


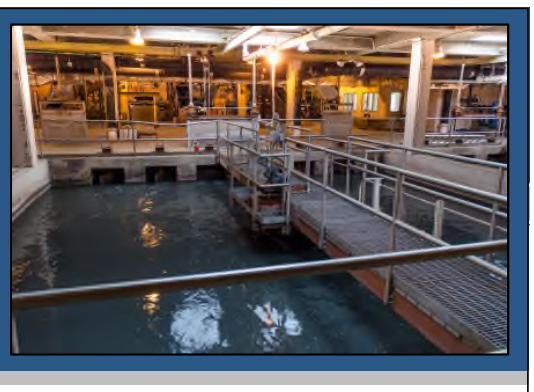

Benefit-Cost Analysis Principles for Hazard Mitigation of Treatment Facilities

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Agenda

- Background:
  - FEMA Hazard Mitigation
  - Benefit-Cost Analysis (BCA)
- BCA Principles for Treatment Facilities
- FEMA BCA Case Studies
  - PVSC Newark Bay Treatment Plant
  - UWLI Bay Park Sewage Treatment Plant
- Conclusions
- Questions

Background: FEMA Hazard Mitigation

- The Federal Emergency Management Agency (FEMA) can offer the following assistance after a declared event
  - Individual Assistance (IA)
  - Public Assistance (PA)
  - Hazard Mitigation Grant Program (HMGP)
- Post-disaster mitigation assistance for public facilities:
  - PA Mitigation (406 Mitigation)
  - HMGP (404 Mitigation)
- Other FEMA hazard mitigation assistance available through the Pre-Disaster Mitigation (PDM) Program

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Background: Benefit-Cost Analysis

- FEMA regulations require that all hazard mitigation projects must be cost-effective
- FEMA approaches to assessing cost-effectiveness:
  - PA Mitigation Projects – FEMA Recovery Policy 9526.1
    - 15% Rule
    - 100% Rule (Appendix A)
    - Benefit-Cost Analysis (BCA)
  - HMGP Projects – BCA required
  - PDM Projects – BCA required

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Benefit-Cost Analysis (BCA)

- The purpose of a **Benefit-Cost Analysis (BCA)** is to demonstrate the benefits of a project outweigh its costs, or the Benefit-Cost Ratio (BCR) is greater than 1.0

$$\mathbf{BCR = \frac{BENEFITS}{COSTS}}$$

- BCA can also provide a common basis for comparison of project alternatives or competitive grants

What are Benefits and Costs?

- Benefits are <u>avoided damages and losses</u> associated with a proposed project:

Σ(PRE-PROJECT EVENT DAMAGES + LOSSES)

- Σ(POST-PROJECT EVENT DAMAGES + LOSSES)

= PROJECT BENEFITS

- Costs are the <u>initial and long-term investments</u> associated with a proposed project – including project construction, operation and maintenance (O&M), and service interruptions related to project construction

FEMA BCA Process

Hazard Information
- Flood hazard data
- Climate Change/ Sea Level Rise

Building/Facility Information
- Structure data
- Contents data
- Service losses

Project Costs
- Construction costs
- Environmental issues
- Operation and maintenance

Project Benefits
- Physical damages
- Loss of function costs
- Social and environmental benefits

FEMA BCA Tool

Results

BCR > 1.0

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BCA Principles for Treatment Facilities

Key Principles:

1) It's All About Risk
2) Focus on Service Losses
3) Beware of BCRs Just Above 1.0
4) Document Values and Assumptions

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Principle 1 - It's All About Risk

Flood Event	Annual Probability	Flood Event Damages Before Mitigation	Flood Event Damages After Mitigation	Total Event Damage Reduction (Damages Before - Damages After)	Total Annualized Damage Reduction (Annual Probability x Damage Reduction)
10-year	0.100	$4,000,000	$0	$4,000,000	$400,000
50-year	0.020	$6,000,000	$0	$6,000,000	$120,000
100-year	0.010	$8,000,000	$0	$8,000,000	$80,000
500-year	0.002	$12,000,000	$12,000,000	$0	$0
Total Annualized Avoided Damages (Annual Project Benefit)					$600,000
Total Project Benefits (Annual Benefit x Present Value Coefficient of 13.80 [50-year project life, 7% discount rate])					$8,280,000
Benefit-Cost Ratio (BCR) = $8,280,000 / $5,000,000					1.66

