

FIRST UPDATE

Murray County Comprehensive Local Water Plan

Developed according to guidelines established by:

**MINNESOTA STATUTES CHAPTER 103B
and
The Board of Water and Soil Resources**

Prepared by:

**Murray County Water Planning Committee
with assistance from the
Redwood-Cottonwood Rivers Control Area**

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HISTORY OF THE WATER PLANNING PROCESS

The Murray County Board of Commissioners adopted a resolution on October 10, 1987 to develop a Comprehensive Local Water Plan according to Minnesota Statutes 110B. This plan was developed as part of a multi-county project under the direction of the Redwood-Cottonwood Rivers Control Area (RCRCA). The purpose of the plan was twofold: to identify existing and potential problems and opportunities for the protection, management and development of water and related land resources; and to develop objectives to carry out a plan of action to promote effective environmental protection of these resources. The plan was to include surface water, ground water and related land resources within its scope.

In August of 1988, a committee was organized to guide the development of the Comprehensive Local Water Plan, advise the Murray County Board on contents of the plan, and act as link between the public and the County Board. The Committee reviewed and evaluated resource information, established goals, objectives and actions, developed an implementation program, and generated public involvement and support. The Committee met on a monthly basis to give direction to RCRCA in formulating the plan.

Several methods were employed to receive input for the plan. Municipalities were sent a questionnaire seeking information on existing water resources and their perceived problems with these resources. A public informational meeting was held on January 11, 1988. In the fall of 1988, information was requested from township boards on where possible problem areas might exist in reference to soil erosion and sedimentation, requesting information on where possible problem areas might be. The result of a survey conducted by the Countryside Council and the Redwood-Cottonwood River Control Area (RCRCA) entitled Water Management Task Force Final Report, 1987, was considered (Appendix A). Considerable time was also spent by the Committee reviewing local controls and plans already in existence within Murray County.

Draft copies of the Murray County Comprehensive Local Water Plan were submitted for preliminary review in October of 1989 to all local units of government in Murray County, all counties contiguous to Murray County, and the Southwest Regional Development Commission. The draft plan was also submitted to various state agencies for their comments.

A public hearing was held in January of 1990, where comments from residents and local agencies were heard by the County Board. Comments were also received from

three state agencies and the Regional Development Commission. Following the review of these comments by the Water Planning Committee the final draft of the plan was prepared.

A final draft was submitted to the Minnesota Board of Water and Soil Resources (BWSR) on June 1, 1990 and officially received approval from BWSR on August 22, 1990. The plan was then adopted by the Murray County Board of Commissioners on September 4, 1990.

According to Minnesota Statutes, Chapter 103B.301, Comprehensive Local Water Management Act, counties are required to update and revise their local water management plans on a periodic basis. The Board of Water and Soil Resources (BWSR) determined that water management plans need to be revised after the first five years of implementation, coinciding with the year 1995. Anticipating the required revisions, the Murray County Comprehensive Local Water Planning Committee has been meeting to re-evaluate the water plan and assess changes that may have occurred in Murray County's goals, issues and priorities over the previous five years.

On December 7, 1995 the Murray County Board of Commissioners adopted a resolution to update and revise the Comprehensive Local Water Plan. A public information meeting regarding revisions to the plan was held on March 13, 1995. The purpose of this meeting was to give the general public, local units of government, and state agencies an opportunity to present information and concerns about water related issues they believe should be considered in revisions to the plan.

On December 20, 1995 the Board of Water and Soil Resources granted Murray County a one-year extension for revisions to the local water plan, due to a delay in receiving the new requirements requested from the State. In July of 1996 draft copies of the revised Murray County Comprehensive Local Water Plan were distributed for a sixty day review period to the Murray County Water Planning Committee, all municipalities and townships located in Murray County, counties contiguous to Murray County, the Southwest Regional Development Commission, the MN Board of Water and Soil Resources and various state agencies.

A public hearing was held on September 24, 1996, where comments from residents and local agencies were heard by the County Board. Comments were also received from three state agencies and the Regional Development Commission. Following the review of these comments by the Water Planning Committee an updated final draft of the plan was prepared.

The revised Murray County Comprehensive Local Water Plan is intended to guide water management decisions for the next ten years, covering the period of 1996-2006.

MURRAY COUNTY, MINNESOTA

Murray County was officially established by the Minnesota Legislature on May 23, 1857. Murray County was named after William Pitt Murray, an early official from the city of Saint Paul, Minnesota.

According to the most recent census report (1990), the population of Murray County is 9,660. Between 1980 and 1990, the County experienced an overall 16 percent decrease in the total population. The County seat, and largest city in Murray County, is the city of Slayton with a population of 2,147.

Murray County is located in southwestern Minnesota and covers a land area of approximately 721 square miles. The predominant land use in the County is agricultural production, with some 1,040 farm sites averaging 393 acres each. The average farm land values are from \$1,000 to \$1,200 per acre, with the most productive land located in the central and eastern portions of Murray County. Farmland is less concentrated along the Bemis Moraine (Buffalo Ridge) in the western portion of the County, due to the unfavorable topography. The only other significant non-farm land use is the recreational and vacation home development around the major lakes of Shetek, Bloody, Sarah, and First and Second Fulda. Unlike most other southwestern counties, Murray County has an abundance of surface water.

Murray County contains the headwaters of four major watersheds. The watersheds of the Redwood River and Cottonwood River drain into the Minnesota River. The Rock River watershed drains into the Big Sioux River which then flows into the Missouri River. The Des Moines River watershed enters the state of Iowa and eventually drains into the Mississippi River.

The rolling topography of Murray County is the result of glacial activity. The Bemis Moraine, which effects the direction of surface water drainage, was formed during the Wisconsin Glaciation. Major aquifers are found in sand and gravel lenses buried at various depths within the glacial till. Regional ground water movement is eastward towards the Des Moines River, and lies within 50 feet of the land surface throughout most of the County. Bedrock underlying Murray County is Sioux Quartzite and Cretaceous sandstone that also produces water similar to that found in deeply buried sand and gravel deposits.

PRESENTING INFORMATION

In order to gain sufficient understanding of existing natural features that serve as the basis for the comprehensive water plan, the Murray County Comprehensive Water Planning Committee has assembled the following information about the physical environment and the surface water, ground water, and related land resources of the County. This information provides the basis for understanding Murray County's present and future water-related opportunities and/or problems.

Information has been gathered from numerous local, regional and state agencies, including the Departments of Natural Resources, Health, Agriculture, Pollution Control, and the Southwest Regional Development Commission. Information was also collected from the Middle Des Moines Watershed District, Area II, Murray County and municipalities. Through careful review and discussion of these materials, it has been determined that no apparent conflicts exist between the Murray County water plan and the mission of other local units of government.

The information presented in this document goes beyond the requirements of the Comprehensive Local Water Management Act (Minnesota Statutes, Chapter 110B) and the associated state rules (MCAR, Chapter 9300). The outline for the plan closely follows the outline used in The Handbook for Comprehensive Local Water Planning, 1987.

During the five year update of the Comprehensive Local Water Plan, several additional requirements were recommended as revisions to the plan by newly enacted laws administered through various state agencies. The recommended changes are summarized as follows:

A watershed context was incorporated into revisions of the water plan. The intent of the watershed context is to relate land management to water management through watersheds. In watershed management, decisions on the land relate to the problem, needs, or goals for a particular water resource. Counties can then identify trends, problems or opportunities specific to a watershed area, rather than assuming the problem or issue is county-wide. Rather than developing a new separate watershed assessment for the Murray County water plan, watershed information has been incorporated into the existing assessments and is included under such headings as: Watersheds, Land Use, Soils and Surface Water Quality (Clean Water Partnership projects).

During the water plan revision, counties were also required to consider water retention devices for all new developments that create more than one acre of impervious surface. A water retention device refers to any constructed control, storm water pond,

or natural depression or installed wetland which temporarily stores storm water runoff with the purpose of retaining sediment and or nutrients. A impervious surface means a constructed hard surface that either prevents or retards the entry of water into the soil and causes water to runoff the surface in greater quantities and at an increased rate prior to the development.

To address this requirement, Murray County added a new objective to the water plan stating their intention to adopt and enforce existing published standards and criteria for erosion control and stormwater design. In the event a new development creates one acre or more of impervious surface, specific criteria for erosion control will be established which will utilize the best available technology to minimize off-site runoff, maximize overland flow over vegetated areas, minimize off-site discharge of pollutants to ground and surface water, and encourage natural filtration functions.

Concerned about the possible contamination of public wells, the Ground Water Protection Act was passed in 1989. The Act, administered through the Minnesota Department of Health (MDH), requires public water servers to develop a wellhead protection plan to protect the wellhead management zone and surrounding area from possible contamination. An objective was added to the water plan stating Murray County's intention to provide assistance to these public water suppliers as they develop and implement wellhead protection plans. Information regarding the ranking schedule assigned by the MDH is included under Ground Water Quality.

To address the issue of ground water sensitivity, a Level 1 Ground Water Assessment was completed by the Minnesota Department of Natural Resources (DNR), Division of Waters for Murray County. The assessment provides a sensitivity rating for each mapped soil unit as reported in the Murray County Soil Survey. The assessment estimates the permeability characteristics of the soil parent material and relates that to a sensitivity rating. Additional information regarding the ground water sensitivity ratings is included under Ground Water Quality.

Recognizing the important benefits of wetlands, the Minnesota Legislature enacted the Wetland Conservation Act (WCA) in 1991. The law regulates the drainage and filling of wetlands, and if wetland loss is unavoidable, requires replacement. Since Murray County is located in a high priority wetland region, the County designated all eligible land area as a high priority wetland area. This designation was included as a new objective during revisions to the Murray County local water plan.

It is recognized that some data considered in this plan was out of date when the plan was originally organized in 1990. An attempt was made to update all data, if such data was readily available when revisions were made to the plan in 1996. In addition to the new requirements, several other information items were incorporated into the update of the water plan. These new information items include: a soil survey of

Murray County; updating rain gauge stations; incorporating a watershed context into land use data; updating the rural water service area under public utility service, providing additional testing data under surface and ground water quality, updating drainage issues and the ditch expense table; listing the number of permitted feedlots, updating the number of abandoned wells sealed; and updating the expected changes for Murray County. It is the intent of Murray County to periodically update the plan as new information becomes available.

PRECIPITATION

Average annual precipitation in Murray County is approximately 25 inches (Illustrations 1 and 2). About 17 inches, or 68 percent of this amount normally falls during the period of May through September. There are 17 precipitation observation sites, recording both rain and snowfall, managed by the Murray County Soil and Water Conservation District (SWCD). Fifteen of these observation sites are located within the Des Moines River watershed. One observation site is in each the Rock and Cottonwood River watershed. There are no sites within the Redwood River watershed.¹

GEOLOGY AND WATER RESOURCES

A thick mantle of glacial drift covers all of Murray County. The thickness of the drift is highly variable ranging in depth from less than 100 feet in the northeastern and southeastern portions of the County to more than 400 feet in the west. The drift has sand and gravel lenses which serve as local aquifers.

Below the glacial drift lies an irregular layer of sandstones and shales of Cretaceous age. A wide band of sandstone runs diagonally across the County from the northwest to the southeast. Areas outside this band consist mostly of shale with some limited sandstone and limestone beds. Very few wells in the western part of the County penetrate the Cretaceous material due to the thickness of the overlying drift. In the northeast and southeast, however, sandstones and shales lie much nearer to the surface.

The deepest rocks in the County consist of Precambrian bedrock of two types. A narrow band of granite runs across the northeast corner; Sioux quartzite underlies the remainder of the County. The quartzite is extremely thick with an irregular upper surface that influences the variable depths of overlaying Cretaceous formations. It lies in a series of peaks and valleys, with the valleys often filled or partially filled with Cretaceous sediments.

Throughout most of the County, water can be readily obtained from aquifers contained within the glacial drift. Well yields from these aquifers are highly variable, however. In addition, there is considerable variation in the depth at which water can be located. In general, sand or gravel aquifers at depths of 75 to 300 feet below the land surface can be expected to supply moderate yields of water.

Outwash underlying the Des Moines River valley forms the largest surficial aquifer in the County (Illustration 4). The river valley is about one-half mile wide near Lake Shetek, increasing to a width of two miles at the Cottonwood County boundary. Deposits consist of fine sand to coarse gravel imbedded with lenses of silt ranging from 6 to 40 feet in thickness. Yields from wells finished in the aquifer are moderate to large with the most productive area extending southeastward from the city of Currie for a distance of about seven miles.

Additional surficial aquifers are located in the valleys of Beaver, Chanarambie, Lime, Plum and Willow Creeks. These aquifers yield only small quantities of water.

Cretaceous rocks underlying the glacial drift can supply moderate to large amounts of water, particularly across the central region of the County. In this region, loosely cemented

¹University of Minnesota, Climates of Minnesota 1951-1994, 1995.

sandstones can be a dependable source of water for a variety of uses.

The Sioux quartzite formations in the County are not reliable sources of water. The yield of water from these basement formations depends upon the quality and size of joints and the degree of cementation. Usually the joints or crevices are small and the beds are only slightly pervious, making it necessary to drill relatively deep in order to make contact with numerous water bearing openings to obtain an adequate supply. Drilling in the Sioux quartzite is slow and difficult.²

Although the exact location of recharge areas in the County have not been identified, there are some general indicators pointing to ground and surface water interconnections. These are primarily related to streams and rivers that derive flow from ground water during late summer, fall and winter and replenish shallow aquifers at other times of the year. (See discussion on surface water quantity).

WATERSHEDS

Murray County contains the headwaters of four major watersheds (Illustrations 6 and 7.) The watersheds of the Redwood and Cottonwood Rivers drain into the Minnesota River, the Rock River watershed drains into the Big Sioux and then into the Missouri River and the Des Moines River watershed enters the state of Iowa and empties into the Mississippi River.

²U.S. Department of the Interior, U.S. Geological Survey, Water Resources of the Des Moines River Watershed, Southwestern Minnesota, HA-553, 1976.
U.S. Department of the Interior, U.S. Geological Survey, Water Resources of the Rock River Watershed, Southwestern Minnesota, HA-555, 1976.

The largest watershed is the West Fork of the Des Moines River, which contains approximately 525 square miles or 72 percent of the surface area in the County. Within this watershed lies the majority of the lake bodies and 49 minor watersheds. Two sub-watersheds worth noting are the Shetek, including Beaver Creek, and Heron Lake watersheds.

The Cottonwood River drains 95 square miles of the northeastern corner of the County. This watershed contains 15 minor watersheds within the County. The Rock River watershed is located in the southwestern corner of the County and contains 12 minor watersheds within the County. The smallest watershed is the Redwood River, which contains approximately 15 square miles or 2 percent of the surface area in the County. It contains four minor watersheds within the County.

Illustration 1 shows the existing dams and control structures (1990) and Illustration 5 is the Minnesota Department of Natural Resources' map of Murray County Public Waters.

