# Gooseberry Falls State Park Vulnerability Assessment

May 2022

*Gooseberry Falls State Park, 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

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# 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 Gooseberry Falls State Park (GFSP) between Two Harbors and Silver Bay, Minnesota. The GFSP assessment identifies five site assets including the Lakeview Lodge (Lodge), Agate Beach north, Agate Beach south, Gitchi Gami Trail north (Trail), and the Lakeview Shelter (Shelter). The exposure analysis for the GFSP indicated the Lodge had a minimal exposure rank, the Trail had a low exposure rank, and the beaches and Shelter had a moderate exposure rank. The sensitivity analysis for the GFSP indicated Agate Beach north had a minimal sensitivity rank, the Lodge and Agate Beach south had a low sensitivity rank, the Trail had a moderate sensitivity rank, and the Shelter had a high sensitivity rank.

The potential impact analysis for the GFSP identifies the Lodge, beaches, and Trail as low potential impact rank while the Shelter had a moderate potential impact rank.

Possible adaptive capacity measures were identified for the GFSP, including living shoreline engineering designs for the beaches, relocating the Trail farther from the shoreline, and maintaining hardening at the Shelter to protect against potential climate impacts.

The identified adaptive capacity strategies ultimately decrease the vulnerability rank of the lower beaches from low to minimal and the Shelter from moderate to low while reducing the vulnerability score for the Trail.

The vulnerability assessment for the GFSP 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.

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# 1.0 INTRODUCTION

Public access sites along the Lake Superior coast are vulnerable to fluctuating lake levels and other natural hazards. Gooseberry Falls State Park (GFSP) 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

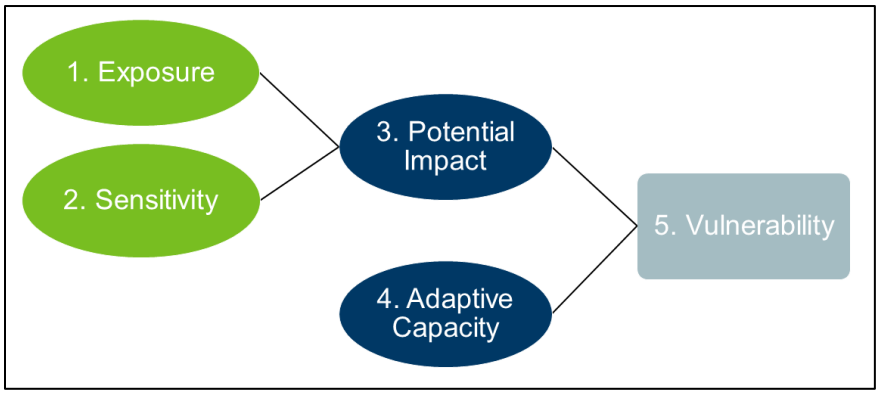


**Figure 1. Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)**

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

GFSP is located along State Highway 61 halfway between Two Harbors and Silver Bay, Minnesota. The area became a state park in 1937 and features campsites along the river and Lake Superior, numerous hiking trails and picnic areas, and beach access where the Gooseberry River meets Lake Superior (Figure 2).


**Figure 2. Gooseberry Falls State Park Location Map**

The GFSP assessment identified five site assets (Figure 2) including the Lakeview Lodge (Lodge), Agate Beach north, Agate Beach south, Gitchi Gami Trail North (Trail), and the Lakeview Shelter (Shelter) (Table 1). The assets were mapped utilizing a geo-referenced PDF provided by the MN DNR available online at https://gdrs.dnr.state.mn.us/gdrs/apps/pub/us_mn_state_dnr/mndnr_geopdf_download/State_Parks/Gooseberry%20Falls%20Summer%20GEO.pdf.

