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## **Unit 3**

### The Benefit-Cost Model

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## Objectives

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

- Describe what the Benefit-Cost Ratio (BCR) is for hazard mitigation projects.
- List allowable benefits and costs for FEMA BCAs.
- Name the other variables that factor into the BCR calculation, and how they impact the result.

## Scope

- Unit 3 Overview & Objectives
- Benefit-Cost Ratio and Model overview
- Benefits
- Costs
- Project Useful Life (PUL)
- Recurrence Intervals (RIs)
- Project effectiveness
- Unit 3 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.

## Time Plan

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 3 Overview and Objectives (5 minutes)
- Benefit-Cost Ratio and Model overview (5 minutes)
- Benefits (50 min)
- Costs (10 min)
- Project Useful Life (PUL) (5 min)
- Recurrence Intervals (RIs) (10 min)
- Project effectiveness (10 min)
- Unit 3 Review (5 minutes)

**Total Time (Estimated): 1 hour 40 minutes**

## Materials

- Unit 3 Visuals
- Unit 3 Instructor Guide
- Unit 3 Student Manual

**Unit 3 Overview**

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## Unit 3 Overview

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- In this unit, we will discuss the following:
  - What count as benefits?
  - What count as costs?
  - How is the BCR calculated for FEMA hazard mitigation projects?

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*Visual 1: Unit 3 Overview*

**Instructor:**

In this unit we will cover several topics:

- What count as benefits?
- What count as costs?
- How is the BCR calculated for FEMA hazard mitigation projects?

**Unit 3 Objectives**

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## Unit 3 Objectives

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- Students should be able to describe what the Benefit-Cost Ratio (BCR) is for hazard mitigation projects.
- Students should be able to list allowable benefits and costs for FEMA BCAs.
- Students should be able to name the other variables that factor into the BCR calculation, and how they impact the result.

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*Visual 2: Unit 3 Objectives*

**Instructor:**

The purpose of this unit is for you to become familiar with benefits, costs, and how the Benefit-Cost Ratio is calculated. At the end of this unit, you should be able to:

- Describe what the Benefit-Cost Ratio (BCR) is for hazard mitigation projects.
- List allowable benefits and costs for FEMA BCAs.
- Name the other variables that factor into the BCR calculation, and how they impact the result.

**Benefit-Cost Ratio**

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## Benefit-Cost Ratio

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- Remember, to know whether a project is cost-effective, we must calculate the **Benefit-Cost Ratio (BCR)**.
- To do this, we must first add up the benefits, then add up the costs, and divide.

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

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*Visual 3: Benefit-Cost Ratio*

**Instructor:**

Remember, to know whether a project is cost-effective, we must calculate the Benefit-Cost Ratio (BCR).

To do this, we must first add up the benefits, then add up the costs, and divide.

## Benefit-Cost Model

## Benefit-Cost Model

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

- However, this equation is deceptively simple:
  - How do we know what counts as a benefit, and as a cost?
  - How do we account for the frequency of the hazard event, the project lifespan, and other factors impacting a project's effectiveness?
- We'll discuss these questions in this unit.
- Keep in mind that the BCR should be thought of as a range. Two different BCA analysts might get different BCRs even with the same basic project information.

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*Visual 4: Benefit-Cost Model*

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

**Instructor:**

However, the BCR equation is deceptively simple.

How do we know what counts as a benefit, and as a cost?

How do we account for the frequency of the hazard event, the project lifespan, and other factors impacting a project's effectiveness?

We'll discuss these questions in this unit.

## Benefits

## Benefits

- **Benefits** are any future costs or losses that can be avoided by completing a mitigation project.
  - i.e., the difference in the costs before mitigation and costs after mitigation.

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

**Benefits** = *Costs Before Mitigation* – *Costs After Mitigation*

- Future costs should be counted regardless of who pays for them, whether federal, state/local, or property owner.

*Visual 5: Benefits*

### **Instructor:**

Benefits are any future costs or losses that can be avoided by completing a mitigation project. They can also be thought of as the difference in the costs before mitigation and costs after mitigation.

