Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

BRIC and FMA Benefit Cost Analysis (BCA) Overview

Tuesday, October 6, 2020

Agenda

- BCA Considerations for BRIC & FMA Programs
- Introduction: General BCA Concepts
- Using FEMA BCA Toolkit Version 6.0
- Project-Specific BCA Overviews
- Submitting a Complete BCA Package
- Case Studies
- BCA Resources

BCA Considerations for BRIC & FMA Programs

BRIC and HMA Benefit Cost Analysis Overview-3

BCA Considerations for BRIC and FMA Programs Part 1

- Projects go through National Technical Review:
  - BCA must be well-documented and robust. It must be able to be replicated and substantiated by BCA technical reviewer.
  - Consider developing technical report to accompany the BCA to easily explain the methodology and any non-standard values.
  - No RFIs will be issued. If there are questions, projects will be denied.

BCA Considerations for BRIC and FMA Programs Part 2

- BRIC Qualitative Criteria scoring evaluates **future conditions** and **ancillary benefits**.
- Projects are evaluated how the project will anticipate *future conditions* and how well this information is documented.

BCA Considerations for BRIC and FMA Programs Part 3

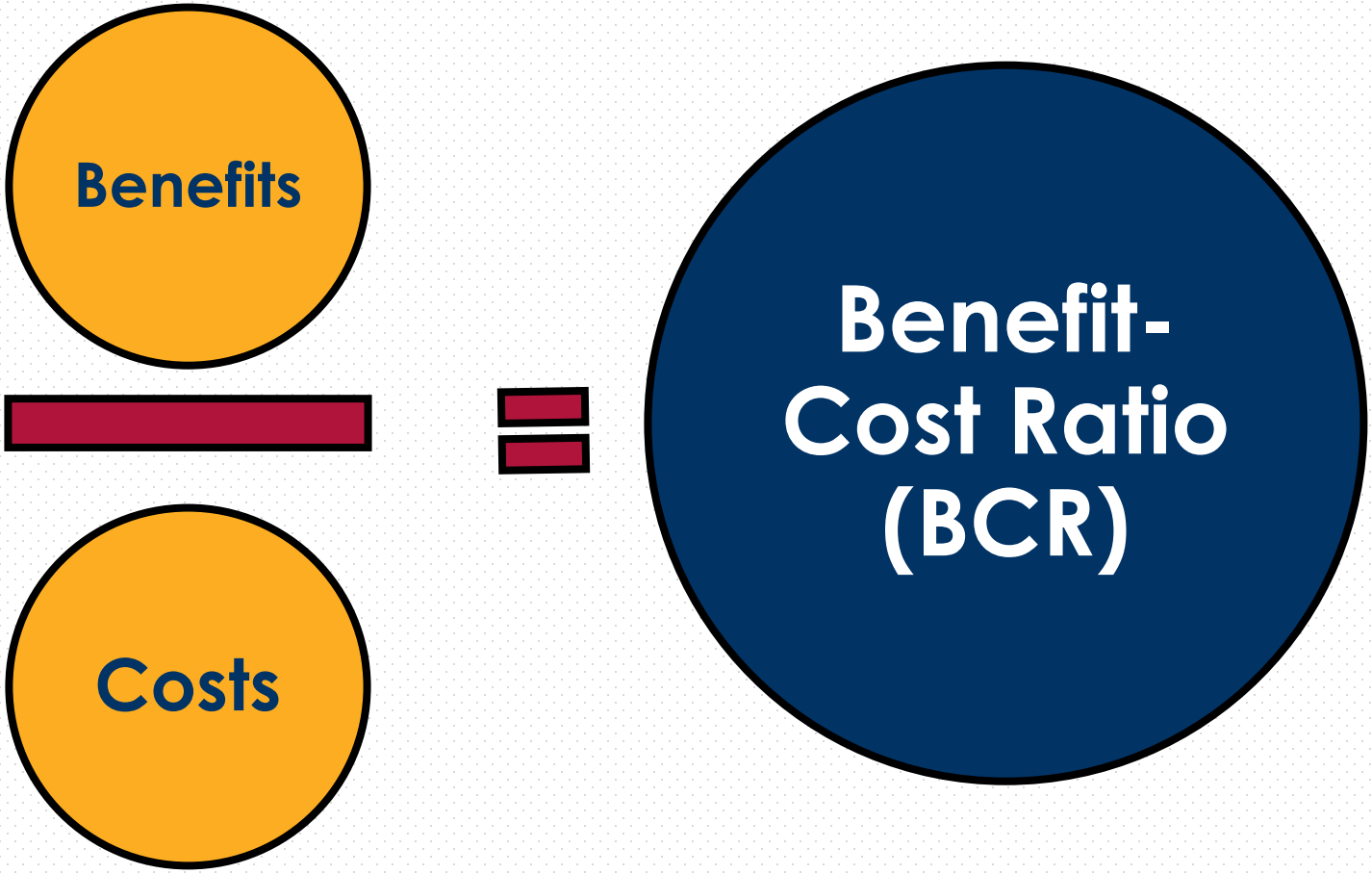
- Example: For a flood project, does the design incorporate sea-level rise. If included in the design, it should be included in the BCA and Evaluation section of the subapplication.
- Projects also evaluated for how well it realizes *ancillary benefits* (e.g. water/air quality, habitat creation, energy efficiency, economic opportunity).
  - Ancillary benefits that can't be quantified in the BCA should can be quantified in the Scope of Work.

Introduction: General BCA Concepts

Introduction: General Concept of BCA

- FEMA **requires** a BCA to validate cost effectiveness of proposed hazard mitigation projects prior to funding.
- A BCA is the method by which the **future benefits** of a hazard mitigation project are determined and **compared to its costs**.
- The end result is a **Benefit-Cost Ratio** (BCR), which is calculated by a project's total benefits divided by its total costs.
- A project is considered to be cost effective when the **BCR is 1.0 or greater**, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs.

Calculating Benefit-Cost Ratio (BCR)



BCA: Benefits and Costs

- Most of the focus of a BCA is on the **benefits** side.
- Benefits are the **net present value of the reduction in damages and losses** over the useful lifetime of the project, using FEMA's 7% discount rate
- The present value **calculation is done automatically** in the BCA software.
- Costs are usually relatively easy, though they must come from a good source AND they must be accurate, because they are used by States and FEMA in budgeting for the grant programs.

BCA Components

- **Hazard:** What natural hazard is your project protecting?
- **Frequency/Recurrence Interval (RI):** How often does that hazard happen?
- **Damage:** What damages does this hazard cause to the community?
- **Project Useful Life:** How long will your project be active for?
- **Effectiveness/Residual Risk:** How much damage does your project prevent



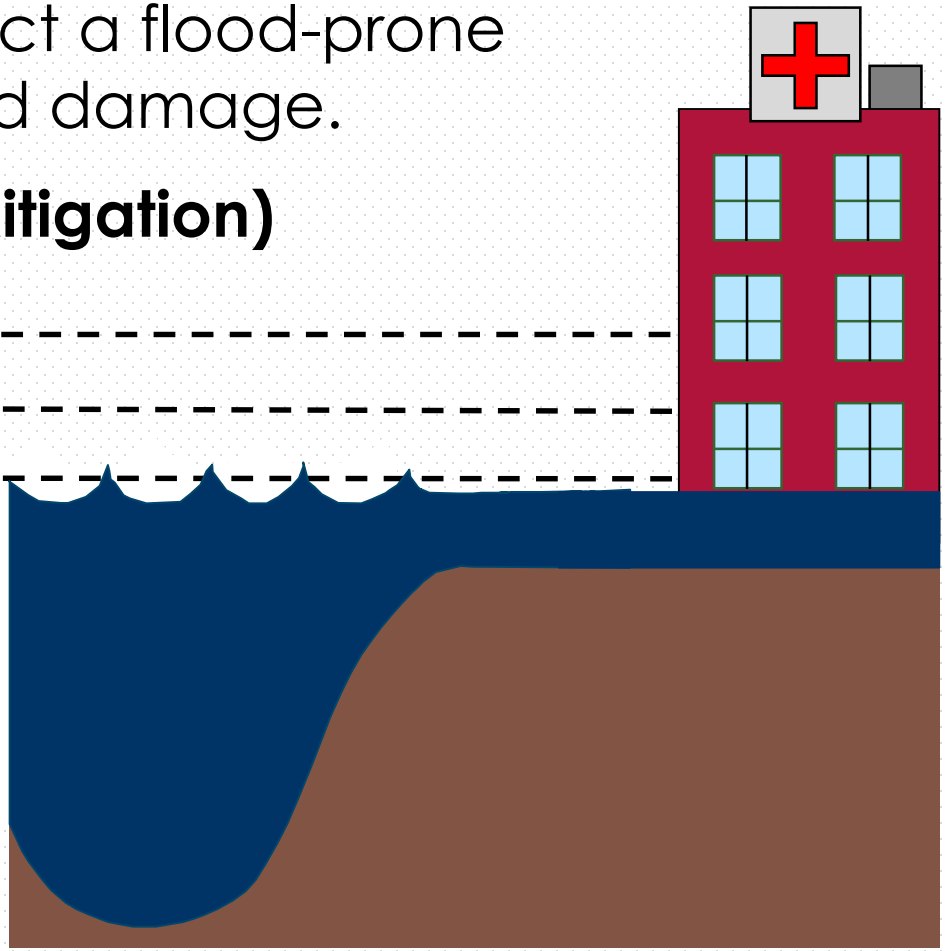


General BCA Example Part 1

A flood protection project is recommended to protect a flood-prone hospital from future flood damage.

