Unit 5

BCAs for Flood Mitigation Projects

Objectives

At the end of this unit, participants will be able to:

- Explain BCA data and documentation requirements for acquisitions, elevations, and flood control projects
- Complete a riverine flood acquisition BCA using modeled damages
- Complete a coastal elevation BCA using modeled damages
- Complete a flood control BCA using historic damages
- Estimate damages to residential structures using Depth Damage Functions (DDFs)

Scope

- Unit 5 Overview & Objectives
- Floods and flood hazard data: key concepts and terms
- Acquisitions and elevations: project basics
- Residential riverine acquisition BCA: BCA Toolkit Exercise and data input overview
- Residential coastal elevation BCA: BCA Toolkit Exercise and data input overview
- Flood control project basics
- Flood control BCA using historic damages: BCA Toolkit Exercise and data input overview
- Estimating damages to residential structures using DDFs
- Unit 5 Review

Methodology

This unit will be delivered as an in-person classroom course, and will use a combination of lecture and discussion.

The instructor will introduce the unit and then go through each slide, pausing for questions and short discussion if needed. The instructor should also prompt students to follow along in their Student Manuals.

Since this is a longer unit, the instructor is encouraged to give the class breaks as needed.

BCA Toolkit Exercise/Case Studies

When the "BCA Toolkit Exercise" slides appear in the presentation (see Figure 1 below), the instructor should open the BCA Toolkit and have the students also open the Toolkit on their computers. The instructor should then guide the students through completing data entry for the project type(s) being discussed, using the slides that follow to describe the data inputs for that project type. As you enter values into the Toolkit, make sure to point out the comment boxes and show how a user would enter a comment describing where they obtained the value and referring the reviewer to the appropriate document in their project application.

Note that once a particular data input (i.e. flood elevations) is covered in a slide it is not covered again in subsequent project type exercises.

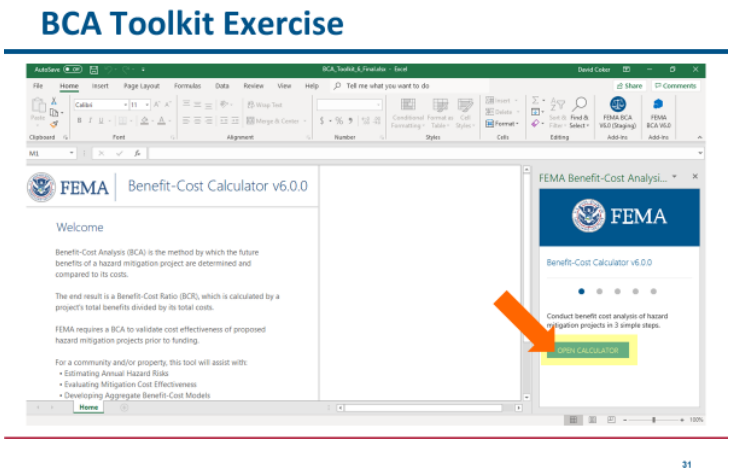


Figure 1: BCA Toolkit Exercise slide

Several case studies are provided as supplements to the training material and may be downloaded at https://www.fema.gov/benefit-cost-analysis. These case studies may be used during the BCA Toolkit exercise portions of the unit. However, instructors are encouraged to use examples from their own Regions or states if appropriate. Students are also encouraged to use projects they might be working on and have the instructors and other students offer suggestions on how to input the data in the BCA Toolkit.

Estimating Damages using DDFs

For the last portion of the unit, the instructor will show the students how to estimate damages using DDFs. The instructor should open Microsoft Excel on their computer and have the students follow along on their own computers. The presentation slides should guide this portion of the unit.

Time Plan

The instructor should advise students that this will be a long unit, but that the class will take a break(s) when needed.

A suggested time plan for each topic in this unit is shown below. More or less time may be required, based on the experience level of the group.

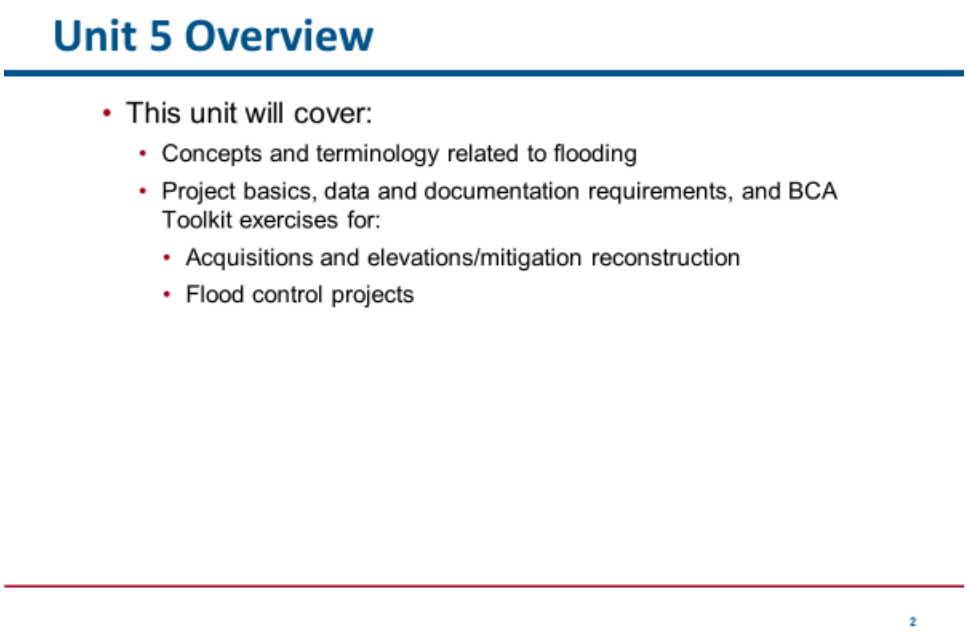
- Unit 5 Overview & Objectives (5 minutes)
- Floods and flood hazard data: key concepts and terms (30 minutes)
- Acquisitions and elevations: project basics (10 minutes)
- Residential riverine acquisition BCA: BCA Toolkit Exercise and data input overview (30 minutes)
- Residential coastal elevation BCA: BCA Toolkit Exercise and data input overview (15 minutes)
- Flood control project basics (10 minutes)
- Flood control BCA using historic damages: BCA Toolkit Exercise and data input overview (45 minutes)
- Estimating damages to residential structures using DDFs (30 minutes)
- Unit 5 Review (5 minutes)

Total Time (Estimated): 3 hours

Materials

- Unit 5 Visuals
- Unit 5 Instructor Guide
- Unit 5 Student Manual
- Computer/BCA Toolkit
- Microsoft Excel
- DDF spreadsheet (available at https://www.fema.gov/benefit-cost-analysis)

Unit 5 Overview



Visual 1: Unit 5 Overview

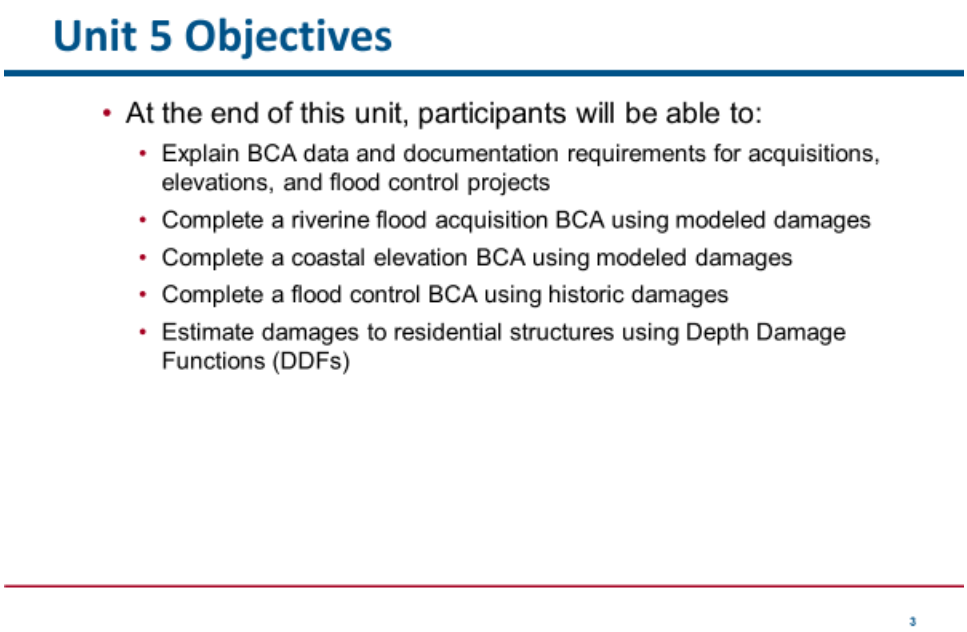
Instructor:

Welcome to Unit 5. This is a longer unit but we will take at least one break part of the way through. The reason this unit is longer is because (1) it discusses concepts/terminology related to flood hazard data, and (2) it walks students through three separate BCA examples.

This unit will cover:

- Concepts and terminology related to flooding
- Project basics, data and documentation requirements, and BCA Toolkit exercises for:
  - Acquisitions and elevations/mitigation reconstruction
  - Flood control projects

Unit 5 Objectives



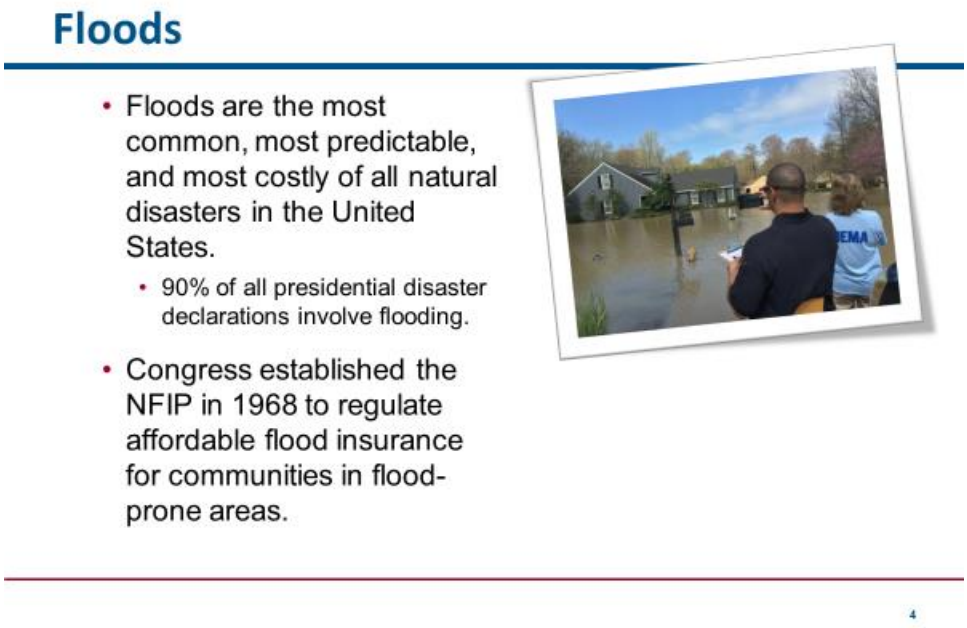
Visual 2: Unit 5 Objectives

Instructor:

Unit 5 has several objectives. At the end of this unit, students should be able to:

- Explain BCA data and documentation requirements for acquisitions, elevations, and flood control projects
- Complete a riverine flood acquisition BCA using modeled damages
- Complete a coastal elevation BCA using modeled damages
- Complete a flood control BCA using historic damages
- Estimate damages to residential structures using Depth Damage Functions (DDFs)

Floods



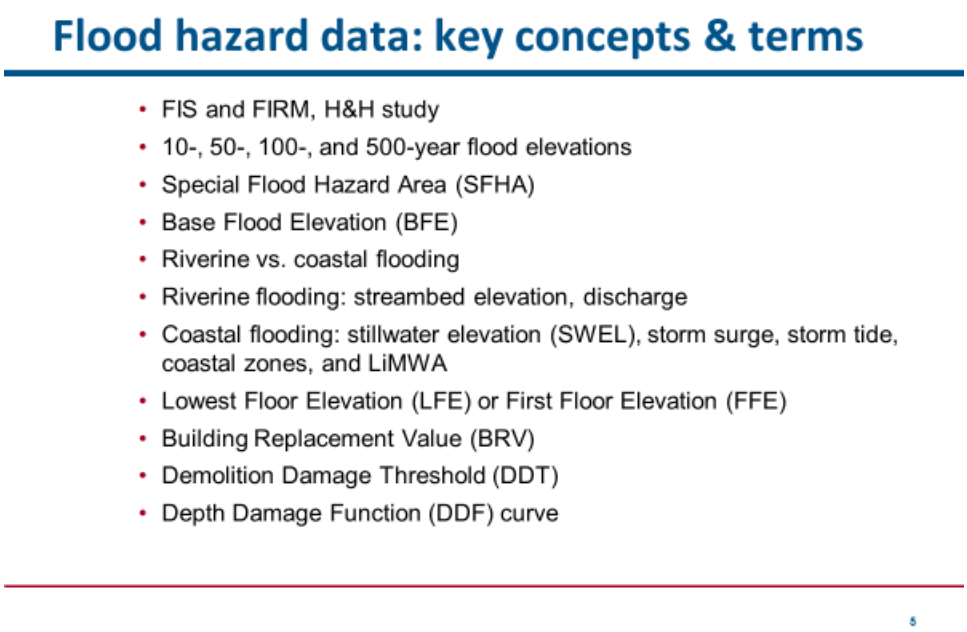
Visual 3: Floods

Instructor:
First we'll discuss some concepts and terminology related to flooding.

Floods are the most common, most predictable, and most costly of all natural disasters in the United States.

90% of all presidential disaster declarations involve flooding.

Congress established the NFIP in 1968 to regulate affordable flood insurance for communities in flood-prone areas.



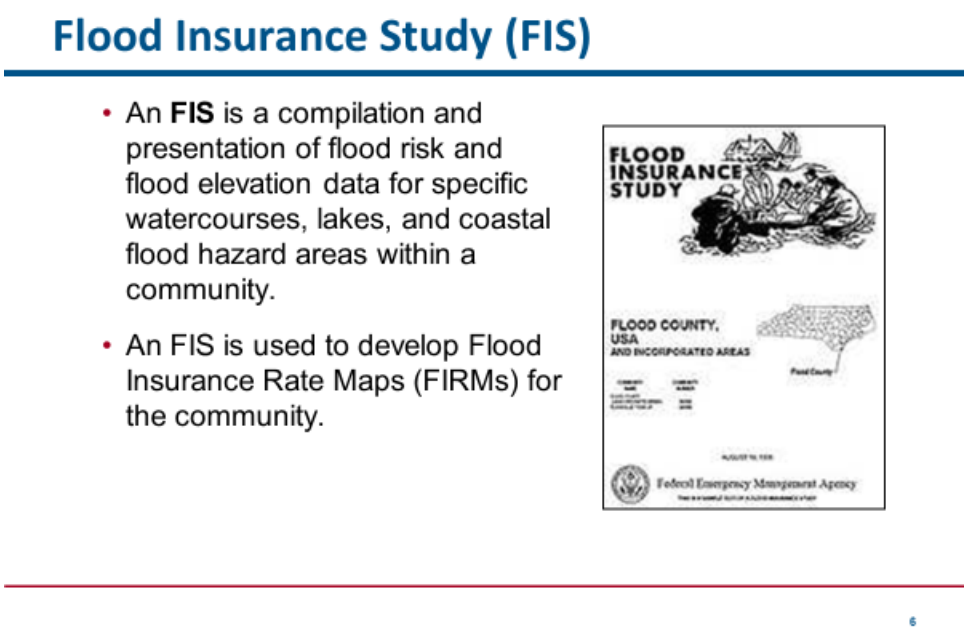
Visual 4: Flood hazard data: key concepts & terms

Instructor:
We will discuss the following:

- FIS and FIRM, H&H study
- 10-, 50-, 100-, and 500-year flood elevations
- Special Flood Hazard Area (SFHA)
- Base Flood Elevation (BFE)
- Riverine vs. coastal flooding
- Riverine flooding: streambed elevation, discharge
- Coastal flooding: stillwater elevation (SWEL), storm surge, storm tide, coastal zones, and LiMWA
- Lowest Floor Elevation (LFE) or First Floor Elevation (FFE)
- Building Replacement Value (BRV)
- Demolition Damage Threshold (DDT)
- Depth Damage Function (DDF) curve

This course is not intended to cover these concepts in detail. There are other FEMA courses that cover these concepts.

Flood Insurance Study (FIS)



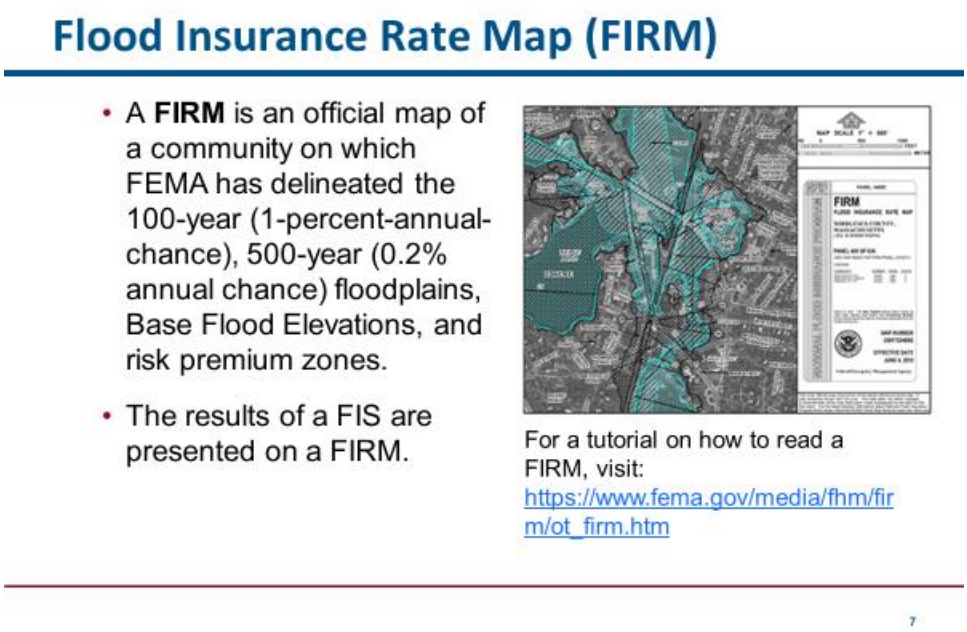
Visual 5: FIS

Instructor:

An **FIS** is a compilation and presentation of flood risk and flood elevation data for specific watercourses, lakes, and coastal flood hazard areas within a community.

An FIS is used to develop Flood Insurance Rate Maps (FIRMs) for the community.

Flood Insurance Rate Map (FIRM)



Visual 6: FIRM

Instructor:

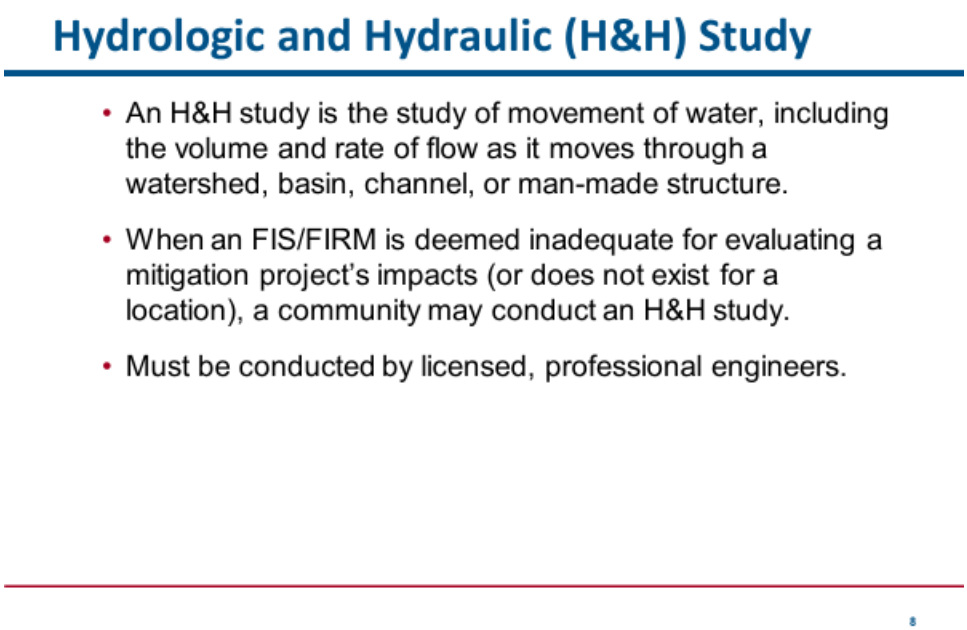
A **FIRM** is an official map of a community on which FEMA has delineated the 100-year (1-percent-annual-chance), 500-year (0.2% annual chance) floodplains, Base Flood Elevations, and risk premium zones.

The results of a FIS are presented on a FIRM.

Some but not all communities have digital FIRMs, aka DFIRMs. For a tutorial on how to read a FIRM, visit: https://www.fema.gov/media/fhm/firm/ot_firm.htm

You may also want to mention some of the different zones on the FIRM—zone AE, zone AR, zone V, zone X, etc.—so that they make more sense during the coastal flooding section.

H&H study



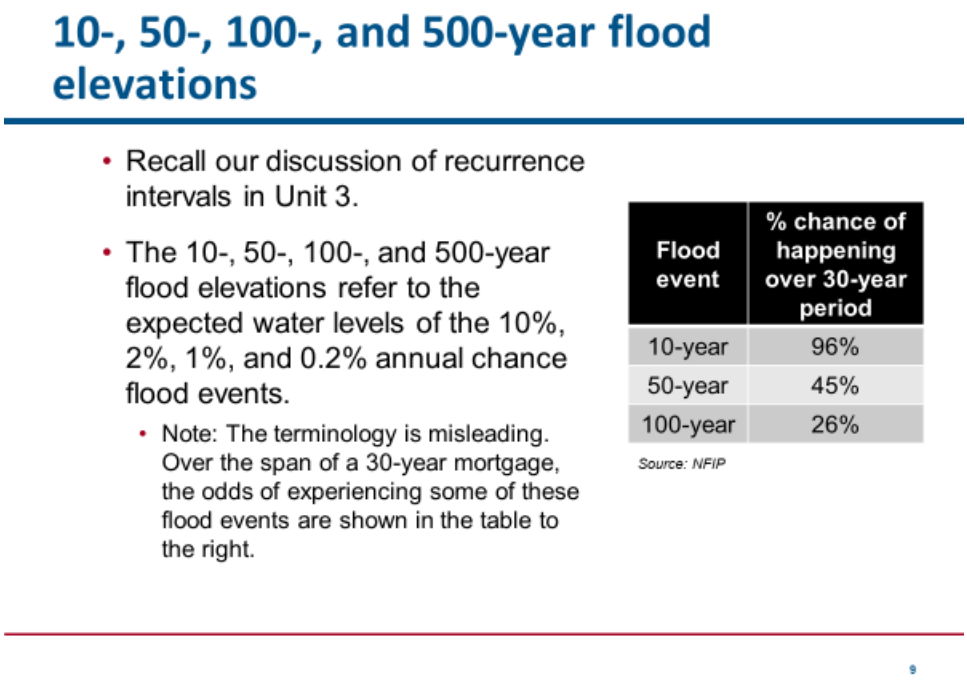
Visual 7: H&H study

Instructor:
An H&H study is the study of movement of water, including the volume and rate of flow as it moves through a watershed, basin, channel, or man-made structure.

When an FIS/FIRM is deemed inadequate for evaluating a mitigation project's impacts (or does not exist for a location), a community may conduct an H&H study.

An H&H study must be conducted by licensed, professional engineers.

10-, 50-, 100-, and 500-year flood elevations



Visual 8: 10-, 50-, 100-, and 500-year flood elevations

Instructor:
Recall our discussion of recurrence intervals in Unit 3.

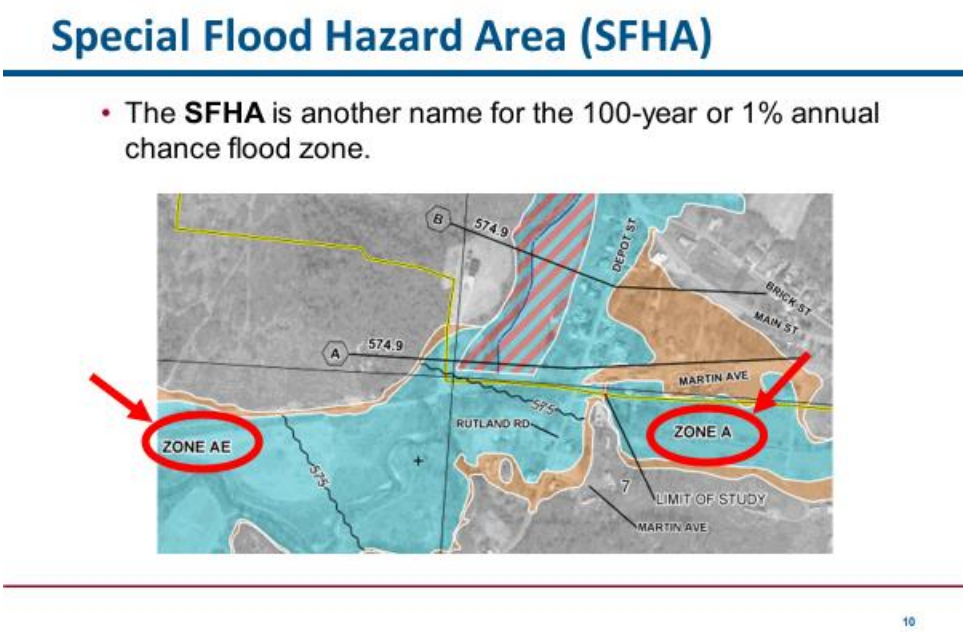
The 10-, 50-, 100-, and 500-year flood elevations refer to the expected water levels of the 10%, 2%, 1%, and 0.2% annual chance flood events.

