildlife Service (USFWS) HEP or the Hydrogeomorphic (HGM) Method to some degree. These methods are very similar and provide a very effective tool for gross rapid assessment of current and projected future conditions for comparing differences between project alternatives. Because of the similarities between the models, there were also some similarities in the comments received across reviews. Common or notable comments can help guide the future development of planning models.

3.1 Results and Analysis Based on Model Complexity

More complex models require a greater number of reviewers from different disciplines in order to cover all relevant perspectives. There is generally a correlation between the number of review comments and the number of experts on the Model Review Panel (Figure 7). It can therefore be concluded that there is a correlation between the number of comments and the complexity of the model. Twenty of the 27 model reviews included a review of model spreadsheets or software (see Table 4); however, this did not seem to affect the number of comments. Other factors that may affect the number of comments received for any given review include the level of contribution a panel member has to a review and the amount of time allowed for a review (working on a compressed schedule could affect the quality of the review).

An outlier analysis indicated that the 55 comments received during the review of the Fish Passage Connectivity Index model are more than would be expected at the 5% significance level. The number of comments from other reviews was within the expected range. Removing the results from the Fish Passage Connectivity Index review from the correlation analysis resulted in an R^2 of 0.44. Closer examination revealed that comments submitted for the Fish Passage Connectivity included positive feedback to charge questions in addition to key issues identified during the review.

Although it is more work to address a greater number of comments, receiving a greater number of comments allows model proponents and developers to prepare better models and model documentation for more reliable and defensible analyses. Many models are only reviewed for immediate use on a specific project or set of projects; however, being able to improve a model and its documentation sufficiently for USACE certification will ultimately result in greater efficiencies and fewer errors across USACE projects and programs. In many cases, model developers have agreed with Model Review Panels regarding recommendations to improve models for more widespread use. Although budgets may only allow for issues that affect approval for the immediate usability of the model to be addressed, model proponents have expressed their intention to implement other recommendations as time and budgets allow.

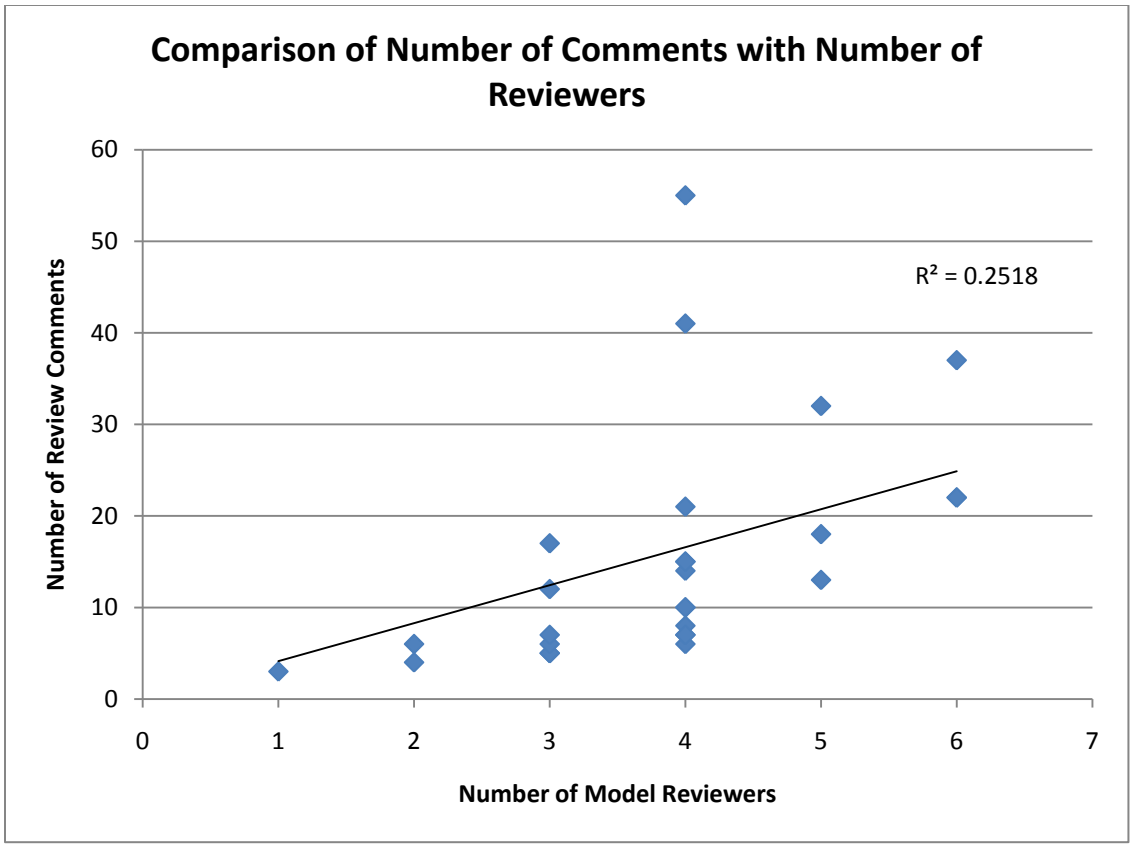


Figure 7. Number of Comments Compared to Number of Reviewers

3.2 Results and Analysis by Discipline

Due to the nature of ecosystem planning models and the need to maintain or restore habitat quality for USACE projects, there were a lot of similarities in how the models were designed and the disciplines required for their development and, consequently, their review. Model review panels required anywhere from one to six experts, averaging about four model reviewers per panel, with expertise in biology, ecology, planning, HEP, and other disciplines. Because several of the model reviews were not conducted by Battelle and because the discipline of the expert that put forward a comment was not provided in model review reports, this information is only available for 281 of the 418 comments from the reviews of 16 models.

The Final Panel Comments from the model reviews represented 26 disciplines. The reason for the high number of disciplines is because, although there are many similarities between ecosystem planning models, each model is also based on highly specific expertise. Table 5 presents the number of comments provided by discipline and model review.

Because each model review required very specific expertise, many disciplines were only required for a small number of reviews. For a more informative analysis, experts from similar disciplines were grouped in Table 6 as follows:

- Physical Scientist = Geomorphologist/Geologist, Geophysicist, Hydraulic Engineer, and Wetland Hydrologist

- Biologist = Aquatic Biologist, Avian Biologist, Fishery Biologist, Fishery Ecologist, Population Biologist/Modeler, Preble's Meadow Jumping Mouse Expert, and Waterfowl Biologist
- Ecologist = Biologist-Ecologist, Coastal Ecosystems Ecologist, Coastal Wetlands Ecologist, Estuarine Ecologist, Forested Wetland Ecologist, Freshwater Ecologist, Prairie Ecologist, and Wetland Ecologist
- Method Specialist = Habitat Evaluation Procedures Specialist, Hydrogeomorphic Method Specialist, and Wetland Habitat Assessment Specialist
- Programmer/Spreadsheet Auditor = Java Specialist and Programmer/Spreadsheet Auditor
- Planner/Plan Formulation Expert.

Biologists and ecologists were kept as separate disciplines because the first deals with specific populations or communities, whereas the second deals with entire ecosystems. Table 6 shows the number of comments for each discipline group for each review.

There were no apparent trends in the number of comments made by each discipline for each review. However, across reviews, ecologists provided the highest number of comments, followed by programmers/spreadsheet auditors (Figure 8). The fewest number of comments were received from experts in the physical sciences, most likely because they participated in relatively few reviews of ecosystem output models. This likely highlights a progression of complexity within a model or method that results from translating physical data to biological responses to ecological condition and the complexities of accounting for their interactions as you move through the conceptualization of the system from stressor to response. In other words, the measurement of physical variables within an ecosystem can be relatively simple; how the physical measurements relate to biological responses, however, is somewhat more complex, and how the physical data and modeled biological responses reflect ecological condition can be even more complex.

Of the 16 model reviews for which information on the number of comments per discipline was available, comments could be broken out by discipline and general comment category (i.e., comments relating to technical quality, system quality, and usability) for five of those reviews (Table 7). Across reviews and disciplines, the largest number of comments received was related to technical quality and usability, and issues relating to technical quality usually also affected usability. As expected, the programming/spreadsheet auditing discipline produced the greatest number of comments related to system quality, and the greatest number of comments on system quality was observed for the two reviews with spreadsheet models (Jamaica Bay EPW and SAM ECT).

Table 5. Number of Comments by Discipline for Each Model Review

Discipline	C-111 BEM	Chatfield PMJM Model	Clear Creek Community Models	SJNM EnviroFish Model	SJNM HGM Method	SJNM WAM	SJNM Shorebird Model (Rev1)	Mid-Chesapeake ICU Model	Jamaica Bay EPW Model	SJNM Shorebird Model (Rev2)	SAM and SAM ECT	Tamiami Trail Model	UDP Community Models	UDP HGM Method	W-14 MCM	WVA Models	Grand Total
Aquatic Biologist											1						**1**
Avian Biologist							5			5							**10**
Biologist-Ecologist								37									**37**
Coastal Ecosystems Ecologist																2	**2**
Coastal Wetlands Ecologist																4	**4**
Estuarine Ecologist	2																**2**
Fisheries Ecologist									4								**4**
Fishery Biologist				10							3						**13**
Forested Wetland Ecologist					4										2		**6**
Freshwater Ecologist	4																**4**
Geomorphologist/Geologist											1						**1**
Geophysicist										2							**2**
Habitat Evaluation Procedures Specialist	3		8	5		1	1			2		1	5			6	**30**
Hydraulic Engineer				8								3				2	**13**
Hydrogeomorphic Method Specialist					8									7			**15**
Java Expert				9													**9**
Planner/Plan Formulation Expert			7						6		4	1	3	5		3	**29**
Population Biologist/Modeler											3						**3**
Prairie Ecologist													4				**4**
Preble's Jumping Meadow Mouse Expert		3															**3**

Table 5. Number of Comments by Discipline for Each Model Review (con't)

Discipline	C-111 BEM	Chatfield PMJM Model	Clear Creek Community Models	SJNM EnviroFish Model	SJNM HGM Method	SJNM WAM	SJNM Shorebird Model (Rev1)	Mid-Chesapeake ICU Model	Jamaica Bay EPW Model	SJNM Shorebird Model (Rev2)	SAM and SAM ECT	Tamiami Trail Model	UDP Community Models	UDP HGM Method	W-14 MCM	WVA Models	Grand Total
Programmer/Spreadsheet Auditor	3				2				26		10				6	5	**52**
Waterfowl Biologist						5											**5**
Wetland Ecologist					7				5				3	5			**20**
Wetland Habitat Assessment Specialist															4		**4**
Wetland Hydrologist	6																**6**
Grand Total	**18**	**3**	**15**	**32**	**21**	**6**	**6**	**37**	**41**	**9**	**22**	**5**	**15**	**17**	**12**	**22**	**281**

Note: The expertise of the comment author was only available for 16 of the 27 models that were reviewed. This information is generally unavailable because comments generated from the reviews are unattributed.

