TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 8, 2016

RECEIVED

JAN 19 2016

COUNTY ENGINEER

Mr. Daniel Clawson II
Continental Homes of Texas, L.P.
210 West Hutchison Street
San Marcos, Texas 78666

Re: Edwards Aquifer, Comal County

NAME OF PROJECT: Manor Creek Subdivision Units 4-6; Located at the intersection of Hamburg Avenue and Hwy 46; New Braunfels, Texas

TYPE OF PLAN: Request for Approval of a Water Pollution Abatement Plan (WPAP); 30 Texas Administrative Code (TAC) Chapter 213 Edwards Aquifer

Investigation No. 1259127; Regulated Entity No. RN108449968; Additional ID No. 13-15061001

Dear Mr. Clawson:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the WPAP application for the above-referenced project submitted to the San Antonio Regional Office by HMT Engineering and Surveying on behalf of Continental Homes of Texas, L.P. on June 10, 2016. Final review of the WPAP was completed after additional material was received on October 22, 2015, November 10, 2015 and December 23, 2015. As presented to the TCEQ, the Temporary and Permanent Best Management Practices (BMPs) were selected and construction plans were prepared by a Texas Licensed Professional Engineer to be in general compliance with the requirements of 30 TAC Chapter 213. These planning materials were sealed, signed and dated by a Texas Licensed Professional Engineer. Therefore, based on the engineer's concurrence of compliance, the planning materials for construction of the proposed project and pollution abatement measures are hereby approved subject to applicable state rules and the conditions in this letter. The applicant or a person affected may file with the chief clerk a motion for reconsideration of the executive director's final action on this Edwards Aquifer Protection Plan. A motion for reconsideration must be filed no later than 23 days after the date of this approval letter. *This approval expires two (2) years from the date of this letter unless, prior to the expiration date, more than 10 percent of the construction has commenced on the project or an extension of time has been requested.*

PROJECT DESCRIPTION

The proposed residential development will have an area of approximately 95.97 acres. The proposed development will consist of 197 residential units with associated driveways, streets and

sidewalks. Impervious cover for the site totals 36.00 acres (37.51 percent). Project wastewater will be disposed of by conveyance to the existing Gruene Wastewater Treatment Plant owned by the New Braunfels Utilities.

PERMANENT POLLUTION ABATEMENT MEASURES

To prevent the pollution of stormwater runoff originating on-site or upgradient of the site and potentially flowing across and off the site after construction, five partial sedimentation/filtration basins, three grassy swales and 14 engineered vegetative filter strips, designed using the TCEQ technical guidance document, Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices (2005), will be constructed to treat stormwater runoff. The required total suspended solids (TSS) treatment for this project is 32,327 pounds of TSS generated from the 36.00 acres of impervious cover. The approved measures meet the required 80 percent removal of the increased load in TSS caused by the project.

Two sedimentation/filtration basins are proposed for Unit 4. The total capture volume of basin 4-1 is 20,432 cubic feet (12,542 cubic feet required). The filtration system for the basin will consist of 1,050 square feet of sand (1,045 square feet required) meeting ASTM C-33, which is 18 inches thick and an underdrain piping system covered with a minimum two inch gravel layer. The total capture volume of basin 4-5 is 34,286 cubic feet (25,317 cubic feet required). The filtration system for the basin will consist of 2,152 square feet of sand (2,110 square feet required) meeting ASTM C-33, which is 18 inches thick and an underdrain piping system covered with a minimum two inch gravel layer.

Two sedimentation/filtration basins are proposed for Unit 5. The total capture volume of basin 5-1 is 41,474 cubic feet (33,114 cubic feet required). The filtration system for the basin will consist of 2,800 square feet of sand (2,759 square feet required) meeting ASTM C-33, which is 18 inches thick and an underdrain piping system covered with a minimum two inch gravel layer. The total capture volume of basin 5-6 is 36,033 cubic feet (34,214 cubic feet required). The filtration system for the basin will consist of 2,943 square feet of sand (2,851 square feet required) meeting ASTM C-33, which is 18 inches thick and an underdrain piping system covered with a minimum two inch gravel layer.

One sedimentation/filtration basin is proposed for Unit 6. The total capture volume of basin 6-1 is 38,839 cubic feet (38,807 cubic feet required). The filtration system for the basin will consist of 3,234 square feet of sand (3,234 square feet required) meeting ASTM C-33, which is 18 inches thick and an underdrain piping system covered with a minimum two inch gravel layer.

Two grassy swales are proposed for Unit 4. The longitudinal slope of grassy swale 4-2 is 1.00 percent with a bottom width of 2 feet, and side slopes with no greater than a 3:1 ratio. The longitudinal slope of grassy swale 4-7 is 0.50 percent with a bottom width of 5 feet, and side slopes with no greater than a 3:1 ratio. One grassy swale is proposed for Unit 5. The longitudinal slope of grassy swale 5-2 is 2.50 percent with a bottom width of 5.5 feet, and side slopes with no greater than a 3:1 ratio. All of the grassy swales will have at least 80 percent vegetative cover to provide adequate treatment of runoff.

Three 15-foot engineered vegetative filter strips (VFS) are proposed for Unit 4, six for Unit 5 and five for Unit 6. Each VFS shall have a uniform slope of less than 20 percent and vegetated cover of at least 80 percent which will extend along the entire length of the contributing area and will be free of gullies or rills that can concentrate overland flow. The contributing area shall be relatively flat to evenly distribute runoff, and the impervious cover in the direction of flow shall not exceed 72 feet.

Please refer to Table 1, Table 2 and Table 3 below for BMP details. Note that overtreatment is provided by the five sedimentation/filtration basins to compensate for grassy swale removal efficiency and untreated releases.

Table 1 Unit 4 BMPs

Sub-basin	BMP	Total Area (acres)	Impervious Area (acres)	Required TSS Removal (lbs/yr)	Provided TSS Removal (lbs/year)
4-1	Sand Filter	4.67	2.38	2,134	2,202
4-2	Grassy Swale	0.49	0.36	322	289
4-3	VFS	2.38	1.06	952	952
4-4	VFS	1.65	0.68	612	612
4-5	Sand Filter	6.63	3.06	2,744	3,020
4-6	VFS	0.61	0.08	68	68
4-7	Grassy Swale	0.68	0.55	495	437
4-15	Untreated release	1.37	0.24	217	--
Total		18.48	8.41	7,544	7,580

Table 2 Unit 5 BMPs

Sub-basin	BMP	Total Area (acres)	Impervious Area (acres)	Required TSS Removal (lbs/yr)	Provided TSS Removal (lbs/year)
5-1	Sand Filter	12.56	5.77	5,183	5,441
5-2	Grassy Swale	1.02	0.68	610	377
5-3	VFS	0.28	0.07	64	64
5-4	VFS	5.24	0.71	641	641
5-5	VFS	0.83	0.29	257	257
5-6	Sand Filter	14.39	6.66	5,982	6,294
5-7	VFS	3.96	1.43	1,283	1,283
5-8	VFS	2.88	0.57	513	513
5-9	VFS	2.60	0.57	513	513
5-12	Untreated release	0.30	0.20	183	--

5-4A	Untreated release	0.28	0.17	152	--
Total		44.34	17.12	15,381	15,383

Table 3 Unit 6 BMPs

Sub-basin	BMP	Total Area (acres)	Impervious Area (acres)	Required TSS Removal (lbs/yr)	Provided TSS Removal (lbs/year)
6-1	Sand Filter	15.59	6.695	6,009	6,323
6-2	VFS	1.56	0.572	513	513
6-3	VFS	1.68	0.572	513	513
6-4	VFS	1.91	0.857	770	770
6-5	VFS	2.24	0.857	770	770
6-6	VFS	1.55	0.572	513	513
6-8	Untreated release	0.22	0.15	131	--
6-12	Untreated release	0.30	0.20	183	--
Total		25.05	10.47	9,402	9,402

GEOLOGY

According to the geologic assessment included with the application, the site is located within the cyclic and marine members and leached and collapsed members of the Person Formation. Twenty-eight geologic features were assessed by the project geologist. Five of the 28 geologic features were rated sensitive and include the following: S-15, S-38, S-70, S-71 and S-85. A 50 foot natural buffer surrounds each sensitive feature and is shown on the site plan for Unit 4, Unit 5 and Unit 6. In addition, a clear span bridge will protect feature S-38 which is located in a watercourse. The San Antonio Regional Office site assessment conducted on July 23, 2015 revealed that the site was generally as described in the application.

SPECIAL CONDITIONS

I. The permanent pollution abatement measures shall be operational prior to first occupancy within their respective drainage areas.

