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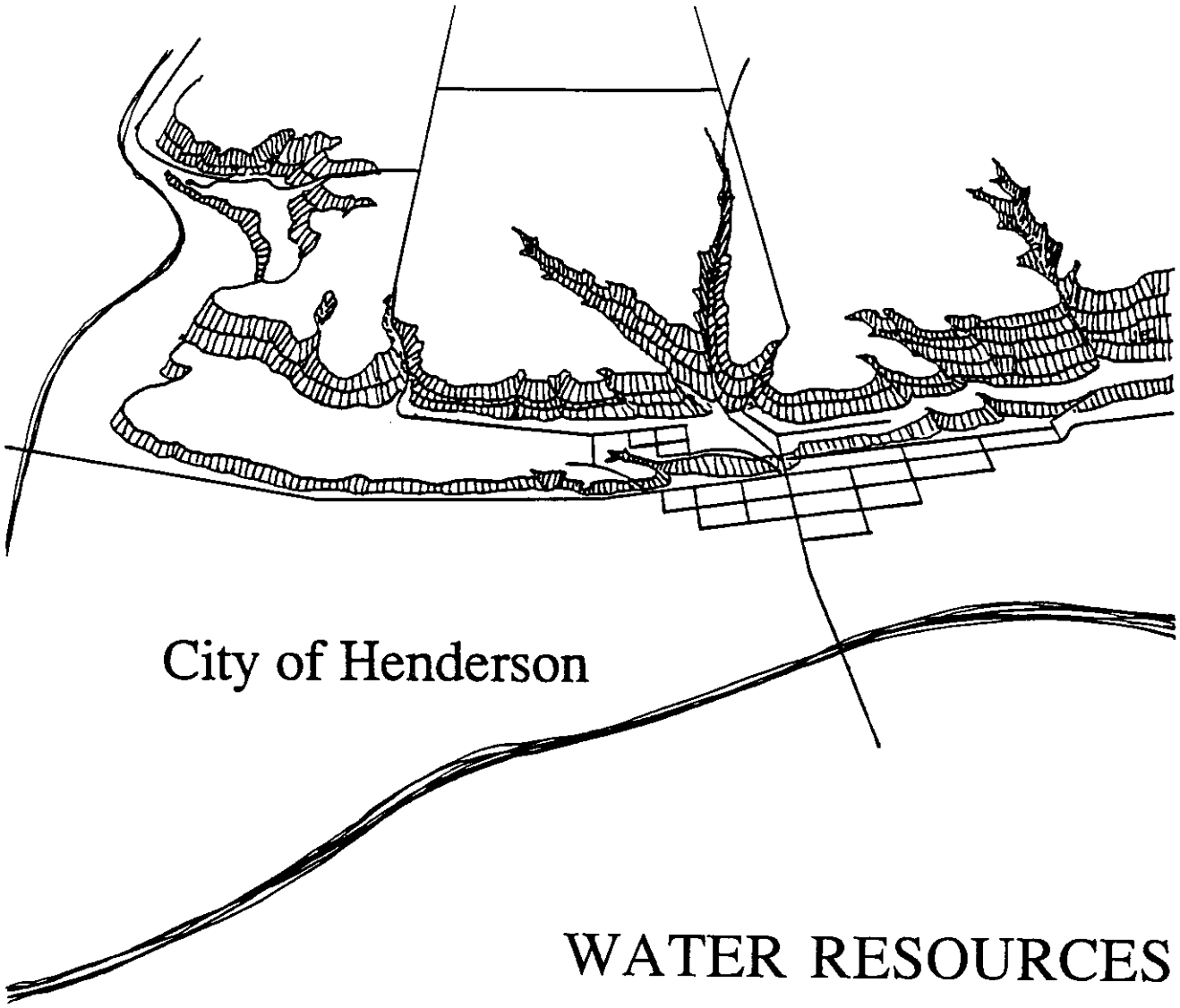

City of Henderson

WATER RESOURCES

University of Minnesota
NRES Seminar
1990 - 1991

Karen Bonde
Tony Brough
Scott Colgan
Patrick Conrad
Bart Jensen

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PREFACE

This project was undertaken within the Natural Resource and Environmental Studies Seminar for 1990-91 under the guidance of "Project Future", within the University of Minnesota. The scope of this project is to examine the natural resources of the city of Henderson, Minnesota. In this section of the project, nondegrading activities associated with the Minnesota River are examined. Nondegrading activities are defined as those that do not severely affect the natural integrity of the river and its surrounding valley. The purpose of this section is to define the activities available and discuss how they can be used as a source for community development for the city of Henderson. In addition to this, the impacts that community development may have on the water resources are examined.

The study begins with an examination of how water quality defines the activities possible for the Minnesota River. These activities are then narrowed by considering only those activities that do not have the potential to severely degrade the river. Of these broadly defined activities three specific activities are examined in detail. The first activity discussed is recreation, specifically canoeing and sport fishing. Next, wildlife resources are explored, followed by an examination of the educational opportunities of the study area.

Following the examination of these potential activities, the implications of these activities are discussed. As stated earlier, the desired results will be an increase in community development. Unfortunately an increase in community development may also lead to degradation of water resources, so the remainder of the study addresses possible negative impacts on water resources.

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EXECUTIVE SUMMARY

The community of Henderson is located along the Minnesota River providing it with the opportunity to implement several water related activities that could promote tourism into the area. However, surface water quality places some restrictions on what can and cannot be done on the Minnesota River. For example domestic consumption, swimming, and consumption of fish are not advisable. However, canoeing and sport fishing, wildlife related activities and educational opportunities are advisable.

Canoeing and sport fishing activities could provide community development for Henderson by increasing the number of visitors to the city. The aesthetics in and around Henderson could also be used to attract more people for river related activities.

Nongame wildlife is another resource which may act as a way to draw people into the area and into the town of Henderson. This is a resource which can be utilized throughout year. Different seasons offer different opportunities for experiencing wildlife. In concert with other activities discussed in this project the wildlife resource can become a valuable asset to the community.

Establishment of an educational program in conjunction with a river signage can benefit Henderson economically. Through an educational program Henderson has the opportunity to increase the public's awareness of environmental concerns. Henderson should seriously consider looking into educational activities when expanding the river corridor.

Henderson has two wells from which they can draw water. The capacity of their main well is roughly 8 times their current annual usage. From a quantity standpoint Henderson is well supplied.

Quality is also an aspect that might want to be examined closely. Testing municipal and domestic wells regularly and keeping a good record of those tests might be useful in monitoring any trends occuring in the quality of groundwater.

WATER QUALITY AS IT DEFINES POTENTIAL USES FOR THE RIVER

INTRODUCTION

The purpose of this section is to examine the nondegrading activities possible for the Minnesota River near Henderson as a source for community development. To do this it is necessary to first examine the issue of surface water quality. This is an important issue because it dictates the available activities or uses of the river. This report, therefore, will begin with a discussion of potential activities for which this segment of the river is classified, including an explanation of how these classifications are made. These potential uses will then be restricted to those that can be supported from a water quality standpoint and those that do not severely degrade the resource. While it is admitted that all uses can degrade the water quality of the river, a nondegrading activity here is defined as one that does not severely impact the water. The purpose of this report is also to serve as an introduction to the entire water resources section.

