DAM MODELING COMMUNICATION FACT SHEET

Phase I: Pre-Analysis Communication Best Practices

PURPOSE

This fact sheet presents a framework for an engineer/modeler to communicate plans for hydrologic, hydraulic, seepage, and stability models to both a dam owner and regulatory agency. Computer models can be useful tools in evaluating the performance of dams and appurtenant structures, watersheds, and a dam's downstream consequences. There are a variety of approaches and methodologies for these modeling efforts, and it is important to owners, consultants, and regulators that clear communication is integrated in the process. The purpose of this fact sheet is to guide communication among all interested parties prior to commencing a modeling effort. Such pre-modeling communication may include a project scoping meeting, a scope of work, and/or a modeling work plan submittal or meeting with a regulator.

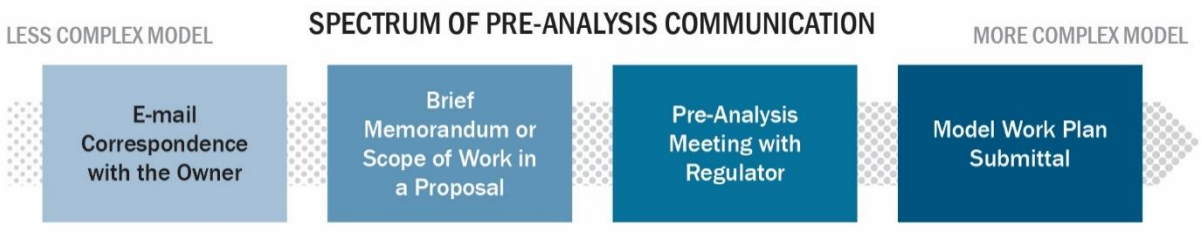
The need for clear communication is apparent in these unfortunate but common dam modeling scenarios:

- A consultant, working on behalf of the dam owner, evaluates an existing structure for seepage and stability performance. The dam owner submits the findings of the modeling effort in a report to the regulator. The regulator reviews the modeling report and responds to the owner with many comments, some of which contest the initial assumptions made by the consultant. The owner, consultant, and regulator attempt to resolve the comments and revise the model and report several times at the expense of the owner's budget and schedule.
- A consultant, working on behalf of the dam owner, develops a hydrologic model used to model a dam's inflow design flood (IDF). The regulator recently published updated guidance documents for hydrologic modeling and IDF development. The consultant develops and submits the model based on the previous guidelines. The regulator reviews the modeling report and asks for a resubmittal using the new guidance documents before further comments are made. The consultant is then required to redevelop the model and resubmit, at the expense of the owner's budget and schedule, prior to the detailed regulatory review.
- The modeling project and expected review timelines are not communicated to the regulator at the start of a modeling effort. Once the modeling report is submitted, the regulator, who may be understaffed, is not able to review the report for over a year at the expense of the owner's schedule and potentially public safety, should the model be used to inform future design efforts to address dam deficiencies.

The following sections outline best practices for pre-analysis communication to hopefully avoid situations such as these.

LEVELS OF PRE-ANALYSIS COMMUNICATION

The complexity and degree of pre-analysis communication will vary from project to project and exists on a spectrum as illustrated below. For simple modeling efforts, email correspondence or a brief proposal may be an adequate level of pre-analysis communication. For more complex or impactful efforts, all of these methods of communication may be needed to adequately plan the modeling effort.



The following factors may influence the level of pre analysis communication on the spectrum:

- Hazard classification or potential downstream consequences of the dam to be modeled
- Modeling purpose (i.e., screening level study, rehabilitation design, risk assessment, hazard reclassification, emergency planning)
- Public interest or involvement in the project
- Technical complexity of the analysis
- Unknowns and data gaps in the analysis and potential for dam safety risks during data acquisition (e.g., borings through an embankment dam)
- Level of previous experience with the dam, owner, and/or regulator
- Regulator familiarity with the dam, behavior of the type of dam, geology of the region, and potential loading scenarios
- Importance of the model in directing critical design decisions
- Level of experience/validation of the analysis method in standard practice
- Availability of regulator guidelines and whether model will be able to follow guidelines

This spectrum should be considered when applying the following steps during the planning of future modeling efforts.