Before Mitigation (Pre-Mitigation)

500-year flood = 504'
50-year flood = 502'
10-year flood = 500'
(FFE = 498')



General BCA Example Part 2

Before Mitigation (Pre-Mitigation) Damage

Recurrence Interval (years)	Annual Probability of Flooding	Flood Depth (feet)	Scenario Damages and Losses	Expected Annual Damages and Losses
10	0.10	2	$4,000,000	$400,000
50	0.02	4	$8,000,000	$160,000
500	0.002	6	$16,000,000	$32,000

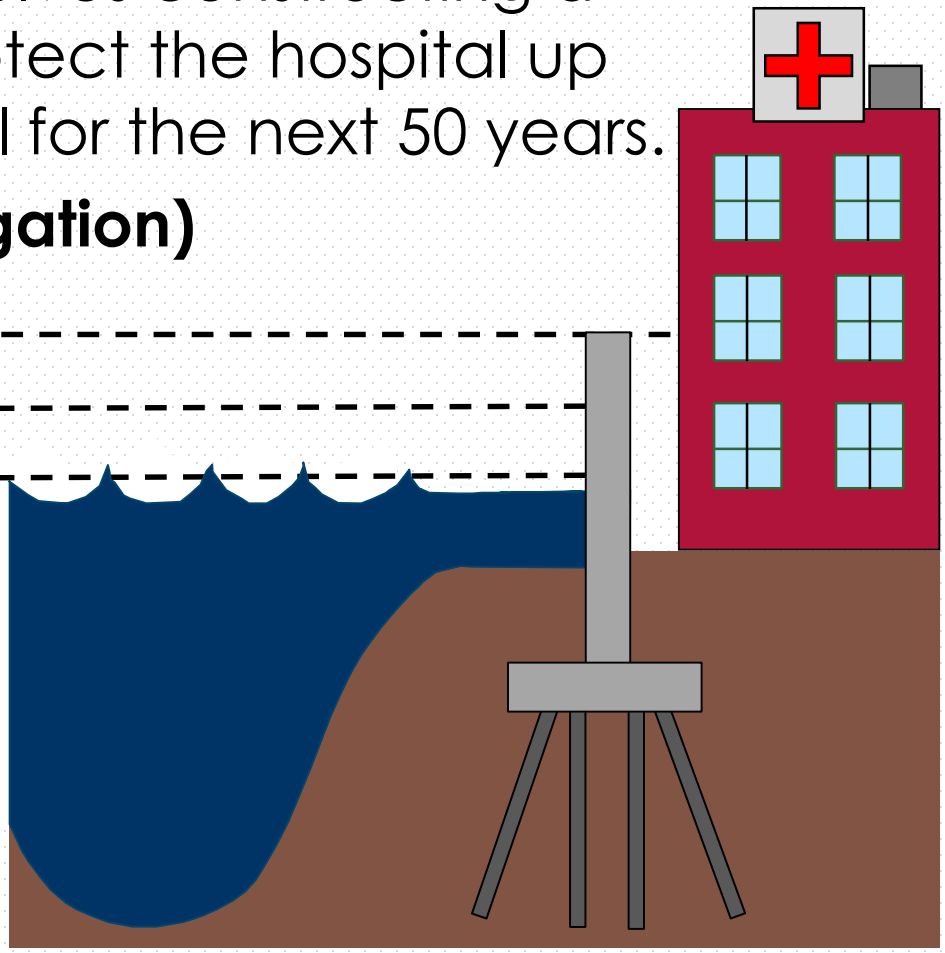
Total Expected Annual Damages and Losses: $592,000

General BCA Example Part 3

The proposed project involves constructing a $5 million flood wall to protect the hospital up to the 500-year flood level for the next 50 years.

After Mitigation (Post-Mitigation)

500-year flood = 504'
50-year flood = 502'
10-year flood = 500'
(FFE = 498')



Hazard doesn't change, but its effect on structure does!

General BCA Example Part 4

After Mitigation (Post-Mitigation) Damage

Recurrence Interval (years)	Annual Probability of Flooding	Flood Depth (feet)	Scenario Damages and Losses	Expected Annual Damages and Losses
10	0.10	0	$0	$0
50	0.02	0	$0	$0
500	0.002	6	$16,000,000	$32,000

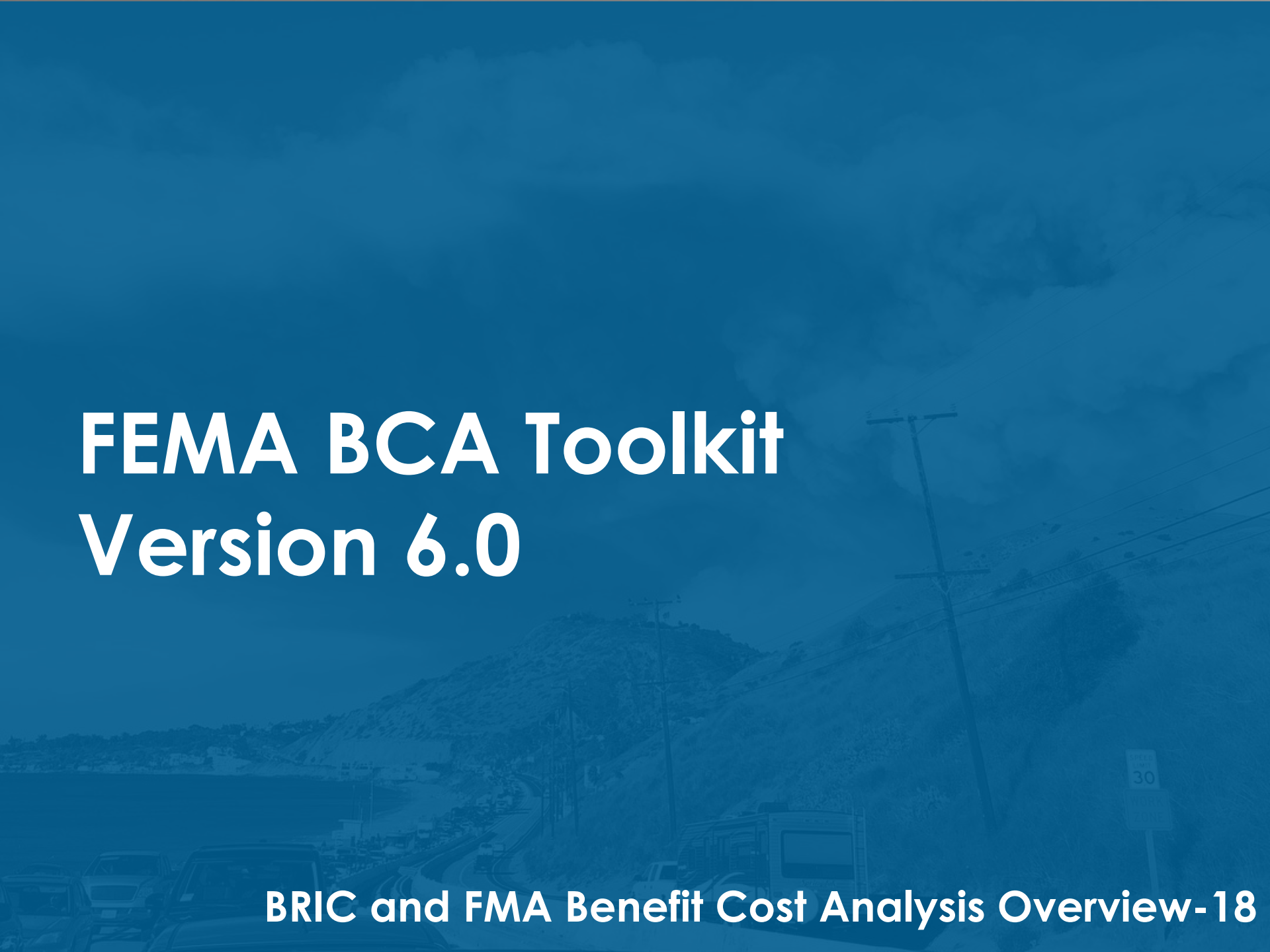
Total Expected Annual Damages and Losses: $32,000

General BCA Example: BCR Calculation

Recurrence Interval (years)	Expected Annual Damages *Before* Mitigation	Expected Annual Damages *After* Mitigation	Expected Annual Avoided Damages and Losses
10	$400,000	$0	$400,000
50	$160,000	$0	$160,000
500	$32,000	$32,000	$0
Totals	**$592,000**	**$32,000**	**$560,000**
PVC (7% Discount Rate, 50 years)			*x 13.80*
Net Present Future Value of Future Benefits			*$7,728,000*
		Costs	**$5,000,000**
		Benefit-Cost Ratio	**1.55**

General Concept of a BCA: Questions?

FEMA BCA Toolkit Version 6.0



BRIC and FMA Benefit Cost Analysis Overview-18

FEMA BCA Toolkit Version 6.0 Overview 1

- FEMA BCA Toolkit Version 6.0 now replaces BCA Toolkit Version 5.3
- **FEMA BCA Toolkit Version 6.0 Key Features:**
  - Excel-based platform
  - Compatible with both Windows and Macintosh operating systems
  - Reduction in the number of manual-input data fields

Hazards in v.5.3.0	Hazards in v.6.0
Flood	Riverine Flood
	Coastal A Flood
	Coastal V Flood
	Coastal Unknown Flood
Hurricane Wind	Hurricane Wind
Hurricane Safe Room	Hurricane Safe Room
Tornado Safe Room	Tornado Safe Room
Earthquake	Seismic
Wildfire	Wildfire
Drought	Drought
N/A	Landslide
	Dam/Levee Break
	Extreme Temperature
	Infrastructure Failure
	Severe Storm
	Tsunami
	Volcano
	Winter Storm
	Uncategorized

Table 1: Hazard Options in v.5.3.0 versus v.6.0

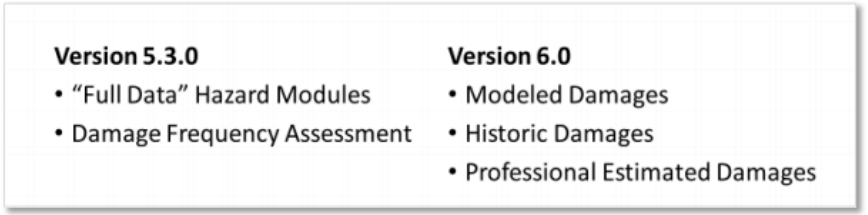


Figure 10: Analysis Methodology Differences between v.5.3.0 and v.6.0

FEMA BCA Toolkit Version 6.0 Overview 2

Hazards in v5.3.0	Hazards in v6.0
Flood	Riverine Flood, Coastal A Flood, Coastal V Flood, Coastal Unknown Flood
Hurricane Wind, Hurricane Safe Room, Tornado Safe Room, Earthquake, Wildfire, Drought	Hurricane Wind, Hurricane Safe Room, Tornado Safe Room, Earthquake, Wildfire, Drought

FEMA BCA Toolkit Version 6.0 Overview 3

Hazards in v5.3.0	Hazards in v6.0
N/A	Landslide, Dam/Levee Break, Extreme Temperature, Infrastructure Failure, Severe Storm, Infrastructure Failure, Severe Storm, Tsunami, Volcano, Winter Storm, Uncategorized

