

## Benefit-Cost Analysis (BCA) and Technical Feasibility: Participant Handout

February 2, 2026

### Core Concepts in Benefit-Cost Analysis (BCA)

#### What BCA is (and why it matters)

At its core, **Benefit-Cost Analysis** is a structured way to compare:

- **Project costs** (what you must spend to build/implement and maintain a mitigation action), and
- **Project benefits** (the **future losses and costs avoided** because the project reduces disaster impacts).

If benefits exceed costs, the project is considered **cost-effective**. FEMA expresses this using the **Benefit-Cost Ratio (BCR)**:

$$\text{BCR} = \text{Benefits} \div \text{Costs}$$

If **BCR  $\geq$  1.0**, the project meets FEMA's cost-effectiveness requirement.

**BCA in plain terms: "before vs. after"** A mitigation project is trying to reduce what the community would otherwise pay—financially and socially—over the life of the project. The key idea is:

$$\text{Benefits} = (\text{Costs/Losses Before Mitigation}) - (\text{Costs/Losses After Mitigation})$$

The BCA process turns that concept into a defensible calculation using hazard probability, damage estimates, and project effectiveness.

**Discount rate and why future benefits are discounted:** Future benefits are not valued the same as benefits today. FEMA BCAs apply a **7% discount rate** (per federal guidance), meaning benefits farther in the future "count" less than near-term benefits. This is why two projects with the same total avoided damage can have different BCAs depending on timing, useful life, and hazard frequency.

#### Key terms you will see often

- **Discount rate:** The rate used to reduce the value of future benefits back to today's dollars.
- **Net Present Value (NPV):** Present value of benefits minus present value of costs; positive NPV indicates a good investment.
- **Recurrence Interval (RI):** How often an event of a certain size is expected (e.g., "100-year" = 1% annual chance).
- **Project Useful Life (PUL):** How long the mitigation action remains effective; longer PUL increases the period over which benefits accrue.
- **Residual risk:** Most projects reduce—but do not eliminate—risk; only acquisition/demolition is treated as fully eliminating future damages for that structure.

**What counts as benefits in FEMA BCAs (high level)**

Common FEMA-allowable benefits include:

- Avoided **physical damages** (structure, contents, site impacts)
- Avoided **loss of service/function** (especially for public facilities, utilities, roads/bridges)
- Avoided **injury/death** (only for certain hazard/project types)
- Avoided **displacement costs** (temporary housing, related costs; can include business income loss for commercial)
- Avoided **emergency management costs** (e.g., response activities, some volunteer-related efforts)
- Avoided **NFIP administration costs** (notably when an NFIP-insured structure is acquired)
- **Social benefits** (mental stress/anxiety and lost productivity, using FEMA standard values)
- **Environmental benefits** (for actions like acquisitions or restoration that improve/preserve natural environments, using FEMA standard values per acre/year)

**What does *not* count:** FEMA does not allow benefits (or costs) that are subjective, not measurable, or “indirect” in the federal economics sense. Examples include aesthetic value, “ease of project,” and broader regional economic effects (jobs/income changes). Insurance premiums are treated as transfer payments under federal guidance and are not counted as costs/benefits in the BCA.

**Avoiding duplication:** Applicants must avoid:

- **Duplication of benefits** (counting the same benefit twice, across projects or across structures), and
- **Duplication of programs** (project is primarily the responsibility of another federal program).

**What the Toolkit is (and what it is not):** FEMA’s BCA Toolkit is used to assemble inputs and calculate results. It is best thought of as a **calculator**: it will compute outcomes based on your assumptions and data quality, but it does not “validate” whether your inputs are correct.

The guiding principle is: **garbage in = garbage out**. Reviewers will evaluate whether your data is credible and well-documented, not just whether the Toolkit outputs a  $BCR \geq 1.0$ .

**How the Toolkit structures projects:** A **project** is made up of one or more **structures**. The Toolkit calculates benefits/costs for each structure, then totals them to produce the project-level BCR.

**What you need to start any BCA:** While data needs vary by hazard and project type, most BCAs require:

- Project title and mitigation action description
- Location and structure type
- Hazard type and the **frequency/damage relationship** approach you will use
- Hazard/damage information (modeled hazard data, historical damage data, or expected damages estimated by a qualified professional)

- Cost estimate and maintenance (as applicable)
- Project Useful Life (PUL)

**Choosing the right “frequency and damage” approach:** The Toolkit requires you to select one of the main approaches:

- **Modeled Damages** (used when you have hazard information such as an FIS/H&H study; also common for several non-flood hazard projects)
- **Historical Damages** (when past documented damages exist for the structure/facility)
- **Professional Expected Damages** (when a qualified professional estimates future damages for defined events)

**Pre-calculated benefits (when a full BCA is not required):** FEMA provides pre-calculated benefit options for certain common project types. If a project qualifies, applicants can use the pre-calculated benefit values instead of running a full BCA, but **all other application requirements still apply**. The training highlights common examples such as acquisitions/elevations in the SFHA and several other mitigation types with specific limits and eligibility rules.

### Where to get help

The Toolkit includes an integrated help system. FEMA also provides job aids, technical review checklists, reference guides, and a BCA Helpline (which can provide guidance but does not perform or review BCAs).

