APPENDIX

PRELIMINARY DESIGN

GIS THEMATIC MAPS

LAND TRANSFORMATION MODELING
BEAVER BAY PRELIMINARY DESIGN:
STREETSCAPE MASTERPLAN & DESIGN FEATURES

The new streetscape along Hwy. 61 in downtown Beaver Bay reworks the existing road into a new configuration slowing traffic and producing a parkway-like pedestrian experience. The entrance to town on both sides will become the transition areas which mark town boundaries and create an awareness of the recreational opportunities found in the region. This corridor will also be used to highlight the change in landscape character when one first encounters the Beaver Bay geologic intrusion that is seen faintly as distant hills and forested valleys. New crosswalks are placed to increase access to area shops and services on both sides of Hwy. 61.

Design features include:

- Colorful paving that marks the crosswalks and
- Safety islands that become green pockets along Hwy. 61
BEAVER BAY PRELIMINARY DESIGN:
BEAVER RIVER PARK MASTERPLAN & DESIGN FEATURES

The Beaver River Park masterplan highlights site features producing a set of experiences that enhance the Gitchi-Gami Trail system and Beaver Bay by creating a gathering space for locals and visitors. Beaver River Park also addresses on-site issues such as traffic and pedestrian safety, Gitchi-Gami Trail routing and trailhead design, and on-site stormwater concerns with an ecologically sustainable design. Key features include:

- Sinuous paths that meander and cross the site leading the visitor to the river,
- Earthen berms symbolic of the North Shore’s landscape that frame site and river gorge views,
- Restroom structures influenced by Norwegian commercial boat house design,
- Informational kiosks with artist rendered drawings depicting the hidden and unique landform subtleties of the Beaver Bay landscape, and
- Bike racks for use by Gitchi-Gami Trail patrons,

These elements combined with the hilltop green, historic mill ruins, and river gorge viewing platforms create a destination along the Gitchi-Gami Trail.
BEAVER BAY PRELIMINARY DESIGN:
MILLSTONE PARK MASTERPLAN & DESIGN FEATURES

The Millstone Park masterplan highlights the Beaver River and Beaver Bay’s settlement history by revealing local history to users. Millstone Park also mitigates on-site issues such as traffic and pedestrian safety, Gitchi-Gami Trail routing and trailhead design, and on-site stormwater concerns. Key features include:

- Paths that direct views to the Beaver Bay hills and Lake Superior while leading the visitor to the river and lake,
- Gently sloping topography and aspen plantings create rooms and frame views,
- Restroom facility design influenced by Scandinavian architecture,
- Information kiosks include artist rendered drawings depicting the hidden and unique landform subtleties of the Beaver Bay landscape, and
- Bike racks for trail users at the trailhead.

These elements combined with the historic mill ruins and river gorge viewing platforms create a unique destination along the Gitchi-Gami trail.
MASTERPLAN AND DESIGN FEATURES:
The master plan manages to highlight Beaver Bay and Millstone Park to project the unique character and identity of the site, while also providing a functional and aesthetic enhancement to the area. The plan aims to create a successful park that not only serves as a recreational and educational resource but also enhances the natural beauty of the site. It includes a variety of features such as trails, seating areas, and pedestrian-friendly pathways to accommodate the needs of visitors. The design emphasizes sustainability, with features that promote water conservation and recycling to reduce the environmental impact of the park. The plan also integrates educational elements, providing opportunities for learning about the flora and fauna of the area. The overall design seeks to create a harmonious balance between the natural environment and the developed elements, ensuring that the park remains visually appealing while maintaining its ecological integrity.
APPENDIX

BEAVER BAY PRELIMINARY DESIGN:
DESIGN DETAILS

STREETLIGHT DETAILS:
The streetlight design uses a vocabulary established for the Gitchi-Gami Trail. The lamp head is designed to direct light onto the trail and produce little ambient light to maintain the night sky.

INTERPRETIVE KIOSK AND BIKE RACK:
The kiosk design is influenced by Scandinavian architecture. The high-pitched roof and wood detailing reflects structures typically seen in Norway and other Scandinavian port towns.

PROTOTYPICAL INTERPRETIVE BOARD:
The interpretive board depicts some information that could be seen at the Gitchi-Gami trailhead kiosk. The same graphic standard and conventions are maintained with all the boards erected along the trial.
LUTSENCROSSING PRELIMINARY DESIGN:
LUTSEN MOUNTAIN ACCESS TRAILHEAD OPTION ONE

DESIGN FEATURES:
Lutsen Crossing is characterized by

- Signs and structures that reflect the Lundie design aesthetic,
- Interpretation of the area on the kiosk,
- Native plants in a North Shore meadow as a setting for the North Shore Scenic Drive sign cairn,
- The reuse of the old Highway 61 alignment as the major pedestrian spine through the site,
- The reuse of the old Highway 61 bridge abutments for a viewing promontory and a new pedestrian bridge across the Poplar River,
- A pedestrian trail that provides public access to the river,
- A pathway to the historic cemetery,
- A setting for a landmark monument or a bed of native plants, and
- Bicycle racks, restrooms, and parking for 50 cars.
LUTSEN CROSSING PRELIMINARY DESIGN:
LUTSEN MOUNTAIN ACCESS TRAILHEAD OPTION TWO