USE CLASSIFICATIONS

The nine mile segment of river that is monitored on highway 19 has specific use classifications assigned to it in accordance to state law. The Minnesota Pollution Control Agency (MPCA) has designated seven uses and has defined the quality of water associated with each use (MPCA, 1990a). Of these seven possible uses, this section of river is classified for five uses. A water body or segment of river is classified for a given use if it is within the water quality specifications for the use. While this segment of river is classified for a variety of uses, it does not necessarily support all these uses. The uses that it is classified for are as follows;

Fisheries and Recreation class b
Industrial Consumption class b
Agriculture and Wildlife
Aesthetic Enjoyment and Navigation
Other Uses

The Fisheries and Recreation class requires that the quality of this water permits the propagation and maintenance of cool or warm water sport or commercial

fishes and their habitats and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. For this use, class b denotes that the water is not suitable as a source of drinking water. The quality of water associated with this use is the highest of all the uses classified.

For the Industrial Consumption use classification the quality of the water must be such as to permit its use for general industrial purposes, except for food processing, with only a moderate degree of treatment. In this case the class b designation is for the restriction of food processing.

For the Agriculture and Wildlife classification the quality of the water must be such that it permits use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area and permit use by livestock and wildlife without inhibition or injurious effect.

The river segment is also classified for Aesthetic Enjoyment and Navigation. The quality of the water in this class must be suitable for aesthetic enjoyment of scenery and to avoid any interference with navigation or damaging effects on property. Since the water level of the river near Henderson is highly variable, the only navigation that is recommended is that of canoeing (see Recreation). As for aesthetics, the only water quality parameter that is defined by law is that of Hydrogen Sulfide which relates to the odor of the water.

In addition to these classifications, the river segment is classified for "Other" uses. This classification of water is basically a provision in the law that allows the MPCA to enact new standards when they deem it necessary. For example, if people began to use a body of water for something that it had never been used for, the MPCA could set standards immediately that would define the quality needed for this use (MPCA 1990a).

It should be noted that the exact water quality specifications for these various uses can be found in the state regulations. Now that the potential uses for the river have been defined and the means for this determination have been discussed, the scope of the discussion will be narrowed by eliminating some of the uses. To do this, the concepts of "use support" and nondegradation must be introduced.

USE SUPPORT

As stated previously, the classification of this segment of the Minnesota River for given uses does not necessarily imply that the water can be used for these purposes. Because of this, the MPCA uses the concept of "use support" (MPCA, 1990b). The quality parameters in the table below, along with other parameters, are tested periodically and are compared to the standards to determine if the river can support various uses. The segment of river is said to be fully supporting a given use if the standards used to determine the use are violated less than 10% of the time. Partial support is defined as the state when violations of standards occur between 10-25% of the time. Finally, a segment of river is nonsupporting of a given use if the standards are violated over 25% of the time (MPCA, 1990b). It is necessary at this time to discuss water quality standards to show the role that they play in determination of use support.

Water Quality Standards

The Clean Water Act of 1972 required that water quality standards had to be established and reviewed every three years (Svanda, 1991). These standards are specific to each water body or in some cases they are specific to the particular segment of a stream or river. They are specific to the water body to take into account baseline concentrations of the different parameters. By setting the standards specific to a water body, its water quality can be analyzed according to its natural composition. Water quality standards have been set for the section of the Minnesota River near Henderson by the Minnesota Pollution Control Agency (MPCA). The water quality standards that have been set for this segment of the Minnesota River are shown in Table 1. This table also shows how the water quality of this segment of river has compared to these standards over the ten year period from October 1979 to September 1989. These standards are set to correspond to the uses that are classified for the section of river and are a reflection of the most strictly defined use.

Minnesota River Water Quality Standards

Table 1 (MPCA, 1990c).

PARAMETER	STANDARD		# OF TESTS	% EXCEEDED STANDARD	MEAN
Fecal Coliform	200	#/100ml	74	33.8	494
Dissolved Oxygen	5	mg/l (min.)	91	0.0	9.88
pH minimum	6.5	SU	91	0.0	8.18
pH maximum	8.5	SU	91	1.1	8.18
Ammonia	0.04	mg/l	90	1.1	.007
Chloride	100	mg/l	0	NA	NA
Turbidity	25	NTU	2	50.0	29.9
Chromium	50	µg/l	13	0.0	4.12
Copper	10	µg/l	15	26.7	8.13
Conductivity	1000	µmho/cm	90	11.1	844

Recreation

Recreational activities are mostly what is monitored for consideration of use support, namely fishing and swimming. Use support for swimming is determined by the level of violations of quality standards for fecal coliform bacteria. The level of support for fishing is determined by the level of violations for dissolved oxygen, unionized ammonia, chromium, copper, and pH and also by the presence of a fish consumption advisory.

From the table above, we see that the concentration of fecal coliform was over the standard value of 200 colonies per ml, 34% of the time. The average value from these samples was nearly 2.5 times the acceptable limit. Because of this high amount of violations of the water quality, this section of the river is judged to be non-supporting of swimming. Any plans for using the river as a source of development, therefore, should not include swimming as a recommended activity. Other activities such as water skiing should also be avoided in a recommendation because of the contact with the water.

For fishing the MPCA has labeled this segment of river nonsupporting because of the level of violations for copper and because there is a fish consumption advisory. The EPA has determined that the river has high enough levels of toxins to warrant an advisory (Svanda, 1991). The advisory states that people should not eat more than one meal per month of any fish caught in the river regardless of size or type (Mn. Dept. of Health, 1989). The plan for utilizing the river therefore, should not include consumption fishing as a recommended activity.

The sources of these contaminants has not been determined, but there is a four million dollar study being preformed by the MPCA to examine the quality of water in the entire river. This information will be available in 1994 (Svanda, 1991).

Although swimming and consumption fishing are not recommended for this segment of the river, there still exists the potential for recreational use. For example, canoeing in this part of the river is an activity that can be recommended. It should be noted that while there is an advisory for fish consumption on this part of the river, this does not mean that fishing should be avoided. Fishing can be recommended as a use if "catch and release" is promoted (sport fishing).

Nondegradation

The idea of a nondegrading use is that it does not negatively impact the environment, or lead to reduction in the quality of the resource over time. An activity would be said to severely degrade the water resource if it led to an unacceptable level of contaminants. This degradation could be determined by monitoring the water quality in comparison to the standards that have been established in table 1. Of the uses classified above, industrial consumption is ruled out due to the potential for this use to negatively impact the quality of the water. Industrial consumption can introduce pollutants into the water upon discharge or can alter the temperature of the water causing thermal pollution. For the purpose of this report, agricultural uses will also be avoided.

RECOMMENDED USES

In light of the preceding discussion on water quality, three particular uses have been chosen for close examination. The first recommended activity deals with recreation as it relates to canoeing and sport fishing. These recreational activities were chosen because they are suitable for the river and do not cause further degradation to the river water quality. The educational potential of the river is then discussed, followed by an examination of the wildlife resource related to the river. These uses cause minimum degradation to the river, and provide excellent ways for Henderson to attract visitors.

RIVER RECREATION

INTRODUCTION

The purpose of this section is to give an analysis of how river recreation can be beneficial to the city of Henderson. Rivers and their corridors by their nature are attractive places for many people. They provide an exciting atmosphere for recreation and allow for a wide array of opportunities. The recreational opportunities that will be discussed in this section are canoeing and sport fishing. These activities are recommended because they are nondegrading and the quality of the river supports them. In addition, these activities provide an excellent opportunity for community development.

