Reference Material

The purpose of this assessment is to develop an inventory and assess the resources within each lakeshed to be used as a tool to assess issues and create a framework of goals and strategies for citizens as well as representatives from local units of government and resources agencies in the region. This information helps support the continued commitment to a collaborative effort to protect and improve water quality of Minnesota lakes and manage our limited resources.

This reference material includes both references and explanations for features in the individual lake reports.

Lakeshed Vitals Rating Criteria

The lakeshed vitals table (page 1 of individual lake reports) identifies where to focus organizational and management efforts for each lake. Criteria were developed using limnological concepts to determine the effect to lake water quality. The table below contains an explanation of each item and the criteria used in the rating process.

Major Basin	Description A basin (or drainage basin) is the area of land drained by a river or lake and its tributaries. Minnesota has 10 major drainage basins. Each drainage basin is made up of smaller units called watersheds, which correspond to the drainage of a tributary or lake system.
Major Watershed	Description A major watershed is the smaller unit within a major basin. The major watershed corresponds to the drainage of a tributary or lake system.
Minor Watershed	Description A minor watershed is the smaller unit within a major watershed. The minor watershed drains directly into a lake through an inlet.
Lakeshed	Description A lakeshed is defined as the land area that drains into a lake.
Ecoregion	Description An ecoregion is a relatively large expanse of land containing a geographically distinct collection of plants, animals, natural communities and environmental conditions. There are seven of them in Minnesota.
Lake Surface Area	Description Lake surface area is the size in acres of the lake's surface. Large lakes (>1000 acres) can behave differently than smaller lakes.
Miles of shoreline	Description Miles of shoreline describes the distance around the lake shore. Lakes with more miles of shoreline have more area for potential shoreline impacts to occur.

Miles of Stream	Description Zero, first and second order streams account for most of the total stream miles within any watershed and cumulatively provide much more habitat for aquatic organism than large rivers. Small streams are also highly productive systems, owing to their relationships with adjacent upland habitats. These areas of high productivity are often used for spawning and nursery habitat by fish that normally inhabit larger waterways as adults. Even intermittent and very small perennial streams play an important role in transporting invertebrates, detritus, and other organic matter that fuel downstream food webs. Small streams provide important summer habitat for cold-water fish that move up into headwater streams to escape unfavorably warm conditions in ponds and rivers. In addition to providing critical habitat for fish, small streams support many animals that do not occur in larger streams and rivers. These include species of stream salamanders and crayfish, and probably countless other invertebrate species. On the other hand, streams are also major sources of nutrients and suspended solids to lakes. It is important that lake residents keep riparian areas natural with vegetated buffers in order to protect the lake and the stream.
Miles of Road	Description Roads are considered impervious surface; they fragment the landscape for wildlife habitat and lead to increased development.
Lake Max Depth	Description The maximum depth of the lake corresponds to the deepest hole in the lake bottom.
Lake Mean Depth	Description The mean or average depth of a lake is calculated by dividing the lake's volume by its area. The mean depth is one of the best indicators of the morphology of a lake, and it tells a great deal about its limnology or water quality characteristics. If the mean depth is shallow (<20 ft), the lake water will mix from the surface to the bottom on windy days. The bottom sediments may be a source of nutrients, which will cause algae blooms when mixed to the surface water, potentially reduce dissolved oxygen levels, and thereby contribute to the risk of winterkill or summerkill. Criteria **"-"** for mean depth of 20 feet or less, **"+"** if greater than 20 feet
Water Residence Time	Description For lakes having longer residence times (a year or more), long-term average pollutant loadings become more important to overall lake water quality. Lakes that have a residence time of more than 5 years have a capacity of retaining about 60% of the phosphorus loading that occurs and is not lost via outflow. This characteristic requires that the longer the water residence time, the longer the time frame needed for in-lake observations to detect any response to loading reduction. Criteria **"-"** for residence time greater than 5 years, **"+"** if 4 years or less
Municipalities	Description Municipalities adjacent to a lake are areas of dense population and impervious surface. Stormwater runoff from streets, parking lots, roofs and storm gutters can contribute nutrient and pollutant loading to a lake. In addition, road salt used in the winter can increase the salinity and conductivity in a lake. Criteria **"-"** if present due to storm water runoff issues, **"+"** if not present