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



*Review the below equation with the students:*

$$\text{Benefits} = \text{Costs Before Mitigation} - \text{Costs After Mitigation}$$

OMB Circular A-94 states that benefits must always be counted from the perspective of the affected community, not from the perspective of FEMA or the federal government. Thus, for benefit-cost analysis of hazard mitigation projects, a broad range of benefits may legitimately be counted, even if Federal programs do not address actually compensate for the damages when they occur.

Similarly, future costs should be counted regardless of who pays for them, whether federal, state/local, or property owner.

Note that just because your project is above a 1.0 does NOT mean you should stop counting benefits. If project costs increase during the project implementation phase, having those benefits included in the

original BCA can make sure your project remains cost-effective. Some Regions require that you re-calculate the BCR if the project costs change or at project closeout, so it's important to capture all your benefits regardless of BCR.

## Annualized benefits

## Annualized benefits

- Due to the unpredictable nature of hazard events, we estimate the benefits of a hazard mitigation project on an annual basis rather than in specific years.
- The BCA Toolkit uses hazard frequency, damage data, and project effectiveness to estimate:
  - Annual costs before mitigation
  - Annual costs after mitigation

$$\text{Annual Benefits} = \text{Annual Costs Before Mitigation} - \text{Annual Costs After Mitigation}$$

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*Visual 6: Annualized benefits*

### **Instructor:**

Due to the unpredictable nature of hazard events, we estimate the benefits of a hazard mitigation project on an annual basis rather than in specific years.

The BCA Toolkit calculates the annualized benefits for you. This slide is just intended to explain why you see results called “Annual Losses” in the BCA Toolkit.

The BCA Toolkit uses hazard frequency, damage data, and project effectiveness to estimate:

- Annual costs before mitigation
- Annual costs after mitigation



*Review the below equation with the students:*

$$\text{Annual Benefits} = \text{Annual Costs Before Mitigation} - \text{Annual Costs After Mitigation}$$

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**What are considered benefits?**

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## What are considered benefits?

- Avoided future costs/losses can include:
  - Physical damage
  - Loss of service/function
  - Injury or death
  - Displacement costs
  - Emergency management costs
  - NFIP administration costs
- Let's discuss each of these.



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*Visual 7: What are considered benefits?*

**Instructor:**

Remember, benefits are any future costs or losses that can be avoided by completing a mitigation project. These avoided future costs/losses can include:

- Physical damage
- Loss of service/function
- Injury or death
- Displacement costs
- Emergency management costs
- NFIP administration costs

Let's discuss each of these.

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**Avoided physical damages**

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## Avoided physical damages

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- One of the primary benefits of a hazard mitigation project is avoided physical damages.
  - For example, if a property is acquired and demolished, it can no longer be damaged by flood or any other hazard.
  - Likewise, if a structure is elevated, it will not flood unless the floodwaters rise higher than the lowest floor.
- Physical damages can include:
  - Structural damage to buildings or infrastructure
  - Contents damage
  - Damage to historic/cultural resources
  - Site contamination

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*Visual 8: Avoided physical damages*

**Instructor:**

One of the primary benefits of a hazard mitigation project is avoided physical damages.

For example, if a property is acquired and demolished, it can no longer be damaged by flood or any other hazard. Likewise, if a structure is elevated, it will not flood unless the floodwaters rise higher than the lowest floor.

Physical damages are probably the easiest category of damages and losses and benefits to understand. Buildings, contents, infrastructure, landscaping, vehicles and equipment are damaged by a flood or other disaster event. The monetary damages are simply the cost to repair or replace the damaged property. For physical damages, benefits are simply the avoided damages; that is, the reduction in future damages attributable to a mitigation project.

Physical damages can include:

- Structural damage to buildings or infrastructure
- Contents damage
- Damage to historic/cultural resources
- Site contamination

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**Avoided physical damages**

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## Avoided physical damages, cont.

- How do we quantify – that is, express in dollar terms – avoided physical damages?
  - We can use either (1) hazard-specific information or (2) past or expected damage data to estimate the amount of damage expected in the future.
  - FEMA's BCA Toolkit (discussed further in Unit 4) will perform these calculations for you, provided you enter the right data. Units 5-16 cover data requirements for various types of mitigation projects.



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*Visual 9: Avoided physical damages, cont.*

**Instructor:**

Remember that to include a benefit in our BCA, it must be quantifiable – that is, able to be put into dollars.

