



Twin Points Protected Water Access Vulnerability Assessment

May 2022



Twin Points PWA, Minnesota

Presented to

Minnesota Department of Natural Resources
Division of Ecological and Water Resources
Minnesota's Lake Superior Coastal Program

and

Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office for Coastal Management

Presented by



Tetra Tech, Inc.
350 Indiana Street
Suite 500
Golden, CO 80401
P +1-925-280-7411 / F +1-925-283-0780
tetratech.com

This assessment was prepared by Tetra Tech, Inc. using Federal funds under award NA18NOS4190081 from the Coastal Zone Management Act of 1972, as amended, administered by the Office for Coastal Management, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce provided to the Minnesota Department of Natural Resources (MN DNR) for Minnesota's Lake Superior Coastal Program. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA, the U.S. Department of Commerce, or the MN DNR.

EXECUTIVE SUMMARY

The Minnesota Department of Natural Resources (MN DNR), Minnesota Department of Transportation, and several coastal counties, cities, and towns manage public access sites along the coast of Lake Superior. These public access sites contain natural and built resources that are potentially vulnerable to lake level change and other natural hazards. To evaluate the vulnerability of these public access sites to natural hazards along the coast of Lake Superior, the MN DNR and the National Oceanic and Atmospheric Administration (NOAA) developed a vulnerability assessment protocol. The protocol standardizes the methodology and data utilized by site managers. The workflow and methods follow five main steps including exposure analysis, sensitivity analysis, potential impact analysis, adaptive capacity analysis, and vulnerability analysis.

This standardized protocol was utilized for a vulnerability assessment of the public access site assets at the Twin Points Protected Water Access (PWA) between Two Harbors and Silver Bay, Minnesota. The Twin Points PWA assessment identifies five site assets including a parking lot, dock, boat launch, a secluded beach, and Iona's Beach Scientific and Natural Area (Iona's Beach). The exposure analysis for the Twin Points PWA indicated the parking lot has a low exposure rank while the dock, boat launch, secluded beach, and Iona's Beach have a moderate exposure rank. The sensitivity analysis for the Twin Points PWA indicated the dock and boat launch have moderate sensitivity while the parking lot, secluded beach, and Iona's Beach have low sensitivity.

The potential impact analysis for the Twin Points PWA identifies the dock and boat launch as having a moderate potential impact rank while the parking lot, secluded beach, and Iona's Beach have a low potential impact rank.

Possible adaptive capacity measures were identified for the Twin Points PWA, including living shoreline engineering designs for the secluded beach and storm-resistant designs for the boat launch and associated dock.

The identified adaptive capacity strategies ultimately decrease the vulnerability rank of the dock and boat launch to low and decrease the vulnerability rank of the secluded beach to minimal. The parking lot remains at a low vulnerability rank because adaptive capacity strategies were deemed unnecessary for the asset, which is at a significantly higher elevation than the other assets and does not need protection from climate impacts. Iona's Beach also remains at a low vulnerability rank because adaptive strategies were deemed unnecessary for the asset due to its natural resistivity to potential climate impacts.

The vulnerability assessment for the Twin Points PWA site and reduction of the vulnerability rank of the assets is dependent upon implementing the highest impact adaptive capacity strategies. The assessment was also based on a desktop analysis that could be further enhanced by site manager knowledge of the assets. This assessment can also be re-evaluated by site managers as necessary when adaptive capacity strategies are implemented or for any new assets that might be identified or built on the site. As new datasets become available or old datasets are updated, this new information can be integrated into the assessment.

Table of Contents

1.0 INTRODUCTION	1
1.1 Site Background	1
1.2 Methods	3
2.0 EXPOSURE ANALYSIS.....	4
3.0 SENSITIVITY ANALYSIS.....	7
4.0 POTENTIAL IMPACT ANALYSIS	10
5.0 ADAPTIVE CAPACITY ANALYSIS.....	12
6.0 VULNERABILITY ANALYSIS.....	12
7.0 DISCUSSION	14
8.0 REFERENCES	14
9.0 GLOSSARY.....	15

List of Tables

Table 1.	Twin Points Protected Water Access Site Assets.....	3
Table 2.	Twin Points Protected Water Access Exposure Analysis Results.....	5
Table 3.	Twin Points Protected Water Access Sensitivity Analysis Results.....	8
Table 4.	Twin Points Protected Water Access Potential Impact Results.....	10
Table 5.	Twin Points Protected Water Access Adaptive Capacity Options	12
Table 6.	Twin Points Protected Water Access Vulnerability Score and Rank.....	12

List of Figures

Figure 1.	Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)	1
Figure 2.	Twin Points Protected Water Access Location Map.....	2
Figure 3.	Twin Points Protected Water Access Exposure Analysis Results Map.....	6
Figure 4.	Twin Points Protected Water Access Sensitivity Analysis Results Map.....	9
Figure 5.	Twin Points Protected Water Access Potential Impact Results Map.....	11
Figure 6.	Twin Points Protected Water Access Vulnerability Rank Map.....	13

List of Appendices

Appendix A:	Twin Points Protected Water Access Vulnerability Assessment Spreadsheet	
-------------	---	--

1.0 INTRODUCTION

Public access sites along the Lake Superior coast are vulnerable to fluctuating lake levels and other natural hazards. Twin Points Protected Water Access (PWA) is no different. But how vulnerable is it?

To answer that question, the Minnesota Department of Natural Resources (MN DNR) and the National Oceanic and Atmospheric Administration's Office for Coastal Management (NOAA OCM) followed a standardized process documented in "Vulnerability Assessment Protocol for Minnesota's Public Access Sites" (MN DNR and NOAA OCM 2022a). The five steps in the process as outlined in Figure 1 are:

1. Exposure Analysis (see Section 9, Glossary, for a definition of exposure)
2. Sensitivity Analysis (see Section 9, Glossary, for a definition of sensitivity)
3. Potential Impact Analysis
4. Adaptive Capacity Analysis (optional analysis based on site and asset[s])
5. Vulnerability Analysis

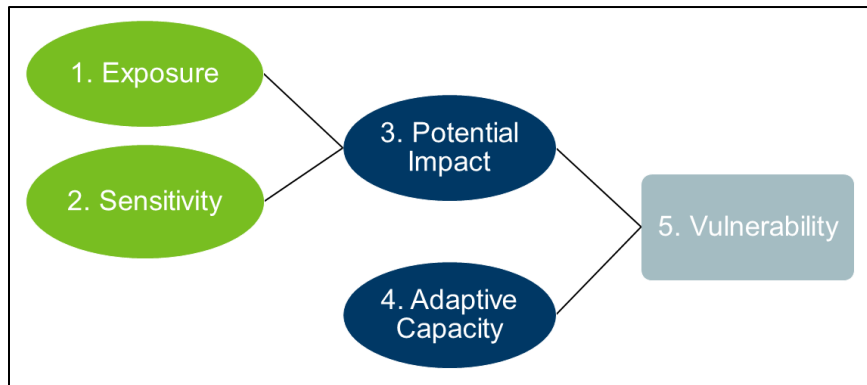


Figure 1. Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

This report documents the findings. It is one of five pilot sites chosen for protocol application. For information about other sites or the protocol itself, contact mlscp.dnr@state.mn.us.

