Avoiding Flood Losses in the American Heartland

A tale of successful risk management and acquisition in Beatrice, Nebraska
On May 7, 2015, the Big Blue River rose to its third highest crest.

The damage that occurred was significantly less due to a flood prone property acquisition program that the city began in the 1970s.

Flood levels that had been devastating in the 1970s, 1980s, and 1990s were significantly reduced in 2015.

Over more than 45 years, the City invested $4.9 Million (2017 adjusted) to purchase 120 properties (95 structures).

According to the study results, nearly $13 million dollars in flood damage was avoided in the 2015 flood.

$12.9 - $4.9 = $8 MILLION SAVINGS IN 2015
A 263% RETURN ON INVESTMENT
An online interactive Story Map has been developed to allow readers to take a virtual journey through the history of flooding turned to mitigation success in Beatrice.

Welcome To Beatrice, Nebraska

Scroll down to see our story!
The story map presents Beatrice's acquisition success story from the aftermath of its highest flood event on record in 1973 through two major flood events that followed in 1984 and 1993 and culminating with the 2015 flood event that demonstrated the benefits of the flood prone property acquisition program.

The goal is to show how this type of investment can have significant long-term economic and flood risk benefits for a community, as well as quantify the return on investment over time.
To provide an understanding of the flood history in Beatrice, we go back before the City's flood prone property acquisition program began to the fall of 1973 as rains began to fall and the Big Blue River began to leave its banks...
“At about 16 feet, water begins to flow out of its banks and officials make a call to action for possible flooding.”

- BEATRICE SUN TIMES -
1973 – Largest Flood of Record

“At 18 feet, lowland flooding begins and portions of Chautauqua Park flood.”

- BEATRICE SUN TIMES -
1973 – Largest Flood of Record

“...The river hit 20 feet before West Court Street bridge was closed”
-BEATRICE SUN TIMES-

CREST = 20’
4’ FT Above Fld Stage
1973 – Largest Flood of Record

“South Sixth Street bridge closed at 26 feet.”
- BEATRICE SUN TIMES -

CREST = 26'
10’ FT Above Fld Stage
1973 – Largest Flood of Record

The 1973 event was the highest event on record.

Cresting at 33ft.

CREST = 33’
17’ FT Above Fld Stage
“...the emptied floodplain would cut the dollar loss from floods and would lessen the chances of people being killed or injured in a flood”

- Terry Doyle, City Clerk-Treasurer (1975)

“...old man river is going to do it ultimately if we don’t.”

- Doug Probst, Beatrice City Councilman (1975)

Learning From The Past
In 1973, flooding throughout the region was devastating. The City of Beatrice’s response was to approach recovery through hazard mitigation planning. The goal was to avoid the same level of devastation with future floods. Spanning over 45 years, community leaders have utilized several funding sources to support the program:

- City funds
- Private contributions
- Gifts
- HUD Community Development Block Grants
- FEMA Hazard Mitigation Grant Program,
- FEMA Flood Mitigation Assistance Program
- FEMA Project Impact Grant
History of the Acquisition Program

The 1973 Beatrice flood event brought many changes to the small Nebraska community.

Homes and businesses that were flooded or destroyed in the 1973 flood event and in other floods through the years were reclaimed as parks, open space, ball fields, and other outdoor uses, giving the Big Blue River room to live.
History of the Acquisition Program

BY 1978

- Acquisitions: 10
- Structures: 3
- Total Cost: $85K

Total Acquisitions: 10
(3 Total Structures)
Total Cost (2017 Adjusted): $84,877
History of the Acquisition Program

By 1980:
- Acquisitions: 24
- Structures: 17
- Total Cost: $1.1 M

14 more were added in 1979 and 1980.
Total Acquisitions: 24
(17 Total Structures)
Total Cost (2017 Adjusted): $1,081,508
By 1983:

- Acquisitions: 36
- Structures: 26
- Total Cost: $1.7 M

By the end of 1983, a total of 36 properties had been acquired.

Total Acquisitions - 36
(26 Total Structures)
Total Cost (2017 Adjusted) - $1,650,696
Beatrice saw its second largest flood event in 1984, cresting at 31.27 feet. By this time, many flood-prone properties and structures had already been removed and Beatrice was already seeing the benefits of its mitigation efforts.
History of the Acquisition Program

By 1989

- Acquisitions: 47
- Structures: 36
- Total Cost: $2.0 M

Immediately after the 1984 flood event, several additional properties were acquired. Nine in 1985, one in 1986, and one more in 1989.

Total Acquisitions - 47
(36 Total Structures)

Total Cost (2017 Adjusted) - $2,017,169
History of the Acquisition Program

In 1993 there were major changes nationally in how communities managed development in the floodplains. The great floods of 1993 had a wide-ranging impact, and in Beatrice, the result was that the program ramped up significantly. In the three years that followed, Beatrice acquired 49 additional floodprone properties.
History of the Acquisition Program

BY 1996

- **ACQUISITIONS**: 96
- **STRUCTURES**: 75
- **TOTAL COST**: $3.6 M

49 acquisitions in just three years following the 1993 floods.

