# [Insert project title here]

**BCA Technical Narrative**

The benefit-cost analysis (BCA) narrative should include each section consistent with the benefit-cost analysis (BCA) toolkit. The narrative should provide additional information and describe each line item in detail and explain how the values/data were estimated.

**ALL ITEMS BELOW** need to include how the values were determined or calculated. For example, include the project useful life (PUL) and number of people impacted, and how these two values were determined. Historical data, professional estimates, vulnerability assessments, H+H studies, maps, etc. should be captured below when used to establish the estimated values.

Please remove these instructions and any other information not related to the project (other hazards). If you have a previous BCA technical narrative format, that can be used in substitution of this template. If applying the alternative cost-effectiveness methodology, ensure that a second narrative is included and labeled “alternative cost-effectiveness methodology narrative.” That additional narrative must address at least one of the mitigation activities on page 2 of the FEMA memo.

### Project Configuration

The details in this section should be included in every technical narrative, independent of the hazard or mitigation action type. Please reference specific cost estimates or separate submitted documents as necessary.

**Introduction**

Explain the FEMA module used here – Version 6.0. Explain the approach of creating a separate mitigation action for each zip code, aggregated into a single analysis, and any additional mitigation actions for projects with multiple zip codes.

**Mitigation Action Type**

State all mitigation measures proposed.

**Project Useful Life**

State the value in years and the FEMA default value if used. If the default or non-default value was used, reference the appropriate supporting documentation or reasoning on how this value was used.

**Scope of Work**

Provide one paragraph summary explaining the mitigation action.

**Project Cost**

State the project cost and refer to the budget spreadsheet.

**Annual Maintenance Cost**

State the maintenance cost and how the maintenance was estimated.

### Project and Hazard Specific Analysis

This section will vary depending on the hazard, mitigation action, and damage and frequency type chosen within the project configuration section. The sections below highlight the different values and documentation that should be explained and referenced within this technical narrative. These items should correspond with the values inputted/changed in the BCA toolkit. Any values that are used in place of default values should be explained and supported within this narrative.

There are two types of benefits that may display on the toolkit, depending on hazard, property type, and mitigation action selected during project configuration. All supporting documentation should be referenced in this narrative.

* **Environmental Benefits**: The total area mitigated, and land use type should be supported with maps and studies. The toolkit will automatically calculate the benefits with these inputted values.
* **Social Benefits**: The number of residences impacted, and number of workers impacted (as loss of service) should be supported with maps, letters from utility companies, and US Census Bureau information. The toolkit will automatically calculate the benefits with these inputted values.

**Damage-Frequency Assessment (DFA) Module**

***This module is used (i) when there is not enough data for flood projects to use the flood module (modeled damages), (ii) when the mitigation action is for a non-building, and(iii) when project benefits come from mitigating loss of function to critical facilities. This module is used for landslide (soil stabilization) projects, generator projects, utilities/roads, and bridges projects. This module can be used with either historical damages or professional expected damages.***

* **Damage Analysis Parameters:** These parameters include year of analysis conducted, year property was built, and analysis duration. The Analysis Duration is auto calculated as the difference between the Year of Analysis Conducted and the Year Property was Built inputs. Users can override the Analysis Duration for instances where the risk to the asset being mitigated has significantly changed. Supporting documentation that can be submitted and referenced here to show a change in local flow conditions can include FIS, CLOMR or LOMR, H & H studies, letter from official on letterhead, or photographs.
* **Historical Damages Before Mitigation**: There are three values needed: damage year (the year the historic event occurred), the recurrence interval, and days of impact. Explain and provide the supporting documentation used to determine the three recurrence intervals (RIs). At a minimum, a single RI is required. If at least three unknown-frequency events are provided, there is a built-in Unknown Frequency Calculator feature that calculates an RI from the unknown-frequency events using the Analysis Duration. The supporting documentation and methodology for determining an RI and the supporting values can include historic storm data from NOAA and USGs, insurance claims and damage repair records citing credible sources (not anecdotal evidence), damage amounts from FEMA worksheets, timesheets, and repair invoices.
* **Expected Damages After Mitigation**: The documentation required will vary based on the hazard, the mitigation measure, and the level of protection by the measure. Regardless of the hazard or project type, documentation should include the data, source of the data (with signature and/or certification stamp if relevant), date the data were determined or provided, the after-mitigation level of protection of the project, and the amount of damage or losses for each recurrence interval. Data may be obtained from agencies, communities, engineers or architects, publications, manufacturers, vendors, or other reliable sources.
* **Professional Expected Damages Before/After Mitigation:** This input table functions the same as the Historical Damages Before Mitigation, except that the measurement of damage is based on a user-provided recurrence interval instead of the year(s) that historic damages occurred. The Professional Expected Damages After Mitigation section examines the same risk as the before mitigation analysis, except assuming the project is complete.

