



ILLINOIS STATE
WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

Flood Vulnerability Assessment for Critical Facilities

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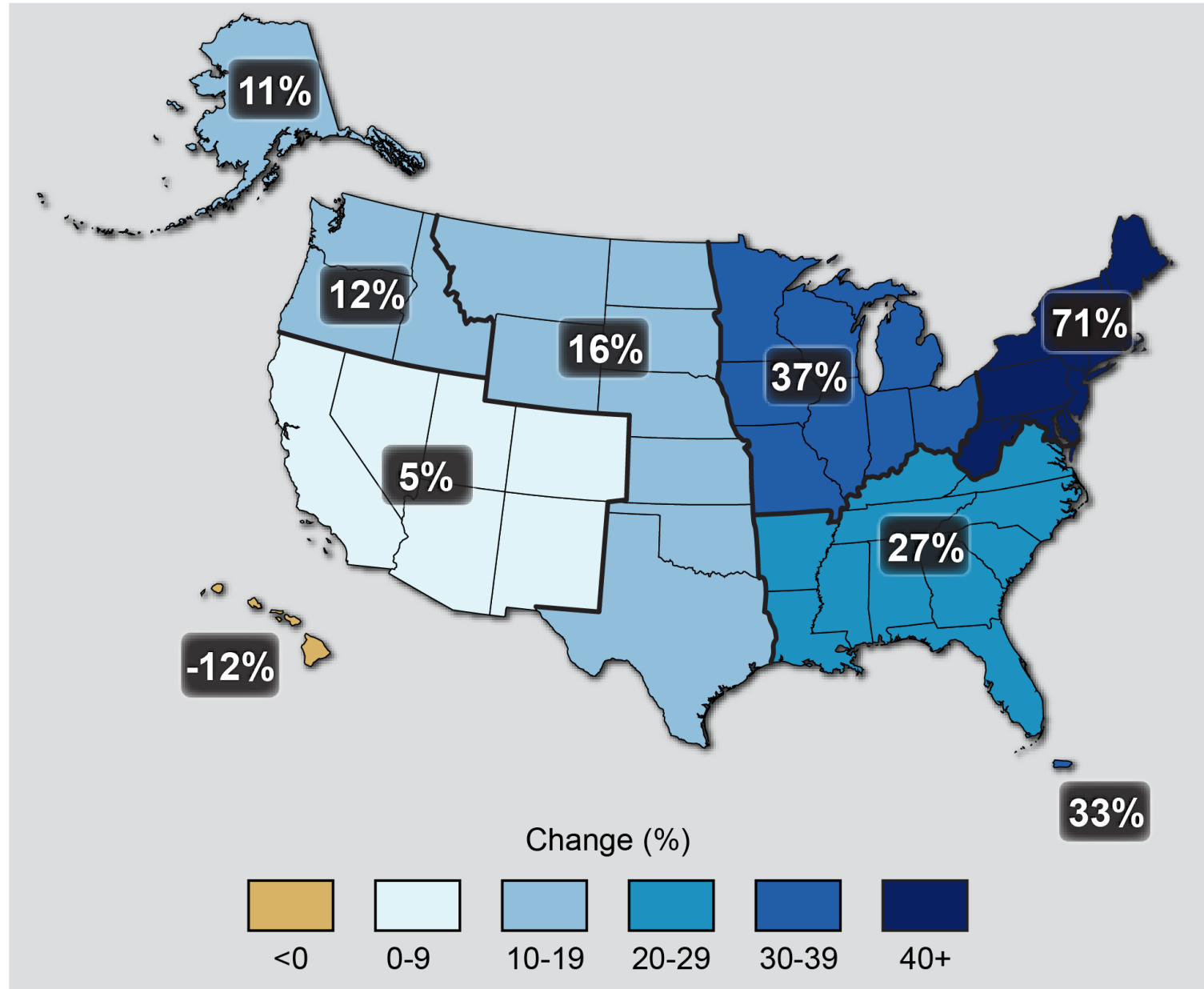
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Emergency