- Total Acquisitions: 96
- (75 Total Structures)
- Total Cost (2017 Adjusted): $3,576,629
History of the Acquisition Program

By 2014

- Acquisitions: 120
- Structures: 95
- Total Cost: $4.9 M

Over the next 20 years that preceded the 2015 flood event, Beatrice added 24 additional property acquisitions.

Total Acquisitions - 120
(95 Total Structures)

Total Cost (2017 Adjusted) - $4,920,267
A Mitigation Success Story

“We were better aware of what could happen this time around if river waters did rise quickly” - Jason Moore, Beatrice Street Superintendent
A Mitigation Success Story

$6.8M
Estimated
2015 Flood Damage

(2017 Dollars)
- $10,000
- $50,000
- $100,000
- $500,000
- $1,000,000
A Mitigation Success Story

$19.7M
Estimated 2015 Flood Damage
(What would have occurred if the program was not implemented)

(2017 Dollars)
- $10,000
- $50,000
- $100,000
- $500,000
- $1,000,000
A Mitigation Success Story

Mitigation Benefit

$12.9M
Estimated 2015 Losses Avoided

(2017 Dollars)
- $10,000
- $50,000
- $100,000
- $500,000
- $1,000,000
A Mitigation Success Story

Mitigation Investment

$4.9M
Program Investment

(2017 Dollars)
- $10,000
- $25,000
- $50,000
- $100,000
- $200,000
A Mitigation Success Story

Return on Investment

263%
Return on Investment

(2017 Dollars)
- $10,000
- $25,000
- $50,000
- $100,000
- $200,000
### Mitigation Effectiveness Summary Results

<table>
<thead>
<tr>
<th>Structures</th>
<th>Millions of Dollars (2017 Adjusted)</th>
<th>Savings (ROI%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure Acquisitions (1973 - 2014)</td>
<td>95 $12.9M $12.9M $4.9M</td>
<td>$8.0M (263%)</td>
</tr>
<tr>
<td>Structures (Remaining)</td>
<td>32 $6.8M - -</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>127 $19.7M - -</td>
<td>-</td>
</tr>
</tbody>
</table>

- "Structures" column lists the number of structures.
- "Millions of Dollars (2017 Adjusted)" column includes the costs and savings in millions of dollars.
- "Savings (ROI%)" column indicates the total savings and the return on investment (ROI) percentage.
“The mitigation efforts in Beatrice and the cost-savings evidenced by this study are the result of a long-term strategy and a commitment on the part of community leaders spanning over 40 years. This is an example of responsible community mitigation planning, dedication, and the ability to make use of multiple programs and available resources to achieve a common goal.”

- David I. Maurstad, Deputy Associate Administrator for the Federal Insurance and Mitigation Administration; Mayor of Beatrice (1991-1994)
Added Benefits

- Increase in natural greenspace, wetland acreage, natural habitat for wildlife, and riparian buffers, which all increase water quality
- Increase in parks, open space, hiking and biking trails, ballfields, and other venues
- Reduction in fire department/law enforcement costs for flood duty and rescue
- Avoidance of future disruption of the community – business, education, health and social services
- Increased public safety
- And more…
How Success Was Measured

Analysis Used To Measure The Success Of The Program
Use of Hazus to Model Mitigation Effectiveness

- Damages modeled for 127 structures based on the 2015 flood inundation area
  - 95 Structures Removed – orange points
  - 32 Structures Remaining - green points
Hazus 4.0 Enhanced Flood Analysis
  • Hazard data replaced with 2015 Flood User Defined Depth Grid
  • Structure data replaced with User Defined Facility (UDF) Data

Modeled loss estimates based on
  • Depth of flooding
  • Property-specific attribute information
  • Location-specific depth-damage curves in Hazus

Hazus UDF Requirements
  • Building Value
  • Content Value
  • Building Type
  • Occupancy Class
  • #Stories
  • Foundation Type
  • Year Built
  • Square Footage
  • First Floor Height
  • Design Level
  • Latitude and Longitude
Data Collection

- Parcel data
- Assessor data
- Historical aerial imagery
- Gauge data
- LiDAR topography
- High water marks
- Property acquisition records back to 1973
- Other local media such as photos and video footage
Depth Grid Development

- Developed Triangular Irregular Network (TIN) to represent surface morphology using
  - High Water Mark data from 2015 flood event from NeDNR
  - High Water Mark data-points from photos and video footage

- Developed 2015 Event Depth Grid
  - Difference from existing ground surface from LiDAR and event water surface
Developing Values/Costs and Assumptions

- **Remaining Structures**
  - Gage County assessor parcel data
  - Defined assumptions to fill any gaps

- **Acquired Structures**
  - Acquisition records
  - Defined assumptions to fill any gaps