DESIGN FEATURES:
Lutsen Crossing is characterized by

- Signs and structures that reflect the Lundie design aesthetic,
- Interpretation of the area on the kiosk,
- Native plants in a North Shore meadow as a setting for the North Shore Scenic Drive sign cairn,
- The reuse of the old Highway 61 alignment as the major planted spine through the site,
- A pedestrian trail that provides public access to the river,
- A pathway to the historic cemetery,
- A setting for a landmark monument or a bed of native plants, and
- Bicycle racks, restrooms, and parking for 65 cars.
GEOGRAPHIC INFORMATION SYSTEMS (GIS) THEMATIC MAPS:

The first step in the design process is analyzing the landscape to understand its complex layers of geology, landform, vegetation, history, and culture. In order to perform the analysis, GIS data was collected and then processed into different layers according to themes. Each theme becomes an individual map. Like laying transparencies over each other, these thematic maps are layered to reveal relationships within the complexity of the landscape.

Hundreds of individual data layers were chosen and combined into the thematic maps representing bedrock geology, surficial geology, infrastructure, elevation, hydrology, original vegetation, native plant communities, biodiversity sites, national wetlands inventory, land use, land cover, population change, and land ownership. Thematic maps from Two Harbors to Grand Marais were then produced.

Analyzing the landscape in this layered manner serves as the basis for developing a regional identity through design. Mapping the attributes of a region allows the design to celebrate the uniqueness of the area through use of regional materials, native vegetation, and local landform vocabulary.
GEOLOGY

The Laurentian Mountains formed 2.7 billion years ago as the Earth’s crust cooled and solidified. Over hundreds of millions of years, several miles’ thickness of this rock eroded away to reveal Ely Greenstone that had formed deep in the Earth’s crust. These deformed and metamorphosed granites make up the Canadian Shield, which forms the ancient core and foundation of the North American continent.

From 2.2 to 1.9 billion years ago a vast inland sea flooded the interior of the continent. Sediments accumulated at the bottom of this sea to depths of several thousands of feet. These are some of the oldest sedimentary rocks in the world. These sandstones and graywacke (muddy or dirty sandstones) are visible in the Rove Formations around the Grand Portage area and include the iron bearing formations of the Mesabi Iron Range.

Approximately 1 billion years ago the Earth’s crust began to pull apart in a great zone of crustal thinning known as the Midcontinent Rift System. Basaltic lava poured through cracks in the Earth’s surface and spread out on the flat landscape. Hundreds of these lava flows accumulated on top of each other to form the North Shore Volcanic Group. Their combined weight caused the already thin crust to subside, forming the Lake Superior basin and tilting up layers of rock on the edges of the rift system. Magma that cooled underground formed the more resistant, diabase rocks of the Duluth Complex that form most of the rugged hills and ridges of the North Shore, including at Split Rock, Manitou, Tettegouche, and Carlton Peak.

The falls on the Gooseberry, Baptism, Cross, and Temperance Rivers flow over different layers of basaltic lava flows. The jagged form of the Sawtooth Mountains illustrates the tilting layers of lava at the edge of the rift system with their gradual slope extending under Lake Superior to the south and their steep slope facing north. Columnar joints and vertical fractures that develop as lava flows cool and shrink are visible at Gooseberry and Temperance Rivers. Gas bubbles trapped in the solidifying lava gradually fill up with dissolved minerals to form amygdules like the Agates are commonly found along the North Shore. Lava dikes cooled vertically in cracks around Grand Portage, instead of horizontally on the surface of the earth as occured elsewhere on the North Shore, resulting in a pattern of steep, narrow ridges that criss-cross the landscape.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

Two Harbors to Beaver Bay is generally flat, except for the more resistant diabase intrusion that forms Silver Cliff and Lafayette Bluff. Outcroppings of the soft, flat, basaltic lava flows can be seen at Gooseberry Falls. Another diabase intrusion occurs at Split Rock Lighthouse.

Beaver Bay to Tofte is characterized by the rocky, humpback forms of the more resistant diabase intrusion known locally as the Beaver Bay Complex. These outcroppings occur along the lake creating a rugged shoreline that forces the road further inland and includes such familiar sights as Palisade Head, Shovel Point, Carlton Peak and the gorges of the Baptism, Manitou, Caribou, Cross and Temperance Rivers.

Tofte to Grand Marais is characterized by the jagged profile of the Sawtooth Mountains rising gradually out of Lake Superior in a series of ridges with steep back slopes. Their cuesta form is the result of the North Shore Volcanic Group’s flat, basaltic lava flows tilting up under their own weight.
TOPOGRAPHY

Two million years ago, mile thick glaciers began advancing out of Canada. Four great periods of glacial advance have been identified; the Kansan, Nebraskan, Illinoian, and Wisconsin, each followed by subsequent periods of retreat. The glaciers scoured away softer sedimentary rocks and basaltic lavas in the Lake Superior basin and left two types of deposits, till and outwash. Till is unsorted material that is directly deposited by the ice in the form of moraines. Outwash is transported by meltwaters and deposited in layers sorted by the size of its particles. While the last ice sheet was blocking existing lower outlets to the east, Lake Superior occupied higher levels than it does today.

