

# **APPENDIX A: Design Guidelines and Standards**

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*City of Minnetonka Water Resources Management Plan*

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## 1.0 Introduction

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This document was prepared to assist developers, consultants and city staff in designing and managing water resource projects within the City of Minnetonka. The design criteria presented here should be taken as guidelines and users should check listed links and contacts for updated requirements and criteria.

This document outlines the city contacts, water resource related ordinances, required permits and approvals from the city, watershed management organization (WMO), state, and federal levels, and city and watershed management organizations (WMO) design standards. In addition, there is detailed information related to the design of various water quality treatment devices. This document will be updated to reflect changes to reviews, requirements, and weblinks, etc., as needed.

## 2.0 City Contacts

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### 2.1 Public Works

952.988.8400

Streets (Maintenance)

Water & Sewer

Parks & Trails

Natural Resources

Recycling

Buildings & Grounds

### 2.2 Development Services

#### Community Development

952.939.8200

Inspections

Environmental Health

Licensing

#### Planning

952.939.8290

Planning & Zoning Administration

#### Engineering

952.939.8206

Streets & Utilities (Design)

Planning & Design

Special Assessments

For all development and redevelopment projects, contact planning and engineering for your specific needs.

## 3.0 Ordinances

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This section summarizes the ordinances established by the City of Minnetonka that outline specific standards and criteria related to new development, redevelopment, and other improvements or modifications that could impact the water resources within the City of Minnetonka.

Below is a link to all of the City of Minnetonka Code of Ordinances:

[http://www.amlegal.com/nxt/gateway.dll/Minnesota/minneton/cityofminnetonkaminnesotacodeofordinance?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:minnetonka\\_mn\\$anc=](http://www.amlegal.com/nxt/gateway.dll/Minnesota/minneton/cityofminnetonkaminnesotacodeofordinance?f=templates$fn=default.htm$3.0$vid=amlegal:minnetonka_mn$anc=)

The following is a summary list of the key water resource-related ordinances currently enforced by the City of Minnetonka:

### Chapter 3: ZONING REGULATIONS

#### **Wetland Protection (300.23)**

*Key Items of Interest:*

Setbacks, Buffers, Water Quality Treatment, Low Floor Elevation

#### **Shoreland Ordinance (300.24)**

*Key Items of Interest:*

Lot Requirements, Structure Height, Parcel Imperviousness, Setbacks, Low Floor Elevation

#### **Floodplain Ordinance (300.25)**

*Key Items of Interest:*

Setbacks, Low Floor Elevation

#### **Performance Standards (300.28)**

15. Grading, Filling, and Excavation
16. Application and Review of Grading Permits and Plans
17. Grading and Erosion Control Plans
18. Grading and Erosion Enforcement
19. Performance Standards Regulating Tree Removal
20. Performance Standards Regulating Steep Slopes

### Chapter 4: SUBDIVISION REGULATIONS

*Key Items of Interest:*

Easement Requirements

## 4.0 Permits, Approvals, and Submittals

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This section summarizes the permits required by the City of Minnetonka as well as the WMOs, the DNR, the MPCA, and the Army Corps of Engineers. Each summary includes links to the actual permit application (if available). In addition, there is discussion of the “triggers” that establish when a permit is required. General submittal requirements are also outlined, although specific details of the required submittals are typically included on the application forms.

### 4.1 City of Minnetonka

There are several permits required for a variety of projects within the City of Minnetonka. Links to the application forms are also included. Details of the required submittals are included on the permit application forms, although a discussion of the minimum requirements of a review submittal follows.

#### 4.1.1 Preliminary Plat Approval

Below is a link to the Preliminary Plat/R.L.S. Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/preliminary\\_plat\\_rls\\_application.pdf](http://www.eminnetonka.com/community_development/planning/applications/preliminary_plat_rls_application.pdf)

#### 4.1.2 Final Plat Approval

Below is a link to the Final Plat Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/final\\_plat.PDF](http://www.eminnetonka.com/community_development/planning/applications/final_plat.PDF)

#### 4.1.3 Rezoning Approval

Below is a link to the Rezoning Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/rezoning.PDF](http://www.eminnetonka.com/community_development/planning/applications/rezoning.PDF)

#### 4.1.4 Comprehensive Plan Amendment

Below is a link to the Comprehensive Plan Amendment Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/comprehensive\\_guide\\_plan.PDF](http://www.eminnetonka.com/community_development/planning/applications/comprehensive_guide_plan.PDF)

#### 4.1.5 Planned Unit Development (PUD) Permit

Below is a link to the Planning Brochures developed by the City of Minnetonka, including one discussing the goals, standards, and process related to the PUD:

[http://www.eminnetonka.com/community\\_development/planning/brochures.cfm](http://www.eminnetonka.com/community_development/planning/brochures.cfm)

#### **4.1.6 Conditional Use Permit**

Below is a link to the Planning Brochures developed by the City of Minnetonka, including one discussing the reasons for and process related to obtaining a conditional use permit:

[http://www.eminnetonka.com/community\\_development/planning/brochures.cfm](http://www.eminnetonka.com/community_development/planning/brochures.cfm)

Below is a link to the Conditional Use Permit Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/conditional\\_use\\_permit.PDF](http://www.eminnetonka.com/community_development/planning/applications/conditional_use_permit.PDF)

#### **4.1.7 Building Permits**

##### **4.1.7.1 Residential**

Below is a link to the Residential Building Permit Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/permits/documents/building\\_residential.pdf](http://www.eminnetonka.com/community_development/permits/documents/building_residential.pdf)

##### **4.1.7.2 Commercial**

Below is a link to the Commercial Building Permit Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/permits/documents/building\\_commercial.pdf](http://www.eminnetonka.com/community_development/permits/documents/building_commercial.pdf)

#### **4.1.8 Grading, Filling, Excavation and/or Mining Permit**

A Grading, Filling, Excavation and/or Mining Permit is required for the following projects:

- Involving the movement of 50 cubic yards of material or land disturbance of areas greater than 5,000 square feet
- Involving any land disturbance in designated wetlands, floodplains, or shorelands
- Involving mining operations for gravel or other materials

A grading and erosion control plan is a required submittal for a grading permit, preliminary plat, site plan review, lot division, wetland/floodplain alteration permit, or a building permit if at least 50 cubic yards of material is moved or material is moved from an area or areas encompassing at least 5,000 square feet.

Below is a link to the Grading, Filling, Excavation, and/or Mining Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/grading\\_filling\\_excavation\\_mining.PDF](http://www.eminnetonka.com/community_development/planning/applications/grading_filling_excavation_mining.PDF)

#### 4.1.9 Wetland and Floodplain Alteration Permit

This permit is required for projects involving any land disturbance in designated wetlands or floodplains. Below is a link to the Wetland/Floodplain Alteration Permit Application, including submittal requirements:

[http://www.eminnetonka.com/community\\_development/planning/applications/wetland\\_floodplain\\_alteration\\_permit.PDF](http://www.eminnetonka.com/community_development/planning/applications/wetland_floodplain_alteration_permit.PDF)

##### 4.1.9.1 Wetland Conservation Act Approval (for all wetland alterations)

For all wetland alteration projects, the "Minnesota Local/State/Federal Application Forms for Water/Wetland Projects" must be completed. This form is available from the Board of Water and Soil Resource's (BWSR) website at:

<http://www.bwsr.state.mn.us>

#### 4.1.10 Requirements for a Review Submittal

The submittal for review will include two sets of exhibits for the city review, one set to be returned with city comments, and one set to be retained in the city files. The following exhibits will be included in a submittal:

1. A set of **Project Plans**, including at least:
  - a. A scale drawing of the site showing property lines and delineation of lands under ownership of the applicant.
  - b. Proposed and existing stormwater facilities location, alignment, and elevation.
  - c. Existing and proposed site contour elevations related to NGVD, 1929 datum.
  - d. Construction plans and specifications of all proposed stormwater management facilities.
2. A **Runoff Water Quality Management Plan**, signed by a professional engineer, and meeting the minimum requirements listed below:
  - a. Delineation of the subwatersheds contributing runoff from off-site, and proposed and existing subwatersheds on-site.
  - b. Delineation of existing on-site wetlands, marshes, and/or floodplain areas.
  - c. Existing and proposed post-development normal, 2-year, 10-year, and 100-year stormwater elevations for the site.
  - d. Stormwater runoff volume and rate analyses for existing and proposed conditions for a 2-year, 10-year, 100-year events.

- e. All hydrologic and hydraulic computations necessary to design the proposed stormwater quality management facilities.
  - f. Documentation indicating conformance with the City's *Water Resource Management Plan*.
  - g. Submittal of a checklist of Best Management Practices (BMPs) demonstrating that, to the maximum extent practical, the plan has incorporated the structural and nonstructural BMPs as described in the following documents:
    - State of Minnesota Stormwater Manual* (MPCA, 2005)
    - Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, 2001)
    - BCWMC guidance document *Requirements for Improvements and Development Proposals* (July 2008)
  - h. Additional items as may be required by the city engineer (e.g. soil boring logs, etc.)
3. A **Stormwater Pollution Prevention Plan (SWPPP)**, signed by a registered professional engineer, and meeting the standards outlined in the Performance Standards Ordinance (300.28), Sections 15 through 18.

## 4.2 WMOs

The following section summarizes the permits and applications requiring WMO review and approval. Figures 3-3 and 3-4 show the location of the four WMOs within the City of Minnetonka, including both the hydrologic boundaries as well as the jurisdictional boundaries.

### 4.2.1 BCWMC

The City of Minnetonka has permitting authority for projects requiring permits within the BCWMC, including all wetland activities. However, the BCWMC provides review and approval before the city issues permits. The BCWMC has developed a document *Requirements for Improvements and Development Proposals* (July 2008, as updated) that outlines the review requirements and process as well as the required design guidelines. The following section summarizes some of the key information that is part of this document.

The types of improvements and development proposals that must be submitted to the BCWMC for review include:

- Alterations within the floodplain
- Proposals within the limits of the proposed floodplain storage sites was established in the BCWMC Plan (2004)
- Proposals affecting water surface elevation, outlet storage capability, shoreline, streambank, or be incompatible with existing/future land use around the lake
- Proposals that would alter water resources in the watershed, including the discharge of industrial or other waste to any watercourse or storm sewer, that would required extensive land alteration, are directly tributary to watercourses, or may otherwise affect existing water quality
- Proposals for the application of chemicals or other treatments to lake or ponds
- Proposals providing intra- and inter-watershed diversions that could affect flood levels, lake levels, and minimum stream flows
- Proposals for changes in land use, zoning, and local watershed management plans
- Proposals for temporary or permanent ground or surface water appropriations
- Proposals for the construction of utilities through or paralleling the creek that will disturb the bed or banks
- Applications to the Minnesota Department of Natural Resources (DNR)
- Proposals requiring 200 cubic yards of cut/fill or more than 10,000 square feet of grading
- Proposals for road construction

The following items are required for review by the BCWMC for each project:

1. Completed Permit Application,
2. Project Review Fee,
3. Project Plans
4. Runoff Water Quality Management Plan and Computations
5. Final Erosion Control Plan
6. Checklist of Best Management Practices incorporated into design

Additionally, more information can be found regarding the BCWMC requirements for improvements and development proposals at the link below:

[http://www.bassettcreekwmo.org/require/2008\\_Requirements/2008RequirementsTOC.htm](http://www.bassettcreekwmo.org/require/2008_Requirements/2008RequirementsTOC.htm)

#### 4.2.2 MCWD

The City of Minnetonka has permitting authority for projects requiring permits under the MCWD erosion control, floodplain, and stormwater rules (Rules B, C, and N, respectively).

Permits for all other MCWD rules must be obtained from the MCWD. The following is a list of the types of projects that may require a permit from the MCWD:

- Single Family Home Construction/Remodel
- Residential Subdivision/Development/Redevelopment
- Commercial Construction/Institutional Construction/Reconstruction

Additionally, the following projects will require a permit from the MCWD:

- Dredging (Rule E)
  - All dredging in the beds, banks, or shores of any protected water or wetland
  - All dredging permit applications for Lake Minnetonka or Lake Minnetonka Tributaries must comply with the provisions of the Lake Minnetonka Dredging Joint Policy Statement
- Wetland Protection (Rule D)
  - All projects associated with the draining, filling, excavation, or alteration of a wetland
- Shoreline/Streambank Improvements (Rule F)
  - All shoreline and streambank improvements, including but not limited to rip rap, retaining walls, sheet piling, and boat ramps
  - All sandblanket projects including family beaches
- Stream and Lake Crossings (Rule G)
- Placement of roads, highways, or utilities in the bed of a protected water or wetland
- Construction of a bridge or related crossing of a water, waterway or wetland.
- Placement of a culvert or similar structure in the bed or channel of a protected water or wetland

More information can be found regarding the MCWD requirements for permits, approvals and submittals at the link below:

[http://www.minnehahacreek.org/permit\\_req.php](http://www.minnehahacreek.org/permit_req.php)

### 4.2.3 NMCWD

A grading and land alteration permit is required from the NMCWD for the following:

- Any project that proposes to alter or disturb more than 50 cubic yards of material.
- If filling (encroachment) is proposed within the 100-year frequency floodplain of the creek system, lakes or detention basins.
- If filling is proposed within a wetland area as defined by the 1991 Wetland Conservation Act (WCA).
- Any project that could reasonably be expected to introduce sediment into public waters within the NMCWD.

The NMCWD permitting program is independent of permits that may be required by other governmental agencies. If a permit is required by the Minnesota Department of Natural Resources (DNR) for a project, the NMCWD reviews and provides comments to the DNR regarding the project. General Permitting authority has been given to the NMCWD by the DNR for projects related to shore protection, docks, road crossings, and maintenance at storm sewer intakes and outfalls.

The following information is required by the NMCWD for each project:

1. Completed Grading and Land Alteration Permit Application,
2. Site Grading Plans
3. Stormwater Management Plan
4. Final Erosion Control Plan

More information can be found regarding the NMCWD requirements for permits, approvals, and submittals at the link below:

<http://www.ninemilecreek.org/Regulatory/Reg.asp>

### 4.2.4 RPBCWD

As of January 2008, the City of Minnetonka has full permitting authority within the RPBCWD for all water resource-related projects. For all projects below the ordinary high water level (OHWL), the Minnesota Department of Natural Resources (DNR) has permitting authority. There are no permit applications that must be submitted to the RPBCWD for review.