II. All sediment and/or media removed from the water quality basins during maintenance activities shall be properly disposed of according to 30 TAC 330 or 30 TAC 335, as applicable.

STANDARD CONDITIONS

1. Pursuant to Chapter 7 Subchapter C of the Texas Water Code, any violations of the requirements in 30 TAC Chapter 213 may result in administrative penalties.
2. The holder of the approved Edwards Aquifer protection plan must comply with all provisions of 30 TAC Chapter 213 and all best management practices and measures contained in the approved plan. Additional and separate approvals, permits, registrations and/or authorizations from other TCEQ Programs (i.e., Stormwater, Water Rights, UIC) can be required depending on the specifics of the plan.
3. In addition to the rules of the Commission, the applicant may also be required to comply with state and local ordinances and regulations providing for the protection of water quality.

Prior to Commencement of Construction:

4. Within 60 days of receiving written approval of an Edwards Aquifer Protection Plan, the applicant must submit to the San Antonio Regional Office, proof of recordation of notice in the county deed records, with the volume and page number(s) of the county deed records of the county in which the property is located. A description of the property boundaries shall be included in the deed recordation in the county deed records. A suggested form (Deed Recordation Affidavit, TCEQ-0625) that you may use to deed record the approved WPAP is enclosed.
5. All contractors conducting regulated activities at the referenced project location shall be provided a copy of this notice of approval. At least one complete copy of the approved WPAP and this notice of approval shall be maintained at the project location until all regulated activities are completed.
6. Modification to the activities described in the referenced WPAP application following the date of approval may require the submittal of a plan to modify this approval, including the payment of appropriate fees and all information necessary for its review and approval prior to initiating construction of the modifications.
7. The applicant must provide written notification of intent to commence construction, replacement, or rehabilitation of the referenced project. Notification must be submitted to the San Antonio Regional Office no later than 48 hours prior to commencement of the regulated activity. Written notification must include the date on which the regulated activity will commence, the name of the approved plan and program ID number for the regulated activity, and the name of the prime contractor with the name and telephone number of the contact person. The executive director will use the notification to determine if the approved plan is eligible for an extension.
8. Temporary erosion and sedimentation (E&S) controls, i.e., silt fences, rock berms, stabilized construction entrances, or other controls described in the approved WPAP, must be installed prior to construction and maintained during construction. Temporary E&S controls may be removed when vegetation is established and the construction area is stabilized. If a water quality pond is proposed, it shall be used as a sedimentation basin during construction. The TCEQ may monitor stormwater discharges from the site to evaluate the adequacy of temporary E&S control measures. Additional controls may be necessary if excessive solids are being discharged from the site.
9. All borings with depths greater than or equal to 20 feet must be plugged with non-shrink grout from the bottom of the hole to within three (3) feet of the surface. The remainder of the

hole must be backfilled with cuttings from the boring. All borings less than 20 feet must be backfilled with cuttings from the boring. All borings must be backfilled or plugged within four (4) days of completion of the drilling operation. Voids may be filled with gravel.

During Construction:

10. During the course of regulated activities related to this project, the applicant or agent shall comply with all applicable provisions of 30 TAC Chapter 213, Edwards Aquifer. The applicant shall remain responsible for the provisions and conditions of this approval until such responsibility is legally transferred to another person or entity.
11. This approval does not authorize the installation of temporary aboveground storage tanks on this project. If the contractor desires to install a temporary aboveground storage tank for use during construction, an application to modify this approval must be submitted and approved prior to installation. The application must include information related to tank location and spill containment. Refer to Standard Condition No. 6, above.
12. If any sensitive feature (caves, solution cavities, sink holes, etc.) is discovered during construction, all regulated activities near the feature must be suspended immediately. The applicant or his agent must immediately notify the San Antonio Regional Office of the discovery of the feature. Regulated activities near the feature may not proceed until the executive director has reviewed and approved the methods proposed to protect the feature and the aquifer from potentially adverse impacts to water quality. The plan must be sealed, signed, and dated by a Texas Licensed Professional Engineer.
13. No wells exist on the site. One well is in use and the other has been properly plugged. All water wells, including injection, dewatering, and monitoring wells must be in compliance with the requirements of the Texas Department of Licensing and Regulation under Title 16 TAC Chapter 76 (relating to Water Well Drillers and Pump Installers) and all other locally applicable rules, as appropriate.
14. If sediment escapes the construction site, the sediment must be removed at a frequency sufficient to minimize offsite impacts to water quality (e.g., fugitive sediment in street being washed into surface streams or sensitive features by the next rain). Sediment must be removed from sediment traps or sedimentation ponds not later than when design capacity has been reduced by 50 percent. Litter, construction debris, and construction chemicals shall be prevented from becoming stormwater discharge pollutants.
15. Intentional discharges of sediment laden water are not allowed. If dewatering becomes necessary, the discharge will be filtered through appropriately selected best management practices. These may include vegetated filter strips, sediment traps, rock berms, silt fence rings, etc.
16. The following records shall be maintained and made available to the executive director upon request: the dates when major grading activities occur, the dates when construction activities temporarily or permanently cease on a portion of the site, and the dates when stabilization measures are initiated.
17. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, and construction activities will not resume within 21 days. When the initiation of stabilization measures by the 14th day is precluded by weather conditions, stabilization measures shall be initiated as soon as practicable.

After Completion of Construction:

18. A Texas Licensed Professional Engineer must certify in writing that the permanent BMPs or measures were constructed as designed. The certification letter must be submitted to the San Antonio Regional Office within 30 days of site completion.
19. The applicant shall be responsible for maintaining the permanent BMPs after construction until such time as the maintenance obligation is either assumed in writing by another entity having ownership or control of the property (such as without limitation, an owner's association, a new property owner or lessee, a district, or municipality) or the ownership of the property is transferred to the entity. The regulated entity shall then be responsible for maintenance until another entity assumes such obligations in writing or ownership is transferred. A copy of the transfer of responsibility must be filed with the executive director through San Antonio Regional Office within 30 days of the transfer. A copy of the transfer form (TCEQ-10263) is enclosed.
20. Upon legal transfer of this property, the new owner(s) is required to comply with all terms of the approved Edwards Aquifer protection plan. If the new owner intends to commence any new regulated activity on the site, a new Edwards Aquifer protection plan that specifically addresses the new activity must be submitted to the executive director. Approval of the plan for the new regulated activity by the executive director is required prior to commencement of the new regulated activity.
21. An Edwards Aquifer protection plan approval or extension will expire and no extension will be granted if more than 50 percent of the total construction has not been completed within ten years from the initial approval of a plan. A new Edwards Aquifer protection plan must be submitted to the San Antonio Regional Office with the appropriate fees for review and approval by the executive director prior to commencing any additional regulated activities.
22. At project locations where construction is initiated and abandoned, or not completed, the site shall be returned to a condition such that the aquifer is protected from potential contamination.

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality. If you have any questions or require additional information, please contact Dianne Pavlicek-Mesa, P.G., of the Edwards Aquifer Protection Program of the San Antonio Regional Office at 210-403-4074.

Sincerely,

Lynn Bumguardner, Water Section Manager
San Antonio Region Office
Texas Commission on Environmental Quality

LB/DPM/eg

Enclosures: Deed Recordation Affidavit, Form TCEQ-0625
Change in Responsibility for Maintenance of Permanent BMPs, Form TCEQ-10263

cc: Mr. Chris Van Heerde, C.F.M., P.E., HMT Engineering & Surveying
Mr. Thomas H. Hornseth, P.E., Comal County Engineer
Mr. Garry Ford, P.E., City of New Braunfels
Mr. Roland Ruiz, Edwards Aquifer Authority
TCEQ Central Records, Building F, MC 212

HMT
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RECEIVED
JAN 04 2016
COUNTY ENGINEER

December 14, 2015

Edwards Aquifer Protection Program
Texas Commission on Environmental Quality
14250 Judson Road
San Antonio, TX 78233

RE: Edwards Aquifer, Comal County
Manor Creek Subdivision, Units 4-6; Located on Hamburg Avenue, New Braunfels, Texas
Plan Type: Request for the Water Pollution Abatement Plan (WPAP); 30 Texas Administrative Code (TAC)Chapter 213
EAPP File No. 13-15061001

To Whom it May Concern:

Please find our response to comments made by the Texas Commission of Environmental Quality in regard to the project mentioned above.