Table 6. Number of Comments by Consolidated Discipline for Each Model Review

Row Labels	Biologist	Ecologist	Physical Scientist	Method Specialist	Programmer/ Spreadsheet Auditor	Planner/Plan Formulation Expert	Total
C-111 BEM		6	6	3	3		**18**
Chatfield PMJM Model	3						**3**
Clear Creek Community Models				8		7	**15**
SJNM EnviroFish Model	10		8	5	9		**32**
SJNM HGM Method		11		8	2		**21**
SJNM WAM	5			1			**6**
SJNM Shorebird Model (Rev1)	5			1			**6**
Mid-Chesapeake ICU Model		37					**37**
Jamaica Bay EPW Model	4	5			26	6	**41**
SJNM Shorebird Model (Rev2)	5		2	2			**9**
SAM and SAM ECT	7		1		10	4	**22**
Tamiami Trail Model			3	1		1	**5**
UDP Community Models		7		5		3	**15**
UDP HGM Method		5		7		5	**17**
W-14 MCM		2		4	6		**12**
WVA Models		6	2	6	5	3	**22**
Grand Total	**39**	**79**	**22**	**51**	**61**	**29**	**281**

Note: The expertise of the comment author was only available for 16 of the 27 models that were reviewed. This information is generally unavailable because comments generated from the reviews are unattributed.

Table 7. Number of Comments by Category and Discipline for Five Representative Model Reviews

Expertise	Comment Category	Jamaica Bay EPW	SJNM Shorebird Model (Rev 2)	SAM and SAM ECT	UDP Community Models	UDP HGM	Grand Total
Aquatic Biologist	Technical Quality			0			0
	System Quality			0			0
	Usability			1			1
Avian Biologist	Technical Quality		4				4
	System Quality		1				1
	Usability		2				2
Fisheries Ecologist	Technical Quality	4					4
	System Quality	2					2
	Usability	4					4
Fishery Biologist	Technical Quality			3			3
	System Quality			0			0
	Usability			2			2
Geomorphologist/ Geologist	Technical Quality			0			0
	System Quality			1			1
	Usability			1			1
Geophysics	Technical Quality		2				2
	System Quality		1				1
	Usability		2				2
Habitat Evaluation Procedures Specialist	Technical Quality		1		5		6
	System Quality		0		2		2
	Usability		2		4		6
Hydrogeomorphic Method Specialist	Technical Quality					3	3
	System Quality					1	1
	Usability					4	4
Planner/Plan Formulation	Technical Quality	5		3	2	5	15
	System Quality	4		2	0	0	6
	Usability	5		4	3	3	15
Population Biologist/Modeler	Technical Quality			2			2
	System Quality			0			0
	Usability			3			3
Prairie Ecologist	Technical Quality				4		4
	System Quality				1		1
	Usability				4		4

Table 7. Number of Comments by Category and Discipline for Five Representative Model Reviews (con't)

Expertise	Comment Category	Jamaica Bay EPW	SJNM Shorebird Model (Rev 2)	SAM and SAM ECT	UDP Community Models	UDP HGM	Grand Total
Programmer/Spreadsheet Auditor	Technical Quality	23		10			33
	System Quality	21		9			30
	Usability	24		10			34
Wetland Ecologist	Technical Quality	4			2	5	11
	System Quality	4			0	0	4
	Usability	4			2	2	8
Total Comments Relating to Technical Quality		**36**	**7**	**18**	**13**	**13**	**87**
Total Comments Relating to System Quality		**31**	**2**	**12**	**3**	**1**	**49**
Total Comments Relating to Usability		**37**	**6**	**21**	**13**	**9**	**86**

Note: Information of the assessment criteria to which comments were related was available for a subset of the 16 model reviews for which information on discipline of the comment author was available.

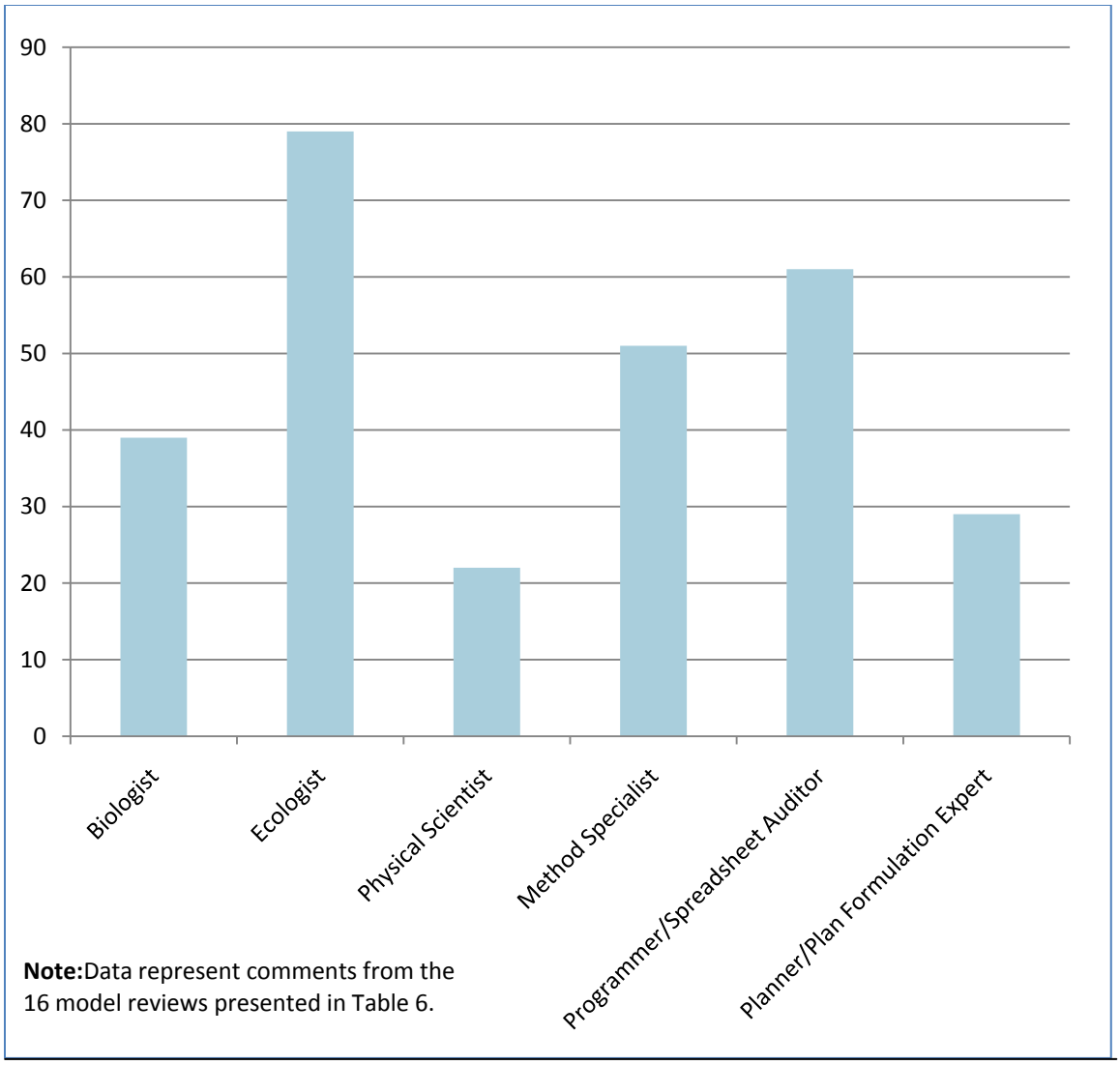


Figure 8. Number of Comments by Discipline Across Model Reviews

3.2.1 Biology/Ecology Comments

The comments provided by biologists and ecologists were very similar in nature. The majority of comments focused on the need for documentation to clearly explain and justify the model development, why some model parameters were selected over others, the weighting of parameters, and the model limitations and assumptions. These comments included the need to clearly explain how index values are assigned to model parameters, information that is particularly important to ensure consistency in model results generated across users, as these types of index models are highly susceptible to subjectivity. Other comments were provided regarding how well the models represent the systems being modeled, the sensitivity of the models, lack of model testing and validation, and general model usability.

Representative comments on documentation:

- The model documentation needs to include more detail to explain the biological/ecological justification for use of variables in the models.
- Documentation of model development, data inputs, and desired outputs needs to be improved.
- A description of how sub-index values of 0.0 to 1.0 were assigned to performance measures used in the model should be provided along with an explanation of how the index values correlate to predicted changes in habitat quality.
- The quality and accuracy of the data required by the model need to be stated.
- The definition of a functional floodplain needs to be more clearly stated.
- The Hydrogeomorphic Guidebook should explain why some functions commonly included in HGM assessments were not chosen for this HGM assessment method.
- Applications and limitations of the model are not thoroughly discussed.
- The Hydrogeomorphic Guidebook needs to explain more fully the overall reliability of the outputs of the model.
- An explicit statement should be provided regarding the minimum area to which the models can be applied.

Representative comments on representation of the system being modeled and the model's ability to distinguish between alternatives:

- The performance measures do not capture the importance of rapid salinity fluctuations on ecological outcomes.
- The model does not specifically address the value of habitat corridors or habitat connectivity.
- Water depth data should be included in the model, and the model should be run separately for each of the shorebird foraging guilds.
- Mean tree diameter at breast height (dbh) alone is not a useful indicator of community condition.
- The Functional Capacity Index (FCI) for the Provide Habitat for Fish and Wildlife component of the model could be made more robust by using fewer subindices in its calculation. Some of the subindices are not sufficiently sensitive to detect differences in condition and reduce the overall sensitivity of the FCI.
- Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
- There has not been any testing or validation of the model.
- The models lack sensitivity to distinguish among various alternatives based on qualitative indices.

- In measuring the correlation of model outputs with expert opinion, there appears to be poor correlation of model outputs with expert opinion regarding what is high, medium, and low quality habitat.
- The biological interpretation of the index scores is not clear. The documentation needs to explain what the possible index scores means for the community being modeled (e.g. the amount by which reproductive success is reduced).

Representative comments on general usability:

- The model workbook does not prevent the user from entering data that are obviously erroneous.
- The meaning and usability of the model outputs are limited because the model condition scores are not transparent.
- The user should not be able to alter the "official" species response curves.
- The usability of the spreadsheets is limited because of the spreadsheets' user interface and user and maintainer documentation.

Although several of the comments are specific to the individual review, other comments provided several times across reviews should be taken into consideration when developing future planning models.

3.2.2 Physical Sciences Comments

Because of the nature of USACE projects, most of the ecological planning models are developed for aquatic ecosystems and habitats. Therefore, they all have hydrologic considerations, some more complex than others. The models with a more complex hydrologic component required specific expertise to review the model's ability to represent the system and successfully distinguish between planning alternatives. Comments from those reviewers focused on model documentation to explain and justify model development, as well as the ability of the model to represent the system being modeled and distinguish between alternatives.

Representative comments on hydrology:

- There is uncertainty about the technical quality of the models because of limited documentation of methods for habitat unit scoring.
- The assumptions and limitations on the ability of the model to calculate benefits for project life need to be clearly documented. This includes assumptions about future development and flood levels.
- The rationale for averaging time series of results across year types (wet, dry, and average) and seasons to create one habitat unit score needs to be provided for each performance measure. Each year type and season may not be an equally important predictor of ecological benefits. For example, extreme salinity during dry years may be ecologically limiting and thus should weigh more heavily in the score. Also, extreme values for one

year type may overwhelm the scores, obscuring important results for other year types that may be more representative of longer term trends of interest.