However, this terminology is misleading. Over the span of a 30-year mortgage, the odds of experiencing some of these flood events are shown in the table below. The source of this data is the NFIP.

Flood event	% chance of happening over 30-year period
10-year	96%
50-year	45%
100-year	26%

Table 1: Chances of experiencing various flood events over a 30-year period

Special Flood Hazard Area (SFHA)



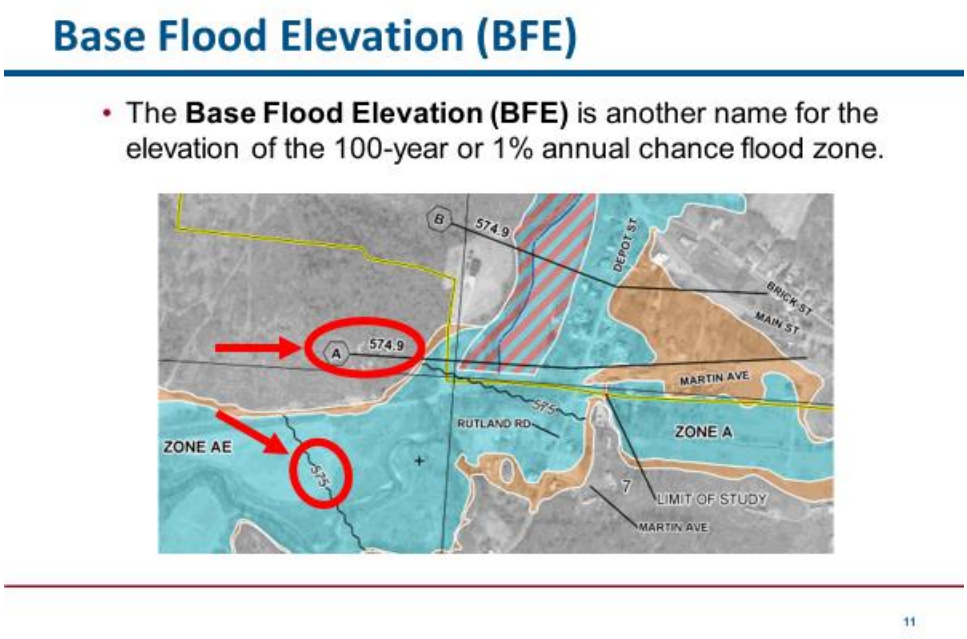
Visual 9: SFHA

Instructor:

This is different than the Base Flood Elevation (BFE) because it is a zone (i.e. area), not an elevation.

On a flood map, this will be labeled as Zone A or A__.

Base Flood Elevation (BFE)



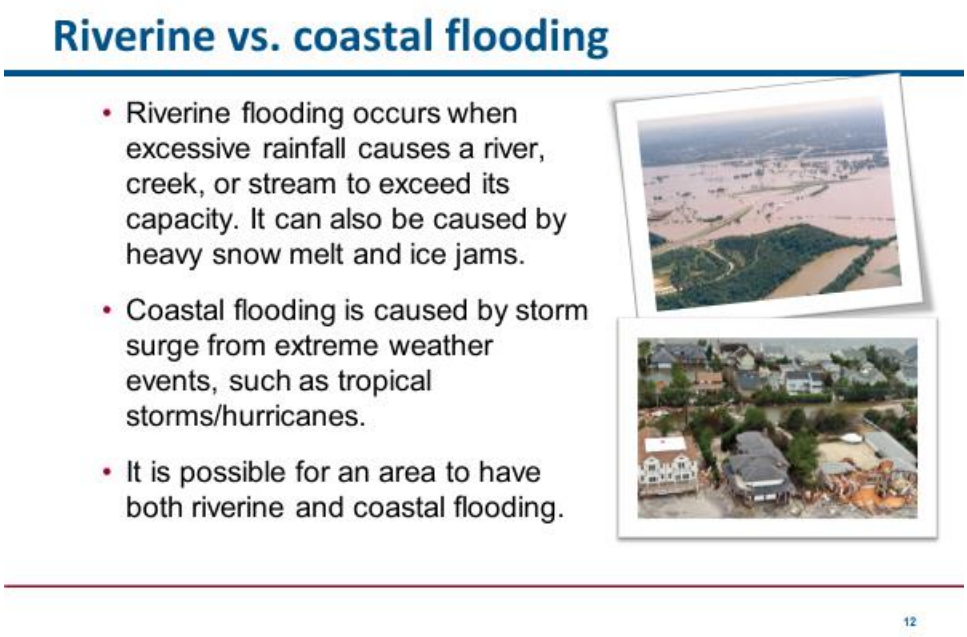
Visual 10: BFE

Instructor:

The **Base Flood Elevation (BFE)** is another name for the elevation of the 100-year or 1% annual chance flood zone.

The BFE can be shown as a number on top of a black wavy line that bisects the floodplain, in parentheses underneath the zone label, or on top of a black straight line that bisects the floodplain.

Riverine vs. coastal flooding



Visual 11: Riverine vs. coastal flooding

Instructor:

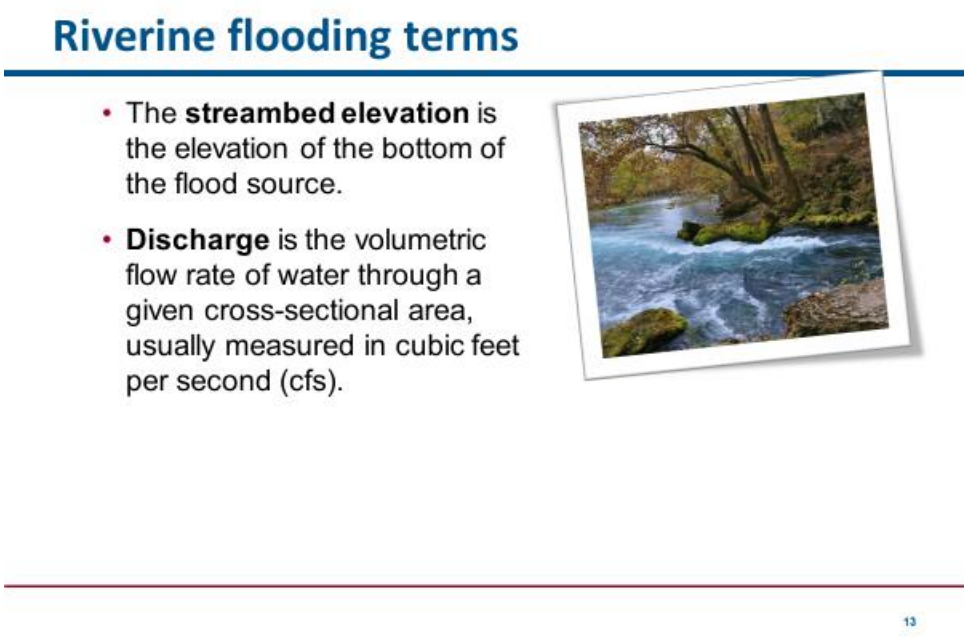
Riverine flooding occurs when excessive rainfall causes a river, creek, or stream to exceed its capacity. It can also be caused by heavy snow melt and ice jams.

Coastal flooding is caused by storm surge from extreme weather events, such as tropical storms/hurricanes.

It is possible for an area to have both riverine and coastal flooding.

Many areas also experience what is known as overland or interior flooding, which is caused by excessive rainfall overwhelming the drainage system, but that this type of flooding is not included in a FIRM. If you are doing a BCA for a project that addresses this type of flooding, you will either need an H&H study or past/expected damage data.

Riverine flooding terms



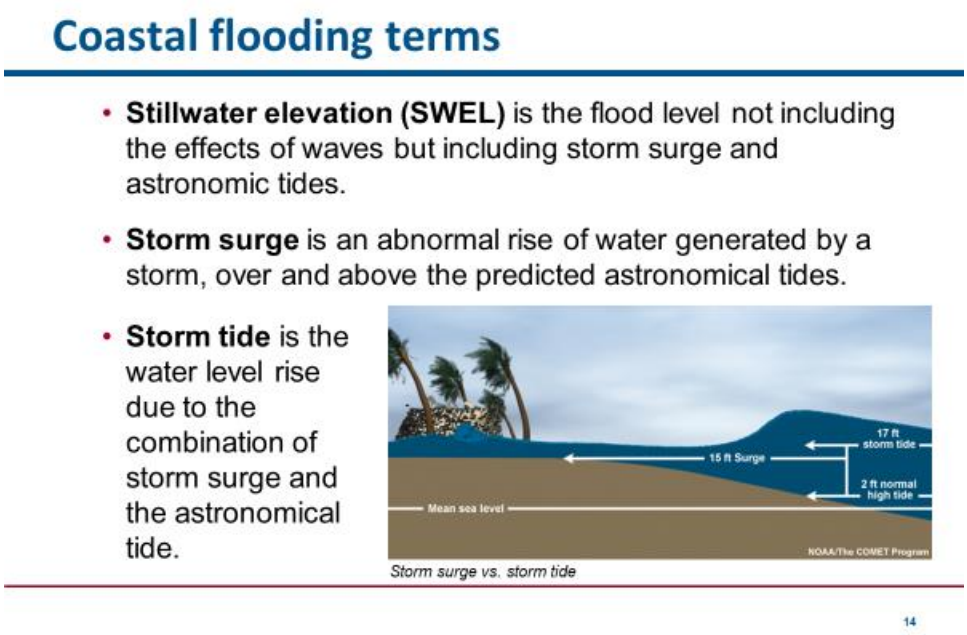
Visual 12: Riverine flooding terms

Instructor:
The **streambed elevation** is the elevation of the bottom of the flood source.

Discharge is the volumetric flow rate of water through a given cross-sectional area, usually measured in cubic feet per second (cfs).

You can use the FIS to find all of this information, as well as flood profiles (the water surface elevation for a specific flood event).

Coastal flooding terms



Visual 13: Coastal flooding terms

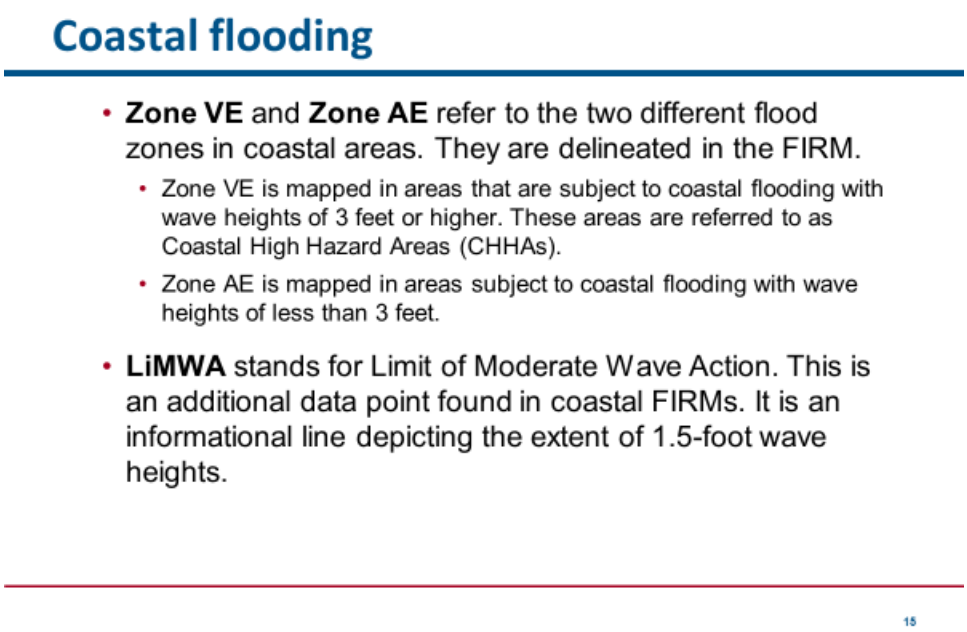
Instructor:

Stillwater elevation (SWEL) is the flood level not including the effects of waves but including storm surge and astronomic tides.

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

Storm tide is the water level rise due to the combination of storm surge and the astronomical tide.

Coastal flooding



Visual 14: Coastal flooding

Instructor:

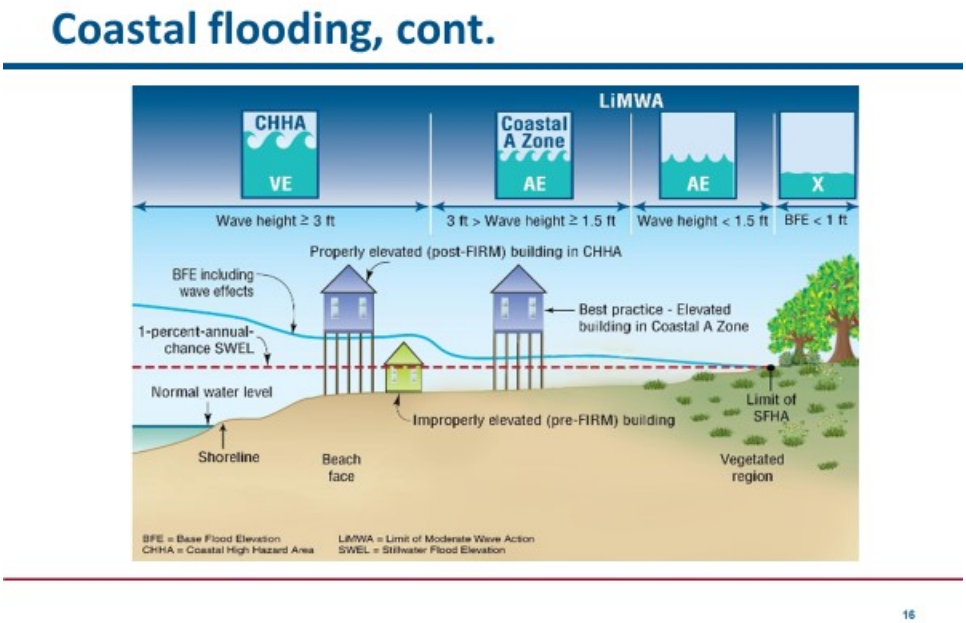
Zone VE and **Zone AE** refer to the two different flood zones in coastal areas. They are delineated in the FIRM.

- Zone VE is mapped in areas that are subject to coastal flooding with wave heights of 3 feet or higher. These areas are referred to as Coastal High Hazard Areas (CHHAs).
- Zone AE is mapped in areas subject to coastal flooding with wave heights of less than 3 feet.

The primary reason for having two different coastal flood zones is that the risk of structural damage is higher within Zone VE, due to the significant wave energy that can occur in these areas. As a result, flood insurance rates are higher and building codes are stricter for structures in Zone VE.

LiMWA stands for Limit of Moderate Wave Action. Over the past decade, post-storm damage surveys have confirmed that even wave heights as low as 1.5 feet can cause significant structural damage to buildings that were not built to withstand forces such as the wave hazards in VE zones. On its recently updated FIRMs, FEMA notifies communities of the potential for significant wave damage by using both the regulatory Zone VE designation (coastal flooding, plus waves of 3 feet or higher) and an informational line depicting the extent of 1.5-foot wave heights. This line is called the LiMWA.

Coastal flooding

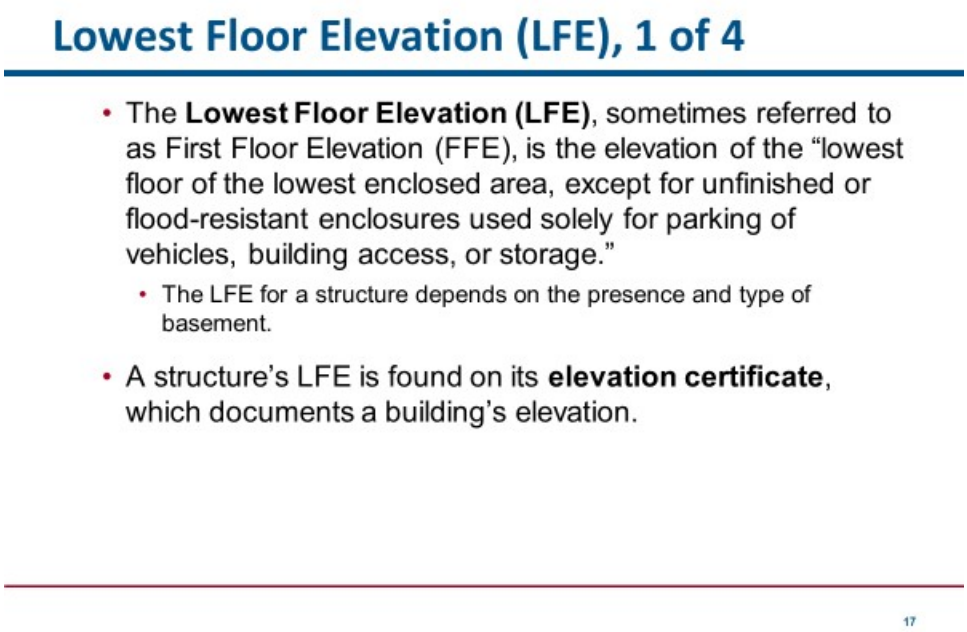


Visual 15: Coastal flooding, cont.

Instructor:

This slide provides a graphic for the various coastal flooding terms we just discussed. You do not need to know these in detail; this is just provided for reference.

Lowest floor elevation (LFE)



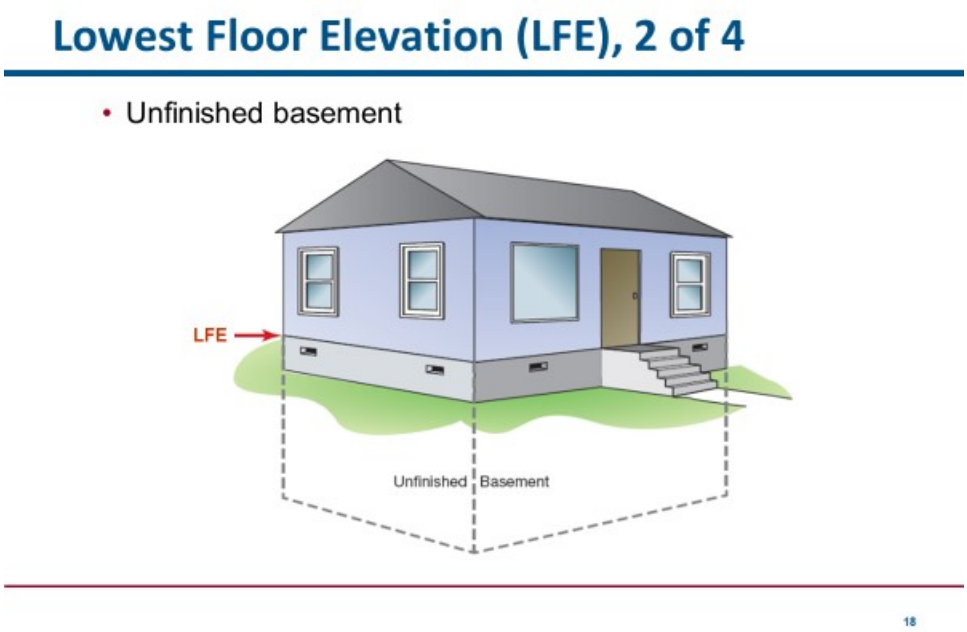
Visual 16: Lowest Floor Elevation (LFE), 1 of 4

Instructor:

The **Lowest Floor Elevation (LFE)**, sometimes referred to as First Floor Elevation (FFE), is the elevation of the "lowest floor of the lowest enclosed area, except for unfinished or flood-resistant enclosures used solely for parking of vehicles, building access, or storage." The LFE for a structure depends on the presence and type of basement. The following slides depict where the LFE is on various basement types.

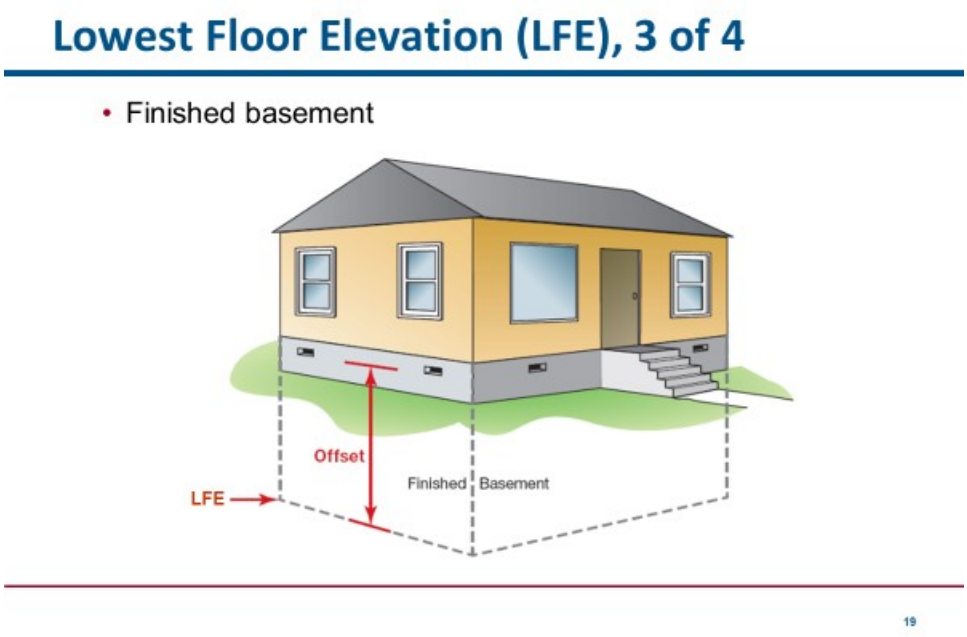
A structure's LFE is found on its **elevation certificate**, which documents a building's elevation.

LFE unfinished basement



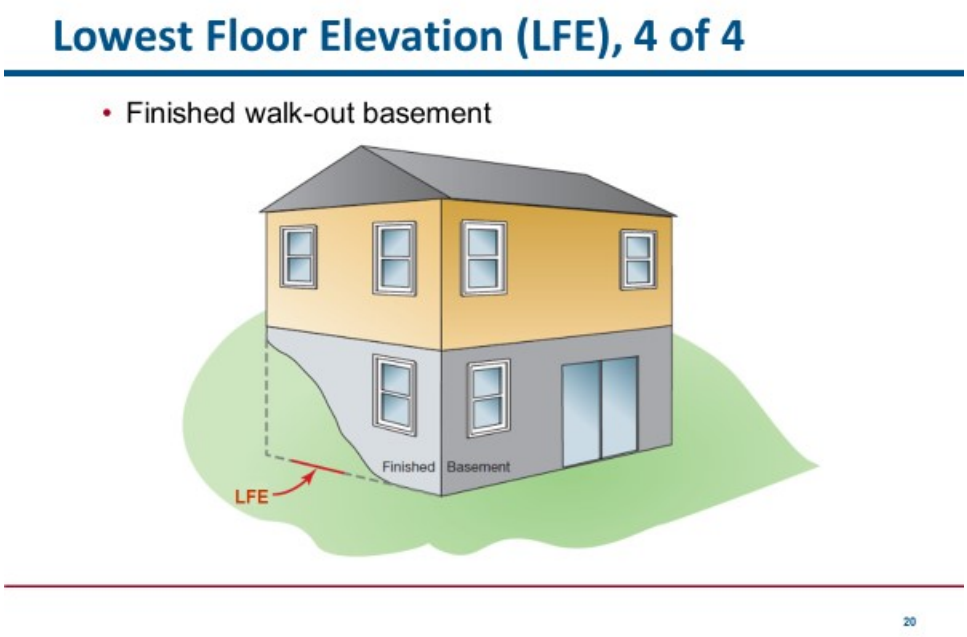
Visual 17: Lowest Floor Elevation (LFE), 2 of 4

LFE finished basement



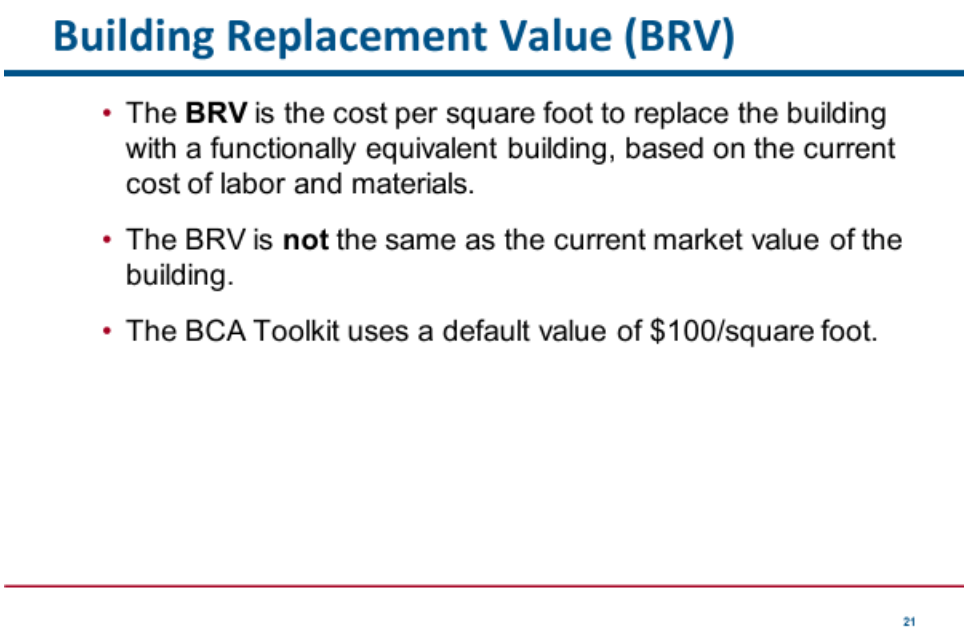
Visual 18: Lowest Floor Elevation (LFE), 3 of 4

LFE finished walk-out basement



Visual 19: Lowest Floor Elevation (LFE), 4 of 4

Building Replacement Value (BRV)



Visual 20: BRV

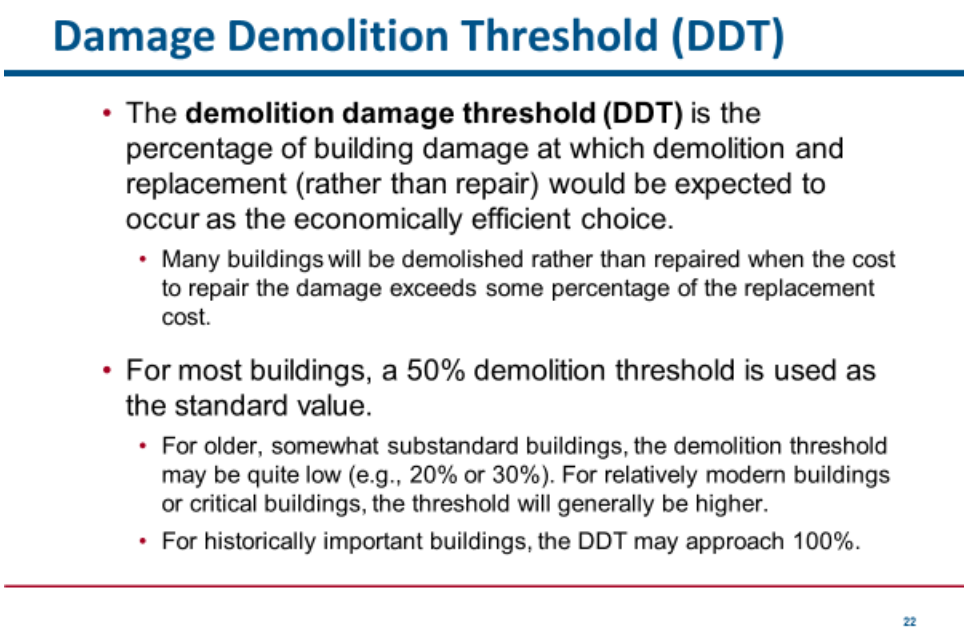
Instructor:

The **BRV** is the cost per square foot to replace the building with a functionally equivalent building, based on the current cost of labor and materials.