1) Upon re-review of the permanent BMP data, additional discrepancies were noted.
   - We acknowledge that additional discrepancies may be noted.
2) Unit 4
   a. For A 4-1, please resolve A_I = 2.32 versus 2.62 acres of impervious cover.
   - The 0.30 acre difference you reference is from impervious cover areas that are not proposed to be treated. Upon a closer examination of the grades for the Emergency Access Road, there are 0.06 acres that goes to the Sand Filter Basin A 4-1. Therefore, we have updated the calculations for that basin and construction plan sheets. Additionally, we have added drainage area A 4-15 to include the remainder (0.24 acres) of the untreated impervious cover areas as a separate item on the summary table. The corresponding change of the attached hard copies is to update the backup calculations and summary tables.
   b. For A 4-2, please resolve A_I = 0.40 versus 0.36 acres of impervious cover.
   - The 0.40 acre number was a typo. It has been changed to be 0.36 acres on the updated summary table.
   c. In addition, overcompensation for under sizing is totally permissible within the same drainage basin.
   - We acknowledge that overcompensation is permissible.

3) Unit 5
   a. For A 5-3, only L_M (80%) can be used for a Vegetative Filter Strip; 64 pounds is the maximum TSS removal for a flow-through VFS.
   - We have revised the calculations to show 64 pounds removed through the VFS. To achieve the 80% TSS removal, we have increased the volume of Sand Basin A 5-1 and shifted the gabion wall within the basin by 3.89 feet.
   b. For A 5-6, please resolve A_I = 6.81 versus 6.87 acres impervious cover.

- The 0.06 acres difference you reference is from impervious cover areas that were not proposed to treated. We have added drainage area A 5-12 to include the untreated impervious cover as a separate item on the Summary Table.

NOTE: While reviewing the calculations, we found that Drainage Area A 5-2 included untreated impervious cover that you did not comment on. Therefore, the impervious cover for this drainage area was reduced from 0.85 acres to 0.68 acres and Drainage Area A 5-4 was added to represent the 0.17 acres that is exiting the site without treatment.

Similarly, the previous calculations included the 0.20 acres of impervious area in Drainage Area A 5-6. Therefore, the impervious cover for Drainage Area A 5-6 was reduced from 6.87 acres to 6.66 acres. The 0.20 acres of impervious area in Drainage Area A 5-12 was added to represent that it is exiting the site without treatment on the summary table.

4) Unit 6
   a. For A 6-1, please resolve A_I = 6.69 versus 7.04 acres impervious cover.
   - The 0.05 acres difference is from impervious cover areas that is proposed to released without treatment. While reviewing the calculations, we found that Drainage Area A 6-1 included untreated impervious cover for Hildeshieim that connects to Manor Creek Unit 5B and the stub street on the east side of the development. The impervious cover for these areas is 0.35 acres. Therefore, the impervious cover for Drainage Area A 6-1 was reduced from 7.04 acres to 6.695 acres and Drainage Areas A 6-8 and A 6-12 were added to represent the 0.35 acres that is exiting the site without treatment.

We believe that everything here is in order, and if you have any further questions or comments, please contact me at (830) 625-8555.

Sincerely,

Chris Van Heerde, PE

Chris Van Heerde, CFM, PE
Sr. Project Manager

Manor Creek Unit 4 Permanent BMP Summary Table									
Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	L_R (lbs)	L_M (lbs)	L_M (lbs) Desired
A 4-1	DA 4.8+DA 4.11	Sand Filter	4.67	4.67	2.38	50.9%	2,453	2,134	2,202
A 4-2	DA 4.12	Grassy Swale	0.49	0.49	0.36	73.3%	289	322	289
A 4-3	DA 4.14	Vegetated Filter Strips	2.38	2.38	1.06	44.6%	988	952	952
A 4-4	DA 4.5	Vegetated Filter Strips	1.65	1.64	0.68	41.3%	636	612	612
A 4-5	DA 4.6+ DA 4.7	Sand Filter	6.63	6.63	3.06	46.1%	3,166	2,744	3,020
A 4-6	DA 4.9	Vegetated Filter Strips	0.61	0.61	0.08	12.4%	77	68	68
A 4-7	DA 4.4	Grassy Swale	0.68	0.68	0.55	81.1%	437	495	437
A 4-15	DA 4.15	Untreated Release	1.37	1.37	0.24	17.7%	-	217	-
Total			**18.48**	**17.10**	**8.41**	**50.0%**	**8,046**	**7,544**	**7,580**
								Required TSS Removal	7,544

Chris Van Heerde, PE
12/22/15

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	23.60	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					141,913	3.26
Total post-development impervious area within the limits of the plan * =	8.41	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.36			64	3,300		211,200	4.85
P =	33	inches			U Channel			
							3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.			Fire Access			
* The values entered in these fields should be for the total project area.							9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8							8.41
							6819	

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 4-1

Total drainage basin/outfall area =	4.67	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	17	3,300		1.29 acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	2.38	acres		44,977		1 03 acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.51					
$L_{M\ THIS\ BASIN}$ =	2134	lbs.		2403		0.06 acres of Fire Access

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	4.67	acres				
A_I =	2.38	acres	# of Lots	SF/Lot		
A_P =	2.29	acres	17	3300		1.29 acres of IC for lots
L_R =	2453	lbs		44,977		1.03 acres of street
				2403		0.06 acres of Fire Access

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 2202 lbs

F = 0.90

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	1.70	inches
Post Development Runoff Coefficient =	0.36	
On-site Water Quality Volume =	10452	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	2090	
Total Capture Volume (required water quality volume(s) x 1.20) =	12542	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	12542	cubic feet	
Minimum filter basin area =	581	square feet	
Maximum sedimentation basin area =	5226	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	1306	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length
Water Quality Volume for combined basins =	12542	cubic feet	2,508.37	5	95	26.40
Minimum filter basin area =	1045	square feet			95	11.00161
Maximum sedimentation basin area =	4181	square feet	For minimum water depth of 2 feet		95	44.00644
	1045	square feet	For Given water depth		95	11.00161
Minimum sedimentation basin area =	261	square feet	For maximum water depth of 8 feet		95	2 750402

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	**0.00**	acres
Impervious Cover in Drainage Area =	**0.00**	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.0205	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 2.38 cfs Error 1 = #DIV/0!
Swale Width= 13.61 ft

Instructions are provided to the right (green comments).

Flow Velocity #DIV/0! ft/s
Minimum Length = #DIV/0! ft

Instructions are provided to the right (blue comments).

Design Width = 16 ft
Design Discharge = 2.74 cfs Error 2 = #DIV/0!
Design Depth = 0.33 ft
Flow Velocity = 0.49 cfs
Minimum Length = 146.69 ft

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.34 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.37 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.37 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0 54)$ = 2591 25 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.5000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project						82288.79		1.889091
County =	Comal							
Total project area included in plan * =	23.60	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					141,913	3.26
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.36			64	3,300		211,200	4.85
P =	33	inches			U Channel			
							3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.			Fire Access			
* The values entered in these fields should be for the total project area.							9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8							8.41

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	A 4-2						
Total drainage basin/outfall area =	0.49	acres	# of Lots		SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres		0	3300	-	acres of IC
Post-development impervious area within drainage basin/outfall area =	0.36	acres			15635	0.36	acres of str
Post-development impervious fraction within drainage basin/outfall area =	0.73						
$L_{M\ THIS\ BASIN}$ =	322	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Grassy Swale
Removal efficiency = 70 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.49	acres					
A_I =	0.36	acres	# of Lots		SF/Lot		
A_P =	0.13	acres		0	3287	-	acres of IC
L_R =	289	lbs			15817	0.36	acres of str

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **289** lbs.

F = **1.00**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **4.00** inches
Post Development Runoff Coefficient = **0.54**
On-site Water Quality Volume = **3859** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **772**
Total Capture Volume (required water quality volume(s) x 1.20) = **4631** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **NA** cubic feet

Minimum filter basin area = **NA** square feet

Maximum sedimentation basin area = **NA** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **NA** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width
Water Quality Volume for combined basins =	**NA**	cubic feet	#VALUE!	5	60
Minimum filter basin area =	**NA**	square feet			60
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet		60
	NA	square feet	For Given water depth		60
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet		60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.49	acres
Impervious Cover in Drainage Area =	0.36	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	0.63	

A_{CS} = cross-sectional area of flow in Swale =	0.95	sf
P_W = Wetted Perimeter =	3.96	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	0.24	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation. $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = 1.86 feet

Q = CiA = 0.34 cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = 0.36 ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = 107.24 feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	0.34 cfs		
Manning's Equation Q =	0.76 cfs	Error 1 =	-0.42
Swale Width=	6.00 ft		

Instructions are provided to the right (green comments).

Flow Velocity	0.36 ft/s
Minimum Length =	107.24 ft

Instructions are provided to the right (blue comments).

