Structured Hazard Assessment Committee Process for Coastal Flooding (Coastal SHAC-F)

Coastal SHAC-F Research Workshop
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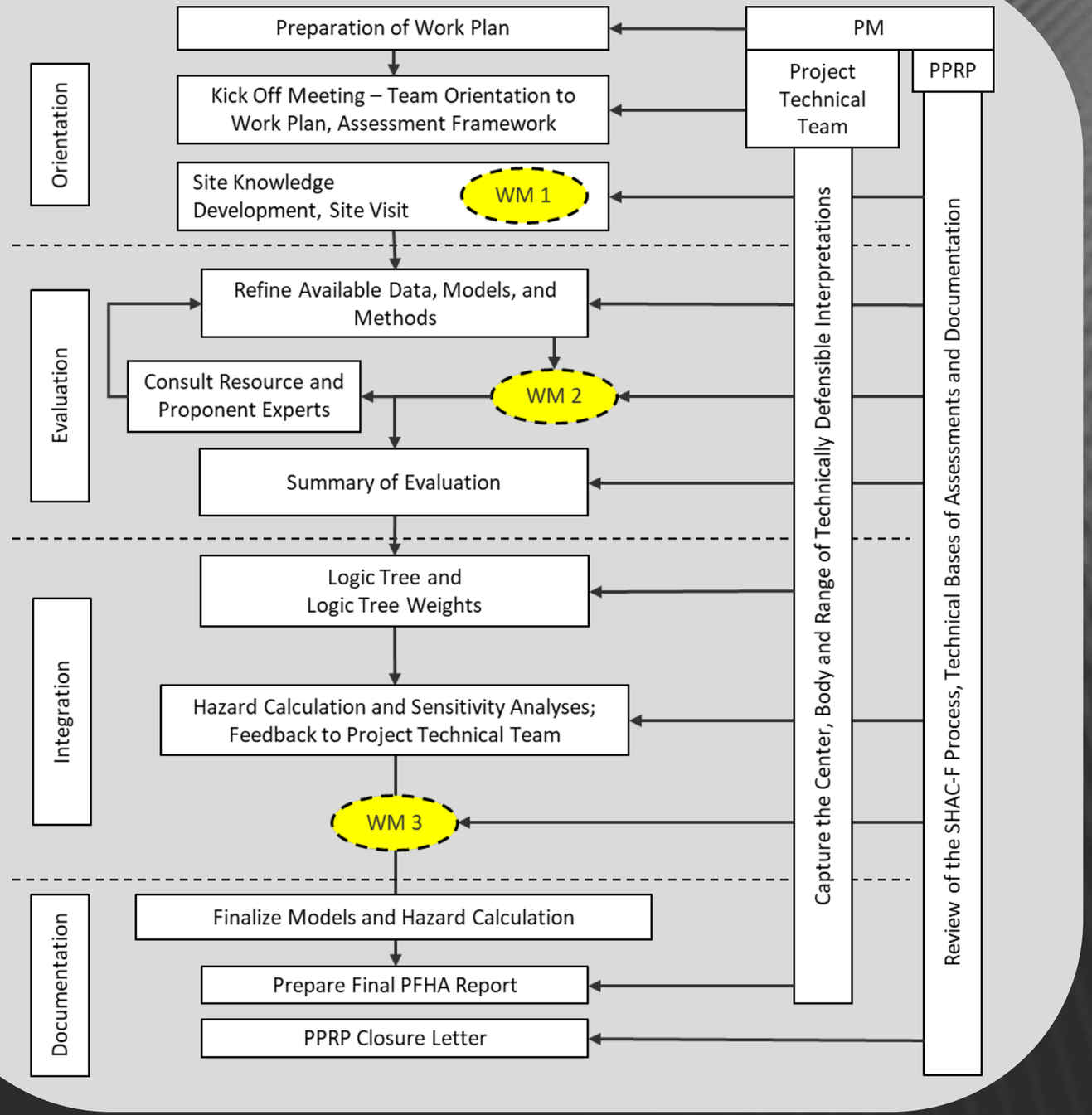
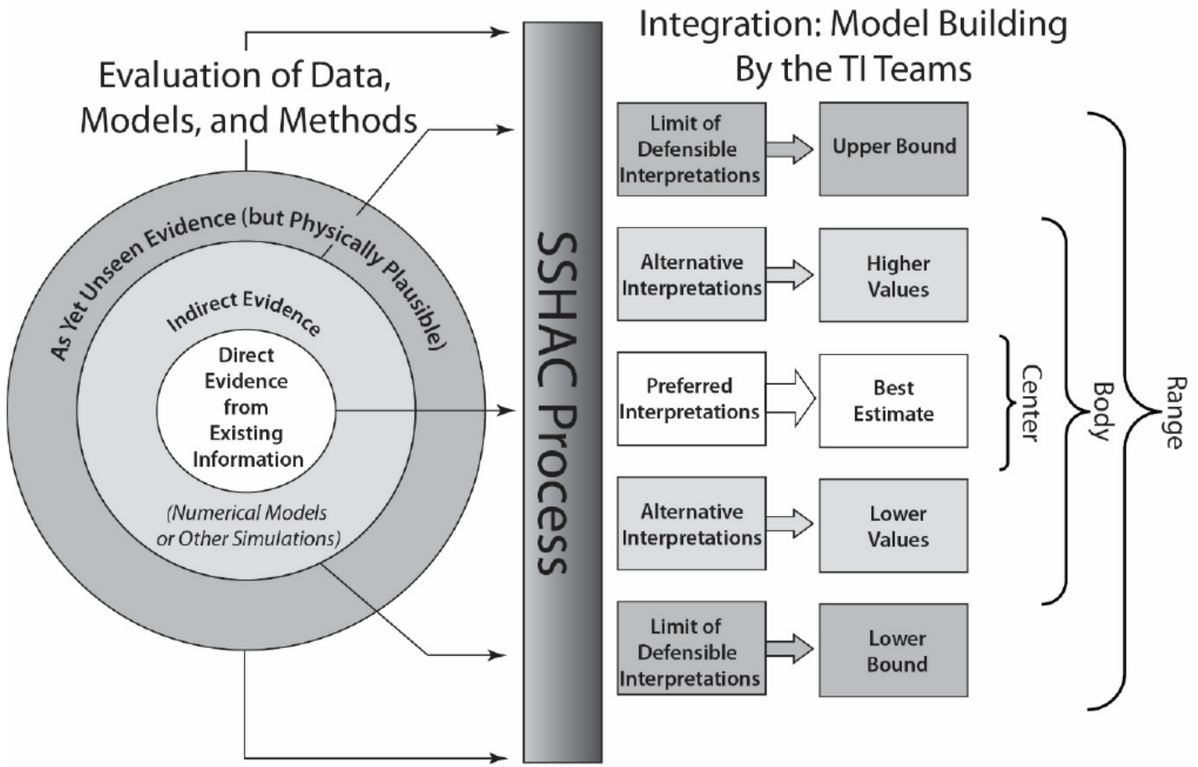


