U.S. Naval Academy

Flood Damage Reduction Project Using Structural and Non-Structural Measures

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Presentation by

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Why has this project received strong customer support?

- The project was customer-focused
- We used all of the “tools” in the “tool box”
- We developed an innovative solution that combines structural and non-structural measures

Background

- Hurricane Isabel struck Annapolis, Maryland in September 2003
- Storm surge created water levels equivalent to the 100-year flood event
- 18 buildings were flooded
- USNA incurred over $80 million in damages
- USNA had never experienced significant flooding prior to this event

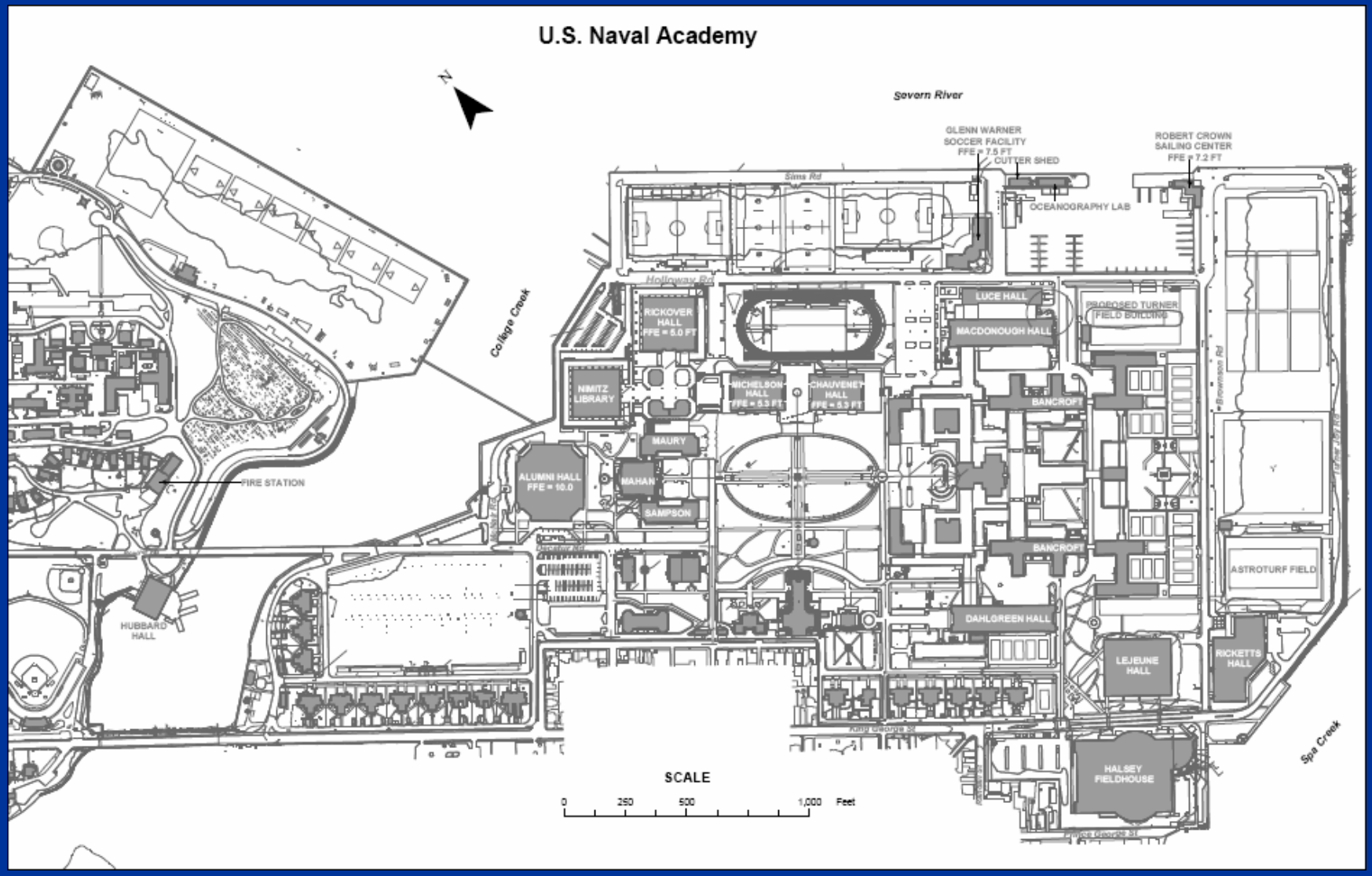
Project Goal

To prevent floodwaters from disrupting operations and damaging the existing structures during the 100-year flood event, or higher

