Evaluating Proposed Stormwater Infiltration Projects in Drinking Water Supply Management Areas

Minnesota Department of Health and Minnesota Pollution Control Agency
January 26, 2016

Introduction

Infiltration of stormwater runoff is widely promoted because it is a practice with demonstrated long-term value. As a management technique, properly designed and executed infiltration practices convey several benefits, including the following (as identified in the Minnesota Stormwater Manual): 1) reducing the volume of stormwater runoff; 2) controlling and improving water quality; 3) recharging groundwater; 4) mitigating thermal effects on cold-water fisheries; and 5) attenuating peak flows. Infiltration is clearly a versatile and effective technique for addressing a wide range of stormwater issues. Accordingly, Minnesota Department of Health (MDH) encourages its use in most settings statewide.

Infiltration practices redirect stormwater into the subsurface, where it becomes groundwater or can be taken up by plants. As most people in Minnesota use groundwater as a source of drinking water, the MDH and Minnesota Pollution Control Agency (MPCA) would like to see care exercised in planning projects involving stormwater infiltration, especially in vulnerable wellhead protection areas. Stormwater runoff often carries with it contaminants that can lead to adverse health effects. The types of contaminants vary widely depending on land use; common contaminants include nitrates, pathogens, metals, chloride, and hydrocarbons. When present at high concentrations, these contaminants can pollute groundwater supplies if infiltrated into the ground. Recent research suggests that many potential contaminants can be effectively removed or attenuated by well-designed and maintained stormwater infiltration structures (Gulliver et.al. 2012; Gulliver, 2015). However, some potential contaminants such as nitrate and chloride can be relatively persistent and the fate of pathogens, including viruses, has not been fully studied. The latter is especially concerning because the effects of such contamination can be devastating. An example involving not urban stormwater but runoff from agricultural fields in Ontario illustrates the danger posed by pathogens. Infiltration of the runoff led directly to bacteriological contamination of a well and the associated public water supply system. The resulting disease outbreak took several lives and sickened hundreds of others (Walkerton E. coli outbreak. (2015, October 29). In *Wikipedia, The Free Encyclopedia*. Retrieved 21:11, November 6, 2015, from https://en.wikipedia.org/w/index.php?title=Walkerton_E._coli_outbreak&oldid=688131829). This example not only demonstrates the potential for rapid connection between surface water and groundwater, but it clearly indicates that groundwater quality can be jeopardized by infiltration of stormwater from the ground surface.

Most of the public water supply systems that distribute drinking water in Minnesota rely on groundwater as their source. Drinking water protection activities are the responsibility in Minnesota of the MDH. As part of these efforts, MDH regulates wellhead protection planning activities carried out by public water suppliers in the state. One of the goals of wellhead protection planning is to determine the recharge area (i.e., the wellhead protection area) for a well and to manage that area in a manner consistent with safeguarding the drinking water supply. Stormwater management occurs in urban or suburban areas and in developing communities where impervious surfaces begin to replace natural ground cover. This document describes suggested considerations for evaluating projects that use infiltration to manage stormwater, with emphasis on how such projects may affect groundwater used for drinking water purposes in wellhead protection areas. A flowchart (Appendix A) is attached to help understand the process.

General Requirements

Federal, regional and state authorities regulate various aspects of the manner in which stormwater is handled, managed, and controlled in Minnesota. For example, the Minnesota Pollution Control Agency (MPCA) administers the Stormwater program, which regulates much of the management of stormwater through the use of permits. The MPCA, regional, and local authorities are typically the governmental entities implementing and enforcing stormwater requirements. The Minnesota Department of Health administers the Wellhead Protection Program and other drinking water protection programs. Wellhead protection planning is largely a local activity in Minnesota. Individual public water supply systems decide how to manage land use within wellhead protection areas. Certain land use activities may adversely affect groundwater supplies. Therefore wellhead protection strategies are balanced with aquifer vulnerability. As wellhead protection planning and stormwater management both involve a substantial amount of local government

involvement and leadership, good opportunities exist for adopting a consistent approach in the application of each. This guidance, jointly developed by the MPCA and MDH, addresses both regulated and non-regulated stormwater management at a site.

Assembling Existing Information

This document is intended for use as guidance for local authorities in evaluating stormwater infiltration projects. Prior to doing so, existing information must be gathered, as described in this section.