FEMA BCA Toolkit Version 6.0 Overview 4

Hazards in v5.3.0 Analysis Methodology	Hazards in v6.0 Analysis Methodology
• "Full Data" Hazard Modules • Damage Frequency Assessment	• Modeled Damages • Historic Damages • Professional Estimated Damages

FEMA BCA Toolkit V6.0 – Getting Started Part 1

1. Download Benefit Cost Toolkit Version 6.0 from the FEMA website (https://www.fema.gov/media-library/assets/documents/179903) – including the BCA Tool (.xlsx), Add-in file (.xml), User Guide (.pdf) and Release Notes (.pdf)

FEMA BCA Toolkit V6.0 – Getting Started Part 2

2. Set up Microsoft® Office 365 profile and then Excel online to launch the BCA Tool
3. Use the Excel online menu bar to upload the BCA Tool Add-in
4. Click on the FEMA BCA V6.0 menu bar
5. Open the FEMA BCA Calculator

FEMA BCA Toolkit V6.0 – Saving & Printing 1

- The full BCA Tool (.xlsx) should be saved automatically when using Excel online, or you can be manually saved offline
- Individual project BCA files (.zip) can be saved by checking the project and clicking the Export Projects button
- To and the project BCA report (.pdf): Click on the project, then click View Report, and then click Print Report

FEMA BCA Toolkit V6.0 – Saving & Printing 2

- Remember when Exported project files are imported back into the BCA Tool, the files will be locked automatically and cannot be changed.
  - To make changes to an imported BCA project file, make a copy of the file and make changes to the copy

FEMA BCA Toolkit V6.0 – Damage-Frequency Assessment (DFA) Module Approach 1

- DFA **no longer a stand-alone module** but the approach is contained **within every hazard option** as two separate analysis methods, whether you have **"historic damages" or "expected damages"**
  - If analysis based on historic damage amounts and years with either known or unknown recurrence intervals, then use the "**Historic Damages**" **approach**

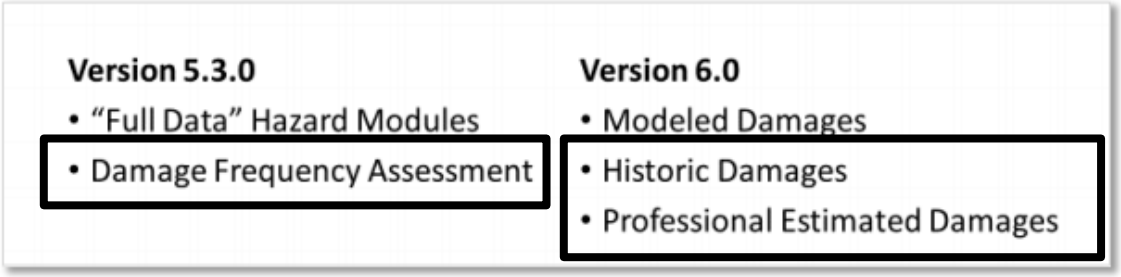


Figure 10: Analysis Methodology Differences between v.5.3.0 and v.6.0

FEMA BCA Toolkit V6.0 – Damage-Frequency Assessment (DFA) Module Approach 2

- If analysis based on expected damage estimates from a licensed professional with known recurrence intervals, then use the **"Professional Estimated Damages" approach**

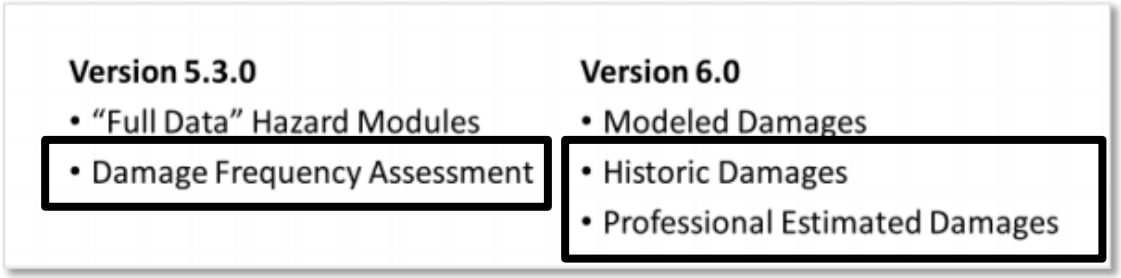
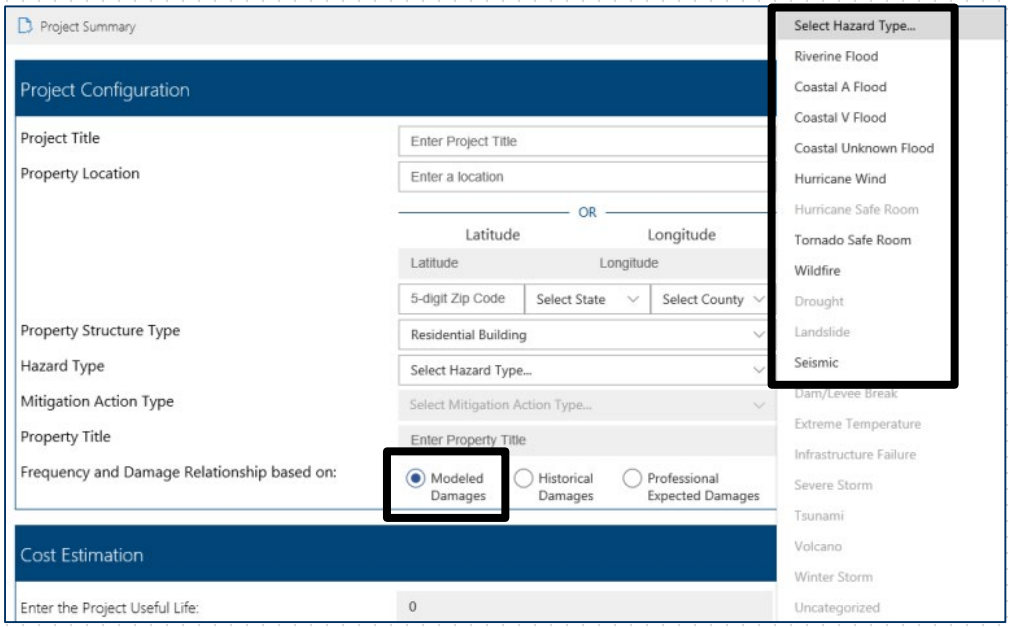


Figure 10: Analysis Methodology Differences between v.5.3.0 and v.6.0

FEMA BCA Toolkit V6.0 – Hazard-Specific (Full Data) Approach Part 1

- **Hazard-specific (Full data) hazard modules** in previous iterations of the Toolkit are now consolidated as the **"modeled damages" approach**



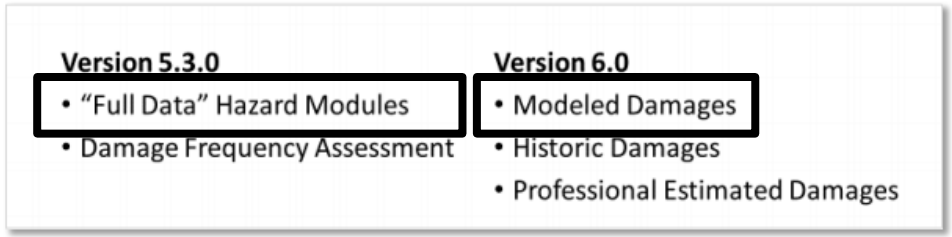
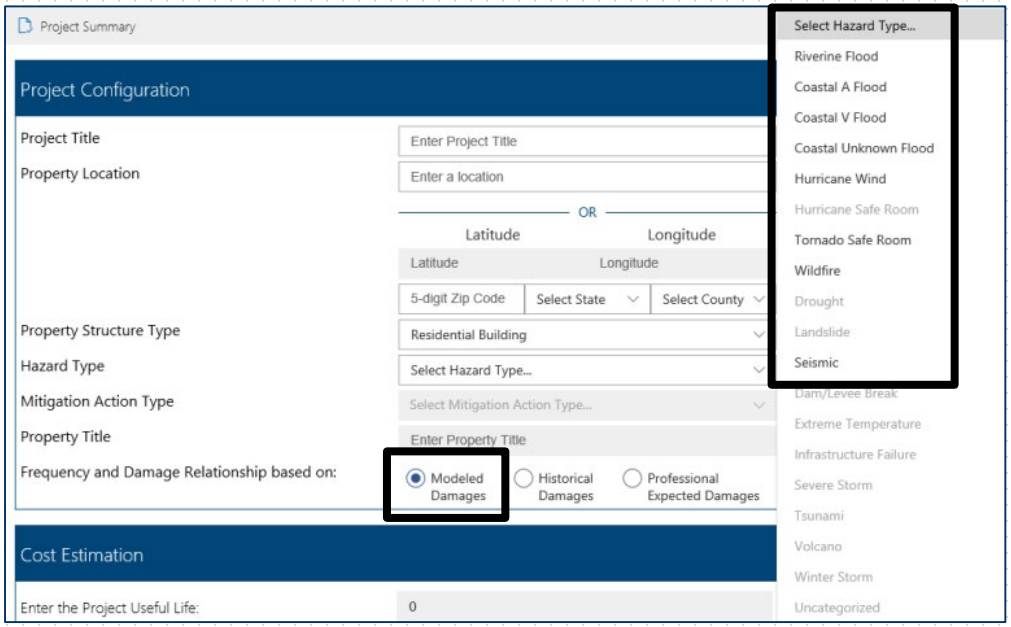


Figure 10: Analysis Methodology Differences between v.5.3.0 and v.6.0

FEMA BCA Toolkit V6.0 – Hazard-Specific (Full Data) Approach Part 2

- The availability of this approach depends on the hazard and structure type selected, but essentially **Full data modules = Modeled damages**