Observed Change in Very Heavy Precipitation



Increase in Rainfall and High Intensity Events

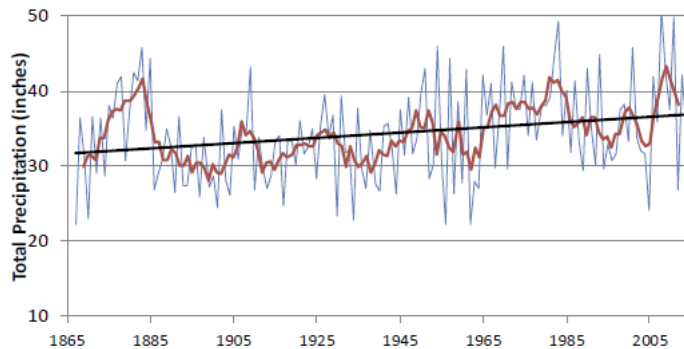


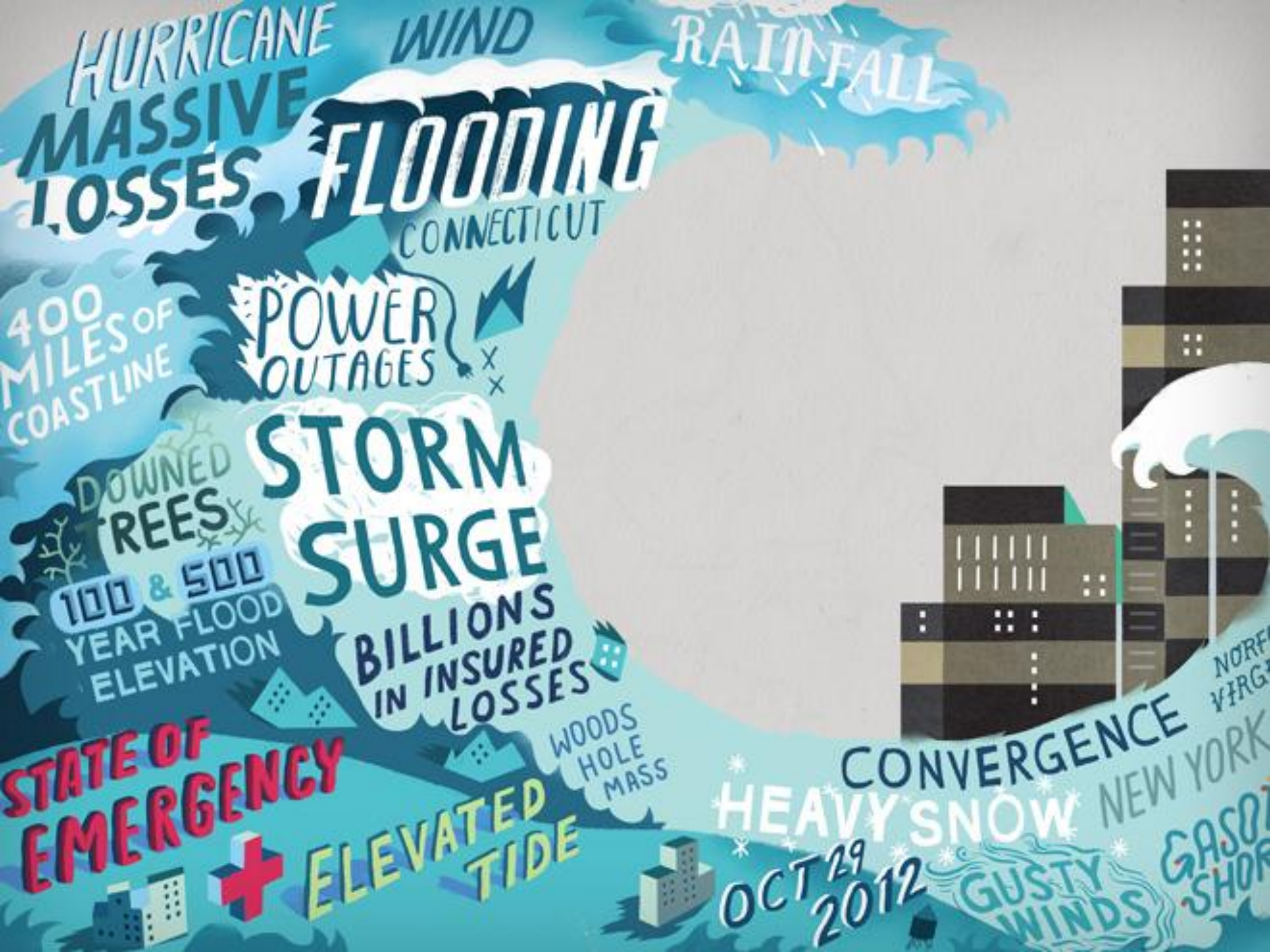
Figure 3. Cook County Annual Precipitation (blue), 1867-2013, including the 5-yr moving average (red) and the overall trend (black).