- **Acquisition Program Costs**
  - Acquisition records converted to 2017 dollars
  - Inflation Calculator from Bureau of Labor Statistics
  - Conversion rate based on date of acquisition (ranged from 1.06 in 2014 to 4.02 in 1977)
  - $4.9 Million total adjusted acquisition program cost
Results

- $19.7 M losses to all structures (32 Remaining + 95 Acquired)
- Minus $6.8 M losses to Remaining Structures
- Equals $12.9 Million in Avoided Losses 2015 Flood

$12.9 \text{ MILLION (FLOOD LOSS AVOIDED)} - $4.9 \text{ MILLION (INVESTED)} = $8 \text{ MILLION SAVINGS IN 2015}

A 263\% RETURN ON INVESTMENT
Beatrice has taken a holistic approach to flood risk identification, assessment, planning and floodplain management that underscores the “MAP” of Risk MAP – Mapping, Assessment, & Planning.
In June 1968, the City of Beatrice Requests a Flood Risk Study to aid in identification of local flood problems and to promote the best utilization of lands subject to overflow.

This was prior to the 1973 flood of record.

As shown in the 1970 study, the “Intermediate Regional Flood” identified the 1-percent-annual-chance floodplain.
Since 1968, Beatrice has been building a strong foundation in floodplain management and risk reduction, including:

- Asked for the flood risk to be mapped in 1968, the USACE created the first flood maps in 1970
- Passing first floodplain zoning ordinance in 1974 restricting development in identified flood risk areas
  - Included Standards above Federal minimum requirements, as required by the State of Nebraska
    - One foot of freeboard for all new and substantially improved structures built in the floodplain
    - No new or substantially improved residential structures in the floodway
- Practicing effective floodplain management to reduce flood risk for future development
- Joining the National Flood Insurance Program (NFIP) emergency program in 1974, and regular program in 1977
- Adopting their first Flood Insurance Rate Map (FIRM), effective on September 30, 1977
- Revised floodplain ordinance regulating development in Special Flood Hazard Areas (SFHA)
- FIRM updated in 1985
- Digital FIRM Updated in 2010
The regulatory floodplain in the effective FIRM for Beatrice, showing the SFHA for the 1-percent-annual-chance flood – represented by the Zone A and Zone AE designations.
Flooding during the 2015 event was just below the modeled extents of FEMA’s regulatory floodplain in the effective FIRM. The 2015 event was the third flood of this magnitude or higher in the span of 42 years, highlighting the value for all communities to be mitigating and preparing for floods at the regulatory level and beyond.
Mitigation Planning has been underway in Beatrice since the 1970s.

1970 pamphlet captures early mitigation planning efforts:

Now that the elevations and areas that future floods could be expected to reach are known, a realistic program of flood damage reduction can be accomplished.

1997 – Beatrice formalized flood mitigation planning efforts with one of the nation’s first Flood Mitigation Plans to secure funds for FEMA’s Flood Mitigation Assistance Program to continue acquisition program.

2008 – Beatrice expanded the Flood Mitigation Plan to an All-hazards Mitigation Plan in accordance with the Disaster Mitigation Act of 2000.

2014 – All Hazard Mitigation Plan Updated.

2018 – Plans underway for 2019 All Hazard Mitigation Plan Update.
Beatrice Acquisitions and the 1-Percent-Annual-Chance Flood

The 1 percent-annual-chance depth grid illustrates the benefit of the acquisitions, as the land where the 95 structures were acquired would be in 5 to 20 feet of water in a 1 percent-annual-chance event.
Beatrice Acquisitions and the 1-Percent-Annual-Chance Flood


Structure Acquisitions (Outside 2015 Flood Extents)

May 8, 2015 Flood Extent

Depth Grid

1 PCT ANNUAL CHANCE Flood Depths (Feet)

- ≤ 5
- ≤ 10
- ≤ 15
- ≤ 20
- > 20

Acquisition Structures

2015 Flood Extent
1 PCT Flood Extent

These 9 additional acquisitions fall within the larger extent of the 1 percent-annual-chance flood hazard area, where the depth grid shows potential flood depths of 5 to 15 feet.
Continued Risk Assessment

As a point of comparison, losses and associated acquisition program savings were modeled for the 1-percent annual chance flood event.

- Included 9 additional structures acquired prior to 2015 but not in 2015 inundation area.
- Included 3 additional structures acquired after the 2015 event.
- The snapshot of savings increases dramatically.

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\text{\$26 \text{ (MILLION) (FLOOD LOSS SAVINGS)}} - \text{\$5 \text{ (MILLION) (INVESTED)}} = \text{\$21 \text{ (MILLION) (SNAPSHOT OF SAVINGS FROM THE 1 PERCENT-ANNUAL-CHANCE ANALYSIS)}}
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Final tab of Story Map is “Get Started in Your Community”
  • Information on Initiating a flood prone property acquisition program
  • Includes links to additional resources

Story Map link - http://arcg.is/1LXin5
  • Also on handout

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Thank you!