- The coastal zone salinity performance measure does not appear to effectively model changes in salinity in Florida Bay, and the primary objective of the project is to improve salinity conditions.
- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy. The level of uncertainty in water depth is greater than the resolution needed to accurately model habitat availability.
- The geographic boundaries/domain of the models are unclear.
- Sea level is an important phenomenon and relative sea level rise and climate change should be included in the models.

3.2.3 Method-Specific Expertise Comments

Most of the planning models developed are based either on USFWS HEP or on HGM, which is very similar to HEP except that it is focused on wetland quality. Both methods typically use projected changes in habitat condition to compare project alternatives. As such, most model reviews included either a HEP expert, an HGM expert, or someone who is very familiar with the application of these approaches. Comments from method-specific specialists focused on documentation and how HEP or HGM was applied.

Representative comments on the selected method:

- There is no documentation to support what is considered to be representative of pre-drainage conditions.
- The results of the models would be more easily interpreted and defensible if performance measures were developed to provide meaning to the Suitability Indices (SIs).
- The strength of the models would be improved by using quantitative rather than qualitative environmental parameters.
- Hydrologic performance measures do not adequately calculate benefits for the total project life because sea level rise is not incorporated into the analysis.
- The conversion from hydrologic outputs, as measured by the three performance measures, to Habitat Units should be linked to ecologically significant thresholds and boundary conditions.
- The documentation does not sufficiently describe the biological systems being modeled.
- The documentation of the protocols does not clearly describe what was done or why.
- Field data should be used for calculating SIs and SIs should then be assessed (and perhaps averaged). It is mathematically inappropriate to average field data and base SI on the averaged field data.
- The Habitat Suitability Index (HSI) values assigned are not scientifically supported or justified regarding how they reflect habitat suitability.

- The FCI for the Detain Floodwater component of the model could be improved by use of channelization and flooding duration indicators and by careful consideration of the calibration of VFREQ (flood frequency).
- The Hydrogeomorphic Guidebook should summarize the assumptions implicit in its approach, including those pertaining to the FCI models.
- The performance of the models has not been tested with independent data.
- The FCI models should be verified to ensure that they are performing properly.
- Because this is not a process-based model, it has limited capability to address the effects of global climate change.
- Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.
- The model documentation should clearly state the basis for the model assumptions, the theoretical basis of the models and how the science is applied for these ecosystems, and how the models were developed to eliminate the appearance of subjectivity.

3.2.4 Programming/Spreadsheet Auditing Comments

Of the 27 models reviewed, 20 had associated software (1 model) or spreadsheets. System quality reviews were directed at the accuracy and usability of the software or spreadsheets. Comments from the programmers/spreadsheet auditors focused on calculation errors identified, spreadsheet architecture, and ease of use.

Representative comments on software and spreadsheets:

- Several errors, inaccuracies, and issues were identified in the spreadsheet model.
- Only the developers who are most familiar with the model will be able to use and understand the model because there is limited user documentation.
- The current model is not a standalone product and it is tedious to run for individual or multiple scenarios, rendering it error-prone and difficult to use for compensatory mitigation.
- Additional error checks and warnings need to be built into the program.
- There are several instances in the model where the code could be simplified by using Java's libraries, using a more object-oriented design, or taking more advantage of the language control structures.
- Additional comments should be added to the code to explain what the code is doing and what the programmer's intentions were.
- There is no evidence the model workbook has been tested for errors.
- The model workbook outputs are difficult to find.
- The model workbook does not allow users to structure alternatives and define alternative names conveniently within the model workbook.
- The current design and implementation of the model workbook can only compute FCIs and FCUs for four alternatives.

- The model workbook is not protected and requires/allows users to alter the model workbook formulas.
- The amount of subjectivity to the method could lead to substantially different results between users.
- Installation and use of the electronic calculation template are difficult for users accustomed only to the more commonly used components of Microsoft Office, namely, Excel, Word, and PowerPoint.
- There are numerous deficiencies in the Visual Basic code.
- The model documentation does not contain the information needed by users, reviewers, testers, developers, and release engineers of the electronic calculation template.
- Due to the architecture of the model workbook, there are many opportunities for errors to be made during development, maintenance, and user data entry.

3.2.5 Planning/Plan Formulation Comments

The purpose of the models and approaches reviewed is to serve as a planning tool for USACE projects involving ecosystem restoration or mitigation. As such, many of the model reviews required a plan formulation expert to be on the panel. Comments from planners generally focused on the same issues as the other disciplines.

Representative comments on planning:

- The application of models by ecological reaches is not appropriate for planning purposes.
- The model does not quantitatively represent wetland function and should only cautiously be used for differentiating between alternatives.
- The model documentation does not define the level of uncertainty associated with assigning element conditions (current and predicted) and how much of a difference between FCI scores is significant.
- The documentation does not adequately specify the methods by which input data are to be collected or modeled, the precision and accuracy of the input data that are required, or the required format of that data to ensure that the model provides repeatable results.
- The model outputs need more precision and sensitivity to support determinations of compensatory mitigation.
- There are a number of variables lacking in sensitivity, limiting the ability of the model to discriminate between sites.

3.3 Results and Analysis for Model Assessment Criteria

Model reviews focus on assessing the technical quality, system quality, and usability of planning tools. More recent reviews conducted by Battelle related each of the Final Panel Comments developed to the individual assessment criteria in the *Protocols for the Certification of Planning Models* (EC 1105-2-412, March 2011). This approach was used on reviews of the Jamaica Bay Evaluation of Planned Wetlands (EPW) model, the revised St. Johns-New Madrid Basin (SJNM) Shorebird Model, the Standard Assessment Methodology (SAM) and SAM Electronic Calculation Template (ECT), the Upper Des Plains (UDP) Community Models, and UDP HGM

reviews. Reviews of these five models/methods yielded 105 comments, of which 87 were related to the technical quality, 49 were related to system quality, and 87 were related to usability (the total is greater than 105 because these categories are not mutually exclusive, and comments often related to more than one aspect of a model/method). The relatively low number of comments on system quality is because the SJNM Shorebird Model, UDP Community Models and UDP HGM did not include a review of software or spreadsheets, so the review of system quality was limited. Table 8 shows the number of comments related to each of the model assessment criteria for each review.

Across reviews, the fewest number of comments was on system quality, even for the review of the SAM and SAM ECT, which had model spreadsheets that were reviewed. The Jamaica Bay EPW Model review had nearly as many comments on system quality as on technical quality and usability, most of which were of high significance. The Jamaica Bay model worksheets had numerous errors, including incorrect formulas, and were generally difficult to review and use. Although there were fewer comments on the SAM ECT, they were also assigned high significance levels and concerned erroneous model calculations and usability issues. In both cases, the calculation errors identified were easily fixed and the reviewers agreed that the model spreadsheets should not be used by individuals outside the model development team unless they worked closely with the development team.

Most of the comments on technical quality were related to how well the model represents the system, unclear or inappropriate assumptions, and model calculations and formulas. The comments assigned high significance identified errors in the spreadsheet calculations or formulas or identified a high likelihood of misuse of the model by anyone not a part of the model development team. The comments assigned medium significance related to the understanding and justification of the model parameters, parameter weighting, and model limitations; the level of subjectivity of the model; and the ability to evaluate uncertainty or the performance of the model. The comments assigned low significance related to the technical quality of the model documentation.

Comments on system quality were related to errors in the model calculations and spreadsheet formulas, lack of model testing and validation, lack of worksheet protection, deficiencies in the programming code, difficulty using the model worksheets, and difficulty finding or understanding model outputs. These comments were assigned either high or medium significance. The comments assigned high significance identified errors in the model calculations and formulas and the apparent lack of testing and validation. The comments assigned medium significance related to difficulty using the model worksheets and limited ability to test and validate the model outputs.

Comments on model usability were related to errors in the model calculations and formulas, difficulty using model worksheets, the level of subjectivity of the model, model testing and validation, limited documentation explaining how to use the model, low model sensitivity, and documentation. The comments assigned high significance identified errors in the model calculations and formulas, lack of testing or validation, difficulty with using the model worksheets, low model sensitivity, and poor correlation of model outputs with expert opinion. The comments assigned medium significance dealt with lack of justification of model parameters and weights, limited discussion of model assumptions and limitations, difficulty using the model and finding model outputs, and limited ability to verify and validate model performance. The

comments assigned low significance related to model documentation, including user documentation.

Overall, the issues identified affected model results with the greatest frequency (Table 8). The second and third greatest number of issues relate to model documentation and model calculations and formulas, respectively. The majority of issues affecting model results have to do with errors in the model calculations and formulas or potential misuse of the model because of limited documentation.

Not surprisingly, there was a high degree of overlap in the comments as they relate to technical quality, system quality, and usability. This is because many comments that relate to technical quality are also related to system quality and usability, and comments that relate to system quality also relate to usability. Examples of representative comments affecting each of the individual model assessment criteria are provided in the following sections.

Table 8. Number of Comments Relating to Each of the Model Assessment Criteria for Five Model Reviews

Relevant Assessment Criteria		Jamaica Bay Model Review	SJNM Shorebird Model	SAM and SAM ETC	UDP Community Models	UDP HGM Method	Grand Total
Criteria Related to Technical Quality	Theory and External Model Components	7	0	5	3	3	**18**
	Representation of the System	14	3	5	7	9	**38**
	Analytical Requirements	5	1	3	1	0	**10**
	Model Assumptions	10	5	6	4	5	**30**
	Ability to Evaluate Risk and Uncertainty	7	5	5	1	0	**18**
	Calculations and Formulas	23	4	11	9	2	**49**
	Ability to Calculate Benefits for Total Project Life	6	2	5	4	1	**18**
Criteria Related to System Quality	Supporting Software	11	0	12	0	0	**23**
	Programming Accuracy	23	0	9	0	0	**32**
	Model Testing and Validation	23	2	11	3	1	**40**
Criteria Related to Model Usability	Data Availability	15	2	7	0	4	**28**
	Results	34	5	15	7	3	**64**
	Model Documentation	24	2	15	8	3	**52**
Technical Quality		**36**	**7**	**18**	**13**	**13**	**87**
System Quality		**31**	**2**	**12**	**3**	**1**	**49**
Usability		**37**	**7**	**21**	**13**	**9**	**87**
Total Number of Comments		**41**	**10**	**22**	**15**	**17**	**105**

3.3.1 Technical Quality Comments

3.3.1.1 Comments Related to Theory and External Model Components

- Several important ecosystem attributes and wetland functions, most importantly flood flow moderation and spawning/breeding habitat, are not considered and quantified by the model.
- The development of the model is not clearly and thoroughly explained or justified.
- How elements are grouped and weighted is not explained or justified.
- The description of the assumptions and limitations of the model is incomplete.
- The biological interpretation of the index scores is not clear.