How do we quantify avoided physical damages?

We can use either (1) hazard-specific information or (2) past damage data to estimate the amount of damage expected in the future.

FEMA's BCA Toolkit (discussed further in Unit 4) will perform these calculations for you, provided you enter the right data. Units 5-16 cover data requirements for various types of mitigation projects.

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**Avoided loss of service/function**

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## Avoided loss of service/function, 1 of 3

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- Another major benefit of a hazard mitigation project can be avoided loss of service or function of the facility.
- This benefit is only applicable to public facilities, such as utilities, emergency operations facilities (i.e. police, fire), and infrastructure such as roads and bridges.
  - For example, a generator project for a fire station can ensure the fire station remains operational even during a storm event.
  - Likewise, a bridge retrofit project can ensure the bridge remains functional during/after a hazard event.

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**Visual 10: Avoided loss of service/function, 1 of 3****Instructor:**

Another major benefit of a hazard mitigation project can be avoided loss of service or function of the facility. This benefit is only applicable to public facilities, such as utilities, emergency operations facilities (i.e. police, fire), and infrastructure such as roads and bridges.

For example, a generator project for a fire station can ensure the fire station remains operational even during a storm event. Likewise, a bridge retrofit project can ensure the bridge remains functional during/after a hazard event.

Loss of function economic impacts are losses and costs that are incurred when facilities are damaged to the point that the normal function of the facility is disrupted. Mitigation projects that reduce physical damages to buildings and other facilities also reduce the loss of function of the facilities, so benefits from mitigation projects often include reducing loss-of-function impacts. The types of reduced loss-of-function benefits to be counted vary, depending on the type of facility, but these benefits can be large and important to count in benefit-cost analysis.

For some types of mitigation projects, especially for utilities, roads, bridges, and critical facilities such as hospitals, the benefits of avoiding the loss-of-function impacts are always important and may be larger than the benefits of avoiding physical damages. Indeed, many mitigation projects for these types of facilities are undertaken primarily to preserve the critical function of the facility, with reduction of physical damages being an important, but secondary consideration.

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**Avoided loss of service/function**

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## Avoided loss of service/function, 2 of 3

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- How do we quantify this benefit?
  - For most **public/nonprofit sector buildings**, the value of services lost when the building becomes unusable due to a hazard event is calculated by assuming that services are worth what the public pays to provide the services.
  - For **critical facilities, (i.e. fire/police stations, hospitals)**, the value of services is estimated based on the service population and the societal benefits of maintaining that facility in the aftermath of a disaster.
  - For **roads and bridges**, the value of services is based on the number of one-way trips, additional time/miles required for detour, the GSA mileage rate, and FEMA standard values.
  - For **utilities**, the value of service is based on the service population and FEMA standard values.

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*Visual 11: Avoided loss of service/function, 2 of 3***Instructor:**

How do we quantify this benefit?

For most public/nonprofit sector buildings, the value of services lost when the building becomes unusable due to a hazard event is calculated by assuming that services are worth what the public pays to provide the services.

For critical facilities, (i.e. fire/police stations, hospitals), the value of services is estimated based on the service population and the societal benefits of maintaining that facility in the aftermath of a disaster.

For roads and bridges, the value of services is based on the number of one-way trips, additional time/miles required for detour, the GSA mileage rate, and FEMA standard values. (FEMA standard values are industry-standard or academically-researched values for various data points.)

For utilities, the value of service is based on the service population and FEMA standard values.

The BCA Toolkit will calculate the daily loss of service value, provided you enter some basic data about the facility.

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 Avoided loss of service/function standard values
 

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## Avoided loss of service/function, 3 of 3

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Loss of service type	FEMA standard value
Electric power	\$148/person/day
Potable water	\$105/person/day
Wastewater	\$49/person/day

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*Visual 12: Avoided loss of service/function, 3 of 3*

**Instructor:**

The table in your student manual shows the FEMA standard values for loss of service for utilities.

Loss of service type	FEMA standard value
Electric power	\$126/person/day
Potable water	\$93/person/day
Wastewater	\$41/person/day

*Table 1: FEMA standard values for loss of service*

Currently, FEMA does not have standard values for loss of service of communications, Internet, or 911 service.

