ML95 Chap. 220 Sec. 19 Subd 5(e)

THE BEACH RIDGE LANDSCAPE IN CLAY COUNTY

an information handbook

About this handbook

This handbook presents information about the prairie and gravel resources found in Clay County. It was compiled by the Clay County Beach Ridges Forum as a way to provide information to the public about the important prairie and gravel resources located in the county. The handbook is a series of one page fact sheets that provide information on twelve key topics relating to gravel and prairie resources. Although some of the information is specific to Clay County, the handbook may be of general interest to others in the Red River Valley.

The Clay County Beach Ridges Forum was convened in 1995 to discuss gravel mining and prairie protection on the beach ridges in Clay County, Minnesota. Clay County is located in the Red River Valley and shares a border with neighboring Cass County in North Dakota. The Forum was an opportunity for landowners, gravel producers, supporters of native prairie, interested members of the public and governmental agencies to learn about the prairie and gravel resources found in the county and to discuss the future of those resources in a proactive setting.

The mission of the Clay County Beach Ridges Forum was "to identify and recommend ways to achieve a balance between the protection of our natural prairie heritage and environmentally yet economically sound gravel mining opportunities through appropriate land use management". An important goal was to "provide key information about the beach ridges to landowners, gravel operators, land managers and the public".

The project for establishing the Forum was funded by the Minnesota Legislature based on the recommendation of the Legislative Commission on Minnesota Resources. The project was staffed by the Minnesota Department of Natural Resources (DNR) who carried out work as directed by the Forum. The Forum concluded in June 1997. For more information about the Clay County Beach Ridges Forum, contact the Clay County Courthouse or the Minnesota Department of Natural Resources at the addresses listed on the inside of the back cover.

Clay County Beach Ridges Forum
June 1997

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What are the Lake Agassiz Beach Ridges?

Thousands of years ago, the Red River Valley was a very different place. Then, glaciers covered much of the upper Midwest. When the glaciers finally melted, huge lakes were formed. One of those lakes was Glacial Lake Agassiz. A series of ancient beach ridges developed at the margin of the lake. Today, the modern day Red River Valley is found on the lake bed of Glacial Lake Agassiz. The shorelines of the former lake are now seen as linear ridges composed of sand and gravel materials that are slightly higher in elevation than the surrounding lands. These features are known as the Lake Agassiz beach ridges.

Why are the beach ridges important?

The Lake Agassiz beach ridges throughout the Red River Valley support a wide variety of important land uses including agriculture. Among the many land uses that occur on the beach ridges are gravel mining and native prairie.

The sand and gravel that underlies the beach ridges are the primary source of construction aggregate for both rural communities and urban centers in the Red River Valley. The gravel mining industry supplies essential building materials, provides good jobs, and contributes significantly to the local economy.

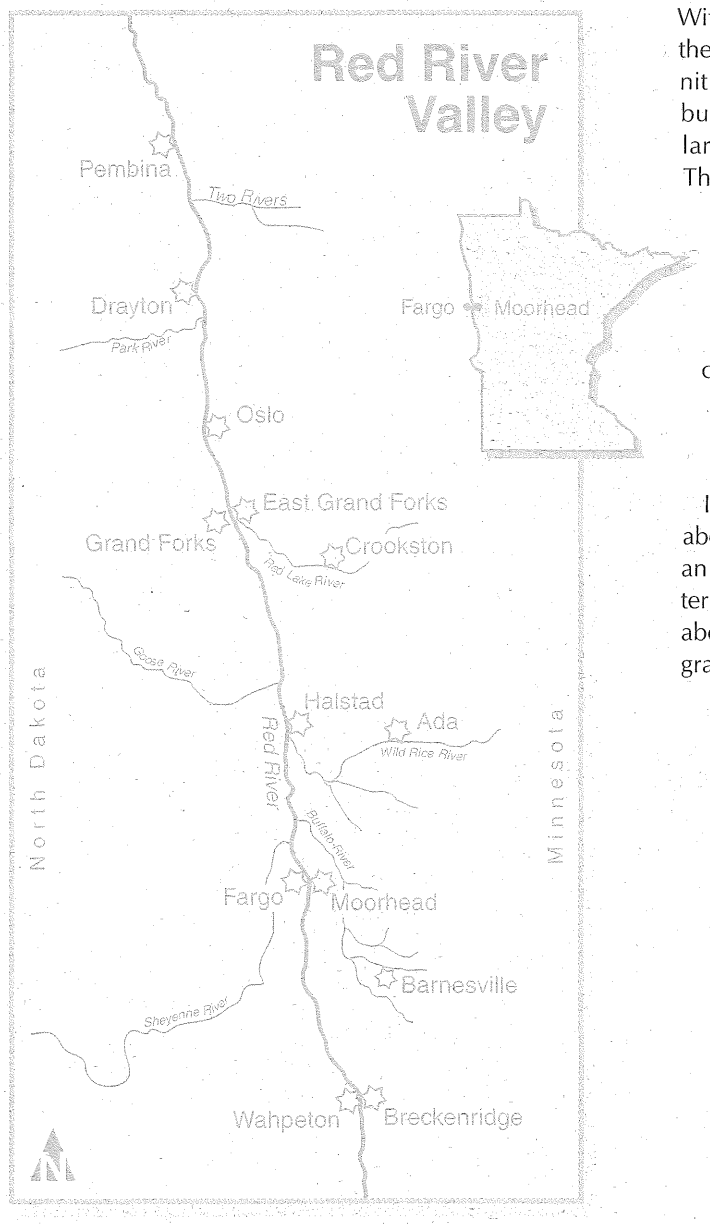
Just as important, the beach ridges support some of the largest and best remnants of native prairie left in the entire Midwest. Throughout the Red River Valley, the last remnants of prairie are in decline due to pressure from a wide range of land uses.

The relationship between prairie and gravel is important because both are nonrenewable resources that are uniquely located. Gravel deposits must be mined where they are found and cannot be relocated. Similarly, native prairie cannot be transplanted elsewhere.

Prairie and gravel resources in the Red River Valley.

Prior to European settlement which began in the mid-1800's, most of the Red River Valley was a vast sea of tallgrass prairie. Wooded areas were found primarily in river and stream bottoms. The tallgrass prairie was home to many plants and animals including herds of roaming bison. The prairie soils, especially those on the former lake bed of Glacial Lake

Agassiz, were highly valued for agriculture. As settlement progressed, almost all of the tallgrass prairie was plowed. The beach ridges were some of the last land to be plowed in the Red River Valley, presumably because the soils were not as productive for agriculture as the clay soils on the lake plain. Most of the tallgrass prairie that remains in the Red River Valley today is found on the beach ridges.



Red River Valley.

With settlement came the need to build the infrastructure important to communities. Building infrastructure like roads, buildings and septic systems requires large amounts of aggregate materials. The beach ridges are a local source of gravel that has supplied the needs of area residents for many years. Over time, the beach ridges have also become an important regional source of aggregate materials for communities elsewhere in the Red River Valley where gravel resources are not commonly found.

In recent years, increased knowledge about the remaining prairie coupled with an escalating demand for aggregate materials has led to a heightened awareness about the importance of both prairie and gravel resources in the Red River Valley.

This is one in a series of twelve fact sheets compiled by the Clay County Beach Ridges Forum. June 1997.

Why study the beach ridges in Clay County?

All across the Red River Valley, gravel mining has expanded on the beach ridges to meet increasing market demands. Clay County, Minnesota is located in the Red River Valley and shares a border with neighboring Cass County in North Dakota. In Clay County, the steady growth of the Fargo/Moorhead area is driving an expansion of the gravel mining industry in the eastern half of the county where the beach ridges are found. As the population of this area continues to increase, the demand for aggregate products will also grow. At the same time, native prairie is declining due to pressure from a variety of land uses.

Because the beach ridges in Clay County support both gravel and prairie resources, questions have been raised about how continued expansion of the gravel mining industry may affect the remaining prairie. Concerns have also been expressed about how prairie protection efforts could affect future availability of aggregate materials. The relationship between prairie and gravel is important because both are nonrenewable resources that are uniquely located. Gravel deposits must be mined where they are found and cannot be relocated. Likewise, native prairie cannot be transplanted elsewhere. The same relationship between gravel and prairie resources observed in Clay County can be seen throughout the Red River Valley.