The BRV is **not** the same as the current market value of the building.

The BCA Toolkit uses a default value of $100/square foot. If your location has a higher BRV, you may use it as long as you provide documentation with your project application.

Damage Demolition Threshold (DDT)



Visual 21: DDT

Instructor:

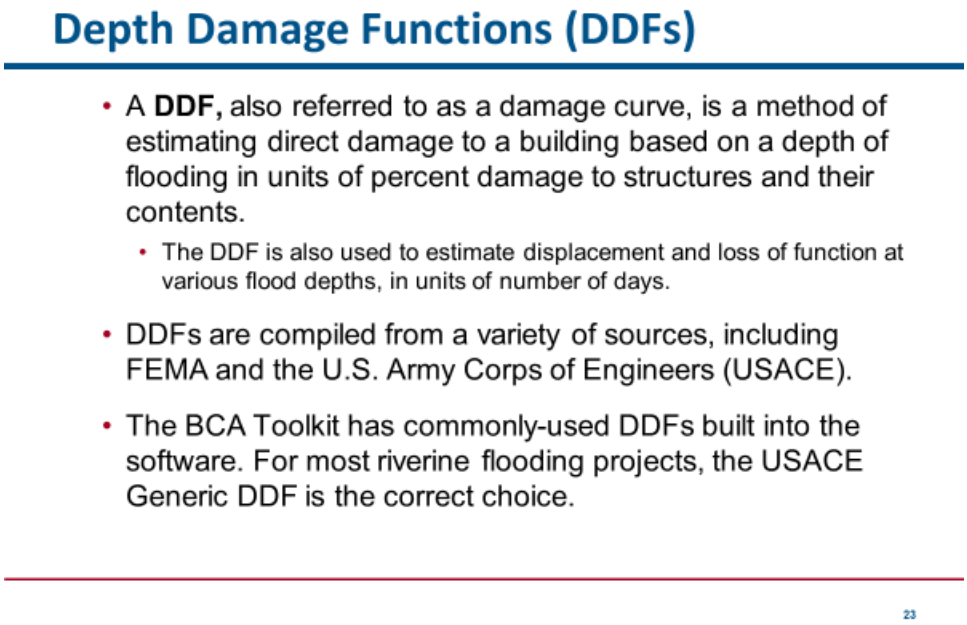
The **demolition damage threshold (DDT)** is the percentage of building damage at which demolition and replacement (rather than repair) would be expected to occur as the economically efficient choice.

Many buildings will be demolished rather than repaired when the cost to repair the damage exceeds some percentage of the replacement cost.

For most buildings, a 50% demolition threshold is used as the standard value. For older, somewhat substandard buildings, the demolition threshold may be quite low (e.g., 20% or 30%). For relatively modern buildings or critical buildings, the threshold will generally be higher. For historically important buildings, the DDT may approach 100%.

The BCA Toolkit has default DDTs for the type of building selected by the user.

Depth Damage Functions (DDFs)



Visual 22: DDFs

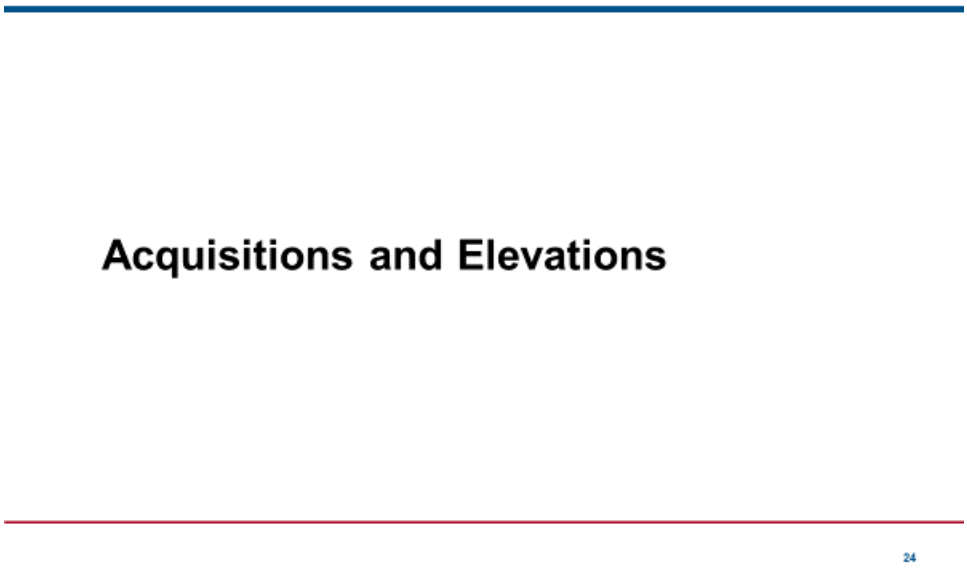
Instructor:

A **DDF,** also referred to as a damage curve, is a method of estimating direct damage to a building based on a depth of flooding in units of percent damage to structures and their contents. Later in this unit we will show how to estimate damage to residential structures using DDFs.

The DDF is also used to estimate displacement and loss of function at various flood depths, in units of number of days.

DDFs are compiled from a variety of sources, including FEMA and the U.S. Army Corps of Engineers (USACE).

The BCA Toolkit has commonly-used DDFs built into the software. For most riverine flooding projects, the USACE Generic DDF is the correct choice. If you are doing a project in a coastal zone, however, make sure to use the coastal DDF for that structure type. Coastal DDFs include wave action damage, which we discussed previously.



Visual 23: Acquisitions and Elevations

Instructor:
We will talk about acquisitions and elevations together because they require most of the same information to run the BCA.

Acquisitions

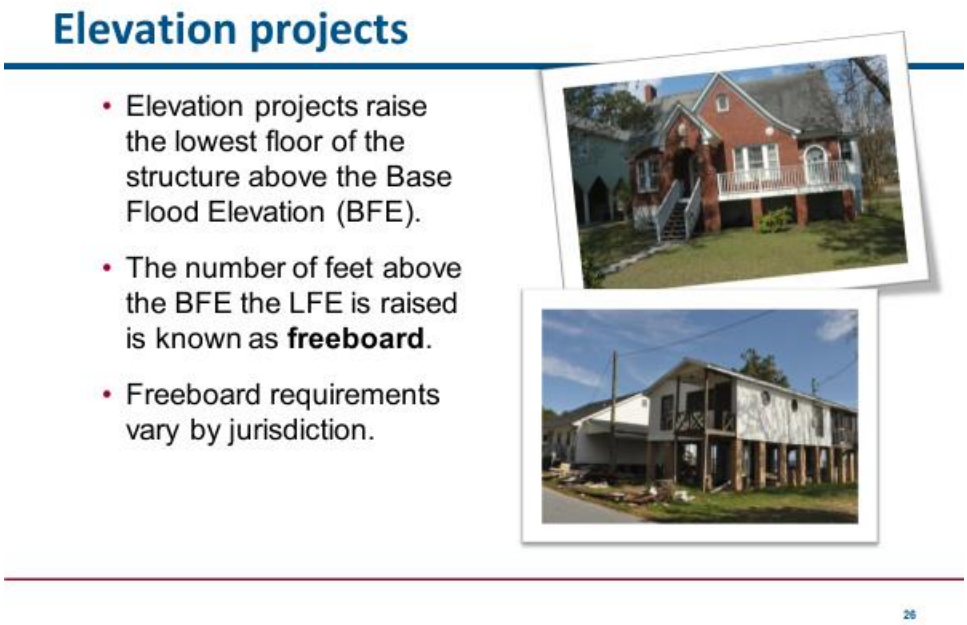
Visual 24: Acquisitions

Instructor:

Acquisitions are the purchase and demolition or relocation of a building. Future damage is eliminated because the project site is deed-restricted as open space.

Many communities utilize the open space as wildlife habitat, active-use parks, or multi-use greenways.

Elevations



Visual 25: Elevations

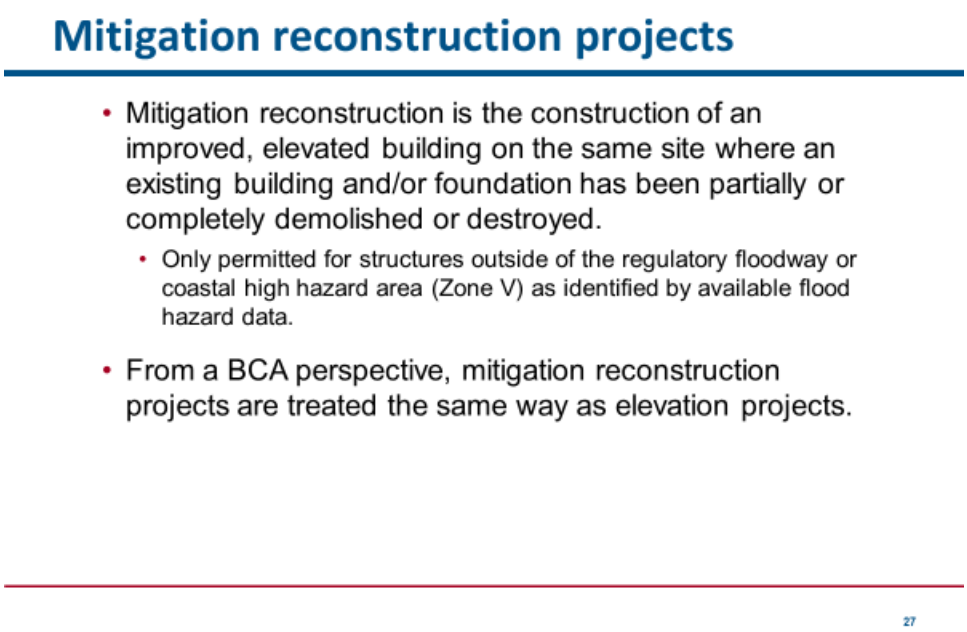
Instructor:

Elevation projects raise the lowest floor of the structure above the Base Flood Elevation (BFE).

The number of feet above the BFE the LFE is raised is known as **freeboard**.

Freeboard requirements vary by jurisdiction.

Mitigation reconstruction



Visual 26: Mitigation reconstruction

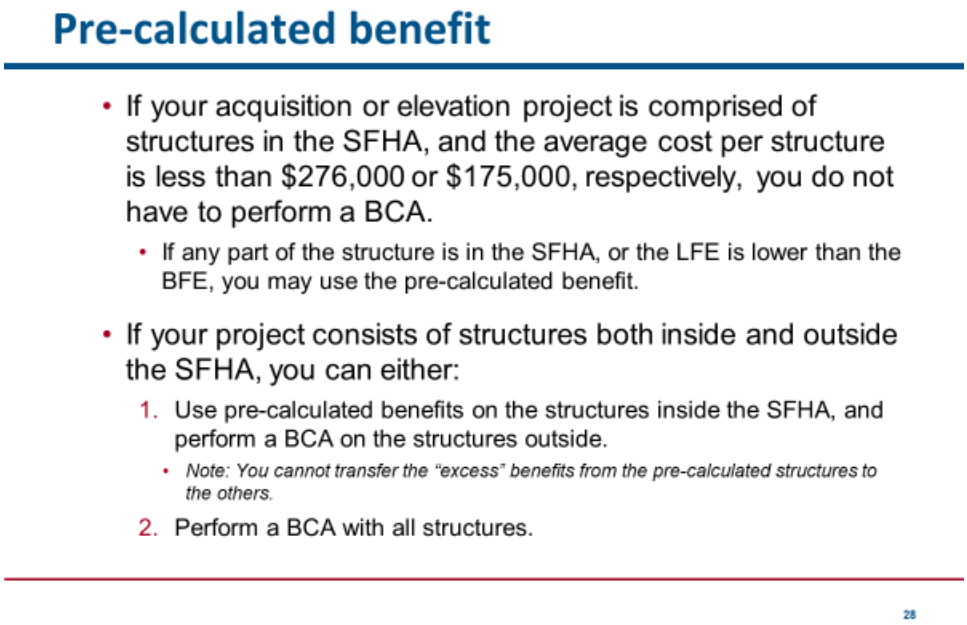
Instructor:

Mitigation reconstruction is the construction of an improved, elevated building on the same site where an existing building and/or foundation has been partially or completely demolished or destroyed.

Only permitted for structures outside of the regulatory floodway or coastal high hazard area (Zone V) as identified by available flood hazard data.

From a BCA perspective, mitigation reconstruction projects are treated the same way as elevation projects. If the mitigation reconstruction project also protects against another hazard (i.e. wind or seismic), those benefits should also be calculated by analyzing the structure twice – once for each hazard.

Pre-calculated benefit



Visual 27: Pre-calculated benefit

Instructor:

If your acquisition or elevation project is comprised of structures in the SFHA, and the average cost per structure is less than $276,000 or $175,000, respectively, you do not have to perform a BCA.

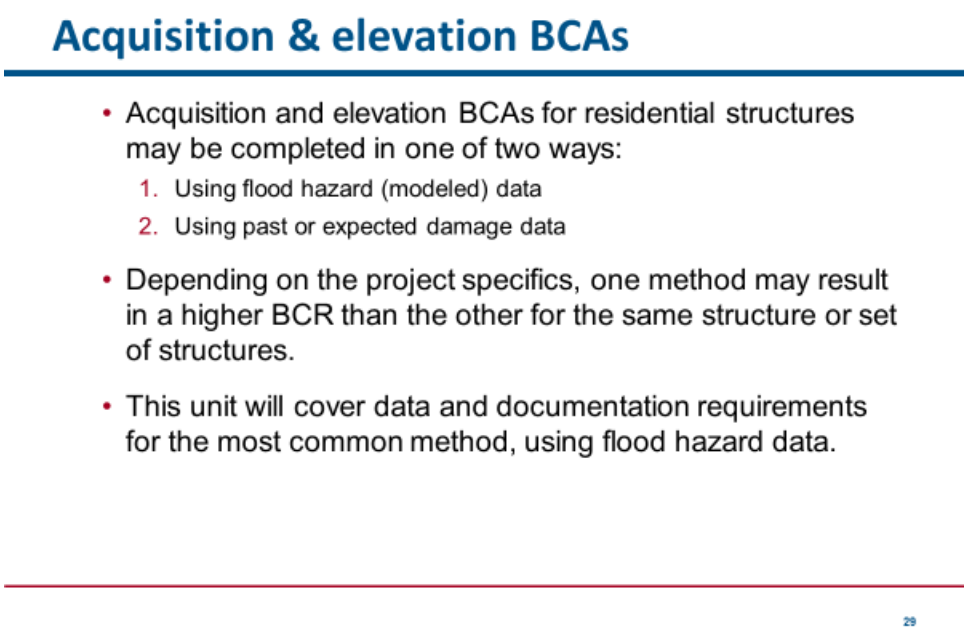
Note that the $276,000 and $175,000 values are **not** intended to be project cost estimates. It is advisable to leave some buffer room in your average structure cost in case a property drops out or there are cost overruns.

If any part of the structure is in the SFHA, or the LFE is lower than the BFE, you may use the pre-calculated benefit.

If your project consists of structures both inside and outside the SFHA, you can either:

- Use pre-calculated benefits on the structures inside the SFHA, and perform a BCA on the structures outside. *Note: You cannot transfer the "excess" benefits from the pre-calculated structures to the others.*
- Perform a BCA with all structures.

Acquisition and elevation BCAs



Visual 28: Acquisition and elevation BCAs

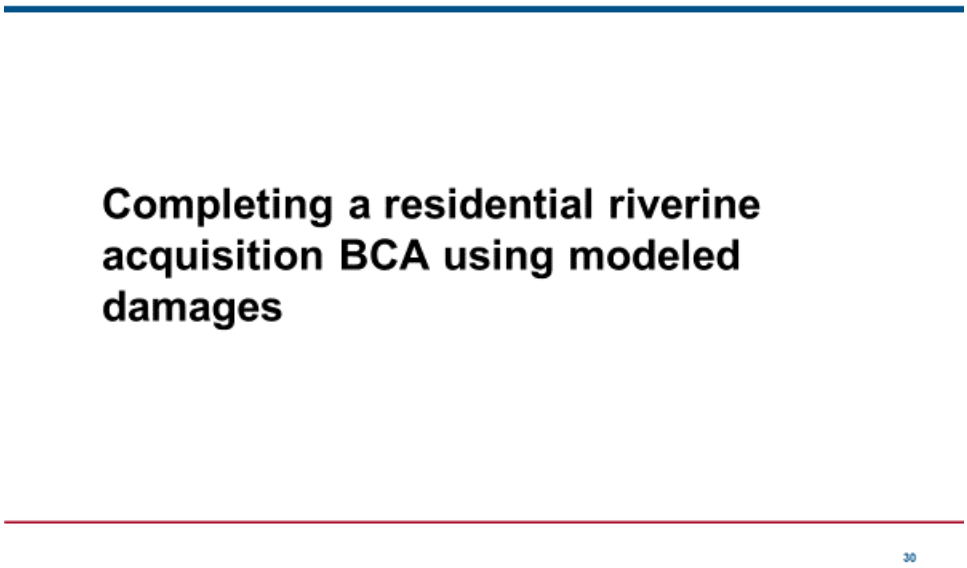
Instructor:

Acquisition and elevation BCAs for residential structures may be completed in one of two ways:

1. Using flood hazard (modeled) data
2. Using past or expected damage data

Depending on the project specifics, one method may result in a higher BCR than the other for the same structure or set of structures.

This unit will cover data and documentation requirements for the most common method, using flood hazard data.

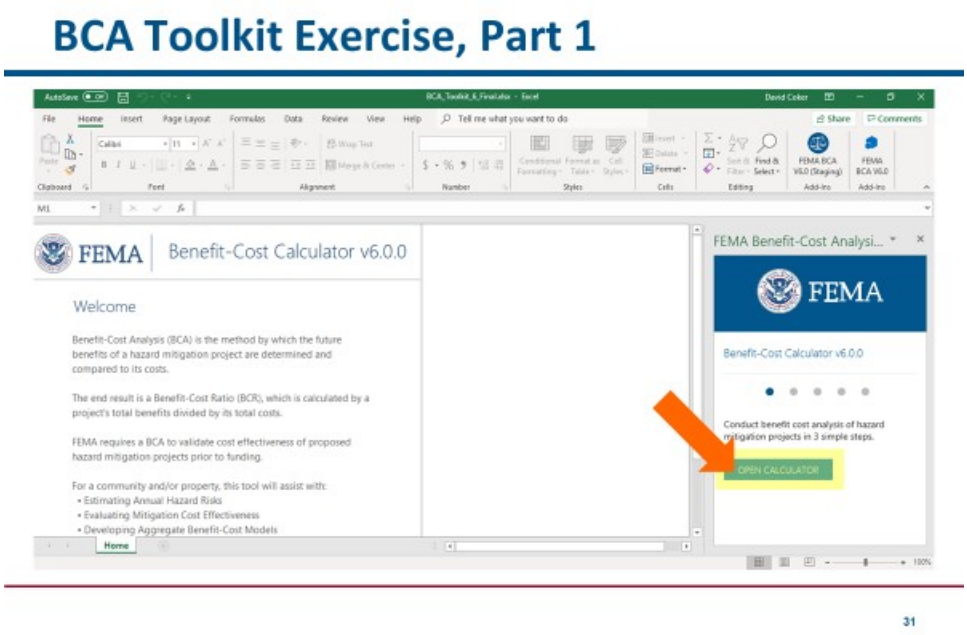


Visual 29: Residential riverine acquisition BCA

Instructor:
First we'll go through a residential riverine acquisition BCA example in the BCA Toolkit, explaining each data point as it's input. Your student manual provides details on where you can obtain the data point and appropriate documentation for it.

We'll then do the same for a residential coastal elevation project. Most of the data points are the same between the two project types.

BCA Toolkit Exercise



Instructor:

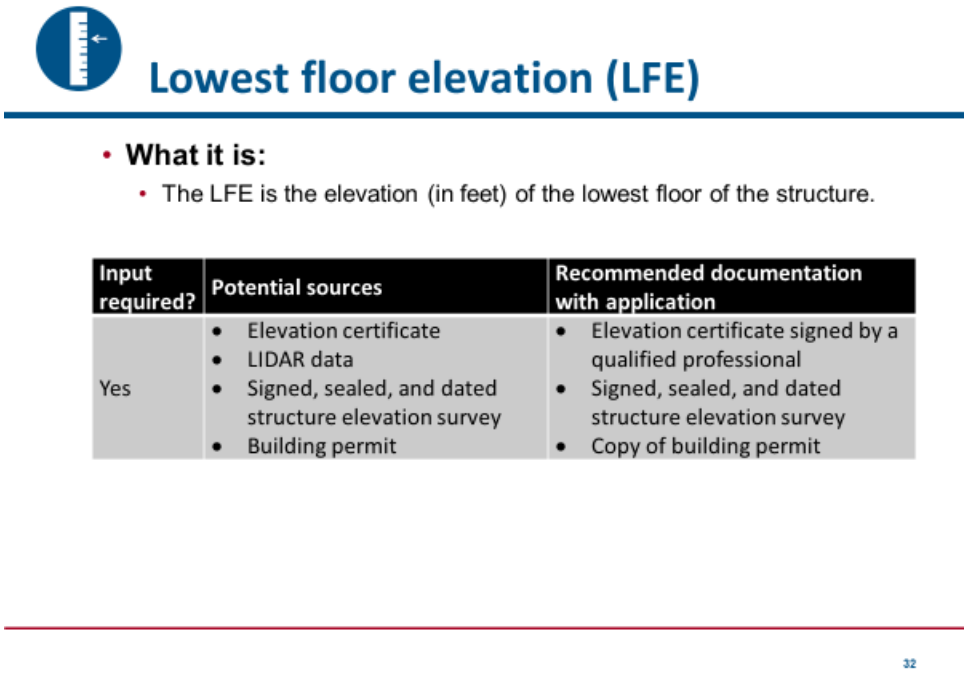
We will show how to complete a residential riverine acquisition BCA in the BCA Toolkit. The following slides describe the data inputs in the Toolkit, sources for finding this information, and required documentation with your project application.

The instructor should open the BCA Toolkit on their computer and instruct the students to do the same. Use the following slides to describe each data point as it is input. You may use one of the provided case studies (or another example from a Region or state) to guide the students through data entry on the Project Configuration and then the Project Information screens.

Case studies may be downloaded at https://www.fema.gov/benefit-cost-analysis.

You may also show students the Data Documentation Templates for this project type, which may be found at https://www.fema.gov/benefit-cost-analysis.

Lowest floor elevation (LFE)



Visual 30: LFE

What it is:

- The LFE is the elevation (in feet) of the lowest floor of the structure.

Why it's important:

- The LFE is a key factor in estimating losses before and after mitigation.
- If the LFE is lower than the BFE, the project is almost always cost-effective.
- The BCR calculation is highly sensitive to this input, meaning that even small changes can have a significant impact on the BCR.