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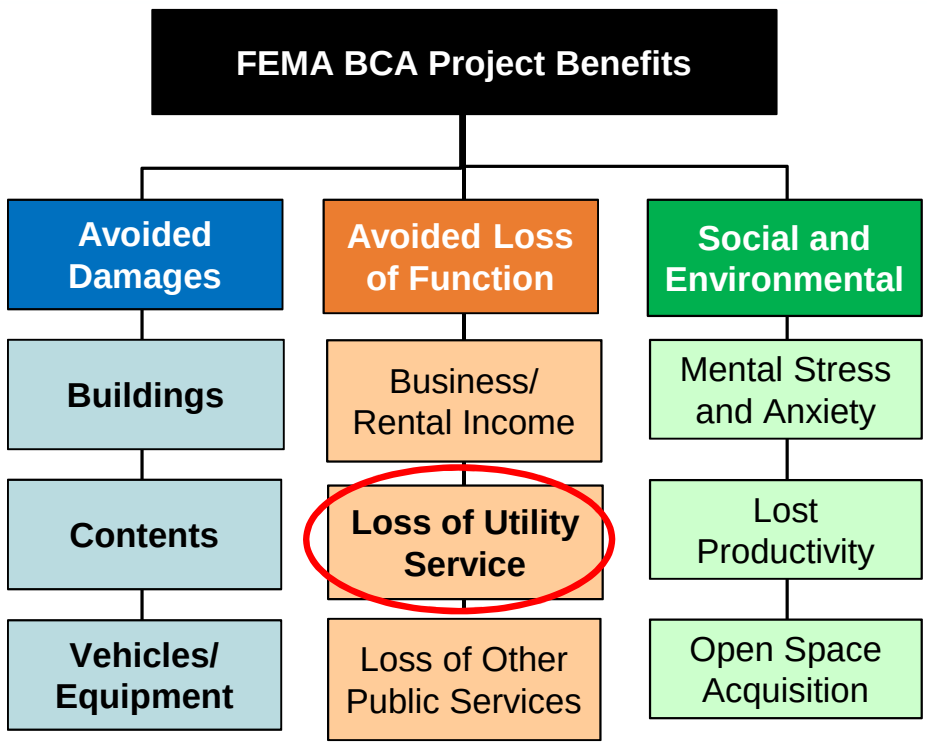
Principle 2 - Focus on Service Losses



Sample damages and utility service losses to a treatment plant serving 1 million residents

- Physical Damage = **$100 M**
- Loss of Wastewater Service (5 days) = **$225 M**
- Loss of Potable Water Service (5 days) = **$515 M**

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Principle 3 - Beware of BCRs Just Above 1.0

- FEMA and many other mitigation grant programs require projects to be cost-effective
- Borderline cost-effective projects with initial BCRs just above 1.0 can drop below 1.0 if:
  - Project costs increase slightly
  - Project design or scope modification reduce project benefits
- If the project BCR drops below 1.0, the project is no longer cost-effective, and FEMA or the grant administrator can de-obligate the mitigation grant funds

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Principle 4 – Document All Input Values

- It is important to track, record, and include the source, dates, assumptions, and analysis procedures for all input values in the application.
- Use data from credible and reliable sources.
- Provide complete technical support data.
- Explain and provide justification for data that exceeds standard values.
- Organize the data via a list of attachments.
- Cite the location of BCA relevant data within the support data (i.e., report name, page no., etc.)
- Do not assume that the grant reviewer has access to the same data that the user does.

