Vulnerability Assessment and Protocol Instructions Training

June 28th 2:30 – 4:30 PM CT

June 29th 1:30 – 3:30 PM CT

DEPARTMENT OF NATURAL RESOURCES | mndnr.gov/mlscp

TETRA TECH

Agenda

5 minutes	Housekeeping and Introductions
5 minutes	Project Background
15 minutes	Vulnerability Assessment Protocol
5 minutes	Break
10 minutes	Assessment Data Sources
30 minutes	Walkthrough Example
5 minutes	Break
40 minutes	Hands-on Exercise
5 minutes	Questions and Wrap-up

Introductions

- Cameron Reister, Tetra Tech
- Amber Westerbur, Minnesota Department of Natural Resources (MN DNR)
- Clinton Little, MN DNR

DEPARTMENT OF NATURAL RESOURCES

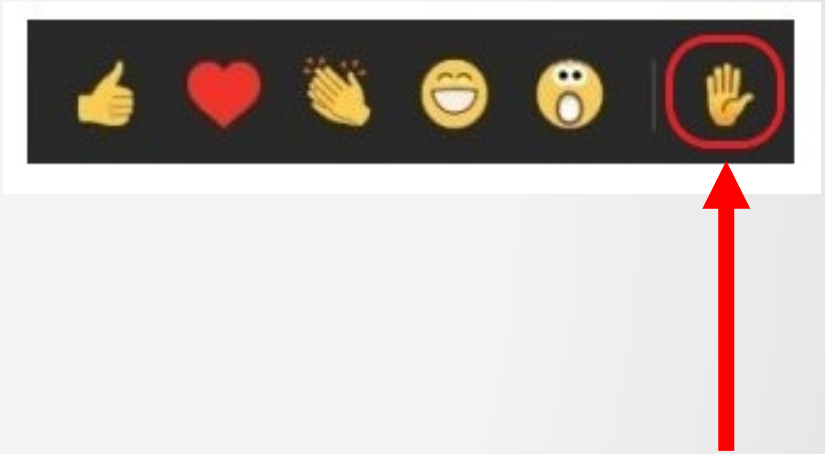
TETRA TECH

For assistance or questions, please contact mlscp.dnr@state.mn.us

Housekeeping

Using MS Teams and General Protocols

- Please keep yourself muted until you have a question or comment
- Utilize the chat to post questions
- Use the “Raise Hand” feature to get the attention of the presenter and ask questions