Table 4. Percent difference between Bulletin 70 and the other estimates of return period thresholds for 24-hour events. Positive differences (greater than Bulletin 70) are in green and negative differences (less than Bulletin 70) are in orange.

	Percent Difference					
	2-year	5-year	10-year	25-year	50-year	100-year
Observed (1961-2000)	3.5%	1.6%	-0.3%	-3.1%	-4.9%	-6.9%
Modeled (1961-2000)	4.1%	3.8%	2.3%	-1.3%	-4.3%	-7.9%
CCPN (1990-2014)	4.6%	5.8%	6.3%	7.6%	N/A	N/A
Climate Model (2046-2065)	12.4-15.4%	12.7-17.2%	11.3-16.3%	8.1-12.8%	5.6-9.4%	2.5-5.1%
Climate Model (2081-2100)	18.4-22.7%	20.1-23.8%	19.7-22.7%	16.1-18.8%	12-15.8%	7.1-11%

Table 2. Percent difference in new return period thresholds (1990-2013) from Bulletin 70 thresholds (1901-1983). Positive values (green) indicate that the new thresholds are higher than Bulletin 70 and negative values (orange) indicate the new threshold is lower.

Duration	1-yr	2-yr	5-yr	10-yr	25-yr
2-hour	-9.0%	-4.3%	-3.4%	-4.0%	-4.5%
3-hour	-5.1%	0.6%	2.3%	2.3%	2.0%
6-hour	-3.2%	1.7%	3.5%	3.9%	4.4%
12-hour	-1.2%	3.7%	4.7%	4.5%	4.4%
18-hour	3.1%	7.2%	8.6%	9.3%	10.9%
24-hour	1.2%	4.7%	5.9%	6.3%	6.5%



HURRICANE

WIND

RAIN FALL

MASSIVE
LOSSES

FLOODING

CONNECTICUT

400
MILES OF
COASTLINE

POWER
OUTAGES



x
x

STORM
SURGE

DOWNED
TREES

100 & 500
YEAR FLOOD
ELEVATION

BILLIONS
IN INSURED
LOSSES

WOODS
HOLE
MASS

STATE OF
EMERGENCY



ELEVATED
TIDE

CONVERGENCE
HEAVY SNOW

OCT 29
2012

GUSTY
WINDS

GASOLINE
SHORTAGE

NORTH
VIRGINIA

NEW YORK

Project Background

Motivation

- Hurricane Sandy's impacts on critical facilities in 2012

Partners

- Cook County DHSEM
- Coordinated Hazards Assessment and Mapping Program
- Midwestern Regional Climate Center

Objective

- Develop a *Flood Vulnerability Assessment for Critical Facilities*
- Make recommendations to facilities on how to reduce risk
- Historical Rainfall Analysis



Project Timeline

Summer 2014-Summer 2015: **Developed the assessment** with CHAMP and DHSEM

October 2015: **Piloted the assessment** at 3 Cook County critical facilities

November 2015: **Finalized assessment**; sent to 30 more Cook County facilities

Winter-Spring 2016: Developing ***Facility Risk Summary and Recommendations Reports***

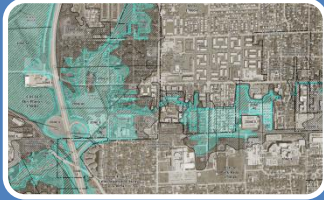
Winter-Spring 2016: Converting into an **online tool**