- *Is your proposed project in an approved Drinking Water Supply Management Area (DWSMA)? If yes, determine if the proposed project also falls within the Wellhead Protection Area (WHPA) and Emergency Response Area (ERA)?* This type of geographic information can be obtained online through the MDH (http://www.health.state.mn.us/divs/eh/water/swp/maps/) or at the MPCA MS4 Mapping Tool (http://pca-gis02.pca.state.mn.us/ms4/index.html). It can also be found in the wellhead protection plan for the community where the infilitration is proposed. Copies of the plan are usually kept with the wellhead protection manager for the public water supplier. While municipalities are typically the largest groundwater users for public consumption, other entities that may have wellhead plans are schools, mobile home parks, and large businesses or employers. Step 1, below, describes how to identify wellhead activities in your area of interest.
- *What aquifer is used by drinking water supply wells in the area of the proposed infiltration?* It is important to know the aquifer used by area wells because in some parts of the state, many potential aquifers are available and depending on local geology, each aquifer may have a different sensitivity to activities at the ground surface.
- *Where is the aquifer(s) vulnerable to contamination from activities at the land surface?* Vulnerability means the degree to which the aquifer is likely to be affected by activities at the ground surface. A wellhead protection plan distinguishes between zones within the wellhead protection area that are vulnerable from those that are not. Those areas that are assigned vulnerability ratings of very high or high are considered the most likely to be impacted by activities at the land surface, including stormwater infiltration. These areas are defined based on the likelihood that water and contaminants traveling from the land surface can reach the aquifer in time periods of hours to a few years at most (Geologic Sensitivity Project Workgroup (1991)). Areas rated moderately vulnerable likely recharge the underlying aquifer in years to decades. These areas are generally considered well-enough protected so that stormwater infiltration is not a concern, although site specific considerations may be warranted. These may include proximity to the public wells, concerns over types of land use being drained, or a past history of groundwater impacts from stormwater infiltration. Areas rated low or very low vulnerability are characterized by vertical times of travel from the land surface to the aquifer of at least several decades. These areas should be geologically well-protected enough so that stormwater infiltration is not a concern.
- *What land uses exist or are proposed for the area generating stormwater?* Local authorities are the best source of information on local land use. Land uses vary in their potential to generate contaminants in stormwater runoff. For example, potential contaminants from industrial or commercial areas are far different from those that may be generated from park or residential areas. The Minnesota Stormwater Manual (links in Appendix B) describes certain land uses and areas with certain activities as “potential stormwater hotspots (PSH)” that may be incompatible with infiltration in wellhead protection areas. Land use is very hard to characterize broadly. Accordingly, site-specific considerations should be made wherever possible. Consult the Minnesota Stormwater Manual for information on land uses and associated stormwater problems.
- *What are the contaminants of concern in the stormwater and can contaminants be managed?* Do the stormwater management protocols identify any type of pretreatment that may help to mitigate contaminants in the runoff and are they appropriate for the types of contaminants that are likely to be present in the stormwater? Each of these items is considered as part of the evaluation process that MDH and MPCA propose for considering stormwater infiltration projects in vulnerable wellhead protection areas. The process is described below and is summarized in the flowchart attached as Appendix A.

Process for Evaluating Stormwater Infiltration Projects in Drinking Water Supply Management Areas (DWSMAs)

Step 1a: **Determine if the site is within a Drinking Water Supply Management Area (DWSMA).**

This type of geographic information can be obtained online through the MDH (http://www.health.state.mn.us/divs/eh/water/swp/maps/) or at the MPCA MS4 Mapping Tool (http://pca-gis02.pca.state.mn.us/ms4/index.html). It can also be found in the wellhead protection plan for the community where

the infilitration is proposed. Copies of the plan are usually kept with the wellhead protection manager for the public water supplier. While municipalities are typically the largest groundwater users for public consumption, other entities that may have wellhead plans are schools, mobile home parks, and large businesses or employers.

If yes, proceed to Step 1b.

If no, then proceed with the project while observing state and local storm water requirements.

Step 1b: **Determine if the site requires a Construction Stormwater (CSW) General Permit (GP).**
A CSW GP is required for construction activity that results in land disturbance of equal to or greater than one acre or a common plan of development or sale that disturbs greater than one acre.

If yes, proceed to Step 2.

If no, proceed to Step 3.

Step 2**: Determine if there is a Local Government Unit (LGU) with a current Municipal Separate Storm Sewer System (MS4) permit that allows infiltration?** Part III.D.5.a of the MS4 permit requires permittees to restrict the use of infiltration techniques to achieve the conditions for post-construction stormwater management, without higher engineering review, sufficient to provide a functioning treatment system and prevent adverse impacts to groundwater.

If yes, proceed to Step 3.

If no, infiltration is prohibited by the CSW GP.

