UNIVERSITY OF MINNESOTA - EAST BANK CAMPUS

Watershed Management Plan

NRES 5061
December 10, 2001

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Cover Page: Figure 1 – Aerial Photo of the University of Minnesota East Bank Watershed (MN NAAP, 1991)

ABSTRACT

Research shows that the cause of the Gulf of Mexico's dead zones is watershed activities that encourage excessive discharge of nitrogen and phosphorus to the Mississippi and Atchafalaya River Basins (MARB) system. Growth in population, changes in land cover, increase in agricultural acreage, and increase in fertilizer use and animal husbandry have resulted in two to ten fold increases in the level of nutrient inputs to the MARB during this century, with particular dramatic increase since the 1950s (Ecosystem Description, URL). In order to reduce the amount of nutrients flowing to the MARB and other sensitive water resource systems, the United State Environmental Protection Agency has mandated local units of government and institutions to develop storm water management plans.

This paper serves as a resource to be incorporated into the U.S Environmental Protection Agency required storm water management plan. First, it discusses the history of the University of Minnesota - East Bank Campus, identifying the culture of the area, geological components and highlighting surrounding neighborhoods in the watershed. Second, it reports on the biophysical components of the University of Minnesota - East Bank Campus runoff discharging to the Mississippi River. Third, it discusses the relationship between land use and the water quality of the Mississippi River. Fourth, it presents a proactive watershed management plan.

University of Minnesota East Bank Watershed and its History

Introduction

The watershed encompassing the East Bank of the University of Minnesota is characterized by diverse land uses and heavy development. It can be divided into four distinct areas (figure 1): 1. University campus 2. Southeast Minneapolis Industrial Area and Bridal Veil Area 3. Prospect Park neighborhood 4. Commercial Areas. The campus itself is mostly paved and has been highly developed. There are no surface water bodies and little vegetation. This was not always the case however. When the University first opened in the mid 1800s there was a creek, springs and even a small wetland. As development progressed however the need for more land increased and these water bodies disappeared, as did the vegetation. Similar situations can be seen in other areas of this watershed as well. Just to the north of campus once existed a large wetland that flowed south to the Mississippi through Bridal Veil Creek. These water bodies were rerouted or filled in to make way for development.

Increased development of the University watershed has implications for the quality of the Mississippi River. As more of the surface area on the landscape gets paved, and drainage areas are covered over, runoff to the Mississippi also increases. Storm water flows over roads and is not filtered through natural processes to remove harmful pollutants from the streets and other sources. The University watershed needs to develop a storm water management plan and Best Management Practices (BMPs) to reduce its impact on the Mississippi. In the following section a description of the East Bank of the University and its watershed is outlined. In addition, a history of the land use and water resources of the area is discussed from a water quality perspective.

Description of the Campus

The East Bank of the University of Minnesota campus is located in Southeast Minneapolis. The southern and western sides are bordered by the Mississippi River, with the exception of a few buildings (Sanford Hall, Roy Wilkins Hall and some of the sports facilities including the track field and softball stadium). The campus is bordered to the north by the Great Northern Railway (BNSF) and to the east by a commercial district. The current size of the East Bank is 250 acres. There are approximately 100 buildings on the site and 13 parking lots. The watershed for the University campus is managed by the Middle Mississippi Management Association and the City of Minneapolis (University of Minnesota, 1999).

There are many different styles of buildings on campus reflecting the time period in which they were built. Most of the buildings have foundations that lie approximately 30 feet underground, into limestone. After heavy rain events building managers are required to pump water out from foundations. The Civil Engineering building, built in the late 1970s has a foundation that was constructed below the water table. As a result, water must be continuously pumped out from its foundation using four pumps to avoid damage to the structure (Reeves, 1979).

Geology

The surface geology of the Minneapolis campus is characterized by glacial features from the Pleistocene Era. The land is relatively flat, sloping slightly towards the Mississippi River, up to the limestone bluff of the Mississippi channel where there is a steep drop off. A layer of topsoil about 2.5 feet thick overlays glacial drift sediments, including a layer of alluvium approximately 13 feet thick and till made up of silty sand that extends approximately 40 feet below ground. Beneath these glacial deposits is a layer of shale approximately 5 feet thick. Below that is a 35-foot thick layer of limestone. The first layer of limestone is the Decorah formation and beneath that lays the Platteville formation, Magnolia Member, Hidden Falls Member and Mifflin Member. St. Peter sandstone lies below the limestone. The water table is at a depth of approximately 60 feet below ground, in the limestone. (Reeves, 1979).

Groundwater

The University watershed has two aquifers including the uppermost bedrock aquifer in the St. Peter Sandstone, and the Prairie du Chein aquifer that underlies the St. Peter aquifer. The Prairie du Chein aquifer holds significantly more water than the St. Peter and is not considered sensitive because the confining layers of shale and sandstone overlie it. Water can be found in the two aquifers' unconsolidated deposits from approximately 20 to 76 feet below ground. Flow is generally to the southwest (City of Minneapolis, 2000).

Storm Sewer System on Campus

Beneath the campus is a large network of underground tunnels and pipes that comprise the storm sewer system. These are connected to the surface by hundreds of manholes and storm drains. The pipes eventually appear at the surface again at one of the approximately 24 storm drain outlets at the shore of the Mississippi River. The storm drain system is owned and operated by the city, county, state and the University. The University owns an enormous, ever expanding system of underground tunnels that collect run-off and excess rain from buildings. These tunnels are deep underground, in the sandstone at approximately 85 feet. The other collection pipes owned by the city and county are much shallower (Campus Planning, 2001).

Before 1915, all storm and sanitary sewers in Minneapolis and St. Paul were combined. The water entering the University pipe system was processed by Pigs Eye treatment plant by 1938 and discharged into the Mississippi River. Pigs Eye was unable to process the large volume of water coming into the plant, particularly after rain events. As a result, two separate sewer systems were built, one for storm water and one for sanitary waste. The Federal Clean Water Act of 1972 set into motion a nationwide effort to separate combined sanitary and storm sewers to improve water quality. Not all of these systems were separated however, including two combined sewer outfalls in the East Bank campus watershed. These are located along Elm Street and Oak Street at the southeastern most edge of campus. Heavy rainfall or spring melt will cause these systems to overflow, spilling raw sewage into the Mississippi River. These combined systems are permitted by the Pollution Control Agency and managed by the Department of Public Works (DPW, 2001).

History of the Campus

Cultural history

The St. Anthony area and present site of the University of Minnesota East Bank is noted as being the final destination of the famous Minnesota explorer and French missionary, Father Hennepin who journeyed down the Mississippi in 1679. Father Hennepin is reportedly the first white man in this area, and it was he who named St. Anthony Falls. Jonathan Carver, a famous English explorer said of the land “The country around the falls is extremely beautiful. On the whole, when the falls are included, which may be seen at a distance of four miles, a more pleasing and picturesque view cannot, I believe, be found throughout the universe” (Shutter, 1923).

The Dakota were the first people to populate this area and were the most populous group of North American Indians in Minneapolis. On September 23, 1805, Lieutenant Pike concluded a treaty with the Dakota bands that ceded to the United States, for the purpose of establishing military posts, a tract of the Mississippi that included the St. Anthony Falls area and nine miles on each side of the river, including the land now called the East bank of the University. This was the first treaty between the United States and any Native American tribe in Minnesota. Because there was doubt as to they validity of this treaty, the land remained un-purchased by the United States until 1837 when it was ceded by treaty. The Falls and nearby surroundings had a religious significance for the Indians. They believed there was something supernatural about the falls (Shutter, 1923).