CANOEING

Canoeing is a very popular activity in Minnesota. It has been estimated that fifteen percent of Minnesotan's participated in canoeing in 1974 (Kaul, 1990). It has the potential to become a particularly favorable activity within this area because the physical features near Henderson provide an excellent landscape for viewing. The willow, cottonwood, elm, and ash lining the river and oak dominated hillside make this section of the river aesthetically pleasing for canoeing. The Minnesota River is one of the few rivers in this area of Minnesota that has officially been designated canoeable by the Minnesota Department of Natural Resources (Kaul, 1990).

There are two access points available in proximity to Henderson. One access is located on the west side of the river and allows direct access to the Minnesota River for canoes and small boats. The other access is located on the east side of the Minnesota River and is limited to access for canoes because there is a quarter mile trail that must be walked to reach the river (Map 1).

Canoeing can be divided into two different types for closer examination. These types of canoeing vary according to the participants objectives. Each type of canoeing would require its own management plan to promote its use. The types of canoeing are discussed in the following section.

Day-Use Canoeing

Day-use canoeing is defined here as canoeing trips that do not include an overnight stay. The trips are generally made with two or more canoes, where the objective of the outing is mainly socializing. This section of river is ideal for this type of canoeing because the environment is nonthreatening and placid. The velocity of the river is slow and meandering with a sufficient width for safe canoeing. Another advantage that Henderson has for day-use canoers is its close proximity to the Twin Cities metropolitan area. It is assumed that there is a large amount of day-use canoers in the Twin Cities area due to its large population. The approximate one hour drive is a benefit for day-use canoers because traveling time is short (see trails report).

Henderson can make certain improvements to attract this type of canoer to the area. These improvements would enhance the users recreation experience. Locate riverside rest areas limited to canoers throughout the corridor with access from the river. This restriction would keep motor boats out of the rest area. The facilities at these sites can include garbage cans, restrooms, and canoeing interpretive information (see educational opportunities section for a further discussion of interpretive information). Information that is specific to canoeing could be provided at these stops and at the accesses. This information would include safety tips and up-to-date river condition data.

Overnight Canoeing

Overnight canoeing is defined here as canoeing where there is at least one overnight stay. Henderson could benefit by this type of canoeing, but an incentive would be needed to attract users to the city. The first concern is to encourage the canoers to use a campsite in the Henderson vicinity. The Minnesota river has several areas in which canoers can camp overnight, so Henderson needs to make its facilities unique. The stretch of the Minnesota river between Le Sueur and Shakopee, which is forty-five river miles long, has seven canoe landings, twelve campsites, and two rest areas (DNR, 1990). One way to make the facilities in Henderson unique would be to provide educational opportunities (see educational opportunities section). Another way to attract overnight canoers is to improve the quality of camping facilities. Once these canoers have stopped in the Henderson area, there must be an incentive for

them to visit the city. One way to accomplish this would be to provide information on the points of interest in Henderson (see image section).

A final possible way that Henderson could capitalize on both day-use and overnight canoers is to provide canoe rental. This recommendation is made with the understanding that the city should investigate the liability issues concerning such rentals.

SPORT FISHING

Another activity that is recommended for the river is sport fishing. Sport fishing is defined here as fishing for any reason other than consumption. Fishing is the most popular outdoor recreational activity of visitors to Minnesota and fishing pressure is projected to increase 13% from 1985 to 2000 (Kaul, 1990). In Minnesota the number of people per registered boat is 6.13 and with more Minnesotan's buying boats gives them greater access to fishing. In the eight years prior to 1988, the number of registered boats rose 16% (Kaul, 1990). From these statistics, it can be assumed that the interest in fishing is also increasing. Henderson can take advantage of this increased interest in fishing by encouraging people to fish nearby. The benefits of fishing to Henderson are the same as those for canoeing; bring people into the city to stimulate the economy.

As discussed previously, there is only one access point for fishing boats located in Henderson. The opportunity for fishing on this section of the river is limited due to the inconsistency of the water level. The only boating that is encouraged is with small horsepower boats, such as fishing boats. The facilities needed to support this activity are already in place in Henderson. The boat landing in Henderson should be sufficient to meet the needs of these users.

One aspect to be considered if fishing is to be promoted is the issue of dead and fallen logs throughout the river. These logs provide excellent fish habitat, but also negatively affect navigation on the river for boaters and canoers. One possible solution is to anchor these logs so that they don't interfere with navigation but still provide habitat. The techniques for anchoring dead logs are still being developed within the Minnesota DNR (Kaul, 1990). Henderson may want to initiate their own

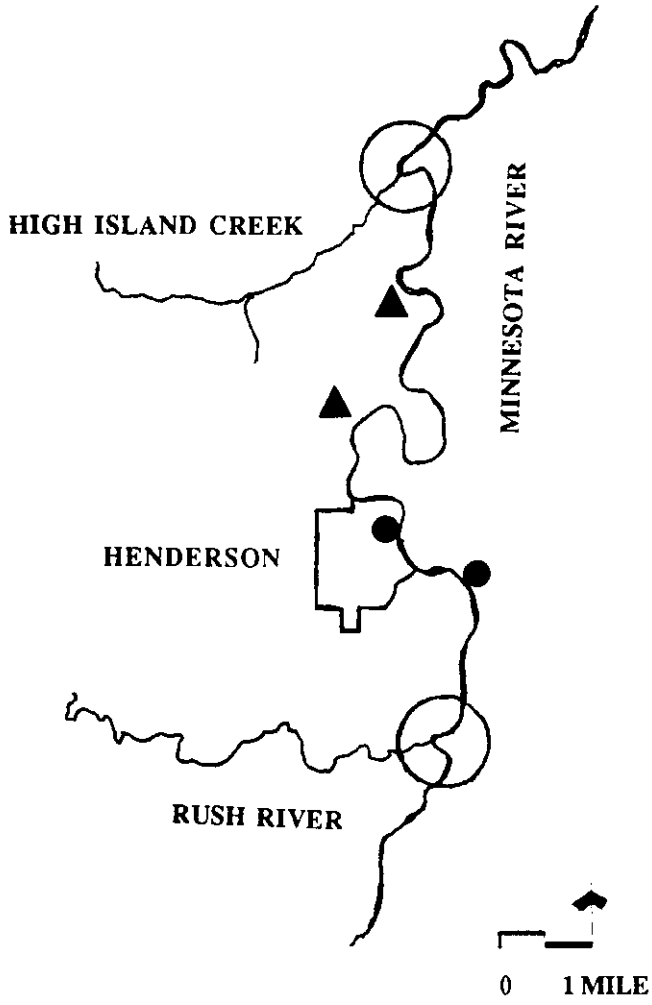
experiments on anchoring these logs to enhance the fishing experience in the area. A special type of fishing that needs separate discussion is bank fishing.

Bank Fishing

Bank fishing could become a popular activity in the area, particularly among senior citizens. Henderson can benefit from a plan that includes bank fishing because this activity expands the user pool. In other words, bank fishing is an activity that invites people to Henderson even if they don't have a boat. The two locations that receive pressure from bank fishing are where the Rush River and High Island Creek enter into the Minnesota River (Kaul, 1990).

One consideration in regards to fishing is that it has the potential to put pressure on the fish resource. This risk is considered to be minimal because the type of fishing recommended is nonconsumptive. Another consideration of fishing is that bank fishing has the potential to lead to streambank erosion. This problem could be avoided by placing rip-rap along the bank in designated fishing areas, and encouraging people to fish only in these areas.

