Incorporating Risk Informed Decision Making for Flood Risk Management (FRM) Studies

PCoP Webinar Series

FRM- PCX
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What part of the team are you?

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SECOND IN A SERIES OF WEBINARS

2 Aug	Water Management and Reallocation Studies
16 Aug	Inland Flood Risk Management
	Coastal Storm Risk Management
	Inland Navigation
	Small Boat Harbors
	Ecosystem Restoration
	Deep Draft Navigation

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Have You Ever Worked on a Flood Risk Management Study?

Yes

No

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AGENDA

- USACE Role in FRM
- FRM Concepts
- FRM Measures
- Risk Informed Decision Making in the Planning Process
- FRM Specific Policies

USACE Role in FRM

USACE Mission in FRM evolved from Navigation Mission

- USACE Navigation Mission
  - Mississippi River Commission (1879)
  - California Debris Commission (1893)
- 1917 Flood Control Act
  - Authorized levee construction
  - Mississippi, Ohio and Sacramento Rivers (project specific)
- 1936 Flood Control Act – established Federal Role

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USACE FRM PROJECT FACTS

- More than 10 million people live or work behind USACE levees.
- 14,000 miles of levees reduce flood risk but don’t eliminate flooding.
- USACE dams have prevented $485 billion from 2004-2013
- USACE FRM projects avoid $8.00 for every $1.00 invested

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Sources: https://www.usace.army.mil/Missions/Civil-Works/Levee-Safety-Program/
https://www.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/590578/dam-safety-facts-and-figures/

FLOOD RISK PRIMER

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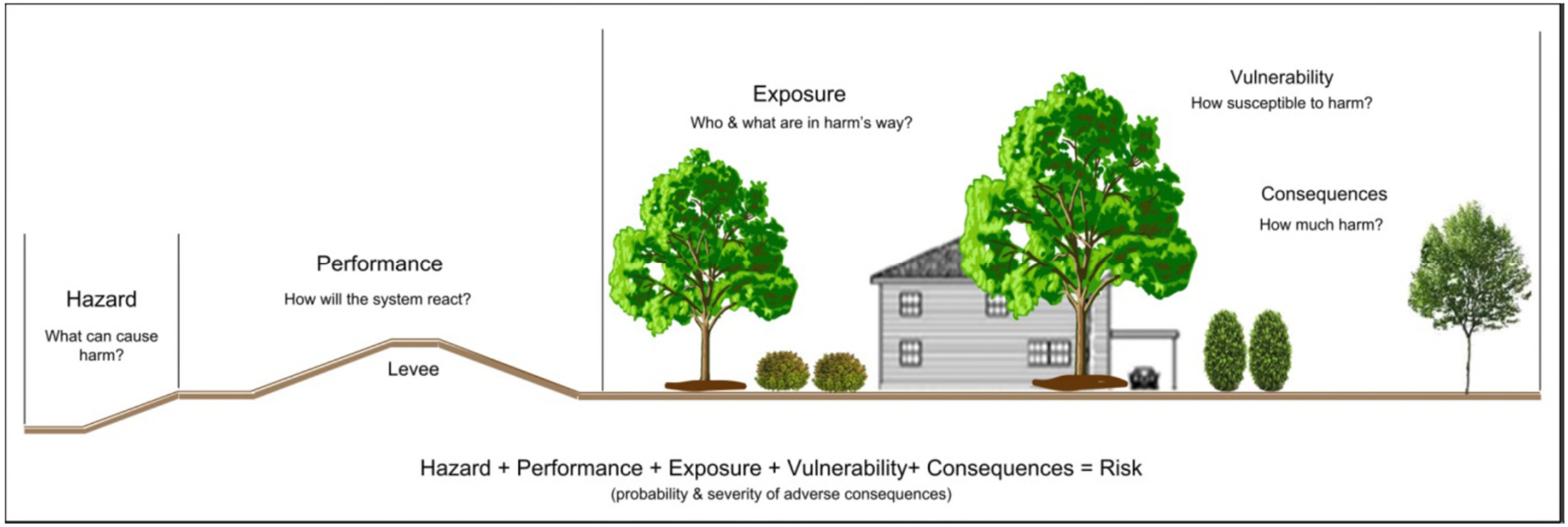
WHAT IS FLOOD RISK?



Risk =

Hazard + Performance + Exposure + Vulnerability + Consequences

Flood Risk (simplified) = Flood Probability x Flood Consequences

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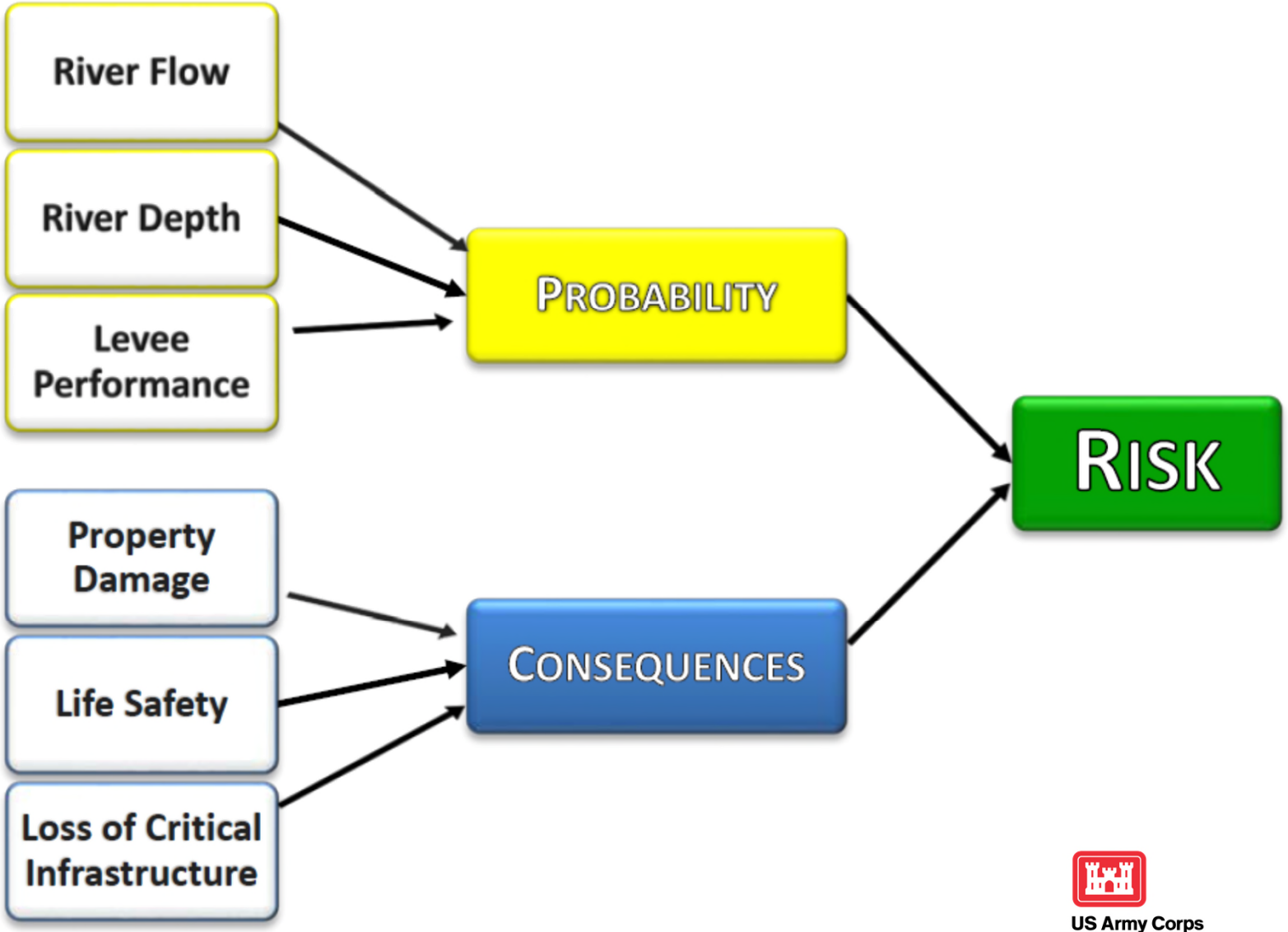
COMPONENTS OF FLOOD RISK



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WHAT IS FLOOD RISK?

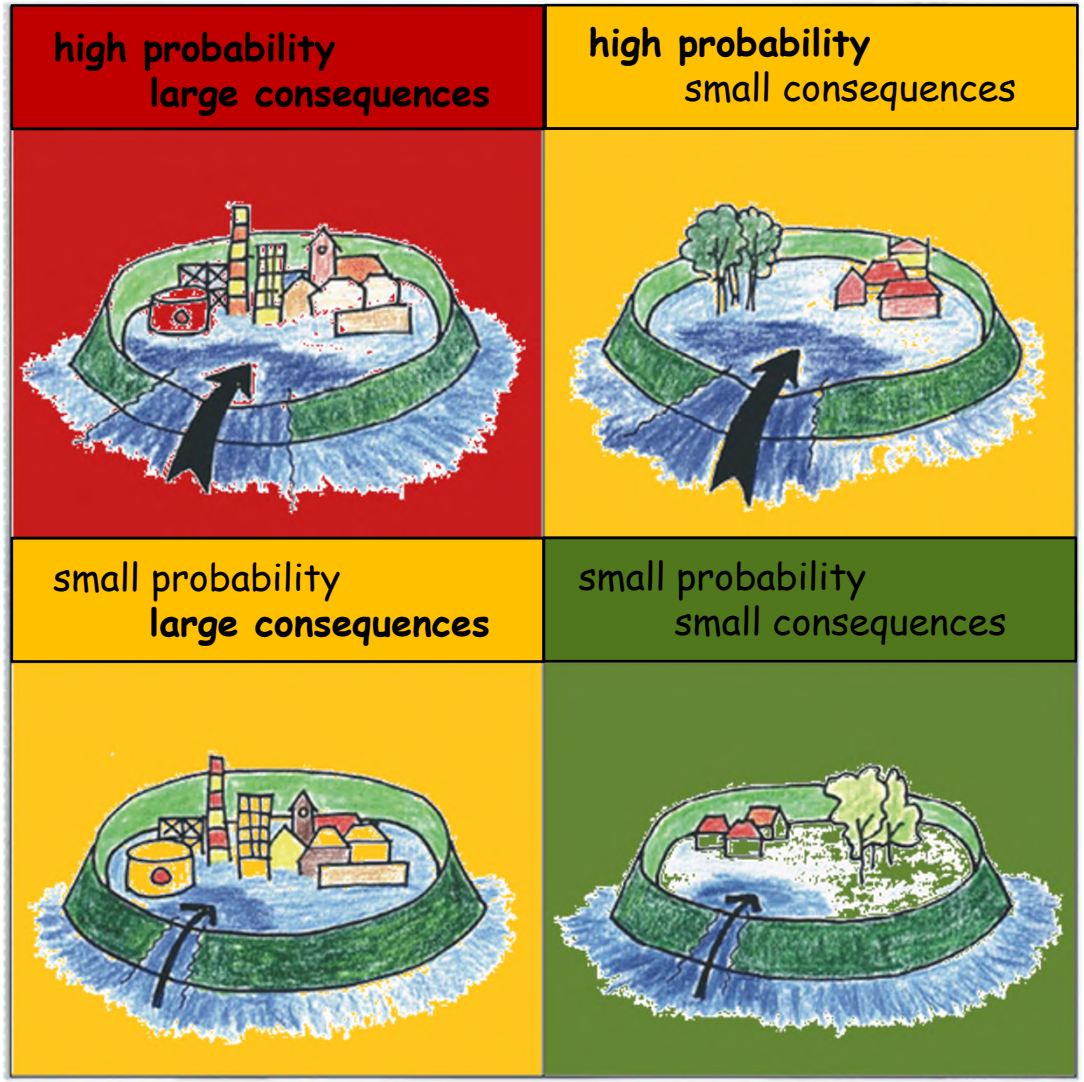

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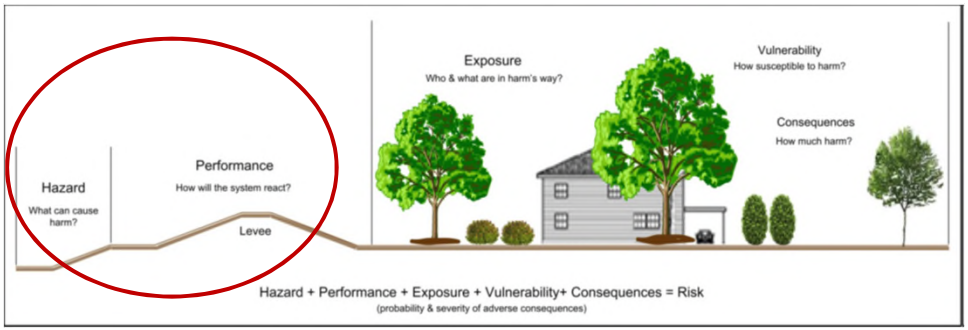
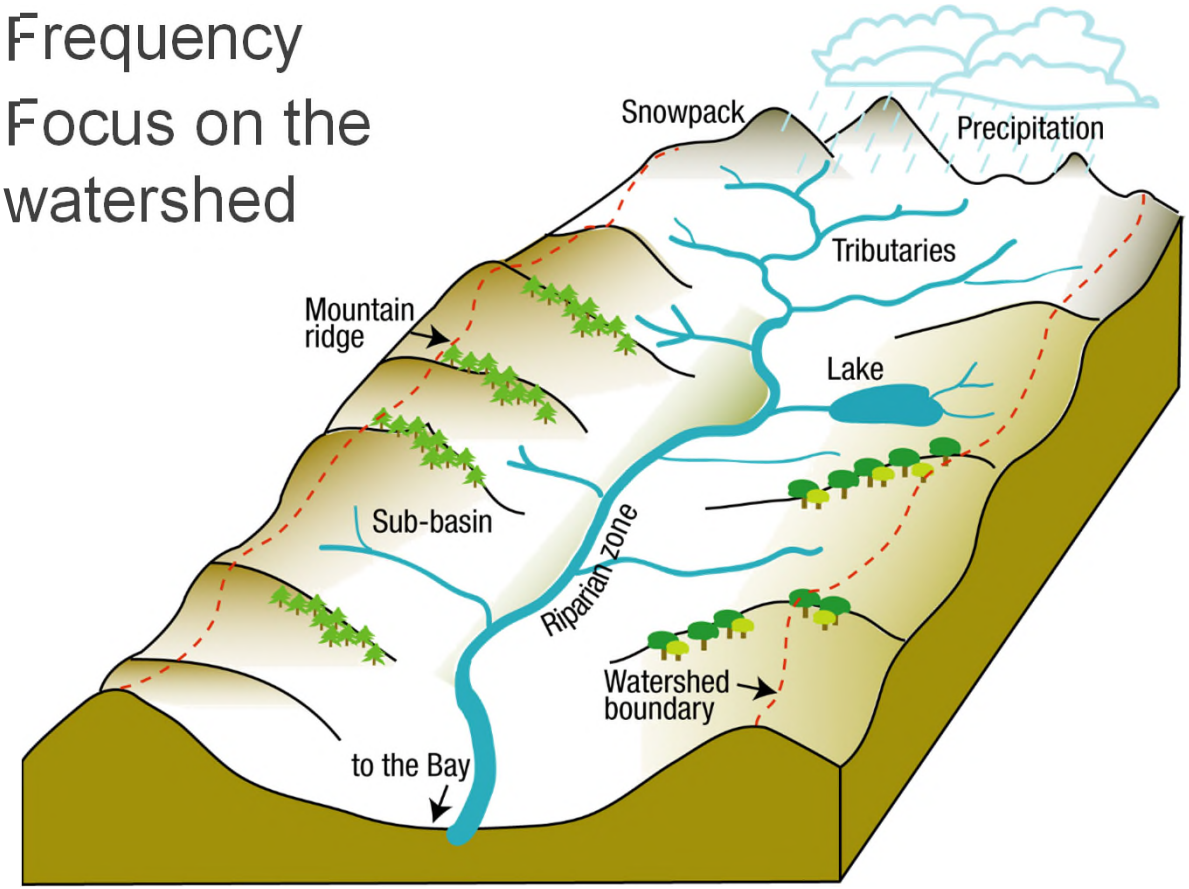
Image from Rijkswaterstaat, The Netherlands