**Avoided injuries/deaths**

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## Avoided fatalities/casualties

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- For some hazard mitigation projects, a major benefit is avoided human injury and/or death.
- This benefit is only applicable to some project types, such as tornado safe rooms, hurricane safe rooms, wildfire mitigation projects, seismic retrofit projects, and others such as tsunami or landslide.
- This is because these project types address hazards that have little or no warning time, or protect emergency personnel that must stay behind.

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*Visual 13: Avoided fatalities/casualties*

**Instructor:**

For some hazard mitigation projects, a major benefit is avoided human injury and/or death.

This benefit is only applicable to some project types, such as tornado safe rooms, hurricane safe rooms, and seismic retrofit projects. This is because these project types address hazards that have little or no warning time, or protect emergency personnel that must stay behind.

Benefits from avoided injuries/deaths for these hazards are automatically calculated in the BCA Toolkit.

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 Avoided injuries/deaths
 

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## Avoided fatalities/casualties, cont.

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- How do we quantify this benefit?
- These are also FEMA standard values. Injury and death costs come from “Value of Statistical Life” academic research that was completed for the Department of Homeland Security for deaths as well as different levels of injuries:

Severity of Injury	Value
Fatal	\$6,900,000
Hospitalized	\$2,300,000
Treat & release	\$61,000
Self-treat	\$14,000

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*Visual 14: Avoided fatalities/casualties, cont.*

**Instructor:**

How do we quantify this benefit?

These are also FEMA standard values. Injury and death costs come from “Value of Statistical Life” academic research that was completed for the Department of Homeland Security for deaths as well as different levels of injuries.

FEMA standard values for avoided casualties may be found in the table in your student manual.

Severity of injury	FEMA standard value
Fatal	\$6,900,000
Hospitalized	\$2,300,000
Treat & release	\$61,000
Self-treat	\$14,000

*Table 2: FEMA standard values for avoided casualties*

**Avoided displacement costs**

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## Avoided displacement costs

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- Displacement costs occur when occupants (of residential, commercial, or public buildings) are displaced to temporary quarters while damage is repaired.
- These costs include rent and other monthly costs, such as furniture rental and utilities, and one-time costs, such as moving and utility hook-up fees.
- They can also include loss of business income for commercial buildings.

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*Visual 15: Avoided displacement costs*

**Instructor:**

Displacement costs occur when occupants (of residential, commercial, or public buildings) are displaced to temporary quarters while damage is repaired.

These costs include rent and other monthly costs, such as furniture rental and utilities, and one-time costs, such as moving and utility hook-up fees.

They can also include loss of business income for commercial buildings.

For 406 mitigation, Category B is the best place to look for these costs.

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**Avoided emergency management costs**

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## Avoided emergency management costs

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- Emergency management costs include a range of disaster response and recovery costs that may be incurred by communities during and immediately after a disaster. In many disasters, these costs are much smaller than physical damages or loss of service impacts.
- These costs can include debris removal and volunteer costs (i.e. sandbagging).

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*Visual 16: Avoided emergency management costs*

**Instructor:**

Emergency management costs include a range of disaster response and recovery costs that may be incurred by communities during and immediately after a disaster. In many disasters, these costs are much smaller than physical damages or loss of service impacts.

These costs can include debris removal and volunteer costs (i.e. sandbagging).

Many common mitigation projects have little or no significant impact on a community's emergency management costs. However, in circumstances where a project affects a large part of a community and may significantly reduce future emergency management costs; counting the benefits of reduced emergency management costs is proper.

For most projects, however, the benefits in this category are negligible or very small. Thus, in most cases it may not be necessary to make the effort to estimate the benefits of reduced emergency management costs. In cases where a project has a benefit-cost ratio very close to 1.0 and has significant potential benefits in reducing future emergency management costs, it may be worthwhile to calculate the damages from this source, and the benefits of reducing or eliminating them.

**Avoided NFIP administration costs**

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## Avoided NFIP administration costs

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- Properties insured under the National Flood Insurance Program (NFIP) incur administrative fees to run the program.
- If a property is acquired and demolished, there is no longer an administrative cost to the government for that property; therefore, it is an avoided cost.

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*Visual 17: Avoided NFIP administration costs*

**Instructor:**

Properties insured under the National Flood Insurance Program (NFIP) incur administrative fees to run the program. If a property is acquired and demolished, there is no longer an administrative cost to the government for that property; therefore, it is an avoided cost.