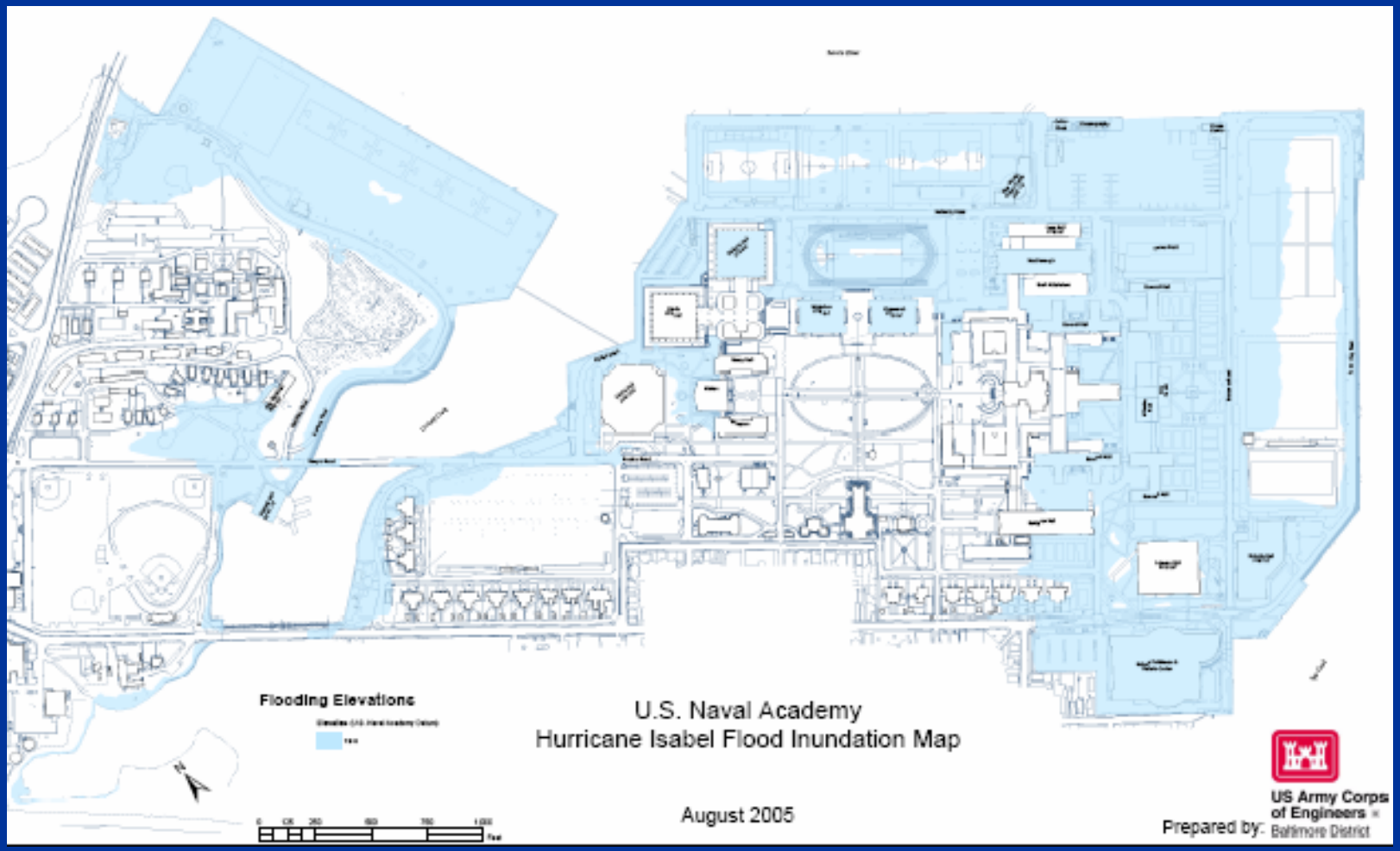
USNA Objectives

- Include the existing buildings as flood protection (dry flood proof to the extent possible)
- Recommend durable, low maintenance, low-tech, easy to use flood protection measures
- Consider and minimize historic and aesthetic impacts
- Recommend a plan that may be constructed incrementally

Orientation



Hurricane Isabel Flooding



Study Process

- Step 1 – Conducted field reconnaissance
- Step 2 – Identified alternative solutions
- Step 3 – Evaluated and compared alternatives
- Step 4 – Recommended a plan for implementation

Step 1 - Field Reconnaissance

- **2 sets of teams were established**
- **Structural team**
  - investigated potential structural solutions (flood walls, berms)
- **Non-Structural team**
  - comprised of representatives from the Corps' National Non-Structural/Flood Proofing Committee
  - investigated each building to identify flood-proofing opportunities

Flood Damage Reduction Considerations

- Flooding characteristics – depth, velocity, duration
- Site characteristics – site location, soil types
- Building characteristics – foundation, construction, condition