HYDROLOGY

- Amount of water
- Rate of flow
- Frequency
- Focus on the watershed



Risk = Probability x Consequences



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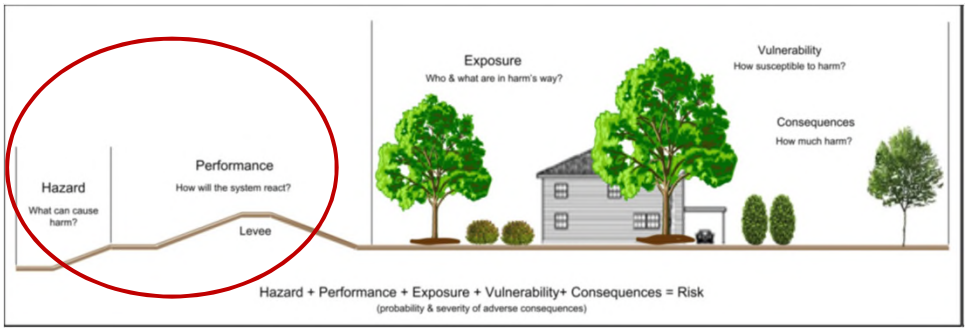
Source: thewatershedproject.org

HYDRAULICS

- Depth of water for a rate of flow
- Velocity
- Focus on the channel or floodplain



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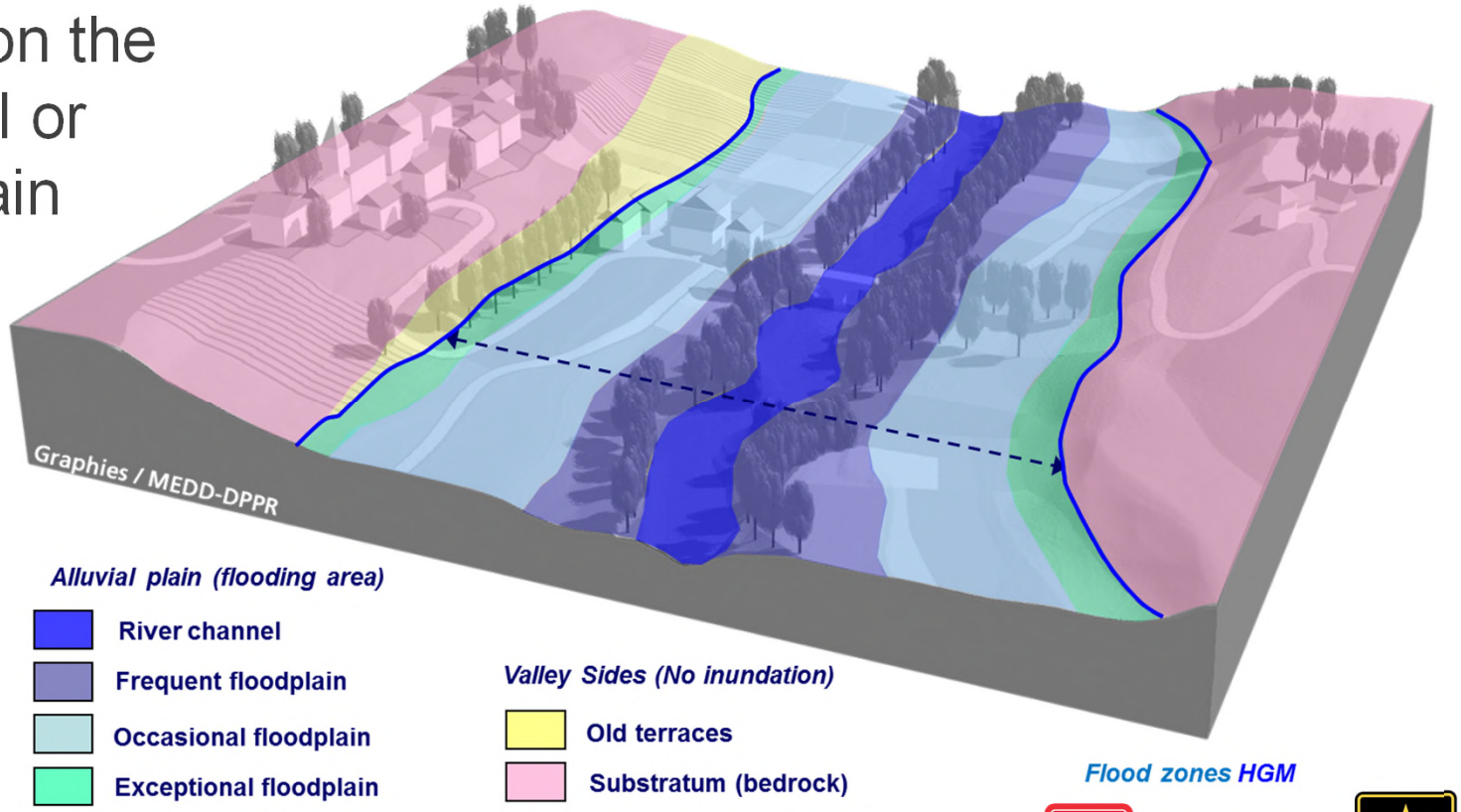

Flood zones HGM

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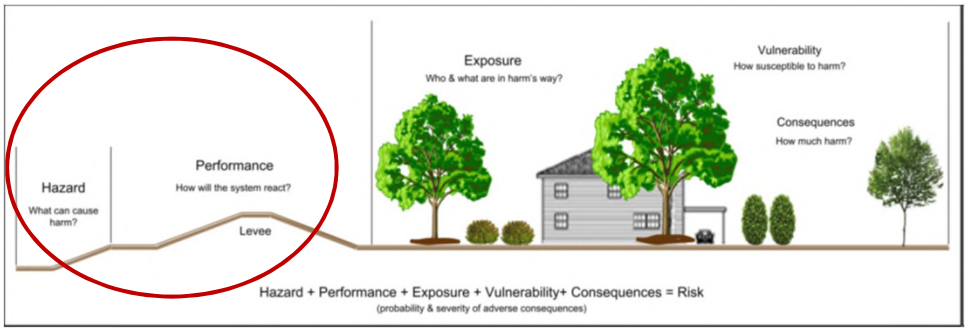
GEOTECH

- chance of levee failure at different water surface elevations.



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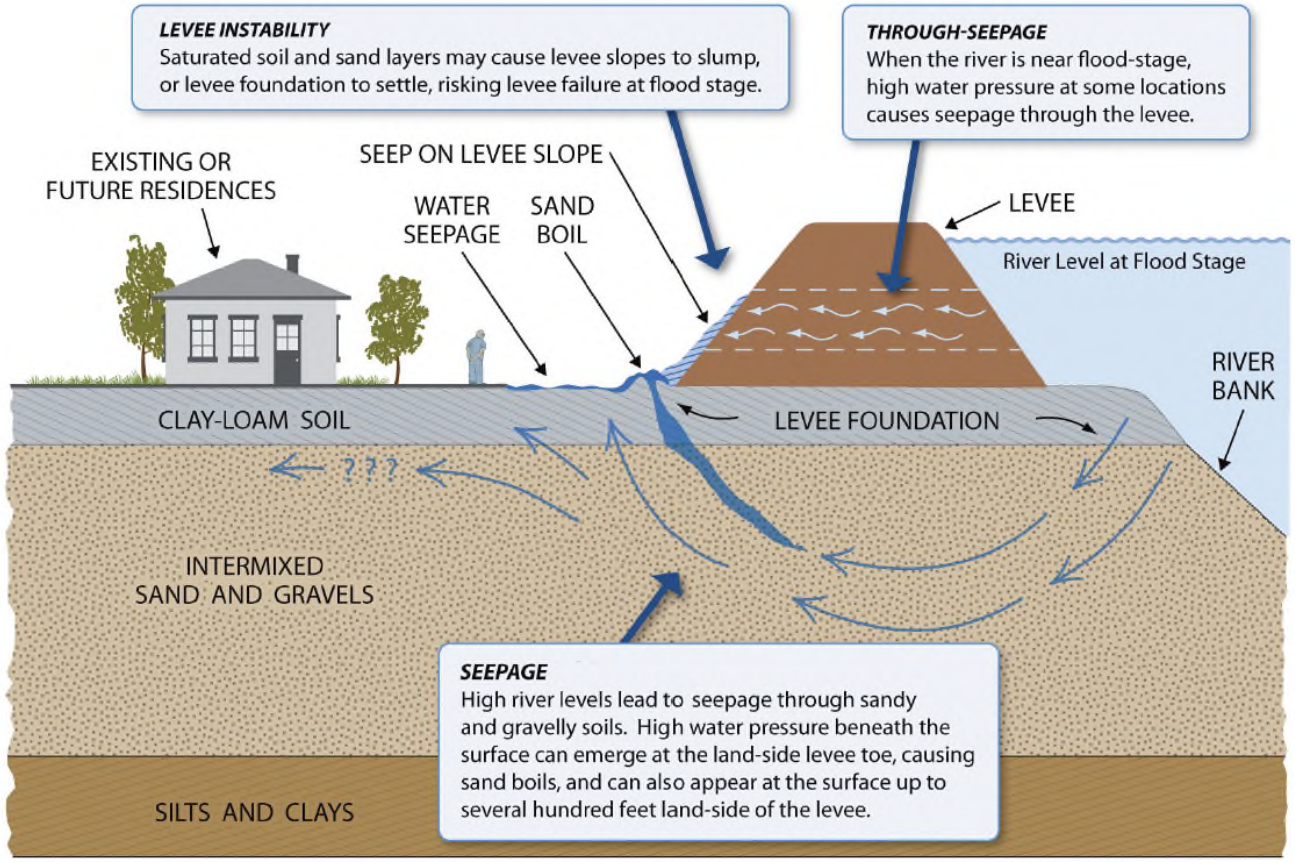

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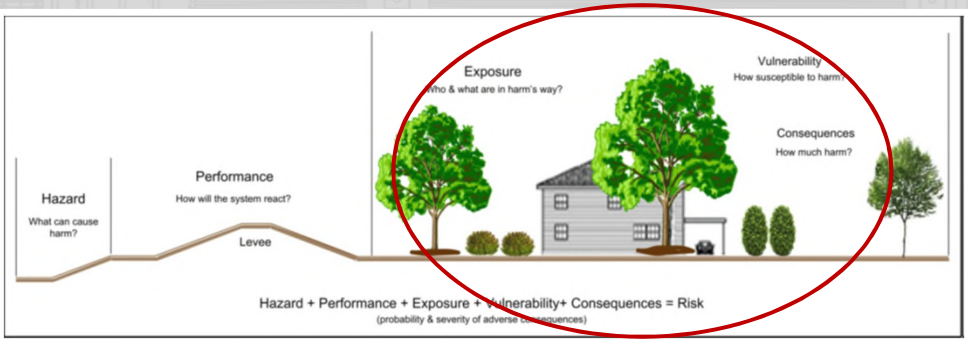
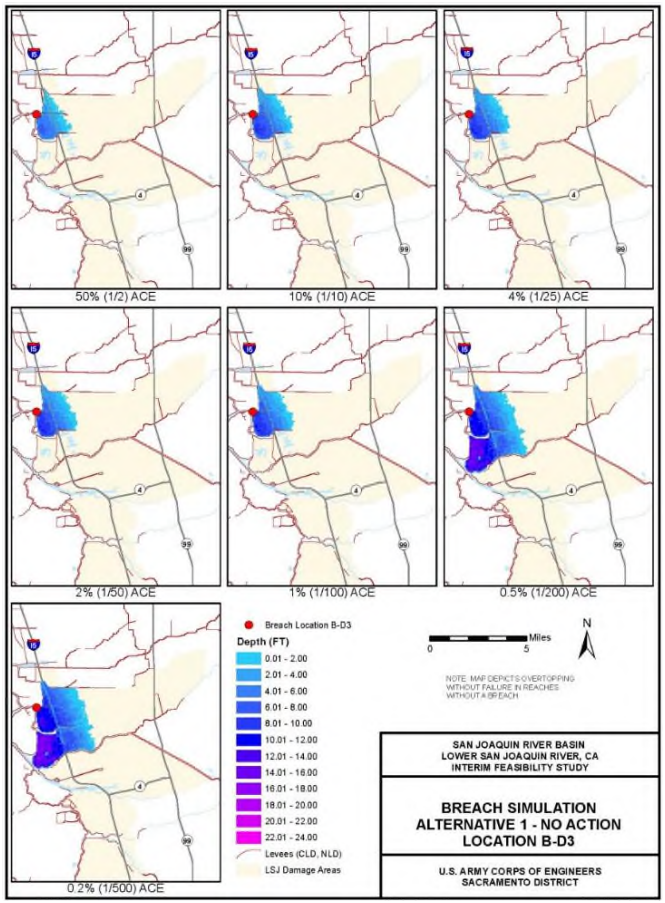
FLOODPLAIN HYDRAULICS

