Municipal Engineering

Resource Guide

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WSB & Associates, Inc.
engineering
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Municipal Engineering

Resource Guide

WSB & Associates, Inc. is pleased to provide you with this Municipal Engineering Resource Guide. As a leading provider of civil engineering, planning, environmental, and technology services to government agencies, we are committed to providing our services in a way that is transparent and understandable for staff and elected officials in order to achieve the best possible decisions for their community.

Our industry frequently changes with new regulations and environmental concerns, and is full of acronyms. With this book, we explain some of the issues that are most commonly addressed at the city council level. We hope it will be a resource for you and spur conversation to produce a better understanding of the items you deal with on a regular basis.

Through our in-house education program (WSB University), we have developed a course that will allow for a question and answer session to explore these topics in greater detail. Please let us know if your organization has an interest in scheduling a presentation.

We trust that you will find this information useful as a resource for making engineering-related decisions.

Sincerely,

Bret A. Weiss, PE
President
bweiss@wsbeng.com

WSB & Associates, Inc.

"WSB's Municipal Engineering Resource Guide is a valuable tool that will assist new council members and staff with gaining a stronger understanding of municipal infrastructure and engineering matters. This increased understanding will result in making more informed decisions."

Jeff Karlson, City Administrator
City of Lino Lakes

The text of this Resource Guide contains general information and is not intended as a substitute for specific recommendations. Your professional staff is more familiar with your community and can provide specific recommendations. Guidelines and regulations change and may be different from when this book was published.

WSB & Associates, Inc.

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What's Inside

"Having worked with WSB on multiple projects, I have always been impressed with the technical proficiency of their staff. By creating the Municipal Engineering Resource Guide, they are taking their services to a new level by focusing on relationship building with elected and appointed officials. This effort is simply another example of how WSB continues to impress."

Dean Lotter, City Manager
City of New Brighton

Transportation Systems

What is roadway functional classification and why is it important?

Roadways are classified into four primary categories and several subcategories. The higher a roadway's functional classification, the more important the roadway is in terms of moving more vehicles at a higher rate of speed. Roadways are classified as principal arterials, minor arterials, collectors, and local roads.

Principal arterials can be freeways or expressways. They are interstates, trunk (state) highways, or U.S. highways. These roadways have the highest posted speeds, have the least amount of direct access, and accommodate the most traffic.

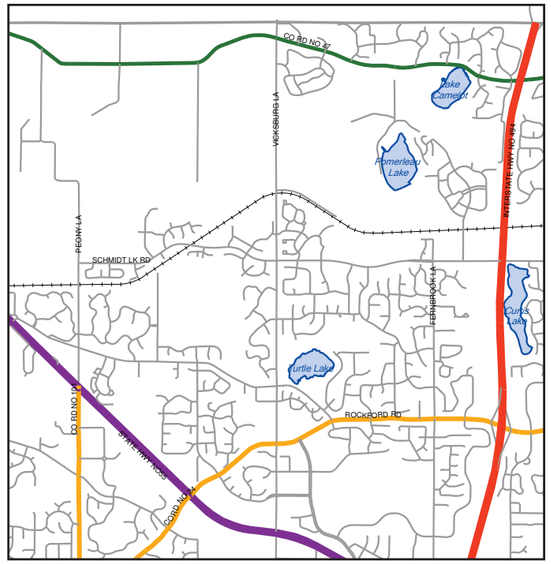
- **Minor arterial roadways** can be expressways, four-lane roadways, or two-lane roadways. They are designed to move traffic and generally have speed limits of 40-55 mph. Access spacing is more frequent than on principal arterials, but less than collector or local roadways. Minor arterials are usually trunk (state) or county highways.
- **Collector roadways** connect to minor arterials. Collector roadways generally link commercial/industrial areas or a large concentration of residential areas in a community to minor arterial roadways. Access is more frequent on these roadways as compared to minor arterial roadways, and speed limits are lower (30-45 mph). Generally, these roadways are managed by a county or city.
- **Local roads** provide direct driveway access to homes and businesses. Access is frequent, speeds are low and the roadways are almost always two lanes. Cities manage local roadways.

Who is responsible for the roads within the city?

The responsibility for constructing and maintaining roads within the city falls under one of the following jurisdictions:

- **State** - Interstates and trunk highways.
- **County** - Most of the minor arterials and some of the collector roadways within the city.
- **City or township** - Any public roadways that are not under the jurisdiction of the state or county. These are generally residential streets and some collector roadways.
- **Private** - Roads constructed and maintained by adjacent residents or businesses.

Although the city does not have direct responsibility for state and county roads within their boundaries, the city is usually involved in the planning, design, construction, and partial financing of these roads because of the impacts on residents and other infrastructure such as trails, sewer, water, and stormwater.



LEGEND

- *Interstate Highway*
- *Trunk Highway*
- *County State Aid Highway*
- *County Road*
- *City Street*

How many vehicles share a road before it is considered congested?

There are many variables that impact the point at which a roadway becomes congested. The most obvious is the volume of traffic, which is typically listed as ADT (Average Daily Traffic). In addition, factors such as amount of access (driveways and side streets), number of lanes, traffic speed, volume of traffic at times of peak usage, and directional distribution contribute to the number of vehicles a roadway can accommodate. Definitions of lane configurations are provided below and all except the four-lane divided, allow for full access:

- **Two-lane undivided** - One through lane in each direction with a yellow stripe separating them.
- **Three-lane** - One through lane in each direction, with a two-way left turn lane separating them. Generally considered safer in lower speed environments due to left-turning vehicles no longer obstructing the through lanes.
- **Four-lane undivided** - Two through lanes in each direction with a yellow stripe separating them.
- **Four-lane divided** - Two through lanes in each direction separated by a physical median with openings and lanes for left turns. Access is reduced to right-in/right-out only, unless allowed by a median opening.
- **Five-lane** - Two through lanes in each direction, with a two-way left turn lane separating them.

		VEHICLE CAPACITY (ADT)
COLLECTOR / LOCAL	Two-lane undivided urban	0-10,000
COLLECTOR / LOCAL	Two-lane undivided rural	0-15,000
MINOR ARTERIAL	Three-lane urban (two-lane undivided with turn lanes)	5,000-17,000
PRINCIPAL ARTERIAL	Four-lane undivided urban	8,000-22,000
PRINCIPAL ARTERIAL	Five-lane urban (four-lane divided with turn lanes)	12,000-32,000
PRINCIPAL ARTERIAL	Four-lane divided rural	12,000-38,000
PRINCIPAL ARTERIAL	Four-lane freeway	30,000-80,000
PRINCIPAL ARTERIAL	Six-lane freeway	60,000-120,000

What are "Complete Streets"?

Non-vehicular modes of transportation are also considered in development of the overall street network. "Complete Streets" simply means providing for, and in many cases encouraging, use of the roadway corridor to accommodate alternate modes of transportation:

- **Transit** - Generally, transit opportunities are planned and administered at a regional level (e.g., Metro Transit, Minnesota Valley Transit Authority, Southwest Transit). These rail or bus routes are accommodated on the local roadway network, and sometimes supported by municipally administered local transit networks.
- **Bicycle** - Typically, bicycle facilities are more frequently used if they connect to or are a part of a larger network, if they connect to transit facilities, or if they access bicycle-friendly destinations or development.
- **Pedestrians** - Accommodation of pedestrians is the general practice along nearly all roadways, regardless of the number of users anticipated. In fact, the Americans with Disabilities Act (ADA) requires that accommodations be made for disabled users on all public facilities.

"Complete Streets"

How are speed limits determined?

Speed limits are regulated by Minnesota Statute 169.14. Statutory speed limits are:

- 10 mph on alleys.
- 25 mph on residential roadways ***only if specifically adopted and signed by the local road authority.***
- 30 mph on streets in urban districts* or in rural residential districts*(no sign required).
- 55 mph on all other roads (except expressways and interstates).

The Commissioner of Transportation has the authority to set regulatory speed limits if the statutory speed limits are not appropriate for the roadway. A city can request that the Commissioner set the speed limits for a specific roadway. The Minnesota Department of Transportation (MnDOT) will then evaluate the roadway and recommend an appropriate speed, considering factors such as roadway geometry, sight distance, land use, traffic speeds, etc., generally defined as the speed with which the 85th percentile is safely driving.

**Defined in the statute.*

GLOSSARY

Peak Volume - *Volume of traffic during peak usage times, such as morning and evening rush hour.*

Divided Roadway - *Physical separation, such as a raised median, between opposing traffic directions.*

Undivided Roadway - *Opposing traffic separated by striping.*

Access - *Ability to enter or exit the roadway via a driveway, side street, intersection, or ramp.*

Complete Street - *Corridors that accommodate multiple transportation modes, including vehicles, transit, bicycles, and pedestrians.*

Traffic Signals/Signage

How are roadways designed?

The design of a roadway affects its safety and capacity and is governed by uniform standards. Traffic lanes are generally 11 or 12 feet wide. Turn lanes are often used when a side street or driveway access poses a safety concern. Other items often accommodated on the roadway include parking, shoulders for disabled vehicles, bicycle lanes, and designated transit lanes or pullouts.