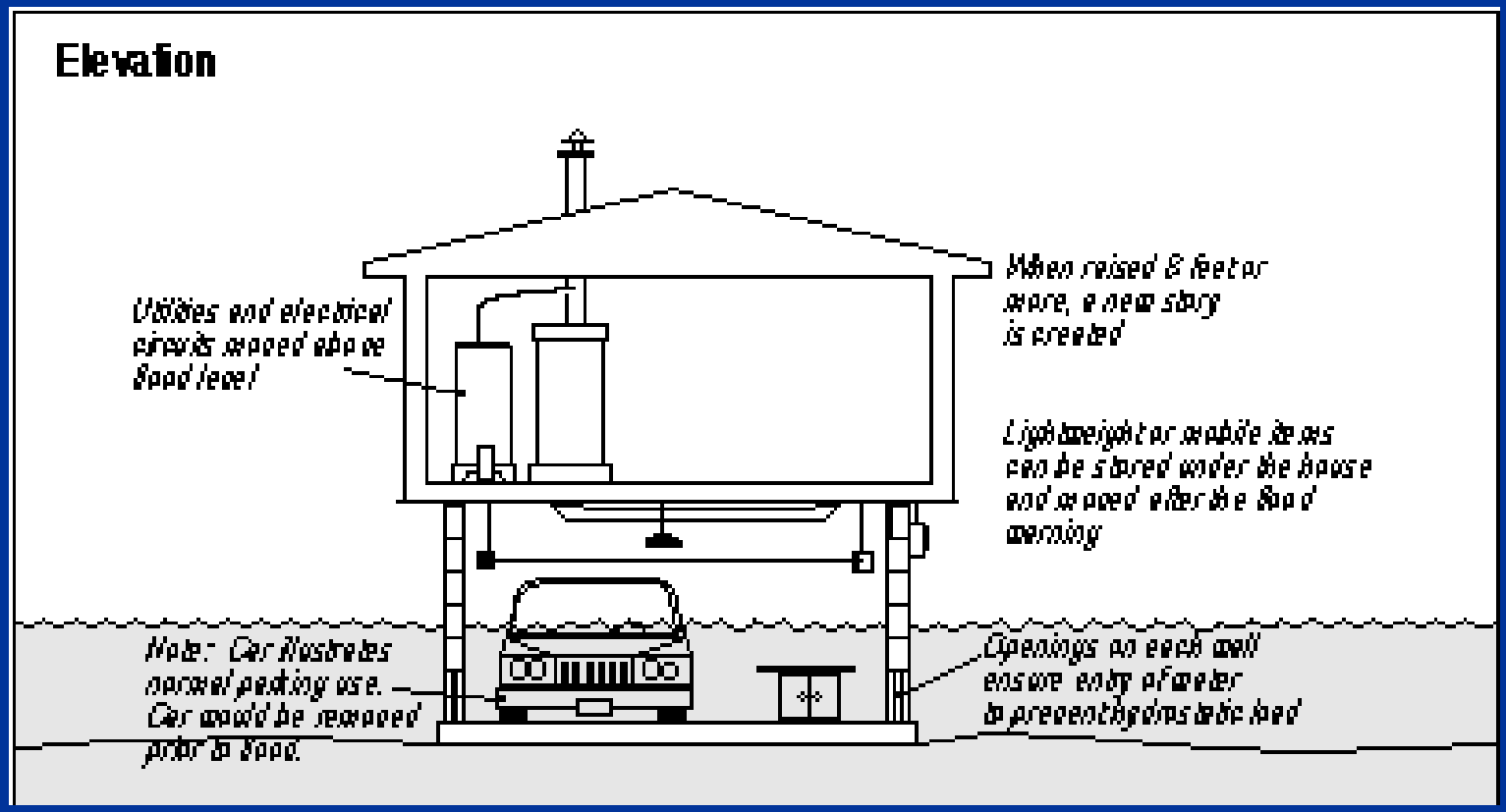
Types of Non-Structural Flood Proofing

- Elevation
- Relocation
- Dry flood proofing
- Wet flood proofing

Elevation

- Raise the building so that floodwaters cannot reach damageable portions of it
- Construct new or extended foundation or elevate on piles or columns

Elevation


Elevation
Utilities and electrical
circuits moved above
flood level
When raised 6 feet or
more, a new story
is created
Lightweight or mobile items
can be stored under the house
and moved after the flood
warning
Note: Car illustrates
normal parking use.
Car would be removed
prior to flood.
Openings on each wall
ensure entry of water
to prevent hydrostatic load

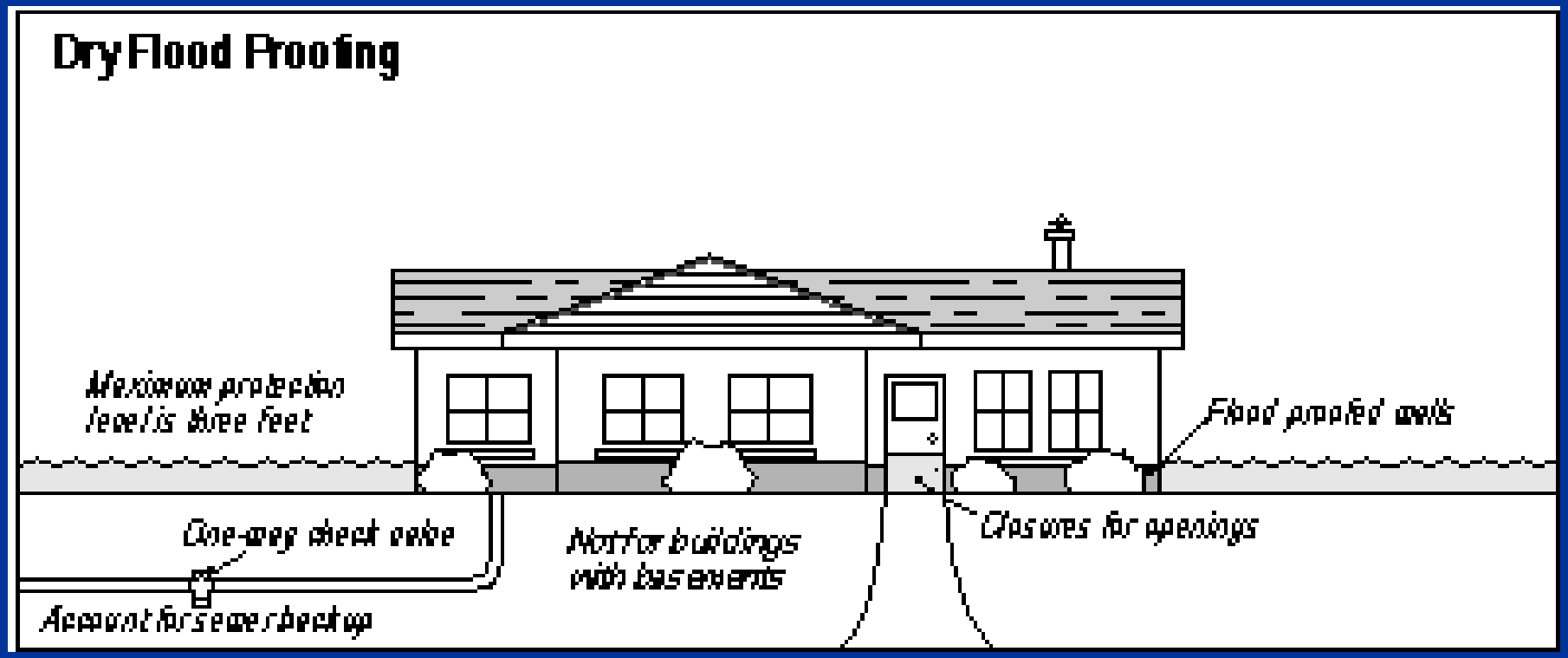
Relocation

- Move the building to another location where floodwaters cannot reach it

Dry Flood Proofing

- **Seal the building so that floodwaters cannot get inside**
- **Typically, can be done only where floodwaters are less than 3 feet deep**
- **Types of features include:**
  - Sealing walls with waterproofing compounds or impermeable sheeting
  - Closing openings such as doors, windows, sewer lines, and vents with permanent closures or removable shields