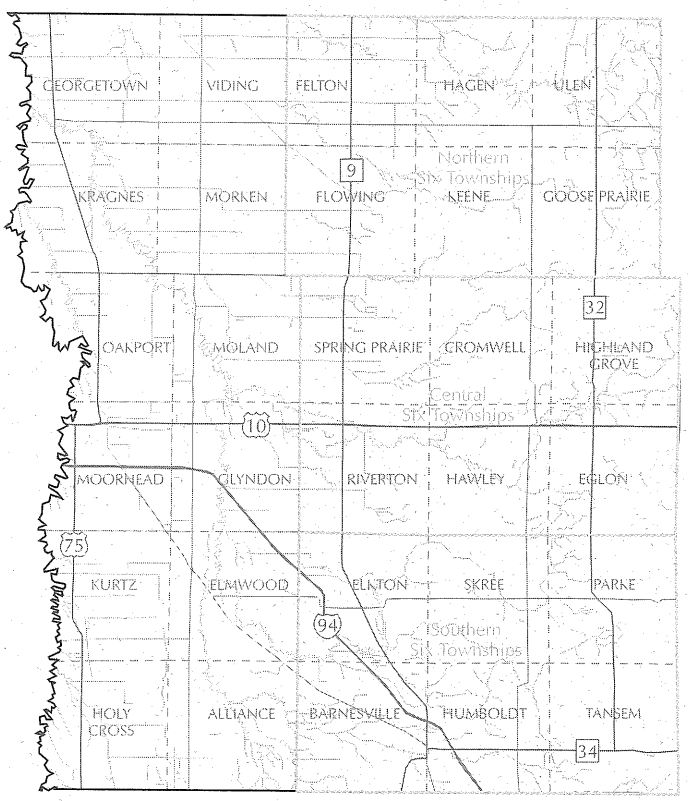
What is the Clay County Beach Ridges Forum?

In 1995, a local Forum was convened to discuss gravel mining and prairie protection on the beach ridges in Clay County, Minnesota. The Forum was an opportunity for landowners, gravel producers, supporters of native prairie, interested members of the public and governmental agencies to learn about the prairie and gravel resources found in Clay County and to discuss the future of those resources in a neutral and proactive setting.

The project for establishing the Forum was funded by the Minnesota Legislature based on the recommendation of the Legislative Commission on Minnesota Resources. The project was staffed by the Minnesota Department of Natural Resources (DNR) who carried out work as directed by the Forum.

The Forum provided a setting for building relationships among people who did not often have the chance to meet informally. It created an organizational frame work for people to first discuss and then make recommendations about the beach ridges. The resource discussions that took place in the Forum centered on information generated by a computerized resource information system that was compiled for the project. The

CLAY COUNTY
Townships, Roads, and Hydrography



Eastern eighteen townships study area

Six township study area

Forum focused on the relationship between gravel and prairie in the eastern half of Clay County, an area of 18 townships that includes most of the gravel mining activity in the county as well as the remaining tracts of prairie. The Forum concluded its work in June 1997.

Provide information to the public.

An important goal of the Forum was to "provide key information about the beach ridges to landowners, gravel operators, land managers and the public". Early on in the project, the Forum gathered an abundance of information about the beach ridges. The Forum sought to be a source of accurate and balanced information about the gravel and prairie resources found in Clay County and believed it was important to emphasize both the economic and natural heritage values. The Forum wanted the information compiled by this project to be summarized in different ways for future use by a wide range of the public. The informational products devised by the Forum include:

1. Computerized resource information system. Computerized resource information that integrates digital resource datasets for the eastern half of Clay County allows users to study prairie and gravel resources in combination and to create custom maps and applications. The information is available to the public on CD-ROM at the Lake Agassiz Regional Library and to visitors at the Moorhead State University Regional Science Center. The information is also housed in the Clay County Courthouse for use by county staff.

2. Map displays. Maps displaying gravel and prairie resources were distributed to all townships and community centers in the county. Several large maps were prepared for display in public settings throughout Clay County.

3. Lake Agassiz Beach Ridges: A Coloring Book for Children. This coloring book for children depicts the value of both the prairie and gravel resources. It was distributed on Earth Day 1997 to all third grade classrooms in the county.

4. The Beach Ridge Landscape in Clay County: An Information Handbook. This handbook is a series of one page fact sheets that provide information on key topics relating to gravel and prairie resources.

5. Final Report. The final report of the Forum documents all aspects of the project and includes a summary of the process, resource information, analysis and recommendations.

For more information about the Clay County Beach Ridges Forum or for copies of the products developed by the Forum, contact the Clay County Courthouse or the Minnesota Department of Natural Resources.

Clay County Courthouse
807 11th Street North
PO Box 280
Moorhead, MN 56560-0280
Telephone: 218/299-5002

MN Department of Natural Resources
Division of Minerals
2115 Birchmont Beach Road NE
Bemidji, MN 56601
Telephone: 218/755-3955

MN Department of Natural Resources
Division of Minerals
500 Lafayette Road
St. Paul, MN 55155-4045
Telephone: 612/296-4807

3 Prairie Resources in Clay County

What is prairie?

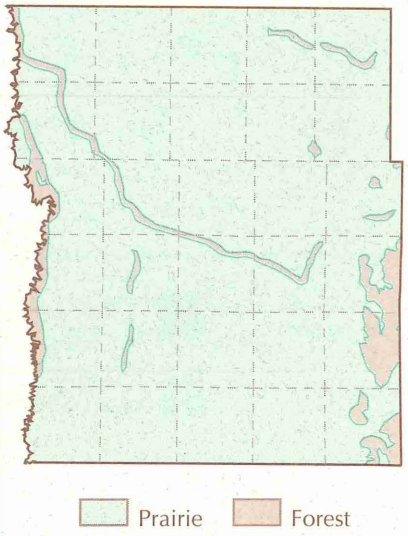
In the simplest of terms, prairie is a community of plants. Prairie plants are specially adapted to the climate and conditions found in western Minnesota including extremes of heat and cold, wind and very dry conditions. These plants evolved to conserve water and survive fire. Much of the plant growth is underground where long roots reach deeply for water. The above ground parts are often fuzzy or hairy and some have sticky juices, all devices to reduce moisture loss. Most prairie plants are perennial, which means that they grow back every year. Different plants come into flower throughout the entire growing season which allows for reduced competition. More than 200 different plants and animals can be found on a single acre of prairie.

There are many different types of prairie found in the Midwest and the type depends on local topography, precipitation and soil. The tallgrass prairie was typically found in western Minnesota where prairie grasses sometimes grew six feet high. Prior to European settlement, almost the entire Red River Valley was covered by tallgrass prairie. The prairie landscape was shaped by large grazing animal herds such as bison, drought, fire, and extreme temperatures.

With settlement underway in the 1860's, many immigrants found the rich prairie soils of the Red River Valley to be valuable for farming. Almost all of the original tallgrass prairie was eventually cleared except for some land on the beach ridges. This land was probably not plowed because the soil was sandy compared to the heavy clay soils on the lake plain of Glacial Lake Agassiz. Prairie land that has never been plowed is generally called native prairie. Today, less than 1% of the original 18 million acres of prairie in Minnesota remains. Most of these prairie remnants are found on the beach ridges in the Red River Valley.

How much prairie is in Clay County?

A hundred and fifty years ago, almost the entire area now known as Clay County was covered by tallgrass prairie. Today, only a small amount of the original prairie remains. The remaining prairie in Clay County was recently mapped by the DNR (Minnesota County Biological Survey (MCBS) Staff. 1997. Natural Communities and Rare Species of Clay County, Minnesota Map, scale 1:75,000. MN Department of Natural Resources). About 21,310 acres in the county were identified as having some prairie characteristics. Prairie resources in the county vary in quality. Included in this figure are areas of prairie of low significance, prairie of modest significance, prairie of medium significance and prairie with high significance, according to MCBS criteria.



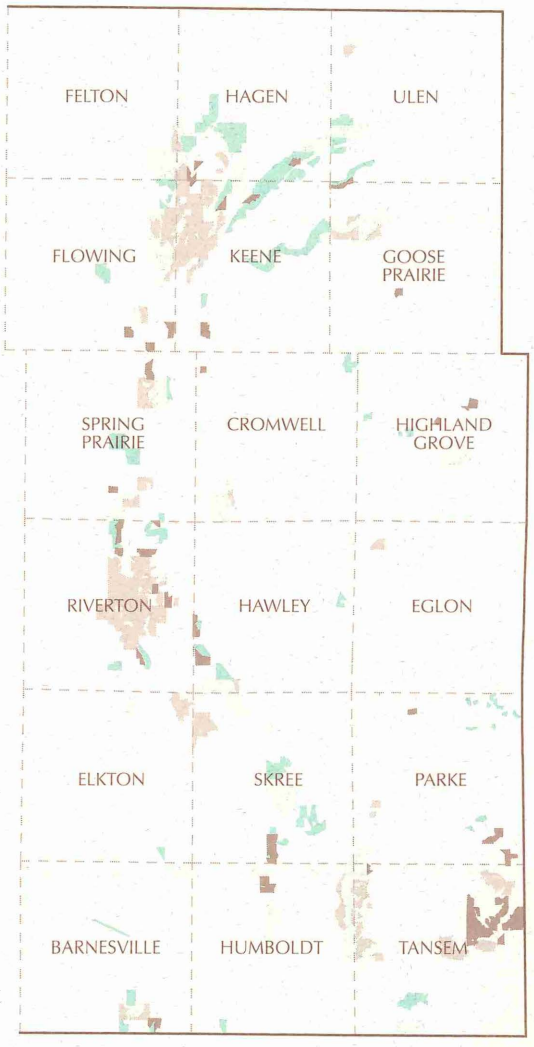
Original vegetation in Clay County [1]

The prairie with medium or high significance represents the best and least disturbed prairie resources in the county. About 14,290 acres of prairie with high or medium significance are found in Clay County. This figure includes some of the best prairie in Minnesota and represents approximately 10% of all the prairie remaining in the state.