Public waters and wetlands listed on the map are subject to Minnesota Statutes, Section 105.42 permit requirements. According to state regulations, public waters are defined as "being capable of substantial beneficial public use." Lakes and ponds less than 25 acres in size and rivers and streams having a total drainage less than two square miles, however, are not regulated.

SOILS

Illustration 8 shows the location of nine soil associations within the County (General Soils Map of Murray County, 1989). All but the

Everly-Litri-Wilmington and Venna-Hidewood-Lismore soil associations are found in the Middle Des Moines watershed. The Everly-Litri-Wilmington association is entirely within the Rock River watershed along with five other associations. The Redwood River watershed is entirely the Barnes-Flom-Vallers soil association.

***BARNES-FLOM-VALLERS
ASSOCIATION***

This association is mainly on irregular, complex slopes on undulating moraines. The elevation is one of the highest in the County. Drainage patterns are complex; the landscape has many closed depressions. Slopes range from 0 to 18 percent.

This association makes up about 26 percent of the County. It is about 35 percent Barnes soils, 20 percent Flom soils, 15 percent Vallers soils, and 30 percent soils of minor extent.

This association generally is well suited to cultivated crops. Water erosion on the Barnes soils and wetness in the Flom and Vallers soils are the major management concerns. In many areas of the Barnes soils, slopes are too irregular or complex for contour farming. Applying a system of conservation tillage and including grasses and legumes in the crop rotation help to control erosion. Tile drains and surface ditches can remove the excess water in the Flom and Vallers Soils.

BARNES-BUSE ASSOCIATION

This association is mainly on irregular, complex slopes on end moraines. The elevation is one of the highest in the County. Drainage patterns are complex; the landscape has many short, deep drainageways. Slopes range from 2 to 40 percent.

This association makes up about 10 percent of the County. It is about 55 percent Barnes soils, 20 percent Buse soils, and 25 percent soils of minor extent.

This association generally is well suited or fairly well suited to cultivated crops. Water erosion is the main management concern. In most areas the slopes are too irregular or too complex for contour farming. Applying a system of conservation tillage and including grasses and legumes in the crop rotation help to control erosion.

***CLARION-WEBSTER-NICOLLET
ASSOCIATION***

This association is mainly on convex slopes on moraines at the lower elevations in the County. The landscape is characterized by shallow, low-gradient swales and by narrow flats at the head of drainageways. Slopes range from 0 to 18 percent.

This association makes up about 21 percent of the County. It is about 35 percent Clarion soils, 20 percent Webster soils, 15 percent Nicollet soils, and 30 percent soils of minor extent.

This association generally is well suited to cultivated crops. Water erosion on the Clarion soils and wetness in the Webster soils are the major management concerns. The Nicollet soils have no major limitations, but soil blowing is a problem if no crop residue is left on the surface when fields are plowed. Contour farming and terraces help to control erosion on the Clarion soils. Conservation tillage helps to control erosion and soil blowing on the Clarion and Nicollet soils. Tile drains and open ditches can remove the excess water in the Webster soils.

CLARION-STORDEN ASSOCIATION

This association is on complex, undulating and steep knolls and very steep side slopes along streams on end moraines. The elevation is generally less than 1,600 feet. Runoff is rapid on the steep knolls. Short, incised drainageways are common. Slopes range from 2 to 40 percent.

This association makes up about 8 percent of the County. It is about 60 percent Clarion soils, 20 percent Storden soils, and 20 percent soils of minor extent.

This association generally is well suited or fairly well suited to cultivated crops. Water erosion is the main management concern. Contour farming and water-control structures help to control erosion in areas where the slopes are suitable for these measures. In some areas where the slopes are too irregular for contour farming, erosion can be controlled by applying a system of conservation tillage and including grasses and legumes in the crop rotation.

EVERLY-LETRI-WILMONTON ASSOCIATION

This association is in slightly convex and plane areas on moraines. In a few areas it is rolling to moderately steep. The steeper areas are mainly along deep drainageways and streams that dissect the association in a northeasterly direction. Slopes range from 0 to 14 percent.

This association makes up about 7 percent of the County. It is about 45 percent Everly soils, 20 percent Letri soils, 15 percent Wilmonton soils, and 20 percent soils of minor extent.

This association generally is well suited to cultivated crops. Wetness in the Letri soils and the hazard of water erosion on the Everly soils are the major management concerns. The

Wilmonton soils have no major limitations, but soil blowing is a problem if no crop residue is left on the surface when fields are plowed. Tile drains remove the excess water in the Letri soils. Contour farming and terraces help to control water erosion on the Everly soils. Conservation tillage reduces the hazard of soil blowing on the Everly and Wilmonton soils.

COLLINWOOD-CLARION-WALDORF ASSOCIATION

This association is mainly on nearly level, slightly convex slopes and on flats, but some areas are on convex, undulating slopes. The water-worked glacial sediments were deposited over a complex topography of glacial till, forming a smoother, gently sloping landscape with broad, flat drainageways and meandering streams. In some areas on the undulating slopes, the glacial till is not overlain by lacustrine sediments. Slopes range from 0 to 12 percent.

This association makes up about 12 percent of the County. It is about 30 percent Collinwood soils, 25 percent Clarion soils, 15 percent Waldorf soils, and 30 percent soils of minor extent.

This association generally is well suited to cultivated crops. Wetness in the Waldorf soils, soil blowing on the Collinwood soils, and water erosion on the Clarion soils are the major management concerns. Tile drains and open ditches remove the excess water in the Waldorf soils. Conservation tillage helps to control soil blowing and water erosion on the Collinwood and Clarion soils. Contour farming and terraces also help to control water erosion on the Clarion soils.

***VIENNA-HIDEWOOD-LISMORE
ASSOCIATION***

This association is on long slopes on loess-mantled ground moraines. The complex topography of the underlying glacial till was filled in and leveled when loess was deposited. Smooth, convex slopes are dissected by broad, low-gradient drainageways. The drainageways are incised into the underlying glacial till. Slopes range from 0 to 15 percent.

This association makes up about 8 percent of the County. It is about 45 percent Vienna soils, 15 percent Hidewood soils, 15 percent Lismore soils, and 25 percent soils of minor extent.

This association generally is well suited to cultivated crops. Water erosion and soil blowing are the major management concerns on the Vienna and Lismore soils. Wetness in the Hidewood soils is an additional concern. Contour farming and terraces help to control water erosion on the Vienna soils. Conservation tillage reduces the hazard of soil blowing on the Lismore and Vienna soils.

***ARVILLA-EGELAND-MARYSLAND
ASSOCIATION***

This association is in convex and plain areas on river terraces, in overflow channels, on outwash plains, and on moraines. In places the outwash is less than 4 feet thick and is underlain by glacial till or silty sediments. Slopes range from 0 to 15 percent.

This association makes up about 7 percent of the County. It is about 35 percent Arvilla soils, 25 percent Egeland soils, 10 percent Marysland soils, and 30 percent soils of minor extent.

This association is well suited to pasture and hay and is fairly well suited or poorly suited to

cultivated crops. Droughtiness and soil blowing are the major management concerns. Water erosion is an additional concern in the sloping and moderately steep areas. Soil blowing can be severe, especially where the soils have been fall plowed. Applying a system of conservation tillage and leaving crop residue on the surface reduce the hazards of water erosion and soil blowing and conserve moisture. Irrigation can improve crop production where an adequate water source is available.

***LAMOURE-LA PRAIRIE
ASSOCIATION***

This association is in long, narrow areas on flood plains. In places deposits of outwash sand and gravel are intermingled with the silty alluvial sediments. Slopes range from 0 to 2 percent.

This association makes up about 1 percent of the County. It is about 60 percent Lamoure soils, 20 percent La Prairie soils, and 20 percent soils of minor extent.

Where artificial drainage and flood control are feasible, this association is well suited to cultivated crops. The Lamoure soils have a seasonal high water table and are occasionally or frequently flooded. The La Prairie soils are occasionally flooded. The flooding usually occurs in the spring. About once every 10 years, it occurs during the growing season, when it damages crops.³

Additionally, Illustrations 9, 10, 11 and 12 show infiltration characteristics of County soils and their potential for erosion. The Murray County Soil Survey contains more detailed information about the County's soils.

³Murray County Soil Survey, 1989.

ORIGINAL VEGETATION

Diverse ecological systems characterized Murray County before European settlement in the region (Illustration 13). Open grasslands covered most of the uplands, while many lakes, ponds and marshes occupied low pockets in areas of gently rolling topography such as around Great Oasis Lake and the river bottom forest by Lake Sarah and Lake Shetek. Large populations of grazing mammals, such as buffalo, elk, antelope and deer ranged the grassland.

Murray County is located in the southern portion of the prairie pothole region. At one time this region was very important for waterfowl production. Numerous wetlands surrounded by grasslands provided abundant nesting cover for vast numbers of waterfowl, shore birds, and wading birds. The snowmelt provided thousands of small ponds for nesting pairs, and deeper pools remained during summers and provided brood habitat. This situation was altered significantly with the advent of modern agriculture. Now only small remnants of these habitats remain.

Trees were not common, except around lakes, larger wetlands and along streams. Narrow bands and blocks of forest evolved along deep gorges and in downstream floodplains. A large oak barren, Great Oasis Lake, was located in the northwestern portion of the County. Today, the lake bed is used for agricultural purposes.

Cottonwood, willow, boxelder, and ash trees dominated the floodplain forest with understory shrubs such as dogwoods, wild roses, various berries, and vines providing ground cover. Plants and animals which adapted to periodic flooding persisted in the floodplain area. White-tailed deer, squirrels,

and beavers were numerous where forest developed.

Narrow and linear riparian forests provided travel corridors for wildlife. Winter cover, food and water were all available there. The abundance and diversity of bird and animal species that use riparian forests made these valuable habitats.⁴

TOPOGRAPHY

The surface features of Murray County are comprised primarily of glacial deposits. The most prominent is the Bemis Moraine, locally referred to as the Buffalo Ridge. The Buffalo Ridge reaches elevations in excess of 1,900 feet in Cameron and Chanarambie Townships, the highest in the County.

The northeastern part of the County contains the Altamont Moraine which is approximately 300 feet lower than the Buffalo Ridge.

Between these ridges is a plain that slopes gradually toward the northeast. Water drainage basins include Beaver Creek and Lake Shetek which combine to form the Des Moines River in a southeasterly flow. Plum Creek which flows to the northeast and Chanarambie Creek which flows to the southwest. These streams have few tributaries and, where rolling terrain is encountered, a network of marshes, swamps, ponds and lakes has resulted. Lake Shetek, the largest water body, and other lakes are found throughout the County. A large wetland area is situated in a former lake bed which is drained by Beaver Creek in Lowville Township.

⁴U. S. Department of Agriculture, The Original Vegetation of Minnesota, Francis Marschner, 1930.

The entire County was covered by the deposits of several ice sheets at widely separated time intervals. The deposits of the late Wisconsin (Mankato) glacier form a thin veneer over the eroded surface of the older Nebraskan and Kansan gray drift. The moraine across the northeastern corner contains an abundance of stony material and a number of gravel knolls. The thickness of the drift ranges from less than 100 feet to more than 400 feet. It is the thickest in the western half of the County and thinnest in the northeastern and southeastern townships. Yellow clays have been encountered under blue clays. The yellow color is due to oxidation that penetrated from the surface downward while the clays were near the surface.⁵

LAND USE

Illustration 17 shows land use characteristics of Murray County in 1969. Updated 1989 land use data shows 84.7 percent (380,896 acres) of the County as cultivated land, 8.9 percent (40,023 acres) as grassland, 1.5 percent (6,746 acres) as rural development, 0.4 percent as urban development, 2.1 percent (9,444 acres) as open water, 0.6 percent as wetlands and 1.7 percent as other uses, such as gravel pits.⁶

The predominate land use in Murray County is agricultural production with some 1,040 farm sites averaging 393 acres. The average farm land values are \$1,000 to \$1,200 per acre, with the most productive land located in the central and eastern portion of the County (Des Moines River watershed). Because of its unfavorable topography, farmsites are less concentrated

along the Buffalo Ridge in the western portion of the County.⁷

The pattern of rural land use is dominated by crop and livestock producing farmsteads. Murray County is ranked in the top ten as a leader in soybean production with 166,600 acres planted annually. Corn is annually planted on 177,900 acres, alfalfa is planted on 15,500 acres, and small grains on another 11,900 acres.

Murray County is the top producer in the state in sheep production with 6,100 animals. The County ranks in the top five on cattle production with 53,800 animals. Hog production is on the increase with 108,000 animals. Murray County has only 40 Grade A and 35 Grade B dairy operations, containing 4,100 cows. These operations are found mainly in the southwest portion of the County (Rock River watershed).⁸

There are 380 contracts enrolling 18,600 acres in the Conservation Reserve Program (Illustration 14). Easements have been obtained on 272 acres of Permanent Wetland Restoration (Illustration 27) and 504 acres of Permanent Wetland Preserve (Illustration 28). The Reinvest in Minnesota Program (RIM) has perpetually idled 244 acres (Illustration 16) and idled 109 acres (Illustration 15) for 10 years.

The only significant non-farm rural land use occurs as recreational and vacation home development around major lakes like Shetek, Bloody, Sarah and First and Second Fulda. Unlike most other southwestern Minnesota counties, Murray County is blessed with an abundance of surface water.

⁵Murray County Comprehensive Plan, 1972.

⁶Murray County Land Use, 1989. EPPL7 Two-Way Count. Murray County Environmental Office.

⁷Murray County Assessors Office, Spring 1996.

⁸Minnesota Agriculture Statistics, 1995.

A lake home density survey conducted by the Department of Natural Resources (DNR) in 1983 revealed a slight increase in the density of homes on Lake Sarah (9.9%). Bloody (5.7%) and Shetek (4.3%). The number of homes for the three lakes per mile of shoreline in 1982 was 13.2, 8.2 and 9.4, respectively.⁹

From 1986 to 1995, the Murray County Environmental Office has issued the majority of its residential zoning permits for homes within shoreland areas. During this ten year period 131 permits have been issued for the Lake Shetek area, 21 permits for the Lake Sarah area, 16 permits for the Bloody Lake area, one for the First Fulda Lake area, and 2 have been issued for other lakes. During the same ten year period 10 plats with 84 lots were approved in the Lake Shetek area and one plat with 13 lots for the Lake Sarah area.

A survey conducted in 1994 for the Lake Shetek Clean Water Partnership indicated that 130 permanent residents and 253 seasonal residents live around lakes Shetek, Sarah, Fremont and Bloody. A 1996 review of the Assessor's records indicates 878 platted lots with 584 lots have an established residence for lakes Shetek, Sarah, Fremont and Bloody.

Land use specific to each major watershed is as follows:

West Fork of the Des Moines River-

Approximately 93 percent of this watershed is under cultivation or pasture, 3 percent is either open water or wetlands, and 3 percent is considered developed, which includes the urban areas of Slayton, Fulda, Avoca, Hadley, Lake Wilson and Currie.

Cottonwood River-

⁹Department of Natural Resources, Lake Home Density Survey, 1983.