3.3.1.2 Comments Related to Representation of the System

- The model does not quantitatively represent wetland function and should only cautiously be used for differentiating between alternatives.
- The model elements do not distinguish between tidal freshwater and tidal saltwater wetlands.
- The model does not include variables for the amount of vegetative cover and vegetation height.
- The model should weight suitable shorebird habitat for patch size.
- Mean tree dbh alone is not a useful indicator of community condition.

3.3.1.3 Comments Related to Analytical Requirements

- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.
- The model documentation does not adequately specify the methods by which input data are to be collected or modeled, the precision and accuracy of the input data that are required, or the required format of that data to ensure that the electronic calculation template provides repeatable results.
- There appears to be poor correlation of model outputs with expert opinion of what is high, medium, and low quality habitat.
- Qualitative variables need to have quantitative boundaries.

3.3.1.4 Comments Related to Model Assumptions

- The amount of subjectivity to the method could lead to substantially different results between users.
- How elements are grouped and weighted is not explained or justified.
- Assuming that site parameters will be identical to present-day conditions for the entire period of analyses under without-project scenarios is not realistic.
- The description of the assumptions and limitations of the model is incomplete.
- Clear definitions of prairie, savanna, and woodland habitats, as well as non-native and invasive species, need to be provided in the documentation.

3.3.1.5 Comments Related to Models Ability to Evaluate Risk and Uncertainty

- The amount of subjectivity to the method could lead to substantially different results between users.
- There is no documented field testing or validation of the model.
- The model documentation does not define the level of uncertainty associated with assigning element conditions (current and predicted) and how much of a difference between FCI scores is significant.
- The models demonstrate limited utility in the evaluation of risk and uncertainty and do not appear to be used for that purpose.

3.3.1.6 Comments Related to Calculations and Formulas

- The development of the model is not clearly and thoroughly explained or justified.
- How elements are grouped and weighted is not explained or justified.
- The mathematical equations in the documentation are poorly formatted, erroneous, and mathematically incorrect.
- The sensitivity of the models appears to be low.
- The performance of the models has not been tested with independent data.
- There appears to be poor correlation of model outputs with expert opinion of what is high, medium, and low quality habitat.

3.3.1.7 Comments Related to the Model's Ability to Calculate Benefits for Total Project Life

- Although the model is likely to be useful for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is uncertain.
- Assuming that site parameters will be identical to present-day conditions for the entire period of analyses under without-project scenarios is not realistic.
- Because this is not a process-based model, it has limited capability to address the effects of global climate change.

3.3.2 System Quality Comments

3.3.2.1 Comments Related to Supporting Software

- Software quality assurance and validation procedures for the electronic calculation template are not documented.
- The design of the user interface of electronic calculation template is likely to contribute to elevated error rates and lowered productivity for developers, users, testers, and reviewers.
- Data entered into the Excel worksheet, and data entered into the Access database to modify habitat response curves, can contain obvious errors that both the Excel and Access components of the electronic calculation template fail to detect.

- Installation and use of the electronic calculation template is difficult for users accustomed only to the more commonly used components of Microsoft Office, namely, Excel, Word and PowerPoint.
- The model workbook outputs are difficult to find.

3.3.2.2 Comments Related to Programming Accuracy

- The model workbook contains numerous computational modularity violations.
- Users, developers, maintainers, and reviewers of the model workbook are prone to error because the model workbook does not make use of defined names.
- The model workbook is not protected and requires/allows users to alter the model workbook formulas.
- Several formulas in the worksheets are incorrect.
- The model workbook does not fully implement the model.
- The current design and implementation of the model workbook can only compute FCIs and FCUs for four alternatives.
- The model workbook does not signal errors in situations where errors are easily detectable.
- The user should only be able to select conditions and should not be able to input condition scores.
- There are numerous deficiencies in the Visual Basic code of the electronic calculation template.

3.3.2.3 Comments Related to Model Testing and Validation

- There is no evidence the model workbook has been tested for errors.
- The models should be verified to ensure that they are performing properly.
- No audit procedures for model workbook revisions are defined.
- The amount of subjectivity to the method could lead to substantially different results between users.
- The model could be strengthened if shorebird use of the habitat is considered during field validation.
- The model documentation does not contain the information needed by users, reviewers, testers, developers, and release engineers of the electronic calculation template.
- Whether the model is capable of achieving its intended purpose is uncertain.

3.3.3 Usability Comments

3.3.3.1 Comments Related to Data Availability

- The documentation does not adequately specify the methods by which input data are to be collected or modeled; the precision and accuracy of the input data that are required; or the required format of that data to ensure that the electronic calculation template provides repeatable results.

- Specific information needs to be provided regarding how data should be collected to ensure that classification, delineation of the assessment area(s), and data collection in support of variable scoring are repeatable.
- The reference standards were not based on data from reference standard sites.
- The reference standards were based on too few reference standard sites.

3.3.3.2 Comments Related to Results

- The amount of subjectivity to the method could lead to substantially different results between users.
- The current design and implementation of the model workbook can only compute FCIs and Functional Capacity Units (FCUs) for four alternatives.
- The model does not quantitatively represent wetland function and should only cautiously be used for differentiating between alternatives.
- There are limitations on the usability of model output chart sheets.
- Although the model is likely to be useful for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is uncertain.
- The user should not be able to alter the "official" species response curves.
- There appears to be poor correlation of model outputs with expert opinion of what is high, medium, and low quality habitat.
- There are a number of variables lacking in sensitivity, limiting the ability of the model to discriminate between sites.

3.3.3.3 Comments Related to Model Documentation

Comments related to model documentation comprise the majority of comments offered. In addition to those already mentioned, a few examples include:

- If the model is released for more widespread use outside of the model development team, the model documentation should be improved by providing additional information.
- Documentation and formatting of the worksheets of the model workbook is limited.
- There is no user documentation for the model.
- Having the description of the model in two sometimes misaligned documents, the original 2004 documentation and the 2010 model updates, can be a source of confusion to users.
- Some terms are not used accurately and/or consistently in the model documentation (e.g. population responses versus habitat changes; study reach, habitat unit, project and site) and other terms are not defined in the glossary or in the List of Acronyms and Abbreviations.

3.4 Results and Analysis of Significance of Comments

Significance levels have been assigned to 326 of the 418 model review comments evaluated. Significance levels were not assigned to comments from the reviews of the Fish Passage Effectiveness Index or the Island Community Units Model for Middle Chesapeake Bay Islands

Restoration Project. Significance levels reflect the level of attention that should be given to the issue and recommendations for resolution. Definitions of the three significance levels that are generally assigned are:

- **High:** Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose
- **Medium:** Affects the completeness or understanding of the model, usability of the model, or the level of performance of the model
- **Low:** Affects the technical quality of the model documentation but will not affect the performance of the model

The level of significance assigned to a comment may differ depending on whether a model is to be certified by USACE for widespread application by a broad user audience or approved by USACE for limited use of a specific project or set of projects. A comment assigned a high or medium level of significance for more widespread application by a broader user group may be assigned a medium or low level of significance, respectively, if the model is only to be used by those who are most familiar with its development and application. Regardless, any issues that may affect the ability of the model to produce the results needed to serve its intended purpose or the degree to which it can do so require attention.

Figure 9 shows the number of high, medium, and low significance comments for each of the reviews assessed. For most reviews, the majority of comments provided were assigned high or medium significance levels. This is because reviews are designed to focus on identifying the most important issues that could affect the ability of the models to serve their intended purpose. Four of the 25 models presented in Figure 9 did not have any high significance comments, and these reviews also yielded relatively low numbers of comments. Across all 25 reviews, 169 high, 115 medium and 42 low significance comments were received.

The numbers of high, medium, and low significance comments for each of the assessment criteria evaluated across five of the reviews are shown in Figure 10. The greatest number of high significance issues identified affects the model results and is related to the model calculations and formulas. The lowest numbers of high significance comments are related to technical quality assessment criteria (theory and external model components, analytical requirements, ability to evaluate risk and uncertainty, and ability to evaluate benefits for total project life) and the model software. The greatest number of low-significance comments relate to model documentation.