SHAC-F for Coastal Flooding

- USACE Coastal and Hydraulics Laboratory and PNNL
- Series of conference calls starting Fall 2019
- Three Levels of coastal flooding SHAC-F studies
  - Levels address purposes of various NRC flood reviews
  - Project teams and level of effort commensurate with complexity of reviews
  - Data and methods commensurate with complexity of reviews

SHAC-F Goals

- The fundamental goal of a SHAC-F process is to properly carry out and completely document the activities of evaluation and integration, defined as:
  - Evaluation: The consideration of the complete set of data, models, and methods proposed by the larger technical community that are relevant to flood hazard analysis.
  - Integration: Representing the center, body, and range of technically defensible interpretations in light of the evaluation process (i.e., informed by the assessment of existing data, models, and methods).



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SHAC-F Features

- Five essential features provide regulatory confidence – that a hazard assessment has followed a sufficiently rigorous and transparent process that can be efficiently reviewed by the regulatory agency:
  1. **Clearly defined roles** for all participants, including the responsibilities and attributes associated with each role.
  2. **Objective evaluation** of all available data, models, and methods that could be relevant to the characterization of the hazard at the site. This will often include additional new data collected specifically for the hazard assessment. This process includes identifying the limits of the existing data, gaps in the existing data, and the resolution and uncertainties in the available data.
  3. **Integration** of the outcome of the evaluation process into models that reflect both the best estimate of each element of the hazard input with the current state of knowledge and the associated uncertainty. This distribution is referred to as the center, body, and range of technically defensible interpretations. This will generally involve the construction of hazard input models … that address both aleatory variability and epistemic uncertainties.
  4. **Documentation** of the study with sufficient detail to allow reproduction of the hazard analyses. The documentation must identify all the data, models, and methods considered in the evaluation, and justify in detail the technical interpretations that support the hazard input models.
  5. **Independent participatory peer review** is required to confirm that the evaluation considered relevant data, models, and methods, and that the evaluation was conducted objectively and without bias. The peer review is conducted following a “participatory” or continual process throughout the entire project.

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Summary of Coastal SHAC-F Levels

Coastal Floods	SHAC-F Level 1	SHAC-F Level 2	SHAC-F Level 3
Potential use	Screening	• Replacing Level 1 studies • Updating/refining Level 3 studies	Supporting design and/or providing input to PRA
Expected Assessment Results	Limited family of water level and wave climate hazard curves.	Family of hazard curves	More complex family of hazard curves
Data	• Readily accessible data: e.g., existing JPM data, tide gauge data	• More extensive effort to find and assemble existing data: historical data (HURDAT), reanalysis data (EBTRK), previous JPM study data	• Extensive effort to find and assemble existing data: topobathy data for new grid development or significant upgrade of existing grid
Models and Methods	Extreme value analysis Response based approach: Monte Carlo TC sampling of existing JPM storm responses.	Replacing extreme value analysis; updating JPM • Storm recurrence rate models • Defining marginal distributions of TC parameters • Re-computing synthetic storm set probability weights. • JPM hazard curve integration Storm subsampling Incorporation of extratropical analysis in hazard. Limited grid modifications.	JPM • Synthetic storm track development. • Development of wind and pressure fields. • Validation of historical TCs • Computation of TC probability masses and generation of synthetic storm sets. Statistical plus simulation Soft coupling of process-simulation models
Principal Sources of aleatory variability	Water level (surge), wave data, and tides, TC frequency.	Water level (surge), wave data, tides, TC frequency.	Water level (surge), wave data, tides, TC frequency, SLC
Principal sources of epistemic uncertainty	Measurement uncertainty in historical storm data, sampling variability, alternative statistical models, parameter uncertainty.	Measurement uncertainty in historical storm data, alternative data sources and statistical models and methods, parameter uncertainty in simulation model parameters, hydrodynamic modeling errors.	Measurement uncertainty in historical storm data, alternative statistical models, parameter uncertainty in simulation model parameters, alternative process representations in simulation models