HENDERSON RIVER CORRIDOR



▲ CAMPSITE

● BOAT ACCESS

◯ BANK FISHING

SOURCE: MN D.N.R.

WILDLIFE RESOURCES OF THE RIVER

INTRODUCTION

This report will address the wildlife resources of the Minnesota River Valley, specifically the eastern one-fourth of Sibley County, with some reference to the surrounding areas. The purpose of this report is to examine how the wildlife resource may potentially be tapped to benefit the residents of Henderson now and in the future. The report will also shed light on the history of the area's wildlife and illustrate how as a resource it has changed from the early days of Henderson up to the present.

Background

The Minnesota River Valley National Wildlife Refuge is being established in part as a wildlife corridor in an attempt to address habitat fragmentation. It will serve to interconnect the federal, state, and regional parks and reserves along the river. The city of Henderson is located at what will eventually be the western end of this corridor (Dept. of the Interior, 1984).

A wildlife corridor is basically a path connecting wild areas that have become isolated or fragmented because of human development and activities. Rivers work particularly well for use as corridors because quite often the surrounding lands are of limited economic value to humans; the land is often prone to flooding, the slope of the valley walls is often excessive, and rivers occasionally shift course (see Land Use report). These lands do however, provide for prime recreational land. Also because of these traits river valleys in many places are relatively undisturbed so they require the least amount of expense to convert into wild areas (Harris, 1984). For Henderson to benefit from this wild area it would have to be managed as more of a recreational area

A BRIEF HISTORY OF THE WILDLIFE IN THE HENDERSON AREA

Natural History

The city of Henderson was settled near the western edge of what is known as the Big Woods, an elm, basswood, sugar maple dominated forest extension of the eastern deciduous forests. This was very near the eastern edge of the the tall-grass prairies of the Great Plains. Both the Big Woods and the tall-grass prairie ecosystems have been heavily fragmented due to urban and agricultural development and are now extremely rare in the state (Grimm, 1981; Wendt, 1984). The Minnesota River Valley was characterized by floodplain forests of elm, ash, cottonwood, silver maple, and willow (Wendt, 1984). These floodplain forests can still be found in many areas along the river valley bottomlands (Dept. of the Interior, 1984). Oak is a common tree species in the region (Grimm, 1981).

Taking a cross-sectional view of the river valley from the river to the uplands one finds distinct vegetational zones. The valley floor begins with bottomland woods and moist, grassy meadows, then moves up to northern hardwood forests, to dry upland forest near the top of the bluff, then to the prairie grass or big woods at the top (Dept. of the Interior, 1984). This tremendous variety of potential habitats makes the valley valuable to wildlife and worth conserving.

CURRENT WILDLIFE STATUS

Game Species

Two popular game species which will be considered here are the white-tailed deer and the wild turkey. Small game such as squirrels, raccoon, fox, woodcock, and so on, although abundant in the river valley, will not be addressed in this report. Fishing is discussed in the recreational section.

The white-tailed deer, a species popular among hunters, does very well in an "edge" type of habitat (the boarder area between forests and open fields). It was very abundant in early settlement times and is often mentioned in early news reports. The Henderson area is good for deer because of the variety of habitat available throughout

the year. The farmlands offer good quality browse and the river valley and side valleys offer a degree of cover from inclement weather (Moen, 1968).

In 1986, 17 wild turkeys were introduced into the area near Blakeley, Minnesota, and shortly after, 18 more were released near East Union by the DNR. The transplanted turkeys were originally acquired in a swap with the state of New York for some Minnesota born Hungarian partridge. By the fall of 1990 a hunting season was designated for them. Another season is planned for the spring of 1991. Turkeys have been very successful at establishing themselves in the river valley habitat and it is expected that as their numbers increase there will be a range expansion. However this is the extreme northern edge of their natural range and as of this writing there has not been a severe winter, so their permanent establishment is yet to be guaranteed. The turkeys can tolerate a habitat area as small as 80 acres as long as there is some proximity or a corridor to more habitat (Bremer, 1991).

For the 1990 hunting season the hunting was allowed between 1/2 hour before sunrise and 12:00 noon (**Commissioners order #2361, Regulations for Turkey Season 1990**). Most of the hunting was over by 9:00 a.m.. The turkeys which are taken must be registered at the nearest registration station which is in Henderson. The 1990 season was considered a success (Bremer, 1991). Similar guidelines are expected to be enacted for future hunting seasons.

One barrier to hunting in the Henderson area is the lack of public lands to hunt on; most of the land in the area is privately owned (see Land Use report). This has two basic effects: 1) the bulk of the hunting is done by local people and their acquaintances (Bremer, 1991), and 2) there may be problems with trespassing (see Trails Report).

A great deal of the deer hunting in Minnesota is traditionally done in the northern half of the state; any increase in local hunting would probably be as a results of significant changes in northern Minnesota such as a crash in northern deer populations. Even this would probably only cause an increase in use by local hunters and not make much of an overall impact. For the foreseeable future participation in hunting will probably remain fairly stable (Bremer, 1991).

One potentially lucrative way to bring outside revenue into the Henderson area is through fee hunting. In the state of South Dakota land owners have had a great deal of success generating extra income by charging hunters to use their land, particularly for game birds (Smith, 1987). The land owners act as hunting guides which allows them to keep the hunters in check as well as maximize the available game. Smith reports that fee hunting contributed from 15 to 25% of one farmers income. Hendersons location puts it in an excellent position to tap the Twin Cities hunting market. The city of Henderson could benefit from this added hunting activity through support facilities such as game registration points, ammunition and license sales, overnight facilities, food and fuel sales, as well as the added income to the land owners who operate fee hunting facilities. Land owners may consider establishing fee hunting cooperatives or similar acting organizations.

Concern has been indicated that added activities will cause conflict when people ignore private property signs and trespass (see Trails report). An increase in hunting activity could possibly contribute to the problem. All this report can offer is advise on how to deal with the issue. In case of a trespass violation the most immediate contact should be the County Sheriff. Landowners can call the Sheriffs' office and leave it to the dispatcher, they will either contact the Sheriff or the local Conservation officer who can also enforce the trespass laws. For a reference, **Minnesota Statutes 97B.001** and **97A.315** are the laws dealing with trespass, particularly during the hunting seasons. The statutes are available from most private and government legal agencies.

Nongame Species

While as many as fifty species of mammals may be found in the river valley, the greatest nongame species resource in the Henderson area is birds. As many as 275 different avian species use the Minnesota River Valley during migration, with as many as 100 species nesting in the valley (Dept. of the Interior, 1984). This could be a tremendous aesthetic resource for drawing people into the area and, with the proper support facilities, into town. Many game species such as white-tailed deer and wild turkeys also have aesthetic appeal and can be a draw to wildlife watchers.

Bird watching, while not entirely seasonal, does have its more rewarding periods. The optimal time for bird watching is between early to mid-March until late

June or early July, with the peak being between early April and mid-May. The spring is particularly good for several reasons: birds are migrating through which means a tremendous variety of species; the vegetation is still sparse enough so as not to hinder the viewing; the birds are in breeding plumage, and; they are very active and make themselves conspicuous for mating purposes. The fall months also see a great deal of migratory activity. Many species such as cardinals, nuthatches, and woodpeckers, are active year round residence of the woodlands.