Flood Vulnerability Assessment for Critical Facilities

- **What are the goals of this assessment?**
 - Identify specific vulnerabilities in a facility by looking at factors such as proximity to floodplain, past flood issues, and location of critical systems.
 - Provide resources and recommendations to reduce a facility's risk to flooding.
- **Who should take this assessment?**
 - A critical facility (e.g., hospital, fire station, etc.)
 - Meant to assess one critical building or site of buildings that function as one critical facility (e.g., medical campus)



Flood Vulnerability Assessment for Critical Facilities



Facility Siting Conditions



Communication and Emergency Operations Planning



Past Flooding Issues and Mitigation Efforts



Importance & Location of Critical Systems



Resources

Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA, 394 pages): <http://www.fema.gov/media-library/assets/documents/8811>

Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds (FEMA, 398 pages): <http://www.fema.gov/media-library/assets/documents/10672>

Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA, 394 pages): <http://www.fema.gov/media-library/assets/documents/8820>

Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds (FEMA, 396 pages): http://www.fema.gov/media-library-data/20130726-1531-20490-0438/fema424_web.pdf

Non-Residential Floodproofing - Requirements and Certification (FEMA, 17-pages): <http://www.fema.gov/media-library/assets/documents/3473>

Defining Flood Risk (FEMA, website): https://www.floodsmart.gov/floodsmart/pages/flooding_flood_risks/defining_flood_risks.jsp

Levee Flood Risk (FEMA, 1-page): <https://www.floodsmart.gov/floodsmart/pdfs/FloodRisksLevee.pdf>

National Flood Insurance Program (NFIP) Floodsmart website: <http://www.floodsmart.gov>

Dams (FEMA, website): https://www.floodsmart.gov/floodsmart/pages/flooding_flood_risks/dams.jsp

Weather Warnings on the Go! (NWS, website): <http://www.nws.noaa.gov/com/weatherreadynation/wea.html#.VpAhRVlywwg>

NOAA Weather Radio All Hazards (NWS, website): <http://www.nws.noaa.gov/nwr/>

National Weather Service (website): www.nws.noaa.gov; search address to find your local page

Continuity of Operations (FEMA, webpage): <http://www.fema.gov/continuity-operations>

Case study - a city's success story utilizing water pumps during a flood (FEMA, 2-pages): http://www.fema.gov/media-library-data/1441824577261-2ed4c68ef85943b76115c050463dcc1a/12_Water-Pumps-Mitigate-Simonton_web.pdf
<http://nad.org/issues/emergency-preparedness>

Emergency Response Plan (FEMA, website): <http://www.ready.gov/business/implementation/emergency>

Taking Action for Flooding: A Guide for Homeowners (RainReady/CNT, 3-pages)

<http://rainready.org/sites/default/files/factsheets/Factsheet-RainReady-Homeowners.pdf>

ASFP Flood Resistant Design (document, 2-pages): <http://alturl.com/ymsww>

Flooding and Sewage Back-Ups (Mass.gov, website):

<http://www.mass.gov/eea/agencies/massdep/water/wastewater/flooding-and-sewage-back-ups-home-care-guide.html>

Dry Floodproofing (FEMA, 120-pages): http://www.fema.gov/media-library-data/20130726-1608-20490-9182/fema_551_ch_07.pdf

Green Infrastructure (EPA, website): <http://www.epa.gov/green-infrastructure>

Presentation on erosion stabilization methods (MWRD, Power Point):

<http://www.drscw.org/reports/Oct2011MWRDGC.pdf>

Floodproofing Non-Residential Buildings (FEMA, 184 pages):

<http://www.fema.gov/media-library/assets/documents/34270>

Build with Flood Resistant Damage Materials (FEMA, 2-pages): http://www.fema.gov/media-library-data/20130726-1627-20490-6534/how2025_build_4_11.pdf

Choosing an Emergency Back-Up Generator (Electric Environments, website): <http://www.eecnet.com/Solutions/Data-Center-Generator/Choosing-a-Generator/>

Elevator Installation for Buildings Located in Special Flood Hazard Areas in Accordance with the NFIP (FEMA, 20 pages): <http://www.fema.gov/media-library/assets/documents/3478>