1.1 Site Background

Twin Points PWA is a protected access site between Two Harbors and Silver Bay, Minnesota. The boat launch was constructed in 2002 and developed on an old resort site immediately adjacent to the Iona's Beach Scientific and Natural Area (Figure 2). The site includes a boat launch, 150-foot crib dock, and paved parking for cars and trailers, and it is adjacent to the Gitchi-Gami State Trail.



Figure 2. Twin Points Protected Water Access Location Map

The Twin Points PWA assessment identified five site assets (Figure 2) including the parking lot, dock, boat launch, secluded beach, and Iona's Beach Scientific and Natural Area (Iona's Beach) (Table 1). The assets were mapped in ArcGIS utilizing aerial imagery.

Table 1. Twin Points Protected Water Access Site Assets

Asset	ID	Acres
Parking Lot	TP1	0.95
Dock	TP2	0.07
Boat Launch	TP3	0.95
Secluded Beach	TP4	0.31
Iona's Beach	TP5	2.45

1.2 Methods

To assess vulnerability at Twin Points PWA, the site assessor used the following data sources (MN DNR and NOAA OCM 2022b):

- Geographic Information Systems (GIS) data compiled by MN DNR (MN DNR, NOAA OCM, and Tetra Tech, Inc. 2021), and
- Publicly available GIS data.

The assessor used the information from these sources to answer questions in the protocol's accompanying spreadsheet (Appendix A). There was no site visit, and the assessor had no prior knowledge of the site.

Further detail regarding how to analyze and gather data for the assessment is provided in a separate document utilizing Flood Bay State Wayside as an example (MN DNR and NOAA OCM 2022c). The document provides step-by-step instructions on how to utilize ArcGIS or other software platforms to gather data for input to the spreadsheet.

2.0 EXPOSURE ANALYSIS

The exposure analysis for the Twin Points PWA assessment characterized exposure indicators for each of the assets including flooding, storm surge/seiche, lake level rise, historical flooding, erosion, geology, soils, and fish and wildlife habitat.

The flooding indicator analysis characterized:

- Federal Emergency Management Agency (FEMA) flood zones,
- Elevation data of the assets from 2012 light detection and ranging (LiDAR), and
- The elevation data compared to the 500-year flood elevation for Lake Superior.

The storm surge/seiche indicator analysis characterized:

- NOAA Cooperative Observer Program (CO-OP) water level data for comparison to the elevation of the asset,
- Lake Superior bathymetry slope data, and
- Fetch Exposure Index data.

The lake level rise indicator analysis characterized:

- NOAA CO-OP water level data historic minimum and historic maximums, and
- The difference in historic minimum and historic maximum in the NOAA CO-OP water level data compared to the elevation of the asset described above.

The historical flooding indicator analysis characterized:

- U.S. Geological Survey (USGS) stream gage and StreamStats data for streams at FBSW, and
- NOAA Advanced Hydrologic Prediction Service (AHPS) average annual precipitation data.

The erosion indicator analysis characterized:

- North Shore Erosion Mapping tool data from 2000, and
- Coastal Erosion Hazard Mapping (CEHM) data.

The geology indicator analysis characterized:

- Bedrock geology data from the Minnesota Geological Survey, and
- Surficial geology data from the Minnesota Geological Survey.

The soils indicator analysis characterized:

- The erosion factors data for Natural Resources Conservation Service (NRCS) mapped soils at Twin Points PWA, and
- North Shore Red Clay Soils data.

The fish and wildlife habitat indicator analysis characterized:

- Scientific and natural area data,

- State aquatic management area data,
- Native plant community data,
- Site of biodiversity significance data,
- National Wetland Inventory (NWI) data, and
- Wildlife management area data.

The results of the exposure analysis indicated the parking lot had a low exposure rank while the other assets had a moderate exposure rank (Table 2, Figure 3). Full results of the exposure analysis are available in the provided Twin Points PWA vulnerability assessment spreadsheet (Appendix A).

Table 2. Twin Points Protected Water Access Exposure Analysis Results

Asset	ID	Exposure Score Sum	Exposure Score	Exposure Rank
Parking Lot	TP1	11	1.5	Low
Dock	TP2	17	2.0	Moderate
Boat Launch	TP3	15	2.0	Moderate
Secluded Beach	TP4	16	2.0	Moderate
Iona's Beach	TP5	17	2.0	Moderate

The parking lot scored lower than the other assets because of the elevation. Since the parking lot is much higher in elevation compared to the other assets, the asset is not as exposed to potential impacts as the others. The parking lot, dock, and boat launch exposure analysis also included an “override” by the assessor because while these assets are located within fish and wildlife habitat polygons, they are not fish and wildlife habitat themselves. Therefore, the fish and wildlife habitat exposure indicator was set to zero for these assets.