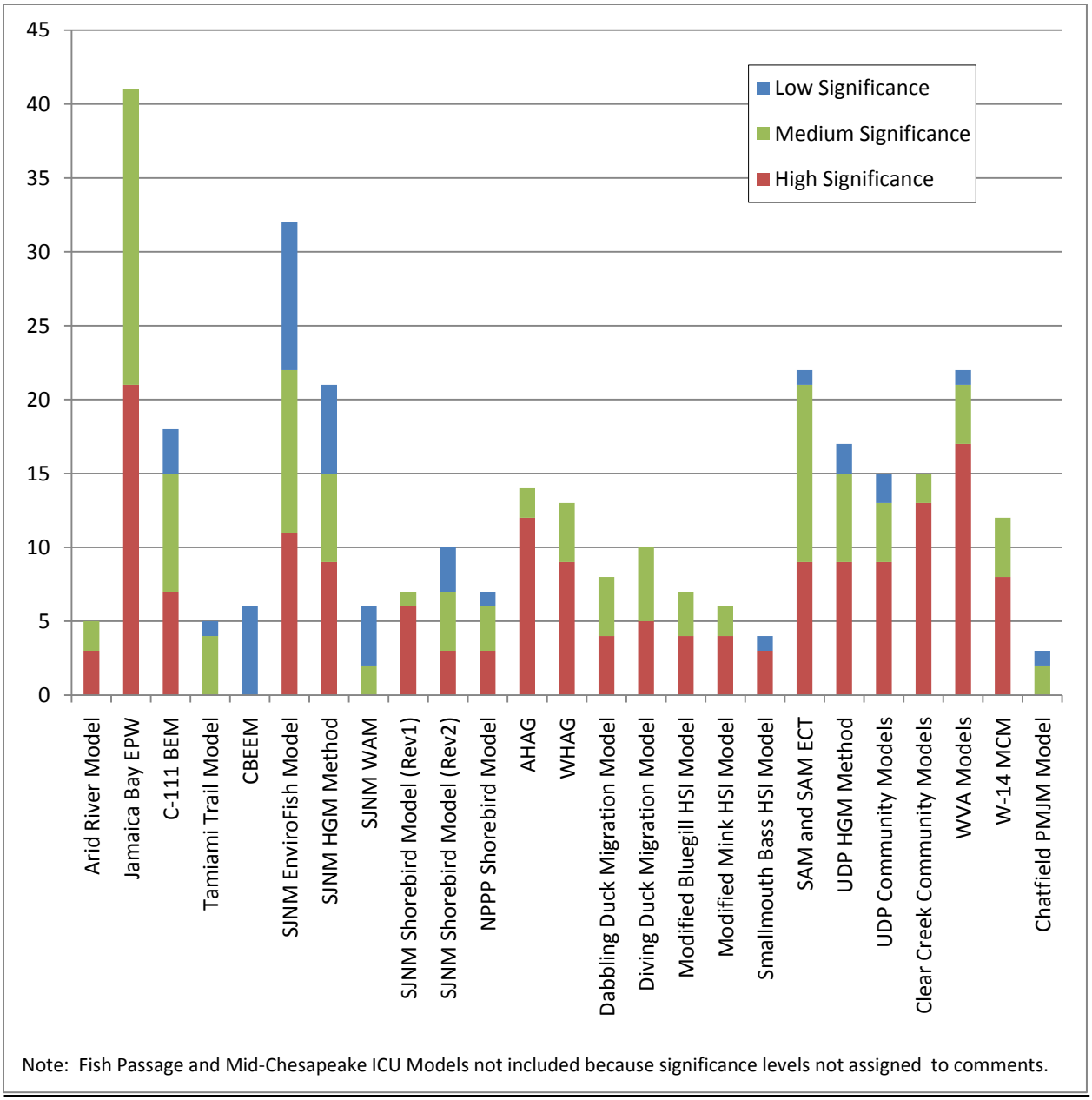


Figure 9. Comment Significance Levels for Each Model Review

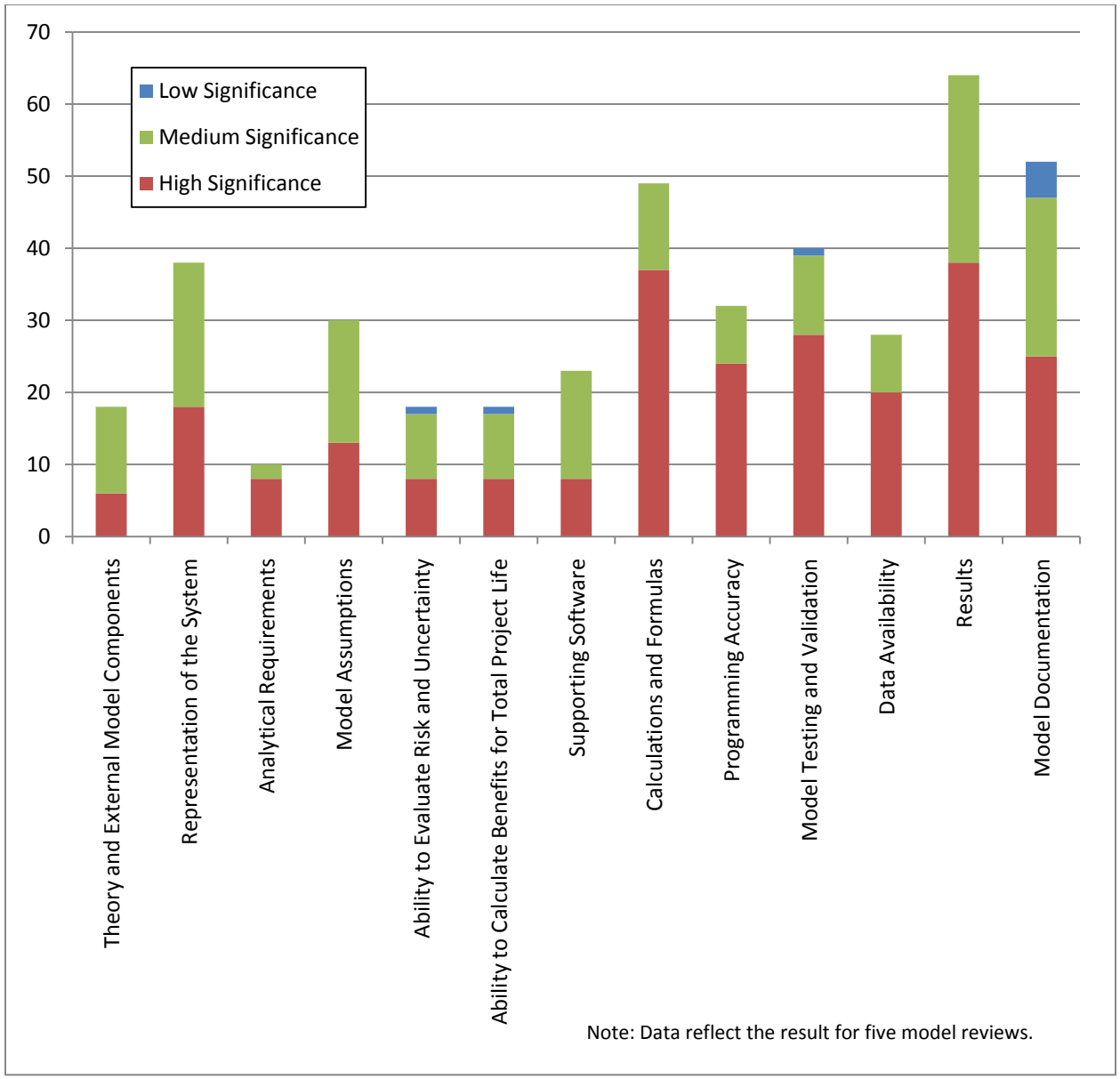


Figure 10. Significance of Comments Relating to Each of the Assessment Criteria

3.5 Considerations for Future Model Development

Common and notable comments are important because they can inform the development of future ecosystem planning models. This information can help model developers build better planning tools, reduce the time spent developing, reviewing, and revising planning tools, and reduce the potential need to redo project analyses if revisions to a model that has already been used are significant. This section provides some considerations for the development of future models.

A majority of the comments received led to recommendations for more detailed documentation, model testing, and validation, and addressed issues with model software or spreadsheets. Common recommendations across model reviews include the following.

3.5.1 Recommendations Regarding Model Documentation

- Model documentation should include:
  - A detailed description of the ecosystem or habitat being modeled
  - The intended purpose of the model, the level of precision and accuracy of model outputs, and how model outputs will be used by decision-makers
  - The spatial resolution and geographic boundaries of the model
  - A detailed description of how the model was developed, including explanation and justification for why some variables were included in the model and others were not, why the variables selected are best for representation of the system being modeled, and variable weights
  - A description of performance measures and how they are calculated
  - An explanation of how index values are assigned to variables and performance measures, how raw field data are used to calibrate Suitability Index (SI) curves, and how the index values correlate to predicted changes in habitat quality
  - A complete detailed description of model assumptions and limitations, including scientific support for the assumptions, to minimize potential misapplication of the model and provide a complete understanding of how model outputs can and cannot be used,
  - A clear description of model variables and how they are measured, including standard sampling methods for collecting data and measuring model input parameters, and the required precision and accuracy for model inputs
  - How to address climate change issues, when appropriate
  - Definition and consistent use of terms.
- Include literature references in the model documentation where appropriate and when possible.
- For models with associated spreadsheets/software, develop model spreadsheet/software user documentation that includes the model version, developers, and technical support contacts and explaining how to use the spreadsheet/software, how to prepare input data, and how to use model outputs.

3.5.2 Recommendations Regarding Model Development, Testing and Validation

- Link model outputs to ecologically significant conditions. For HSI and HGM models, it has been suggested that the resulting index should be linked to an ecologically significant condition, such as species richness, for example.
- Field-verify that index values accurately reflect habitat suitability/quality and are sufficiently robust to small variations in inputs that do not reflect a difference in habitat suitability/quality and sensitive to variations in inputs that do reflect a difference. Index values should correlate with expert opinion and or literature on ecological condition.
- Perform and document model testing and validation to ensure and support that:
  - The model performs as expected

- Model variables and outputs are sufficiently sensitive to measure differences between alternatives and sufficiently robust to yield meaningful results
- Sensitivity of the model outputs to variability in the model inputs is thoroughly understood
- The precision and accuracy of model outputs are determined
- How well measures of habitat suitability correlate with population or community abundances (i.e., performance measures) is determined.

- Review and update models regularly (e.g., every five years) to ensure that the model reflects contemporary theory.

3.5.3 Recommendations Regarding Model Analytical Requirements

- Use the highest reasonable level of precision when measuring model variables for the greatest accuracy and sensitivity of model outputs. The level of precision should be determined based on the expected sensitivity of model outputs for determining differences between proposed project alternatives, and the level of precision needed should be clearly documented (e.g., the level of precision for measuring water depth or elevation).
- Assign quantitative boundaries to qualitative variables to improve model sensitivity to differences in variable scores and reduce subjectivity, which can lead to differences in results between users.
- Use sufficient data to represent all sets of reference conditions.

3.5.4 Recommendations Regarding Model Spreadsheets and Software

- Make sure each model spreadsheet/software program includes the revision number and date, as well as the names and contact information for the developers.
- Document all revisions to the model.
- Keep model spreadsheets/software as simple as possible so that they are easy to use and revise in order to minimize errors. This includes:
  - Eliminating redundancies
  - Removing any vestigial inputs and calculations that aren't being used by the model
  - Making use of defined names and avoiding explicit cell references and switching sheets, which would reduce error and make development, maintenance and review easier
  - Using model worksheet architecture that is aligned with the input data worksheet format
  - Avoiding computational modularity violations (i.e., computing a quantity multiple times in various places in the model workbook)
  - Making use of programming libraries (as appropriate)
  - Using a more object-oriented design for Java programming

- Using a template engine for developing model code in order to make the programming language more compact and flexible and making code review and revision easier
- Adding comments to the code explaining the developer's intentions
- Developing the model as a spreadsheet or relational database when possible
- Making use of spreadsheet links to ensure that changes made to the data or formulas are updated throughout the spreadsheet
- Keeping model calculations separate from the user interface
- Making use of different fonts and cell fill colors to make finding input and output cells easier
- Providing clear instructions within the spreadsheets/software to guide the user's regarding data inputs
- Providing users with options for input variables that have a very specific set of values rather than allowing a user to enter any value
- Building in error checks and setting up warnings that alert the user when inputs or erroneous or out of range
- Designing the model so that the user is not limited running a single alternative scenario or very limited number (e.g. four) alternative scenarios at one time
- Allowing the user to define the model output folder for a project so that the user does not have to navigate to the project folder after each model run
- Making model outputs transparent and easy to find and understand (e.g., make sure units are included in outputs).

- Protect model calculation worksheets so that they cannot be altered either unintentionally or intentionally without a user password.
- Conduct and document a thorough review of model spreadsheets or software, including:
  - A quality assurance review of model spreadsheets/software to ensure the calculations and formulas are accurate
  - Unit testing for Java programming
  - Using a code analysis tool for Java programming
  - Document all code developed and subject it to code inspection.
- Maintain transparency in the model calculations to allow verification of model outputs.