STEPS OF PRE-ANALYSIS COMMUNICATION

STEP 1: DEVELOP PROJECT UNDERSTANDING AND OBJECTIVES

Prior to commencing any modeling effort, an understanding of the model objectives, project constraints, and overall approach should be developed. In order to develop this project understanding, the dam owner and engineer/modeler should meet to discuss the modeling approach, including items that can substantially impact cost and/or schedule. Commonly, the regulator is not involved in early scope of work discussions that have financial or contractual components. Discussion items could include the following:

- A definition of the **model's purpose**. To facilitate discussion, this can be organized as a problem statement followed by a justification (i.e., Why is the model needed and what problem is the model trying to solve? What are the potential consequences of not

conducting the proposed model?). If the need for the model is driven by a regulatory requirement, how the model addresses such requirement should be discussed.

- Anticipated **assumptions and methods** required to complete the modeling effort that may impact result accuracy, level of effort, and/or schedule. Key assumptions may include software selection, scenarios, parameter selection, etc. It is beneficial to identify which assumptions are foundational and may require additional communication and concurrence from regulators or other stakeholders. Examples of key assumptions and important considerations for specific model types including seepage analysis, slope stability analysis, hydrologic analysis, hydraulic analysis, and consequence estimation are included in the Attachments.

- Necessary **field data collection** efforts to fill data gaps and reduce potential for error and uncertainty in the model. This may include topographic and/or bathymetric survey, geotechnical subsurface explorations, material testing, water quality sampling, etc. An initial parametric study can be helpful in identifying the importance of additional field data.

- Preliminary planning for **model validation and/or calibration** based on the known available data or lack thereof. Some considerations for model validation are also included in the Attachments to this fact sheet. The possibility a model may not calibrate or result in significant uncertainties should be considered, noting that other benefits of the attempted modeling effort may warrant taking this chance.

- Proposed **quality assurance and review plan**. This may include an internal review, external review, or regulator review. The intended use and potential complexity of the model should be considered in developing the plan. Associated financial impacts of the selected review also need to be discussed. When the model is to be used for a complex design, to assess the risk of a high consequence facility, as input to other critical analyses, or when other circumstances merit, the regulator may require an external board of consultants or other third-party reviewer. Both the dam owner and modeler would benefit from discussing this possibility prior to developing the scope of
- work.

- Possible **model outcomes**. A clear understanding of the intended or unintended outcomes resulting from a modeling effort is beneficial to all involved parties.

- Preferences and expectations for **deliverables**. This may include formatting of report or technical memorandum, formatting of data files, level of detail, interim deliverables, etc.

- Expected **level of effort**. Each of the previous discussion items can impact the level of effort. In some cases, it may be beneficial to show how the level of effort may change should the assumptions or validation/calibration plan need to change. Effort for coordination with regulatory agencies also needs to be discussed, including the potential need for a formal model work plan submittal (described in more detail in Step 3). Additionally, the previous bullet points could lead the engineer to need a subcontractor for certain portions of the work. For example, it may be more cost-effective and time-

efficient to hire a subconsultant with 3D CFD modeling expertise rather than purchase and learn to use the software in-house.

- Anticipated **schedule** for the modeling effort. This is particularly important if the schedule may impact project objectives or must comply with regulatory deadlines. The schedule discussion may also include the potential to phase the modeling effort. This may be beneficial when uncertainty is expected to be high or when initial results may influence the approach to future modeling efforts such as scenario selection, analysis method (e.g., 2D versus 3D), etc.

STEP 2: DEVELOP SCOPE OF WORK

Once each of the aforementioned items have been evaluated and project objectives are understood, the owner and/or modeler will have the key information necessary to develop an adequate scope of work for the modeling effort. The scope of work should include all tasks needed to fulfill the model's purpose and address key items from the list above. The scope of work may include contingency tasks for a phased modeling approach.