Dry Flood Proofing



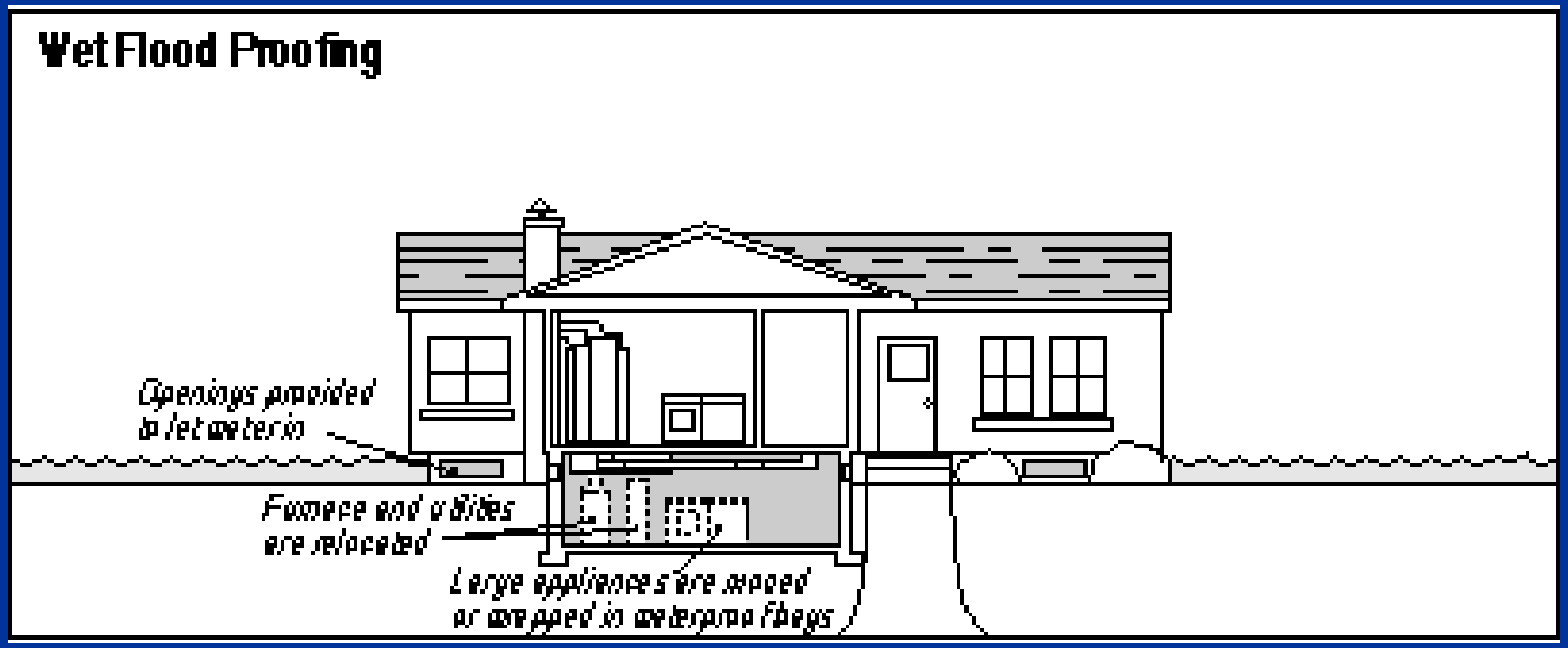
Types of Flood Gates

Courtesy of Reelan Industries and PS Doors

Wet Flood Proofing

- **Wet flood proofing – Modify the building to allow floodwaters inside, but ensure that there will be minimal damage to the structure and its contents**
- **Often only used when other measures are not possible or too costly**
- **Types of features include:**
  - Protecting or moving utilities and furnaces to an area above anticipated flood level
  - Installing vents so that floodwaters can easily enter and exit the structure
  - Raising or moving critical items prior to the flood event
  - Retrofitting items below the flood level to make them water resistant