Ninety-five percent of this watershed is cultivated and pasture, 2 percent is open water and wetlands, and less than 2 percent is developed area, which includes most of the village of Dovray.

Rock River-

Ninety-six percent of the land use is area cultivated or pastured, only 0.5 percent is wetlands or open water, and 2 percent is developed area, which includes the city of Chandler.

Redwood River-

Approximately 96 percent of this watershed is under cultivation or pasture, less than 3 percent is either wetlands or open water, and 1 percent is developed.

PUBLIC UTILITY SERVICES

All nine incorporated municipalities have central water distribution systems which is providing service to 2,233 residences. All but the City of Dovray obtain their water from wells that are located within their respective city limits. The City of Dovray is provided water from Red Rock Rural Water system.

Dependence on two rural water systems has been on the increase. Presently, the northeast and east central portion of the County is served by Red Rock Rural Water and the western one-third of the County is served by Lincoln-Pipestone Rural Water (Illustration 3). Besides the City of Dovray, 241 rural residences including 37 on the northeast shore of Lake Shetek depend on well fields located outside of the County.

The remaining 2,137 rural residents rely on individual wells for water. All drinking water

for County residents is drawn from ground water supplies.

The cities of Slayton, Fulda, Lake Wilson, Currie and Chandler have central sewer systems and wastewater treatment facilities that provide service to 2,106 residences. The community of Iona utilizes a common septic tank rather than a treatment facility.

Households in Hadley, Dovray, Avoca and all rural residences, operate individual sewage treatment systems (ISTS) which total 2,505 systems.¹⁰

Slayton and Fulda are the only communities in Murray County with a storm sewer system.

LAND OWNERSHIP

Murray County has 449,700 acres of which 96 percent is privately owned (Illustration 18). Most of the remaining acres are owned by the Department of Natural Resources (DNR). DNR Wildlife Management Areas contain 8,396 acres of land and the DNR Lake Shetek State Park contains 1,109 acres. In addition, DNR has 21 public water accesses located in Murray County (Illustration 29). Murray County owns approximately 80 acres consisting of parks, a landfill and several building sites.

EXPECTED CHANGES TO LAND USE, PUBLIC UTILITIES AND LAND OWNERSHIP

Based on the projection from the Minnesota Office of the State Demographer, the population of Murray County will decrease through the year 2010 (Table 1). This will

¹⁰U.S. Census, Population and Housing Characteristics, 1990.

probably hold true for the rural agricultural areas and the communities, however, population is expected to increase around the major lakes in the County. The net change will probably be closer to constant population through the year 2010.

The largest land use, agricultural production, is seeing, and most likely will continue to see, larger farm operations. This will lead to fewer rural farm sites and increased concentrations of livestock numbers. The County has also experienced a resurgence in hog numbers (animal units) during the past few years, but the shift is from numerous small operations to several large operations. The number of acres planted to corn and soybeans is expected to stay constant with some changes in management of soil erosion, and fertilizer and herbicide usage.

The emphasis on CRP eligibility has shifted from highly erodible land to riparian areas. The majority of the original CRP contracts are due to expire soon and uncertainty exists on exactly how many acres will be renewed. The same situation exists with the 10 year RIM Program as emphasis is now on perpetual easements for wet areas.

The greatest potential for change, and possible land use conflict, will exist as the traditionally agricultural producing lands within shoreland areas are converted to platted lots for development. This will also have an impact on surface and ground water quality, and fish and wildlife habitat.

Permanent residences are on the increase for lakes Shetek, Sarah, Fremont, Bloody, and First and Second Fulda. As population density increases so does the demand for utility services like roads, water, sewer, stormwater control and garbage collection. In 1996, a feasibility study will be conducted on the

possibility of providing water and sewer to the shoreland areas of lakes Shetek, Sarah, Fremont, and Bloody.

Dependence on the two rural water systems is expected to increase, especially via the Red Rock system. Wells for these systems will most likely be located outside of Murray County. The County is expected to depend on ground water as its sole source of potable water. All incorporated municipalities in Murray County will be developing wellhead protection plans. The City of Slayton has already started the process with the remaining communities ranked so low that it will be five to ten years before required to develop a plan.

Very little change is expected in land ownership with the vast majority staying under private ownership. DNR will always be in the market to purchase more land for Wildlife Management Areas and the number of acres are expected to increase. The Lake Shetek State Park has no plans to expand, nor is Murray County interested in purchasing additional land.

A potential land use change in Murray County is windpower development. There are currently approximately 4,800 acres that have been recorded for windpower easements. However, State law excludes this type of development from local planning and zoning regulations because it could produce over 5 megawatts of power.

SURFACE WATER QUANTITY

Murray County is fortunate to have a relatively large number of lakes. These lakes are distributed fairly evenly throughout the County, although the largest are concentrated in the north-central portion. Most County lakes are relatively shallow, having depths ranging from about six to ten feet. These depths are very common for lakes in southwestern Minnesota. Shetek, the largest lake in the County, has a surface area of about 3,400 acres and a maximum depth of ten feet. Lake Sarah, located just to the northwest of Shetek, is the second largest lake in the County. It is about 1,100 acres in size, having a maximum depth of about nine feet. (See Table 2 for other significant County lakes.)

The relatively small number of streams and rivers in Murray County are, for the most part, utilized as drainage channels. Spring flooding is mainly confined to the Des Moines River watershed, particularly along Beaver Creek with the majority of damages related to loss of crops. During periods of low flow, the principal source of streamflow is ground water.

The U. S. Geological Survey does not currently maintain any stream flow gauging stations in Murray County. Typically, most streams and rivers in the County show highly variable flow rates ranging from little or no flow during late summer, fall and winter months to flood stage during spring snowmelt. This becomes a limiting factor for developing the rivers as a source of water for irrigation, as well as for developing a permanent fishery.

Past streamflow records on the Des Moines River indicate that periods of no flow are common from late summer through winter, perhaps indicating that some aquifers do not

readily transmit water to the streams. It is also possible that aquifers adjacent to the River were depleted from lack of recharge, or contained only small quantities of water.

Also, within the Des Moines River watershed, lakes play an important role in flow of the River. Snowmelt, spring rains and intense storm runoff are absorbed by the lakes. Flow peaks are reduced in magnitude and high flows are prolonged as the lake water is released from storage.

The State of Minnesota has established Ordinary High Water Levels (OHWL) for the following County lakes.

<u>Basin</u>	<u>OHW Elevation</u>
Louisa (51-0006)	1439.4
Hanson Marsh (51-0031)	1495.3
Shetek (51-0046)	1482.6
Clear (51-0047)	1513.7
Corabella (51-0054)	1658.8
Maria (51-0062)	1526.1
Sarah (51-0063)	1525.6
Stoderl Slough (51-0067)	1703.6
Unnamed (51-0076)	1640.2
Wilson (51-0081)	1643.1
Current (51-0082)	82.7*
Unnamed (51-0133)	1691.3
Unnamed (51-0159)	1677.3
Unnamed (51-0175)	1678.5
Unnamed (51-0184)	1496.1

*There was no bench mark located within four miles so the survey was done on assumed datum.

In 1994, there were four active permits in the County for surface water withdrawals (Table 3). Golf courses comprised two of the active permits, with the remaining two for industry and crop irrigation. Average annual withdrawals from the Slayton Country Club

and the Rolling Hills Golf Course from 1990 to 1994 total 9.5 million gallons and 2.6 million gallons, respectively. The permit for crop irrigation, although active, has not utilized surface water since 1990.

There are no lakes or streams in Murray County for which state protected levels or flows have been established.

Records indicate that there was one known water use conflict related to surface water appropriations in Murray County. The result of the conflict in 1980 was a suspended permit.

SURFACE WATER QUALITY

The Minnesota Pollution Control Agency (MPCA) has established standards that must be met to insure best use of water resources. Based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, the waters of the state are grouped into one or more of the following classes:

1. DOMESTIC CONSUMPTION
2. AQUATIC LIFE AND RECREATION
3. INDUSTRIAL CONSUMPTION
4. AGRICULTURE AND WILDLIFE
5. AESTHETIC ENJOYMENT AND NAVIGATION
6. OTHER USES
7. LIMITED RESOURCE VALUE WATERS

Each of these classifications have been subdivided to further define the upper level of

contaminants which can be introduced without impairing the designated use of the water.

All waters of the state that are not specifically listed are classified as 2B, 3B, 4A, 4B, 5, and 6. This is in accordance with the need for water quality protection and consideration of best use in the interest of the public.¹¹

Only one unnamed creek by Iona has been classified by MPCA (Illustration 3). The classification is that of Limited Resource Value Waters #7. The quality of this class of waters of the state is such as to protect aesthetic qualities, secondary body contact use, and ground water for potable water supplies.

In addition, there is one Outstanding Resource Value Waters (ORVW) in Murray County. The calcareous fen, Lost Timber Mountain Prairie fen is located in the southwest portion of the County and has the classification of 2D, 3C, 4A, 4B, 5 and 6 water. Calcareous fen waters generally exhibit high water quality, wilderness characteristics, unique scientific or ecological significance, exceptional recreational value or other special guidelines which warrant stringent protection.

As in most of southern Minnesota, the lakes in Murray County tend to be large, shallow and rich in nutrients. Additionally, assessments by the Minnesota Pollution Control Agency (MPCA) between 1973-1985 indicated an increase in nitrates and total suspended solids observed in surface waters of the southwest portion of the state.¹²

According to reports by the Department of Natural Resources (DNR), Division of Fish

¹¹Minnesota Pollution Control Agency, Chapter 7050: MPCA Classification and Standards for Water of the State, 1994.

¹²Minnesota Pollution Control Agency, The Land-Use Connection, 1986.

and Wildlife, seven of eight County lakes surveyed between 1985 and 1989 showed evidence of bank erosion resulting in sedimentation. Heavy algal blooms related to agricultural runoff were noted in three lakes (Summit, Shetek and Louisa).¹³

Minnesota's waters are classified for a variety of designated uses: to provide habitat for fish and aquatic life; to supply drinking water; and to serve recreational needs. Each designated use has a unique set of water quality requirements or criteria that must be met for the use to be realized. If these standards are met, the waterbody is said to be "supporting" the use.

Monitoring data collected on Bloody, Current, First and Second Fulda, Fox, Sarah, Shetek, and Lake Wilson is considered impaired. The waterbody has an assessment of either being "not supporting" or "partially supporting" all designated uses. This means that Carlson's Trophic Status Index exceeds ecoregion-specific criteria.

Monitoring data collected on Summit Lake is within the Carlson's Trophic Status Index ecoregion specific range for "fully supporting" but is threatened.

Based on a Nonpoint Source Survey of local resource managers, Fremont, Louisa, Maria, Lime, North and South Badger, and Round Lake show signs of degradation. Based on a Nonpoint Source Survey of local resource managers, Buffalo and Willow Lakes do not show signs of degradation but watershed conditions are likely to cause problems that will impair the waterbody.¹⁴

¹³Department of Natural Resources, Lake Survey Summaries, 1988.

¹⁴Minnesota Pollution Control Agency, Minnesota Lake Water Quality Assessment Report, 1996.

The MPCA conducts a Citizen Lake-Monitoring Program. Five lakes within Murray County are monitored through this program. They are Bloody, Sarah, Shetek, Summit, and Wilson. The Secchi disc transparency values for these lakes varies from 0.5 feet to 9.0 feet indicating an advanced state of eutrophication. Out of the 463 lakes monitored by citizens in Minnesota, lakes Shetek and Wilson were two of seven lakes with the lowest reading of 0.5 feet during the 1992 monitoring season.

Several lake and river watershed restoration projects are currently in progress throughout portions of Murray County:

Lake Shetek Watershed Improvement Project

Lake Shetek is located in the gently rolling hills of Murray County near the headwaters of the Des Moines River. Lake Shetek is an important recreational resource in southwestern Minnesota, where very few lakes exist. A hardwood fringe covers much of the gentle to moderately steep slopes which surround the Lake. An extensive woodland within Lake Shetek State Park lies adjacent to the Lake.

The Lake covers approximately 3,351 acres and is about eight miles long by one and one half miles wide, with 32 miles of shoreline. Lake Shetek is divided by a constriction of three islands into the north and south basin with a long narrow inlet extending to the northwest from the northern basin. Lake Shetek is generally a large, wind swept lake with an irregular shoreline. Lake Shetek has an average depth of six feet, with a maximum depth of ten feet. The DNR management

classification for the Lake is warmwater gamefish lake.

Hydrologically connected to Lake Shetek through channels or small streams are numerous wetlands and the lakes of Sarah, Fremont, Bloody, Smith, Fox and Armstrong Slough. The second largest lake, Lake Sarah, lies to the west of Lake Shetek and is 1,093 acres in size. Lake Sarah has an average depth of five feet, with a maximum depth of nine feet.

The Lake Shetek watershed has an area of 129 square miles and is located in northwestern Murray County and southern Lyon County. The Beaver Creek watershed lies south and west of the Lake Shetek watershed in Murray County and Pipestone County. Drainage from the Beaver Creek watershed may be diverted into Lake Shetek during periods of moderate to high flows through a diversion ditch.

Water from Beaver Creek can also enter Lake Shetek during periods of high water when the flow from Beaver Creek and Lake Shetek exceed the receiving capacity of the Des Moines River causing the flow to reverse and flow backwards over the Shetek outlet dam and into Lake Shetek. This additional drainage area of Beaver Creek is 180 square miles, increasing the potential Lake Shetek watershed to 309 square miles.

The soils of the watershed are highly erodible prairie soils (medium to fine textured Barnes-Flom-Vallers and Barnes-Buse). The watershed varies from nearly flat to rolling glacial moraine topography. The elevation ranges from 1,940 feet Mean Sea Level (MSL) to 1,480 feet MSL at the outlet of the watershed. Agriculture is the predominate land use within the Lake Shetek-Beaver Creek watershed.

Lake Shetek is located in a region of Minnesota with very few recreational quality lakes. The lake is home to the Lake Shetek State Park, which draws over 100,000 visitors per year. The large size of the Lake helps to make it an important regional resource. Regional use of Lake Shetek draws over 200,000 visitors from Minnesota and other states for varied year round recreational activities. The area receives a significant economic impact due to the influx of Lake Shetek visitors.

Historical water quality data on Lake Shetek is limited in scope to a few specific previous studies or sample collections. Limited water quality data were reported in 1956 and 1988 DNR fisheries survey results. An in lake study done in 1970 by the DNR, Division of Waters had a range of Total Phosphorus (TP) of 200 ug/l in April, to 50 ug/l in July. Sampling in 1973 had an average TP of 375 ug/l for the north basin and 520 ug/l for the south basin.

The MPCA monitored Lake Shetek in 1985 in their regional survey of lakes. The Lake was characterized as hypereutrophic, based on trophic indicators (TSI = 72.5). Lake transparency has decreased, since records started in 1951, as reported by average July - August Secchi disc readings.

Indications show Lake Shetek as hypereutrophic based on low Secchi disc readings and frequency and severity of algal blooms. Other previous studies are related to historic problems of fluctuating water levels including reports on re-establishing the ordinary high water mark of the Lake, condition and height of outlet dam structures, and the Beaver Creek Diversion.