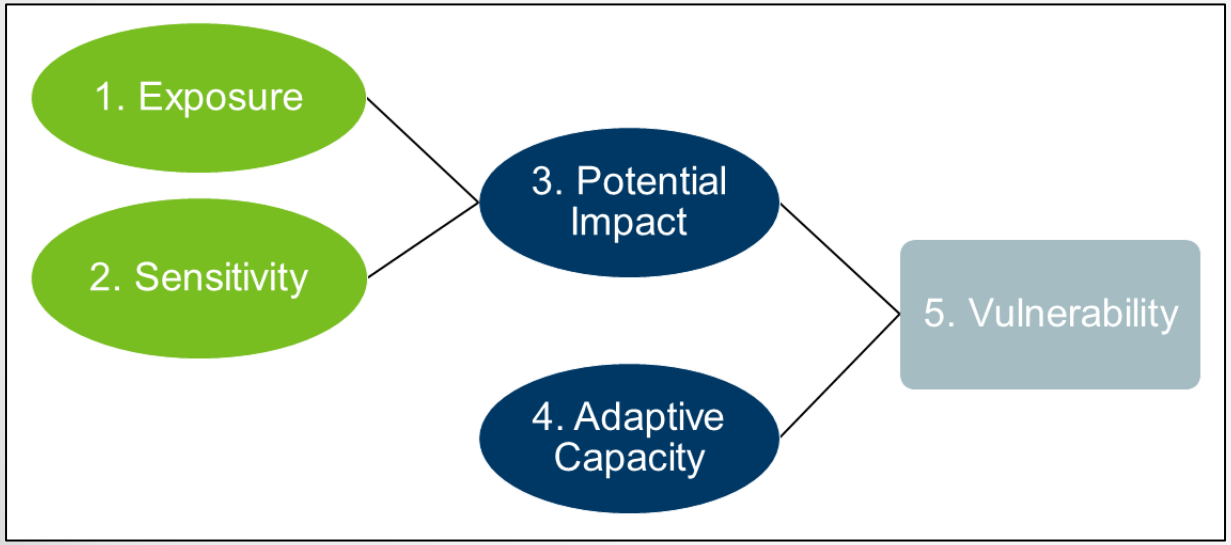
Project Background

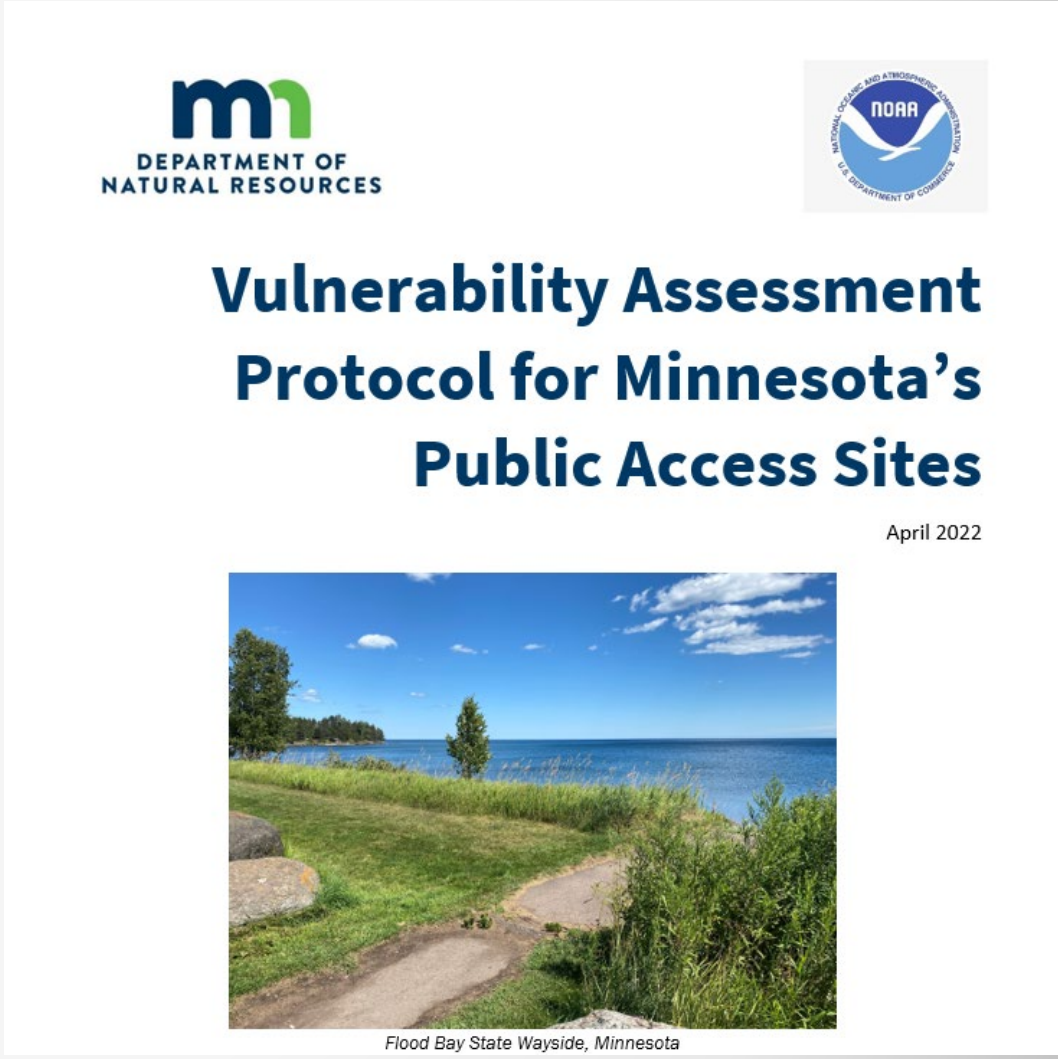
Project Need and Goals

- Public access sites are managed along the coast of Lake Superior
- Sites contain **natural** and **built** resources
  - Natural includes fish and wildlife species and habitat and vegetation
  - Built includes campgrounds, docks, buildings, piers
- Resources are potentially vulnerable to lake level change and other natural hazards

Project Need and Goals (cont'd)

- Resources are potentially vulnerable to lake level change and other natural hazards
- To evaluate vulnerability, MN DNR and NOAA Office of Coastal Management (OCM) developed this protocol **for site managers to use at their own sites**






Pilot Sites
Locations of 5 pilot sites.
Virginia
Biwabik
Hoyt Lakes
Chisholm
Eveleth
Hibbing
Iron Junction
Palo
Murphy City
Finland
Fairbanks
Lax Lake
Silver Bay
Brimson
Beaver Bay
Cotton
Castle Danger
Meadowlands
Two Harbors
Alborn
Floodwood
Culver
Duluth
Port Wing
La Pointe
Superior
Cloquet
Cromwell
Schroeder
Tofte
1. Flood Bay State Wayside
2. Minnesota Point Scientific and Natural Area (SNA)
3. Twin Points Public Water Access (PWA)
4. Temperance River State Park
5. Gooseberry Falls State Park
Google Earth
Image NOAA
Image Landsat / Copernicus
20 mi
N

Pilot Sites

Pilot Sites – Flood Bay State Wayside

Flood Bay State Wayside

- 4 assets identified
  - Parking Lot
  - North Beach (rip rap protected)
  - South Beach (natural)
  - Wetlands

Pilot Sites – Minnesota Point SNA

Minnesota Point SNA

- 5 assets identified
  - Park Point Nature Trail
  - Lakeside Beach
  - Lakeside Dunes
  - Bayside Beach
  - Bayside Dunes

Pilot Sites – Twin Points PWA

Twin Points PWA

- 5 assets identified
  - Parking Lot
  - Dock
  - Boat Launch
  - Secluded Beach
  - Iona's Beach

Pilot Sites – Temperance River State Park

Temperance River State Park

- 3 assets identified
  - Lower Campground
  - Beach
  - Retaining Wall

Pilot Sites – Gooseberry Falls State Park

Gooseberry Falls State Park

- 5 assets identified
  - Lakeview Lodge
  - Agate Beach North
  - Agate Beach South
  - Gitchi Gami Trail North
  - Lakeview Shelter