STEP 3: OBTAIN CONCURRENCE FROM REGULATORY AGENCY

Once the owner and modeler have agreed upon a scope of work, it is time to involve the regulatory agency or agencies. It is often helpful to hold a meeting with regulators to present portions of the agreed upon Scope of Work such as:

- Purpose of the model
- Justification for model in terms of regulatory agency requirements
- Modeling approach, including software, assumptions, scenarios, validation/calibration plan, etc.
- Regulator's reporting requirements and expectations
- Quality assurance plan
- Anticipated schedule including timelines and desired timeline for regulatory feedback

As a best practice, meeting minutes ought to be recorded during the meeting and distributed to all parties afterward to serve as official record of the meeting. If all parties agree with the model work plan as presented in the initial meeting with the regulator, the official meeting minutes may serve as official record of the modeling work plan. In some cases, the regulator(s) may request a formal modeling work plan submittal. This submittal documents the items mentioned in Step 1 and should be reviewed and agreed upon prior to commencing the modeling effort. For the owner/modeler to be able to comply with the work plan, the regulatory agency must also give concurrence and not later add scope or additional model scenarios. Model Work Plan development guidance and other related considerations are included in the Attachments.

STEP 4: PROCEED WITH MODELING AND KEEP COMMUNICATION CHANNELS OPEN

After the scope of work is developed, agreed upon by the dam owner and engineer, and a corresponding modeling plan is approved by the regulatory agency, the modeling effort can begin. After the consultant or modeler has collected and reviewed all pertinent data and

performed preliminary analysis, it may be beneficial to hold an additional meeting with the owner or both the owner and regulator. This allows the project team to reassess key assumptions and further agree upon the modeling approach moving forward or make course corrections to the modeling effort, prior to using too much of the budget. Presentation of the preliminary analysis should be clear and concise to allow the regulator to quickly comprehend the preliminary results, evaluate that appropriate assumptions have been made, validate that the model inputs are appropriate, and assess the credibility of results. Presentation preparation may require significant effort and should be scoped accordingly. Documentation of the outcome of any preliminary meetings should be prepared as meeting minutes and shared with the regulator for concurrence.

While working through these initial steps, the modeler should also develop a plan or framework for final documentation of the modeling effort. This documentation will represent the culmination of the modeling effort and should summarize how the modeling effort met its objectives. Changes from pre-analysis communication are part of the process, and these should also be documented and justified in final documentation. Consideration should be given to how the results of the model will be presented both prior to and throughout the analysis process to ensure effective reporting. Detailed guidance regarding final documentation of modeling results is provided in the Post-Modeling Communication Fact Sheet.

ATTACHMENTS

Application-Specific Model Work Plan Guidance & Considerations

Attachment A – Slope Stability Modeling Considerations

Attachment B – Seepage Modeling Considerations

Attachment C – Hydrologic Modeling Considerations

Attachment D – Hydraulic Modeling Considerations

Attachment E – Consequence Estimating Considerations

ATTACHMENT A – DAM SLOPE STABILITY MODELING

MODEL WORK PLAN CONSIDERATIONS

The Model Work Plan should address each of the following topics. The level of detail will vary depending on the complexity of the project. If something is not applicable to the project, a brief statement on why it is not applicable may be sufficient. General topics should be addressed in all modeling efforts, while Slope Stability topics should be addressed for modeling efforts that plan to use these analyses. Some projects might not require combined seepage and slope stability models. It is not necessary at this stage to have all the answers, but the method for answering the questions should be stated.