## 4.3 State Agencies

### 4.3.1 Minnesota Department of Natural Resources (DNR)

The DNR requires a variety of permits related to work in or around public waters which are summarized in the section below. The following is a link to all of the water-related permits required by the DNR:

<http://www.dnr.state.mn.us/permits/water/index.html>

In some cases, the DNR has transferred permitting authority to local WMOs. Each WMO should be contacted to establish their permitting authority with regards to permits required by the DNR.

#### 4.3.1.1 Public Waters Work Permits

The Public Water Work Permit is required for water development activities below the ordinary high water level (OHWL) in public waters and public waters wetlands, including:

- filling
- excavation
- shore protection
- bridges and culverts
- structures
- docks
- marinas
- water level controls
- dredging
- dams

There are two types of public waters work permits, general and individual. More discussion of the types of public waters permits can be found at the link below:

[http://www.dnr.state.mn.us/waters/watermgmt\\_section/pwpermits/requirements.html](http://www.dnr.state.mn.us/waters/watermgmt_section/pwpermits/requirements.html)

#### 4.3.1.2 Water Appropriations Permit

A water use (appropriation) permit from DNR Waters is required for all users withdrawing more than 10,000 gallons of water per day or 1 million gallons per year. There are several exemptions to water appropriation permit requirements including:

- domestic uses serving less than 25 persons for general residential purposes,
- test pumping of a ground water source,
- reuse of water already authorized by a permit (e.g., water purchased from a municipal water system), or
- certain agricultural drainage systems (check with your area hydrologist for applicability).

For more information regarding DNR water appropriations and permits requirements, follow the link below:

[http://www.dnr.state.mn.us/waters/watermgmt\\_section/appropriations/permits.html](http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/permits.html)

#### 4.3.1.3 Dam Safety Permit

A DNR Dam Safety Permit is required for the construction, alteration, repair, or removal of dams. For more information regarding the permit and application process as well as the DNR definition of a dam, follow the link below:

<http://www.dnr.state.mn.us/permits/water/index.html>

#### 4.3.1.4 Aquatic Plant Management Control Permit

A DNR Aquatic Plant Management Control Permit may be required for removal of aquatic plants, algae, swimmer's itch or leeches. This includes both mechanical and chemical treatment methods. For more information about the DNR Aquatic Plant Management Permit Application, follow the link below:

<http://www.dnr.state.mn.us/permits/water/index.html>

#### 4.3.1.5 Other Fishery Permits

There are several other DNR Fishery Permits required for rough fish removal, fish transport and stocking, as well as operation of lake aeration systems. For more information about these permits required by the DNR, follow the link below:

<http://www.dnr.state.mn.us/permits/water/index.html>

### 4.3.2 Minnesota Pollution Control Agency (MPCA)

#### 4.3.2.1 National Pollution Discharge Elimination System (NPDES) Construction Stormwater General Permit

An NPDES/SDS permit is required if you are the owner or operator for any construction activity disturbing:

- One acre or more of soil.
- Less than one acre of soil if that activity is part of a "larger common plan of development or sale" that is greater than one acre.

- Less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources.

For more information regarding the MPCA NPDES permit, follow the link below:

<http://proteus.pca.state.mn.us/water/stormwater/stormwater-c.html>

## 4.4 Federal Agencies

### 4.4.1 United States Army Corps of Engineers (COE)

This section describes several of the specific permits and approvals required from the COE for work in waters and wetlands of the United States. Below is a link that generally describes the COE regulatory program, while the second link provides information regarding the COE permit and application information:

<http://www.usace.army.mil/cw/cecwo/reg/oceover.htm>

[http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=mainpage\\_Permit\\_Applicant\\_Info](http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=mainpage_Permit_Applicant_Info)

#### 4.4.1.1 Section 10 of the Rivers and Harbors Act Permit

Section 10 of the Rivers and Harbors Act requires authorization from the COE for the construction of any structure in or over any navigable water of the United States, the excavation/dredging or deposition of material in these waters or any obstruction or alteration in a navigable water. Structure or work outside the limits defined for navigable waters of the U.S. require a Section 10 permit if the structure or work affects the course, location, condition, or capacity of the water body.

Activities not requiring a Section 10 permit:

- Bridges or causeways - includes highway, railroad, and foot bridges as well as aqueducts, aerial tramways, conveyers, and overhead pipelines. It does not include power transmission lines, communication cables, submerged pipelines or tunnels. Bridges do, however, require authorization for discharges or fill material under Clean Water Act (CWA) Section 404.
- Wharves and piers - must be located on water wholly within a single state and determined navigable, and not have an unacceptable impact on navigation.
- Hydropower facilities licensed by the Department of Energy. Discharges of dredged or fill material associated with these facilities still require a CWA Section 404 permit.
- Floating recreational facilities at COE owned reservoirs.
- COE civil works projects.
- CERCLA (Superfund) cleanup actions

There are no navigable waters of the United States within the City of Minnetonka that will require a COE Section 10 Permit.

#### 4.4.1.2 Section 404 Permit

Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the United States, including wetlands. Activities regulated by this program that required a COE Section 404 permit, include:

- Fill for development
- Water resource projects (such as dams and levees)
- Infrastructure development (such as highways and airports)
- Mining projects

There are some activities exempt from Section 404 regulation.

There are often questions and concerns about which water bodies fall under the jurisdiction of Section 404. A summary of Section 404 jurisdiction can be found in the June 5, 2007 EPA/Corps guidance, *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States*.

Below is a link to the 2007 COE guidance document Practices for Documenting Jurisdiction under Section 404 of the Clean Water Act (CWA) and Sections 9 & 10 of the Rivers and Harbors Act (RHA) of 1899:

<http://www.usace.army.mil/cw/cecwo/reg/rgls/rgl07-01.pdf>

## 5.0 Review Process

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This section discusses the general permit review process for the City of Minnetonka as well as for the WMOs within the city, including a submittal and review timelines.

### 5.1 City of Minnetonka Procedure for Review

#### 5.1.1 Procedural Steps

1. All applications related to development or redevelopment must be submitted to the City of Minnetonka Planning Department, with the required attachments. The required submittals are outlined on the application forms.
2. The Planning and Engineering Departments will review the submitted application, plans, and design computations within 10 days of receiving the complete submittal packet.
3. The city has 60 days to make a final decision on a development or redevelopment review.
3. The planning commission is a seven-member volunteer body appointed by the city council to make recommendations to the city council. All of the meetings are open to the public and the public is invited to speak during public hearings. Meetings are held generally twice a month on Thursday at 6:30 p.m.
4. The city council is a seven-member elected body. As elected representatives, the council is responsible for implementing the Zoning Ordinance and Comprehensive Guide Plan. The council generally meets twice a month on Monday at 6:30 p.m.

#### 5.1.2 Variances

A variance is needed for any project that is non-compliant with any of the water resource related zoning codes. Below is a link to the Planning Brochures developed by the City of Minnetonka, including one discussing the reasons and criteria for a variance, the general process, and typical timelines for variance review:

[http://www.eminnetonka.com/community\\_development/planning/brochures.cfm](http://www.eminnetonka.com/community_development/planning/brochures.cfm)

## 5.2 WMOs

### 5.2.1 BCWMC

1. The BCWMC will review the applicant's submittal only after the project has received preliminary approval from the municipality indicating general compliance with existing local watershed management plans.
2. The BCWMC meetings are generally held the third Thursday of each month. In order for a proposed project to be included on the agenda, plans must be submitted to BCWMC staff at least two weeks prior to the meeting date. Complex projects may require additional review time. However, not all projects are presented to the BCWMC for its review and approval. All submittals involving floodplains, Bassett Creek trunk system, appropriations, variances and underground wet vaults are presented to the BCWMC. Staff review and approval are generally provided for submittals that are designed in accordance to the BCWMC policies outlined in the *BCWMC Requirements for Improvement and Development Proposals* (July 2008, as updated).
3. Upon receipt of a submittal, BCWMC staff will review the submittal and prepare recommendations to the BCWMC. A memorandum describing each project and the staff recommendations will be sent to the BCWMC approximately one week before each meeting.
4. The BCWMC will review and comment upon the submittal at its regularly scheduled meeting. The BCWMC will approve, conditionally approve, or reject the submittal. A letter with its comments, including a list of deficiencies or required modifications, will be sent to the municipality and to the applicant.
5. The applicant must provide a revised submittal addressing each deficiency, required modifications, or comment. A letter of approval will be sent to the municipality and to the applicant after comments have been addressed.

More information can be found regarding the BCWMC requirements for improvements and development proposals at the link below:

[http://www.bassettcreekwmo.org/require/2008\\_Requirements/2008RequirementsTOC.htm](http://www.bassettcreekwmo.org/require/2008_Requirements/2008RequirementsTOC.htm)

### 5.2.2 MCWD

1. Before attending a board meeting regarding permit issuance, the applicant must submit all materials that the District Technician requires 21 days prior to the meeting.
2. The Board of Managers meets on the first and third Thursday of each month at 6:45PM.

3. Persons applying for a District permit must supply a certified list of property owners and mailing labels for each property on that list obtained from Hennepin County or Carver County who reside within 600 feet of a parcel on which the proposed project is to occur.
4. Applications involving land development will be reviewed only after the applicant demonstrates that the plan has received preliminary approval from each municipality.
5. The Board of Managers will act within 45 days of receipt of a complete application and materials.
6. The Board of Managers may approve or deny an application and, if approving, may impose reasonable conditions. Conditions may include requirements for sureties, maintenance agreements and declarations and may require that those documents be properly executed or recorded before permit issuance.

More information can be found regarding the MCWD permit requirements and review process can be found at the link below:

[http://www.minnehahacreek.org/permit\\_req.php](http://www.minnehahacreek.org/permit_req.php)

### 5.2.3 NMCWD

1. As the planning process for a project begins, the developer is required to submit several copies of the preliminary development plan to the municipality for review. The municipality typically forwards one set of the development documents to the NMCWD. The NMCWD reviews and submits comments to the municipality, normally within one month of receipt of the information, outlining policies and criteria of the NMCWD applicable for the project.
2. Information regarding the project must be submitted by the permit applicant or a representative of the permit applicant a minimum of 10 business days prior to the NMCWD meeting day to be on the agenda. The regular meeting of the Board of Managers is the third Wednesday of each month, at 7:00 PM, at the Nine Mile Creek Watershed District Office at Edina Business Center, 7710 Computer Ave., Suite 135 Edina, MN. Meetings are open to the public.
3. All grading and land alteration permits must be reviewed by the Board of Managers. For the Board of Managers to formally review a project, a project must have received approval from the City Planning Commission and preliminary (first reading) approval by the city council.
4. The formal review by the NMCWD typically is held at a regular Board of Managers meeting within one month from the approval of the project by the city council. NMCWD meetings are open to the public. At the meeting, Managers receive comments from the permit applicant and the general public regarding the project. After review of the application and all comments, the Board of Managers vote to approve, approve with modification, or deny the application on behalf of the

NMCWD. If the project is approved by the NMCWD, correspondence is prepared summarizing the conditions of the NMCWD's approval. This correspondence and approved permit is usually sent to the permit applicant within two weeks of the Board of Managers' meeting date.

More information can be found regarding the NMCWD permit requirements and review process can be found at the link below:

<http://www.ninemilecreek.org/Regulatory/Reg.asp>

#### **5.2.4 RPBCWD**

As of January 2008, the City of Minnetonka has full permitting authority within the RPBCWD for all water resource-related projects. For all projects below the ordinary high water level (OHWL), the Minnesota Department of Natural Resources (DNR) has permitting authority. There are no permit applications that must be submitted to the RPBCWD for review.

## 6.0 City of Minnetonka Guidelines and Design Standards

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The City of Minnetonka has established specific guidelines and design standards that meet, or exceed, those standards outlined by the most restrictive WMO. These standards will be applied city-wide.

### 6.1 Stormwater Treatment Standards

#### 6.1.1 General Guidelines

The City of Minnetonka has established policies within the WRMP that state that the city will meet or exceed the stormwater management rules established by all the WMOs within the city. Figure AppA-1 includes a flow chart to assist developers in determining the required level of treatment for a specific project. Additionally, this figure includes a discussion of the Volume Reduction Compliance Approach, which is the recommended approach to achieving the volume retention standard and also discusses the process if meeting the city's volume retention standard cannot be met. Figure AppA-2 provides examples illustrating the general application of the rules.

Stormwater treatment must meet the following criteria:

- **Runoff Rate Control:** Limit the peak runoff flow rates to that from existing conditions for the 2-, 10-, and 100-year storm events for all points where stormwater leaves the parcel.
- **Runoff Volume Control:** Provide on-site retention of 1-inch of runoff from all impervious surfaces. The City of Minnetonka prefers that the 1-inch of runoff be retained through the implementation of infiltration practices. However, if site conditions preclude infiltration, volume control can be achieved through alternative reduction methods.
- **Water Quality Treatment:** Provide for all runoff to be treated to at least 60 percent annual removal efficiency for total phosphorus and 90 percent total annual removal efficiency for total suspended solids. Pollutant removal efficiencies can be achieved through onsite or offsite detention/retention designed to treat the 2.5-inch storm event (NURP criteria) or through use of alternative practices providing equivalent or better treatment.
- **Nondegradation:** For some redevelopment scenarios, nondegradation (no increase in the total phosphorus load) is required. See Figure AppA-1 for more information.

### 6.1.2 Specific Standards and Criteria

There are a number of best management practices (BMPs) that can be implemented to help achieve the stormwater treatment standards required by the City of Minnetonka. These BMPs include, but are not limited to, infiltration, filtration, and detention systems. Table AppA-1, as updated, includes a list of BMPs that are typically used to help achieve the city's runoff volume control criteria. The applicant should contact the city for the most recent version of Table AppA-1.

To ensure that these BMPs function as designed, they must be properly maintained in perpetuity. The city requires that applicants provide a maintenance plan that identifies and protects the design, capacity, and functionality of both onsite and offsite stormwater management facilities; specifies the methods, schedule, and responsible parties for maintenance; and provides for the maintenance in perpetuity of the facility. The plan will be recorded on the deed in a form acceptable to the city.

Along with proper maintenance of the BMPs, the city requires that BMPs include pretreatment of runoff to remove solids before discharging to infiltration and filtration systems, helping to maintain the designed function.

A performance surety for the construction of stormwater BMPs, as well as other permitted activities, may be required for various projects.