Striations etched into the bedrock by slow moving glaciers are visible in many locations along the North Shore. Abandoned beach terraces are visible at Caribou River where sand and gravel from higher lake levels covers the volcanic bedrock.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

Two Harbors to Beaver Bay is generally flat, except for a single rugged intrusion that extends in a perpendicular direction toward the shoreline. The intrusion creates a rugged shoreline where it meets Lake Superior, necessitating the tunnels at Silver Cliff and Lafayette Bluff, and generating spectacular views out over the lake. Another smaller intrusion meets the shoreline up the road to create the promontory at Split Rock Lighthouse.

The humpback form of the Beaver Bay Complex intrusion parallels Lake Superior from Beaver Bay to Tofte creating a rugged shoreline of alternating rocky headlands, sheer cliffs, and secluded coves. The road moves further inland and to higher elevations where it can be wider and straighter through the inland forests to avoid such familiar landmarks as Palisade Head, Shovel Point, Carlton Peak and the gorges of the Baptism, Manitou, Caribou, Cross and Temperance Rivers.

Tofte to Grand Marais is characterized by the jagged profile of the Sawtooth Mountains rising gradually out of Lake Superior in a series of ridges with steep back slopes. Their cuesta form is the result of the North Shore Volcanic Group’s flat, basaltic lava flows tilting up under their own weight and provides the opportunity to connect the numerous peaks and ridges with recreational trails and ski hills.
HYDROLOGY

The streams of the North Shore are generally short and steep, draining small watersheds. They flow southeast to Lake Superior through surface deposits of glacial till, uplifted glacial lake sediments, and bedrock in which they have eroded deep gorges. Near Duluth the streams have virtually no lakes in the headwaters so that during times of snowmelt or heavy rain, floodwaters develop rapidly and run off quickly. During drought, flows are extremely low. To the northeast the streams have a more stable flow; lakes and marshes in the headwaters act as natural regulators retarding high flows during storms and slowly releasing stored water during drought to maintain higher minimum flows.

With relatively deep water so close to shore, Lake Superior’s biological communities are concentrated in the narrow and shallow nearshore areas. The lake’s clear water is extremely cold and infertile resulting in food production rates that are much lower than in other lakes. Non-point source pollution is one of the major threats affecting water quality in Lake Superior. These threats are due to erosion, sedimentation, and run-off from failing septic systems. Approximately 36 miles of Minnesota’s shoreline has been identified as high erosion hazard by the Minnesota Pollution Control Agency. Approximately 55% of North Shore septic systems are deemed failures as described by Chapter 7080 of the Individual Sewage Treatment Systems Standards. Lake Superior and its tributaries are extremely fragile ecosystems that retain their pristine conditions because they have not experienced the same amount of development and pollution as the other Great Lakes.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

The Gooseberry and Baptism Rivers lack water storage in their headwaters and consequently discharge fluctuates seasonally. They may be virtually dry in late summer. High waterfalls in their lower reaches dropping 400-900 feet in the last several miles provide scenic opportunities in state parks.

From the Manitou to Two Island Rivers, large watersheds and high waterfalls with some head water storage in lakes and swamps stabilize water flow, thereby creating some of the best trout streams along the North Shore.

From the Cross to Devil Track Rivers, large watersheds with many lakes and marshes in their headwaters result in more stable flows and relatively high water temperatures more suited to warm water fish species such as northern pike and smallmouth bass in the upper reaches. These streams cascade through state park gorges so narrow and deep they seem more like caves than river channels.
APPENDIX

ORIGINAL VEGETATION

The original vegetation along most of the North Shore was coniferous forest. The Great Lakes Pine Forest, comprised of white and red pine, paper birch and aspen, occurred on thin glacial till over the underlying bedrock in northern Minnesota. White and red pines dominated the shoreline to Little Marais. Beyond Little Marais, paper birch and aspen outnumbered the pines in the forest. Near Hovland several tracts of white and red pine dominated the forest.

The dry open conditions under the jack pine canopy allow for a variety of understory plants. Ericaceous (heath family) shrubs such as wintergreen and blueberry are especially common. On deeper soils hazel may form impenetrable thickets. Balsam fir, owing to its great shade tolerance, tends to form extensive stands in the absence of frequent fires. Natural disturbances including fire, wind, and spruce budworm epidemics often result in extensive areas of even aged aspen-birch forest. All along the North Shore mixed hardwood, maple, and pine forests occurred on the cooler, shadier backslopes of hills and ridges inland from the lake. Conifer bogs and swamps also occurred inland, where hills and ridges blocked the drainage to Lake Superior.

Forest fires created a dynamic ecosystem composed of early post-fire stands of jack pine and red pine and mature old growth stands of white pine. In general, red pine was more abundant than white pine and occurred on coarsely textured dry sites prone to fire. White pine stands occurred on the mesic (moist) sites of stream margins and lower slopes less subject to fires. Fire opens the ground plane to direct sunlight and exposes the mineral soil seedbed, both of which are necessary requirements for jack pine reproduction.

Disturbance is a natural part of the ecological cycle. Fire was responsible for the origin and presence of the vast pine stands. Red and white pines with their thick, insulated layers of bark, and branches that don’t start until half way up the trunk, were usually able to survive fires raging on the forest floor, aspen and birch with their thin bark and numerous branches were not. Without periodic fires to remove the quick growing aspen and birch, pine saplings are quickly crowded out and denied access to the sunlight they needed to survive. If there are no young pines when the mature trees die of old age, the forest will slowly evolve from pine to aspen and birch. Today the entire forest has been disturbed by logging.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

Two Harbors to Beaver Bay was dominated by white and red pine forest.