Local groups, County organizations and concerned citizen have express great interest in the deteriorating water quality of Lake Shetek. The developed and remaining lake shore around Lake Shetek has an increasing level of economic importance. Decreased water quality can have adverse affects on lake shore values and diminished recreational activities.

In the fall of 1992 a Clean Water Partnership Resource Investigation grant was applied for and approved by MPCA. A work plan was developed in 1993, which started an information and education campaign, along with a watershed assessment. In 1995 hydrologic and water quality monitoring, a septic survey, and sediment and core sampling were conducted. A report on the diagnostic study and implementation plan were developed and approved in 1996. For more detailed information, please refer to the study and plan.

Sources of nutrient loading from subwatersheds into Lake Shetek were divided into eleven locations. On where the locations of the test sites are located and how the subwatersheds are divided, please refer to the color plates attached to the diagnostic study. The highest Total Suspended Solids (TSS) of 2,102 pounds per acre and Total Phosphorus (TP) of 3.03 pounds per acre were reported at the Beaver Creek test site. However, the subwatersheds that enter Lake Shetek from the northwest and west via Lake Sarah, collectively make up over 91 percent of the inflow water volume. Thus, these two subwatersheds, names 11 and 12, account for over 79 percent of the TSS and 72 percent of the TP loading in the Lake. Septic system inputs, while not initially a large percentage of loading, contain a high level of Soluble Reactive Phosphorus and pathogens that lead to other related heath issues. Table 10

contains additional information on average test results.

Modeling results predict that Total Phosphorus can be reduced from the average of 130 ug/l to 92 ug/l within the next five to seven years and down to 82 ug/l in seven to ten years. At these levels of TP the clarity of water should increase, the number of alga blooms should decrease which will increase the number of swimming and fishing days available for use.

The implementation plan addresses both shoreland and watershed practices that will be utilized to reach the reduced levels of TP. Some of the practices within shoreland include: education and control of phosphorus lawn fertilizer; septic system upgrade to centralized sewer, where possible; shoreline stabilization; controlling Beaver Creek from entering Lake Shetek; and management of aquatic plants. Some of the practices within the watersheds include: best management practices for manure application and pasture land; establishing buffer strips and grass waterways; enrolling land into CRP and RIM; investigating Long Lake as a settling basin; and wetland restoration.

Middle Des Moines Watershed Clean Water Partnership/Fulda Lakes

Located in the southeast portion of the County are the lakes of First (southern basin) and Second (northern basin) Fulda. The northern basin is mainly located within the city limits of Fulda. Both First and Second Fulda are warmwater game fish, prairie lake systems. Prior to 1883, the lakes were separated by a swampy delta.

Historically, the two smaller Lakes were susceptible to low water levels during periods

of reduced rainfall. In an effort to relieve the low water problem, the residents dammed the outlet. In the early 1960's the swampy delta was filled and a channel was cut between the north and south basin. The filled area became a county park.

The main inlet channel enters the Lakes between the two basins on the west side. The estimated watershed is 3,439 acres and is 85 percent the lakes watershed. Ninety-five percent of the watershed and land use is agricultural. The outlet is on the east side of First Fulda and flows into the Graham Lake system.

The Lakes were mapped by the DNR in 1957. The normal water depth of Fulda Lakes is 4-5 feet with a maximum of 7-8 feet. First Fulda is 122 acres with a maximum length of 3,643 feet and maximum width of 2,140 feet. First Fulda has 9,240 feet of shoreline. Second Fulda is 65 acres with a maximum length of 3,062 feet and maximum width of 1,540 feet. Second Fulda has 8,448 feet of shoreline.

In 1976 a helixor aeration system was installed on First Fulda Lake and operated every year since it was installed. Copper sulfate was added to both Lakes to control algal production from 1980 to 1985. In 1987, 4,900 feet of the shoreline of First Fulda Lake was rip-rapped with rock to alleviate siltation and to provide habitat for forage fish species. There are 21 homes or cottages scattered around the First Fulda Lake.

In 1988 a MPCA Lake Assessment Program (LAP) was conducted on the Fulda Lake System. The LAP reported that the average summer total phosphorus was 230 ug/l for First Fulda and 221 ug/l for Second Fulda. The average summer chlorophyll a was 160 ug/l and 206 ug/l, respectively, and Secchi disc

readings were 1.0 feet for First Fulda and 1.1 feet for Second Fulda. The mean Carlson Trophic Status Index for the two Lakes is 80 (hypereutrophic). The LAP study suggested that both external and internal loading contributed to the hypereutrophic status.

In 1992 the Middle Des Moines Watershed Clean Water Partnership conducted a diagnostic study on the Fulda Lakes. Data was collected on temperature, conductivity and dissolved oxygen gradients. Water samples were taken and tested for total phosphorus, chlorophyll a, and total kjeldahl nitrogen. Transparency was measured using the Secchi Disc. Phytoplankton and zooplankton data was also collected.

The results can be found in the "Middle Des Moines Watershed Restoration Project Diagnostic Study and Implementation Plan". For a more detailed assessment read Section V, pages 74 to 89 of the study. A summary of the results and analysis follows: Second Fulda is negatively impacted by the large amounts of nitrate-nitrogen and, to a lesser extent, phosphorus that enter the Lake during storms. This was deduced by the large increases in nutrients found in Second Fulda after storm events.

Ground water flowing into the Lakes through springs was responsible for most of the ammonia-nitrogen (60-98%), and much of the phosphate-phosphorus (30-60%), total phosphorus (33-60%), and total kjeldahl nitrogen (30-65%). The variability in the ground water contribution to these Lakes is due to the two different modeling approaches used.

Assuming that in lake loading from ground water is approximately 35 percent, a 50 percent reduction in nonpoint source loading

from the main surface inflow channel will reduce total phosphorus to 104-112 ug/l. If the loading of nutrients in the storm water runoff from in and around the City of Fulda was controlled, the levels would be at or slightly below 90 ug/l of total phosphorus. This is well within the expected range for lakes in the Western Corn Belt Plain Ecoregion.

The short term goal of the Fulda Lake system is to reduce nonpoint source surface loading through the main surface channel by 25 percent within six years. The long term goal (12 years) is to reduce urban nonpoint sources into the Lake by 35 percent through storm water runoff diversion and further reduce nonpoint source loading into the system by another 10 percent.

To achieve these goals the following Best Management Practices were chosen:

- Buffer Strips
- On-site Septic Systems
- Storm Water Runoff
- Shorebank Erosion Control/Rip-Rap
- Storm Water Retention Basins
- Wetland Interception System
- Exclusion of Livestock from Shorebanks
- Prioritized Critical and Sensitive Areas for Acquisition
- Urban Fertilizer Management Education
- Yard Waste Management Education

Areas of concern that need more investigation include: the past and current management practices of fertilizer plants; the build up of nutrients in adjacent fields around the lakes; and the flushing and water circulation patterns in the lake system.

Redwood River Clean Water Project

The Redwood River Clean Water Project is sponsored by Redwood-Cottonwood Rivers Control Area (RCRCA), an eight county joint-powers organization that works to enhance and protect the Redwood and Cottonwood Rivers. The Redwood River originates in the northeastern corner of Pipestone County and descends eastward into Murray County before flowing in a generally easterly direction towards Lake Redwood in the city of Redwood Falls.

Between 1990-1992 a diagnostic study was conducted to investigate sedimentation in Lake Redwood, a sixty acre reservoir on the Redwood River in Redwood Falls, Mn. The central component of the study was a three year sampling program to evaluate water quality in the Redwood River, its tributaries, and Lake Redwood.

The watershed draining to Lake Redwood is predominately agricultural and covers approximately 640 square miles. It has an extensive artificial drainage system made up of subsurface tile lines and open ditches.

Annual sediment delivery to Lake Redwood during the study period is estimated at over 140,000 tons, or 226 tons per square mile of drainage area. This equates to about one foot of sediment per year.

The mission of the Redwood River Clean Water Project is: *to create awareness and appreciation for the value of a clean Redwood River, promote watershed identity, and cooperatively achieve land use changes necessary to restore the River's health.* Goals of the Redwood River Clean Water Project include: reducing sediment loadings by 15-30%; expanding game fishery habitat and fishing opportunities; reducing peak flows and improving flow stability. A main component

of the Project is to organize 75% cost-share on projects for residents of the Redwood River watershed to implement Best Management Practices (BMPs). BMP primary emphasis will be on conservation tillage, buffer strips, and wetland restoration.

Cottonwood River Clean Water Partnership

In February 1996 a Phase I Clean Water Partnership Grant was awarded to Redwood-Cottonwood Rivers Control Area (RCRCA) to initiate a diagnostic study for the Cottonwood River.

The Cottonwood River begins in northwest part of Murray County and flows in a north easterly direction into Lyon County and then easterly through Redwood County before emptying into the Minnesota River in the city of New Ulm in Brown County. The Cottonwood River watershed drains the northeast portion of Murray County through the Plum Creek subwatershed.

Water quality in the Cottonwood River and its tributaries is affected by suspended sediment, nutrients (phosphorous, nitrate-nitrogen), and bacteria. Recent studies (e.g., MRAP) show a strong correlation between streamflow and suspended solids and indicates a large percentage of sediment carried by the Minnesota River and its tributaries originates from cropland, the primary land use in the Cottonwood watershed.

The ultimate goal for the Cottonwood River Clean Water Partnership project is to enact land use changes within the watershed that will reduce sediment and nutrient discharges to the River. The goal of the diagnostic study is to document factors affecting sediment and nutrient transport to the Cottonwood River

and to select an implementation plan that will address local water quality objectives that meet downstream goals established for the Minnesota River.

GROUND WATER QUANTITY

All the communities in Murray County, in addition to rural residents, rely on ground water for their water supplies. Primarily, the supplies are derived from aquifers contained in the glacial drift. (Table 4 contains a list of ground water appropriations.)

Four observation wells are located in the County (Table 5 and Illustration 2). These wells are monitored monthly by personnel from the Soil and Water Conservation District (SWCD). Data collected over the past seventeen years suggest that aquifers in the County have a relatively slow rate of recharge.

There are no official records available indicating well interference problems in the County. Additionally, informal evidence does not suggest that conflicts have arisen at any time in the past.

In general, there is an adequate supply of ground water in the County to meet current and future demands. Shortages in the past have tended to be localized and it is likely similar problems will occur in the future.

The topography and surface water features of the County preclude the development of surface water for domestic supplies. They may potentially assist in meeting future livestock and irrigation needs, but it is apparent that the County is dependent on ground water for drinking and industrial supplies. An important consideration therefore is the attention given to ground water protection efforts. This is particularly significant in light of the fact that

major aquifers are located in the glacial drift and that these aquifers are the ones most susceptible to contamination.

GROUND WATER QUALITY

Ground water in Murray County, as in most of southwestern Minnesota, has a very high mineral content. Iron and manganese concentrations regularly exceed recommended standards. In addition, much of the ground water has high concentrations of sulfate and dissolved solids. As a result, municipalities within the County are required to treat water supplies to meet Minnesota Department of Health (MDH) drinking water quality standards.

Bacteria and nitrate contamination of ground water supplies is a concern in the rural areas of the County. The Lincoln, Lyon, Murray and Pipestone Community Health Service (CHS) conducts tests on water samples submitted by County residents. Samples are usually submitted for testing when water users suspect contamination has occurred. Results of the testing program may not, therefore, be representative of ground water conditions in the surrounding area. Nevertheless, data collected by the CHS do provide one indicator of the overall quality of ground water in the County.

A review of test results for sulfates between 1979 and 1987 reveals about three-fourths of the samples had concentrations exceeding the recommended limit of 250 mg/l. Bacteria contamination during the same time period occurred in 47 percent of the samples. When retested, 56 percent of the wells providing the samples, were still found to show contamination. Nitrates were detected in two-thirds of the samples tested between 1979 and 1987 at limits greater than 1 mg/l. One-third

of these samples exceeded the recommended limit of 10 mg/l.

In 1991, Murray County conducted private well water tests on the 1,020 useable samples received for data analysis. Observations based on the results of the data are:

- Two hundred and twenty-three samples (21.84%) contained nitrate-nitrogen levels of 10 ppm or above.
- Townships in extreme southwest Murray County had the highest average nitrate-nitrogen levels.
- Townships in north central and northeast Murray County had the highest average sulfate levels.
- Drilled wells were deeper than bored wells (159 versus 84 feet).
- Nitrate-nitrogen levels were higher in bored than drilled wells at depths over 50 feet.
- Sulfate levels were lower in shallow wells.
- The percent of samples positive for coliform bacteria were higher in bored than drilled wells (50% versus 33%)
- Predominant well type varied by township.
- In drilled wells, the level of nitrate-nitrogen declined with increasing well depth.
- Septic tanks, drain fields, and livestock barns and yards were associated with higher nitrate-nitrogen levels, if located within 50 feet of the well.

Water quality data have been collected on two County wells as part of the Minnesota Pollution Control Agency's (MPCA) Ground Water Quality Monitoring Program. One of the wells is located southeast of Avoca and the other is about two miles west of Dovray (Illustration 2). The well near Avoca is 348 feet, drawing water from the Sioux Quartzite. Data collected between 1981 and 1985 show the water to be hard, high in sulfates and total solids, but lacking any volatile organic

chemicals (VOCs). Tests on water from the well near Dovray, which draws water from a buried sand aquifer, show similar results.¹⁵

Water quality data has also been collected on five aquifer sites in Murray County as part of the MPCA Ground Water Monitoring and Assessment Program (GWMAP). The sites were tested in June of 1993 and consisted of three different aquifer sites. The Sioux quartzite aquifer underlies most of southwestern Minnesota and furnishes water to several municipalities, as well as to numerous domestic and stock wells. The data collected on this specific well showed the water to be hard and high in total dissolved solids.

A second aquifer type sampled is a buried sand and gravel aquifer that was formed as a result of continental glaciation. This site also displayed characteristics of hardness and was high in total dissolved solids and sulfates, not uncommon for this particular aquifer. High levels of nitrates were also detected at this site, which exceeded the recommended limit of 10 mg/l.

The third aquifer type sampled was the surficial sand and gravel aquifer. The ground water in this aquifer is easily obtained in quantities suitable for domestic and agricultural use. However, the surficial sands and gravel are susceptible to contamination since their recharge areas are extensive and the aquifer surface is highly permeable. Test results in this aquifer also revealed high concentrations of nitrates exceeding the recommended limit, as well as high total dissolved solids

Six public wells in the County were sampled by the MDH between 1985 and 1987 as part of a statewide pesticide survey. Samples were

¹⁵Minnesota Pollution Control Agency, Ambient Ground Water Data, 1988 and 1993.

taken in areas of the state that were considered to be susceptible to ground water contamination from pesticides. One of the wells sampled in Murray County contained a detectable level of pesticide at a concentration below that considered a threat to public health. The Minnesota Department of Agriculture sampled one private well in the County as part of the same survey. No pesticides were detected in the well.¹⁶

In 1985, the Minnesota Department of Health (MDH) conducted a sampling program of public drinking water supplies to test for the presence of volatile organic chemicals (VOCs). None of the wells sampled in Murray County had detectable levels of these chemicals. The statewide survey involved tests on 1,801 municipal wells. Volatile organic chemicals were detected in 109 of the wells sampled and twenty wells were found to have concentrations exceeding standards set by MDH.