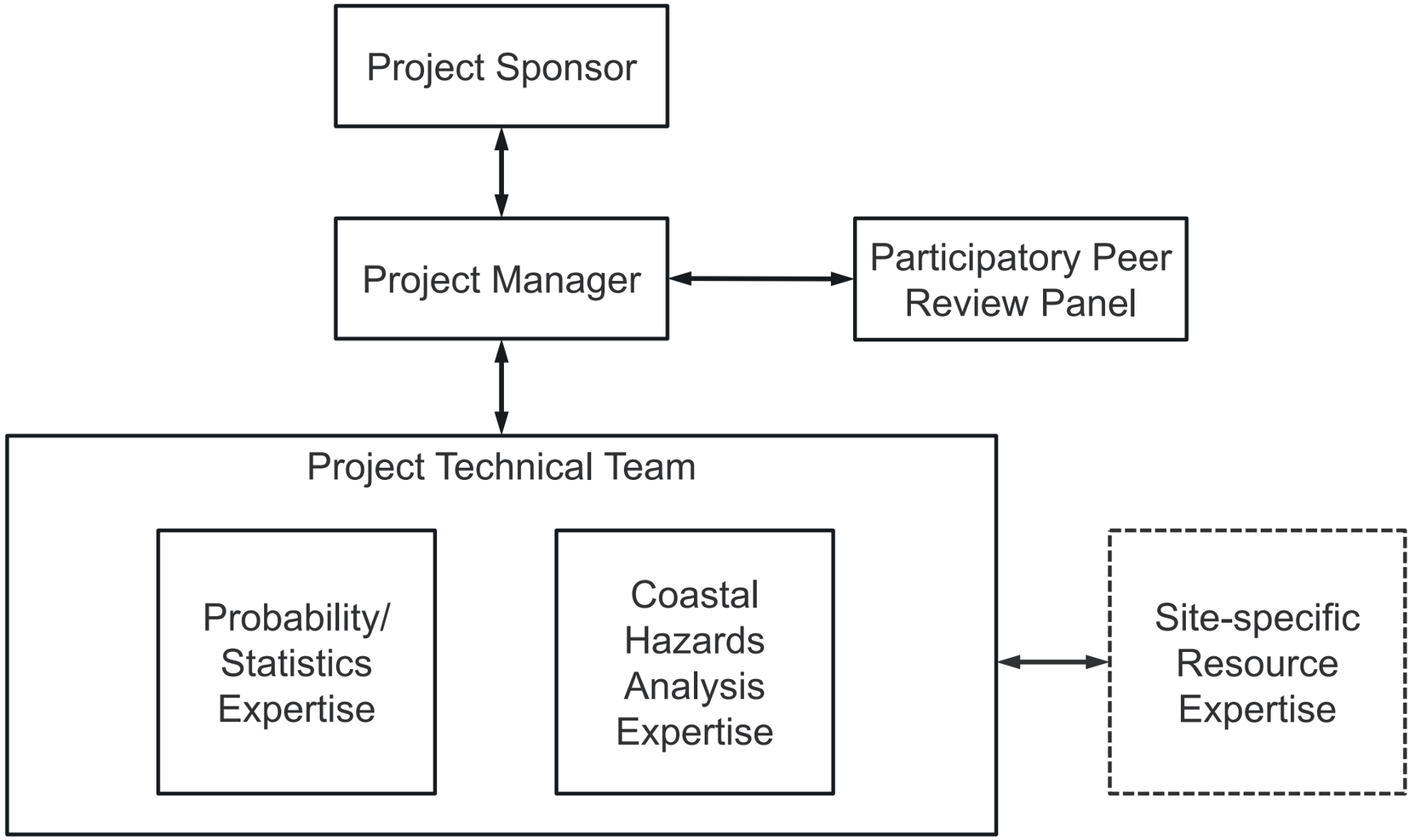
SHAC-F Study – Project Roles

- Project Sponsor
  - Has a need for PFHA, funds the study, and owns the products
- Project Manager (PM)
  - Responsible for successful execution of the study
- Project Technical Integrator (PTI)
  - Responsible for overall technical execution of the study
- Project Technical Team (Levels 1 and 2) and Technical Integration (TI) Lead and Team Members (Level 3)
  - Responsible for the evaluation and integration of data, models, and methods
- Hazard Analyst and Specialty Contractor
- Resource Experts
- Proponent Experts
- Participatory Peer Review Panel (PPRP)

