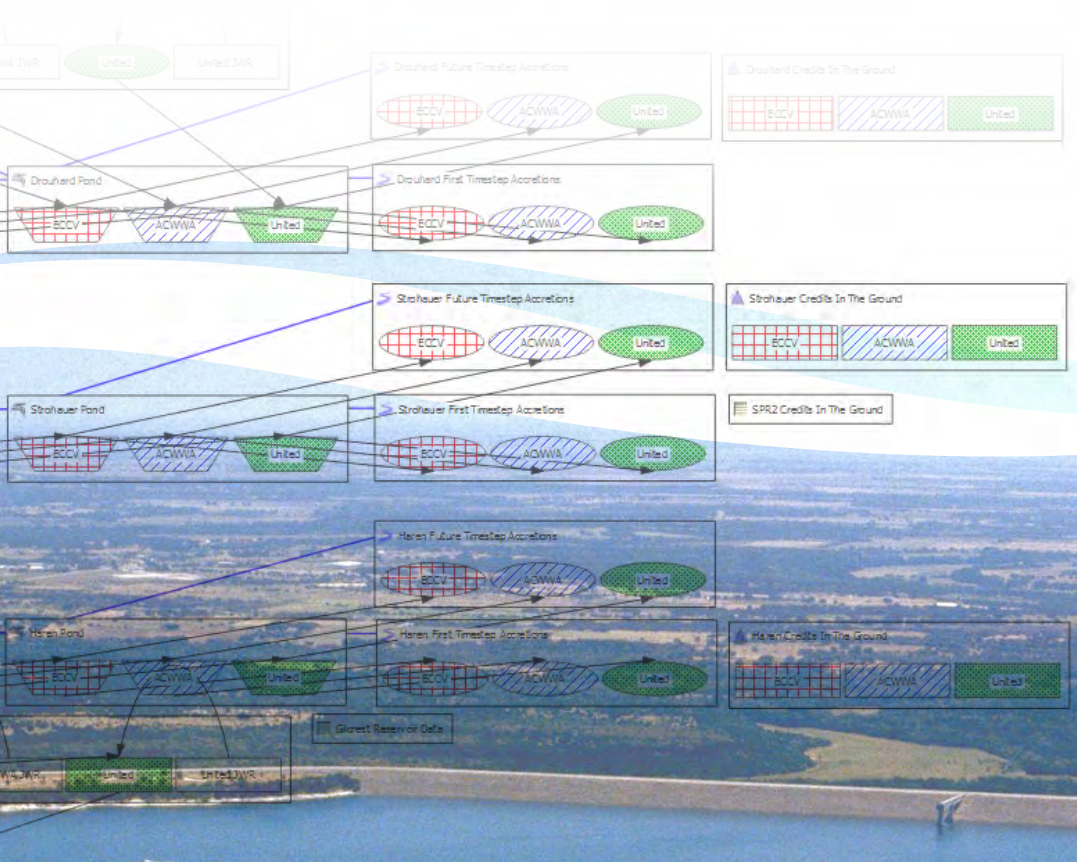
US Army Corps of Engineers®
Fort Worth District

Hydrologic Modeling Guidelines for Regulatory Permit Actions

CHECKLIST



January 22, 2018

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Hydrologic Modeling Guidelines Checklist

The Hydrologic Modeling Guidelines (HMGs) checklist is derived from the detailed descriptions of each HMG provided in the *Hydrologic Modeling Guidelines for Regulatory Permit Actions* Technical Report (DiNatale 2018).

The checklist is a simplification and condensation of the more detailed information presented in this Technical Report that can be used by Regulatory project managers and Applicants to quickly identify the topics, potential Corps data needs and expected hydrologic analysis and modeling process. The HMGs and checklist do not address specific resource impact analysis or needs since such evaluations are beyond the scope of the HMGs.

The HMGs checklist is intended for everyday use and reference by Regulatory project managers and Applicants. However, to appropriately utilize the checklist ***users need to be familiar with the underlying information*** and rationale contained in the Technical Report that supports each guideline as well as the listed items in the checklist.

The HMGs are divided into three tiers of increasing complexity.

- Tier-1 HMGs: Standard Information Needs and HMGs for all Projects
- Tier-2 HMGs: Medium-Level Project and Effect Analysis
- Tier-3 HMGs: Major Project and Detailed Analysis of Project Effects

Every project is unique and includes its own set of different conditions that must be evaluated on a case-by-case basis. Therefore, the tiered organization of the HMGs should not be construed as a restrictive organizational structure. Instead, the Corps regulator and Applicant should utilize the information in any of the HMGs that are appropriate for a specific project.

The final HMGs in Tier-1 and Tier-2 include a decision point on whether additional detailed analysis should be undertaken and the next-tier HMGs should be applied, or whether sufficient hydrologic information has been gathered for the Corps permit decision using the information collected through the lower-tier analysis.

In some cases, it would be appropriate to use one or some of the higher-tier HMGs to complete the evaluation, but may not require all aspects to be considered at the more detailed level. For example, a project requires detailed evaluation of a single aspect of the project, but other aspects are more straightforward and sufficient information has already been gathered through the application of lower-tiered HMGs. In that case, the Corps and Applicant can target specific higher-tiered HMGs that will appropriately address the areas where more detail is needed, while not unnecessarily applying the more detailed HMGs to other aspects of the project that were sufficiently addressed through the lower-tiered HMGs.

