Flood Risk Management Study
Washington Navy Yard

27 February 2018
3:00PM
Building 33, Room 2026

Presentation Agenda

- Flood Vulnerability Report Results
- "Menu" of Flood Risk Management Measures
- Preliminary Alternatives
- FRM Alternatives
- Conclusion

Flooding at Washington Navy Yard

Current

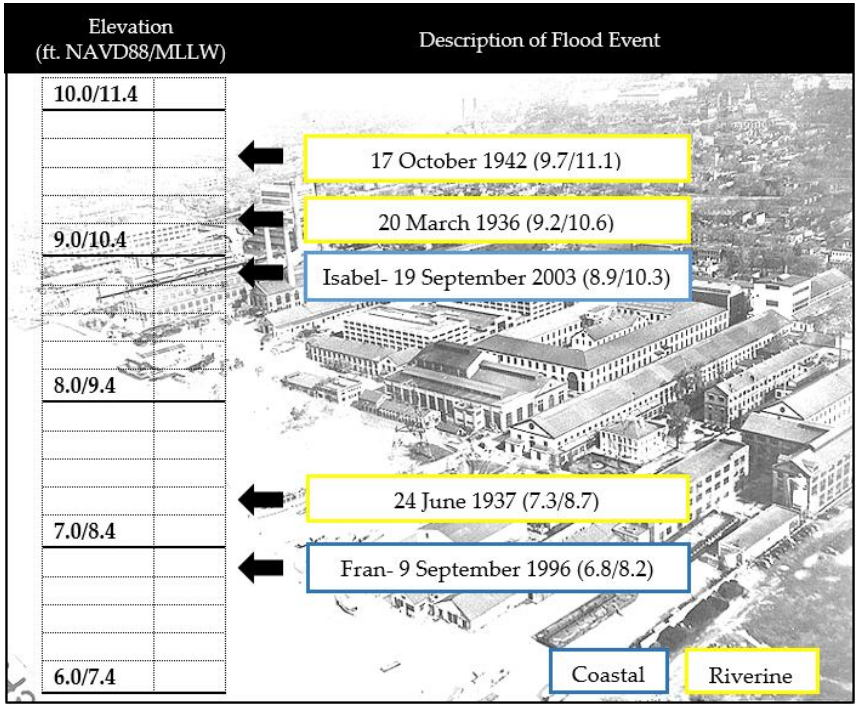
FEMA

10% (10 yr.)= 7 ft. NAVD88
2% (50 yr.)= 9 ft. NAVD88
1% (100 yr.)= 10.5 ft. NAVD88
0.2% (500 yr.)= 14 t. NAVD88

SLOSH

Category 1 Hurricane= 4.7 ft.
Category 2 Hurricane= 7.5 ft.
Category 3 Hurricane= 11.5 ft.
Category 4 Hurricane= 16 ft.

Historic



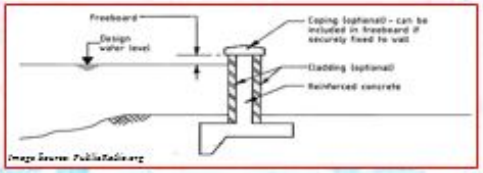
Flood Vulnerability Report (FVR) Results

Essential buildings at risk: *Moderate*: 21 | *Major*: 32 | *Severe*: 37

- USACE 2100 Sea Level Rise (2.3 ft.) + 10% Annual Chance storm:
  - ❖ 14 Bldgs. → 29 Bldgs. at risk of flooding

Menu of Flood Risk Management Measures

Structural Flood Risk Measures: Floodwall



APPLICABILITY:

Floodwalls can be used to reduce the risk of riverine or coastal storm surge flooding by confining flood waters and keeping them from reaching buildings and infrastructure.

TYPES OF FLOODING MITIGATED:

1. Coastal/Storm Surge
2. Riverine

DESCRIPTION:

A floodwall is a permanent engineered structure, usually constructed of reinforced concrete or a sheetpile, with concrete cap, designed to prevent the encroachment of flood waters. Similar to a levee, a floodwall requires high ground into which to connect on either end of its reach.

Semi-permanent floodwalls can also be constructed when aesthetic views of the waterway are imperative. There are a variety of products that allow a low floodwall to be constructed, and then increase the height of wall either manually or hydraulically just prior to the flood event.

Pumps may be required within the area of protection in order to provide interior drainage (for rainfall on the protected side when a flood is occurring). Where openings in the floodwall are required for vehicle or pedestrian crossings, closure structures such as stoplogs, roller or slide gates, or hinged swing gates are used to provide the full level of protection when deployed, while minimizing the impact on traffic under normal flow conditions.

"Menu" of FRM Measures
Navy Facilities
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Structural Flood Risk Measures: Floodwall

ADVANTAGES:

- Less space required (than for levees)
- Aesthetic benefits (many types of facades for wall)
- Ideal for urban situations
- Low maintenance needs

VS

DISADVANTAGES:

- High cost of construction
- Alters local hydrology
- Requires openings and closure structures for access through floodwall
- May block views

IMPACTS:

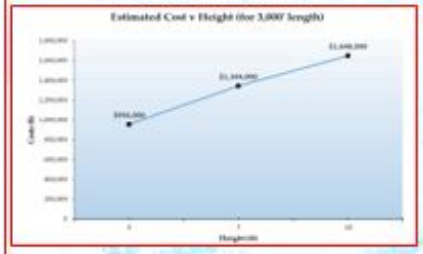
Similar to a levee system, a floodwall can affect the benefits of the floodplain, including species diversity, groundwater recharge, soil health, water filtration, and recreation.

PRE-FLOOD ACTIONS:

Closure structures must be deployed in the case of a flood event. Advanced warning times will vary on a site-by-site basis depending on local hydrology and gage availability, so the deployment times of different closure structure types must be considered. The characteristics of each closure type are discussed separately in the "Menu".

SPECIAL CONSIDERATIONS:

Required maintenance on a floodwall is generally minimal, but a plan for periodic inspections must be developed in order to regularly assess the soundness of the structure and prevent sudden failure.



$$ COSTS: $$

- General costs estimates developed using the following dimensions:
  - 3' high x 3,000' long
  - 7' high x 3,000' long
  - 10' high x 3,000' long
- Assume additional drainage structures (24" diameter RCP)- $46,000 each
- Costs will vary based on project size, location, and soil type.