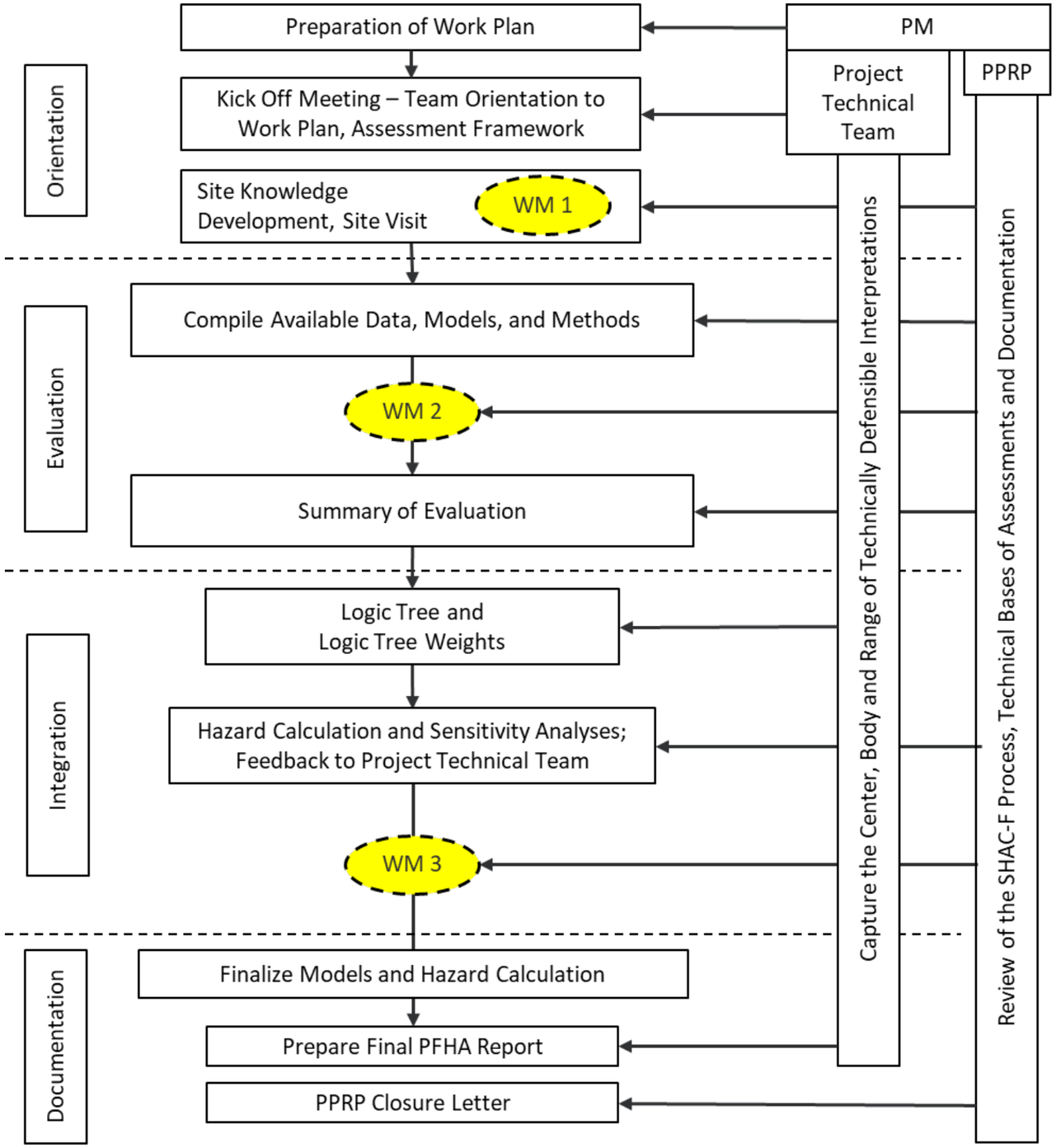
SHAC-F Study – Essential Steps

- Selection of SHAC-F level
- Selection of project participants
- Development of the project plan
- Development of site-specific knowledge, possibly using a site visit
- Compilation of project database
- Hold workshops
  - Organized for a Level 3 study, and optional for Level 2 studies
- Hold working meetings
  - Organized for a Level 3 study, optional for Levels 1 and 2
- Perform sensitivity analyses and preliminary hazard calculation
- Provide feedback to Project Technical Team; perform final hazard calculation
- Document and close the study

Level 1 SHAC-F Study – Project Team Structure



Level 1 SHAC-F Study: Workflow



WM: Working Meeting (optional)

SHAC-F Level 1 for Coastal

Data Preparation

Data

Gauge Data
- Tides
- Currents
- Streamflow

Sea Level Change Curves

Site data

Data Analysis Techniques

De-trending

Sampling Uncertainty Bootstrapping

Data Series

Block Maxima Series

Partial Duration Series

Existing JPM Results

Model Responses

Probability Weights

Hazard Curves

Alternative Conceptual Models

Extreme Value Analysis

GEV

GPD

Fit Method

L Moments

Method of Moments

Maximum Likelihood Method

Frequency Analysis

Response Based
- Monte Carlo

Event Based
- 100-year Water Levels

At-site vs. Regional

Simplified Simulation Models

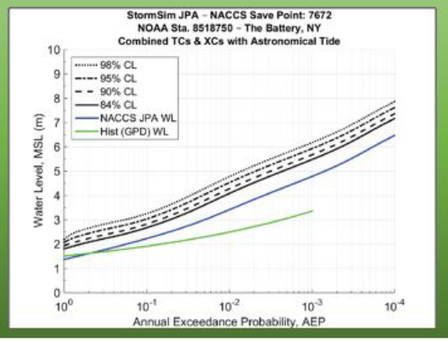
Empirical Models

Logic Tree

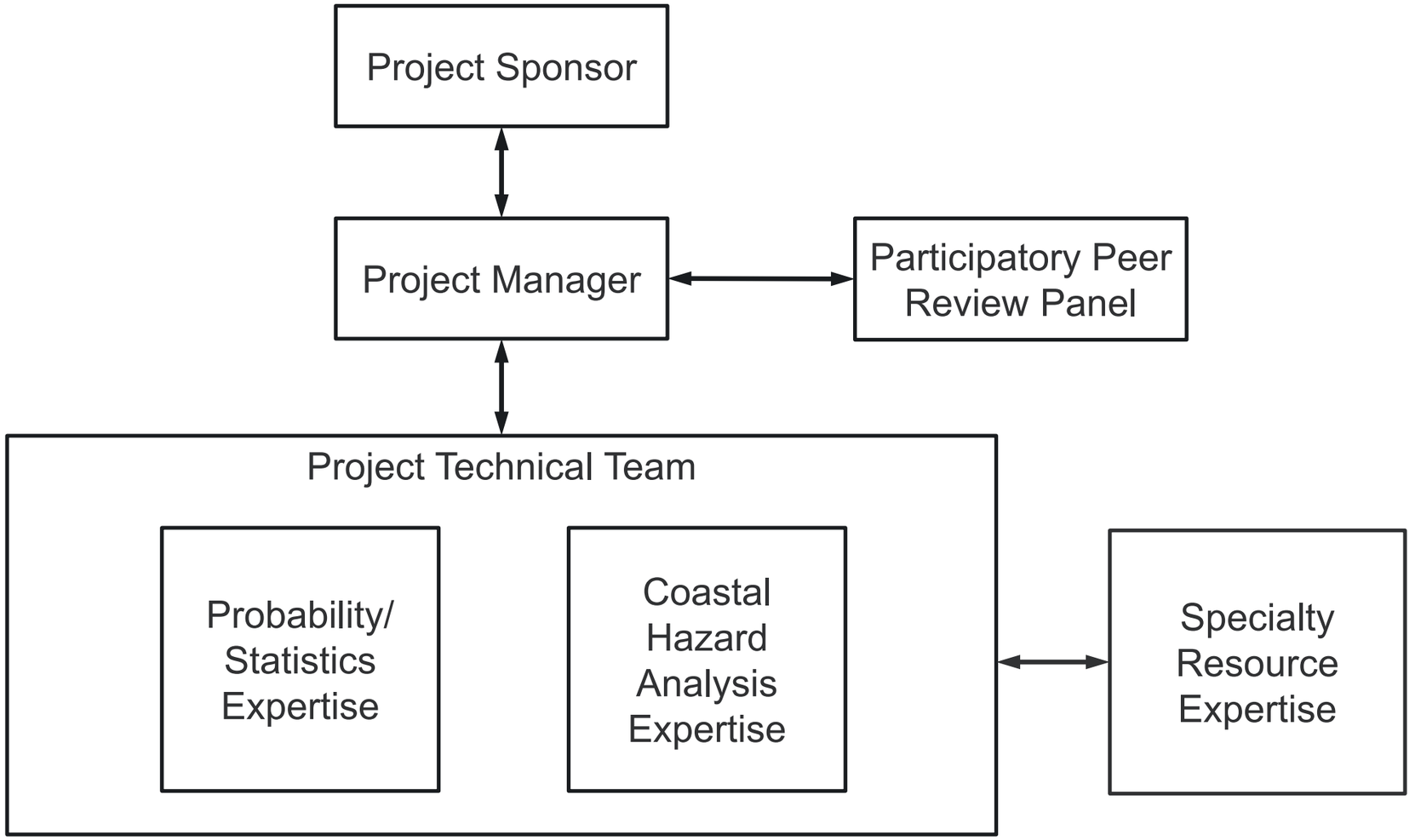
Data → Data Analysis Techniques → Data Series → Extreme Value Analysis → Fit Method → Logic Tree Weights