The HMGs are intended to have scalability so that the Corps regulator and Applicant begin with the Tier-1 general guidelines and proceed to more detailed and in-depth hydrologic modeling if warranted by the project size, operations, and impacts. When familiar with the Technical Report and its content, this checklist should be used by both the Corps project manager and the Applicant as the initial reference

and general guide to identify applicable information topics are being addressed and to inform the anticipated level of hydrologic analysis and/or modeling. As more information is learned about the project or the Applicant seeks more detailed guidance on the hydrological modeling requirements, both the Corps and Applicant should refer back to the Technical Report as needed.

Spaces for answering specific questions are provided in the following form, but should not be considered as limiting the information that can be provided. Each HMG concludes with a key question. If the question has been answered affirmatively, the objective of the HMG has been met. When answered negatively, the Corps should determine if additional information should be requested. ***Wherever appropriate, the Regulatory project manager or Applicant should provide additional information relevant to the HMG even if there is not a specific check box or question in the checklist.***

The table on pages 3 and 4 provides a quick reference to each hydrologic modeling guideline and its associated key question.

Project Name	_____
Project File Number	_____
Brief Description of Proposed Project	

HMG	KEY QUESTION
1.A Describe the organizational structure of the Applicant	Does the description inform the Corps on the level of detail and information that Applicant likely can provide to support its permit application?
1.B. Describe the Applicant's existing system and operations	Does the description inform the Corps how current usage (pre-project) is impacting water resources?
1.C. Describe the proposed project and operations	Does the description inform the Corps about where and when the proposed project operations may impact aquatic resources?
1.D. Identify existing relevant hydrologic data and hydrologic models	Do the hydrological data and analyses performed inform the Corps how the proposed project will alter the flows in the stream?
1.E. Determine the geographic scope of assessment	Does the identified geographic scope inform the Corps about all areas where the proposed project can affect the aquatic environment?
1.F. Minor level project analysis and determination	Is the information gathered in HMG 1.A through 1.E and evaluated in 1.F sufficient for the Corps to adequately characterize the proposed project impacts without additional detailed hydrologic analysis or modeling?
2.A. Gather the best available hydrologic data for project area	Do the hydrologic data, reports, and modeling provide adequate relevant information for the Corps to evaluate the degree of hydrologic modification caused by the proposed project?
2.B. Determine critical hydrologic period for analysis	Does the choice of hydrologic period inform the Corps about when the proposed project operations may most heavily impact aquatic resources?
2.C. Determine the time-step required for hydrologic modification analysis	Does the choice of time-step provide adequate detail to evaluate potential effects to aquatic resources caused by the proposed project?
2.D. Understand assumptions included in any modeling used	Do the modeling assumptions inform the Corps about how well modeling simulates expected streamflow and reservoir conditions?
2.E. Hydrologic modification analysis should preferentially use observed data for a baseline and modeled data secondarily	Is the hydrology data based on observed data or does it use well-documented estimations or alterations where observed data are not available?
2.F. Coordination with resource agencies	Does the Corps have sufficient and complete data to share with resource agencies if initial determination of affected resources has been made and the permit sought requires coordination with resource agencies?
2.G. Simplify hydrologic modification analysis as much as possible to make determination of adequacy of analysis	Does the hydrologic modification analysis performed under the Tier-2 HMGs provide the Corps with adequate information to evaluate proposed project effects and render a permit decision?

HMG	KEY QUESTION
3.A. Use any applicant-provided modeling where appropriate to save time and money in hydrologic model development	Was existing modeling designed to accurately represent streamflows in the project area? If not, consider development of a new model to save time and money.
3.B. Hydrologic modeling should be designed around known or anticipated needs of aquatic resources to be evaluated	Do the known or expected hydrologic data needs for aquatic resources analysis inform the Corps about specific aspects of the design or modification of hydrologic modeling?
3.C. Model purpose should be centered on reasonably representing stream flows under a variety of conditions, including critical periods	Does the model selection or modification to existing models accurately simulate changes to streamflows or changes to other relevant hydrologic features?
3.D. Simulate avoidance and minimization actions separate from compensatory mitigation	Does the hydrologic modeling allow for distinct simulation of avoidance and minimization actions and compensatory mitigation actions?
3.E. Model domain should encompass geographic extent and a sufficient study period to accurately reflect the range of effects	Do the geographic and temporal extents of the model adequately cover upstream and downstream effects over a wide range of hydrologic and critical flow conditions?
3.F. Model time-step should reflect the critical time-scale of the aquatic resources being evaluated	Are the model time-steps and underlying data sufficient to adequately assess the impacts on aquatic resources?
3.G. Proposed operations and administration should be incorporated into the hydrologic modeling	Does the hydrologic modeling adequately incorporate the proposed operations and administration?
3.H. The study period time frame should consider reasonably foreseeable future actions for the development of a future conditions baseline	Does the hydrologic modeling adequately incorporate reasonably foreseeable future actions from other projects, changes in use and management, and climate change?

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1. Tier-1 HMGs: Standard Information Needs and HMGs for all Projects

Tier-1 HMGs provide the Corps with much of the basic information about the project and Applicant and help identify areas that may be impacted by the project. Much of the information requested in the Tier-1 HMGs will be information the Applicant is either already familiar with or has provided through the permit application itself.