Floodplain Depths



Risk = Probability x Consequences



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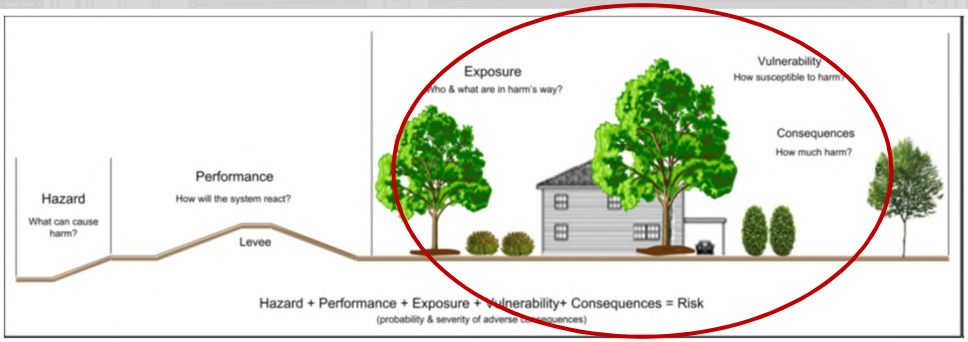
ECONOMICS

- Inventory of property in the Floodplain
- Estimate Flood Damages
- Estimate Project Performance



Risk = Probability x Consequences

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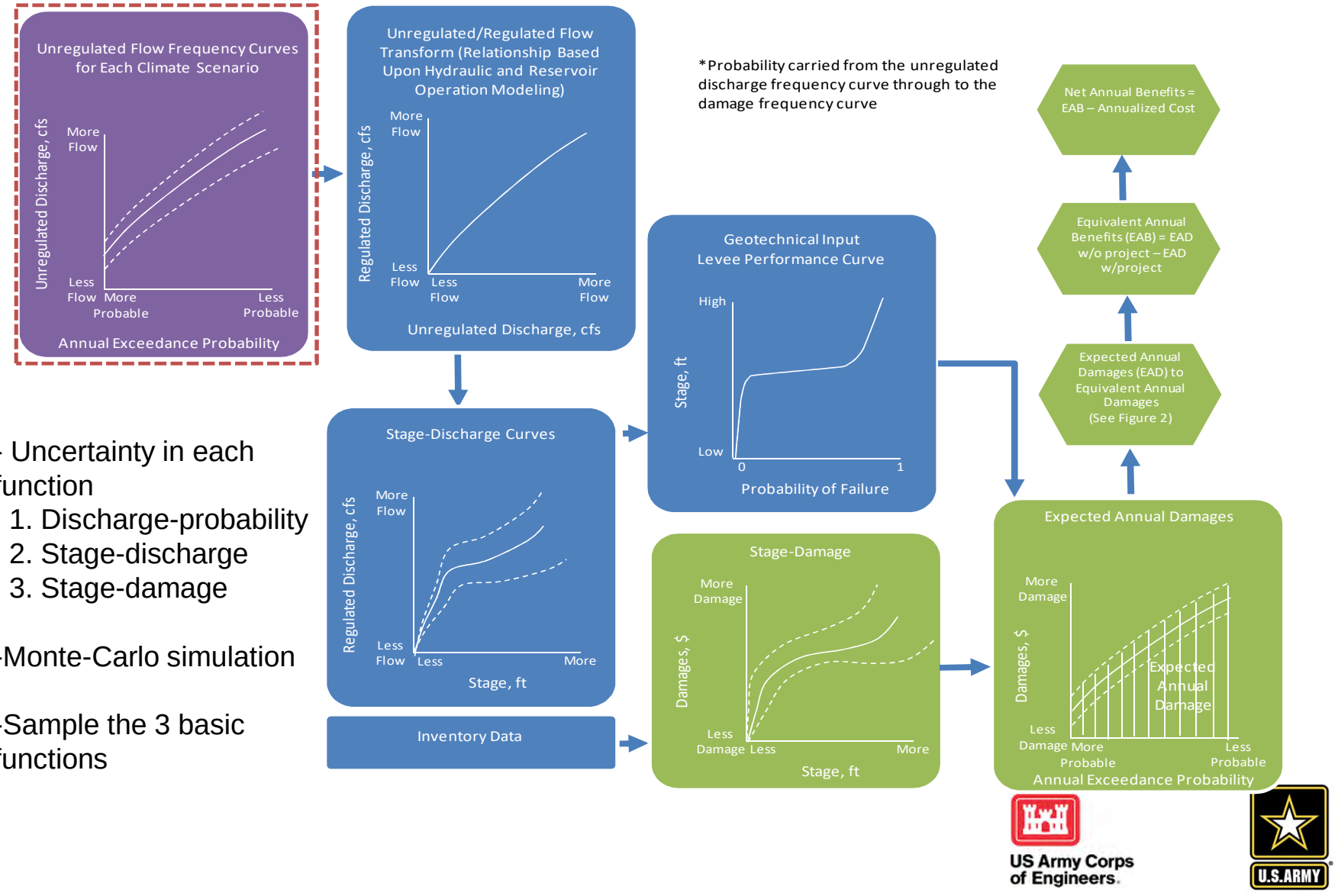
FRM ECONOMIC ANALYSIS WITH R&U



- Uncertainty in each function
  1. Discharge-probability
  2. Stage-discharge
  3. Stage-damage

-Monte-Carlo simulation

-Sample the 3 basic functions

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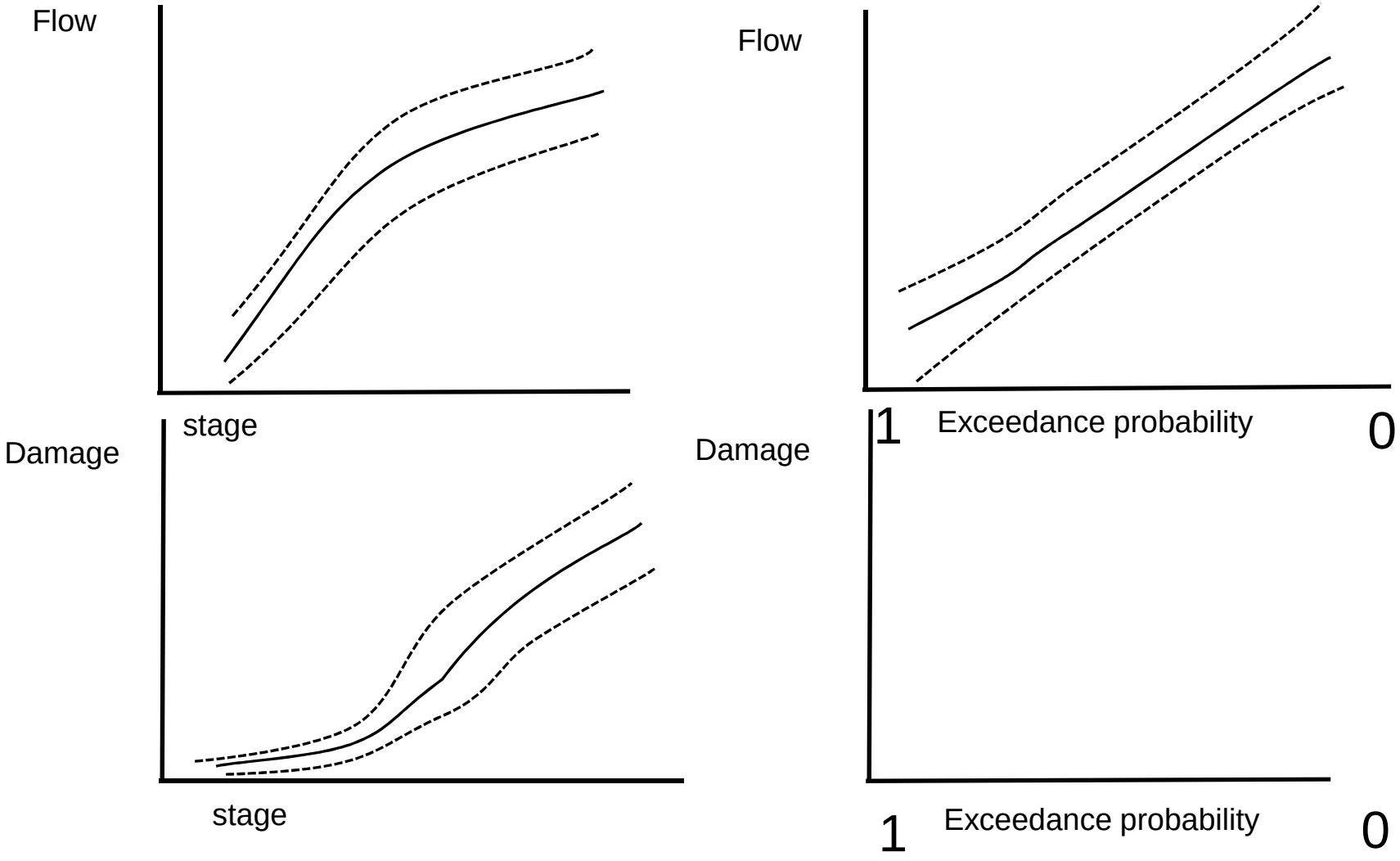
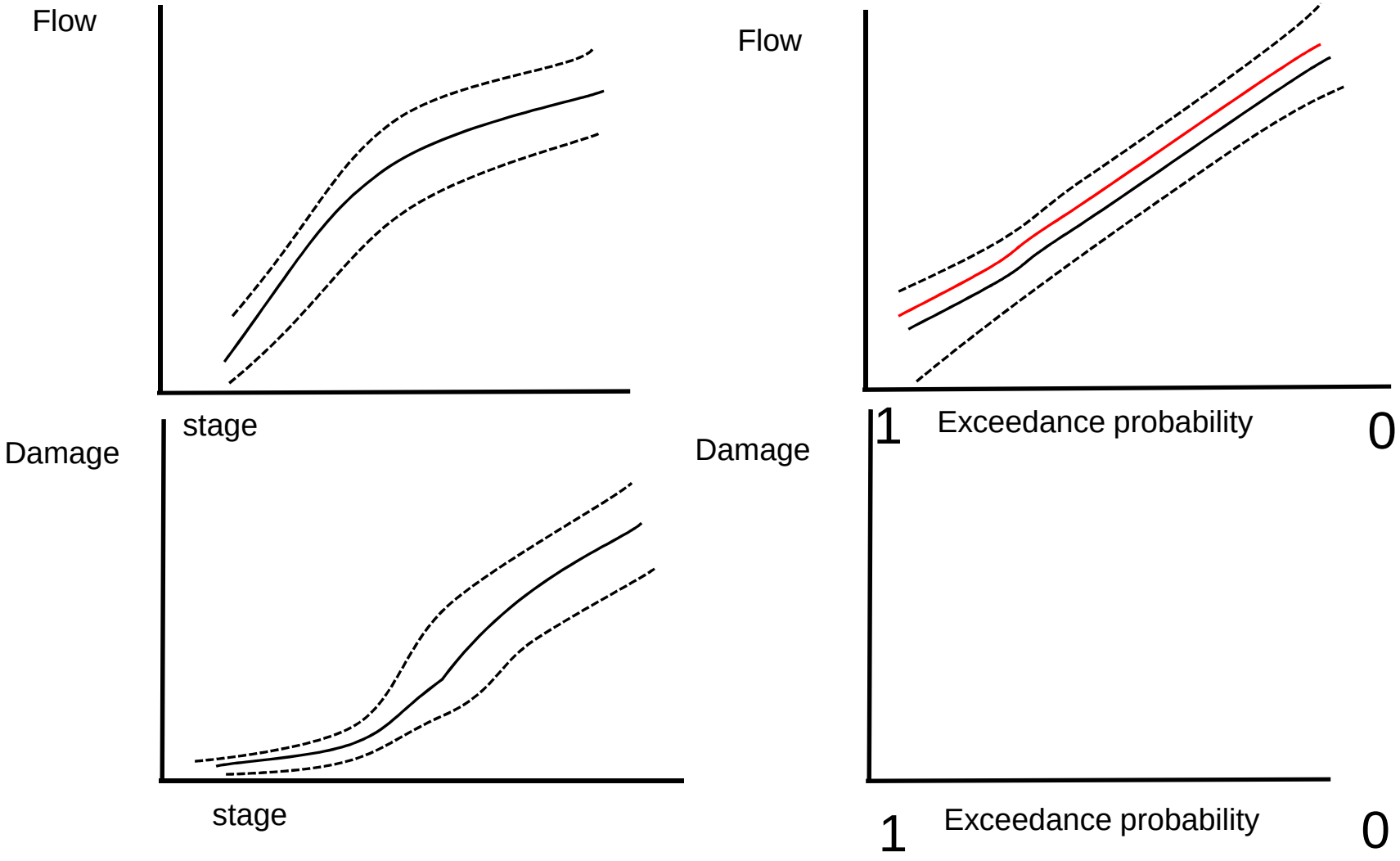
FRM UNCERTAINTY ANALYSIS VISUALIZATION



This process results in **1 realization** of EAD, it is not the final estimate of EAD