Information from City of Chicago on downspout disconnection (website):

http://www.cityofchicago.org/city/en/depts/water/supp_info/conservation/downspout_disconnection.html

Clean Your Home's Gutters Twice a Year to Prevent Flood Damage (website article): <http://goldcoastflood.com/clean-your-homes-gutter-twice-a-year-to-prevent-flood-damage/>

Precipitation Frequency Data Server (PFDS) for NOAA Atlas 14 (NOAA, website):

<http://hdsc.nws.noaa.gov/hdsc/pfds/>

<http://americanfloodoor.com/flood-doors/>

Hurricane Sandy Recovery Advisory report for critical facilities (11-pages):

http://www.fema.gov/media-library-data/1381404651877-881a2cf70a90ac63b9c067100ffccace/SandyRA2CriticalFacilities_508_FINAL2.pdf

Facility Siting Conditions

Facility Description and Information:

Facility Address 1:

Facility Address 2:

City:

Select State: Select County: Zip Code:



Facility type: (please check all that apply)

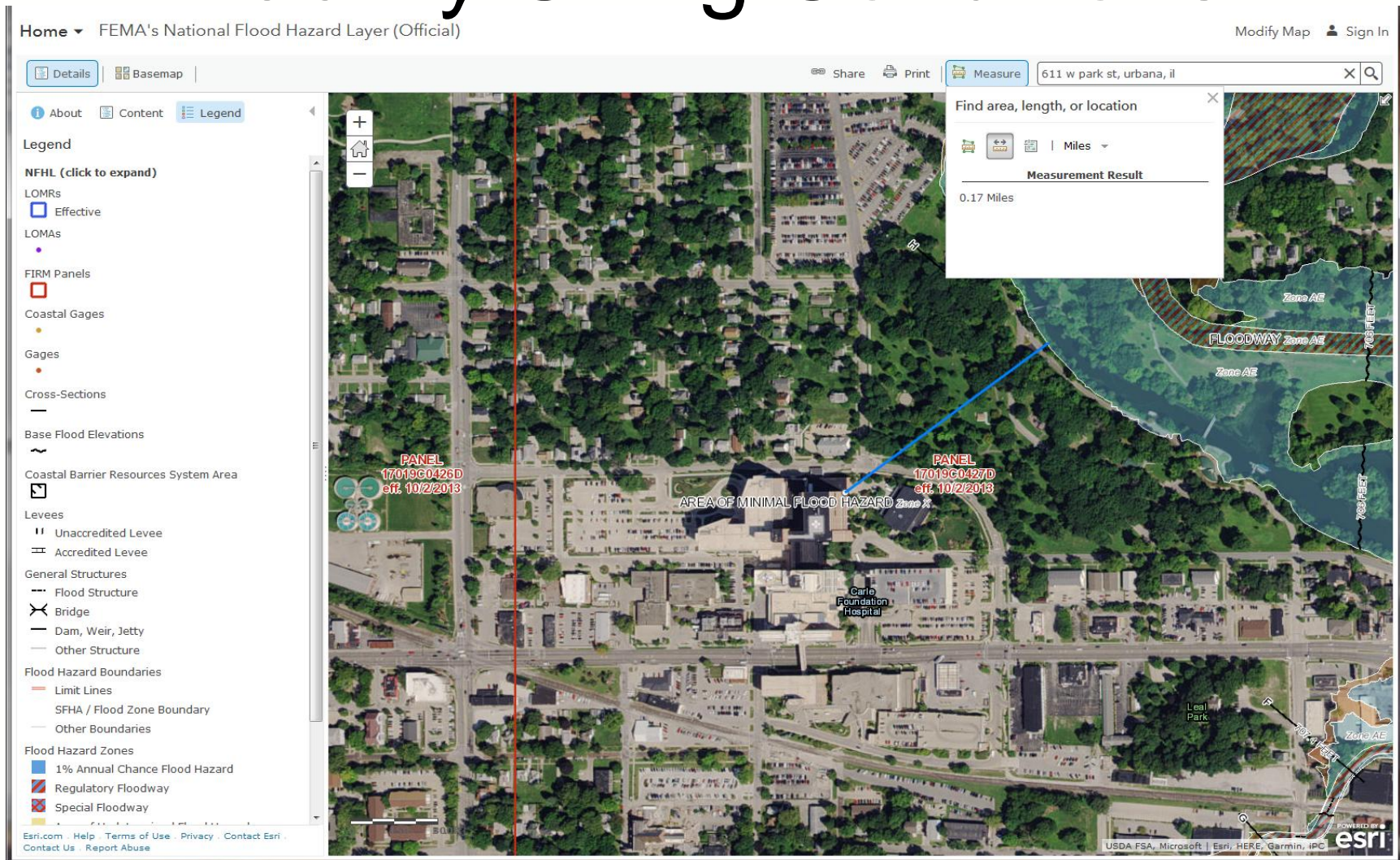
- | | | | |
|---|--|--|--|
| <input type="checkbox"/> Electric power facility | <input type="checkbox"/> Natural gas facility | <input type="checkbox"/> Communication facility | <input type="checkbox"/> Transportation facility |
| <input type="checkbox"/> Water treatment facility | <input type="checkbox"/> Hazardous material facility | <input type="checkbox"/> Military facility | <input type="checkbox"/> Nuclear facility |
| <input type="checkbox"/> Oil facility | <input type="checkbox"/> Emergency Operations Center | <input checked="" type="checkbox"/> Hospital or medical clinic | <input type="checkbox"/> Fire or Police station |
| <input type="checkbox"/> Business | <input type="checkbox"/> School | <input type="checkbox"/> Nursing home | <input type="checkbox"/> Government building |