1.A. Describe the organizational structure of the Applicant

Applicant Name _____

Organizational structure of Applicant

☐ river authority ☐ municipal ☐ industrial
☐ agricultural ☐ private ☐ other _____

Does Applicant or their agent have experience with hydrologic modeling and analysis? ○ Yes ○ No

If yes, in what context?
(e.g., water rights, floodplain analysis, other) _____

Does Applicant receive water from another water provider? ○ Yes ○ No

If yes, fill out section below:

Source Water Provider Name _____

Organizational structure of Source Water Provider

☐ river authority ☐ municipal ☐ industrial
☐ agricultural ☐ private ☐ other _____

Does Source Water Provider or their agent have experience with hydrologic modeling and analysis? ○ Yes ○ No

If yes, in what context?
(e.g., water rights, floodplain analysis, other) _____

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the description inform the Corps on the level of detail and information that Applicant likely can provide to support its permit application? ○ **Yes** ○ **No**

1.B. Describe the Applicant's existing system and operations

Description of existing system prior to construction of proposed project

Include areas ***upstream and downstream*** of the proposed project that could potentially be affected by the proposed project.

Is the proposed project:

◯ a new water supply system **OR** ◯ supplementing an existing water supply system?

☐ **Detailed mapping and/or** ☐ **system schematic**

Infrastructure Listing

☐ Name of river or stream basin(s) _____

☐ Reservoir(s)/lakes(s) _____

☐ Dam(s)/diversion(s) _____

☐ Release structure(s) _____

☐ Intake(s) _____

☐ Pipeline(s) _____

☐ Water treatment plant(s) _____

☐ Wastewater treatment plant(s) _____

☐ Other structures that potentially impact water quantities _____

Administrative and Operational Items

☐ Timing and rate of diversions/ withdrawals _____

☐ Water right(s)/permit(s) _____

☐ Swaps/trades/exchanges with other entity(ies) _____

☐ Contracted deliveries _____

☐ Water accounting form/models(s) _____

☐ Impact in other basin(s) _____

1.B. APPLICANT'S EXISTING SYSTEM AND OPERATIONS, CONT.

Environmental Considerations

☐ Known low-flow areas of concern _____

☐ 303(d) listed streams or other known water quality concerns _____

☐ Known environmentally sensitive areas (state/national parks or wildlife areas, ESA, existing compensatory mitigation sites/ banks) _____

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the description inform the Corps how current usage (pre-project) relates to conditions of existing aquatic resources? ○ **Yes** ○ **No**

1.C. Describe the proposed project and operations

Information in HMG 1.C should be taken in context with the existing system described in HMG 1.B.

Description of existing system <u>operations after</u> construction of <u>proposed project</u>

Include areas ***upstream and downstream*** of the proposed project that could potentially be affected by the proposed project.

☐ **Detailed mapping and/or** ☐ **system schematic of the <u>proposed modifications</u>**

Infrastructure and Operation of Proposed System

☐ Location(s) of proposed new diversion, storage or withdrawal _____

1.C. PROPOSED PROJECT AND OPERATIONS, CONT.

☐ Amount of diversion, storage or withdrawal _____

☐ Variability in rate of diversion from stream system _____

Constant Rate _____

Seasonal Demand (describe range and timing) _____

Daily variations (describe range and rationale for variation) _____

Other variations that could result in changes to upstream and/or downstream flows _____

☐ Water rights or other administrative restrictions on diversion, storage or withdrawal (see also 1.D) _____

Will operations of the proposed project affect operations at other Applicant facilities described in 1.B? ◯ Yes ◯ No

If yes, describe interaction:

Will operations of the proposed project allow changes in operations at other non-Applicant facilities? ◯ Yes ◯ No

If yes, describe:

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the description inform the Corps about where and when the proposed project operations may impact aquatic resources? ◯ **Yes** ◯ **No**

1.D. Identify existing relevant hydrologic data and hydrologic models

Identify existing relevant hydrologic data

- ☐ Nearby stream gage(s) (flow, stage, rating tables, temperature, water quality parameters, etc.) _____
- ☐ Relevant reservoir data (inflows, outflows, storage amount, withdrawals) _____
- ☐ Wastewater treatment plant discharge(s) _____
- ☐ Water supply outfalls/intakes which may require water quantity measurements _____
- ☐ Timing/dates of major water resources development or projects that would affect gage data from different time periods _____
- ☐ Reports or data by other entities available in basin (e.g. studies, plans, etc.) _____

Identify existing hydrologic modeling or analysis for the area

- ☐ Regional or basin-wide models available? _____
- ☐ Modeling performed in support of water right or other permit(s) in project area? _____

  Documentation for models provided? ○ Yes ○ No
- ☐ Modifications to observed data to adjust for ungauged locations (e.g. contributing area calculations, neighboring gage correlation, etc.)? _____
- ☐ Timing/dates of major water resources development or projects that would affect gage data from different time periods _____

1.D. EXISTING RELEVANT HYDROLOGIC DATA AND HYDROLOGIC MODELS, CONT.

☐ List reports or data by Applicant or other entities available in basin (e.g. E-flow analysis, studies, plans, etc.) _____

Does description of the system (from HMGs 1.B and 1.C) and the information on available hydrologic data, modeling and analysis support truncating existing models or analysis to evaluate specific areas? ○ Yes ○ No

If yes, describe area of focus:

Has Applicant estimated project yield? ○ Yes ○ No

If yes, how was this performed (e.g. WAM modeling)? _____

If yes, was a critical period identified in the analysis? _____

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Do the hydrological data and analyses performed inform the Corps how the proposed project will alter the flows in the stream? ○ **Yes** ○ **No**

1.E. Determine the geographic scope of assessment

Does the proposed project affect operations in areas of the system (or others system component) that are not at the project site (e.g. change in diversion rate at an existing intake, involve/support an inter-basin transfer)? ○ Yes ○ No

If yes, ensure the other areas are included in the geographic area of interest.