Why are there so many signs and stripes?

Regulatory and warning signs are regulated nationwide. The location of signs with respect to turn lanes, intersections, and changes to lane configuration is also governed by the Minnesota Manual of Uniform Traffic Control Devices (MMUTCD) manual. Informational signs, such as street names or places of interest, are placed at the discretion of the jurisdictional agency and its engineer.

Striping along the roadway is also uniformly placed (in accordance with the MMUTCD) and is used to direct traffic. Striping is often misconstrued as a cheaper equivalent to a curb or median. Caution should be used in these applications, as drivers can drive over or ignore stripes, and winter conditions often obscure striping.

Street striping and signage

Can we put in a stop sign to slow traffic?

Stop signs have not proven successful for slowing traffic. Many drivers drive by "feel"; if a stop sign is in an unwarranted location, drivers might not see it, resulting in an unsafe situation. Without constant enforcement presence, the typical driver may slow down at the stop sign, but compensates for the inconvenience by traveling faster between stop signs. Intersection controls such as stop signs are installed based on meeting specific criteria (called "warrants"), such as higher traffic volumes, accident history, and pedestrian volume. A stop sign installed at a location where it is not warranted can often create a less safe environment.

Stop sign or traffic signal?

Traffic signals are a form of intersection control that accommodates high vehicle volumes. When a signal is considered, an engineering study of the intersection is performed to see if a signal is warranted and is the most appropriate type of control (stop signs, roundabouts, and grade separation are other possibilities). This study is known as a Signal Justification Report (SJR) when a signal is the only type of control considered, or an Intersection Control Evaluation (ICE) when all forms of control are being considered. The information gathered includes:

- Intersection traffic volumes and turns
- Pedestrian counts and directions
- Speed and gap studies
- Crash history
- Intersection delay studies

A traffic signal should not, and usually cannot, be installed unless it meets the warrant criteria AND it improves intersection safety or operations. Where traffic signals are close together or are in sequence on a commuting corridor, they are often interconnected so their timing can be coordinated to facilitate flow between them.

Roundabout

Why add a roundabout?

Roundabouts are an alternate form of intersection control that can also accommodate high vehicle volumes. Similar to traffic signals, an engineering study is typically performed to understand if a roundabout is the appropriate form of control for the specific intersection and whether it is adequate to accommodate traffic needs. Roundabouts generally have a single circulating lane for smaller volumes and two circulating lanes for higher volumes. Specific design parameters related to the entry angle and island lengths must be analyzed for the roundabout to achieve the best results. Roundabouts are statistically proven to be significantly safer than signals (70% reduction in injury crashes, 90% reduction in fatal crashes) due to the low entering speeds (15-20 mph). Roundabouts are relatively new and often generate a stronger public reaction than signals. However, studies have repeatedly shown that public opinion is strongly favorable after installation and a period of time under operation.

Street signal

GLOSSARY

MMUTCD - *Minnesota Manual of Uniform Traffic Control Devices, a guide for designing and locating signs and stripes in a consistent manner throughout the state.*

Design Speed - *Vehicle speed that is used to make engineering decisions regarding curvature, grades, sight distance, and clear zones.*

Posted Speed - *The speed posted for enforcement or regulatory purposes; generally less than or equal to design speed.*

Signal Justification Report (SJR) - *Engineering analysis of an intersection to determine if a traffic signal is warranted.*

Intersection Control Evaluation (ICE) - *Engineering analysis of an intersection to determine appropriate form of control (e.g., stop sign, signal, or roundabout).*

Streets

How wide should the street and right of way be?

Many cities establish guidelines for street widths and right of way widths based on traffic volumes, vehicle types, accommodations for alternate modes of transportation (transit, bicycles, and pedestrians), turn lane needs, parking, stormwater facilities, and city or private utilities. A typical cross-section of a road is shown in the figure on the facing page. While general guidelines are useful for planning purposes, specific widths should be determined based on the needs of each roadway and corridor.

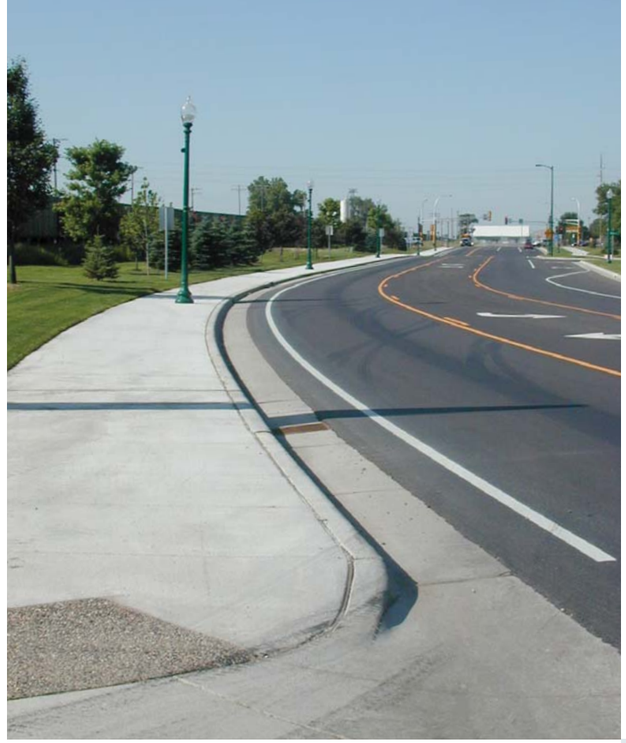
Why can't we park on every street?

Many streets are paved beyond the minimum needs for the through and turn lanes. Often, this width is minimal (about 2 feet). However, on high-speed roadways or roadways that have only one through lane, a shoulder area wide enough to accommodate a disabled vehicle should be considered for both safety and capacity reasons. General shoulder widths are 8-10 feet. Many cities also allow additional width (usually 8 feet) for on-street parking. Typically, this is a feature of a low-speed, residential environment, as parked vehicles significantly reduce the driver's field of vision.

Why do we need boulevards?

The area between the curb and the sidewalk or trail is commonly known as the boulevard. Some urban streets are built with sidewalks immediately behind the curb, such that there is no actual boulevard. However, there are many reasons to establish a boulevard, including space for roadway signs, roadway or pedestrian lighting, snow storage, and to provide a buffer between the roadway and pedestrians or bicyclists.

Boulevard



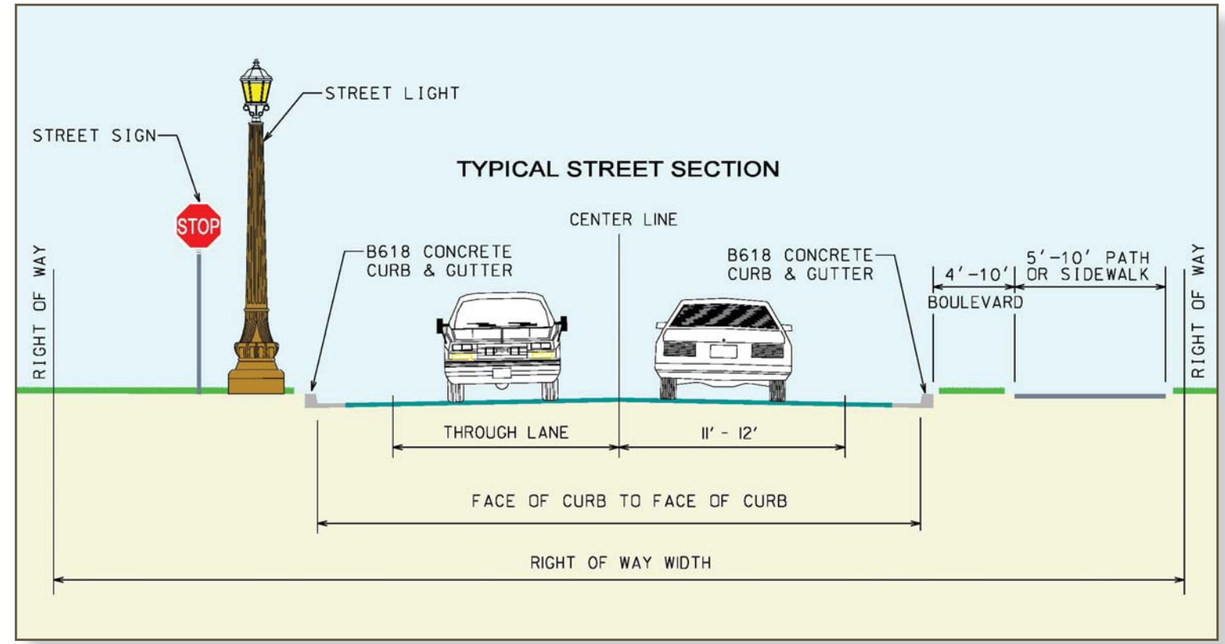
City street with sidewalk and pedestrian ramp

What is LED lighting all about?