**Table 1. Gooseberry Falls State Park Site Assets**

| Asset | ID | Measurement |
|---|---|---|
| Lakeview Lodge | GF1 | 0.06 acres |
| Agate Beach North | GF2 | 0.14 acres |
| Agate Beach South | GF3 | 0.67 acres |
| Gitchi Gami Trail North | GF4 | 1,090 feet |
| Lakeview Shelter | GF5 | 0.01 acres |

## 1.2 Methods

To assess vulnerability at GFSP, 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 GFSP 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 GFSP, 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 mapped soils at GFSP, 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,
- NWI data, and
- Wildlife management area data.

The results of the exposure analysis indicated the beaches and the Shelter had a moderate exposure rank, the Trail had a low exposure rank, and the Lodge had a minimal exposure rank (Table 2, Figure 3). Full results of the exposure analysis are available in the provided GFSP vulnerability assessment spreadsheet (Appendix A).

**Table 2. Gooseberry Falls State Park Exposure Analysis Results**

| Asset | ID | Exposure Score Sum | Exposure Score | Exposure Rank |
|---|---|---|---|---|
| Lakeview Lodge | GF1 | 10 | 1.0 | Minimal |
| Agate Beach North | GF2 | 18 | 2.3 | Moderate |
| Agate Beach South | GF3 | 19 | 2.4 | Moderate |
| Gitchi Gami Trail North | GF4 | 12 | 1.5 | Low |
| Lakeview Shelter | GF5 | 18 | 2.8 | Moderate |

The Lodge had a minimal exposure rank because of its location high on a bluff and far from the shoreline. The Trail had a low exposure rank because of its similar location high on the bluff above the shoreline. The Agate Beach North and South as well as the Shelter fell into the moderate exposure rank. These assets ranked higher in the exposure analysis because of their low-lying elevations and locations near the shoreline. An "override" was utilized by the assessor for the picnic shelter for the flooding indicator and for the storm surge/seiche indicator because the asset was assumed to be at higher risk of flooding than the beaches, which are naturally resistant to flooding. Because the Shelter was built on a retaining wall, the assessor also used an override on the erosion indicator because it was assumed that the area is more prone to erosion. The Lodge, Trail, and Shelter also had an override for the fish and wildlife habitat indicator because while the assets are located within fish and wildlife habitat polygons, they are not actually fish and wildlife habitat. Therefore, the fish and wildlife habitat exposure indicator was zero for these assets.


**Figure 3. Gooseberry Falls State Park Exposure Analysis Results Map**

# 3.0 SENSITIVITY ANALYSIS

The sensitivity analysis for the GFSP 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 Shelter had a high sensitivity rank, the Trail had a moderate sensitivity rank, the Lodge and Agate Beach south had a low sensitivity rank, and Agate Beach north had a minimal sensitivity rank (Table 3, Figure 4). Full results of the sensitivity analysis are available in the provided GFSP vulnerability assessment spreadsheet (Appendix A).

**Table 3. Gooseberry Falls State Park Sensitivity Analysis Results**

| Asset | ID | Sensitivity Score Sum | Sensitivity Score | Sensitivity Rank |
|---|---|---|---|---|
| Lakeview Lodge | GF1 | 13 | 1.8 | Low |
| Agate Beach North | GF2 | 11 | 0.9 | Minimal |
| Agate Beach South | GF3 | 12 | 1.0 | Low |
| Gitchi Gami Trail North | GF4 | 17 | 2.0 | Moderate |
| Lakeview Shelter | GF5 | 19 | 3.0 | High |

The Agate Beach north asset was ranked as minimal sensitivity and Agate Beach south was ranked as low sensitivity because these assets are naturally resistant to potential climate impacts. The Lodge was also ranked as low sensitivity. The sensitivity score was higher than the beach assets because the asset is not naturally resistant to potential impacts. The Trail was ranked as moderate sensitivity due to the trail not having natural resistance to potential impacts and being built on a potentially erosive bluff with little room to be moved. The Shelter was ranked as high sensitivity because the asset is close to the shoreline, is not naturally resistant, and has been assumed to have experienced damage in the past. An “override” was utilized by the assessor for the picnic shelter for the flood damage, protective engineering, and infrastructure indicators because the asset was assumed to be at higher risk of flooding than the other assets as evidenced by the protective engineering built for the picnic shelter. The Lodge, Trail, and picnic shelter also had an override for the fish and wildlife habitat and the water quality indicators because while the assets are located within fish and wildlife habitat polygons and have water quality issues around the site, they are not actually fish and wildlife habitat nor are they contributing to water quality issues. Therefore, the fish and wildlife habitat and water quality sensitivity indicators were set to zero for these assets.