**Note:** Insurance premiums and claims payments are considered transfer payments by OMB, and do NOT count as benefits or costs for BCAs. This means that avoided future flood insurance premiums are NOT an eligible benefit for FEMA mitigation projects. Increased Cost of Compliance coverage can be used to provide the non-federal costs for a project, but they cannot be included as benefits since this would be duplication of benefits.

**Other benefits**

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## Other benefits

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- In addition to avoided costs, hazard mitigation projects can have other benefits.
- These can include:
  - Social benefits
  - Environmental benefits
- Let's discuss each of these.

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*Visual 18: Other benefits*

**Instructor:**

In addition to avoided costs, hazard mitigation projects can have other benefits. These can include:

- Social benefits
- Environmental benefits

Let's discuss each of these.

## Social benefits

## Social benefits

- **Social benefits** capture the avoided costs associated with mental stress and anxiety and lost wages that disaster survivors would otherwise experience.
- Only projects that protect residential structures may include social benefits.
- Project must have a 0.75 BCR before social benefits can be applied.

Social Benefit	Value
Mental stress & anxiety	\$2,443/person
Lost productivity	\$8,736/person

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*Visual 19: Social benefits*

### **Instructor:**

Social benefits capture the avoided costs associated with mental stress and anxiety and lost wages that disaster survivors would otherwise experience. This is a one-time benefit, not over the PUL.

Project must have a 0.75 BCR before social benefits can be applied. This is because the primary purpose of FEMA's hazard mitigation grants is to reduce damages from natural hazards.

FEMA standard values for social benefits may be found in the table in your student manual. These values are one-time benefits, meaning they do not occur on an annual basis.

Social benefit	FEMA standard value
Mental stress & anxiety	\$2,443/person
Lost productivity	\$8,736/person

*Table 3: FEMA standard values for social benefits*

**Environmental benefits**

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## Environmental benefits

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- **Environmental benefits** capture the benefits resulting from an improved natural environment.
- These benefits are applicable to any project type that results in a preserved or improved natural environment, such as acquisitions, relocations, and floodplain, stream, or coastal restoration.
- Project must have a 0.75 BCR before environmental benefits can be applied.

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*Visual 20: Environmental benefits*

**Instructor:**

Environmental benefits capture the benefits resulting from an improved natural environment. These benefits are applicable to any project type that results in a preserved or improved natural environment, such as acquisitions, relocations, and floodplain and stream restoration.

Project must have a 0.75 BCR before environmental benefits can be applied. This is because the primary purpose of FEMA's hazard mitigation grants is to reduce damages from natural hazards.

## Environmental benefits

## Environmental benefits, cont.

Type of Space	Value
Green open space	\$8,308/acre/year
Riparian	\$39,545/acre/year
Wetlands	\$6,010/acre/year
Forest	\$554/acre/year
Marine & estuary	\$1,799/acre/year

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*Visual 21: Environmental benefits, cont.*

**Instructor:**

FEMA standard values for environmental benefits may be found in the table in your student manual.

Type of space	FEMA standard value
Green open space	\$8,308/acre/year
Riparian	\$39,545/acre/year
Wetlands	\$6,010/acre/year
Forest	\$554/acre/year
Marine & estuary	\$1,799/acre/year

*Table 4: FEMA standard values for environmental benefits*

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**What are NOT considered benefits?**

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## What are NOT considered benefits?

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- Anything that is subjective or non-quantifiable cannot be counted as a benefit in FEMA BCAs. For example:
    - Ease of project
    - Aesthetic value of project
  - Anything not impacted by the proposed project. A definitive connection must be made between the project and claimed benefits.
  - Additionally, OMB Circular A-94 dictates that indirect benefits must not be considered in a BCA. For example:
    - Changes in gross regional economic product, incomes, or employment
    - Avoided criminal justice system costs for disaster-related crime
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*Visual 22: What are NOT considered benefits?*

**Instructor:**

Generally, anything that is subjective or non-quantifiable cannot be counted as a benefit in FEMA BCAs. For example:

- Ease of project
- Aesthetic value of project

However, although ease of project, aesthetic value, and cheapest/most effective option are not considered benefits for the BCA, these are considerations to take into account when developing the project, as discussed more in the 212 class, Developing Hazard Mitigation Assistance Applications.