Design Width =	6 ft		
Design Discharge =	0.76 cfs	Error 2 =	-0.42
Design Depth =	0.33 ft		
Flow Velocity =	0.32 cfs		
Minimum Length =	97.48 ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3 4. Q = CiA

C = runoff coefficient for the drainage area =	0.56		C = Runoff Coefficient = 0.546 (IC)^2 + 0.328 (IC) + 0.03
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.62	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5· V_{OR} = Q/A

Q = Runoff rate calculated above =	0.62	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ =	388.58	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3. $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	23.60	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					141,913	3.26
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.36			64	3,300		211,200	4.85
P =	33	inches			U Channel			
							3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.			Fire Access			
* The values entered in these fields should be for the total project area.							9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8							8.41

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	A 4-3						
Total drainage basin/outfall area =	2.38	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	14	3300	1.06	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	1.06	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.45						
$L_{M\ THIS\ BASIN}$ =	952	lbs					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7. L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.38	acres					
A_I =	1.06	acres	# of Lots	SF/Lot			
A_P =	1.32	acres	14	3300	1.06	acres of IC for lots	
L_R =	988	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 952 lbs.

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.33	
On-site Water Quality Volume =	7962	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1592	
Total Capture Volume (required water quality volume(s) x 1.20) =	9554	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = *i* =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 = #DIV/0!
Swale Width=	6.00	ft	

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.28		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.31	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.31	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ =	1160.50	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	23.60	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					141,913	3.26
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.36			64	3,300		211,200	4.85
P =	33	inches			U Channel			
							3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.			Fire Access			
							9222	0.21

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 8 — 8.41

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 4-4

Total drainage basin/outfall area =	1.65	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	9	3300	0.68	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.68	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.41						
$L_{M\ THIS\ BASIN}$ =	612	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.64	acres					
A_I =	0.68	acres	# of Lots	SF/Lot			
A_P =	0.96	acres	9	3300	0.68	acres of IC for lots	
L_R =	636	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 612 lbs

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.31	
On-site Water Quality Volume =	5242	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1048	
Total Capture Volume (required water quality volume(s) x 1.20) =	6290	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.26		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.28	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.28	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X 0.54)$ =	747.88	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	23.60	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres			141,913	3.26	
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.36		64	3,300	211,200	4.85	
P =	33	inches		U Channel			
					3,787	0.09	
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.		Fire Access			
					9222	0.21	
Number of drainage basins / outfalls areas leaving the plan area =	8					8.41	

* The values entered in these fields should be for the total project area.

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 4-5

Total drainage basin/outfall area =	6.63	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	23	3300	1.74	acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	3.06	acres		57265	1.31	acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.46					
$L_{M\ THIS\ BASIN}$ =	2744	lbs				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	6.63	acres				
A_I =	3.06	acres	# of Lots	SF/Lot		
A_P =	3.57	acres	23	3300	1.74	acres of IC for lots
L_R =	3166	lbs		57399	1.32	acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 3020 lbs.

F = 0.95

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.60	inches
Post Development Runoff Coefficient =	0.34	
On-site Water Quality Volume =	21097	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	4219	
Total Capture Volume (required water quality volume(s) x 1.20) =	25317	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	25317	cubic feet	
Minimum filter basin area =	1172	square feet	
Maximum sedimentation basin area =	10549	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	2637	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length
Water Quality Volume for combined basins =	25317	cubic feet	5,063.39	5	90	56.26
Minimum filter basin area =	2110	square feet			90	23.4416
Maximum sedimentation basin area =	8439	square feet	For minimum water depth of 2 feet		90	93.76641
	2110	square feet	For Given water depth		90	23.4416
Minimum sedimentation basin area =	527	square feet	For maximum water depth of 8 feet		90	5.860401

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 1.20 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	1.20	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.51	cfs	
Minimum Length =	154.12	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.30		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.33	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.33	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ =	3344.38	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	$V_{o/}$
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	23.60	acres			Streets		141,913	3.26
Predevelopment impervious area within the limits of the plan * =	0.00	acres						
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.36		64		3,300		211,200	4.85
P =	33	inches			U Channel			
							3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs			Fire Access			
							9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8							8.41

* The values entered in these fields should be for the total project area.

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 4-6

Total drainage basin/outfall area =	0.61	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	1	3300	0 08	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.08	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.12						
$L_{M\ THIS\ BASIN}$ =	68	lbs					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.61	acres					
A_I =	0.08	acres	# of Lots	SF/Lot			
A_P =	0.53	acres	1	3300	0.08	acres of IC for lots	
L_R =	77	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 68 lbs.

F = 0.89

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 1.60 inches
Post Development Runoff Coefficient = 0.15
On-site Water Quality Volume = 516 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 103
Total Capture Volume (required water quality volume(s) x 1.20) = 619 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = NA cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{cs} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_w = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{cs}/P_w =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{cs} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ =	#DIV/0!	feet
Q = CiA =	#DIV/0!	cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{cs} =	#DIV/0!	ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) =	#DIV/0!	feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	#DIV/0!	cfs		
Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.08		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.09	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.09	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D. P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X 0.54)$ =	90.26	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{OR}
Rounded Overflow Rate =	#VALUE!	V_{OR}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	23.60	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				141,913	3.26
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.36		64	3,300		211,200	4.85
P =	33	inches		U Channel			
						3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs		Fire Access			
* The values entered in these fields should be for the total project area.						9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8						8.41

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 4-7

Total drainage basin/outfall area =	0.68	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0	3300	-	acres of IC	
Post-development impervious area within drainage basin/outfall area =	0.55	acres		24037	0.55	acres of str	
Post-development impervious fraction within drainage basin/outfall area =	0.81						
$L_{M\ THIS\ BASIN}$ =	495	lbs					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Grassy Swale
Removal efficiency = 70 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.68	acres					
A_I =	0.54	acres	# of Lots	SF/Lot			
A_P =	0.14	acres	0	3300	-	acres of IC	
L_R =	437	lbs		23698.2	0.54	acres of str	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 437 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	4.00	inches
Post Development Runoff Coefficient =	0.62	
On-site Water Quality Volume =	6160	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1232	
Total Capture Volume (required water quality volume(s) x 1.20) =	7392	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	5		60
Minimum filter basin area =	NA	square feet				60
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			60
	NA	square feet	For Given water depth			60
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.68 acres
Impervious Cover in Drainage Area =	0.54 acres
Rainfall intensity = i =	1.1 in/hr
Swale Slope =	0.005 ft/ft
Side Slope (z) =	3
Design Water Depth = y =	0.33 ft
Weighted Runoff Coefficient = C =	0.66

A_{CS} = cross-sectional area of flow in Swale =	1.95 sf
P_W = Wetted Perimeter =	6.95 feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	0.28 feet
n = Manning's roughness coefficient =	0.2

15A. Using the Method Described in the RG-348

Manning's Equation. $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.3}} - zy$ = 4.84 feet

Q = CiA = 0.49 cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = 0.25 ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = 75.83 feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	0.49 cfs		
Manning's Equation Q =	0.54 cfs	Error 1 =	-0.04
Swale Width=	6.00 ft		

Instructions are provided to the right (green comments).

Flow Velocity	0.25 ft/s
Minimum Length =	75.83 ft

Instructions are provided to the right (blue comments).

Design Width =	6 ft		
Design Discharge =	0.54 cfs	Error 2 =	-0.04
Design Depth =	0.33 ft		
Flow Velocity =	0.23 cfs		
Minimum Length =	68.93 ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area =	0.66		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.72	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5 V_{OR} = Q/A

Q = Runoff rate calculated above =	0.72	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ =	586.22	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Permanent BMP Summary Table

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 4
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	23.60	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				141,913	3.26
Total post-development impervious area within the limits of the plan* =	8.41	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.36		64	3,300		211,200	4.85
P =	33	inches		U Channel			
						3,787	0.09
$L_{M\ TOTAL\ PROJECT}$ =	7544	lbs.		Fire Access			
* The values entered in these fields should be for the total project area.						9222	0.21
Number of drainage basins / outfalls areas leaving the plan area =	8						8.41

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. =	A 4-15			
Total drainage basin/outfall area =	1.37	acres		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	6819	0.15
Post-development impervious area within drainage basin/outfall area =	0.24	acres	3,787	0.09
Post-development impervious fraction within drainage basin/outfall area =	0.18			0.24
$L_{M\ THIS\ BASIN}$ =	217	lbs.		

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = 0 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.37	acres
A_I =	0.25	acres
A_P =	1.12	acres
L_R =	0	lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = 0.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = #N/A inches
Post Development Runoff Coefficient = 0.19
On-site Water Quality Volume = #N/A cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = #N/A cubic feet

Storage for Sediment = #N/A
Total Capture Volume (required water quality volume(s) x 1.20) = #N/A cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	5		60
Minimum filter basin area =	NA	square feet				60
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			60
	NA	square feet	For Given water depth			60
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale.