**Figure 4. Gooseberry Falls State Park Sensitivity Analysis Results Map**

# 4.0 POTENTIAL IMPACT ANALYSIS

The potential impact analysis for the GFSP 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 Shelter had a moderate potential impact rank while the Lodge, Agate Beach north, Agate Beach south, and Trail have a low potential impact rank (Table 4, Figure 5). Full results of the potential impact analysis are available in the provided GFSP vulnerability assessment spreadsheet (Appendix A).

**Table 4. Gooseberry Falls State Park Potential Impact Results**

| Asset | ID | Exposure Score | Exposure Rank | Sensitivity Score | Sensitivity Rank | Potential Impact Score | Potential Impact Rank |
|---|---|---|---|---|---|---|---|
| Lakeview Lodge | GF1 | 1.0 | Minimal | 1.8 | Low | 1.4 | Low |
| Agate Beach North | GF2 | 2.3 | Moderate | 0.9 | Minimal | 1.6 | Low |
| Agate Beach South | GF3 | 2.4 | Moderate | 1.0 | Low | 1.7 | Low |
| Gitchi Gami Trail North | GF4 | 1.5 | Low | 2.0 | Moderate | 1.8 | Low |
| Lakeview Shelter | GF5 | 2.8 | Moderate | 3.0 | High | 2.9 | Moderate |