FRM UNCERTAINTY ANALYSIS VISUALIZATION



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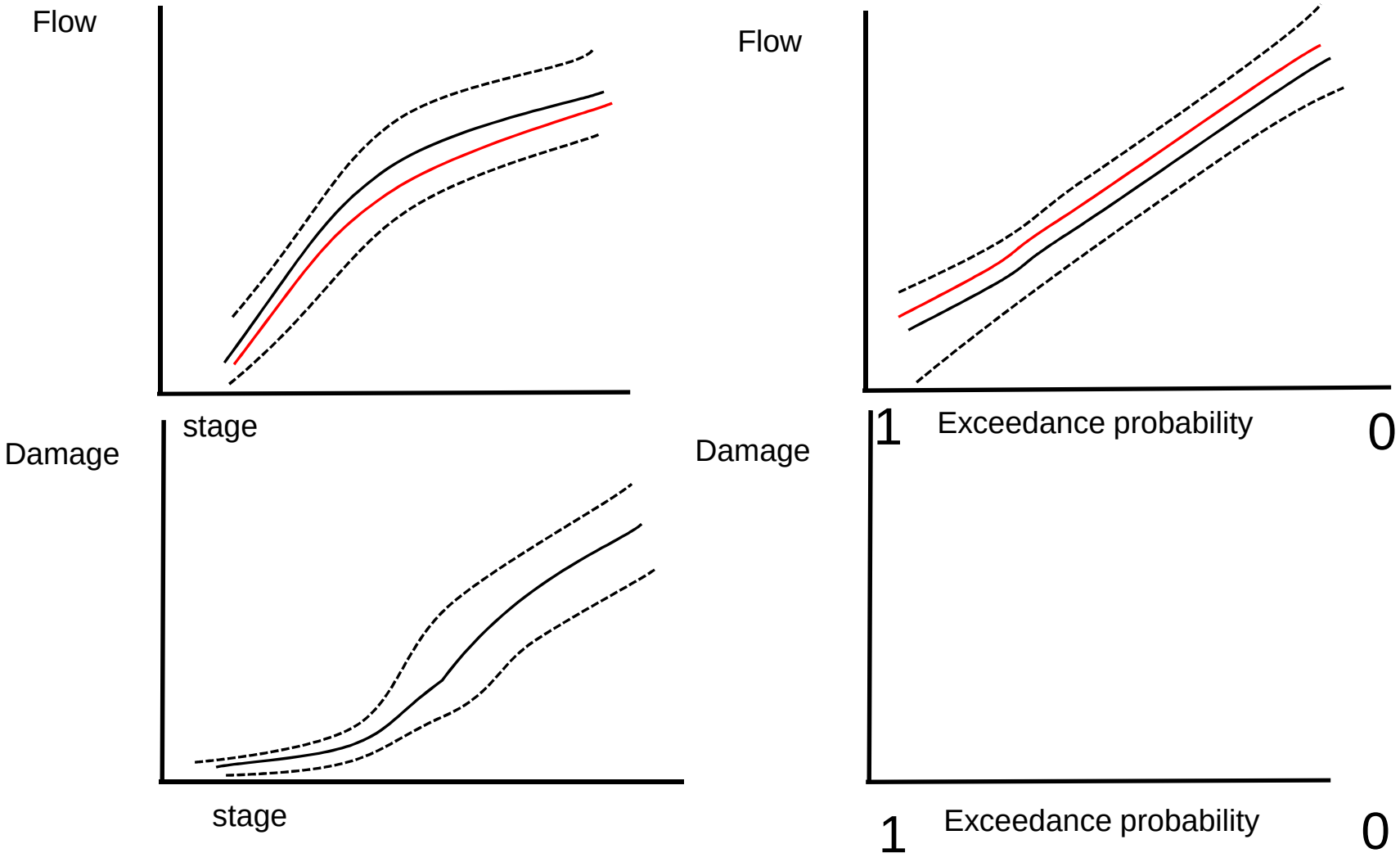

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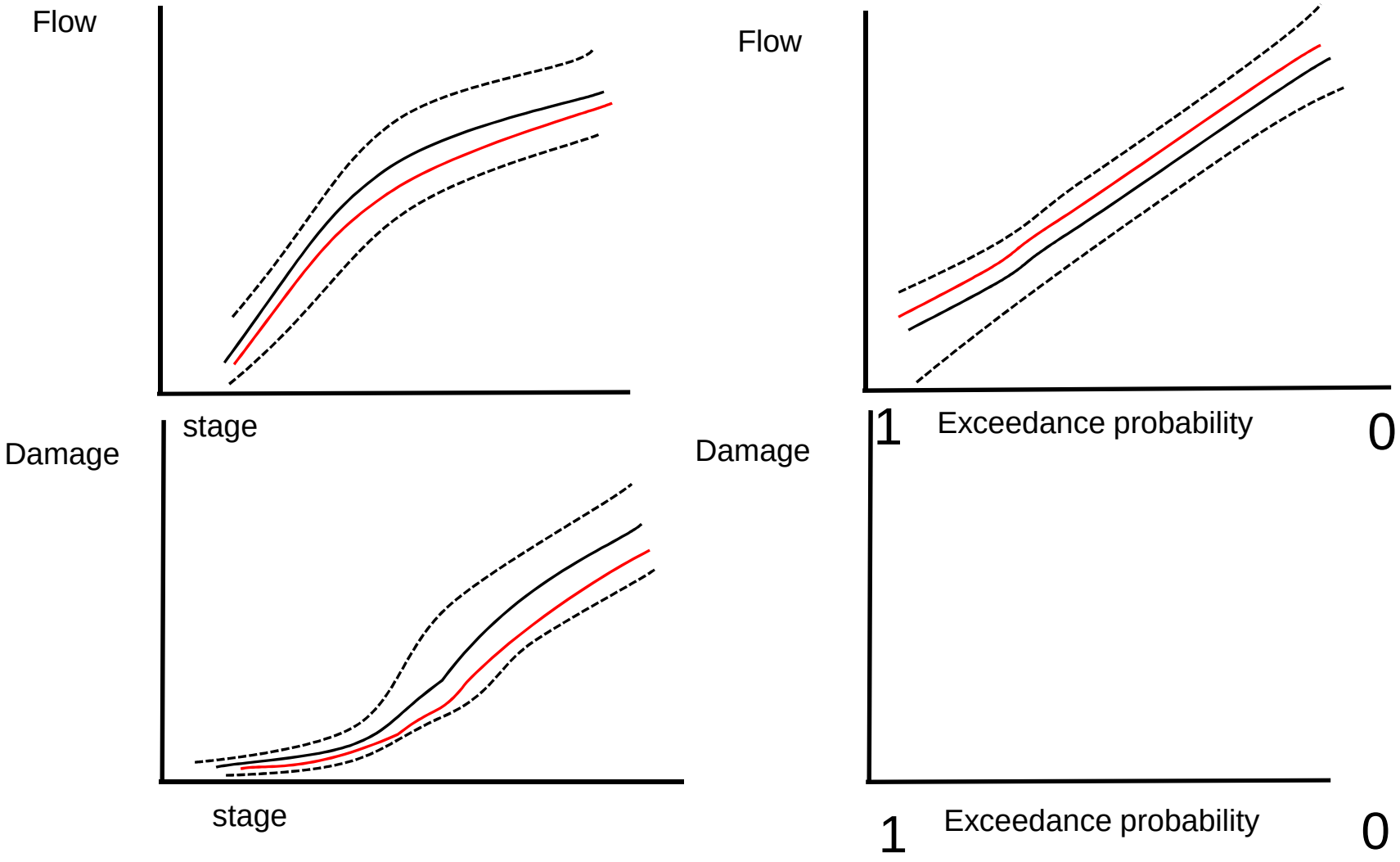

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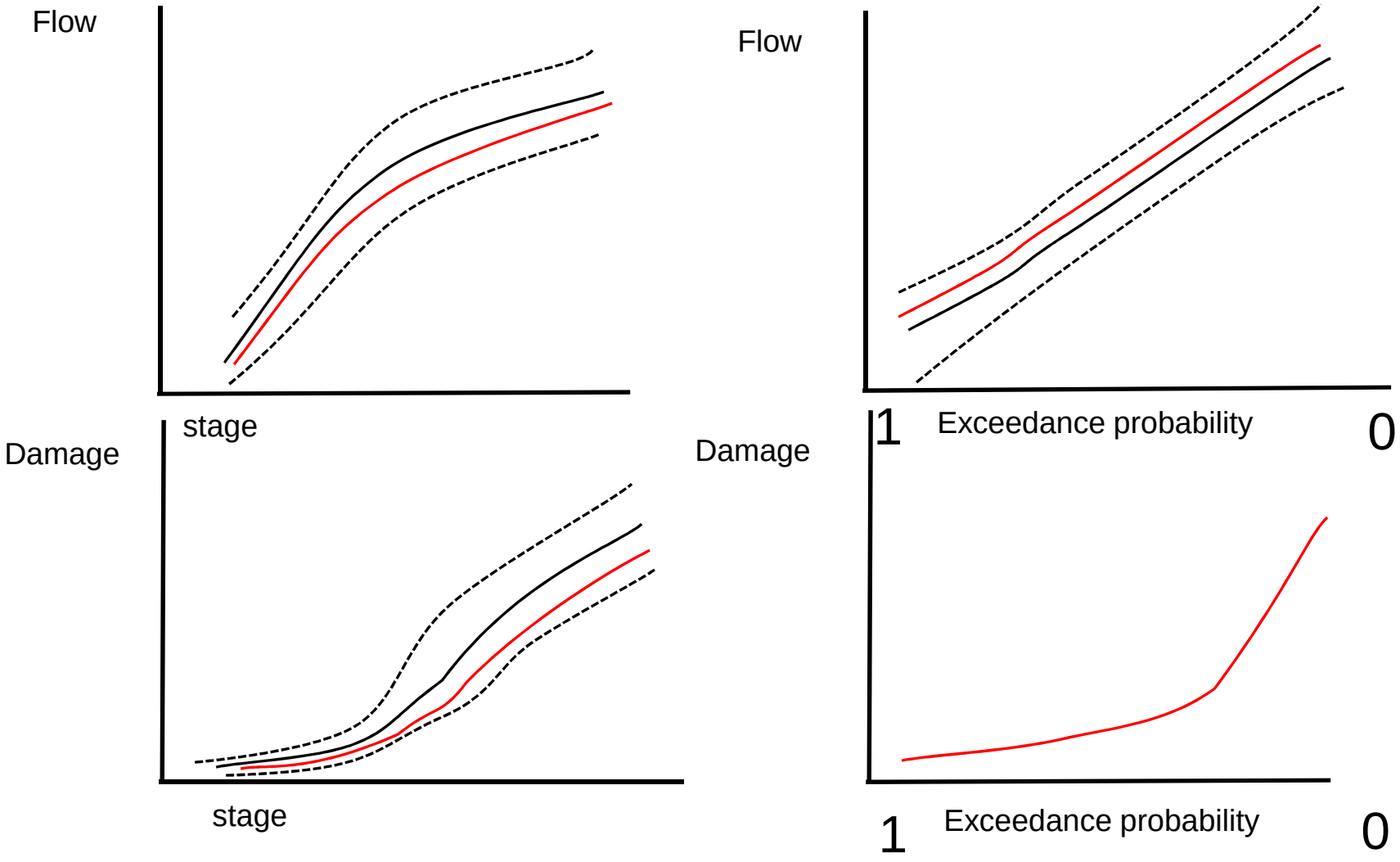

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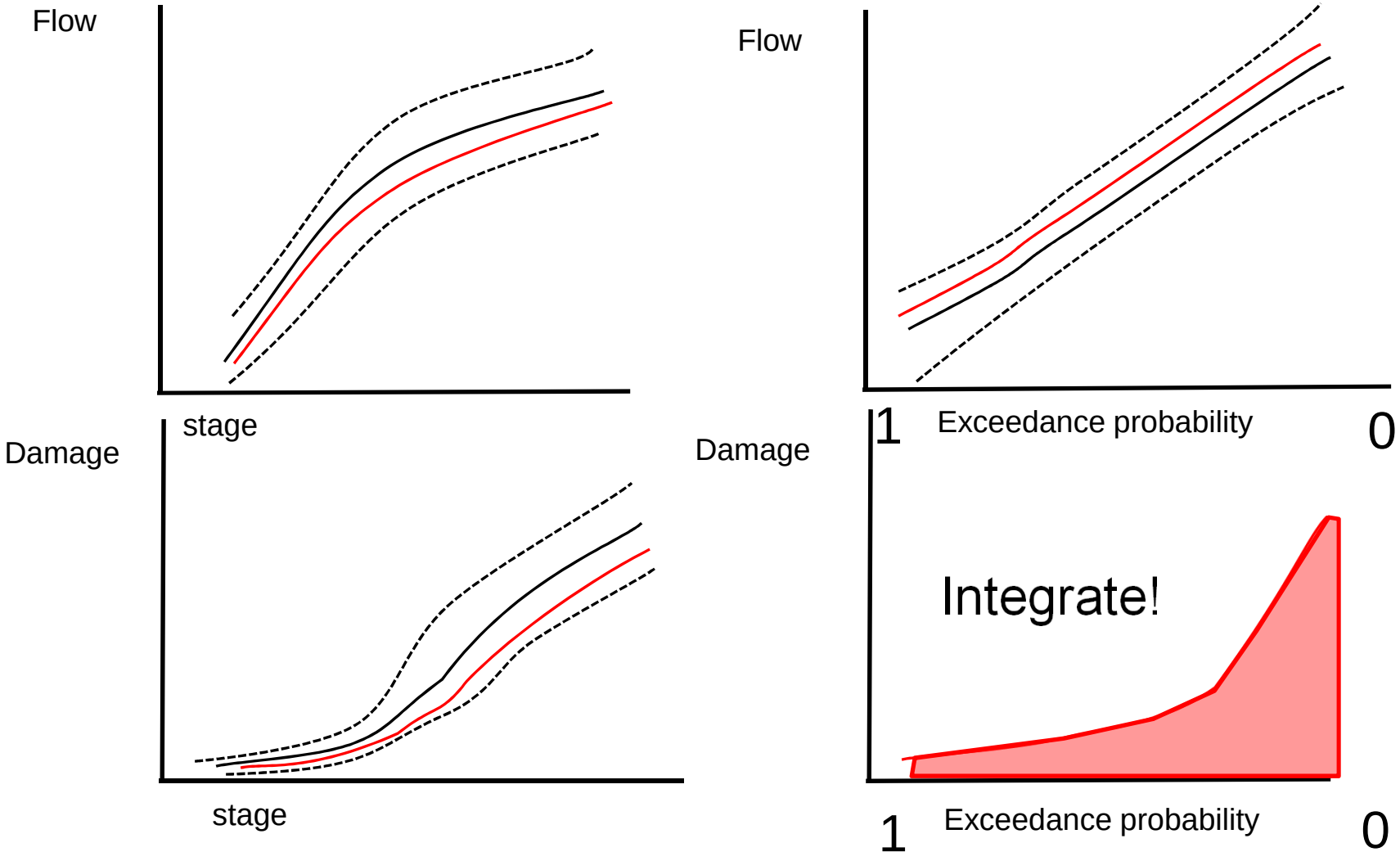

This process results in **1 realization** of EAD, it is not the final estimate of EAD

LIFE SAFETY RISK

- Critical component of Other Social Effects (OSE) Analysis
- Detailed analysis for Dam and Levee Safety programs
  - HEC FIA and LifeSim
- Critical inputs/uncertainties:
  - Population at Risk (PAR)
  - Flood warning times
  - Flood arrival times
  - Evacuation decisions, routes & speed
  - Flood velocity & depth
  - Depth-Mortality rates
  - Exposure (water temperature)

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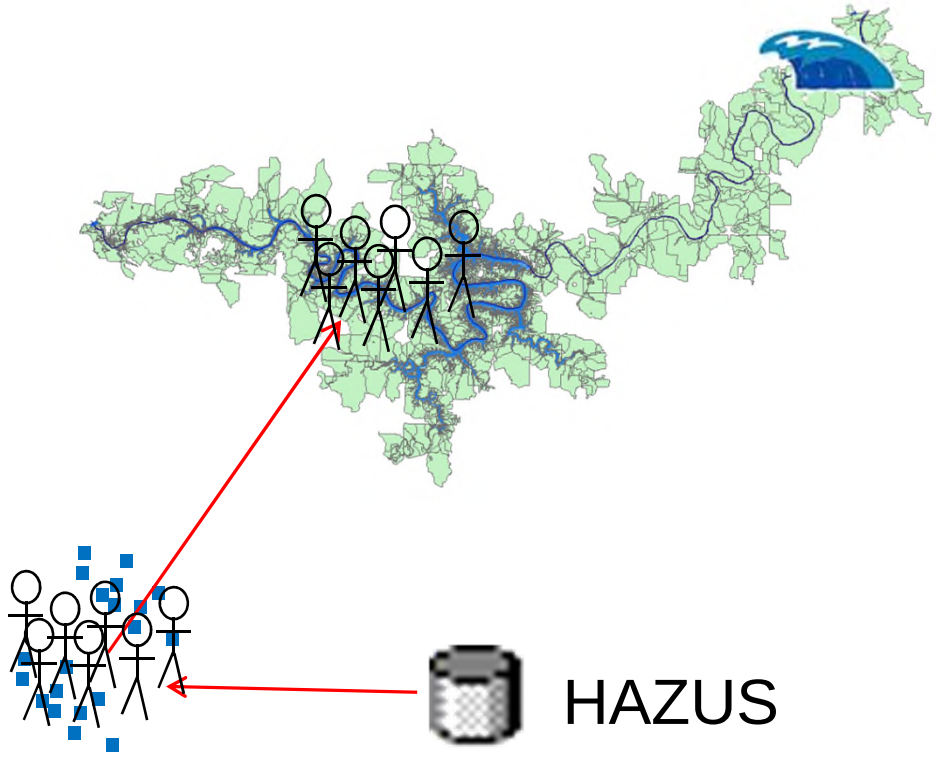
SIMPLIFIED HEC-FIA/LIFESIM CONSEQUENCE ANALYSIS

- Gather data
- Create Inventory
- Populate Inventory
- Flood/Evacuate Inventory



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CHECK IN

- Any Questions?