LEDs, or Light Emitting Diodes, are being considered as a replacement for traditional street lighting in many roadway and area lighting applications. LEDs have been used for these purposes for about a decade. As technology advancements occur and energy and maintenance costs increase, LED lighting is becoming a more viable alternative for roadway and area lighting. LED lighting is typically 30%-40% more energy efficient than traditional street lighting. Some manufacturers claim up to 60% greater efficiency when maintenance costs are considered. Another benefit is that LEDs provide a clean white light, which actually seems brighter than other lighting technologies with similar light output. This white light does look different, so that should be considered when adding lights into an existing lighted area.

What are ADA requirements?

The Americans with Disabilities Act requires that all public facilities meet design standards to accommodate disabled pedestrian users. For streets, this means that transitions between sidewalk and road surface at crossings must conform to certain slopes and surface treatments. In addition, there are requirements for longitudinal slopes of trails and sidewalks, as well as for cross-slopes. Traffic signals also contain design components, such as height of crosswalk push buttons and video/audio warnings to adhere to the standards. All new facilities must comply with the requirements as part of design and construction. Roads built prior to enactment are largely exempt, but cities must have a plan for transitioning non-compliant roadways.



Urban street cross-section

What are typical street maintenance procedures?

Gravel roadways require regular grading in the summer months and resurfacing every 3-5 years. Some communities apply calcium chloride to the surface to reduce dust and minimize the need for regular grading.

Asphalt roadways require surface repair such as pothole patching, crack filling, and seal coating on an as-needed basis. Many cities have a crack filling and seal coating program for their paved streets, which is typically completed every seven years to protect the street surface and extend the life of the street.

Winter maintenance on gravel and paved roadways includes snow and ice control. Each city typically has its own policies with regard to how much snow needs to fall before plowing, when plows are sent out, and how much sand and salt are applied. Many cities have reduced or eliminated the use of sand for ice control, since it can wash into the city's storm drainage system, wetlands, and ponds.

Street maintenance activity - pavement overlay

GLOSSARY

Seal Coat - *Applying a thin, non-structural, bituminous seal to the existing roadway surface.*

Boulevard - *Area between the curb and the sidewalk or trail.*

ADA - *Americans with Disabilities Act, federal guidelines to accommodate disabled users in public spaces.*

Road Reconstruction - *Complete removal and replacement of a roadway.*

Mill and Overlay - *Milling the top layer (usually 2"-4") of a road and replacing it with new bituminous pavement.*

State Aid Funding - *Municipal state aid funds are derived from a portion of the constitutionally dedicated, transportation-related taxes collected by the state. The funds are available to cities with populations over 5,000, and can be used to construct and maintain streets that are included on a city's state-aid roadway system.*

Municipal State Aid for Streets

How do cities become eligible for state aid and how do they receive funds?

Cities with a population over 5,000 are eligible to receive state aid funding. A portion of the funds from the state gas tax is apportioned on a yearly basis to each eligible city, with 50% of the apportionment being distributed based on that city's population compared to the total population of all the other state aid cities. The remaining 50% of the allocation is distributed based upon the cost to construct the roadways to state aid standards. Currently, distribution of the gas revenue is 62% MnDOT, 29% county, and 9% city.

How are state aid streets determined?

State aid streets typically carry higher traffic volumes and connect major roadways or points of traffic interest. For example, a collector road that connects a county roadway to a state highway would likely be designated as a state aid street. Having state aid roadways within a network of state highways and county roads helps provide an integrated traffic system.

State aid cities are allowed to designate up to 20% of their total road mileage as state aid streets. This mileage is calculated and reported annually by completing a certification of mileage.

The city's population is determined by the Federal Census and/or the State Demographer's estimate. Cities that are growing rapidly can choose to do a separate census to increase their population apportionment. Construction needs are determined by completing an assessment of the existing and future proposed roadway characteristics of each state aid street. The population and construction needs of each state aid city are reviewed and recalculated on a yearly basis with funds being apportioned to each city every January using the available gas tax revenues.

Intersection of city streets

How are state aid funds spent?

Cities can use state aid funds to pay for roadway construction and maintenance improvements to state aid roadways, or they can use them to fund the city's share of work on county or state highways. With each annual apportionment, the city receives a certain amount of funds that can be spent on maintenance activities. The remaining funds are available to be spent on roadway improvement projects. In order to utilize state aid funds, the design of the improvements must meet specific criteria and must be reviewed and approved by MnDOT prior to beginning construction. After construction is completed, MnDOT inspects the final improvements to verify the project is in compliance with state aid requirements and issues final payment to the city.

What are Cooperative Agreements?

MnDOT allocates funds to assist cities and counties in making improvements that benefit the state trunk highway system. Typically, these funds are awarded on a competitive basis and are targeted to locally initiated projects that improve safety and capacity on the state trunk highway system. Often, these projects are not part of MnDOT's planned highway projects but do benefit the traveling public.

Can cities receive federal funding?

The federal government has numerous funding programs for a wide range of transportation projects at the city, county, and state level. In the Twin Cities, the Metropolitan Council administers a federal funding solicitation process that allocates funding to selected projects through a competitive process. Outside the Twin Cities Metropolitan Area, the projects are selected through Area Transportation Partnerships made up of MnDOT districts and the cities and counties within the MnDOT district.

MN Chapter 429 Special Assessment

What is a special assessment?

Most cities use special assessments to fund a portion of roadway improvement projects. A special assessment is a charge levied against properties by the city for a pubic improvement that benefits the owners of the selected properties. Cities that levy special assessments typically have a policy related to calculating special assessment amounts. They are usually based on the frontage of the lot, the area, or by the individual household or unit. Regardless of the method used to calculate the amount, state law requires that the amount of a special assessment cannot exceed the actual benefit to the property in terms of value.

What types of improvements can be assessed?

Cities have the ability to finance the following improvements typical to most cities:

- Streets, sidewalks, alleys, curbs, and gutters.
- Storm drainage, water supply, and sanitary sewer systems.
- Street lights.
- Parks, playgrounds, and recreational facilities.
- Burying overhead utility lines within public right of way.

There are a number of other improvements that can also be at least partially assessed; however, many of these are far less common in most cities.

How does the public participate?

Residents are typically notified of construction projects well before the project begins through open houses and neighborhood meetings. Many communities also communicate with residents and businesses through the use of flyers, websites, and newspaper correspondence. It typically takes 2-6 months to get through the process, depending upon the scope of improvement. The outline to the right provides an at-a-glance look at the special assessment process.

THE SPECIAL ASSESSMENT PROCESS

1. **Project Initiation** - Petition or by council vote.
2. **Feasibility Report** - Includes factors such as when the project is necessary, availability of city funds to pay the city's share, an estimate of the cost, and whether the improvement is cost effective. The report must also include an estimate of the amount to be specially assessed and a methodology for calculating assessments.
3. **Improvement Hearing** - This is a public hearing in which the city council can discuss a specific improvement before ordering it to be completed. The council considers the information in the feasibility report, testimony from affected property owners, and any other information necessary for deliberation. Specific notice of the improvement hearing needs to be published in the city's official newspaper and delivered via mail to all affected property owners.
4. **Order Improvements** - The council can order the improvements by passing a resolution within six months of the improvement hearing.
5. **Construction Plans and Bidding** - Plans and specifications are prepared by city staff or a consulting engineer, and then put out for bids to contractors. All bidding needs to comply with competitive bidding requirements.
6. **Assessment Hearing** - This hearing gives property owners an opportunity to express concerns about the proposed special assessments. The hearing is held following specific notice, like the improvement hearing. This can be held before or after the project is complete.
7. **Adopt Assessment Roll** - The council must adopt specific assessments by passing a resolution. The resolution typically includes an interest rate for the assessments, plus the payment timelines (i.e., number of years).

****Challenging Special Assessments** - Property owners can object to special assessments at the assessment hearing and must then file an appeal to the District Court within 30 days. If an assessment is appealed, the property owner must provide evidence to show that the assessment does not meet or exceed the benefit to the property. There are various methods to address the concerns; a ruling by a judge is the last resort.

Stormwater Runoff

What is stormwater runoff?

Stormwater runoff is rainfall that does not absorb into the ground. Stormwater runoff travels many paths - over land, in roadway gutters, through pipes and culverts - and often carries pollutants to public waters. This is why the Federal Environmental Protection Agency (EPA) issued rules to consider untreated stormwater as a pollutant and why cities over a certain size now must obtain an NPDES MS4 Permit to operate stormwater systems.

How do we keep from flooding?

Over the last three decades, intense precipitation and runoff events have become more common, making flood control an area of emerging concern. Flood control systems rely on the complex interaction among ponds, storm sewer, culverts, outlet structures, channels, levees, reservoirs, and other components to keep runoff water away from major roadways, buildings, and homes for a specific design event - usually the 100-year event in newer communities. Due to cost considerations, most local governments opt for the 100-year design for flood control, although some frequently flooded cities like Fargo have considered the cost feasibility of more robust flood control systems.