Development of the East Bank Campus

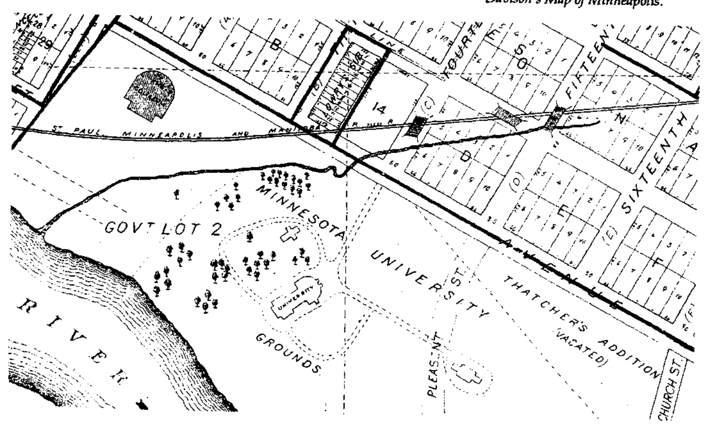
The University of Minnesota was built as a result of an act of the Territorial Legislature in 1851. Long before the campus was erected, planners recognized the need for a beautiful location for the campus to attract students. It was stipulated in the acquisition of land that the campus be built at or near St. Anthony Falls. When it came to the actual purchase the land, the St. Anthony Falls site itself was thought of as being too valuable to build a University on so it was not purchased. Instead, the University was built just south of the Falls in a beautiful, scenic location perched on a rolling bluff-top plain overlooking the Mississippi River (Landscape research, 1998). The University purchased the undeveloped land from a farmer named Calvin Tuttle (Johanson, 1910).

The earliest plans for the campus emphasized the need for parks and green areas throughout the University and many of the early campus landscape designs are focused on the lawn as the symbolic center of the campus. Planners even recognized the need for grass between buildings. At that time however, the desire for green space was entirely for aesthetic purposes. Much of the area wasn't paved yet and the idea of urban runoff was not an issue (University of Minnesota Contexts, 1998).

In 1858 the first building called "the Old Main Building" was constructed on the present site of Shevlin Hall (figure 2). In financial trouble, the University did not expand until the 1860s when the University was reorganized by an act of the Legislature. The first class finally began in September 1869. The University remained small, with only one building added to the Main Building until the 1890s when the Law building, Chapel, the Coliseum and Drill Hall, Mechanics and Art, Foundry, Science Building and Pillsbury Hall were built (Johanson, 1910). Eddy hall is the oldest remaining building on campus. This building is the former Mechanics and Art Building.

Figure 2- (University of Minnesota, 1998)

The Minneapolis Campus in 1887.
Davison's Map of Minneapolis.

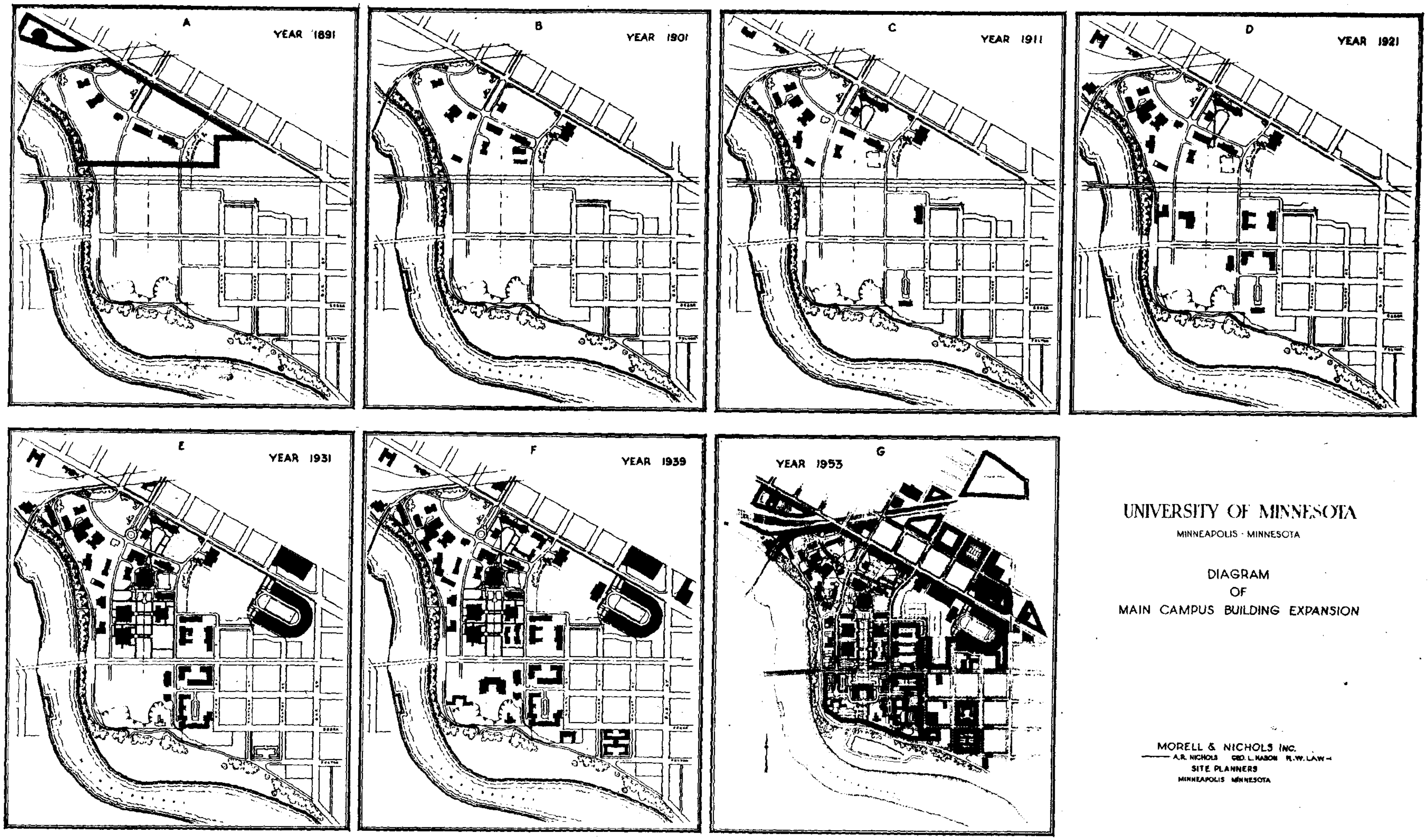


As the number of students attending the University grew, so did the need for more land and buildings. In 1907 the State legislature authorized the purchase of 50 acres of land south of the original campus site for expansion (Buchan, 1952). By 1909 the campus grew to a total of 23 buildings. Soon after, the need to expand became apparent again, but was hindered by the Northern Pacific railroad that ran between Washington St. and the south edge of campus. In 1885 the University regents sold the right-of-way to the St. Paul and Northern Pacific railroads. The University attempted for a number of years to purchase the rail land back and finally in 1922 the Northern Pacific Railroad agreed to reroute its trains over the Great Northern Railway nearby (A Livable Campus, 1998). The Northern Pacific Railroad tracks were removed in 1923. They were filled-in and buildings were constructed over them, one of the first of which was Walter library (University of Minnesota Contexts, 1998). (Figure 3)