Beaver Bay to Tofte saw the transition from white and red pine to forest dominated by aspen and birch.

Tofte to Grand Marais was aspen and birch dominated pine forest.
ECOLOGY

Rare plant communities and animal nesting sites occur with great frequency along the North Shore. Remnant patches of original vegetation support populations of plants and animals that have otherwise disappeared from the North Shore as humans alter the landcover. Habitat is especially critical to migratory birds that must go around rather than across the expanse of Lake Superior on their migratory flights. The abundance of rocky cliffs minimizes the nesting habitat available for waterfowl and shorebirds. Arctic plant communities occur under favorable microclimates in disjunct locations. Local stream trout and anadromous trout from Lake Superior use the streams and rivers of the North Shore to spawn and reproduce.

Diverse old-growth pine forests no longer exist on the North Shore. The current forest is mostly highly disturbed, young, even-aged, second-growth aspen and birch forest. Even the few places where remnant patches of old-growth pine forest remain are not what they used to be. The suppression of forest fires over the last 100 years has halted the natural cycle of regeneration. As mature pine trees age and die there are no young pines in the forest to take their place. Without fire, the aspen, birch, and fir out-compete young pines.

In 1854 woodland caribou were common, moose uncommon, and deer nonexistent along the North Shore. The young aspen and birch forests of today, with frequent openings created by logging, are not able to support wolf and caribou populations. In the absence of predators, deer have moved into the forest in great numbers and are devouring their favorite food source, tender, young pine saplings. The presence of deer in old-growth forests, further disrupts the natural cycle of regeneration by removing young pines and further shifting the forest composition to aspen and birch.

Optimum deer habitat is 45-60% deciduous of which 25-35% is aspen and 25% is ten years old or less. Another 5-10% should be grassy openings and 15-20% should have conifers for protective cover. Logging the pine forests replaced moose and caribou habitat with deer habitat. Large deer populations were reported on the North Shore by the 1930s. Second growth aspen is short-lived, maturing in 50-70 years. When second growth aspen forest began maturing in the 1960s, deer numbers decreased and moose recovered. Wolves were blamed for the decline in deer. Today, as loggers harvest the mature second growth aspen forest for pulpwood, deer numbers are rebounding, and moose are once again in decline.

State Parks are important habitat centers on the North Shore that are managed to increase their habitat value. Controlled fires can be set to keep the aspen and birch at bay. Fenced exclosures keep deer out until the pines are tall enough that deer can’t reach their tender branches. State parks also provide habitat corridors for the movement of birds and animals between the shore of Lake Superior and the state and national forests inland.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

The Two Harbors to Beaver Bay segment contains colonial waterbird nesting habitat, and rare plant and animal habitat, and shorebird migratory habitat.

The Beaver Bay to Tofte contains arctic disjunct plant communities, northern hardwood and upland cedar forests, fish spawning areas, and deer yards.

The Tofte to Grand Marais segment contains arctic and alpine disjunct plant communities, fish spawning areas, and poor fen wetland habitat.
LANDCOVER

During the economic boom years following World War II, the supply of high-grade iron ore slowly declined. Researchers at the University of Minnesota perfected a method for taconite beneficiation and the Reserve Mining plant was built in 1955 to process low-grade taconite ores and the new town of Silver Bay sprang up around it. The opening of the St. Lawrence Seaway in 1959 connected the Great Lakes to international markets.

The first artificial connection between the Atlantic Ocean and the Great Lakes - the Erie Canal completed in 1823 - introduced the sea lamprey to the lower Great Lakes. The Welland Ship Canal allowed sea lampreys access to the Great Lakes above Niagara Falls in 1829. The first sea lamprey was observed in Lake Ontario in 1835, in Lake Erie in 1921, in Lake Huron in 1937 and in Lake Superior in 1946. By the late 1940s, lake trout in Lakes Huron and Michigan were essentially extirpated. Sea lampreys devastated Lake Superior’s native trout populations during the 1950s, until effective sea lamprey control programs were initiated in the 1960s.

Today tourism is the leading economic activity on the North Shore. Naniboujou Lodge was built in 1928 as a private club. The Nelson family built Lutsen Ski Resort in 1949.

A variety of experiences is available on the North Shore moving through alternating stands of pine and then aspen or birch. Today the forests are primarily mixedwood forest along the shore with aspen and paper birch dominating pines on the front slopes and deciduous sugar maples on the back slopes. There are many stands of shrubs and young regenerating forest where logging has recently occurred. Coniferous forests survive only in wetland areas. The gravel bars at some of the North Shore streams formed after clear-cutting exposed the bare slopes and hillsides of the river valleys to erosion. Spawning beds in the rivers silted over and water temperatures increased due to the lack of shade. Logs gouged streambeds to the point they are only now healing. A logjam once blocked the Stewart River for 3 years.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

This segment contains the historic communities of Two Harbors and Beaver Bay and many small, rustic, Ma & Pa resorts and cabins.

This segment contains the large industrial operations and iron ore loading facilities at Silver Bay and Taconite Harbor.