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

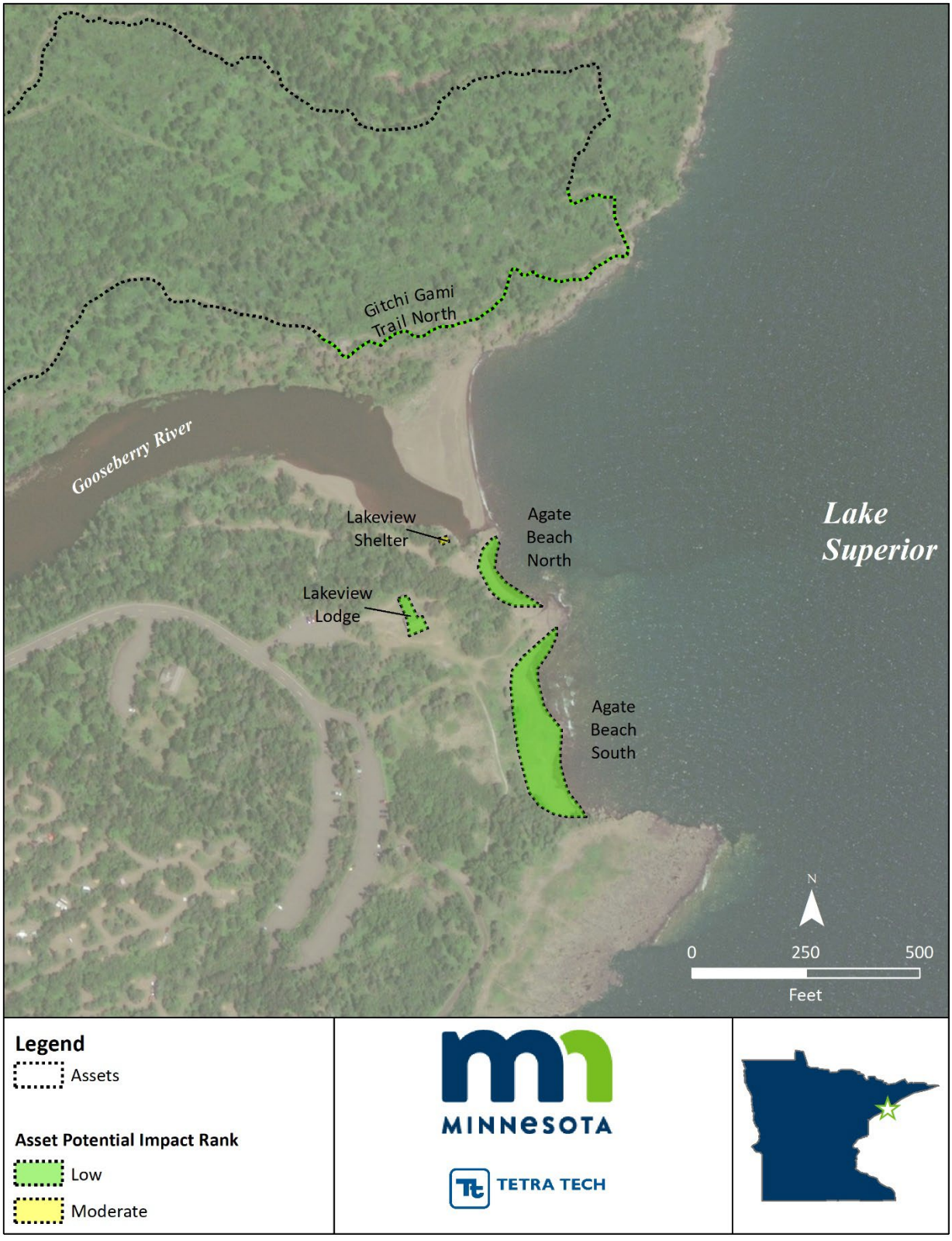


**Figure 5. Gooseberry Falls State Park Potential Impact Results Map**

# 5.0 ADAPTIVE CAPACITY ANALYSIS

Based on the potential impact analysis previously described, adaptive capacity strategies for GFSP 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. Gooseberry Falls State Park Adaptive Capacity Options**

| Asset | ID | Adaptive Capacity Strategy | Adaptive Capacity Strategy Example |
|---|---|---|---|
| Lakeview Lodge | GF1 | None | N/A |
| Agate Beach North | GF2 | Protect/Engineer | Living shoreline design |
| Agate Beach South | GF3 | Protect/Engineer | Living shoreline design |
| Gitchi Gami Trail North | GF4 | Relocate | Relocate the trail farther from the shore |
| Lakeview Shelter | GF5 | Protect/Engineer | Maintaining hardening to continue protecting the structure |

No adaptive capacity strategies were identified for the Lodge because the asset is elevated and far enough from shore to not need to be adaptable to climate impacts. Implementing a living shoreline design strategy for the beaches would enhance and protect these assets. Relocating the Trail farther from the shore would reduce potential impacts from climate change as the bluff continues to recede. Maintaining the hardening at the Shelter would ensure the asset is protected against potential impacts from climate change.

# 6.0 VULNERABILITY ANALYSIS

This final vulnerability analysis for the GFSP 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 beaches can be reduced from low to minimal, the Trail vulnerability is reduced slightly, and the Shelter is reduced from moderate to low vulnerability (Table 6, Figure 6). The Lodge did not have any strategies identified and the vulnerability rank was not changed. Utilizing living shoreline designs at the beaches would decrease vulnerability from low to minimal for those assets. While relocating the Trail from the shoreline would not reduce the vulnerability rank, it would decrease the overall vulnerability score for the asset. Maintaining hardening for the Shelter would also decrease the vulnerability from moderate to low for that asset.

**Table 6. Gooseberry Falls State Park Vulnerability Score and Rank**

| Asset | ID | Potential Impact Score | Potential Impact Rank | Adaptive Capacity Score | Vulnerability Score | Vulnerability Rank |
|---|---|---|---|---|---|---|
| Lakeview Lodge | GF1 | 1.4 | Low | 0.0 | 1.4 | Low |
| Agate Beach North | GF2 | 1.6 | Low | 1.5 | 0.1 | Minimal |
| Agate Beach South | GF3 | 1.7 | Low | 1.5 | 0.2 | Minimal |
| Gitchi Gami Trail North | GF4 | 1.8 | Low | 0.5 | 1.3 | Low |
| Lakeview Shelter | GF5 | 2.9 | Moderate | 1.1 | 1.8 | Low |