Initial evaluation of geographic scope

☐ Downstream gages where change in flow from project is small _____

- ☐ Flow thresholds based on drought conditions or low-flow scenario
- ☐ Consider seasonal variation in flow or diversion rate

☐ Downstream extent considerations for

- ☐ Large water rights or interstate/inter-basin compact considerations
- ☐ Environmental considerations downstream (e.g. E-flow analyses, ESA species, state or national parks, designated wildlife areas, existing compensatory mitigation sites/banks, etc.)
- ☐ Known aquatic resources in downstream reaches

☐ Upstream extent considerations for

- ☐ Reservoir/dam backwater effects
- ☐ Changes to existing or new upstream operations caused by proposed project

Do the maps and system schematics provided with HMG 1.B and 1.C include areas potentially affected that were identified in 1.D and the downstream and upstream considerations above? ○ Yes ○ No

If no, obtain additional mapping and system schematics.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the identified geographic scope inform the Corps about all areas where the proposed project can affect the aquatic environment? ○ **Yes** ○ **No**

1.F. Minor level project analysis and determination

Determination of whether additional analysis is required based on HMG 1.A through 1.E.

Can the Corps draw adequate conclusions on changes to flow based on information gathered in 1.A through 1.E? ◯ Yes ◯ No

Were changes in flows evaluated during a worst-case or critical period? ◯ Yes ◯ No

Based on the above and HMGs 1.A through 1.E,
Additional detailed analysis is:

◯ Not required (all 1.F questions above should be “Yes”)
◯ Required. Initial specific higher-tiered HMGs are applicable: _____
◯ Required. Proceed to Tier-2 HMGs

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Is the information gathered in HMG 1.A through 1.E and evaluated in 1.F sufficient for the Corps to adequately characterize the proposed project impacts without additional detailed hydrologic analysis or modeling? ◯ **Yes** ◯ **No**

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2. Tier-2 HMGs: Medium-Level Project and Effect Analysis

To appropriately assess effects to aquatic resources, the Corps will evaluate an increasingly sophisticated level of data and analysis commensurate with the scope of the project. The Tier-2 HMGs are intended to evaluate hydrologic data and information at a more detailed level than the Tier-1 HMGs, focusing on hydrologic modification to inform determinations of potential effects to aquatic resource functions. A hydrologic modification analysis compares current hydrologic conditions (baseline conditions) to conditions with the proposed project operations superimposed on the baseline conditions. Considerations of various aspects of data used in a hydrologic modification analysis are addressed through the Tier-2 HMGs.

2.A. Gather the best available hydrologic data for project area

HMG 2.A builds from information gathered in Tier-1 HMGs and should be more detailed or specific.

Does the proposed project affect operations in areas of the system (or others system component) that are not at the project site (e.g. change in diversion rate at an existing intake, involve/support an inter-basin transfer)? ○ Yes ○ No

If yes, ensure the other areas are included in the geographic area of interest.

Initial evaluation of geographic scope

☐ Stream gages (USGS, Corps District office or other entities): _____

- ☐ Gages represent geographic area of interest
- ☐ Gage data available daily over representative period of study
- ☐ Less frequent gage data collected for potential correlation analysis

☐ Known discharges to stream (WWTP, tributary inflow, etc.): _____

☐ Reservoir data (inflows, outflows, storage amounts): _____

- ☐ Upstream reservoirs where operations may change with proposed project or if flow naturalization will be needed.
- ☐ Downstream reservoirs potentially affected by proposed project
- ☐ Checked for accounting plans associated with such reservoirs as a data source

☐ Existing or Ongoing Reports or Studies (Corps, resource agencies, regional planning authority documents, water quality studies, etc.): _____

☐ Other planned water development/modification activities in the region? _____

2.A. BEST AVAILABLE HYDROLOGIC DATA FOR PROJECT AREA, CONT.

☐ Mapping and Schematics

- ☐ Additional detail on maps/schematics provided in Tier-1
- ☐ FEMA floodway and floodplain mapping
- ☐ Mapping, operational schematics or drawings of proposed and existing project features, and alternatives (if applicable)

☐ Existing hydrologic modeling data

- ☐ State or regional models for the project area (e.g. WAM)
- ☐ Corps-developed models
- ☐ Applicant operational, forecasting, predictive models
- ☐ Any known or proposed deviations of actual operations from model?

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Do the hydrologic data, reports, and modeling provide adequate relevant information for the Corps to evaluate the degree of hydrologic modification caused by the proposed project? ◯ **Yes** ◯ **No**

2.B. Determine critical hydrologic period for analysis

Has the Applicant identified a critical period and a study period? ◯ Yes ◯ No

If yes, when is the critical period? _____

If yes, when is the study period? _____

☐ Study period considers range of expected hydrologic conditions (e.g. wet, average, dry)

How was the critical period determined (large drought, lowest flow, percent change in hydrology, long-term trends, etc.)?

Were flow requirements identified for aquatic resources considered in determination of critical period?

Does the chosen period of record consider the following?

- ☐ Timing (frequency and duration) and quantity of water withdrawals from the system
- ☐ Variability of flows during period of record, including extreme events
- ☐ Existing and predicted changes in hydrology and land use
- ☐ Long-term trends that bias results from earlier time periods

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the choice of hydrologic period inform the Corps about when the proposed project operations may most heavily impact aquatic resources? ◯ **Yes** ◯ **No**

2.C. Determine the time-step required for hydrologic modification analysis

Daily data is preferred for hydrologic analysis and modeling

Is daily data available from data sources identified in 2.A? ○ Yes ○ No

If yes, use daily data and proceed.

If no, determine if longer time-step is adequate for aquatic effects analysis

☐ Study period considers range of expected hydrologic conditions (e.g. wet, average, dry)

Are flows: ○ relatively constant throughout a time-step
or do they ○ vary significantly within a single time-step?