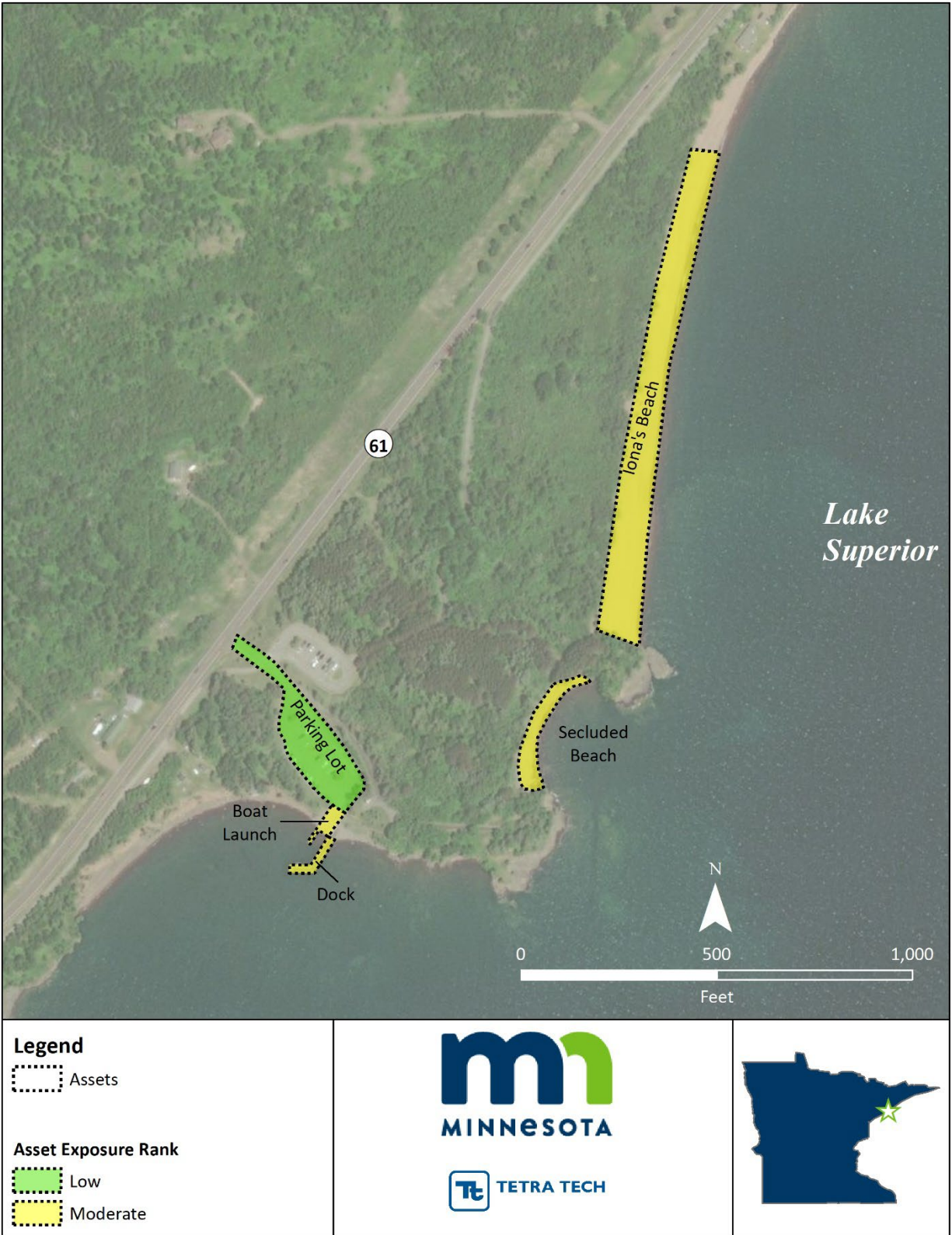


Figure 3. Twin Points Protected Water Access Exposure Analysis Results Map

3.0 SENSITIVITY ANALYSIS

The sensitivity analysis for the Twin Points PWA assessment characterized sensitivity indicators for each of the assets including flood damage potential, storm resistance and condition, historical damage, protective engineering, infrastructure, fish and wildlife habitat, climate, and water quality.

The flood damage potential indicator analysis characterized:

- FEMA flood zones,
- Elevation data of the assets from 2012 LiDAR,
- User input regarding whether the asset is currently elevated, and
- The elevation data compared to the 500-year flood elevation for Lake Superior.

The storm resistance and conditions indicator analysis characterized:

- User input regarding whether the asset has built resistivity to storms, and
- User input regarding whether the asset has natural resistivity to storms.

The historical damage indicator analysis characterized:

- User input regarding whether the asset has sustained damage in the past, and
- User input regarding the current maintenance level for the asset.

The protective engineering indicator analysis characterized:

- User input regarding whether the asset currently features protective engineering, and
- User input regarding the current condition of any protective engineering elements.

The fish and wildlife habitat indicator analysis characterized:

- Scientific and natural area data,
- State aquatic management area data,
- Native plant community data,
- Site of biodiversity significance data,
- NWI data, and
- Wildlife management area data.

The climate indicator analysis characterized:

- Increases or decreases in precipitation for the site compared to historic levels, and
- Increases or decreases in temperatures for the site compared to historic levels.

The water quality indicator analysis characterized:

- Invasive species (terrestrial and aquatic) data, and
- Buffer protection data for waterbodies on the site.

The results of the sensitivity analysis indicated the dock and boat launch had a moderate sensitivity rank while the parking lot and beaches had a low sensitivity rank (Table 3, Figure 4). Full results of the sensitivity analysis are available in the provided Twin Points PWA vulnerability assessment spreadsheet (Appendix A).

Table 3. Twin Points Protected Water Access Sensitivity Analysis Results

Asset	ID	Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
Parking Lot	TP1	12	1.4	Low
Dock	TP2	19	2.5	Moderate
Boat Launch	TP3	17	2.5	Moderate
Secluded Beach	TP4	14	1.5	Low
Iona's Beach	TP5	13	1.4	Low

The parking lot, secluded beach, and Iona's Beach are ranked as low sensitivity while the dock and boat launch are ranked as moderate sensitivity. The parking lot was low sensitivity because of the elevation of the asset making it less likely to experience any kind of potential impacts. The secluded beach and Iona's Beach are ranked as low because they are natural assets that have a natural resistivity that make them better adapted to adjust to potential impacts. The dock and boat launch are built assets that are more sensitive to potential impacts because they do not have natural resistivity like the natural assets. Similar to the exposure analysis, the assessor applied overrides in the sensitivity analysis for the parking lot, dock, and boat launch. While these assets are located within fish and wildlife habitat polygons, the assets are not fish and wildlife habitat themselves. Therefore, the fish and wildlife habitat sensitivity indicator was set to zero for these assets.