**Figure 6. Gooseberry Falls State Park Vulnerability Rank Map**

## 7.0 DISCUSSION

While Table 6 above shows the potential reduction of vulnerability of assets at GFSP, this reduction is dependent upon implementing the highest impact adaptive capacity strategies identified in Table 5. Site managers at GFSP 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

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# 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: GOOSEBERRY FALLS STATE PARK 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | N/A | 638.3 | 33.5 | 601.5 | 5.56 | 226621 | 36.8 | 4.594 | 32.2 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | N/A | 610.5 | 5.7 | 601.5 | 5.56 | 226621 | 9.0 | 4.594 | 4.4 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | N/A | 609.5 | 4.7 | 601.5 | 5.56 | 226621 | 8.0 | 4.594 | 3.4 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | N/A | 616.0 | 11.2 | 601.5 | 5.56 | 226621 | 14.5 | 4.594 | 9.9 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | N/A | 613.6 | 8.8 | 601.5 | 5.56 | 226621 | 12.1 | 4.594 | 7.5 |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 910 | 31.4 | Low | Unknown | Basalt/Rhyolite | Barnum Formation | 0.17 | N/A |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 910 | 31.4 | High | Unknown | Basalt/Rhyolite | Alluvium | 0.17 | N/A |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 910 | 31.4 | Low | Unknown | Basalt/Rhyolite | Alluvium | 0.43 | 0-8% |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 910 | 31.4 | Low | Unknown | Basalt/Rhyolite | Barnum Formation | 0.17 | 8-15% |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 910 | 31.4 | Low | Unknown | Basalt/Rhyolite | Barnum Formation | 0.17 | N/A |

| 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 Signficance? | National Wetland Inventory? | Wildlife Management Area? |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | No | No | Yes | Yes | No | No |
| GF2 | Agate Beach North | Gooseberry Falls State Park | No | No | Yes | Yes | Yes | No |
| GF3 | Agate Beach South | Gooseberry Falls State Park | No | No | Yes | Yes | Yes | No |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | No | No | Yes | Yes | No | No |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | No | No | Yes | Yes | No | 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 0 | 1 | 1 | 1 | | 1 | 1 | 2 | 1 | 1 | 1 | | 1 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 0 | 4 | 1 | 2 | | 2 | 1 | 2 | 1 | 4 | 2 | | 2 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 0 | 5 | 1 | 2 | | 2 | 1 | 2 | 1 | 5 | 2 | | 2 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 0 | 2 | 1 | 1 | | 1 | 1 | 2 | 1 | 2 | 2 | | 2 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 0 | 3 | 1 | 1 | 3 | 3 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 4 | 1 | 3 | | 3 | 1 | 4 | 3 | | 3 | 1 | 0 | 1 | | 1 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 4 | 4 | 4 | | 4 | 1 | 4 | 3 | | 3 | 4 | 0 | 2 | | 2 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 4 | 5 | 5 | | 5 | 1 | 4 | 3 | | 3 | 1 | 0 | 1 | | 1 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 4 | 2 | 3 | | 3 | 1 | 4 | 3 | | 3 | 1 | 0 | 1 | | 1 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 4 | 3 | 4 | | 4 | 1 | 4 | 3 | | 3 | 1 | 0 | 1 | 3 | 3 |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 2 | 2 | 2 | | 2 | 1 | 0 | 1 | | 1 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 2 | 3 | 3 | | 3 | 1 | 0 | 1 | | 1 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 2 | 3 | 3 | | 3 | 3 | 1 | 2 | | 2 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 2 | 2 | 2 | | 2 | 1 | 2 | 2 | | 2 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 2 | 2 | 2 | | 2 | 1 | 0 | 1 | | 1 |

