CITY OF FRANKLIN STORMWATER MANAGEMENT WATER QUALITY DESIGN TOOL

SDS-SWQ Version 1.0

INSTRUCTIONS FOR USE

Those who use this software are responsible for ensuring that they have obtained the most current version from the City of Franklin, Stormwater Department.

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What is the Software?

The Site Development Software – Stormwater Quality (SDS-SWQ) is a tool that allows both developers and review staff to quickly evaluate whether proposed developments are meeting water quality treatment requirements in the City of Franklin. When the required information about a proposed development is entered into the software, the software calculates the quality of stormwater runoff from the site.

All new developments and redevelopments are required to achieve the goal of an 80 percent reduction in the average annual Total Suspended Solids (TSS) load that leaves the site. Both non-structural, low-impact development methods included in the City of Franklin Stormwater Management Manual and structural stormwater controls included in the Metro Nashville Stormwater Management Manual may be used. With the software, you can quickly try different options for meeting Franklin's water quality requirements.

Assumptions

1. One Drainage Area

The Software assumes that *all* of the runoff from the site drains to one drainage area, stream, or water body. Therefore, **if your development lies in two or more watersheds**, the site should be divided according to these watersheds and a separate copy of the software should be used and submitted for each of the watersheds.

The software's calculations are based on the following equations and variables:

2. Land Use Type

All area entered into the spreadsheet shall be in acres. There are three types of land use that can be entered into the spreadsheet (under drainage areas):

- Impervious Area (IA) - The planned impervious (paved or covered) area. This includes streets and roadways, sidewalks, buildings, parking areas, structures, homes, driveways, walkways, patios, and all other surfaces that do not allow the infiltration of rainwater. For residential developments in which the exact impervious area has not yet been determined, average percent

impervious areas shown in Table 1, below, may be used to determine the impervious acreage for the site. (An example problem is presented below the table.)

- Disturbed Pervious Area (DP) -- All other areas that will be cleared/graded and revegetated.
- Natural Conservation Area (NC) - The area that will be left in an undisturbed natural vegetated state in perpetuity. (This type of use must fulfill certain criteria and is covered under **Water Quality Treatment Through Non-structural Controls** below.)

Table 1. Average Percent Impervious Area for Residential Developments
(Source: Metro Stormwater Management Manual Volume 2, Chapter 2, Table 2-5)

Residential Districts by Average Lot Size	Average Percent Impervious Area
1/8 acre or Less (town houses)	65
¼ acre	38
1/3 acre	30
½ acre	25
1 acre	20
2 acres	12

Example: Estimating Impervious Acreage based on Average Percent Impervious Area.
The example property is a 20-acre residential development with ½-acre lots. The average impervious percentage for ½-acre lot residential developments from Table 1 is 25%. Impervious acreage for the site is 20 acres * 0.25, or 5 acres.

3. Cumulative TSS Removal for the Site

The TSS reduction on the site is computed as follows:

$$CumulativeTSS = \frac{[(A1 * A1R) + (A2 * A2R) + ...]}{(A1 + A2 + ...)}$$

Where:
Cumulative TSS = the cumulative TSS removal for the site
A = area (acres) of drainage area
R = the TSS removal of the drainage area

4. Water Quality Volume Calculation

This calculation yields a volume of water (acre/feet) that is to be treated for water quality on each site. The calculation is based on two principles. 1) Small, frequent storms produce the most polluted runoff, and any water quality treatment standard should require treatment of the most polluted runoff. Some methodologies refer to this runoff as the first flush, but Franklin has adopted a somewhat more specific standard, treating the 85th percentile storm. In Franklin, this storm is 1.1 inches of rainfall. 2) As imperviousness on a site increases, the resulting degradation to water quality increases. Therefore, the amount of imperviousness on a site is factored into the water quality volume (WQv) equation through Rv, the runoff coefficient. As imperviousness increases, the amount of water that must be treated on a site increases.

$$WQv = P \times Rv \times \frac{A}{12}$$

Where:
WQv = water quality treatment volume, ac-ft
P = rainfall for the 85% storm event (1.1 in)

Rv = runoff coefficient (see below)
A = site area, ac

$$Rv = 0.015 + 0.0092 * I$$

Where:
I = site impervious cover, % (50% imperviousness would be 50)

5. Water Quality Treatment Through Non-structural Controls

Non-structural controls are not physical structures, but are BMPs designed to limit the amount of pollutants that would potentially end up in stormwater runoff. Non-structural BMPs typically lessen the need for the more costly structural BMPs. Franklin encourages the use of non-structural controls on site through low impact site design practices.