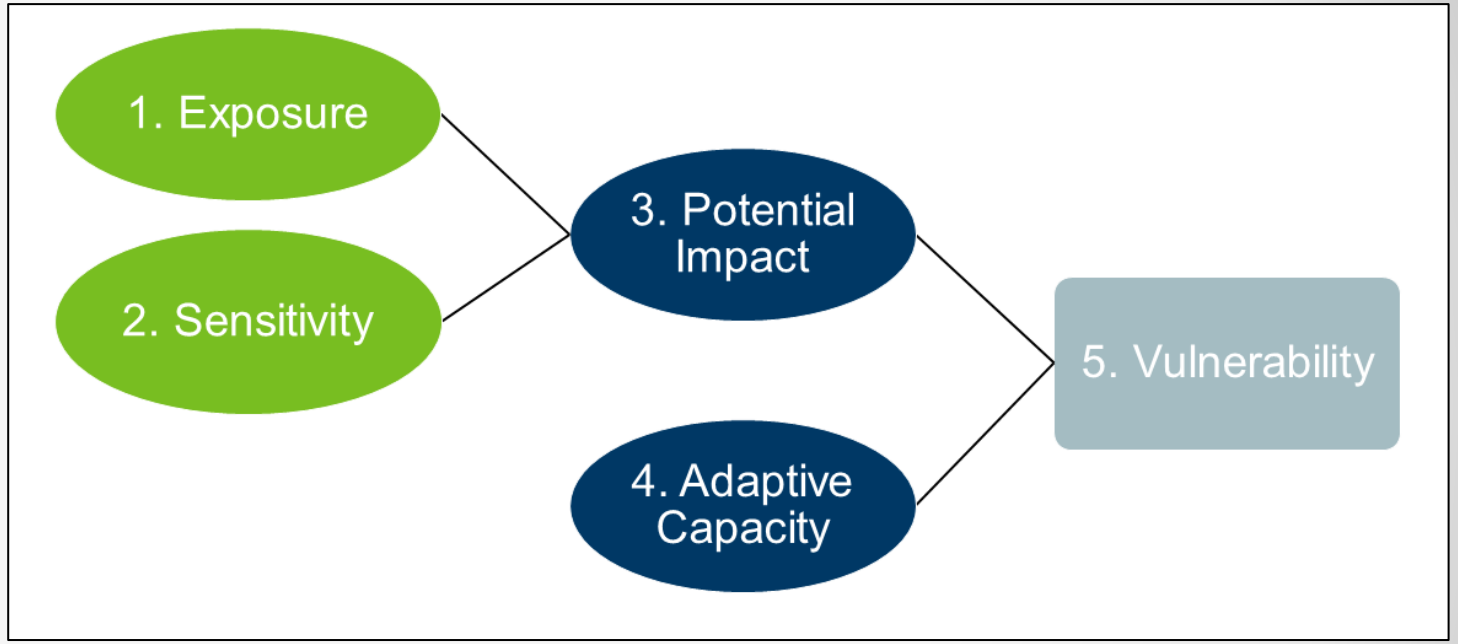
Vulnerability Assessment Protocol

Assessment Background

- Glick et al. (2011) examined the natural environment
  - Vulnerability = Exposure + Sensitivity + Adaptive Capacity
- NPS (2016) modified Glick et al. (2011) for the built environment
  - Vulnerability = Exposure + Sensitivity
- MN DNR protocol utilizes both to examine vulnerability of natural and built environment
- References:
  - Glick, P., B.A. Stein, and N.A. Edelson, editors. 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation. Washington, D.C. ISBN 978-0-615-40233-8. Available at: www.nwf.org/vulnerabilityguide
  - NPS (National Park Service). 2016. *Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol.* Available at: https://irma.nps.gov/DataStore/DownloadFile/665481?Reference=1049253.

Protocol Steps

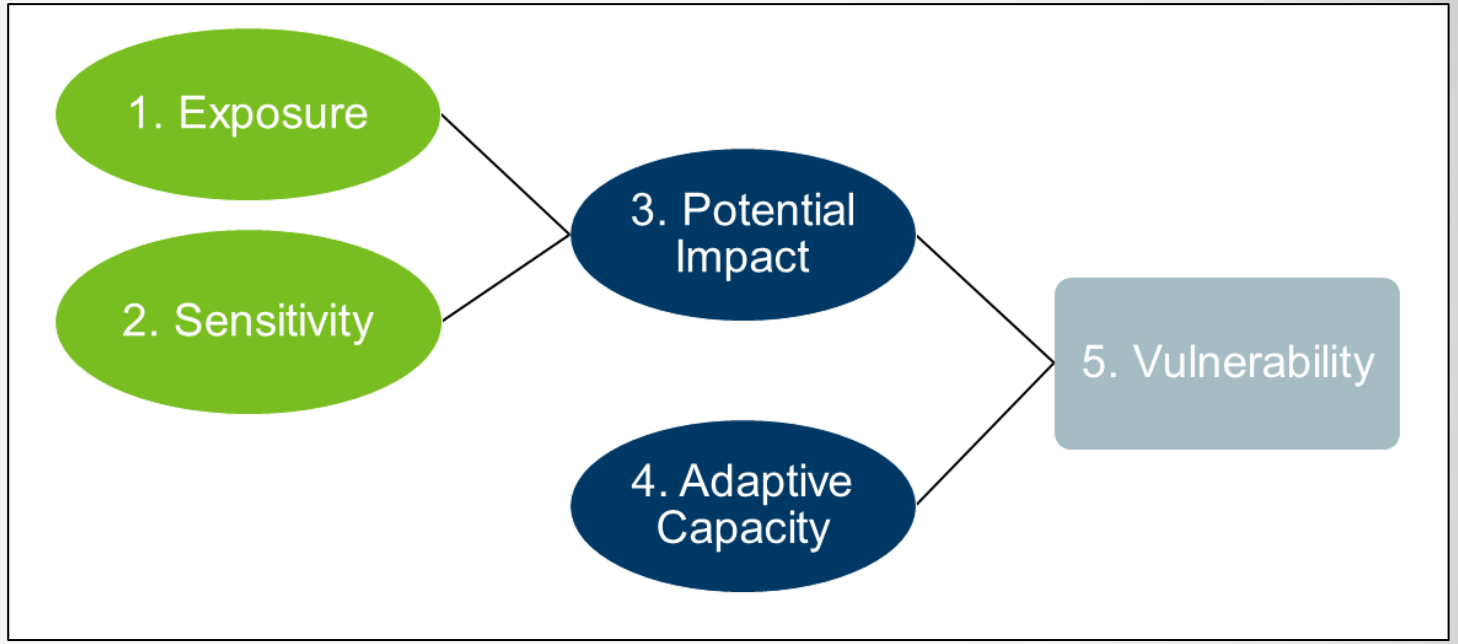
- Step 1. Exposure Analysis
- Step 2. Sensitivity Analysis
- Step 3. Potential Impact Analysis
- Step 4. Adaptive Capacity Analysis
- Step 5. Vulnerability Analysis