Sewage Management	Description If properly maintained, septic systems can be an effective way to manage sewage waste near a lake. If improperly maintained, septic systems can leech into the groundwater and/or lake water and contribute harmful bacteria and nutrients. The excess nutrients can fuel plant and algae growth in front of the property. Criteria **"-"** if comprehensive septic inspections around the lake not completed in last 10 years, **"+"**if comprehensive septic inspections around the lake completed in last 10 years
Public Drainage Ditches	Description Public drainage ditches can contribute nutrient enriched runoff to lakes during heavy rain events and spring thaw. Channelized streams or constructed ditches effectively increase the slope of the watershed and reduce the time it takes water to reach the lake. Criteria If present, "warrants attention" due to nutrient loading, "+" if not present
Lake Management Plan	Description A lake management plan is an excellent way to get lakeshore owners involved in evaluation and future planning for the lake. The planning process can set goals for lake management and give property owners a reason to practice stewardship in the future. Criteria "warrants attention" " if no plan, "+" if plan exists
Lake Vegetation Survey/Plan	Description Native lake vegetation is crucial to healthy fish and wildlife habitat, tying up nutrients that would otherwise be in the water column, and stabilizing lake sediments. A lake vegetation survey describes the current vegetation in the lake and identifies any invasive species. A lake vegetation plan is a way to move forward for management of native and invasive species in a way that benefits the lake and its habitat quality. Criteria "warrants attention" if no survey/plan, "+" is survey/plan exists
Forestry Practices	Description Properly planned and managed forestry will have little impact on lake water quality; however, clear-cutting along a tributary or in the lakeshed can accelerate erosion and runoff. Criteria "-" if clear-cutting is occurring in lakeshed, "+" if no clear-cutting is occurring in the lakeshed
Shoreland Development Classification	Description Minnesota's lakes range from the sterile, rock basin lakes of the Arrowhead region to the naturally fertile, shallow lakes of the southwest prairie region. These different types of lakes require different shoreland development standards. A classification system was developed so that the appropriate development standards could be applied. Lakes are divided into the following classes based on a combination of factors. Natural Environment Lakes usually have less than 150 total acres, less than 60 acres per mile of shoreline, and less than three dwellings per mile of shoreline. They may have some winter kill of fish; may have shallow, swampy shoreline; and are less than 15 feet deep. Recreational Development Lakes usually have between 60 and 225 acres of water per mile of shoreline, between 3 and 25 dwellings per mile of shoreline, and are more than 15 feet deep. General Development Lakes usually have more than 225 acres of water per mile of shoreline and 25 dwellings per mile of shoreline, and are more than 15 feet deep. Criteria "-" General Development Lake "x" Recreational Development Lake "+" Natural Environment Lake