One species which may draw nature lovers into the area is the bald eagle. However, care must be taken that an increased human presence does not drive the eagles away. In the past few years eagles have been reported to over winter in the area (Bremer, 1991). These magnificent birds can often be found in areas where human activity is minimal, open water can be reached, and there are mature trees to use for roosting. The river valley and smaller side valleys provide the eagles with some degree of cover from inclement weather. Many eagles use the valley as a stopover in there seasonal migrations.

Wild turkeys have appeal as both a game and nongame species. The wild turkeys mate in the spring and the males gobble and display to attract females; the peak activity is from late April to early May. This offers a unique opportunity for bird watching activities. One potential conflict here may be turkey hunters and bird watchers stalking the same quarry. This could be a nuisance to hunters as well as present a possible safety problem for nonhunters. As noted earlier, turkey hunting had to be finished by noon, and the hunting itself normally over by 9:00 a.m.. With adequate information and proper coordination, conflict will be minimized.

EDUCATIONAL OPPORTUNITIES

INTRODUCTION

This report will present possible educational opportunities that the city of Henderson can implement concerning their water resources to enhance tourism and/or development in the area. Educational programs will entail both a historical approach as well as a futuristic approach. The focus will be on the water resources in and around the city of Henderson, namely the Minnesota River. The first approach will be to develop an educational signage display that emphasizes geology, history, wildlife, and environmental concerns. The second approach will be to develop an interpretive educational station; a floating classroom, that incorporates the city of Henderson with the Minnesota River Valley.

The development of these educational activities will require facilities capable of accommodating the increase of visitors to the area. The expansion of the boat access parking lot and satellite restrooms near the parking lot are some of the additions that will have to be addressed. The environmental impacts on the Minnesota River quality due to this expansion will also have to be considered. Monitoring along the river before and after expansion may help in determining the impacts on the river.

Henderson, located within the flood plains of the Minnesota River Valley, has been influenced historically by the river and will continue to be affected by the river for many years to come. Henderson can benefit from its location by developing educational programs that focus on environmental concerns particularly those specific to the Minnesota River, such as erosion/sedimentation and water pollution. Educational programs could be used to attract visitors to Henderson. The river corridor around Henderson has the advantage of being located outside of a metropolitan area. The scenery has had minimal impact from development creating the opportunity to interact with the environment. The preceding discussion provides the basis for this report, which is to inform Henderson and the surrounding communities on the importance of the river and the environmental implications associated with it.

EDUCATIONAL SIGNAGE

The Minnesota River Valley National Wildlife Refuge/Recreational Area has been expanding toward Henderson. Henderson can capitalize on the influx of visitors to the area by offering them a small town atmosphere along with a valuable educational opportunity. Those arriving in Henderson by way of canoe or boat will be the first to see the aesthetic value that the river holds. The following section will discuss possible ways in which Henderson can capture the attention of visitors who arrive by canoe.

The Minnesota Valley National Recreational Area was established to provide a recreational travel route by either land or water through areas with significant scenic, historical and recreational value (University of Minnesota, 1981). Henderson has the potential to provide all these aspects for those who travel into the area, especially those who travel by water. Because of this, Henderson should pay particular attention to the needs of canoers. In order to capitalize on this resource, Henderson needs to make its presence known. In other words, there has to be a reason for canoers to stop in Henderson instead of simply passing by. One plan that can be used to achieve this goal is a self-guided interpretive canoe trail.

The self-guided interpretive canoe trail could provide those entering the Henderson area with a brief historical tour along with a discussion of the environmental concerns of the Minnesota River. The trail would consist of signs placed along the river at various points of interests, such as places that reflect special concerns, and historical significance. Sign placement would also be determined by issues such as safety, convenience and aesthetics. The following signs could be placed at campsites or boat accesses, where canoers could pull up to read the information. The topics that could be discussed on these signs are as follows.

Geology of the Minnesota River

One of the more interesting aspects of the Minnesota River is its geology. Because of this, the geology can be discussed on signs in various places along the river. The following discussion provides an example of the type of issues that could be placed on signs.

The geology of the river is such that there are high bluffs on either side. These bluffs were created millions of years ago by the carving action of the Glacial River Warren, formed by one of the largest of the glacial lakes, Lake Agassiz. Glacial River Warren was several miles wide and several hundred feet deep. The river headed in a southeasterly direction until it ran into bedrock, near where Mankato is located today. It was then forced to swing sharply to the northeast where it continued until it joined the Mississippi River at Fort Snelling.

Although minute in comparison to the River Warren, the Minnesota River has the ability to carry out forceful action of its own, as the city of Henderson well knows. Henderson has many times experienced flooding along the Minnesota River. The flooding history, therefore is another topic that could be included on signs.

Floods

One of the major consequences of living by a river is the constant threat of flooding. The city of Henderson has experienced many flood events throughout its existence since 1852. Some of these floods have caused extensive property damage. However, Henderson has been fortunate in its flood history to have no loss of lives. Records show that flooding has occurred in the following years; 1852, 1856, 1858, 1881, 1908, 1951, 1952, 1959, 1965, 1969, 1975. This impressive flood history has drawn the people of Henderson together and has made it a special place of interest. Signs could be placed along the river that briefly discuss the flood history of Henderson. An idea would be to place high water marks that show the levels of the three worst floods in history. An example of the flood sign could be:

Floods can extend over a long period of time and consequently produce extensive amounts of destruction. During flood events most of the floodplain is under water. Much of the flooding on the Minnesota River takes place during the spring when warm weather creates heavy runoff due to snowmelt. Henderson has encountered three floods that have been estimated at or over the 100 year reoccurrence interval, or less than a 1 percent probability of occurring in a given year. The greatest flood was in 1881. In that year 14 feet of snow fell. A very warm spring in combination with changes in landscape caused the river to crest at 34 feet above normal. More recently, the years of 1965 and 1969 saw the river crest at 31.4 feet and

29.1 feet respectively. More information on Henderson's flood history is available at Henderson's interpretive center (U.S. Army Corp of Engineers, 1990).

Bridges and Ferries

Along with the flood history of Henderson interesting information concerning the bridges and ferries of the past years can also be displayed. The bridges built for Henderson have played an important part in the cities history. They have made the town more accessible to the surrounding area. A sign could be placed near the boat landing with the following information.

In the early days of Henderson, in order to reach the eastern side of the river a ferry service was installed. So in 1854, only two years after the town was developed a ferry was in place. The ferry had a flat bottom and was pulled across the river by ropes. It could hold two teams and a wagon. The use of the ferry increased when the Minnesota Valley Railroad was finished on the eastern side of the river in 1867. Corn and grain had to be ferried over to the trains for loading. The ferry became a very good investment with prices ranging from 25 cents to $40. When the 1877 bridge was finished the ferry service suffered and soon folded, only to be used again during times of flooding. The present bridge was built in 1987 and is five feet lower than the first bridge.

Wildlife

All along the corridor of the river wildlife can be seen. The canoeist could learn about the wildlife through a signage display in areas where wildlife may also be seen. An example of a sign could be:

The Minnesota River corridor holds a vast number of both game and nongame species. The most prominent is the 275 different species of birds. Many of these birds can be found within the Henderson area, six of which are listed on the threatened or special concern list. Included in this list is the bald eagle. While canoeing through the Henderson area look for the bald eagles during the fall as it migrates south. In 1986 wild turkeys were introduced to Henderson. The turkeys have been successful in establishing themselves in this habitat, their numbers have continued to increase

over the past five years. Listen for the noisy call of the wild turkey while canoeing through the corridor (see Wildlife report for more details).