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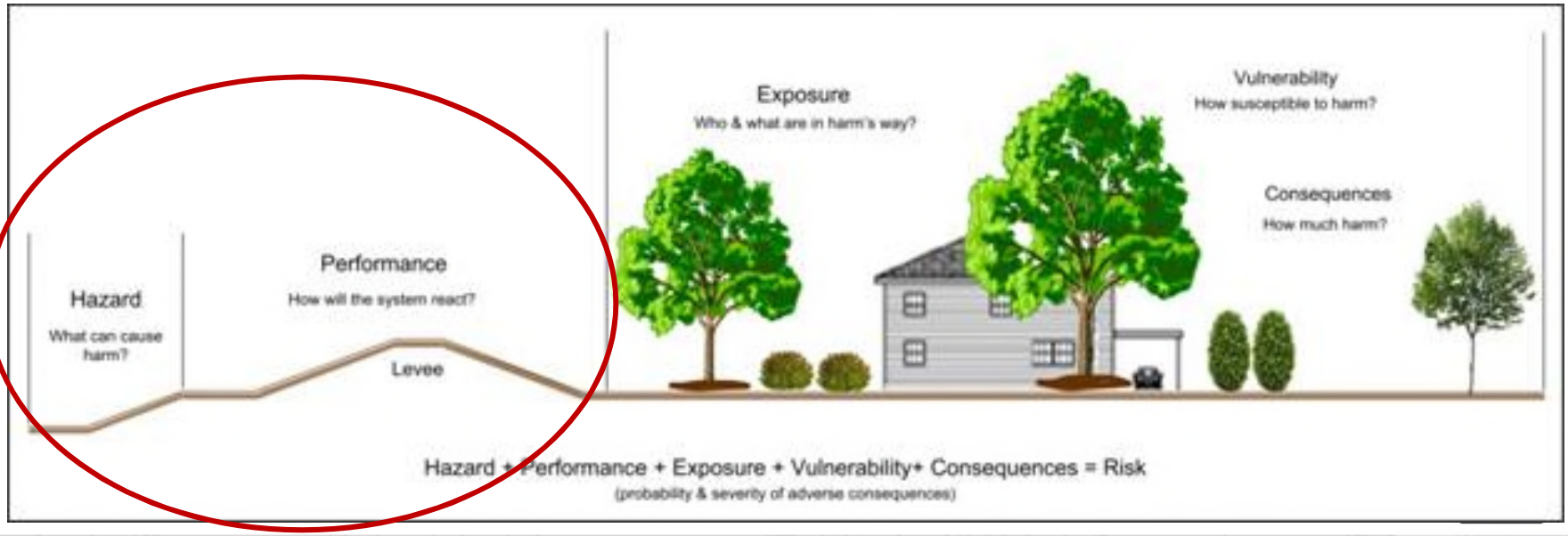
FLOOD RISK MANAGEMENT MEASURES

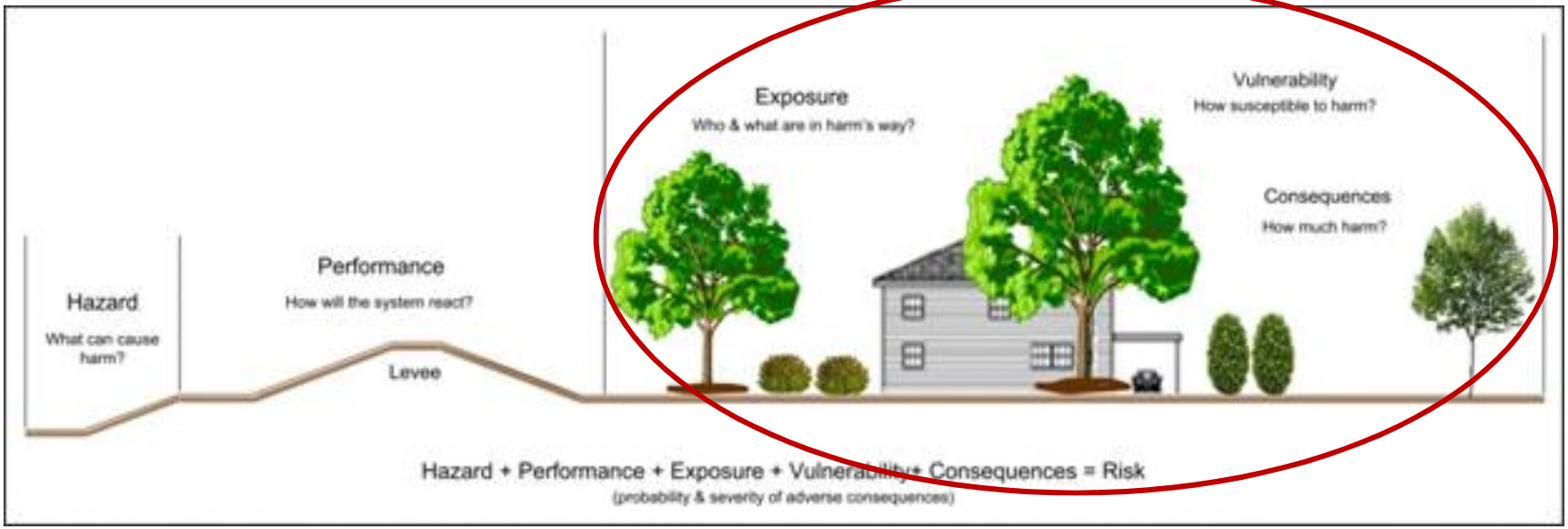
STRUCTURAL MEASURES

- Focused on Changing the Probability of Flooding
  - Reservoirs
  - Channels Improvements (including natural stream design)
  - Levees and Floodwalls
  - Diversions
  - Pumps



NON-STRUCTURAL MEASURES

- Changing the Consequences of Flooding
  - Flood Proofing
  - House Raising
  - Relocation
  - Flood Warning & Evacuation
  - Floodplain Regulation



NET BENEFIT ANALYSIS

PLAN	Annual Benefits	Annual Costs	Benefit to Cost Ratio (BCR)	Net Benefits
W/O Project	0	0		0
Plan 1	$700	$350	2.0	$350
Plan 2	1000	910	1.1	90
Plan 3	500	750	0.7	-250
Plan 4	1500	1000	1.5	500
Plan 5	1650	1500	1.1	150

Which one is the NED Plan?

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USING ANALYTICAL PROBABILITIES IN DECISION MAKING

Plan	Expected Annual Benefit and Cost ($1000) Benefits	Cost	Net Benefits ($1000) mean	std. dev	Prob. Net Benefit is > 0	Net Benefit that is Exceeded with Specified Probability ($1000) 0.75	0.5	0.25
20 foot levee	355	300	57	68	0.80	9	54	100
25 foot levee	500	400	104	88	0.87	47	106	166
30 foot levee	570	550	21	116	0.58	-57	24	94
channel	375	300	73	74	0.83	18	70	118
detention basin	325	275	53	96	0.70	-17	51	113
relocation	355	250	107	62	0.97	63	102	146

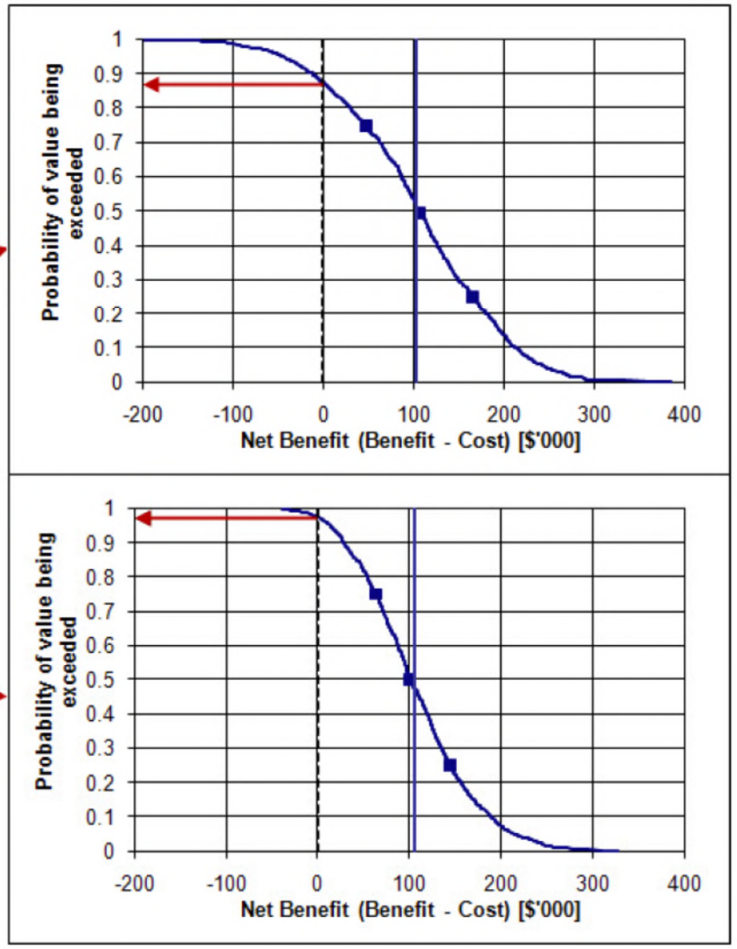

Figure A-1. Expected value and probabilistic values for net benefits

WHICH STUDY AREA HAS HIGHER FLOOD RISK?

Probability x Consequences

Study A:
50% Annual Chance of Flooding
15 foot Flood Depth

Study B:
1% Annual Chance of Flooding
4 foot Flood Depth

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CHECK IN

- Any Questions?

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OUR MISSION IS TO REDUCE FLOOD RISK

There Are Lives And Property At Risk…

HOW DO WE DO THAT?

Follow the SMART planning process….

SMART Planning is Risk-Informed

Specific

Measurable

Attainable

Risk-Informed

Timely

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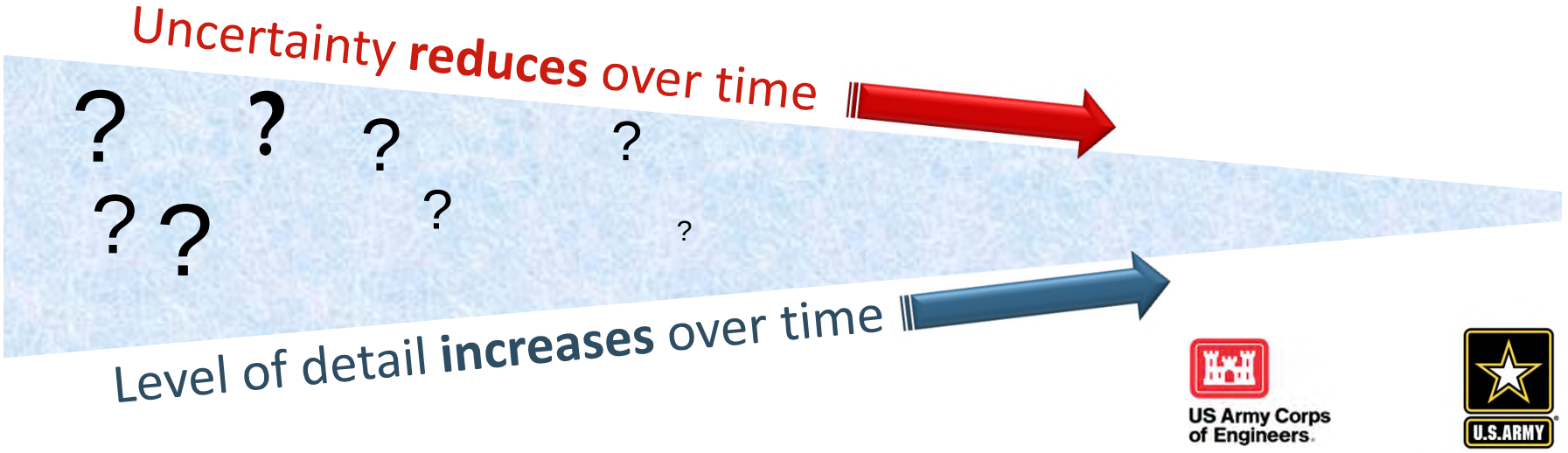
SMART FEASIBILITY STUDY PROCESS

Conceptual *Comparative* *Confirm* *Refine*

3 Months	9 Months	6 Months	12 Months	6 Months
SCOPING	ALTERNATIVE EVALUATION AND ANALYSIS		FEASIBILITY LEVEL ANALYSIS	WASHINGTON LEVEL REVIEW
1		2	3	4	5
ALTERNATIVES MILESTONE *Vertical Team concurrence on array of alternatives*		**TSP MILESTONE** *Vertical Team concurrence on tentatively selected plan*	**AGENCY DECISION MILESTONE** *Agency endorsement of the recommended plan*	**FINAL REPORT MILESTONE**	**CHIEF'S REPORT**