GENERAL CONSIDERATIONS FOR ALL MODELS

- Describe the model purpose and justification of need.
- Summarize the overall assumptions and modeling approach.
- Note the guidance documents used as basis for approach (e.g., State published guidance, USBR Design Standards, FERC Engineering Guidelines for Evaluation of Hydropower Projects, USACE Engineering Manuals, etc.)
- Summarize the possible and expected outcomes.
- Summarize the data that is available or will be collected as part of the process.
- Provide an assessment of which assumptions are foundational (i.e., modifying assumptions would require additional communication and concurrence) and which can be modified through the analysis process.
- If an Independent Review is planned, describe the relationships and responsibilities of the parties involved (third party, internal to modeling firm or expectations for regulatory agency review)
- Note factors that may increase the modeling level of effort. This is also a discussion item with the dam owner during scope of work negotiations.
- Describe how interim and final modeling results will be presented (written report, presentation, discussion, etc.). This is also a discussion item with the dam owner during scope of work negotiations.
- Include a recommended schedule for submittals, review, and regulatory feedback. Note critical deadlines to avoid project delays. Request regulatory agency concurrence with the schedule as part of feedback on the Model Work Plan.

DAM SLOPE STABILITY MODEL CONSIDERATIONS

- State the software selection and describe the limitations of the program as they apply to this project.

- State whether a two-dimensional or three-dimensional model will be used. Consider a phased approach if there is uncertainty whether the problem warrants a two-dimensional or three-dimensional model. Document reasons for this uncertainty.

- Describe the basis for material parameters to be selected. Summarize existing materials and new materials.

- Note the sources of information and describe the uncertainties or limitations of that information.

- If a parametric sensitivity analysis is planned, describe the approach.

- Note the minimum factors of safety or other performance criteria.

- If seismic analysis is planned, describe the approach for analysis (e.g., pseudo-static, minimum factor of safety, deformation based) and materials (residual strengths).

- Describe the approach for developing the section geometry and pore pressure assignment (flow net, phreatic or potentiometric surfaces) including the source of information and the uncertainties or limitations that could impact results. Is a seepage model needed and useful or can a reasonable phreatic surface(s) and pore pressure gradients (e.g., adjusting unit weight of water to account for downward drainage) be assumed? Should a range of pore pressure assumptions be analyzed and presented to determine sensitivity to this assumption?

- Describe the decision process for selecting the number of cross sections chosen for analysis. One cross section may be enough, but more than one section may be needed depending on conditions and geometry. Reviewers often want to know what was considered but will not be used.

- Describe how potential failure surfaces will be determined. Justify with information specific to the dam and problem to be determined. For example, if deciding to use a particular point and radius search pattern to determine the critical failure surface, explain why this is appropriate. Consider including specified failure surfaces.

- Describe uncertainties with laboratory testing with potential impact on failure surfaces. For example, if using index testing to estimate strength parameters of a material that contains likely failure surfaces, what is the impact? Would it be appropriate to perform sensitivity analyses to bracket the potential range of response for materials where strength parameters are less certain?

- Consider including one or more rough cross-sectional drawings that illustrate dam geometry, materials, reservoir water surface(s) to be modeled with estimated phreatic and potentiometric water surfaces that correspond to these reservoir levels. A hand drawing may be acceptable. If a berm or other stabilizing structure is to be added, include rough dimensions of this structure on this drawing. Show location of boreholes piezometers and interpreted material types/boundaries. Note piezometer influence zones (perforated intervals plus gravel pack) and measured water levels that correspond with the reservoir water surfaces on the drawing. Note location of laboratory test samples on this drawing. Graphical presentation of this information is an important communication aid, particularly for less technical readers. Vertical exaggeration may be helpful to show small vertical differences, but should be used with caution.

ATTACHMENT B – DAM SEEPAGE MODELING

MODEL WORK PLAN CONSIDERATIONS

The Model Work Plan should address each of the following topics. The level of detail will vary depending on the complexity of the project. If something is not applicable to the project, a brief statement on why it is not applicable may be sufficient. General topics should be addressed in all modeling efforts, while Seepage topics should be addressed for modeling efforts that plan to use these analyses. Some projects might not require combined seepage and stability models. It is not necessary at this stage to have all the answers, but the method for answering the questions should be stated.