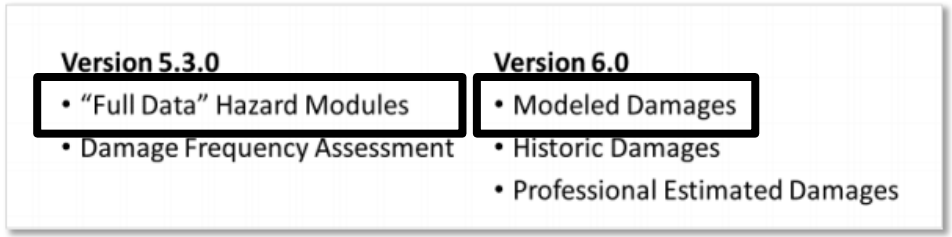


Figure 10: Analysis Methodology Differences between v.5.3.0 and v.6.0

Pre-Calculated Benefits Part 1

- FEMA has released several benefit-cost efficiencies to provide pre-determined cost effectiveness values
- Using pre-calculated benefits eliminates the requirement for applicants to conduct a separate BCA for eligible projects:
  - Acquisitions and Elevations in the Special Flood Hazard Area (SFHA)
  - Residential Hurricane Wind Retrofits
  - Non-Residential Hurricane Wind Retrofits
  - Individual Tornado Safe Rooms
  - Post-Wildfire Mitigation

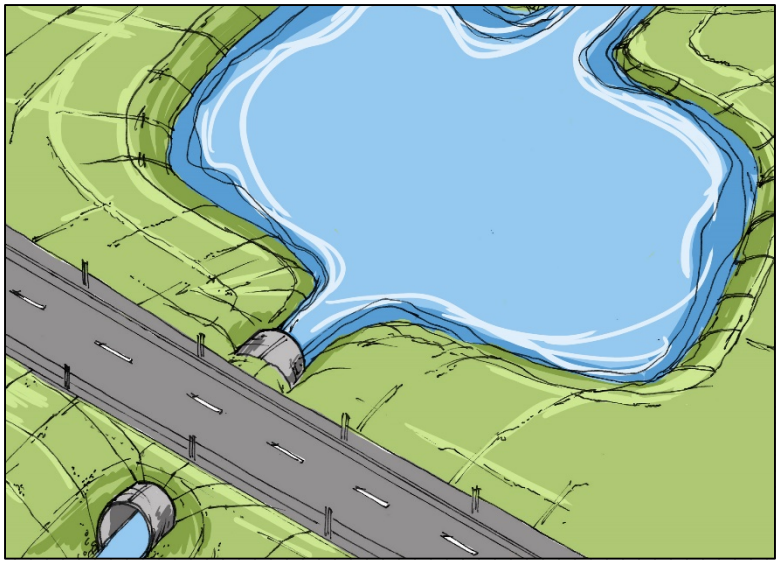
Pre-Calculated Benefits Part 2

- The pre-calculated benefits and benchmark costs are not intended to drive actual project costs or to serve as detailed project cost estimates; individual project cost estimates must be based on industry standards, vendor estimates or other acceptable sources.

Project Specific Overviews: Flood Risk Reduction, Utility and Infrastructure Protection, Seismic Retrofit

Flood Risk Reduction Projects – Overview

Activity: Construction or expansion of existing drainage, pumping, and/or water storage capacity to reduce flood damage within a community or subdivision. Also known as flood control or drainage improvement projects.



Flood Risk Reduction Projects – BCA Components

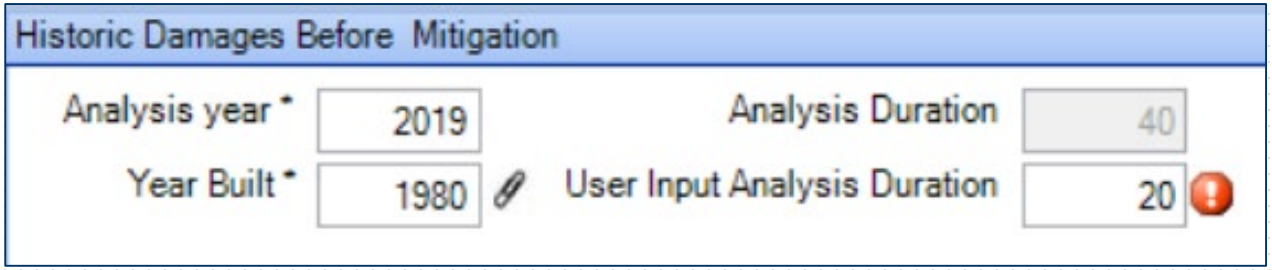
- **Hazard:** Flood risk reduction projects generally protect against flooding, but some involve adding protection against seismic or wildfire
- **Recurrence Interval (RI):** Depends on RI(s) of flood events; determined by a hydraulics and hydrology (H&H) analysis
- **Damage:** Damage to flooded structures, infrastructure damage and losses
- **Project Useful Life:** Typically 30-50 years (FEMA Standard value), depending on specifics
- **Effectiveness/Residual Risk:** Moderately effective against moderate flood events (50-year RI) depending on design

Flood Risk Reduction Projects – Common Errors 1

- Project does not address upstream and downstream impacts
- Hydrologic and Hydraulic study (H&H) results are based on a study that includes improvements other than the proposed project
- Not including flood elevation for each Recurrence Interval (RI) in project area
- Not providing elevation data for each structure

Flood Risk Reduction Projects – Common Errors 2

- Incorrect methods are used to determine recurrence intervals
- Regional Estimates are used rather than best available, site-specific data
- Missing residual risk (after mitigation)
- Incorrect Analysis Duration



Flood Risk Reduction Projects – Best Practices 1

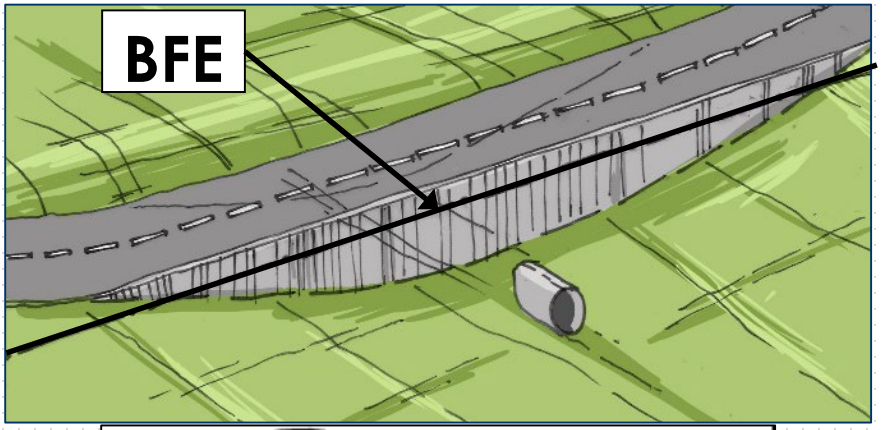
- RI from reputable source: FIS reports, FEMA models, USGS historic streamflow calculations
  - ID nearest coastal transect to project site
- Best available data used
- Provide a stage-frequency documentation at project site from H&H modeling or other statistical calculations

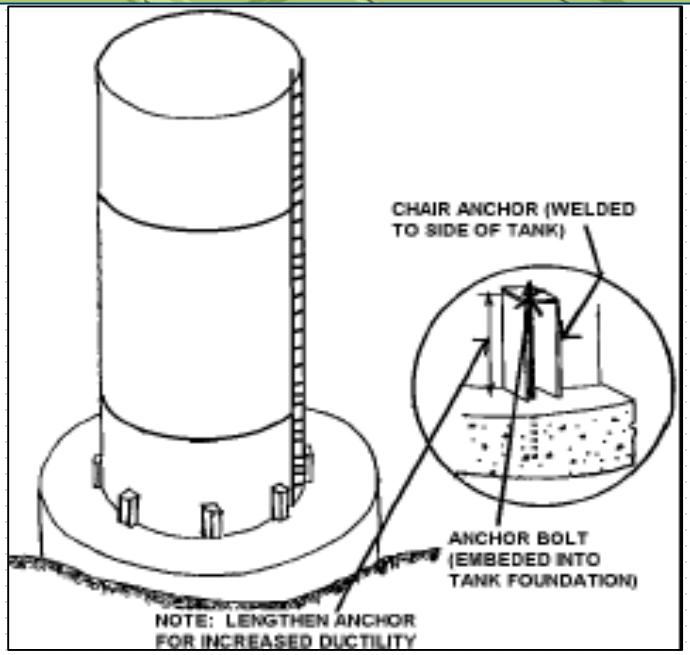
Flood Risk Reduction Projects – Best Practices 2

Use data of PAST costs from flood events:	Estimate FUTURE costs of flood events:
NFIP insurance claims	Show pre-project flood elevation
Town pay stubs/time sheets	Use FEMA Flood Insurance Studies (FIS)
Receipts for work & materials	Use building elevation
Detour information if road closed	Use replacement value of structures
Cost of emergency measures	Show post-project reduced flood elevation & saved costs
Past Project Worksheets (PWs)	

Utility and Infrastructure Protection Projects – Overview

Activity: Construction, retrofitting or other improvement of utilities, roads or other infrastructure to reduce damage and service losses from one or more hazards within a community.





Utility and Infrastructure Protection Projects – BCA Components

- **Hazard:** Utility and infrastructure projects can protect against flood, wind, earthquakes and/or wildfire hazards.
- **Recurrence Interval (RI):** Depends on RI(s) of hazard events; determined by hazard analysis or damage event history.
- **Damage:** Damage to infrastructure, service losses.
- **Project Useful Life:** Range from 15 to 50 years (FEMA Standard value), depending on specifics
- **Effectiveness/Residual Risk:** Moderately effective against moderate to severe hazard events, depending on mitigation type.

Utility and Infrastructure Protection Projects – Common Errors

- Hazard event RIs not documented based on unreliable sources or historic damages
- Over-estimating the project useful life
- Insufficient documentation of utility or road/bridge service values and durations
- Assuming zero damages after mitigation

Utility and Infrastructure Protection Projects – Best Practices

- RIs from reputable source: FIS reports, H&H studies, USGS earthquake data, ATC wind hazard site, Landfire model for wildfire; historic damage events
- Best available data used
- Documented utility/roadway service loss values and durations
- After-mitigation damages (residual risk) based on engineering analysis

Seismic Retrofit Projects – Overview

Activity: Structural and/or non-structural retrofits to an existing building or group of buildings to reduce earthquake damage and potential casualties.

Seismic Retrofit Projects – BCA Components

- **Hazard:** Seismic retrofit projects protect against earthquakes.
- **Recurrence Interval (RI):** Depends on RI(s) of earthquake events; based USGS data by location (lat/long) and modified by site soil/rock conditions.
- **Damage:** Damage to buildings, contents, service losses and potential loss of life.
- **Project Useful Life:** Typically 25-50 years (FEMA Standard value), depending on retrofit and building type.
- **Effectiveness/Residual Risk:** Moderately to highly effective against seismic events, depending on the existing structure condition and retrofit type.