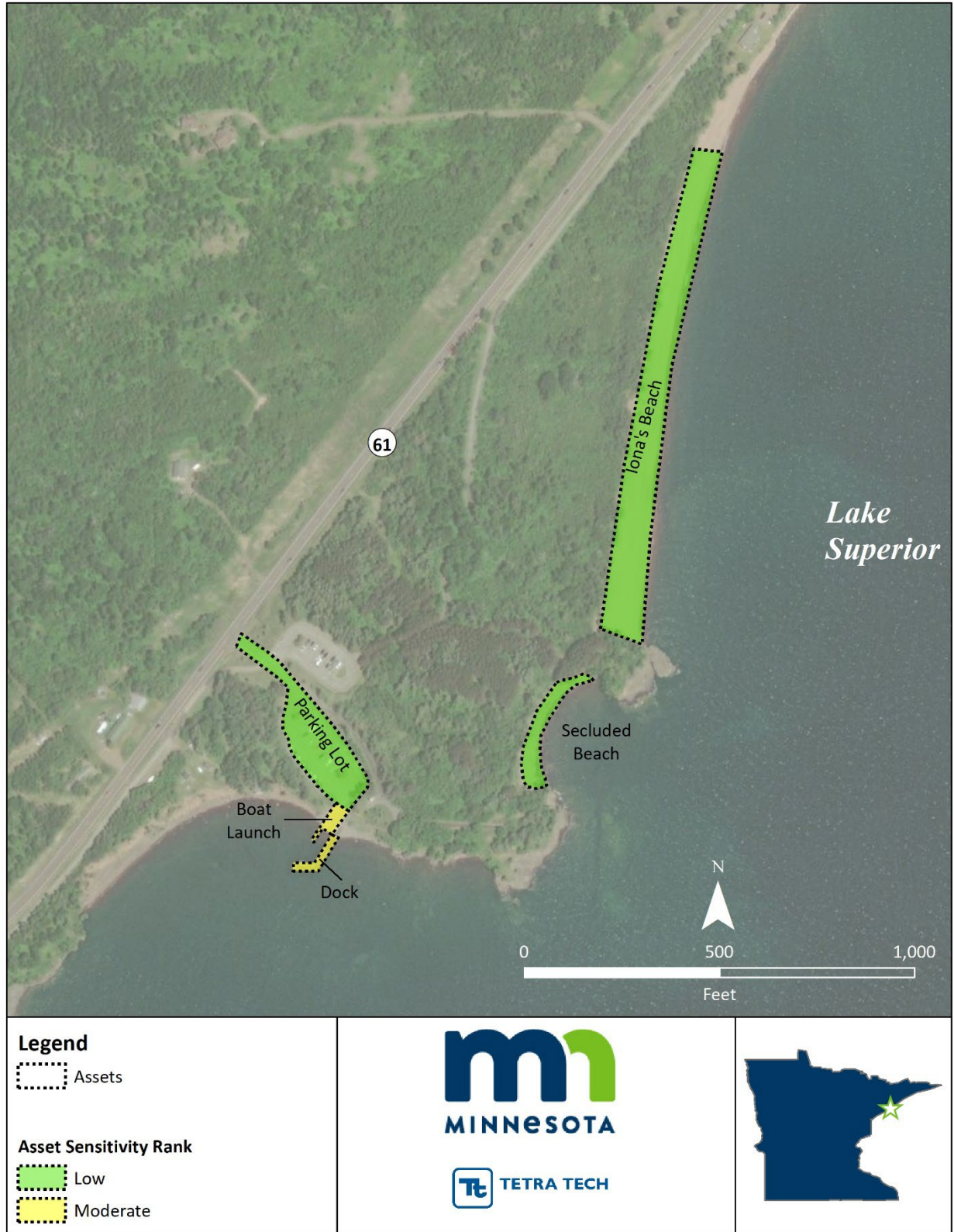


Figure 4. Twin Points Protected Water Access Sensitivity Analysis Results Map

4.0 POTENTIAL IMPACT ANALYSIS

The potential impact analysis for the Twin Points PWA assessment characterized the results of the exposure and sensitivity analyses. The potential impact to the assets was calculated by averaging the exposure and sensitivity scores from the previous analyses. The results of the potential impact analysis indicated the dock and boat launch have a moderate potential impact rank while parking lot, secluded beach, and Iona's Beach have a low potential impact rank (Table 4, Figure 5). Full results of the potential impact analysis are available in the provided Twin Points PWA vulnerability assessment spreadsheet (Appendix A).

Table 4. Twin Points Protected Water Access Potential Impact Results

Asset	ID	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
Parking Lot	TP1	1.5	Low	1.5	Low	1.4	Low
Dock	TP2	2.0	Moderate	2.5	Moderate	2.3	Moderate
Boat Launch	TP3	2.0	Moderate	2.5	Moderate	2.3	Moderate
Secluded Beach	TP4	2.0	Moderate	1.5	Low	1.8	Low
Iona's Beach	TP5	2.0	Moderate	1.4	Low	1.7	Low

At this point, the potential impact analysis can be used to characterize the vulnerability of the assets identified at Twin Points PWA. The following section (Section 5) presents potential adaptive capacity strategies to lower the vulnerability of the assets at Twin Points PWA. Adaptive capacity strategies identified in this document are conceptual and can be updated or removed as deemed necessary by the Twin Points PWA site manager.