There are two main concentrations of prairie found in Clay County - Felton Prairie and Bluestem Prairie. Felton Prairie is a special kind of prairie that supports animals and plants specially adapted to dry conditions. It is the best example of dry prairie left in the state and perhaps the entire Midwest. Several endangered plants and animals are found in this location.

Bluestem Prairie is located south of Trunk Highway 10 near Buffalo River State Park. It is an excellent example of the tallgrass prairie landscape. Much of Bluestem Prairie is contiguous and offers uninterrupted views of the tallgrass prairie.

[1] *(Adapted from Marschner, F. J. 1974. The original vegation of Minnesota (map, scale 1:500,000). USDA Forest Service, North Central Forest Experiment Station. Redraft of the original 1930 edition).*



Prairie resources in Clay County[2]

A third area of shrub swamp and marsh with scattered prairie remnants is found in the southeastern corner of the county and is known as the Barnesville Slough. Also found in this general location is a concentration of prairie/savanna/woodland remnants.

These three areas combined account for the bulk of what remains of the county's original prairie vegetation. Other smaller and isolated parcels of prairie are scattered throughout the eastern half of the county. Copies of the MCBS map displaying natural communities and rare features in Clay County can be obtained by contacting the DNR at the following address.

MN Department of Natural Resources
Division of Fish and Wildlife
Minnesota County Biological Survey
500 Lafayette Road
St. Paul, MN 55155-4007
Telephone: 612/296-8324

Special prairie plants and animals.

Because of the loss in prairie habitat since European settlement began, many plants and animals that live on the prairie are considered endangered or threatened. In Clay County, 17 animal species and 19 plant species have been identified by the state as threatened, endangered, or special concern species. Of these, the western prairie fringed orchid is the only federally-listed species known to occur in the county, all the rest are state-listed. Most but not all of these species are found on the beach ridges. There are also as many as 40 prairie chicken booming grounds located in Clay County on an annual basis. The DNR and the U.S. Fish and Wildlife Service can provide additional information about these plants and animals.

MN Department of Natural Resources
1221 East Fir Avenue
Fergus Falls, MN 56537
Telephone: 218/739-7576

U.S. Fish & Wildlife Service
RR1 Box 32
Audubon, MN 56511.
Telephone: 218/439-6319

Where to view the prairie.

The most accessible places to see the prairie in Clay County are at Buffalo River State Park and the Moorhead State University Regional Science Center. Both are located 4.5 miles east of Glyndon, MN. Entrance to the park and the science center is from Trunk Highway 10. Information about the Bluestem Prairie Preserve can be obtained by contacting The Nature Conservancy. At present, there is no established access for the public at Felton Prairie.

Buffalo River State Park
Department of Natural Resources
Route 2, Box 118
Glyndon, MN 56545
218/498-2124

Moorhead State University
Regional Science Center
1104 7th Avenue South
Moorhead, MN 56563
218/236-2904

Bluestem Prairie Preserve
The Nature Conservancy
Route 2, Box 240
Glyndon, MN 56547
218/498-2679

This is one in a series of twelve fact sheets compiled by the Clay County Beach Ridges Forum. June 1997.

[2] *Based on the natural community and biodiversity significance data from the Minnesota County Biological Survey, Minnesota Department of Natural Resources.*

4 Prairie Conservation Programs for Private Landowners

Some of the best prairie in Clay County is protected by designation as state Scientific and Natural Areas (SNAs) or through conservation efforts by private landowners or conservation organizations like The Nature Conservancy. Several state and federal conservation programs are available to interested private landowners to protect prairie remnants on their lands and some acres of prairie has been enrolled in these programs by willing private landowners. Because the majority of prairie that remains in Clay County is in private ownership, landowners are an important factor in future prairie conservation efforts. In addition, prairie that occurs on public land in a designated management unit - such as a wildlife management area, a waterfowl production area or a state park - is likely to remain as prairie.

The prairie landscape is neither explicitly recognized nor protected by law in Minnesota. However, other existing laws can apply to prairie landscapes. For example, prairie wetlands are regulated like other wetlands under the jurisdiction of the Wetlands Conservation Act of 1991 (Laws of Minnesota for 1991, Chapter 354). In general, proposed development that would impact prairie wetlands requires mitigation. Calcareous fens are a unique type of wetland often associated with prairies found down slope from beach ridges in the Red River Valley. Calcareous fens are protected through the Wetlands Conservation Act. Ten calcareous fens are located in Clay County from a total of 103 listed statewide. Certain federal farm programs may also apply to agricultural use of prairie lands. Finally, some animals and plants that live on prairie remnants in Clay County have legal status as threatened or endangered species. Proposed development that would potentially impact those species may require careful review.

Western prairie fringed orchid

Prairie conservation programs.

The following programs are available to private landowners who are interested in protecting prairie remnants on their land.

DNR Scientific and Natural Areas Programs

This program established a system of public natural areas that encompasses the rarest and most precious of Minnesota's natural features. The lands and waters that qualify are protected through fee acquisitions, gifts, easements, or leases. In addition, people can make land or financial contributions to the Natural Areas Legacy Endowment Fund.

- For more information, contact: DNR Scientific and Natural Areas Program, Box 7, 500 Lafayette Road, St. Paul, MN 55155. Telephone 612/297-2357.

State Wildlife Management Areas

State Wildlife Management Areas are lands acquired by the DNR to promote wildlife populations and their habitats, including native prairie. WMAs are typically open to the public for compatible uses such as hunting, bird watching, general nature observation, and hiking. Motorized vehicle use is restricted to designated trails.

- For more information, contact: DNR Area Wildlife Management Office, 1221 Fir Avenue East, Fergus Falls, MN 56537. Telephone: 218/739-7576.

RIM Prairie Bank Easements
The RIM(Reinvest in Minnesota) Prairie Bank program authorizes the DNR to buy conservation easements from landowners who own native prairie. These easements protect the prairie resource while still allowing the land to remain in private ownership. Easements may allow selected agricultural practices such as mowing for wild hay.

- For more information, contact: DNR Prairie Biologist, 1221 East Fir Avenue, Fergus Falls, MN 56537. Telephone: 218/739-7576.

Prairie chicken

Native Prairie Tax Exemption
This program exempts approved native prairie from property taxes. Qualifying lands may be hayed but not grazed. Contact your county assessor's office to apply.

RIM Critical Habitat Match Account
This unique RIM (Reinvest in Minnesota) program provides a way for private individuals to help fund the cost of acquiring land and developing critical fish and wildlife habitats, such as prairies. Contributions of cash, land, easements, or pledges are matched dollar for dollar by state funds appropriated to the account. This program allows for the acquisition of native prairie for Wildlife Management Areas, state parks, and Scientific and Natural Areas as well as for controlled burning on existing prairie in these management units.

- For more information, contact: DNR Wildlife, Box 7, 500 Lafayette Road, St. Paul, MN 55155. Telephone: 612/296-3344.

Minnesota Registry of Natural Areas
The registry is designed to honor and recognize the owners of outstanding natural areas for their commitment to the preservation of the state's natural lands. Landowners receive a plaque from The Nature Conservancy bearing their name and the name of the registered natural area. The Nature Conservancy is a private, nonprofit conservation organization committed to the preservation of natural diversity. The registry is a voluntary, non-binding agreement based on the Minnesota tradition of self-reliance and citizenship.

- For more information, contact: The Nature Conservancy, 1313 Fifth Street Southeast, Suite 320, Minneapolis, MN 55414-1588. Telephone: 612/331-0750.

Federal Grassland Easements and Waterfowl Production Areas
The U. S. Fish & Wildlife Service works with interested landowners on landowner agreements, grassland easements and fee title acquisitions to protect prairie.