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Protocol Steps – Exposure Analysis

- **Step 1. Exposure Analysis**
- Step 2. Sensitivity Analysis
- Step 3. Potential Impact Analysis
- Step 4. Adaptive Capacity Analysis
- Step 5. Vulnerability Analysis



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Step 1. Exposure Analysis

- Exposure is the nature and degree to which a resource or system is exposed to direct climate change impacts or indirect impacts (IPCC 2001, Glick et al. 2011, NPS 2016)
  - Direct impacts include temperature and precipitation changes
  - Indirect impacts include lake level-fluctuations
- References

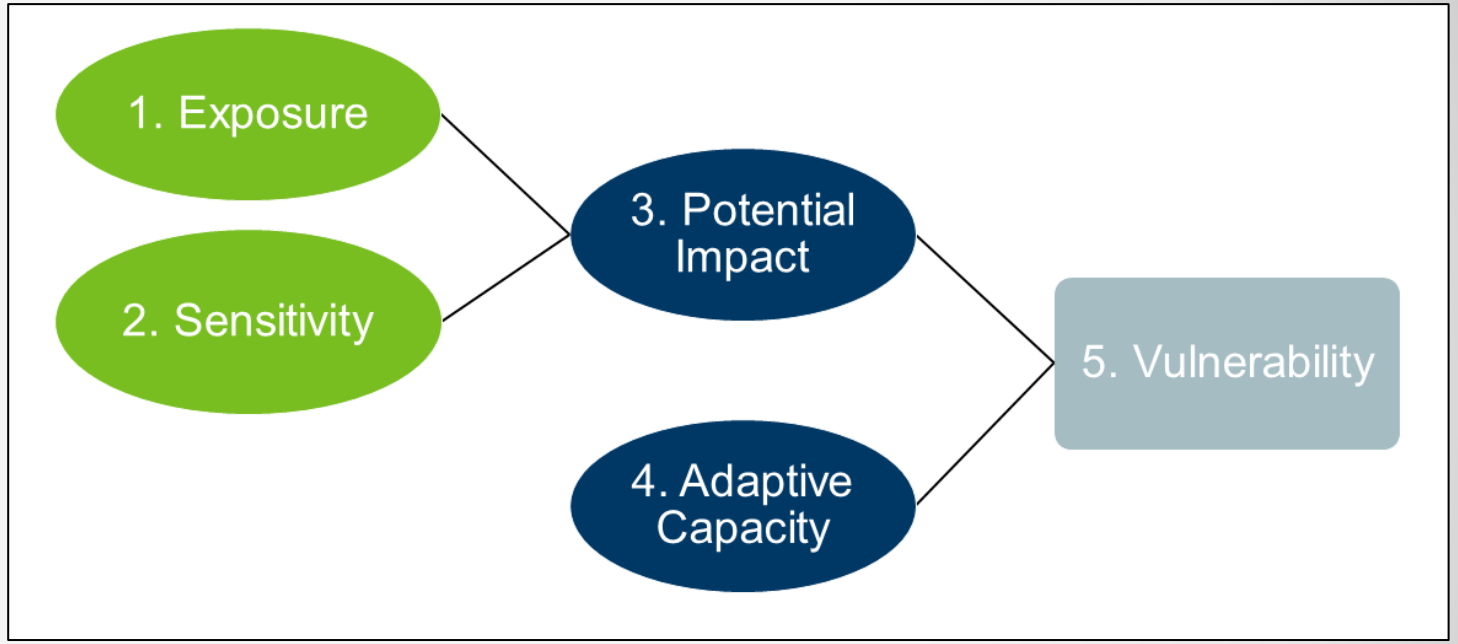
  - IPCC (Intergovernmental Panel on Climate Change). 2001. *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.
  - Glick, P., B.A. Stein, and N.A. Edelson, editors. 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation. Washington, D.C. ISBN 978-0-615-40233-8. Available at: www.nwf.org/vulnerabilityguide
  - NPS (National Park Service). 2016. *Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol.* Available at: https://irma.nps.gov/DataStore/DownloadFile/665481?Reference=1049253.

Exposure Analysis Indicators

Indicator	Data Sources
Flooding	Federal Emergency Management Agency (FEMA) flood maps; Light Detection and Ranging (LiDAR) or other elevation dataset
Storm Surge; Seiche	NOAA buoy data; LiDAR or other elevation dataset
Lake Level Rise	NOAA buoy data; LiDAR or other elevation dataset
Historical Flooding	United States Geological Survey (USGS) stream gage; NOAA Advanced Hydrologic Predictor Service (AHPS)
Erosion	1989 Erosion Susceptibility
Geology	USACE topobathymetric LiDAR; USGS bedrock geology; USGS surficial geology
Soils	Gridded Soil Survey Geographic Database (gSSURGO); North Shore Red Clay Soils project
Fish and Wildlife Habitat	Scientific and Natural Areas; State Aquatic Management Areas