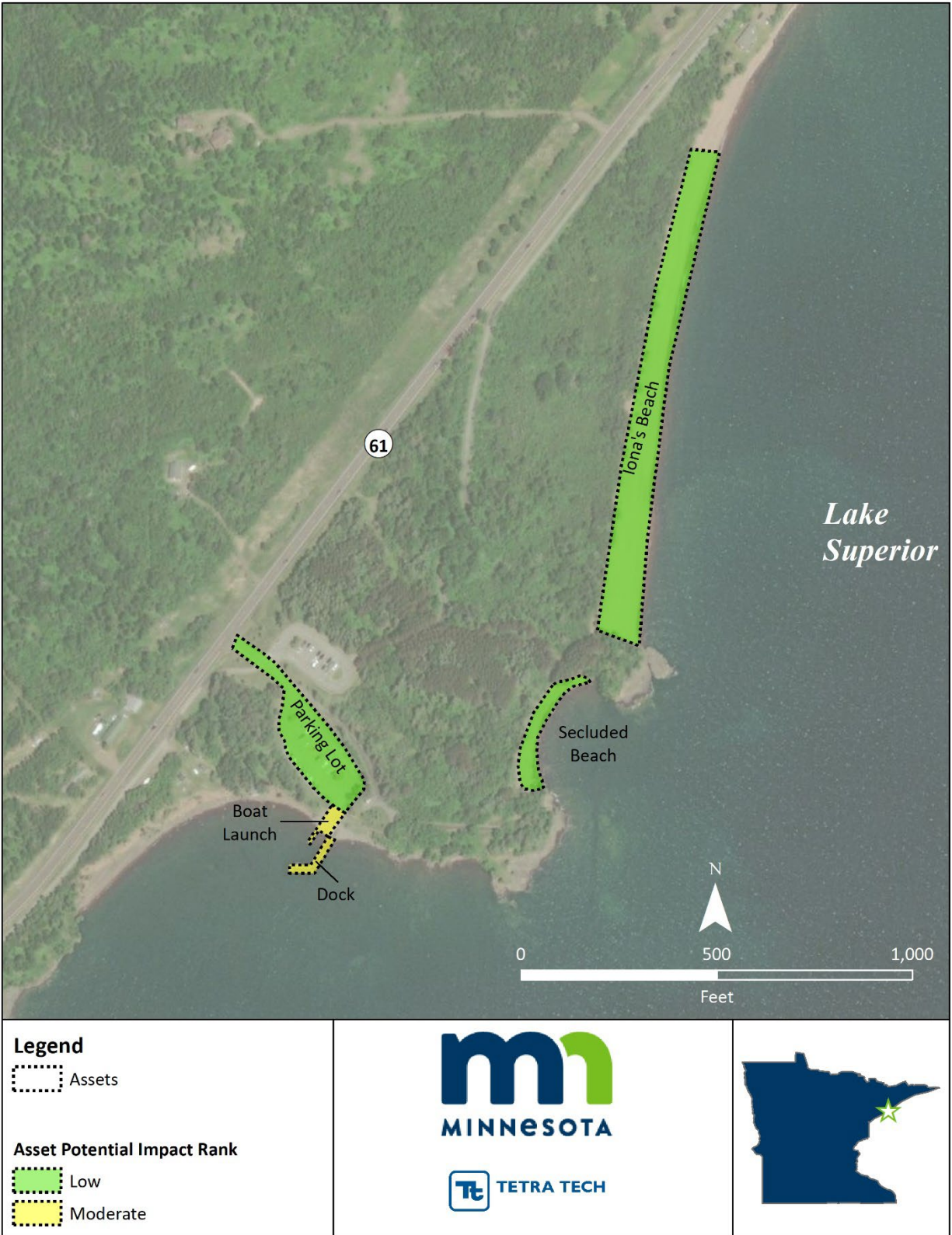


Figure 5. Twin Points Protected Water Access Potential Impact Results Map

5.0 ADAPTIVE CAPACITY ANALYSIS

Based on the potential impact analysis previously described, adaptive capacity strategies for Twin Points PWA assets are identified below. Table 5 describes the general adaptive capacity strategy identified for each asset and provides more specific examples of the strategies.

Table 5. Twin Points Protected Water Access Adaptive Capacity Options

Asset	ID	Adaptive Capacity Strategy	Adaptive Capacity Strategy Example
Parking Lot	TP1	None	N/A
Dock	TP2	Elevate Above; Storm Resistant Design	Ensure dock base is elevated above 500-year flood elevation; design dock to withstand storms
Boat Launch	TP3	Storm Resistant Design	Design boat launch to withstand storms
Secluded Beach	TP4	Protect/Engineer	Living shoreline design
Iona's Beach	TP5	None	N/A

The dock and boat launch assets should be constructed with a storm-resistant design that reduces potential impacts from climate change like larger and more frequent storms. The dock base where it connects with the shore should be elevated above the 500-year flood elevation. While the secluded beach asset is generally resistant to climate impacts because of natural resistivity, a living shoreline approach to further protecting and enhancing this asset could be undertaken. No adaptive capacity strategies were identified for the parking lot asset because the trail is at a higher elevation and generally less affected by potential climate impacts. No strategies were identified for Iona's Beach because the site is naturally resistant to potential climate impacts and is a protected Scientific and Natural Area.

6.0 VULNERABILITY ANALYSIS

This final vulnerability analysis for the Twin Points PWA site summed the potential impacts as and subtracts the adaptive capacity scores. Based on the final vulnerability score for each asset, the asset was assigned to one of four categories: high vulnerability, moderate vulnerability, low vulnerability, or minimal vulnerability. By utilizing the adaptive capacity strategies described previously, the vulnerability of the beaches can be reduced to minimal while the dock and boat launch vulnerability can be reduced to minimal (Table 6, Figure 6). The parking lot does not have any adaptive capacity strategies identified because the asset is already elevated well above any potential impacts.

Table 6. Twin Points Protected Water Access Vulnerability Score and Rank

Asset	ID	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
Parking Lot	TP1	1.4	Low	0.4	1.1	Low
Dock	TP2	2.3	Moderate	1.6	0.6	Low
Boat Launch	TP3	2.3	Moderate	0.9	1.4	Low
Secluded Beach	TP4	1.8	Low	1.5	0.3	Minimal
Iona's Beach	TP5	1.7	Low	0.0	1.7	Low