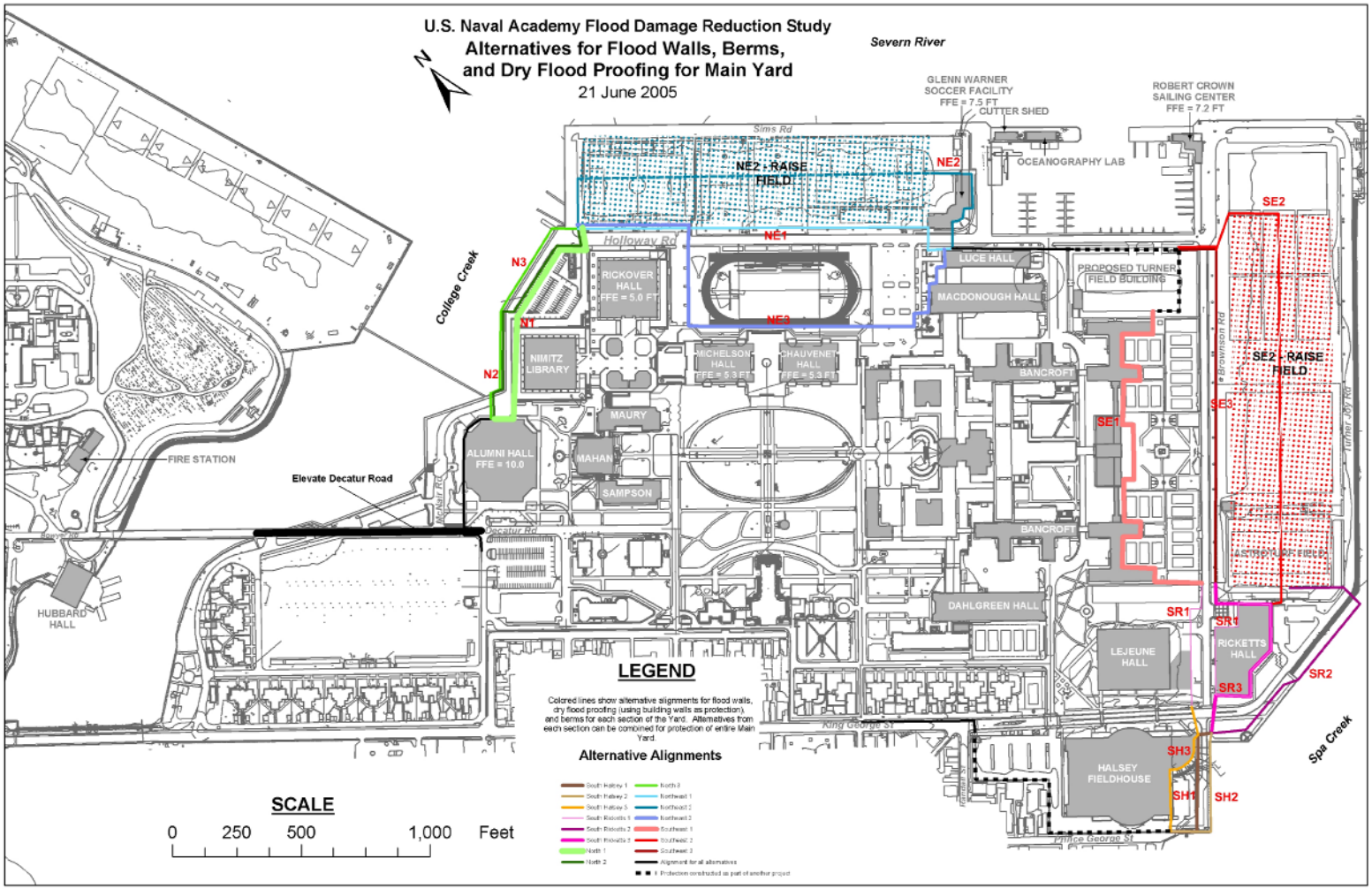
Wet Flood Proofing



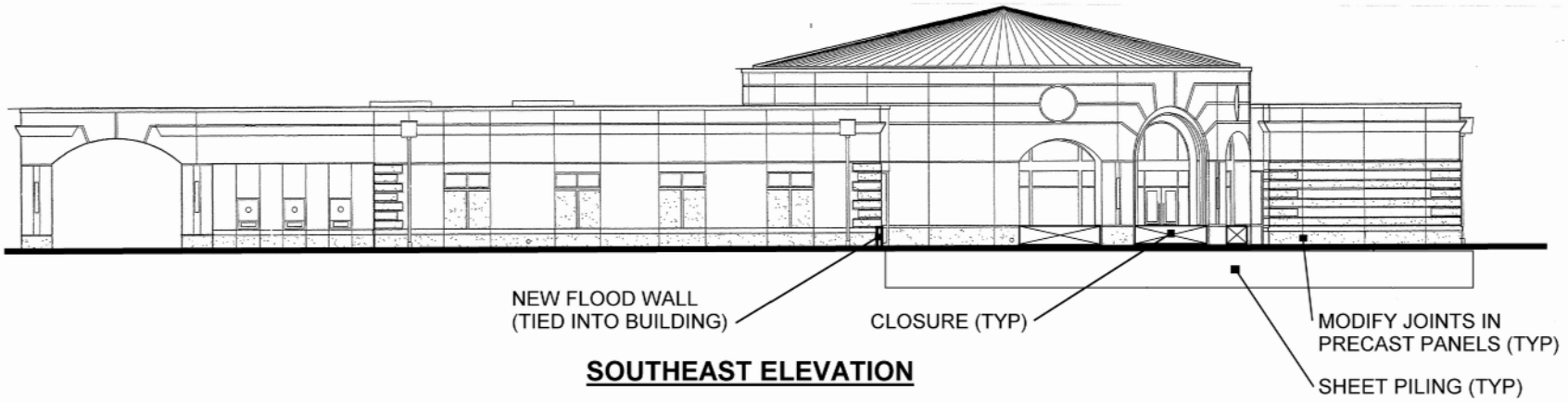
Step 2 – Identify Alternative Solutions

- Entire team gathered to develop comprehensive solutions to the flooding problem
- Team investigated flood proofing individual buildings and using sides of buildings as part of the flood wall
- Types of structural features investigated include flood walls, berms, and raising ball fields
- Due to numerous combinations of alternatives, the USNA was divided into 5 areas