Step 3: **Determine if any part of the proposed infiltration site is within a DWSMA that exhibits very high, high or moderate vulnerability as defined by Minnesota Rules (4720.5100-5590).** This information is available online through the MDH (http://www.health.state.mn.us/divs/eh/water/swp/maps/) or at the MPCA MS4 Mapping Tool (http://pca-gis02.pca.state.mn.us/ms4/index.html). It can also be found in the wellhead protection plan for the community where the infilitration is proposed. To see a copy of the WHP plan, contact the Wellhead Protection Manager at the public water supplier or MDH staff (Appendix B). The term 'infiltration site" refers to any structure or device designed to transfer surface waters to the subsurface. In practice, these facilities range in size from rain gardens designed to handle runoff from residential rooftops to basins collecting runoff from large commercial areas. The scale of the infiltration project, in terms of the volume of stormwater handled, clearly must be considered, along with land use, as part of this review process. MDH generally encourages multiple small-scale infiltration projects distributed over a large site in lieu of one large structure to handle stormwater from a site.

If yes, proceed to Step 4. Yes means that the infiltration site is in close proximity to wells used to supply a public water system. The wellhead protection plan may indicate the travel time in years between the proposed site and the wells. A vulnerable determination (very high, high, or moderate vulnerability) means the aquifer will likely be affected by activities at the ground surface. Hence, the proposed infiltration needs to be considered in more detail.

If no, it is unlikely that the proposed stormwater management project will affect drinking water supplies for a public water supply system (with a defined wellhead area), but the project still must comply with MPCA and local requirements for stormwater handling.

Step 4: **Is the proposed infiltration site within the WHPA of an aquifer that exhibits fracture flow or karst conditions and that has less than 50 feet of unfractured geologic cover?** Aquifers characterized by secondary porosity, such as the Prairie du Chien Dolomite and the Galena Limestone, can display extremely rapid groundwater travel times that can put a well at risk in a matter of hours and can have complicated and tortuous flowpaths that are difficult to predict without special testing. Infiltration of stormwater within WHPAs is not recommended in such settings, especially if karst features exist. However, infiltration might be acceptable if the karst or fractured aquifer is covered by 50 feet or more of other

unfractured materials. The Minnesota Stormwater Manual identifies karst settings as especially problematic in managing stormwater. Appendix B contains web links to the complete stormwater manual, which should be consulted for more background on managing stormwater in karst areas, as well as maps showing the location of Minnesota's karst areas. However, the manual does not specifically cover the issue of stormwater infiltration in wellhead protection areas of a fractured or solution-enhanced aquifer.

If yes, infiltration is generally not appropriate for this setting. Consider other stormwater handling procedures such as stormwater retention and conveyance outside of the WHPA or moving the infiltration area to a non-vulnerable part of the DWSMA. Additional handling alternatives are presented in the Minnesota Stormwater Manual (see reference in Appendix B). For more information, discuss with MDH subject matter experts or the hydrologist or planner for the DWSMA or with stormwater staff at the MPCA.

If no, proceed to Step 5.

Step 5: **Is the proposed infiltration site within the ERA (1-year time-of-travel area) and the vulnerability is very high or high?**

If yes, infiltration is generally not appropriate in this setting. A 1-year travel time is significant for several reasons. Most pathogens are not viable in the groundwater after this time period. So a 1-year travel time represents a margin of safety that will likely allow pathogens and some other contaminants to attenuate or, additionally, sufficient time for local authorities to react. Extenuating circumstances here might be the presence of a sufficiently thick unsaturated zone between the water table and the base of the infiltration site that would allow for pathogen attenuation to take place. For more information, discuss with MDH subject matter experts or the hydrologist or planner for the DWSMA or with stormwater staff at the MPCA.

If no, proceed to Step 6.

Step 6.
Is the proposed infiltration site within the ERA and the vulnerability is moderate, or outside the ERA (but still inside the WHPA) and the vulnerability is high or very high? Infiltration may be appropriate within a WHPA but outside the ERA, even where the vulnerability is very high or high, because of the limitations on the viability period of pathogens in groundwater described above. Moderate vulnerability generally implies vertical travel times from the land surface to aquifer in question of years (Geologic Sensitivity Project Workgroup, 1991). While such times of travel are generally sufficient to protect drinking water aquifers from pathogen contamination due to their limited viability period in the subsurface, there may be factors that need to be taken into account when assessing the appropriateness of stormwater infiltration in these settings. These may include proximity to the well(s), types of land uses drained and their BMPs, and any past history of aquifer impacts related to stormwater infiltration. For more information, discuss with MDH subject matter experts or the hydrologist or planner for the DWSMA or with stormwater staff at the MPCA.

If yes, proceed to Step 7.

If no, it is unlikely that the proposed stormwater management project will affect drinking water supplies for a public water supply system (with a defined wellhead area), but the project still must comply with MPCA and local requirements for stormwater handling.

Step 7: Will runoff from Potential Stormwater Hotspots (PSHs), as defined in the Minnesota Stormwater Manual, or runoff from highways enter the infiltration practice?