Catch basin

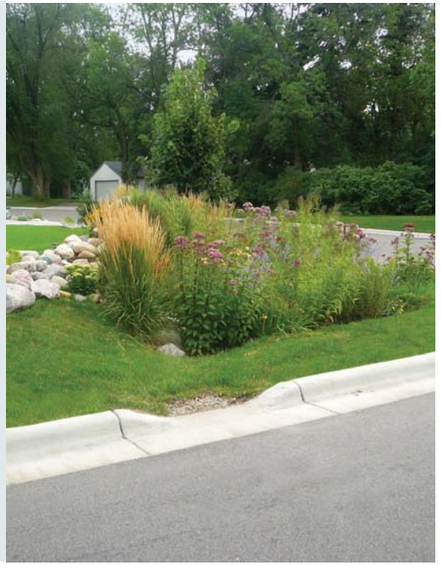
Typical stormwater runoff schematic

Stormwater outlet

Why is water quality important?

In the 1980s, the EPA concluded that untreated stormwater runoff significantly degraded the water quality of the nation's public waters and thus determined that the Clean Water Act gave it the authority to regulate urban stormwater. Among other initiatives, the Minnesota Clean Water Land and Legacy Amendment signified Minnesota's commitment to protecting and improving water quality. Water quality practices, known as Best Management Practices (BMPs), are used on construction sites and urban and agricultural land to protect public waters so they maintain healthy aquatic life and can serve their intended uses, such as providing aquatic habitat, being a source of drinking water, and accommodating recreational uses like swimming and fishing. When Minnesota's public waters do not meet their designated uses, the MPCA develops a Total Maximum Daily Load (TMDL) to determine how to restore water quality through the implementation of BMPs. BMPs treat polluted runoff through one or more physical and biological processes: sedimentation, filtration, plant uptake, infiltration, and evaporation. All the diverse BMPs used today combine one or more of these processes. Trends in stormwater have changed from ponding to treating the water at the source through infiltration.

The Minnesota Pollution Control Agency (MPCA)has made infiltration the centerpiece of their water quality protection strategy through the development of Minimum Impact Design Standards (MIDS). In general, if municipalities integrate MIDS into their own requirements, the state can assume that the municipality has endeavored to protect water quality to the maximum extent feasible. However, cities should be careful in how infiltration requirements get applied, since surface infiltration takes a significant amount of land and the success of the practice depends on having reasonably porous soils.



Rain garden

What is a design storm?

Design storms are defined based on their probability of occurrence in a given year. For example, a 10-year event means an event that has a 10% chance occurrence and a 100-year event has a 1% change of occurrence. Cities use different design storms: a 100-year for flood control, a 10-year for local street storm sewer, a 1-year to 2-year for water quality, and generally a 2-year to 5-year for stream protection. The use of different design storms is based on economic and hydrologic considerations. Flood protection for large, infrequent events is a public benefit that is worthwhile. However, draining local streets for the 100-year event is cost prohibitive, so we have learned to live with transient street flooding for large rainfalls greater than a 5-year or 10-year storm.

GLOSSARY

Point Source Pollution - *Pollution that comes from a single source, such as a factory or wastewater treatment plant.*

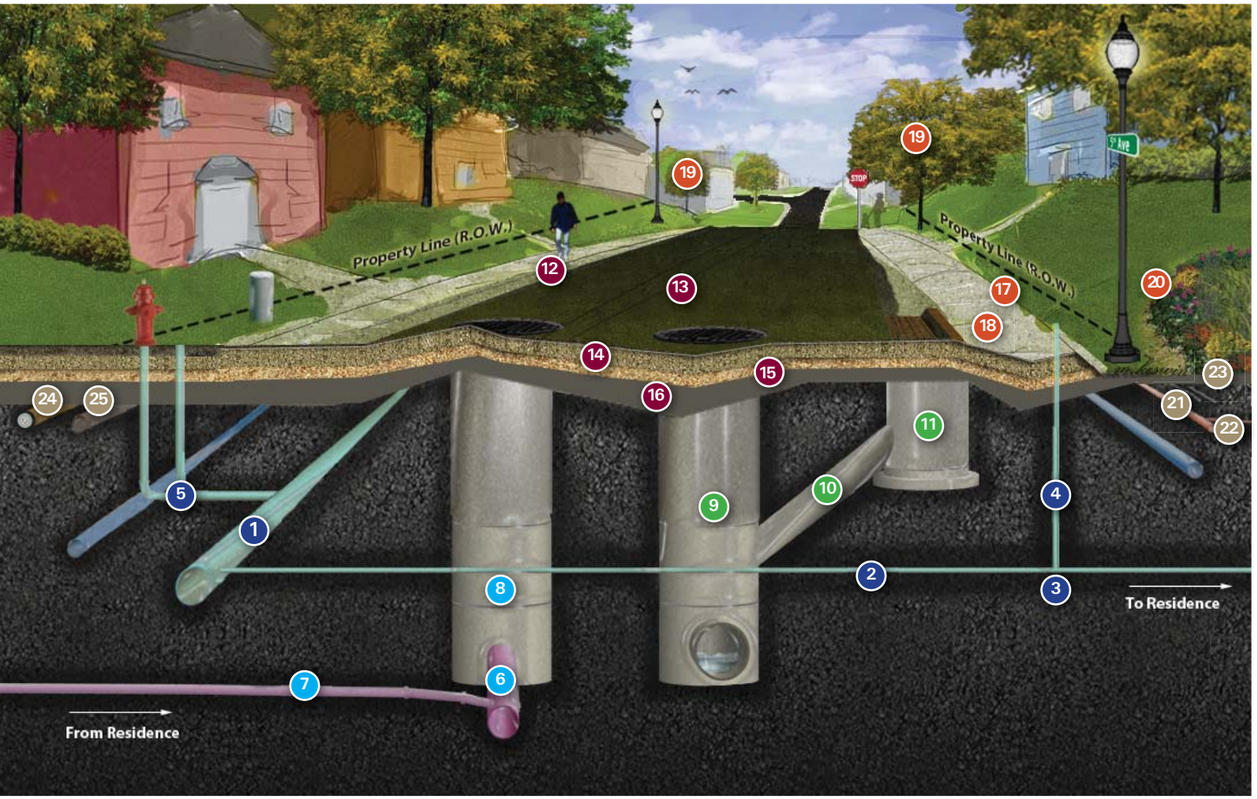
Non-point Source Pollution - *Pollution that comes from the cumulative effect of a region's residents going about their everyday activities, such as fertilizing a lawn or driving a car.*

MS4 - *Municipal Separate Storm Sewer Systems.*

Porous Soils - *Soil characterized by a good mix of sand, clay, and organic material that holds moisture and drains water.*

NPDES - *National Pollutant Discharge Elimination System (NPDES) permit program that controls water pollution by regulating point sources that discharge pollutants into waters.*

A Typical Municipal Street and What Lies Beneath



LEGEND

WATER

1 *Watermain (typically 7 1/2 ft. depth)*
2 *Water Service*
3 *Water Service Shut-Off Valve*
4 *Curb Stop and Valve Box*
5 *Gate Valve and Box*

SANITARY SEWER

6 *Sanitary Sewer Main (depth varies)*
7 *Sanitary Sewer Service*
8 *Sanitary Sewer Manhole*

STORM SEWER

9 *Storm Sewer Manhole*
10 *Storm Sewer (4-10 ft. depth)*
11 *Storm Sewer Catch Basin*

STREET

12 *Concrete Curb and Gutter*
13 *Bituminous Pavement (asphalt)*
14 *Gravel Base*
15 *Granular Material*
16 *Geotextile Fabric (in certain cases)*