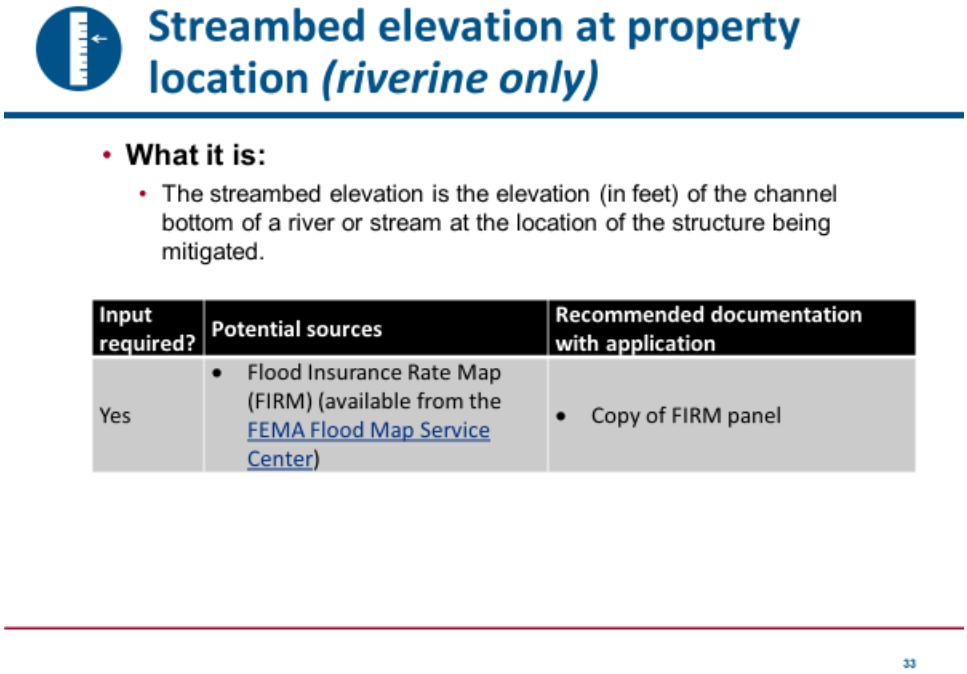
Sources:

- FEMA elevation certificates
- Signed, sealed, and dated structure elevation surveys
- Building permits

Recommended BCA documentation with application:

- Elevation certificate signed by a qualified professional
- Signed, sealed, and dated structure elevation survey
- Copy of building permit

Streambed elevation at property location *(riverine only)*



Visual 31: Streambed elevation at property location (riverine only)

What it is:

- The streambed elevation is the elevation (in feet) of the channel bottom of a river or stream at the location of the structure being mitigated.

Why it's important:

- The streambed elevation is used to calculate the depth of flow in the stream.

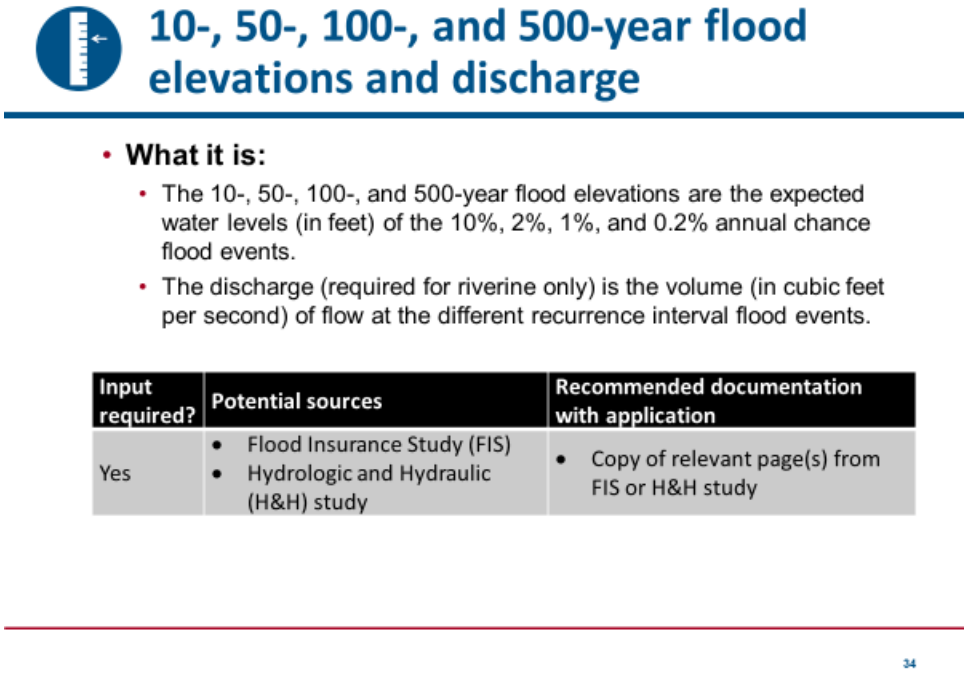
Sources:

- Flood Insurance Rate Map (FIRM), available from the FEMA Flood Map Service Center (Note: Not all locations have FIRMs.)
- Hydrologic and Hydraulic (H&H) study

Recommended BCA documentation with application:

- Copy of FIRM panel or relevant page(s) from H&H study

10-, 50-, 100-, and 500-year flood elevations and discharge



Visual 32: 10-, 50-, 100-, and 500-year flood elevations and discharge

What it is:

- The 10-, 50-, 100-, and 500-year flood elevations are the expected water levels (in feet) of the 10%, 2%, 1%, and 0.2% annual chance flood events.
- The discharge (required for riverine only) is the volume (in cubic feet per second) of flow at the different recurrence interval flood events.

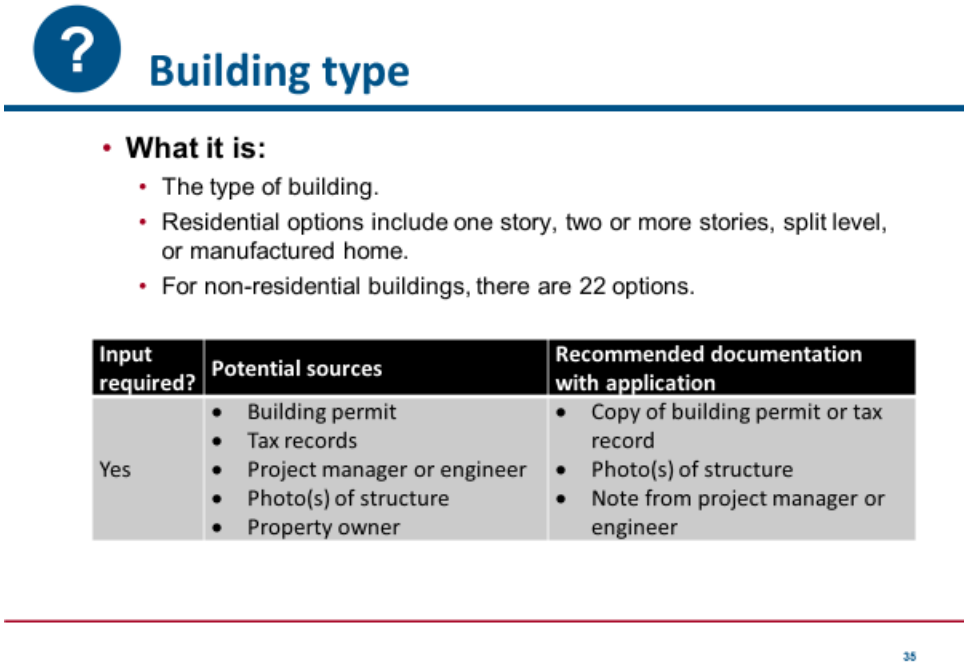
Sources:

- Flood Insurance Study (FIS)
- Hydrologic and Hydraulic (H&H) study

Recommended BCA documentation with application:

- Copy of relevant page(s) from FIS or H&H study

Building type



Visual 33: Building type

What it is:

- The type of building.
- Residential options include one story, two or more stories, split level, or manufactured home.
- For non-residential buildings, there are 22 options.

Why it's important:

- These inputs determine the correct DDF for the property.

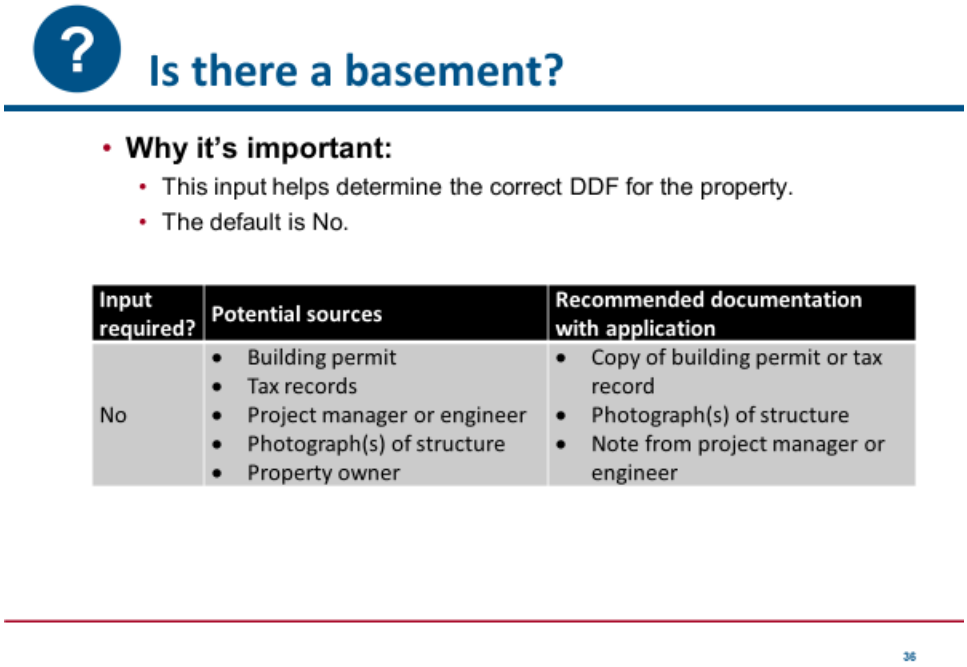
Sources:

- Building permit
- Tax records
- Photo(s) of structure
- Project engineer

Recommended BCA documentation with application:

- Copy of building permit or tax records
- Photo(s) of structure
- Note from project manager or engineer

Is there a basement?



Visual 34: Basement?

Why it's important:

- This input helps determine the correct DDF for the property.

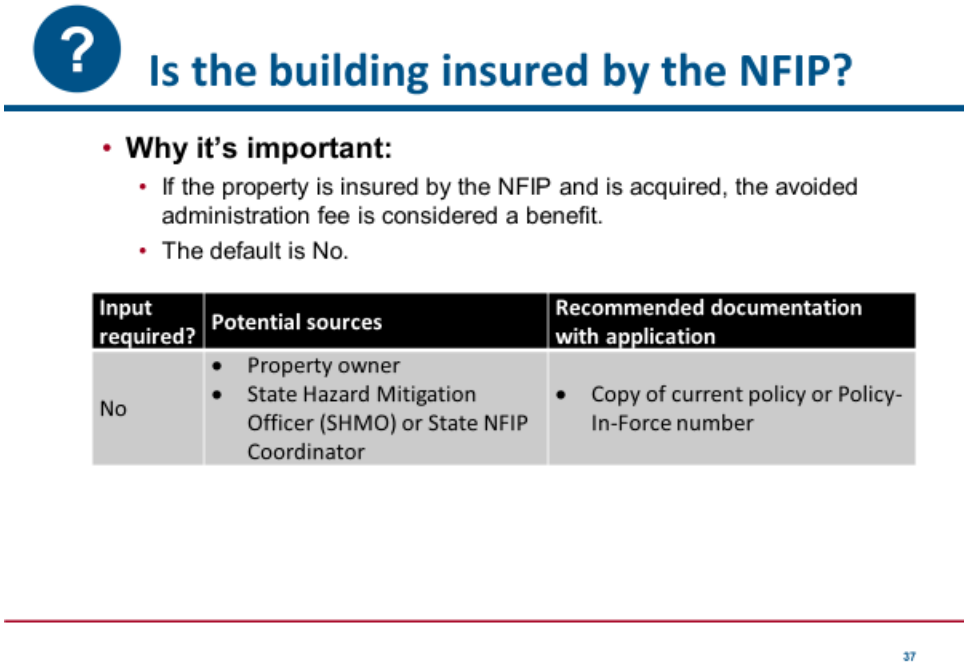
Sources:

- Building permit
- Tax records
- Photo(s) of structure
- Project manager or engineer
- Property owner

Recommended BCA documentation with application:

- Copy of building permit or tax records
- Photo(s) of structure
- Note from project manager or engineer

Is the building insured by the NFIP?



Visual 35: NFIP?

Why it's important:

- If the property is insured by the NFIP and is acquired, the avoided administration fee is considered a benefit.

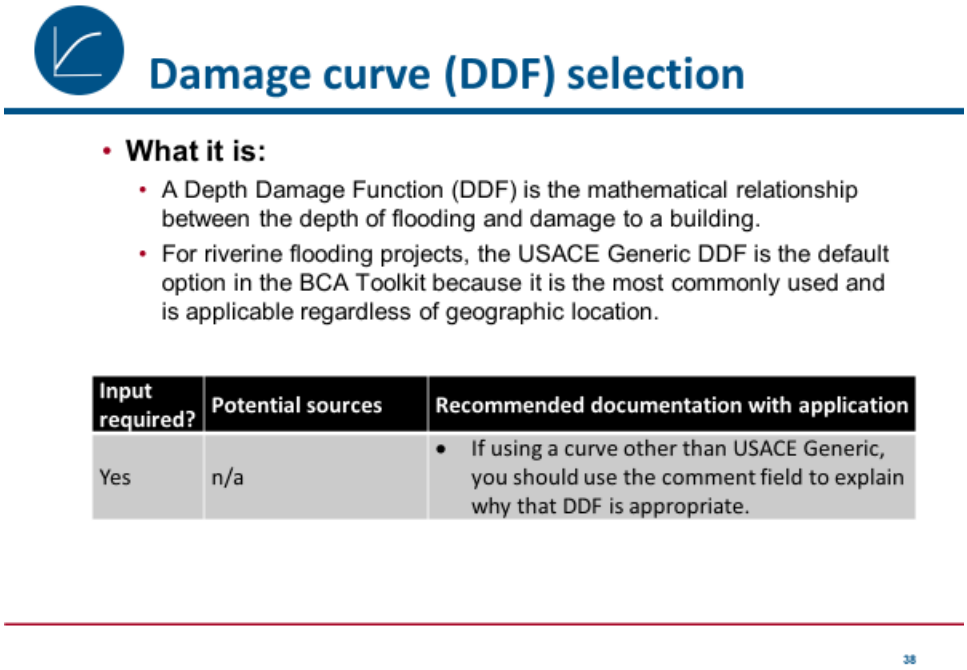
Sources:

- Property owner
- State Hazard Mitigation Officer (SHMO) or State NFIP Coordinator

Recommended BCA documentation with application:

- Copy of current policy or Policy-In-Force number

Damage curve (DDF) selection



Visual 36: DDF selection

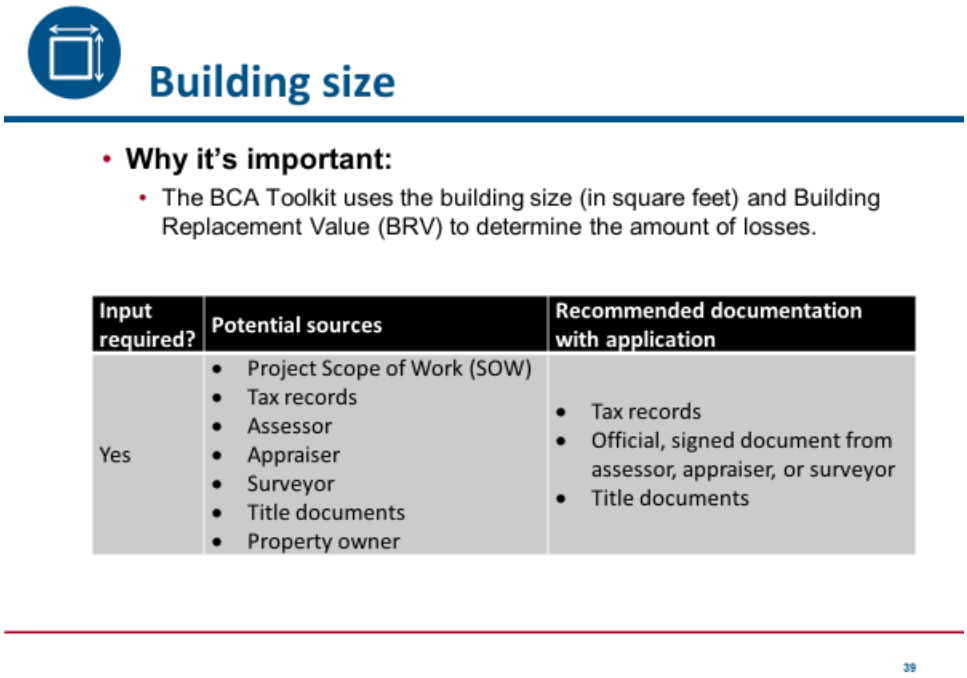
What it is:

- A Depth Damage Function (DDF) is the mathematical relationship between the depth of flooding and damage to a building.
- For riverine flooding projects, the USACE Generic DDF is the default option in the BCA Toolkit because it is the most commonly used and is applicable regardless of geographic location.
- Depending on your project location and structure characteristics, you may see other DDF options in the Toolkit. If choosing an alternate DDF (or using a custom DDF) you should explain why.

Recommended BCA documentation with application (if choosing an alternate or custom DDF):

- Note from project manager, engineer, or BCA analyst (can put in comment field in BCA Toolkit)

Building size



Visual 37: Building size

Why it's important:

- The BCA Toolkit uses the building size (in square feet) and Building Replacement Value (BRV) to determine the amount of losses.

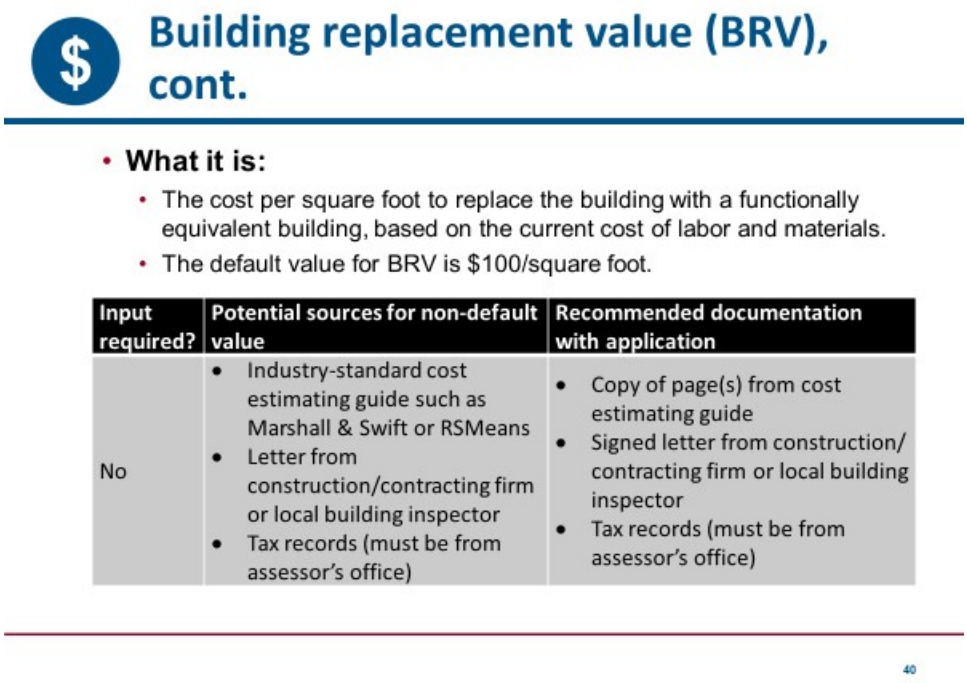
Sources:

- Project SOW
- Tax records
- Assessor
- Appraiser
- Surveyor
- Title documents
- Property owner

Recommended BCA documentation with application:

- Copy of tax records or title documents
- Official, signed document from assessor, appraiser, or surveyor
- Note from project manager or engineer

Building replacement value (BRV)



Visual 38: Building replacement value (BRV), cont.

What it is:

- The cost per square foot to replace the building with a functionally equivalent building, based on the current cost of labor and materials.
- The default value for BRV is $100/square foot.

Why it's important:

- The BCA Toolkit uses the building size and Building Replacement Value (BRV) to determine the amount of losses.

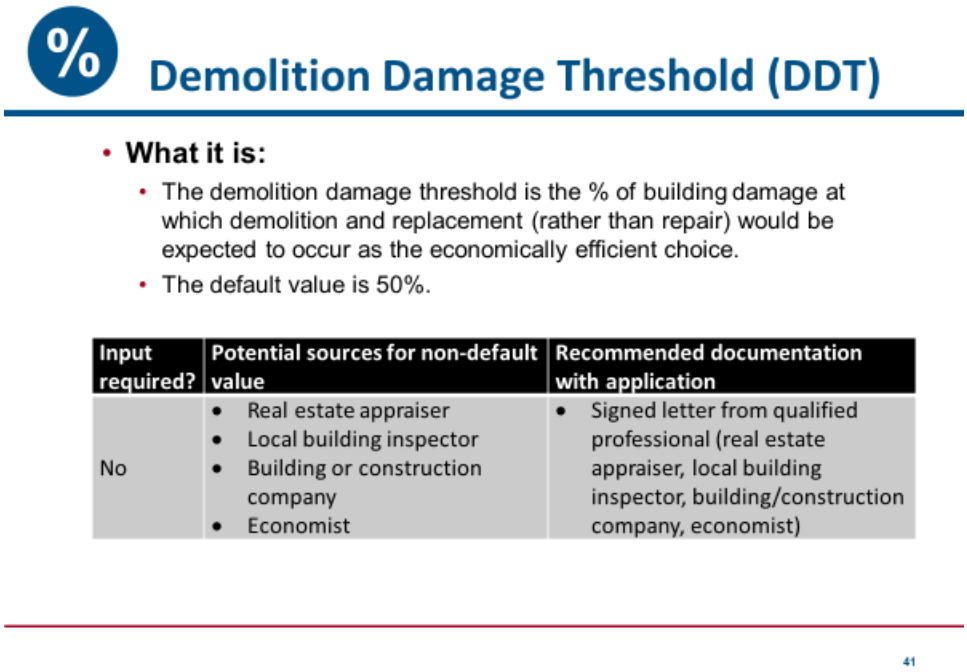
Sources for non-default values:

- Industry-standard cost estimating guide such as Marshall & Swift or RSMeans
- Construction/contracting firm or local building inspector
- Tax records (must be from assessor's office)

Recommended BCA documentation with application:

- Copy of relevant page(s) from cost estimating guide
- Signed letter from qualified professional (local building inspector, building/construction company)
- Copy of tax records from assessor's office

DDT



Visual 39: DDT

What it is:

- The demolition damage threshold is the % of building damage at which demolition and replacement (rather than repair) would be expected to occur as the economically efficient choice.
- The default DDT will populate based on the building type selected.
- For outdated or marginal buildings, much lower demolition thresholds are sometimes appropriate. For relatively modern buildings or critical buildings, the threshold will generally be higher. For some particularly important historical buildings, the demolition threshold may approach 100 percent.

Why it's important:

- The demolition threshold is used when calculating the dollar value of expected damages to the building.

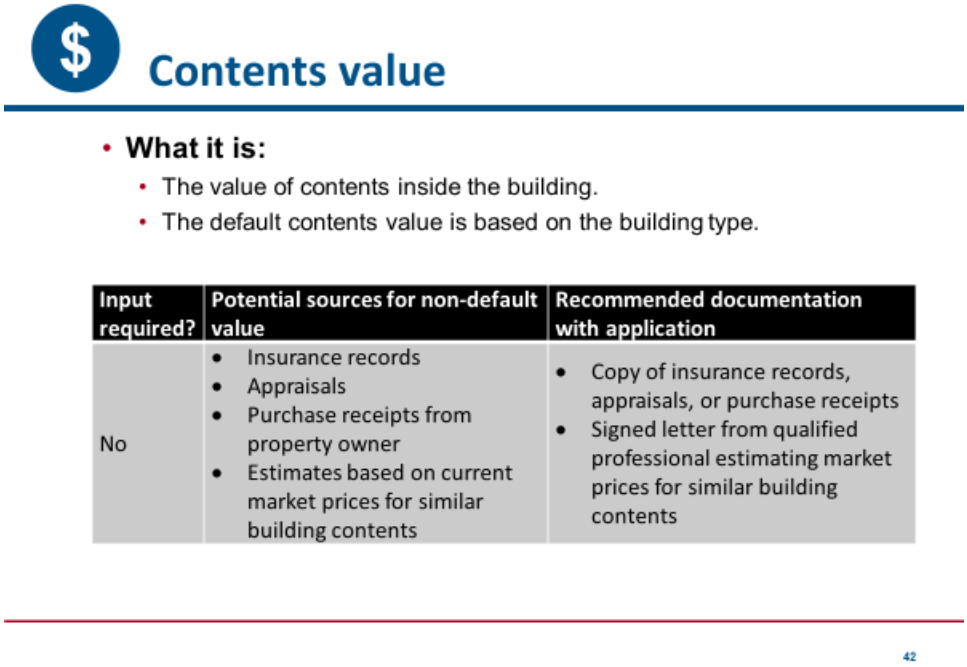
Sources for non-default values:

- Real estate appraiser
- Local building inspector
- Building or construction company
- Economist

Recommended BCA documentation with application:

- Signed letter from qualified professional (real estate appraiser, local building inspector, building/construction company, economist, etc.)

Contents value



Visual 40: Contents value

What it is:

- The value of contents inside the building.
- The default contents value is based on the building type.

Why it's important:

- The BCA Toolkit uses the contents value to determine the amount of losses.