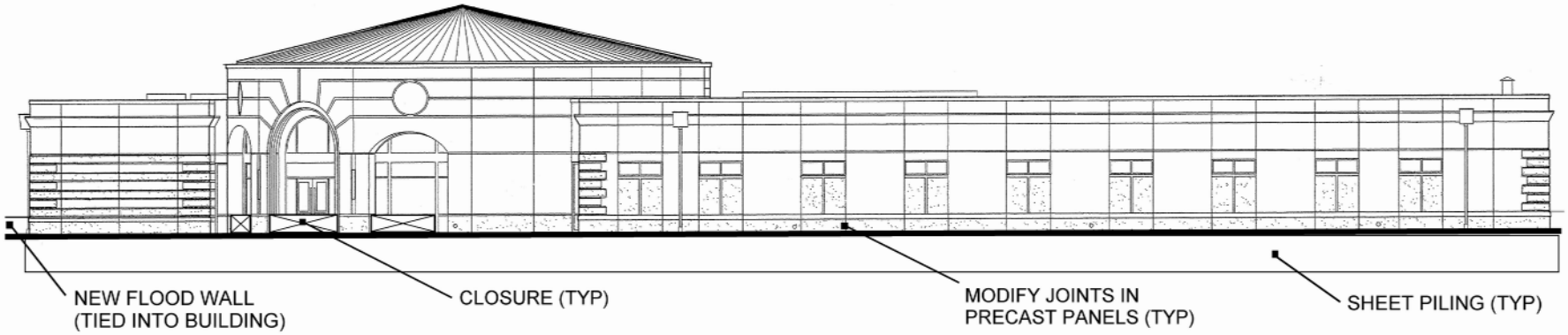
Alternative Solutions



Soccer Facility



SOUTHEAST ELEVATION

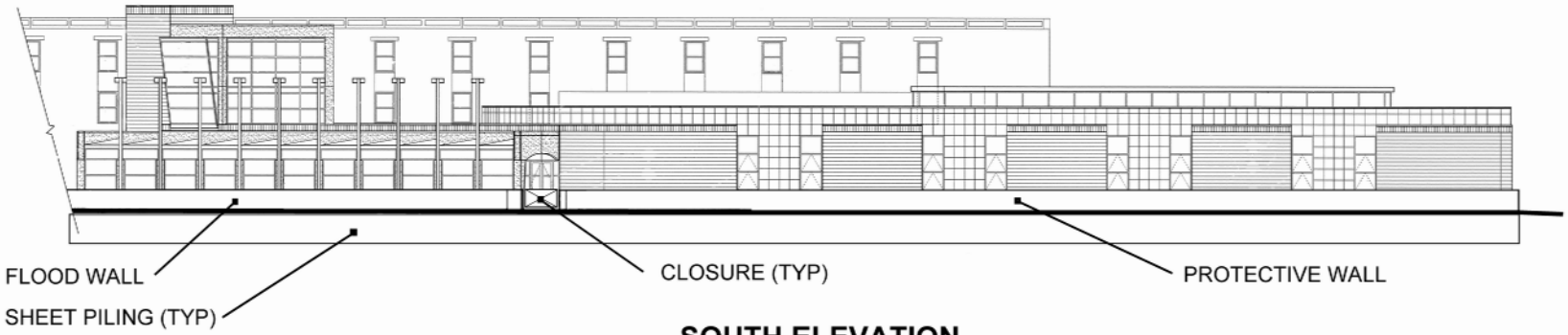


SOUTHWEST ELEVATION

BLDG/DRWG/PHASE **GLENN WARNER** **BUILDING ELEVATIONS - SW&SE** **5% - CONCEPT DESIGN**	ALTERNATIVE PROTECTIVE WALL	SCALE NTS	NATIONAL NON-STRUCTURAL/ FLOOD PROOFING COMMITTEE
	LEVEL OF PROTECTION ELEV. 10.8'	DATE MAR 05	

Ricketts Hall

Ricketts Hall



SOUTH ELEVATION

EAST ELEVATION

BLDG/DRWG/PHASE			
RICKETTS HALL **BUILDING ELEVATIONS - S&E** **5% - CONCEPT DESIGN**	ALTERNATIVE PROTECTIVE WALL	SCALE NTS	NATIONAL NON-STRUCTURAL/ FLOOD PROOFING COMMITTEE
	LEVEL OF PROTECTION ELEV. 10.8'	DATE MAR 05	

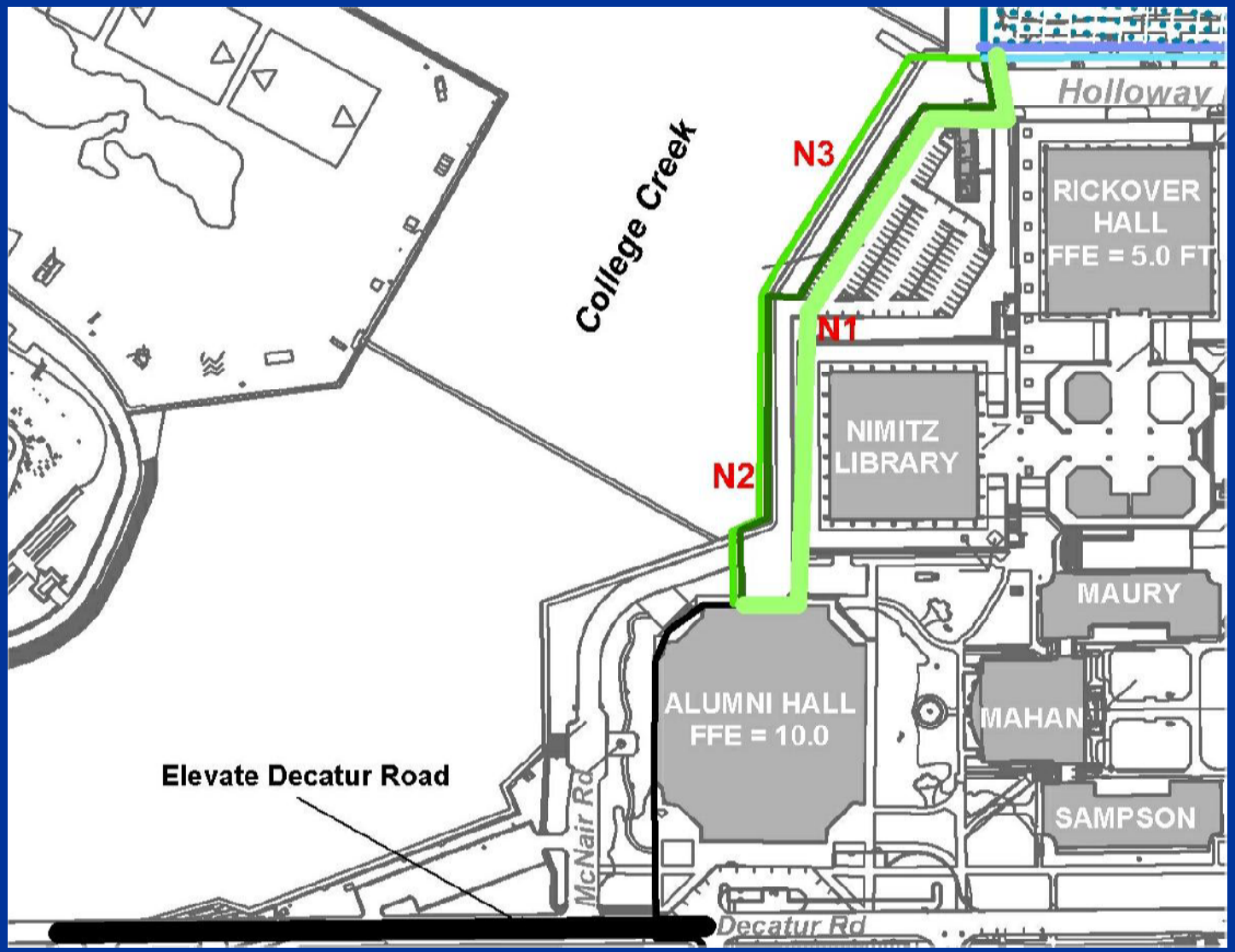
North side of Nimitz Library

Potential Flood Wall Location

Step 3 – Evaluate and Compare Alternatives

- **Evaluation Criteria:**
  - Construction Cost
  - Operation and Maintenance Activities
  - Actions Prior to Flood
  - Cultural and Historic Impacts
  - Aesthetic Impacts
  - Accessibility through Yard
  - Impact to facility/operations
  - Dual-use of flood wall as inner security fence

Alternatives for North Area



North side of Nimitz

Flood Proof Alumni Hall

Alternatives for North Area

***N1 – Flood wall along Nimitz and dry flood proof Alumni**

- 4 closure structures
- Minimal impact to water view
- $5-6 million; highest cost
- McNair Rd closed during construction