☐ If flows are governed by upstream reservoir releases, are releases typically:
○ more constant or do they ○ vary day-to-day?

☐ If there is variation in the flow within a time-step, would the range of variation or changes to flow likely affect aquatic resources? ○ Yes ○ No

☐ Gather input from resource specialists or other regulatory agencies to assist in determination (see also HMG 2.F).

Large variability in flows within a time-step are indicators that finer-resolution data should be sought. If the variability in flow would not affect the resource effects analysis, the longer time-step can be used.

Note that many water supply yield models use monthly data.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the choice of time-step provide adequate detail to evaluate potential effects to aquatic resources caused by the proposed project? ○ **Yes** ○ **No**

2.D. Understand assumptions included in any modeling used

This HMG applies to any existing hydrologic modeling identified in 2.A

What was the purpose of the original model?

☐ Project Yield
☐ Flood Control
☐ Streamflow simulation
☐ System Operations/Projection/Forecasting
☐ Basin-wide simulation
☐ Other: _____

Is documentation available for the model? ○ Yes ○ No

The Corps requires hydrologic modeling that accurately simulates conditions within the stream or lake system through a range of flow conditions. Many models are not necessarily designed for this purpose. The following questions will help determine whether a model is more likely to simulate stream conditions or whether it simulates other factors:

Does the model generally track

○ all water in the system OR ○ the Applicant's supply (or other subset) of water in the system?

Does the model generally

○ simulate real-world conditions OR ○ include adjustments to demand levels, inflows, historical gage flow, return flows, or other model inputs?

Does the model generally

○ incorporate any operational restrictions or limitations from a water right or other regulatory authority OR ○ focus on specific extreme events (e.g. droughts or floods)?

The first options in the above questions indicate models that simulate actual conditions, while the second options indicate models that are designed to evaluate other system responses that are less likely to simulate expected streamflows in a manner that meets the Corps' needs.

Additional Relevant Information fill out here or attach any relevant documentation

2.D. MODELING ASSUMPTIONS, CONT.

KEY QUESTION

Do the modeling assumptions inform the Corps about how well modeling simulates expected streamflow and reservoir conditions? ◯ **Yes** ◯ **No**

2.E. Hydrologic modification analysis should preferentially use observed data for a baseline and modeled data secondarily

Observed data is available at the area of interest for a hydrologic modification analysis. ◯ Yes ◯ No

If no, how are flows in the area of interest derived (e.g. existing model output, reconstructed flows, etc.)? _____

Are assumptions for arriving at flows documented? ◯ Yes ◯ No

Are assumptions for arriving at flows conducive to evaluating stream conditions in the area of interest (see also 2.D)? ◯ Yes ◯ No

☐ Hydrologic analysis output should be in time-series format.

☐ Applicant-provided statistical summaries of hydrology should not replace provision of time-series hydrology for evaluation by the Corps.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Is the hydrology data based on observed data or does it use well-documented estimations or alterations where observed data are not available? ◯ **Yes** ◯ **No**

2.F. Coordination with resource agencies

Based on Tier-1 and Tier-2 HMGs, has the Corps made an initial determination of potential aquatic resource factors and functional areas potentially affected by the proposed project?

- ☐ fisheries
- ☐ aquatics
- ☐ macroinvertebrates
- ☐ water quality
- ☐ wetlands
- ☐ riparian connectivity
- ☐ geomorphology/sediment transport
- ☐ other(s) _____

Does the permit type require coordination with key resource agencies?

- ☐ US Environmental Protection Agency (EPA)
- ☐ US Fish and Wildlife Service
- ☐ Texas Parks and Wildlife
- ☐ Texas Commission on Environmental Quality – Water Quality Division
- ☐ Other _____

The following information can be provided to resource agencies:

- ☐ Identification of the desired and target resource factors
- ☐ Hydrologic information gathered through the HMGs
- ☐ Model outputs or analysis results used for effects determinations
- ☐ Hydrological model outputs needed for input to resource-specific assessment methods
- ☐ Information regarding operational actions needed to avoid, mitigate, and possibly compensate impacts to aquatic resources

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the Corps have sufficient and complete data to share with resource agencies if initial determination of affected resources has been made and the permit sought requires coordination with resource agencies? ○ **Yes** ○ **No**

2.G. Simplify hydrologic modification analysis as much as possible to make determination of adequacy of analysis

What format is the hydrologic analysis presented?

☐ Spreadsheet
☐ RiverWare
☐ WAM
☐ Other model software _____
☐ Other _____

Does the information used in the hydrologic modification analysis:

- ☐ Use the best available data and information (HMG 2.A)?
- ☐ Establish a critical period for evaluation (HMG 2.B)?
- ☐ Use an appropriate time-step for initially identified resources (HMG 2.C)?
- ☐ Identify any assumptions in data or models used in hydrologic modification analysis, and generally represent total streamflow or reservoir conditions (HMG 2.D)?
- ☐ Use observed data preferentially over model output when available and make appropriate adjustments to estimate flows when data are not available (HMG 2.E)?
- ☐ Coordinate with resource agencies when appropriate or required?