| Step 1. Exposure Data Scores | | | Fish and Wildlife Habitat Indicator | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | Exposure Score Sum | Exposure Score | Exposure Rank |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 1 | 1 | 4 | 4 | 1 | 1 | 3 | 0 | 0 | 10 | 1.0 | Minimal |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 1 | 1 | 4 | 4 | 4 | 1 | 3 | | 3 | 18 | 2.3 | Moderate |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 1 | 1 | 4 | 4 | 4 | 1 | 3 | | 3 | 19 | 2.4 | Moderate |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 1 | 1 | 4 | 4 | 1 | 1 | 3 | 0 | 0 | 12 | 1.5 | Low |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 1 | 1 | 4 | 4 | 1 | 1 | 3 | 0 | 0 | 18 | 2.8 | Moderate |

| Step 2. Sensitivity DATA | | | Flood Damage Potential Indicato | | | | Storm Resistance and Condition Indicator | |
|---|---|---|---|---|---|---|---|---|
| ID | Asset | Site | FEMA Flood Data | LiDAR Elevation Data | Asset Elevated? | 500 Year Flood Potential? | Built Resistivity? | Natural Resistivity? |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | N/A | 638.3 | Yes | No | No | No |
| GF2 | Agate Beach North | Gooseberry Falls State Park | N/A | 610.5 | N/A | No | N/A | Yes |
| GF3 | Agate Beach South | Gooseberry Falls State Park | N/A | 609.5 | N/A | No | N/A | Yes |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | N/A | 616.0 | No | No | No | No |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | N/A | 613.6 | No | No | Yes | No |

| 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? |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | No | Good | No | None | Yes | N/A |
| GF2 | Agate Beach North | Gooseberry Falls State Park | No | None | N/A | None | No | N/A |
| GF3 | Agate Beach South | Gooseberry Falls State Park | No | None | N/A | None | No | N/A |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | No | Moderate | No | None | Yes | No |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | Yes | Moderate | Yes | Moderate | Yes | Yes |

| 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 Signficance? | National Wetland Inventory? | Wildlife Management Area? |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | No | No | Yes | Yes | No | No |
| GF2 | Agate Beach North | Gooseberry Falls State Park | No | No | Yes | Yes | Yes | No |
| GF3 | Agate Beach South | Gooseberry Falls State Park | No | No | Yes | Yes | Yes | No |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | No | No | Yes | Yes | No | No |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | No | No | Yes | Yes | No | No |

| Step 2. Sensitivity DATA | | | Climate Indicator | | Water Quality Indicator | |
|---|---|---|---|---|---|---|
| ID | Asset | Site | Precipitation Change Data | Temperature Change Data | Invasive Species? | Buffer Protection Data |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 0.18 | 0.34 | Yes | 50 Foot Buffer |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 0.18 | 0.34 | Yes | 50 Foot Buffer |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 0.18 | 0.34 | Yes | 50 Foot Buffer |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 0.18 | 0.34 | Yes | 50 Foot Buffer |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 0.18 | 0.34 | 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 0 | 1 | 1 | 1 | 1 | | 1 | 4 | 4 | 4 | | 4 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 0 | 4 | 0 | 1 | 1 | | 1 | 0 | 1 | 1 | | 1 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 0 | 5 | 0 | 1 | 2 | | 2 | 0 | 1 | 1 | | 1 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 0 | 2 | 4 | 1 | 2 | | 2 | 4 | 4 | 4 | | 4 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 0 | 3 | 4 | 1 | 2 | 3 | 3 | 1 | 4 | 3 | | 3 |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 1 | 2 | 1.5 | | 2 | 4 | 0 | 2 | | 2 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 1 | 0 | 0.5 | | 1 | 0 | 0 | 0 | | 0 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 1 | 0 | 0.5 | | 1 | 0 | 0 | 0 | | 0 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 1 | 3 | 2 | | 2 | 4 | 0 | 2 | | 2 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 4 | 3 | 3.5 | | 4 | 1 | 3 | 2 | 3 | 3 |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 4 | 0 | 2 | | 2 | 4 | 4 | 1 | 1 | 4 | 4 | 3 | 0 | 0 |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 0 | 0 | 0 | | 0 | 4 | 4 | 1 | 1 | 1 | 4 | 3 | | 3 |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 0 | 0 | 0 | | 0 | 4 | 4 | 1 | 1 | 1 | 4 | 3 | | 3 |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 4 | 4 | 4 | | 4 | 4 | 4 | 1 | 1 | 4 | 4 | 3 | 0 | 0 |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 4 | 1 | 3 | 4 | 4 | 4 | 4 | 1 | 1 | 4 | 4 | 3 | 0 | 0 |