GENERAL CONSIDERATIONS FOR ALL MODELS

- Describe the model purpose and justification of need.
- Summarize the overall assumptions and modeling approach.
- Note the guidance documents used as basis for approach (e.g., State published guidance, USBR Design Standards, FERC Engineering Guidelines for Evaluation of Hydropower Projects, USACE Engineering Manuals, etc.)
- Summarize the possible and expected outcomes.
- Summarize the data that is available or will be collected as part of the process.
- Provide an assessment of which assumptions are foundational (i.e., modifying assumptions would require additional communication and concurrence) and which can be modified through the analysis process.
- If an Independent Review is planned, describe the relationships and responsibilities of the parties involved (third party, internal to modeling firm or expectations for regulatory agency review)
- Note factors that may increase the modeling level of effort. This is also a discussion item with the dam owner during scope of work negotiations.
- Describe how interim and final modeling results will be presented (written report, presentation, discussion, etc.). This is also a discussion item with the dam owner during scope of work negotiations.
- Include a recommended schedule for submittals, review and regulatory feedback. Note critical deadlines to avoid project delays. Request regulatory agency concurrence with the schedule as part of feedback on the Model Work Plan.

DAM SEEPAGE MODEL CONSIDERATIONS

- State the software selection and describe the limitations of the program as they apply to this project.

- State whether a steady state or transient model will be used. Consider a phased approach if there is uncertainty whether the problem warrants a steady-state or transient model. Document reasons for this uncertainty.

- State whether a two-dimensional or three-dimensional model will be used. Consider a phased approach if there is uncertainty whether the problem warrants a two-dimensional or three-dimensional model. Document reasons for this uncertainty.

- State basis for boundary conditions that will be used and uncertainties or limitations of those boundary conditions versus the site conditions.

- Describe the basis for material parameters to be selected. Summarize existing materials and new materials. If unsaturated materials are used, describe the approach for developing volumetric water content and hydraulic conductivity functions.

- Note the sources of information and describe the uncertainties or limitations of that information.

- If a parametric sensitivity analysis is planned, describe the approach.

- Describe the calibration approach. If piezometers are used for calibration, provide detailed descriptions of the available information and the metrics to be used for evaluation of model calibration (average percent error across the system for ballpark seepage quantity versus spatial considerations for use in stability analyses and evaluation of more localized seepage issues).

- Consider including one or more rough cross-sectional drawings that illustrates dam geometry, foundation, materials, reservoir water surface(s) to be modeled, along with estimated phreatic and potentiometric water surfaces from piezometer measurements. A hand drawing may be acceptable. If additional drainage features are to be evaluated, show the approximate location of these features. Show location of boreholes and piezometers. Note piezometer influence zones (perforated intervals plus gravel pack) and measured water levels that correspond with the water surfaces on the drawing. Graphical presentation of this information is an important communication aid, particularly for less technical readers. Vertical exaggeration may be helpful if small vertical differences need to be highlighted.

ATTACHMENT C – HYDROLOGIC MODELING

MODEL WORK PLAN CONSIDERATIONS

The Model Work Plan should address each of the following topics. The level of detail will vary depending on the complexity of the project. If something is not applicable to the project, a brief statement on why it is not applicable may be sufficient. General topics should be addressed in all modeling efforts, while Hydrologic topics should be addressed for modeling efforts that plan to use these analyses. It is not necessary at this stage to have all the answers, but the method for answering the questions should be stated.

GENERAL CONSIDERATIONS FOR ALL MODELS

- Describe the model purpose and justification of need.
- Summarize the overall assumptions and modeling approach.
- Note the guidance documents used as basis for approach (e.g., State published guidance, USBR Design Standards, FERC Engineering Guidelines for Evaluation of Hydropower Projects, USACE Engineering Manuals, etc.)
- Summarize the possible and expected outcomes.
- Summarize the data that is available or will be collected as part of the process.
- Provide an assessment of which assumptions are foundational (i.e., modifying assumptions would require additional communication and concurrence) and which can be modified through the analysis process.
- If an Independent Review is planned, describe the relationships and responsibilities of the parties involved (third party, internal to modeling firm or expectations for regulatory agency review)
- Note factors that may increase the modeling level of effort. This is also a discussion item with the dam owner during scope of work negotiations.
- Describe how interim and final modeling results will be presented (written report, presentation, discussion, etc.). This is also a discussion item with the dam owner during scope of work negotiations.
- Include a recommended schedule for submittals, review and regulatory feedback. Note critical deadlines to avoid project delays. Request regulatory agency concurrence with the schedule as part of feedback on the Model Work Plan.