Based on the above and HMGs 1.A through 2.G, additional detailed analysis is:

- ○ Not required (Tier-2 HMGs and hydrologic modification indicate)
- ○ Required. Specific Tier-3 HMGs are applicable: _____
- ○ Required. Proceed to Tier-3 HMGs

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the hydrologic modification analysis performed under the Tier-2 HMGs provide the Corps with adequate information to evaluate proposed project effects and render a permit decision? ○ **Yes** ○ **No**

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3. Tier-3 HMGs: Major Project and Detailed Analysis of Project Effects

Some projects are large and are expected to have more substantial impacts to aquatic resources than smaller projects. As projects are evaluated through the Tier-1 and Tier-2 HMGs, the Corps may determine that additional detailed analysis is required to reasonably assess impacts to aquatic resources. Generally, projects that require a larger Standard Individual Permit and may include an EIS will require detailed hydrologic modeling to support impact evaluation of specific resources. Much of the information gathered and analysis performed in the initial and medium-sized project level HMGs are re-examined in more detail for the detailed analysis of project effects.

3.A. Use any Applicant-provided modeling where appropriate to save time and money in hydrologic model development

The Corps will use existing hydrologic modeling where appropriate for aquatic effects analysis.

Check box if discussed/considered.

Was the original purpose of the modeling to simulate streamflow (see HMG 2.D and 3.C)? ○ Yes ○ No

If yes, modeling may be appropriate for use.

If no, modeling will likely require modification to function for the Corps' needs. Thorough model documentation should describe inputs, assumptions, and operations so appropriate adjustment for streamflow can be made.

Applicant and Corps acknowledge that modification to existing models designed with original purposes other than accurately simulating streamflow may result in ☐ higher costs, ☐ delays/ additional time, and ☐ other unforeseen issues as compared to developing a new model with the Corps' effects analysis as the primary objective.

If a new model is developed, underlying data and inputs used in other models can be used to reduce costs and time.

☐ Observed data (e.g. streamflow, evaporation, precipitation, discharges, demands, reservoir volumes, sedimentation rates, etc.)

☐ Data and modeling assumptions identified in Tier-1 and Tier-2 HMGs

☐ Data verification is less costly and quicker than new data vetting and development

RiverWare tip: use of data objects, RiverWare Policy Language rules (RPL Rules) or the Multi-Run Manager to facilitate management of multiple modeling scenarios or alternatives may be beneficial to the review process.

3.A. USE APPLICANT-PROVIDED MODELING WHERE APPROPRIATE, CONT.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Was existing modeling designed to accurately represent streamflows in the project area? If not, consider development of a new model to save time and money. ◯ **Yes** ◯ **No**

3.B. Hydrologic modeling should be designed around known or anticipated needs of aquatic resources to be evaluated

To the extent resource modeling needs can be known beforehand, hydrologic modeling should be developed to fulfill those specific needs.

Check box if discussed/considered.

Have specific aquatic resource factors been identified through Tier-2 HMGs, public notice, or public scoping process? ◯ Yes ◯ No

- ☐ surface water
- ☐ groundwater
- ☐ water quality
- ☐ geomorphology
- ☐ fisheries
- ☐ aquatics including macro- and micro-invertebrates
- ☐ riparian functions
- ☐ water-based recreation
- ☐ aesthetics
- ☐ other(s) _____

If none have been identified, default to shorter time-steps (daily) and more extensive geographic area which may be reduced through additional review/discussion.

Design of hydrologic modeling should consider the following aspects of providing model outputs for each of the resource needs identified above:

- ☐ location of evaluation
- ☐ frequency of data needs
- ☐ time-step of model output
- ☐ critical period for resource
- ☐ sensitive flow ranges for resource
- ☐ other resource-specific model needs _____

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Do the known or expected hydrologic data needs for aquatic resources analysis inform the Corps about specific aspects of the design or modification of hydrologic modeling? ◯ **Yes** ◯ **No**

3.C. Model purpose should be centered on reasonably representing stream flows under a variety of conditions, including critical periods

Hydrologic modeling used for the Corps' effects analysis must adequately represent the effects of the proposed project on aquatic resources. This requires reasonably accurate simulation of stream flows (or other relevant hydrologic parameters such as reservoir stage) at locations where aquatic resources could be affected.

Has the Applicant provided hydrologic modeling that was designed to simulate:

☐ streamflow ☐ project yield ☐ flood control ☐ system operations
☐ other _____

Commonly available modeling in the form of project yield models and flood control models have the following characteristics that should be thoroughly understood if used in lieu of a model designed with accurate streamflow simulation as its purpose.

Project yield models typically:

- Do not necessarily have to simulate stream conditions to effectively simulate project yield
- Can more easily use monthly data due to the buffering effect of storage facilities
- Use conservative assumptions about demands, return flows, strict water rights administration, and risk considerations (e.g., safety factors or safe yield)

Use or modification of yield models for effects analysis should consider:

☐ All model inputs not directly derived from observed data

☐ Representation and assumptions on operational constraints

☐ Representation of contracted supplies, exchanges, swaps, etc.

☐ If streamflow data has been modified from observed to consider future changes such as potential climate change effects

Flood control models typically:

- Focus on large flow events
- Often neglect or do not simulate low-flow events or operations that may contain critical periods for aquatic resources

Use or modification of flood control models may require significant modification. Use of the following aspects may increase efficiency in any such modifications:

☐ Model configuration (i.e. physical layout of the river basin)

☐ Model input data (streamflows from gages sources, precipitation, evaporation, and reservoir stage-capacity information)

Other model types, such as system models, operational models, and forecasting models are typically custom-developed and may include a wide range of assumptions and configurations that cannot be easily generalized and require individual review for suitability related to the Corps' effects analysis.

3.C. REASONABLY REPRESENTING STREAM FLOWS, CONT.

Proposed projects that must meet certain needs or multiple needs (e.g. project yield, flood control) can use different models or scenarios to demonstrate these needs are met and to evaluate effects to aquatic resources through a wider range of expected operational flow conditions. RiverWare scenario management capabilities provide opportunities to simulate different scenarios to test project performance at extremes (yield and flooding) and more typical ranges of operations (effects analysis).