**Drought Module**

***This module is only used for aquifer storage and recovery (ASR). ASR projects plan to capture water when there is abundant supply, store water in brackish subsurface aquifers, and recover water from storage if there is a need. The narrative must address all potential impacts to hydrologic and environmental resources and provide necessary proof of compliance with environmental requirements. Data needed can include site-specific conditions, source water quality and quantity, and potential for any contamination.***

* **Recurrence Interval**: Explain and provide the supporting documentation used to determine the three recurrence intervals (RIs). At a minimum, a single RI is required. The supporting documentation and methodology for determining an RI must be deemed appropriate by a licensed professional engineer or similarly qualified professional.
* **Water Demand**: State the amount of water of the system in million gallons per day (MGD) being mitigated under normal, non-drought conditions. The explanation provided should reference a letter from the water utility company.
* **Supply yield**: State the estimated average supply before and after the mitigation project. The explanation provided should reference a letter from the water utility company
* **Duration of impact**: State the number of days the water system is affected or experiencing abnormal conditions (before and after the mitigation project). The explanation of how the value was derived should be explained in detail by a project engineer.
* **Population**: State the number of people impacted by the event and benefitting from the project. The population value can be calculated by the number of utility connections and US Census information on average household size in impacted area. Source letter or data from a utility company, the project SOW, GIS data, and/or US Census Bureau data should be provided and referenced. A map of the project benefitting area/population should also be provided and referenced here.

**Wildfire Module**

***This module is used for three types of eligible wildfire mitigation project activities: defensible space, hazardous fuels reduction, and ignition-resistant construction. A wildfire project can include more than one of these eligible project types; ignition-resistant construction must be combined with one of the other two project types. Eligible FEMA wildfire mitigation projects must be in a WUI, and must be adjacent to, or intermingled with the built environment.***

* **Average Burn Recurrence Interval for Zip Code:** The toolkit will automatically calculate a BRI based on the zip code provided in the project configuration, based on LANDFIRE data. If the default value is overridden, documentation should be submitted and referenced to support the value, such as LANDFIRE maps, local fire hazard data, academic studies, or a letter from local fire management authority.
* **Project Effectiveness**: This value is determined by the software and cannot be overridden. The default value for a single mitigation action is 10%; a combined mitigation action, which will always be the case for ignition-resistant construction, is 20%.
* **Number of Buildings protected**: This value should be stated and supported by municipal maps, local tax assessor/city planner office, aerial photographs, GIS maps, etc. The appropriate supporting documentation should be referenced in the narrative. There is a 2-mile radius limit to where the mitigation action is occurring.
* **Building Replacement Value**: This value should be provided for all structure types within the mitigation action (there is a 2-mile radius limit). The supporting documentation should be submitted and referenced here. Documentation should be provided for the square footage of each structure (tax assessor records, appraisals, etc.) and the average cost per square foot for the type of structure (building officials, national construction cost estimate guides, contractors, consulting firms). The default value is $100, if there is no data available.
* **Value of Building Contents ($)**: The default value is 50% of the BRV. If the default value is overridden, supporting documentation such as insurance records, appraisals, and purchase receipts should be submitted and referenced in this narrative.
* **Value of Infrastructure vulnerable to fire in project area ($)**: This value should be supported and have references to notes from engineers on how the value was determined, letter from utility companies, etc.
* **Value of timber to be sold within proposed project area ($)**: The value of potential lumber in the area should be supported by letters or documentation from the US Forest Service, forester representative, property owner, etc. A methodology to the value’s determination by an engineer should be referenced.
* **Fire suppression costs within project area ($)**: This value must be supported by a signed letter by the local jurisdiction.
* **Other costs:** All other costs (displacement, volunteer costs, etc.) should be supported by letters from the local jurisdiction, documentation from similar recent disasters, and documentation from utility companies.