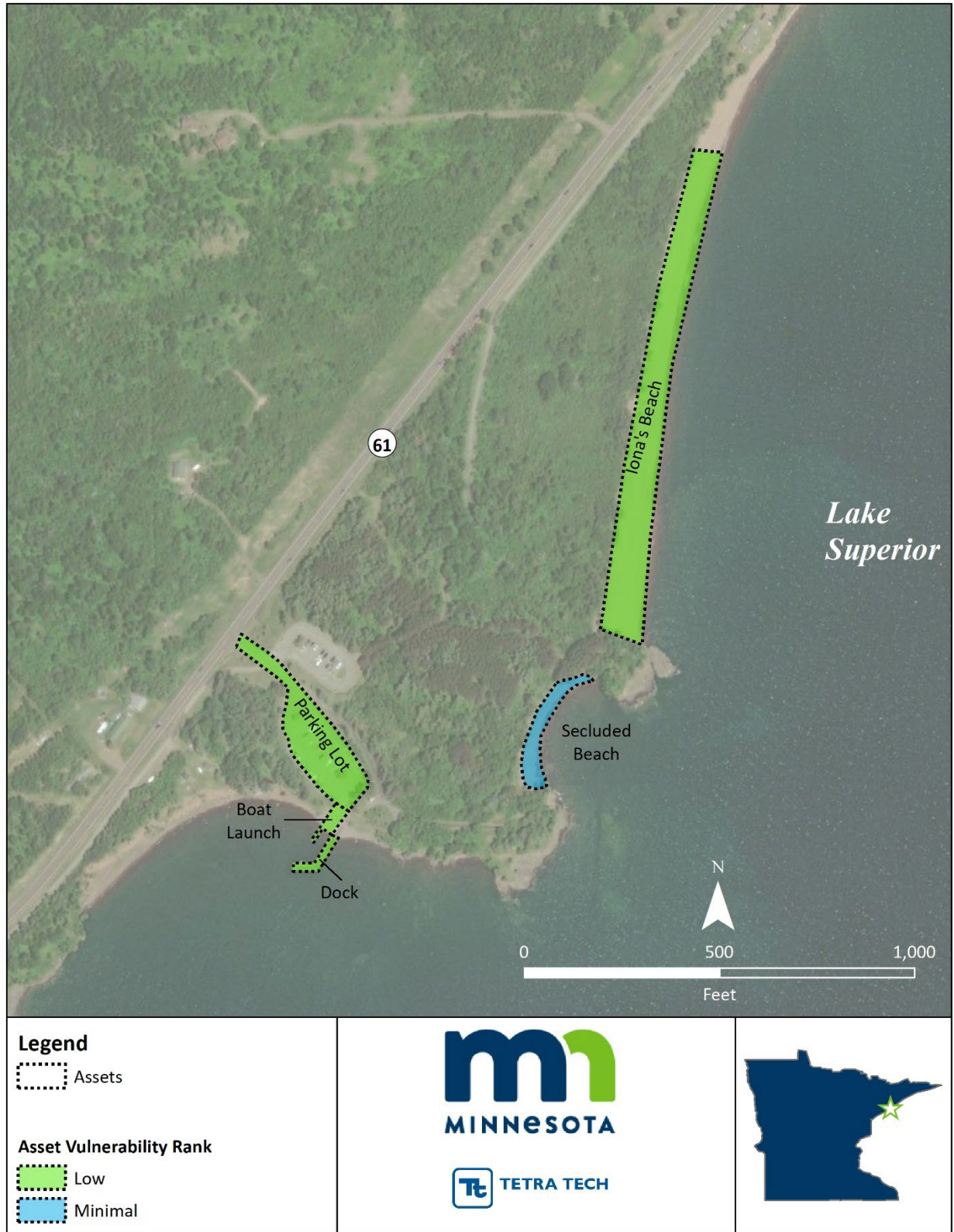


Figure 6. Twin Points Protected Water Access Vulnerability Rank Map

7.0 DISCUSSION

While Table 6 above shows the potential reduction of vulnerability of assets at Twin Points PWA, this reduction is dependent upon implementing the highest impact adaptive capacity strategies identified in Table 5. Site managers at Twin Points PWA may not have the ability to fund these options or may not be able to implement these actions in a timely fashion. This vulnerability assessment has also been performed as a desktop analysis without a visit to the site itself. Site managers should utilize the best available knowledge of the site and the knowledge of what adaptive strategies are most readily available or feasible in order to fully assess the vulnerability of the assets. As new datasets become available or old datasets are updated, it may behoove the site manager or others interested in the site to integrate it into the assessment. Furthermore, if adaptive capacity strategies are implemented on certain assets, the vulnerability assessment can be redone to update the vulnerability rank of the assets or of any new assets that might be identified or built at the site.

8.0 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
- MN DNR and NOAA OCM (Minnesota Department of Natural Resources and National Oceanic and Atmospheric Administration Office for Coastal Management). 2022a. *Vulnerability_Assessment_Protocol_MDNR_03032022.docx*. Word Document submitted to MN DNR and NOAA OCM March 3, 2022.
- MN DNR and NOAA OCM. 2022b. *Vulnerability Assessment Protocol and Scoring Spreadsheet Instructions*. Word document submitted to MN DNR and NOAA OCM April 2022.
- MN DNR and NOAA OCM. 2022c. *Flood Bay State Wayside Example Vulnerability Assessment GIS Instructions.docx*. Word document submitted to MN DNR and NOAA OCM May 2022.
- MN DNR, NOAA OCM, and Tetra Tech, Inc. 2021. *Existing Vulnerability Assessments, Datasets, and Data Gaps_10282021.xlsx*. Spreadsheet submitted to MN DNR and NOAA OCM October 28, 2021.
- NPS (National Park Service). 2016. *Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol*. Available at: <https://irma.nps.gov/DataStore/DownloadFile/665481?Reference=1049253>.

9.0 GLOSSARY

Exposure. The nature and degree to which a system is exposed to direct climate change impacts (Glick et al. 2011). For example, an asset that is sited well above a beach or riverbank will be less exposed to variations than an asset that is sited near the elevation of the lake or river.

Sensitivity. The degree to which a system is affected, either adversely or beneficially, when exposed to climate variations (Glick et al. 2011). For example, an asset with natural resistivity to climate change impacts like a wetland or unobstructed beach will be less sensitive to changes in lake level or storm damage than an asset with built features like a beach with rip rap or a parking lot that do not have natural resistivity to changes.

APPENDIX A: TWIN POINTS PROTECTED WATER ACCESS VULNERABILITY ASSESSMENT SPREADSHEET

Step 1. Exposure DATA			Flooding Indicator			Storm Surge/Seiche Indicator				Lake Level Rise	
ID	Asset	Site	FEMA Flood Data	LiDAR Elevation Data	Flood Elevation Data	NOAA CO-OP Data	Slope Data	Fetch Exposure Index Data	Elevation Data	NOAA CO-OP Data	Elevation Data
TP1	Parking Lot	Twin Points PWA	N/A	619.2	14.4	601.5	2.66	47689	17.7	4.594	13.1
TP2	Dock	Twin Points PWA	N/A	604.0	-0.8	601.5	2.66	47689	2.5	4.594	-2.1
TP3	Boat Launch	Twin Points PWA	N/A	607.9	3.1	601.5	2.66	47689	6.4	4.594	1.8
TP4	Secluded Beach	Twin Points PWA	N/A	609.5	4.7	601.5	5.81	231899	8.0	4.594	3.5
TP5	Iona's Beach	Twin Points PWA	N/A	609.9	5.1	601.5	5.81	231899	8.4	4.594	3.8

Step 1. Exposure DATA			Historical Flooding Indicator		Erosion Indicator		Geology Indicator		Soils Indicator	
ID	Asset	Site	USGS Stream Gage Data	NOAA AHPS Data	Erosion Data	CEHM Data	Bedrock Geology Data	Surficial Geology Data	gSSURGO Data	North Shore Red Clay Soils Data
TP1	Parking Lot	Twin Points PWA		31.4	High	Unknown	Basalt/Rhyolite	Barnum Formation	0.15	0-8%
TP2	Dock	Twin Points PWA		31.4	High	Unknown	Basalt/Rhyolite	Barnum Formation	0.43	0-8%
TP3	Boat Launch	Twin Points PWA		31.4	High	Unknown	Basalt/Rhyolite	Barnum Formation	0.43	0-8%
TP4	Secluded Beach	Twin Points PWA		31.4	High	Unknown	Basalt/Rhyolite	Barnum Formation	0.15	0-8%
TP5	Iona's Beach	Twin Points PWA		31.4	High	Unknown	Basalt/Rhyolite	Barnum Formation	0.43	0-8%

Step 1. Exposure DATA			Fish and Wildlife Habitat Indicator					
ID	Asset	Site	Scientific and Natural Areas?	State Aquatic Management Areas?	Native Plant Communities?	Site of Biodiversity Significance?	National Wetland Inventory?	Wildlife Management Area?
TP1	Parking Lot	Twin Points PWA	No	No	No	Yes	No	No
TP2	Dock	Twin Points PWA	No	No	No	Yes	No	No
TP3	Boat Launch	Twin Points PWA	No	No	No	Yes	No	No
TP4	Secluded Beach	Twin Points PWA	No	No	Yes	Yes	No	No
TP5	Iona's Beach	Twin Points PWA	Yes	No	Yes	Yes	Yes	No