Drainage Area to be Treated by the Swale = A =	1.37	acres
Impervious Cover in Drainage Area =	0.25	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.005	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	0.40	

A_{CS} = cross-sectional area of flow in Swale =	2.41	sf
P_W = Wetted Perimeter =	8.35	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	0.29	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = 6.24 feet

Q = CiA = 0.61 cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = 0.25 ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = 75.83 feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	0.61 cfs		
Manning's Equation Q =	0.54 cfs	Error 1 =	0.07
Swale Width=	6.00 ft		

Instructions are provided to the right (green comments).

Flow Velocity	0.25 ft/s
Minimum Length =	75.83 ft

Instructions are provided to the right (blue comments).

Design Width =	6 ft		
Design Discharge =	0.54 cfs	Error 2 =	0.07
Design Depth =	0.33 ft		
Flow Velocity =	0.23 cfs		
Minimum Length =	68.93 ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.10 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.12 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.12 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 287.10 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_α
Rounded Overflow Rate = #VALUE! V_α
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Phase 5A & 5B Permanent BMP Summary Table									
Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	L_R (lbs)	L_M (lbs)	Desired L_M (lbs)
A 5-1	DA 5.8+DA5.7	Sand Filter	12.56	12.56	5.77	46.0%	5976	5183	5441
A 5-2	DA 5.5	Grassy Swale	1.02	0.86	0.68	66.6%	546	610	377
A 5-3	DA 5.4	Vegetated Filter Strips	0.28	0.28	0.07	25.5%	68	64	64
A 5-4	DA 5.6	Vegetated Filter Strips	5.24	5.24	0.71	13.6%	717	641	641
A 5-5	DA 5.11	Vegetated Filter Strips	0.83	0.83	0.29	34.4%	269	257	257
A 5-6	DA 5.9A +DA 5.9B+DA 5.9C	Sand Filter	14.39	14.09	6.66	46.3%	6891	5982	6294
A 5-7	DA 5.16	Vegetated Filter Strips	3.96	3.96	1.43	36.1%	1341	1283	1283
A 5-8	DA 5.13	Vegetated Filter Strips	2.88	2.88	0.57	19.8%	555	513	513
A 5-9	DA 5.10	Vegetated Filter Strips	2.6	2.6	0.57	22.0%	551	513	513
A 5-12	DA 5.12	Untreated Release	0.3	0.3	0.20	68.1%	0	183	0
A 5-4A	DA 5.4A	Untreated Release	0.28	0.28	0.17	60.6%	0	152	0
Total			**44.06**	**43.60**	**17.14**	**38.8%**	**16914**	**15383**	**15383**

Required TSS Removal 15383

Phase 5A Permanent BMP Summary Table									
Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	L_R (lbs)	L_M (lbs)	Desired L_M (lbs)
A 5-1 (5A)	DA 5.8+DA5.7	Sand Filter	12.56	12.56	5.49	43.7%	5690	4927	5441
A 5-2 (5A)	DA 5.5	Grassy Swale	1.02	0.86	0.68	66.6%	377	610	377
A 5-3 (5A)	DA 5.4	Vegetated Filter Strips	0.28	0.28	0.07	25.5%	68	64	64
A 5-4 (5A)	DA 5.6	Vegetated Filter Strips	5.24	5.24	0.71	13.6%	717	641	641
A 5-5 (5A)	DA 5.11	Vegetated Filter Strips	0.83	0.83	0.29	34.4%	269	257	257
A 5-7 (5A)		Vegetated Filter Strips	3.96	3.96	0.43	10.8%	442	385	385
A 5-4A (5A)	DA 5.4 A	Untreated Release	0.28	0.28	0.17	60.6%	0	152	0
Total			**23.89**	**23.73**	**7.84**	**45.3%**	**7563**	**7036**	**7165**

Required TSS Removal 7036

TCEQ R-13 2015 DEC 23 1553

STATE OF TEXAS
CHRISTOPHER P. VAN HEERDE
93047
LICENSED
PROFESSIONAL ENGINEER

Chris Van Heerde, PE 12/22/15

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38		82		6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-1

Total drainage basin/outfall area =	12.56	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	25	6225	3.57	acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	5.77	acres		95920	2.20	acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.46				**5.77**	**Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	5183	lbs				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	12.56	acres				
A_I =	5.77	acres	# of Lots	SF/Lot		
A_P =	6.79	acres	25	6225	3.57	acres of IC for lots
L_R =	5976	lbs		95920	2.20	acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **5441** lbs.

F = **0.91**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **1.80** inches
Post Development Runoff Coefficient = **0.34**
On-site Water Quality Volume = **27595** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **5519**
Total Capture Volume (required water quality volume(s) x 1.20) = **33114** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **33114** cubic feet

Minimum filter basin area = **1533** square feet

Maximum sedimentation basin area = **13797** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **3449** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length
Water Quality Volume for combined basins =	**33114**	cubic feet	6,064.80	5.46	90	67.39
Minimum filter basin area =	**2759**	square feet			90	30.66093
Maximum sedimentation basin area =	**11038**	square feet	For minimum water depth of 2 feet		90	122.6437
	2295	square feet	For Given water depth		90	25.49462
Minimum sedimentation basin area =	**690**	square feet	For maximum water depth of 8 feet		90	7.665231

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.25	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	2.74	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area = 0.30 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.33 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.33 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 6311.91 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7 10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	45.67	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.38		82	6,225		510,450	11.718
P =	33	inches					17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-2

Total drainage basin/outfall area =	1.02	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	3.5	6225	0.50	acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	0.68	acres		7825.4103	0.18	acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.67				**0.68**	**Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	610	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Grassy Swale
Removal efficiency = 70 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.86	acres				
A_I =	0.47	acres	# of Lots	SF/Lot		
A_P =	0.39	acres	2	6225	0.29	acres of IC for lots
L_R =	377	lbs		7825.4	0.18	acres of street
					0.47	**Total IC (acres)**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 377 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	4.00	inches
Post Development Runoff Coefficient =	0.38	
On-site Water Quality Volume =	4762	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	952	
Total Capture Volume (required water quality volume(s) x 1.20) =	5714	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet				
Minimum filter basin area =	NA	square feet				
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	90 #VALUE!
Minimum filter basin area =	NA	square feet				90 #VALUE!
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			90 #VALUE!
	NA	square feet	For Given water depth			90 #VALUE!
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			90 #VALUE!

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	1.02	acres
Impervious Cover in Drainage Area =	#VALUE!	acres
Rainfall intensity = I =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.25	ft
Weighted Runoff Coefficient = C =	#VALUE!	

A_{CS} = cross-sectional area of flow in Swale =	#VALUE!	sf
P_W = Wetted Perimeter =	#VALUE!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#VALUE!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #VALUE! feet

Q = CiA = #VALUE! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #VALUE! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #VALUE! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #VALUE! cfs

Manning's Equation Q =	4.34 cfs	Error 1 =	5.82
Swale Width=	36.91 ft		

Instructions are provided to the right (green comments).

Flow Velocity	#VALUE!	ft/s
Minimum Length =	#VALUE!	ft

Instructions are provided to the right (blue comments).

Design Width =	6 ft		
Design Discharge =	1.20 cfs	Error 2 =	#VALUE!
Design Depth =	0.33 ft		
Flow Velocity =	0.51 cfs		
Minimum Length =	154.12 ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area = 0.49 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.54 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.54 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{CR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 506.21 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{OR}
Rounded Overflow Rate = #VALUE! V_{OR}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82	6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-3

Total drainage basin/outfall area =	0.28	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0.5	6225	0.07	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.07	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.26						
$L_{M\ THIS\ BASIN}$ =	64	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.28	acres					
A_I =	0.07	acres	# of Lots	SF/Lot			
A_P =	0.21	acres	0.5	6225	0.07	acres of IC for lots	
L_R =	68	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 64 lbs

F = 0.94

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 2.40 inches
Post Development Runoff Coefficient = 0.23
On-site Water Quality Volume = 571 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 114
Total Capture Volume (required water quality volume(s) x 1.20) = 685 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = NA cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.87} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs	

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4. Q = CiA

C = runoff coefficient for the drainage area =	0.15		C = Runoff Coefficient = 0.546 $(IC)^2$ + 0.328 (IC) + 0.03
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.16	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: V_{OR} = Q/A

Q = Runoff rate calculated above =	0.16	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ =	80.19	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38		82		6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **9**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-4

Total drainage basin/outfall area =	5.24	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	5	6225	0.71	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.71	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.14						
$L_{M\ THIS\ BASIN}$ =	641	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.24	acres					
A_I =	0.71	acres	# of Lots	SF/Lot			
A_P =	4.53	acres	5	6225	0.71	acres of IC for lots	
L_R =	717	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **641** lbs.