Shoreline Development Index	Description The shoreline development index is the ratio of the length of shoreline to the circumference of a circle with an area equal to the lake area. As the index value increases from 1, it indicates a more irregularly shaped shoreline. An index value of 1 is the smallest possible value and indicates a lake that is perfectly circular. Lakes with an index value of approximately 2 are more elliptical in form, while elongated or dendritic-shaped lakes can have values greater than 4. The shoreline development index is an important morphological parameter to consider because it can give an idea of a lake's susceptibility to the impacts of shoreline development. Lakes with high index values are more susceptible to the impacts of development because there is more shoreline to be developed compared to a more regularly shaped (round) lake with a similar surface area. (Wetzel 2001) Criteria "-" if greater than 2, "+" if less than or equal to 2
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	The lakeshed to lake area ratio shows how much land area drains into the lake compared to the size of the lake. "+" if less than 2 "warrants attention" if over 2
Public Lake Accesses	Description Public lake accesses enable the public to use the lake for fishing and recreation. They are also one of the main locations for the spread of aquatic invasive species. All public lake accesses should have signs that identify any invasive species present in the lake. Boaters should be aware of invasive species and inspect their boat before and after entering the lake. Criteria "warrants attention" due to potential spread of exotic species
Inlets	Description Inlets are the #1 source of nutrient loading in most lakes; however, they are also important in decreasing the lake residence time and "flushing" the lake. Inlets can also be a source of invasive species from lakes upstream. Lake Associations should be familiar with lake conditions upstream from their own lake and know the locations of all tributaries entering the lake. Criteria Any inlets "warrant attention" due to invasive species and nutrients
Outlets	Description If there is a controlled structure at an outlet, it can affect water levels and manipulate water levels artificially. If this control structure were to fail or wash out, water levels would drop significantly in the lake. In addition, outlets can be a source of invasive species to the lake from downstream lakes. Lake Associations should be aware of downstream lake conditions and whether or not they have an outlet control structure. Criteria "warrants attention"
Shoreland Conservation Potential (% shoreland identified for conservation potential)	Description Conservation efforts to limit or slow down the development process can only assist in the preservation of the lakeshed and inevitably the water quality of water bodies found within. Parcels within the lakeshed that are large enough to warrant the investigation of parcel conservation practices and purchase will slow future development on the lake. Criteria "-" if there is no shoreland identified for conservation potential, "+" if there is shoreland identified for conservation potential
Feedlots	Description Feedlots are sources of concentrated nutrients that can enter a lake during a storm event and spring runoff. Any feedlots within the lakeshed should be investigated for their land and manure practices. Criteria "-" if feedlots found within lakeshed, "+" if no feedlots present

Agriculture Zoning	Description Agriculture practices along a lakeshore should have a proper buffer to filter and absorb nutrient runoff and prevent it from entering the lake. Agriculture practices within the lakeshed should have a proper buffer along any tributaries to the lake. Criteria "-" if zoning within 200 ft of lake, "warrants attention" if in lakeshed but greater than 200 from lake, "+" if no agriculture zoning present
Public Land : Private Land	Description Public land is protected, and therefore additional development cannot occur in those areas. Private land that is undeveloped has the potential to be developed unless there are wetlands present that are protected by the Wetland Conservation Act. Criteria "-" if the ratio is less than 1:1, "warrants attention" if 1:1, "+" if the ratio is more than 1:1
Wetland Coverage	Description Wetland protection is a critical component for the long-term protection of water quality and recharge of groundwater. Historically, wetlands were drained for various land-use practices. Today, environmental awareness and increased stewardship has lead practices to restoration. All wetlands in the National Wetlands Inventory are protected by the Wetland Conservation Act and cannot be developed. The more land tied up in protected wetlands around a lake, the less development and impact there will be on the lake water quality. Criteria "-" if less than 1% of the lakeshed area is wetlands "warrants attention" if 1-2% of the area is wetlands "+"if greater than 2% of the lakeshed area is wetlands
Lake Transparency Trend	Description For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended. Minimum confidence accepted by the MPCA is 90%. This means that there is a 90% chance that the data are showing a true trend and a 10% chance that the trend is a random result of the data. Only short-term trends can be determined with just a few years of data, because there can be different wet years and dry years, water levels, weather, etc, that affect the water quality naturally. The data was analyzed using the Mann Kendall Trend Analysis. For more details on individual lake trend analyses, see the individual lake reports. Criteria "-" if there is a declining trend in transparency "+" if there is no trend or an improving trend in transparency
Exotic Species	Description Species that have been introduced by human activities to a location where they do not naturally occur are termed "exotic," "nonnative," and "alien". When nonnative species cause ecological or economic problems, they are termed "invasive" or "harmful exotic species." Minnesota's natural resources are threatened by invasive species such as the zebra mussel, Eurasian watermilfoil, purple loosestrife, and curly-leaf pondweed. These species, along with new invasive species, could be easily spread within the state if citizens, businesses, and visitors don't take necessary steps to contain them (MN DNR). Criteria "-" if exotic invasive species are present "+" if no exotic invasive species are present

Geospatial Information and Mapping

Most all of the listed GIS layers are also viewable from a single source at RMB Environmental Laboratories' interactive mapping tool (http://gims.eorinc.com/pmapper/map.phtml?config=rmb). Here a user can overlay various geospatial layers to better understand the interaction and relationship of each informational data set. Cass County also has a very complete listing of geospatial information on its interactive mapping website (http://www.co.cass.mn.us/cassmnpublic/Default.aspx).