Protocol Steps – Sensitivity Analysis

- Step 1. Exposure Analysis
- **Step 2. Sensitivity Analysis**
- Step 3. Potential Impact Analysis
- Step 4. Adaptive Capacity Analysis
- Step 5. Vulnerability Analysis



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Step 2. Sensitivity Analysis

- Sensitivity is the degree to which a resource or system is affected when exposed to a climate related change, either adversely or beneficially (U.S. CCSP 2008, Glick et al. 2011, NPS 2016)
- For example, a natural system (i.e., wetland or beach) might be *less* sensitive to climate impacts because of the **natural** ability to adjust
- On the other-hand, a built system (i.e., building or dock) might be *more* sensitive to climate impacts because of the **lack** of natural ability to adjust
- References

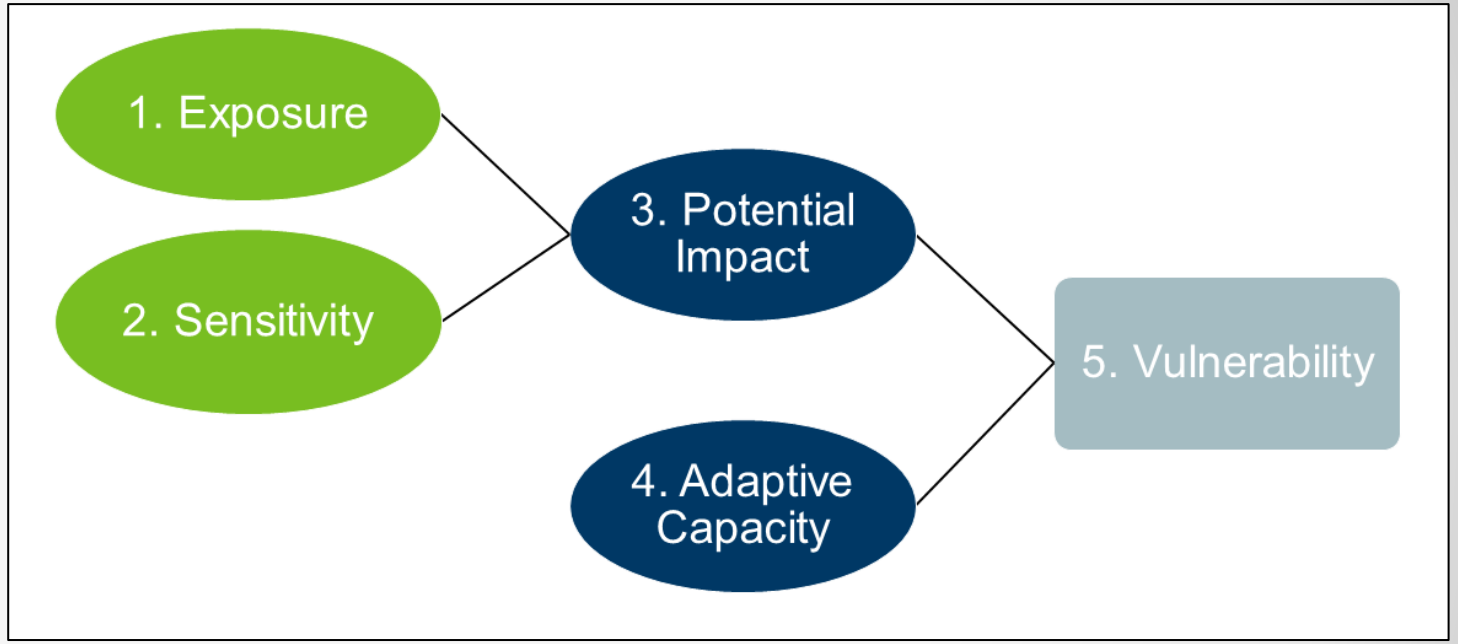
  - U.S. CCSP (U.S. Climate Change Science Program). 2008. *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. S.H. Julius and J.M. West (eds.) U.S. Environmental Protection Agency, Washington, D.C.
  - U.S. CCSP (U.S. Climate Change Science Program). 2008. *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. S.H. Julius and J.M. West (eds.) U.S. Environmental Protection Agency, Washington, D.C.
  - NPS (National Park Service). 2016. *Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol.* Available at: https://irma.nps.gov/DataStore/DownloadFile/665481?Reference=1049253.

Sensitivity Analysis Indicators

Indicator	Data Sources
Flood Damage Potential	Asset questionnaire; direct measurements of threshold elevation
Storm Resistance and Condition	Asset questionnaire
Historical Damage	Asset questionnaire; discussion with site staff
Protective Engineering	Asset questionnaire; field and aerial imagery analysis
Infrastructure	Critical Infrastructure GIS data for Minnesota field and aerial imagery analysis
Fish and Wildlife Habitat	Minnesota Biological Survey (MBS) Sites of Biodiversity Significance; National Land Cover Dataset; National Wetland Inventory; Coastal Change Analysis Program; Wildlife Management Areas; invasive species observations
Climate	Precipitation and temperature averages from the MN DNR Climate Trends tool
Water Quality	Watershed Health Assessment Scores; buffer protection map; aquatic invasive species observations