- For more information, contact the U.S. Fish & Wildlife Service, RR1 Box 32, Audubon, MN 56511. Telephone: 218/439-6319.

For more information about conservation options for landowners, contact the DNR or The Nature Conservancy for a publication entitled "Land Protection Options—A Handbook for Minnesota Landowners".

This is one in a series of twelve fact sheets compiled by the Clay County Beach Ridges Forum. June 1997.

There are several excellent examples in Clay County where lands that once were covered by tallgrass prairie have been restored to prairie vegetation. With time, effort, and patience, it is possible and in some cases desirable, to restore an assemblage of the original prairie vegetation. Once established, native prairie grasses can provide a long-term vegetative cover that is self-sustaining and requires little maintenance. Another advantage is that prairie grasses do not usually require fertilizer amendment for establishment. Native grasses also have a high value to wildlife. Although a restored prairie offers many benefits, it can never fully substitute for a native prairie. Restoring more than a fraction of the species found in a native prairie is beyond present capabilities.

Prairie restoration can be a challenging endeavor. Most warm-season prairie grass seed will not germinate until prolonged moisture is available at warm temperatures. As a result, it may be the spring after initial seeding before seedlings are observed. After germination, warm-season prairie grasses establish an extensive root system during the first year. The top growth during this time amounts to small leaves that can be difficult to identify. It is usually not until the second year when success becomes apparent. Due to the slow initial growth, native plantings should not be used alone for erosion control on steep slopes.

Prairie grass seed can be relatively expensive to purchase and sometimes difficult to find. A specially-adapted seed drill is sometimes needed for seeding large areas. Adequate site preparation and regular weed control are essential for establishment. Due to the increasing popularity of native prairie plantings, however, these difficulties are quickly being overcome. Although the initial costs may be higher, the long term benefits of native plantings are great. Several government agencies and private vendors in the area can provide advice and technical assistance to private landowners on how to restore prairie. Provided here is some basic information about planting native species.

Site preparation: Adequate site preparation is essential to a successful planting. Several herbicide applications followed by disking or mowing will probably be necessary on sites where vegetation is already established.

Seed source: It is best to use seed harvested from as close to the project site as possible to preserve genetic characteristics. This will help to establish the vegetation type best adapted to your site.

Seeding method: Native seed can be drilled using a specially adapted drill that accommodates the light fluffy native seed. The final planting depth should be 1/2 to 1 inch and maximum row spacings of about 8 inches. All drill seeding should be done at right angle to surface drainage. An alternative to drilling is to till the site and broadcast the seed. Planting depth should be from 1/4 t o 1/2 inch. The site should then be dragged with a rake or harrow and packed following seeding. Hand seeding is a good method for small areas. Hydroseeding is an acceptable seeding method on steep slopes or other areas inaccessible to a seed drill. Hydroseeding is not recommended if the weather conditions are hot and dry.

Cover crop: A cover crop can be seeded with native seed mixtures. The type of cover crop depends on the season. Some possible cover crops are oats at a rate of 20 lbs per acre in the spring plantings, winter wheat at 20 lbs per acre for fall plantings, and annual rye grass at 10 lbs per acre for dormant seedings.

Timing: The best time of year to plant native grasses from seed is May 1st to June 30th. Dormant seeding in the fall is also a good time to seed, but the seeding rates should be increased slightly to account for seed mortality over the winter. Many species of wildflowers require a cold period to break

dormancy and are best seeded late in the fall. If seeded in the spring, they may not be seen until the second year. Seedling plants can be used to add extra diversity to plantings. Some desirable species are difficult to propagate from seed and are only available as seedlings.

Maintenance: During the first growing season, if the cover crop or annual weeds reach 18 inches or more in height, the site should be mowed to a height not less than 6 inches with a rotary mower. Prescribed burns can be implemented on a 3 to 5 year rotation starting the third or fourth year after planting. Fall haying is an alternative to burning for those sites where burning is not possible.

Native seed vendors: Prairie seed can be purchased from many sources around the state. MnDOT has developed specifications for native seed vendors that address purity, germination, and seed treatment. A current list of approved vendors is available from MnDOT. Local vendors and contractors are also found in the Clay County area.

For more information about prairie restoration and native seed sources, contact:

MN Department of Transportation
Office of Environmental Services
3485 Hadley Avenue North
Oakdale, MN 55128
Telephone: 612/779-5087

MN Department of Natural Resources
1221 East Fir Avenue
Fergus Falls, MN 56537
Telephone: 218/739-7576

U.S. Fish & Wildlife Service
RR1 Box 32
Audubon, MN 56511
Telephone: 218/439-6319

Natural Resources Conservation Service
Clay County Soil and Water Conservation District
2223 East Highway 10
Moorhead, MN 56560
Telephone: 218/233-7994

What is aggregate?

Gravel deposits occur throughout Minnesota and are a legacy of the state's glacial history. Sand and gravel are most often found as a surficial deposit of unconsolidated material that is mined using shovels, draglines, loaders, trucks and other similar equipment. Crushed stone, in contrast, is made by crushing large blocks of rock that are usually extracted from the earth using hard rock mining methods.

Gravel, rock and crushed stone can be further crushed, washed, and blended to meet size and quality specifications. Together, sand, gravel, rock, crushed stone and their various size fractions are referred to as aggregate materials. Aggregate materials are the building blocks from which a variety of construction products can be made. Aggregate materials are used in concrete products, asphalt, road base, fill, snow and ice control and other miscellaneous uses.

Importance of the aggregate industry.

Sand and gravel mining contributes significantly to the federal, state and local economy. Every year, people living in the United States consume on average about 10.0 tons of aggregate materials per person. On a national level, the 1996 total annual production for both crushed stone and construction sand and gravel was the highest production ever recorded. According to mineral industry surveys prepared by the U. S. Geological Survey, the estimated annual production of crushed stone consumed in 1996 was 1.3 billion tons (a 5.6% increase over 1995) while the estimated output of construction sand and gravel produced in 1996 was 963 million tons (a 5.8% increase over 1995). In Minnesota, an estimated 31.9 million tons of construction sand and gravel was sold or used by producers in 1996 for an estimated value of $99.4 million. Sand and gravel consumption is so important to the economy that it is considered to be a reliable measure of economic activity. Aggregate production is commonly reported by weight (as in tons) and by volume (as in cubic yards).

Sand and gravel deposits vary considerably in quality. To most people, all gravel looks the same. In reality, the characteristics of the deposit are an important consideration in how the material will be used. For example, the manufacture of concrete requires an aggregate that is free of deleterious materials such as shale and iron oxides. If a gravel deposit meets the specifications for concrete manufacture, it is considered more valuable than a deposit that could be used for fill material. Strength and durability of the aggregate is another important consideration in meeting specifications for road building. Sometimes, material from two or more sources must be blended to meet the specifications for a particular project.

Sand and gravel mining is the most common form of mining in the state. Because sand and gravel are relatively inexpensive to mine but expensive to transport, most operations are located close to where the resource will be used. As a result, gravel pits are found in every county in Minnesota. There are an estimated 4,000 gravel pits statewide (according to a 1991 informal survey conducted by the DNR).

Population growth and aggregate demand.

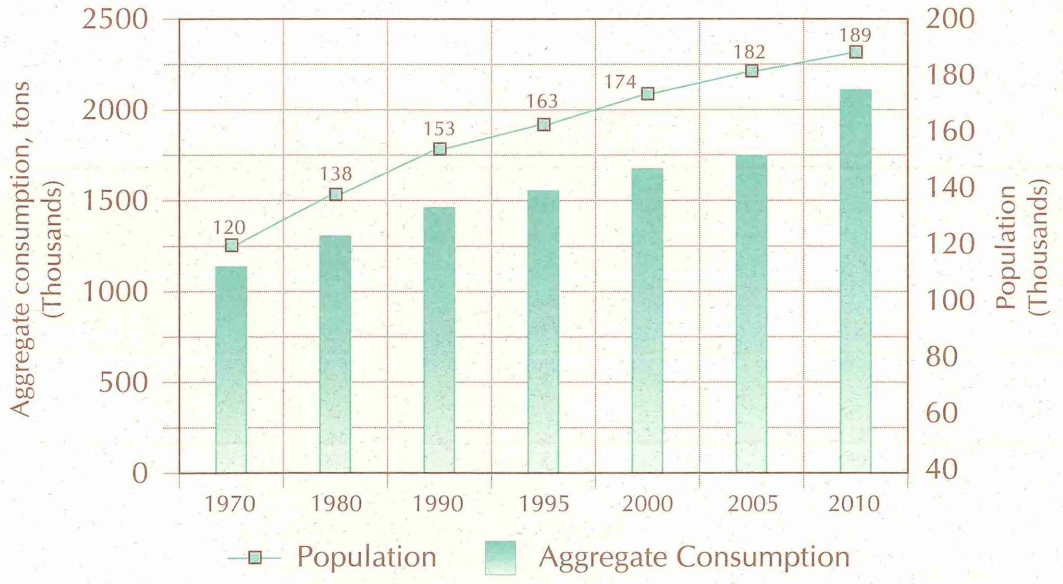
One way to look at aggregate demand is by per capita consumption. On average, people in the rural areas of Cass/Clay counties consume about 8 tons of aggregate/person/year - without even realizing it - through road building and infrastructure development. Within the Fargo/Moorhead area, the consumption is higher at 10 tons/person/year due to the special needs of that market and the growth rate.