**Flood Module (Riverine and Coastal)**

***This module calculates a flood depth, which is calculated based on the elevations for the 10-, 50, 100-, and 500-year events and subtracts the Lowest Floor Elevation (LFE) of the structure The Coastal A and Coastal V modules differ from the Flood Module as follows: (i) coastal flooding requires stillwater elevations while the riverine flooding requires flood elevations and discharges; (ii) sea level rise impacts can only be considered for coastal flooding; and (iii) coastal flooding may use a different set of depth-damage functions (DDFs) that factor in the damage of waves on top of the stillwater elevations***

* **Lowest Floor Elevation (ft):** The LFE is the elevation of the top of the lowest finished floor of the structure being studied or the bottom of the lowest horizontal structural member for V Zone (coastal) construction. Sources of LFE supporting documentation should include FEMA elevation certificates, signed, sealed, and dated structure elevation surveys, building permits, or other documentation where the LFE is certified by a State-licensed professional surveyor or State-registered professional engineer.
* **Ground surface elevation (ft) (coastal flooding):** By subtracting the Ground Surface Elevation value from the Lowest Floor Elevation input, the height of the building above the ground can be calculated. This height may be important for selecting the Damage Curve, but also determines whether the wave height will cause damage. Note: Ensure that the LFE and Ground Surface Elevations are in the same elevation datum. Potential sources of documentation are an elevation certificate, professional survey, or others. The supporting documentation and methodology must be explained and referenced in this narrative.
* **Streambed elevation (ft) (riverine flooding):** The streambed elevation is the elevation of the channel bottom of a river or stream at the location of the structure being mitigated. The streambed elevation is used in the Benefit-Cost Analysis (BCA) to compute the depth of flow in the stream. The mathematical relationship between the flood depth in the stream and the stream discharge is used for BCA computations. The most common source for determining a streambed elevation value is the Flood Insurance Study (FIS) for the community. A less common source of the streambed elevation is a hydrology and hydraulics (H&H) study or similar engineering or modeling assessment. The supporting documentation and methodology must be explained and referenced in this narrative.
* **Elevation for the top of barrier or floodproofing:** This is the elevation for the top of the floodproofing or flood barrier. Assuming there is no basement, the difference between this elevation and the Lowest Floor Elevation equals the number of feet of flood depth that damage will be reduced in the depth damage function (DDF). Refer to the project engineering design or specifications to determine the elevation for the top of the barrier or dry floodproofing.
* **Base Flood Elevation (BFE) (coastal flooding):** The best source of the Base Flood Elevation (BFE) is the Flood Insurance Rate Map (FIRM) because it includes the BFE on the map. The FIRM needs to be submitted and referenced in this narrative.
* **Additional Projected Sea Level Rise above BFE (ft) (riverine flooding):** Sea level rise (SLR) refers to “relative” sea level rise, which takes into consideration whether the ground is rising or falling in addition to the seas rising. The main requirement is that the increase in SLR must be documented and be based on reasonable assumptions. One of the easiest sources of SLR data is the United State Army Corps of Engineers (USACE) Climate Change Adaptation Sea-Level Change Curve Calculator.
* **Recurrence intervals (coastal flooding):** The stillwater elevations for the 10-, 50-, 100-, and 500-year coastal flood events (these may appear as the 10% annual chance, 2% annual chance, 1% annual chance, and 0.02% annual chance flood events in the flood data source) is another required data entry for the Flood Model. The most common source of the stillwater elevations is the Flood Insurance Study (FIS). The 10-, 50-, 100-, and 500-year stillwater elevations are the default recurrence intervals, but it is possible to use different values. The most common source for documentation of the flood elevation and discharge values after mitigation for the four flood events is a coastal flood study. For a study being completed in support of a potential mitigation project, the scope of work should include the stillwater elevation values needed for entry into the Flood Model.
* **Recurrence intervals (riverine flooding):** The flood elevation and discharge values for four flood recurrence intervals is required. The 10-, 50-, 100-, and 500-year flood events (these may appear as the 10% annual chance, 2% annual chance, 1% annual chance, and 0.02% annual chance flood events in the flood data source) are the most used recurrence intervals since they are used in a FEMA Flood Insurance Study. Some locations may have only three recurrence intervals in the Flood Insurance Study (FIS) profile for the project location. For these situations, users may enter zero values for the Water Surface Elevation and Discharge for the Recurrence Interval that is missing from the FIS data. The two most common sources of the elevation and discharge values are the Flood Insurance Study (FIS) or hydrology and hydraulics (H&H) study. The Water Surface Elevation is most often determined from the flood profiles of a Flood Insurance Study. The most common source for documentation of the flood elevation and discharge values after mitigation for the four flood events is a hydrology and hydraulics (H&H) study. For an H&H study is being completed in support of a potential mitigation project, the scope of work should include the elevation and discharge values needed for entry into the Flood Model.
* **Building type:** The Building Type selection determines the appropriate depth-damage function to use behind the scenes when calculating the amount of expected damage for different depths of flooding inside the structure. Potential sources of documentation include the property owner, local building inspector, tax assessor’s office, title documents, or others. Documentation should also include materials that reviewers can use to verify the correct Building Type value, such as scans, screen captures, or photocopies of tax records, photographs, appraisals, or letters from the property owner.
* **Damage-Depth Curve:** A depth-damage function (DDF) is used to estimate direct damage to a building based on the depth of flooding. It is measured in percent damage to the structure and its contents. The DDF is also used to estimate displacement and loss of function at various flood depths, in units of number of days. For coastal flooding, there is a range of flood zones, each with separate definitions and DDFs available to them: (i) Coastal V Zone: closest to the coast and defined as having wave heights of at least 3 feet; (ii) Coastal A: inland from the V Zone and defined as having wave heights between 1.5 and 3 feet; and (iii) A Zone: further inland from the Coastal A Zone and defined as wave heights less than 1.5 feet. This zone functions the same as a riverine Zone A designation. For projects without enough data, “USACE Generic” should be chosen.
* **First Floor Area (sq.ft):** For non-residential buildings, it is assumed that only the first floor area will have damage to the building and contents in a flood event. This input prevents the user from entering the entire square footage incorrectly for a multi-story building.
* **Building Size:** For residential buildings, the Building Size consists of the enclosed area within the building, including the entire finished and livable space. It does not include unfinished basements, porches, garages, or other outside areas. Sources for the Building Size can be tax or assessment records, appraisals, surveys, or similar resources. For non-residential buildings, the Building Size is the enclosed square footage for the entire building and is used to auto calculate the displacement costs in the Standard Benefits – Displacement section. It is assumed that the same square footage would need to be rented in a theoretical alternate location.
* **Building Replacement Value**: The supporting documentation should be submitted and referenced here. Documentation should be provided for the square footage of each structure (tax assessor records, appraisals, etc.) and the average cost per square foot for the type of structure (building officials, national construction cost estimate guides, contractors, consulting firms). The default value is $100, if there is no data available. Important note: the BRV is based on replacement value and is not the same as the current market value of the building or the assessed value. Therefore, the BRV should not be calculated as the market value of the building divided by its square footage. Acceptable documentation for the BRV includes a letter from a construction or contracting firm or local building inspector; or a photocopy of pages from a national cost estimation resource such as Marshall & Swift or RS Means. Your State Hazard Mitigation Officer may know of other cost estimation resources. If tax records are used, the source must be an assessor.
* **Value of Building Contents ($):** The default value is 0% of the BRV. If the default value is overridden, supporting documentation such as insurance records, appraisals, and purchase receipts should be submitted and referenced in this narrative.
* **Other costs:** All other costs (displacement, loss of income, volunteer costs, etc.) should be supported by letters from the local jurisdiction, documentation from similar recent disasters, and documentation from rental housing companies. Note: For residential buildings, the input is loss of rent, and loss of function or loss of income applies to critical facilities and non-residential buildings.