Protocol Steps – Potential Impact Analysis

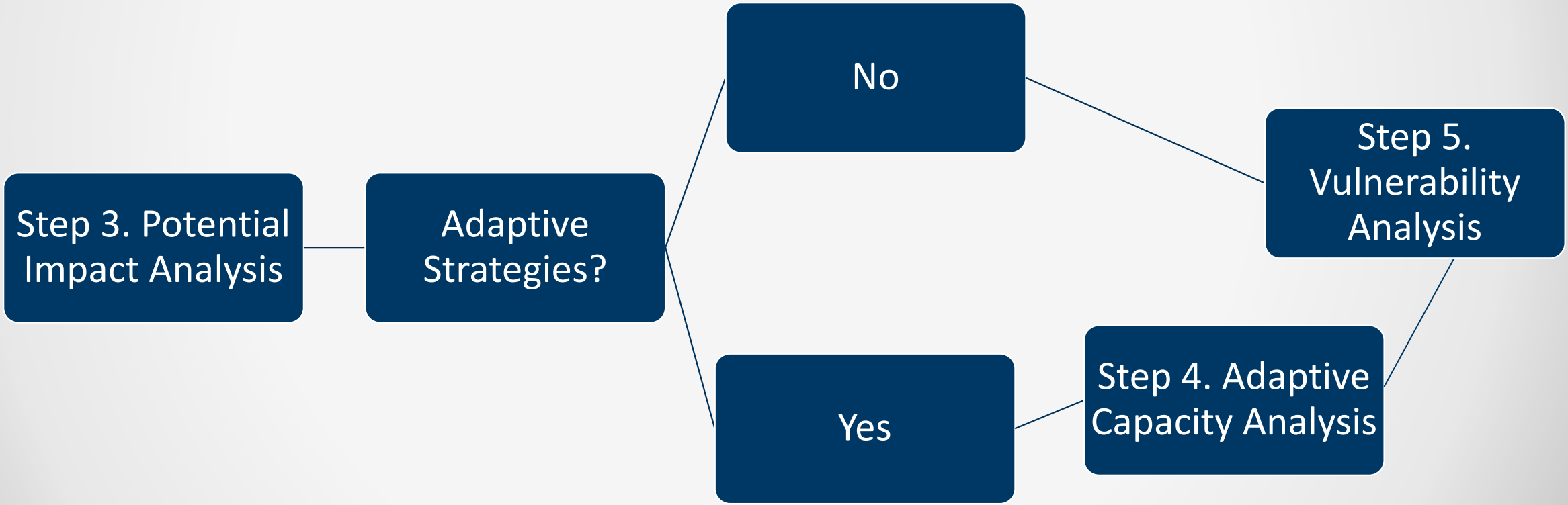
- Step 1. Exposure Analysis
- Step 2. Sensitivity Analysis
- **Step 3. Potential Impact Analysis**
- Step 4. Adaptive Capacity Analysis
- Step 5. Vulnerability Analysis



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

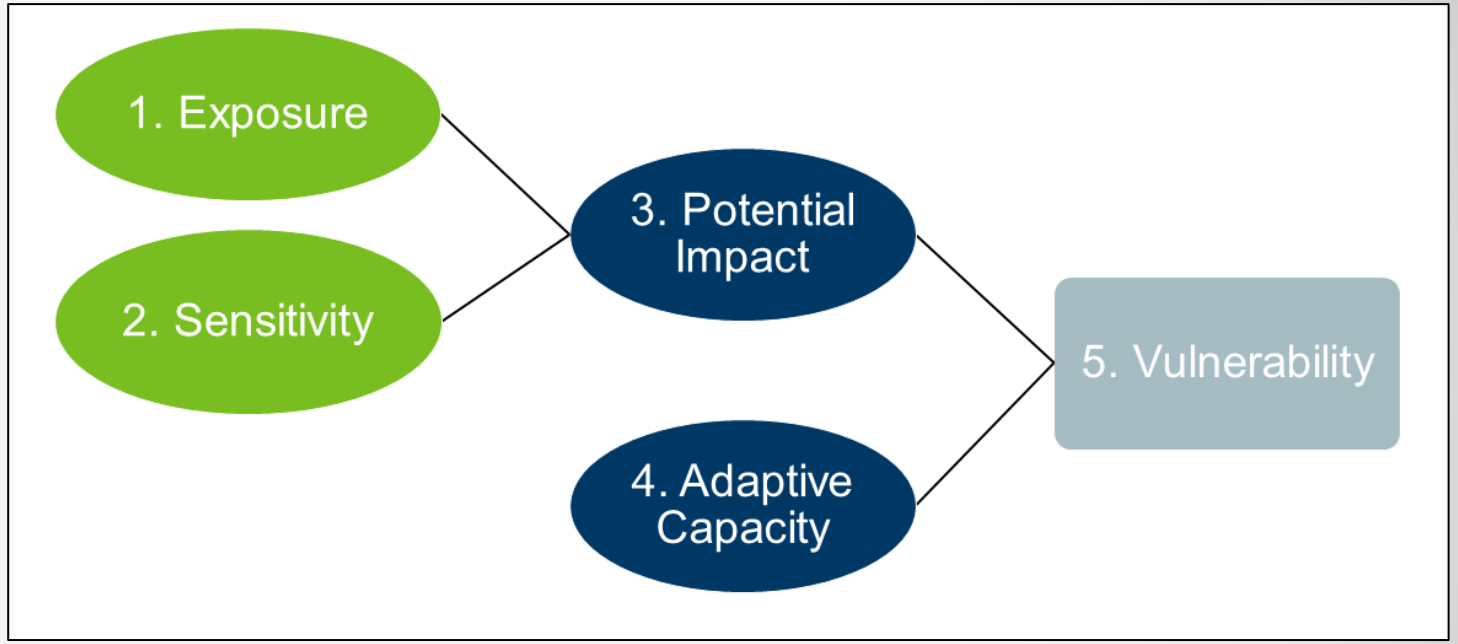
Step 3. Potential Impact Analysis

- Potential Impact = Vulnerability Analysis + Sensitivity Analysis
- **Managers decide if adaptive capacity is a possibility at the site**