Seismic Retrofit Projects – Common Errors

- Using default building vulnerability parameters without consulting a structural seismic engineer
- Over-estimating the project useful life
- Incorrect input of project location (latitude, longitude) and site soil/rock type
- Insufficient documentation of building properties (size, BRV, model building type)
- Using the maximum building occupancy rather than the average 24/7/365 occupancy

Seismic Retrofit Projects – Best Practices

- Evaluating the seismic vulnerability of an existing building and designing a seismic retrofit are **very different** from designing a new building to current building codes and require different skills and expertise.
- To support a FEMA BCA and grant application for a seismic retrofit, it is **essential** in nearly all cases to **consult with a structural engineer with substantial experience** with seismic evaluations of the existing buildings and with designing seismic retrofits to the desired performance level.

Project-Specific Overviews: Questions?

Submitting a Complete BCA Package: Documentation Requirements

Submitting a Complete BCA Package

- Along with your subapplication documents, you must include:
  - BCA Toolkit Version 6.0 (Excel format)
  - BCA Report (PDF format)
  - A zip file of all the supporting documentation

Documentation Requirements Part 1

- **BCA documentation is essential**
- This is what OES and FEMA use to evaluate the accuracy and completeness of the BCA
- All data entries should be backed up with records or citations like web sites, etc.
- Backup can include letters, FEMA Project Worksheet (PWs), photographs, estimates from experts, etc. etc. etc.

Documentation Requirements Part 2

- **For all projects:**
  - Use data from ***credible and reliable*** sources (Federal, state, local agencies)
  - Provide ***complete technical support data*** – copy of hazard data (FIS, FIRM, discharge data, flood profiles) or reports from other agencies (USFS, USGS)
  - Explain and ***provide justification*** for data that supersedes FIS or standard FEMA data

Documentation Requirements Part 3

- **For all projects:**
  - ***Organize the data*** via a list of attachments
  - *Cite the location of BCA relevant data* within the support data (i.e., report name, page no., etc.)
  - ***Do not assume*** that, during review, FEMA has access to the same data that the user does
- **What To Do with All this Information**
  - Keep it organized

Documentation Requirements Part 4

What To Do with All this Information

- Emphasize documentation of key elements, e.g. for DFA, frequency, damages, duration of service loss, and people served. For other methodologies more specific information like building type, soils, elevation, so on
- Relate documentation to specific data entry fields in software
- Write a technical report that explains data, data sources, assumptions, and technical approach – tie it all together
- Combine all this material in zip file included with the BCA Toolkit file and BCA report.

Flood Risk Reduction Projects – Recommended Supporting Documentation 1

- Project useful life based on FEMA Standard values
- Flood Damages
  - Building damages based on historic events or calculated based on flood depths from hydraulics and hydrology (H&H) analysis and building depth damage functions (DDFs)
  - Non-building damages and service losses based on historic events or developed by qualified design professionals or other subject matter experts

Flood Risk Reduction Projects – Recommended Supporting Documentation 2

- Flood event recurrence intervals (RIs)
  - Estimated based on known hazard event RIs or H&H analysis
  - Use unknown frequency calculator in FEMA BCA Tool if you have three or more documented events occurring in different years
- Residual risk estimated based on reduced flood damages up to design event recurrence interval

Utility and Infrastructure Protection Projects – Recommended Supporting Documentation 1

- Project useful life based on FEMA Standard values
- Utility/infrastructure damages and service losses based on historic events or developed by qualified design professionals or other subject matter experts

Utility and Infrastructure Protection Projects – Recommended Supporting Documentation 2

- Hazard event recurrence intervals (RIs)
  - Estimated based on known hazard event RIs or hazard analysis data (FIS or H&H, USGS earthquake data, ATC hazards, Landfire)
  - Use unknown frequency calculator in FEMA BCA Tool if you have three or more documented events occurring in different years
- Residual risk estimated based on reduced hazard damages and service losses up to design event RI

Seismic Retrofit Projects – Recommended Supporting Documentation

- Project useful life based on FEMA Standard values
- Earthquake hazard based on default data in the model based on location (lat/long) from an online map and soil/rock type from a geotechnical report
- Building occupancy data based on average 24/7/365 data supported by staff lists, attendance sheets and similar records.
- Building vulnerability parameters before-mitigation and after-mitigation established by a structural engineering report or a structural engineer with extensive seismic retrofit experience.

Project Case Studies: Flood Risk Reduction, Utility and Infrastructure Protection, Seismic Retrofit

Flood Risk Reduction Project Part 1

BCA Toolkit v 6.0 (Location: Malibu, CA 90265)

- **Project:** Drainage improvements to protect 50-home (100 resident) subdivision along N9 near Route 1
  - Project Useful Life: 50 years
  - Cost: $850,000 ($8,500/year O&M)

Expected Damage Analysis

FLOOD DIVERSION AND STORAGE PLAN H&H STUDY
MATTEL SUBDIVISION, MALIBU, CA
Prepared
October 2019

Flood Risk Reduction Project Part 2

BCA Toolkit v 6.0 (Location: Malibu, CA 90265)

Event RI	Damages Before Mitigation		
	Structure	Contents	Displacement
10 year	$250,000	$125,000	$500,000
50 year	$400,000	$200,000	$800,000
100 year	$500,000	$250,000	$1,000,000

Flood Risk Reduction Project Part 3

BCA Toolkit v 6.0 (Location: Malibu, CA 90265)

Event RI	Damages After Mitigation		
	Structure	Contents	Displacement
10 year	$0	$0	$0
50 year	$200,000	$100,000	$400,000
100 year	$500,000	$250,000	$1,000,000

Flood Risk Reduction Project Part 4

Project Configuration, Cost Estimation

Project Configuration

Project Title	Drainage Project Case Study	
Property Location	Malibu, CA, USA	Use Property Location? Yes
	OR	
	Latitude: 34.03652 / Longitude: -118.68796	Use Decimal Degrees? Yes
	90265 / California / Los Angeles	
Property Structure Type	Residential Building	
Hazard Type	Coastal Unknown Flood	
Mitigation Action Type	Drainage Improvement	
Property Title	Drainage Improvement @ Malibu, CA, USA	
Damage and Frequency Relationship based on:	○ Modeled Damages ○ Historical Damages ◉ Professional Expected Damages	

Cost Estimation

Enter the Project Useful Life (years):	50	
Enter the Initial Project Costs ($):	850,000	
Enter the Number of Maintenance Years:	50	Use Default? Yes
Enter the Annual Maintenance Costs ($):	8,500	
Total Mitigation Project Cost ($)	967,306	

Flood Risk Reduction Project Part 5

Damage Analysis Parameters – DFA, Professional Expected Damages Before Mitigation

Damage Analysis Parameters - Damage Frequency Assessment

Year of Analysis Conducted:	2019	
Year Property was Built:	0	
Analysis Duration (years):	10	Use Default? Yes

Professional Expected Damages Before Mitigation

Damages Before Mitigation

Add Row | Delete Row(s)

SELECT	RECURRENCE INTERVAL (YEARS)	OTHER DAMAGES ($)	OPTIONAL DAMAGES Structure ($)	OPTIONAL DAMAGES Contents ($)	OPTIONAL DAMAGES Displacement ($)	VOLUNTEER COSTS NUMBER OF VOLUNTEERS	VOLUNTEER COSTS NUMBER OF DAYS	TOTAL DAMAGES ($)
☐	10	0	250,000	125,000	500,000	0	0	875,000
☐	50	0	400,000	200,000	800,000	0	0	1,400,000
☐	100	0	500,000	250,000	1,000,000	0	0	1,750,000

View Annualized Results

Flood Risk Reduction Project Part 6

Professional Expected Damages After Mitigation, Additional Benefits - Social

Professional Expected Damages After Mitigation

Damages After Mitigation

+ Add Row Delete Row(s)

SELECT	RECURRENCE INTERVAL (YEARS)	OTHER DAMAGES ($)	OPTIONAL DAMAGES Structure ($)	OPTIONAL DAMAGES Contents ($)	OPTIONAL DAMAGES Displacement ($)	VOLUNTEER COSTS NUMBER OF VOLUNTEERS	VOLUNTEER COSTS NUMBER OF DAYS	TOTAL DAMAGES ($)
☐	10	0	0	0	0	0	0	0
☐	50	0	200,000	100,000	400,000	0	0	700,000
☐	100	0	500,000	250,000	1,000,000	0	0	1,750,000

View Annualized Results

Additional Benefits - Social

Note: Available only if Residential and Benefit Cost Ratio is greater than or equal to 0.75

What is the Number of Residents?	100
How many of the 100 Resident(s) work?	50
Expected Annual Social Benefits ($):	681,100

Flood Risk Reduction Project Part 7

Benefit-Cost Summary

Benefit-Cost Summary	
Total Standard Mitigation Benefits ($):	$ 1,285,236
Total Additional Benefits - Social ($):	$ 681,100
Total Mitigation Project Benefits ($):	$ 1,966,336
Total Mitigation Project Cost ($):	$ 967,306
Benefit Cost Ratio - Standard:	1.33
Benefit Cost Ratio - Standard + Additional:	2.03