Classify the predominant land use upgradient of the infiltration site into one of the following categories:
1. Commercial and industrial;
2. Transportation corridors;
3. Forest, parkland, open space;
4.Residential;

5. Golf course, active agricultural (i.e., cropland, feedlots).
Stormwater infiltration in commercial and industrial areas, as well as in transportation corridors is only appropriate if the collection and infiltration system is designed to allow spill containment. MPCA permitting requirements currently prohibit infiltration from industrial areas containing exposed potential contaminant sources or from vehicle fueling or maintenance areas. Categories 3 through 5 represent land uses from which infiltrated runoff is not as likely to contain contaminants that may adversely affect human health if introduced into a drinking water supply, although this may depend on 1) the degree to which land management BMPs have been adopted, and 2) stormwater pretreatment measures. The use of stormwater infiltration devices may be acceptable in areas where they would otherwise be inappropriate if flows from, say, rooftop drainage could be collected for infiltration separate from runoff from industrial areas.

The land use categories presented here are quite broad and there will be differences in the kinds of contaminants that could be generated in runoff from each. The Minnesota Stormwater Manual contains a lengthy discussion (chapter 13) about PSHs, which are land uses that have the potential to affect the water quality of stormwater. The Minnesota Stormwater Manual describes conditions under which infiltration of runoff from land uses containing PSHs as a practice is not appropriate.

Users of this guidance should be familiar with the PSHs identified in the Minnesota Stormwater Manual as a means of providing context for evaluating general land uses. While the manual identifies many PSHs, the list is not exhaustive, and each land use should be considered on its own merits.

If yes, go to Step 8.

If no, proceed according to state and local stormwater requirements.

Step 8: A**re infiltration guidelines in the Minnesota Stormwater Manual followed?**

Infiltration practices require scrutiny prior to implementation at a PSH. Preventing the introduction of contaminated runoff to groundwater is an essential consideration in developing effective stormwater management plans at PSHs. With appropriate site and conveyance design it is possible to incorporate infiltration into many sites to treat areas sufficiently separated from pollutant generating activities. Most design modifications are simple and in the form of enhanced pretreatment, over-design, or design redundancies. Others are added features that limit the likelihood of groundwater recharge. For example, practice groups such as bioretention, ponds and wetlands that receive runoff from pollutant generating activities should be designed with the necessary features to minimize the chance of groundwater contamination. This includes using impermeable liners. The use of ponds and wetlands without liners should also be avoided where water tables are shallow and the practice would likely intercept the water table. Where uncertainty is present, designers should avoid infiltration practices. The Minnesota Stormwater Manual contains infiltration guidelines for potential stormwater hotspots.

If yes, proceed according to state and local stormwater requirements.

If no, infiltration is not appropriate in this setting.

Special Situations
Certain circumstances may dictate a response to the proposed infiltration different from the recommendations of this guidance. For instance, a project involving the infiltration of volumes of water that are large relative to the amount pumped by a nearby well may leave little room for natural processes to dilute the stormwater. Or perhaps specialized predictive tools, such as a groundwater flow model, are available that can help to forecast the effects of the infiltration. Such tools may make it easier to interpret likely effects of the proposed infiltration. While it is impossible to predict all such extenuating circumstances, it will be the role of the user to decide how to incorporate such conditions in the analysis of site-specific infiltration proposals.

Contacting Minnesota Department of Health Staff

Appendix B lists various resources available to help work through this guidance, including MDH staff contacts. MDH hydrologists and planners are generally assigned to specific regions of the state (see Appendix B) but additional assistance is available by calling the Source Water Protection Unit at 651-201-4700.

References

1. Geologic Sensitivity Project Workgroup (1991), *Criteria and guidelines for assessing geologic sensitivity of ground water resources in Minnesota*, Minnesota Department of Natural Resources, Division of Waters, St. Paul, Minn., 122 p.
2. Gulliver, J.S., Weiss, P.T., Nieber, J.L. and Arika, C., 2012, *Pollution of Drinking Water Aquifers Due to Infiltration*. Presentation to the Minnesota Groundwater Association Spring Conference, April, 2012.
   Gulliver, J.S., 2015, *Role of Green Infrastructure in Groundwater Protection: A Local Perspective*. Presentation to the University of Minnesota Extension Clean Water Summit, September, 2015.

Appendix A

Flowchart for determining stormwater siting requirements in Drinking Water Supply Management Areas: http://stormwater.pca.state.mn.us/index.php/File:Flow_Chart_-_MDH_Stormwater_Guidance_for_Sites_in_Drinking_Water_Supply_Management_Areas_1.png

Appendix B

Minnesota Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Stormwater_Manual_Table_of_Contents

MDH Subject Matter Experts:

- John Woodside (Hydrologist, 651-201-4658, john.woodside@state.mn.us)
- Pat Bailey (Planner, 507-206-2741, pat.bailey@state.mn.us)

MDH Hydrologists by Region: http://www.health.state.mn.us/divs/eh/water/org/swpstaffmap.pdf