Historical Water bodies on campus

Early maps of the campus from 1872 show a creek flowing southwest across 14^{th} and 15^{th} Ave, across the East Bank of the University, and finally discharging into the Mississippi River. There appear to have been bridges on the current U of M property over this creek at one time. This creek was named after the original owner of the land and was called appropriately Tuttle's Creek. Building of the railroad line eventually cut off the creek, decreasing it by more than half

Figure 3


A
YEAR 1891
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UNIVERSITY OF MINNESOTA
MINNEAPOLIS · MINNESOTA
DIAGRAM
OF
MAIN CAMPUS BUILDING EXPANSION
MORELL & NICHOLS Inc.
SITE PLANNERS
MINNEAPOLIS MINNESOTA

its original size by1892. This creek eventually disappeared altogether. The only sign of the creek that remains is a dry gulch between Dinky Town and the East bank of campus (Brick, 1997).

There is evidence that the East bank of the University had at least four freshwater springs in the 1800s and early 1900s. One of these springs, the University Spring was located near the banks of Tuttle's creek behind the S.C.A building. Throughout the spring's history, its flow was greatly manipulated. It was the only supply of fresh drinking water for that part of town, providing water for an estimated 500 people a day. At one time, a hydraulic arm was used to raise the water from this creek to supply the University with water. Students described the other water sources, including the Mississippi in the late 1890's as being disease ridden and undrinkable. Students described poorly operating filters in buildings making the spring the only option. Owing to changes on the University grounds, the underground feeders of the spring were diverted and the spring ceased to exist (Ariel, 1984). Another spring located behind the present Boyton Health Center could be found in an old botany greenhouse building and may have provided water for vegetation. Other springs included the Russell Mineral Spring that reached the surface in a cellar in Dinky Town and a "Petrified Moss" spring somewhere in the bluffs (Brick, 1997)(Figure 4).

Other historical water features on Campus include a small wetland behind the present day hospital. This area was once the University gravel pit. As with the other water bodies, it too disappeared. Like the green spaces on campus, planners recognized the beauty and need for water. According to planning documents from the early 1900s there was talk of using the natural depression behind the physics and Pillsbury buildings where Northrop Memorial Auditorium now stands for a wetland. This, according to planners, would improve the look of the campus during summer and provide a nice ice-skating rink in winter (Parking on Campus).

In the late 1800s students recognized the value of their water resources. When sewage threatened the University Spring a group banded together to attempt to clean it up. The class of 1885 even built a wall around it as a memorial. Eventually, the value of "progress" and development for the University outweighed the value of the natural resources on the East Bank of campus and they were eliminated to make room for buildings. Only now are we slowly coming to realize the value that of these resources once had.

The Greater East Bank Watershed

Commercial Area

Located east of the University is a tract of commercial land that was owned at one time by the University. In 1868, the legislature passed a provision to unite a new agricultural college to the existing University. This authorized regents to purchase a 120-acre lot near the University from what is now Oak Street to Prospect Park neighborhood. By the 1880s, the land was found to have poor soils for agriculture and was considered more profitable for residential and commercial development. It was sold at a huge profit, and the funds were then used to purchase a new farm near St. Anthony Park and the current sight of the St. Paul campus (A Livable Campus, 1996). Because of its strategic location along the rail lines this land turned out to be perfect for commercial usage. Currently restaurants and local businesses can be found in this area.

Figure 4- Historical Water Bodies in the East Bank Watershed (DNR, 2001)

Prospect Park Neighborhood

Prospect Park is one of the oldest residential communities in Minneapolis, settled in the 1800s. It is built on a kame, an isolated hill formed by melting glaciers at the end of the Pleistocene Era. This neighborhood was one of the stops along the Great Northern and Milwaukee railroad line between Minneapolis and St. Paul, in Southeast Minneapolis about one half mile from the East Bank campus. Its present day boundaries are Oak Street on the west, BNSF railroad on the north, the Minneapolis city limits on east and the Mississippi on the south. A large band of commercial, industrial and railroad land borders the neighborhood. The defining feature of Prospect Park neighborhood is the old water tower, sometimes referred to as the "witch's hat". The tower was constructed in 1914 to rectify a recurring problem of low water pressure in the hilly neighborhood. It is not currently used for the storage of water but it has a capacity of 150,000 gallons of storage. The tower functioned as a storage tank until 1950 when the Water Works Department developed other methods for water control. It now serves as a radio tower (Prospect Park, URL).

Prospect Park-East River Road Improvement Association (PPERRIA) was organized in the early 1900s. This is a group of community residents who have been actively involved in industrial and commercial development plans in the neighborhood, ensuring that the development be compatible with the desires of the community. Since 1993, PPERRIA has been working with the city on a Neighborhood Revitalization Plan. Volunteers are overseeing development this plan to prioritize spending and community improvement projects.

Southeast Minneapolis Industrial Area and Bridal Veil Area.

The Southeast Minneapolis Industrial (SEMI) and Bridal Veil Area is a 700-acre tract of land that is bordered by the East Bank of campus, Prospect Park neighborhood, St. Anthony Park neighborhood and Marcy Holmes neighborhood. It was originally a vast wetland area that was characterized by interconnecting spring-fed ponds. The area drained to the Mississippi on a southwestward path via Bridal Veil Creek, eventually falling over the limestone bluff of the Mississippi River creating Bridal Veil Falls. The creek has long since been re-routed through a system of storm sewers and the wetland was filled in with poorly graded sand by the 1880s. All that remains of the wetland are a couple of small ponds, one spring and a tall grass prairie remnant. The Falls still exist as an out-pouring of storm water from a large culvert and that is only visible from the walking trail down by the Mississippi.

This industrial area was developed in the late 1800s as a primary railroad corridor between Minneapolis and St. Paul. Development consisted of railroad lines and facilities, grain storage facilities, automotive recycling, residential and commercial business, oil extraction operations, agriculture chemical blenders and general manufacturing. By the 1900s the area was characterized by environment degradation including many areas of soil and groundwater contamination. An inventory of the area identified 55 contaminated sites in the area, and 26 sites in the surrounding areas. Some of the sites have been cleaned up, however two superfund still exist in the area. The costs to cleanup the site range from $1.00 to $10.00 per square foot. Contaminants in the area include petroleum, pesticides, chemicals, sewer runoff, asbestos, lead paint, devices containing PCBs and mercury (City of Minneapolis, 2000).

The majority of the storm water runoff from this site drains through the storm sewer system within Bridal Veil watershed. A portion of the site west of 25th Ave. drains by overland flow underneath the 15th Ave. railroad bridge through the campus, and into the Mississippi River. Another section of the watershed near the intersection of Elm Street and Kasota is poorly drained and connects to a combined storm and sanitary sewer running west under Elm Street. The storm sewer in which most of Bridal Veil Creek flows gets narrower as it passes under the rail yard. As a result, heavy rainfall in the area has caused significant back up flooding in the railroad yard. The storm system is in a state of near collapse in this area and needs to be replaced in the near future.