It is not possible to make accurate assessments about the overall quality of ground water in Murray County since monitoring has been conducted by numerous agencies for various reasons. Therefore, it is difficult to generalize results due to the large number of variables involved. Many individual well owners have had their wells tested, but the results of those tests have not been analyzed on a regional basis, nor have they been compared to historical records.

Cities also conduct regular tests on their wells and these too have not been studied to determine trends in ground water quality over time. Because of the limited volume and

¹⁶ Minnesota Department of Health/Minnesota Department of Agriculture, Pesticides and Groundwater: Survey of Selected Minnesota Wells, 1988.

usefulness of existing data, a ground water data management program could be employed to better determine the quality of ground water within the County. At a minimum, more emphasis needs to be given to insuring that required data is collected and maintained in files that are available to the public.

Slayton	1,650
Lake Wilson	750
Chandler	1,200
Iona	250
Avoca	1,800
Fulda	1,400
Hadley	250
Currie	1,050

Concerned about the possible contamination of public wells, the Ground Water Protection Act was passed in 1989. The Act requires each public water supplier to develop a wellhead protection plan to protect the wellhead management zone and surrounding area from possible contamination.

The Minnesota Department of Health (MDH) has developed a “phasing in” ranking for the development of these plans. The MDH is hoping to work with 20 to 30 communities per year. Eight of the nine cities within Murray County have been ranked by MDH. The ninth, the city of Dovary, does not have a well but water is instead supplied by Red Rock Rural Water System. The MDA ranking for the eight city wells is as follows:

<u>City</u>	<u>Rank (#)</u>
Slayton	53
Lake Wilson	199
Chandler	216
Iona	272
Avoca	291
Fulda	625
Hadley	688
Currie	1,195

The Act also requires all public water suppliers to maintain the isolation distances defined in the State Well Code. A quick survey of the wells indicates the minimum distance each well is from the nearest city boundary is as follows:

<u>City</u>	<u>Distance (feet)</u>
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Murray County will provide assistance to these public water suppliers as they develop and implement the wellhead protection plans.

A Level 1 Ground Water Assessment was completed by the Minnesota Department of Natural Resources (DNR), Division of Waters in 1995. The assessment gave a sensitivity rating for each mapped soil unit as reported in the Murray County Soil Survey. The assessment estimates the permeability characteristics of the soil parent materials and relates that to a sensitivity rating of low, medium, high and very high.

Twenty-six of the 85 soil mapping units were rated as having a “Very High Sensitivity”. At this time no grouping of the mapping units or County wide survey has been done that shows where these “Very High Sensitivity” soil mapping units lie in relation to the aquifers of municipal wells.

Using only the DNR Level 1 Assessment to identify high priority land use areas would be premature at this time. A Level 2 Assessment and identification of aquifers needs to be completed before sensitive ground water recharge areas can be identified.

SPECIAL LAND USES AND CONDITIONS

ERODING LANDS

The Murray County Soil and Water Conservation District (SWCD) estimates that 55 percent of the County's cropland is subject to water erosion. Based on information from the Land Management Information Center (LMIC) and Natural Resource Inventory (NRI) data, most land with potential soil loss greater than or equal to 2 T (10 tons per acre) is located in the southwest corner (Rock River watershed) of the County, which includes the townships of Moulton, Chanarambie and Fenton (Illustrations 11 and 12). According to data compiled by the 639 Study, most cropland within the Cottonwood watershed also has the potential to exceed the tolerable level (T) of soil erosion.¹⁷ Throughout the entire County approximately 81,690 acres of cropland are potentially subject to high rates (>2 T) of soil erosion from the combined effects of wind and water. (Illustration 11 only shows areas exhibiting water erosion.)

Sedimentation is adversely affecting all of the County's waterbodies. The most critical sedimentation problems appear to be located within the Rock River watershed in the southwest and the Des Moines River watershed in the central portion of the County. The manner in which the sedimentation data have been compiled suggests bank erosion is a major contributing factor, particularly in the case of Beaver Creek (Des Moines watershed).

Sedimentation resulting from cropland erosion normally occurs during two distinct periods of time. One is in the early spring when frozen ground prevents infiltration of melting snow or rainfall. The other is in late spring and early summer, a time when intense thunderstorms

¹⁷U. S. Department of Agriculture, Soil Conservation Service, U. S. Department of Army, Corps of Engineer, Upper Minnesota River Subbasins Study (Public Law 87-639), 1989.

are most likely to occur. Crops at this time are not well established resulting in excessive runoff rates.

The Murray County SWCD also recognizes that critical soil erosion occurs on pasture land as a result of flooding and overgrazing. The District encourages land owners to use proper grazing management practices by postponing grazing, resting land for a prescribed time period, or grazing at an intensity level that will maintain enough cover to protect the soil and prolong the life of desirable forage species. This practice will help to maintain or improve the quantity and quality of desirable vegetation.

Other damages associated with soil erosion within Murray County include increased downstream flood damages and sediment damages to roads, drainage ditches, and fish and wildlife habitat. Water quality in streams and lakes is reduced from the sediment, plant nutrients, fertilizer, and other chemicals contained in the runoff waters. Large volumes of sediment and other pollutants are delivered to the Minnesota River and the Des Moines River annually from the tributaries in each watershed. Many of these off-site damages are due to runoff from areas immediately adjacent to the major streams. Opportunities exist for reducing crop production costs with reduced tillage operations, thereby increasing net income as well as achieving soil and water conservation.

IRRIGATION

Surficial aquifers in the valleys of Beaver, Chanarambie, Lime, Plum, and Willow Creeks yield only small quantities of water to wells, limiting the possibilities of irrigation in the County. One crop irrigation permit has been issued for surface water withdrawals, but

records indicate (Tables 3 and 4) that the permit has not been utilized since 1990.¹⁸

DRAINAGE

Although Murray County soils are generally well-suited for agriculture, the existence of wetlands throughout the area, and particularly in its northwestern section, has created the demand for a fairly extensive system of County ditches to drain the wet areas for cultivation. Many existing outlets, both open ditch and tile, need improvements and maintenance. Quite a few areas have never had a proper outlet developed. Some petitions have been filed for new appraisals and reviews of County ditch and tile systems.

There are 69 County ditches and 31 judicial ditches within Murray County. Land owners within each ditch system have spent over \$1,742,105 during the years 1979-1988 for ditch expenses. Since 1989, the average annual expenditures for construction, repair or improvements for all the systems is \$142,395. Between 1989 and 1994, Murray County has spent a total of \$852,428.81 on ditch expenses (Table 6). A map of the public drainage ditches is available at the Auditor's Office located in the Murray County Courthouse.

Murray County, acting as the drainage authority, will continue to be responsible for the maintenance, repairs and improvement of its ditches in a manner consistent with provisions of the drainage law. The drainage law (M.S. 103E.015) establishes environmental and land use criteria for proposed drainage systems. Prior to establishing a drainage system, the drainage authority must consider: (1) private and public

benefits and costs of the proposed drainage project; (2) the present and anticipated agricultural land acreage availability and use in the drainage project or system; (3) the present and anticipated land use within the drainage project or system; (4) flooding characteristics of property in the drainage project or system and downstream for 5, 10, 25, and 50-year flood events; (5) the waters to be drained and alternative measures to conserve, allocate, and use the waters including storage and retention of drainage waters; (6) the effect on water quality of constructing the proposed drainage project; (7) fish and wildlife resources affected by the proposed drainage project; (8) shallow groundwater availability, distribution, and use in the drainage project or system; and (9) the overall environmental impact of all the above criteria.

A one rod vegetative strip is required for all new or improved ditches as of 1977 (M.S. 106A.085, subd. 1). The policy of the Murray County Board of Commissioners is that all 66 miles of public ditches are required to have the one rod vegetative strip on both sides.

POLLUTANT SOURCES

Sanitary Landfills and Dumps

A total of 11 solid waste disposal facilities were investigated in Murray County in 1980 by the Minnesota Pollution Control Agency (MPCA) (Illustration 3). Since then all sites have been officially closed in accordance with MPCA regulations. These sites include the Murray County Sanitary Landfill and municipal dumps located in Avoca, Fulda, Iona, Dovray, Currie, Slayton, Valhalla Resort, Lake Wilson, and Currant Lake.

¹⁸Department of Natural Resources, Division of Waters. Water Appropriation Permits. June 1995.

The Murray County Sanitary Landfill covered approximately twenty-five acres. Soils are generally black loam over clay and sandy clays. A slough located approximately 800 feet southeast of the southeast corner of the landfill operation drains much of the site. Three wells have been installed to monitor ground water. One is located in the northwest edge of the landfill boundary and monitors upgradient ground water. The downgradient well is located in the southeast edge of the landfill. Another well for general use is located south of the equipment shed. Local ground water movement is from northwest to southeast and the static water level is found 4-15 feet below the land surface. Records indicate only minor fluctuations in ground water quality due to seasonal differences.

Murray County has entered into an agreement with Cottonwood County to transport solid waste to their facility. Murray County is one of twelve counties that have formed a Solid Water Commission to cooperate in joint ventures. One such venture is the collection and disposal of household hazardous waste. The Murray County Solid Waste Plan was adopted in 1992 along with an ordinance that bans the landfilling of several items. Both documents are available at the Murray County Environment Services Office.

Murray County has developed and is implementing a Recycling Plan with required updates. The County met the goal requirements established by the Select Committee on Recycling and the Environment (SCORE), on recycling 25 percent of all solid waste generated in 1994 and 1995. One element of the Plan is the operation of the Tri-County Recycling Facility which processes and markets recyclables for the counties of Cottonwood, Murray and Pipestone.

Feedlots

Based on a 1977 report by the Murray Soil and Water Conservation District (SWCD), there were over 1,000 farmsteads that operated some form of livestock operation. About 220 of those feedlots were located in areas where runoff could reach lakes, streams, and wildlife management areas.

As of 1995, the Murray County Environmental Office has issued 119 permits to feedlot owners in the County. These feedlots confine dairy and beef cattle, swine, sheep, and chickens for a total of 23,750 animal unit. The receiving waters listed for these permitted feedlots are Lake Louisa, Badger Lake, Lake Shetek, Summit Lake, Fox Lake, Chanarambie Creek and a County ditch (Table 7). The Minnesota Agricultural Statistics Report indicates a decreasing trend in livestock production in Murray County over the past twenty years. The number of operations are now estimated to be less than half of what they were in 1977. Several large hog operations have been permitted in the last few years. These operations have been built to meet the minimum requirements of Minnesota Chapter 7080 and MPCA administrative rules.

Murray County has adopted the MPCA Feedlot Program and currently administers the program through the County Environmental Office.

Abandoned Wells

The Minnesota Department of Health (MDH) completed field surveys of abandoned wells in selected areas of the state. Based on that information, estimates have been established for the number of abandoned wells in each

County. Murray County has an estimated 2,500-3,500 abandoned wells. A list of abandoned wells not sealed in accordance with state statutes and rules is unavailable. There are also no ground water quality data available for abandoned well sites.

In 1993 the Murray County Water Plan began an abandoned well sealing program in which applicants would be eligible to receive 75% cost-share to properly seal a well. To date, 270 wells have been sealed using the cost-share program.

Underground Storage Tanks

According to a September 1996 Minnesota Pollution Control Agency (MPCA) list, Murray County has 42 underground storage tank (UST) sites with active tanks, 8 UST sites with all tanks removed, and 2 UST sites with tanks closed in place. Each active UST site has an average of 2.4 UST's. The same list has Murray County with 10 aboveground storage tank AST sites with active tanks, no AST sites with all tanks removed, and 2 active sites with both USTs and ASTs. These tanks contain gasoline, unleaded gasoline, diesel, waste oil, fuel oil, and kerosene.

Since 1986, 27 spills have been reported in Murray County. Of these spills, 13 have been listed by MPCA as closed. The closed status of a spill means that no more work needs to be completed on this site, since analysis and the extent of the contamination have already been determined by MPCA. Leaksites listed consist of both underground and above ground stationary tanks. As of September 1996, 25 leaksites in Murray County have been reported to MPCA.

Wastewater Discharges

There are six municipalities and one state park in Murray County which have permits to discharge wastewater (Illustration 3). The permit holders and their discharge points are listed below. According to the Minnesota Pollution Control Agency (MPCA), all are in compliance with permitted discharge standards.

- CHANDLER.....CHANARAMBIE CREEK
- CURRIE.....WEST FORK DES
MOINES RIVER
- FULDA.....LIME CREEK
- IONA.....STREAM OF LIME
CREEK
- LAKE WILSON....BEAVER CREEK
- SLAYTON.....BEAVER CREEK
- LAKE SHETEK
- STATE PARK.....LAKE SHETEK

Avoca, Hadley, Iona and Dovray do not have a central sewage collection and treatment system. Each household operates an individual sewage treatment system (ISTS). Depending on the location and construction of these systems, they may be adversely effecting surface and ground water quality.

Hazardous Waste Generators

As of September 1996 there are 34 hazardous waste generators in Murray County licensed by the MPCA. These include one hospital, three publishers, one power company and numerous private businesses (Table 8).

The state of Minnesota does not have a hazardous waste disposal site. Therefore, the hazardous waste generated by these Murray County businesses is shipped to a disposal site out of state.

Murray County participates in the Lyon County Regional Household Hazardous Waste program, has access to the permanent facility in Marshall, and to the mobile collection unit.

Pesticides and Fertilizers

There are currently 337 licensed or certified pesticide applicators in Murray County. In addition, there are 32 commercial and 3 non-commercial pesticide applicators within Murray County.

Murray County cooperates with the Minnesota Department of Agriculture annually to collect emptied pesticide containers for recycling. In addition unusable and unwanted pesticides are collected every other year within the county for proper disposal.

SPECIAL GEOLOGIC CONDITIONS

The Bemis Moraine (Buffalo Ridge) is a major river basin divide which crosses through the southwest quarter of the County. To the northeast side of the divide water flows to the Des Moines River which has a low gradient and flows southeast down the regional slope. The tributaries, for the most part, flow northeast down the slope of the moraine to meet the mainstream.

This geologic feature influences the surface drainage pattern in the County. The tributaries to the Des Moines River are young in their development and continue to cut into the land. This erosion has accelerated during the 20th century primarily due to a change in land use and the draining of natural water retention and sedimentation basins. Reducing the volume of water washing into the streams during storms and snow melt could reduce the amount of

sediment and nutrients entering the lakes and rivers.

RELATED LAND RESOURCES

WETLANDS

The amount of wetlands drained throughout Murray County since settlement is unknown. It is estimated that 90 percent of the original wetlands have been drained and are now used for agricultural purposes. Presently, there are eight variable crest water control structures for wetlands in the County, impounding 1,130 acres.