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the model selection or modification to existing models accurately simulate changes to streamflows or changes to other relevant hydrologic features? ○ **Yes** ○ **No**

3.D. Simulate avoidance and minimization actions separate from compensatory mitigation

Actions proposed by the Applicant must distinguish between avoidance and minimization of impacts and compensatory mitigation.

The Corps must determine the LEDPA based on avoidance and minimization and cannot consider compensatory mitigation until the LEDPA is determined

Are actions that are considered avoidance and minimization clearly distinguished from compensatory mitigation by the Applicant and Corps? ◯ Yes ◯ No

If no, develop this distinction.

If yes, does the model allow for simulation of the proposed project with only avoidance and minimization without compensatory mitigation actions? ◯ Yes ◯ No

RiverWare tip: RiverWare's RPL can be implemented with different "policy goups" that can be easily switched on and off. Any additional actions for compensatory mitigation can be simulated as its own policy group so the incremental impacts from compensatory mitigation can be evaluated.

Actions to avoid and minimize as well as for compensatory mitigation will likely be included as permit conditions.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the hydrologic modeling allow for distinct simulation of avoidance and minimization actions and compensatory mitigation actions? ◯ **Yes** ◯ **No**

3.E. Model domain should encompass geographic extent and a sufficient study period to accurately reflect the range of effects

Use modeling to determine if the initially proposed boundaries could be reduced or expanded

Are effects at the initially proposed boundaries small or large?

◯ Small – Expansion of the boundaries is not needed, if the effects at the initially proposed boundaries are negligible, the boundaries may be reduced.

◯ Large – Consider enlarging the geographic extent of the model.

Professional judgment, rationale, and documentation for the established limits is needed, supported by hydrologic modeling data and consideration of aquatic resources at the boundaries.

Potential upstream operational changes were initially identified under HMGs 1.B and 1.C. Are there significant anticipated upstream impacts? ◯ Yes ◯ No

If yes, the upstream impacts should be supported by hydrologic modeling similar to the downstream impacts.

Does the study period include a wide range of hydrologic conditions, including dry, wet, and average periods? ◯ Yes ◯ No

If no, the study period should be expanded to include this range of conditions.

Are the critical periods initially identified in HMG 2.B sufficiently captured by the study period? ◯ Yes ◯ No

If no, the study period should be expanded to properly capture the critical periods.

Have there been significant changes to regional hydrology (e.g., construction of a reservoir upstream) within the study period? ◯ Yes ◯ No

If yes, will a shortened study period provide an adequate range of hydrologic conditions and critical flow conditions? ◯ Yes ◯ No

If no, modified or reconstructed hydrology may be appropriate. All modifications should be well documented, and the methods and assumptions used should undergo a sensitivity analysis using the hydrologic modeling.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Do the geographic and temporal extents of the model adequately cover upstream and downstream effects over a wide range of hydrologic and critical flow conditions? ◯ **Yes** ◯ **No**

3.F. Model time-step should reflect the critical time-scale of the aquatic resources being evaluated

As discussed in HMG 2.C, daily time-steps are the default for hydrologic modeling since weekly and monthly data can mask potential effects on aquatic resources between time-steps.

The Corps and Applicant should be aware that models that are operated on a daily time-step may not be using daily model input.

Is the model time-step daily? ◯ Yes ◯ No

If yes, model inputs should be verified back to source data reported on a daily basis if possible. If daily source data are not available, the Corps should evaluate the method used to develop daily inputs for the hydrologic modeling.

Have specific aquatic resources been identified for evaluation? ◯ Yes ◯ No

If yes, model developers should consult with resource specialists to best evaluate the effects of the project on each identified resource. The consultation should include discussion of any known model inputs that are not available on the time scale required for the aquatic resource evaluation, and the best way to develop these inputs at the required time-step.

Were any assumptions and methods used to modify source data to develop model inputs at the required time-step? ◯ Yes ◯ No

If yes, all modifications should be well documented, and the methods and assumptions used should undergo a sensitivity analysis using the hydrologic modeling.

Some aquatic resources may only require data at longer time-steps than other resources. Model output can be easily summed over longer time-periods, but disaggregation into smaller time steps is much more difficult.

Is the model time-step set to the shortest time-step required for the effects analysis of any of the aquatic resources? ◯ Yes ◯ No

If no, the model time-step should be refined.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Are the model time-steps and underlying data sufficient to adequately assess the impacts on aquatic resources? ◯ **Yes** ◯ **No**

3.G. Proposed operations and administration should be incorporated into the hydrologic modeling

Applicants may be required to submit an operations plan to the Corps.

Operations plans should include detailed information about operations under various conditions.

Applicants can make commitments associated with project operations that avoid and minimize impacts to aquatic resources and allow for the elimination of certain geographic and/or resource effects evaluations during the permit evaluation process.

In regions where water rights are actively administered and affect a proposed project's operations, models that do not simulate water rights should be avoided or at a minimum evaluated carefully to determine the magnitude of potential error introduced by ignoring water administration practices.

The hydrologic modeling should include reasonable representations of all of the following:

- ☐ Project Operations
- ☐ Commitments/Contract Requirements
- ☐ Assumptions
- ☐ Water Administration/Water Rights

If the modeling platform is not able to model the proposed range of operations without oversimplification, a new modeling platform should be chosen.