Population projections can be used to roughly forecast aggregate demand. In 1995, the rural population of Cass and Clay Counties was projected to be 33,152 while the urban population was projected to

be 129,896. Multiplying the rural population by the per capita consumption rate of 8 tons/person/year and the urban by the rate of 10 tons/person/year yields a total estimated gravel consumption for 1995 of 1,564,176 tons. Similar calculations can be made for past and future population projections. The figure below shows the projected increase in population and estimated aggregate consumption over time. A steady increase in aggregate consumption can be seen and the trend is projected to continue to the year 2010 and beyond.

PROJECTED POPULATION GROWTH & AGGREGATE CONSUMPTION
for the Fargo/Moorhead area.

Year	Population Cass + Clay	Estimated Aggregate Consumption tons/year
1970	120,261	1,143,156
1980	137,574	1,308,722
1990	153,296	1,468,878
1995	163,048	1,564,176
2000	173,695	1,667,722
2005	182,287	1,752,268
2010	189,323	2,108,300



Sources: Population figures provided by Fargo-Moorhead Metropolitan Council of Governments; total aggregate consumption based on per capita consumption estimates provided by sand and gravel industry.

Although these are only estimates, the projections clearly show that the growth in the Fargo/Moorhead area is expected to continue at a steady rate. Aggregate materials contribute significantly to the area's quality of life and it is assumed that the demand for gravel will continue to increase parallel to population growth.

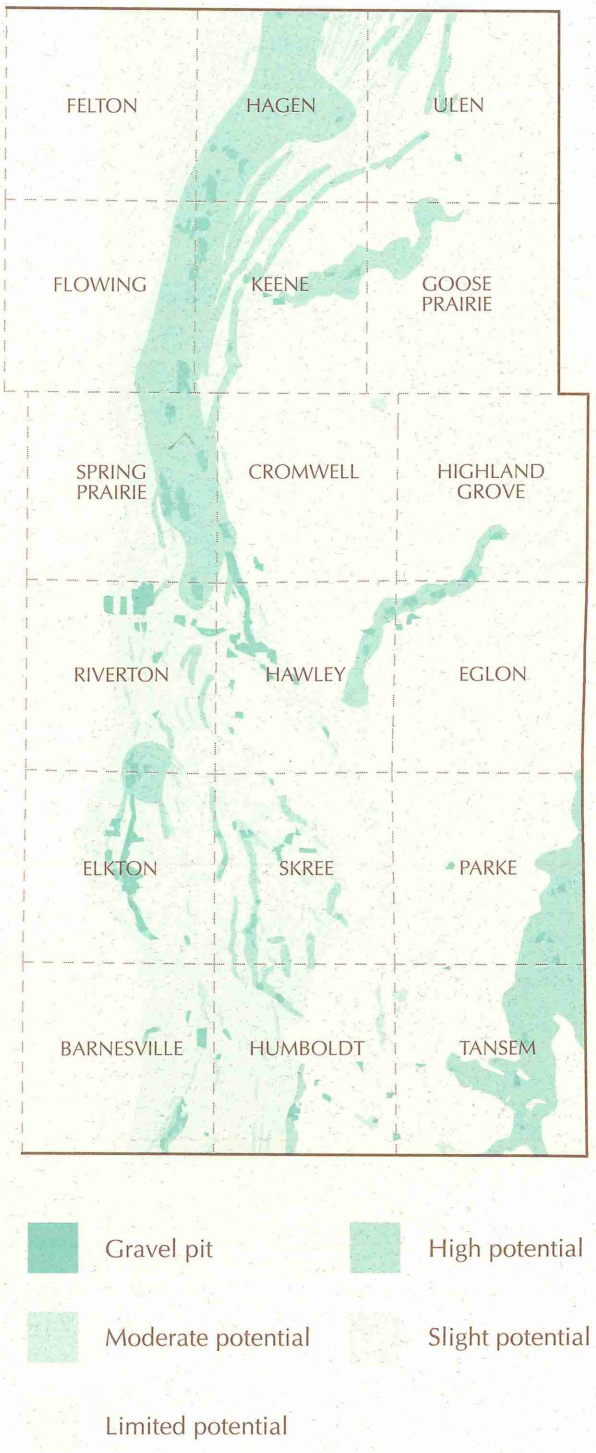
This is one in a series of twelve fact sheets compiled by the Clay County Beach Ridges Forum. June 1997.

7 Aggregate Potential in Clay County

An aggregate potential map for Clay County recently completed by the DNR indicates where there is potential within the eastern half of the county to find future gravel deposits (Lehr, J.D. In press. Aggregate Resource Potential of eastern Clay County, Minnesota Map, scale 1:50,000. MN Department of Natural Resources). The map shows that there is not a uniform blanket of good gravel found in the eastern half of the county. Instead, the gravel resource is variable throughout the area and the potential to discover future deposits of good gravel reserves is limited to certain locations. Because it is expensive to haul gravel, aggregate potential is realistically modified by proximity to market and location of current construction projects. The haul distance from mining site to market is a critical factor.

Gravel resources in Clay County differ in quality and characteristics. The physical properties of the aggregate combined with the haul distance determine the price and what the material will be used for. Some companies are now blending materials from different locations in the county to meet contract specifications. A rare deposit of high quality aggregate needed for the manufacture of concrete is found near Felton. This is one of the best and largest sources of concrete aggregate in the Red River Valley.

The aggregate potential map indicates graphically that aggregate resources are finite. Clay County contains some exceptionally high quality aggregate deposits not commonly found elsewhere and the potential to discover future deposits is limited. In the Red River Valley and across the state, good aggregate deposits are not being mined



Aggregate resources in Clay County based on the Aggregate Resource Potential data from the Aggregate Mapping Program, Minnesota Department of Natural Resources.

because other land uses preclude their development. As gravel resources become more scarce, aggregate deposits will undoubtedly become more valuable. The aggregate potential map can be used for broad planning purposes. However, to accurately determine the presence of an economic gravel deposit on a specific parcel may require further testing.

Copies of the aggregate potential map for the eastern half of Clay County can be obtained by contacting the DNR at the following address.

MN Department of Natural Resources
Division of Minerals
500 Lafayette Road
St. Paul, MN 55155-4045
Telephone: 612/296-4807

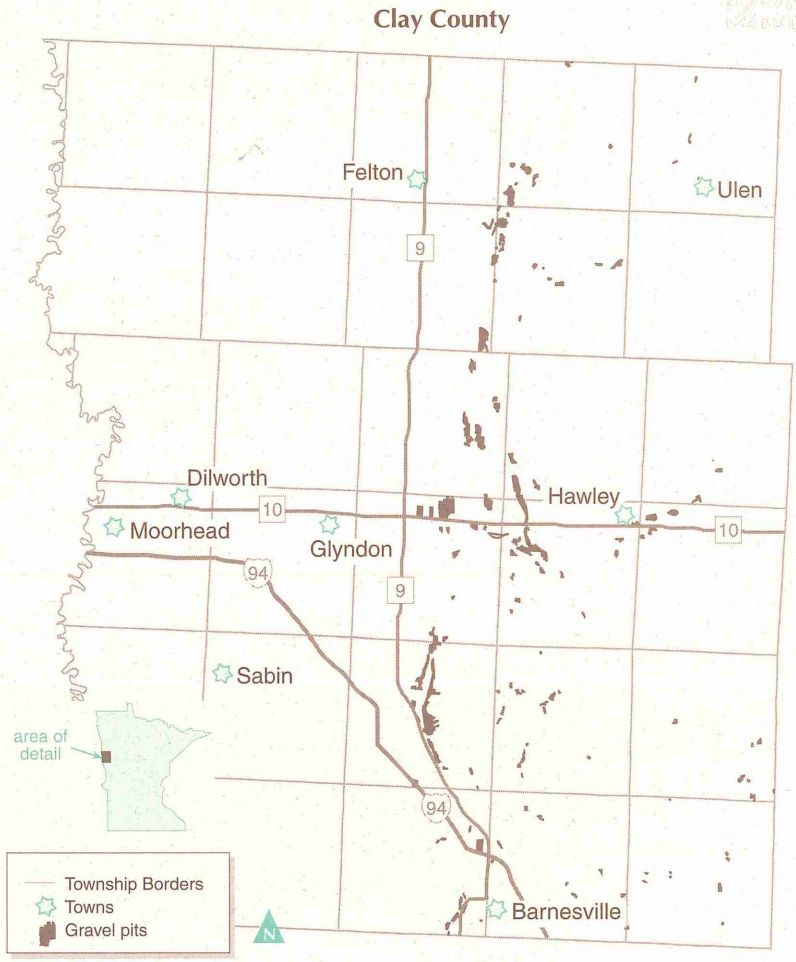
This is one in a series of twelve fact sheets compiled by the Clay County Beach Ridges Forum. June 1997.