In 1994 the SEED (Southeast Economic Development) Committee was formed to redevelop the area. The water quality management plan focuses on managing both the quantity and quality of rainwater runoff from the area.

Summary

The University East bank landscape has been altered significantly through history. Natural vegetation has been removed and paved over and surface water has been eliminated. The result is a parcel of land that bears little resemblance to its predevelopment days in the early 1800s. In addition, the water quality of the Mississippi River has been greatly reduced by this development and improvements need to be made to ensure the health of this system. The next portion of this paper will look at the biophysical components of the University East Bank and its watershed. The Mississippi River as a nationally significant natural resource will be discussed and the major sources for water quality degradation to the River are analyzed.

Biophysical Components

The Minneapolis campus area is the largest in the University complex and is situated adjacent to the Mississippi River. The Mississippi River has historically been, and continues to be a natural resource of national significance and prominence. Ninety two percent of the nation's agricultural exports and seventy eight percent of the world's exports are produced within the Mississippi River basin (National Park Service, URL). Sixty percent of all grain exported from the US is shipped via the Mississippi River through the Port of New Orleans and the Port of South Louisiana. Much of the commercial and agricultural activities in Minnesota have been centered on the River and its tributaries. Perhaps most significantly, this critical river originates from within the boundaries of Minnesota itself.

Mississippi River in the Twin Cities Metropolitan Area
In 1988 Congress designated the Mississippi River as a Nation River and Recreation Area. Currently, the National Park Service manages educational, recreational, and outreach activities directed at the Mississippi. The Mississippi also hosts a diverse wildlife community. Twenty five percent of all fish species in North America are found in the Mississippi, Forty percent of the nation's migratory waterfowl and sixty percent of all North American birds use the river corridor during spring and fall migration (National Park Service, URL).

The Mississippi River serves as a vital recreational area and home to important species, and also provides drinking water for countless millions from the upper half of the basin to the lower portion. More than 50 cities rely upon the Mississippi for daily water supplies (EPA, URL), Minneapolis and St. Paul among them. The largest users of water in the Minneapolis Water Treatment and Distribution Services area are the University of Minnesota, the Metropolitan Airport Commission, and Hennepin County Energy Recovery Center accounting for an average of twenty two percent of the volume sold (City of Minneapolis, URL). The seasonal student population contributes a major portion of the residential usage in Minneapolis.

Despite the improvement in watershed management in the last few decades, several problems still exist which threaten the surface and ground water resources in the immediate area of the East bank campus. Contributions to impairment of the Mississippi River are storm water runoff, impervious surfaces, industrial and wastewater treatment discharge, and modification of the watershed and riparian corridor. Contributions to the impairment of ground water resources include leaching from industrial containment sites, historical or current, poor land use or construction practices, and decaying and poorly designed infrastructure in existing buildings including sewage lines and waste disposal.

Impact on Biological Communities
Throughout the Upper Mississippi River watershed a change in land use can be correlated to a change in the resident biological communities. A reduction in invertebrate and fish populations in urban streams in comparison to agricultural or rural streams is evident. According to a 2000 United States Geological Survey (USGS) report, urban streams host far fewer mayflies, stoneflies, and caddisflies, the three most important bioindicator families. Fish communities are dominated by those species tolerant of low dissolved oxygen levels and higher water temperatures (Stark, et al. 2000). The Mississippi River itself has undergone dramatic changes as the area around the University has become increasingly developed. Biological populations may be the first indication of an impact. Stonefly communities were virtually nonexistent while the numbers of mayflies were severely reduced from samples taken in urban areas as opposed to

forested areas (Stark, et al. 2000). An absence of indicator species in a sample illustrates potential water quality problems.

Wooded riparian areas provide the best habitat for aquatic life by reducing water temperature, stabilizing stream banks, providing sources of organic matter for consumption, and reducing and filtering runoff. With a decrease in wooded riparian cover comes a decrease in species diversity and richness, while the number of species tolerant to disturbance increases. As the amount of impervious surface increases, species diversity and density decreases.

Impact on water chemistry

One of the major factors in surface water contamination comes from non-point source including storm water runoff, construction site erosion, landscape and agricultural application of chemicals including phosphorus, and general waste from city streets. Point sources, including wastewater treatment plants, also contribute to the nutrient-loading problem.

Major sources of groundwater contamination in urban areas originate from industrial manufacturing that includes spillage or improper disposal. Several pollutants are of concern across the Mississippi River basin, but especially in metropolitan areas. Parameters of interest and concern include bacteria, sediment, nutrients (phosphorus), and volatile organic compounds (UMN Department of Soils, URL).

Bacteria – Pathogens

Bacteria counts, including fecal coliform, are of a major concern due to the implications to human health. The Mississippi River and ground water serve as drinking water supplies for thousands of people in the immediate metropolitan area alone. Sources of possible bacterial contamination include sewage treatment plants, septic systems, agricultural and livestock production facilities, and wildlife.

Sediment

Sediment carried in the water column from construction site and agricultural erosion decreases clarity, adversely affecting biological populations. A major concern in the Upper Mississippi River basin is the contribution of the amount of sediment to the Gulf of Mexico contributing to the hypoxia problem.

Nutrients

Nutrient loading, including excess phosphorus, increases algal production impacting the amount of dissolved oxygen available for biological communities. An increase in algal production can impact drinking water supplies by creating taste and odor problems. Sources of nutrient loading into the Mississippi can be natural or human induced. Natural sources tend to be of no concern because of the balance built in to the system. Human induced sources may include the use of fertilizers in both the private sector and farming community. Manufacturing processes are also a major source of nutrients (USGS, URL).

Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are commonly contained in household products such as paints, solvents, cosmetics, refrigerants, and dry-cleaning agents. Gasoline solvents are also a prime source. VOCs are released into the atmosphere or directly onto the land or water. Some VOCs are suspected carcinogens and can be toxic to wildlife and humans in high concentrations. VOCs are volatile in open air and difficult to detect in surface water unless monitored immediately downstream of source.

VOCs are more likely to be detected in ground water where contact with the air is limited. Highest concentrations are found in areas where leaking or spillage has occurred such as near a landfill. According to the USGS, most of the wells with detectable concentrations were located in the Minneapolis, St. Paul metropolitan area (USGS, URL).

Many of these concerns are related directly to land use. As the area surrounding the University became increasingly urbanized impairments to water quality were accentuated. Increasing impervious surfaces led directly to an increase in storm water runoff, thereby increasing the amount of pollution being carried to the surface waters. In the next section, land use components of the watershed will be examined and defined.

Land Use Components

Over the last 150 years, the East Bank of the University of Minnesota campus has had significant changes in land use. During the earlier years of its existence, the East Bank of campus consisted of 8 buildings; the Old Main building, the Law building, the Chapel, the Coliseum and Drill Hall, The Mechanic and Art building, the Foundry, the Science building, and Pillsbury Halls, and vast fields of open space (University of Minnesota, 1999). Today, the East Bank portion of campus contains over 100 buildings and 13 parking ramps and facilities (University of Minnesota, 1999). With an approximate 1400 percent changes in land use brings significant stress to surrounding water resources, namely the adjoining Mississippi River. Increased urbanization, imperviousness and construction activity coupled with the fact that most, if not all, of the storm sewer drains directly to the Mississippi River has contributed to adverse changes in the basin hydrology, channel morphology, water quality and fish populations of the Mississippi River. A devastating result of changes to the Mississippi River can be observed through the annually increasing size of the Gulf of Mexico’s hypoxic zone. The Minnesota Pollution Control Agency estimates that seven percent of the nutrients robbing the Gulf of oxygen arrives via the Mississippi River from Minnesota (Minnesota Environment, URL).