Anything not impacted by the proposed project may also not be counted in the BCA. A definitive connection must be made between the project and claimed benefits.

Additionally, OMB Circular A-94 dictates that indirect benefits must not be considered in a BCA. For example:

- Changes in gross regional economic product, incomes, or employment
- Changes in future economic development or tourism
- Avoided criminal justice system costs for disaster-related crime (i.e. looters)

**Duplication of benefits and programs**

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## Duplication of benefits and programs

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- It is important to include all possible quantifiable benefits when developing the project, but you must also be sure that you are not double-counting your benefits or duplicating programs.
  - Duplication of benefits occurs when:
    - You are counting the same benefits in two different projects, or counting the same benefits on multiple structures in your project.
    - An example of duplication of benefits would be elevating a home in one project but then using the original elevation of that home in a separate drainage project.
  - Duplication of programs occurs when:
    - Project falls mainly under another federal program (e.g. certain levee projects are the domain of the U.S. Army Corps of Engineers).
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*Visual 23: Duplication of benefits and programs*

It is important to include all possible quantifiable benefits when developing the project, but you must also be sure that you are not double-counting your benefits or duplicating programs.

Duplication of benefits occurs when:

- You are counting the same benefits in two different projects, or counting the same benefits on multiple structures in your project.
- An example of duplication of benefits would be elevating a home in one project but then using the original elevation of that home in a separate drainage project.

Duplication of programs occurs when:

- Project falls mainly under another federal program (e.g. certain levee projects are the domain of the U.S. Army Corps of Engineers).

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**Aggregating project benefits**

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## Aggregating project benefits

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- Aggregating multiple projects into one can often increase the overall BCR. Aggregating project benefits does NOT count as duplication of benefits **as long as** the benefits apply to multiple structures **or** the structure is at risk from multiple hazards.
- For example, you could:
  - Count 100 properties protected by one drainage improvement as one project.
  - Count both avoided physical damages and avoided loss of function if floodproofing utilities.
  - Count flood reduction benefits and seismic retrofit benefits for the same structure if the project protected against both hazards.

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*Visual 24: Aggregating project benefits***Instructor:**

Aggregating multiple projects into one can often increase the overall BCR. Aggregating project benefits does NOT count as duplication of benefits as long as the benefits apply to multiple structures or the structure is at risk from multiple hazards.

Aggregating structures into one project so that you can aggregate the benefits is often a good way to increase a project's overall BCR. One structure with a very high BCR can often "carry" another structure with higher costs or lower benefits.

For example, you could:

- Count 100 properties protected by one drainage improvement as one project.
- Count both avoided physical damages and avoided loss of function if floodproofing utilities.
- Count flood reduction benefits and seismic retrofit benefits for the same structure if the project protected against both hazards.

For more information on how to aggregate projects, please refer to the BCA Guidance.

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**What are considered costs?**

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## What are considered costs?

- **Costs** of a mitigation project include:
  - Construction costs
  - Any other project-related costs such as title searches, permits, etc.
  - Maintenance costs
  - Any in-kind contributions or match from the recipient or subrecipient



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*Visual 25: What are considered costs?*

**Instructor:**

Costs of a mitigation project include:

- Construction costs
- Any other project-related costs such as title searches, permits, etc.
- Maintenance costs
- Any in-kind contributions or match from the recipient or subrecipient

Again, all project costs must be counted regardless of who is paying for them.

What are NOT considered costs?

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## What are NOT considered costs?

