**REPORT for OBJ2.TASK 5: STORMWATER PRE-TREATMENT**

To: MPCA

From: The Kestrel Design Group Team (The Kestrel Design Group Inc, with Dr. William Hunt, PE, Ryan Winston, PE, Dwayne Stenlund – Minnesota Department of Transportation, Dr. John Gulliver, PE – University of Minnesota)

Date: July 31, 2013

Re: Contract CR5332 Objective 2 Task 5

**SCOPE PER FEBRUARY WORKSHOPS MEETING MINUTES:**

“wait to see what Barr sends on pretreatment and then look for gaps”

# Importance of Pre-Treatment

Pre-treatment is needed to protect bioretention cells from the build-up of trash, gross solids, and particulate matter. When the velocity of stormwater decreases, sediment and solids drop out. If pre-treatment is not provided, this process will occur in the bioretention cell, resulting in long-term clogging and poor aesthetics. Therefore, pre-treatment is a required part of bioretention design. There are three typical methods, detailed below, for bioretention pre-treatment: vegetated filter strips (VFS), forebays, and vegetated swales.

The type of vegetation in the bioretention cell determines the appropriate flow velocity for which the pre-treatment device should be designed. For tree-shrub-mulch bioretention cells, velocity through the pre-treatment device should not exceed 1 ft/s, which is the velocity that causes incipient motion of mulch. For grassed bioretention cells, flow velocity through the pre-treatment device is not to exceed 3 ft/s. In all cases, appropriate maintenance access should be provided to pre-treatment devices.

# Vegetated Filter Strips (VFS)

Note: this section is not a comprehensive discussion of Vegetated Filter Strips, but complements the section on Vegetated Filter Strips in the memorandum on “Selected Pretreatment Devices” produced by Barr Engineering, dated May 31, 2013.

Vegetated filter strips should receive sheet flow from the watershed; this may be provided through grading of the parking lot or roadway or by providing an appropriate flow-spreading device. Vegetated filter strips convey flow from the parking lot or drainage area to the bioretention cell at a slope not to exceed 8%. Field experience has shown that steeper slope applications result in erosion unless well vegetated. When concentrated flow enters a bioretention cell (i.e. from a pipe or flow diversion structure), another method of pre-treatment should be used. When using a VFS as pretreatment, it is recommended to use wheel stops that allow water to sheet flow underneath them to prevent the formation of concentrated flow between wheel stops.

Vegetated filter strip can be edged with a gravel verge at the upper edge. The gravel verge (if utilized) should be a minimum of 8 inches in width with a minimum gravel depth of 3 inches. There should be a 1-2 inch drop from the parking lot to the gravel verge or vegetated filter strip to allow for sediment accumulation as well as accretion of the vegetated filter strip.

If a gravel verge is not included, it is particularly crucial to use wheel stops that allow water to sheet flow underneath them to prevent the formation of concentrated flow between wheel stops.

Flow should not be directed to a filter strip before vegetation is established.

Vegetation can range from turf grass to woody species with native herbaceous species.

The University of Minnesota’s Sustainable Urban Landscape Series website provides guidance for turf species selection at:  <http://www.sustland.umn.edu/maint/maint.htm>.

The Minnesota Crop Improvement Association has developed production requirements for salt tolerant turf seed and sod available at: http://www.mncia.org/assets/documents/pub/sod/Production\_Requirements\_MNST-12-Sod.pdf

The minimum vegetated filter strip width is 3 feet, which is based upon research showing that the majority of sedimentation occurs during this portion of the filter strip. For filter strips with slopes <10%, Lantin and Barrett (2005) showed that a width of 14 feet resulted in irreducible concentrations for sediment and heavy metals in highway runoff. For slopes between 10-35%, highway filter strips in CA produced irreducible concentrations after 15 feet. These results suggest that the current 10-20 foot filter strip width could be reduced to a maximum of 15 ft. The vast majority of the pollutant removal in this study occurred within the first 3 ft of the filter strip (Lantin and Barrett 2005). Substantial sediment reductions from filter strips as short as 3 ft have also been observed in agricultural settings (Van Dijk et al. 1996; Blanco-Canqui et al. 2004). Therefore, filter strips for pretreatment should be between 3-15 feet wide. Filter strips greater than 15 feet in width will provide diminishing marginal utility on the installation cost.

If the VFS is vegetated with turf, the turf will be healthier and better able to reduce flow velocity, thereby increasing particle settling, if it is not mowed too short. The University of Minnesota’s Sustainable Urban Landscape Series website provides guidance for turf mowing heights at:  <http://www.sustland.umn.edu/maint/maint.htm>.

Accumulated sediment should be removed from the gravel verge (if applicable) and vegetated filter strip approximately quarterly. If the watershed is especially dirty, this frequency may need to be increased to monthly. Trash removal should occur in conjunction with removal of debris from the bioretention cell, at least quarterly. During quarterly maintenance, check for erosion in the filter strip. If it is visible, it should be repaired with topsoil and re-planted.