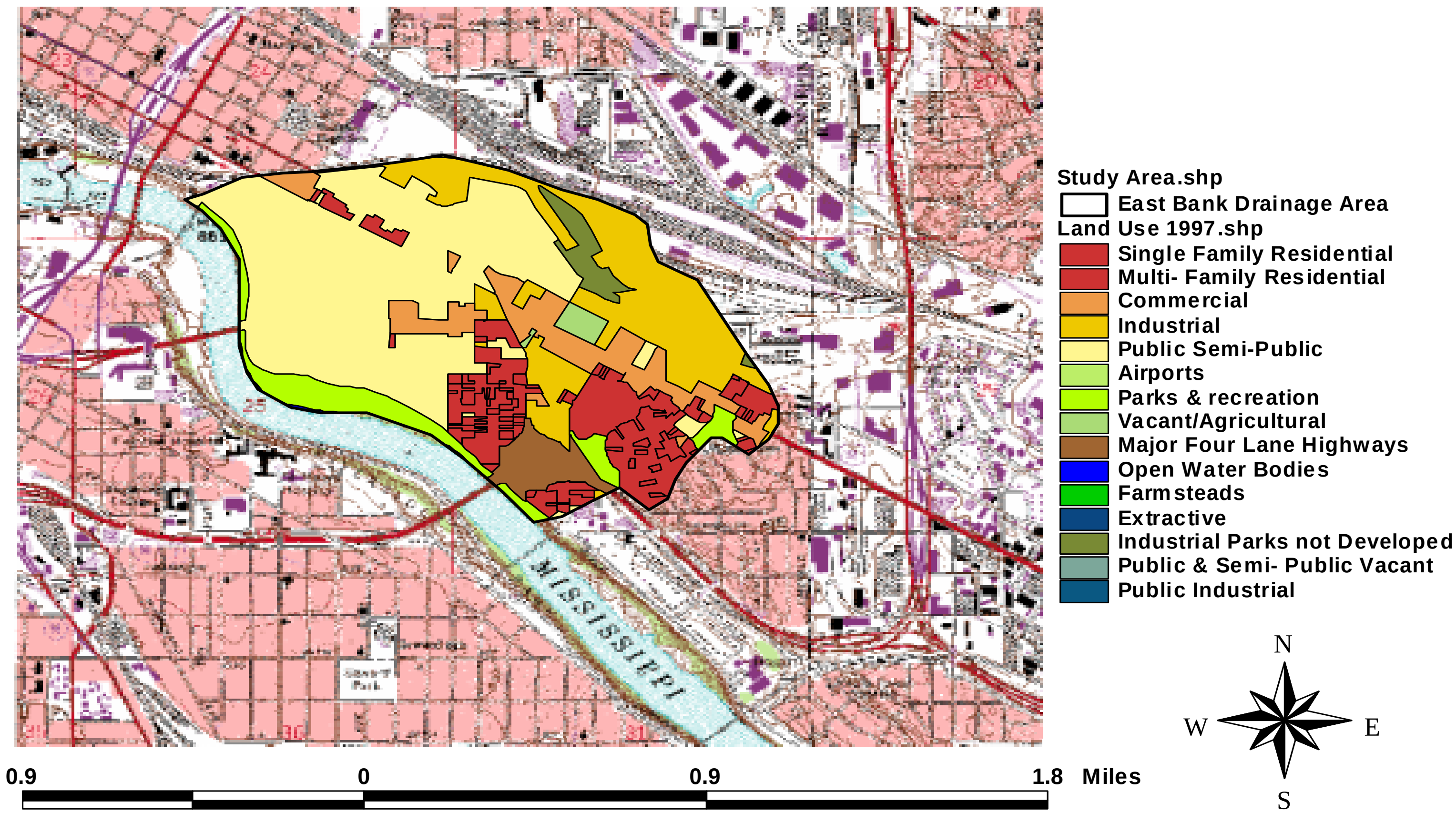
In this section, probable impacts University of Minnesota East Bank land use has had on the quality of the Mississippi River will be identified. It is important to note that even though the watershed of the East Bank represents a small portion of the total area draining to the Gulf of Mexico, every additional unit of nutrients contribute to the problem.

Land Use Allocation

There has been approximately a 2-fold increase in the amount of buildings populating the University East Bank campus since 1851. An increase in impervious surface area of this magnitude presents significant concerns about the impact it has had and continues to have on the water quality of the Mississippi River. Using land use data produced by the Minnesota Metropolitan Council, it was determined that 67 percent of University of Minnesota East Bank watershed is impervious (Figure 5 and Table1).

Figure 5 – East Bank, U of MN – Twin Cities Campus

Drainage Area and Land Use Map



Based on 1997 Generalized Land Use Produced by the Minnesota Metropolitan Council

Table 1 – Impervious Area (Minnesota Metropolitan Council, 1997)

Land Use	Area, acre	Average Percent Impervious, %	Impervious Area, acre
Single Family Residential	46.8	38	17.78
Multi-Family Residential	67.2	65	43.68
Commercial	61	85	51.85
Industrial	129.2	72	93.02
Public Semi-Public	272.2	79	215.04
Parks & Recreational Areas	45.6	0	0
Vacant/ Agricultural	6.5	0	0
Major Four Lane Highway	23.6	98	23.13
Open Water	.9	100	.9
Industrial Parks not Developed	15.5	0	0
Total	668.7	-	445.4

Single Family Residential

Includes all individual, freestanding single-family housing (including manufactured housing). Within the MUSA (metropolitan urban service area) and in residential developments outside the MUSA, the lot lines visible on the photos were used for determining residential land use boundaries. Where residential developments were visibly not complete, the undeveloped area was classified as vacant. For the scattered, rural residential areas outside the MUSA, only the portion of lots used for residences was assigned to the residential category.

Multi-Family Residential

Includes all multiple dwelling units such as duplexes, bungalows, twin homes, townhouses, quad homes and apartment complexes. Also, buildings that are primarily apartments that have some group dining facilities are included (however, not those buildings that fit the census definition of 'Group Quarters', such as, dormitories, nursing homes or medical care facilities).

Commercial

Includes all retail sales, services, hotels and motels, health care facilities (e.g. medical and dental clinics and offices and medical laboratories, but not hospitals and nursing homes) and recreational services that are predominantly privately owned and operated for profit (e.g. theaters, bowling alleys, equestrian ranches) except golf courses. Hospitals and nursing homes are included in the 'Public & Semi-Public' category and golf courses are in the 'Parks & Recreation Areas' class. For large shopping centers, only actual developed areas are shown. This is done so that over the years new development can be shown (e.g. restaurants or gas stations on parameter roads).