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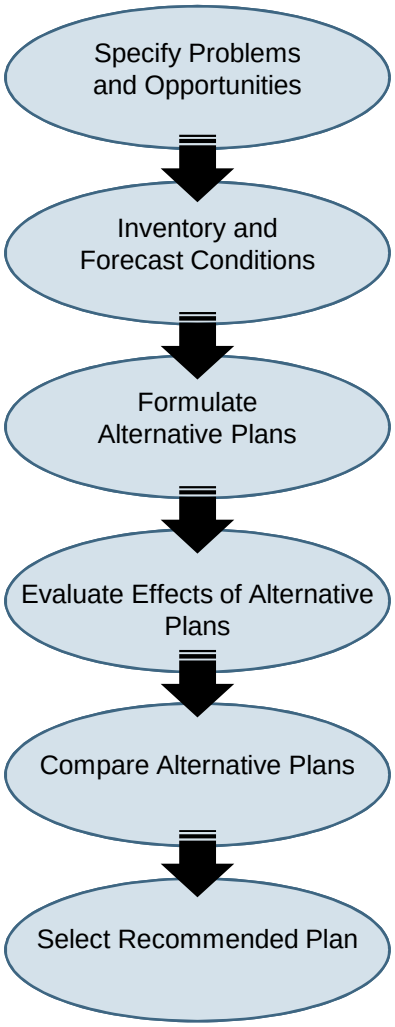
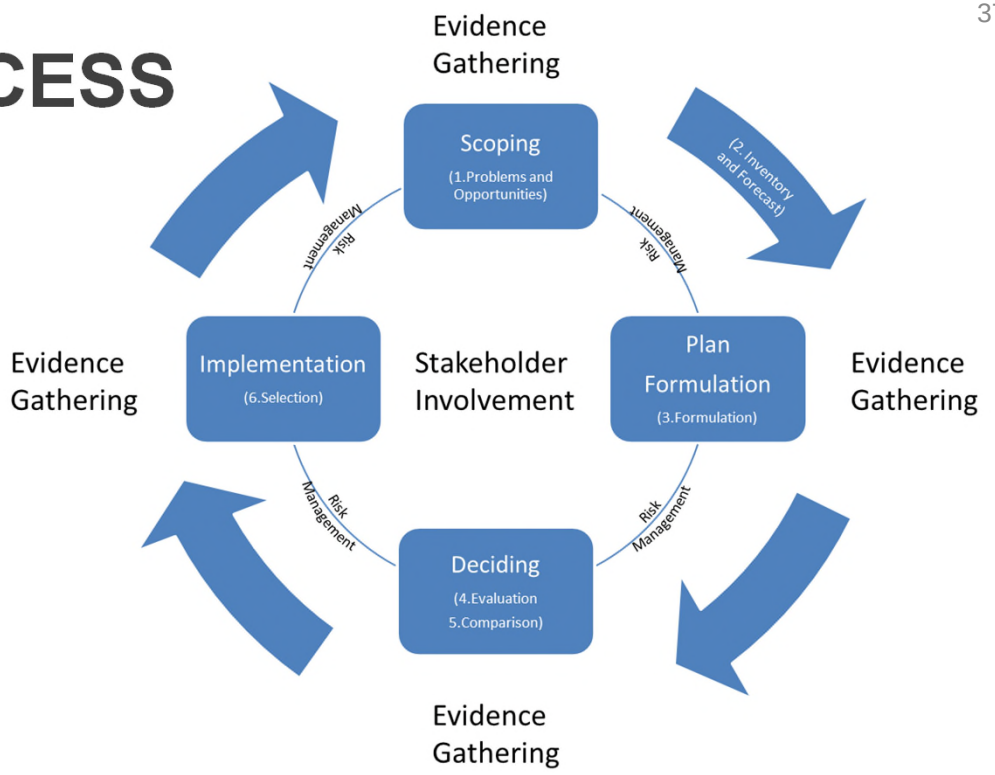
THE PLANNING PROCESS





- Planning is an iterative, logical process
- Revisit previous steps as we learn
- Adjust as we move forward
- Conduct multiple iterations – as many as needed!

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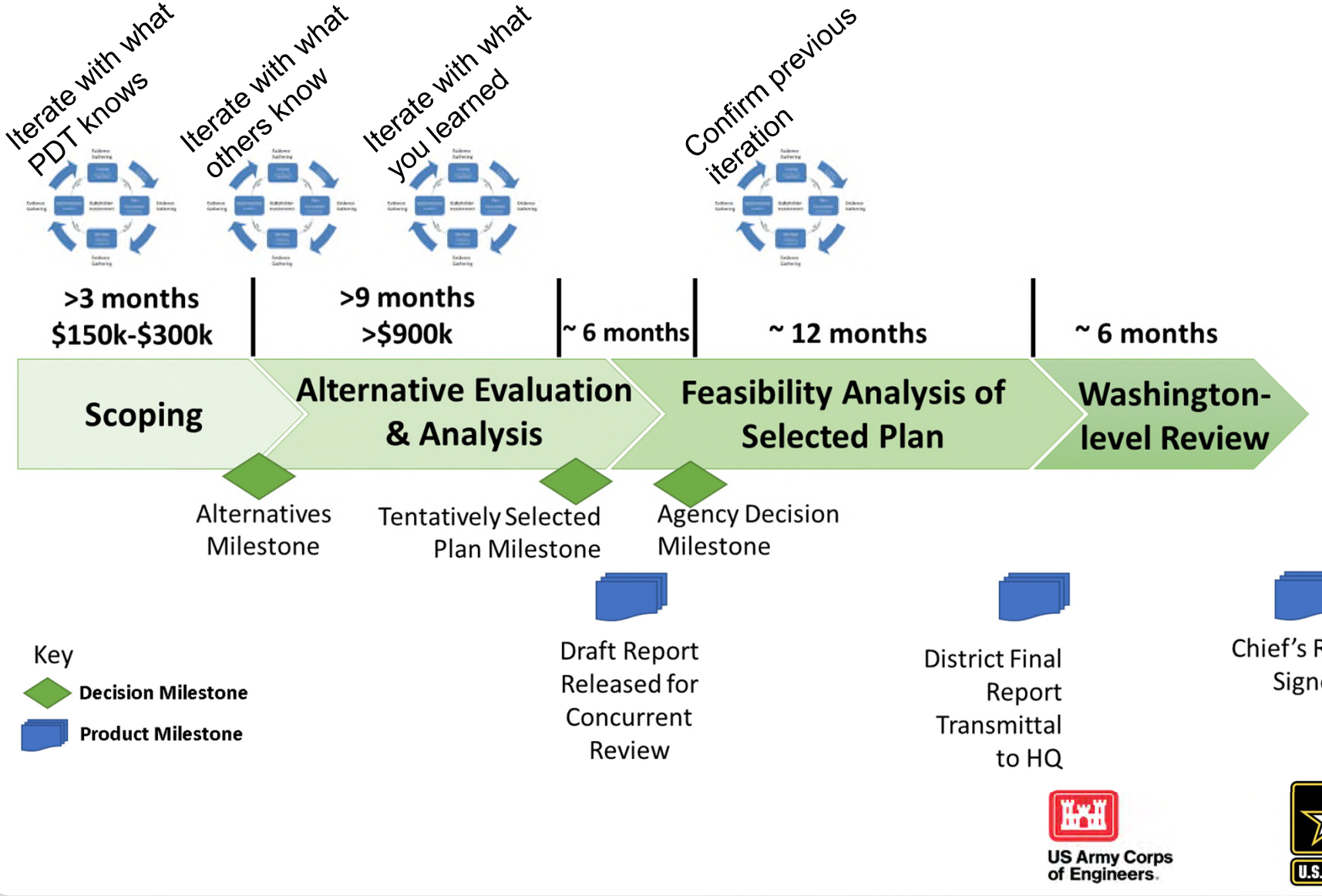
ITERATE THE SIX-STEP PLANNING PROCESS AND GATHER EVIDENCE TO REDUCE UNCERTAINTY AND MANAGE STUDY AND PROJECT RISK



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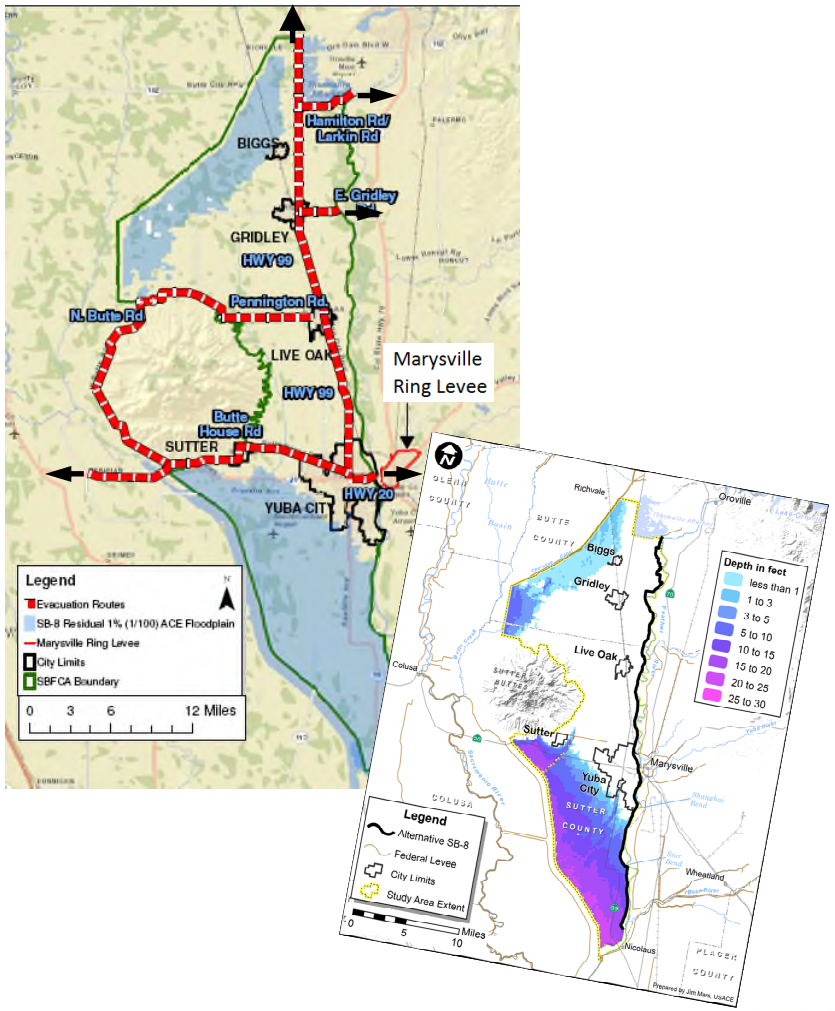
TELL THE RISK STORY AT MILESTONES

- Focus on risks that could affect the decision:
  - Study risk
  - Implementation risk
  - Outcome risk
- Provide recommendations for how to manage those risks.
- Document in Risk Register



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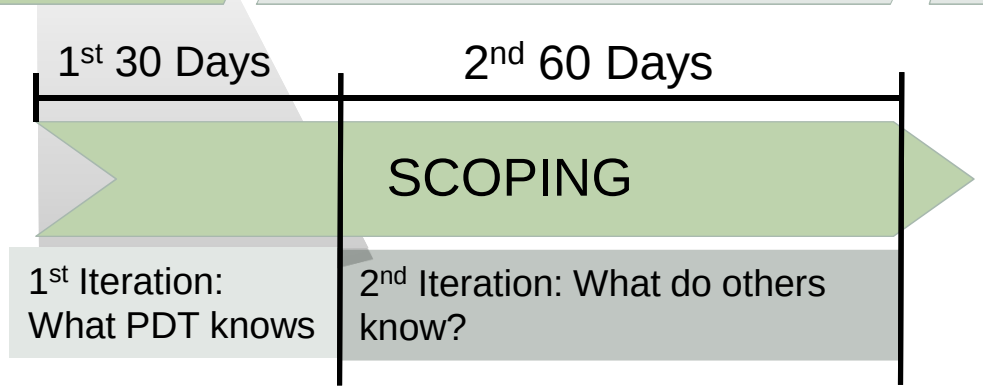
SCOPING | ALTERNATIVE EVALUATION AND ANALYSIS | FEASIBILITY LEVEL ANALYSIS | WASHINGTON LEVEL REVIEW



SCOPING: ROADMAP FOR THE STUDY

Why do we Scope a Study?

- Determine focus/vision/goal of the study
- Define study area
- Identify the team members

What are the Products/Outcomes?

- Project Management Plan (PMP)
- Review Plan – how reviews will be managed

What are the Key Decisions or Actions?

- Identify a range of alternatives
- What are the primary drivers of uncertainty?
- Start developing Hydrology, Hydraulics, Econ and parametric cost tools for later phase

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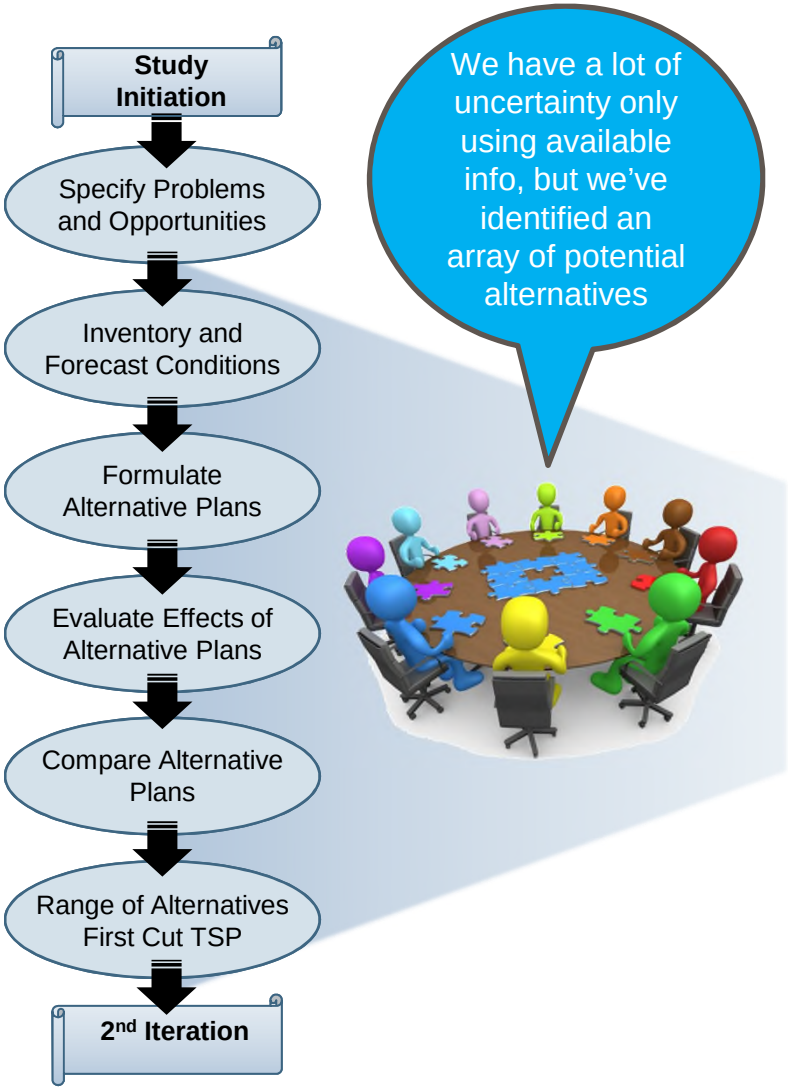
1ST ITERATION: USE OF PDT KNOWLEDGE FOR SCOPING