This segment contains the resort communities of Tofte, Lutsen, and Grand Marais.
DEVELOPMENT

Historically, communities nestled into the rugged North Shore had more of a connection to the land or the lake than they did to each other. Finnish, Swedish, Norwegian, and German communities were isolated from each other as much by the rugged landscape as they were by language. Frequent river gorges and impenetrable forests made travel along the shore nearly impossible, except for the most hardy, like postman John Beargrease. Most of the communities on the North Shore were only accessible to the outside world by boat until the mid 1920s. In fact, most community locations were selected for the shelter provided by a harbor or river mouth for loading and unloading boats.

Traveling inland was typically much easier, especially along the path of least resistance cut by rivers through the hills and trees. Communities prospered or perished based on the availability of inland natural resources, including iron ore deposits, harvestable lumber, the presence of game birds and animals, and the supply of fish in the streams and waters of Lake Superior. Today’s communities depend on the steady flow of tourists into the region, seeking outdoor recreation on the forested hills above the river gorges and Lake Superior.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

There are many small, rustic homes and Ma & Pa resorts visible along the Gitch-Gami Trail from Two Harbors to Beaver Bay. You pass directly through the historic towns of Beaver Bay and Two Harbors. Popular, historic state parks at Gooseberry Falls and Split Rock Lighthouse have numerous scenic views from bridges over river gorges.

The Trail from Beaver Bay to Tofte is planned to be further inland through the forest to avoid rugged landforms along the lakeshore. There are fewer buildings and services visible in this stretch of the trail. The modern town of Silver Bay is entirely inland and not visible from the proposed trail. Tettegouche and Crosby-Manitou contain the most inland backcountry areas of all the state parks and require getting out of your car to enjoy the scenic views. Iron ore loading docks at Silver Bay and Taconite Harbor are visible along the lakeshore. Highway 1 is major inland artery to Finland, Wolf Ridge ELC, Ely, and the Boundary Waters Canoe Area.

Larger, newer homes and resorts occur along the trail from Tofte to Grand Marais. Schroeder, Tofte, Lutsen and Grand Marais have many seasonal homes, resorts, and numerous scenic views of the Sawtooth Mountains, and state park river gorges are visible from the planned trail including Carlton Peak, Leveaux Mountain, Cross River, Temperance River, and Cascade River.
INFRASTRUCTURE

The Gitchi-Gami Trail is planned to run from Two Harbors to Grand Marais. Except for iron ore shipments from the range to Silver Bay and Taconite Harbor, railroads extend up the North Shore only to Two Harbors. Loading dock facilities for ore boats occur in Two Harbors, Silver Bay, and Taconite Harbor. Public Access Boat Launches on Lake Superior are maintained in Two Harbors, Twin Points, Silver Bay Marina, Taconite Harbor, Schroeder, Tofte, Grand Marais, Hovland, Horseshoe Bay, and Grand Portage. Additional public access boat ramps occur on numerous inland lakes and streams.

Municipal sewage treatment lagoons exist in Two Harbors, Beaver Bay, Lutsen, and Grand Marais. Airports serve the communities of Two Harbors, Beaver Bay, Tofte, and Grand Marais. Interior roads to inland areas occur at Two Harbors (County Road 2 to Ely), Beaver Bay (SNF Scenic Byway to the Iron Range), Ilgen City (Highway 1 to Ely), Tofte (Sawbill Trail to BWCAW), Lutsen (Caribou Trail to BWCAW), Grand Marais (Gunflint Trail to BWCAW), and Hovland (Arrowhead Trail to BWCAW).

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

The area from Two Harbors to Beaver Bay contains the most people and the most infrastructure, including; 4 public access boat launches, 2 airports, 2 municipal sewage treatment lagoons, 2 roads inland, and the terminus of passenger railroad service.

The area from Silver Bay to Taconite Harbor contains very little infrastructure, including; rail road lines to carry iron ore to the loading facilities at Silver Bay and Taconite Harbor, 1 public access boat launch, and 1 road inland.

The area from Tofte to Grand Marais contains 3 public access boat launches, 2 airports, 2 sewage treatment lagoons, and 3 inland roads.
LAND OWNERSHIP

Federal ownership dominates the North Shore within the Superior National Forest from Schroeder to beyond Grand Marais. The Grand Portage Indian Reservation dominates the tip of the Arrowhead Region. State parks and state forests dominate locally at Gooseberry Falls, Split Rock Lighthouse, Tettegouche, Crosby-Manitou, Temperance River, Cascade River, Judge Magney, Finland, Pat Bayle and Grand Portage. Large parcels of privately owned industrial land occur in Two Harbors, Silver Creek, Silver Bay, and Taconite Harbor.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

The shoreline from Two Harbors to Beaver Bay is mostly in private ownership except for state land at Gooseberry Falls and Split Rock Lighthouse State Parks and along the shore’s backslopes.

Much of the shoreline and inland areas from Beaver Bay to Tofte are privately owned except in Tettegouche and Crosby-Manitou State Parks and in Finland State Forest.

Only a narrow corridor of private ownership exists along the shore from Tofte to Grand Marais, interrupted by public land at Cascade River State Park. All inland areas are federally owned in the Superior National Forest.
HISTORIC STRUCTURES

Historic structures occur mainly in the communities of Two Harbors, Beaver Bay, Finland, Schroeder, Lutsen, Grand Marais, Hovland, and Grand Portage as well as at Gooseberry Falls, the oldest state park on the North Shore. Silver Bay, the newest town on the North Shore in 1955, has no historic structures.