"Menu" of FRM Measures
Navy Installations
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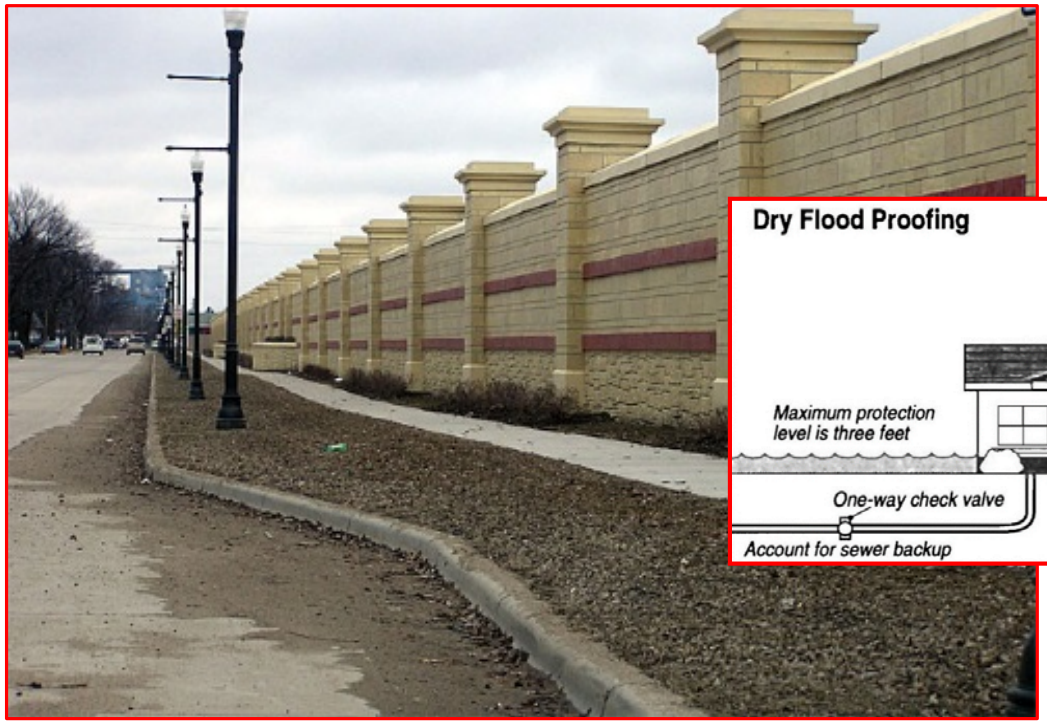
Planning Tool describing FRM measures

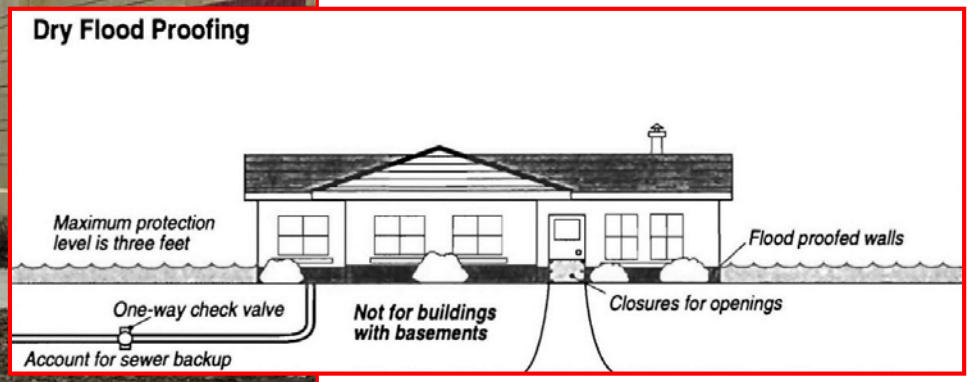
- ***Structural*: 16 | *Nonstructural*: 6**

Preliminary Analysis

- **Preliminary Screening of Measures**
  - FRM measures considered



Floodwall



Flood Proofing

Preliminary Analysis (con't)

- **Sea Level Rise**
  - 2035, 2065, and 2100 planning horizons
  - *Strategic Environmental Research and Development Program (SERDP)* Database (2016)

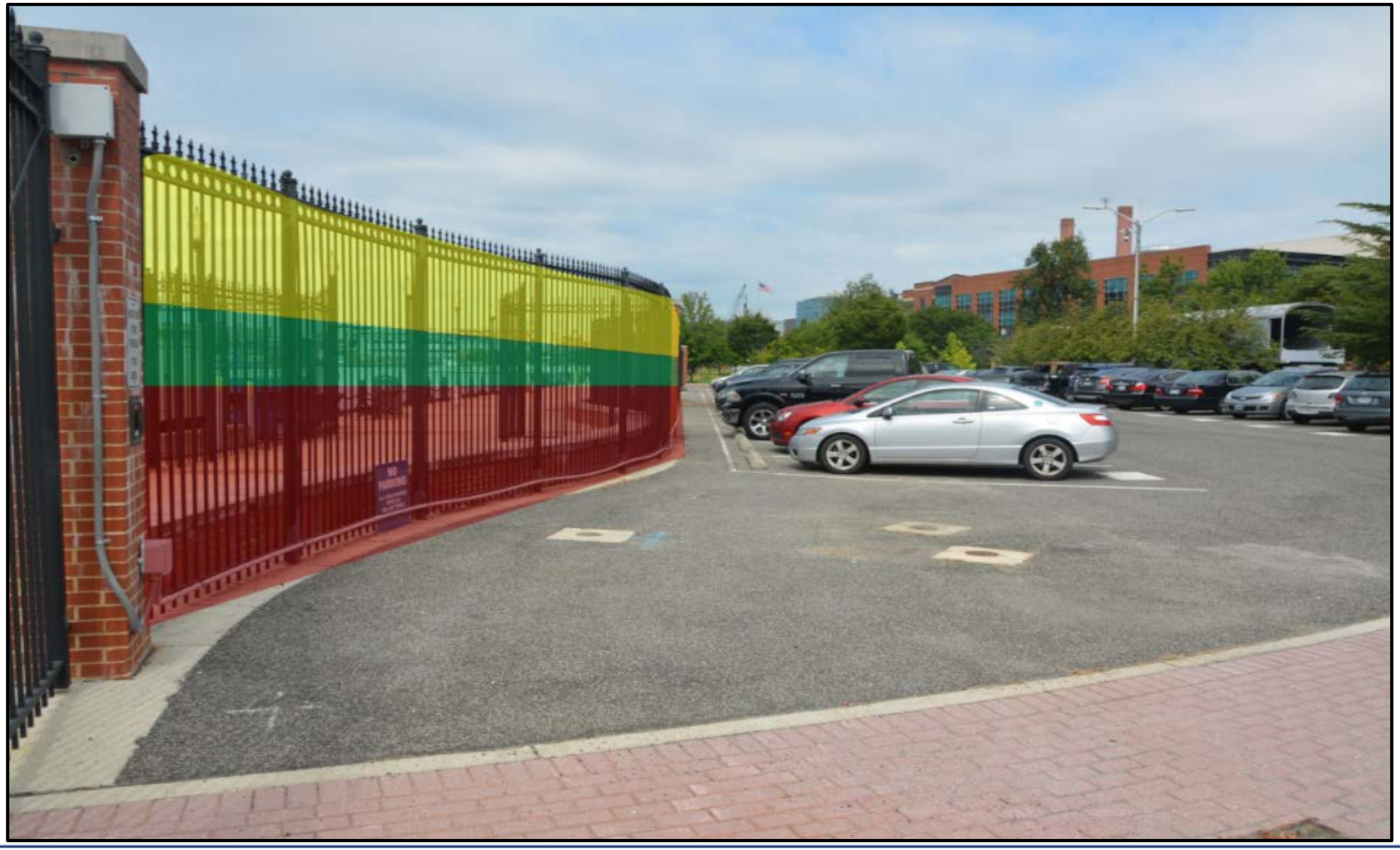
Global Scenario	2035	2065	2100
Medium	1.3 ft. increase	1.9 ft. increase	4.0 ft. increase
High	1.3 ft. increase	2.6 ft. increase	5.6 ft. increase