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- Reduced tax base
- Indirect economic losses
- Transfer payments: per OMB Circular A-94, insurance premiums (including flood insurance) are considered transfer payments and are thus not considered costs (or benefits)

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*Visual 26: What are NOT considered costs?*

**Instructor:**

The following are not considered costs for FEMA BCAs:

- Reduced tax base
- Indirect economic losses
- Transfer payments: per OMB Circular A-94, insurance premiums are considered transfer payments and are thus not considered costs (or benefits)

## The Benefit-Cost Model

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### The Benefit-Cost Model

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- We've discussed what can be counted as benefits and costs. Now, we'll talk about other variables that factor into the BCR calculation, including:
  - Project Useful Life (PUL)
  - Recurrence interval (RI)
  - Project effectiveness

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*Visual 27: The Benefit-Cost Model*

**Instructor:**

We've discussed what can be counted as benefits and costs. Now, we'll talk about other variables that factor into the BCR calculation, including:

- Project Useful Life (PUL)
- Recurrence interval
- Project effectiveness

**Project Useful Life (PUL)**

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## Project Useful Life (PUL)

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- **Project Useful Life (PUL)** is the estimated amount of time (in years) that the mitigation action will be effective.
- The PUL is important in the calculation of the BCR because it establishes the timeframe to calculate benefits.
- Higher PUL values extend the duration over which benefits are calculated, thus raising the final BCR.

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*Visual 28: Project Useful Life (PUL)*

**Instructor:**

Project Useful Life (PUL) is the estimated amount of time (in years) that the mitigation action will be effective.

The PUL is important in the calculation of the BCR because it establishes the timeframe to calculate benefits.

Higher PUL values extend the duration over which benefits are calculated, thus raising the final BCR.

**Project Useful Life (PUL)**

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## Project Useful Life (PUL), cont.

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Let's think back to the example of the leaky toilet in Unit 1.

- Let's say I've decided to replace the toilet.
- My PUL is the amount of time I expect the new toilet to last, assuming proper maintenance (the costs of which I must include in my overall project cost).
- For this example, we will assume the PUL of the new toilet is 30 years.

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*Visual 29: Project Useful Life (PUL), cont.*

**Instructor:**

Let's think back to the example of the leaky toilet in Unit 1.

Let's say I've decided to replace the toilet.

My PUL is the amount of time I expect the new toilet to last, assuming proper maintenance (the costs of which I must include in my overall project cost).

For this example, we will assume the PUL of the new toilet is 30 years.

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**Recurrence interval**

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## Recurrence interval (RI)

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- A **recurrence interval (RI)** is how often a hazard event of specific severity is likely to occur in a particular location.
- A RI is often talked about as the “X-year” or “Y% annual chance” event.
  - For example, the “100-year flood” is the 1% annual chance flood, meaning that in any given year, there is a 1% chance it will occur. (The actual depth of the 1% chance annual flood varies by location.)
  - The percent annual chance is calculated by dividing 1 by X. Here, 1/100.
- Projects that mitigate more frequent events are more likely to be cost-effective.

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*Visual 30: Recurrence interval (RI)***Instructor:**

A recurrence interval is how often a hazard event of specific severity is likely to occur in a particular location.

A recurrence interval is often talked about as the “X-year” or “Y% annual chance” event. For example, the “100-year flood” is the 1% annual chance flood, meaning that in any given year, there is a 1% chance it will occur. (The actual depth of the 1% chance annual flood varies by location.)

The percent annual chance is calculated by dividing 1 by X. Here,  $\frac{1}{100}$ .

Projects that mitigate more frequent events are more likely to be cost-effective.

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**Recurrence interval**

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## Recurrence interval (RI), cont.

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Using the example of the leaky toilet:

- Perhaps, just as with hazard events, my toilet does not leak all the time. The RI is **how often** the toilet is leaking **at a particular severity**, averaged over the life of the toilet.
- For example, let's say the toilet has been in my house for 20 years, and has leaked 5 times, but only 2 of those times it actually flooded the floor.
  - The RI for flooding the floor is 2 divided by 20, or 10%. This could be referred to as the "10-year" event.

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*Visual 31: Recurrence interval (RI), cont.*

**Instructor:**

Using the example of the leaky toilet:

Perhaps, just as with hazard events, my toilet does not leak all the time. The recurrence interval (RI) is **how often** the toilet is leaking **at a particular severity**, averaged over the life of the toilet.

For example, let's say the toilet has been in my house for 20 years, and has leaked 5 times, but only 2 of those times it actually flooded the floor.

The RI for flooding the floor is 2 divided by 20, or 10%. This could be referred to as the "10-year" event.