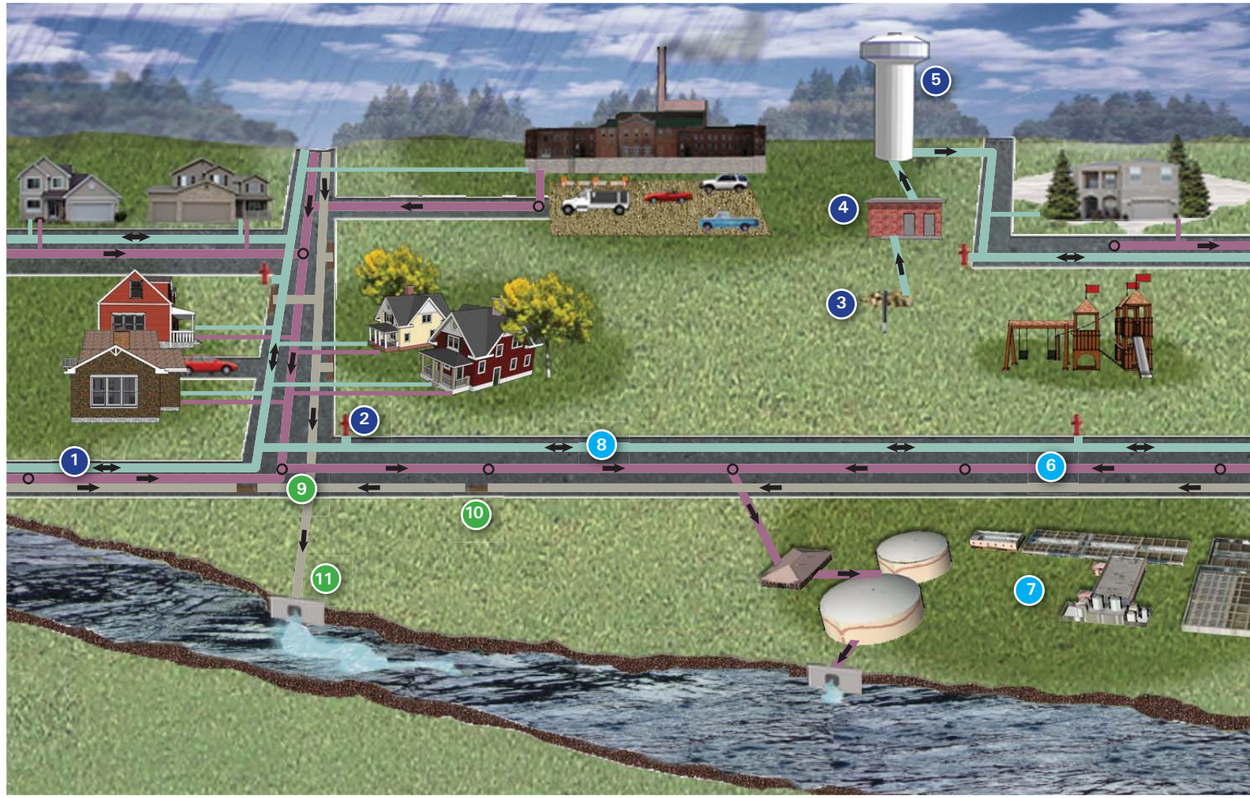
BOULEVARD

17 *Boulevard*
18 *Sidewalk (width depends on site conditions)*
19 *Boulevard Trees*
20 *Rain Garden*

PRIVATE UTILITIES

21 *Natural Gas Main (Private)*
22 *Natural Gas Service (Private)*
23 *Electrical Cable*
24 *Fiber Optic Cable*
25 *Cable Television*

Typical Utility System



LEGEND

WATER

1 *Watermain*
2 *Fire Hydrant*
3 *Well*
4 *Water Treatment Plant*
5 *Water Tower*

SANITARY SEWER

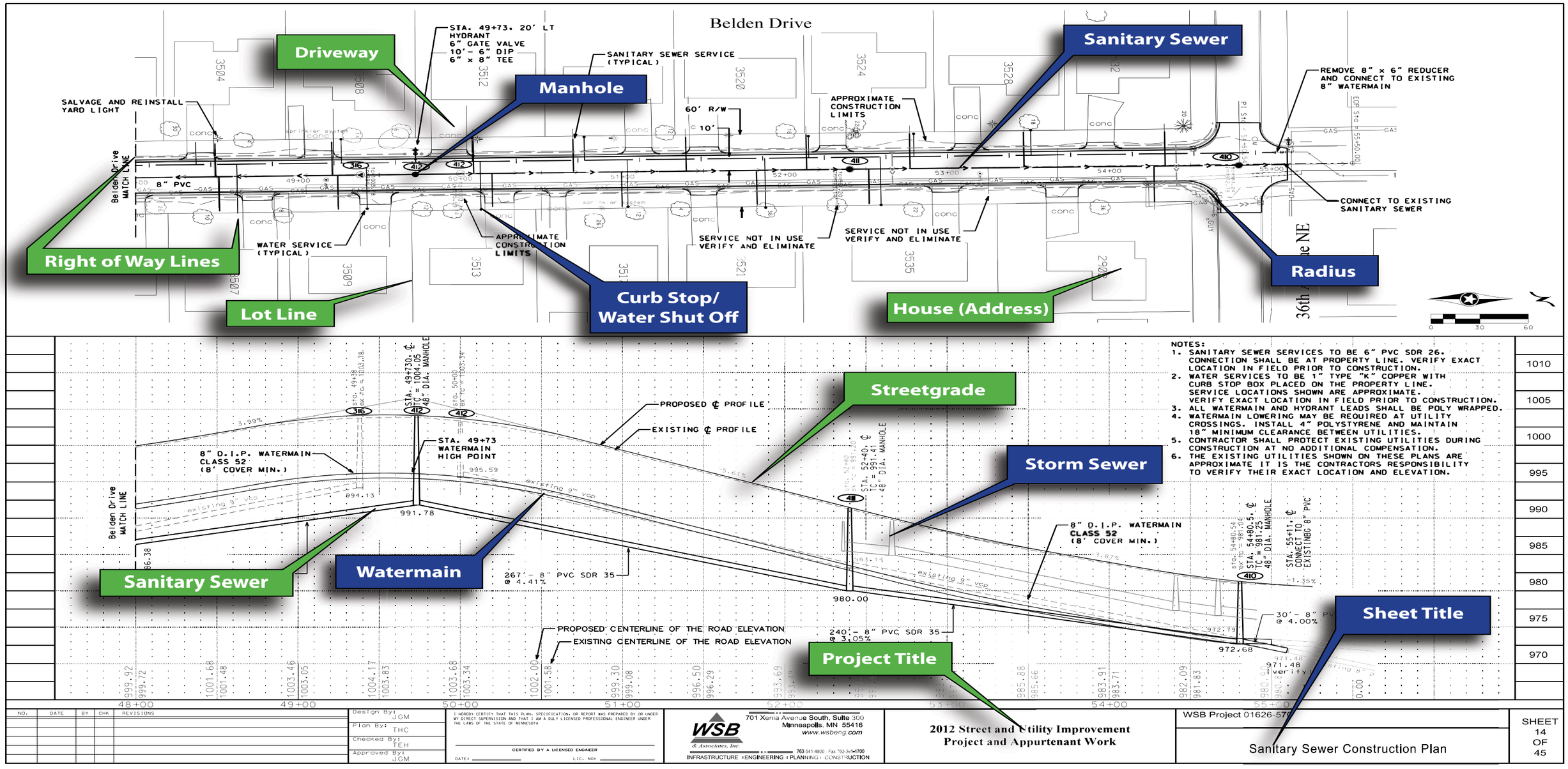
6 *Sanitary Sewer Main*
7 *Wastewater Treatment Plant*
8 *Sanitary Sewer Manhole*

STORM SEWER

9 *Storm Sewer Main*
10 *Storm Sewer Catch Basin*
11 *Storm Sewer Outlet*

Typical Construction Plan

Highlighted on the sanitary sewer and watermain construction plan sheet below are items typically included on infrastructure construction plans. In addition to plan sheets, construction documents include specifications that provide the contractor with material and workmanship requirements and payment terms. These documents form the basis for a construction contract.



Water Supply and Treatment

Where does our drinking water come from?

The vast majority of Minnesota cities use groundwater pumped from wells located within an underground aquifer (water-bearing rock formation). However, some cities use surface water (lakes or rivers) for water supply. The Minnesota Department of Natural Resources is responsible for managing the use of groundwater.

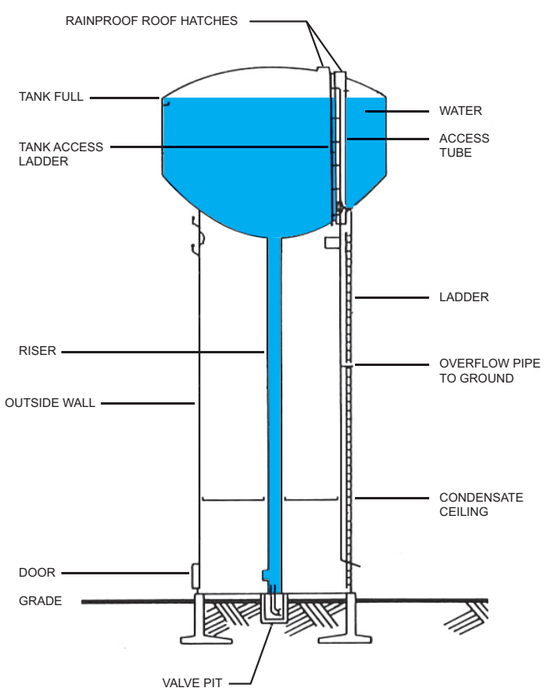
How much water does a typical city use?

Typical water use is:

- 100 gallons per person per day as an annual average.
- 300 gallons per person per day on a peak day.

Peak water use days typically occur during the summer when irrigation is prevalent.

Most cities are seeking ways to conserve water, recognizing the value of this critical natural resource. Watering limits (e.g., odd/even) and conservation rates (higher rates for higher usage) are common ways that cities encourage conservation.



Typical water tower schematic

Well house

What level of treatment is required?

Minimum treatment requirements:

Fluoridation to prevent tooth decay is mandated by state law.

Chlorination, which prevents bacterial contamination is:

- Mandatory for surface water supplies (lakes or rivers).
- Recommended for groundwater supplies.