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Case Study: PVSC Newark Bay Treatment Plant - Profile

- Name and Operator: Passaic Valley Sewerage Commission (PVSC) Newark Bay Treatment Plant
- Location: Newark, NJ
- Capacity: 70 MGD
- Population Served: 3.43 million residents
  - 1.47 million PVSC wastewater district
  - 1.96 million Liquid Waste Assistance (LWA) program

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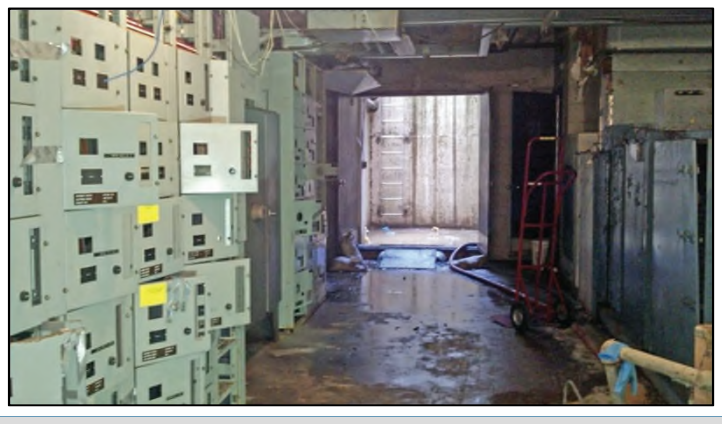
Case Study: PVSC Newark Bay Treatment Plant – Sandy Impacts

- Damage: Over $90 M in documented physical damage to vehicles, buildings, inventory, equipment and contents at ground level and catastrophic damages to lower levels
- Service Impacts:
  - Complete loss of wastewater and LWA treatment for 4 days
  - 45 days to restore full wastewater and LWA treatment
  - 840 M gallons of untreated sewage and 3 B gallons of partially treated sewage flowed into Newark Bay



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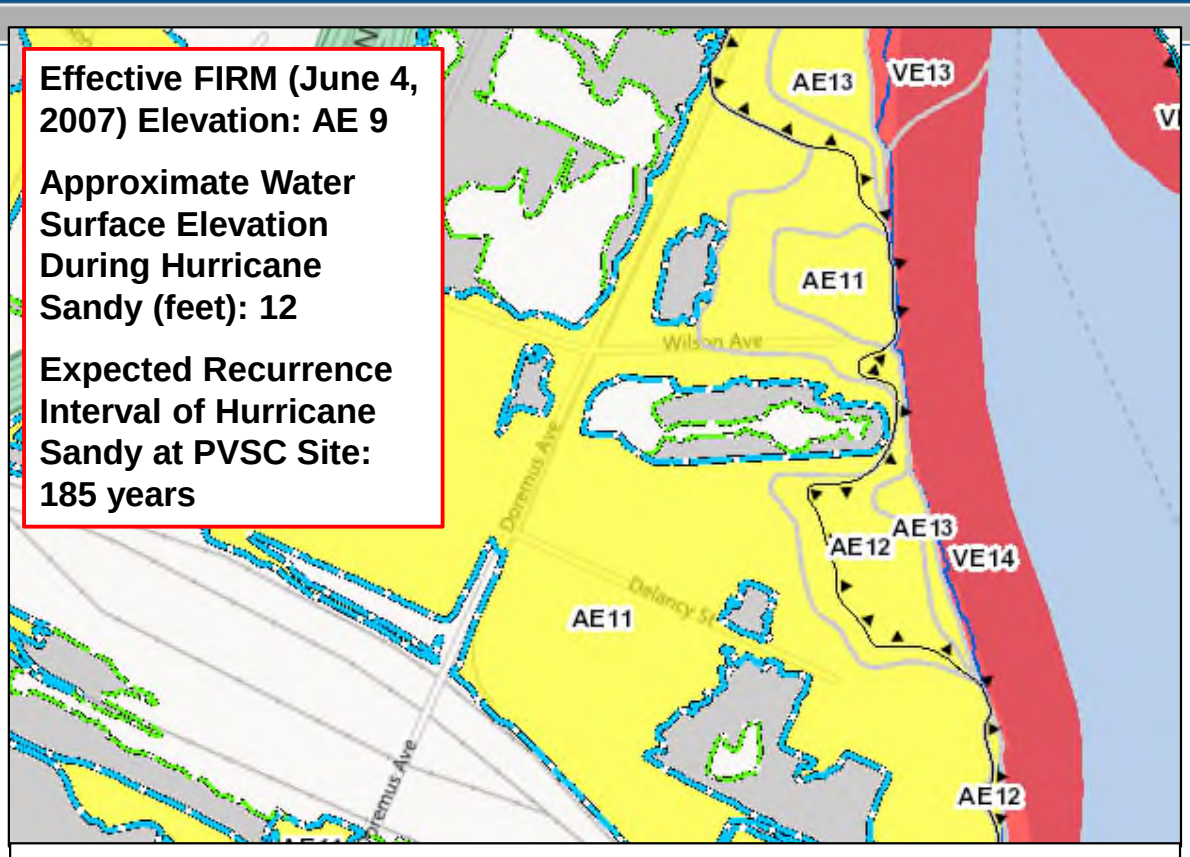
Case Study: PVSC Newark Bay Treatment Plant – Current Flood Map