F = **0.89**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **1.60** inches
Post Development Runoff Coefficient = **0.16**
On-site Water Quality Volume = **4731** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **946**
Total Capture Volume (required water quality volume(s) x 1.20) = **5677** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **NA** cubic feet

Minimum filter basin area = **NA** square feet

Maximum sedimentation basin area = **NA** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **NA** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = **NA** cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = **NA** square feet

Maximum sedimentation basin area = **NA** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **NA** square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft
Design Discharge =	0.76	cfs
Design Depth =	0.33	ft
Flow Velocity =	0.32	cfs
Minimum Length =	97.48	ft

Error 2 = #DIV/0!

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.08 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.09 cubic feet/sec

RG-348 Page 3-31 Equation 3 5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.09 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - \{(1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3)\}] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_t AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_t X 34.6 X A_P X0.54)$ = 842.75 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %
L_R Value = #VALUE! lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{ol}
Rounded Overflow Rate =	#VALUE!	V_{ol}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82	6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **9**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-5

Total drainage basin/outfall area =	0.83	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	2	6225	0.29	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.29	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.34						
$L_{M\ THIS\ BASIN}$ =	257	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.83	acres					
A_I =	0.29	acres	# of Lots	SF/Lot			
A_P =	0.54	acres	2	6225	0.29	acres of IC for lots	
L_R =	269	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 257 lbs.

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.28	
On-site Water Quality Volume =	2364	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	473	
Total Capture Volume (required water quality volume(s) x 1.20) =	2836	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.21		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.23	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.23	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54)$ =	315.89	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7 10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5 & 6
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82	6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-6

Total drainage basin/outfall area =	14.39	acres	# of Lots		SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres		28	6225		4.00 acres of IC
Post-development impervious area within drainage basin/outfall area =	6.66	acres			116018		2.66 acres of str
Post-development impervious fraction within drainage basin/outfall area =	0.46						**6.66 Total IC (a**
$L_{M\ THIS\ BASIN}$ =	5982	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	14.09	acres	# of Lots		SF/Lot		
A_I =	6.81	acres		29	6225		4.14 acres of IC
A_P =	7.28	acres			116018		2.66 acres of str
L_R =	7033	lbs					**6.81 Total IC (a**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **6294** lbs.

F = **0.89**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **1.60** inches
Post Development Runoff Coefficient = **0.35**
On-site Water Quality Volume = **28511** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **5702**
Total Capture Volume (required water quality volume(s) x 1.20) = 34214 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **34214** cubic feet

Minimum filter basin area = **1584** square feet

Maximum sedimentation basin area = **14256** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **3564** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	**34214**	cubic feet	6,842.72	5	60	
Minimum filter basin area =	**2851**	square feet			60	
Maximum sedimentation basin area =	**11405**	square feet	For minimum water depth of 2 feet		60	
	2851	square feet	For Given water depth		60	
Minimum sedimentation basin area =	**713**	square feet	For maximum water depth of 8 feet		60	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3 3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area = 0.30 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.33 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.33 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0 83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0 25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 7429.02 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{OR}
Rounded Overflow Rate = #VALUE! V_{OR}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82		6.225	510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **9**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-7

Total drainage basin/outfall area =	3.96	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	10	6225	1.43	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	1.43	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.36						
$L_{M\ THIS\ BASIN}$ =	1283	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.96	acres					
A_I =	1.43	acres	# of Lots	SF/Lot			
A_P =	2.53	acres	10	6225	1.43	acres of IC for lots	
L_R =	1341	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 1283 lbs.

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.29	
On-site Water Quality Volume =	11598	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	2320	
Total Capture Volume (required water quality volume(s) x 1.20) =	13918	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-55 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.22		C = Runoff Coefficient = $0.546 (IC)^3 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.24	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.24	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$	1576.28	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82	6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-8

Total drainage basin/outfall area =	2.88	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	4	6225	0.57	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.57	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.20						
$L_{M\ THIS\ BASIN}$ =	513	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.88	acres					
A_I =	0.57	acres	# of Lots	SF/Lot			
A_P =	2.31	acres	4	6225	0.57	acres of IC for lots	
L_R =	555	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 513 lbs.

F = 0.92

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 2.00 inches
Post Development Runoff Coefficient = 0.20
On-site Water Quality Volume = 4181 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 836
Total Capture Volume (required water quality volume(s) x 1.20) = 5017 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = NA cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 = #DIV/0!
Swale Width=	6.00	ft	

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3 3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.12 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.13 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.13 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 652.22 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %
L_R Value = #VALUE! lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan * =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82		6,225	510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-9

Total drainage basin/outfall area =	2.60	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	4	6225	0.57	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.57	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.22						
$L_{M\ THIS\ BASIN}$ =	513	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.60	acres					
A_I =	0.57	acres	# of Lots	SF/Lot			
A_P =	2.03	acres	4	6225	0.57	acres of IC for lots	
L_R =	551	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **513** lbs.

F = **0.93**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	**2.20**	inches
Post Development Runoff Coefficient =	**0.21**	
On-site Water Quality Volume =	**4433**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**887**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**5319**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	**0.1**	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	**NA**	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**NA**	cubic feet	
Minimum filter basin area =	**NA**	square feet	
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**NA**	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	**NA**	square feet		
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	**NA**	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	**NA**	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area =	0.13		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.14	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: V_{OR} = Q/A

Q = Runoff rate calculated above =	0.14	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY QF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 647.53 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0 0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5 & 6
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27\ 2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	45.67	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.38		82	6,225		510,450	11.718
P =	33	inches					17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-12

Total drainage basin/outfall area =	0.30	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0	6225		0.00 acres of IC
Post-development impervious area within drainage basin/outfall area =	0.20	acres		8905		0.20 acres of str
Post-development impervious fraction within drainage basin/outfall area =	**0.68**					**0.20 Total IC (a**
$L_{M\ THIS\ BASIN}$ =	**183**	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = **0** percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.30	acres	# of Lots	SF/Lot		
A_I =	0.20	acres	0	6225		0.00 acres of IC
A_P =	0.10	acres		8905		0.20 acres of str
L_R =	**0**	lbs				**0.20 Total IC (a**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = #DIV/0!

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	#DIV/0!	inches
Post Development Runoff Coefficient =	0.49	
On-site Water Quality Volume =	#DIV/0!	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	#DIV/0!	cubic feet
Storage for Sediment =	#DIV/0!	
Total Capture Volume (required water quality volume(s) x 1.20) =	#DIV/0!	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	5	60	
Minimum filter basin area =	NA	square feet			60	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet		60	
	NA	square feet	For Given water depth		60	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet		60	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = I =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.51 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.56 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.56 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X 0.54) =$ 221.03 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5 & 6
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38			82		6,225	510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-4A

Total drainage basin/outfall area =	0.28	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres		0	6225	0.00 acres of IC
Post-development impervious area within drainage basin/outfall area =	0.17	acres			7396	0.17 acres of str
Post-development impervious fraction within drainage basin/outfall area =	0.61					**0.17 Total IC (a**
$L_{M\ THIS\ BASIN}$ =	152	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = 0 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.28	acres	# of Lots	SF/Lot		
A_I =	0.17	acres		0	6225	0.00 acres of IC
A_P =	0.11	acres			7396	0.17 acres of str
L_R =	0	lbs				**0.17 Total IC (a**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = #DIV/0!

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = #DIV/0! inches
Post Development Runoff Coefficient = 0.42
On-site Water Quality Volume = #DIV/0! cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = #DIV/0! cubic feet

Storage for Sediment = #DIV/0!
Total Capture Volume (required water quality volume(s) x 1.20) = #DIV/0! cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	60
Minimum filter basin area =	NA	square feet				60
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			60
	NA	square feet	For Given water depth			60
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (R/A_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0 2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0 32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.43 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.47 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.47 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 184.08 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{OR}
Rounded Overflow Rate = #VALUE! V_{OR}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					111,142	2.551
Total post-development impervious area within the limits of the plan* =	7.84	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.17			37	6,225		230,325	5.288
P =	33	inches						7.84
$L_{M\ TOTAL\ PROJECT}$ =	7036	lbs.						

