Example 1A: Grass Drainage Channel BMP

Adding onto Example 1, and examining possible water quality measures:

Examining the benefit of utilizing the existing ditch (Sta. 19+0 RT) as a grass drainage channel Best Management Practice (BMP.) For this BMP we need to calculate the Water Quality Flow (WQF.)

Following the Grass Channel “One-Pager”, the first 150’ of the existing ditch has a slope of about 2%, afterward it becomes steeper, exceeding the 6% maximum criteria. It was decided to utilize trapezoidal grass channel with a 4’ bottom, 3:1 side slopes and a 2% slope. Assuming that channel will have to first be designed (using Stormcad, Flowmaster, or the FHWA Hydraulic Toolbox) to meet the required design storm, freeboard and shear stress requirements, we now need to determine if it meets Water Quality Flow criteria.

Using information about the drainage area to the BMP, the depth and velocity of the Water Quality Flow will be determined. This will be found after a few steps.

Using the WQV/WQF Worksheet found at:

`.\MS4 Water_Quality_Volume__Water_Quality_Flow_Worksheet.xlsx`

Skip the WQV tab that you used to determine the Water Quality Volume for the “Site” in Example 1.
Choose the **BMP WQV WQF** tab.

- Enter the Drainage Area to the BMP.
- Enter the impervious area \((C \geq 0.7)\)

The Water Quality Volume for the BMP will be calculated.

- Enter Time of Concentration \((T_c)\). For this example: Assumed 10 minutes (this is the minimum \(T_c\) that should be used.)

(Inputs are shown in **blue**.)

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**WATER QUALITY VOLUME (WQV) CALCULATION**

<table>
<thead>
<tr>
<th>Drainage Area to BMP ((A))</th>
<th>3.37 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00527 sq mi</td>
</tr>
</tbody>
</table>

**BMP DRAINAGE AREA**

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Impervious Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcatchment-1</td>
<td>0.62</td>
</tr>
<tr>
<td>Subcatchment-2</td>
<td>0.08</td>
</tr>
<tr>
<td>Subcatchment-3</td>
<td>0.00</td>
</tr>
<tr>
<td>Total Impervious</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Design Precipitation \((P)\) = 1 inch

% Impervious Cover \((I)\) = 21

Volumetric Runoff Coefficient \((R)\) = 0.237

\[ WQV = \frac{0.067}{2899} \text{ ac-ft} \]

\[ 1/2 WQV = \frac{0.033}{1449} \text{ ac-ft} \]

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**WATER QUALITY FLOW (WQF) CALCULATION**

**RUNOFF CURVE NUMBER (CN)**

<table>
<thead>
<tr>
<th>Runoff Depth ((Q))</th>
<th>0.237 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN</td>
<td>87</td>
</tr>
</tbody>
</table>

**TIME OF CONCENTRATION \((T_c)\), 10 minute minimum**

\[ T_c = \frac{10}{60} \text{ min} \]

\[ T_c = 0.17 \text{ hours} \]

Initial Abstraction \((I_a)\) = 0.299

\(I_a/P\) Calculation = 0.299

Unit Peak Discharge \((q_u)\) = 520

\[ WQF = \frac{0.65}{0.520} \text{ cfs} \]

\[ 1/2 WQF = \frac{0.32}{0.520} \text{ cfs} \]
Everything will be calculated except for Unit Peak Discharge (qu), which will have to be looked up using Exhibit 4-111 using the calculated Initial Abstraction (Ia).

WQF has been calculated and is now used to determine if Grass Channel BMP criteria are met for depth and velocity.

Use the **Trapezoidal Channel Calculator** tab (or any of the previously mentioned Hydraulic programs to determine these parameters for your calculated WQF.

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Note: For determining the 10 or 25-year flow capacity of a grass channel, typically a Manning’s “n” of 0.03 will be used. The depth of the water quality flow is shallow (in the order of an inch.) A good stand of natural grass in a channel may present a Manning’s “n” of 0.05 - 0.08 to a shallow water flow (HEC-15.)

From the Stage/Discharge Table, Grass Channel criteria is met:
- depth will be less than 4”
- velocity less than 1 fps
Editing the Example 1 Worksheet to add the Grass Channel:

It has been determined by the above work that all Design Considerations/Criteria in the Grass Channel one-pager are met. Therefore treatment and disconnection credits apply:

**Full WQV: 15% treatment and 15% Disconnection Credit**

(This example has a Full WQV Goal since the “Total Site” was <40% impervious cover.)

The WQV for the drainage area to the Grass Channel was previously calculated to be 0.067

\[
\text{WQV} \times 15\% = 0.067 \times 0.15 = 0.01 \text{ ac-ft}
\]

Entering this value into Section 4 of the Example 1 Worksheet:

![Section 4: Stormwater BMP Selection Summary](image)

The total WQV treated will be entered into DC3 on the front page.
Finally determining the value for DC5 Post-construction DCIA:

This value will be the disconnection credit = 15% of the amount of the impervious area contained in the drainage area to the Grass Channel BMP:

\[
\text{Impervious Area to BMP} \times 15\% = 0.70 \text{ ac} \times 0.15 = 0.11 \text{ ac}
\]

This calculated value will be subtracted from the Post-construction Directly Connected Impervious Area entered in DC5. For Example 1, DC5 was 0.66 ac, which yielded a slight increase of 0.04 ac for DCIA. Adding the Grass Channel, it will now be 0.66 - 0.11 = 0.55 ac. Therefore, there is now a slight decrease in DC7 shown below. This is more in the direction of what the Department needs to do for MS4!

<table>
<thead>
<tr>
<th>Water Quality Calculations</th>
<th>30% Design</th>
<th>60% Design</th>
<th>90% Design</th>
<th>FDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC1 WQV retention design goal</td>
<td>ac-ft</td>
<td>0.079 ac-ft</td>
<td>ac-ft</td>
<td>ac-ft</td>
</tr>
<tr>
<td>DC2 WQV goal retained (refer to page 2)</td>
<td>ac-ft</td>
<td>0.012 ac-ft</td>
<td>ac-ft</td>
<td>ac-ft</td>
</tr>
<tr>
<td>DC3 WQV goal treated (refer to page 2)</td>
<td>ac-ft</td>
<td>0.022 ac-ft</td>
<td>ac-ft</td>
<td>ac-ft</td>
</tr>
<tr>
<td>DC4 Total WQV retained and treated</td>
<td>ac-ft</td>
<td>0.034 ac-ft</td>
<td>0 ac-ft</td>
<td>0 ac-ft</td>
</tr>
<tr>
<td>DC5 Post-construction DCIA(acres)</td>
<td>ac-ft</td>
<td>0.55 ac-ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC6 Pre-construction DCIA (refer to EC2 above)</td>
<td>ac-ft</td>
<td>0.62 ac-ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC7 Change in DCIA from pre- to post-construction</td>
<td>ac-ft</td>
<td>-0.07 ac-ft</td>
<td>0 ac-ft</td>
<td>0 ac-ft</td>
</tr>
</tbody>
</table>

Note: Grass Channels are better than culverts or paved channels for treating water quality, but as can be seen from this example, they provide very little treatment of WQV and no retention (since channels are designed for conveyance. But they can be used to build upon. (ie: stone check dams, infiltration swale...)}