8 Gravel Mining in Clay County

Gravel mining areas are a common sight throughout Clay County. Gravel mining is concentrated in the eastern 18 townships of the county where the gravel is located. Within these townships, there are approximately 236 gravel mining sites, about 75 of these have been recently active (estimates based on the aggregate potential map for eastern Clay County). The remainder are reclaimed and inactive sites. The number of active sites is quite variable and changes every year, if not more often. Roughly 3,700 acres have been affected by gravel mining in the eastern half of the county. These figures do not include mining that occurs in the western half of the county.

There are about 8 to 12 companies mining gravel in Clay County, the exact number depends on current road construction projects and other contracts. This estimate does not include an unknown number of mobile operators who work for short periods of time in the county on various construction projects. In total, the aggregate industry contributes significantly to the local economy not only by supplying gravel to build infrastructure but also by providing good jobs. It is estimated that approximately 500 people are directly employed by the industry during peak construction season.

Within the group of 18 townships, there are distinct differences in the gravel resources. The northern six townships contain a unique deposit of high quality aggregate needed for the manufacture of concrete. The central six townships supply fill and lower quality materials and are closer to market. The southern six townships have experienced an expansion of gravel mining and represents a new source that, with processing or blending, can meet higher specifications.

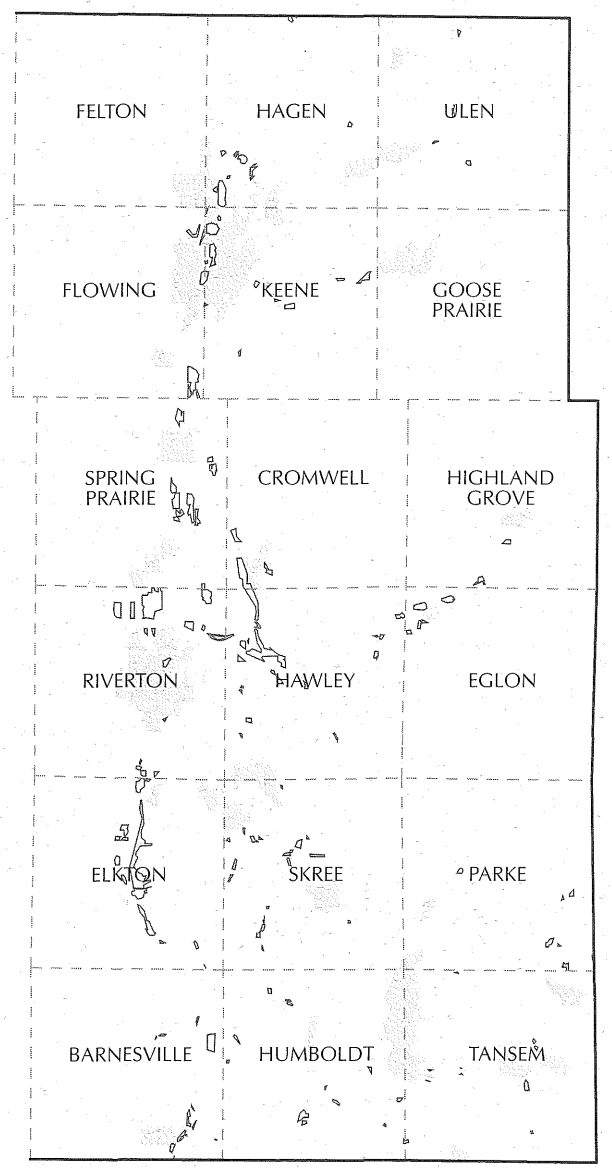


Gravel mining areas in Clay County (adapted from Aggregate Potential Map).

Uses for gravel.

The gravel mined in Clay County is used for a variety of purposes ranging from fill material to concrete aggregate. A significant (but unknown) amount of gravel mined in Clay County is used for projects in the Fargo/Moorhead area and in Cass County, North Dakota. Uses for gravel include the manufacture of concrete, blocks, fill, road materials, road sand, pea gravel, sewer rock, asphalt, riprap and landscaping among others.

Fargo/Moorhead is a high growth market that requires large volumes of aggregate to build, maintain and improve infrastructure. Consider that an average new home contains about 250,000 pounds of mineral materials. With the surge in population over the last decade, large amounts of aggregate have been needed to build new homes in the Fargo/Moorhead area. In addition, construction in Fargo/Moorhead requires more aggregate than most other areas because of the heavy clay soils found in the Red River Valley.



High/medium prairie Gravel pit

An example of how prairie and gravel resource data can be combined.

A substantial amount of gravel is also used within Clay County for road maintenance and construction. For example, Clay County maintains 475 miles of gravel road. Township roads account for an additional 860 miles of gravel road. Approximately 175,000 cubic yards of aggregate material are used by the county or townships in road maintenance in a given year. Use of gravel materials for the maintenance of roads is a very important local concern.

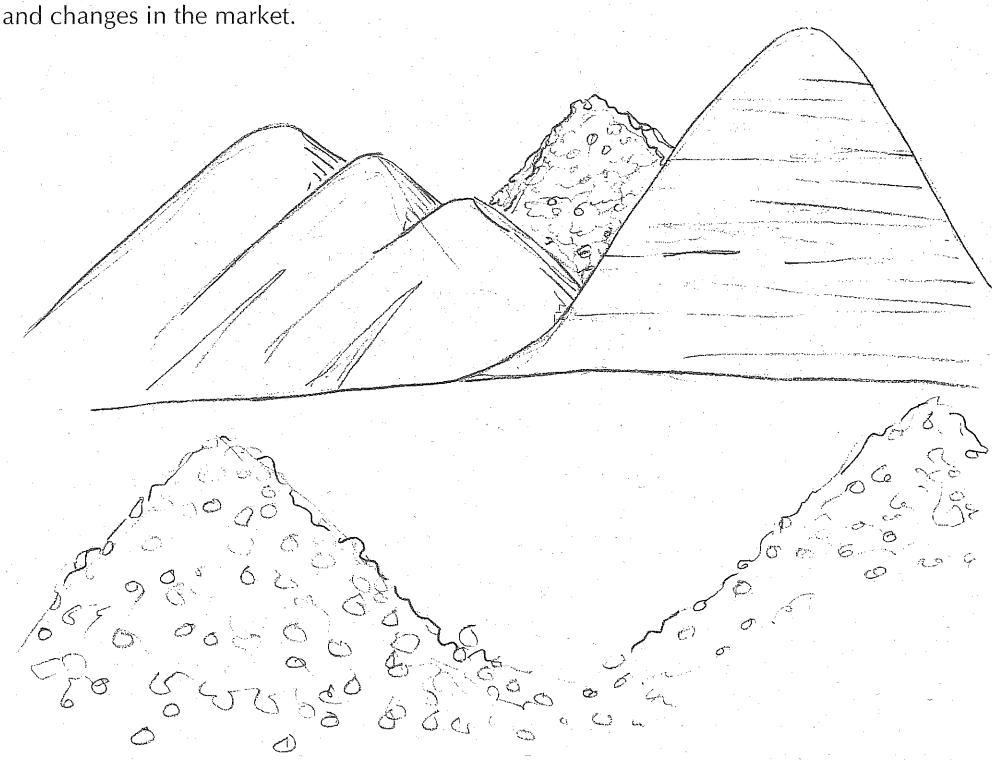
To accommodate the increase in traffic and the need to upgrade and repair roads, the Minnesota Department of Transportation (MnDOT) is planning for several major road upgrades and bridge repairs in the state trunk highway system over a ten year planning horizon. The Clay County Highway Department also has an ongoing need for aggregate materials to improve the county highway network.

Aggregate drilling.