Existing JPM Results → MC Sampling → Simplified Simulation Models → Logic Tree Weights

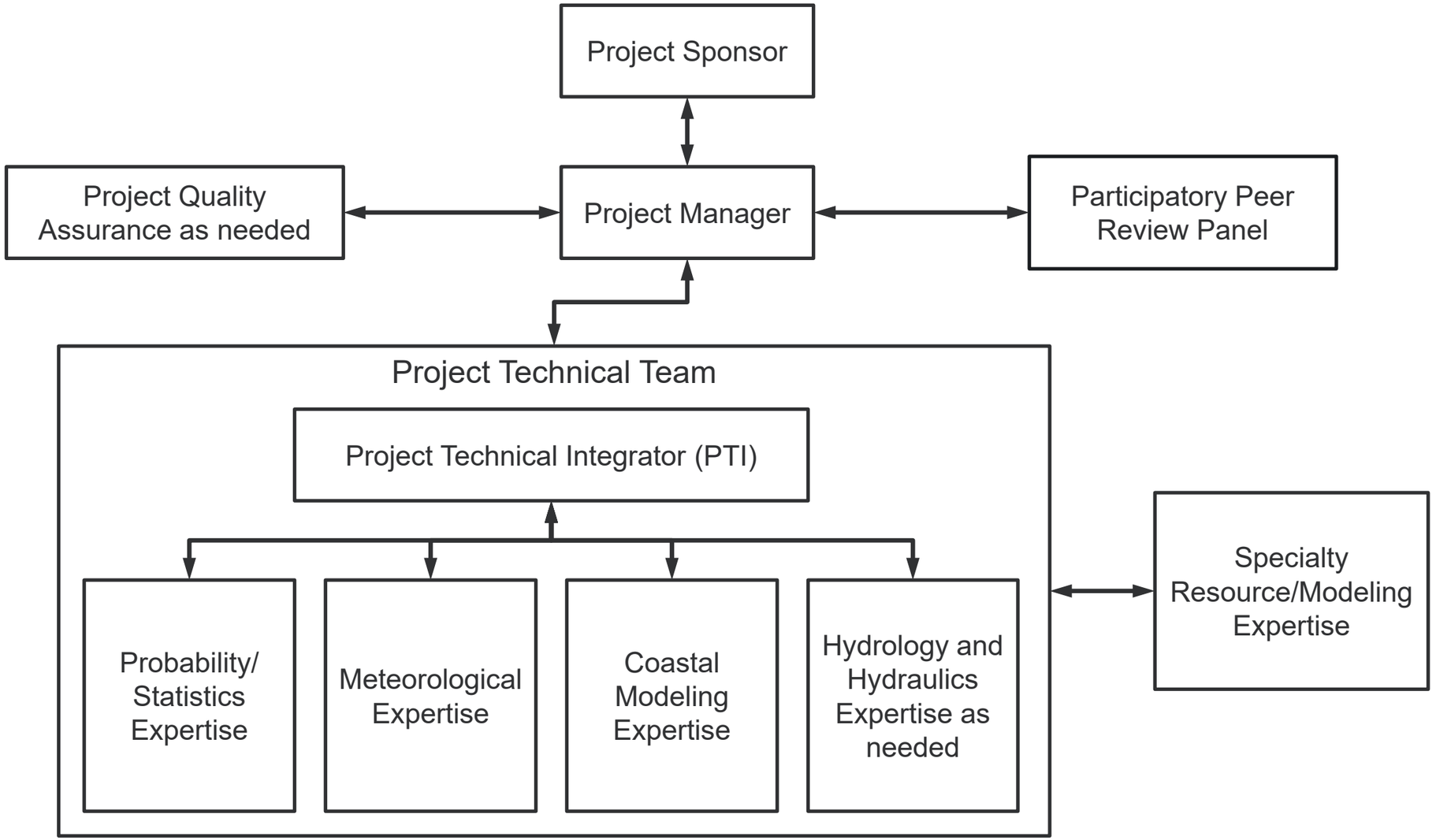
Limited Number of Hazard Curves



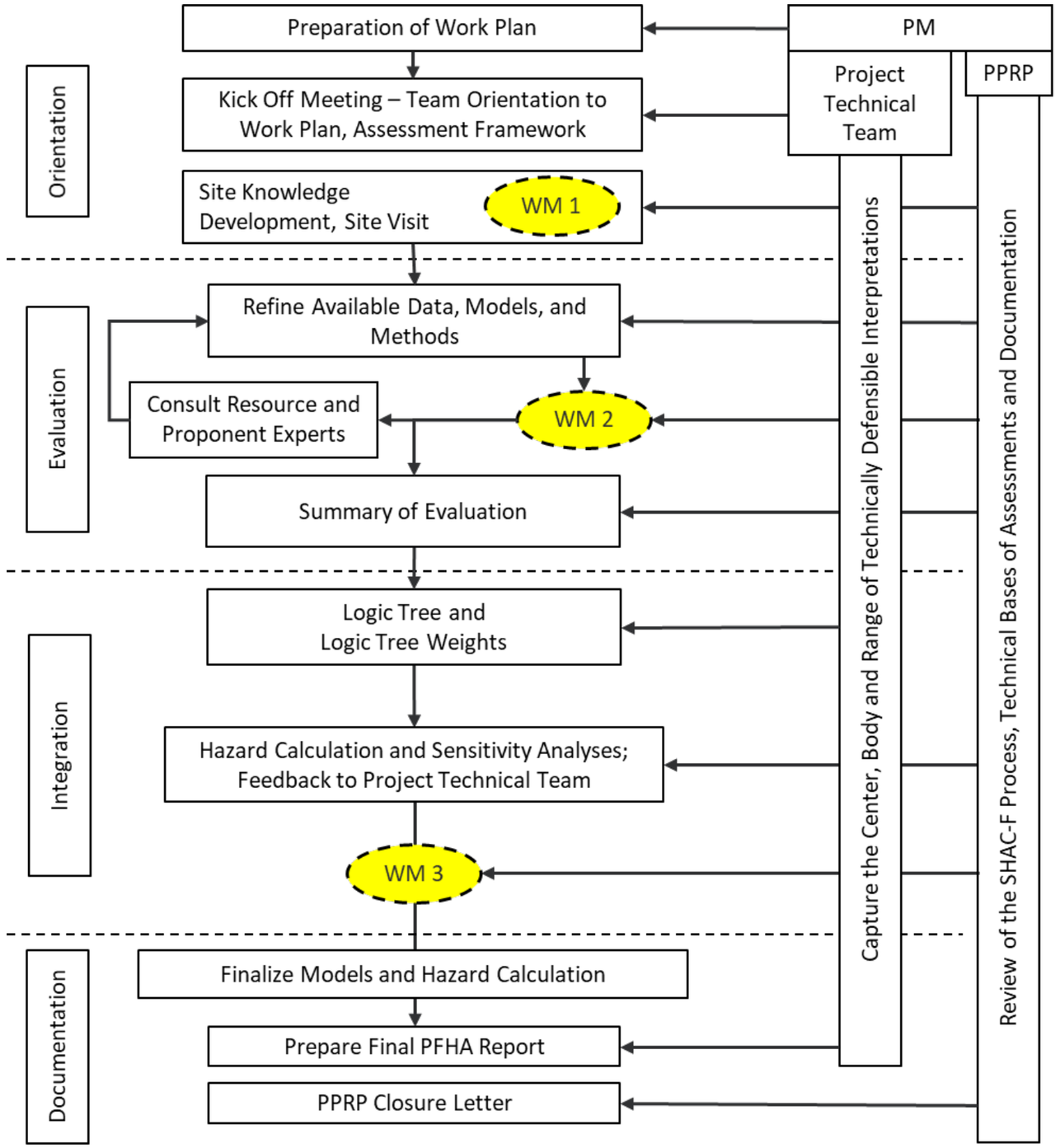
Level 2 SHAC-F Study – Project Team Structure for Replacing a Level 1 Study



Level 2 SHAC-F Study – Project Team Structure for Update of a Level 3 Study



Level 2 SHAC-F Study: Workflow



WM: Working Meeting (optional)

SHAC-F Level 2 for Coastal for Replacing a Level 1 Study

Data Preparation

Data
- Gauge Data
- Sea Level Change Curves
- Site Data
- **Additional Data/Data Sources**

Data Analysis Techniques
- De-trending
- Sampling Uncertainty Bootstrapping

Data Sampling
- Block Maxima Series
- Partial Duration Series

Existing JPM Results
- Model Responses
- Probability Weights
- Hazard Curves

Alternative Conceptual Models

Extreme Value Analysis
- GEV
- GPD
- **New models and methods**

Fit Method
- L Moments
- Method of Moments
- Maximum Likelihood Method
- **New models**

Frequency Analysis
- Response Based
  - Monte Carlo
- Event Based
  - 100-year Water Levels
- At-site vs. Regional

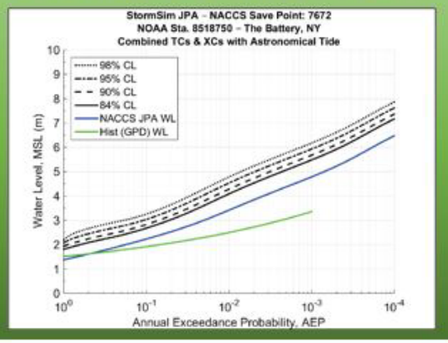
Simplified Simulation Models
- Empirical Models
- **New models and methods**

Logic Tree

Data → Data Analysis Techniques → Data Series → Extreme Value Analysis → Fit Method → Logic Tree Weights

Existing JPM Results → MC Simulation → Simplified Simulation Models → Logic Tree Weights