When investigating development or conservation potential of parcels within the lakeshed, individuals must consider the relationships between each land attribute. Below is a quick reference listing of available geospacial layers

Land Use / Land Cover
www.land.umn.edu

The information at the University of Minnesota shows land cover and impervious surface information. See page 6 in the individual lake report for analysis.

Soils
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
http://www.co.cass.mn.us/cassmnpublic/Default.aspx

It is important to understand the soil types surrounding the lake because they can affect the effectiveness and location of septic system drainfields. In addition, hydric soils can be restored to wetland conditions.

Aerial Imagery
http://www.dnr.state.mn.us/airphotos/search.html
http://gims.eorinc.com/pmapper/map.phtml?config=rmb
http://www.co.cass.mn.us/cassmnpublic/Default.aspx

Comparing aerial imagery from past to present can identify changes in land use, especially forestation and agriculture.

Topographical
http://www.dnr.state.mn.us/maps/tomo.html?x=468087.0000&y= 5160799.0000&size=3&layer=24k

Topographical information is important for determining the location of escarpments, which are steep slopes adjacent to the lake. Escarpments are areas where natural vegetation is crucial for bank stabilization and prevention of erosion.

Wetland Inventory
http://www.co.cass.mn.us/cassmnpublic/Default.aspx
http://gims.eorinc.com/pmapper/map.phtml?config=rmb

Wetland protection is a critical component for the long-term protection of water quality and recharge of groundwater. Historically, wetlands were drained for various land-use practices. Today, environmental awareness and increased stewardship has lead practices to restoration. Overlaying soil, topographic, and wetland inventory GIS layers help identify areas where wetland restoration as well as protection is possible. Identifying areas with hydric soils that are not included in the wetland inventory have restoration potential. Landowners can work with the SWCD on wetland banking/restoration projects.

Parcel Information
http://gims.eorinc.com/pmapper/map.phtml?config=rmb

Parcel information can be analyzed along with other layers to see the impact that development has on sensitive lakeshore. By overlaying parcels with wetlands, soils or topographical information, one can determine areas that need special attention and protection.

Zoning Information
http://www.co.cass.mn.us/cassmnpublic/Default.aspx

Zoning information is helpful for locating areas that are available for commercial or residential development.

Land Cover

The information at the University of Minnesota shows land cover and impervious surface information. The information below describes the different land cover classes and what they include. See page 5 in the individual lake report for analysis and lakeshed map.

Land Cover Classes Key (http://land.umn.edu)

Classification categories attempt to group land cover into classes based on structure, taxonomy, or function. There can be many "levels" of complexity to a classification. The land cover classifications are all considered "level one" or fairly simple categorically.

Land Cover Class	Description
Agriculture	Agricultural cropland including row crops, forage crops and small grains. Examples: corn, soybeans, alfalfa, oats, wheat, barley and sugarbeet.
Forest	Land covered with trees reaching a mature height of at least 6 feet tall with a definite crown. Examples: white pine, red pine, black spruce, fir, mixed conifer, aspen, maple, oak, and mixed deciduous.
Grassland	Golf courses, lawns, sod fields, upland areas covered by cultivated or non-cultivated herbaceous vegetation predominated by grasses, grass-like plants and forbs. Examples: pasture and dry prairie.
Shrubland	An upland or lowland area with vegetation that has woody stems, generally with several basal shoots, low growth of less than 20-feet height, and fairly uniformly distributed throughout and moderate to high density. Examples: alder, willow, buckthorn, hazel, sumac, and scrub oak.
Wetland	A lowland area with a cover of persistent and non-persistent herbaceous plants standing above the surface of wet soil or water. Examples: cattails, march grass, sedges and peat.
Water	Permanent open water, lakes, reservoirs, streams, bays and estuaries.
Urban	Residential, commercial, industrial, transportation, industrial and commercial, mixed urban or build-up land, other urban or built-up land.