Building Identification:

How many critical buildings are on site? (*consider the building "critical" if the facility could not function without it*): ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

Building 1 Name: Square Feet: Number of Floors: Has Basement? ☐

Facility Siting Conditions



Increased Risk of Flooding

The following four factors can make a facility be at a higher risk for flooding. The ones that apply to your facility are bolded and checked:

- You are located in a FEMA mapped floodplain.
- ✓ **You are located within 0.5 miles of a floodplain.**
- Your facility has been affected by past flooding.
- You have identified that either your potable water supply or wastewater/sewer pipes enter the building in the same room as either your primary electric power, secondary power source, back-up generator, or fuel/gas system



Facility Siting Conditions - Recommendations

- Flooding can occur outside of the mapped floodplain as well depending on the situation (e.g., urban/stormwater flooding, change in surrounding development, antecedent conditions).
- Essential utility systems and equipment installed below grade can be vulnerable to flooding even when the building is outside of the Special Flood Hazard Area
- Properties outside of high-risk flood areas account for over 20% of National Flood Insurance Program (NFIP) claims and one-third of disaster assistance for flooding.

Communications and Emergency Operations Planning

Communications & Emergency Operations Planning:

Receiving Weather Info:

Please check all ways in which your facility receives information about the potential for heavy rainfall and/or flooding:

- ☒ Wireless Emergency Alerts (WEA) - concise, text-like messages sent to users' WEA-capable mobile phones and devices about local threats
- ☐ Weather/Emergency Radio
- ☐ Reverse 911 - system used to notify residents in a defined geographic area during emergencies
- ☐ Local Emergency Agency weather update (e.g., Cook County DHSEM Weather Situational Awareness)
- ☐ Local Dispatch Center
- ☒ Television or Radio
- ☒ Online / Internet

Is the National Weather Service (NWS) a source for your weather/rainfall information and forecasts? ☒ Yes ☐ No

If YES to the question above, is your contact with the NWS direct or indirect? (check all that apply)

- ☐ Direct (e.g., speak to a forecaster)
- ☒ Indirect (e.g., website, general watches/warnings)

Continuity of Operations & Planning Agreements:

Is there an alternate facility if the main building cannot be used due to flooding? ☒ Yes ☐ No

If YES to the question above, are there any critical functions that would be lost during relocation to the alternate facility? ☒ Yes ☐ No

Are there any assistance agreements in place with other agencies? (e.g., mutual aid agreements, memorandums of understanding (MOUs)) ☐ Yes ☒ No