Preliminary Analysis (con't)

- **Design Flood Elevations**
  - **Floodwall**
    - Historic Preservation
    - Anti-Terrorism Force Protection
    - Site Constraints

Red= 4 ft. wall; **Green=** 6 ft. wall; **Yellow=** 8.5 ft. wall

Preliminary Analysis (con't)



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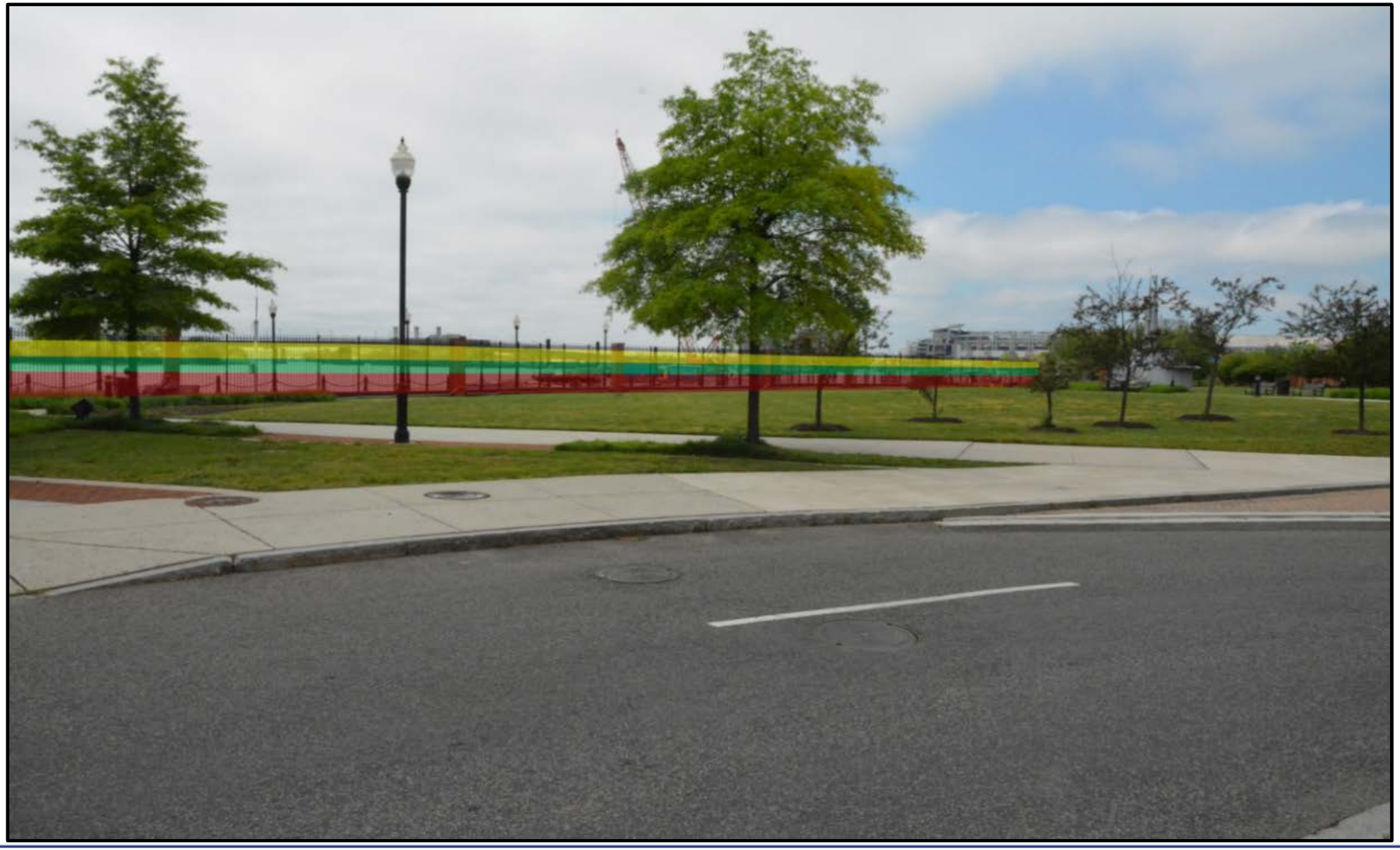
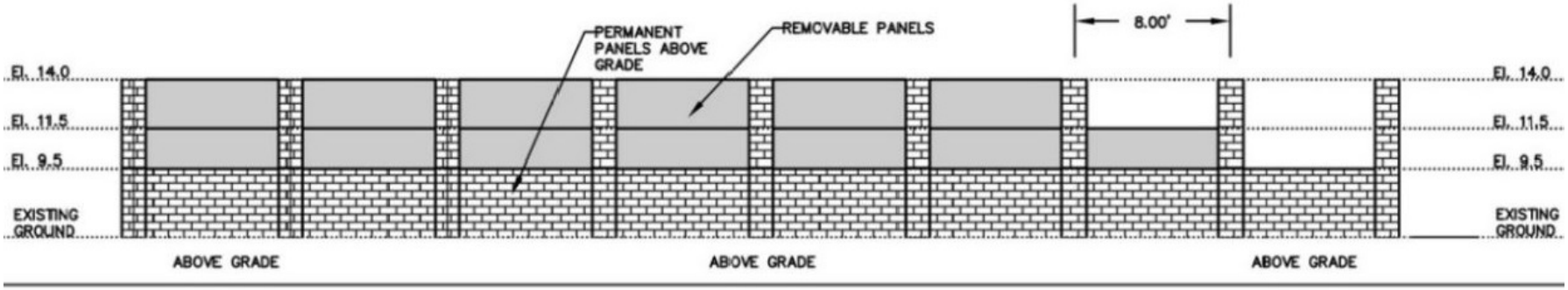
Preliminary Analysis (con't)