The primary wildlife management objectives in Murray County for wetlands with control structures are to manage water levels and to produce emergent and submergent aquatic vegetation and invertebrates which are attractive and beneficial to waterfowl production. Principal breeding waterfowl species that will benefit through the management of these wetland lakes include Canadian geese, mallards, redheads, blue-wing teal, and wood ducks. Many more species of wading birds, waterbirds, shorebirds, raptors and mammals will also benefit from these projects.

Opportunities to enhance waterfowl habitat are possible through management of existing wetland habitat, providing adequate upland nesting cover, and restoration of drained basins. A major factor restricting waterfowl habitat quality is the limited and poor quality of nesting cover. Nesting cover improvement around existing wetlands should be implemented wherever possible. Management plans to create optimum open water conditions

should be implemented where control of water levels is feasible.¹⁹

Murray County is one of 51 counties in the State of Minnesota that is recognized as being in the prairie pothole region of the United States. Projects involving the discharge of dredged or fill material into waters of the U. S. or wetlands in Murray County require individual permit authorization under Section 404 of the Clean Water Act. Proposed discharges of this nature are subject to the U.S. Army Corps of Engineers' public interest review process, and permits will only be issued for those discharges found to be in the public interest.

According to the Clean Water Act, anyone who wishes to obtain a federal permit must first obtain a state 401 water quality certification. The Minnesota Pollution Control Agency reviews permits for: construction of boat ramps, riprap for erosion, fill in a wetland, building in a wetland, construction of dams or dike, stream channelization and stream diversion. The MPCA may require storm water ponds or other appropriate best management practices as a condition of 401 certification.

Wetland drainage is presently being restricted by the swampbuster provision of the 1985 Food Security Act. This provision is aimed at discouraging the conversion of wetlands for agricultural purposes. If wetlands are converted to croplands, then landowner eligibility for certain U.S. Dept. of Agriculture program benefits could be lost. Wetlands, as defined by the Act, consist of soils that are covered with standing water or are saturated

¹⁹**U. S. Department of Agriculture, Soil Conservation Service, U. S. Department of Army, Corps of Engineer, Upper Minnesota River Subbasins Study (Public Law 87-639), 1989.**

most of the year, and that support mostly water-living plants.

The Natural Resource Conservation Service or NRCS (formerly known as the Soil Conservation Service), maintains lists of the kinds and combinations of soils and plants that define a wetland area. The NRCS, as well as the SWCD and County Environmental Office, have maps available of wetlands in Murray County that have been identified under the National Wetland Inventory prepared by the U.S. Fish and Wildlife Service. (See Illustration 19)

Recognizing the important benefits of wetlands, the Minnesota Legislature in 1991 enacted the Wetland Conservation Act (WCA). The law regulates drainage and filling of wetlands, and if wetland loss is unavoidable, requires replacement. Since Murray County is located in a high priority wetland region, due to the drainage over 80 percent of its original wetlands, the County designated all eligible land area within Murray County as a high priority wetland area. This designation, which serves to preserve, enhance, and restore wetlands, will ensure that landowners having wetlands on their property are eligible for enrollment in the WCA Wetland Preservation Program.

The concept of "no net loss of wetlands" is promoted by the Department of Natural Resources within the County. Education is needed to inform the public of the many benefits of wetlands management. Wetlands are an excellent revenue source when used as recreational, hunting, and trapping lands.

In addition to regulatory programs, technical and financial assistance is also available from many agencies and groups to aid landowners who wish to pursue wetland development.

Examples include Department of Natural Resources, U. S. Fish and Wildlife, and Pheasants Forever. Programs to protect and enhance wetlands include the Conservation Reserve Program (CRP), Reinvest in Minnesota (RIM), and the Wetland Reserve Program, as well as others. A complete list is included in Nonregulatory Wetland Protection Options edited by the Minnesota Board of Water and Soil Resources.

FLOODPLAINS

Murray County has adopted Flood Plain Regulations intended to provide measures which ensure minimum protection to the public health and safety and to property and improvements from hazards and damage resulting from flood waters. The Flood Plain regulations apply to land within the County subject to periodic flooding. The Environmental Administrator determines if land lying adjacent to a stream or river is subject to flooding. In order to determine the exact location of land subject to periodic flooding, the Environmental Administrator uses the available technical data, including past records of flooding, Natural Resource and Conservation Service data, Army Corps of Engineers' data or other technical information. National Flood Insurance Rate Maps for Murray County are available in the Environmental Office. (A preliminary sample map is shown on Illustration 20.) The County believes that the Floodplain Regulations are being adequately enforced.²¹

At present, floodplain ordinances have not been adopted by municipalities within Murray County.

Flooding does occur in Murray County along its many lakes and streams (Illustration 1). Flooding on Beaver Creek in particular results in sedimentation and backwash of floodwater into Lake Shetek. It is possible that impoundment areas along the creek could be constructed to reduce damages.

A study was done on the effects of flood waters in the Lake Wilson Area and the benefits that structures might have to reduce the flooding problems. It was determined that the cost of structural improvements would exceed benefits to the land.

The many valleys in the southwestern portion of the County could be used as water retention areas. These would not only slow the rate of water coming out of the hills during heavy rain thereby reducing erosion, but would also provide some wetland areas which have many benefits including possible recreation areas for local residents.

Area II Minnesota River Basin Project, Inc. was developed by State Legislation to provide technical and financial assistance for the installation of floodwater retarding / retention structures within the southern portion of the Minnesota river basin. Although Murray County does not suffer the same severity of damages as does adjacent counties, Murray County does support regional efforts.

As a result of the heavy rains and flooding that occurred in 1993, fifty-three Minnesota counties, including Murray County, were declared Federal Disaster Areas eligible for federal assistance. The State of Minnesota estimated that the 1993 floods caused damages of \$1.167 billion across the state. The Federal Emergency Management Agency (FEMA) awarded Murray County \$470,911 to repair

²⁰Murray County Zoning Ordinance, 1994.

public property. In addition, \$100,000 was awarded for repairs to the open ditch system.

Estimated average annual flood damages are not available for Murray County.

SHORELANDS

Murray County has adopted a shoreland ordinance containing classifications of Natural Environment and General Development (Table 2). Thirty-five lakes are listed as Natural Environment. These waters need a significant amount of protection because of their unique natural characteristics and their unsuitability for development and sustained recreational use. They also demand strict development standards. All public bodies of water not specifically designated or enumerated in the ordinance are also given the classification of Natural Environment.

Seven lakes and eleven rivers and streams are listed in the ordinance as General Development. This classification guides the wise development or utilization of shorelands for the preservation of water quality, natural characteristics, economic value, and the general health, safety and welfare of all public waters in the unincorporated areas of the County. All other rivers and streams in Murray County having a total drainage area of greater than two square miles are assigned a public water classification of General Development.²²

The protection of surface water from the effects of nonpoint source pollution can be greatly enhanced through shoreland ordinances. Murray County, as well as the city of Fulda, have instituted shoreland ordinances to satisfy DNR Shoreland Regulations

WATER-BASED RECREATION LANDS

Murray County has a state park, a state wayside rest area, a state historic site, seven County parks, fourteen village parks and playfields and numerous public accesses (Illustration 1). In addition to these recreation facilities, there are 56 wildlife management areas maintained by the State of Minnesota throughout the County totaling more than 8,396 acres.

According to the Minnesota Statewide Comprehensive Outdoor Recreation Plan (SCORP), there are projected demand areas in Murray County for boating, camping, canoeing, ice fishing and swimming (Illustration 21, 22, 23, 24, and 25). The SCORP also shows the demand area in 1978 for hunting (Illustration 26). Additionally, requests have been received by the Department of Natural Resources for accesses or access improvements on Lakes Shetek, Sarah, Buffalo, and Louisa. Providing access to lakes is critical to allow the majority of County residents and other Minnesotans who do not own lakeshore property to enjoy the County's water resources.

The Minnesota Pollution Control Agency's List of Impacted Waterbodies identifies Fulda Lake and Lake Shetek as having good potential for both swimming and fishing. All the lakes are effected by either eutrophication and/or bottom sedimentation. Current agricultural practices are the suspected cause of this increased sedimentation. Second, wastewater is indicated as a pollution source in Lime Lake and Second Fulda Lake has some indication of urban surface runoff.

²¹Murray County Zoning Ordinance, 1994.

FISH AND WILDLIFE HABITAT

The Department of Natural Resources Land Acquisition program has purchased 56 areas containing 8,396 acres and has proposals for twelve additional project areas containing 13,145 acres. These areas are mostly marshland. The County has completed hearings on the Protected Public Waters and Wetlands Identification. This process has identified the protected wetlands that are in private ownership and will be protected against further destruction by drainage.

The DNR has proposed establishing Lake Maria, located in the North central part of the County, as a game lake designation. This would improve water quality, fisheries and waterfowl habitat in the total lake area of Maria, Sarah, and Shetek. Financing is available once the lake is designated. An educational program to inform local residents about the benefits of the game lake designation is needed.

Many lakes in the County are stocked with game fish.²³ Lakes Sarah, Shetek, Buffalo, Bloody, Lake Wilson, Lake Louisa, Currant and First Fulda have aerators which are maintained by the County.

The SWCD has placed a high priority on encouraging all cooperators to include additional wildlife habitat improvements in their farm plans. As of March 1987, 1,132 acres of wetlands habitat have been developed or retained. Private landowners have established 920 acres of farmstead windbreaks which are well distributed throughout the County.

²²**Department of Natural Resources, Division of Game and Fish, Lake Survey Summaries for First Fulda, Lime, Louisa, Sarah, Second Fulda, Shetek, Summit Lakes, 1985-89.**

Fifteen lakes in Murray County have Department of Natural Resources ecological and management classifications. (See Table 9 for lake and stream classifications.)

There is a need to develop a County-wide program that will consider the distribution of lakes, marshes, pits, ponds, windbreaks and pasture land from the standpoint of a biological community. Future wildlife habitat development in the County should be based on this consideration.

Landowners are encouraged to develop wildlife habitat. One way they can do this is to participate in the Federal Conservation Reserve Program by bringing highly erodible land out of production and develop more wildlife habitat on these areas by planting trees and grasses.

UNIQUE FEATURES AND SCENIC AREAS

North and South Badger Lakes and Maria Lake have been designated as Wildlife Management Lakes. Management plans for these lakes are on file at the Slayton Wildlife office. As a result of the designation process, variable level water control structures have been constructed at the outlets of North and South Badger Lakes. A fish barrier has also been constructed at the outlet of Maria Lake.

The Department of Natural Resources' Natural Heritage Program has identified rare and endangered species and natural communities in Murray County.

These unique features located in the County include the Glacial Till Hill Prairie, the Mesic Blacksoil Prairie, the Wet Blacksoil Prairie and the flora and fauna that they support.

Threatened species that have been sighted are the Eastern Spotted Skunk, Loggerhead Shrike, Blanding's Turtle, and Dakota Skipper. Special Concern species are the Yellow Rail, Common Moorhen, Forster's Tern, Snapping Turtle, Western Hognose Snake, Poweshiek Skipper, Red Three-awn, and Hall's Sedge.

Although natural habitats or plant communities are not currently protected by law, the DNR's Natural Heritage Program has classified natural plant communities and ranked them based on their relative endangerment in the state. The Non-game Wildlife Program monitors other sensitive natural features such as colonial waterbird nesting sites.

Information on specific occurrences in the County of all of the rare natural features mentioned above has been compiled into the Natural Heritage database. This database represents the best information available on the locations of these rare features, but because a comprehensive biological inventory of the County has not been done, it is likely that there are other occurrences that have yet to be documented.²⁴

EXPECTED CHANGES TO SURFACE WATER, GROUND WATER AND RELATED LAND RESOURCES

The quantity of surface water is mainly dependent on normal fluctuation of wet and dry weather patterns. Data will continue to be compiled on surface water quality by the various Clean Water Partnerships. More lake level and streamflow gauging stations would be useful in protecting lakes, streams and wetlands.

²³Department of Natural Resources, Natural Heritage Program, July 1996.

Surface water will continue to be used primarily for recreational purposes. If degradation of the County's surface water quality continues, the use of water-based recreation will decrease, thus having an adverse affect on tourism, economic development, jobs and population trends. Hopefully implementation of the Clean Water Partnership projects will reverse the degradation.

Very little is known of the location and direction of flow of deep aquifers. With the requirement of municipalities to develop wellhead protection plans more information is likely to be made available. Ground water quality information will continue to be obtained.

There is a lack of any water quality information for the Murray County ditch systems. It can be assumed, however, that discharges from feedlots and septic systems, soil erosion, and pesticide and nutrient runoff are having an adverse effect on the quality of water running through the ditches.

It is expected that maintenance costs will increase, along with filed petitions for improvements, as the overloaded County owned tile lines as part of the ditch system fail and need to be replaced with a workable system of open ditches and tile.

There are state and federal regulations which if enforced could alleviate or reduce pollution hazards. These rules and regulations include permitting of feedlots, landfills, and buried storage tanks; codes for drilling and sealing water wells; floodplain and shoreland ordinances, wastewater facilities standards and accepted disposal of septic tank effluent. The County Zoning Ordinance is periodically

updated to reflect changes in state and federal regulations affecting land use activities.

The emphasis on permitting feedlots will continue to bring feedlots into compliance with state rules and regulation, while efforts on well sealing is expected to decrease in about two to four years. Dumps, tanks, and hazardous waste will continue to be regulated by MPCA.

As of 1993, the Environmental Protection Agency (EPA) has required that all underground storage tanks having a capacity of 1,100 gallons or more be required to have some means of leak detection. Beginning in December, 1998 tanks will also need to have corrosion protection along with spill and overfill prevention devices. These requirements are intended to reduce the likelihood of underground storage tanks contaminating ground water supplies.²⁵

The transitional area of wetlands, floodplains and shoreland is where most of the expected change will occur. As the issues over the idealistic use of these areas, the present use, and the historical use are debated and decided.

²⁵ 40 C.F.R., parts 280, 281, 1988.

ISSUES, PROBLEMS AND OPPORTUNITIES

The issues, problems and opportunities listed below have been identified through various forums. These include public meetings, Comprehensive Water Planning Committee Meetings held monthly, a study conducted by the Countryside Council and the Redwood-Cottonwood Rivers Control Area published November, 1987 entitled Water Management Task Force Final Report, and a review of the data required by Minnesota Statutes, 103B.

Through careful review of the information gathered during the planning process, the following water-related concerns of Murray County were revealed.

1. Abandoned farmsteads have a large potential to contaminate surface and ground water. At these locations there can be abandoned wells, leaking underground storage tanks and/or pesticides and their containers.

2. The County's lakes and streams are adversely affected by nonpoint source pollution. Runoff from feedlots, unprotected cropland and improperly designed septic systems are the major contributors to this condition.

3. Expanded development around Lake Shetek and Lake Sarah will increase the likelihood of water quality problems in these lakes. An opportunity exists to establish a water and sewer district in the Lake Shetek and Lake Sarah region.