The following sections summarize some of the more common water quality treatment practices. The detailed design standards and criteria for these water quality treatment practices, including a more specific discussion of pretreatment and maintenance, are included in Section 7.0 of Appendix A.

#### 6.1.2.1 Infiltration Systems

An infiltration basin is a stormwater runoff impoundment designed to capture and hold stormwater runoff and infiltrate it into the ground over a period of days. It does not retain a permanent pool of water. Generally, infiltration basins are suitable for sites with gentle slopes, permeable soils, relatively deep groundwater levels, and a small contributing watershed area (less than two acres, ideally). See Section 7.1 of Appendix A for the detailed design criteria.

#### 6.1.2.2 Filtration Systems

Bioretention basins and surface sand filters are examples of stormwater filtration systems that improve runoff water quality. A bioretention basin is a shallow, landscaped depression that receives stormwater runoff. Stormwater flows into the bioretention area, ponds on the surface, and gradually infiltrates into the soil bed. Filtered runoff can either be allowed to infiltrate into the surrounding soil (functioning as an infiltration basin or rainwater garden), or collected by an under-drain system and discharged to the storm sewer system or directly to receiving waters (functioning like a filtration system). Bioretention areas should usually be used on small sites (i.e., 2 acres or less). Bioretention areas can be applied in almost

any soils, since runoff percolates through an engineered soil bed and can be collected in an under-drain system. See Section 7.2 of Appendix A for the detailed design criteria.

A surface sand filter consists of a pretreatment basin, a water storage reservoir, flow spreader, and under-drain piping. A basin liner may also be needed if the treated runoff cannot be allowed to infiltrate into the soil underlying the filtration basin because of groundwater concerns. Sand filters are adaptable, and have few site constraints. They can be applied in areas with thin soils, high evaporation rates, low soil-infiltration rates, and limited space. Surface sand filters are not as commonly used as bioretention systems and detailed design criteria for these systems are not outlined in this document. More guidance for the design of the surface sand filter can be found in Chapter 12-6, Section 1.5.1 of the *Minnesota Stormwater Manual*.

### 6.1.2.3 Detention Systems

The most commonly used detention systems include water quality (NURP) ponds and underground wet vaults. A water quality pond (also known as wet pond, detention basin, water quality basin, or “NURP” pond [if the pond incorporates specific design parameters]), is a constructed stormwater pond that retains a permanent pool of water. Water quality ponds are appropriate for most sites that are not restricted by area. See Section 7.3 of Appendix A for the detailed design criteria.

A wet vault is a subterranean structure designed to provide temporary and permanent storage for stormwater runoff from a specified storm event. Wet vaults have a permanent pool of water which dissipates energy and improves the settling of particulate stormwater pollutants. Wet vaults are typically used for commercial, industrial, or roadway projects if there are space limitations precluding the use of other treatment BMPs. See Section 7.4 of Appendix A for the detailed design criteria.

## 6.2 Flooding and Water Quantity

### 6.2.1 General Guidelines

The City of Minnetonka requires the control of peak runoff flow rates and volume for:

- Land-altering activities disturbing more than 50 cubic yards
- Land-altering activities disturbing more than 5,000 square feet
- Subdivision of a parcel into 3 or more lots
- Development/redevelopment of a single-family home if a portion of the parcel is within 300 feet of the centerlines of Minnehaha Creek, Nine Mile Creek, and

Purgatory Creek, within 500 feet of the OHWL of any other public water or wetland, or is below the 100-year flood elevation.

**Exemptions:** Development/redevelopment of all other single-family homes.

- For redevelopment, if a proposed activity will disturb more than 50 percent of the existing impervious surface on the parcel or will increase the imperviousness of the entire parcel by more than 50 percent, the requirements apply to the entire project parcel. Otherwise, the requirements will apply only to the disturbed areas and additional impervious surface on the project parcel. For purposes of this paragraph, disturbed areas are those where underlying soils are exposed in the course of redevelopment.
- Linear projects constructing/reconstructing more than 1 acre of new or additional imperviousness

### 6.2.2 Specific Standards and Criteria

Additional details on the City of Minnetonka flooding and water quantity standards can be found in the Wetland Protection (300.23), Floodplain District (300.24), and Shoreland Protection (300.25) Ordinances.

#### 6.2.2.1 Low Floor Elevations

The City of Minnetonka has established the low-floor elevation for all principal structures as 2 feet above the 100-year flood elevation for wetlands, floodplains, and shorelands. In landlocked basins, the low-floor elevation is set at 2 feet above the elevations based on two back-to-back 100-year storm events (first event assuming AMC-II, the second event assuming AMC-III).

Complete details on the City of Minnetonka low-floor elevation standards can be found in the Wetland Protection (300.23), Floodplain District (300.24), and Shoreland Protection (300.25) Ordinances.

#### 6.2.2.2 Storm Water Conveyance System Sizing

The City of Minnetonka has established the following requirements for the design of all trunk storm drainage systems, evaluated using a hydrograph method and ultimate land use conditions:

- In areas where flood damage is likely to occur, the storm sewer system will be designed to convey the critical duration (1/2 hour to 30 day) 1-percent chance flood (100-year)
- In areas where no significant flood damage is likely to occur, the storm sewer system will be designed to convey the critical duration (1/2 hour to 30 day) 10-percent chance flood (10-year)

### 6.2.2.3 Catch Basin Spacing and Sag Points

The City of Minnetonka restricts the maximum length of pipe between storm structures (manholes and catch basins) to 300 feet. For all State-Aid roadways, the catch basin spacing should follow Mn/DOT's MSA Standards for catch basin spacing and sag (low) points. These standards follow those outlined by the Federal Highway Administration (FHWA) HY-22.

- For catch basin spacing, the critical 10 percent chance storm event is used (10-year) to estimate the spacing.
- For sag points, the critical 2 percent chance storm event is used (50-year) to locate the low areas along the roadway.

### 6.2.2.4 Peak Runoff Rates

The City of Minnetonka has established the following requirements for the control of peak flow rates:

- Peak runoff flow rates from all points leaving a parcel must be controlled to the existing conditions peak flow rates for the 2-, 10-, and 100-year storm events

### 6.2.2.5 On-site Volume Retention

The City of Minnetonka has established the following requirements for the control of runoff volumes:

- On-site retention of 1-inch of runoff from all impervious surfaces

## 6.3 Erosion and Sediment Control

### 6.3.1 General Guidelines

The City of Minnetonka has established guidelines for the preparation and implementation of grading and erosion control plans for land disturbing activity in order to prevent sediment deposition on public roads, prevent disruption or damage to water resources and public stormwater systems, prevent adverse impacts to neighboring property; prevent damage to natural resources, such as trees, that are intended to be preserved, and to maintain stable slopes.

Grading and erosion control plans are required for the following projects:

- Involving the movement of 50 cubic yards of material or land disturbance of areas greater than 5,000 square feet.
- Involving any land disturbance in designated wetlands, floodplains, or shorelands
- Involving mining operations for gravel or other materials

### 6.3.2 Specific Standards and Criteria

The specific grading and erosion control standards and criteria for the City of Minnetonka are outlined as part of the Performance Standards Ordinance (300.28), Sections 15 through 18. The city uses the Mn/DOT standard plan sheets for drainage and erosion control. Below is a link to the Mn/DOT Standard Plans website:

<http://www.dot.state.mn.us/tecsup/splan/>

## 6.4 Wetlands

### 6.4.1 General Guidelines

The City of Minnetonka has established wetland regulations to recognize, preserve, and protect the environmental, aesthetic and hydrologic functions of the city's wetlands by regulating the use of wetlands and their adjacent properties. The intent is to protect wetlands to the maximum extent possible, resulting in no net loss of wetland functions and values, while allowing a reasonable use of the property.

The city has established standards related to the setback of structures and low floor elevations and the establishment of vegetative buffers. Additionally, all new discharges to wetlands will be required to incorporate water quality treatment, regardless of the wetland management classification.

For projects requiring wetland delineations and assessment of functions and values, a methodology authorized under the Wetland Conservation Act should be used. The wetland assessment methodology required by the WMOs within the City of Minnetonka typically refers to the most current version of the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM). Applicants should contact the WMOs regarding any potential changes to their wetland assessment methodology requirements. For the most current version of MnRAM, contact the Minnesota Board of Water and Soil Resources (BWSR).

### 6.4.2 Specific Standards and Criteria

The specific wetland protection standards and criteria for the City of Minnetonka are outlined in the Wetland Protection Ordinance (300.23). Additional information regarding the city's wetlands can be found in Chapter 3.

## 6.5 Floodplains

### 6.5.1 General Guidelines

The City of Minnetonka has established floodplain regulations to recognize, preserve, and protect recreational and hydrological resources and functions of the city's creeks and associated lakes and drainageways by regulating the use of the creeks, associated lakes,

and adjacent properties in order to minimize loss of life and property damage due to flooding.

The city has established standards related to the setback of structures and establishment of low floor elevations. Additionally, the city restricts land uses within the established floodplains. However, there are some specific land uses permitted within the floodplain (outside the floodway) if they do not result in the net fill of the floodplain or does not involve the excavation or fill of

- more than 20 cubic yards
- more than 1,000 square feet

### 6.5.2 Specific Standards and Criteria

The specific floodplain district standards and criteria for the City of Minnetonka are outlined in the Floodplain District Ordinance (300.24).

## 6.6 Shorelands

### 6.6.1 General Guidelines

The City of Minnetonka has established shoreland regulations to recognize, preserve, and protect the environmental, recreational and hydrologic resources and functions of the city's lakes and streams by regulating the use of both the public waters and adjacent land in order to protect their viability and minimize loss from flooding. In order to promote the general health, safety and welfare, certain DNR public waters in the city have been given a shoreland management classification by the DNR.

The city has established standards for the restriction of minimum lot sizes, water frontage, structure heights, and imperviousness, based on the DNR shoreland management classification. The city also established standards for the setback of structures from the OHWL and the top of bluffs as well as low floor elevations of structures on shoreland parcels.

### 6.6.2 Specific Standards and Criteria

The specific shoreland district standards and criteria for the City of Minnetonka are outlined in the Shoreland Protection Ordinance (300.25).

## 7.0 Water Quality Treatment Standards and Criteria

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This section outlines the specific design standards for the most commonly used water quality treatment practices, including surface infiltration basins, bioretention areas, water quality (NURP) ponds, and underground wet vaults. As previously mentioned, there are additional BMPs that can be used to improve water quality and reduce runoff volumes. Table AppA-1, as updated, lists a variety of BMPs that can be implemented to help achieve the city's runoff volume control criteria.

The design standards included in the following sections were modified from the BCWMC guidance document *Requirements for Improvements and Development Proposals* (July 2008, as updated) which was based on the review of the *State of Minnesota Stormwater Manual* (MPCA, 2005) and the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, 2001). The following are links to the *State of Minnesota Stormwater Manual* (1) and the *Minnesota Urban Small Sites BMP Manual* (2):

- 1) <http://proteus.pca.state.mn.us/water/stormwater/stormwater-manual.html>
- 2) <http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

### 7.1 Infiltration Basin Design and Maintenance Requirements

#### 7.1.1 Description

An infiltration basin is a stormwater runoff impoundment designed to capture and hold stormwater runoff and infiltrate it into the ground over a period of days. It does not retain a permanent pool of water. A key feature of an infiltration basin is its vegetation. It is important to vegetate the bottom of the basin with deep-rooted plants to increase the infiltration capacity of the basin.

For infiltration basins to perform as designed, pretreatment of stormwater must be provided to remove as many of the suspended solids from the runoff as possible before the water enters the infiltration basin.

Infiltration basins have limited capabilities for controlling peak discharge from storms greater than the design storm. Because infiltration basins will not significantly affect peak discharges of runoff, they should be used in conjunction with other BMPs to meet peak runoff rate control requirements.

More discussion of infiltration basins can be found in Chapter 12-7 of the *Minnesota Stormwater Manual*: <http://proteus.pca.state.mn.us/water/stormwater/stormwater-manual.html>

The design and placement of infiltration BMPs will also be done in accordance with the Minnesota Department of Health guidance document called *Evaluating Proposed Stormwater Infiltration Projects in Vulnerable Wellhead Protection Areas*.

### 7.1.2 Site Analysis

Before an infiltration system can be designed, a site sensitivity analysis must be performed. This evaluation may eliminate an infiltration practice from consideration because of soil characteristics or potential effects on groundwater. Because of varying geologic settings, a site evaluation needs to be tailored to the specific site conditions.

The suitability of using infiltration basins on a site depends on numerous site factors, including soils, slope, depth to water table, depth to bedrock or impermeable layer, contributing watershed area, land use, proximity to wells, surface waters, foundations, and others. Generally, infiltration basins are suitable for sites with gentle slopes, permeable soils, relatively deep groundwater levels, and a small contributing watershed area (less than two acres, ideally).

When performing a site evaluation, the following items must be considered:

- **Geology:** A site with highly sensitive geology, such as one with a surficial sand aquifer, may eliminate this practice from consideration.
- **Groundwater:** The seasonally high water table must be far enough below the bottom of the infiltration basin to allow the structure to function hydraulically and to allow trapping and treatment of pollutants by the soil. Specifically, the seasonally high groundwater table must be at least 3 feet from the bottom of the infiltration basin. Basins must be located at least 150 feet away from drinking water sources to limit the possibility of groundwater contamination, and must be situated at least 10 feet downgradient and 100 feet upgradient from building foundations to avoid potential seepage problems.
- **Soils:** Sites with clayey soils may not be appropriate for infiltration basins. If the infiltration rate of the site's soils is not acceptable, the filtration family of BMP systems must be considered. (See Section 6.2)
- **Drainage Area:** Generally, the contributing drainage area to any individual infiltration basin must be restricted to two acres or less.
- **Wetlands:** Wetland issue must be assessed to ensure the BMP conforms to the Wetland Conservation Act and other wetland regulations.

### 7.1.3 General Design Considerations

#### 7.1.3.1 Design Volume

Infiltration basin systems should be designed to infiltrate one inch of the runoff from a rain event over the impervious surface of the development, while the remaining runoff bypasses the infiltration basin.

#### 7.1.3.2 Off-line Placement

The purpose of the basin is to temporarily store surface runoff and allow it to infiltrate through the bottom and sides of the basin. A flow splitter or weir is

typically used to divert runoff into an off-line infiltration basin. Infiltration basins provide total peak discharge, runoff volume and water quality control for all storm events equal to or less than the design storm. Storm events greater than the design storm simply continue down the larger conveyance system, bypassing the infiltration basin.