### Flooding concepts you must know for flood BCAs

Floods are a primary driver of disaster declarations and mitigation work. Flood mitigation BCAs rely heavily on understanding and documenting flood hazard data. Key references include:

- **Flood Insurance Study (FIS):** Flood risk and elevation data used to develop mapping.
- **Flood Insurance Rate Map (FIRM):** Official map showing floodplains (1% and 0.2% annual chance), BFEs, and zones.
- **Hydrologic & Hydraulic (H&H) study:** Engineering study of water movement and flood elevations/discharges; may be needed where mapping is inadequate or absent and must be completed by licensed professional engineers.
- **10-, 50-, 100-, 500-year events:** Recurrence intervals corresponding to 10%, 2%, 1%, 0.2% annual chance events; the “X-year” wording can be misleading because even “100-year” events have meaningful probability over a 30-year period.

### **Core flood-related terms (used frequently in the Toolkit)**

- **SFHA:** Special Flood Hazard Area; essentially the 1% annual chance floodplain.
- **BFE:** Base Flood Elevation; elevation of the 1% annual chance flood.
- **LFE/FFE:** Lowest (or First) Floor Elevation; typically sourced from an elevation certificate or certified survey and depends on basement conditions.
- **BRV:** Building Replacement Value; replacement cost per square foot for a functionally equivalent building (not market value).

- **DDT:** Demolition Damage Threshold; percent damage level at which demolition/replacement is economically preferred over repair (often 50% by default, but can vary).
- **DDF:** Depth Damage Function; relationship between flood depth and percent damage (and often displacement/loss-of-function days), with commonly used curves included in the Toolkit.

### Common flood mitigation project types covered

1. **Acquisitions:** Acquisition projects purchase and demolish or relocate buildings, then place the land under deed restriction as open space, eliminating future damages for that building and often enabling environmental/recreational co-benefits.
2. **Elevations (and mitigation reconstruction):** Elevation projects raise the structure's lowest floor above the BFE; the additional height above BFE is **freeboard** and varies by jurisdiction. Mitigation reconstruction (rebuilding improved/elevated on the same site after partial/complete demolition) is treated similarly to elevation in the BCA process, with siting limitations (e.g., regulatory floodway/coastal high hazard areas).
3. **Flood control projects:** Flood control is used here as a broad category for systemic projects that reduce flood damage for an area or facility (culverts, drainage improvements, flood diversion/storage, floodwalls, levees, pumping stations, restoration, etc.). These are commonly evaluated using **Historical Damages** or **Professional Expected Damages** because the project affects multiple assets and is often best supported with past or professionally estimated damages.

**Pre-calculated benefits for flood acquisitions/elevations:** For acquisitions or elevations where structures are in the SFHA and costs are below specified per-structure thresholds, applicants may be able to use pre-calculated benefits and avoid a full BCA. Projects with a mix of structures inside/outside the SFHA may either split methods (pre-calculated inside SFHA and full BCA outside) or run one full BCA for all structures, but benefits cannot be "shifted" between structures.

### Demonstrating Technical Feasibility and Documenting Your BCA

**Technical feasibility vs. cost-effectiveness:** These are related but distinct:

- **Technical feasibility** asks: *Is the mitigation action reasonable and grounded in accepted engineering principles and practice?*
- **Cost-effectiveness** asks: *Do the quantified avoided losses over time outweigh the project costs using FEMA-approved methods?*

The training emphasizes that **technical feasibility supports cost-effectiveness**, and cost-effectiveness supports overall project effectiveness.

### What "technical feasibility" typically includes

A strong technical feasibility package is not just a statement of intent; it is a set of connected documents that tell a consistent story:

1. **Project narrative and Scope of Work (SOW):** A clear narrative explains the project purpose, what risk is being mitigated, where, and what will be built/done. The SOW should define the mitigation action, describe the level of protection, list tasks, and include project-specific technical details.

Good narratives:

- explain approach and methodology
  - describe and support assumptions
  - cite sources (studies, models, storm data, etc.)
  - include enough detail that a reviewer can visualize what you are proposing and why it will work
2. **Project schedule:** The schedule should reflect duration for each major task, include milestones, and align with the SOW and cost estimate. (The training highlights FEMA performance period limits and the importance of consistency.)
  3. **Cost estimate and budget narrative:** Cost estimates must match the SOW and schedule, identify the source/methodology, confirm eligibility, and provide line-item detail. Lump sums are not acceptable in this context.
  4. **Design criteria, codes, and standards:** Design criteria are project-specific. Construction documents should be signed/sealed by the appropriate licensed design professional, and the applicant should demonstrate awareness of applicable requirements and standards.

**Common resource types:** The slides point participants to common data sources that often support BCAs and technical feasibility documentation, such as rainfall frequency data, census demographics, building valuation tools, flood event data, and hazard parameter tools. The main takeaway is not “use these exact tools,” but: **use credible sources, and cite them clearly.**

### Practical takeaways

**1) Start early, iterate, and document as you go:** Conduct BCAs early in project development to ensure the project is likely to meet cost-effectiveness and to support smarter scoping and alternative selection.

**2) Think like a reviewer:** Reviewers are looking for:

- logical consistency (SOW ↔ schedule ↔ cost estimate ↔ BCA inputs)
- credible, defensible sources
- clear explanation of assumptions and methodology
- evidence that the project will perform as described (technical feasibility)

**3) Treat the Toolkit output as the *end* of a good process, not the start:** A BCR alone is not persuasive without solid, traceable documentation.

### **ARRO Contact:**

Brian E. Wagner, P.E. ▪ (240) 513-3586 ▪ [brian.wagner@arroconsulting.com](mailto:brian.wagner@arroconsulting.com) or [disastersupport@arroconsulting.com](mailto:disastersupport@arroconsulting.com)