Step 1. Exposure Data Scores			Flooding Indicator						Storm Surge/Seiche Indicator						
ID	Asset	Site	FEMA Flood Score	LIDAR Elevation Score	Flood Elevation Score	Flooding Score	Override?	Flooding Score Final	NOAA CO-OP Score	Slope Score	Fetch Exposure Index Score	Elevation Score	Storm Surge/Seiche Score	Override?	Storm Surge/Seiche Score Final
TP1	Parking Lot	Twin Points PWA	0	1	1	1		1	1	1	0	1	1		1
TP2	Dock	Twin Points PWA	0	5	4	3		3	1	1	0	5	2		2
TP3	Boat Launch	Twin Points PWA	0	4	1	2		2	1	1	0	4	2		2
TP4	Secluded Beach	Twin Points PWA	0	3	1	1		1	1	2	1	3	2		2
TP5	Iona's Beach	Twin Points PWA	0	2	1	1		1	1	2	1	2	2		2

Step 1. Exposure Data Scores			Lake Level Rise Indicator					Historical Flooding Indicator					Erosion Indicator				
ID	Asset	Site	NOAA CO-OP Score	Elevation Score	Lake Level Rise Score	Override?	Lake Level Rise Score Final	USGS Stream Gage Score	NOAA AHPS Score	Historical Flooding Score	Override?	Historical Flooding Score Final	Erosion Score	CEHM Score	Erosion Score	Override?	Erosion Score Final
TP1	Parking Lot	Twin Points PWA	4	1	3		3	0	4	2		2	4	0	2		2
TP2	Dock	Twin Points PWA	4	5	5		5	0	4	2		2	4	0	2		2
TP3	Boat Launch	Twin Points PWA	4	4	4		4	0	4	2		2	4	0	2		2
TP4	Secluded Beach	Twin Points PWA	4	3	4		4	0	4	2		2	4	0	2		2
TP5	Iona's Beach	Twin Points PWA	4	2	3		3	0	4	2		2	4	0	2		2

Step 1. Exposure Data Scores			Geology Indicator					Soils Indicator				
ID	Asset	Site	USGS Bedrock Geology Score	USGS Surficial Geology Score	Geology Score	Override?	Geology Score Final	gSSURGO Score	North Shore Red Clay Soils Score	Soils Score	Override?	Soils Score Final
TP1	Parking Lot	Twin Points PWA	2	2	2		2	1	1	1		1
TP2	Dock	Twin Points PWA	2	2	2		2	3	1	2		2
TP3	Boat Launch	Twin Points PWA	2	2	2		2	3	1	2		2
TP4	Secluded Beach	Twin Points PWA	2	2	2		2	1	1	1		1
TP5	Iona's Beach	Twin Points PWA	2	2	2		2	3	1	2		2

Step 1. Exposure Data Scores			Fish and Wildlife Habitat Indicator									Exposure Score Sum	Exposure Score	Exposure Rank
ID	Asset	Site	Scientific and Natural Areas Score	State Aquatic Management Areas Score	Native Plant Communities Score	Site of Biodiversity Significance Score	National Wetland Inventory Score	Wildlife Management Area Score	Fish and Wildlife Habitat Score	Override?	Fish and Wildlife Habitat Score Final			
TP1	Parking Lot	Twin Points PWA	1	1	1	4	1	1	2	0	0	11	1.5	Low
TP2	Dock	Twin Points PWA	1	1	1	4	1	1	2	0	0	17	2.0	Moderate
TP3	Boat Launch	Twin Points PWA	1	1	1	4	1	1	2	0	0	15	2.0	Moderate
TP4	Secluded Beach	Twin Points PWA	1	1	4	4	1	1	3		3	16	2.0	Moderate
TP5	Iona's Beach	Twin Points PWA	4	1	4	4	4	1	3		3	17	2.0	Moderate

Step 2. Sensitivity DATA			Flood Damage Potential Indicator				Storm Resistance and Condition Indicator	
ID	Asset	Site	FEMA Flood Data	LiDAR Elevation Data	Asset Elevated?	500 Year Flood Potential?	Built Resistivity?	Natural Resistivity?
TP1	Parking Lot	Twin Points PWA	N/A	619.2	Yes	No	Yes	No
TP2	Dock	Twin Points PWA	N/A	604.0	Yes	Yes	Yes	No
TP3	Boat Launch	Twin Points PWA	N/A	607.9	N/A	No	Yes	No
TP4	Secluded Beach	Twin Points PWA	N/A	609.5	N/A	No	N/A	Yes
TP5	Iona's Beach	Twin Points PWA	N/A	609.9	N/A	No	N/A	Yes

Step 2. Sensitivity DATA			Historical Damage Indicator		Protective Engineering Indicator		Infrastructure Indicator	
ID	Asset	Site	Historical Damage?	Current Maintenance Level Data	Protective Engineering?	Engineered Element Condition Data	Critical Infrastructure Present?	Infrastructure Protected?
TP1	Parking Lot	Twin Points PWA	No	None	N/A	None	Yes	N/A
TP2	Dock	Twin Points PWA	Yes	New	Yes	New	Yes	Yes
TP3	Boat Launch	Twin Points PWA	Yes	New	Yes	New	Yes	Yes
TP4	Secluded Beach	Twin Points PWA	N/A	None	No	None	No	N/A
TP5	Iona's Beach	Twin Points PWA	N/A	None	No	None	No	N/A

Step 2. Sensitivity DATA			Fish and Wildlife Habitat Indicator					
ID	Asset	Site	Scientific and Natural Areas?	State Aquatic Management Areas?	Native Plant Communities?	Site of Biodiversity Significance?	National Wetland Inventory?	Wildlife Management Area?
TP1	Parking Lot	Twin Points PWA	No	No	No	Yes	No	No
TP2	Dock	Twin Points PWA	No	No	No	Yes	No	No
TP3	Boat Launch	Twin Points PWA	No	No	No	Yes	No	No
TP4	Secluded Beach	Twin Points PWA	No	No	Yes	Yes	No	No
TP5	Iona's Beach	Twin Points PWA	Yes	No	Yes	Yes	Yes	No

Step 2. Sensitivity DATA			Climate Indicator		Water Quality Indicator	
ID	Asset	Site	Precipitation Change Data	Temperature Change Data	Invasive Species?	Buffer Protection Data
TP1	Parking Lot	Twin Points PWA	0.46	0.26	Yes	None
TP2	Dock	Twin Points PWA	0.46	0.26	Yes	50 Foot Buffer
TP3	Boat Launch	Twin Points PWA	0.46	0.26	Yes	50 Foot Buffer
TP4	Secluded Beach	Twin Points PWA	0.46	0.26	Yes	50 Foot Buffer
TP5	Iona's Beach	Twin Points PWA	0.46	0.26	Yes	50 Foot Buffer