Effective FIRM (June 4, 2007) Elevation: AE 9

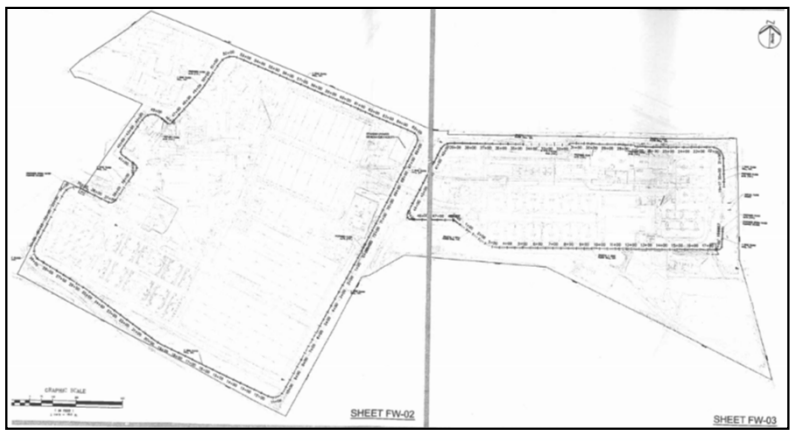
Approximate Water Surface Elevation During Hurricane Sandy (feet): 12

Expected Recurrence Interval of Hurricane Sandy at PVSC Site: 185 years

Best Available Flood Data for PVSC Newark Bay Treatment Plant Site (Source: FEMA Region II Coastal Analysis and Mapping website)

Case Study: PVSC Newark Bay Treatment Plant – Mitigation Project

- Description: Perimeter floodwalls with seven passive floodgates, storm water drainage with pump stations, and an onsite standby power system with natural gas-powered generators.
- Design Level of Effectiveness: 500-year flood event
  - Estimated Cost: $246.7 M
  - Funding Source: FEMA PA Hazard Mitigation (406)



Case Study: PVSC Newark Bay Treatment Plant – BCA Results

- In October 2013, a detailed review of the initial FEMA PA mitigation project BCA confirmed the initial cost-effective BCR of 1.29, and additional alternative analyses also supported project cost-effectiveness and indicate the project BCR is approximately equal to if not higher than the initial project BCR.
- Unlike most projects, the cost-effective BCR is based solely on Sandy using a 185-year recurrence interval (RI).
- Sandy Damages of $90 million are minor compared to 45 days of complete and partial wastewater service losses to 3.43 million people.