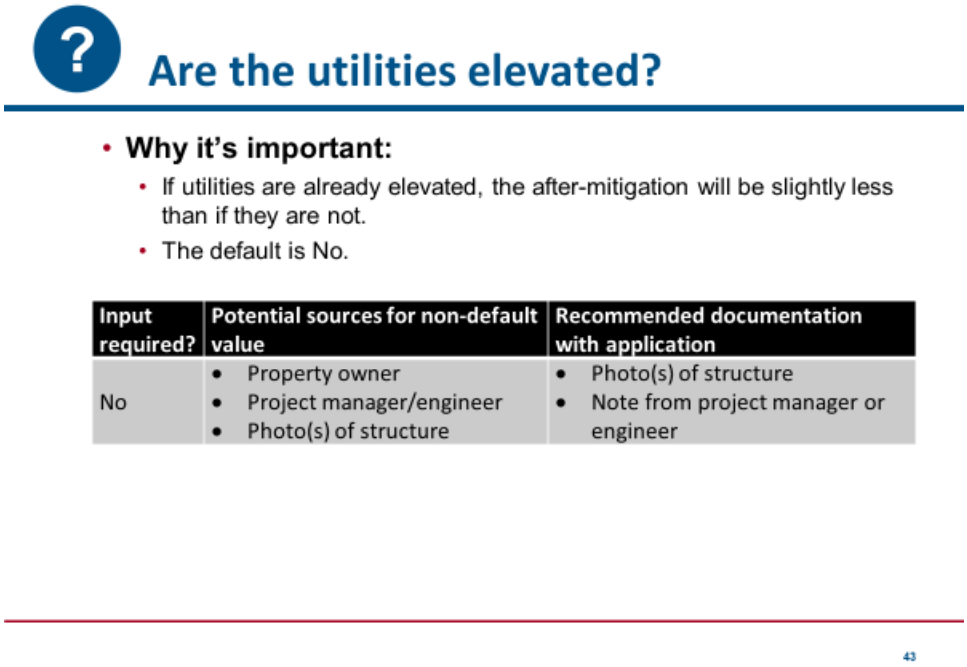
Sources for non-default values:

- Insurance records
- Appraisals
- Purchase receipts from property owner
- Estimates based on current market prices for similar building contents

Recommended BCA documentation with application:

- Copy of insurance records, appraisals, or purchase receipts
- Signed letter from qualified professional estimating market prices for similar building contents

Are the utilities elevated?



Visual 41: Are the utilities elevated?

Why it's important:

- If utilities are already elevated, the after-mitigation will be slightly less than if they are not.
- The default value for this input is No.

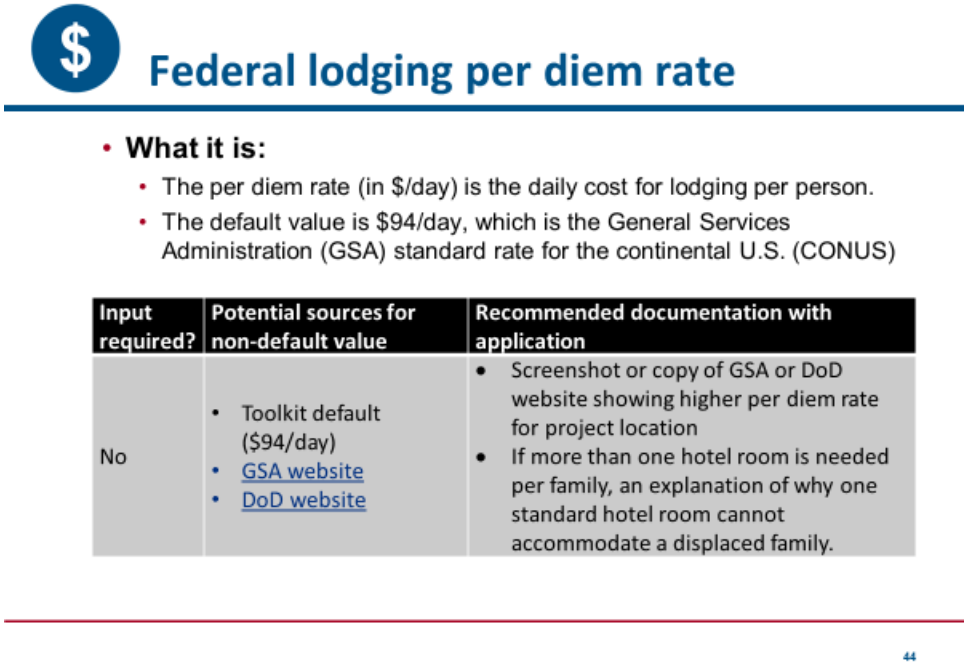
Sources for non-default values:

- Property owner
- Photo(s) of structure

Recommended BCA documentation with application:

- Photo(s) of structure
- Note from project manager or engineer

Federal lodging per diem rate



Visual 42: Federal lodging per diem rate

What it is:

- The per diem rate (in $/day) is the daily cost for lodging per person.
- The default value is $94/day, which is the General Services Administration (GSA) standard rate for the continental U.S. (CONUS)

Why it's important:

- The BCA Toolkit uses the per diem rate to calculate the displacement costs.

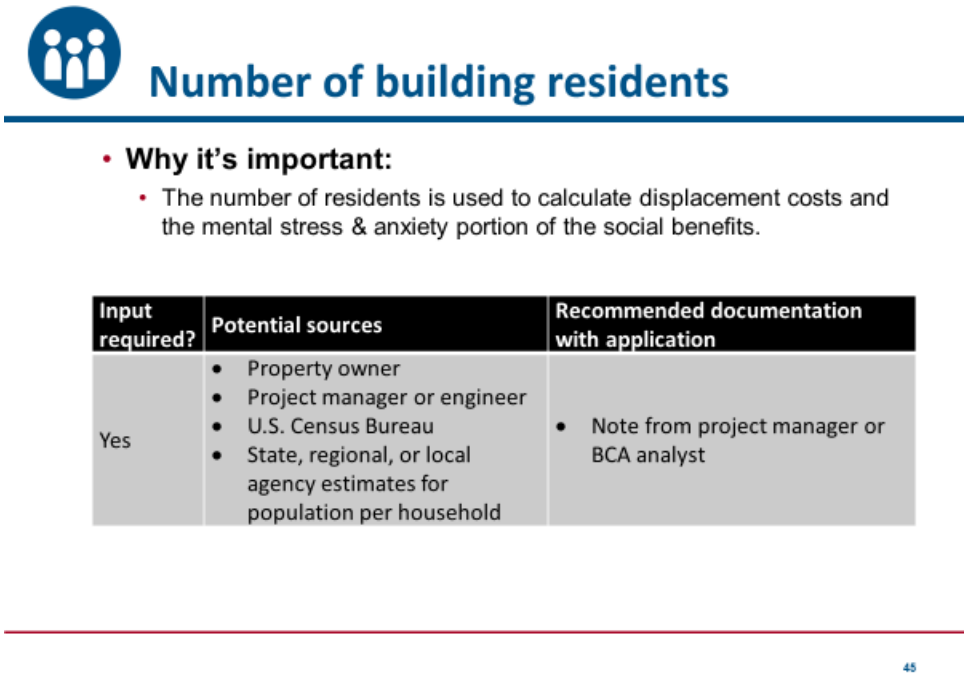
Sources for non-default values:

- GSA website
- DoD website

Recommended BCA documentation with application:

- Screenshot or copy of GSA or DoD website showing higher per diem rate for project location
- If more than one hotel room is needed per family, an explanation of why one standard hotel room cannot accommodate a displaced family.

Number of building residents



Visual 43: Number of building residents

Why it's important:

- The number of residents is used to calculate displacement costs and the mental stress & anxiety portion of the social benefits.

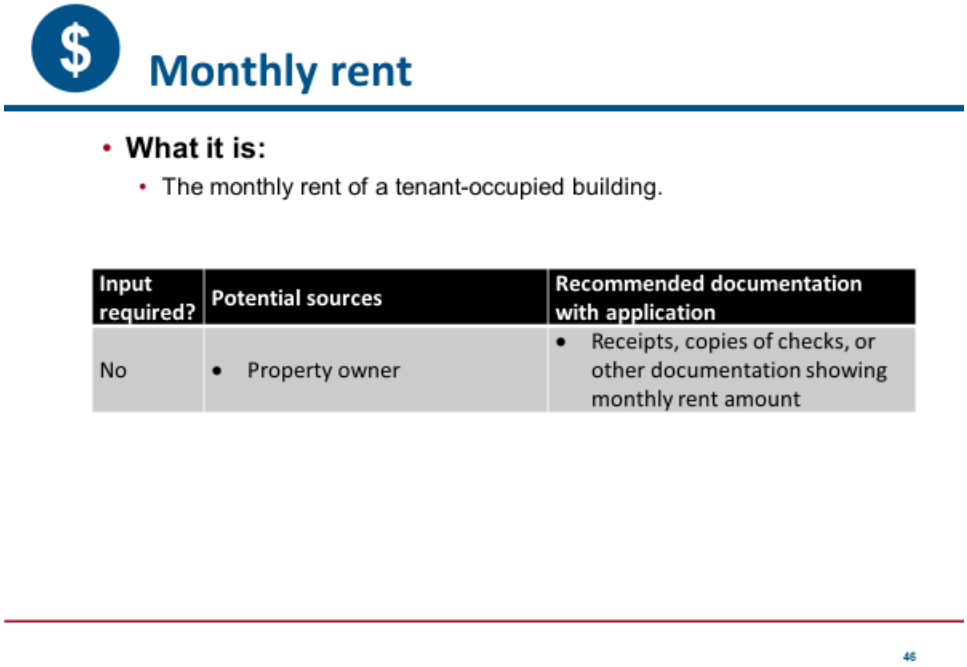
Sources:

- Project SOW
- Property owner
- Census data

Recommended BCA documentation with application:

- Note from project manager or engineer or BCA analyst

Monthly rent



Visual 44: Monthly rent

Note that counting both displacement costs for the renter and the full loss of rental income is double counting benefits. Users should choose which option provides more benefits.

What it is:

- The monthly rent of a tenant-occupied building.

Why it's important:

- For residential properties, when tenants vacate a premise because of damages, it results in a loss of income for the owner.

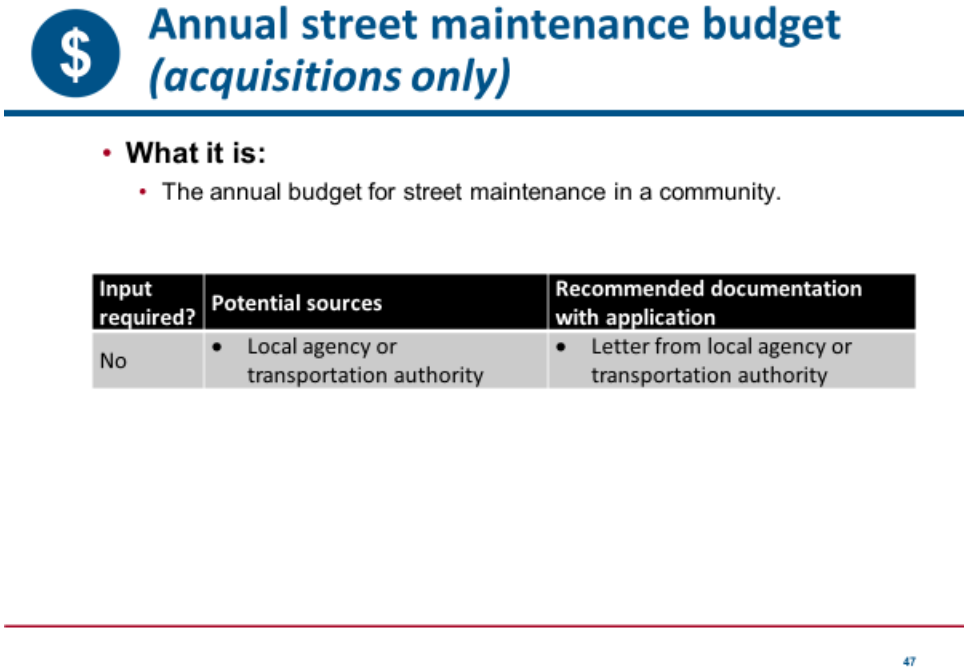
Sources:

- Property owner
- Rent receipts

Recommended BCA documentation with application:

- Receipts, copies of checks, or other documentation showing monthly rent amount

Annual street maintenance budget *(acquisitions only)*



Visual 45: Annual street maintenance budget (acquisitions only)

What it is:

- The annual budget for street maintenance in a community.

Why it's important:

- For acquisition projects that clear a large area of structures (and result in removed or abandoned streets), a community might realize an economic benefit in reduced street maintenance costs in the project area.

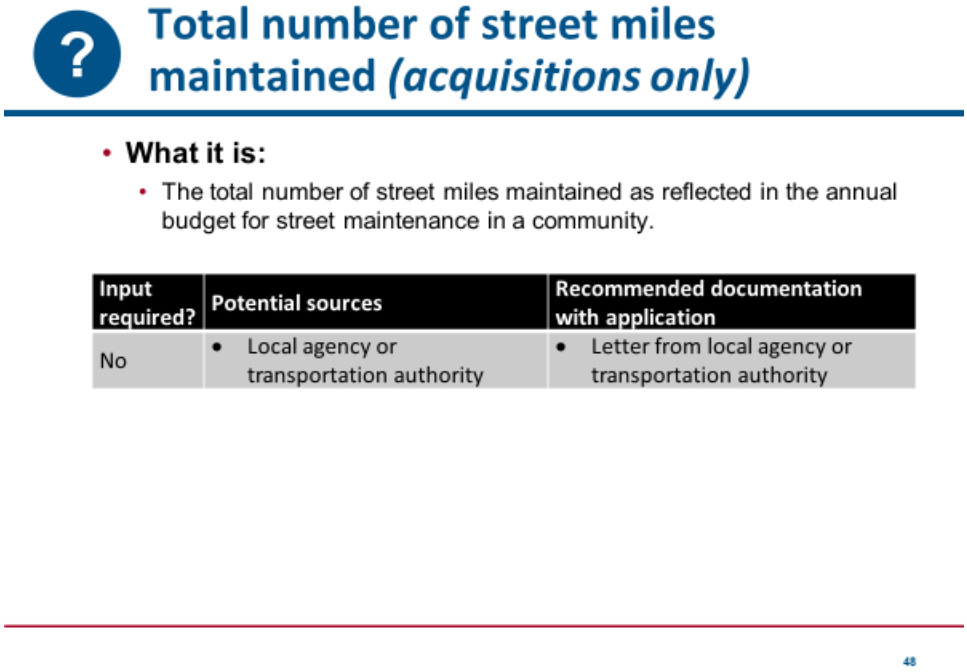
Sources:

- Local agency or transportation authority

Recommended BCA documentation with application:

- Letter from local agency or transportation authority

Total number of street miles maintained *(acquisitions only)*



Visual 46: Total number of street miles maintained (acquisitions only)

What it is:

- The total number of street miles maintained as reflected in the annual budget for street maintenance in a community.

Why it's important:

- For acquisition projects that clear a large area of structures (and result in removed or abandoned streets), a community might realize an economic benefit in reduced street maintenance costs in the project area.

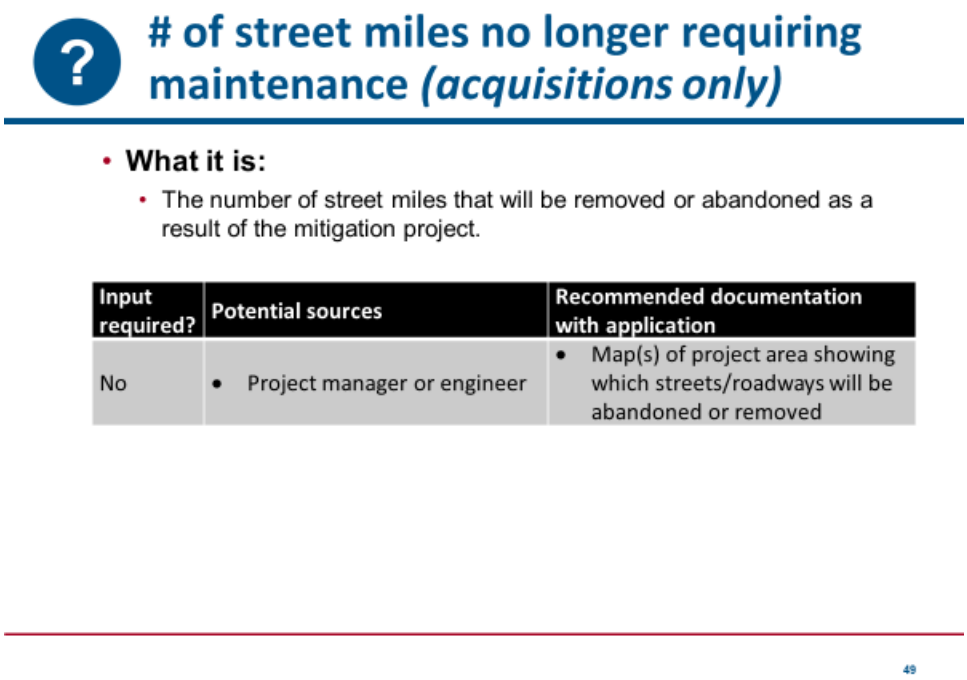
Sources:

- Local agency or transportation authority

Recommended BCA documentation with application:

- Letter from local agency or transportation authority

Number of street miles no longer requiring maintenance *(acquisitions only)*



Visual 47: Number of street miles no longer requiring maintenance (acquisitions only)

What it is:

- The number of street miles that will be removed or abandoned as a result of the mitigation project.

Why it's important:

- For acquisition projects that clear a large area of structures (and result in removed or abandoned streets), a community might realize an economic benefit in reduced street maintenance costs in the project area.

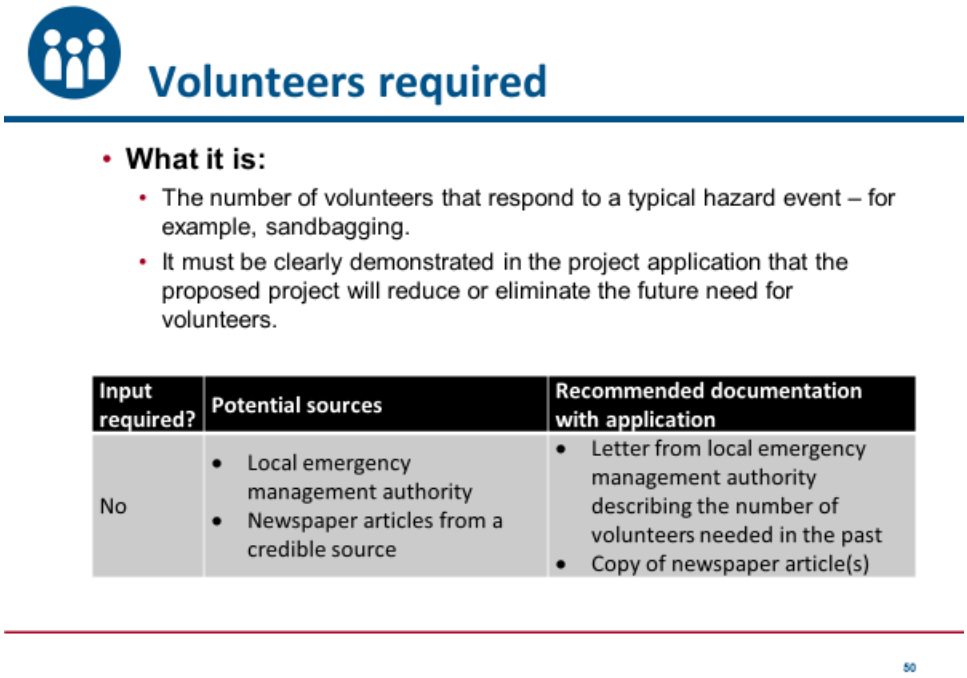
Sources:

- Project manager or engineer

Recommended BCA documentation with application:

- Map(s) of project area showing which streets/roadways will be abandoned or removed

Volunteers required



Visual 48: Volunteers required

What it is:

- The number of volunteers that respond to a typical hazard event – for example, sandbagging.
- It must be clearly demonstrated in the project application that the proposed project will reduce or eliminate the future need for volunteers.

Why it's important:

- The reduced costs associated with volunteers is a benefit of the mitigation project.

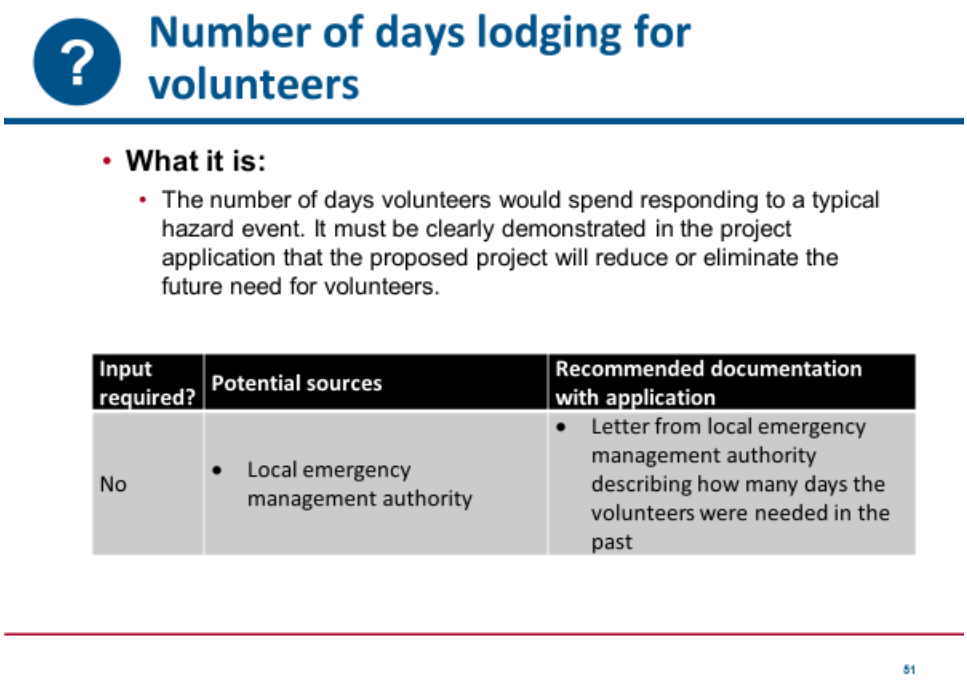
Sources:

- Local emergency management authority
- Newspaper articles from a credible source

Recommended BCA documentation with application:

- Letter from local emergency management authority describing the number of volunteers needed in the past
- Copy of newspaper article(s)

Number of days lodging for volunteers



Visual 49: Number of days lodging for volunteers

What it is:

- The number of days volunteers would spend responding to a typical hazard event. It must be clearly demonstrated in the project application that the proposed project will reduce or eliminate the future need for volunteers.

Why it's important:

- The reduced costs associated with volunteers is a benefit of the mitigation project.

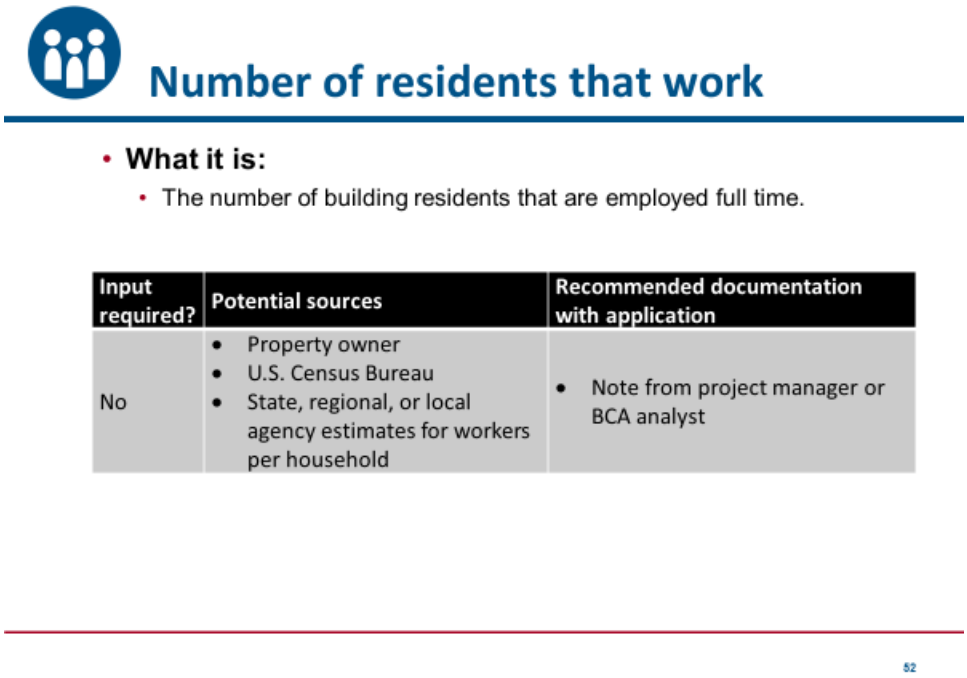
Sources:

- Local emergency management authority
- Newspaper articles from a credible source

Recommended BCA documentation with application:

- Letter from local emergency management authority describing the number of volunteers needed in the past
- Copy of newspaper article(s)

Number of residents that work



Visual 50: Volunteers required

What it is:

- The number of building residents that are employed full time.

Why it's important:

- The number of workers is used to calculate the social benefits of the project.