3.5.5 Unique Notable Recommendations

Recommendations that were unique to a single review but notable because of their significance include:

- For models that will be used for assessing habitat suitability and changes in habitat suitability for particular species or guilds (e.g. fish or shorebirds), consult with the most recent literature and/or local experts regarding:
  - Which species or guilds should be represented
  - What parameters are most appropriate for modeling habitat suitability for those species or guilds

    - The level of precision necessary to provide the highest quality, most meaningful model outputs possible.
- SIs should be based on raw field data rather than averaged field data. When field data for characterizing a habitat or ecosystem are collected from more than one location within that habitat or ecosystem, a suitability index should be developed for each location across the site and then averaged rather that averaging data and developing a single suitability index for the site.
- Provide a detailed technical rationale for the number of years and range of years used to characterize hydrologic conditions.
- Develop performance measures that consider changes in critical model variables for highly dynamic environments (e.g. fluctuations in salinity).
- Include variables that address the importance of habitat patch size and shape, habitat corridors, and habitat connectivity.
- Model documentation should be a complete stand-alone document rather than relying on or referencing other documents developed for other purposes.
- When model outputs are based on a series of calculations, do not round results at each step in the calculations. Rounding at each step is mathematically inappropriate and could lead to model outputs being artificially robust and inappropriately sensitive.
- Hydrogeomorphic Guidebooks should include a table for each wetland subclass that provides a matrix of sub-indices and the FCI models in which they occur.
- Model habitat conditions during spring and fall migration of waterfowl separately.
- Waterfowl habitat suitability models should account for differences in feeding guilds.
- For models that are sensitive to topographic gradients, use the highest resolution data available and clearly explain any spatial resolution limitations of the model.
- Create a Developers' Guide that describes the technical details of the model spreadsheets/software at a level of detail required for continuing engineering. This document should be updated and subjected to review with each subsequent release.
- Develop a documented test procedure (Test Plan) and a documented release procedure (Release Plan) for each release, if it is desirable to issue subsequent releases.
- Protect the official species response or suitability index curves in model spreadsheets/ software so that users cannot alter the foundations of the model. However, allow users to experiment with their own relation set that receives a tamper-evident marking containing metadata sufficient to clearly identify the basis for alternative model outputs.
- HSI scores should be calculated as the aggregation of Average Annual Habitat Units (AAHUs) for individual species, and this calculation should be made transparent so that USACE planners can see which species would benefit from an alternative and which would not, since not all species will receive similar benefits from a project.
- Increasing the number of target years can improve the predictive ability of a model, given that projected changes are often non-linear.

4 LESSONS LEARNED

Over the past four years of conducting planning model quality assurance reviews, Battelle and other organizations have helped improve and refine the model review process by facilitating constructive discussions, identifying problematic issues, and developing practical and specific recommendations. At Battelle, After Action Reviews conducted with the Model Review Panel have assessed specific elements of the review process (communication, scope of work, schedule, and model review process) so that the process can be further improved for future model reviews.

The following sections discuss in detail the lessons learned that have been used to improve the model review process since 2005. Some lessons learned apply to all the types of peer reviews, while others are specific to model reviews.

4.1 Planning

Lessons Learned Affecting Battelle Actions

- Subcontractor COI statements should be comprehensive from the start so that expanding after the fact is not necessary. Without a complete COI from the start, time can be wasted going after a possible panel member who has a conflict with the project.
- Whenever possible, Model Review Panels should include one experienced reviewer or more, depending on the size of the Model Review Panel. The experienced members can serve as mentors on reviews with aggressive schedules.
- Members of a Model Review Panel who show a low level of performance during a review should be eliminated from consideration for panels for subsequent model reviews. Only those individuals who show a high level of performance should be considered for additional reviews. Subject matter experts who have been invited to participate in multiple model reviews have served on Model Review Panels from 2 to 5 model reviews. Of the 47 subject matter experts who have participated in the model reviews evaluated for this work, 12 have participated in more than one, and most have of these have not participated in more than two reviews.
- Identification of standard timeframes is needed to meet milestones and submit deliverables. Battelle has conducted reviews whose schedules have been affected by natural disasters, panel members being replaced, and technical difficulties (e.g., loss of electricity).
- Although a schedule is prepared at the beginning of the project and included in the work plan, the availability of panel members can necessitate changes to the schedule, which can affect milestones and deliverable dates.

Lessons Learned Affecting USACE Actions

- Delays in obtaining any of the review documents can affect the project schedule and overall costs, especially if the experts chosen for the panel are no longer available for a delayed schedule.
- Delays in receiving the contract award will affect any schedule because, in most cases, approximately 80 days are needed to conduct a review and deliver a quality product.

- Conflict of interest criteria and model review candidates should be reviewed within USACE by individuals with institutional knowledge of prior activities in the region to help prevent a delayed start resulting from non-disclosed COIs being identified after selected reviewers are under subcontract.
- Based on feedback from software/spreadsheet model experts, USACE should provide as many of the following items as possible for background when a model review includes a review of software or spreadsheets:
  - A certified packet identical to what would be distributed to users
  - Source code
  - All test artifacts: test plans, test suites, test results, any automation, etc.
  - All model/method documentation, including internal documents and user documents
  - User documentation in Word format
  - Tutorials, including the files users would generate by running the exercises of the tutorials
  - Any application files that were used to generate figures for the user documentation.
- Also based on feedback from software/spreadsheet model experts, USACE might benefit from either spreadsheet review preparation, code review, or tool review preparation prior to conducting the review. Preliminary review or preparation could result in a more efficient peer review with and fewer review comments based on issues or misconceptions.

4.2 Communication

Lessons Learned Affecting Battelle Actions

- It is essential that everyone receives the same information and has the same understanding of the model review process, and that deliverable dates can be met. With the exception of the kick-off teleconference, 100% attendance is required for teleconferences. In a very limited number of instances, the kick-off teleconference meeting has been conducted without one of the panel members because of extenuating circumstances (e.g., illness, death of a loved one, need to replace a panel member after participation in the kick-off meeting), and a separate kick-off meeting has been held for that individual. This is considered the least critical point in the review process and the kick-off meeting is held as scheduled in order to maintain the review schedule.
- Model reviewers need to be continuously available during the Final Panel Comment development phase in order to produce a high quality product and maintain the review schedule.
- All individuals involved in a review should use a standard/constant subject heading for all e-mail communication associated with an individual review. This minimizes the potential that critical communications will get lost in inboxes. It also helps people organize/track information when dealing with multiple reviews/projects, etc. (for instance, in Outlook, one develops rules to flag, move, archive e-mails).

Lessons Learned Affecting USACE Actions

- Rapid response by the USACE model proponents to information requests from the model reviewers is essential to ensure that they have all of the information they need to perform a thorough, high quality review within the required schedule. Failure to fulfill information requests during the review period can result in review comments that reflect a lack of information or understanding.
- Communication is critical for managing possible disruptions in schedule and funding. Failure to communicate project progress and schedule could lead to a reduction in the quality of review results (e.g., when a review is too rushed or when it is dragged out over too long a period of time without any activity on the review), missed deadlines (e.g., when the schedule and quality for a planning project hinges on the results of a planning model review), or failure to use funding within the required period of performance.

4.3 Conduct Model Review

Lessons Learned Affecting Battelle Actions

- Reviews should be staggered for projects involving reviews of multiple models, if the review schedule allows, and the same subject matter experts should be used across all of the reviews that have similar expertise requirements. This approach is more cost-effective because there are fewer individuals to brief on the model and model review process for a kick-off call. Having fewer members of a Model Review Panel also makes it easier to coordinate schedules for teleconferences.
- Appoint a separate Project Manager for each model when a review of multiple models is conducted for the same project and the individual models are reviewed simultaneously (or with very close or the same deliverable dates). Each person conducting a review needs to be focused on that review and must be able to devote time to just that one review, rather than trying to work with two different groups to prepare final panel comments and reports at the same time. The Program Manager oversees simultaneously conducted reviews to ensure consistency.
- Prepare a formal PowerPoint presentation at the kick-off meeting to provide panel members with a better understanding of the process, schedule, and communication responsibilities.
- Schedule a formal kick-off meeting with USACE to ensure that the PCX, model proponents, and review coordinators start the project with a common understanding of the project, expectations, and schedules.
- Double-check that reviewers receive all items (e.g., documents via Federal Express, final panel comments via e-mail, meeting notices). Some mailing addresses do not work for mail and Federal Express, and some e-mail systems will not accept a large number of files sent in the same e-mail, send unknown e-mail addresses to Junk mail, or sometimes drop e-mails due to system or mailbox problems.
- Recognize that not all panel members are alike; some may need extra help in getting started as well as additional hours for the review.
- If subcontractors are requested to provide additional review or conduct additional work, modify their subcontracts, whether they need additional hours or not.

- Ask USACE to demonstrate any software being reviewed, as needed, prior to providing it to the model reviewers so the review coordinator knows how it is supposed to work.
- Do not formulate specific charge questions for each section of model documentation. General questions related to the assessment criteria described in the *Protocols for the Certification/Approval of Planning Models* (EC 11-5-2-142) are sufficient to guide the model reviewers and help them identify any issues/concerns with the models and their documentation.
- Additional assessment criteria/charge questions that are specific to reviews involving software or spreadsheet models need to be developed. As applicable, a review involving software should include an assessment of the source code, user interface design, and software or spreadsheet usability (as opposed to the model usability). When a review involves software or spreadsheets, the term "model" should clearly be defined as the underlying theoretical basis for the method that has been implemented in the software. Other definitions and a revised list of charge questions is also recommended (see Appendix B).
- During the model review teleconference, discuss guidance for the development of Final Panel Comments to improve chances that first drafts will be closely aligned with expectations.
- Schedule approximately 5 days to finalize the Final Panel Comments after the draft versions are received from the panel. The original Final Panel Comments always need review and editing to conform to the expectations of the model review; it is important to ensure that the comments are clear and well-written, there is consistency within each Final Panel Comment, and there is no duplication.
- Provide the panel with any additional information requested without delay; otherwise Final Panel Comments may be based on a lack of understanding of the materials provided.

Lessons Learned Affecting USACE Actions

- It is best to involve individuals who are most experienced with the development and/or application of the model in all meetings involving dialogue between reviewers and the model proponent. This practice can significantly reduce the duration of meetings/ teleconferences and provide an opportunity to more immediately, directly, and credibly respond to inquiries and comments of the Model Review Panel, which in turn can reduce frustration levels that might otherwise contribute to a decline in "team" mentality.
- USACE must be diligent in responding completely to requests for information if the review is to remain on schedule. PCX review managers should be prepared to engage the model proponent (or seek alternative means) to ensure satisfactory responses to pending information requests.

4.4 Reporting

Lessons Learned Affecting Battelle Actions

- Develop a standard template for the Planning Model Quality Assurance Review Report to ensure consistency and efficiency in assembling report material.

- Schedule the preparation of the final Planning Model Quality Assurance Review Report to allow sufficient time for USACE to prepare final Evaluator Responses, the model reviewers to prepare final BackCheck Responses, and Battelle to incorporate the responses, address comments, and submit the report for technical and editorial review prior to submission of the report to USACE. Previously, the time scheduled was five business days because revisions to the draft report were typically minor in nature. Under the new approach, approximately 20 days is necessary between the model review findings teleconference meeting and the submission of the final report to allow the development of final Evaluator and BackCheck responses.

Lessons Learned Affecting USACE Actions

- The need for the PCX review managers to be diligent in reminding members of the model proponent's team of upcoming milestones, pending requests for information, and/or review response timelines cannot be understated or overvalued. Given the multiple priorities frequently experienced by USACE field staff, it will frequently be up to the PCX review coordinator to prompt USACE action.

4.5 Comment/Response

Lessons Learned Affecting Battelle Actions

- It is easier for USACE to provide draft Evaluator Responses if they are provided with a Word file with the Final Panel Comments.
- It is more efficient and effective to convene a teleconference with the PCX, Model Proponents, and Model Review Panel to discuss each of the Final Panel Comments rather than exchanging responses via e-mail.
- The comment-response exchange should be formally in the final Planning Model Quality Assurance Review Report to provide a better record of the review results, recommendations, and outcomes.