Does this facility own a water pump in the event of flooding? ☐ Yes ☒ No

(A portable electric water pump that can be utilized to remove water during and/or after a flood event)

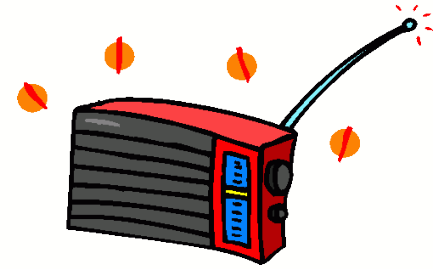
If NO to the question above, since the facility does not own a pump, do you know how to obtain access to a water pump in the event of flooding?

- ☐ Yes
- ☒ No

Communications and Emergency Operations Planning – Recommendation Categories

- Receiving Weather Information
- Continuity of Operations & Planning Agreements
- Communication System Redundancy
- Emergency Management Plans

Communications and Emergency Operations Planning - Recommendations



Receiving Weather Information

- Wireless Emergency Alerts (WEAs) are very useful as they are automatically sent and received via WEA-capable mobile devices (mobile users are not charged for receiving these).
- It is possible to talk directly to a forecaster in your National Weather Service office if desired during severe weather events.
- It is recommended that critical facilities either have access to a weather radio and/or Wireless Emergency Alerts.



Communications and Emergency Operations Planning - Recommendations

Continuity of Operations & Planning Agreements

- Even though an alternate facility is established, FEMA's Emergency Management Institute [offers a worksheet](#) that could help ensure it is the best option for an alternate critical facility
- With no assistance agreements in place with other agencies, we recommend you explore the potential for partnering with others in the event of an emergency.
- It is recommended that you reach out to your local emergency management department or your city's fire department to inquire on water pump availability in the event of flooding.

Communications and Emergency Operations Planning - Recommendations

Communication System Redundancy

- It is recommended you assess the need for an emergency communication system for the deaf and hearing impaired at your facility.
- Contact your local emergency management department and/or city government to obtain information on how to communicate with your EOC as needed in the event of an emergency.

Communications and Emergency Operations Planning - Recommendations

Emergency Management Plans

- It is recommended that your facility formalizes its emergency response plan. FEMA provides a helpful worksheet to develop an emergency response plan:
<http://www.ready.gov/sites/default/files/documents/files/EmergencyResponsePlan.pdf>
- To ensure all material still applies or that new issues have not come up, it is recommended that you review and update your emergency response plan for flooding once a year.

Past Flooding Issues and Mitigation Efforts

Past Flooding Issues and Mitigation Efforts:

Historical Flood Information

Has this site been affected by past flood events? ☐ Yes ☐ No ☒ I don't know

Other Flood-Related Issues

Is there frequently standing water at the facility? ☐ Yes, inside only ☒ Yes, outside only ☐ Yes, inside and outside ☐ No ☐ I don't know

Do debris problems or erosion problems exist on the site (roadways, other paved surfaces, soil landscapes)?

☐ Yes, debris issues ☐ Yes, erosion issues ☒ Yes, debris and erosion issues ☐ No ☐ I don't know

Have adjacent buildings and/or areas had flooding issues? ☒ Yes ☐ No ☐ I don't know

Mitigation Efforts

Have steps been taken to reduce the impact from flooding? ☐ Yes ☒ No

Are future efforts planned to reduce the impact from flooding? ☐ Yes ☒ No

SAVE PAST FLOODING ISSUES AND MITIGATION EFFORTS

Next: Building Specifics

Past Flooding Issues and Mitigation Efforts – Recommendation Categories

- Historical Flood Information
- Other Flood-Related Issues
- Mitigation Efforts

Past Flooding Issues and Mitigation Efforts - Recommendations

Historical Flood Information

- With repetitive flooding an issue, it is recommended that you assess your property to understand how water falls on your property and flows through your pipes. You may need the help of an engineer, plumber, electrician, or landscape designer.
- While not possible or feasible in all situations, with reoccurring flooding an issue, you may want to explore relocating your facility to a less flood-prone location (i.e., relocation of services to a different building).
- Floods can also cause sewage from sanitary sewer lines to back up into a structure through drain pipes. These backups not only cause damage that is difficult and expensive to repair, but also create health hazards.