Optional treatment (groundwater):

- Iron and manganese removal filtration, which is commonly used in Minnesota to eliminate the problems (staining, tastes, and odors) caused by these elements.
- Softening to remove hardness, which is far less common in Minnesota communities.

Surface water:

- Treatment of surface water sources is mandatory.
- Softening of surface water supplies is optional, but most often surface water supplies are also softened.

What makes up a city water system? What are the functions of each component?

A typical city water system includes:

- Wells that supply the water.
- Water reservoirs and/or towers that store a reserve of water for peak day needs and fire-fighting, and to maintain consistent water pressure.
- Water treatment plants that treat the water to the desired or mandated levels.
- Water distribution systems which are a series of pipes, valves, and hydrants that deliver water to users.

Who operates and maintains the water system? How is it operated and maintained?

A typical city has a public works department that operates and maintains the water system. Operation and maintenance activities include:

- Daily checks and operational adjustments of wells, water towers, and water treatment plants.
- Daily maintenance of water treatment plants.
- Repair of water main breaks.
- Semi-annual flushing of hydrants and exercising valves.
- Periodic well maintenance and pump replacement.
- Periodic repainting of water reservoirs and towers.

Water tower under construction

How is the water system paid for?

Sources of revenue to construct, operate, and maintain water systems include:

User fees - Nearly all Minnesota communities charge for water based on monthly, bi-monthly, or quarterly water meter readings. Water user fees typically fund operation and maintenance of the system, and are used to create reserves necessary for replacing aging water infrastructure.

City Water Area Charges (WAC) - Many communities require payment of a WAC at the time a new user connects to the system. WAC charge revenues are utilized to fund construction and expansion of the water system including wells, towers, and treatment plants.

Trunk charges - Some growing communities require a trunk charge, typically paid at the time property is subdivided for new development. These charges are used to construct trunk system improvements (water towers, wells, and larger trunk water mains) needed to serve the new development areas.

New watermains - New water mains to serve newer developing areas are typically financed by developers or industrial/commercial users.

Water treatment plant

GLOSSARY

System Looping - *Needed to improve pressure and reduce the need for larger pipes. This also provides more assurances that residents and businesses will not be out of water at any time.*

Water Storage - *Needed to meet peak demands throughout the day and provide additional volume for fire flows.*

Wastewater

What is wastewater and where does it come from?

Wastewater is sanitary sewage or the discharge from toilets and washing machines from homes, businesses, and industries. Typically, each resident generates approximately 100 gallons of wastewater per day.

Wastewater also includes process wastewater from industries. Industrial wastewater generation is highly variable in terms of strength and contaminants, and depends on the industrial process and size of the industry.

How is wastewater collected?

Wastewater is discharged to a wastewater collection system (also referred to as sanitary sewer system). Each home, business, or industry has a small-diameter pipe called a service line. This line connects to the collection system, which is a pipe network that conveys wastewater to a treatment facility. The pipe network is a series of pipes that increase in size as the volume of collected flow increases.

How are wastewater collection systems designed?

Typically, wastewater collection systems are designed for gravity flow, as this is the most reliable. At times, it becomes necessary to pump wastewater from a lower elevation to a higher elevation via a lift station. The typical lift (pumping) station includes a wet well to temporarily store wastewater and two or more pumps to pump it from a lower elevation to a higher elevation where the sewage returns to a gravity flow condition. Two pumps are required for redundancy in case one fails.

What makes up a city wastewater collection and treatment system? What are their functions?

The typical wastewater collection and treatment system includes:

- **Service lines** - Pipes from individual homes, businesses, and industries that convey wastewater to the collection system.
- **Wastewater collection system** - Pipe network that collects and conveys wastewater flow by gravity from the service lines to the wastewater treatment facility.
- **Lift stations** - Pumping facilities that pump wastewater from a lower elevation to a higher elevation where necessary in the collection system.
- **Wastewater treatment facility** - Stabilization pond system or mechanical plant to treat wastewater prior to discharge to a stream, river, or lake. (In the Metro Area, discharged wastewater goes to the Metropolitan Council interceptor sewer system for treatment in one of its seven wastewater treatment facilities.) Outside of the Metro Area, cities operate their own facilities.

Lift station

Who operates and maintains the wastewater collection and treatment system? How is it operated and maintained?

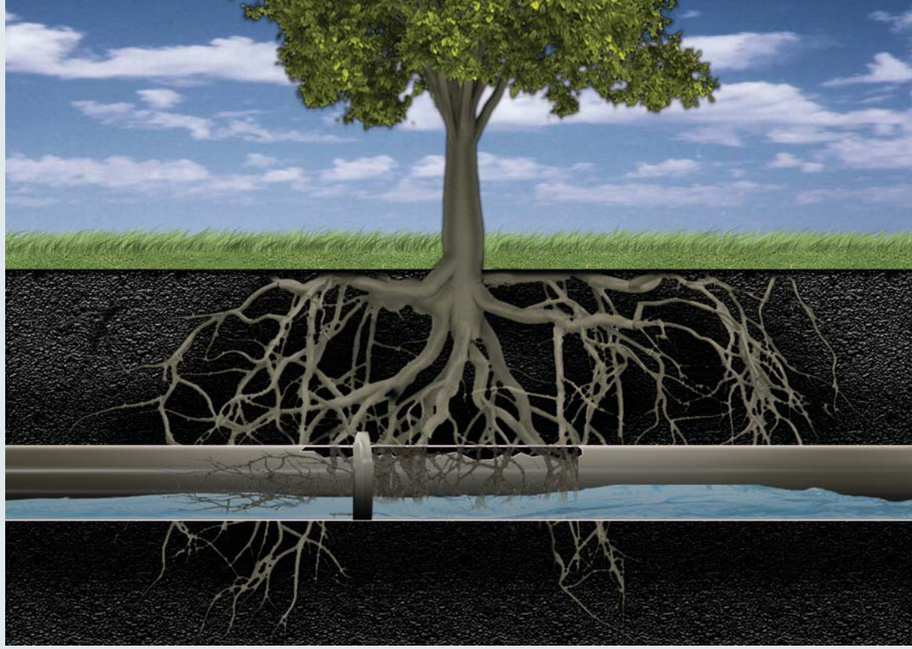
Typically, cities have a sewer department to operate and maintain the wastewater collection and treatment system. Most Twin Cities area communities do not have treatment facilities. Generally, cities will have utility staff with appropriate operator's licenses who manage both the water and sewer systems.

Operation and maintenance duties include:

- Daily checks of lift stations.
- Annual wet well cleaning and periodic maintenance of lift stations.
- Daily operation of treatment facilities.
- Jetting (high-pressure water), cleaning, and televising all collection system pipes on a 4-year to 5-year cycle.
- Minor repairs to the collection system.

Wastewater treatment plant

***Inflow and Infiltration** is clean storm and/or groundwater that enters the sanitary sewer system through holes, breaks, joint failures, connection failures, illegally connected sump pumps, downspouts, footing drains, and from cross-connections with storm sewers. Most inflow comes from stormwater and most infiltration comes from groundwater. Excessive inflow and infiltration can cause sewers to back up or can overload sewage treatment plants, causing a reduction in treatment time or a complete bypass of the treatment process during periods of significant rainfall, increasing treatment expense.*



Inflow and infiltration schematic

How is the sewer system paid for?

Sources of revenue to construct, operate, and maintain water systems include:

User Fees - Nearly all Minnesota communities charge for sewer based on monthly, bi-monthly, or quarterly meter readings. Sewer user fees typically fund operation and maintenance of the system and are used to create reserves necessary for replacing aging sewer infrastructure.

City Sewer Area Charges (SAC) - Many communities require payment of a SAC at the time a new user connects to the system. SAC revenues are utilized to fund construction and replacement of the sewer collection system and principally the treatment plants.

Metropolitan Council SAC Charge (Twin Cities Metro Area only) - This is required when a new user connects to the system. The city collects the charge and provides it to the Metropolitan Council. The revenue is used to construct and maintain the Metropolitan Council's sewage collection system and wastewater treatment plants.

Trunk charges - Some growing communities require a trunk charge, typically paid at the time the property is subdivided for new development. These charges are used to construct trunk system improvements (lift stations, and larger trunk sewer mains) needed to serve the new development areas.

New sewer mains - New sewer mains required to allow for growth, or to serve existing areas served by septic systems, are typically financed by the property owners who will connect to the sewer mains.

Manhole construction

GLOSSARY

Metropolitan Council Environmental Services (MCES) - *The government agency created by the legislature that serves Minneapolis, St. Paul, and 180 metro communities. It provides regional services, including bus, rail transit, and wastewater collection and treatment.*

Environmental

Minnesota's Environmental Policy Act (MEPA)

Through Minnesota Rule 4410, environmental review is required for projects that meet the environmental review threshold. These projects include: residential, commercial, industrial, some road projects, and large sanitary sewer projects, along with many others. Environmental review can be accomplished through the development of an Environmental Assessment Worksheet (EAW), Alternative Urban Areawide Review (AUAR), or an Environmental Impact Statement (EIS).

What is an EAW?