4. Sensitive areas that have the potential to influence water quality are not now adequately recognized and managed.

5. Some wetlands in the County may be restored to achieve flood damage reduction benefits and water quality improvements; additional ground water recharge and wildlife habitat would also result from wetland restorations.

6. Comprehensive assessments of wetland contributions to the environment are available but not fully realized.
7. Wetlands should be recognized for their intrinsic and economic values to the community.
8. Sufficient water supplies are required to retain existing industries (e.g., Huiskens) and attract new ones.
9. Revisions in the shoreland ordinance aimed at preventing streambank erosion are needed.
10. The County's tax base restricts its ability to undertake expensive water management projects.
11. Less than 20% of County land eligible for the Conservation Reserve Program (CRP) has been enrolled. Aggressive promotion of CRP and Reinvest in Minnesota (RIM) could lead to erosion reduction and restoration of drained wetlands.
12. Seventy percent of the County's highly erodible soils could remain unprotected because landowners are not required to have a conservation plan on their property. This is due to inadequate requirements of the 1985 Food Security Act.
13. Downstream flood damage reduction in adjacent counties can be achieved through joint County initiatives such as impoundments and land treatment. In particular, multi-purpose reservoirs can be developed on the slopes of the Buffalo Ridge within the Rock, Cottonwood and Redwood watersheds.
14. Communication is needed with adjacent counties to deal with watershed problems and opportunities.
15. Flooding occurs throughout the County along the shores of its many rivers and ditches with damages restricted mainly to cropland and roadways.
16. An area of special concern is Beaver Creek which, during periods of high flow, causes erosion, sedimentation, and flood damage throughout its watercourse.

17. Tourism and recreation potential can be enhanced through improved surface water quality. Improvements include on-site sewage treatment repair or replacement (urban and rural), land treatment, and bufferstrips along ditches and streambanks to reduce soil erosion and runoff from pesticides and fertilizers.

18. Drinking water supplies for County residents are primarily obtained from aquifers in the glacial drift. Information regarding sensitive land areas that influence ground water quality in these aquifers should be considered when determining best management practices.

19. Wastewater treatment improvements are needed in Iona, Avoca, Dovray and Hadley. These communities currently rely on individual sewage treatment systems.

GOALS, OBJECTIVES AND ACTIONS

Goals and objectives related to natural resource protection have been identified in the Murray County Comprehensive Plan which was prepared in 1972. In addition, the Murray County Comprehensive Water and Sewer Plan (1971) contains recommendations for improving public water and sewer systems within the County. The Murray Soil and Water Conservation District Comprehensive Plan and the Overall Plan of the Middle Des Moines Watershed District also establish goals and objectives for protecting and enhancing soil and water resources.

The goals and policies contained in these documents provide guidance in addressing current and future water resource issues and problems. For example, these plans establish policies for land use and development, conservation of agricultural and natural resources, County recreational facilities, and water and sewer systems. Objectives have been listed calling for such things as wetland preservation, erosion and sedimentation control, flood damage reduction, enhanced water-based recreational opportunities, improved municipal drinking water supplies and expanded wastewater treatment facilities. Most of the planning objectives are directly aimed at protecting and improving the County's natural environment. And, as noted throughout the information sections of this Plan, many of these objectives have already been achieved or are actively being pursued.

The Comprehensive Water Planning Committee has reviewed the above-listed plans to assess how effective they are in addressing the issues identified in the water planning process. In some cases it was determined that although specific water-related problems and solutions had been identified, little direction had been given for achieving the desired results. In other cases, it was apparent that improvements or solutions had already been implemented. And, finally, by reviewing these plans, the Committee realized that certain issues have only recently come to the forefront of public concern.

The following list of goals and objectives, therefore, represent areas of concern the Committee felt were in need of additional attention. Those items not listed, according to the viewpoint of the Committee, are presently being addressed in a satisfactory fashion. Objectives are listed in order of priority.

GOAL I

IMPROVE THE QUALITY OF MURRAY COUNTY'S SURFACE WATER TO ENHANCE RECREATION AND ECONOMIC OPPORTUNITIES

OBJECTIVE A: Protect County lakes, especially Lake Shetek and Lake Sarah, from potential pollution caused by private septic systems and other sources.

Environmental Service, Economic Development, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$50,000,000.

1. Encourage Lake Shetek Area Improvement Association (LSAIA) and People Around Lake Sarah (PALS) to pursue development of water and sewage systems.
2. Assess all developed residential lakes in the County for pollution potential.
 - a. An assessment will be made to determine what effect septic systems are having on lake water quality.
 - b. Provide opportunities to all lake homeowners to become part of a central sewage collection and treatment system, if feasible.
 - c. Encourage efforts to seek funding for a feasibility study for central sewage systems on all developed residential County lakes.
 - d. Recommend to County Planning & Zoning that all future plats around all developed residential County lakes be required to have a centralized sewer system.
3. Continue the efforts of the Lake Fulda Improvement Project. Specific concerns include non-complying septic systems and agricultural runoff from field and fertilizers.

OBJECTIVE B: Promote land treatment techniques to reduce cropland erosion.

The Soil and Water Conservation District is the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$5,000,000.

1. Establish a coordinated information program on behalf of the SWCD and the Univ. of MN. Extension Service, stressing water quality benefits of enrolling land in the Conservation Reserve Program (CRP) and Reinvest in Minnesota (RIM).
2. Promote wetland restoration within the County, where economically feasible.
3. Increase conservation practices on land in Murray County by fifty percent in the next ten years.

OBJECTIVE C: Protect the County waterbodies from sedimentation.

County Board of Commissioners are the local officials involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$50,000.

1. Continue to enforce the one rod buffer strip provision of the Drainage Code along County drainage ditches.
2. Instruct the County Attorney to follow state guidelines concerning prosecution.
3. All landowners having property adjacent to lakes and streams will be contacted and requested to plant cover by the next growing season. An incentive for these plantings will be a re-classification of the land value for tax credit.

OBJECTIVE D: Develop a river restoration program for Beaver Creek, the Cottonwood River, the Des Moines River, and other areas in the Des Moines Watershed.

Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$25,000.

1. Inventory the major problem areas along the streams.
2. Investigate funding options.
3. Research interest of local organizations to undertake a cooperative program.
4. Work in conjunction with efforts put forth by the Redwood-Cottonwood Rivers Control Area (RCRCA), joint powers board within the Cottonwood River watershed.

OBJECTIVE E: Develop wetlands within the County for their value for filtering surface water, recharging ground water and wildlife habitat.

Soil and Water Conservation District, and Environmental Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$200,000.

1. Promote restoration and development of wetlands through the SWCD, the area DNR offices and Fish and Wildlife.
2. Support the Wetlands Conservation Act (WCA) of 1991.
3. Designate Murray County as a high priority wetland area to ensure that all landowners having wetlands on their property would be eligible for enrollment as wetland preservation areas and may apply for property tax exemption in accordance with the WCA of 1991.

OBJECTIVE F: Improve the sewage treatment systems in Murray County, including the communities of Avoca, Hadley, Iona and Dovray.

Economic Development, Environmental Services, and Extension Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$100,000,000.

1. Public meetings will be conducted with Minnesota Pollution Control Agency (MPCA) and plans will be developed to remedy sewage treatment problems in the four communities, when economically feasible to the community.
2. These actions will be initiated through the communities and coordinated through the Office of Economic Development.
3. All four of these communities will have systems in place that meet the MPCA standards for waste water discharge, when economically feasible to the community.
4. Improvements will be dependent upon the availability of outside funding.
5. Educate the public on management and maintenance of individual sewage treatment systems.

OBJECTIVE G: Foster communication between the Middle Des Moines Watershed District and other watersheds represented in Murray County.

Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$25,000.

1. Continue support of joint powers boards (RCRCA and AREA II).
2. Work toward implementation of flood reduction plans.
3. Work with the Middle Des Moines Watershed District to administer their program.
4. Cooperate with efforts of the Heron Lake Clean Water Partnership Project.
5. Participate in the Minnesota River Basin Joint Powers Agreement.

OBJECTIVE H: Continue efforts to bring high priority feedlots into compliance.

Environmental Service is the local office involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$200,000.

1. The feedlot officer will monitor operators throughout the County and notify those not in compliance with the County feedlot standards.

OBJECTIVE I: Assess the adequacy of County Recreational and Tourism Opportunities.

Economic Development is the local office involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$5,000.

1. Determine the need for additional public accesses and improvements to the existing accesses.

**GOAL II
ELIMINATE THE INTRODUCTION OF CONTAMINANTS TO
GROUND WATER**

OBJECTIVE A: Adopt an ordinance to require a permit before demolition of abandoned farm sites. This would provide the opportunity to investigate the condition of the well and require proper sealing of that well along with locating any underground storage tanks or pesticide/fertilizer containers.

Environmental Service, Soil and Water Conservation District, and Extension Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$25,000,000.

1. Preparation of the ordinance will be under the direction of the Planning and Zoning administrator.
2. The contents of the ordinance will be developed in conjunction with revisions to the shoreland ordinance to enhance consistency and efficiency.
3. Murray Soil and Water Conservation District and well drillers will be the contact to obtain information on the sealing of abandoned wells in the County.
4. Ordinance will comply with all state laws, rules and regulations.
5. Inform the public of the pollution potential of leaking underground storage tanks and encourage removal of tanks not covered by MPCa regulation (tanks with less than 1,100 gallons capacity).

OBJECTIVE B: Encourage people of Murray county to cooperate in household hazardous waste, pesticide, and container collections.

Environmental Service, and Extension Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$250,000.

1. In cooperation with neighboring counties, promote the reduction, reuse and at-home treatment and disposal of hazardous waste. Conduct collections and exchanges for wastes that cannot be reused or treated and disposed of at home.
2. Provide an opportunity for pesticide users to dispose of waste pesticides in an environmentally safe manner by organizing collections with efforts by the Minnesota Department of Agriculture.
3. Organize and implement an empty pesticide container collection and recycling program in cooperation with area agricultural chemical dealers.

OBJECTIVE C: Upon request, serve as an advisor and provide assistance to public water suppliers as they develop their wellhead protection plans.

Environmental Service, and each community are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$500,000.

1. Provide public water suppliers with data collected as part of the water planning process.
2. Assist with the collection of information on potential contaminant sources within the overall wellhead protection area.
3. Advise public water suppliers about County programs that can support protecting public water supply wells from contamination.
4. Advise public water suppliers about County land use authority to help manage potential contaminant sources within the wellhead protection area.
5. Use County zoning, permitting, and inspection programs to ensure that contaminant source isolation distances specified in the state well code are maintained for public water supply wells.
6. Assist public water suppliers with coordinating state agency involvement in managing potential contaminant sources in wellhead protection areas.
7. Review wellhead protection plans for consistency with County water protection goals, programs, and legal authorities.

**GOAL III
TO EFFECTIVELY MONITOR THE CONDITION OF SURFACE AND
GROUND WATER IN MURRAY COUNTY**

OBJECTIVE A: Assess the nature of the problem / presence of pesticides, nutrients and other contaminants in the ground water system.

Extension Service, Environmental Service, and Economic Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$250,000.

1. Track test results on private wells through the efforts of the Extension Service and the Community Health Service.
2. Encourage best crop management practices by education and regulation.
3. Review and support compliance with existing state and federal pesticide, fertilizer, land use and water quality regulations.
4. Conduct educational programs in needed areas.
5. Work with appropriate state agencies (MGS, MDA, DNR, MPCA) to secure funds and technical assistance to identify geologic sensitive areas.

OBJECTIVE B: Establish additional surface water monitoring stations with assistance from the Minnesota Pollution Control Agency.

Environmental Service, and Extension Service are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$2,500.

1. Review available information to determine suitable sites.
2. Encourage local citizens to participate in the Citizen Lake Monitoring Program.

**GOAL IV
MANAGE SURFACE AND GROUND WATER QUANTITY**

OBJECTIVE A: Update the 1952 Beaver Creek Diversion System Management Plan.

Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$750,000.

1. Review similar water diversion systems in the state.
2. Determine if water quantity is more or less important than quality of Beaver Creek.
3. Explore possibilities of increasing the quality of water in Beaver Creek.
4. Murray County Commissioners will hold formal public hearings to review the Beaver Creek Diversion management plan.

OBJECTIVE B: Reduce stormwater runoff through water retention management.

Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$25,000.

1. Adopt and enforce existing published standards and criteria for erosion control and stormwater management as referenced in: *Minnesota Construction Site Erosion Control Planning Handbook* Minnesota Board of Water and Soil Resources, 1988; and *Protecting Water Quality in Urban Areas* Minnesota Pollution Control Agency , 1989.
2. Utilize the above mentioned reference materials to establish specific criteria and standards to establish the best available technology, or best management practices (BMPs), to:
 - minimize off-site runoff
 - maximize overland flow over vegetated areas
 - replicate pre-development hydrologic conditions

OBJECTIVE C: Modify existing culverts and bridges to be used as water retention structures.

Highway Engineer, Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$2,500,000.

1. Murray County Engineer will undertake road retention projects by following the "*Design Guideline Manual For Road Retention*", created in joint effort by Area II, BWSR, MnDot, DNR, and Lyon and Lincoln County Engineers.
2. Explore the possibility of jointly funding projects with Lyon, Cottonwood and Redwood Counties through efforts of Area II and RCRC.

OBJECTIVE D: Murray County will develop a local review process for the established and/or correction of water elevation for the type 3-6 wetlands.

Environmental Service, and Soil and Water Conservation District are the local offices involved with this Objective. This Objective will take more than 10 years to achieve, at a cost of \$25,000.

1. Review all issues leading up to the present lake elevations at Current Lake and Lake Wilson and develop a compromised elevation.
2. Investigate reports of a hydrological connection between the wetlands near Chandler and quantity of water in the aquifer used by the City of Chandler.
3. Establish a local public hearing process that all proposed control structures must adhere to regardless of agency involvement.

IMPLEMENTATION PROGRAM

The Murray County Comprehensive Local Water Plan establishes goals for protecting and improving the water resources of the County for the benefit of future generations. Objectives of the Plan have been developed for the purpose of providing effective environmental protection and sound management of water and related resources. It is intended that the objectives listed in the Plan will be accomplished by the end of 2006.

In order for the actions contained in the Plan to be completed and to insure that all components of the Plan are adhered to, it will be necessary for the Comprehensive Local Water Planning Committee to be formally established as an advisory committee to the Board of Commissioners. At that time the name of the Committee will be changed to the Murray County Water Management Committee to accurately reflect its focus. Membership on the Committee will be drawn from the following groups: County Board of Commissioners; Soil and Water Conservation District; County Extension Service; Community Health Service; townships; municipalities; special interest groups; and the general public. The duties of the Committee will consist of 1) monitoring Plan implementation progress; 2) reviewing Plan amendments; 3) researching new issues as they arise; 4) overseeing development of the educational components of the Plan; 5) recommending changes in the Plan whenever new circumstances warrant; 6) reviewing state and federal legislation as they affect the Water Plan; and, 7) updating the Plan at the end of 2006 and every ten years afterward. It is anticipated that the Committee will meet at least quarterly and provide an annual report to the County Board on progress of Plan implementation.