Environmental Concerns

A final idea for signage along the river may incorporate concerns of river ecology. One idea for such signage could read as follows:

One of the major pollution concerns on the river is sedimentation. Sediments carried from agricultural, urbanization and road construction sites have settled into the Minnesota River. Because of the high bluffs careful attention needs to be given to the potential runoff. Chemical pollutants from industries along the river are also a major concern. Guidelines on the consumption of fish have been issued in places along the river. Henderson has been working to clean up the river through the program of "adopt a river". In the future the Minnesota River may once again be restored to it natural state.

FLOATING CLASSROOM

Henderson also has the opportunity to take advantage of the water resource for educational purposes. The Minnesota River, whether realized or not, has had quite an impact on the shaping and developing of Henderson. A unique program that Henderson could implement would be a floating classroom. This would provide the public with a special opportunity to learn first hand about the Minnesota River and Henderson's unique river and flood history. One way of approaching this type of service would be for Henderson to reconstruct a small steamboat to be placed in the Minnesota River. This steamboat could serve as an educational center where students of all ages can come and learn about the history of the Minnesota River as well as ways to protect it. Programs could provide informative classes on history, flooding, levee development, water treatment, and future environmental concerns.

Programs on Hendersons history could emphasize the steamboat hay-day and flood events. Artifacts from the early steamboat era could be displayed within the floating classroom. Steamboats first arrived on the Minnesota River in the mid-

1850's, during this time they were the best means for transportation. Many of the early settlers of Henderson probably came by way of the steamboat.

Flood history could be displayed using photos or newspaper clippings. Hendersons majors flood events could be highlighted and explanations on cause, damage, and prevention measures could be explained. Incorporated into the flood history would be the development of the levee system in and around Henderson.

Water treatment seminars could be offered throughout the summer months. Demonstrations of how water is collected and tested would provide an on hands opportunity to the public. Henderson would have the only educational use boat on the Minnesota River. Henderson could work with the Fresh Water Institute or the Geological Survey in designing such a program. Special speakers involved on the cutting edge of environmental issues could present current problems and possible solutions concerning surface water.

Another method of getting Henderson or the surrounding community more involved with the river is to establish an "adopt a river" program. School children, companies or society clubs could participate in helping to provide a clean river for the future. Each of the groups could be responsible for keeping clean a mile of the river.

ENVIRONMENTAL IMPLICATIONS

INTRODUCTION

The activities that have been proposed were chosen specifically because the quality of the water can support them and they are, to a certain extent, nondegrading. Since no activity is completely nondegrading, the environmental impacts of the recommended activities will be discussed in this section. In addition, the basic idea behind recommending these activities is that they will attract visitors into Henderson, which in turn can result in development of the community. The environmental implications of development will also be discussed in this section.

RECREATIONAL ACTIVITIES

The recreational activities that were recommended in this report were canoeing and sport fishing. These activities have the potential to result in minor degradation to the water resource. If parking facilities are expanded their surfaces can decrease the amount of precipitation infiltrated thus increasing the amount and speed of runoff into the river. Because of this, the runoff will contain a higher amount of sediment and possibly other pollutants such as rust, gasoline and oil from automobiles. One way to lessen the impact of an expanded parking facility would be to keep the surface gravel along with a small catchment to intercept parking lot runoff. This would allow time for precipitation to infiltrate and not flow directly into the river. Another impact of recreation is that motor boats can leak oil and gasoline into the water. With the amount and size of boats that would be expected in the area, this problem would not be very significant.

As discussed earlier, bank fishing and even canoe landing can lead to streambank erosion. These activities can also destroy the vegetation along the stream which can affect the animals that use this vegetation and the fish that use the vegetation for shade. Because of this, these activities should only take place in specified areas where the streambank is stabilized.

EDUCATIONAL ACTIVITIES

The potential environmental impacts of the educational activities that were discussed here are similar to those discussed above in regards to the parking facilities and canoe landings. Another consideration of the educational activities is that signage can have a negative impact on the natural environment. To minimize this impact, signs would be placed in areas where they can be viewed by a canoer that is looking for interpretive information, but are not so visible that they take away from the natural integrity of the area.

Another aspect of the educational opportunities that was discussed is that of the floating classroom. The possible areas of concern with this activity are that it could pollute the river and that it would need an expanded parking lot. These impacts were discussed above. The pollution involved with the boat itself could be kept to a minimum just by proper maintenance of the boat and by training the operators as to proper methods for fueling and operating.

WILDLIFE VIEWING ACTIVITIES

The environmental implication associated with wildlife activities is that an increase in human activity can be detrimental to certain wildlife species. Specific species that could be affected by human activity are those that are categorized as rare species. The Minnesota Department of Natural Resources, the state agency which is in charge of wildlife resources, uses three definitions to categorize rare species:

State endangered (E) - Any species threatened with extinction throughout all or a significant part of its range, or
- A species threatened with extirpation within Minnesota and dependant on a scarce, sensitive, and/or exploited habitat in Minnesota and neighboring states.

State threatened (T) - A species likely to become endangered (based on the criteria listed for the endangered category) within the foreseeable future.

Special concern (SC) - A species that, although not endangered or threatened, is extremely uncommon in Minnesota, or has unique or highly specified habitat requirements and deserves careful monitoring of its status, or

- A species on the periphery of its range that is not listed as endangered or threatened,
- A species that was once endangered or threatened but now has increasing or protected, stable populations, and/or
- A species whose breeding biology is affected by human activities.

(Pfannmuller and Coffin, 1989).

Bird species which may still be found in the Henderson area, listed as threatened or special concern by the DNR include: the bald eagle (T), the loggerhead shrike (T), the American bittern (SC), the common moorhen (SC), the upland plover (SC), and Forster's tern (SC). Other animal species include the eastern spotted skunk (SC), the gopher snake (SC), the shovelnose sturgeon (SC), and the Poweshiek skipper butterfly (SC), (Coffin and Pfannmuller, 1988). Although there are other species of wildlife that could be impacted by an increase in human contact, the species on these lists are considered more vital due to their rarity.

Endangered and threatened plant and animal species are listed under the provisions of the **Federal Endangered Species Act of 1973, Public Law 93-205** and/or **Minnesota Statute 97.488**. The federal law prohibits the "taking" of endangered animals wherever they occur and protects plants wherever there is federal involvement in the form of funding or permits. The state law imposes the same restrictions on taking, import, transport or sale to both endangered and threatened animal and plant species. Both federal and state laws have substantial penalties for violations.

URBAN DEVELOPMENT

A possible outcome if these recommendations are followed is that the city of Henderson could expand spatially. In other words, houses, retail spaces, etc. could be added. For a discussion of these changes see the Land Use report. For this

discussion, it is assumed that a moderate amount of urban development will occur so that the impacts on water quality can be examined.

Note that these impacts are due to development of the community and are not restricted to water based activities. Any land use changes or development ideas can result in these problems.

The first thing to consider when discussing the effects of urban development on water quality is the implications of new construction of buildings and roads. Construction typically involves the removal of vegetative cover and the exposure of soil for long periods of time. This bare soil is then quite susceptible to erosion, either by wind or rain. Since erosion is one of the major ways pollutants travel to the river, an increase in erosion could mean a further reduction in water quality for this section of the river.

Another aspect of urban development that should be discussed is that of the increase in impervious surfaces. With any development it is safe to assume that there will be an increase in surfaces, such as concrete or pavement, that do not allow precipitation to penetrate. The implications of this is that more water will run off into the river directly off these polluted surfaces instead of being naturally cleaned by traveling through the soil. The water that travels across these surfaces will also flow at a higher velocity which increases its potential for erosion when it does contact soil.