If, over time, the grade of the vegetated filter strip rises above the adjacent impervious surface draining into it, the grade of the vegetated filter strip needs to be lowered to ensure proper drainage.

# Flow-Through Structures

Note: this section is not a comprehensive discussion of Flow-Through Structures, but complements the section on Flow-Through Structures in the memorandum on “Selected Pretreatment Devices” produced by Barr Engineering, dated May 31, 2013.

Another proprietary flow-through pretreatment structure designed specifically for bioretention is the Rainguardian, made in Minnesota. It is a drop box with both a grate and a filter to capture sediment and debris (See Figures 1-3).

INSERT FIGURE 5.1: Schematic Drawing of Commercial/Industrial Rainguardian Bioretention Pretreatment Structure (Adapted from http://www.rainguardian.biz/images/Handouts/Rain%20Guardian%20Pretreatment%20Chambers.pdf)

INSERT FIGURE 5.2: Schematic Drawing of Residential Raingarden Pretreatment Structure (Adapted from http://www.rainguardian.biz/images/Handouts/Rain%20Guardian%20Pretreatment%20Chambers.pdf)

INSERT FIGURE 5.3: Examples of Commercial and Residential Pretreatment Structure Installations (Image from http://www.rainguardian.biz/index.php?option=com\_content&view=article&id=52&Itemid=98)

Advantages include:

* Provides inlet protection and at the same time captures leaf litter, coarse debris, and sediment
* It includes overflow points to prevent inlet debris from causing bypass before maximum volume capacity is reached.
* Easy maintenance: sediment and debris can be removed with a shovel, filter can be cleaned with a broom or hose
* Can be customized to fit project needs

More information, including details, installation guidance, and pricing are available at:

http://www.rainguardian.biz/ (current as of July 31, 2013)

# Forebays

Forebays can be used for pre-treatment when concentrated flow enters a bioretention cell. Forebays generally accept flow from a pipe or curb cut, and provide stilling, sedimentation, and gross pollutant filtration. They have two specific regions: one for dissipation of velocity and one for sedimentation (Figure 4). The energy dissipation zone is located immediately adjacent to the pipe or conveyance, and should be 12-18 inches deep. The forebay should then taper to a 6-9 inch depth adjacent to the bioretention cell, which provides a zone for sedimentation to occur. The plan view size of the forebay should be approximately 10% of the size of the bioretention cell. Length to width ratio should be 2:1.

Forebays are typically lined with a non-woven geotextile and rip-rap that has been sized per MnDOT standards. An underdrain may be provided beneath the forebay to allow for dewatering between storm events to reduce the potential for mosquito habitat. Forebays may also be lined in concrete, which allows for easier maintenance when removing sediment and trash. Weep holes in the concrete should be provided to drain the forebay between storm events. Maintenance of forebays typically involves removal of accumulated trash and sediment, usually using a small excavator. Maintenance should be performed when the forebay is half-full with gross solids or more frequently; frequency of maintenance will depend on the amount of sediment and trash generated by the watershed.

INSERT Figure 5.4: Cross sectional view of bioretention forebay

A proprietary product such as Scourstop can often be used as an alternative to rip rap for pretreatment forebays. Scourstop transition mats are semi rigid, high density polyethylene mats that are installed over sod or turf re-inforcement mats and secured with anchors. See manufacturer’s website for details and engineering guidance: http://www.erosion-management.com/scourstop.asp

INSERT Figures 5-7:

Figure 5.5: Schematic Drawing of Scourstop function (from http://www.erosion-management.com/Content/documents/scourstop-brochure.pdf)

Figure 5.6: Schematic Drawing of Scourstop close-up (from http://www.erosion-management.com/Content/documents/scourstop-brochure.pdf)

Figure 5.7: Example of Scourstop installation before and after vegetation matures (from http://www.erosion-management.com/Content/documents/scourstop-brochure.pdf)

# Vegetated Swales

Vegetated swales may also be used as a pretreatment device for bioretention cells, particularly in residential areas. They should be designed in accordance with Chapter 12-7, Section 1.6.2 of the Minnesota Stormwater Manual. Grassed swales are open channel conveyances that, when properly vegetated and designed with a shallow slope, provide for sedimentation and trash deposition. Grassed swale maintenance involves removal of debris, accumulated sediment, and trash.

The University of Minnesota’s Sustainable Urban Landscape Series website provides guidance for turf species selection and maintenance, including mowing heights:  <http://www.sustland.umn.edu/maint/maint.htm>.

The Minnesota Crop Improvement Association has developed production requirements for salt tolerant turf seed and sod available at: http://www.mncia.org/assets/documents/pub/sod/Production\_Requirements\_MNST-12-Sod.pdf

# References

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grass strips.” *Hydrological Processes* 10:1069-1080.

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