To accurately determine the presence of an economic gravel deposit on a specific parcel may require further testing. Backhoe trenching is commonly used in the Red River Valley as an economical means of testing for aggregate. Another type of testing is aggregate drilling. Drilling into the ground to obtain samples of the underlying material is used to evaluate aggregate deposits. In general, there are two types of drilling methods. The first is conventional rotary auger drilling. This type of drill rig can reach about 50 to 60 feet below ground. If rock is encountered in the drill hole, the drill cannot penetrate and the hole is abandoned. The information obtained from rotary drilling can be less accurate than through other types of drilling methods but the costs are less. Estimated costs in 1996 were about $750/day. The greatest limitation for this type of drilling is encountering rock in the drill hole and poor sample recovery.

Another drilling method is rotosonic drilling. The rotosonic rig has a diamond tipped drill which can penetrate through rock. A continuous drill core can be extracted from the drill hole. The primary advantages with this drilling method are that the drill can penetrate rock, very accurate information can be obtained and, the area of disturbance on the surface is small. Estimated costs in 1996 were about $1,000 for a 50 foot hole but costs can be highly variable. With rotosonic drilling, fewer drill holes may be needed because of the greater accuracy.

The depth of overburden material covering a gravel deposit in part determines if the material is economically feasible to mine. Drilling can provide information on the thickness of the overburden. For example, if aggregate drilling reveals 30 or 40 feet of overburden material lying on top of gravel, the deposit may be beyond economic consideration for mining in today's economy. It is important to note that deeply buried deposits could become economic to mine in the future with advances in processing technology and changes in the market.

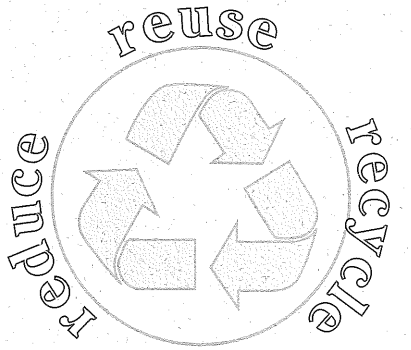


Aggregate recycling.

These days, when a building is torn down or a road is repaved, the rubble can be recycled. Concrete and asphalt pavement from demolition can be ground up and reused in another construction project. Recycled aggregate is made from demolition material that is crushed, cleaned of impurities and then sold for a variety of uses, mostly as fill or base. In 1996, about 100,000 tons of recycled aggregate went back into the Fargo/Moorhead area. Recycled aggregate accounts for approximately 10% of all aggregate consumed in this market. The demand for recycled aggregate was not met because the supply of clean demolition material was limited. With demand for recycled material so great, almost all available demolition is recycled by the aggregate industry.

Most of the gravel used in the Fargo/Moorhead market is "fresh" aggregate (also known as "virgin" aggregate) mined from a deposit most likely in Clay County. An increasing amount of aggregate material enters the Fargo/Moorhead market from Becker County, Minnesota located just east of Clay County. Although the majority of construction products require a fresh aggregate (concrete, for example), there is a growing demand for recycled aggregate product in both national and local markets.

Aggregate recycling is a good way to extend the use of gravel resources. Recycling can help to minimize the need to open new mining sites. It is important to recognize, however, that even with an expanding market for recycled aggregate, the demand for freshly mined aggregate will always be great.



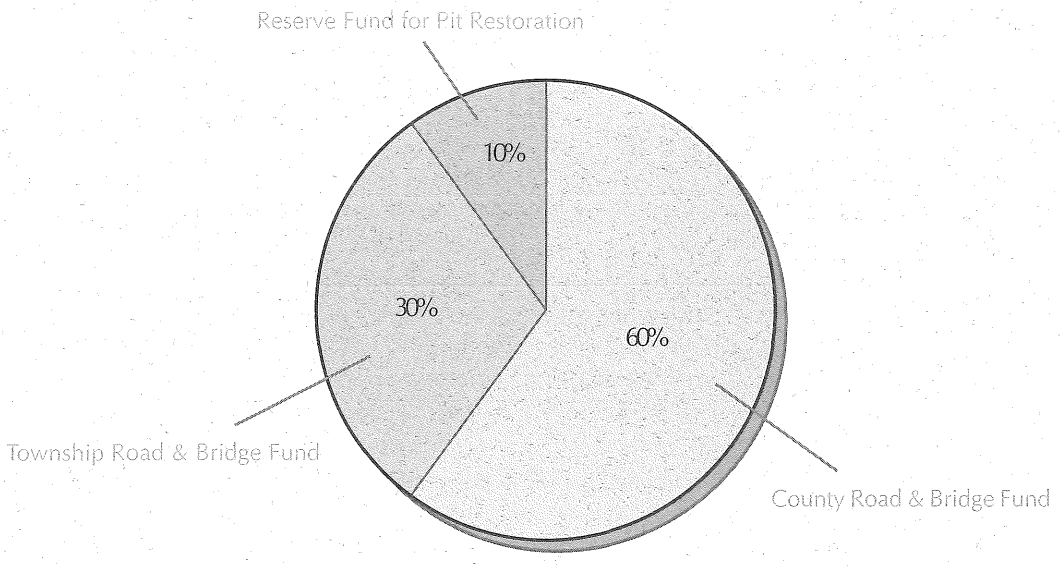
For more information about recycled aggregate, contact local contractors or gravel operators in your area.

The Aggregate Material Tax is a state statute (Minnesota Statute 298.75) that is imposed in 25 counties. It is commonly known as "the gravel tax". All of the counties on the Minnesota side of the Red River Valley have authority to collect the tax as well as counties in the St. Cloud and Twin Cities areas. Recent amendments provide for two counties in southwestern Minnesota to collect the tax. The Aggregate Material Tax originated in Clay County in the 1960's and later was amended to include other interested counties.

The Aggregate Material Tax is a production tax on the removal of gravel material. The tax is calculated on a per cubic yard or per ton basis. According to the statute, an operator is any person engaged in removing aggregate material from the surface or subsurface for the purpose of sale.

The Aggregate Material Tax is imposed upon operators at the rate of ten cents per cubic yard of gravel produced in any county imposing this tax. The original purpose of the tax was to provide funds to maintain local roads and bridges used heavily by gravel haulers. The statute requires all counties that collect the tax to distribute the proceeds as follows: County Road and Bridge Fund (60%); Township Road and Bridge Fund (30%), and a special reserve fund for the restoration of abandoned or depleted pits on public lands (10%).

All operators must file a quarterly report and payment with the county auditor in the county in which the gravel material is removed. If a governmental unit or other individual or entity owns a pit, quarry or deposit and removes gravel for their own use, then no aggregate tax would be imposed. In 1995, approximately $2,114,823 in revenue was collected by all counties imposing the tax. The table below summarizes the amount of gravel tax revenue collected by Clay County from 1980 to 1996.



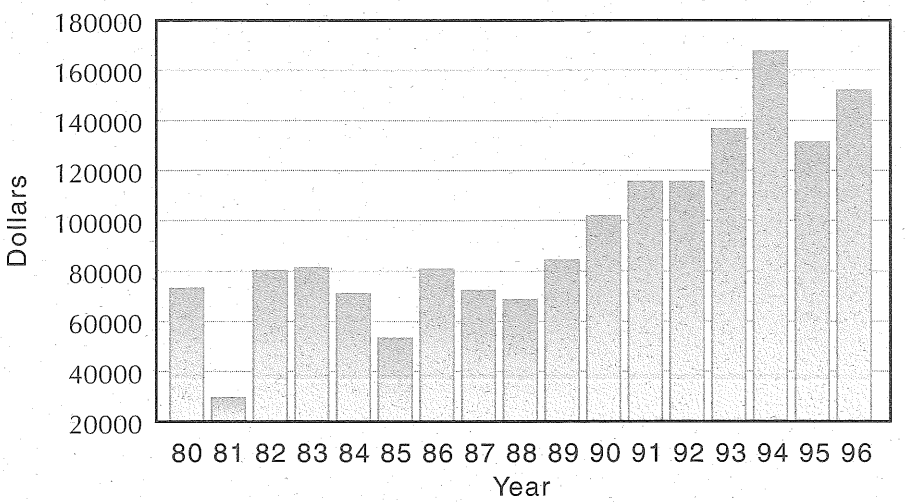
GRAVEL TAX DISTRIBUTION

GRAVEL TAX REVENUE FOR CLAY COUNTY

1980 to 1996

1980 - $ 73,434	1986 - $ 80,993	1992 - $115,753
1981 - $ 29,865	1987 - $ 72,484	1993 - $136,927
1982 - $ 80,503	1988 - $ 68,806	1994 - $167,805
1983 - $ 81,533	1989 - $ 84,574	1995 - $131,526
1984 - $ 71,279	1990 - $102,214	1996 - $152,236
1985 - $ 53,566	1991 - $115,849	

Total for all Years = $ 1,605,117



Source: Clay County Planning Office

For more information about the Aggregate Material Tax, contact the courthouse.