Other areas of urban stress to water quality road de-icing, and lawn fertilization. If more roads are built in the Henderson area, the amount of salt used for ice melting will need to be increased as will the amount of lawns needing fertilization The implication of this is that these agents will travel into the river which can negatively impact the quality of the water.

Sewer

Sewer treatment is provided for the residents by the city of Henderson. The treatment plant was constructed in 1969. It is a mechanical stabilization system with total daily usage of approximately 85,000 gallons. Maximum design capacity is 250,000 gallons per day. The system serves about 280 customers. The sewer system is an important consideration, if the amount of visitors to town increased. The system

can handle 250,000 gallons per day, but after that point is reached considerations must be made as to expansion.

GROUNDWATER

INTRODUCTION

Groundwater is a valuable resource, with numerous uses; including domestic, animal production, heating and cooling, and fire protection just to name a few. Groundwater is defined as water that occurs in saturated zones beneath the soil surface (Brooks, Ffolliot, Gregerson, and Thames, 1991). When examining groundwater, quality and quantity are of the utmost importance, as they determine how much and for what purpose it will be used. Water-bearing porous soil or rock strata that yield significant amounts of water to wells are defined as aquifers (Brooks et al., 1991). The Mount Simon aquifer supplies the main source of water to the city of Henderson Minnesota (figure 1). The Mount Simon aquifer is the most extensive bedrock unit in southeast Minnesota and is a good source of water, because of large quantities of water in storage, adequate yields to wells, and good water quality (Wolf, 1983). Aquifer characteristics can be an important consideration for development. Defining what use the water is intended for, and the funds available for the development, can be a critical factor in determining the construction of the well and the depth to the most suitable aquifer. The city of Henderson has two municipal wells from which they can draw water. Municipal well #1 is their main source of water whereas municipal well #2 is their secondary or backup source.

MUNICIPAL WELL #1

Municipal well #1 was drilled in 1981 by Hydro Engineering Inc. and is the main source of water for the city of Henderson. The original specifications for well #1 are as follows:

Depth: 900 ft.
Capacity: 465 gallons per minute (g.p.m.).
Aquifer: Mount Simon.
Annual Usage: 28,000,000 gallons
Storage Capacity: 169,000 gallons

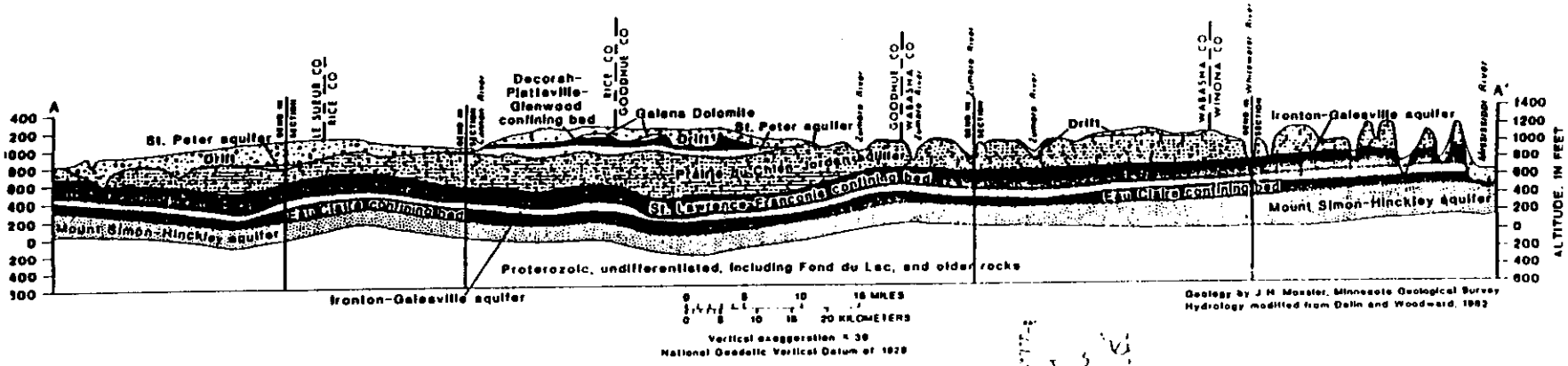
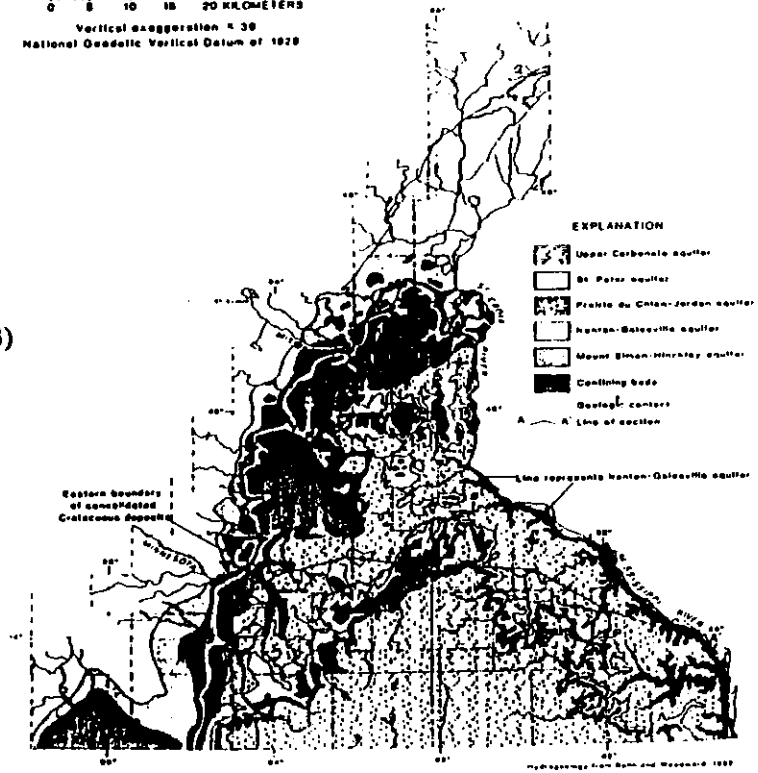


FIGURE #1 (U.S.G.S. 1983)



In June of 1989 , well #1 was Gamma Logged by the Minnesota Geological Survey. A Gamma Log is a test which measures radioactivity of the various strata to determine geologic formations. An instrument which detects radioactivity is inserted to the bottom of the well; and as it is brought back up it records the radioactivity of the various layers that it is passing through. The results of the test, which were performed on well #1, indicated that the formations at a depth of 750ft.-900ft, were showing signs of a higher level of radioactivity.

High levels of radium, exceeding the Department of Healths set standard of 5 picocuries per liter (pci/l) for the combined total of radium 226 and radium 228, were showing up on test results. A picocurie is a unit of measurement, defined as one trillionth of a unit of radioactivity. Radium is a known carcinogen, so there can be health risks associated with exposure to these isotopes (see Radiological).

In December of 1990 the city of Henderson grouted the well from a depth of 750-900ft. in hopes of reducing the radium levels. Grouting, is a process of filling in with cement. The grouting reduced the depth of the well to roughly 750 ft. Soon after the grouting was completed problems arose with the well in terms of not supplying enough water. Pumping capacity fell below 465 gallons per minute (gpm). The pump had to be lowered inside the well to accommodate for the reduction in depth due to grouting. After the pump was lowered the capacity was brought back up to acceptable levels.