4.6 Project Closeout

- Clearly document any lessons learned during the model review process rather than waiting until project closeout so that important lessons learned are not overlooked or forgotten.

5 VALUE OF PLANNING MODEL QUALITY ASSURANCE REVIEWS

Battelle asked the USACE Technical Points of Contact (POCs) for model reviews to comment on the value of the independent model reviews conducted by Battelle. Of the six POCs contacted, two responded directly to the request while others had responded at the time of the review. For all reviews, the insight was helpful and led to changes that improved the model/method, the software, and/or the model documentation. Model reviews have helped model developers:

- Identify and correct calculation errors in model spreadsheets or software
- Recognize and reduce the potential for errors and inaccuracies

- Identify ways to improve the model code, interface, and documentation for future revisions of the model spreadsheets or software,
- Improve the resolution of model results
- Improve model documentation.

All but two of the 37 ecosystem planning models reviewed have been approved either for a specific regional project or broader general application, as intended. USACE model proponents have unanimously agreed that review recommendations to improve the planning models have been valuable. Model reviews provide meaningful information that supports USACE decisions on the acceptable use and certification of planning models. This ultimately leads to higher quality, more defensible planning decisions for USACE.

6 SUMMARY AND CONCLUSIONS

Model reviews provide indispensible value to USACE by helping identify issues or potential issues with planning tools being used. By identifying these issues, higher quality, more accurate analyses have been conducted for the evaluation of project alternatives. Addressing issues early in the process has resulted in efficiencies for project planning and planning decisions that are more technically defensible.

Since 2008, the model review process has been developed and improved, resulting in the conduct of efficient, high quality reviews that meet USACE needs in an effective and timely manner. The use of approved procedures and templates, development of an extensive expertise database, and conduct of model reviews by highly experienced technical individuals and project managers contribute to these efficiencies, along with the dedicated support of subcontracted subject matter experts, to meet deliverable deadlines and provide a high quality review. The success of model reviews hinges on the positive team culture fostered among the review planning team, the Model Review Panel, and the USACE team.

Across reviews, the greatest number of comments received related to model documentation: documentation of the model development, model testing and validation, data collection methods, and use of model spreadsheets/software and output. Clear documentation is critical for both users and reviewers and is particularly important to justify and support planning decisions based in part on planning model outputs.

Most reviews also yielded comments on model testing and validation. Testing and validation of model performance is necessary to confirm that model outputs are meaningful and sufficiently sensitive to distinguish between alternatives. Results of testing and validation exercises must be documented to demonstrate the ability of models to serve their intended purpose.

Many model reviewers found model spreadsheets or software to be error-prone and difficult to use. They identified calculation errors and recommended simplifying the model code, architecture, and interface. They also suggested developing user documentation that describes how to process input data, use the model, and use model outputs. To reduce the number of issues identified with model spreadsheets and software, it is recommended that a programming/

spreadsheet specialist work with model developers to inform them about common errors, provide recommendations for ways to simplify the development, use, and maintenance of model spreadsheets/software, and perform a thorough check for errors prior to release for review by an independent Model Review Panel.

Overall, model reviews have provided significant value to the development of USACE ecosystem planning models and the projects for which the planning models have been used. The results of model reviews have led to the improvement of planning tools being used by USACE and either approval of models for limited or regional use, or certification of models for more widespread use across USACE projects. This ultimately has led to higher quality analyses and greater confidence in USACE planning decisions.

7 REFERENCES

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APPENDIX A

Examples of Master Schedules

- **Traditional 75-day schedule**
- **Delayed Documents Schedule**
- **Updated Expanded Schedule to Accommodate Comment-Response**

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Traditional Schedule

8/5/2010

Milestones and Deliverable Schedule by Task
Deliverables are noted with an asterisk (*)

TASK	ACTION	DAYS TO COMPLETE ACTION	DUE DATE
	NTP		8/5/2010
	Review documents available		8/5/2010
1	USACE/Battelle Kick-off Meeting	Within 5 days of NTP	8/10/2010
2	*Battelle submits Draft Schedule to USACE	Within 5 days of NTP	8/10/2010
	USACE provides comments on Schedule	Within 2 days of kickoff meeting with Battelle	8/12/2010
	*Battelle submits Final Schedule with Final Work Plan andFinal Charge	Within 10 days of kickoff meeting with USACE	8/24/2010
3	*Battelle submits Draft Charge	Within 5 days of NTP or receipt of review documents	8/12/2010
	USACE provides comments on draft charge	Within 2 days of receipt of draft charge	8/16/2010
	*Battelle submits Final Charge with Final Work Plan and Final Schedule	Within 10 days of kickoff meeting with USACE	8/24/2010
	USACE approves Final Work Plan, Charge, and Schedule	Within 2 days of receipt of Final charge	9/1/2010
4	Battelle provides USACE with conflicts of interest (COI)	Within 5 days of kickoff meeting with USACE	8/17/2010
	Battelle recruits and screens up to 12 potential model reviewers for panels A&B and prepares summary information	Within 15 days of kickoff meeting with USACE	8/31/2010
	*Battelle submits list of selected model reviewers for panel	Within 15 days of kickoff meeting with USACE	9/1/2010
	USACE provides comments on expert list for panel	Within 2 days of receipt of expert list	9/3/2010
	Battelle completes subcontracts for model reviewers for panel	Within 10 days of USACE comments on potential list	9/17/2010
5	Review documents sent to model reviewers	Within 1 day of panel being under subcontract	9/20/2010
	Battelle/panel Kick-off Meeting	Within 3 days of panel being under subcontract	9/24/2010
	USACE/Battelle/panel Kick-off Meeting with peer reviewers	Within 3 days of panel being under subcontract	9/24/2010
	Model review panel completes their review	Within 15 days of Kick off meeting	10/18/2010
	Battelle collates comments from model review panel	Within 2 days of receipt of peer reviewer comments	10/20/2010
	Battelle convenes model review teleconference	Within 3 days of receipt of peer reviewer comments	10/21/2010
	Model reviewers provide comments on Draft Model Review Report	Within 2 days of receipt of MODEL report	11/16/2010
6	*Battelle submits Draft Model Review Report to USACE for review	Within 3 days of receiving comments from model reviewers on draft report	11/19/2010
	USACE provides comments on Draft Model Review Report	Within 5 days of receipt of draft report	12/3/2010
7	Battelle convenes teleconferences to discuss USACE comments on Draft Model Review Report	Within 2 days of receipt of comments	12/7/2010
8	*Battelle submits the Final Model Review Report to USACE	Within 5 days of review conference call on USACE Draft Report Comments	12/14/2010
	Project Closeout	Within 45 days of report or end of period of performance	2/18/2011

Documents Delayed Schedule

8/11/2010

Milestones and Deliverable Schedule by Task
Deliverables are noted with an asterisk (*)

TASK	ACTION	DAYS TO COMPLETE ACTION	DUE DATE
	NTP		10/1/2010
	Review documents available		3/17/2011
1	USACE/Battelle kick-off meeting	Within 5 days of receipt of review documents	3/24/2011
2	*Battelle submits proposed schedule to USACE	Within 5 days of receipt of review documents	3/24/2011
	USACE provides comments on proposed schedule	Within 2 days of kickoff meeting with Battelle and USACE	3/28/2011
	*Battelle submits revised schedule and draft charge to USACE	Within 5 days of kick-off meeting with Battelle and USACE	3/31/2011
3	Battelle provides USACE with conflicts of	Within 5 days of kick-off meeting with Battelle	3/31/2011
	Battelle recruits and screens up to 10	Within 15 days of kickoff meeting with Battelle	4/14/2011
	*Battelle submits list of up to 10 selected model reviewers for panel	Within 15 days of kickoff meeting with USACE	4/14/2011
	USACE provides comments on expert list	Within 2 days of receipt of expert list	4/18/2011
	Battelle completes subcontracts for model reviewers for panel	Within 10 days of USACE comments on potential list	5/2/2011
4	Review documents sent to model reviewers	Within 1 day of panel being under subcontract	5/3/2011
	Battelle/Panel kick-off meeting	Within 3 days of panel being under subcontract	5/5/2011
	USACE/Battelle/Panel kick-off meeting	Within 3 days of panel being under subcontract	5/5/2011
	Model reviewers complete their review	Within 21 days of kick-off meeting	6/6/2011
	Battelle collates comments from model reviewers	Within 2 days of receipt of model reviewer comments	6/8/2011
	Battelle convenes model review teleconference	Within 3 days of receipt of model reviewer comments	6/9/2011
	Model reviewers provide comments on draft Planning Model Quality Assurance Review Report	Within 1 day of receipt of draft Model Review Report from Battelle	6/28/2011
5	*Battelle submits draft Planning Model Quality Assurance Review Report to USACE	Within 3 days of receiving comments from model reviewers on draft report	7/1/2011
	USACE provides responses to Final Panel Comments and comments on draft Planning Model Quality Assurance Review Report	Within 15 days of receipt of draft report	7/25/2011
6	Battelle convenes findings teleconference to discuss USACE response to model review findings and comments on draft Planning Model Quality Assurance Review Report	Within 4 days of receipt of comments	7/29/2011
7	*Battelle submits the Final Planning Model Quality Assurance Review Report to USACE	Within 7 days of findings teleconference	8/9/2011
	Project Closeout	Within 45 days of report or end of period of performance	10/13/2011

Updated Expanded Schedule to Accommodate Comment-Response

Date of Schedule: 11/2/2011

Milestones and Deliverable Schedule by Task
Deliverables are noted with an asterisk (*)