**Seismic (Structural) Module**

***This module applies to seismic retrofit projects for structural mitigation. Seismic hazard data is one of the most important inputs in the Earthquake Module. This varies by location and is automatically imported into the tool based on the structure’s latitude and longitude coordinates. The measure of earthquake risk that is used in the BCA Tool is “Peak Ground Acceleration,” or PGA. Like it sounds, PGA refers to the speed at which the ground moves because of the earth movement caused by a seismic event.***

* **Soil Type:** The default value is soil type D. If the default value is overridden, supporting documentation, such as geotechnical analysis or USGS reports, should be submitted and referenced in this narrative. If the Soil Type is F- Liquefiable, then the liquefaction hazard must be addressed in the proposed mitigation for the project to be eligible.
* **Building Vulnerability Parameters**: All building vulnerability parameters should be supported by seismic vulnerability assessments, drawings or records from project engineers, and studies from structural engineers. All supporting documentation should be referenced and explained in this narrative.
* **Building Use and Total Building Area**: The building area is the total enclosed area of the building expressed in square feet. Various forms of documentation to justify the building area include tax or assessment records, signed appraisals, surveys, and estimates from photographs. Either reference or provide a copy of the source of the information, such as local tax office, appraiser’s office, surveyor, title, and documents with building footprint. Building area is often listed on architectural design drawings. If it is not specifically listed, estimate building dimensions, calculate areas for each floor, and then add the floor areas to determine the total building area.
* **Percentage of building replacement value:** Default values in this section can be overridden but structure-specific data must be submitted and referenced in this narrative.
* **Average Number of Occupants:** Explain the methodology used to establish the number of employees and visitors at different times of the day and different days of the week. Building owners or managers can provide this information from sources such as employment records and attendance records.
* **Other costs:** All other costs (displacement, loss of income, volunteer costs, etc.) should be supported by letters from the local jurisdiction, documentation from similar recent disasters, and documentation from rental housing companies. Note: Users should be aware of the potential for double-counting rental income losses. Counting both the displacement costs for the renter and the full loss of rental income for the owner is double-counting and must be avoided. The simplest way to avoid potential double-counting is to not count rental income losses.