An EAW is the basic level environmental review document in Minnesota. Projects that trigger an EAW are required to evaluate environmental impacts. The analysis for an EAW includes evaluating a wide range of potential impacts such as wildlife, stormwater, infrastructure, traffic, and others by answering approximately 30 questions. The purpose of an EAW is to determine if there are environmental impacts that cannot be addressed through regulations or permitting and whether an Environmental Impact Statement is needed. An EAW process can take between 3-6 months to complete and includes a 30-day review period for agencies and other interested individuals to comment. The Responsible Government Unit (RGU) is required to issue the ruling on whether an EIS is necessary, based on the results of the EAW.

Wetland buffering residential area

Water sampling/data collection

What is an EIS?

An EIS is a more extensive and in-depth EAW. A project either triggers an EIS based on its own magnitude pursuant to Minnesota Rule or the results of the EAW indicate an EIS is needed. The EIS evaluates the same potential environmental impacts as an EAW, but with more in-depth analysis. An EIS process can generally take between 12-24 months to complete.

What is an AUAR?

An AUAR is a hybrid between an EAW and an EIS. It is a good tool if a specific project has not been identified but a city wants to evaluate the environmental impacts of development over a larger area in a portion of the city. This allows cities to plan for the needed infrastructure for development and also allows developers to know what sorts of environmental mitigation may be needed to develop in an area. An AUAR can take between 10-18 months to complete. The result of an AUAR is a guide plan for the suggested or required mitigation items.

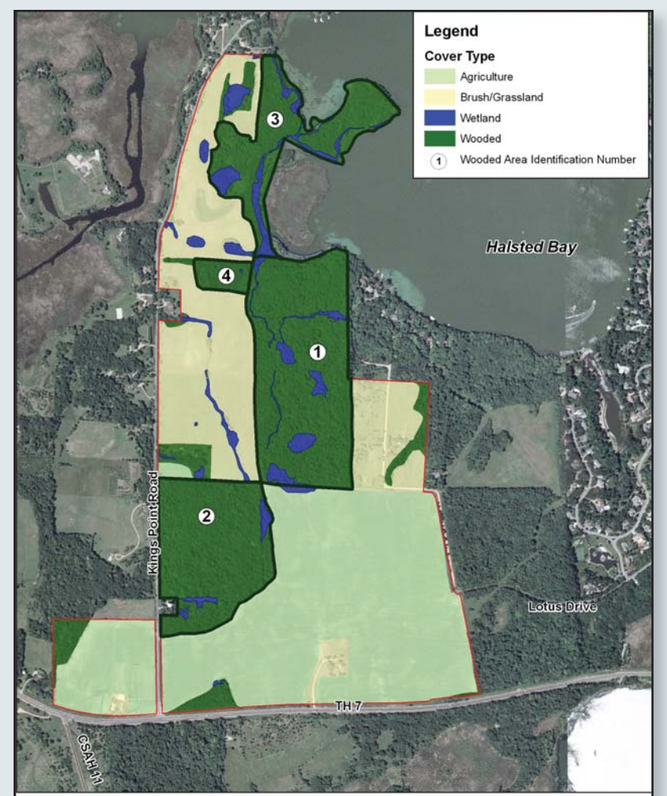


Figure 10-1
Existing Conditions Cover Type Map
Park Cove AUAR

Wetland Regulations

Minnesota has a wide variety of natural resources, wetlands being one of them. Wetlands provide a variety of benefits such as flood protection, open space, habitat for wildlife, and filtering of water. In Minnesota, a number of agencies regulate wetlands, including the U.S. Army Corps of Engineers, local watershed districts, the Department of Natural Resources, and the Local Government Unit (LGU) for the Wetland Conservation Act (WCA).

If a project is proposed near a wetland, a wetland delineation needs to be completed to determine the actual wetland boundary. This is done by a certified wetland delineator or a scientist knowledgeable in wetland science. Design of projects must try to first avoid all wetland impacts. If impacts are unavoidable, they must be minimized. Finally, if impacts cannot be avoided, replacement (or mitigation) for those impacts is needed, and permits are generally required from many of the permitting agencies. Mitigation can be accomplished through the purchase of wetland credits from the state's wetland banking system, or mitigation can be created onsite through restoration or creation of new wetland. Wetland mitigation is generally required at a 2:1 ratio, but these ratios can vary, depending on the project.

GLOSSARY

Responsible Government Unit (RGU) - *The governmental unit with the greatest responsibility to approve or carry out the project.*

Air Quality/Noise Analysis - *Process to determine if a proposed condition will increase or decrease the quality of air or the audible noise level in a given area.*

Wetland Assessment - *Monitoring, compiling, and analyzing data on the condition of wetlands.*

Natural Resource Planning - *The planning of natural resources, such as land, water, soil, habitat, and animals, with a particular focus on how planning affects the quality of life for present and future generations.*

Right of Way

What is right of way?

Right of way is the interest the city has in a property defined as either fee title, an easement, or possibly prescriptive easements. Rights to the use of property may also be granted by a license or permit.

What kinds of right of way (property interests) may be acquired?

- **Fee title** - all inclusive but subject to existing encumbrances.
- **Permanent easement** - for a specific use such as a roadway, drainage, utilities, trail, wall, pipeline, etc.
- **Temporary easement** - to obtain working space for project construction.
- **Access rights** - to limit access, as in "access control" or to obtain access right to maintain a public improvement, such as a structure.
- **Air rights** - overpass.
- **Underground rights** - tunnel.
- **Others**

Right of way limits impact construction activities

Right of way marker

GLOSSARY

Easements by Prescription, (also called prescriptive easements) - *Implied easements granted after the dominant estate, such as the city, has used the property in a hostile, continuous, and open manner for a statutorily prescribed number of years. Prescriptive easements differ from adverse possession by not requiring exclusivity.*

Eminent Domain - *"The power to take private property for public use by a state, municipality, private person, or corporation authorized to exercise functions of public character, following the payment of just compensation to the owner of that property."*

When should right of way staff be included in a project?

Early discussions are necessary to scope a project, identify potential project challenges or improvements, draft a solid schedule, and contact and secure subconsultants, if needed. Sometimes it is possible to pursue "early" or "advanced" acquisitions which further improve the schedule and assist the landowner in special circumstances.

What basic principles are followed for right of way acquisition?

Coordination with city staff and the city's legal counsel is a necessary first step when considering right of way acquisition. The 14th Amendment to the United States Constitution states that "No person shall... be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation."

How are relocation benefits for residential and commercial properties determined?

There are relocation guidelines established by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and the Minnesota Department of Transportation has added some benefits for projects that use state funds.

For residential property owners, this would include moving compensation and replacement housing payments for a housing supplement, interest differential, and incidental closing costs. For residential tenants, who would be eligible for moving compensation and a rental supplement or down payment assistance. For commercial owners and tenants, who are eligible for moving costs, searching, and business re-establishment payments. Consult an expert if you are intending to purchase a property with tenants so that you understand the full cost of the acquisition.

GIS/Asset Management

What is GIS?

Geographic Information Systems (GIS) is a computerized mapping system for collecting, managing, and analyzing data. GIS allows you to overlay various spatial layers, which can help visualize information and understand relationships between data sets that may not be apparent with spreadsheets. This can help give decision makers a better understanding of the issue at hand.

How is GIS used by cities?

Uses for GIS vary widely by department.

Administrative staff often use GIS to help staff quickly access accurate information. This helps staff provide more accurate answers to residents in a timely fashion. Staff can also use GIS to save time by automating tasks such as generating mailing labels.

Planning and building officials often use GIS to review historic building information such as aerial photography, code violations, and detailed data regarding plan reviews. Having a single repository of this data can streamline operations and provide a permanent data warehouse for future reference.

Engineers and public works operators often use GIS to access detailed information about city infrastructure, such as as-built drawings. Because many assets are located throughout the city or county, mobile GIS solutions are frequently used to give staff access to the information they need in the field when they need it.

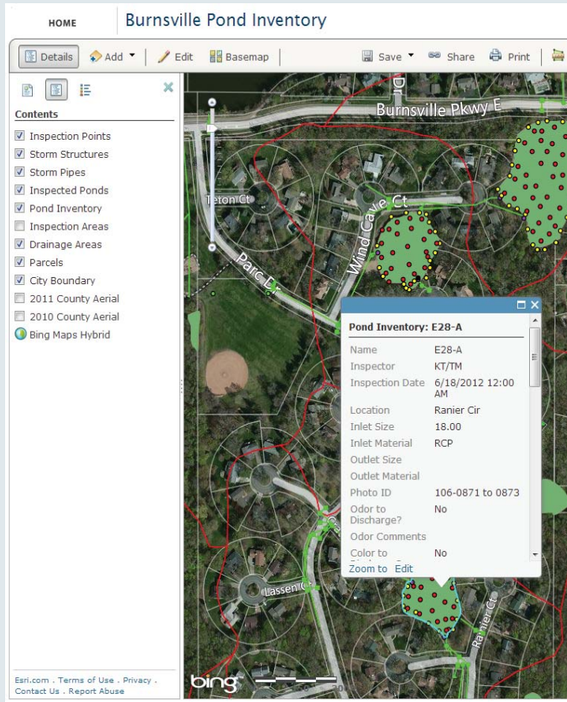
What is an AMS?