Industrial

Includes the Federal Standard Industrial Classification (SIC) codes 14 through 50. This includes manufacturing, transportation, construction, communications, utilities, and wholesale trade. Also included in the 'Industrial' category are some horticultural specialty land uses (e.g. large greenhouses that do not sell to the public). As of 1997, gravel pits and quarrying have been placed in a new category called 'Extractive' and all publicly owned areas that are predominantly of industrial nature have been placed in a new category called 'Public Industrial.'

Public Semi-Public
Includes the land under and adjacent to schools (public and private), hospitals, churches, cemeteries, ice arenas and all facilities of local, state and federal governments, including convalescent homes, mental institutions and penal facilities maintained by any level of government. All lands within the boundaries of these institutions and facilities are included in this category. However, in certain instances unused lands were included in the 'Public & Semi-Public Vacant' category (e.g. the University of Minnesota's property in Rosemount, or part of the Minnesota Veterans Home in Hastings).

Parks & Recreation Areas
Includes all parks (city, regional and state), wildlife refuges, playgrounds, zoos, gun clubs, golf courses and similar areas (this includes DNR wildlife management areas and scientific and natural areas). Parks are delineated using their actual boundaries taken directly off comprehensive plans, park maps or county parcel data.

Vacant/Agricultural
Includes land identifiable from aerial photos as open and in agriculture uses, other uses where no buildings are present or unused land. Please note that indoors horticultural specialty land uses (the growing of nursery stock, flowers, seeds, sod and food crops in large greenhouses that do not sell to the public; and large concentrations of agricultural buildings (e.g., barns, sheds and silos)) are included in the 'Industrial' category where they can be delineated.

Major Four Lane Highways
Includes only the major interstate freeways and 4 lane divided highways with rights-of-way of 200 feet or greater. Also included in 1997 are all 4-lane roads with a Metropolitan Council functional class designation of 'Principal Arterial.'

Open Water Bodies
Includes lakes larger than 5 acres and rivers wider than 200 feet.

Industrial Parks not Developed
Parcels of land in a designated (named) industrial park but not developed.

Probable Land Use Impacts to the Mississippi River Water Quality
The flow path of water to the Mississippi River has become less impeded by pervious area because the majority of the campus has been converted to impervious areas. Any increase in impervious area generates greater runoff volumes and higher rates of discharge. Because pervious area serves as buffers, which traps sediment and nutrients (phosphorus, nitrogen, etc), the decrease in pervious area that has happened over time on campus, translates to a greater transport of sediments and nutrients to the Mississippi River system. Below are potential impacts of increased imperviousness (Safe Water for The Future, URL):

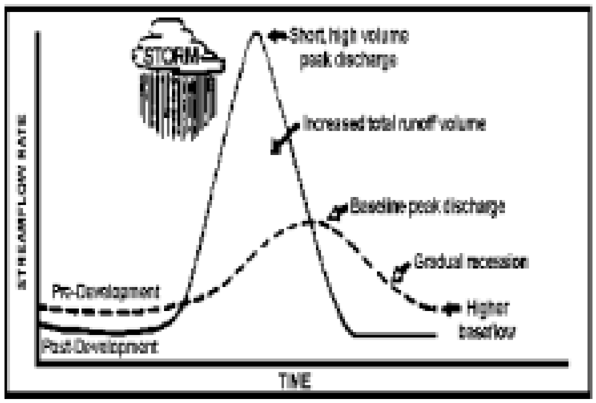
- **Increased frequency and severity of flooding**. If the runoff from a storm is greater, the chance of the flow exceeding the stream capacity and causing flooding increases (Figure 6).

- **Decreased base flow in streams**. Base flow is the water that flows even during dry periods. Aesthetically, most people prefer to look at a stream that has water throughout the year rather than one that is periodically dry. More important, continuous base flow is vital to the health of aquatic life in the stream (Figure 6).

- **Reduced ground water recharge**. Water that runs off, particularly if it is channeled through storm sewers, never has a chance to recharge ground water.

- **Increased erosion**. Stream channel erosion is an important source of sediment in channels. Erosion is very dependent on flow. Doubling of the flow may cause the stream bank erosion to increase by a factor of 4 or more.

Figure 6- Impact of urbanization on stream flow (Schueler, 1987)



- **Reduced natural filtration of the water.** The process of passing through the soil is one of the most important purifiers of water. Many pollutants are filtered, attached to soil particles, or degraded by microbes as water passes through the soil. Bypassing this route has a severe negative effect on water quality.

- **Negative impact on stream health.** Stream flow varies even under natural conditions, and most aquatic life is adapted to this. But increased stream bank erosion due to higher peak flows and periods of very low flow due to the decreased base flow add stress for many organisms.

The University of Minnesota – East Bank campus although a small area compared to the total area draining to the Gulf of Mexico, contributes to the hypoxia problem currently plaguing the area. The degradation of the water quality of the Mississippi River is a result of land use, namely; increased urbanization, increased imperviousness and poor construction practices.

Using the information provided in the biophysical and land use portion of the text, a watershed management plan was created. The proposed University of Minnesota – East Bank Watershed Management Plan is provided in the next segment.

University of Minnesota – East Bank Watershed Management Plan

The concern over natural resource degradation and conservation has been building in recent years. Activism has become commonplace among neighborhood associations and the University community. Many activities involving citizens and volunteers have proven to be effective at outreach and education as well as data collection. Recruiting, promoting, and supervising volunteers groups continue to be a priority to protect the Mississippi River.

Current Management Activities

Volunteer citizen groups

Local citizens are in a unique position to become the first line of defense for natural resource protection. In many cases, citizen volunteers are emotionally tied in to the resources in their neighborhood, and are motivated to become stewards for action. Citizen volunteers have effectively conducted monitoring activities to restore and maintain the Mississippi River corridor. These activities include erosion surveys along the shoreline, testing water quality including chemical parameters and biological communities, conducting trash pickups, storm drain stenciling, or installing grate mates (Planet CPR, URL). All contribute to the reduction of pollution as well as increase citizen awareness. The Adopt-a-River Program provides assistance and materials for volunteer groups to participate in river cleanups. Through this program volunteers remove litter, household hazardous waste, appliances, auto parts and other products containing hazardous substances. The University currently has an active group, the U of M Chapter of Fish and Wildlife that cleans up a section of the Mississippi shoreline of the East Bank from Church St. to the Great Northern Railroad.

Another successful program includes citizens removing invasive exotic species and restoring the habitat by planting native species. A highly organized and successful neighborhood alliance is called the “Mississippi River Gorge Stewards”. This group conducts many of these activities to help spread the word of conservation throughout their community as well as become highly effective environmental stewards for the Mississippi. Once the local community becomes interested and involved in their local resources, there is no limit to what they may achieve.

The Prospect Park-East River Road Improvement Association (PPERRIA) is another group citizens who are actively involved in industrial and commercial development in the University of Minnesota watershed. Since 1993, PPERRIA has been working with the city of Minneapolis on a Neighborhood Revitalization Plan. Volunteers are overseeing development of this plan to prioritize spending and community improvement projects.

City of Minneapolis

On September 28, the City Council of Minneapolis passed an ordinance to regulate the sale and use of phosphorus fertilizers. The goal of the ordinance is to maintain and improve surface water quality by regulating the amount of lawn fertilizer and miscellaneous chemicals being released into surface water by storm water runoff or other means. The ordinance also states recommendations and restrictions of appropriate application surfaces and times (City of Minneapolis, URL).