Utility Infrastructure Protection Project Part 1

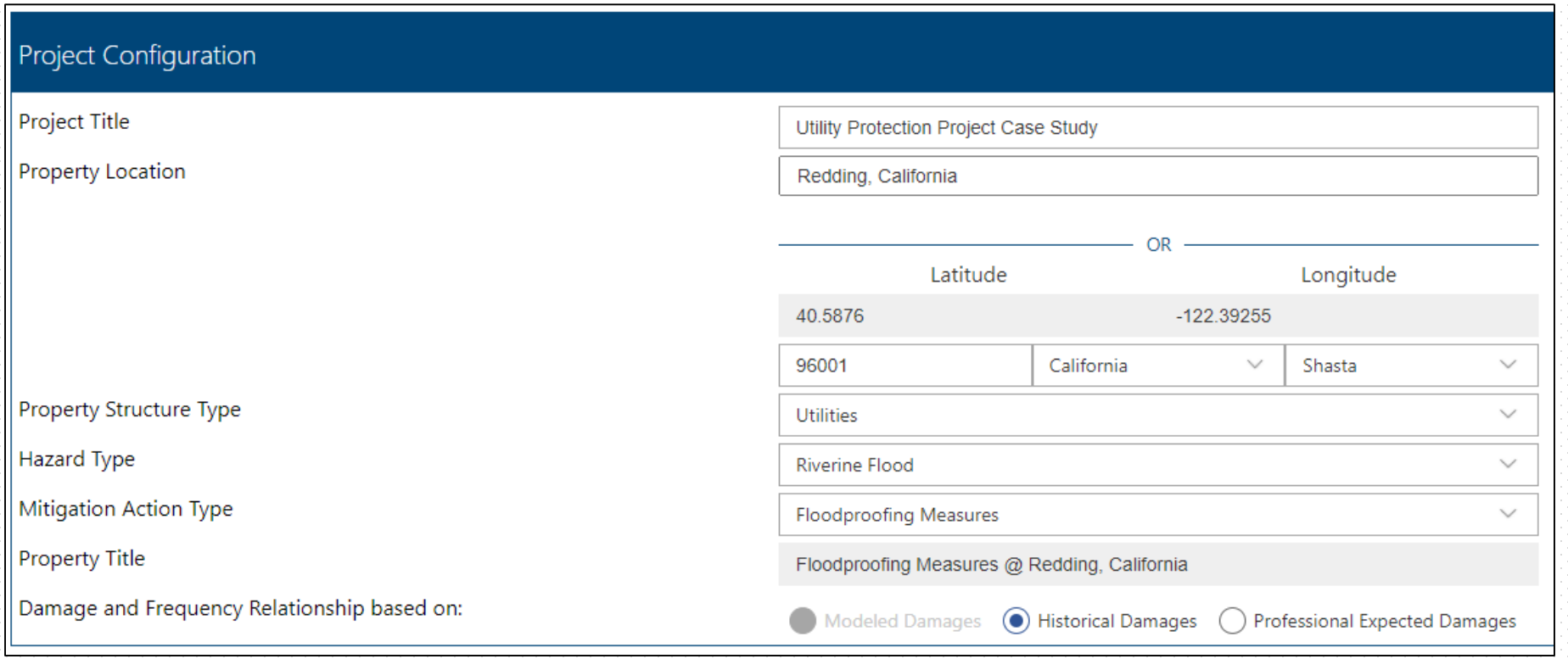
BCA Toolkit v 6.0 (Location: Redding, CA 96001)

- **Project:** Floodwall to protect city wastewater treatment plant from a 100-year (base) flood event
  - Cost: $4,000,000 ($200,000/year O&M)
  - Project Useful Life: 50 years
- **Treatment Plant:**
  - Year Built: 1975
  - Population Served: 90,000
- **Flood Damage History:**

Damage Year	Service Loss	Damage
2000	1 Day	$100,000
2017	3 Days	$300,000
2020	2 Days	$200,000

Utility Infrastructure Protection Project Part 2

Project Configuration



Utility Infrastructure Protection Project Part 3

Cost Estimation

Cost Estimation	
Enter the Project Useful Life (years):	50
Enter the Initial Project Costs ($):	4,000,000
Enter the Number of Maintenance Years:	50
Enter the Annual Maintenance Costs ($):	200,000
Total Mitigation Project Cost ($)	6,760,149

Utility Infrastructure Protection Project Part 4

Damage Analysis Parameters, Utilities Properties

Damage Analysis Parameters - Damage Frequency Assessment

Year of Analysis Conducted:	2020
Year Property was Built:	1975
Analysis Duration (years):	46

Utilities Properties

Type of Service	Wastewater
Number of Customers Served:	90,000
Value of Unit of Service ($/person/day):	58
Total Value of Service Per Day ($/day)	5,220,000

Utility Infrastructure Protection Project Part 5

Historical Damages Before Mitigation

Historical Damages Before Mitigation

Damages Before Mitigation

Add Row | Delete Row(s)

			WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL		
SELECT	DAMAGE YEAR	RECURRENCE INTERVAL (YEARS)	IMPACT (DAYS)	Category 1 ($)	Category 2 ($)	Category 3 ($)	NUMBER OF VOLUNTEERS	NUMBER OF DAYS	DAMAGES ($)	CURRENT DOLLARS?	INFLATED DAMAGES ($)
☐	2000	0	1	100,000	0	0	0	0	5,320,000	No	5,400,359
☐	2017	0	3	300,000	0	0	0	0	15,960,000	No	15,980,584
☐	2020	0	2	200,000	0	0	0	0	10,640,000	No	10,640,000

View Annualized Results

Annualized Results: Before Mitigation

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
15.70	5,400,359	160,254
23.5	10,640,000	277,440
47	15,980,584	340,011
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	32,020,943	777,705

Utility Infrastructure Protection Project Part 6

Expected Damages After Mitigation

Expected Damages After Mitigation

Damages After Mitigation

Add Row | Delete Row(s)

		WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
SELECT	RECURRENCE INTERVAL (YEARS)	IMPACT (DAYS)	Category 1 ($)	Category 2 ($)	Category 3 ($)	NUMBER OF VOLUNTEERS	NUMBER OF DAYS	DAMAGES ($)
☐	100	3	300,000	0	0	0	0	15,960,000

View Annualized Results

Annualized Results: After Mitigation

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
100	15,960,000	159,598
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	15,960,000	159,598

Utility Infrastructure Protection Project Part 7

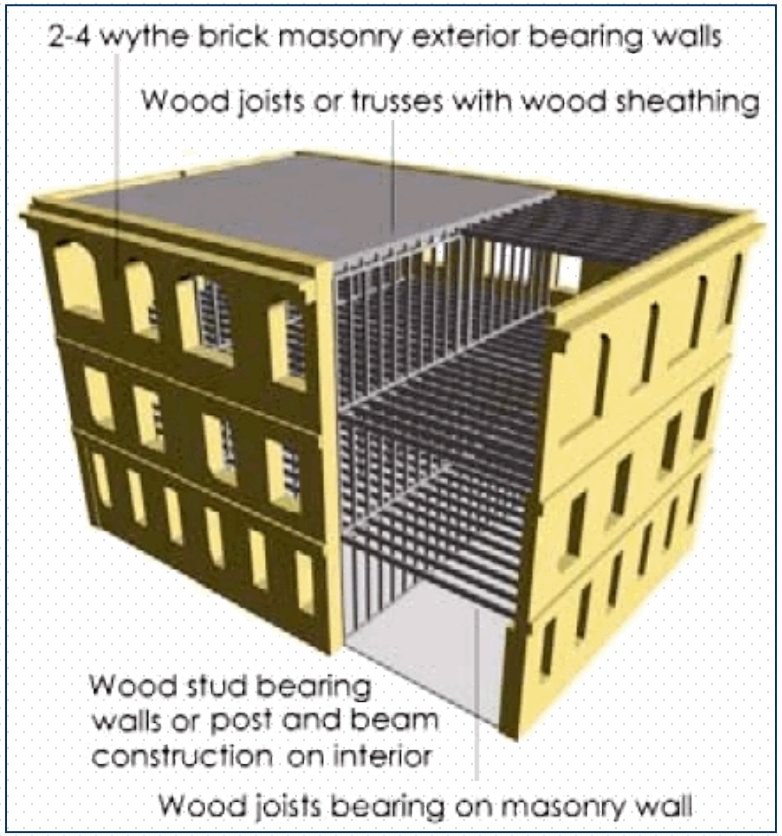
Benefit-Cost Summary

Benefit-Cost Summary	
Total Standard Mitigation Benefits ($):	$ 8,530,338
Total Mitigation Project Benefits ($):	$ 8,530,338
Total Mitigation Project Cost ($):	$ 6,760,149
Benefit Cost Ratio - Standard:	1.26
Benefit Cost Ratio - Standard + Additional:	1.26

Seismic Structural Retrofit Project Part 1

BCA Toolkit v 6.0 (Location: Beverly Hills, CA 90210)

- **Project:** Retrofit historic unreinforced masonry (URM) building as modern concrete shear wall structure (C2)
  - Project Useful Life: 50 years
  - Cost: $3,000,000 ($0 O&M)

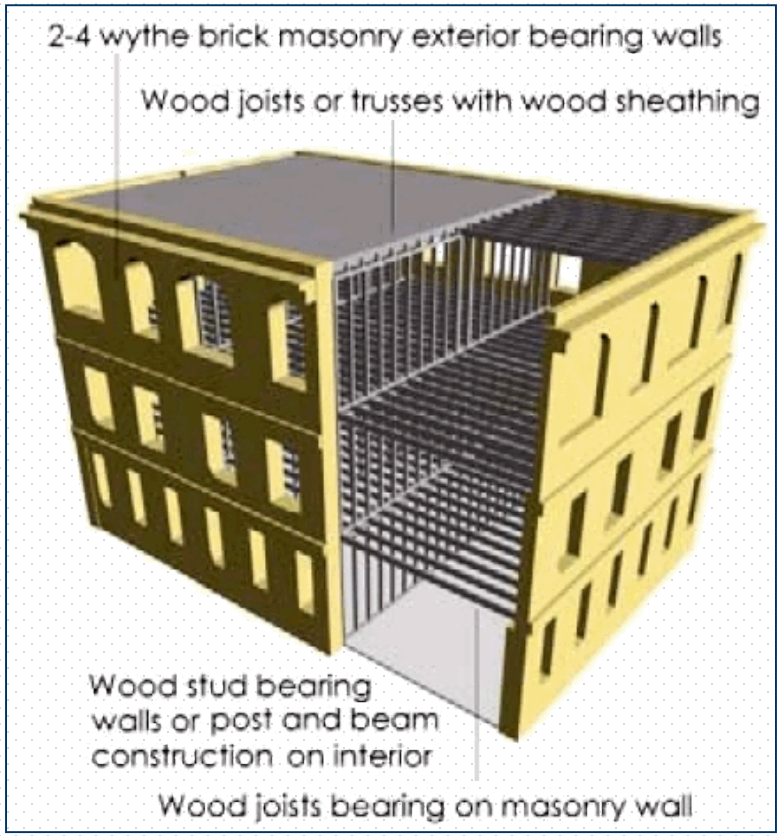


- School annual operating budget: $5,000,000

Seismic Structural Retrofit Project Part 2

BCA Toolkit v 6.0 (Location: Beverly Hills, CA 90210)