Protocol Steps – Adaptive Capacity Analysis

- Step 1. Exposure Analysis
- Step 2. Sensitivity Analysis
- Step 3. Potential Impact Analysis
- **Step 4. Adaptive Capacity Analysis**
- Step 5. Vulnerability Analysis



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Step 4. Adaptive Capacity Analysis

- Adaptive capacity refers to the ability of the resource or system to adjust, moderate potential damages, take advantage of opportunities, or cope with consequences associated with natural hazards or future climate extremes (IPCC 2001, Glick et al. 2011, NPS 2016)

- References

  - IPCC (Intergovernmental Panel on Climate Change). 2001. *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

  - Glick, P., B.A. Stein, and N.A. Edelson, editors. 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation. Washington, D.C. ISBN 978-0-615-40233-8. Available at: www.nwf.org/vulnerabilityguide

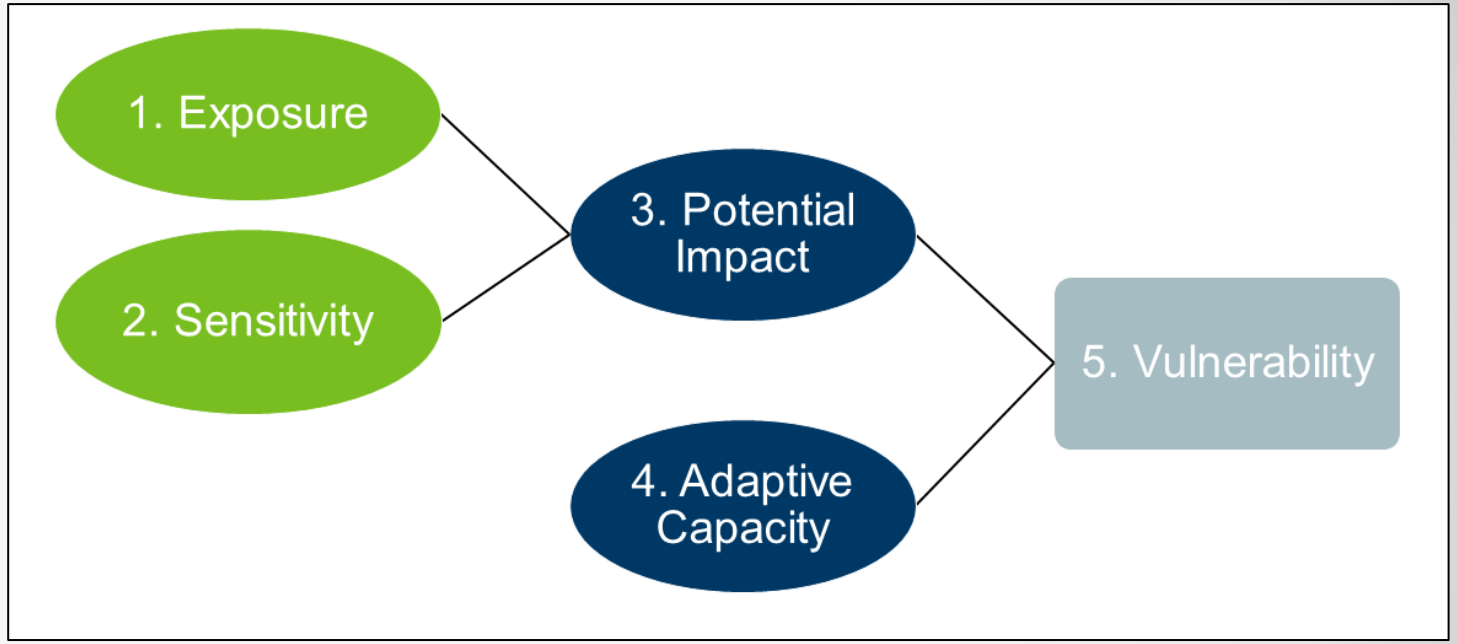
  - NPS (National Park Service). 2016. *Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol.* Available at: https://irma.nps.gov/DataStore/DownloadFile/665481?Reference=1049253.

Adaptive Capacity Strategies

Adaptation Action	Effect on Vulnerability and Rationale
Elevate	Reduces the sensitivity of the asset. By elevating a built asset, it will reduce the risk of flood damage or inundation from lake level rise.
Relocate	Reduces the exposure of the asset. By relocating an asset to a lower risk area, it will reduce the likelihood it will experience impacts from coastal natural hazards.
Protect/Engineer	Reduces the exposure and/or sensitivity of the asset. By protecting the asset with an engineered structure or landscape modifications (e.g., living shorelines) it can reduce the likelihood that the asset will experience damage from natural coastal hazards.
Decommission and Remove	Eliminates the vulnerable asset.
Storm Resistant Design	Reduces the sensitivity of the asset. Redesigning the asset to be more storm resistant can reduce the likelihood of damage from coastal natural hazards.
Engineering Downgrade	Reduces the sensitivity of the asset. Downgrading engineered features (i.e., replacing paved trail with gravel trail) can reduce the cost of rebuilding after damage and gives more flexibility for replacement and restoration, including living shorelines.