Case Study: PVSC Newark Bay Treatment Plant – BCA Results (continued)

Flood Event Recurrence Interval (years)	Annual Probability	Flood Event Damages	Total Flood Event Losses	Total Flood Event Damages and Losses	Total Annualized Flood Event Damages and Losses
Damages Before Mitigation					
185	0.0054	$90,657,870	$4,539,779,552	$4,629,942,422	$23,836,000
Damages After Mitigation					
185	0.0054	$557,000	$0	$557,000	$3,000
Total Annualized Avoided Damages & Losses (Annual Project Benefit)					$25,026,000
Total Project Benefits (Annual Benefit x PVC of 13.80 [50-year project life, 7% discount rate])					$345,336,000
Total Project Costs ($226,713,000 project cost + $1,490,000 in annual maintenance over 50 years)					$267,276,000
Benefit-Cost Ratio (BCR)					1.29

Case Study: UWLI Bay Park Sewage Treatment Plant - Profile

- Name and Operator: United Water Long Island (UWLI) Bay Park Sewage Treatment Plant
- Location: East Rockaway, NY
- Capacity: 70 MGD
- Population Served: 550,000 residents

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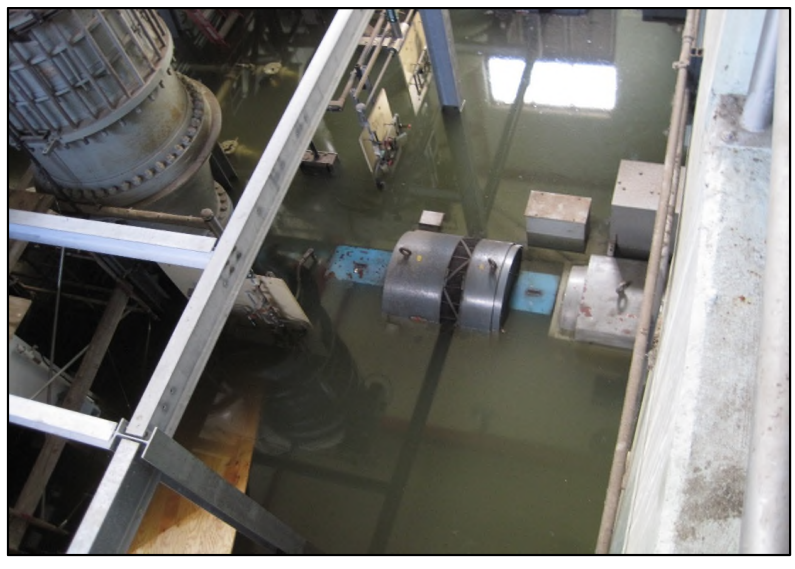
Case Study: UWLI Bay Park Sewage Treatment Plant – Sandy Impacts

- Damage: Up to $700 million in physical damages to plant buildings, systems, treatment facilities, pumps and other equipment
- Service Impacts: 200 million gallons of raw sewage poured into bay waterways and channels for 44 days