Low impact design is *implicitly* encouraged through the WQv equation, since the volume of water to be treated decreases as the impervious cover decreases. In addition, low impact design is *explicitly* encouraged since developers can use certain non-structural controls to decrease the amount of the WQv that is required for the site. Each non-structural control must meet specific design criteria in order to adjust (decrease) the water quality volume. The criteria are detailed in the City of Franklin Stormwater Management Manual, Section 1.5.

The non-structural controls and method used to decrease the WQv are as follows:

Site Design Credit #1: Natural Area Conservation: Undisturbed natural area(s) in the drainage area that is conserved and protected in its existing vegetated state.
To be credited:

- Conservation area cannot be disturbed during project construction.
- The limits of disturbance around the conservation area must be clearly shown on all construction drawings and staked in the field.
- Areas must be located within an acceptable conservation easement or other legal instrument that ensures **perpetual** protection of the proposed area. The easement or legal instrument must clearly specify how the natural area vegetation will be managed and boundaries will be marked. Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management.
- Areas must have a minimum contiguous area of 10,000 square feet.
- **Credit can also apply to waterway buffers** if they meet these requirements and those of the City of Franklin Stormwater Management Ordinance.

The Natural Area Conservation credit decreases the WQv as follows:

- The runoff coefficient, Rv, remains constant (as if there were no Natural Area Conservation).
- When the WQv is calculated, however, the area (A) that is in a Natural Area Conservation easement is subtracted from the area (A). So, for instance, if the total area of development is 5 acres and 2 acres are in Natural Area Conservation, the A for calculating the WQv would be 5 acres – 2 acres = 3 acres

The Natural Area Conservation credit counts towards the pollutant removal goal as follows:

- The area that is in Natural Area Conservation receives 100% TSS reduction.

Site Design Credit #2: Drains to Buffer: Area that drains to and is effectively treated by a buffer.
To be credited:

- The minimum undisturbed buffer width shall be 50 feet or the width set forth in the Stormwater Management Ordinance, whichever is greater.
- Runoff must reach the buffer as overland sheet flow.
- The maximum contributing length shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces.

- The average contributing slope shall be no more than 3% unless a flow spreader is used.
- This credit can not be used if the overland flow filtration credit is being used for the same area.
- Buffers shall remain unmanaged other than routine debris removal, where roots are left intact.

The Drains to Buffer credit decreases the WQv as follows:

- The runoff coefficient, Rv, remains constant (as if there were no credit used).
- When the WQv is calculated, however, the area (A) that drains to the buffer via overland sheet flow is subtracted from the area (A). So, for instance, if the total area of development is 5 acres and 2 acres drain to the buffer, the A for calculating the WQv would be 5 acres – 2 acres = 3 acres.

The Drains to Buffer credit counts towards the pollutant removal goal as follows:

- The area that drains to the buffer receives 80% TSS reduction.

Site Design Credit #3: Specially Engineered Vegetated Channels: Portion(s) of the drainage area treated by specially designed vegetated (grass) channels.
To be credited:

- The credit shall only be applied to moderate or low density residential land uses (3 dwelling units per acre maximum).
- The maximum flow velocity for water quality design storm shall be less than or equal to 1.0 feet per second.
- The minimum residence time in the channel for the water quality storm shall be 5 minutes.
- The channel bottom width shall be a maximum of 6 feet. If a larger channel is needed, use of a benched or compound cross section is required
- The channel side slopes shall be no steeper than 3:1 (horizontal: vertical).

The Specially Engineered Vegetated Channel credit decreases the WQv as follows:

- The runoff coefficient, Rv, remains constant (as if there were no credit used).
- When the WQv is calculated, however, the area (A) that is in a Vegetated Channels credit is subtracted from the area (A). So, for instance, if the total area of development is 5 acres and 2 acres drain to specially designed vegetated channels, the A for calculating the WQv would be 5 acres – 2 acres = 3 acres.

The Specially Engineered Vegetated Channel credit counts towards the pollutant removal goal as follows:

- The area that drains to vegetated channels receives 80% TSS removal.