### 7.1.3.3 Pretreatment

Pretreatment, such as proprietary environmental stormwater treatment systems, grit chambers, swales with check dams, filter strips, or sediment forebays/traps are a fundamental component of any BMP system relying on infiltration. Pretreatment devices should be installed to remove at least 25-30% of sediment loads.

### 7.1.3.4 Infiltration Rate

Infiltration volumes and facility sizes shall be calculated using the appropriate hydrological soil group classification and design infiltration rate from Table AppA-2. The design infiltration rate shall be selected from Table AppA-2 based on the least permeable soil horizon within the first five feet below the bottom elevation of the proposed infiltration basin. Soil horizon must be classified under direction of a licensed soil scientist, geologist, or engineer.

**Table AppA-2 Design Infiltration Rates**

Soil Group	Rate	Soil Textures	ASTM Unified Soil Class Symbols
A	1.63 in/hr	Gravel, sandy gravel, or silty gravel	GW, GP, GM, SW
	0.80 in/hr	Sand, loamy sand, or sandy loam	SP
B	0.60 in/hr	Silt loam	SM
	0.30 in/hr	Loam	MH
C	0.20 in/hr	Sandy clay loam	ML
D	<0.20 in/hr	Clay loam, silty clay loam, sandy clay, silty clay, or clay	GC, SC, CL, OL, CH, OH

Source: *Minnesota Stormwater Manual, November 2005 (Updated July 2008)*.

As an alternative, the applicant may complete double-ring infiltrometer test measurements at the proposed bottom elevation of the infiltration BMP to the requirements of ASTM D3385. The measured infiltration rate shall be divided by the appropriate correction factor selected from the *Minnesota Stormwater Manual*. This test must be completed under the direction of a licensed soil scientist, geologist, or engineer.

### 7.1.3.5 Duration of Ponding

The drawdown time for infiltration basins shall be 48 hours (or up to 72 hours if justification can be provided) from the peak water level in the infiltration basin. The

depth and area of the infiltration basin must be adjusted accordingly. Certain types of vegetation will require shorter ponding duration to survive storm events.

#### 7.1.3.6 Maximum Depth

After the infiltration rate of the soil has been determined, the maximum depth of the infiltration basin is calculated with the following equation:

$$d_{\max} = (f) * (T_p)$$

Where:  $d_{\max}$  = maximum design depth (inches),

$f$  = soil infiltration rate (in/hr), and

$T_p$  = design ponding time (hours).

The maximum depth and ponding time of the infiltration area must promote the survival of vegetation. The maximum depth shall be calculated based on infiltration rates from Table AppA-2 and shall be no greater than 2 feet.

#### 7.1.3.7 Basin Slopes

The bottom of the basin must be graded as flat as possible (1% or less) to provide uniform ponding and infiltration of the runoff across the floor. The side slopes of the basin must be no steeper than 3H:1V (flatter slopes are preferred) to allow for proper stabilization and maintenance

#### 7.1.3.8 Basin Shape

The length and width of the basin must be determined by the characteristics of the site in question (topography, size and shape). A desirable length-to-width ratio for an infiltration basin is 3:1 or greater.

#### 7.1.3.9 Plants

Plants are an important component of an infiltration basin. Plants remove water through evapotranspiration and remove pollutants and nutrient through uptake. It is important to vegetate the bottom of the basin with deep-rooted plants to increase the infiltration capacity of the basin. The plant species selected for an infiltration basin must be designed to survive frequent periods of inundation during runoff events and drying during inter-event periods.

The bottom and side slopes of the basin must be stabilized with appropriate plants within 7 days following construction. Vegetative buffers around the perimeter of the basin are recommended for erosion control and additional sediment and nutrient removal. A diversity of plant species must be planted to allow for best survivability. Plants that are tolerant of both wet weather and drought must be used.

Plant recommendations based on different site conditions are included in *Plants for Stormwater Design, Species Selection for the Upper Midwest* (MPCA, July 2003).

#### 7.1.3.10 Inflow/Bypass

If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice must be designed as an off-line practice.

To prevent incoming flow velocities from reaching erosive levels and scouring the basin floor, inlet channels to the basin must be stabilized with riprap designed to terminate in a broad apron, which spreads the runoff more evenly over the basin surface to promote better infiltration.

A bypass system must be implemented for all infiltration basins. A bypass flow path or pipe must be incorporated into the design of an infiltration basin to convey high flows around the basin. This will necessitate the construction of a flow splitter upstream of the basin.

#### 7.1.3.11 Overflow

All infiltration basins must have an emergency spillway capable of passing runoff from large storms without damage to the impounding structure.

#### 7.1.3.12 Groundwater Mounding

Calculations to determine groundwater mounding may be necessary in cases where slope stability is a concern and/or a high water table is encountered.

### 7.1.4 Sequencing and Construction

- Prior to construction, the area of infiltration basin must be protected by silt fence, construction fence or other method to prevent construction equipment from compacting the underlying soils.
- Infiltration basins must not be used as temporary sediment traps during construction. Diversion berms or silt fence must be placed around the perimeter of the infiltration basin during construction.
- The infiltration basin must be constructed after the remaining site and tributary area has been graded and stabilized.
- To the extent possible, excavation must be performed by equipment with tracks exerting relatively light pressures (4 psig or less) to prevent compacting of the basin floor and reducing the infiltration capacity.
- After final grading, the basin floor must be tilled to a depth of at least six inches to provide a well-aerated, porous surface texture. Six inches of compost must be tilled in at this time.
- The bottom and side slopes of the basin must be stabilized with appropriate plants within 7 days following construction.

### 7.1.5 Maintenance

Maintenance is required for the proper operation of infiltration basins. The city must ensure that a maintenance agreement and maintenance plan is prepared for operation of infiltration basins. The maintenance plan must include the following.

- The plan must identify owners, parties responsible for maintenance, and an inspection and maintenance checklist and schedule.
- Pretreatment devices for basins must be inspected and cleaned at least twice a year.
- Inspections must occur after every rainfall greater than 0.5-inches in the first year after construction to ensure proper stabilization and function. Attention must be paid to how long water remains standing in the basin after a storm; water standing within the basin more than 48 hours after a storm indicates that the infiltration capacity may have been overestimated. Factors responsible for clogging (such as upland sediment erosion and excessive compaction of soils) must be repaired immediately. Also, the newly-established vegetation must be inspected to determine if any remedial actions (reseeding, irrigation, etc.) are necessary.
- Thereafter, the infiltration basin must be inspected at least twice per year. Important items to check include: differential accumulation of sediment, erosion of the basin floor, condition of riprap and the health of the vegetation. Eroded or barren spots must be replanted immediately after inspection to prevent additional erosion and accumulation of sediment.
- Sediment removal within the basin must be performed when the sediment is dry enough so that it is cracked and readily separates from the basin floor to prevent smearing of the basin floor.
- Light equipment, which will not compact the underlying soil, must be used to remove the top layer of sediment. The remaining soils must be decompacted by tilling and revegetated as soon as possible.
- Vegetation must be maintained to control weed growth and maintain the health of the vegetation in the basin. Weeding once monthly is required during the first two growing seasons. Weeding two or three times per growing season is required after the first two growing seasons.
- Adequate access for appropriate equipment and vehicles must be provided for inspection, maintenance and landscaping upkeep.
- Snow storage is discouraged inside of the infiltration area.
- General maintenance activities and schedules are also provided in the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, July 2001) and the *Minnesota Stormwater Manual*, (MPCA, November 2005).

- It is required that the maintenance agreement between the city and applicant be filed against the property with the County for private systems.

## 7.2 Bioretention Systems Design and Maintenance Requirements

### 7.2.1 Description

In general, bioretention systems can be described as shallow, landscaped depressions 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 (*Design Manual for Bioretention in Stormwater Management*, Prince George's County, MD, 1993). Filtered runoff can either be allowed to infiltrate into the surrounding soil (functioning as an infiltration basin or rainwater garden), or collected by an under-drain system and discharged to the storm sewer system or directly to receiving waters (functioning like a surface sand filter). Runoff from larger storms is generally diverted past the area to the storm drain system.

More discussion of bioretention systems, including figures and schematics, can be found in Chapters 12-5 and 12-6 of the *Minnesota Stormwater Manual*:

<http://proteus.pca.state.mn.us/water/stormwater/stormwater-manual.html>

### 7.2.2 Site Analysis

Before a biofiltration system can be designed, site conditions must be considered to ensure that a bioretention system is the appropriate BMP for the site.

- **Drainage area:** Bioretention areas should usually be used on small sites (i.e., 2 acres or less). When used to treat larger areas, they tend to clog. In addition, it is difficult to convey flow from a large area to a bioretention area. For larger sites, multiple basins can be used to treat runoff.
- **Available area for the bioretention system:** The surface area of the bioretention system should be between 5% and 10% of the impervious area draining to it, with a minimum of 200 square feet for small sites.
- **Soils:** Bioretention areas can be applied in almost any soils, since in some designs, runoff percolates through an engineered soil bed, and is returned to the stormwater system. However, it is also possible to design a bioretention system to function like an infiltration system, where runoff percolates through into the native soil below the system. The infiltration option can be applied only when the soils and other site characteristics are appropriate for infiltration (see Infiltration Basin section).

- **Groundwater:** The seasonally high water table must be far enough below the bottom of the bioretention system to allow the structure to function hydraulically and to allow trapping and treatment of pollutants by the soil. Specifically, the seasonally high groundwater table must be a least 3 feet from the bottom of the bioretention area if filtered water is to be infiltrated.
- **Under-Drain:** An under-drain is a perforated pipe in a gravel bed, installed along the bottom of a soil bed that collects and removes filtered runoff, directing it to a storm drain system. Bioretention systems may or may not incorporate an under-drain in their design, depending on treatment goals and site constraints.
- **Wetlands:** Wetland issue must be assessed to ensure the BMP conforms to the Wetland Conservation Act and other wetland regulations.

### 7.2.3 General Design Considerations

#### 7.2.3.1 Design Volume

Bioretention systems should be designed to treat one inch of the runoff from a rain event over the impervious surface of the development, while the remaining runoff bypasses the bioretention area.

#### 7.2.3.2 Pretreatment

Pretreatment such as proprietary environmental stormwater treatment systems, grit chambers, swales with check dams, filter strips, or sediment forebays/traps are a fundamental component of any Bioretention system. Pretreatment devices should be installed to remove at least 25-30% of sediment loads. Grass filter strips, when used, must be at least 20 feet long for new sites and at least 10 feet long for retrofits.

#### 7.2.3.3 Maximum Depth

The maximum depth and ponding time of the bioretention basin must promote the survival of vegetation. Where feasible the bioretention area must be designed to pond 6 to 9 inches (the maximum pooling depth may be up to 2 feet if justification for increased depth can be provided).

#### 7.2.3.4 Duration of Ponding

Where feasible, the drawdown time for bioretention systems shall be 48 hours (or up to 72 hours if justification can be provided) from the peak water level in the bioretention area. The depth and area of the bioretention area must be adjusted accordingly. Certain types of vegetation will require shorter ponding duration to survive storm events.

#### 7.2.3.5 Basin Slopes

The bottom of the basin must be graded as flat as possible (1% or less) to provide uniform ponding and filtration of the runoff across the floor. The side slopes of the

area must be no steeper than 3H:1V (flatter slopes are preferred) to allow for proper stabilization and maintenance.

#### 7.2.3.6 Planting Soil Bed

The planting soil bed provides water and nutrients to support plant life in the bioretention system. Stormwater filters through the planting soil bed where pollutants are removed by the mechanisms of filtration, plant uptake, adsorption and biological degradation.

- A well-blended, homogenous mixture of 50-60% sand: 20-30% top soil; and 20-30% organic leaf compost is necessary to provide a soil medium with a high infiltration/filtration capacity.
  - **Sand**—Provide clean sand, free of deleterious materials. AASHTO M-6 or ASTM C-33 with grain size of 0.02"-0.04".
  - **Top Soil**—Sandy loam, loamy sand, or loam texture per USDA textural triangle with less than 5% clay content.
  - **Organic Leaf Compost**—(MnDOT Grade 2)
- The minimum depth of the prepared soil is 30 inches. However, if large trees are preferred in the design, a soil depth of 48"-52" must be utilized. The soil depth generally depends upon the root depth of the prescribed vegetation and content of underlying soils.

#### 7.2.3.7 Plants

Vegetation is an important component of a bioretention system. Plants remove water through evapotranspiration and remove pollutants and nutrient through uptake. Plant roots enhance the infiltration capacity of the soil, providing conduits for percolation. The plant species selected for a bioretention area must be designed to survive frequent periods of inundation during runoff events and drying during inter-event periods.

The bottom and side slopes of the basin must be stabilized with appropriate plants within 7 days following construction. Vegetative buffers around the perimeter of the basin are recommended for erosion control and additional sediment and nutrient removal. A diversity of plant species must be planted to allow for best survivability. Plants that are tolerant of both wet weather and drought must be used.

Plant recommendations based on different site conditions are included in *Plants for Stormwater Design, Species Selection for the Upper Midwest* (MPCA, July 2003).

#### 7.2.3.8 Inflow/Bypass

- If runoff is delivered by a storm drain pipe or along the main conveyance system, the bioretention practice must be designed as an off-line practice to convey high

flows around the basin. This will necessitate the construction of a flow splitter upstream of the basin.

- To prevent incoming flow velocities from reaching erosive levels, scouring the basin floor, inlet channels to the basin must be stabilized with riprap designed to terminate in a broad apron, which spreads the runoff more evenly over the basin surface to promote better filtration.

#### 7.2.3.9 Overflow

All bioretention systems must have an emergency spillway capable of passing runoff from large storms without damage to the impounding structure.

#### 7.2.4 Sequencing and Construction

- Prior to construction, the area of the bioretention system must be protected by silt fence, construction fence or other method to prevent construction equipment from compacting the underlying soils.
- Bioretention systems must not be used as temporary sediment traps during construction. Diversion berms or silt fence must be placed around the perimeter of the bioretention system during construction.
- The bioretention system must be constructed after the remaining site and tributary area has been graded and stabilized.
- To the extent possible, excavation must be performed by equipment with tracks exerting relatively light pressures (4 psig or less) to prevent compacting of the basin floor and reducing the infiltration capacity.
- After final grading, the bioretention area floor must be tilled to a depth of at least 6 inches to provide a well-aerated, porous surface texture. Six inches of compost must be tilled in at this time.
- The bottom and side slopes of the basin must be stabilized with appropriate plants within 7 days following construction

#### 7.2.5 Maintenance

Maintenance is required for the proper operation of bioretention systems. The city must ensure that a maintenance agreement and maintenance plan is prepared for operation of bioretention systems. The maintenance plan must include the following.