Limited Number of Hazard Curves



SHAC-F Level 2 for Coastal for Updating a Level 3 Study

HURDAT2, EBTRK, Statistical Models

Coastal Reference Locations

Data Preparation

Data Partitioning

TC Intensity
All
High Intensity
Medium Intensity
Low Intensity

Storm Subsampling

Storm Recurrence Rate

UKF Mean

EKF Mean

GKF Mean

GKF +/- SD

Update Values

Storm Generation

Univariate Distributions

TC Parameters
Δp, R_{max}, V_t, θ

Update Distributions
Gumbell
Weibull
Normal
Lognormal
GP

Alternative Conceptual Models

Probability Masses

Meta-Gaussian Copula

Response Surface

Bayesian Quadrature

Update

Numerical Modeling

Atmospheric
PBL

Hydro
ADCIRC
STWAVE
SWAN

Limited Grid Updates

Error Estimation

Numerical Modeling

Holland B

Tide

JPM Integration

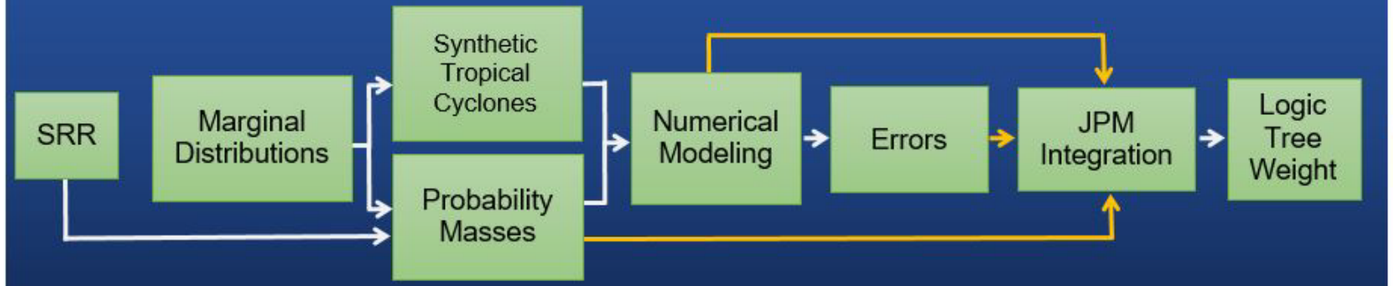
Probability Masses

Modeling Results

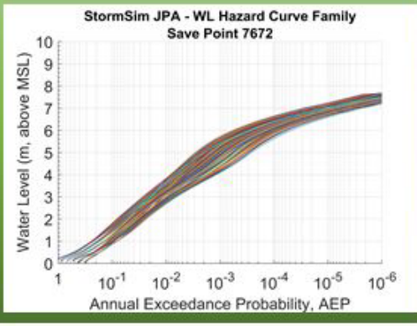
Errors

Surrogate Modeling

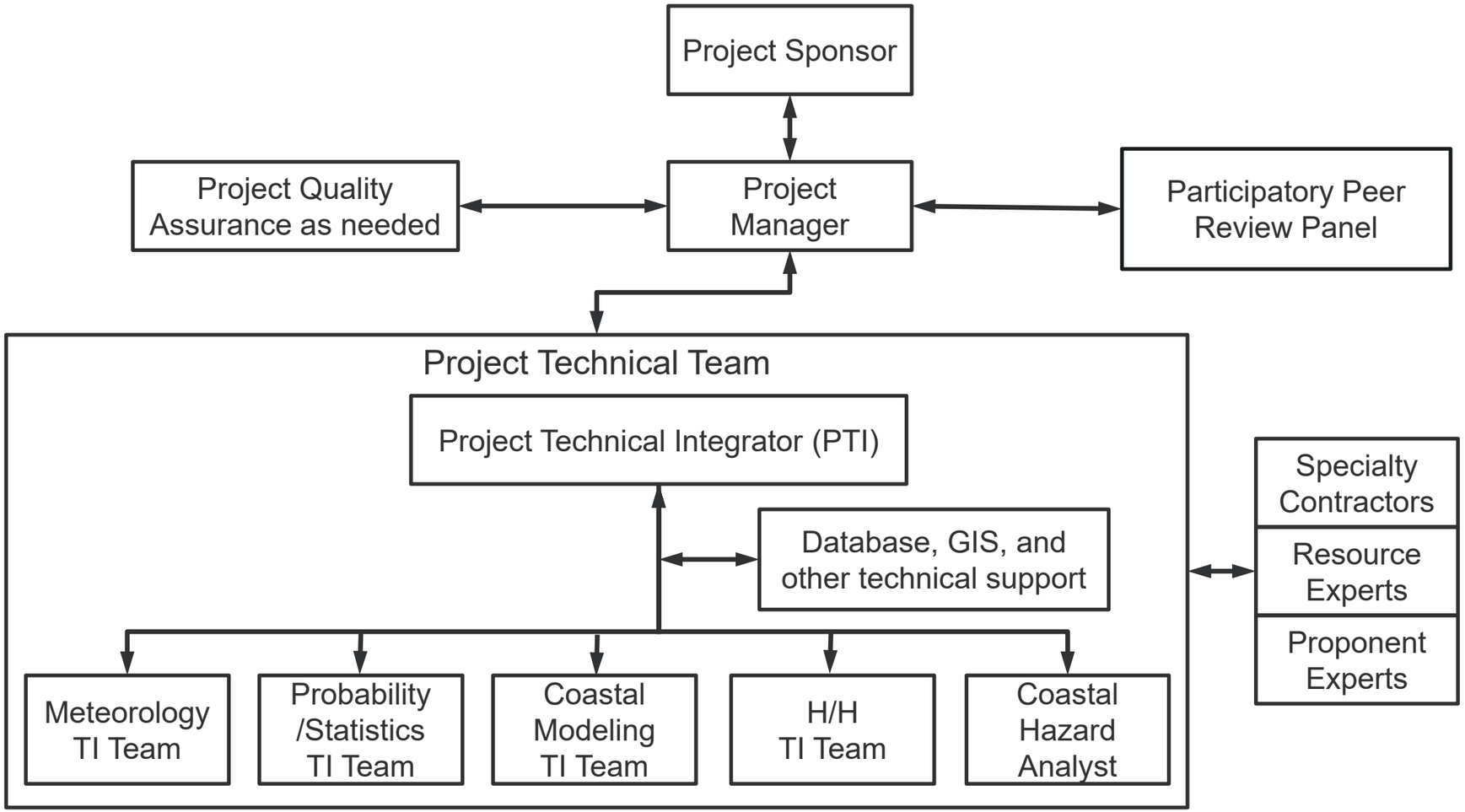
Logic Tree



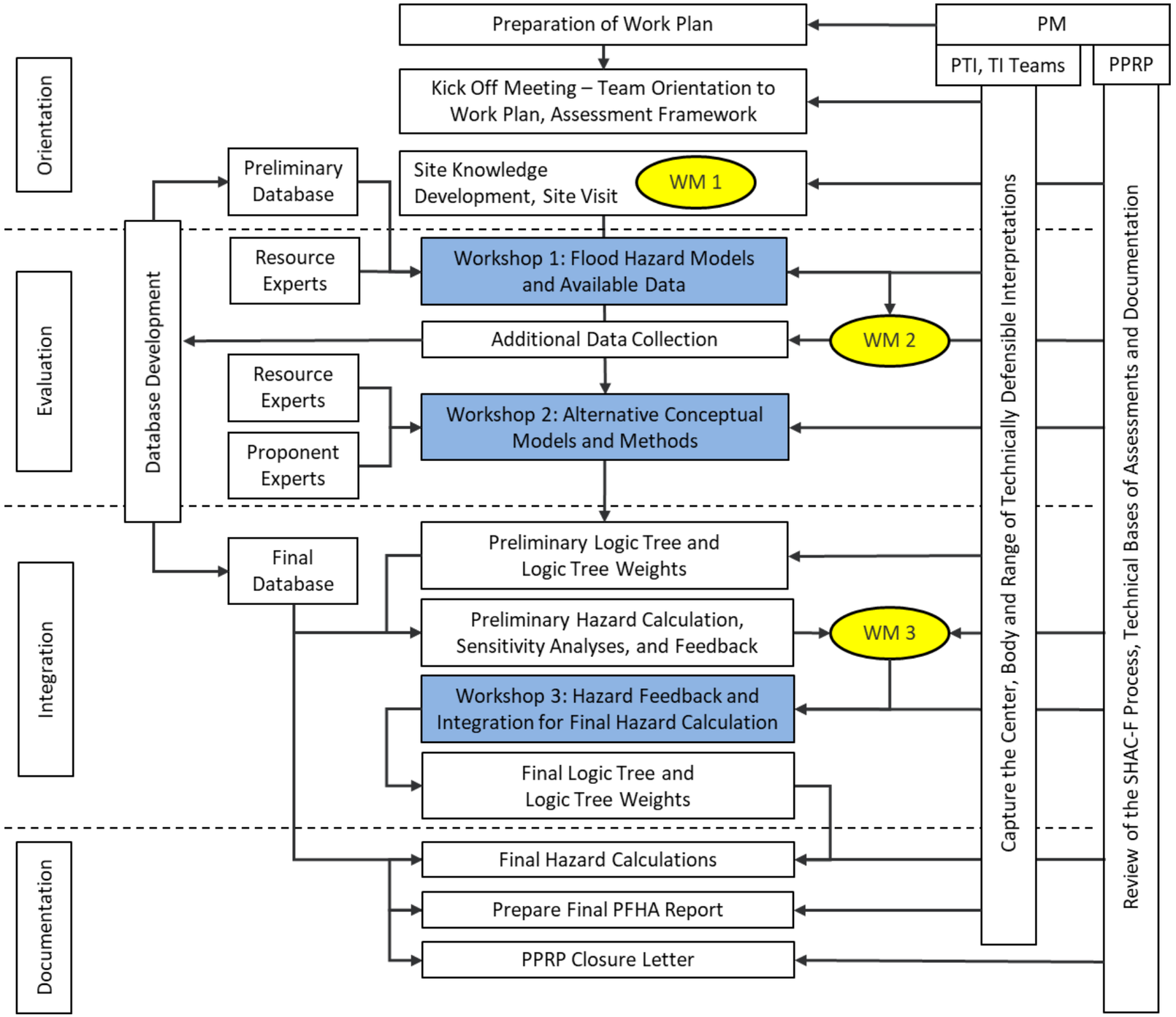
Family of Hazard Curves



Level 3 SHAC-F Study – Project Team Structure