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**Recurrence interval vs. Project Useful Life**

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## Recurrence interval vs. Project Useful Life

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- When calculating benefits and hazard probability, the relationship between the RI and the PUL is important to consider. If the PUL is 10 years but it protects against an event with a 500-year RI, is it likely to be cost-effective?
- While these projects can be cost-effective if their benefits are large enough, it's important to keep in mind that projects that protect against multiple, lower frequency events are more likely to be cost-effective.
- RIs can change over time, however, so it's important to use up-to-date information when possible.

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*Visual 32: Recurrence interval vs. PUL*

**Instructor:**

When calculating benefits and hazard probability, the relationship between the RI and the PUL is important to consider. If the PUL is 10 years but it protects against an event with a 500-year RI, is it likely to be cost-effective?

While these projects can be cost-effective if their benefits are large enough, it's important to keep in mind that projects that protect against multiple, lower frequency events are more likely to be cost-effective.

RIs can change over time, however, so it's important to use up-to-date information when possible.

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**Project effectiveness**

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## Project effectiveness

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- Recall that:

$$\text{Benefits} = \text{Costs Before Mitigation} - \text{Costs After Mitigation}$$

- How do we know what the costs after mitigation are?
- **Project effectiveness** measures how well the project will reduce future damages.
  - Only structure acquisition/demolition projects are 100% effective – i.e., they have \$0 costs after mitigation.
  - ALL other project types assume that there is still some (but reduced) hazard risk upon project completion—this is called **residual risk**.
  - For example, if a floodwall protects up to the 0.2% annual chance (500-year) flood, then it will no longer be effective in events exceeding the 500-year.

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*Visual 33: Project effectiveness***Instructor:**

Recall that:

$$\text{Benefits} = \text{Costs Before Mitigation} - \text{Costs After Mitigation}$$

How do we know what the costs after mitigation are?

Project effectiveness measures how well the project will reduce future damages.

Only structure acquisition/demolition projects are 100% effective – i.e., they have \$0 costs after mitigation. All other project types assume that there is still some (but reduced) hazard risk upon project completion—this is called residual risk. For example, if a floodwall protects up to the 0.2% annual chance (500-year) flood, then it will no longer be effective in events exceeding the 500-year.

The maximum level of benefit can be achieved only if the estimated damages and losses are completely eliminated by a mitigation project (i.e., by acquiring and demolishing the house). The relationship between damages and losses before mitigation and the maximum possible benefit achieved after mitigation is very important. The best mitigation projects are often those where the damages and losses are greatest before mitigation is undertaken. In other words, the greater the damage and losses are prior to mitigation project, the greater the potential benefits of mitigation. Conversely, when the damages and losses before mitigation are minor, the maximum possible benefits are limited. This relationship is very important for mitigation planning.

**Unit 3 Review**

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## Unit 3 Review, 1 of 3

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- What count as **benefits**?
  - Avoided physical damages
  - Avoided loss of service/function
  - Avoided injuries/deaths
  - Avoided displacement costs
  - Avoided emergency management costs
  - Avoided NFIP administration costs
  - Social benefits
  - Environmental benefits

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*Visual 34: Unit 3 Review, 1 of 3*

**Instructor:**

In this unit, we talked about what count as benefits for FEMA BCAs.

*Review each of the following with the students:*

- Avoided physical damages
- Avoided loss of service/function
- Avoided injuries/deaths
- Avoided displacement costs
- Avoided emergency management costs
- Avoided NFIP administration costs
- Social benefits
- Environmental benefits

**Unit 3 Review**

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## Unit 3 Review, 2 of 3

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- What count as **costs**?
  - Construction costs
  - Other project-related costs
  - Maintenance costs
  - In-kind contributions/match

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*Visual 35: Unit 3 Review, 2 of 3*

**Instructor:**

We also talked about what count as costs:

- Construction costs
- Other project-related costs
- Maintenance costs
- In-kind contributions/match

**Unit 3 Review**

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## Unit 3 Review, 3 of 3

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- The BCR is calculated by estimating the difference between damages before mitigation and after mitigation.
- The BCA Toolkit does this by using hazard/damage data, recurrence intervals for that hazard, and project information.

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*Visual 36: Unit 3 Review, 3 of 3*

**Instructor:**

Finally, we discussed how the BCR is actually calculated.

The BCR is calculated by estimating damages before mitigation and after mitigation. The BCA Toolkit does this by using hazard/damage data, recurrence intervals for that hazard, and project information.