- The plan must identify owners, parties responsible for maintenance, and an inspection and maintenance checklist and schedule.
- Adequate access must be provided for all bioretention facilities for inspection, maintenance, and landscaping upkeep, including appropriate equipment and vehicles.

- Pretreatment devices for bioretention areas must be inspected and cleaned at least twice a year.
- Inspections must occur after every rainfall greater than 0.5-inches in the first year after construction to ensure proper stabilization and function. Attention must be paid to how long water remains standing in the basin after a storm; water standing within the basin more than 48 hours after a storm indicates that the filtration capacity may have been overestimated. Factors responsible for clogging (such as upland sediment erosion and excessive compaction of soils) must be repaired immediately. Also, the newly-established vegetation must be inspected to determine if any remedial actions (reseeding, irrigation, etc.) are necessary.
- Thereafter, the bioretention area must be inspected at least twice per year. Important items to check include: differential accumulation of sediment, erosion of the floor, condition of riprap and the health of the vegetation. Eroded or barren spots must be replanted immediately after inspection to prevent additional erosion and accumulation of sediment.
- The surface of the ponding area may become clogged with fine sediment over time. Core aeration or cultivating of non-vegetated areas may be required to ensure adequate filtration.
- Sediment removal within the bioretention area must be performed when the sediment is dry enough so that it is cracked and readily separates from the floor to prevent smearing of the floor.
- Light equipment, which will not compact the underlying soil, must be used to remove the top layer of sediment. The remaining soils must be tilled and revegetated as soon as possible.
- Vegetation must be maintained to control weed growth and maintain the health of the vegetation in the basin. Weeding once monthly is recommended during the first two growing seasons. Weeding two or three times per growing season is recommended after the first two growing seasons.
- Adequate access for appropriate equipment and vehicles must be provided for inspection, maintenance and landscaping upkeep.
- Snow storage is encouraged outside of the bioretention area.
- General maintenance activities and schedules are also provided in the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, July 2001) and the *Minnesota Stormwater Manual*, (MPCA, November 2005).
- It is recommended that the maintenance agreement between the city and applicant be filed against the property with the County.

## 7.3 Water Quality (NURP) Pond Design and Maintenance Requirements

### 7.3.1 Description

Water quality ponds (also known as wet ponds, detention basins, water quality basins, or “NURP” ponds [if the pond incorporates specific design parameters]), are constructed stormwater ponds that retain a permanent pool of water. Water quality ponds are generally on-line, end-of-pipe BMPs. The primary pollutant removal mechanism in a water quality pond is sedimentation. Significant loads of suspended pollutants, such as metals, nutrients, sediments, and organics, can be removed by sedimentation. Water quality ponds have a moderate to high capacity for removing most urban pollutants, depending on how large the volume of the permanent pool is in relation to the runoff from the surrounding watershed. Removal efficiency is primarily dependent on the length of time that runoff remains in the pond, which is known as the pond’s Hydraulic Residence Time (HRT).

Water quality ponds can also be constructed using multiple cells to enhance removal efficiency, incorporate skimming and provide accessible maintenance.

More discussion water quality ponds, including figures and schematics, can be found in Chapter 12-8 of the *Minnesota Stormwater Manual*:

<http://proteus.pca.state.mn.us/water/stormwater/stormwater-manual.html>

### 7.3.2 Site Analysis

- **Treatment Standard:** Natural or excavated low areas shall be used for the water quality ponds. Generally accepted reservoir routing procedures using critical duration runoff events shall be used for design of these areas and outlets. All stormwater will be regulated to city water quality standards.
- **Alternatives to Onsite Ponds:** Alternative water quality management features may be used where onsite ponds are not feasible. Alternative features must be designed to provide water quality benefits that equal or exceed design criteria outlined in existing City of Minnetonka policies.
- **Bedrock:** As with other stormwater BMPs, soils depth to bedrock, and depth to water table must be investigated before designing a water quality pond. At sites where bedrock is close to the surface, high excavation costs may make water quality ponds infeasible. If the soils on the site are relatively permeable or well-drained, it will be difficult to maintain a permanent pool. It may be necessary to line the bottom of the water quality pond to reduce infiltration.
- **Wetlands:** Wetland issue must be assessed to ensure the BMP conforms to the Wetland Conservation Act and other wetland regulations.

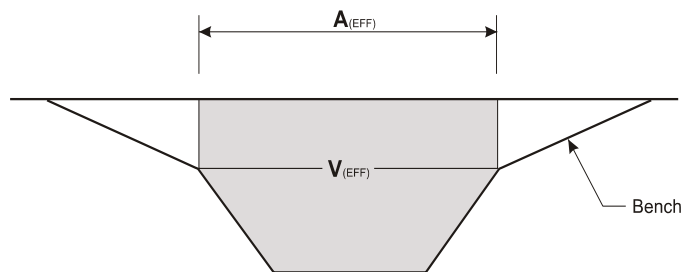
### 7.3.3 Design Requirements

#### 7.3.3.1 Design Volume

- The permanent pool (dead storage) volume below the principal spillway (normal outlet) must be greater than or equal to the runoff volume from a 2.5-inch, 24-hour storm over the project site, assuming full development. The project site includes all tributary area draining to the pond.
- The dead storage volume must be calculated separately from impervious and pervious surfaces to prevent artificially low volumes due to composite curve numbers.
- Under special conditions, such as expansions to existing water quality ponds, the entire contributing drainage area must be considered in computing the dead storage volume, assuming full development of the drainage area. For design purposes, the water quality volume must be considered an instant flow to the pond, not an inflow-outflow calculation. In other words, this volume must be considered to arrive at the pond all at once, rather than over the course of several hours or days. The assumption of instant runoff is conservative, but it accounts for a great deal of the variability that occurs in both storm events and runoff conditions.

#### 7.3.3.2 Average Depth

The permanent pool average depth (basin volume/basin surface area) shall be  $\geq 4$  feet, with a maximum depth of  $\leq 10$  feet. For small ponds (less than 3 acre-feet in volume) average depth shall be  $\geq 3$  feet, with a maximum depth of  $\leq 10$  feet. An “effective average depth” (“effective volume”/ “effective surface area”) may be calculated for ponds that include benches. The “effective volume” and “effective surface area” are computed by extending the basin side slopes below the basin bench, vertically, to the water surface.



#### 7.3.3.3 Emergency Overflow

An emergency overflow (emergency outlet) must be in place and adequate designed to accommodate the 100-year frequency critical duration rainfall event.

#### 7.3.3.4 Basin Side Slopes

Basin side slopes above the normal water level shall be no steeper than 3:1 and preferably flatter. A basin bench with a minimum width of 10 feet and 1 foot deep below the normal water level is recommended to enhance wildlife habitat, reduce potential safety hazards, and improve access for long-term maintenance. Slopes that extend below the bench to the bottom of the pond must be at a stable slope, usually no steeper than 3:1.

#### 7.3.3.5 Short Circuiting

To prevent short-circuiting, the distance between the major inlets and normal outlet must be maximized.

#### 7.3.3.6 Flood Pool (Live Storage)

The flood pool (live storage) volume above the principal spillway shall be such that the peak discharge rates from the 2-, 10-, and 100-year frequency, critical duration storms do not exceed the peak discharge for similar storms under predevelopment conditions.

#### 7.3.3.7 Pond Shape

To maximize stormwater contact and residence time in the pool, a length to width ratio of 3:1 is recommended. A minimum pool surface area of 0.25 acres is recommended. Performance of the water quality pond may be enhanced by enlarging the surface area to increase volume, as opposed to deepening the pool. However, average depth criteria must be achieved.

#### 7.3.3.8 Multi-Stage Outlets

Water quality ponds may be designed with a multi-stage outlet structure to control discharges from different size storms. Usually the pond is designed to control multiple design storms (e.g., 2- and 10-year storms) and safely pass the 100-year storm event.

#### 7.3.3.9 Extended Detention

Extended detention of runoff from the more frequent (1-year to 5-year) storms shall be achieved through a principal spillway design which shall include a perforated vertical riser, small orifice outlets, or a compound weir.

#### 7.3.3.10 Stormwater Outfalls

The design must include effective energy dissipation devices that reduce outlet velocities to 4 fps or less. These outlets shall consist of stilling basins or other such devices that prevent erosion at all stormwater outfalls into the water quality pond, and at the basin outlet. Storm sewer outfalls must extend to the water quality pond or other receiving water body and must discharge at or below its normal water elevation.

#### 7.3.3.11 Outlet Structure (Skimming)

Trash and floatable debris skimming devices must be placed on the outlet of all onsite water quality ponds to provide treatment up to the critical duration 5-year storm event. Submerged inlets, permanent baffled weirs or similar devices may be employed. Timber baffled weirs are discouraged. Velocities through the devices shall be less than 0.5 fps. The top of submerged inlets shall be at least one foot below the water surface.

#### 7.3.3.12 Pretreatment

Pretreatment, such as grit chambers, swales with check dams, filter strips, or sediment forebays/traps should be implemented to extend the life of the water quality pond. Pretreatment devices should be installed to remove at least 25-30% of sediment loads.

#### 7.3.3.13 Flow Conveyance Capacity

Onsite water quality ponds shall maintain predevelopment runoff rates.

### 7.3.4 Sequencing and Construction

- Water quality ponds must be constructed in the initial phases of a development project, in order to treat site runoff during construction.
- If the water quality pond is used as a sediment trap during construction, all sediment deposited during construction must be removed before normal operation begins.
- During construction of the basin, discharge of waterborne sediments to downstream water bodies must be prevented.
- The side slopes of the water quality pond and must be stabilized with appropriate plants within 7 days following construction.

### 7.3.5 Maintenance

Maintenance is required for the proper operation of water quality ponds. The city must ensure that a maintenance agreement and maintenance plan is prepared for operation of water quality ponds. The maintenance plan must include the following.

- The plan must identify owners, parties responsible for maintenance, and an inspection and maintenance checklist and schedule.
- Water quality ponds must be inspected after every rainfall greater than 0.5-inches in the first year after construction.
- Thereafter, water quality ponds must be inspected at least twice per year during the growing season to ensure that they are operating as designed. Potential problems that must be checked include: subsidence, erosion, cracking or tree growth on the embankment, damage to the emergency spillway; sediment accumulation around the outlet; and erosion within the basin and banks. Any

necessary repairs must be made immediately. During inspections, changes to the water quality pond or the contributing watershed must be noted, as these may affect basin performance.

- Accumulated trash and debris must be removed from the side slopes, embankment, emergency spillway, weirs, and trash grates as often as needed (at least twice during the growing season). Accumulated sediment in the forebay must be inspected at the same time.
- Sediment must be removed from the pond, as necessary. The frequency of sediment removal depends on the years of sediment accumulation that were incorporated into the design volume of the water quality pond's permanent pool and forebay and on the occurrence of any high-loading events.
- Sediment removal from water quality ponds and disposal may currently be regulated by the MPCA. Sediment testing, disposal and permitting may be required and shall be investigated on an individual site basis. Sediments must be tested for toxicants in compliance with current disposal requirements as required by local, state, or federal laws or regulations.
- Adequate access for appropriate equipment and vehicles must be provided for inspection, maintenance and landscaping upkeep.
- General maintenance activities and schedules are also provided in the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, July 2001) and the *Minnesota Stormwater Manual*, (MPCA, November 2005).
- It is recommended that the maintenance agreement between the city and applicant be filed against the property with the County.

## 7.4 Underground Wet Vaults Design and Maintenance Requirements

### 7.4.1 Description

A wet vault is a subterranean structure designed to provide temporary and permanent storage for stormwater runoff from a specified storm event. Wet vaults have a permanent pool of water which dissipates energy and improves the settling of particulate stormwater pollutants. Wet vaults are typically on-line, end-of-pipe BMPs.

Pollutant removal mechanisms for particulate pollutants in wet vaults are similar to water quality ponds. The primary pollutant removal mechanism in a wet vault is sedimentation. Significant loads of suspended pollutants, such as metals, nutrients, sediments, and organics, can be removed by sedimentation. However, in a wet vault, the permanent pool of water is covered by a lid which blocks sunlight from entering the facility, limiting light-dependent biological activity. Consequently, biological pollutant

removal mechanisms that function in the surface water quality ponds are not a part of stormwater treatment in a wet vault.

Wet vaults are typically used for commercial, industrial, or roadway projects if there are space limitations precluding the use of other treatment BMPs.

More discussion on wet vaults, including figures, can be found in Chapter 3 of the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, 2001):

<http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm>

## 7.4.2 General Design Requirements

### 7.4.2.1 Design Volume

- The permanent pool (dead storage) volume below the principal spillway (normal outlet) must be greater than or equal to the runoff volume from a 2.5-inch, 24-hour storm over the project site, assuming full development. The project site includes all tributary area draining to the pond.
- The “dead storage” volume shall be calculated separately from impervious and pervious surfaces to prevent artificially low volumes due to composite curve numbers.
- Under special conditions, such as expansions to existing wet vaults, the entire contributing drainage area must be considered in computing the dead storage volume, assuming full development of the drainage area. For design purposes, the water quality volume must be considered an instant flow to the wet vault, not an inflow-outflow calculation. In other words, this volume must be considered to arrive at the wet vault all at once, rather than over the course of several hours or days. The assumption of instant runoff is conservative, but it accounts for a great deal of the variability that occurs in both storm events and runoff conditions.

### 7.4.2.2 Average Depth

The permanent pool average depth (vault volume/vault surface area) shall be  $\geq 4$  feet, with a maximum depth of  $\leq 10$  feet.

### 7.4.2.3 Vault Inlet/Outlet Structures and Pipes

- The inlet to the wet vault shall be submerged with the inlet pipe invert a minimum of 3 feet from the vault bottom. The top of the inlet pipe must be submerged at least 1 foot, if possible. The submerged inlet is intended to dissipate energy of the incoming flow. The distance from the bottom is intended to minimize resuspension of settled sediment. Alternative inlet designs that accomplish these objectives are acceptable.
- Unless designed as an off-line facility, the capacity of the outlet pipe and available head above the outlet pipe must be designed to convey flows larger

than the water quality design flow for developed site conditions without overtopping the vault. The available head above the outlet pipe must be a minimum of 6 inches.