Protocol Steps – Vulnerability Analysis

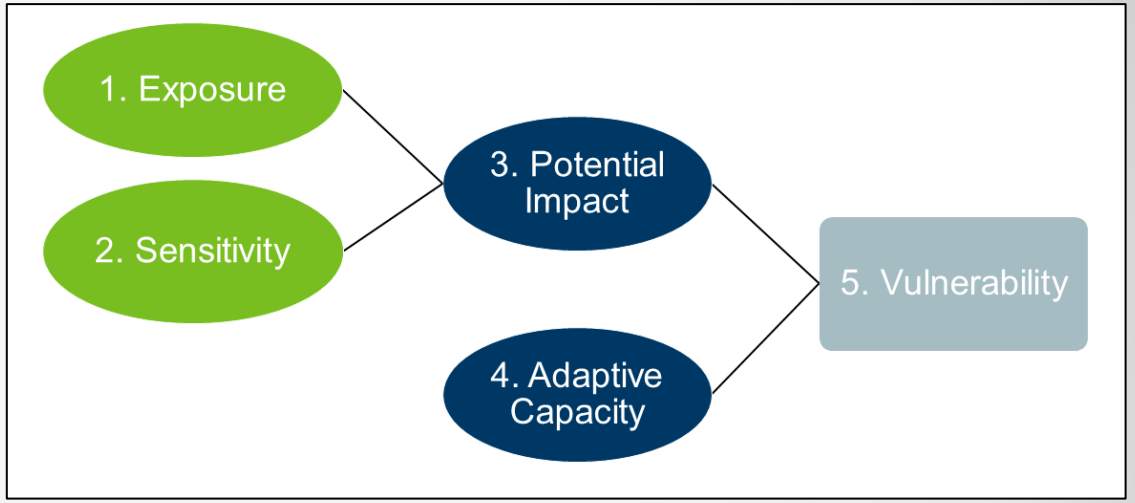
- Step 1. Exposure Analysis
- Step 2. Sensitivity Analysis
- Step 3. Potential Impact Analysis
- Step 4. Adaptive Capacity Analysis
- **Step 5. Vulnerability Analysis**



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Step 5. Vulnerability Analysis

- Vulnerability is the sum of the exposure and sensitivity scores minus any adaptive capacity scores
- Based on the total score, vulnerability is assigned to one of four categories:
  - High
  - Medium
  - Low
  - Minimal



Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

Visualizing the Process

Step 1. Exposure Analysis

Step 2. Sensitivity Analysis

Step 3. Potential Impact Analysis

Step 5. Vulnerability Analysis (following Adaptive Capacity Analysis)

Break 1 (5 minutes)

Assessment Data Sources

Exposure Analysis Data Sources

- Flooding Indicator
  - FEMA Flood Zones
  - Elevation data (i.e., LiDAR, topographic map, Google Earth)
- Storm Surge/Seiche Indicator
  - NOAA CO-OP water level data
  - Lake Superior bathymetry slope data
  - Fetch Exposure Index data
- Lake Level Rise Indicator
  - NOAA CO-OP historic min. and max.

Exposure Analysis Data Sources (cont'd)

- Historical Flooding Indicator
  - USGS stream gage and StreamStats data
  - NOAA AHPS average annual precipitation data
- Erosion Indicator
  - North Shore Erosion Mapping tool (2000)
  - Coastal Erosion Hazard Mapping (CEHM)
- Geology Indicator
  - Bedrock geology and surficial geology from the Minnesota Geological Survey
- Soils Indicator
  - Erosion factors data from NRCS mapped soils
  - North Shore Red Clay soils data

Exposure Analysis Data Sources (cont'd, cont'd)

- Fish and Wildlife Habitat Indicator
  - Scientific and natural areas
  - State aquatic management areas
  - Native plant community areas
  - Site of biodiversity significance
  - National Wetlands Inventory (NWI) data
  - Wildlife Management Area data

Sensitivity Analysis Data Sources

- Flood Damage Potential Indicator
  - FEMA Flood Zone data
  - Elevation data (i.e., LiDAR, topographic map, Google Earth)
  - User input about asset elevation
- Storm Resistance and Conditions Indicator
  - User input regarding asset built resistivity to storms
  - User input regarding asset natural resistivity to storms
- Historical Damage Indicator
  - User input regarding historical damage sustained by asset
  - User input regarding current maintenance levels for asset

Sensitivity Analysis Data Sources (cont'd)

- Protective Engineering Indicator
  - User input regarding asset protective engineering features
  - User input regarding current condition of protective engineering features
- Fish and Wildlife Habitat Indicator
  - Same information characterized in the exposure analysis
- Climate Indicator
  - Increases or decreases in precipitation compared to historic levels
  - Increases or decreases in temperature compared to historic levels
- Water Quality Indicator
  - Invasive species (terrestrial and aquatic) data
  - Buffer protection data for waterbodies

Adaptive Capacity Strategies

- Decommission and Remove
  - Yes, No, or N/A
- Elevate
  - Elevate above 500-year flood elevation
  - Fill above 500-year flood elevation
  - Elevate asset essential needs above 500-year flood elevation
  - No Elevating
  - N/A

Adaptive Capacity Strategies (cont'd)

- Relocate
  - Outside floodplain
  - Outside base-flood area
  - Away from shore
  - No relocating
  - N/A
- Protect/Engineer
  - Living Shoreline design
  - "Soft" Hardening
  - Hardening
  - No protection
  - N/A

Adaptive Capacity Strategies (cont'd cont'd)

- Storm Resistant Design
  - Yes, No, N/A
- Engineering Downgrade
  - Yes, No, N/A

Walkthrough Example

Flood Bay State Wayside

Break 2 (5 minutes)

Hands On Exercise Time!

40 minutes

Hands On Time

- Utilize the next 40 minutes to walkthrough a site (or replicate Flood Bay State Wayside site)
- Use the GIS Instructions document and the spreadsheet simultaneously to walk through a particular site
- Remember: the override function is your friend!
- Raise your hand with questions. Utilize screenshare.

Questions and Final Wrap

Questions?

- Any lingering questions remaining?
- Any surprises?
- Any issues?
- For further assistance in the future, reach out to: mlscp.dnr@state.mn.us

Thank You!

Thank you for attending.

Thank you to NOAA for funding the development of this protocol.