Level 3 SHAC-F Study: Workflow



WM: Working Meeting

SHAC-F Level 3 for Coastal

HURDAT2, EBTRK, Statistical Models

Coastal Reference Locations

Data Preparation

Data Partitioning

TC Intensity
All
High Intensity
Medium Intensity
Low Intensity

Storm Recurrence Rate

UKF Mean
EKF Mean
GKF Mean
GKF +/- SD

Storm Generation

Univariate Distributions

TC Parameters
Δp, R_{max}, V_t, θ

Distributions
Gumbell
Weibull
Normal
Lognormal
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Alternative Conceptual Models

Probability Masses

Meta-Gaussian Copula
Response Surface
Bayesian Quadrature

Numerical Modeling

Atmospheric
PBL

Hydro
ADCIRC
STWAVE
SWAN

Error Estimation

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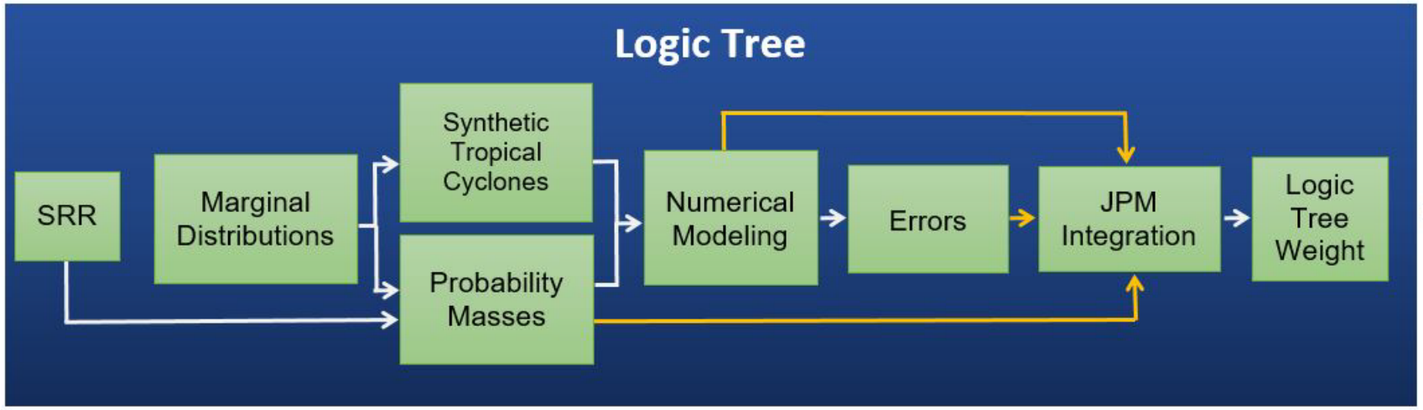
Holland B
Tide

Joint Probability Method Integration

Probability Masses
Modeling Results
Errors

Logic Tree



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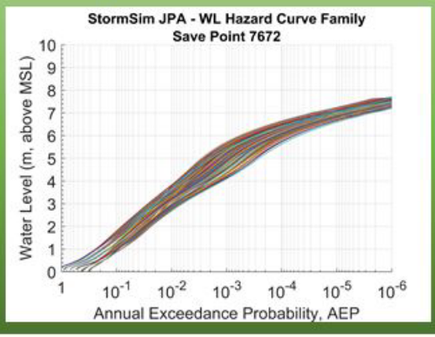

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Thank you