- The outlet pipe must be back-sloped or have tee section, the lower arm of which must extend 1 foot below the normal water surface to provide for trapping of oils and floatables in the vault.
- A gravity drain for maintenance is recommended if grade allows. Gravity drains must be as low as the site situation allows; however, the invert shall be no lower than the average sediment storage depth. At a minimum, the invert shall be 6 inches above the base elevation of the vault side walls. This placement prevents highly sediment-laden water from escaping when the vault is drained for maintenance. A lower placement is allowed than for water quality ponds since the v-shaped vault bottom will capture and retain additional sediments.
- Wet vaults may be constructed using arch culvert sections provided the top area at the normal water surface is, at a minimum, equal to that of a vault with vertical walls designed with an average depth of 6 feet. This is to prevent decreasing the surface area available for oxygen exchange.
- Galvanized materials must be avoided whenever possible.
- Adequate vents in the vault or other provisions must be included to ensure the water in the vault does not become “stagnant” resulting in anoxic conditions and the release of phosphorus in the water column. Lockable grates instead of solid manhole covers are recommended to increase air contact with the wet pool.
- Operational access to the valve that controls the gravity drain must be provided to the finished ground surface. The valve location must be accessible and well-marked with 1 foot of paving placed around the box. It must also be protected from damage and unauthorized operation.

#### 7.4.2.4 Short-Circuiting and the Promotion of Plug Flow

To prevent short-circuiting, water must be forced to flow, to the extent practical, to all potential available flow routes, avoiding “dead zones” (corners, etc.) and maximizing the time that water stays in the vault during the active part of a storm. Design features that encourage plug flow and avoid dead zones are:

- Providing a broad surface for water exchange across cells rather than a constricted area.
- Maximizing the distance between the major inlets and normal outlet.
- The ratio of flowpath length to width from the inlet to the outlet must be at least 3:1.
- All inlets must enter the first cell. If there are multiple inlets, the length-to-width ratio must be based on the average flowpath length for all inlets.

- Flow rates must be uniform to the extent possible and not increased between cells.

#### 7.4.2.5 Flood Pool (Live Storage)

The flood pool (live storage) volume above the principal spillway shall be such that the peak discharge rate from the 5-year and 100-year frequency, critical duration storm does not exceed the peak discharge for a similar storm under predevelopment conditions.

#### 7.4.2.6 Outlet Structure (Skimming)

Trash and floatable debris skimming devices shall be placed on the outlet of all wet vaults to provide treatment up to the critical duration 5-year storm event. Submerged inlets, permanent baffled weirs or similar devices may be employed. Timber baffled weirs are discouraged. Velocities through the devices shall be less than 0.5 fps. The top of submerged inlets shall be at least one foot below the water surface.

#### 7.4.2.7 Pretreatment

Pretreatment, such as proprietary environmental treatment systems, grit chambers, swales with check dams, filter strips, or sediment forebays/traps must be provided to extend the life of the wet vault. Pretreatment devices should be installed to remove at least 25-30% of sediment loads.

#### 7.4.2.8 Flow Conveyance Capacity

Onsite wet vaults shall maintain predevelopment runoff rates.

#### 7.4.2.9 Vault Structures

Detailed examples of wet vault structures are provided in the following document:

- *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, July 2001)  
<http://www.metrocouncil.org/environment/water/BMP/manual.htm>

### 7.4.3 Sequencing and Construction

- Wet vaults may be constructed in the early phases of a development project, in order to treat site runoff during construction.
- Sediment that has accumulated in the wet vault must be removed after the remaining site and tributary area has been graded and stabilized.

### 7.4.4 Maintenance

Maintenance is required for the proper operation of water quality ponds. The city must ensure that a maintenance agreement and maintenance plan is prepared for operation of water quality ponds. The maintenance plan must include the following.

- The plan must identify owners, parties responsible for maintenance, and an inspection and maintenance checklist and schedule.
- Following construction, the underground wet vault must be inspected after every rainfall greater than 0.5-inches in the first year after construction. Thereafter, wet vaults must be inspected at least annually.
- Accumulated trash, floating debris and petroleum products must be removed as necessary, but at least annually from the wet vault, forebay/pretreatment area, emergency spillway, weirs, and trash grates. The frequency of sediment removal depends on the years of sediment accumulation that were incorporated into the design volume of the wet vault's permanent pool and forebay and on the occurrence of any high-loading events.
- Sediment removal from underground wet vault and disposal may currently be regulated by the MPCA. Sediment testing, disposal and permitting may be required and shall be investigated on an individual site basis. Sediments must be tested for toxicants in compliance with current disposal requirements as required by local, state, or federal laws or regulations.
- Vault maintenance procedures must meet OSHA confined space entry requirements, which include clearly marking entrances to confined space areas.
- Adequate access for appropriate equipment must be provided for inspection, maintenance and landscaping upkeep.
- General maintenance activities and schedules are also provided in the *Minnesota Urban Small Sites BMP Manual* (Metropolitan Council, July 2001) and the *Minnesota Stormwater Manual*, (MPCA, November 2005).
- It is recommended that the maintenance agreement between the city and applicant be filed against the property with the County.

## 8.0 Comparison of City and WMO Guidelines and Standards

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This section includes Table AppA-3 which compares the general design standards for the City of Minnetonka as well as those standards for each of the WMOs within the City of Minnetonka. Those standards highlighted standards indicate the most restrictive set of rules as outlined by the four WMOs. Additionally, Figure AppA-1 is a flow chart helping outline the situations when nondegradation standards must be met.

Table AppA-1. Best Management Practices for Stormwater Volume Control Criteria

Draft- Rev. 12/30/2009

Category	Method	Storage Volume Credit Formulas	Nomenclature
<b>Preferred Volume Retention Practices</b>			
Rain Gardens/Surface Infiltration	Storage & Infiltration	$V = \text{BMP Area} \times I \times 4$	BMP area using max depth from Appendix A (ft <sup>2</sup> ) I = infiltration rate (in/hr) 4 = conversion for 48 hr drawdown
Subsurface Infiltration	Storage & Infiltration	$V = (\text{pipe volume} + \text{rock void volume})$ Pipe Vol. = Pipe [A x L] Rock Void Vol. = ([W x H x L] - Pipe[A x L]) x n	n = porosity (ft <sup>3</sup> /ft <sup>3</sup> ) of rock media W = width of trench (ft) H = height of trench (ft) L = length of trench and pipe (ft) A = area of pipe (ft <sup>2</sup> )
Pervious Pavement	Storage & Infiltration	$V = (W \times H \times L) \times n$	n = porosity (ft <sup>3</sup> /ft <sup>3</sup> ) of media W = width of BMP (ft) H = height of BMP (ft) L = length of BMP (ft)
Rain Barrel/Cistern (Irrigation Reuse)	Storage & Slow Release, Evaporation	TBD- see city staff	
Green Roof/Roof Gardens	Storage & Slow Release, ET	TBD- see city staff	
<b>Alternative Volume Reduction Practices</b>			
<b>Better Site Design Credits</b>			
Rooftop Disconnection Credit	Moisture Retention, Infiltration, & ET	1/2-inch credit per unit area of impervious surface disconnected. Note: may not be applicable to sites with hydrologic soil groups C or D.	
Non-rooftop Disconnection Credit	Moisture Retention, Infiltration, & ET		
Grass Channel Credit	Moisture Retention, Infiltration, & ET	1/2-inch credit per unit area of channel bottom. Note: may not be applicable to sites with hydrologic soil groups C or D.	
Buffer Credit	Moisture Retention, Infiltration, and/or ET	1/2-inch credit per unit area of buffer	
Soil Amendment Credit	Infiltration	1/2-inch credit per unit area of soil amended.	
Forest/Prairie Restoration/Conservation Credit	Moisture Retention & ET	1/2-inch credit per unit area of forest or prairie restored or conserved.	
<b>Filtration Techniques* (for use on sites where conditions preclude infiltration practices)</b>			
* Bioretention Systems w/ Underdrain	Storage, Moisture Retention & ET	$V = (\text{BMP Area} \times I \times 4) \times 70\%$	BMP area using max depth from Appendix A (ft <sup>2</sup> ) I = infiltration rate (in/hr) 4 = conversion for 48 hr drawdown
* Surface Sand Filter	Moisture Retention & Slow Release, Evaporation	$V = (W \times H \times L) \times n$	n = porosity (ft <sup>3</sup> /ft <sup>3</sup> ) of media W = width of BMP (ft) H = height of BMP (ft) L = length of BMP (ft)
ET = Evapotranspiration			
* Filtration techniques are not recognized by the Nine Mile Creek Watershed District (NMCWD) as acceptable volume retention practices, and therefore should not be used to achieve compliance with the Rule A volume control criteria within the NMCWD.			

**Table AppA-3 - Comparison of Key Standards (City of Minnetonka vs. WMOs)**

	City of Minnetonka	WMOs			
		BCWMC <sup>1</sup>	MCWD <sup>2</sup>	NMCWD	RPBCWD <sup>3</sup>
<b>Required if:</b>					
<b>Grading and Erosion Control</b>	Land disturbance of ≥ 50 cu yds of material OR land disturbance of areas ≥ 5,000 sq ft	Movement of ≥ 200 cu yds of material OR land disturbance of areas ≥ 10,000 sq ft	Movement of ≥ 50 cu yds of material OR land disturbance of areas ≥ 5,000 sq ft	Movement of ≥ 50 cu yds of material OR disturbance of areas ≥ 5,000 sq ft of vegetation	Land disturbances ≥ 1 acre
	Any land disturbance in designated wetlands, floodplains, or shoreland				
	Mining operations for gravel or other material				
<b>Treatment (Water Quality and Quantity)</b>	Land-altering activities disturbing ≥ 50 cu yds	New commercial development ≥ 0.5 acres	See Figure 1 of MCWD Rule N (January, 2005)	Land-altering activities disturbing ≥ 50 cu yds	Land disturbances ≥ 1 acre
	Land altering activities disturbing ≥ 5000 sq ft	New residential development ≥ 2 acres AND contains more than 4 or more proposed living units		Land altering activities disturbing ≥ 5000 sq ft of vegetation	
	Subdivision of a parcel into ≥ 3 residential lots	Commercial redevelopment ≥ 5 acres		Subdivision of a parcel into ≥ 3 residential lots	
	Development/redevelopment of single family homes is exempt unless any portion of the parcel is within 300 ft of the centerlines of Nine Mile Creek, Minnehaha Creek, or Purgatory Creek, within 500 ft of the OHWL of any other public water or wetland, or is below the 100-year flood elevation	Residential redevelopment ≥ 10 acres with > 4 existing units		Development/redevelopment of single family homes is exempt unless any portion of the parcel is within 300 ft of the centerline of Nine Mile Creek, within 500 ft of the OHWL of any other public water or wetland, or is below the 100-year flood elevation	
	Redevelopment: See Figure AppA-1: Redevelopment Flow Chart <sup>4</sup>	<b>Other redevelopment = nondegradation Exceptions: Single Family Homes, Sites &lt; 0.5 acres, and see table in BCWMC document</b>		For redevelopment, treatment of the disturbed area and net additional impervious surfaces is required unless there is disturbance of more than 50% of the existing impervious surface or an increase of entire parcel imperviousness by 50%, then entire parcel must be treated	
	For linear projects: construction/reconstruction creating > 1 acre of new or additional imperviousness	Road Projects: Work with BCWMC		For linear projects: construction/reconstruction creating > 1 acre of new or additional imperviousness	

Table AppA-3 - Comparison of Key Standards (City of Minnetonka vs. WMOs)

	City of Minnetonka	WMOs			
		BCWMC <sup>1</sup>	MCWD <sup>2</sup>	NMCWD	RPBCWD <sup>3</sup>
<b>Standards:</b>					
<b>Water Quality Treatment</b>	Onsite retention: 1-inch of runoff from all impervious surfaces AND Water Quality Treatment: all runoff from 2.5-inch storm event treated at 60% TP removal and 90% TSS removal AND Nondegradation for certain redevelopment projects <sup>4</sup>	Level 1 Standards <sup>5</sup> (NURP pond OR Infiltration of 1/2-inch of runoff from all impervious surfaces OR Surface Sand Filter OR Bioretention Basin); Nondegradation for certain redevelopment projects <sup>5</sup>	50% TP removal on an annual average removal basis	<b>Onsite retention: 1-inch of runoff from all impervious surfaces AND Water Quality Treatment: all runoff from 2.5-inch storm event treated at 60% TP removal and 90% TSS removal</b>	Control measures outlined in MPCA (1989) "Protecting Water Quality in Urban Areas" (typically NURP ponds)  Significant discharges may require additional treatment
<b>Nondegradation</b>	Nondegradation for certain redevelopment projects <sup>4</sup>	<b>Nondegradation for certain redevelopment projects<sup>5</sup></b>	N/A	N/A	N/A
<b>Peak Discharges</b>	Limit peak runoff flow rates to existing conditions (before proposed development) for the 2-, 10-, and 100-year storm events	Limit discharge from 5- and 100-year events to predevelopment conditions (Extended detention for 1- to 5-year events)	Limit peak runoff flow rates to existing conditions (before proposed development) for the 1-, 10-, and 100-year storm events	<b>Limit peak runoff flow rates to existing conditions for the 2-, 10-, and 100-year storm events</b>	N/A
<b>Volume Control</b>	Onsite retention: 1-inch of runoff from all impervious surfaces	N/A	N/A	<b>Onsite retention: 1-inch of runoff from all impervious surfaces</b>	N/A
<b>Low Floor Elevation</b>	2 feet above the 100-year flood elevation  In Landlocked Basins, 2 ft above 2 back-to-back 100-year storm events (first event assuming AMC-II, second event assuming AMC-III)	<b>2 feet above the 100-year flood elevation</b>	all door and window openings are at a minimum of 2 feet above the 100-year high water elevation	<b>2 feet above the 100-year flood elevation</b>  In Landlocked Basins, 1 foot above the surface overflow elevation OR the calculated high water level from back-to-back 100-year, 24-hour storm events or the 100-year, 10-day snowmelt, whichever is higher	<b>2 feet above the 100-year flood elevation</b>