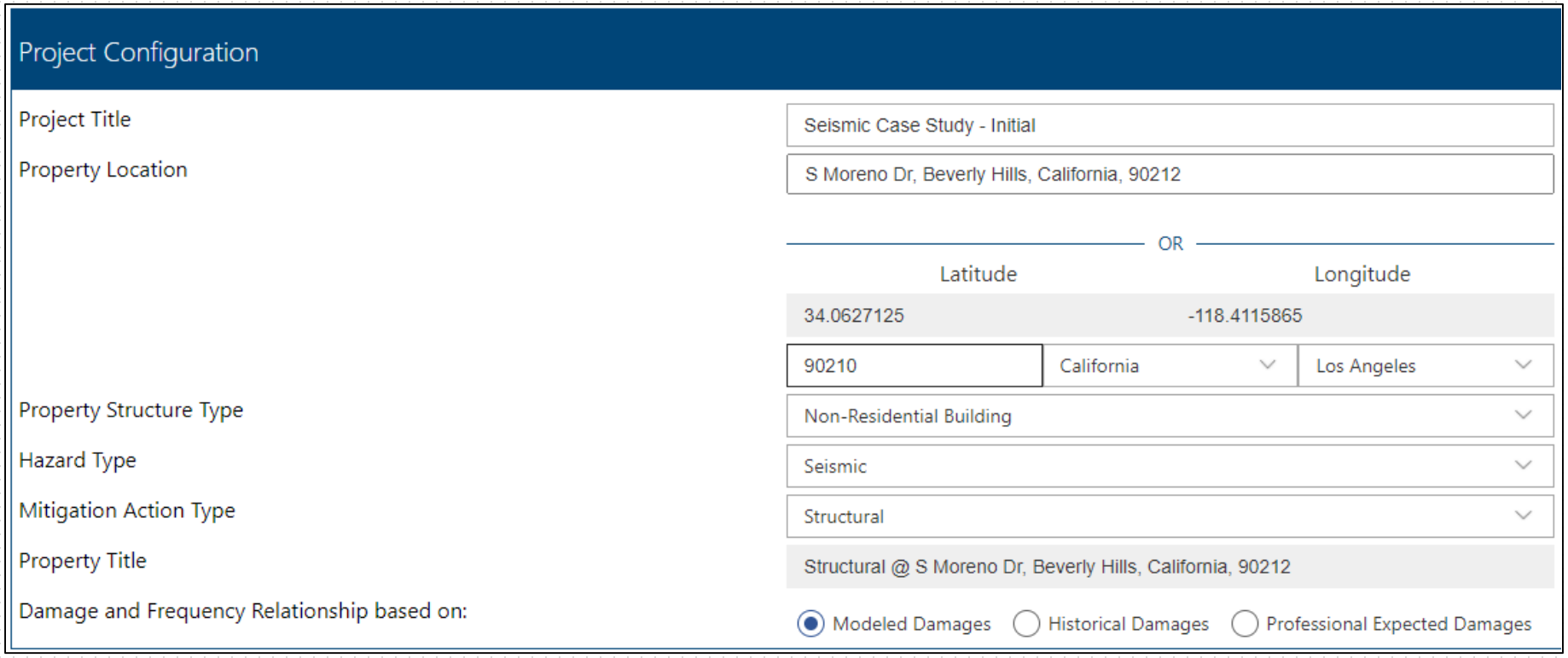
- **Existing Structure:** High school (EDU1)
  - Size: 50,000 SF
  - Building Value: $22,500,000
  - Average Occupancy: 100
  - 3 stories, 36 feet high
  - Pre-Code Design Level



- School annual operating budget: $5,000,000

Seismic Structural Retrofit Project Part 3

Project Configuration



Seismic Structural Retrofit Project Part 4

Cost Estimation, Seismic Hazard Data

Cost Estimation

Enter the Project Useful Life (years):	50
Enter the Initial Project Costs ($):	3,000,000
Enter the Number of Maintenance Years:	50
Enter the Annual Maintenance Costs ($):	0
Total Mitigation Project Cost ($)	3,000,000

Hazard Properties - Seismic

Latitude:	34.0627125
Longitude:	-118.4115865

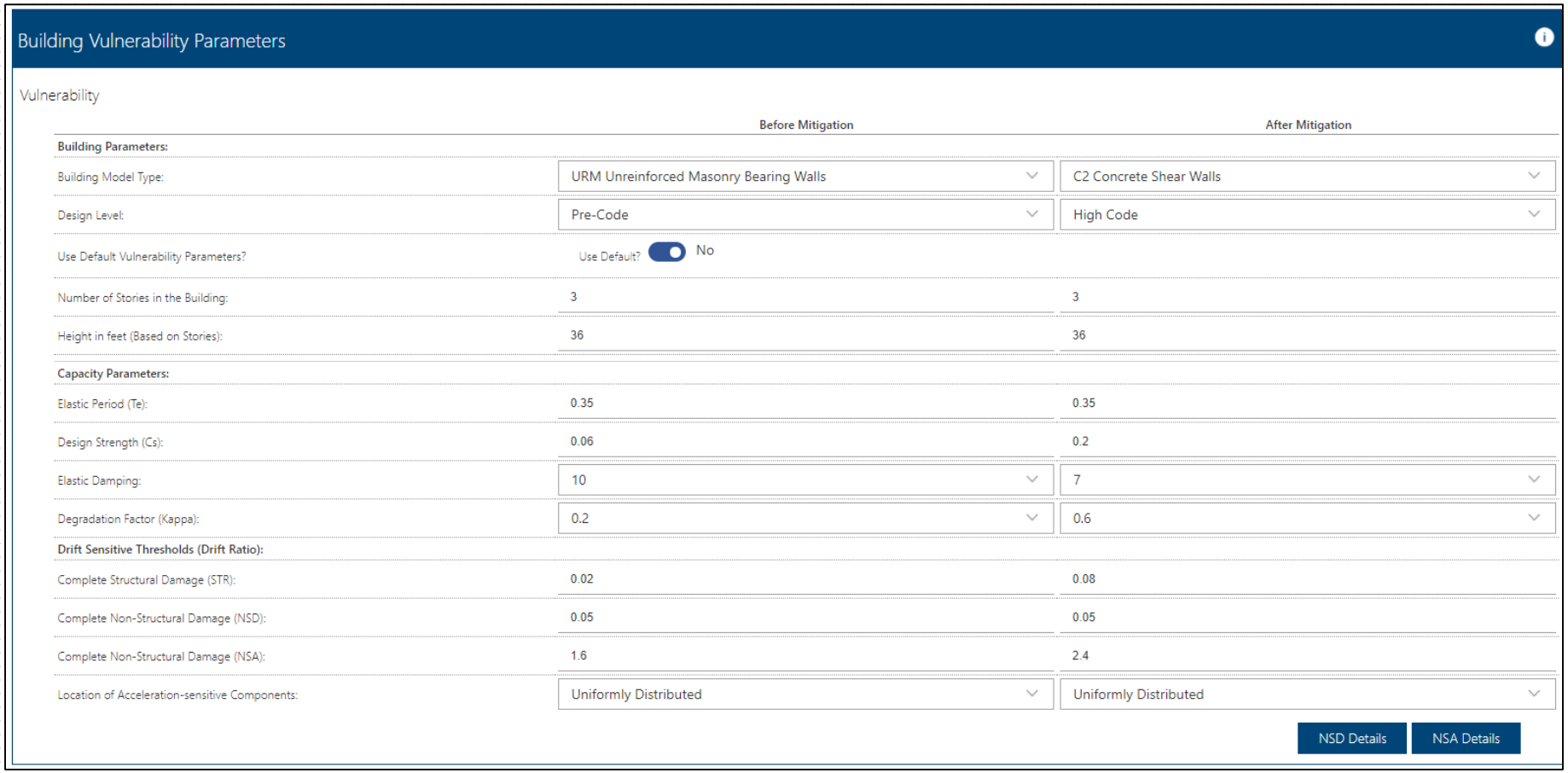
*If this location information is incorrect or blank, please return to the Project Configuration Screen to update or enter the Lat/Lon information for the structure. Lat/Lon is required for earthquake analysis

Parameter	Year 10	Year 20	Year 35	Year 50	Year 72	Year 200	Year 475	Year 975	Year 1500	Year 2475
PGA (g)	0.030	0.057	0.089	0.117	0.151	0.285	0.448	0.622	0.744	0.894
SA03 (g)	0.054	0.102	0.160	0.209	0.272	0.521	0.838	1.178	1.427	1.727
SA10 (g)	0.018	0.033	0.051	0.068	0.089	0.177	0.294	0.423	0.518	0.639

Select the Soil Type: D - Stiff soil

Seismic Structural Retrofit Project Part 5

Building Vulnerability Parameters – Initial (Default)



Building Vulnerability Parameters

Vulnerability

	Before Mitigation	After Mitigation
Building Parameters:		
Building Model Type:	URM Unreinforced Masonry Bearing Walls	C2 Concrete Shear Walls
Design Level:	Pre-Code	High Code
Use Default Vulnerability Parameters?	Use Default? No	
Number of Stories in the Building:	3	3
Height in feet (Based on Stories):	36	36
Capacity Parameters:		
Elastic Period (Te):	0.35	0.35
Design Strength (Cs):	0.06	0.2
Elastic Damping:	10	7
Degradation Factor (Kappa):	0.2	0.6
Drift Sensitive Thresholds (Drift Ratio):		
Complete Structural Damage (STR):	0.02	0.08
Complete Non-Structural Damage (NSD):	0.05	0.05
Complete Non-Structural Damage (NSA):	1.6	2.4
Location of Acceleration-sensitive Components:	Uniformly Distributed	Uniformly Distributed

NSD Details NSA Details

Seismic Structural Retrofit Project Part 6

Standard Building Benefits - Initial

Standard Benefits - Building

Select Building Use:	EDU1: Education - Schools/Libraries	
Enter the Total Building Area (sq.ft):	50,000	
Building Replacement Value ($/sq.ft):	450	Use Default? No
Total Building Value ($):	22,500,000	
Percentage of Building Replacement Value by:		
Structural Frame Sensitive to Drift (STR) (%):	18.9	Use Default? Yes
Non-Structural Frame Sensitive to Drift (NSD) (%):	48.7	Use Default? Yes
Non-Structural Frame Sensitive to Acceleration (NSA) (%):	32.4	Use Default? Yes
Expected Average Annual Losses due to Complete Structural Damage (STR) before mitigation ($):	7,654	
Expected Average Annual Losses due to Complete Structural Damage (STR) after mitigation ($):	561	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSD) before mitigation ($):	12,711	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSD) after mitigation ($):	2,270	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSA) before mitigation ($):	22,380	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSA) after mitigation ($):	10,718	
Expected Average Annual Building Benefits ($):	29,195	