The University Community
The University of Minnesota has been vocal in its support of protecting the environment. The Department of Environmental Health and Safety is responsible for overseeing the chemical waste management program. One of the main goals of this program is pollution prevention, source reduction, waste abatement, and waste reduction (Minnesota Daily, URL). Another organized group, the Waste Abatement Committee, is dedicated to focusing on the activities that are impacting natural resources and developing recommendations for future actions of the University for management of waste.

University students can serve as the link to the local population for outreach and education as well as implementation of several recommendations. The installation of the rain garden on the St. Paul campus is one example of successful program. Located on Commonwealth Avenue at the bus transit way, the rain garden was designed by a Landscape Restoration Specialist from the Association of Metropolitan Soil and Water Conservation Districts (Thompson, 2001). The project was implemented with the assistance of faculty, graduate and undergraduate students, and staff from the Bell Museum. The rain garden is designed to infiltrate storm water runoff from the nearby parking lot.

Another successful project undertaken by University students from Water Resource Sciences was the restoration of the Sarita wetland on the St. Paul campus. The project area receives major runoff from area roads and parking lots. The goal of the project was to divert this volume of water into an area converted to wetland. The wetland functions both as a way to improve water quality and as an educational tool to illustrate the effects of constructed wetlands. The students have instituted a monitoring plan that will be used to collect data and draw comparisons before and after restoration (WRSSA, URL).

Neighborhood groups
Managers for the Minneapolis Industrial area, Bridal Veil area and Prospect Park neighborhood have developed plans as recently as this year to improve surface and ground water resources in their immediate areas. These plans include public education and awareness activities, methods for removing existing pollution problems and measures to prevent or reduce future pollution impacts. Table 2 lists plans developed for the Minneapolis Industrial area by SEED. Table 3 lists plans for Prospect Park Neighborhood developed by PPERRIA and the City of Minneapolis.

Table 2 – Management Plan for the Minneapolis Industrial Area and Bridal Veil

- A new storm sewer system that would eliminate the existing combined sanitary storm system.
- A new weir diverting excess flow.
- Constructed wetlands.
- Filter strips.
- Biofilter swales.
- Green space and boulevards.
- Rain gardens (specially designed depressions with special soils and plantings that promote infiltration, evaporation and plant uptake of runoff).
- Bioretention facilities (enhanced vegetated swales designed to move water through vegetation and crushed stone to filter, absorb and infiltrate runoff).

(Prospect Park East River Road NRP Plan, URL)

Table 3 – Management Plan for the Prospect Park Neighborhood

- Increase the health and safety for humans, animals, birds, fish insects and plants by improving all aspects of our environment. reducing air and chemical pollution, protecting residential, public and commercial sites from contamination and cleaning up existing problem areas.
- PPERRIA will work with Citizens for a Better Environment (CBE) to monitor existing industrial and commercial operations and educate businesses and residents on pollution prevention.
- Polluted sites will be identified and cleaned up.
- The use of toxin-absorbing plant species in neighborhood landscaping projects will be encouraged.
- Educating residents to limit chemical use in landscaping through alternative methods. This would involve publishing a resource manual for residents and coordinating landscaping educational programs.
- Educate residents and review development plans in order to reduce surface water runoff through landscape and building design.
- Providing storm water detention on lawns and roofs, etc.
- Supporting city efforts to restore natural drainage systems, retain storm water and create wetland buffers against groundwater contamination around industrial areas.
- Undertake storm drain stenciling as a volunteer effort " Do not dump; drains to river".
- Improve solid waste services. Community composting. Hazardous waste collection. Organize community cleanup days to eliminate litter and solid waste on the landscape (approximate cost $40,00).

(Prospect Park East River Road NRP Plan, URL)

Recommendations

The following are recommendations for management of the University of Minnesota – East Bank Campus.

1. Complete a comprehensive analysis of existing storm sewer and sanitary sewer networks. Identify all inlets, outlets and problems in the system network. A component of the analysis should be outlet monitoring to be certain that storm and sanitary sewer pipes are not connected.

   Involve University students in the monitoring and design: students through classroom activities can propose and implement recommendations. Degree programs such as landscape architecture or water resource sciences can provide detailed investigation, observation, and implementation. The University is in a unique position to share information with the community to increase knowledge and understanding of this important resource. Successful management of the Mississippi River requires collaboration between the local citizens, University students, and the University community as a whole.

2. Complete a thorough analysis of the groundwater system. Determine flow directions, existing and potential point and non-point pollution source(s).

3. Isolate viable locations to retrofit Best Management Practices (BMPs) and components that would require solicitation of community involvement. Also find temporary BMPs to be implemented during construction to prevent erosion (See Appendix A-BMPs for consideration).

   Decrease runoff volume: increase infiltration by using water-permeable materials for parking areas and sidewalks; reduce impervious surfaces with vegetated boulevards or margins; route storm water to available lawn and vegetated areas. Promote the conservation or restoration of wetlands, vegetated swales, detention ponds, and institute bioretention techniques.

4. Develop with the input of the community at large a comprehensive watershed management plan with a goal of "no net" increase or a 25 percent reduction of nutrient loads and/ or concentration to the Mississippi River.

Additional Suggestions
The following are suggestions that should be considered in additions to the recommendations:

- Increase green space and expand existing green spaces creating a corridor.
- Recreation and sport fields should be encouraged on the river flats.
- Grass parking lots should be investigated and implemented where appropriate. Vertical parking should also be constructed to reduce impervious surface area needed.
- Emergency spill confinement and cleanup team should be established for major and minor spills.
- Solid waste handling on campus needs to examine for efficiency and it must be determined whether leakage from storage containers is a potential source of contamination.
- New developments should attempt to maintain the volume of runoff at predevelopment levels by using structural controls and pollution prevention strategies.
- Ecological restoration provides opportunities for the public to help out with a wide variety of projects, such as tree planting and bank stabilization.
- Using technologies that limit water use in buildings can reduce the demand on existing water supplies and limit the amount of water runoff.
- Decisions made during public hearings on storm water permitting and planning will ensure management of pollution continues over the long term. Notices about hearings often appear in the newspaper or in government office buildings.
- Recreate historic water bodies on campus.

Estimated Budget
A budget estimate for the above-mentioned recommendations was developed and is presented below (Table 4).

Staffing
A full-time staff hydrologist or water resource engineer with a background in water quality should be hired to facilitate the research and development of the U of Mn – East Bank Campus watershed management plan.

The duties of this position should include but not be limited to hiring a part-time intern; writing grants for additional funds; organizing and drafting all components of the strategic plan; developing partnerships; and assuring quality control and quality assurance measures are implemented through out the process. Term of 5 years with an annual salary of $50,000 the first year. Subsequent years, depending on performance a 3% cost of living increase and a merit increase not the exceed 5% should be assessed.

To aide the full time staff with day-to-day activities, a part-time intern with a major in hydrology, biology, hydrogeology, civil engineering or natural resources (Geographical Information Systems experience preferred not required) should also be hired.

The duties of this position will consist of assisting the staff hydrologist or water resources engineer. Term of 5 years with an hour salary of $10.00 the first year. Subsequent years, depending on performance a 3% cost of living increase and a merit increase not the exceed 5% should be assessed (assuming hours will be 20 during the school year and 40 during the summer and breaks).