Information pertaining to the history of, and the construction of a well may be useful to planners. The company that drilled the well might be of assistance in helping plan for an increase in usage due to community development. Any record of past repairs to the well might be useful in predicting future problems as well as capacities that are attainable with the current setup.

MUNICIPAL WELL #2

Municipal well #2 was constructed in or about 1896 and has been in continuous use since that time. This well is approximately 706 ft. deep and has a pumping capacity of 96 gallons per minute (g.p.m.). This well is a multi-aquifer well, meaning it draws water from more than one aquifer. Because this well is a multi-aquifer well it is

outdated and could pose a risk for contamination of more than one aquifer. For this reason the well is used as a secondary source. Once the well runs dry it must be sealed properly to protect against contamination.

Considerations must be made on the part of the community to ensure that a secondary source of water is available in the event their primary source of water is for some reason reduced, tainted, or unavailable do to mechanical failure.

GROUNDWATER QUALITY

Substances that alter the quality of water as it moves over or below the surface of the earth may be classified under four major headings, Physical, Chemical, Biological, and Radiological characteristics (Wetsell, Lee, Hockman, and Briggs, 1982). Water quality is an important characteristic to examine, because the degradation of water quality adversely affects the lives of all the community members.

Physical

Physical characteristics relate to the quality of water and are usually associated with its color, taste, and odor in particular.

Turbidity is associated with the presence of clay, silt, or finely divided organic material. The principle objection to turbidity is that it is aesthetically displeasing. Turbidity can be used as an indicator of surface pollution entering the groundwater, due to the variation in turbidity after a rainfall event.

Taste and odor in groundwater can be affected by salts or dissolved gases. these substances can come from agriculture, domestic, or natural sources (Wetsell et al., 1982). Due to the depth of the Mount Simon aquifer that well #1 is pumping from, any clay particles or decaying vegetation would be filtered out, and would not affect the color, taste, or odor of the drinking water.

Chemical

Chemical analysis of well water can reveal a plethora of information, such as the presence of harmful or disagreeable substances, potential for corrosion, and the tendency for water to stain fixtures and clothing. Examples of parameters that can be a nuisance or harmful are as follows.

The Environmental Protection Agency (EPA) recommends that the sulfate content should not exceed 250 mg/l. Higher levels of sulfates may be undesirable because of their laxative effects.

Hard water due to high levels of calcium carbonate can be a nuisance in the respect that it retards the cleaning action of soaps and detergents, causing an expense in the form of extra work and detergents.

The presence of iron in water is considered a nuisance because it imparts a brownish color to laundered goods, stains fixtures, and adversely affects the taste of beverages such as tea and coffee. Recent studies indicate that eggs spoil faster when washed in water containing iron in excess of 10 mg/l. The EPA recommends that the iron limit remain at .3 mg/l or less (Wetsall et al., 1982).

Nitrates have been linked to methemoglobin in infants who have been given water or fed formulas prepared with water having high nitrate levels. This disease is also known as blue baby syndrome. Methemoglobin reduces the amount of oxygen that can be transported from the lungs to the body cells. Nitrate levels should not exceed 10 mg/l. If this level is exceeded, the water should not be fed to an infant (Markley, 1991).

Biological

Biological factors include bacteria, such as fecal coliform. Water for cooking and drinking must be made free from such organisms. Some organisms that cause disease in men and women originate with the fecal discharges of infected animals. The presence of coliform bacteria is often used as an indicator of groundwater contamination (Markley, 1991). The causes of coliform contamination can be due to faulty septic systems or improper disposal of animal feces. The recommended levels for drinking water are limited to one organism per 100 milliliters of water. As far as Henderson is concerned, the depth of the aquifer and confining layers play a big role in filtering and reducing the possibility of contamination.

Radiological

The effects of human exposure to radiation are viewed as harmful and any unnecessary exposure should be avoided. The maximum allowable radium levels in municipal supplies is 5 picocuries per liter (pci/l) for both radium 226 and radium 228. Hendersons well #1 has averaged 14 pci/l over the past 4 tests. Hendersons well #2 is within the allowable limit of 5 pci/l. Henderson took the necessary steps to try reduce the level of radium to the set standards of 5 pci/l by grouting. Recent tests have shown that the level of radium was reduced to 6.6 pci/l.. The United States Environmental Protection Agency is proposing to raise the maximum allowable limits of radium. The proposal would increase the allowable limits from a combined (Ra 226, Ra 228) of 5pci/l to 20 pci/l for radium 226 and radium 228 respectively. The maximum contaminant level (MCL) for radium will be some value from 5 to 20 pci/l for each radium isotope. It will be approximately three years before these new MCL's are legally enforceable (Clark, 1991). What this increase means, is that communities that were over the MCL's for radium, including Henderson, will most likely be in compliance when the new MCL's for radium are put into effect.

The economic implications associated with hike in radium levels will be noticed by communities that are over the maximum contaminant level. Because this is in the proposal stage, communities will not be held responsible and will not need to allocate funds to remedy the situation. Economics, and the fact that there is still more information that needs to be gathered pertaining to radium and threshold limits, may be the reasons that the maximum contaminant level is under consideration for an increase.

DOMESTIC WELLS

Water quality tests that have been performed on domestic wells in and around the Henderson area should be kept on file in Henderson.. This information can be useful for new homeowners as well as the city for monitoring water quality data, and observing changes in levels of contaminants over the years.

Wells that are abandoned and properly sealed should also be kept on record. This information can be useful in determining what wells were abandoned, how they were sealed, who sealed the well, and the date they were abandoned. Contamination

can enter aquifers if wells are improperly sealed or not sealed at all. Before the sale of a property can be closed, any abandoned well must be properly sealed by a contractor that is certified by the state. This, and other information pertaining to water well records, is easily obtained from the Minnesota Geological Survey.

CONCLUSION

In this description of the water resources in the Henderson area, various aspects have been looked at closely. The Minnesota River was the major area of focus, but the groundwater in Henderson was also studied. The main purpose was to describe the possible uses of the river and how these uses could benefit Henderson. These activities had to be narrowed because of the somewhat poor quality of the water in the river. The uses that were eliminated because of the water quality were domestic consumption, swimming and consumption of fish. The uses that were considered degrading to the water resources were also eliminated. After these considerations, the activities that were examined were canoeing and sport fishing, wildlife related activities and educational opportunities.

Canoeing and sport fishing were found to be the best suited recreational activities for the river because of the limitations placed on the river by its quality. Possible future uses, such as swimming may also be implemented only when the water quality improves enough to warrant it.

The rivers wildlife resources, which if properly managed, will be sustainable for many generations. The white tailed deer and wild turkey mentioned here are two game species for which there is solid management experience to draw upon. Fee hunting is one promising way this resource may be tapped.

The river corridor near Henderson was found to offer an excellent opportunity for educational activities. Through both a self-guided interpretive canoe trail and a floating classroom, Henderson can lay the groundwork for an innovative method of learning about environmental education. Henderson can also use the river to share its history and development with those who enter into the area. This report presents ideas and examples that Henderson may wish to consider for future planning of their city.

If community development is a possibility, the groundwater resources might want to be examined closely, in terms of quantity and quality. When examining groundwater, quantity and quality are of the utmost importance, as they determine how much and for what purpose it will be used.

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