A wide variety of historic structures has been designated along the North Shore including churches, cemeteries, abandoned CCC camps and logging camps, lighthouses, iron ore loading docks, locomotives, train depots, tugboats, shipwrecks, fishing piers, farm buildings, fur trade stockades, log lodges and resorts, missionary camps, and Native American sites. This wide variety reflects the broad scope of human industries and occupations that existed in North Shore communities multiple cultures.

Cultural festivals and public gatherings are also centered in the communities of the North Shore. Two Harbors hosts the county fair, Folk Festival, Harbor Fest, and Heritage Days. Beaver Bay sponsors the Smelt Fry. Ilgen City hosts St. Urho’s Days, Tofte has a fireworks display on the Fourth of July. Grand Marais sponsors the Fisherman’s Picnic, Playhouse, Dog Days Winter Carnival, and Northern Lights. Hovland proclaims itself the Lake Trout Capital of the World and Grand Portage re-enacts Rendezvous Days.

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

- Historic structures are concentrated in the historic communities of Two Harbors, Castle Danger, and Beaver Bay as well as Gooseberry Falls and Split Rock Lighthouse State Parks.

- There are fewer historic structures along the North Shore from Silver Bay to Taconite Harbor. There are a couple of historic structures in the communities of Little Marais and Schroeder. There is also a collection of Finnish log homes in Finland, but there are no historic structures in Silver Bay, since it was only built in 1955. Historic structures from old logging camps survive at Tettegouche State Park and Sugarloaf Interpretive Center.

- There are more historic structures in the communities of Tofte, Lutsen, and Grand Marais. There are historic log lodges at Lutsen and at the Cascade River. An historic lighthouse and harbor facilities are in Grand Marais and the ruins of an old pier remain in Tofte.
RECREATIONAL SITES

There are several regional trails that parallel the shoreline. They are the North Shore State Trail, Lake Superior Hiking Trail, Lake Superior Water Trail, and Gitchi Gami State Trail. Otherwise, recreation opportunities tend to be concentrated in population centers, especially in and around Silver Bay and in the stretch from Lutsen to Grand Marais. Silver Bay trails are more popular with local residents, while the trails at Lutsen are more frequented by visitors and tourists.

Lutsen Mountain is one of the largest downhill ski hills in the Midwest. There are 4 golf courses on the North Shore; Lakeview National in Two Harbors, Silver Bay Country Club in Silver Bay, Superior National in Lutsen, and Gunflint Hills in Grand Marais. Rock climbing is a popular activity, especially on the cliffs at Palisade Head, Shovel Point, and along the Baptism River. Fishermen flock to the North Shore streams all summer, but especially during the spring and fall spawning runs. Charter fishing boats and excursion boats are available in most communities. Rock hounds collect numerous agates and thomsonite. Hunting for deer, moose, black bear, and upland game birds, is popular. Scuba diving to shipwrecks is possible.

Inland roads provide access to additional recreational opportunities amidst the lakes and trees of Superior National Forest, Finland, Pat Bayle, and Grand Portage State Forests, and the Boundary Waters Canoe Area Wilderness. County Road 2 heads inland from Two Harbors, Superior National Forest Scenic Byway Highway 15 leaves Silver Bay, and Highway 1 turns north from Illgen City. The Sawbill Trail out of Tofte, Caribou Trail out of Lutsen, Gunflint Trail out of Grand Marais, and Arrowhead Trail out of Hovland all reach the southern edges of the Boundary Waters.

Public Water Access boat launches for Lake Superior occur at Two Harbors, Twin Points, Silver Bay Marina, Taconite Harbor, Schroeder, Tofte, Grand Marais, Hovland, Horseshoe Bay and Grand Portage. Numerous inland access points also exist for backcountry lakes of all shapes and sizes. Those portions of the North Shore’s streams and rivers held in public ownership also provide recreation opportunities, including the magnificent string of State Parks from Flood Bay, Gooseberry Falls, and Split Rock Lighthouse to Palisade Head, Tettegouche (Baptism River), Crosby-Manitou, Caribou Falls, Cross River, Temperance River, Ray Bergland (Onion River), Cascade River, Devil’s Track River, Kadunce River, Judge C. R. Magney (Brule River), and Grand Portage (Pigeon River).

RESOURCES FOUND ALONG THE GITCHI-GAMI TRAIL:

The district from Two Harbors to Beaver Bay contains 4 Public Water Access boat launches, 2 very popular state parks in Gooseberry Falls and Split Rock Lighthouse, 1 golf course, and 1 road inland. Numerous hiking, cross-country skiing, snowmobiling, and kayaking trails parallel the shore.

The district from Silver Bay to Taconite Harbor contains 1 Public Water Access boat launch, 1 golf course, 2 state parks, and 2 inland roads. In addition there are many local recreational trails in the woods around Silver Bay.