| Step 2. Sensitivity Data Scores | | | Climate Indicator | | | | | Water Quality Indicator | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | Sensitivity Score Sum | Sensitivity Score | Sensitivity Rank |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 2 | 4 | 3 | | 3 | 4 | 3 | 3.5 | 0 | 0 | 13 | 1.8 | Low |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 2 | 4 | 3 | | 3 | 4 | 3 | 3.5 | | 4 | 11 | 0.9 | Minimal |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 2 | 4 | 3 | | 3 | 4 | 3 | 3.5 | | 4 | 12 | 1.0 | Low |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 2 | 4 | 3 | | 3 | 4 | 3 | 3.5 | 0 | 0 | 17 | 2.0 | Moderate |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 2 | 4 | 3 | | 3 | 4 | 3 | 3.5 | 0 | 0 | 19 | 3.0 | High |

| Step 3. Potential Impact | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Asset | Site | Exposure Score | Exposure Rank | Sensitivity Score | Sensitivity Rank | Potential Impact Score | Potential Impact Rank |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 1.0 | Minimal | 1.8 | Low | 1.4 | Low |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 2.3 | Moderate | 0.9 | Minimal | 1.6 | Low |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 2.4 | Moderate | 1.0 | Low | 1.7 | Low |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 1.5 | Low | 2.0 | Moderate | 1.8 | Low |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 2.8 | Moderate | 3.0 | High | 2.9 | Moderate |

| Step 4. Adaptive Capacity DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Asset | Site | 1. Decommission and Remove | 2. Elevate | 3. Relocate | 4. Protect/Engineer | 5. Storm Resistant Design | 6. Engineering Downgrade |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | No | N/A | N/A | N/A | N/A | N/A |
| GF2 | Agate Beach North | Gooseberry Falls State Park | N/A | N/A | N/A | Living Shoreline | N/A | N/A |
| GF3 | Agate Beach South | Gooseberry Falls State Park | N/A | N/A | N/A | Living Shoreline | N/A | N/A |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | N/A | N/A | From Shore | N/A | N/A | N/A |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | N/A | No Elevating | No Relocating | Hardening | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 1 | 0 | 0 | 0 | 0 | 0 | **0** | **0** | **0** | **0.0** |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 0 | 0 | 0 | 4 | 0 | 0 | **2** | **1** | **3** | **1.5** |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 0 | 0 | 0 | 4 | 0 | 0 | **2** | **1** | **3** | **1.5** |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 0 | 0 | 2 | 0 | 0 | 0 | **1** | **0** | **1** | **0.5** |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 0 | 1 | 1 | 2 | 0 | 0 | **2** | **1** | **2** | **1.1** |

| 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 |
| GF1 | Lakeview Lodge | Gooseberry Falls State Park | 1.0 | Minimal | 1.8 | Low | 1.4 | Low | 0.0 | 1.4 | Low |
| GF2 | Agate Beach North | Gooseberry Falls State Park | 2.3 | Moderate | 0.9 | Minimal | 1.6 | Low | 1.5 | 0.1 | Minimal |
| GF3 | Agate Beach South | Gooseberry Falls State Park | 2.4 | Moderate | 1.0 | Low | 1.7 | Low | 1.5 | 0.2 | Minimal |
| GF4 | Gitchi Gami Trail North | Gooseberry Falls State Park | 1.5 | Low | 2.0 | Moderate | 1.8 | Low | 0.5 | 1.3 | Low |
| GF5 | Lakeview Shelter | Gooseberry Falls State Park | 2.8 | Moderate | 3.0 | High | 2.9 | Moderate | 1.1 | 1.8 | Low |