**Table AppA-3 - Comparison of Key Standards (City of Minnetonka vs. WMOs)**

	City of Minnetonka	WMOs			
		BCWMC <sup>1</sup>	MCWD <sup>2</sup>	NMCWD	RPBCWD <sup>3</sup>
<b>Setbacks</b>	No principal structures within 50 - 75 feet of OHWL or extent of floodplain, depending on shoreland management classification; 20 ft from upland edge of floodplain district; 60 feet from Preserve wetland overlay district and 35 feet from all other wetland overlay districts	N/A	N/A	No structures or paving within 50 feet of centerline of any watercourse	No structures within 100 feet of centerline of any watercourse
<b>Wetland Buffers</b>	Buffers based on Management Classification: Preserve - 50 feet Manage 1 - 25 feet Manage 2 - 16.5 feet	City of Minnetonka has authority to enforce WCA	Buffers based on Size: 2.5 - 5 acres - 25 feet 1 - 2.5 acre - 20 feet 0 - 1acres - 16.5 feet	Buffers based on Value: High Value - Average 60 feet from the edge, minimum 30 feet Medium Value - Average 40 feet from the edge, minimum 20 feet Low Value - Average 20 feet from the edge, minimum of 10 feet	City of Minnetonka has authority to enforce WCA
<b>Performance Surety</b>	Performance sureties are required for stormwater BMPs, as well as other permitted activities	N/A	Performance sureties are required for stormwater BMPs, as well as other permitted activities	Performance sureties are required for stormwater BMPs, as well as other permitted activities	N/A

1 - As of May 2008, BCWMC is working on revisions of the required water quality treatment standards

2 - As of May 2008, MCWD is working on revisions of its Water Resource Management Rules

3 - As of January 2008, the City of Minnetonka has been granted permitting authority for all water resources related projects within the RPBCWD

4 - The Redevelopment Flow Chart was developed to determine when BCWMC Nondegradation requirements would apply over the NMCWD rules (See Figure AppA-1)

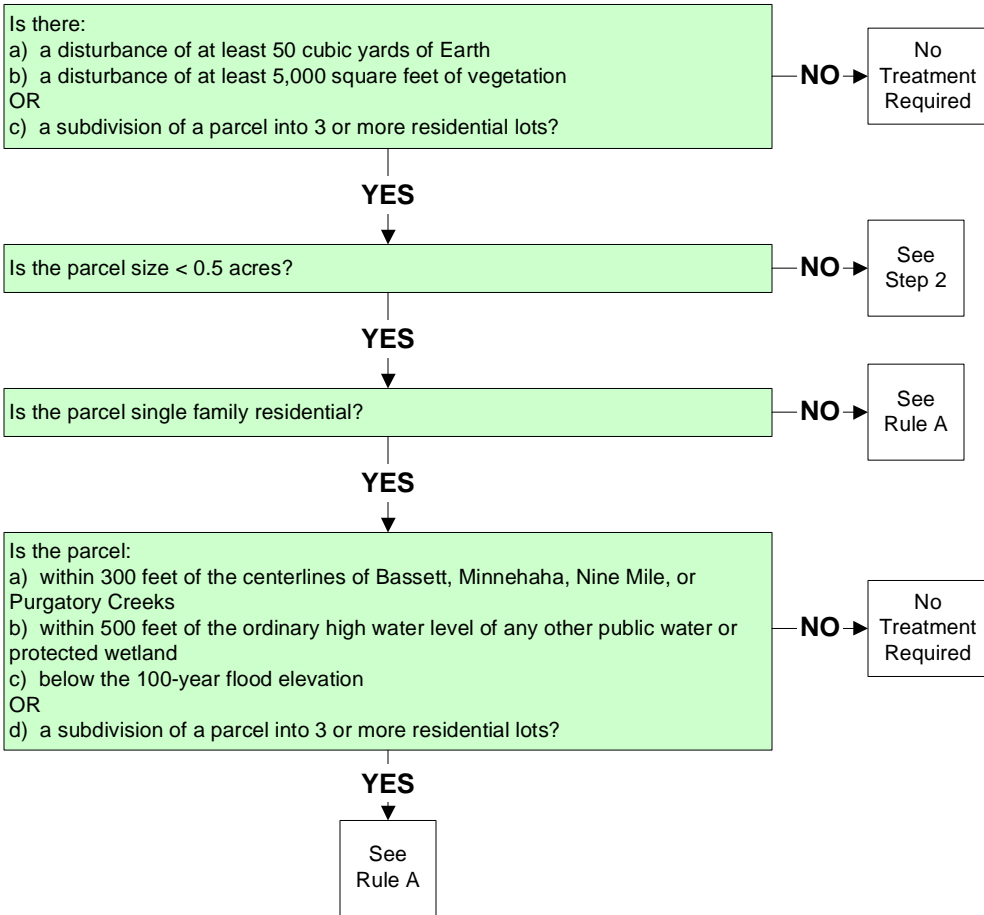
5 - See BCWMC Requirements for Improvements and Development Proposals (April 2008, draft, as updated)

**Figure AppA-1:  
Flow Chart for Stormwater Management Requirements  
City of Minnetonka, Water Resources Management Plan**

Each of the four watershed management organizations (WMOs) within the City of Minnetonka have different stormwater management rules. To promote consistency, the City of Minnetonka has adopted the most stringent stormwater management rules of the four WMOs within the city, and applies these rules to all projects city-wide. The flowchart below was designed to help identify the stormwater treatment standards required for specific projects.

For most scenarios, the Nine Mile Creek Watershed District (NMCWD) stormwater management rules apply (see Rule A below). However, Bassett Creek Watershed Management Commission (BCWMC) has a nondegradation standard for redevelopment and there are certain cases where application of the nondegradation standard results in treatment requirements more stringent than those of the NMCWD (see Rule B).

**Step 1**



**Rule A<sup>1</sup>:**

If a proposed activity will disturb more than 50 percent of the existing impervious surface on the parcel or will increase the imperviousness of the entire parcel by more than 50 percent, **Rule A** criteria applies to the entire parcel. Otherwise, **Rule A** criteria applies only to the disturbed areas and additional impervious surface on the project parcel. See **Figure AppA-2** for examples of the application of this rule.

**Criteria:**

- **Runoff Rate Control:** Limit peak runoff flow rates to that from existing conditions for the 2-, 10- and 100-year storm events for all points where stormwater discharge leaves the parcel.

- **Runoff Volume Control:** Provide for onsite retention of 1-inch of runoff from impervious surfaces as outlined in Rule A above. The City of Minnetonka prefers that the 1-inch of runoff be retained through implementation of infiltration practices. If site conditions preclude infiltration, volume control can be achieved through alternative volume reduction methods (see Volume Reduction Compliance Approach, page 2).

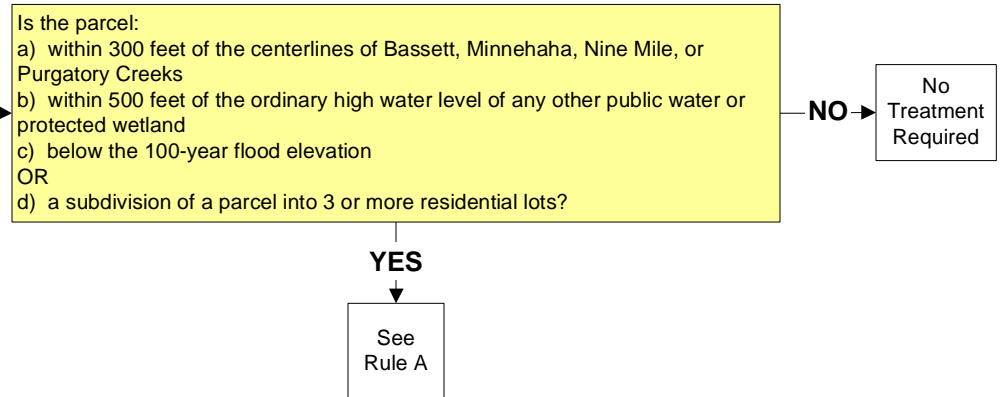
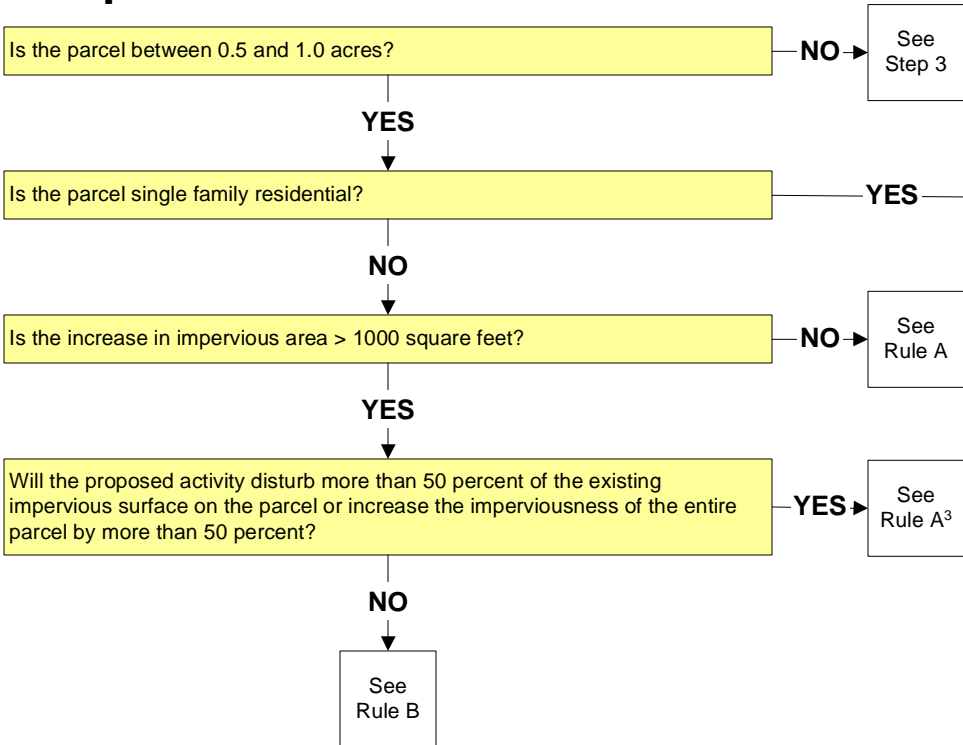
- **Water Quality Treatment:** Provide for all runoff to be treated to at least 60 percent annual removal efficiency for total phosphorus and 90 percent annual removal efficiency for total suspended solids. Pollutant removal efficiencies can be achieved through onsite or offsite detention/retention designed to treat the 2.5-inch storm event (NURP criteria) or through use of alternative practices providing equivalent or better treatment. The onsite retention of runoff may be included in demonstrating compliance with the total suspended solids and phosphorus removal requirements.

**Rule B<sup>2</sup>:**

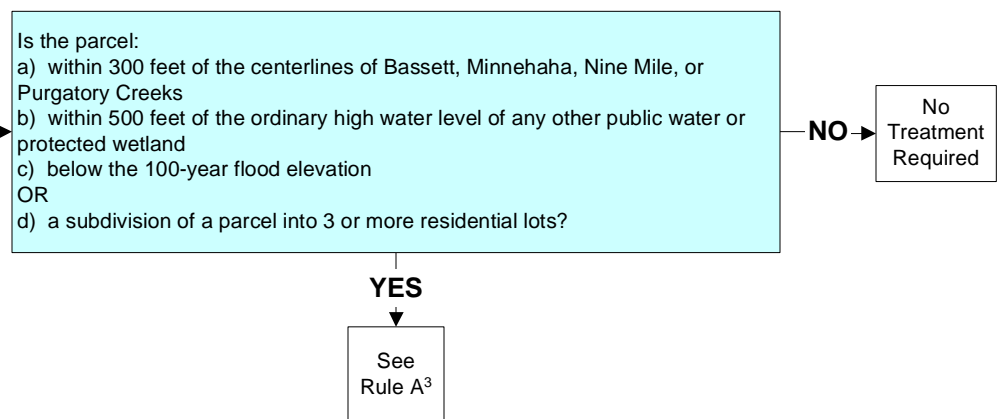
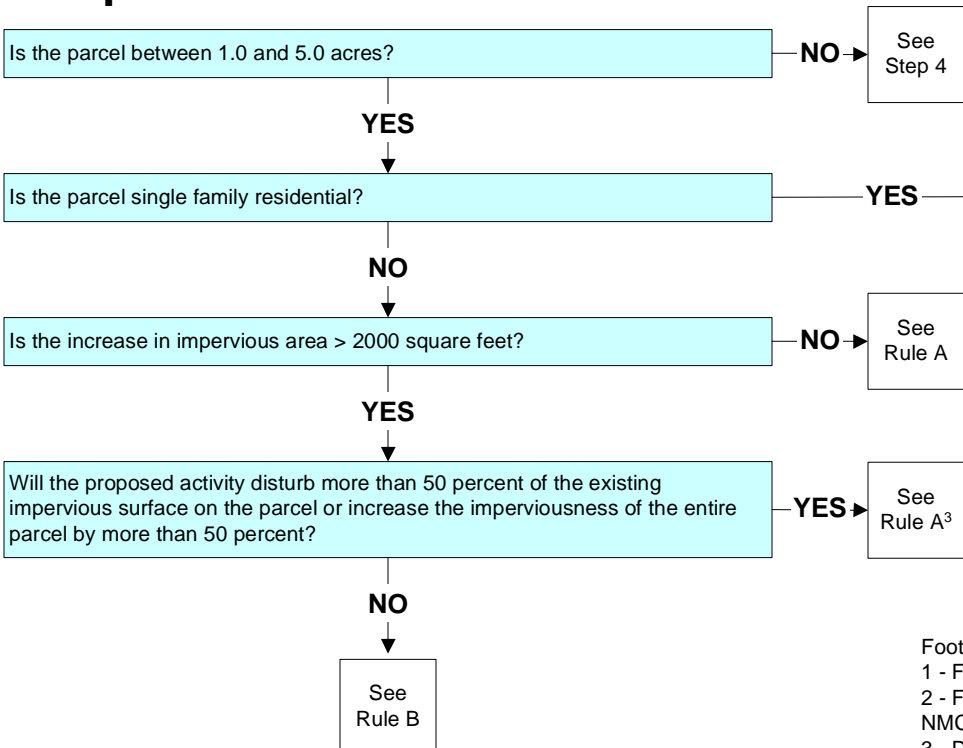
- **Nondegradation** must be achieved. Best management practices must be implemented to prevent an increase in phosphorus load from the site. As an alternative, the entire parcel shall be developed/redeveloped in accordance with BCWMC Level 1 standards. See Bassett Creek WMC *Requirements for Improvements and Development Proposals* (July 2008, as updated) for additional details.