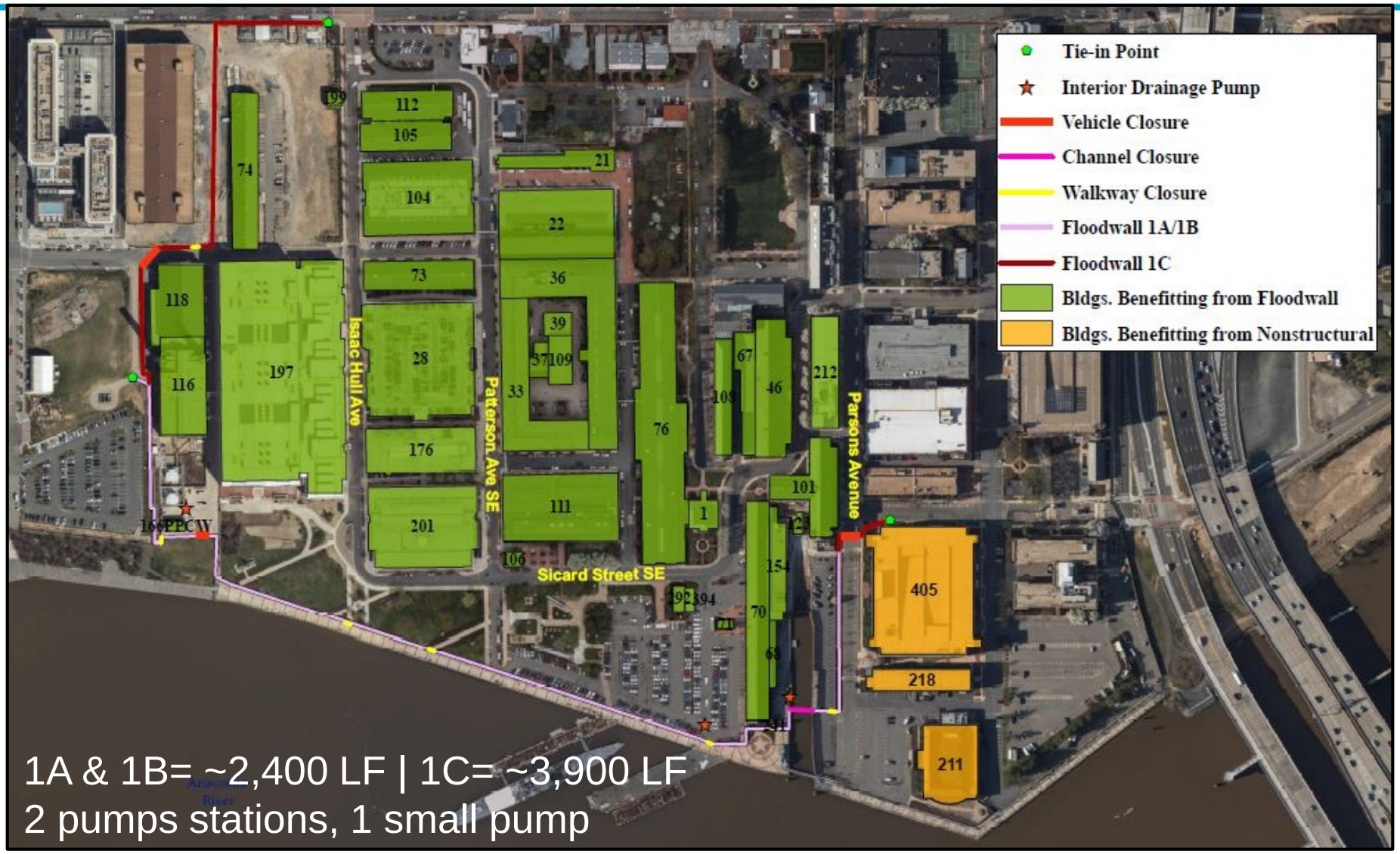
Red= 4 ft. wall; **Green=** 6 ft. wall; **Yellow=** 8.5 ft. wall

Preliminary Analysis (con't)

- **Final Design Flood Elevations (DFEs)**
  - **Floodwall**
    - *Low: 9.5 ft. NAVD88*
    - *Medium:11.5 ft. NAVD88*
    - *High: 14.0 ft. NAVD88*
  - **Non-Structural**
    Variable



Alternative #1



1A & 1B= ~2,400 LF | 1C= ~3,900 LF
2 pumps stations, 1 small pump

Alternative #1

Advantages:

- *9.5 ft. permanent wall*
- *Adaptability for floodwall*
- *Majority along current fenceline*

Disadvantages:

- *Significant manpower and storage*
- *Maintenance to pump stations*
- *Risk of failure to entire system*
- *Adaptability of (3) FP structures*

Costs:

- *~$14 - $21million*

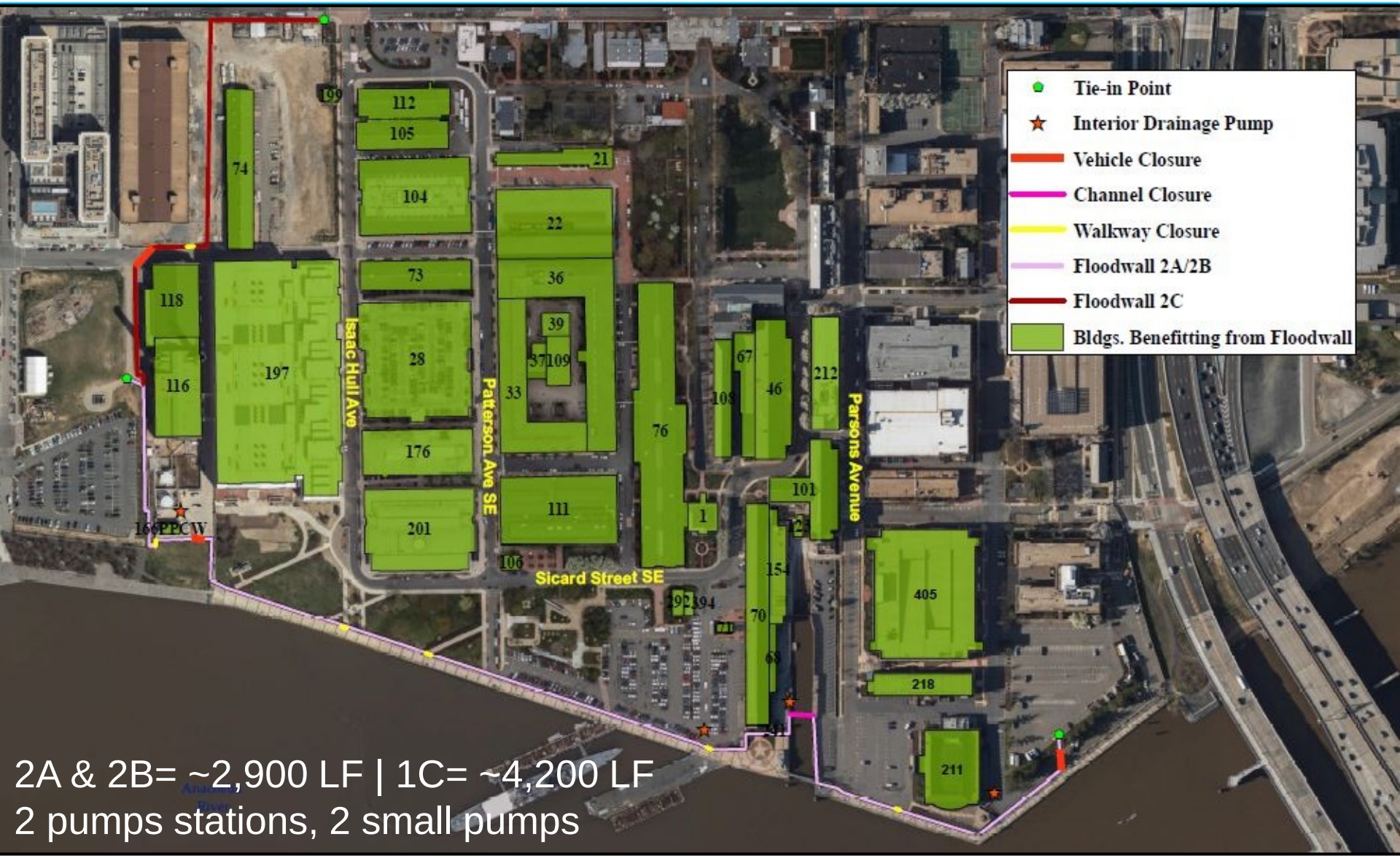
Benefit-to-Cost:

- *3.3- 54.2*

Manpower:

- *4 work crews for 1B*
- *8 work crews for 1C*

Alternative #2



2A & 2B= ~2,900 LF | 1C= ~4,200 LF
2 pumps stations, 2 small pumps

Alternative #2

Advantages:

- *9.5 ft. permanent wall*
- *Adaptability for entire floodwall*
- *Majority along fenceline*
- *Protects all buildings*

Disadvantages:

- *Significant manpower*
- *Maintenance to pump stations (additional pump)*
- *Risk of failure to system*

Costs:

- *~$13.7 - $20.7 million*

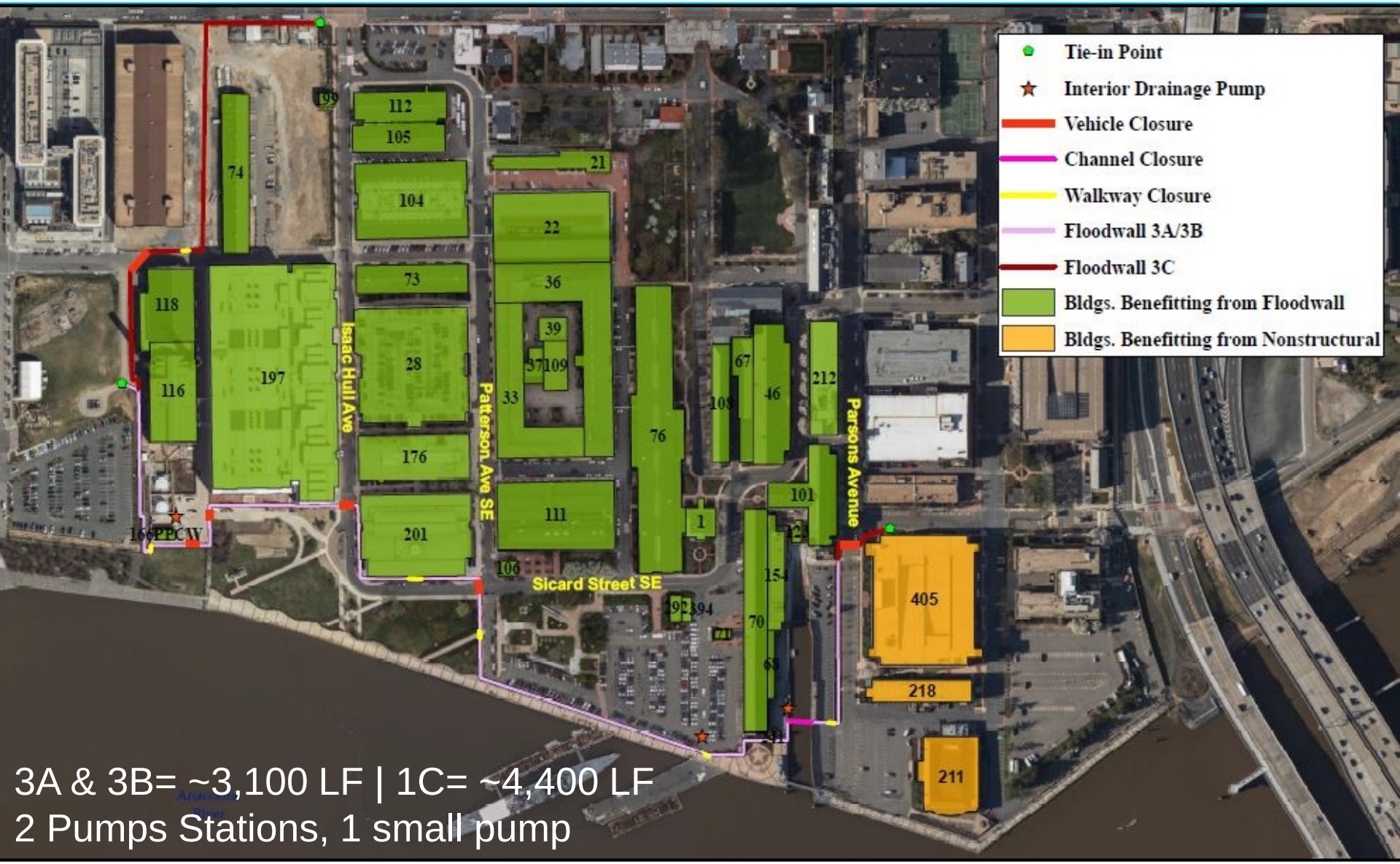
Benefit-to-Cost:

- *3.5- 55.3*

Manpower:

- *6 work crews for 2B*
- *11 work crews for 2C*

Alternative #3



3A & 3B= ~3,100 LF | 1C= ~4,400 LF
2 Pumps Stations, 1 small pump

Alternative #3

Advantages:

- *9.5 ft. permanent wall*
- *Decreased viewshed impact*
- *Potential for strategic design in southwest area*

Disadvantages:

- *Significant manpower*
- *Maintenance to pump stations*
- *Additional closures*
- *Risk of failure to system*
- *Adaptability of (3) FP structures*

Costs:

- *~$13.2 - $20.4 million*

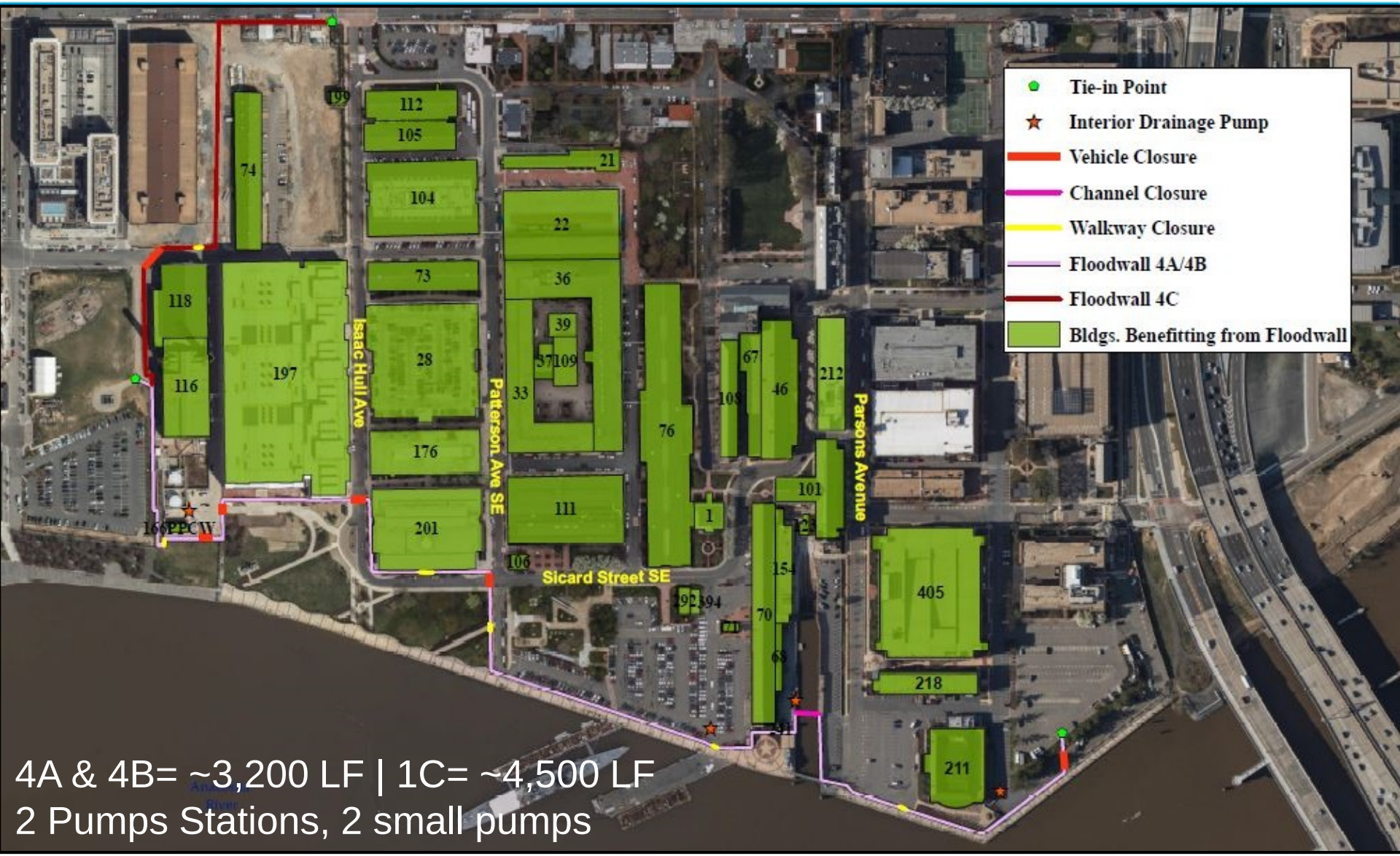
Benefit-to-Cost:

- *3.6- 57.5*

Manpower:

- *7 work crews for 3B*
- *13 work crews for 3C*

Alternative #4



4A & 4B= ~3,200 LF | 1C= ~4,500 LF
2 Pumps Stations, 2 small pumps

Alternative #4

Advantages:

- *9.5 ft. permanent wall*
- *Decreased viewshed impact*
- *Potential for strategic design in southwest lawn area*
- *Protects all buildings*

Disadvantages:

- *Significant manpower*
- *Maintenance to pump stations (additional pump)*
- *Additional closures*
- *Risk of failure to system*

Costs:

- *~$13.1 - $19.8 million*

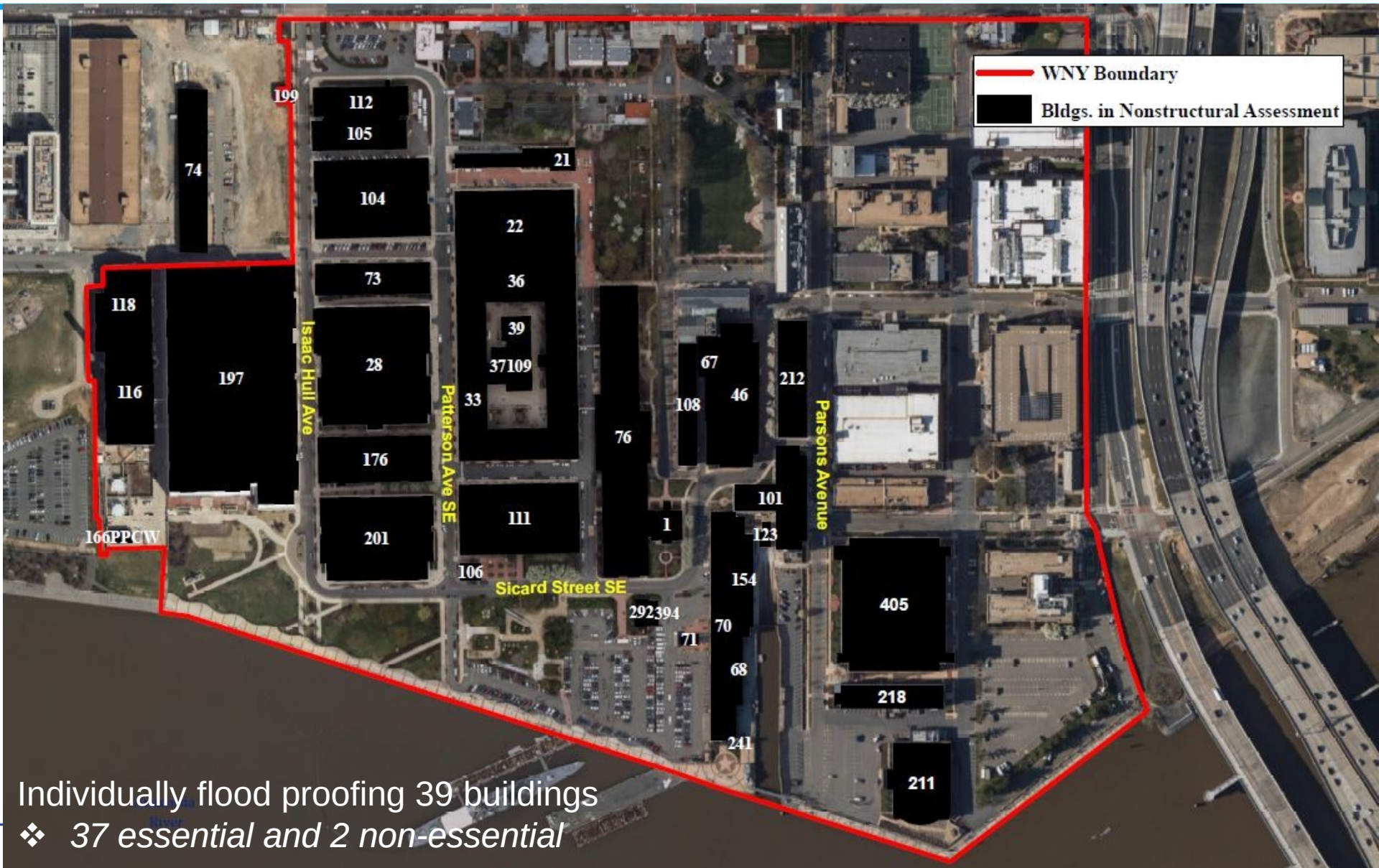
Benefit-to-Cost:

- *3.6 – 57.7*

Manpower:

- *8 work crews for 4B*
- *14 work crews for 4C*

Alternative #5



Individually flood proofing 39 buildings

- *37 essential and 2 non-essential*

Non Structural Flood Proofing Assessment

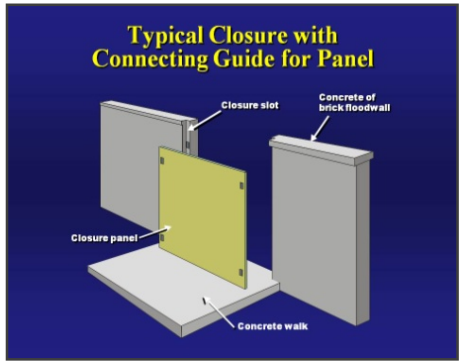
The most common physical flood proofing measures implemented for flood damage and life loss reduction are considered to be:

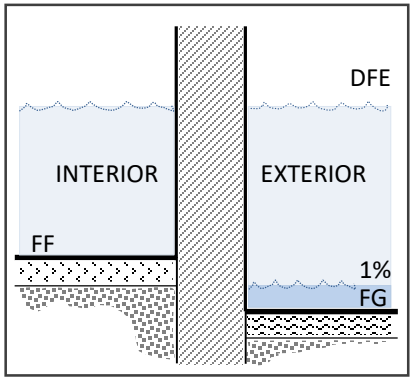
- Acquisition; Relocation; Elevation; Dry Flood Proofing; Wet Flood Proofing

Nonphysical flood proofing measures are considered to be:

- Floodplain Mapping; Land Use; Flood Insurance; Evacuation Plans; Flood Warning Zoning; Operational Changes; Emergency Preparedness Plans