Step 2. Sensitivity Data Scores			Flood Damage Potential Indicator							Storm Resistance and Condition Indicator				
ID	Asset	Site	FEMA Flood Score	LiDAR Elevation Score	Asset Structure Elevation Score	500 Year Flood Score	Flood Damage Potential Score	Override?	Flood Damage Potential Score Final	Built Resistivity Score	Natural Resistivity Score	Storm Resistance and Condition Score	Override?	Storm Resistance and Condition Score Final
TP1	Parking Lot	Twin Points PWA	0	1	1	1	1		1	1	4	3		3
TP2	Dock	Twin Points PWA	0	5	1	4	3		3	1	4	3		3
TP3	Boat Launch	Twin Points PWA	0	4	0	1	1		1	1	4	3		3
TP4	Secluded Beach	Twin Points PWA	0	3	0	1	1		1	0	1	1		1
TP5	Iona's Beach	Twin Points PWA	0	2	0	1	1		1	0	1	1		1

Step 2. Sensitivity Data Scores			Historical Damage Indicator					Protective Engineering Indicator				
ID	Asset	Site	Historical Damage Score	Current Maintenance Level Score	Historical Damage Score	Override?	Historical Damage Score Final	Protective Engineering Score	Engineered Element Condition Score	Protective Engineering Score	Override?	Protective Engineering Score Final
TP1	Parking Lot	Twin Points PWA	1	0	0.5		1	0	0	0		0
TP2	Dock	Twin Points PWA	4	1	2.5		3	1	1	1		1
TP3	Boat Launch	Twin Points PWA	4	1	2.5		3	1	1	1		1
TP4	Secluded Beach	Twin Points PWA	0	0	0		0	4	0	2		2
TP5	Iona's Beach	Twin Points PWA	0	0	0		0	4	0	2		2

Step 2. Sensitivity Data Scores			Infrastructure Indicator					Fish and Wildlife Habitat Indicator								
ID	Asset	Site	Critical Infrastructure Present Score	Infrastructure Protection Score	Infrastructure Score	Override?	Infrastructure Score Final	Scientific and Natural Areas Score	State Aquatic Management Areas Score	Native Plant Communities Score	Site of Biodiversity Significance Score	National Wetland Inventory Score	Wildlife Management Area Score	Fish and Wildlife Habitat Score	Override?	Fish and Wildlife Habitat Score Final
TP1	Parking Lot	Twin Points PWA	4	0	2		2	4	4	4	1	4	4	4	0	0
TP2	Dock	Twin Points PWA	4	1	3		3	4	4	4	1	4	4	4	0	0
TP3	Boat Launch	Twin Points PWA	4	1	3		3	4	4	4	1	4	4	4	0	0
TP4	Secluded Beach	Twin Points PWA	0	0	0		0	4	4	1	1	4	4	3		3
TP5	Iona's Beach	Twin Points PWA	0	0	0		0	1	4	1	1	1	4	2		2

Step 2. Sensitivity Data Scores			Climate Indicator					Water Quality Indicator					Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
ID	Asset	Site	Precipitation Change Score	Temperature Change Score	Climate Score	Override?	Climate Score Final	Invasive Species Score	Buffer Protection Score	Water Quality Score	Override?	Water Quality Score Final			
TP1	Parking Lot	Twin Points PWA	4	4	4		4	4	0	2		2	12	1.4	Low
TP2	Dock	Twin Points PWA	4	4	4		4	4	3	3.5		4	19	2.5	Moderate
TP3	Boat Launch	Twin Points PWA	4	4	4		4	4	3	3.5		4	17	2.5	Moderate
TP4	Secluded Beach	Twin Points PWA	4	4	4		4	4	3	3.5		4	14	1.5	Low
TP5	Iona's Beach	Twin Points PWA	4	4	4		4	4	3	3.5		4	13	1.4	Low

Step 3. Potential Impact			Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
ID	Asset	Site						
TP1	Parking Lot	Twin Points PWA	1.5	Low	1.4	Low	1.4	Low
TP2	Dock	Twin Points PWA	2.0	Moderate	2.5	Moderate	2.3	Moderate
TP3	Boat Launch	Twin Points PWA	2.0	Moderate	2.5	Moderate	2.3	Moderate
TP4	Secluded Beach	Twin Points PWA	2.0	Moderate	1.5	Low	1.8	Low
TP5	Iona's Beach	Twin Points PWA	2.0	Moderate	1.4	Low	1.7	Low

Step 4. Adaptive Capacity DATA			1. Decommission and Remove	2. Elevate	3. Relocate	4. Protect/Engineer	5. Storm Resistant Design	6. Engineering Downgrade
TP1	Parking Lot	Twin Points PWA	No	No Elevating	No Relocating	N/A	N/A	N/A
TP2	Dock	Twin Points PWA	No	Elevate Above	No Relocating	No Protection	Yes	N/A
TP3	Boat Launch	Twin Points PWA	No	N/A	N/A	No Protection	Yes	N/A
TP4	Secluded Beach	Twin Points PWA	N/A	N/A	N/A	Living Shoreline	N/A	N/A
TP5	Iona's Beach	Twin Points PWA	N/A	N/A	N/A	N/A	N/A	N/A

Step 4. Adapt. Capacity Scores												
ID	Asset	Site	1. Decommission and Remove	2. Elevate	3. Relocate	4. Protect/Engineer	5. Storm Resistant Design	6. Engineering Downgrade	Exposure Adaptive Capacity Score	Sensitivity Adaptive Capacity Score	Adaptive Capacity Score Sum	Adaptive Capacity Score
TP1	Parking Lot	Twin Points PWA	1	1	1	0	0	0	1	0	1	0.4
TP2	Dock	Twin Points PWA	1	4	1	1	4	0	1	2	3	1.6
TP3	Boat Launch	Twin Points PWA	1	0	0	1	4	0	1	1	2	0.9
TP4	Secluded Beach	Twin Points PWA	0	0	0	4	0	0	2	1	3	1.5
TP5	Iona's Beach	Twin Points PWA	0	0	0	0	0	0	0	0	0	0.0

Step 5. Vulnerability Analysis											
ID	Asset	Site	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
TP1	Parking Lot	Twin Points PWA	1.5	Low	1.4	Low	1.4	Low	0.4	1.1	Low
TP2	Dock	Twin Points PWA	2.0	Moderate	2.5	Moderate	2.3	Moderate	1.6	0.6	Low
TP3	Boat Launch	Twin Points PWA	2.0	Moderate	2.5	Moderate	2.3	Moderate	0.9	1.4	Low
TP4	Secluded Beach	Twin Points PWA	2.0	Moderate	1.5	Low	1.8	Low	1.5	0.3	Minimal
TP5	Iona's Beach	Twin Points PWA	2.0	Moderate	1.4	Low	1.7	Low	0.0	1.7	Low