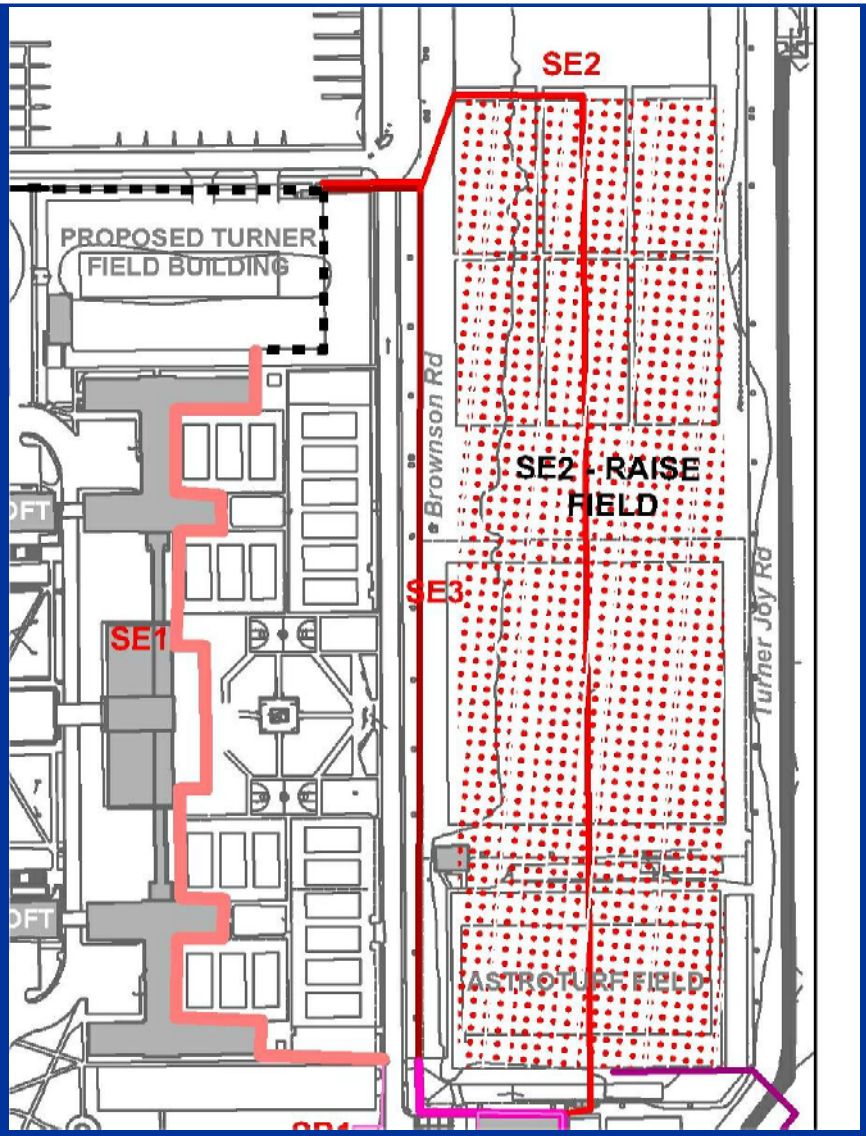
N2 – Flood wall along sea wall and parking area and dry flood proof Alumni

- 4 closure structures
- Moderate impact to water view; sidewalk could be raised
- $4,200,000

N3 – Flood wall along sea wall and dry flood proof Alumni

- 2 closure structures
- Severe impact to water view; sidewalk could be raised
- $3,400,000; least cost

Alternatives for Southeast Area



Bancroft Hall

Alternatives for Southeast Area

***SE1 – Dry flood proof Bancroft and Levy**

- Only 1 closure structure
- No impact to view; protection would be nearly “invisible”
- Numerous flood gates across doorways
- Larger area would be flooded; smaller pumps needed
- $1,710,000; least cost

SE2 – Raise football fields

- Only 1 closure structure
- Minimal impact to view (field raised ~2 feet)
- Would need to ensure safe slopes around fields
- $3,620,000; highest cost

SE3 – Flood wall along Brownson Road

- 4 closure structures
- Severe impact to view (water and fields)
- $1,770,000

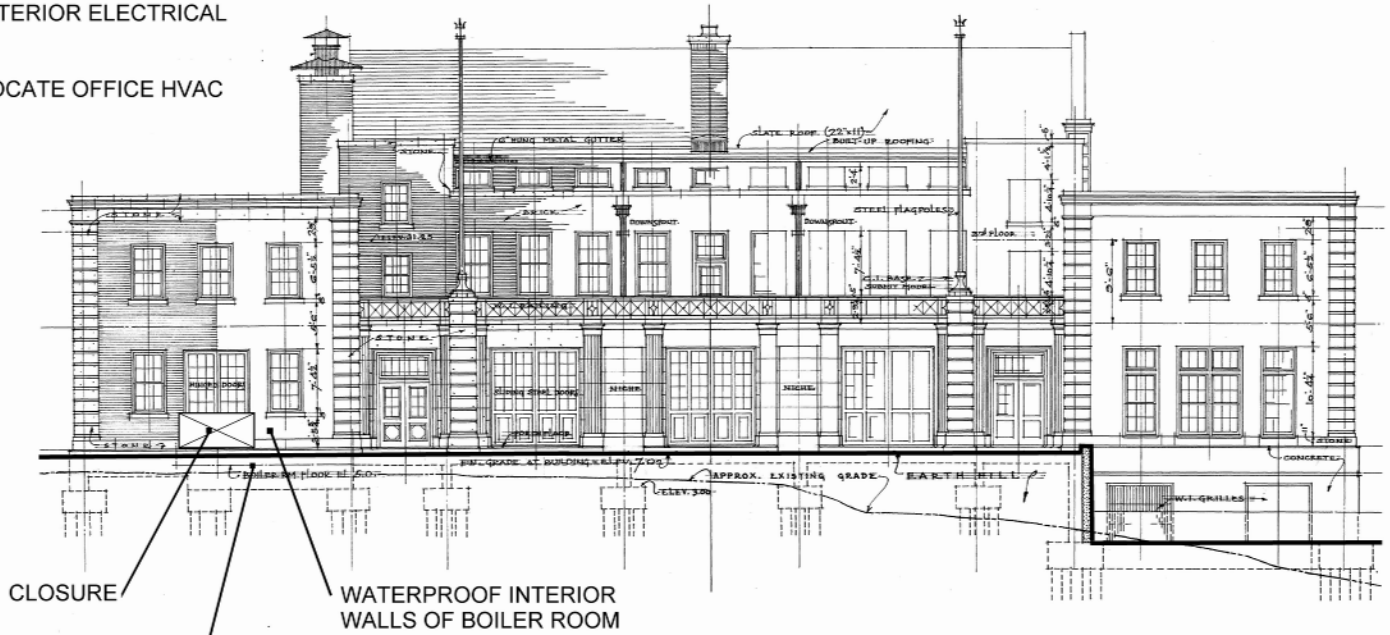
NOTES:

1. RELOCATE OFFICES FROM 1ST FLOOR TO UPPER LEVEL

2. RELOCATE ELECTRICAL SYSTEM (OUTLETS, SWITCHES, PANELS, ETC.,..) ABOVE THE DEIGN ELEVATION

3. RING WALL EXTERIOR ELECTRICAL EQUIPMENT

4. ELEVATE/RELOCATE OFFICE HVAC EQUIPMENT



NORTH ELEVATION

BLDG/DRWG/PHASE		ALTERNATIVE	SCALE	
HUBBARD HALL **BUILDING ELEVATION - NORTH** **5% - CONCEPT DESIGN**		WET FLOOD PROOF	NTS	NATIONAL NON-STRUCTURAL/ FLOOD PROOFING COMMITTEE
		LEVEL OF PROTECTION ELEV. 10.8'	DATE MAR 05	

Alternatives for Hubbard Hall

H1 – No action

- No flood protection
- Similar flood damages would be incurred during similar flood event; Isabel damages were $500,000

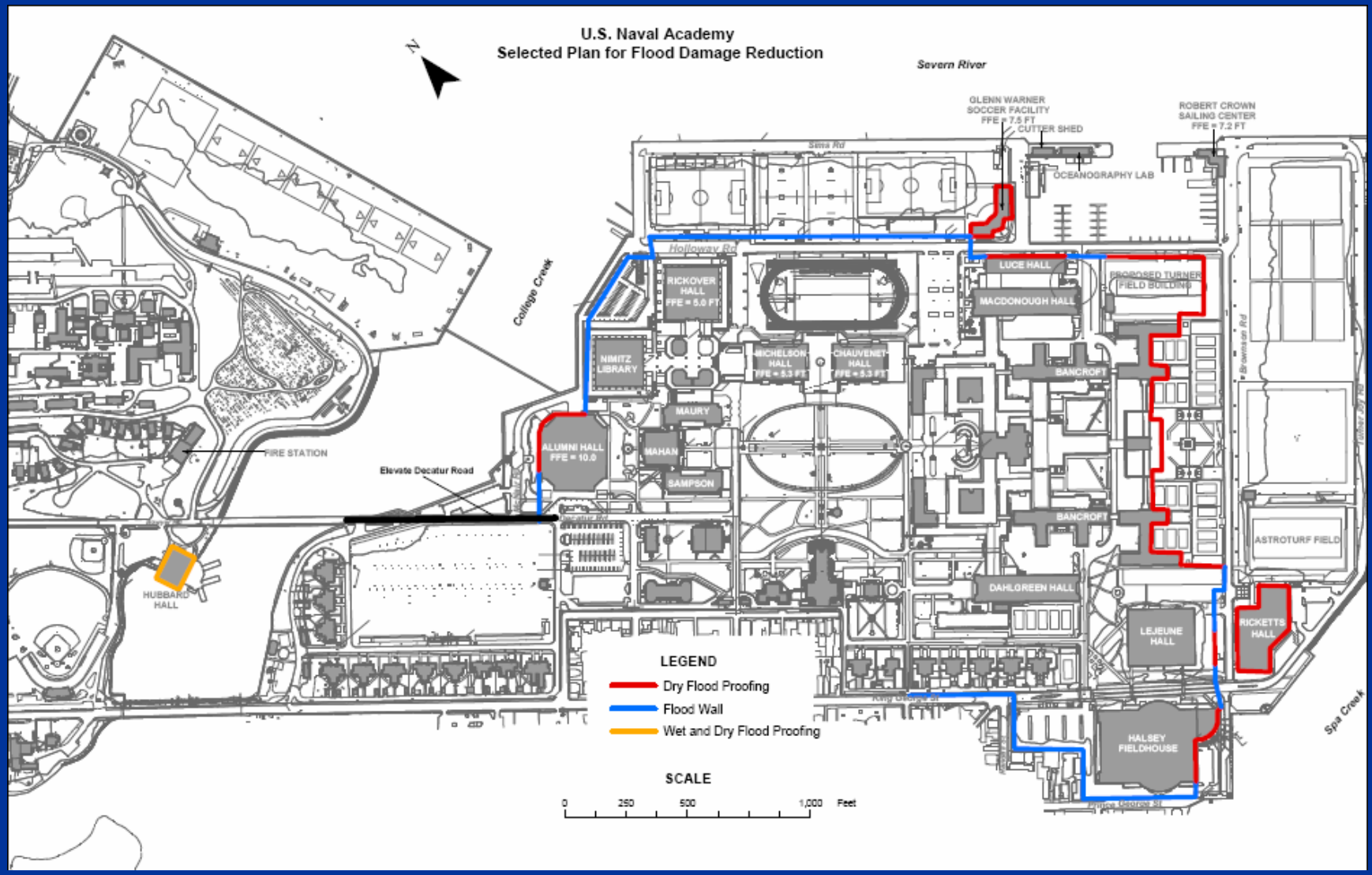
*H2 – Wet flood proof structure and dry flood proof mechanical room

- Relatively low cost and damages would be minimized
- Building would still be flooded and clean-up would be required
- Critical items must be moved/raised prior to flood
- $160,000

Selected Course of Action

- Based on evaluation of alternatives, USNA selected a plan for implementation
- Final selected plan includes:
  - Approx. 4000 linear feet of flood walls
  - 2 buildings entirely dry flood proofed
  - 6 buildings dry flood proofed on 1 or 2 sides
  - 1 building combination wet and dry flood proofed

Selected Plan



Questions?

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