**Seismic (Non-Structural) Module**

***This module applies to seismic retrofit projects for non-structural mitigation. Seismic hazard data is one of the most important inputs in the Earthquake Module. This varies by location and is automatically imported into the tool based on the structure’s latitude and longitude coordinates. The measure of earthquake risk that is used in the BCA Tool is “Peak Ground Acceleration,” or PGA. Like it sounds, PGA refers to the speed at which the ground moves because of the earth movement caused by a seismic event.***

* **Soil Type:** The default value is soil type D. If the default value is overridden, supporting documentation, such as geotechnical analysis or USGS reports, should be submitted and referenced in this narrative. If the Soil Type is F- Liquefiable, then the liquefaction hazard must be addressed in the proposed mitigation for the project to be eligible.
* **Non-Structural Parameters**: All non-structural parameters should be supported by drawings or photographic records from project engineers, and studies from structural engineers. All supporting documentation should be referenced and explained in this narrative.
* **Building Area**: The building area is the total enclosed area of the building expressed in square feet. Various forms of documentation to justify the building area include tax or assessment records, signed appraisals, surveys, and estimates from photographs. Either reference or provide a copy of the source of the information, such as local tax office, appraiser’s office, surveyor, title, and documents with building footprint. Building area is often listed on architectural design drawings. If it is not specifically listed, estimate building dimensions, calculate areas for each floor, and then add the floor areas to determine the total building area.
* **Standard Benefits-Cost:** The values for cost per unit and number of units should be supported by documentation from a project engineer. Depending on the non-structural element chosen, different fields will open in the BCA toolkit. Provide supporting documentation (letters or analysis from project engineers, surveyors, or building owners) to support values used.
* **Occupancy data for room containing non-structural contents:** Enter the documented occupancy data for Day, Evening, and Nighttime periods for weekdays and weekend days. “Day” refers to the time period of 6am to 6pm; “Evening” refers to the period of 6pm to Midnight; and “Night” refers to Midnight to 6am. The data may be distributed based on the time periods during an average weekday and weekend day. The model will calculate an average occupancy based on all times of the day, all days of the week. The occupancy data may be derived employment records, attendance records, or other information from the building owner or manager. Provide the methodology for determining occupancy for the different time periods.
* **Estimated casualty rates per 1000 occupants – User Entered Typical Rate**: Users may override the Typical Rate with documentation from a reliable source. Care should be taken that they are expressed in injuries and fatalities per 1,000 people. Documentation must be provided and referenced in this narrative.
* **Secondary Damages:** Quantified damages must be associated with a frequency or seismic intensity level (i.e., PGA). Examples of secondary damages may be fire following an earthquake or hazardous material spills. For documentation, provide and reference in this narrative an engineering analysis from a civil or structural engineer experienced with non-structural element behavior during earthquakes.
* **Other costs:** All other costs (loss of function, volunteer costs, etc.) should be supported by letters from the local jurisdiction, documentation from similar recent disasters, and documentation from rental housing companies. Note: Users should be aware of the potential for double-counting rental income losses. Counting both the displacement costs for the renter and the full loss of rental income for the owner is double-counting and must be avoided. The simplest way to avoid potential double-counting is to not count rental income losses.

### Benefit-Cost Summary

This section provides the final values for cost and benefits, which are used to calculate the benefit cost ratio (BCR). The BCR is used to determine final cost-effectiveness.

|  |  |
| --- | --- |
| **Discount Rate** | **Value** |
| Total Standard Mitigation Benefits ($) |  |
| Total Mitigation Project Benefits ($): |  |
| Total Mitigation Project Cost ($): |  |
| Benefit Cost Ratio – Standard: |  |
| Benefit Cost Ratio – Standard + Social |  |