An Asset Management System (AMS) allows an organization to track and predict asset performance, maintenance costs, and replacement costs over time. Many cities are tracking their pavement and utility systems to help guide maintenance and future replacement.

How does AMS add value to a city or county?

Cities and counties can use an AMS to analyze the cost of managing the entire life-cycle of an asset, such as a road or sewer line. By taking an AMS-based life-cycle approach, an organization can make proactive decisions that increase the quality of service and reduce costs.

AMS is also used to engage citizens more effectively. Allowing citizens to use their iPhones to report issues in their community can streamline operations, speed response times, and keep citizens informed about the city's progress in addressing their request.



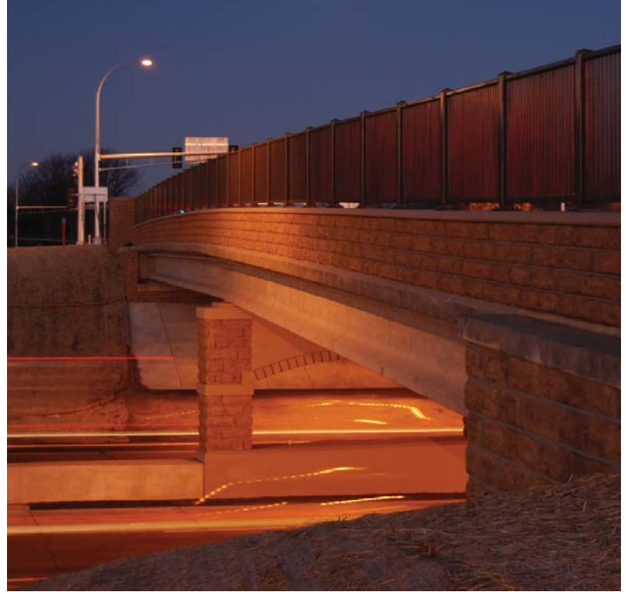
ArcGIS mapping tool

What's new for Public Works Work Order Management?

Over the last few years, we have seen more cities move towards Work Order Management systems that link directly to their AMS. This allows cities to monitor the level of service provided to residents and track the time and resources spent maintaining infrastructure.

More cities are taking the next step by using Cartegraph YourGov® to provide residents direct access to work orders with smart phones. This allows residents to see how cities are responding to issues in real time. This same technology allows public works operators to use iPhones, iPads, and Android devices to access the information they need to do their jobs more efficiently.

Structures



What legal responsibilities do bridge owners have?

Any municipality that owns a bridge in Minnesota is responsible to appoint a bridge program administrator. This administrator needs to be a professional engineer with a bridge background, as they are responsible for ensuring their bridges are inspected, load rated, and load posted if required, according to state and federal law.

What does a bridge safety inspection involve?

A bridge safety inspection is an evaluation of the physical condition of a bridge. The inspection involves both visual and hands-on evaluation of all bridge components. The inspector looks for corrosion, deterioration, settlement, damage, and scour. The results are detailed in a report based on each component. The overall condition is then compiled in an online database. Bridges are required by law to be inspected either annually or biannually, depending on the bridge type and condition. Special inspections include underwater inspection for bridges that have components that are not visible during low water conditions.

How does a bridge owner know when it is time to replace a bridge?

The answer to this question varies, based on the volume and type of traffic over the bridge. Bridges should always be replaced before the safety of the traveling public is at risk. Every bridge is assigned a sufficiency rating score, which varies from 0-100 and factors in the condition of the bridge, traffic volume importance of the route, and load carrying capacity. This sufficiency rating is used to determine when a bridge should be replaced and when it qualifies for funding. Bridges are also replaced when they are no longer able to meet traffic needs. Bridge owners can significantly extend the life of bridges by performing routine maintenance such as painting, cleaning, and crack sealing.

GLOSSARY

Load Rating – *A calculation to determine the safe load carrying capacity of a bridge.*

Load Posting - *To restrict the weight of vehicles that cross a bridge in order to prevent overloading.*

Sufficiency Rating Score - *Ranges from 0-100 based on the bridge condition, traffic volume importance, and load carrying capacity.*

Load limit posting

What is a bridge load rating?

A bridge load rating is a calculation to determine the safe load carrying capacity of a bridge. The load rating is based on the original capacity of the bridge and factors in any deterioration or changes to the bridge. A load rating calculation is required when the bridge is first constructed and when the condition or configuration of the bridge has changed. The results determine if a bridge should be load posted and if it is safe for special permit vehicles to cross the bridge.

Construction Administration

What is the role of a construction inspector?

The construction inspector serves many roles on a project including; addresses concerns from residents/business owners, analyzes the safety of site conditions, provides real time communication to the responsible parties regarding project progress and issue management. Additionally, the construction inspector documents the work as it progresses and continually assists with project risk management through changing field conditions, reviewing project costs, contractor workmanship and schedule, and overall quality of the product. Construction inspector reporting and documentation is often used in claims avoidance situations if they arise on a project.

When do surveyors get involved on a project?

Surveyors are typically involved in all phases of a municipal improvement project. Initially, they provide data collection that is used during the preliminary and final design phases. Data collection also includes gathering topographic information and the analysis of existing easements and public rights of way, which is used to document existing site conditions for a project.

During the construction phase of a project, surveyors provide stakes for the limits of construction, alignment and grade for sewer, water, street and other site work improvement items. The purpose of the construction staking is to provide the contractor with on-site control and direction for proposed infrastructure improvement items. Depending on the contracted method of payment used for a project, surveyors can also get involved with measuring material quantities in the field.

Once the construction project has been completed, surveyors gather field data which is used to complete as-built drawings that assist in verifying that the project has been completed according to the construction documents provided.

Why do material testing?

Material testing on a construction project is performed to verify that the materials provided and the construction methods meet the quality control requirements outlined in the construction documents. Both destructive and non-destructive forms of material testing can be used to gain information about the materials being used on a project. Often times, the success of a project comes down to the quality and consistency of materials used in the construction process, which is why material testing is provided.

GLOSSARY

Coring - *A hole extracted from inside the roadway for construction quality control, testing, quality assurance testing, materials acceptance testing, and to determine the roadway history, level of cracking, etc.*

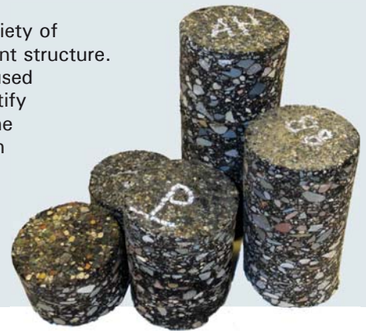
As-built Drawing - *A drawing that shows the existing conditions as they are.*

Topographic Survey - *Used to identify and map the contours of the ground and existing features on the surface of the Earth or slightly above or below the Earth's surface (i.e., trees, buildings, streets, sidewalks, manholes, utility poles, retaining walls, etc.).*

Destructive/Non-destructive Testing - *Testing methods used to analyze pavement materials. Destructive testing mechanically breaks down the materials during the analysis. Non-destructive testing analyzes materials without impairing their future usefulness.*

What is pavement forensics?

Pavement forensics encompasses a variety of approaches used to assess the pavement structure. For example, pavement coring can be used to extract a pavement sample and identify what exists under the visible layer of the pavement. This analysis gives a wealth of information including depths of the pavement layers, signs of bonding or unbonding, and distresses that might not be visible from the road surface.



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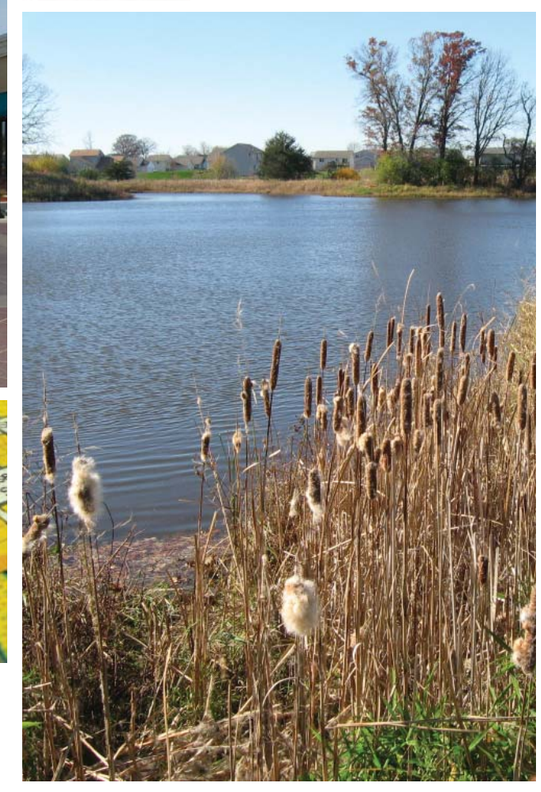

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