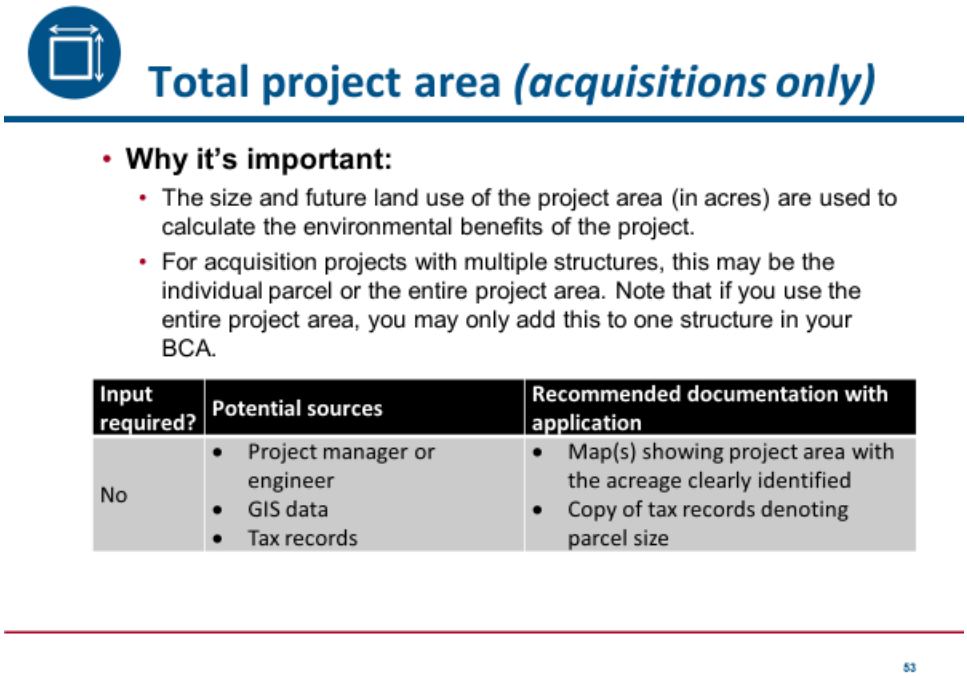
Sources:

- Property owner
- U.S. Census Bureau
- State, regional, or local agency estimates for workers per household

Recommended BCA documentation with application:

- Note from project manager or BCA analyst

Total project area *(acquisitions only)*



Visual 51: Total project area (acquisitions only)

Why it's important:

- The size and future land use of the project area (in acres) are used to calculate the environmental benefits of the project.
- For acquisition projects with multiple structures, this may be the individual parcel or the entire project area. Note that if you use the entire project area, you may only add this to one structure in your BCA.

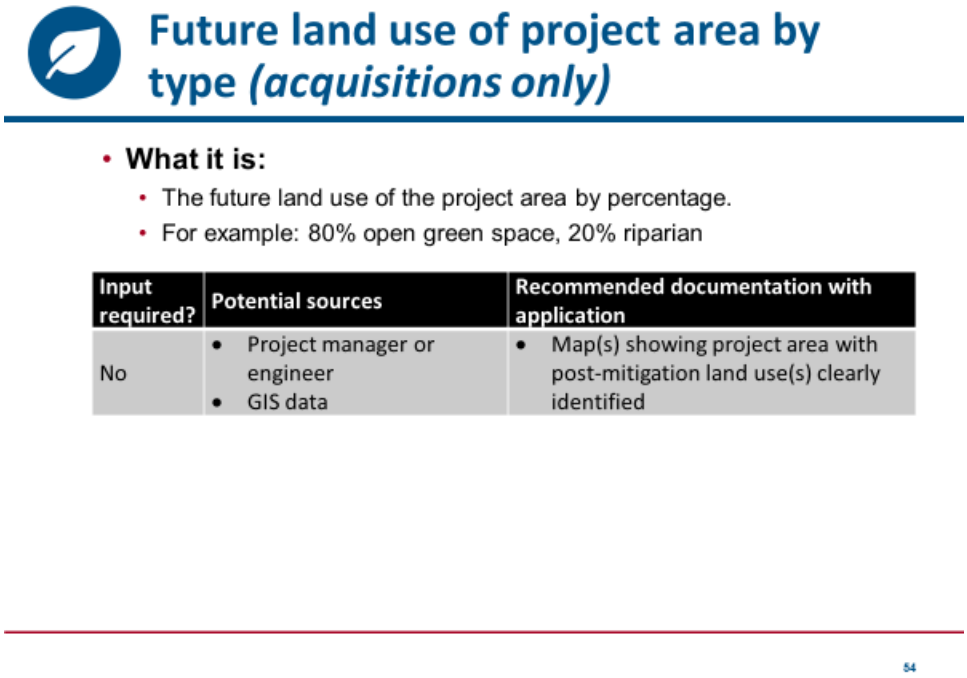
Sources:

- Project manager or engineer
- GIS data
- Tax records

Recommended BCA documentation with application:

- Map(s) showing project area with the acreage clearly identified
- Copy of tax records denoting parcel size

Future land use of project area by type *(acquisitions only)*



Visual 52: Future land use of project area by type (acquisitions only)

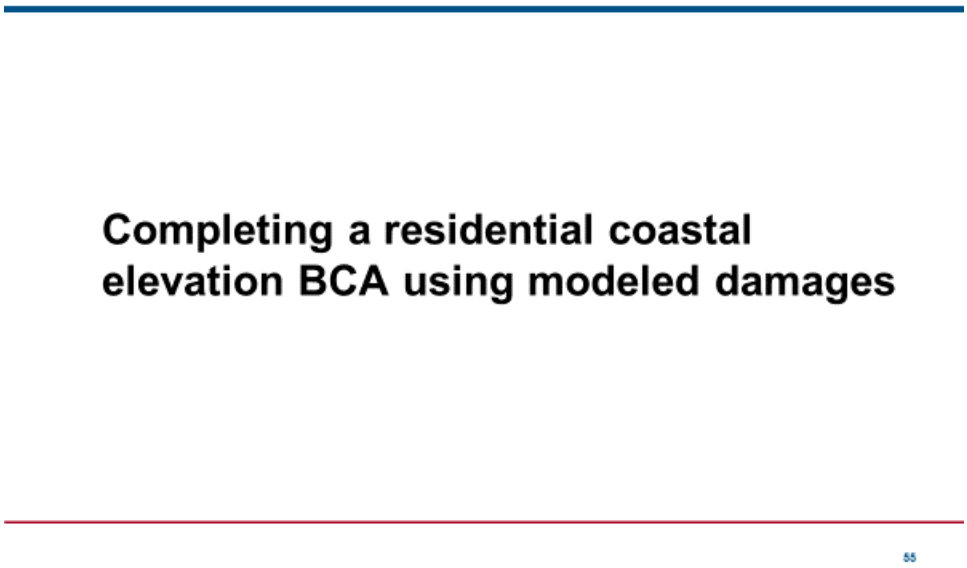
What it is:
- The future land use of the project area by percentage.
- For example: 80% open green space, 20% riparian

Why it's important:
- The size and future land use of the project area are used to calculate the environmental benefits of the project.

Sources:
- Project manager or engineer
- GIS data

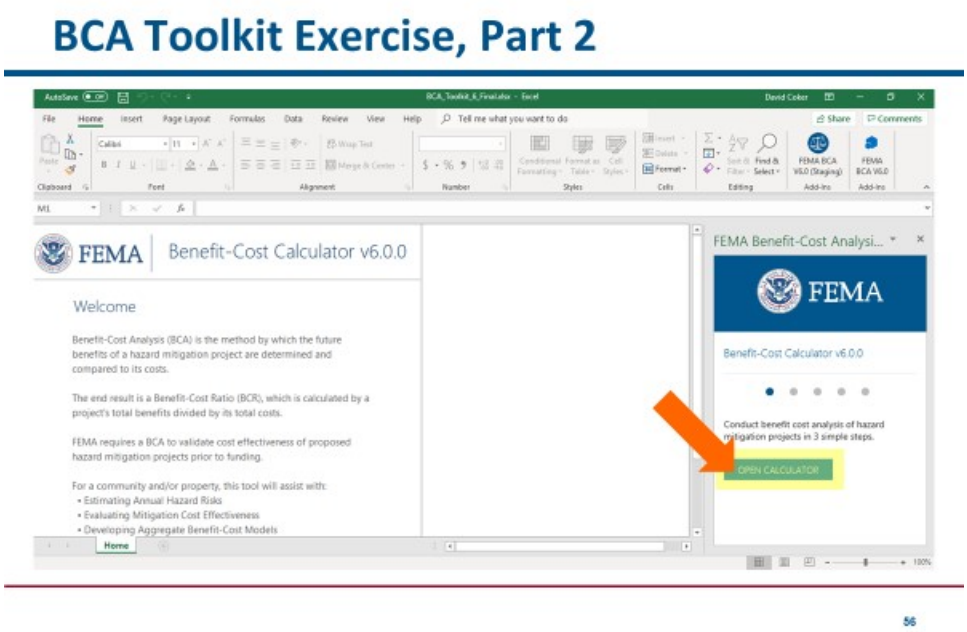
Recommended BCA documentation with application:
- Map(s) showing project area with post-mitigation land use(s) clearly identified

Coastal elevation



Most of the data points for elevations are the same as for acquisitions. Here we will cover the different data points needed for (1) elevations and (2) coastal flood projects using Modeled Damages.

BCA Toolkit Exercise



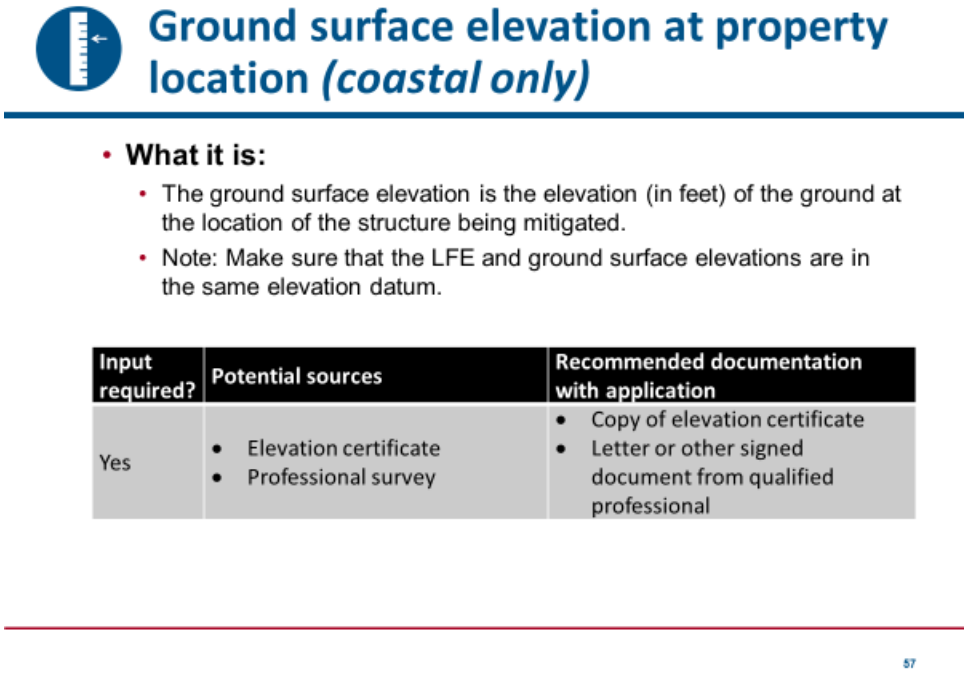
Instructor:

We will show how to complete a residential coastal elevation BCA in the BCA Toolkit. The following slides describe the data inputs in the Toolkit, sources for finding this information, and required documentation with your project application.

The instructor should open the BCA Toolkit on their computer and instruct the students to do the same. Use the following slides to describe each data point as it is input. You may use one of the provided case studies (or another example from a Region or state) to guide the students through data entry on the Project Configuration and then the Project Information screens.

You may also show students the Data Documentation Templates for this project type, which may be found at https://www.fema.gov/benefit-cost-analysis.

Ground surface elevation at property location *(coastal only)*



Visual 53: Ground surface elevation at property location (coastal only)

What it is:

- The ground surface elevation is the elevation (in feet) of the ground at the location of the structure being mitigated.
- Note: Make sure that the LFE and ground surface elevations are in the same elevation datum.

Why it's important:

- By subtracting the ground surface elevation from the lowest floor elevation, the height of the building above the ground can be calculated.

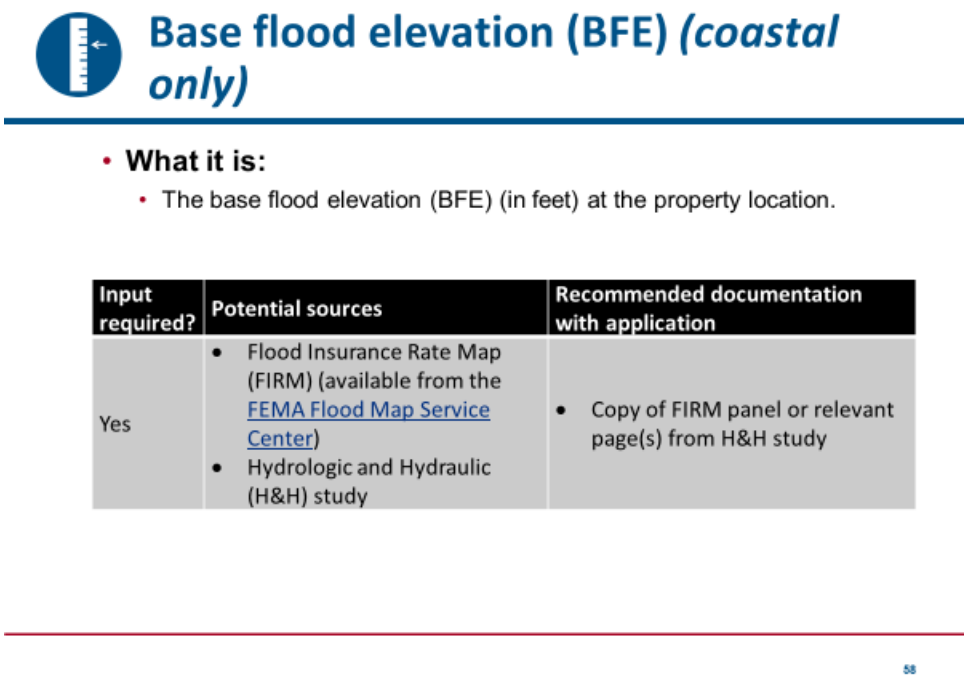
Sources:

- Elevation certificate
- Professional survey

Recommended BCA documentation with application:

- Elevation certificate signed by a qualified professional
- Copy of survey signed by a qualified professional

Ground surface elevation at property location *(coastal only)*



Visual 54: Base flood elevation (coastal only)

What it is:

- The ground surface elevation is the elevation (in feet) of the ground at the location of the structure being mitigated.
- Note: Make sure that the LFE and ground surface elevations are in the same elevation datum.

Why it's important:

- By subtracting the ground surface elevation from the lowest floor elevation, the height of the building above the ground can be calculated.

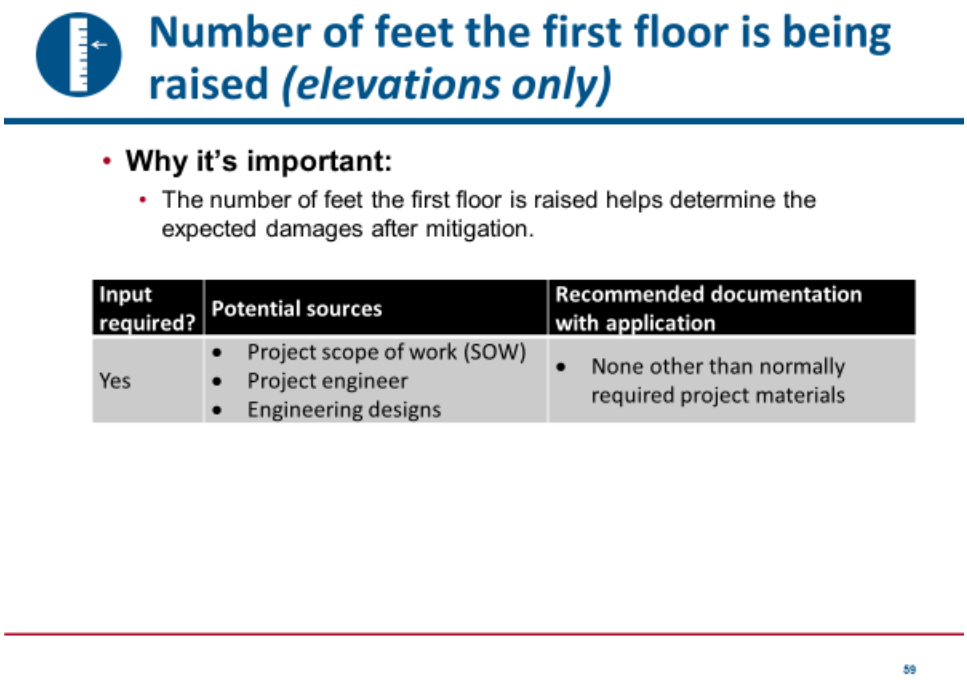
Sources:

- Elevation certificate
- Professional survey

Recommended BCA documentation with application:

- Elevation certificate signed by a qualified professional
- Copy of survey signed by a qualified professional

Number of feet the first floor is being raised *(elevations only)*



Visual 55: Number of feet the 1st floor is being raised (elevations only)

Why it's important:

- The number of feet the first floor is raised helps determine the expected damages after mitigation.

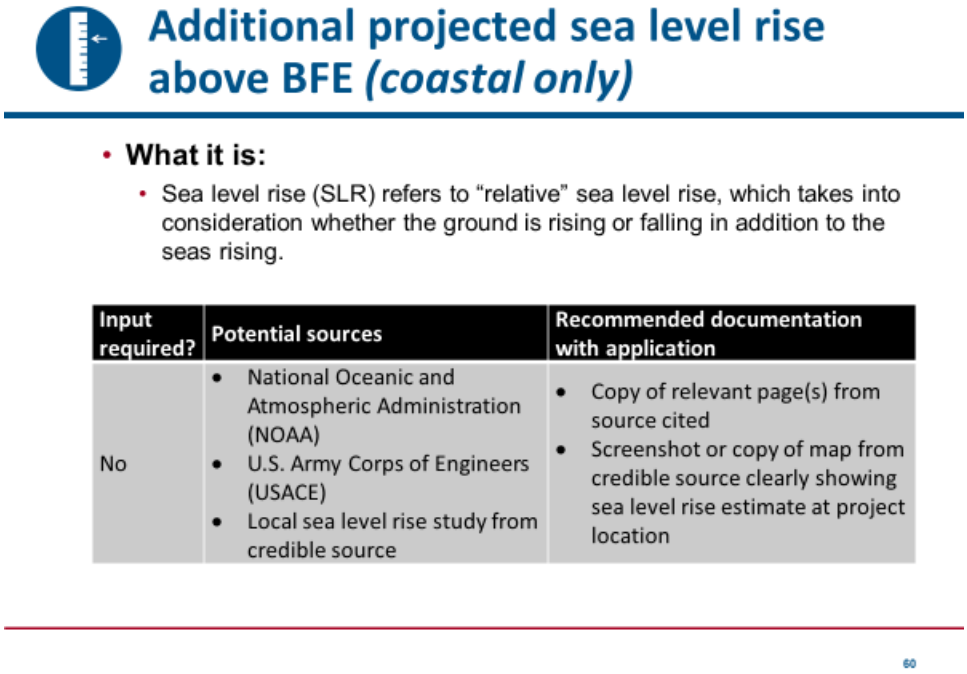
Sources:

- Project scope of work (SOW)
- Project engineer
- Engineering designs

Recommended BCA documentation with application:

- None other than normally required project materials
- Note: The local freeboard requirement may need to be documented in your project application.

Additional projected sea level rise above BFE *(coastal only)*



Visual 56: Additional projected SLR above BFE (coastal only)

What it is:

- 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. Currently, the Toolkit assumes that SLR is static across the PUL of the project.
- For tidal rivers, flood elevations with SLR can also be included as long as there is sufficient supporting documentation.

Why it's important:

- Incorporating sea level rise improves the accuracy of the estimated future losses.
- Adding SLR to stillwater flood elevations creates deeper flood depths used in the BCA Toolkit's calculations, increasing the benefits of the project.

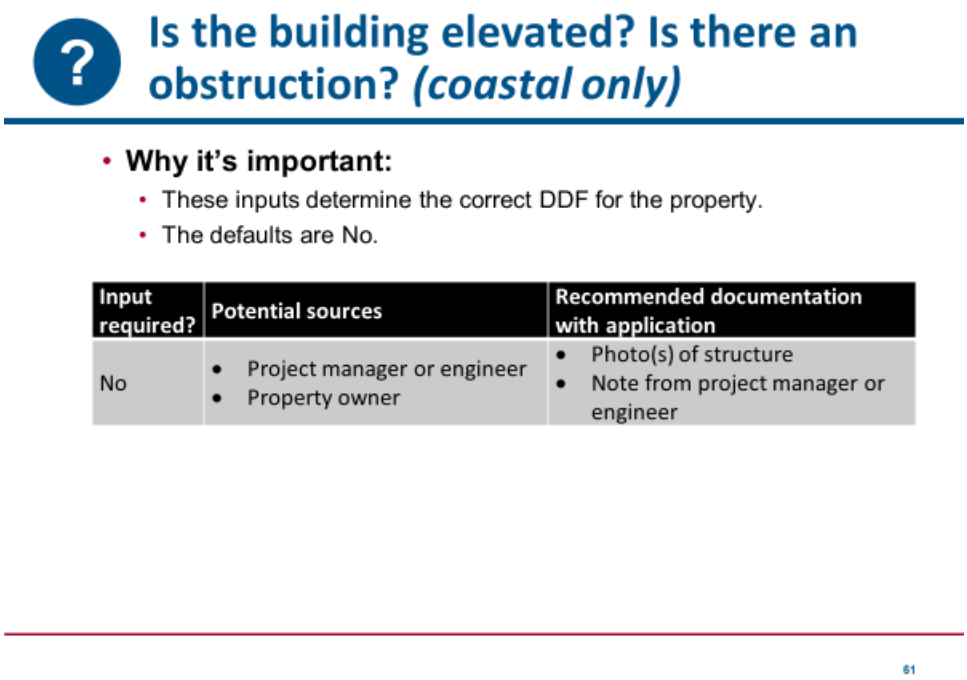
Sources:

- NOAA
- U.S. Army Corps of Engineers (USACE)
- Local sea level rise study from credible source

Recommended BCA documentation with application:

- Copy of relevant page(s) from source cited
- Screenshot or copy of map from credible source clearly showing sea level rise estimate at project location

Is the building elevated? Is there an obstruction? *(coastal only)*



Visual 57: Is the building elevated? Is there an obstruction? (coastal only)

Why it's important:

- These inputs determine the correct DDF for the property.

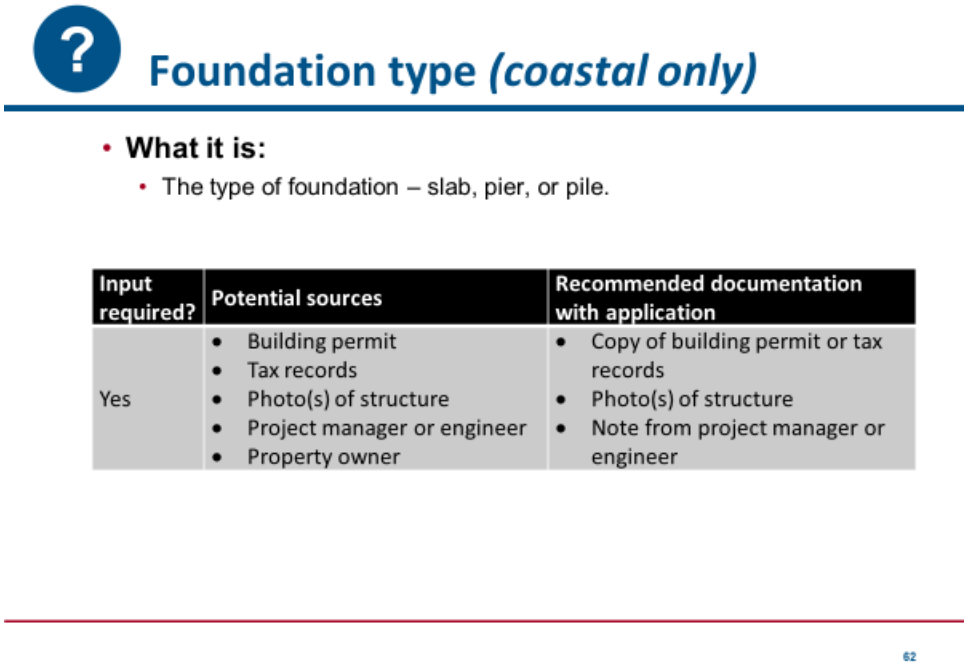
Sources:

- Elevation certificate
- Photo(s) of structure
- Project engineer

Recommended BCA documentation with application:

- Copy of elevation certificate
- Photo(s) of structure
- Note from project manager or engineer

Foundation type *(coastal only)*



Visual 58: Foundation type (coastal only)

What it is:

- The type of foundation – slab, pier, or pile.

Why it's important:

- These inputs determine the correct DDF for the property.