[NOTE: This credit *cannot* be taken if grass channels are being used as a structural control for the same portion of the drainage area.]

Site Design Credit #4: Overland Flow Filtration: Portion(s) of the drainage area such as rooftops, driveways or small parking lots that drain to pervious, vegetated areas and those areas themselves.
To be credited:

- Relatively permeable soils (hydrologic soil groups A and B) must be present.
- Runoff cannot come from car washes, car care facilities, landfills, junk yards, gas stations or other land uses that have the potential to have higher than normal pollutant loading.
- The maximum contributing impervious flow path length shall be 75 feet.
- Downspouts shall be at least 10 feet away from the nearest impervious surface to discourage “re-connections”.
- The disconnection shall drain continuously through a grass channel, swale, or filter strip to the property line or structural stormwater control.
- The length of the “disconnection” shall be equal to or greater than the contributing impervious flow path length.
- The entire vegetative “disconnection” shall be on a slope less than or equal to 3 percent.
- The maximum impervious area discharging to any one overland flow filtration zone shall not exceed 5,000 square feet.

- For those areas draining directly to a buffer, either the Overland Flow Filtration Credit or the Drains to Buffer Credit can be used.

The Overland Flow Filtration credit decreases the WQv as follows:

- The runoff coefficient, Rv, remains constant (as if there were no credit used).
- When the WQv is calculated, however, the pervious area (A) that drains via overland flow to overland flow filtration zone and the zone itself is subtracted from the area (A). So, for instance, if the total area of development is 5 acres and 2 acres flow to and are contained within overland flow filtration zones, the A for calculating the WQv would be 5 acres – 2 acres = 3 acres.

The Overland Flow Filtration credit counts towards the pollutant removal goal as follows:

- The area that drains to and is contained within overland flow filtration zones receives 80% TSS removal.

Site Design Credit #5: LID Large Lot Subdivisions: Because the water quality volume treatment requirements and the pollutant removal requirements are waived, there is no direct entry in the software for the LID Large Lot Subdivision credit that is described in Franklin's Stormwater Management Manual. The criteria for this credit:

- The minimum lot size must be 2 acres unless clustering is used.
- Total impervious cover must be less than 15% of the total area.
- Grass channels must be used instead of curb and gutter.
- Runoff from rooftops must be disconnected as overland flow filtration.

6. Water Quality Treatment Through Structural Controls

Structural stormwater controls, or structural BMPs, are engineered structures designed to treat stormwater or mitigate the impact from stormwater runoff. The following table presents a pre-approved listing of structural BMP practices. These BMPs have been assigned a TSS removal capability, based upon existing research, and can be used by developers to meet Franklin's pollutant reduction goal of 80% TSS removal. Design and maintenance information for each BMP type can be found in Permanent Treatment Practices (PTP) Section 6 of Volume 4 of the Metro (Nashville) Stormwater Management Manual. The structural BMPs have been divided into two categories:

- General Application BMPs. These structural BMPs alone can achieve the pollutant removal goal of 80% TSS reduction and have been found to be appropriate for use in middle Tennessee.
- Limited Application BMPs. These structural BMPs
  - must be used in combination with other BMPs to achieve the 80% TSS reduction;
  - require site conditions that are not typically found in middle Tennessee; or
  - require intensive and frequent maintenance in order to function properly.

Structural Stormwater Control Removal Efficiency for Total Suspended Solids (TSS)	
Structural Control	**TSS Removal (%)**
General Application Structural Stormwater Controls	
Stormwater Pond	80
Stormwater Wetland	80
Bioretention Area	80
Surface Sand Filter	80
Water Quality Swales	80
Limited Application Structural Stormwater Controls	
Filter Strip	50
Grass Channel	50

Organic Filter	80
Underground Sand Filter	80
Submerged Gravel Wetland	80
Infiltration Trench	80
Gravity (Oil-Grit) Separator	40
Proprietary Structural Control	Based on Testing (see Volume 1, Section 7.6)
Dry Detention / Dry ED Basin	60
Perimeter Sand Filter	80