Clay County Courthouse
807 11th Street North
PO Box 280
Moorhead, MN 56560-0280
Telephone: 218/299-5002

Permits.

The primary authority for regulating extractive uses like gravel mining is at the county or township level. In Clay County, gravel mining is a conditional land use that requires a Conditional Land Use Permit from the Clay County Planning Commission. Depending on location, a township permit may also be required for new gravel mining operations. Operations that were active before a Conditional Land Use Permit was required do not have to obtain a permit. About 25 permits have been issued by the Planning Commission since the late 1980's. Guidelines have been developed for gravel mining but they are offered only as guidelines and do not address reclamation.

State permits from the DNR may be required for some gravel mining operations if there is a need to appropriate water. Permits from the Minnesota Pollution Control Agency (MPCA) may be required for storm water discharge, water quality concerns, air emissions, and above ground storage tanks. Wetland mitigation may also be necessary if wetlands are impacted by the operation.

Environmental review in the form of an Environmental Assessment Worksheet (EAW) is required when a gravel mining operation is expected to exceed 40 acres in size to a mean depth of 10 feet. Environmental Impact Statements (EIS) are mandatory for operations exceeding 160 acres. EAWs can be conducted on a discretionary basis if a proposed project is below the mandatory threshold. In 1996, Clay County completed three EAWs relating to gravel mining. No EISs have been conducted. The expansion of the gravel mining industry in the eastern half of the county is reflected in the number of new permits and EAWs. For more information about permits, contact the courthouse.

Clay County Courthouse
807 11th Street North
PO Box 280
Moorhead, MN 56560-0280
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What is a mining plan?

Many permits today require the preparation of a mining plan. The purpose of a mining plan is to ensure that mining will proceed in an environmentally sound manner and that the area will be left in a safe, nonpolluting condition that has some future land value. A mining plan may also address concerns like view, hours of operation, noise, dust, and traffic.

A mining plan is a combination of maps and written information that describe every aspect of the proposed operation from inventory of the gravel resource to post mining management of the site. The mining plan describes activities to be conducted at the mine site over the life of the operation. A mining plan is prepared before mining begins, often as a requirement for a permit.

A mining plan is geared to the size and scope of the project. For small projects, the plan may be quite simple while a larger operation may require a more elaborate plan. All sand and gravel operations share similarities but no two are exactly alike. A mining plan must be site-specific and tailored to the unique setting of the proposed operation.

Because the sand and gravel industry fluctuates dramatically with economic conditions, there must be flexibility within the mining plan to accommodate unanticipated changes in the market that affect

mining activities. A mining plan ensures that activities move forward according to a general concept that includes reclamation of the site. Mining plans can be updated at regular intervals to reflect changes in operating plans.

Benefits that come from a mining plan are early identification of environmental concerns, efficient removal of the gravel resource, and cost-effective reclamation. With planning, materials are placed in the appropriate location during stripping operations. Areas requiring fill material are identified. Final landforms are constructed during active mining.

The information needed to prepare a mining plan generally includes:

- an inventory of the gravel resource
- an assessment of premining conditions
- a description of mining methods
- a discussion on the staging of operations
- proposed reclamation

This information is needed for all mining plans but the amount of detail depends on the scope of the proposal.

Reclamation.

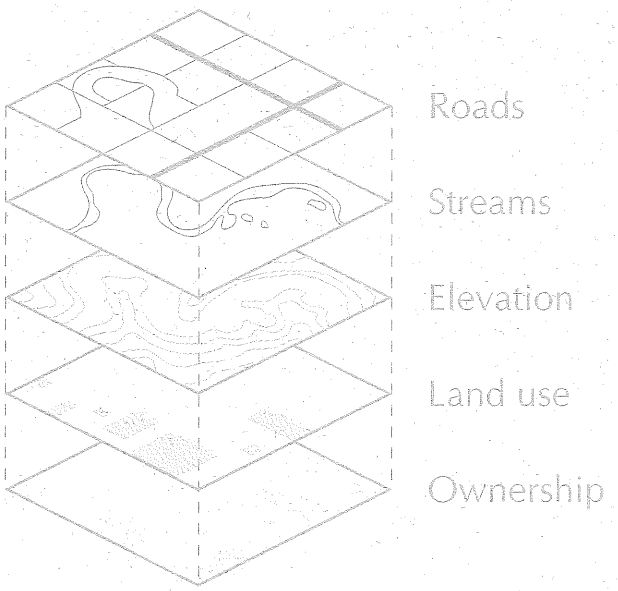
An "end use" is a term that describes the subsequent use of a site following mining. Some gravel pits are reclaimed to end uses that require post mining management. In these cases, the end use is usually known at the start of operations. The mining plan includes a description of post mining management necessary to support the end use and identifies the responsible party for conducting it.

For many gravel pits, however, no managed end use is contemplated. The goal of reclamation for these pits is to leave the site in a safe, nonpolluting condition that has future land value. Final reclamation is directed at slope stabilization, revegetation, and site cleanup. For more information about reclamation of sand and gravel mining areas, contact the DNR for a copy of a publication entitled "A Handbook for Reclaiming Sand and Gravel Pits in Minnesota".

MN Department of Natural Resources
Division of Minerals
500 Lafayette Road
St. Paul, MN 55155-4045
Telephone: 612/296-4807

An important accomplishment of the Clay County Beach Ridges Forum was to combine existing resource data into a computerized resource information system for the eastern half of Clay County. A substantial amount of resource information already existed before the Forum was initiated but it had never been combined or integrated. Two datasets were of particular interest. One was a digital map showing the remaining prairie resources in Clay County. The other was a digital map showing the aggregate potential in the eastern half of the county and the location of existing gravel mining areas. Combining these two maps and looking at the areas of significant prairie in relation to the aggregate potential was of great interest to the Forum.

The computerized resource information was compiled by technical staff at the DNR in close coordination with the Forum. The computerized resource information system allowed the Forum to view datasets in combination. That means that a single map can be overlaid digitally with other maps to create customized map products. More importantly, the computerized resource information can be queried according to questions specified by users. Having both the prairie and gravel resources available as maps in digital format provided a unique opportunity to study these two datasets in combination. The following information was incorporated into the computerized resource information.



- aggregate potential
- existing gravel mining areas
- prairie resources
- public land management units/prairie easements
- ownership (public vs private)

Need for future analysis.

After developing a general understanding of the individual map layers, the Forum formulated questions to ask the computerized resource information relating to prairie and gravel resources in the eastern half of Clay County. Many other analyses are possible using the computerized resource information and should be considered in the future. The Forum conducted one analysis based on a particular set of questions. With the completion of the computerized resource information, other users could look at the data in a different light.

For more information about the computerized resource information.

For a casual user in the general public, a copy of the computerized resource information has been placed in the Lake Agassiz Regional Library in Moorhead at the address shown below where it is

installed on a computer available to the public. Another set is available at the Moorhead State University Regional Science Center for use by visitors. Users in these locations will be able to view a short demo and learn about the datasets. The system is also housed in the Clay County Courthouse for use by county staff.

Lake Agassiz Regional Library
118 South 5th Street
Moorhead, MN 56560
Telephone: 218/233-7594

Moorhead State University Regional Science Center
1104 7th Avenue South
Moorhead, MN 56563
Telephone: 218/498-2904

For advanced users, the information is available on CD-ROM. The CD-ROM contains the demo, complete datasets, user's guide, data documentation and selected maps. Users of the CD-ROM will need the appropriate hardware and software to access the information. While supplies last, copies of the CD-ROM can be obtained by contacting the courthouse or the DNR.

Clay County Courthouse
807 11th Street North
PO Box 280
Moorhead, MN 56560-0280
Telephone: 218/299-5002

Department of Natural Resources
Division of Minerals
2115 Birchmont Beach Road NE
Bemidji, MN 56601
Telephone: 218/755-3955

Department of Natural Resources
Division of Minerals
500 Lafayette Road
St. Paul, MN 55155-4045
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Resource information was supplied by the MN Department of Natural Resources, MN Department of Transportation, Clay County Planning Office, Clay County Highway Department, Clay County Historical Society, Fargo-Moorhead Metropolitan Council of Governments and the sand and gravel industry of Clay County.

This report prepared for the Clay County Beach Ridges Forum by the Minnesota Department of Natural Resources. For more information, contact:

Clay County Courthouse
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PO Box 280
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