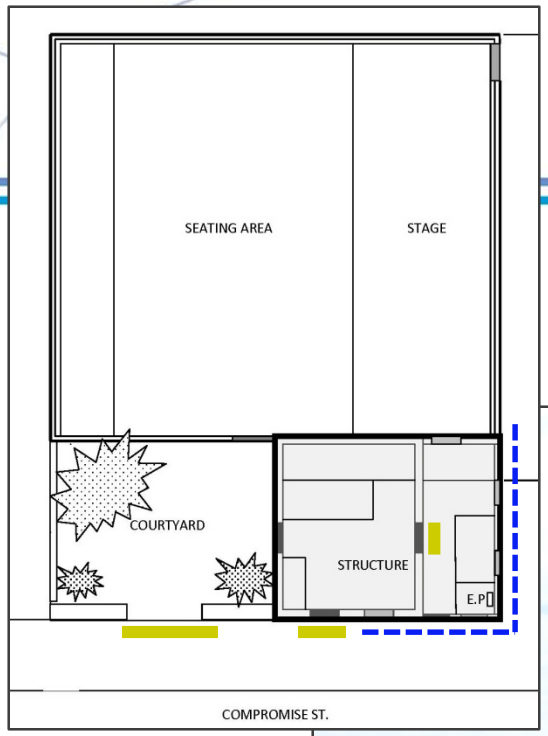
Flood Barriers for Doors and Windows

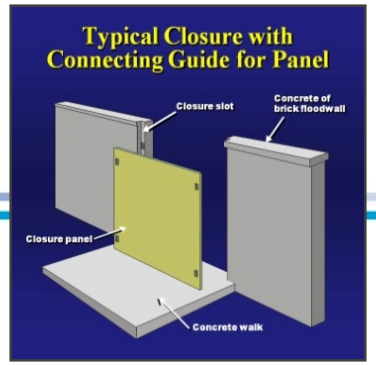




BUILDING SECTION (at Grade)
Not to Scale

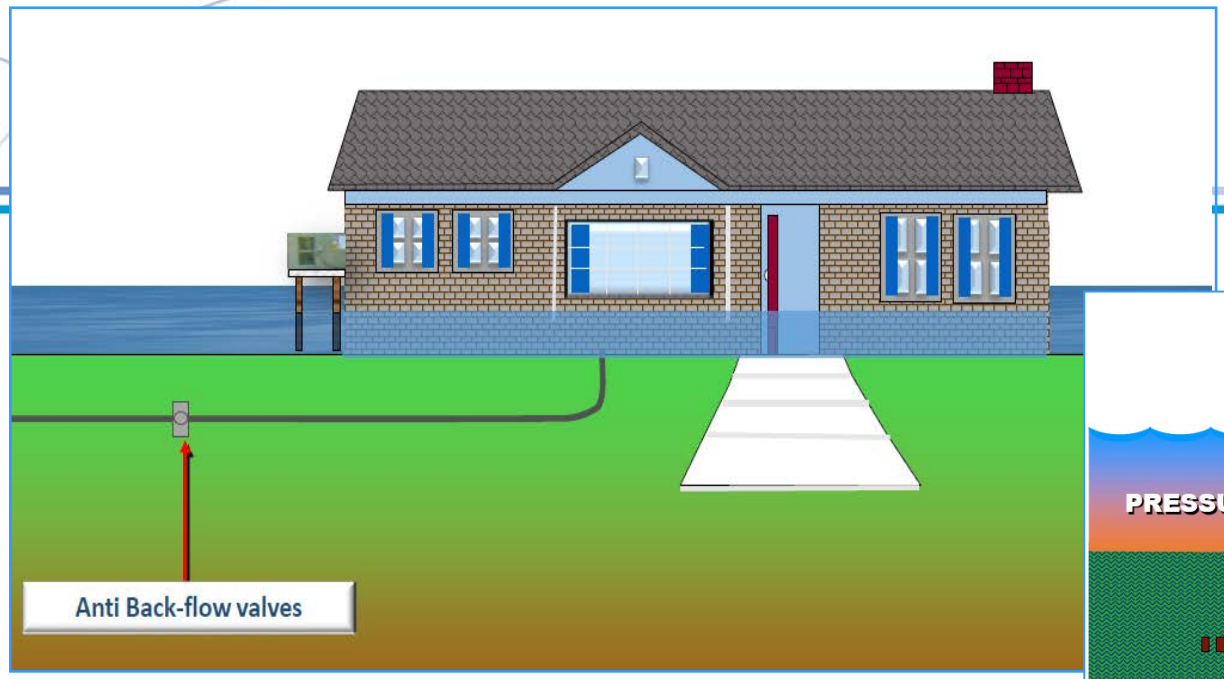
Dry Flood Proofing Historic Structures

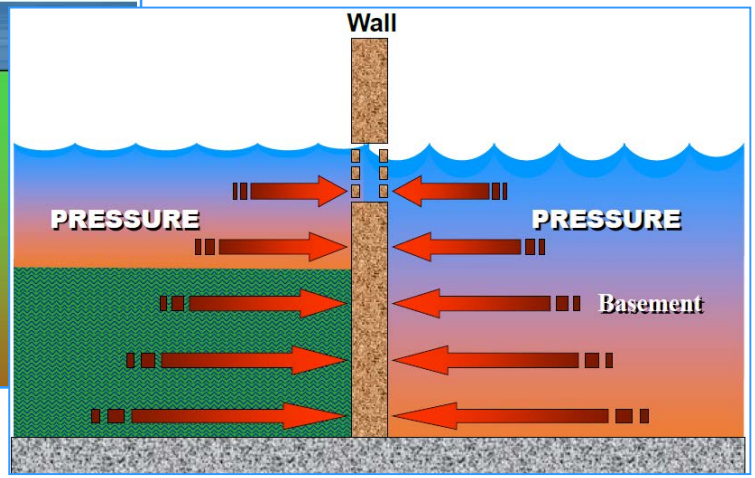




Dry Flood Proofing Historic Structures

Wet Flood Proofing





Elevate External Utilities

Alternative #5

Advantages:

- *Flood risk managed for individual structures*
- *Less storage required*
- *Can be budgeted and implemented in phases*
- *Least expensive alternative*

Disadvantages:

- *Not as adaptable*
- *Historic preservation standards*
- *FRM level varies (many buildings less than 11.5 ft.)*
- *WNY property still flooded*

Costs:

- *~$12 million*

Benefit-to-Cost:

- *4.2- 61.4*

Manpower:

- *Varies per building; Significantly reduced with certified flood proof doors*

Alternative #5- FRM Comparison

Flood proofed buildings at flood elevation 11.5 ft. NAVD88

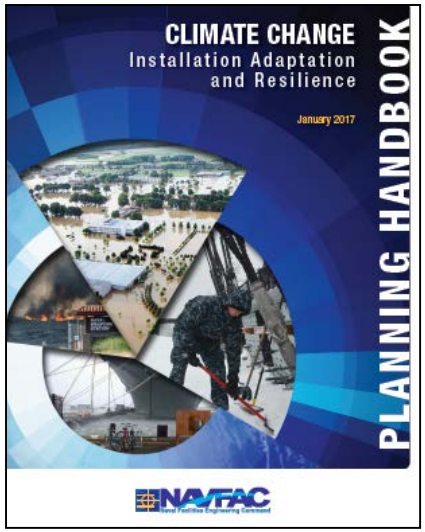
Green= flood proofed to elevation 11.5 ft. or higher

Red= flood proofed to 11.4 ft. or below

Conclusion

- **FRM measures selected: flood wall, closures, dry and wet flood proofing**

- **Cost and Economic Analysis**
  - **$12K (Alternative #5 – nonstructural flood proofing)**
  - **$13K - $20K (all floodwall alternatives)**
  - **BCR is highest for the Alternative # 5**
  - **Of the floodwall alternatives - BCR is highest for Alternative #4**

- **Advantages – Disadvantages**

- **BCR for each individual building for dry and wet flood proofing.**