7. BMPs in a Series

The software allows for the use of more than one structural control in a series. That is, water may pass through one treatment device, into another in a "treatment train" to achieve added treatment. It is necessary to calculate the cumulative pollutant removal from BMPs in a series with an equation that accounts for the fact that the majority of the heavy (easily removed) suspended pollutants and particulate matter are removed by the first structural control in a series. In other words, the first control removes the "low-hanging fruit." The runoff that enters the second and subsequent controls contains sediment with much smaller particles, which are more difficult for the control to remove. Thus, the second control has a pollutant removal efficiency that is less than it would ordinarily have. The following equation accounts for the cumulative pollutant removal of BMPs in a series.

$$TR = \mathrm{A} + (100 - \mathrm{A}) * \mathrm{B}$$

Where:
TR = Total Removal, in percent
A = % of TSS removal of 1st structural control in series
B = % of TSS removal of 2nd structural control in series

Notes:

1) When runoff flows from a more efficient structure (one with a higher removal rate) to a less efficient structure (one with a lower removal rate), the cumulative pollutant removal of a structure does not increase. The reason is that a structure with a lower removal efficiency that follows a structure with higher removal efficiency does not have an appreciable affect on cumulative pollutant reduction.
2) Runoff can be routed to a structure in another drainage area. The software contains a checkbox area for this circumstance. *Assumption:* The software assumes that *all* of the runoff from the drainage area routes to the second drainage area. Therefore, the checkbox may only be use under this circumstance.

Step by Step Instructions

Step 1. Opening Screen – General Information

The opening screen for the software is the "General Information" screen. In this area, enter the appropriate information in each of the *yellow* boxes. All other information will be calculated automatically by the software after more site information is entered in the "Drainage Area Input" screen.

Step 2. Drainage Area Input

After entering the General Information, click on the "Drainage Area Input" button. Most sites will have multiple subwatershed areas with multiple outlets. Add information about the first drainage area on the Drainage Area 1 (opening) screen. To add information about other drainage areas, simply click the "Add Drainage Area" button on the left hand side of the screen. Then, toggle between the different drainage areas by clicking on the Drainage Area number (for example DA1 or DA2) in the column on the left hand side of the screen, above the "Add Drainage Area" button.

The information that is needed for each drainage area is as follows (information entered, from top left to bottom left of the screen).

1. Impervious Area (see **Assumptions**, above)
2. Disturbed Pervious Area (see **Assumptions**, above)
3. Natural Conservation Area (see **Water Quality Treatment Through Non-structural Controls**, above)

The software will calculate the Total Acres, Percent Impervious, Water Quality Volume, and Adjusted Water Quality Volume, and a preliminary Total TSS Removal (bottom right) from this information.

Then input any area that drains to the following non-structural controls:

1. Buffers
2. Vegetated Channels
3. Overland Flow Filtration / Infiltration Zones

For applicability of these areas refer to **Water Quality Treatment Through Non-structural Controls.**

The software will recalculate the Adjusted Water Quality Volume, and Total TSS Removal based on this information.

Third, select the structural controls that will be used in the drainage area from the drop-down menus under "Structural Controls." The software assigns each structural control an identification number, creates a tracking form (found under the "Tracking Forms" screen), calculates the "TSS Reduction using Structural Controls" and recalculates Total TSS Reduction using this information.

Finally, if all of the water from one drainage area routes to and is treated by a structural control in another drainage area, check the appropriate box under "Additional Downstream Treatment." The software will make a final recalculation of the Total TSS Reduction using this information. Total TSS Reduction is reflected on the Opening Screen.

Step 3: Additional Calculations

Based on all of the information entered in the drainage areas, the "General" screen (the opening screen or the first page) will calculate the overall land use information and the cumulative TSS removal on the site. The site must achieve a cumulative TSS removal of 80% to comply with Franklin's regulations. A summary of the structural controls used is available at the bottom left of the "General" screen, as well as a summary of the site's removal of pollutants other than TSS.

Step 4: Submittal Documents – Summary Form and Tracking Forms

When the site calculations have been completed so that the site meets the 80% TSS removal goal, as indicated on the "General" screen, the water quality volume calculations are ready for submission to the City of Franklin Engineering Department. These calculations should be submitted with site plans as part of a complete submittal package.

The site information is summarized on the "Project Report" screen. Using the print button, print the "Project Summary" for submission to the City of Franklin. The structural controls information is summarized on the "Structural Control Report" screen. Use the "Print" button to print these forms for submission as well.