Past Flooding Issues and Mitigation Efforts - Recommendations Other Flood-Related Issues

- With standing water an issue outside of your building, green infrastructure may be a good solution to absorb the excess water. Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes to manage water.
- With debris an issue at your facility, it is recommended that you routinely check and subsequently clean problem areas regularly.
- Site design should account for deposition of debris and sediment, as well as the potential for erosion-related movement of the waterway. Buildings exposed to debris impact or undermining by scour and erosion should be designed to account for these conditions.

Past Flooding Issues and Mitigation Efforts - Recommendations

Mitigation Efforts

- Flood mitigation can reduce vulnerabilities in one of two ways: (1) improve equipment to reduce risk or (2) establish redundancies. Elevating equipment is an example of improving equipment to reduce risk, and providing alternate methods of supplying critical services is an example of redundancy (this can be either internal or external).
- One goal of this assessment is to provide recommendations and resources on ways to mitigate flooding, based on the specifics of your facility. Hopefully using this Facility Risk Summary and Recommendations report, your facility can make future flood mitigation plans where necessary and reduce future flood risk.

Importance & Location of Critical Systems

Importance of Critical Systems

According to FEMA, major components of essential systems and equipment are frequently placed on the lowest floors or subgrade (basement) levels potentially well below the base flood elevation (BFE). Equipment located on lower floors and basements is often vulnerable to flood damage even when the building is located outside of mapped Special Flood Hazard Areas (SFHA) or is above the BFE. In order to address these issues, this last section of the assessment aims to identify the importance and location of critical systems within your facility. ("Reducing Flood Effects in Critical Facilities", FEMA)

Please rank the following critical systems in terms of their importance to this building's function (and subsequently, your facility function), where 1=not important and 5=critically important. Critical systems or essential equipment is any equipment that is required for the facility to serve its critical function:

Servers	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Routers	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Computer work stations	<input type="radio"/> 1	<input checked="" type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Primary electric power system	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> We do not have this system
Secondary electric power system (from utility)	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> We do not have this system
Back-up generator	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> We do not have this system
Heating system	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> We do not have this system
Air conditioning system	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> We do not have this system
Security system controls	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Telephone/communication system	<input type="radio"/> 1	<input checked="" type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Fuel/gas system	<input type="radio"/> 1	<input checked="" type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Hazardous material storage (Hazmat storage)	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Critical data (non-electric)	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Potable water system	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input checked="" type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system
Wastewater system	<input checked="" type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> We do not have this system

Importance & Location of Critical Systems

Importance & Location of Critical Systems

Critical system	Importance Ranking	Lowest Location
Servers	2	1st floor
Routers	2	1st floor
Computer work stations	3	1st floor
Primary electric power system	5	Basement
Secondary electric power system (from utility)	5	Basement
Back-up generator	5	1st floor
Heating system	4	Basement
Air conditioning system	4	Basement
Security system controls	2	Basement
Telephone/communication system	3	Basement
Fuel/gas system	2	Basement
Hazardous material storage (Hazmat storage)	2	Basement
Critical data (non-electric)	1	1st floor
Potable water system	3	Basement
Wastewater system	1	Basement

The critical systems in red are ones that were ranked high (4/5) in terms of importance to facility function and are also either located in the basement or the first floor of the building.

Importance & Location of Critical Systems - Recommendations

- Two techniques for reducing flood damage to essential utility systems and equipment: elevating and dry flood proofing systems and equipment.
- All essential equipment necessary for a critical facility to function should be protected. Mitigation measures should be considered even in areas outside of the SFHA, as damaging flooding can still occur in these areas.
- If necessary, some facilities choose to have a more in-depth vulnerability assessment conducted by a team of architects and engineers to lay the groundwork for planning and budgeting capital improvements, identifying mitigation opportunities, and developing contingency plans that address flood risks. [FEMA's Risk Management Series](#) provides guidance on conducting vulnerability assessments.

Flood Vulnerability Assessment for Critical Facilities

<http://mrcc.isws.illinois.edu/FVA/>



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