TASK	ACTION	DAYS TO COMPLETE ACTION	DUE DATE
	Award Effective Date		9/20/2011
	Review documents available		9/20/2011
1	USACE/Battelle kick-off meeting	Within 5 days of NTP	9/28/2011
2	*Battelle submits draft schedule to USACE	Within 5 days of NTP	9/28/2011
	USACE provides comments on Schedule	Within 2 days of kick-off meeting with Battelle	9/30/2011
	*Battelle submits revised schedule and draft Work Plan and charge, including charge questions, to USACE	Within 5 days of kick-off meeting with USACE	10/5/2011
	USACE provides comments on draft charge	Within 2 days of receipt of draft charge	10/7/2011
	*Battelle submits Final Work Plan with final charge and final schedule	Within 10 days of kick-off meeting with USACE	10/13/2011
	USACE approves Final Work Plan, charge and schedule	Within 2 days of receipt of Final charge	10/17/2011
3	Battelle provides USACE with conflicts of interest (COI) questionnaire	Within 5 days of kick-off meeting with USACE	10/5/2011
	USACE provides comments on COI questionnaire	Within 2 days of receipt of COI questionnaire	10/7/2011
	Battelle recruits and screens up to 6 potential model reviewers	Within 10 days of kick-off meeting with USACE	10/13/2011
	*Battelle submits list of selected model reviewers for panel	Within 10 days of kick-off meeting with USACE	10/13/2011
	USACE confirms no COI for panel	Within 2 days of receipt of expert list	10/17/2011
	Battelle completes subcontracts for model reviewers for panel	Within 7 days of USACE comments on potential list	10/26/2011
4	Review documents sent to model reviewers	Within 1 day of Panel being under subcontract	10/27/2011
	Battelle/Model Review Panel kick-off meeting	Within 3 days of Panel being under subcontract	11/3/2011
	USACE/Battelle/Model Review Panel kick-off meeting	Within 3 days of Panel being under subcontract	11/3/2011
	Battelle convenes mid-review teleconference	Within 10 days of kick-off meeting with Battelle, Model Review Panel and USACE	11/18/2011
	Model Review Panel completes their review	Within 21 days of kick-off meeting	12/7/2011
	Battelle collates comments from Model Review Panel	Within 2 days of receipt of model reviewer comments	12/9/2011
	Battelle convenes model review teleconference	Within 3 days of receipt of model reviewer comments	12/12/2011
	Model reviewers provide Final Panel Comments to Battelle	Within 7 days of model review teleconference	12/21/2011
5	Battelle provides draft Planning Model Quality Assurance Review Report to Model Review Panel for review	Within 11 days of receipt of FPCs and writing assignments from panel members	1/9/2012
	Model reviewers provide comments on draft Planning Model Quality Assurance Review Report	Within 2 days of receipt of model review report	1/11/2012
	*Battelle submits draft Planning Model Quality Assurance Review Report to USACE for review	Within 3 days of receiving comments from model reviewers on draft report	1/17/2012
6	USACE provides draft Evaluator Responses to Final Panel Comments in the draft Planning Model Quality Assurance Review Report and comments on the report	Within 10 days of receipt of draft report	1/31/2012
	Model reviewers provide Battelle with draft comments on draft Evaluator Responses (i.e., draft BackCheck Responses)	Within 3 days of receipt of draft Evaluator Responses from Battelle	2/8/2012
	Battelle convenes teleconference with Model Review Panel and USACE to discuss Final Panel Comments and draft responses	Within 8 days of receipt of USACE Evaluator Responses	2/10/2012
7	USACE provides final Evaluator Responses	Within 5 days of Final Panel Teleconference	2/17/2012
	Panel members provide Battelle with final BackCheck Responses	Within 3 days of receipt of final Evaluator Responses	2/28/2012
	*Battelle submits the final Planning Model Quality Assurance Review Report to USACE	Within 14 days of receipt of final Evaluator Responses	3/9/2012
	Project Closeout	Within 45 days of report or end of period of performance	5/11/2012

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APPENDIX B

Recommendations for Revising Charge Questions for Planning Model Quality Assurance Reviews Involving a Review of Spreadsheets or Software

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Recommendations for Revising Charge Questions for Planning Model Quality Assurance Reviews Involving a Review of Spreadsheets or Software

The recommendations below reflect the viewpoints of one software programmer/ spreadsheet auditor that has served on more than one Model Review Panel. The feedback provided indicted that charge questions currently being provided to model reviewers either lack specificity or use terminology that leads to confusion among panel members when the review involves spreadsheets or software and the Model Review Panel includes a software programmer/spreadsheet auditor. That confusion can lead to ambiguity in Final Panel Comments. Developing a customized set of charge questions that addresses these two issues depends on two preliminary clarifications:

1. A set of terms and associated usage that will reduce ambiguity and foster clarity in panel discussions and in development of Final Panel Comments.
2. A set of assessment criteria that builds on the existing set of assessment criteria, but which refines and extends them to obtain a better fit to the needs model reviewers when the review materials include software.

Proposed terminology

In the review materials for systems, the terms *model* and *system* have been used in ways that can lead to some confusion in discussions among panelists, when the materials reviewed included software components. This confusion has at times propagated into Final Panel Comments. The existing terminology works well for reviews of materials that do not include software components. However, when software is involved, a small adjustment in terminology can result in a more effective and efficient review. Below is one set of possible clarifying adjustments to the terminology for reviews that involve software components. Alternative approaches are certainly possible.

Model

The Model is the underlying theoretical basis for the method that has been implemented in the *software*.

Software

The Software includes any proponent-implemented software components that are being offered for review.

System

The System is the aggregation of the Software and any substrate elements needed for the execution of the Software.

User

A User is someone who will actually be employing the System, directly and personally.

User Platform

The User Platform is any configuration of hardware and software that supports the Model during use. It is essentially the System minus the Software.

User Documentation

User Documentation is the collection of documents, in whatever form, that have been developed to assist Users as they employ the Software. These documents are the documents written specifically to support users of the Software. User

documentation includes stand-alone documents distributed in Word or Acrobat format, and on-line documentation that is available within the System. User Documentation includes User Guides, Tutorials, on-line help, and Reference Guides. It specifically excludes Model Documentation.

Model Documentation

Model Documentation includes any documents, in whatever form, that have been developed or selected by the proponents for the purpose of explaining, describing, or presenting the Model to Users of the System, or to decision makers considering adopting the system for use in their organizations.

System Administrator Documentation

System Administrator Documentation includes any documents, in whatever form, provided in association with the System for the use of System Administrators when they install, de-install, or update the Software.

Development Environment

The Development Environment is the full set of software and hardware tools employed by the development team to create and test the Software.

Note: The document "ASSURING QUALITY OF PLANNING MODELS" (EC 1105-2-412) contains this sentence: "The supporting software tool/programming language is appropriate for the model." It is Criterion (a) of System Quality. This wording assumes that only one tool, or only one programming language, is required for developing a software system. Although many systems are developed that way, restricting evaluation criteria to single-tool/single-language systems is increasingly unrealistic. A criterion more fitting to modern software development practice would be, "The Development Environment employed is appropriate for the Software." This change might convey to proponents the desirability of documenting and justifying the fitness of their Development Environments.

Release Stream

If the proponents intend to release future updates, the release stream is the sequence of updates.

Release Environment

The Release Environment is the full set of software and hardware tools employed by the release team to prepare the software for distribution.

Note: To date, model review materials have only included cursory information about the Release Environment. Unless such information is provided, it is impossible for any outside party to make any reasonable projections as to the ability of the release team to provide reliable subsequent releases. Model Review Panels that do not have access to information about the Release Environment and the Release Documentation cannot make conclusions about the quality of any future release.

For Systems that are intended to have release streams, adding a charge question about the Release Environment and Release Documentation, and publicizing that question, might cue proponents to consider the importance of justifying their claims of ongoing release capability.

Test Documentation

Test Documentation is the set of documents, in whatever form, that support the testing effort. It includes test plans, test procedures, test suites, and test results.

Test Infrastructure

Test infrastructure includes Test Documentation, testing software, testing tools, test scripts, defect tracking software, and defect tracking databases.

Release Documentation

The Release Documentation is the set of documents, in whatever form, that support the release stream. It includes release plans, release procedures, budgets, schedules and any other material that is needed to document the means of supporting the Software and its Users with respect to production and distribution of updates.

Support Infrastructure

The Support Infrastructure is the set of people, communications infrastructure, and training infrastructure that serve Users. It includes e-mail distribution lists, support lines, Web sites, and staff.

Charge questions for use when review materials include spreadsheets or software

Below, is an example of the proposed customizations for charge questions when a planning model quality assurance review includes spreadsheets or software. The terms defined above are capitalized to enable easy identification. Some are also hyperlinked to their definitions. Model reviewers will need access to terminology definitions, probably in the form of a Glossary.

General Questions

Q1. Are the Model's design objectives and intended uses clearly communicated?

Q2. To what extent does the Model meet the expressed design objectives?

Q3. To what extent is the Model suitable for the expressed intended uses?

Q4. Are the System's design objectives and intended uses clearly communicated?

Q5. To what extent does the System meet the expressed design objectives?

Q6. To what extent is the System suitable for the expressed intended uses?

Technical Quality

Q7. Please comment on the quality of the User Documentation, Model Documentation, System Administrator Documentation, Test Documentation, and Release Documentation. (Note: For some reviews, only some of this documentation may be provided.)

Q8. Please comment on the technical quality of the Model and System relative to their expressed design objectives.

a. Please comment on the degree to which the assumptions and limitations of the Model are clearly communicated.

b. Please comment on the degree to which the assumptions and limitations of the System, to the extent that they differ from the assumptions and limitations of the Model, are clearly communicated.

Q9. Is the Model based on well-established contemporary concepts?

Q10. Is the System implemented according to well-established contemporary concepts?

Q11. Has the System been tested according to well-established contemporary concepts?

Q12. With respect to reasonable variation of variables critical to the intended uses (*i.e.*, application of the model during planning of water resource and restoration activities):

a. Does the Model provide for such variation?

b. Does the System enable the User to take such variation into account?

Q13. Comment on sensitivities of the Model and identify the variables/factors to which the model is most sensitive.

Q14. Are the input requirements of the Model and the System evident to the User (*i.e.*, types as well as accuracy and precision)?

Q15. Is it evident to the User how the inputs are used by the model?

Q16. Are assumptions critical to valid application of the System clearly identified and characterized such that violation of a critical step or assumption would become apparent?

Q17. Please comment on the degree to which Model assumptions or System assumptions might invalidate the use of the System for specific applications.

Q18. Please comment on the degree to which the Model and System, respectively, facilitate/accommodate uncertainty and risk analyses.

Q19. For the Model and for the System, and all or their documentation, respectively:

a. Are the formulas used correct?

b. Are computations adequately documented?

b. Are computations correct?

c. Are computations (mathematical logic) appropriate?

Q20. Please comment on the security of the formulas implemented in the System, relative to intentional User modification.

Q21. If the System contains internal data tables, please comment on the security of those tables relative to User modification.

Q22. Please comment on the degree to which the Model and System, respectively, are configured to accept modified assumptions and inputs regarding future global events such as, but not limited to, global climate change.

System Quality

Q23. Please comment on the adequacy of the description of the rationale for:

a. The selection of the Development Environment

b. The range of acceptable User Platforms

Q24. Is the Development Environment appropriate for the System?

Q25. Is the Release Environment appropriate for the System, and for its intended release stream (if any)?

Q26. Is the Test Infrastructure appropriate for the System?

Q27. To what degree is the System stable?

Q28. Is the User protected from internal System errors?

Q29. Please comment on the degree to which the Model and System, respectively, have been tested for errors.

Q30. Does the System respond appropriately to illicit or inconsistent inputs?

Q31. To what degree are error checks built into the System?

Usability

Q32. Please comment on the usability of the Model for selecting the best course/plan of action.

Q33. Please comment on the usability of the System.

Q34. Please comment on the Model's practicality and application/input requirements.

Q35. Please comment on the availability of the data required by the Model.

Q36. Please comment on the understandability of Model output(s) and System output(s), respectively.

Q37. Please comment on the transparency of Model output(s).

Q38. Is the User Documentation user friendly and complete?

Q39. Please comment on the quality, availability, and ease of use of the Support Infrastructure.

Q40. Please comment on the survivability of User data with respect to the Software's update stream.

Q41. Is the System transparent and does it allow for easy verification of calculations and outputs?

Q42. Can data be readily imported from/into other data analysis tools?