The district from Tofte to Grand Marais contains 3 Public Water Access boat launches, 2 state parks, 2 golf courses, 3 inland roads, Lutsen Mountain, and an abundance of local trails in the Sawtooth Mountains.
LAND TRANSFORMATION MODELING:

THE LAND TRANSFORMATION MODEL (LTM)

Before analysts could make the 2020 and 2050 urban transformation projections, they first simulated a projection for a year for which they had actual urban transformation data. Using data from the years 1991 and 2000, they projected urban transformation of the Gitchi Gami Trail area for this 9-year period. To do so, they first obtained raw data including satellite images, road maps, land cover maps, and various geographic data layers of the area from the 1991 and 2000 dates.

DATA FOR LTM MODELLING: Data for input to the LTM model was obtained from a variety of sources noted below.

LANDSAT THEMATIC MAPPER IMAGES: Landsat satellites capture moderate resolution images of the earth from space. For the Gitchi Gami, analysts classified Landsat images from 1991 and 2000 to generate land cover/land use maps of the study area. The land cover/land use was classified as: Water and rivers, lowland forest, upland forest, agriculture/grass, urban and lowland non-forest.

GAP ANALYSIS PROGRAM (GAP) VEGETATION MAP: The Minnesota GAP vegetation map is a detailed, hierarchically organized vegetation cover map produced by computer classification of combined two-season pairs of early 1990s Landsat imagery. The GAP vegetation map was used to create a lowland mask to separate lowland forest areas from lowland non-forest areas in the Landsat images noted above. It also served as an aid to the generation of land cover/land use classifications.

U.S. GEOLOGICAL SURVEY DIGITAL ELEVATION MODELS: Digital Elevation Models, commonly referred to as DEMs, are data files that illustrate an area’s elevation. Before computers, DEMs were simply a collection of elevation points for an area organized into lists or tables. But today, computer software takes this data and generates three-dimensional views of an area based on these elevation points and allowing for a more thorough analysis. DEMs are available through the U.S. Geological Survey (USGS).

DEPARTMENT OF TRANSPORTATION 2001 ROADS: This data set contains roadway centerlines for roads from the USGS 1:24,000 mapping series. Those roadways that are interstate, trunk highway, or county state aid highway are current through the 2001 construction season. Other roads, if not updated, are described as shown on the published quadrangle.

DIGITAL LINE GRAPHS HYDROLOGICAL WATER AND WETLAND DATA: Digital Line Graphs (DLGs) are datasets that represent cartographic information from USGS maps. For the Gitchi Gami Trail area, analysts used the hydrological water and wetland data layers.

NATIONAL FOREST: The dataset that represents the location of national forest boundaries within the state is Natforest which was created by the U.S. Forest Service. This data was used in the development of an exclusionary layer for the LTM.

INDIAN RESERVES: The dataset that represents the location of Indian reservation boundaries within the state is Reservtn. This data was used in the development of an exclusionary layer for the LTM.

CENSUS BLOCK: U.S. Census block level data with population information for 1991 and 2000. Next, these data were processed using ArcGIS, a computer software package. This allowed analysts to identify ten factors, or predictor variables, affecting urban transformation between 1991 and 2000.
TEN PREDICTOR VARIABLES:

- Elevation
- Slope
- Aspect
- Distance to interstate highway
- Distance to County aid highway
- Distance to lakes
- Distance to streams
- Distance to lowland
- Distance to urban
- Population density

Next, these predictor variables, along with the land cover maps from 1991 and 2000 and an exclusionary layer, were loaded into the LTM. The exclusionary layer, which is a data layer representing land where development is prohibited, included interstate highway, county aid highway in 1991, water and rivers, state and national parks, Indian reservations, and the initial 1991 urban area. To generate the 1991-2000 urban transformation projection, analysts relied on the LTM’s Artificial Neural Network (ANN) to sort the predictor variables, land cover/land use maps, and the exclusionary layer. Artificial neural networks serve the LTM the same way that neurons serve the human brain. Both are an information processing hub.

After the LTM ran its course, a map of “change likelihood values” for the Gitchi Gami Trail was generated illustrating which areas were highly likely to change from non-urban to urban by 2000. For the Gitchi Gami Trail, the three most significant variables for predicting land-use change were, in decreasing order of importance: distance to urban; elevation; and; distance to highways and county roads, specifically highway 61.

URBAN TRANSFORMATION SIMULATION: 2000

With the “change likelihood values” and the land cover maps from 1991 and 2000, analysts determined that the Gitchi Gami Trail experienced a major increase in transformation of non-urban to urban land during this period. In fact, the area classified as urban land increased by 30 percent from 1991 to 2000. To aid the understanding of these changes, we note the area classified as urban land in 1991 was 13,724 acres.

By overlaying this projection on the actual urban transformation between 1991 and 2000, analysts were also able to examine the accuracy of the projections. The projection was typically 30-50 percent accurate depending on the part or subregion of the study area considered — a typical pixel level of accuracy for the LTM. Accuracies exceeding 45-50% are considered very unusual and perhaps due to overfitting of the model. However, accuracy can be judged several ways: agreement in the actual pixels that changed and/or agreement in the total number of pixels changing to urban.
LAND TRANSFORMATION MODELING:

The LTM model is a digital tool developed by Michigan State University to assist planners and resource managers to develop improved decisions that affect the environment and local to regional economies. The LTM uses recent land use change, population growth, transportation, proximity or density of important landscape features such as rivers, lakes, recreational sites, and high-quality vantage points as inputs to model future land use change.