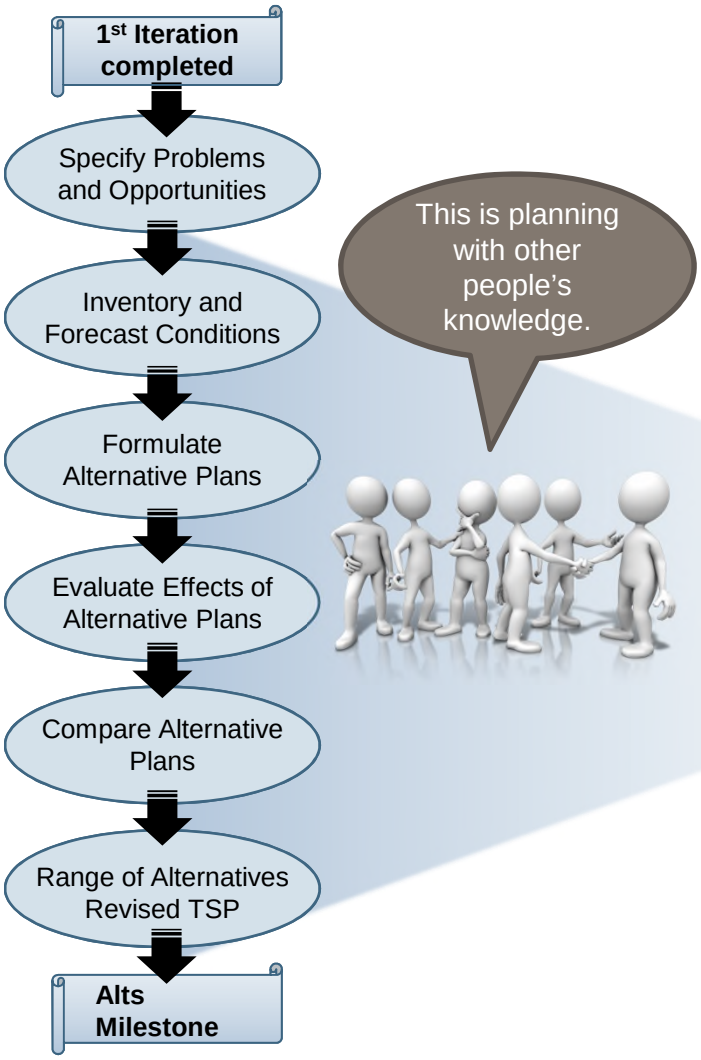
Within the first 30 days…



- What is the **flooding problem(s)** (sources, location, consequences, historical flooding)?
  - Obtain/review a Map of the **Watershed and topography.**
- Are there **previous studies** in the area?
  - Is there recent **Hydrology**?
- Known or potential changes to study area in **future**?
- Are there **Endangered Species** in the area?
- Brainstorm **measures** to address problem(s)
- Combine measures into a **range of alternatives to meet objectives**
- **Evaluate** costs, benefits and effects using qualitative metrics (i.e. high-medium-low)
- **Compare** alternatives based on evaluation metrics
- Identify **conceptual array of alternatives**
- Analyze risks to **identify key uncertainties and data gaps**
- Implement **risk reduction strategy**

2ND ITERATION: WHAT DO OTHERS KNOW?

By The Alternatives Milestone – Within The First 90 Days



- Refine our understanding of the **flooding problem(s).**
  - Obtain/review existing FEMA Maps, Flood Insurance Study Report, detailed topo (LiDar), geospatial inventory data (assessor), Levee Screening Tool, River Gage data, etc.
- Review previous studies in the area
- Review community **development plans**.
- Request/review species list from USFWS
- Refine or identify new **measures** to address problem(s)
- Refine **range of alternatives to meet objectives**
- **Evaluate** costs, benefits and effects using qualitative metrics (i.e. high-medium-low)
- **Compare** alternatives based on metrics
- Refine **conceptual array of alternatives**
- Analyze risks to **identify key uncertainties and data gaps**
- Implement **risk reduction strategy**

1

ALTERNATIVES MILESTONE
Vertical Team concurrence on array of alternatives

ALTERNATIVES MILESTONE

Conceptual level of detail

Planning Decision

- Do we have logical formulation and evaluation rationale?
- Have we considered full range of measures, alternatives?

Focus on:

- Understanding the study area
- Use existing information where possible
- Clearly articulating the problems (Why are we here?)
- Professional judgment
- Identify methods to reduce uncertainty in next phase

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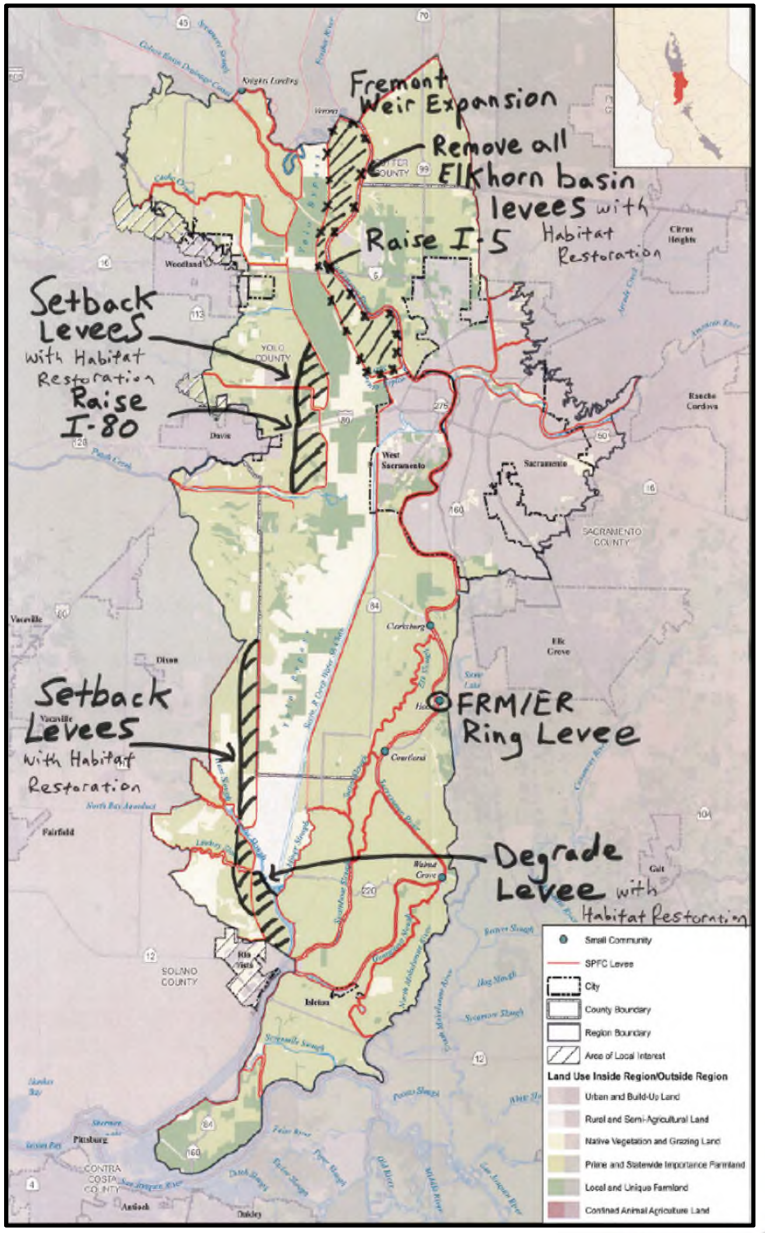
1

ALTERNATIVES MILESTONE

Vertical Team concurrence on array of alternatives

CONCEPTUAL LEVEL OF DETAIL EXAMPLE

- Map sketch – use sharpies!
- Draw locations for structural measures
  - Setback levees
  - Degrading/removing levees
  - Weir expansions
  - Ring levees
- Non-structural measures may be less site specific



3rd Iteration: What must we learn?

ALTERNATIVE EVALUATION AND ANALYSIS:

Identifying Federal Interest

Why do we evaluate and analyze alternatives?

- Determine best value for Federal investment
- Weigh pros and cons of different alternatives
- Be transparent in decision making process

What are the Products/Outcomes?

- Develop report summary / keep writing report

What are the Key Decisions or Actions?

- Identify Tentatively Selected Plan (TSP)

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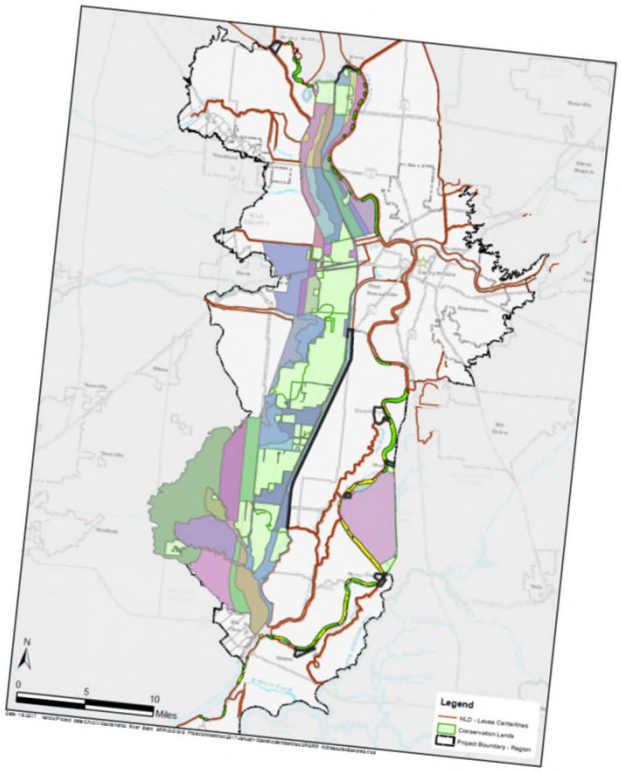
2 **TSP MILESTONE**
Vertical Team concurrence on tentatively selected plan

COMPARATIVE LEVEL OF DETAIL LESSONS LEARNED

- Develop data to reduce uncertainties
  - Avoid complex models
  - Need tools to simulate alternatives quickly, with less precision
- Use qualitative screening to narrow down array of alternatives
- Identify separable units/elements to mix and match
- Develop rough costs that show range of costs, benefits, effects
- Don’t wait for perfection to move forward



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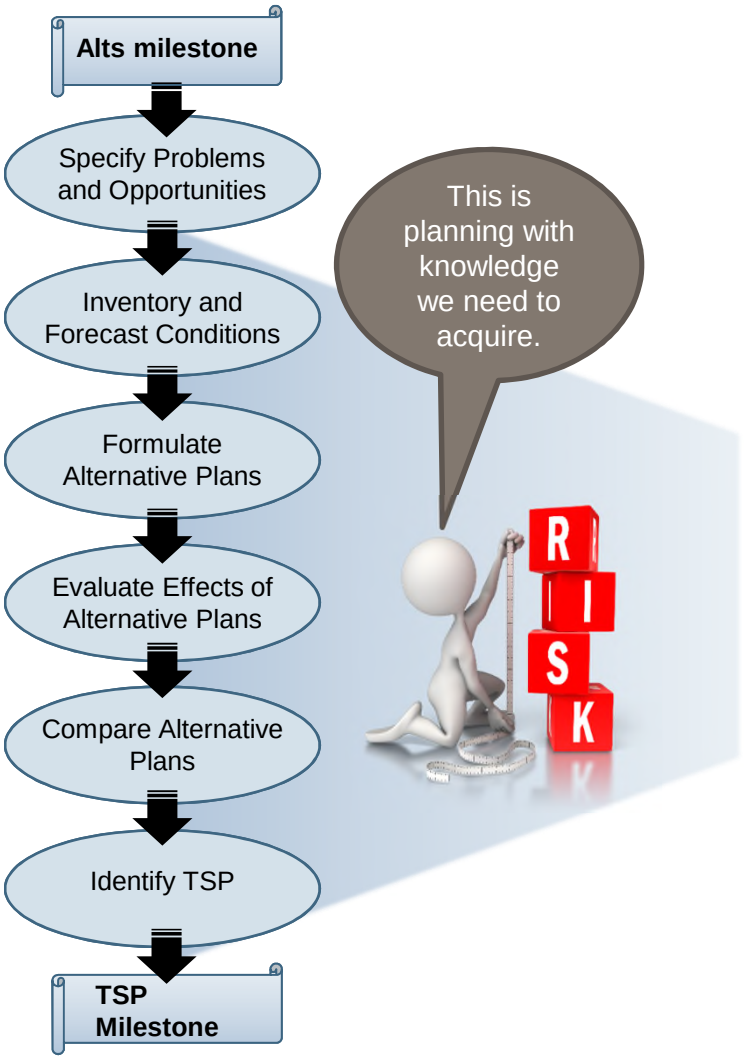
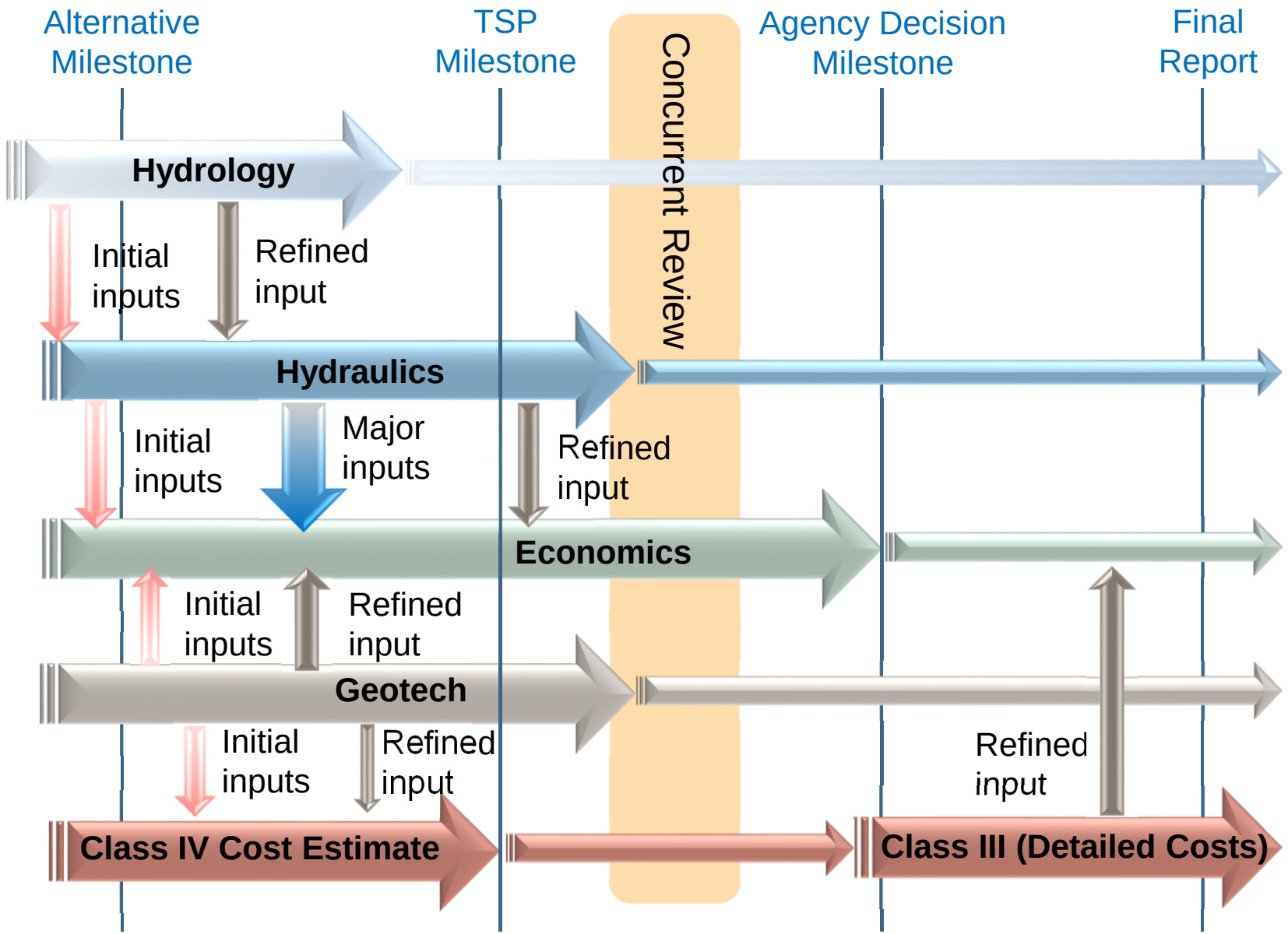
3RD ITERATION (AND BEYOND): APPLY WHAT WE'VE LEARNED