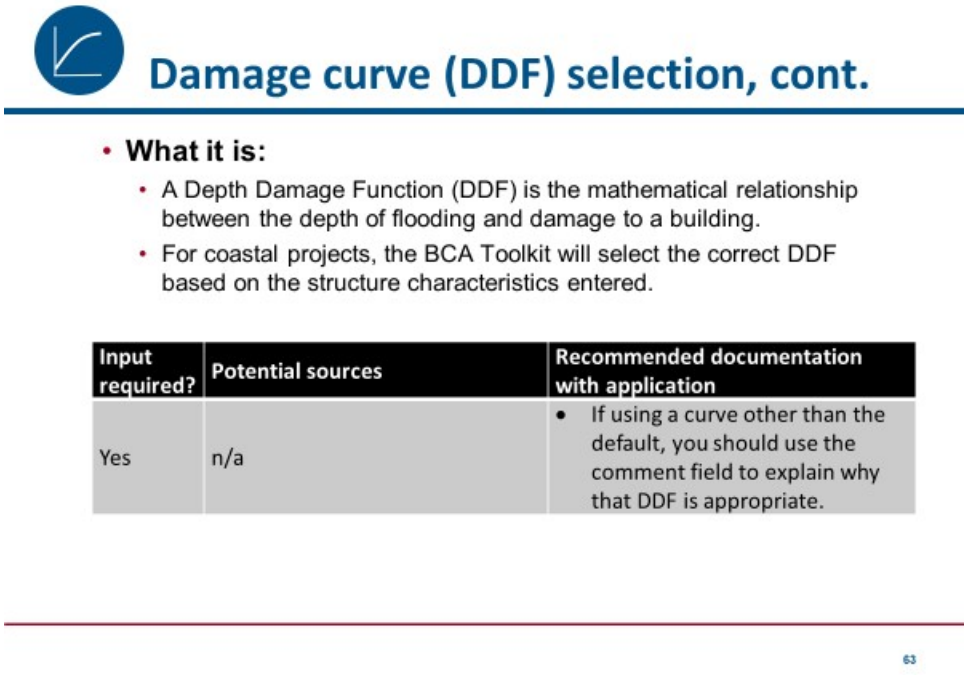
Sources:

- Building permit
- Tax records
- Photo(s) of structure
- Project manager or engineer
- Property owner

Recommended BCA documentation with application:

- Copy of building permit or tax records
- Photo(s) of structure
- Note from project manager or engineer

DDF selection



Visual 59: DDF selection , cont.

What it is:

- A Depth Damage Function (DDF) is the mathematical relationship between the depth of flooding and damage to a building.
- For coastal projects, the BCA Toolkit will select the correct DDF based on the structure characteristics entered.

Recommended BCA documentation with application (if choosing an alternate or custom DDF):

- Note from project manager, engineer, or BCA analyst


Flood Control Projects
64

Flood control projects

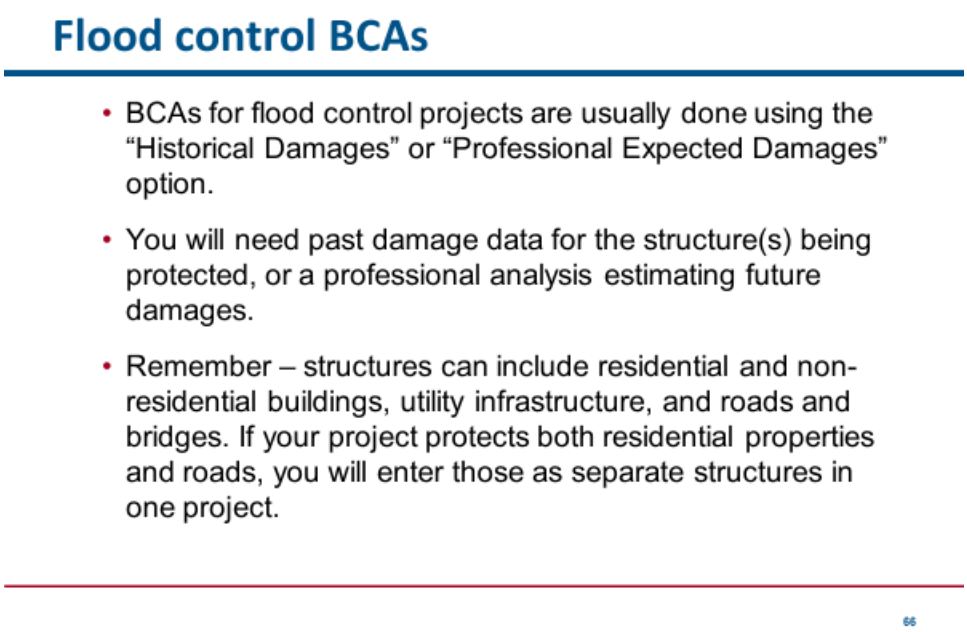
Visual 60: What are flood control projects?

The term "flood control" refers to systemic projects designed to reduce flood damage to a facility or area.

For example:

- Culverts
- Floodplain & stream restoration
- Drainage improvements
- Floodwater diversion & storage
- Floodwalls
- Levees
- Pumping stations

Flood control BCAs



Visual 61: Flood control BCAs

BCAs for flood control projects are usually done using the "Historical Damages" or "Professional Expected Damages" option. If your flood control project lowers the 10-, 50-, 100-, and 500-year flood elevations, and you have an H&H study documenting these values, then you may use the Modeled Damages methodology.

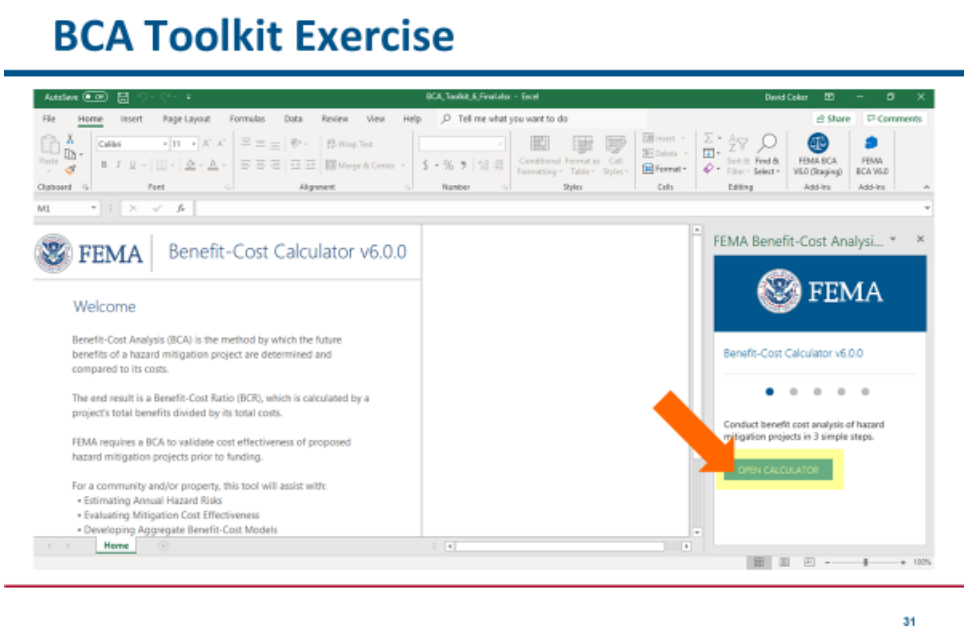
You will need past damage data for the structure(s) being protected, or a professional analysis estimating future damages.

Remember – structures can include residential and non-residential buildings, utility infrastructure, and roads and bridges. If your project protects both residential properties and roads, you will enter those as separate structures in one project.

Completing a flood control BCA using historical damages

67

BCA Toolkit Exercise



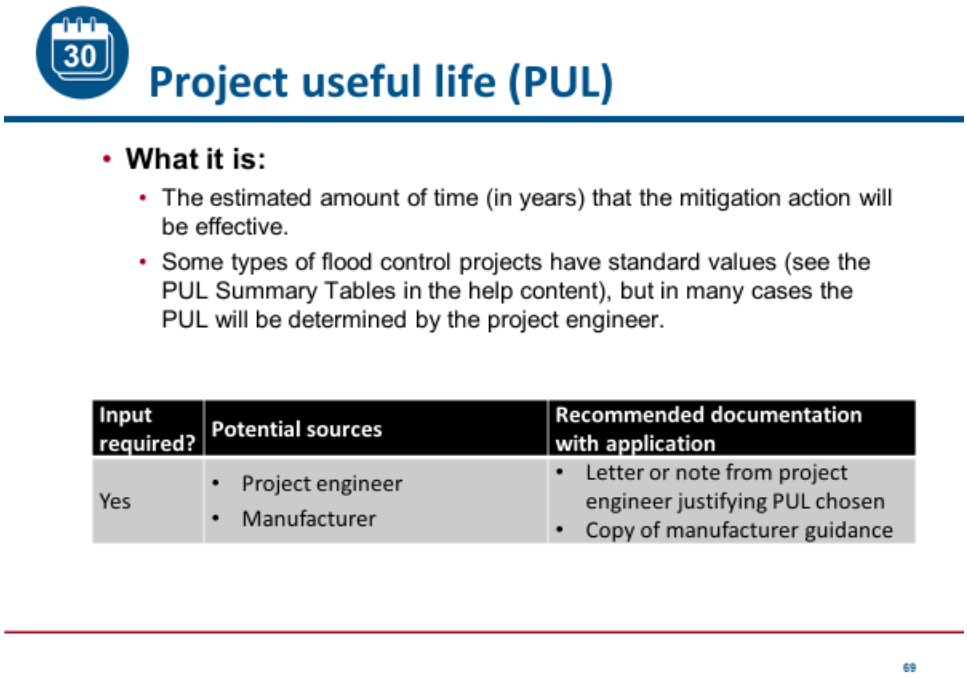
Instructor:

We will show how to complete a flood control BCA using historical damages in the BCA Toolkit. The following slides describe the data inputs in the Toolkit, sources for finding this information, and required documentation with your project application.

The instructor should open the BCA Toolkit on their computer and instruct the students to do the same. Use the following slides to describe each data point as it is input. You may use one of the provided case studies (or another example from a Region or state) to guide the students through data entry on the Project Configuration and then the Project Information screens.

You may also show students the Data Documentation Templates for this project type, which may be found at https://www.fema.gov/benefit-cost-analysis.

PUL for flood control projects



Visual 62: PUL for flood control projects

What it is:

- The estimated amount of time (in years) that the mitigation action will be effective.
- Some types of flood control projects have standard values (see the PUL Summary Tables in the help content), but in many cases the PUL will be determined by the project engineer.

Why it's important:

- The PUL determines the duration of project benefits. Higher PULs result in more benefits.
- The PUL is also used to calculate the amount of project maintenance costs.

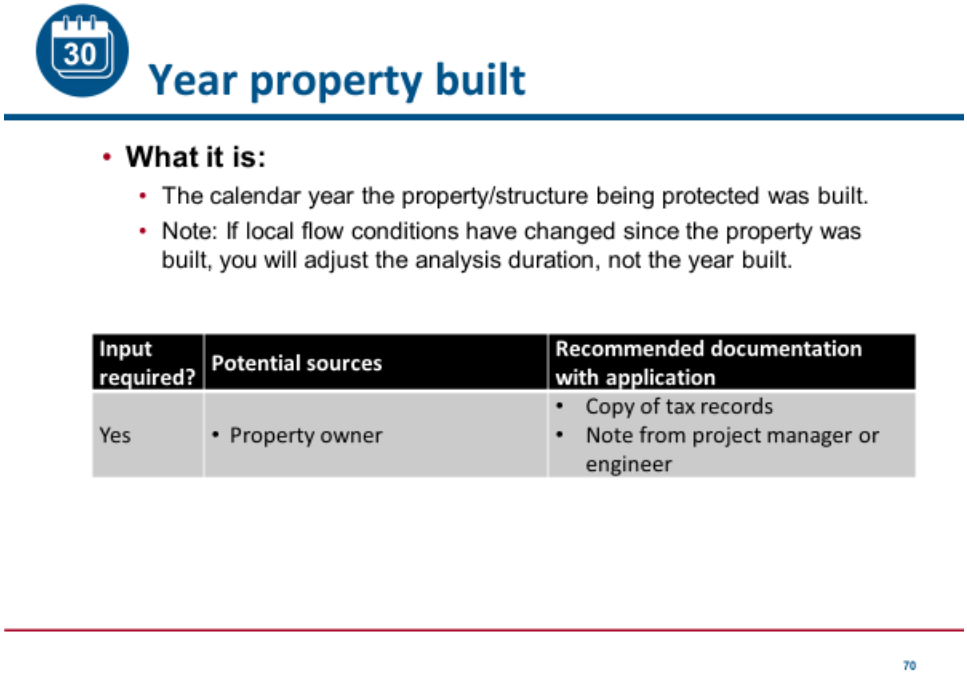
Source(s) for non-standard values:

- Project engineer
- Manufacturer

Required BCA documentation with application:

- Letter or note from project engineer justifying PUL chosen
- Copy of manufacturer guidance

Year property built



Visual 63: Year property built

What it is:

- The calendar year the property/structure being protected was built.
- Note: If local flow conditions have changed since the property was built, you will adjust the analysis duration, not the year built.

Why it's important:

- The BCA Toolkit uses the year the facility was built to determine the analysis duration for calculating benefits.
- The shorter the analysis duration, the higher the BCR.

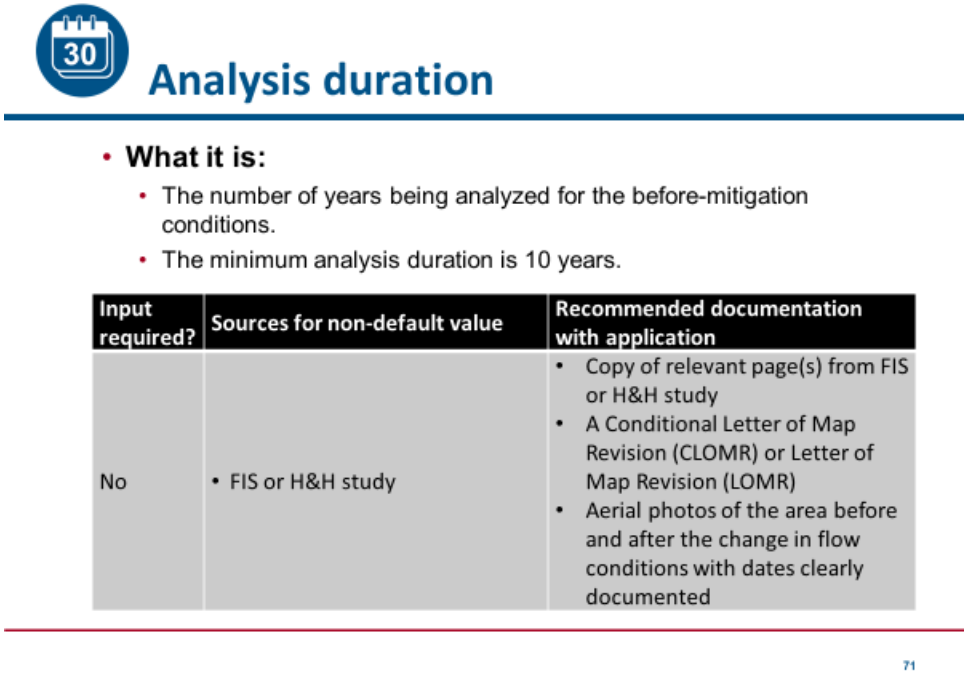
Source(s):

- Tax records
- Property owner

Recommended BCA documentation with application:

- Copy of tax records
- Note from project manager or engineer

Analysis duration



Visual 64: Analysis duration

What it is:

- The number of years being analyzed for the before-mitigation conditions.
- The minimum analysis duration is 10 years.
- The default value is the analysis year minus the year the property was built. However, if there has a been a change in local flow conditions since the property was built, the user may wish to enter a different analysis duration. For example, if a property was built in 1980, but a large shopping center was built nearby in 1990 that changed the local flow conditions, the analysis duration would be:

$$analysis\ duration\ =\ [analysis\ year]\ -\ 1990$$

Why it's important:

- The shorter the analysis duration, the higher the BCR.

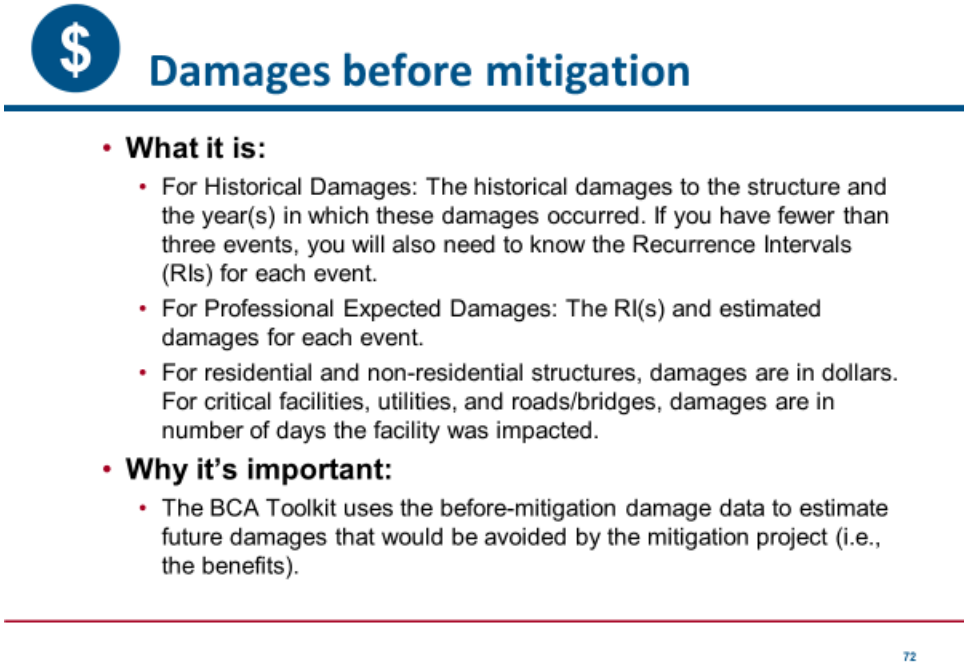
Source(s) for non-default value:

- FIS or H&H study

Recommended BCA documentation with application:

- Copy of relevant page(s) from FIS or H&H study
- A Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR)
- Aerial photos of the area before and after the change in flow conditions with dates clearly documented

Damages before mitigation



Visual 65: Damages before mitigation

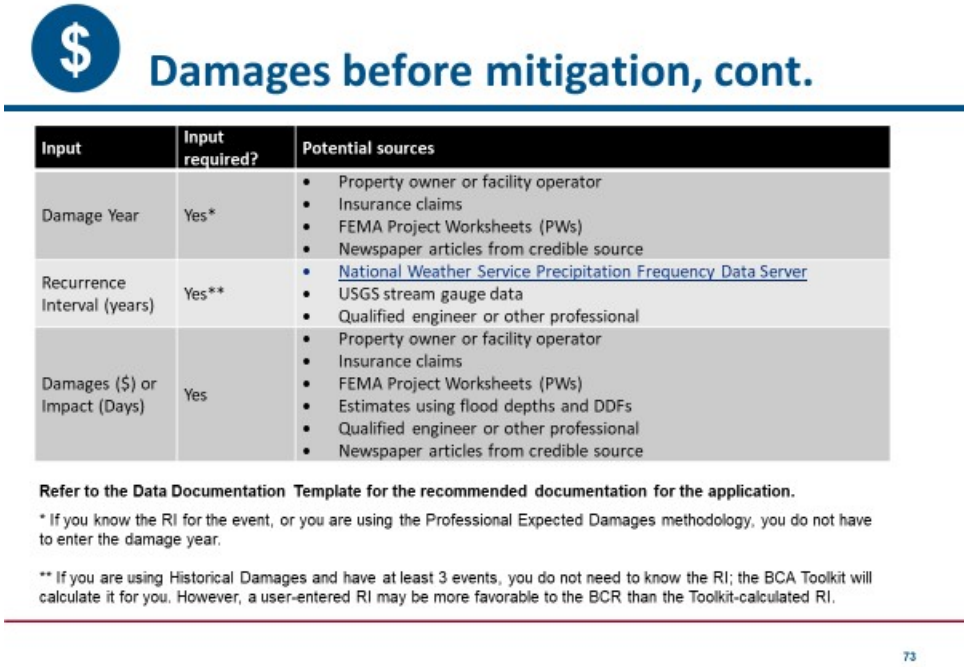
What it is:

- The historical damages to the structure and the year(s) in which these damages occurred. If you have fewer than three events, you will also need to know the Recurrence Intervals (RIs) for each event.
- For residential and non-residential structures, damages are in dollars. For critical facilities and roads/bridges, damages are in number of days the facility was impacted.

Why it's important:

- The BCA Toolkit uses the before-mitigation damage data to estimate future damages that would be avoided by the mitigation project (i.e., the benefits).

Damages before mitigation



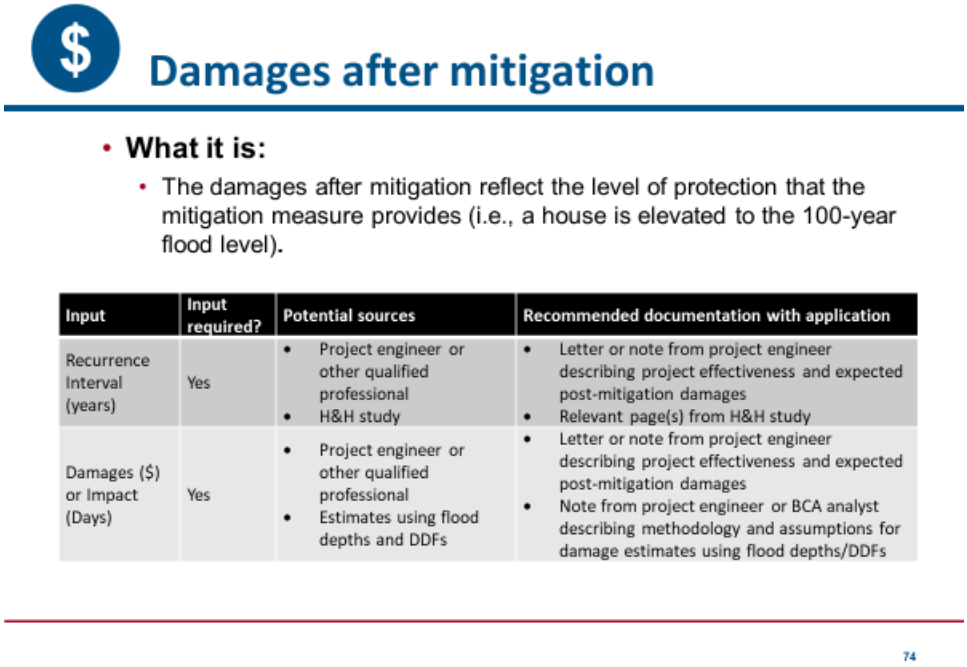
Visual 66: Damages before mitigation , cont.

See the Data Documentation Template for full details.

Remember that **extraordinary claims require extraordinary documentation**! A 1-year RI means that event happens **every year**. You must have documentation for this!

We will show how to calculate damages using flood depths and DDFs later in this unit.

Damages after mitigation



Visual 67: Damages after mitigation

What it is:

- Recall that only acquisition projects are 100% effective. All other project types will have some damages after mitigation.
- The damages after mitigation reflect the level of protection that the mitigation measure provides (i.e., a house is elevated to the 100-year flood level)**.**
- For non-residential structures, the after-mitigation damages will be in number of days the service is expected to be down. Likewise, the number of days of lost service should be lower after mitigation, up to the level of protection.

Why it's important:

- The BCA Toolkit uses project effectiveness to estimate damages after mitigation.

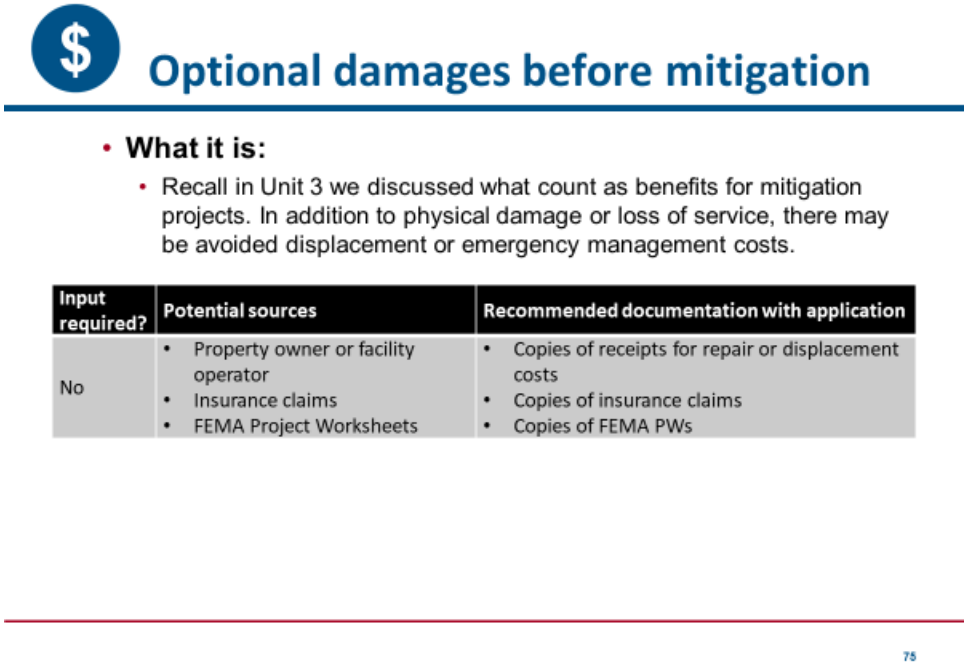
Source(s):

- H&H study
- Project engineer or other qualified professional
- For residential structures, we can use DDFs to estimate these damage amounts, but the difference is that for the after-mitigation damages, we need to know the recurrence interval for the flood depths. For a flood control project, the flood depths for the same recurrence interval should be lower after mitigation, at least up to the level of protection. (Otherwise, the mitigation project is not effective!)

Recommended BCA documentation with application:

- Letter or note from project engineer describing project effectiveness and expected post-mitigation damages
- Relevant page(s) from H&H study
- Note from project engineer or BCA analyst describing methodology and assumptions for damage estimates using flood depths/DDFs

Optional damages before mitigation



Visual 68: Optional damages before mitigation

What it is:

- Recall in Unit 3 we discussed what count as benefits for mitigation projects. In addition to physical damage or loss of service, there may be avoided displacement or emergency management costs.
- For residential and non-residential structures, optional damages might include displacement costs.
- For critical facilities, utilities, and roads/bridges, optional damages might include physical damages or one-time displacement costs.

Why it's important:

- Any additional before-mitigation damages that can be identified add to the benefits of the project, increasing the BCR.