Table 4 – Total Budget

Recommendations	Time to Complete, yr	Salaries, $	Operating Expense*, $	Total Expense
1	1	64,400	100,000	164,400
2	1	69,590	75,000	144,590
3	2	156,250	100,000	256,250
4	1	87,630	25,000	112,630
Total	5	377,840	300,000	**677,840**

* Operation Expense - Budget to be used for purchasing monitoring equipment, analyzing laboratory results, computers, and miscellaneous items – paper, postage, etc.

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Appendix A

Best Management Practice for Consideration

Section 1 – Permanent Best Management Practice

Section 2 – Temporary Construction Best Management Practice

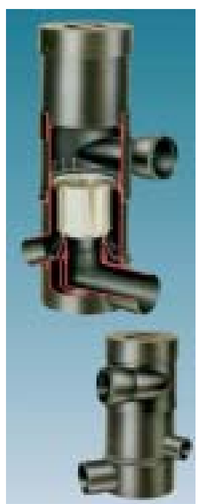
Section 1: Permanent Best Management Practice

Structural and non- structural devices designed to store or treat runoff in order to mitigate flooding, reduce pollution and provide other amenities.

- Underground Infiltration Filter
- Grit Chamber
- Swales/Ditches
- Bioretention System
- Infiltration Trenches
- Bio-Retention
- Green Rooftops
- Wet vaults

1.1.1 Underground Filter

Underground filters are intended to address spatial constraints that can be found in intensely developed urban areas where the drainage areas are highly impervious. They are most effective when designed as off-pine BMPs, they are intended primarily for quality control not quantity control. The filter typically contains 3 chambers. The first chamber takes care of pretreatment, utilizes a wet pool and temporarily stores runoff. The second chamber temporary stores water during storms. A submerged weir connects the first and second chambers. Perforated drains extend into the third chamber, which collects filtered runoff.



(WISY Vortex Underground Filter, URL)

1.1.2 Grit Chamber

Grit chambers are systems designed to remove trash, debris, and some amount of sediment oil, nutrients and grease from stormwater runoff. Grit chambers operate based on the principle of sedimentation for the grit and phase separation for the oil.

(CDS Technologies Inc, URL)

1.1.3 Swales/Ditches

Swales are a type of open vegetated channel used to treat and attenuate the water quality volume of stormwater runoff as well as convey excess storm water downstream. In the swales, the entire water quality volume of a given storm is temporarily held in a pool or series of pools created by permanent check dams or ditch blocks. The holding time serve to settle pollutants, especially sediments.

(Stormwater, URL)

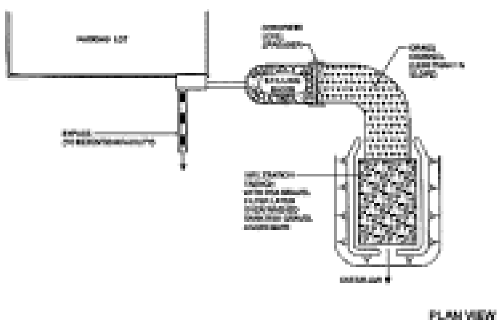
1.1.4 Bioretention System (Rain Gardens)

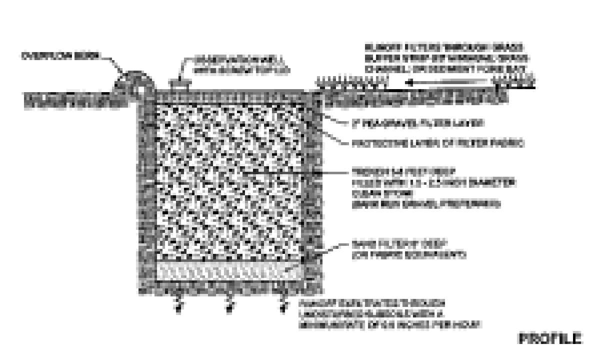
Bioretention systems can be described as shallow landscaped depressing commonly located in parking lot islands or within small pockets in residential areas that receive stormwater runoff. Stormwater flows into the bioretention area, ponds, on the surface, and gradually infiltrates into the soil bed. Pollutants are removed by a number of processes including adsorption, filtration, volatilization, ion exchange and decomposition.

(Virginia Dept. of Enforcement, URL)

1.1.5 Infiltration Trenches

Infiltration trenches are shallow excavations that are lined with filter fabric and filled with stone to create underground reservoirs of stormwater runoff from specific design storms. The runoff gradually percolates through bottom and sides of the trench into the surrounding subsoil over a period of days. Infiltration trenches are typically implemented at the ground surface to intercept overland flows.





A schematic of an infiltration trench (Source: MDE, 2000)

(EPA Office of Waste Management, URL)

1.1.6 Green Rooftops

Green rooftops are veneers of living vegetation installed atop building, from small garages to large industrial structures. Green Rooftops help manage stormwater by mimicking a variety of hydrologic processes normally associated with open space. Plants capture rainwater on their foliage and absorb it in their root zone, encouraging evapotranspiration and preventing much stormwater from ever entering the runoff stream.

(Greenroofs.com, URL)

Section 2: <u>Temporary Construction Best Management Practice</u>

Temporary erosion and sediment controls for site grading activities include the following (MPCA, 1989):

- Limiting land disturbance to preserve existing ground cover.
- Inlet protection for storm sewers.
- Silt fences to prevent sediments from leaving site.
- Temporary mulching and seeding.
- Temporary slope drain
- Temporary rock construction entrance

2.1.1 Inlet Protection

Inlet protection is intended to prevent the transport of sediments from entering the existing storm sewer system. Storm sewer inlets in the vicinity of construction activities will be protected by riprap, silt fences, catch basin inserts or other approved methods.

2.1.2 Silt Fences

The Contractor shall place silt fences to prevent the transport of sediment from the construction limits and as directed by the Owner's designated representative. Silt fences can be omitted if the disturbed area can be stabilized within fourteen (14) days of the commencement of stripping operations. The Contractor shall install silt fences following Mn/DOT Specification 2573 *Temporary Erosion Control* prior to commencement of any soil disturbing activities.

2.1.3 Temporary Mulching and Seeding

Mulch shall be placed on exposed soil areas to provide temporary protection from erosion within fourteen (14) days of completion of any construction activities that have disturbed and exposed soil. The Contractor shall use Type 1 mulch at a rate of 2 tons per acre in accordance with Mn/DOT Specification 3882 *Mulch Material*. A temporary seeding of winter wheat or annual ryegrass, applied at a rate of 10 lbs/acre, may be used if permanent turf establishment is delayed.

2.1.4 Temporary Slope Drain

A temporary slope drain is a flexible conduit extending from the top to the bottom of a disturbed slope and serves as a temporary outlet for a diversion. The slope drain conveys water down a disturbed slope with out causing erosion on or at the bottom of the slope. The contractor shall install slope drains wherever there is significant disturbance of steep slopes or wherever practical.

2.1.5 Temporary Rock Construction Entrance

A temporary rock construction entrance is a stone pad located ay points where vehicles leave a constructions site. The stone pad is to provide an area where mud can be removed from vehicles tires before the vehicles leaves to site. The contractor shall used 1 to 2-inch size rocks for the gravel pads as specified by MN/DOT CA-1 and CA-2 coarse aggregate. The aggregate should be placed in a layer at least 6 inches thick.