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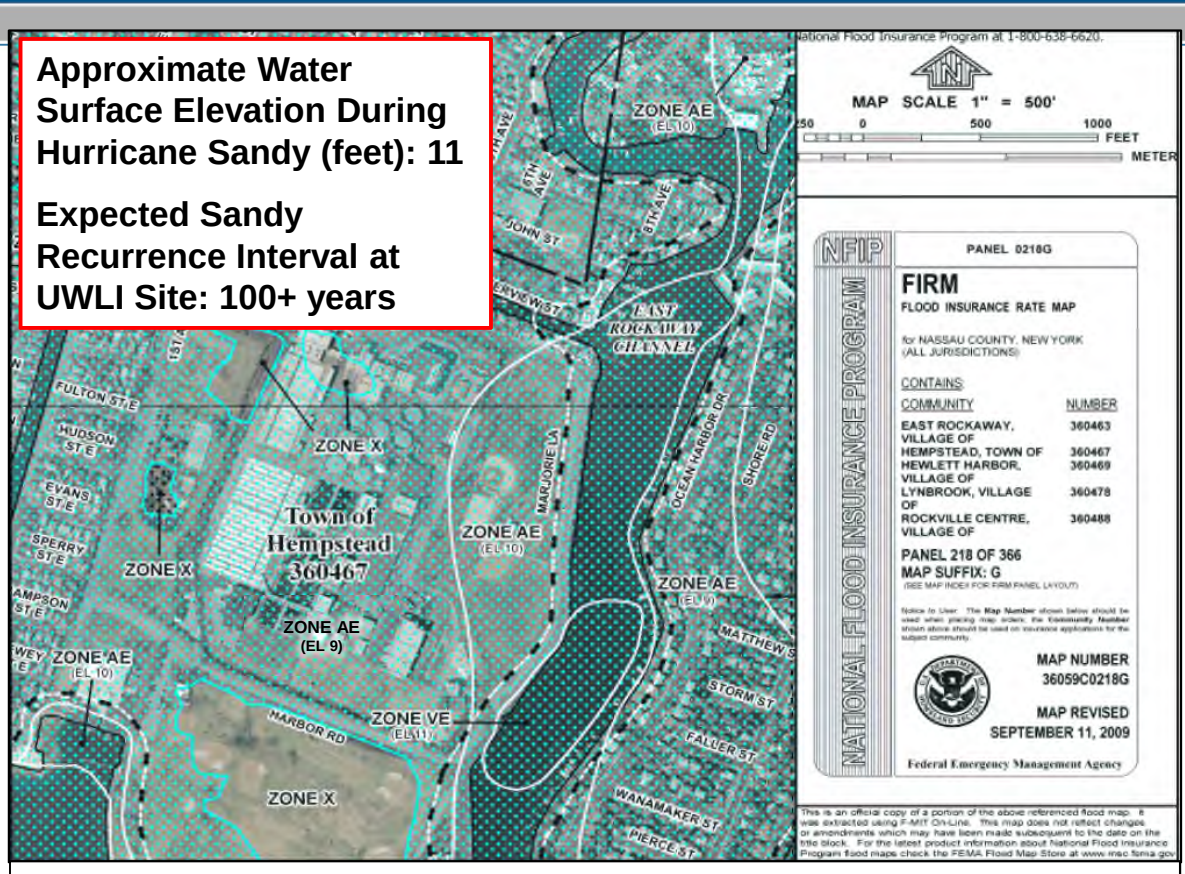
Case Study: UWLI Bay Park Sewage Treatment Plant – Current Flood Map



Current Flood Insurance Rate Map for UWLI Bay Park Sewage Treatment Plant Site (Source: FIRMette from FEMA Map Service Center website)

Case Study: UWLI Bay Park Sewage Treatment Plant – Mitigation Project

- Description: Construction of a large perimeter berm; elevating and/or hardening electrical plant distribution system, sludge dewatering equipment, and pump stations; and construction of a larger sewage collection system
- Design Level of Effectiveness: 500-year flood event plus anticipated sea level rise (SLR)
- Estimated Cost Range: $120 M to $800 M
- Funding Source: FEMA PA Hazard Mitigation (406) and HUD Community Development Block Grant (CDBG) program

Case Study: PVSC Newark Bay Treatment Plant – BCA Results

- Limited information available for this project
- Potential BCA scenarios

Scenario	Project Cost Range	Repair Cost Range	Cost Effective – FEMA Recovery Policy 9526.1
1	Less than $121.5 million	More than $688.5 million	Yes – 15% Rule
2	$121.6 million to $405 million	$405 million to $688.4 million	Yes – 100% Rule
3	More than $405 million	$405 million or less	Yes – FEMA Benefit-Cost Analysis

- Project BCA (Scenario 3) will require over 44 days of wastewater service losses to all 550,000 customers during Sandy (100-year Recurrence Interval) for a cost-effective BCR of 1.0

Conclusions

- Cost-effectiveness is critical for obtaining FEMA and other federal funds for hazard mitigation project grants
- Remember the key BCA principles for treatment facilities:
  1) It's All About Risk
  2) Focus on Service Losses
  3) Beware of BCRs Just Above 1.0
  4) Document Values and Assumptions

Questions?

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