In addition to the above listed duties, the Committee will be responsible for preparing an annual work plan and budget that establishes a framework for carrying out planning actions. The work plan will list priority actions along with fiscal needs and criteria for measuring attainment of objectives and actions. The work plan and budget will be submitted to the Board of Water and Soil Resources at the beginning of each fiscal year (state) and to the County Board of Commissioners during each annual budgeting period (August).

Many of the action items listed in the Comprehensive Local Water Plan can be implemented through efforts of existing staff and governmental units at the local level. Resources in this category include the offices of Environmental Service, Economic Development, Soil and Water Conservation District, Natural

Resources Conservation Service, University of Minnesota Extension office, Redwood-Cottonwood Rivers Control Area, Area II Minnesota River Basins Projects, Inc., DNR Area Wildlife Manager, Heron Lake Watershed District, and the Community Health Service agency. Through these organizations, the County already annually spends approximately \$150,000 on natural resource protection programs consistent with the goals and objectives listed in the Comprehensive Water Plan. Other action items will require assistance from a number of state and federal agencies including, but not limited to, the Department of Natural Resources, Minnesota Pollution Control Agency, Minnesota Department of Health, Minnesota Department of Agriculture, and Minnesota Geological Survey. Murray County recognizes that limitations on local staff and financial resources will restrict Plan implementation. Outside funds will therefore be sought to strengthen local capabilities.

Most of the actions developed in the Plan will be pursued upon Plan adoption even in the absence of state funding. It is recognized, however, that many of the actions will be enhanced through greater financial and technical assistance from state agencies including such actions as:

- 1) An assessment to determine what effect septic systems are having on the lake water quality in Lakes Sarah, Shetek, Fulda and other County lakes. (Goal I, Objective A, Action 2a)
- 2) Wetland restorations within the County supported by economic incentives. (Goal I, Objective B, Action 2)
- 3) Sewage treatment systems improvements for four County communities. (Goal I, Objective F)
- 4) An assessment to determine the presence of pesticides and nutrients in ground water. (Goal III, Objective A)
- 5) Identification of geologically sensitive areas within Murray County. (Goal III, Objective A, Action 5)
- 6) Establishing additional surface water monitoring stations. (Goal III, Objective B)

AMENDMENT PROCEDURE

The Murray County Comprehensive Water Plan is intended to extend through the year 2006. The County may prepare proposed amendments to the Plan prior to 2006, however the Plan will be updated including any proposed Plan Amendments before the end of 2006.

The following procedure will be used by Murray County to deal with proposed amendments to the Comprehensive Water Plan.

- A. When issues are brought to the attention of the County with regards to the need for amendments to its adopted Comprehensive Water Plan, the County will refer that person, group, local unit of government, or agency to the Murray County Water Management Committee.
- B. The Water Management Committee will review the issue and may if necessary undertake studies or investigations to gather information relating to the issue. After reviewing the issue the Water Management Committee will determine whether the Comprehensive Water Plan should be amended.
- C. If the Water Management Committee determines that the Comprehensive Water Plan should be amended it will make recommendations to the County Board. The County Board shall approve or disapprove the proposed amendment.

After development but before final adoption by the County Board, a proposed amendment to the Comprehensive Water Plan must be submitted for local review and comment in the following manner. The County must submit the proposed plan amendment to all local units of government wholly or partly within the County, the Southwest Regional Development Commission, each contiguous county and watershed management organization, and other counties or watershed management organizations within the same watershed unit and ground water system that may be affected by the proposed plan amendment.

A local unit of government must review the proposed amendment and its existing water and related land resources plans or official controls and in its comments describe in a general way possible amendments to its existing plans or official controls, and an estimate of the fiscal or policy effects that would be associated with those amendments, to bring them into conformance with the proposed plan amendment. A County or watershed management organization within the same watershed unit or ground water system must review the proposed plan amendment and describe in its comments possible conflicts with its existing or proposed Comprehensive Water Plan and suggest measures to resolve the conflicts. The Regional Development Commission must review the proposed amendment under section 462.391, subdivision 1.

Comments from local review must be submitted to the County Board within 60 days after receiving a proposed plan amendment for comment, unless the County Board determines that good cause exists for an extension of this period and grants an extension.

The County Board must conduct a public hearing on the proposed Plan Amendment pursuant to section 375.51 after the 60-day period for local review and comment is completed, but before submitting it to the State.

After conducting the public hearing but before final adoption, the County Board must submit the proposed plan amendment, all written comments, a record of the public hearing, and a summary of changes incorporated in the proposed plan amendment as a result of the review process to the Board of Water & Soil Resources (BWSR) for review. The Board of Water and Soil Resources must complete the review within 90 days after receiving the proposed Comprehensive Water Plan Amendment and supporting documents. The Board of Water and Soil Resources must consult with the Departments of Agriculture,

Health, and Natural Resources; the Pollution Control Agency; the State Planning Agency; the Environmental Quality Board; and other appropriate state agencies during the review.

The Board of Water and Soil Resources may disapprove a proposed Comprehensive Water Plan Amendment if it determines the amendment is not consistent with state law or the principles of sound hydrologic management, effective environmental protection, and efficient management. If the Amendment is disapproved, BWSR must provide a written statement of its reasons for disapproval. A disapproved Comprehensive Water Plan Amendment must be revised by the County Board and resubmitted for approval by BWSR within 120 days after receiving notice of disapproval, unless BWSR extends the period for good cause. The decision of BWSR to disapprove the Amendment may be appealed by the County to district court.

A County Board must adopt and begin implementation of its Amended Comprehensive Water Plan within 120 days after receiving notice of approval of the Amendment from the Board of Soil and Water Resources.

CONFLICT RESOLUTION PROCESS

At this time, there are no known conflicts between the Murray County Comprehensive Water Plan and plans of local units of government or other counties. Conflicts are not expected but if one should arise in the future, they may be addressed in either the local, informal, or formal resolution process.

LOCAL RESOLUTION PROCESS

Murray County realizes that the resolution of conflicts on the local level will give the County greatest control over the implementation of its Plan. The County also realizes that cooperation on all fronts will be needed to implement the Comprehensive Water Plan and reduce areas of conflict. Murray County therefore intends to minimize conflict wherever possible during implementation.

To assist in the orderly implementation of the Plan, Murray County will continue the Water Management Committee. Any conflicts that arise in the County or between counties will be brought to the attention of the Committee. The Committee will then determine if a solution can be found to resolve the conflict.

If conflict still persists, the Murray County Board of Commissioners will be presented the facts to determine if a solution to the conflict can be achieved. Conflicts arising within the jurisdiction of the Redwood-Cottonwood Rivers Control Area (RCRCA) may be presented for resolution at a regular meeting of the RCRCA Board of Directors to determine if a cooperative solution can be found to resolve the conflict.

All attempts at conflict resolution on the local level will be based on good will and good intentions where every effort will be made to cooperatively find solutions to areas of conflict.

INFORMAL RESOLUTION PROCESS

Murray County or other local units of government may request a meeting with the chair of the Board of Water and Soil Resources (BWSR) to informally resolve the following disputes:

- a) to determine the meaning of any provision of Minnesota Statutes Chapter 110B;
- b) to resolve conflicts between any two Comprehensive Water Plans;
- c) or to settle any other dispute relating to a Comprehensive Water Plan.

The informal resolution process is as follows:

- A meeting with the chair of the Board of Water and Soil Resources (BWSR) may be requested in writing by any of the involved parties.
- The nature of the provision or omission causing the conflict must be described, whether it is in the Comprehensive Water Plan, local plan, or other control. All parties in the conflict must be identified.
- The chair shall acknowledge the request in writing, and request a meeting of all parties. If requests for a meeting do not satisfy the parties, or if there is no response from one of the parties, the chair shall make a reasonable effort to obtain the information needed for resolution in another manner.
- The chair shall establish the meeting time and place, and inform all parties in writing. A local unit of government may be represented by any person or persons of its choosing, subject to control of the chair. The chair may consider any relevant and reasonable evidence or argument by a local unit of government in reaching a resolution.

- The decision of the chair may be announced at the meeting, or made later. In any case, the decision shall be submitted in writing to all parties, and will be effective 60 days following the decision of the chair.
- A petition may be filed within that time pursuant to Minnesota Statutes, section 110B.25, subdivision 3, for a contested case hearing under that section.

FORMAL RESOLUTION PROCESS

The formal resolution process specifies procedures for contested case hearings and is detailed in M.S. 110B.25

APPENDIX A

WATER RESOURCES SURVEY

The information gathered from the following Water Resources Survey was incorporated into the Water Management Task Force Final Report published in November, 1987. The Task Force was co-sponsored by the Countryside Council and the Redwood-Cottonwood Rivers Control Area.

Included here is a copy of the survey along with a listing of the basic percentage of responses to each survey question. Most questions, other than those asking for a "yes/no" response, were listed with potential responses on a scale of 1 through 4, such as from "not worried" (1) to "worried" (4). (In a few instances the scale was from 1 to 5.)

Six hundred and thirty of the 3,000 randomly selected households returned their surveys, for a return rate of 21 percent. By most survey standards this is considered good for a one-time mail survey of such length and complexity. The return rate illustrates deep concern and interest in water quality, which is further represented by the extensive and unsolicited written questions and comments on several returned surveys.

For comparative purposes, a second set of the same survey was sent to 237 county commissioners, soil and water supervisors, and to Water Management Task Force members. Results of that survey are reviewed after the section describing the results of the random survey.

Respondents to the survey reflect a wide variety of occupations, and a slightly higher number of farmers or farm residents compared to the population in the nineteen county area receiving the questionnaire. Farm residence accounts for 27.9 percent of responses, while farm population for the nineteen counties averages 25 percent according to the 1980 census. Responses were received from each county. Compared to census figures, males are over-represented in the returned surveys, because names were derived from telephone directories. Under-represented are the age group of 18-29 year olds, who may not be listed in directories or move frequently. Home ownership is over-represented (89 percent homeowners; 11 percent renters); this may suggest a greater sense of belonging and commitment by homeowners, while those who rent may feel unaffected by water quality issues because of their temporary status as residents.

GLOSSARY

- Abandoned well:** Well once used to withdraw ground water now unused.
- Algae:** Simple, rootless plants that grow in bodies of water in relative proportion to the amounts of nutrients available. Algal blooms, or sudden growth spurts, can affect water quality adversely.
- Aquatic Plants:** Plants that grow and live in water; they may be floating, submerged, or emergent.
- Aquifer:** An underground bed or layer of earth, gravel or porous stone that contains water.
- Conservation practices:** The protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.
- Cretaceous bedrock:** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
- Dump:** A site used to dispose of solid waste without environmental controls.
- Erosion:** The wearing away of land surface by water or wind; occurs naturally from weather or runoff, but is often intensified by human activities.
- Eutrophication:** The aging process by which lakes are fertilized with nutrients. Natural eutrophication will very gradually change the character of a lake. Cultural eutrophication is the accelerated aging of a lake as a result of human activities.
- Fertilizer:** Class of substances such as manure, decaying vegetative matter, ammonia, potash, etc., which, naturally or chemically, add Nitrogen to the soil.
- Glacial drift:** Pulverized and other rock material transported by glacial ice and then deposited. Also, sorted and unsorted material deposited by streams flowing from glaciers.
- Ground water:** The supply of fresh water under the earth's surface found in pores, cracks and fractures of subsurface rocks or between the particles in sand and gravel deposits.
- Habitat:** The place where a plant or animal naturally grows or lives.
- Hazardous Waste:** Waste material which by their nature are inherently dangerous to handle or dispose of, such as old explosives, radioactive materials, some chemicals, and some biological wastes. Minnesota law also contains a specific delineation of hazardous - as opposed to solid - wastes as part of its waste management act. In Minnesota, counties are responsible for solid waste disposal and the state for hazardous waste disposal.
- Hydrologic cycle:** Water reaches the aquifer through a process called the hydrologic cycle. Water is continually exchanged between the atmosphere, the surface of the earth, and those underground areas. Water evaporates from our rivers, lakes, streams and plants. The evaporated water rises into the atmosphere and forms clouds. Water returns to the earth as dew, rain, sleet, hail and snow. Water which soaks through the soil layers and reaches the water table is said to have "recharged" the ground water.
- Nitrate-Nitrogen (NO₃-N):** A substance composed of one atom of nitrogen and three atoms of oxygen. Nitrogen is a component of all living things. Nitrogen is converted into compounds used by plants and animals in formation of proteins. Decay of plant and animal matter releases Nitrogen to its original state. Nitrate-Nitrogen is dangerous to infants less than six months old if the level in drinking water exceeds 10 milligrams per liter (mg/L) of 10 parts

per million (ppm). Nitrates cause changes in the blood which reduce the blood's ability to transport oxygen. This condition, methemoglobinemia ("Blue Baby Syndrome") causes a blue tint in the infants skin because the blood is carrying less oxygen. Before using well-water for infant formula, it should be tested. Boiling water high in nitrates does not help; it will increase the nitrate concentration.

Nonpoint Source Pollution (NPS): A contributing factor to water pollution that cannot be traced to a specific spot, such as agricultural fertilizer runoff or construction site sediment.

Nutrient: Elements or compounds essential to growth and development of living things (e.g., nitrogen, potassium phosphorus).

Pesticides: Class of substance used to control a variety of living things. An inclusive term for herbicide, insecticide or fungicide.

Pollution: The presence of matter or energy whose nature, location, or quantity produces undesired environmental effects.

Point Source Pollution: A stationary location where pollutants are discharged such as industrial or municipal waste discharge.

Recharge area: Location where replenishment of aquifer or movement of surface water to groundwater occurs.

Runoff: Water from rain, snow melt, or irrigation that flows over the ground and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Relief: The elevations or inequalities of a land surface, considered collectively.

Sediment: Material deposited by water, wind or glaciers.

Suspended solids: Small particles that hang in the water column and create turbid or cloudy conditions.

Tolerable Soil Loss "T": Average annual soil loss in tons per acre that soils can withstand and still maintain long-term productivity. It is designated as "T". Most soils in southwestern Minnesota have a "T" value of 3-5 tons/acre. This is equivalent to about the thickness of a dime across one acre.

Volatile Organic Chemical (VOC): A broad class of substances found in industrial, commercial, and residential products like pesticides, petroleum products, paint thinners, cleaners, refrigerants, inks, preservatives, among others. Potential health risks are associated with exposure at levels so small they are measured in parts per billion. Several VOCs are suspected of causing cancer, genetic changes or birth defects in humans.

Water Quality Standards: A management plan that considers: 1) what water will be used for; 2) setting levels to protect those uses; 3) implementing and enforcing the water treatment plans and 4) protecting existing high quality waters.

Watershed: The surrounding land area that drains into a lake, river or river system.

Wetlands: Low-lying lands that frequently have standing water on them, such as swamps, marshes, and meadows.

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