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-1

Total drainage basin/outfall area =	12.56	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	23	6225		3.29 acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	5.49	acres		95920.4406		2.20 acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.44					**5.49 Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	4927	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	12.56	acres				
A_I =	5.49	acres	# of Lots	SF/Lot		
A_P =	7.07	acres	23	6225		3.29 acres of IC for lots
L_R =	5690	lbs		95920		2.20 acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **5441** lbs.

F = **0.96**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **2.80** inches
Post Development Runoff Coefficient = **0.32**
On-site Water Quality Volume = **41470** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **8294**
Total Capture Volume (required water quality volume(s) x 1.20) = **49764** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **49764** cubic feet

Minimum filter basin area = **2304** square feet

Maximum sedimentation basin area = **20735** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **5184** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width		Length
Water Quality Volume for combined basins =	**49764**	cubic feet	9,114.26	5.46		90	101.27
Minimum filter basin area =	**4147**	square feet				90	46.07765
Maximum sedimentation basin area =	**16588**	square feet	For minimum water depth of 2 feet			90	184.3106
	3448	square feet	For Given water depth			90	38.31365
Minimum sedimentation basin area =	**1037**	square feet	For maximum water depth of 8 feet			90	11.51941

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.25	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	2.74	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.28		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.31	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.31	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54) =$	6009.92	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3. $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					121,983	2.800
Total post-development impervious area within the limits of the plan* =	8.231	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.18			38	6,225		236,550	5.430
P =	33	inches						8.23

$L_{M\ TOTAL\ PROJECT}$ = **7388** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-2

Total drainage basin/outfall area =	1.02	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	3.5	6225	0.50	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.68	acres		7825.4103	0.18	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.67				**0.68**	**Total IC (acres)**	
$L_{M\ THIS\ BASIN}$ =	610	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Grassy Swale
Removal efficiency = 70 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.86	acres				
A_I =	0.47	acres	# of Lots	SF/Lot		
A_P =	0.39	acres	2	6225	0.29	acres of IC for lots
L_R =	377	lbs		7825.4	0.18	acres of street
					0.47	**Total IC (acres)**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 377 lbs.

F = 1.00

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 4.00 inches
Post Development Runoff Coefficient = 0.38
On-site Water Quality Volume = 4762 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 952
Total Capture Volume (required water quality volume(s) x 1.20) = 5714 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	90	#VALUE!
Minimum filter basin area =	NA	square feet				90	#VALUE!
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			90	#VALUE!
	NA	square feet	For Given water depth			90	#VALUE!
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			90	#VALUE!

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	1.02	acres
Impervious Cover in Drainage Area =	#VALUE!	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.25	ft
Weighted Runoff Coefficient = C =	#VALUE!	

A_{CS} = cross-sectional area of flow in Swale =	#VALUE!	sf
P_W = Wetted Perimeter =	#VALUE!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#VALUE!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #VALUE! feet

Q = CiA = #VALUE! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #VALUE! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #VALUE! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #VALUE! cfs

Manning's Equation Q =	4.34	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#VALUE!	ft/s
Minimum Length =	#VALUE!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	1.20	cfs	Error 2 =	#VALUE!
Design Depth =	0.33	ft		
Flow Velocity =	0.51	cfs		
Minimum Length =	154.12	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area = 0.49 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.54 cubic feet/sec

RG-348 Page 3-31 Equation 3 5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.54 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 506.21 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					121,983	2.800
Total post-development impervious area within the limits of the plan* =	8.231	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.18			38		6,225	236,550	5.430
P =	33	inches						8.23

$L_{M\ TOTAL\ PROJECT}$ = **7388** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-3

Total drainage basin/outfall area =	0.28	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0 5	6225	0.07	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.07	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.26						
$L_{M\ THIS\ BASIN}$ =	64	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.28	acres				
A_I =	0.07	acres	# of Lots	SF/Lot		
A_P =	0.21	acres	0.5	6225	0.07	acres of IC for lots
L_R =	68	lbs			0	acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 64 lbs.

F = 0.94

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 2.40 inches
Post Development Runoff Coefficient = 0.23
On-site Water Quality Volume = 571 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 114
Total Capture Volume (required water quality volume(s) x 1.20) = 685 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = NA cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00 acres
Impervious Cover in Drainage Area =	0.00 acres
Rainfall Intensity = i =	1.1 in/hr
Swale Slope =	0.01 ft/ft
Side Slope (z) =	3
Design Water Depth = y =	0.33 ft
Weighted Runoff Coefficient = C =	#DIV/0!

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft
Design Discharge =	0.76	cfs
Design Depth =	0.33	ft
Flow Velocity =	0.32	cfs
Minimum Length =	97.48	ft

Error 2 = #DIV/0!

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.15 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.16 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.16 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 80.19 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %
L_R Value = #VALUE! lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					121,983	2.800
Total post-development impervious area within the limits of the plan* =	8.231	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.18			38		6,225	236,550	5.430
P =	33	inches						8.23

$L_{M\ TOTAL\ PROJECT}$ = **7388** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-4

Total drainage basin/outfall area =	5.24	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	5	6225	0.71	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.71	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.14						
$L_{M\ THIS\ BASIN}$ =	641	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	5.24	acres					
A_I =	0.71	acres	# of Lots	SF/Lot			
A_P =	4.53	acres	5	6225	0.71	acres of IC for lots	
L_R =	717	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **641** lbs.

F = **0.89**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **1.60** inches
Post Development Runoff Coefficient = **0.16**
On-site Water Quality Volume = **4731** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **946**
Total Capture Volume (required water quality volume(s) x 1.20) = **5677** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **NA** cubic feet

Minimum filter basin area = **NA** square feet

Maximum sedimentation basin area = **NA** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **NA** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = **NA** cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = **NA** square feet

Maximum sedimentation basin area = **NA** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **NA** square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	NA	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.08		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.09	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.09	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0\ 25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$	842.75	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (If multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres		Streets				
Predevelopment impervious area within the limits of the plan * =	0.00	acres					121,983	2.800
Total post-development impervious area within the limits of the plan* =	8.231	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.18		38		6,225		236,550	5.430
P =	33	inches						8.23

$L_{M\ TOTAL\ PROJECT}$ = **7388** lbs

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **9**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-5

Total drainage basin/outfall area =	0.83	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	2	6225	0.29	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.29	acres			-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.34						
$L_{M\ THIS\ BASIN}$ =	257	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.83	acres					
A_I =	0.29	acres	# of Lots	SF/Lot			
A_P =	0.54	acres	2	6225	0.29	acres of IC for lots	
L_R =	269	lbs			0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 257 lbs.

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.28	
On-site Water Quality Volume =	2364	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	473	
Total Capture Volume (required water quality volume(s) x 1.20) =	2836	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.21 — $C = \text{Runoff Coefficient} = 0.546\,(IC)^3 + 0.328\,(IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.23 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.23 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) \times (1 - 0.65E_2) \times (1 - 0.25E_3))] \times 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} \times P \times (A_I \times 34.6 \times A_P \times 0.54)$ = 315.89 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{OR}
Rounded Overflow Rate = #VALUE! V_{OR}
BMP Efficiency % = #VALUE! %
L_R Value = #VALUE! lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	$V_{o/}$
Rounded Overflow Rate =	#VALUE!	$\mathbf{V_{o/}}$
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27\ 2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					121.983	2.800
Total post-development impervious area within the limits of the plan* =	8.231	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.18			38	6,225		236,550	5.430
P =	33	inches						8.23

$L_{M\ TOTAL\ PROJECT}$ = **7388** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **9**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-7

Total drainage basin/outfall area =	3.96	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	3	6225	0.43	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.43	acres		0	-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.11						
$L_{M\ THIS\ BASIN}$ =	385	lbs					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	3.96	acres					
A_I =	0.43	acres	# of Lots	SF/Lot			
A_P =	3.53	acres	3	6225	0.43	acres of IC for lots	
L_R =	442	lbs		0	0.00	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **385** lbs.

F = **0.87**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	**1.44**	inches
Post Development Runoff Coefficient =	**0.13**	
On-site Water Quality Volume =	**2738**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**548**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**3285**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	**0.1**	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	**NA**	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**NA**	cubic feet	
Minimum filter basin area =	**NA**	square feet	
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**NA**	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	**NA**	square feet		
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	**NA**	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	**NA**	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.07		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.08	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.08	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ =	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 519.32 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 5 & 6
Date Prepared: 3/10/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	45.67	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					236,065	5.419
Total post-development impervious area within the limits of the plan* =	17.14	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.38		82		6,225		510,450	11.718
P =	33	inches						17.14

$L_{M\ TOTAL\ PROJECT}$ = **15383** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 9

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 5-4A

Total drainage basin/outfall area =	0.28	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0	6225		0.00 acres of IC
Post-development impervious area within drainage basin/outfall area =	0.17	acres		7396		0.17 acres of str
Post-development impervious fraction within drainage basin/outfall area =	0.61					0.17 Total IC (a
$L_{M\ THIS\ BASIN}$ =	152	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = 0 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.28	acres	# of Lots	SF/Lot		
A_I =	0.17	acres	0	6225		0.00 acres of IC
A_P =	0.11	acres		7396		0.17 acres of str
L_R =	0	lbs				0.17 Total IC (a

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = #DIV/0!