HYDROLOGIC MODELING CONSIDERATIONS

- State the software selection and describe the limitations of the program as they apply to this project.

- Describe the hydrologic scenarios to be modeled and any scenario-specific assumptions that will be applied.

- Note the sources of information and describe the uncertainties or limitations of that information. Also identify data needs and how those gaps will be addressed.

- Describe the approach to watershed and subbasin delineation. Watersheds should be subdivided as needed to maintain hydrologic homogeneity and reasonable size.

- Note the sources of precipitation depths and durations including how rainfall will be temporally and spatially distributed over the watershed. Also describe how seasonality and antecedent conditions will be considered in the analysis. It may be necessary to model multiple different storm types based on the basin size and prevailing meteorological storm producing conditions observed in the region.

- Describe the anticipated methods for simulating hydrologic response of the watershed including precipitation losses and infiltration, unit hydrograph transformation and the associated time of concentration, and reach routing.

- Summarize information regarding dams, spillways, and reservoirs where reservoir routing will occur. This should include a description of reservoir routing methodology, initial reservoir levels, stage-storage-discharge curves, and assumed operation of gated spillways or outlet works. Information and assumptions regarding dam breach approach should also be provided if applicable.

- If a parametric sensitivity analysis is planned, describe the approach.

- Describe the model validation or calibration approach. If historic gage data are used for calibration, provide detailed descriptions of the available information. If no basin-specific data is available, describe what, if any, regional data may be available to inform calibration of the basin response. Verify regional data is applicable for the drainage basin size and physiographic characteristics.

ATTACHMENT D – HYDRAULIC MODELING

MODEL WORK PLAN CONSIDERATIONS

The Model Work Plan should address each of the following topics. The level of detail will vary depending on the complexity of the project. If something is not applicable to the project, a brief statement on why it is not applicable may be sufficient. General topics should be addressed in all modeling efforts, while Hydraulic topics should be addressed for modeling efforts that plan to use these analyses. It is not necessary at this stage to have all the answers, but the method for answering the questions should be stated.

GENERAL CONSIDERATIONS FOR ALL MODELS

- Describe the model purpose and justification of need.
- Summarize the overall assumptions and modeling approach.
- Note the guidance documents used as basis for approach (e.g., State published guidance, USBR Design Standards, FERC Engineering Guidelines for Evaluation of Hydropower Projects, USACE Engineering Manuals, etc.)
- Summarize the possible and expected outcomes.
- Summarize the data that is available or will be collected as part of the process.
- Provide an assessment of which assumptions are foundational (i.e., modifying assumptions would require additional communication and concurrence) and which can be modified through the analysis process.
- If an Independent Review is planned, describe the relationships and responsibilities of the parties involved (third party, internal to modeling firm or expectations for regulatory agency review)
- Note factors that may increase the modeling level of effort. This is also a discussion item with the dam owner during scope of work negotiations.
- Describe how interim and final modeling results will be presented (written report, presentation, discussion, etc.). This is also a discussion item with the dam owner during scope of work negotiations.
- Include a recommended schedule for submittals, review and regulatory feedback. Note critical deadlines to avoid project delays. Request regulatory agency concurrence with the schedule as part of feedback on the Model Work Plan.

HYDRAULIC MODELING CONSIDERATIONS

- State the software selection and describe the limitations of the program as they apply to this project.

- Describe the hydraulic scenarios to be modeled and any scenario-specific assumptions that will be applied.

- Note the sources of information and describe the uncertainties or limitations of that information. Also identify data needs and how those gaps will be addressed.

- State whether a steady or unsteady flow condition will be modeled. Also state whether a one-dimensional, two-dimensional, or three-dimensional hydraulic model will be used. Justification should be provided for the selected approach based on project objectives and available data.