For The TSP Milestone



- Refine understanding of the **flooding problem(s).**
  - DQC'd and ATR'd Hydrology
  - DQC'd Hydraulic & Economic Models
  - DQC'd Geotech
- Refine or identify new **measures** to address problem(s)
- Refine range of alternatives
- **Evaluate** costs, benefits and effects using **quantitative** metrics (Class 4 costs, Annual Damages/benefits) from approved models (i.e. HEC-FDA)
- **Compare** alternatives based on quantitative metrics
- Analyze risks to **identify key uncertainties and any remaining data gaps**
- Identify likely **NED (LPP), and TSP**
- Provide recommendations for **risk reduction strategy in Feasibility design**

TEAM HANDOFFS



2 **TSP MILESTONE**
Vertical Team concurrence on tentatively selected plan

TENTATIVELY SELECTED PLAN (TSP) MILESTONE

Comparative Level of Detail

Planning Decision:

Compared to other alternatives, have we identified plan which maximizes outputs?

Focus on:

- Describe the plan and it's outputs
- Describe remaining uncertainties in the TSP (LPP)
  - How confident are we in the plan?
  - What is our strategy for reducing study risk moving forward into feasibility design?

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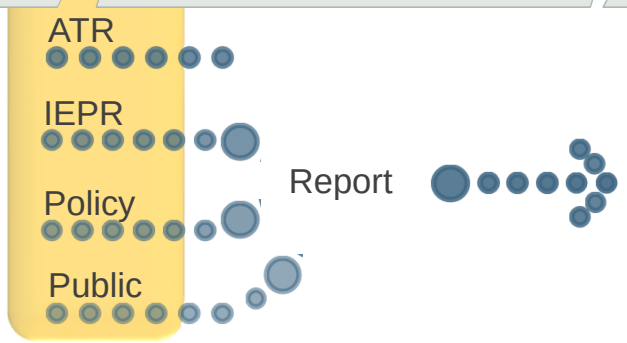
CONCURRENT REVIEW



Why do we conduct Concurrent Review?

- Improve Quality of Analysis and Products
- Transparency in Process

What are the Products/Outcomes?

- Agency Technical Review (ATR)
- Independent External Peer Review (IEPR)
- Policy Review
- Public Review

What are the Key Decisions or Actions?

- Ensures analyses supporting the documents are technically sound
- policy compliant and
- publically acceptable

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3 **AGENCY DECISION MILESTONE**
Agency endorsement of the recommended plan

AGENCY DECISION MILESTONE (ADM)

Confirm TSP Recommendation

Planning Decision: does the analysis or the review change the recommendation?

Focus on:

- Would additional data change the recommendation?
  - If yes, describe the recommended path forward.
- Describe strategy for responding to comments received during concurrent review.

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4 **FINAL REPORT MILESTONE**

FEASIBILITY LEVEL ANALYSIS

Refine the TSP

Planning Decision:

- What is the Recommended Plan
- What does it do? (performance/benefits)
- What does it cost?

Focus on:

- Feasibility Level Design (refined project features)
- Outputs/Benefits (price level updates)
- Costs (Class 3 with full Cost and Schedule Risk Analysis)
- Effects / Mitigation
- Completion of Environmental Compliance

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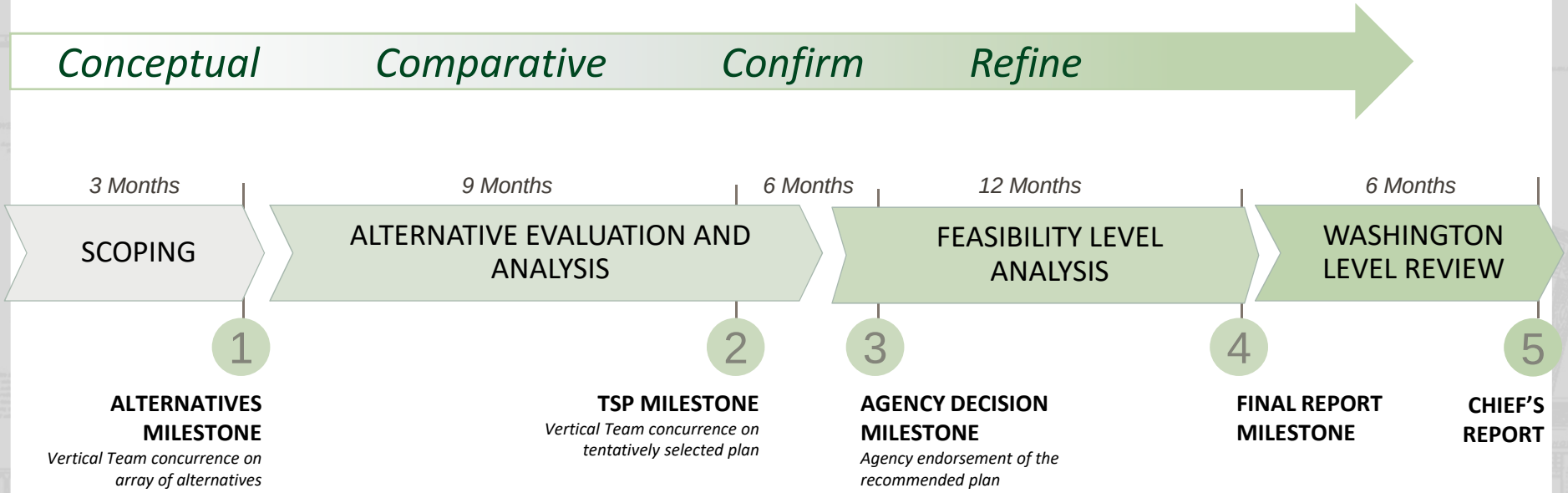
**See Planning Bulletin 2017-01 Reissue*

SMART FEASIBILITY STUDY PROCESS SUMMARY



- Alts Milestone is **Conceptual**
- **Comparative** level of detail for the TSP
- **Confirm** through concurrent review
- **Refine TSP** for the Final Report
- *Use appropriate level of detail to your advantage*

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How Many Times Should a Team go through the Iterative Planning Process?

A. Once is enough!

B. 2 times should do it!

C. As many as needed…

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CHECK IN

- Any Questions?

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FRM-SPECIFIC POLICIES

- ER 1105-2-100: Planning Guidance Notebook,
  Section 3-3 and Appendix E - Section III
- ER 1105-2-101: Risk Assessment for
  Flood Risk Management Studies
- ER 1165-2-26: Implementation of Executive Order 11988
  on Flood Plain Management
- EC 1165-2-217: Civil Works Peer Review,
  Section 9.h (ATR teams)

Additional FRM-specific guidance can be found in the Planner's Library on the Planning Community Toolbox

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Source: Sacramento District, Fremont Weir - 1963

FRM-SPECIFIC POLICIES

Executive Order (EO) 11988 - Floodplain Management
(ER 1105-2-100; ER 1165-2-26)

- Avoid floodplain development
- Reduce hazards and risk associated with floods
- Restore and preserve natural floodplain values

➢ ER 1165-2-26 establishes an 8 step procedure for implementing EO 11988

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Source: NRDC, Willamette River, Oregon

FRM-SPECIFIC POLICIES

Project Performance and Risk Framework
(ER 1105-2-100, ER 1105-2-101, EM 1110-2-1619)

- Risk framework: risk assessment, risk communication, risk management
- Risk assessment is a systematic approach for describing the nature of the flood risk, including uncertainty
- Explicit tradeoffs between risks, performance, and costs
- Expected performance, not level of protection
- No minimum level of performance/protection/size; however, smaller size means greater residual risk

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FRM-SPECIFIC POLICIES

Planning Guidance Notebook (ER 1105-2-100)

- **Induced flooding** – mitigate if appropriate
  - Economically justified
  - Overriding safety, economic or social concerns
  - Determination of a real estate taking
- **Minimum Flows in Urban Areas**
  - 800 cfs for a 10% flood event; exception for hydrologic disparity (see ER 1165-2-21)
- **Single Properties** – project can't benefit single property

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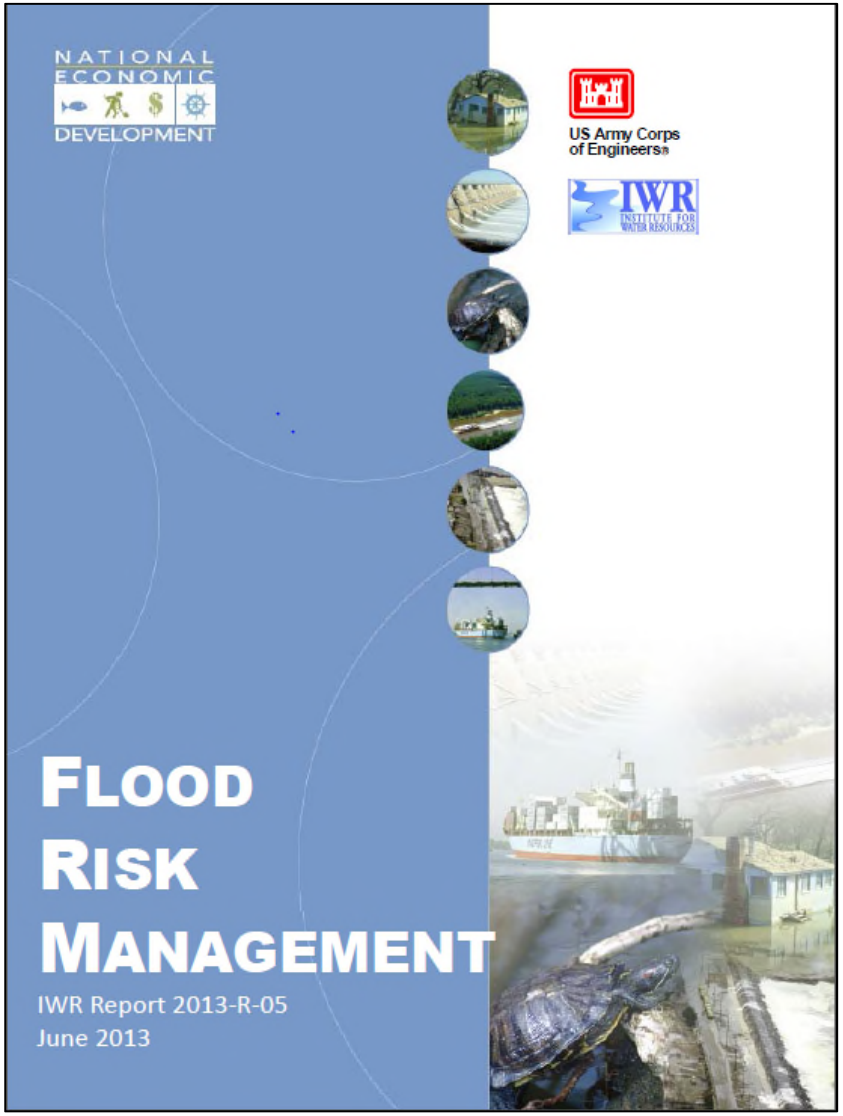
FRM-SPECIFIC POLICIES

ATR Considerations (EC 1165-2-217)

- For decision documents involving hydrologic, hydraulic, and/or coastal related risk management measures, the ATR Team will include a subject matter expert in multi-discipline flood risk analysis.
- At least one member of an ATR Team for inland hydrology and coastal studies, designs, and projects must be certified by the Climate Preparedness and Resilience CoP in CERCAP.

FRM-SPECIFIC POLICIES



- **National Economic Development Procedures Manual: Flood Risk Management (2013)**

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KEY TAKEAWAYS

- Understand risk and how it's used in FRM Planning
- First 90 days are critical to success (dedicated team)
- Seamless quality control throughout entire process reduces likelihood of significant setbacks. Robust DQC.
- Uncertainty is reduced as the study progresses
- Each iteration helps to highlight key areas where additional critical information can be obtained to reduce decision risk
- Level of detail progression through study process: Conceptual….Comparative….Confirm….Refine

✓ USACE Planning Manuals, Part I and Part II
✓ Planning SMART Guide:
https://planning.erdc.dren.mil/toolbox/smart.cfm

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Questions?

Type questions in the chat box.
We will answer as many
as time allows.

This webinar will be posted to the
Planning Community Toolbox:
http://www.corpsplanning.us

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