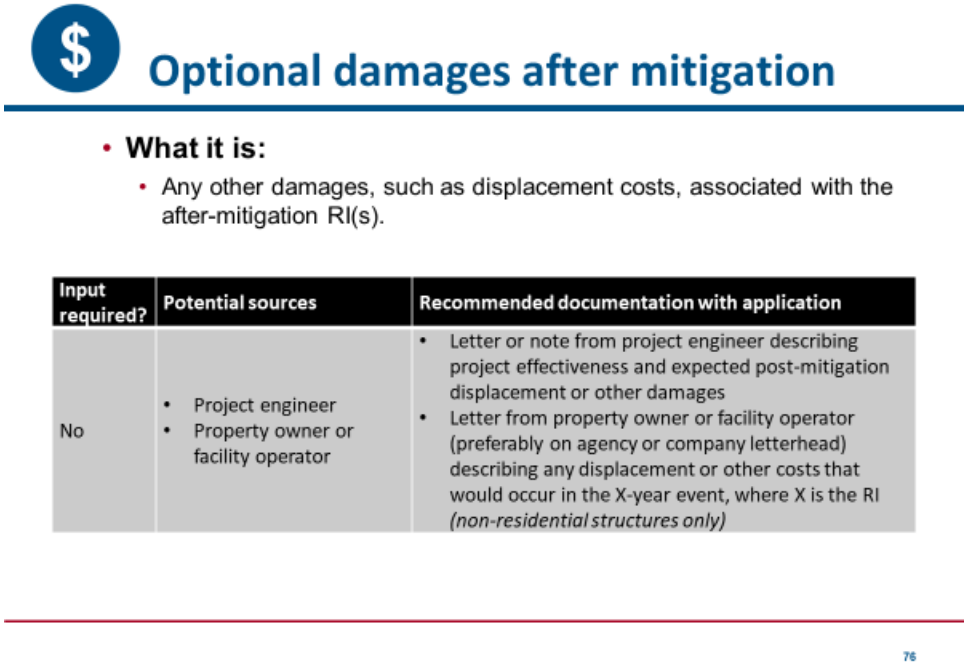
Source(s):

- Property owner or facility operator
- Insurance claims
- FEMA Project Worksheets (PWs)

Recommended BCA documentation with application:

- Copies of receipts for repair or displacement costs
- Copies of insurance claims
- Copies of FEMA PWs

Optional damages after mitigation



Visual 69: Optional damages after mitigation

What it is:

- Any other damages, such as displacement costs, associated with the after-mitigation RI(s).

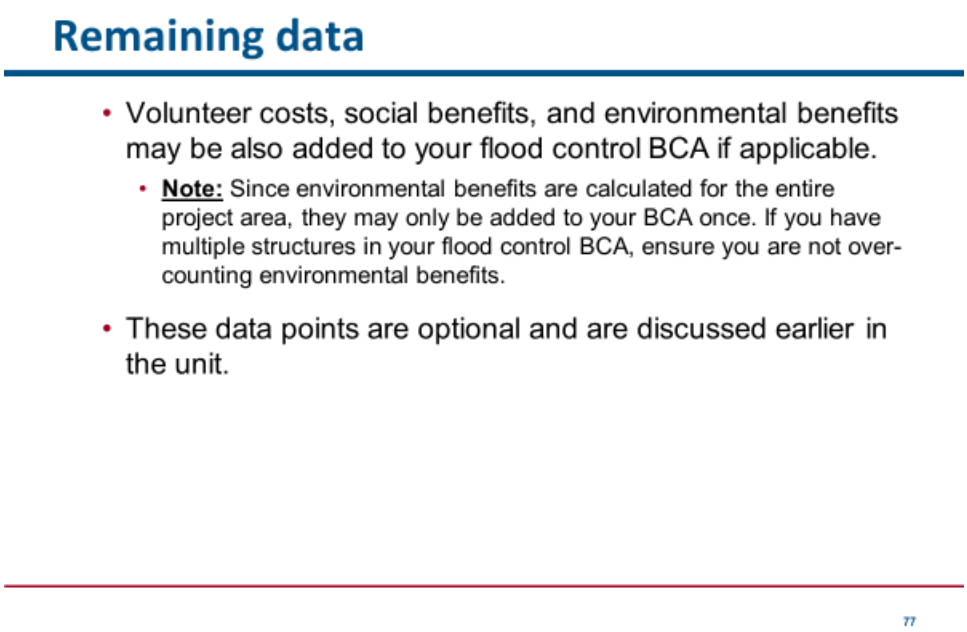
Source(s):

- Project engineer
- Property owner or facility operator

Recommended BCA documentation with application:

- Letter or note from project engineer describing project effectiveness and expected post-mitigation displacement or other damages
- Letter from property owner or facility operator (preferably on agency or company letterhead) describing any displacement or other costs that would occur in the X-year event, where X is the RI *(non-residential structures only)*

Remaining data



Visual 70: Remaining data

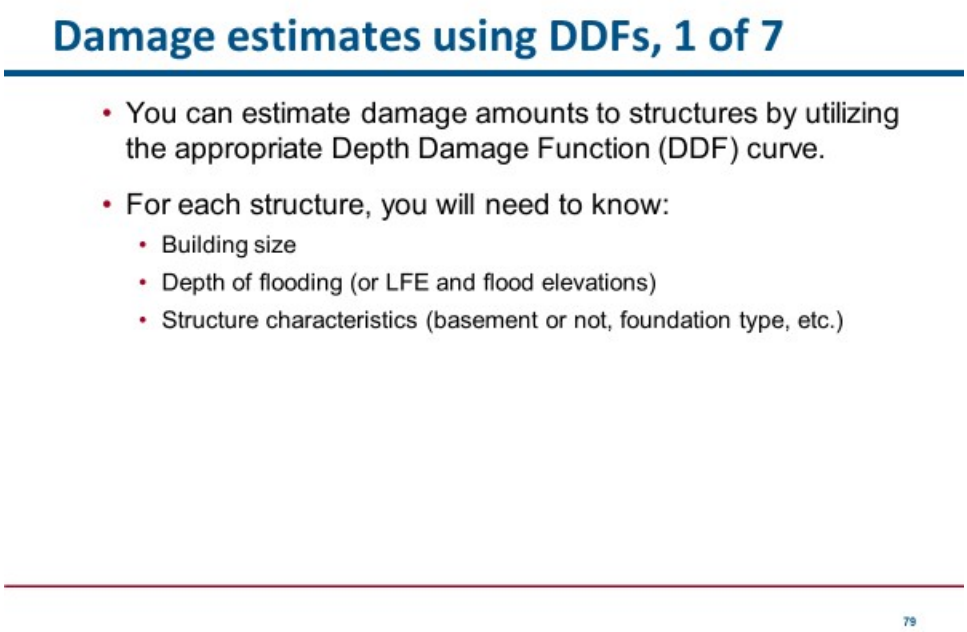
Volunteer costs, social benefits, and environmental benefits may be also added to your flood control BCA if applicable.

- **Note:** Since environmental benefits are calculated for the entire project area, they may only be added to your BCA once. If you have multiple structures in your flood control BCA, ensure you are not over-counting environmental benefits.

These data points are optional and are discussed earlier in the unit.


Damage estimates using DDFs
78

Damage estimates using DDFs



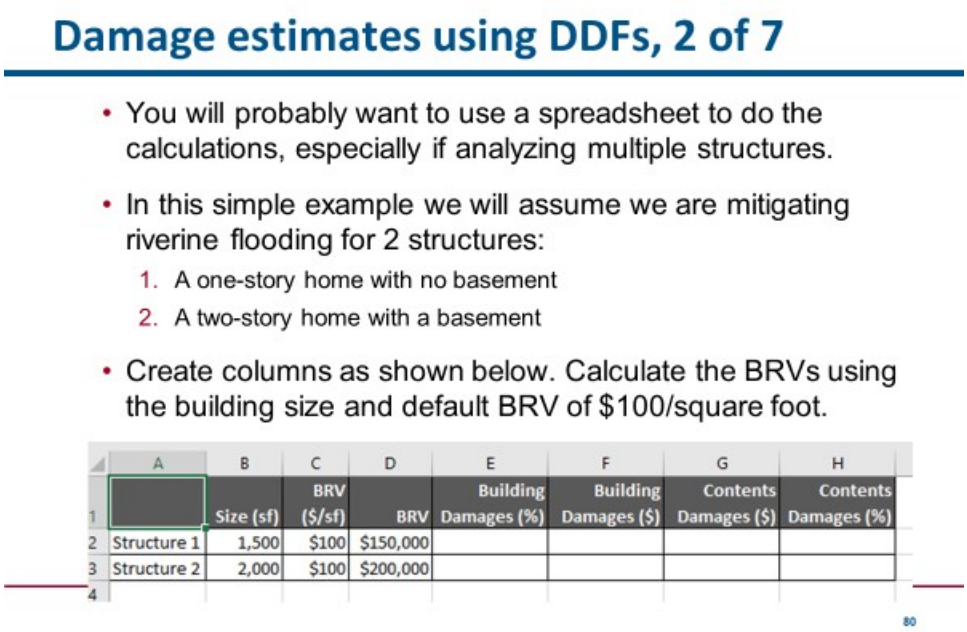
Visual 71: Damage estimates using DDFs, 1 of 7

Instructor:
You can estimate damage amounts to residential structures by utilizing the appropriate Depth Damage Function (DDF) curve.

For each structure, you will need to know:

- Building size
- Depth of flooding (or LFE and flood elevations)
- Structure characteristics (basement or not, foundation type, etc.)

Damage estimates using DDFs



Visual 72: Damage estimates using DDFs, 2 of 7

Instructor:
You will probably want to use a spreadsheet to do the calculations, especially if analyzing multiple structures.

In this simple example we will assume we are mitigating riverine flooding for 2 structures:

1. A one-story home with no basement
2. A two-story home with a basement

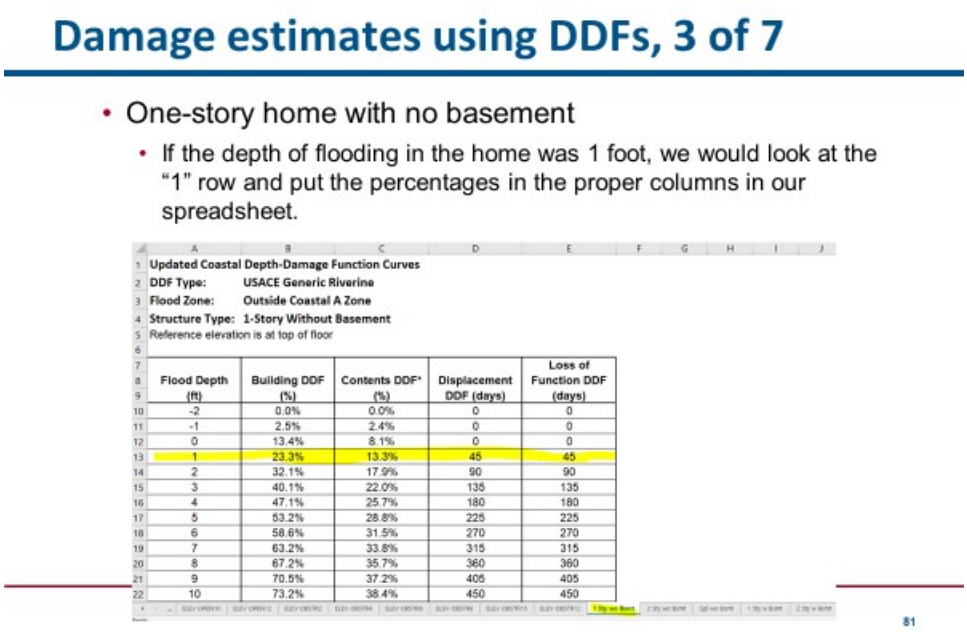
If time allows, open Microsoft Excel on your computer and create columns as shown below. Have the students follow along on their own computers. Calculate the BRVs by multiplying the building size by the default BRV of $100/square foot.

	A	B	C	D	E	F	G	H
1		Size (sf)	BRV ($/sf)	BRV	Building Damages (%)	Building Damages ($)	Contents Damages ($)	Contents Damages (%)
2	Structure 1	1,500	$100	$150,000				
3	Structure 2	2,000	$100	$200,000				
4								

Figure 2: Spreadsheet example showing BRV calculation

Note that some FEMA Regions and disaster staff have developed their own spreadsheets to do this math quickly. You can ask your Region or disaster POC if they know of any.

Damage estimates using DDFs



Visual 73: Damage estimates using DDFs, 3 of 7

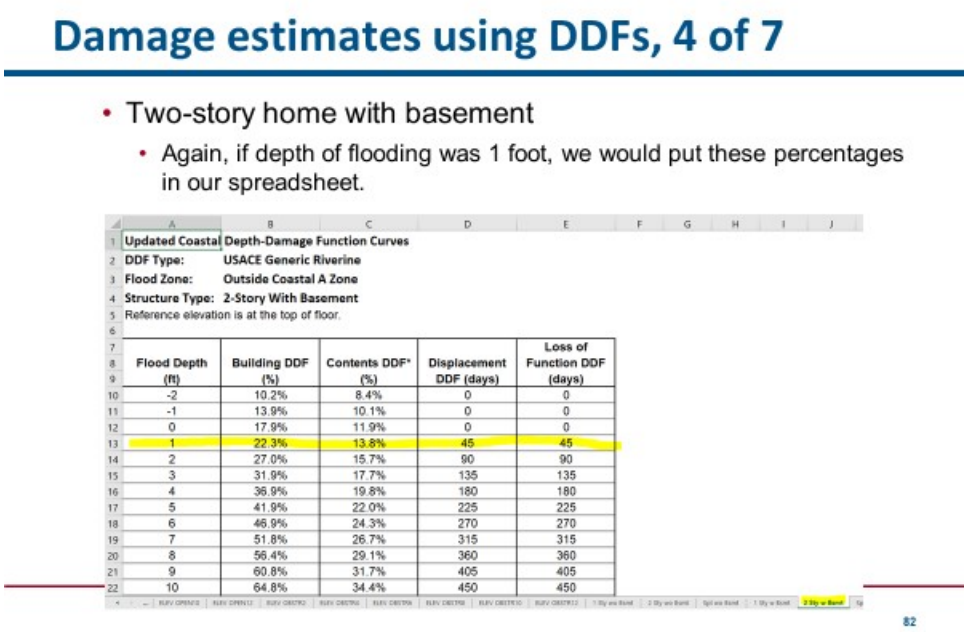
Instructor:

Open the DDF spreadsheet and navigate to the correct tab (One-story home with no basement):

- If the depth of flooding in the home was 1 foot, we would look at the "1" row and put the percentages in the proper columns in our spreadsheet.

For depths of flooding that are in between feet (say 1.4 feet, which is between 1 and 2) you should use the lesser number.

Damage estimates using DDFs



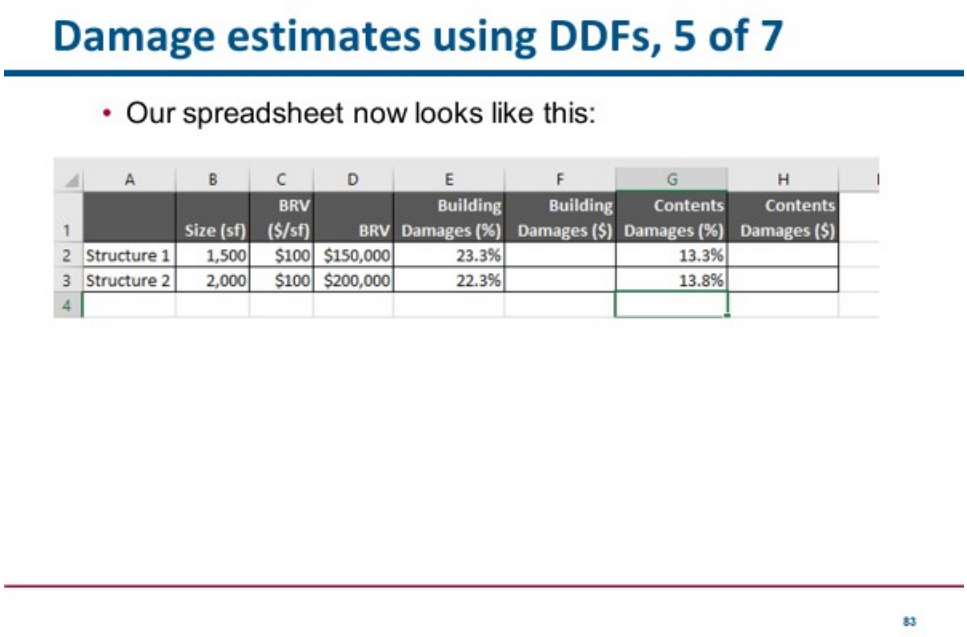
Visual 74: Damage estimates using DDFs, 4 of 7

Instructor:

Open the DDF spreadsheet and navigate to the correct tab for the other structure (Two-story home with no basement):

- If the depth of flooding in the home was 1 foot, we would look at the "1" row and put the percentages in the proper columns in our spreadsheet.

Damage estimates using DDFs



Visual 75: Damage estimates using DDFs, 5 of 7

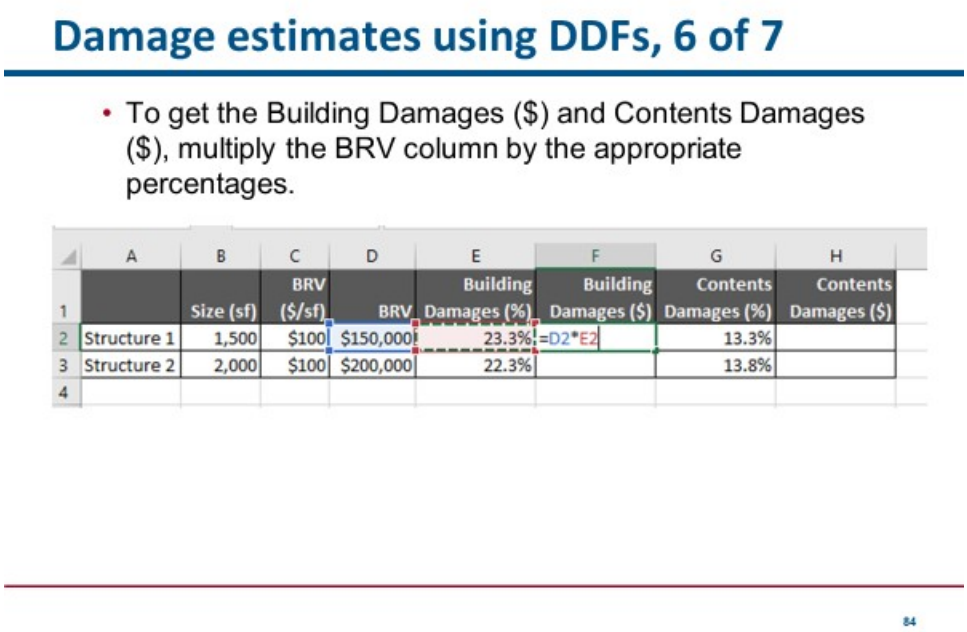
Our spreadsheet now looks like this:

	A	B	C	D	E	F	G	H
1		Size (sf)	BRV ($/sf)	BRV	Building Damages (%)	Building Damages ($)	Contents Damages (%)	Contents Damages ($)
2	Structure 1	1,500	$100	$150,000	23.3%		13.3%	
3	Structure 2	2,000	$100	$200,000	22.3%		13.8%	
4								

Figure 3: Spreadsheet example showing building and contents damage percentages

Instructor should pause here to make sure everyone understands where the percentages came from.

Damage estimates using DDFs



Visual 76: Damage estimates using DDFs, 6 of 7

Instructor:

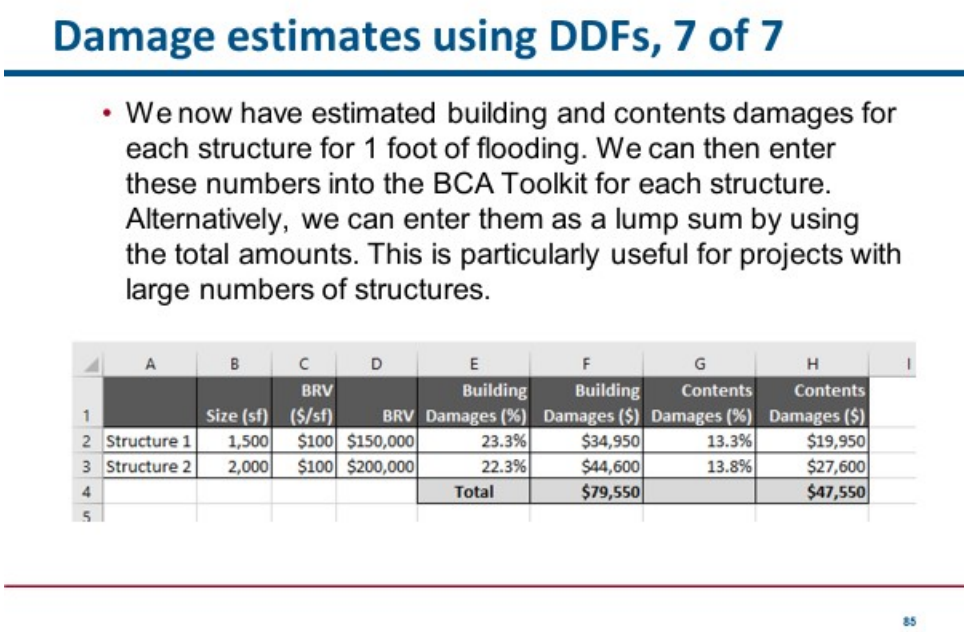
To get the Building Damages ($) and Contents Damages ($), multiply the BRV column by the appropriate percentages.

	A	B	C	D	E	F	G	H
1		Size (sf)	BRV ($/sf)	BRV	Building Damages (%)	Building Damages ($)	Contents Damages (%)	Contents Damages ($)
2	Structure 1	1,500	$100	$150,000	23.3%	=D2*E2	13.3%	
3	Structure 2	2,000	$100	$200,000	22.3%		13.8%	
4								

Figure 4: Spreadsheet example showing how building damages (in dollars) are calculated

Instructor should pause here to make sure everyone understands how to calculate the Building Damages ($) and Contents Damages ($) columns.

Damage estimates using DDFs



	A	B	C	D	E	F	G	H	I
1		Size (sf)	BRV ($/sf)	BRV	Building Damages (%)	Building Damages ($)	Contents Damages (%)	Contents Damages ($)	
2	Structure 1	1,500	$100	$150,000	23.3%	$34,950	13.3%	$19,950	
3	Structure 2	2,000	$100	$200,000	22.3%	$44,600	13.8%	$27,600	
4					Total	$79,550		$47,550	
5									

Visual 77: Damage estimates using DDFs, 7 of 7

Instructor:

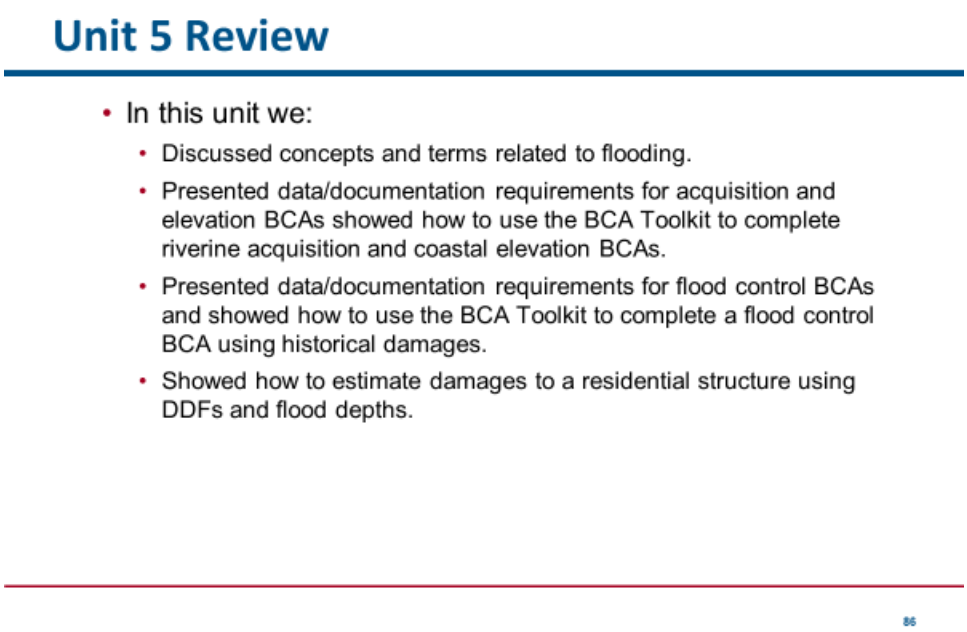
We now have estimated building and contents damages for each structure for 1 foot of flooding. We can then enter these numbers into the BCA Toolkit for each structure. Alternatively, we can enter them as a lump sum by using the total amounts. This is particularly useful for projects with large numbers of structures.

If time allows, show the students how to enter the damage totals into the BCA Toolkit. You may use the same project file as the flood control project exercise.

In order to enter these values into the BCA Toolkit, we will need to know the recurrence interval for the event that caused these damages OR we must have at least 3 events.

If you use a spreadsheet to do these estimates, you should include it in some form in your project application so the reviewer can see how you arrived at the values.

Unit 5 Review



Visual 78: Unit 5 Review

Instructor:

In this unit we:

- Discussed concepts and terms related to flooding.
- Presented data/documentation requirements for acquisition and elevation BCAs showed how to use the BCA Toolkit to complete riverine acquisition and coastal elevation BCAs.
- Presented data/documentation requirements for flood control BCAs and showed how to use the BCA Toolkit to complete a flood control BCA using historical damages.
- Showed how to estimate damages to a residential structure using DDFs and flood depths.