- Describe the anticipated model extent and boundary conditions. Also note how model boundaries will be evaluated to assess calculation independence at the location(s) of interest in the model.

- Describe the source of flow data (including base flows, design flows, and hydrographs) and energy loss coefficients.

- Describe the model geometry data including terrain data source and resolution as well as bridge, culvert, and other hydraulic structures within the wetted area of the model.

- Summarize information regarding dams, spillways, and reservoirs where reservoir routing will occur. This should include a description of reservoir routing methodology, initial reservoir levels, stage-storage-discharge curves, and assumed operation of gated spillways or outlet works. Information and assumptions regarding dam breach approach should also be provided if applicable.

- If a parametric sensitivity analysis is planned, describe the approach.

- Describe the model validation or calibration approach. If historic gage data are used for calibration, provide detailed descriptions of the available information.

ATTACHMENT E – CONSEQUENCE ESTIMATING

MODEL WORK PLAN CONSIDERATIONS

The Model Work Plan should address each of the following topics. The level of detail will vary depending on the complexity of the project. If something is not applicable to the project, a brief statement on why it is not applicable may be sufficient. General topics should be addressed in all modeling efforts, while Consequence Estimating topics should be addressed for modeling efforts that plan to use these analyses. It is not necessary at this stage to have all the answers, but the method for answering the questions should be stated.

GENERAL CONSIDERATIONS FOR ALL MODELS

- Describe the model purpose and justification of need.
- Summarize the overall assumptions and modeling approach.
- Note the guidance documents used as basis for approach (e.g., State published guidance, USBR Design Standards, FERC Engineering Guidelines for Evaluation of Hydropower Projects, USACE Engineering Manuals, etc.)
- Summarize the possible and expected outcomes.
- Summarize the data that is available or will be collected as part of the process.
- Provide an assessment of which assumptions are foundational (i.e., modifying assumptions would require additional communication and concurrence) and which can be modified through the analysis process.
- If an Independent Review is planned, describe the relationships and responsibilities of the parties involved (third party, internal to modeling firm or expectations for regulatory agency review)
- Note factors that may increase the modeling level of effort. This is also a discussion item with the dam owner during scope of work negotiations.
- Describe how interim and final modeling results will be presented (written report, presentation, discussion, etc.). This is also a discussion item with the dam owner during scope of work negotiations.
- Include a recommended schedule for submittals, review and regulatory feedback. Note critical deadlines to avoid project delays. Request regulatory agency concurrence with the schedule as part of feedback on the Model Work Plan.

CONSEQUENCE ESTIMATION CONSIDERATIONS

- State the software selection and describe the limitations of the program as they apply to this project.

- Describe the scenarios to be modeled and any scenario-specific assumptions that will be applied.

- Note the sources of information for project-specific input and model-specific parameters and describe the uncertainties or limitations of that information. Also identify data needs and how those gaps will be addressed.

- Describe the anticipated model extent and the associated source of flood inundation depth, velocity, and timing data. The analysis should extend far enough downstream that additional incremental consequences due to dam failure are not anticipated.

- Describe the source of population-at-risk estimates. This often consists of structure inventories that have population assigned to each structure point or footprint. Data should be recent and reflect current distribution of the population within the hazard area. If necessary, structure data should be supplemented with population estimates for major roadways, recreational areas, or other transient populations in the inundation area. Depending on the complexity of the analysis, data may need to reflect both daytime and nighttime populations or include structure type and size.

- Describe how warning, intervention, and evacuation will be considered as part of the analysis. Warning time and the preparedness of communities to respond to emergency conditions can have a significant impact on overall consequences of a dam failure. Also describe the methodology that will be used to evaluate flood lethality should evacuation efforts fail.

- If a parametric sensitivity analysis is planned, describe the approach.

- Mention the process that will be used to model the dam breach. Will more than one method be applied and how does the modeler plan to select or screen methods to develop the breach hydrograph? This would also likely be addressed in the parametric sensitivity analysis portion. Consider the use of stochastic simulation of breach hydrograph and resulting inundation zone and consequences.