- **Rule A** criteria also applies to the disturbed areas and additional impervious surfaces on the project parcel.

**Step 2**



**Step 3**



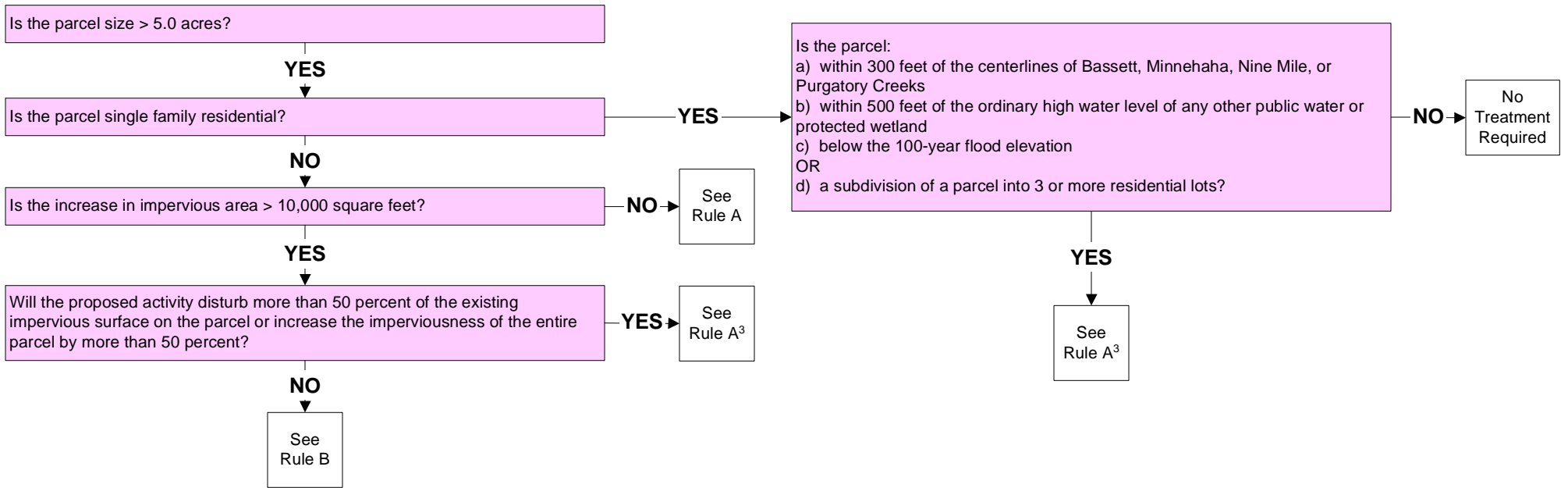
**Footnotes:**

1 - From NMCWD Amended Rules, March 19, 2008

2 - From BCWMC *Requirements for Improvements and Development Proposals*, July 2008, as updated and NMCWD Amended Rules, March 19, 2008

3 - Due to BCWMC Nondegradation Policy, proof that Nondegradation standards are met may be required based on comment from BCWMC.

## Step 4



### Volume Reduction Compliance Approach:

The runoff volume control rule requires an applicant to provide for onsite retention of 1-inch of runoff from impervious surfaces. It is the City of Minnetonka's preference that the 1-inch of runoff be retained through implementation of infiltration practices.

If site conditions limit, or preclude onsite infiltration, the following compliance alternatives shall be pursued in order of preference:

1. The applicant will retain at least ½-inch of runoff from impervious surfaces onsite using infiltration or other preferred volume retention practices listed in Table AppA-1. The remaining ½-inch required volume retention shall be achieved through alternative onsite volume reduction methods, as listed in Table AppA-1 or as approved by the city.
2. If site conditions preclude infiltration practices (see Table 1 below), the applicant will achieve at least ½-inch of runoff volume reduction onsite through alternative volume reduction methods, as listed in Table AppA-1 or as approved by the city.
3. Any remaining volume reduction required may be accomplished at an offsite location, as approved by the city. When possible, offsite compliance will be achieved in the same drainage area or watershed as the project site.
4. As a last alternative, the applicant may contribute to the city's Stormwater Volume Reduction Fund to satisfy the remainder of their volume retention requirement. The city will use this fund for implementation of BMPs to achieve equivalent volume retention. The required contribution rate will be set by the city based on the cost of implementing volume retention practices elsewhere in the watershed.

**Table 1: Site Conditions that Preclude Infiltration or Other Preferred Volume Retention Methods**

Type	Site Specific Conditions	Submittal Requirements
Potential Contamination	Potential Stormwater Hotspots (PSHs)	PSH locations and flow paths
	Contaminated Soils	State Permitted Brownfield Documentation; Soil Borings
Physical Limitations	Low Permeability (Type D Soils)	Soil Borings
	Bedrock within 3 vertical feet of the bottom of the infiltration area	Soil Borings
	Seasonal High Groundwater within 3 vertical feet of bottom of the infiltration area	Soil Borings
	Karst Areas	Soil Borings
Land Use Limitations	Utility Locations	Site Map
	Adjacent Wells	Well Locations

**\*Volume reduction compliance approach is allowed for the runoff volume control portion of the Rule A criteria**

### For Linear Projects:

For a linear project entailing construction or reconstruction, including mill and overlay or other maintenance, that creates less than 1 acre of new or additional impervious surface, implementation of Best Management Practices (BMPs) is required, as defined below:

- A) BMPs addressing the potential water resource impacts associated with the proposed activity must be incorporated to limit creation of impervious surface, maintain or enhance on-site infiltration and peak flow control and limit pollutant generation on and discharge from the site. BMPs include site design, structural and non-structural practices.
- B) BMPs must be designed and installed in accordance with generally accepted design practices and, if specifications for the BMP are contained in the MPCA manual "Protecting Water Quality in Urban Areas (revised July 1991) and its subsequent revisions, consistent with that manual.
- C) No new point source may discharge to a wetland without pretreatment for sediment and nutrient removal. Pretreatment may be provided by non-structural means. An activity changing flow that discharges from an existing point source is not a new point source.
- D) All applications for which compliance only with BMPs is required shall delineate buildings and structures showing that door and window openings are a minimum of two feet above the 100 year high water elevation.

For linear projects creating more than 1 acre of new or additional impervious surface, Rule A Criteria will apply to the net new or additional impervious surface.

### For Stormwater Discharged to a Wetland<sup>1</sup>:

Stormwater must be treated before discharge to a wetland.

High value wetlands (Preserve Wetland Management Classification, see Figure 9-3) cannot be used for stormwater management where another alternative is feasible; when permitted, any discharge to a high value wetland must be treated to at least sixty percent (60%) annual removal efficiency for phosphorus and at least ninety percent (90%) annual removal efficiency for total suspended solids prior to discharge to the wetland.

#### Footnotes:

- 1 - From NMCWD Amended Rules, March 19, 2008
- 2 - From BCWMC *Requirements for Improvements and Development Proposals*, July 2008, as updated and NMCWD Amended Rules, March 19, 2008
- 3 - Due to BCWMC Nondegradation Policy, proof that Nondegradation standards are met may be required based on comment from BCWMC.

## Figure AppA-2:

### Examples to help demonstrate the application of the City of Minnetonka Stormwater Management Rules

Rule A Criteria apply to the entire parcel if the proposed activity:

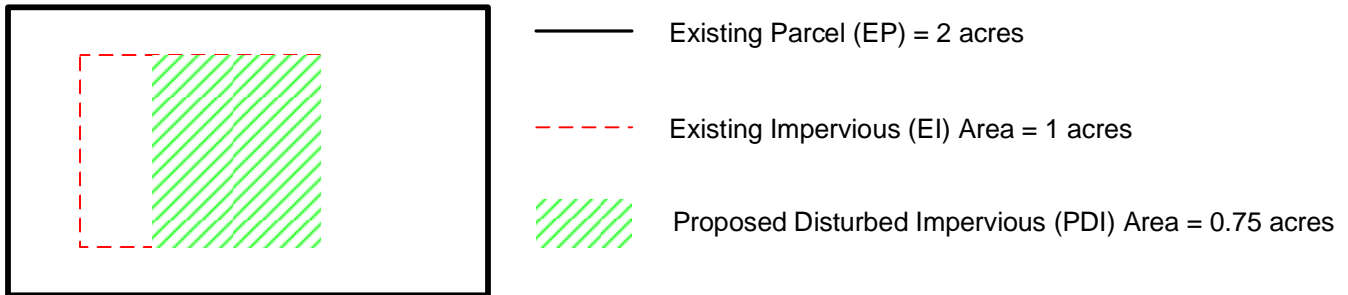
- 1) Disturbs more than 50% of the existing impervious surface on the parcel

OR

- 2) Increases the imperviousness of the entire parcel by more than 50%

Otherwise, Rule A Criteria only apply to the disturbed impervious area(s) and the net additional impervious area(s).

#### Example 1: Disturbance of Impervious Areas on a Parcel



***Will I disturb more than 50% of the existing impervious surface on the parcel?***

$$\% \text{ Disturbance} = \text{PDI} / \text{EI} = 0.75 \text{ acres} / 1.0 \text{ acres} \times 100\% = 75\%$$

**YES** - Because 75% > 50%, runoff from the ENTIRE parcel must be treated.

***Will I increase the imperviousness of the entire parcel by more than 50%?***

**NO** - Because the total amount of imperviousness has not changed from existing conditions to proposed conditions.

## Figure AppA-2:

### Examples to help demonstrate the application of the City of Minnetonka Stormwater Management Rules

Rule A Criteria apply to the entire parcel if the proposed activity:

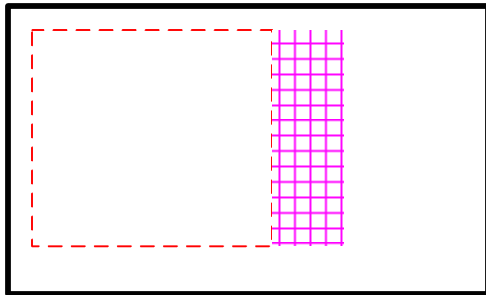
- 1) Disturbs more than 50% of the existing impervious surface on the parcel

OR

- 2) Increases the imperviousness of the entire parcel by more than 50%

Otherwise, Rule A Criteria only apply to the disturbed impervious area(s) and the net additional impervious area(s).

#### Example 2: Addition of Impervious Areas on a Parcel



— Existing Parcel (EP) = 1 acres

- - - Existing Impervious Area (EI) = 0.5 acres

■ Proposed Additional Impervious (PAI) Area = 0.2 acres

**Will I disturb more than 50% of the existing impervious surface on the parcel?**

**NO** - None of the existing impervious surface will be disturbed.

**Will I increase the imperviousness of the entire parcel by more than 50%?**

Total Proposed Site Impervious Area (TPI) = EI + PAI = 0.5 acres + 0.2 acres = 0.7 acres

% Increase in Imperviousness =  $(TPI - EI) / EI = (0.7 \text{ acres} - 0.5 \text{ acres}) / 0.5 \text{ acres} \times 100\% = 40\%$

**NO** - Because  $40\% < 50\%$ , only runoff from the net additional impervious surface must be treated.

## Figure AppA-2:

### Examples to help demonstrate the application of the City of Minnetonka Stormwater Management Rules

Rule A Criteria apply to the entire parcel if the proposed activity:

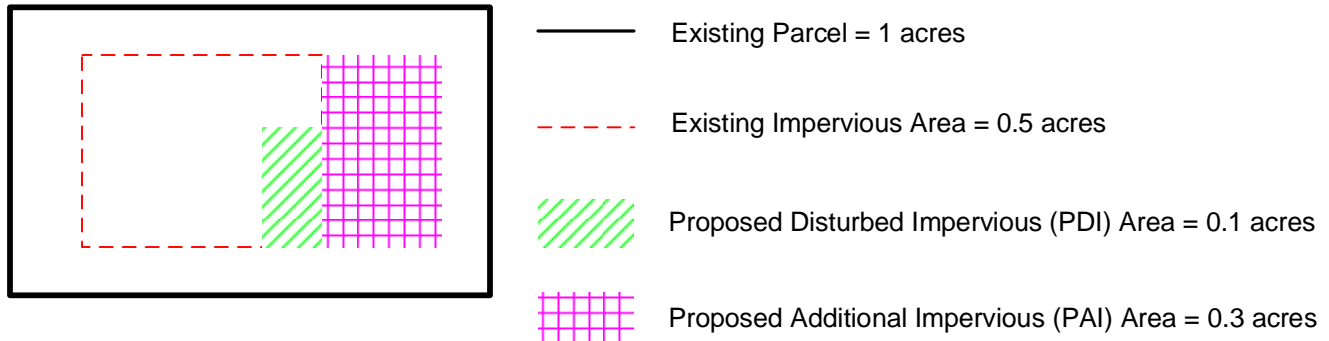
1) Disturbs more than 50% of the existing impervious surface on the parcel

OR

2) Increases the imperviousness of the entire parcel by more than 50%

Otherwise, Rule A Criteria only apply to the disturbed impervious area(s) and the net additional impervious area(s).

#### Example 3: Disturbance of Impervious Area on and Addition of Impervious Area to a Parcel



#### ***Will I disturb more than 50% of the existing impervious surface on the parcel?***

$$\% \text{ Disturbance} = \text{PDI} / \text{EI} = 0.1 \text{ acres} / 1.0 \text{ acres} \times 100\% = 10\%$$

**NO** - Because  $10\% < 50\%$ .

#### ***Will I increase the imperviousness of the entire parcel by more than 50%?***

$$\% \text{ Increase in Imperviousness} = \text{Total Proposed Site Impervious Area (TPI)} = \text{EI} + \text{PAI} = 0.5 \text{ acres} + 0.3 \text{ acres} = 0.8 \text{ acres}$$

$$(\text{TPI} - \text{EI}) / \text{EI} = (0.8 \text{ acres} - 0.5 \text{ acres}) / 0.5 \text{ acres} \times 100\% = 60\%$$

**YES** - Because  $60\% > 50\%$ , runoff from the ENTIRE parcel must be treated.