The LTM models employs Artificial Neural Networks, similar to the intricate pathways established in the human brain. The Artificial Neural Net is a process that utilizes a machine learning approach to numerically solve relationships between inputs and outputs (Michigan State University 1996). The LTM relies on Geographic Information Systems (GIS), artificial neural network routines, land use data from at least two dates, and customized geospatial analysis tools. Raw GIS data (e.g., thematic layers) is first acquired, then processed, and converted to an ARC/INFO GRID format with cell sizes of 30m x 30m.

INPUTS TO THE LTM MODELLING PROCESS

LandSat Thematic Mapper Images:

Landsat satellites capture moderate resolutions images of the earth from space. For this project, analysts classified LandSat TM5 image data from dates in or near 1991 and 2000 to generate land cover/land use maps of the study area. Specifically, one Landsat scene, path-26 row-27, covers the extent of the Gitchi Gami Trail. The land cover classification of the 1991 base layer used a TM image from August 28, 1991. The image was selected based its quality (i.e., lack of clouds and haze) and nearness to the base date of 1991. The 2000 land cover classification used a single image from the ETM+ sensor corresponding to July 25, 1999. Again the image was chosen based on clarity and nearness to the base date 2000. All the images were rectified to the MDOT road layer, with a final rectification error of less than 15 meters.

The ISODATA algorithm was used to classify the images into the following classes: Water and rivers, lowland forest, upland forest, agriculture/grass, urban and lowland non-forest. These classes were established based on the abilities of the sensor, our research requirements, and by referencing Anderson’s Land Use / Land Cover classification system. The resulting classes are described in Table 1.

Table 1. Description of land cover/land use classes.

<table>
<thead>
<tr>
<th>Land cover/land use class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water and Rivers</td>
<td>Permanent open water, lakes</td>
</tr>
<tr>
<td>Lowland forest</td>
<td>Lowland forest area. Forest defined as a minimum of 70% canopy closure. It includes coniferous, deciduous, and mixed forest.</td>
</tr>
<tr>
<td>Upland forest</td>
<td>Upland forest area. Forest defined as a minimum of 70% canopy closure. It includes coniferous, deciduous, and mixed forest.</td>
</tr>
<tr>
<td>Agriculture/grass</td>
<td>Includes planted cropland, rangeland, fallow, and natural grassland.</td>
</tr>
<tr>
<td>Urban</td>
<td>Includes commercial, industrial, residential, and transportation.</td>
</tr>
<tr>
<td>Lowland non-forest</td>
<td>Lands that are sometimes covered with water or have waterlogged soils.</td>
</tr>
</tbody>
</table>
GAP ANALYSIS PROGRAM (GAP) VEGETATION MAP:
The Minnesota GAP vegetation map is a detailed, hierarchically organized vegetation cover map produced by computer classification of combined two-season pairs of early 1990s Landsat imagery. The map was developed as part of the Upper Midwest Gap Analysis Program whose goal it is to maintain biodiversity by identifying those species and plant communities that are not adequately represented in existing conservation lands. There are typically 4 levels or classes in Gap Analysis. The GAP vegetation map was used to create a lowland mask to separate lowland forest areas from lowland non-forest areas in the Landsat images noted above. It also served as an aid to the generation of land cover/land use classifications.

U.S. GEOLOGICAL SURVEY (USGS) DIGITAL ELEVATION MODELS (DEM):
The DEMs were standardized to 30-meter grid cells, UTM Zone 15, NAD83, vertical units in feet and were joined into one statewide file. All the DEMs are Level 2 quality. Level 2 DEMs have been processed or smoothed for consistency and edited to remove identifiable systematic errors. A vertical RMSE of one-half of the contour interval, determined by the source map, is the maximum permitted. Systematic errors may not exceed one contour interval specified by the source graphic.

DEPARTMENT OF TRANSPORTATION 2001 ROADS:
This data set contains roadway centerlines for roads found on the USGS 1:24,000 mapping series. Those roadways that are Interstate, Trunk Highway, or CSAH (county state/aid Highway) are current through the 2001 construction season. Other roads, if not updated, are depicted as shown on the published quadrangle.

HYDROLOGICAL LAKE AND WETLAND DATA:
The 1:100,000 scale hydrography data was derived from USGS Digital Line Graphs (DLG)'s of the same scale. This data contains only the polygon portion of the DLG database. Area features are described as lakes, wetlands, inundated areas, tailings ponds, sewage ponds, fish hatcheries, and other minor water body types.

NATIONAL FOREST:
Natforest, which represents national forest boundaries within the state, is a layer of the State of Minnesota BaseMap 2001 which consists of a number of individual data layers or themes digitized from 1:24000 USGS 7.5-minute quadrangles. These data layers fall into the following broad categories: transportation system, civil and political boundaries, and surface water. Natforest originated as a polygon coverage with the U.S. Forest Service. It is available through the Minnesota Department of Transportation.

INDIAN RESERVES:
Reservtn, which represents Indian reservation boundaries within the state, is a layer of the State of Minnesota BaseMap 2001, which consists of a number of individual data layers, or themes digitized from 1:24000 USGS 7.5-minute quadrangles. It is available through the Minnesota Department of Transportation.

CENSUS BLOCK:
U.S. Census block level data with population information for 1990 and 2000 was obtained from the U.S. Census Bureau.
REFERENCES AND LITERATURE CITED