RiverWare tip: RiverWare has several built-in functions to simulate a variety of standard operational procedures. If operations are reasonably represented by these built-in functions, they should be used preferentially because they reduce the overall complexity of the model. For more complicated operations that are not conducive to the built-in functions, RiverWare has a customizable "RiverWare Programming Language (RPL)" that allows complicated operations to be simulated.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the hydrologic modeling adequately incorporate the proposed operations and administration? ◯ **Yes** ◯ **No**

3.H. The study period time frame should consider reasonably foreseeable future actions for the development of a future conditions baseline

Hydrologic modeling for a proposed project must consider other risk factors that influence hydrology within the project area. A proposed project located in an area, watershed, or drainage basin that is expected to experience significant changes in water use, management, and possibly land use must consider how those expected changes in the future will alter the hydrology relative to current or historical conditions.

Several different model runs may be needed to quantify the effects to aquatic resources from a project as well as its alternatives.

The Corps must use professional judgment as well as local knowledge to determine what level (if any) of analysis is required to incorporate the potential changes to hydrology from other proposed projects.

Does the modeling allow for appropriate determination of which effects are:

- ☐ caused by the project?
- ☐ caused by other actions?
- ☐ cumulative effects to the aquatic ecosystem?

In basins where significant changes to water use and management are reasonably foreseeable, the Corps should develop two baseline conditions: one that simulates the current conditions, and one that represents the expected future conditions without the proposed project.

To the extent that the effects of climate change are sufficiently quantified, they may be evaluated in the context of the proposed project

If included in the needs and yield analyses for the project, are the effects in the hydrologic modeling consistent? ○ Yes ○ No

- If no, consistency in predictive effects analysis and conditions needs to be maintained.

Additional Relevant Information fill out here or attach any relevant documentation

KEY QUESTION

Does the hydrologic modeling adequately incorporate reasonably foreseeable future actions from other projects, changes in use and management, and climate change? ○ **Yes** ○ **No**

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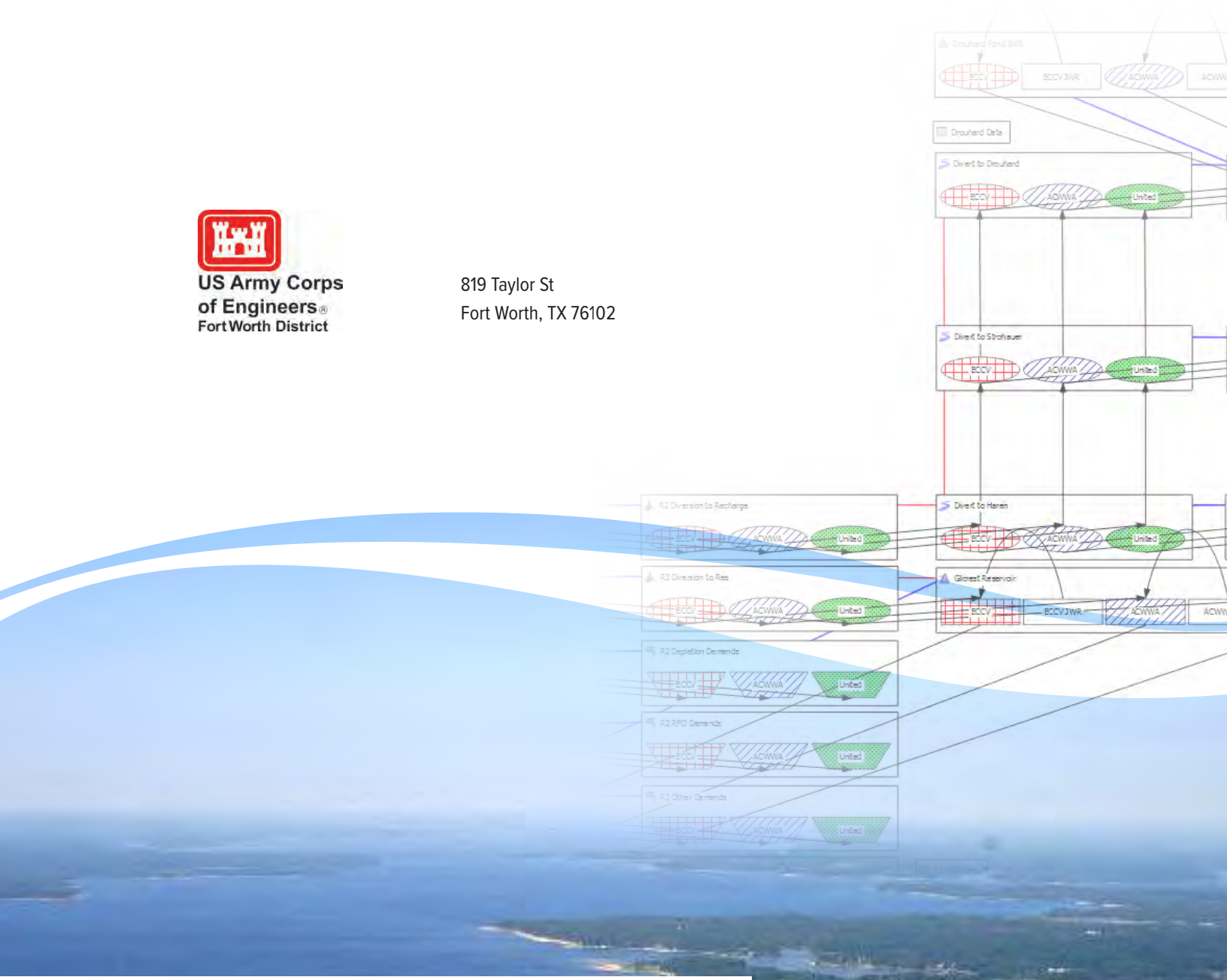

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