Seismic Structural Retrofit Project Part 7

Life Safety, Displacement - Initial

Life Safety

Average Number of Occupants:	100
Casualty Cost Values:	
Minor Injuries for 100 Occupant(s) ($/10,000 population/year):	15,000
Major Injuries for 100 Occupant(s) ($/10,000 population/year):	1,918,000
Deaths for 100 Occupant(s) ($/10,000 population/year):	7,500,000
Expected Average Annual Losses due to Casualties before mitigation ($):	12,875
Expected Average Annual Losses due to Casualties after mitigation ($):	52
Expected Average Annual Benefits due to Casualties ($):	12,823

Standard Benefits - Displacement

Monthly Cost of Temporary Space ($/sq.ft/month):	1.02	Use Default? Yes
One-time Displacement Cost ($/sq.ft):	0.95	Use Default? Yes
Total Displacement Cost ($)	0.00	
Expected Average Annual Losses due to Relocation before mitigation ($):	2,205	
Expected Average Annual Losses due to Relocation after mitigation ($):	125	
Expected Average Annual Benefits due to Displacement ($):	2,080	

Seismic Structural Retrofit Project Part 8

Loss of Function, Initial BCA Results

Additional Benefits - Loss of Function

Critical Facility Type: Other

Other Facilities Table

Add Row | Delete Row(s)

SELECT	SERVICE NAME	ANNUAL OPERATING BUDGET ($)
☐	High School	5,000,000

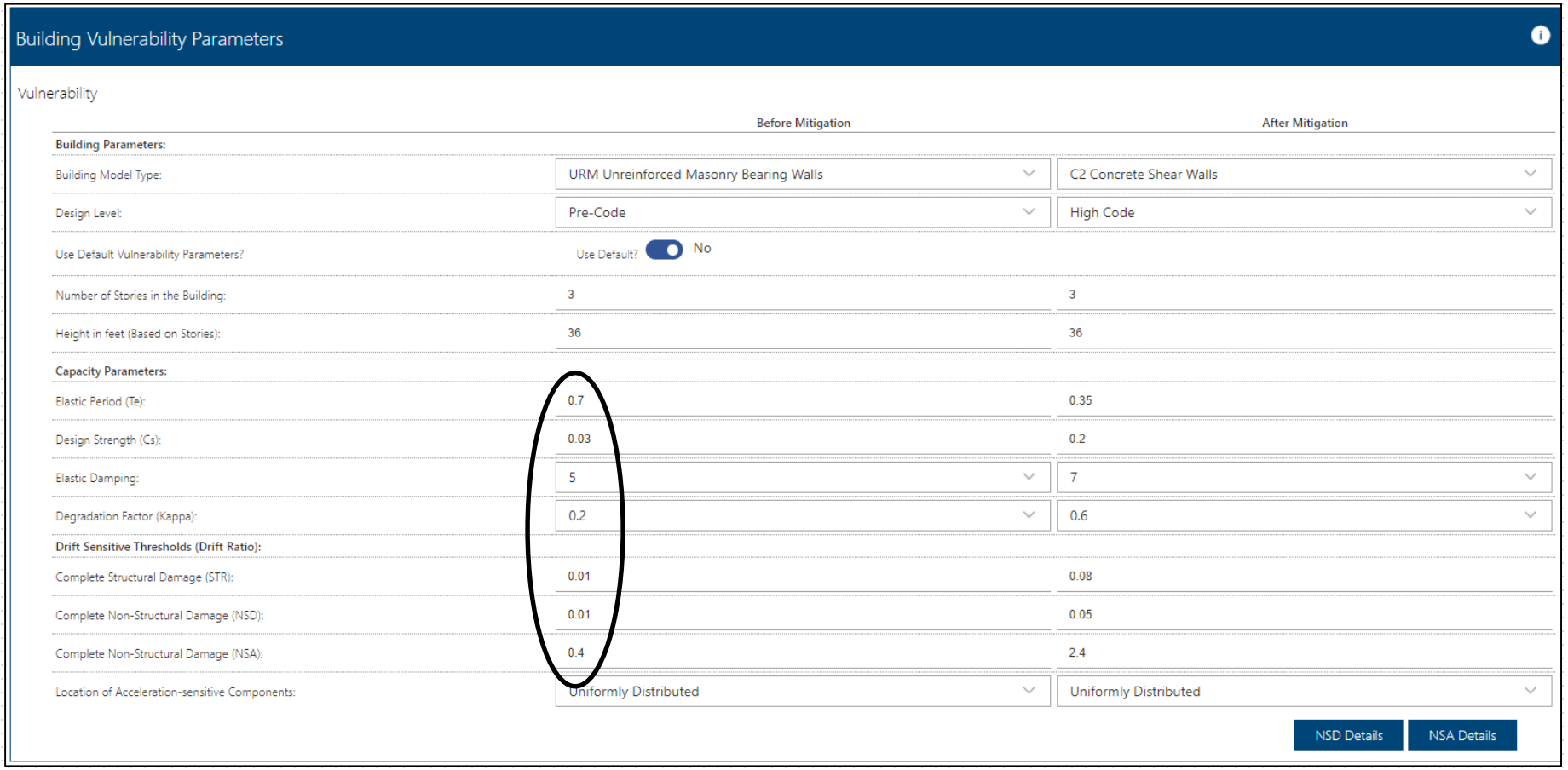
Total ($/day): 13,699

Benefit-Cost Summary

Total Average Annual Loss before mitigation ($):	57,825
Total Average Annual Loss after mitigation ($):	13,727
Total Standard Mitigation Benefits ($):	$ 797,639
Total Mitigation Project Benefits ($):	$ 797,639
Total Mitigation Project Cost ($):	$ 3,000,000
Benefit Cost Ratio - Standard:	0.27
Benefit Cost Ratio - Standard + Additional:	0.27

Seismic Structural Retrofit Project Part 9

Building Vulnerability Parameters – Updated (User-Entered)



Building Vulnerability Parameters

Vulnerability

	Before Mitigation	After Mitigation
Building Parameters:		
Building Model Type:	URM Unreinforced Masonry Bearing Walls	C2 Concrete Shear Walls
Design Level:	Pre-Code	High Code
Use Default Vulnerability Parameters?	Use Default? No	
Number of Stories in the Building:	3	3
Height in feet (Based on Stories):	36	36
Capacity Parameters:		
Elastic Period (Te):	0.7	0.35
Design Strength (Cs):	0.03	0.2
Elastic Damping:	5	7
Degradation Factor (Kappa):	0.2	0.6
Drift Sensitive Thresholds (Drift Ratio):		
Complete Structural Damage (STR):	0.01	0.08
Complete Non-Structural Damage (NSD):	0.01	0.05
Complete Non-Structural Damage (NSA):	0.4	2.4
Location of Acceleration-sensitive Components:	Uniformly Distributed	Uniformly Distributed

NSD Details NSA Details

Seismic Structural Retrofit Project Part 10

Standard Building Benefits - Updated

Standard Benefits - Building

Select Building Use:	EDU1: Education - Schools/Libraries	
Enter the Total Building Area (sq.ft):	50,000	
Building Replacement Value ($/sq.ft):	450	Use Default? No
Total Building Value ($):	22,500,000	
Percentage of Building Replacement Value by:		
Structural Frame Sensitive to Drift (STR) (%):	18.9	Use Default? Yes
Non-Structural Frame Sensitive to Drift (NSD) (%):	48.7	Use Default? Yes
Non-Structural Frame Sensitive to Acceleration (NSA) (%):	32.4	Use Default? Yes
Expected Average Annual Losses due to Complete Structural Damage (STR) before mitigation ($):	91,282	
Expected Average Annual Losses due to Complete Structural Damage (STR) after mitigation ($):	561	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSD) before mitigation ($):	259,083	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSD) after mitigation ($):	2,270	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSA) before mitigation ($):	179,930	
Expected Average Annual Losses due to Complete Nonstructural Damage (NSA) after mitigation ($):	10,718	
Expected Average Annual Building Benefits ($):	516,745	

Seismic Structural Retrofit Project Part 11

Life Safety, Displacement - Updated

Life Safety

Average Number of Occupants:	100
Casualty Cost Values:	
Minor Injuries for 100 Occupant(s) ($/10,000 population/year):	15,000
Major Injuries for 100 Occupant(s) ($/10,000 population/year):	1,918,000
Deaths for 100 Occupant(s) ($/10,000 population/year):	7,500,000
Expected Average Annual Losses due to Casualties before mitigation ($):	232,502
Expected Average Annual Losses due to Casualties after mitigation ($):	52
Expected Average Annual Benefits due to Casualties ($):	232,450

Standard Benefits - Displacement

Monthly Cost of Temporary Space ($/sq.ft/month):	1.02	Use Default? Yes
One-time Displacement Cost ($/sq.ft):	0.95	Use Default? Yes
Total Displacement Cost ($)	0.00	
Expected Average Annual Losses due to Relocation before mitigation ($):	24,774	
Expected Average Annual Losses due to Relocation after mitigation ($):	125	
Expected Average Annual Benefits due to Displacement ($):	24,648	

Seismic Structural Retrofit Project Part 12

Loss of Function, Updated BCA Results

Additional Benefits - Loss of Function

Critical Facility Type: Other

Other Facilities Table

Add Row | Delete Row(s)

SELECT	SERVICE NAME	ANNUAL OPERATING BUDGET ($)
☐	High School	5,000,000

Total ($/day) 13,699

Benefit-Cost Summary

Total Average Annual Loss before mitigation ($):	787,570
Total Average Annual Loss after mitigation ($):	13,727
Total Standard Mitigation Benefits ($):	$ 10,868,666
Total Mitigation Project Benefits ($):	$ 10,868,666
Total Mitigation Project Cost ($):	$ 3,000,000
Benefit Cost Ratio - Standard:	3.62
Benefit Cost Ratio - Standard + Additional:	3.62

BCA Resources

BCA Resources Part 1

- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- BCA Toolkit Version 6.0 & User Guide
- BCA Reference Guide
- Cal OES BCA Project-Specific BCA Guidance
- HMA Job Aids
- FEMA BCA Helpline
  - FEMA BCA Helpline Email, bchelpline@fema.dhs.gov
  - Phone: 1-855-540-6744

BCA Resources Part 2: Questions?

Thank you!

Send all questions to the Hazard Mitigation Grant Program email inbox at:
HMA@caloes.ca.gov