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	#DIV/0!	inches
Post Development Runoff Coefficient =	0.42	
On-site Water Quality Volume =	#DIV/0!	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	#DIV/0!	cubic feet
Storage for Sediment =	#DIV/0!	
Total Capture Volume (required water quality volume(s) x 1.20) =	#DIV/0!	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	60
Minimum filter basin area =	NA	square feet				60
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			60
	NA	square feet	For Given water depth			60
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 60% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: Q = CiA

C = runoff coefficient for the drainage area = 0.43 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.47 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.47 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100$ = 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54)$ = 184.08 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_α
Rounded Overflow Rate =	#VALUE!	V_α
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Manor Creek 6 Permanent BMP Summary Table									
Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	L_R (lbs)	L_M (lbs)	Desired L_M (lbs)
A 6-1	DA 6.5 & DA 6.6	Sand Filter	15.59	15.07	6.695	42.9%	6936	6009	6323
A 6-2	DA 6.13	Vegetated Filter Strips	1.56	1.56	0.572	36.6%	536	513	513
A 6-3	DA 6.11	Vegetated Filter Strips	1.68	1.68	0.572	34.0%	538	513	513
A 6-4	DA 6.10	Vegetated Filter Strips	1.91	1.91	0.857	44.9%	798	770	770
A 6-5	DA 6.9	Vegetated Filter Strips	2.24	2.24	0.857	38.3%	803	770	770
A 6-6	DA 6.7	Vegetated Filter Strips	1.55	1.55	0.572	36.9%	536	513	513
A 6-8	DA 6.8	Untreated Release	0.22	0.22	0.15	66.2%	-	131	-
A 6-12	DA 6.12	Untreated Release	0.30	0.30	0.20	67.9%	-	183	-
Total			**25.05**	**24.53**	**10.47**	**46.0%**	**10147**	**9401**	**9402**

Required TSS Removal 9401

Chris Van Heerde, PE
12/22/15

TCEQ R-13 2015 DEC 23 1553

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	40.55	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					138,758	3.185
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.26			51	6,225		317,475	7.288
P =	33	inches						10.47

$L_{M\ TOTAL\ PROJECT}$ = **9401** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-1

Total drainage basin/outfall area =	15.59	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	27	6225	3.86	acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	6.69	acres		123538.05	2.84	acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.43				**6.69**	**Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	6009	lbs				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Sand Filter
Removal efficiency = 89 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	15.07	acres				
A_I =	6.69	acres	# of Lots	SF/Lot		
A_P =	8.38	acres	27	6225	3.86	acres of IC for lots
L_R =	6936	lbs		123538.05	2.84	acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **6323** lbs

F = **0.91**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **1.80** inches
Post Development Runoff Coefficient = **0.33**
On-site Water Quality Volume = **32339** cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **6468**
Total Capture Volume (required water quality volume(s) x 1.20) = **38807** cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = **0.1** in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = **NA** square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = **38807** cubic feet

Minimum filter basin area = **1797** square feet

Maximum sedimentation basin area = **16170** square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = **4042** square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length
Water Quality Volume for combined basins =	**38807**	cubic feet	7,761.38	5	90	86.24
Minimum filter basin area =	**3234**	square feet			90	35.93232
Maximum sedimentation basin area =	**12936**	square feet	For minimum water depth of 2 feet		90	143.7293
	3234	square feet	For Given water depth		90	35.93232
Minimum sedimentation basin area =	**808**	square feet	For maximum water depth of 8 feet		90	8.98308

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = **NA** cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = **NA** cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	6.90	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	1.20	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.51	cfs		
Minimum Length =	154.12	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.27		C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.30	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.30	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1)\ X\ (1 - 0.65E_2)\ x\ (1 - 0.25E_3))]\ X\ 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT}\ X\ P\ X\ (A_I\ X\ 34.6\ X\ A_P\ X0.54) =$	7325.85	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	40.55	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				138,758	3.19
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.26		51	6,225		317,475	7.29
P =	33	inches					10.47

$L_{M\ TOTAL\ PROJECT}$ = **9401** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **6**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-2

Total drainage basin/outfall area =	1.56	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	4	6225	0.57	acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	0.57	acres		0	0.00	acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.37				**0.57**	**Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	513	lbs.				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = **80** percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.56	acres				
A_I =	0.57	acres	# of Lots	SF/Lot		
A_P =	0.99	acres	4	6225	0.57	acres of IC for lots
L_R =	536	lbs		0	0.00	acres of street
					0.57	**Total IC (acres)**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 513 lbs.

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.29	
On-site Water Quality Volume =	4611	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	922	
Total Capture Volume (required water quality volume(s) x 1.20) =	5533	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	90	#VALUE!
Minimum filter basin area =	NA	square feet				90	#VALUE!
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			90	#VALUE!
	NA	square feet	For Given water depth			90	#VALUE!
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			90	#VALUE!

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = **A** =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.25	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation. $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ =	#DIV/0!	feet
Q = CiA =	#DIV/0!	cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} =	#DIV/0!	ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) =	#DIV/0!	feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	#DIV/0!	cfs
Manning's Equation Q =	4.34	cfs
Swale Width=	36.91	ft

Error 1 = 5.82

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft
Design Discharge =	1.20	cfs
Design Depth =	0.33	ft
Flow Velocity =	0.51	cfs
Minimum Length =	154.12	ft

Error 2 = #DIV/0!

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.22		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.25	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.25	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$	630.11	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data. Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	40.55	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres			138,758	3.19	
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.26		51	6,225	317,475	7.29	
P =	33	inches				10.47	

$L_{M\ TOTAL\ PROJECT}$ = **9401** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = **6**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-3

Total drainage basin/outfall area =	1.68	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	4	6225	0.57	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.57	acres		0	-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.34						
$L_{M\ THIS\ BASIN}$ =	513	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: L_R = (BMP efficiency) x P x (A_I x 34.6 + A_P x 0.54)

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.68	acres					
A_I =	0.57	acres	# of Lots	SF/Lot			
A_P =	1.11	acres	4	6225	0.57	acres of IC for lots	
L_R =	538	lbs		0	0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 513 lbs.

F = 0.95

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = 2.60 inches
Post Development Runoff Coefficient = 0.28
On-site Water Quality Volume = 4411 cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = 0 cubic feet

Storage for Sediment = 882
Total Capture Volume (required water quality volume(s) x 1.20) = 5293 cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins = NA cubic feet #VALUE! sf at 4' of depth

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.20 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.23 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.23 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{OR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE.
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 632.12 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %
L_R Value = #VALUE! lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3. $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	40.55	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					138,758	3.19
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.26			51	6,225		317 475	7.29
P =	33	inches						10.47
$L_{M\ TOTAL\ PROJECT}$ =	9401	lbs.						

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-4

Total drainage basin/outfall area =	1.91	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	6	6225	0.86	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.86	acres		0	-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.45						
$L_{M\ THIS\ BASIN}$ =	770	lbs					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.91	acres					
A_I =	0.86	acres	# of Lots	SF/Lot			
A_P =	1.05	acres	6	6225	0.86	acres of IC for lots	
L_R =	798	lbs		0	0	acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 770 lbs

F = 0.96

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	2.80	inches
Post Development Runoff Coefficient =	0.33	
On-site Water Quality Volume =	6421	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	0.00	acres
Off-site Impervious cover draining to BMP =	0.00	acres
Impervious fraction of off-site area =	0	
Off-site Runoff Coefficient =	0.00	
Off-site Water Quality Volume =	0	cubic feet
Storage for Sediment =	1284	
Total Capture Volume (required water quality volume(s) x 1.20) =	7706	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	0.1	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	NA	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	NA	cubic feet	
Minimum filter basin area =	NA	square feet	
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	NA	square feet		
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	NA	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	NA	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.29		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.32	cubic feet/sec	

RG-348 Page 3-31 Equation 3 5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.32	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$ 937.96 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs
BMP Sizing		
Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	40.55	acres			Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres					138,758	3.19
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.26			51	6,225		317,475	7.29
P =	33	inches						10.47
$L_{M\ TOTAL\ PROJECT}$ =	9401	lbs.						

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-5

Total drainage basin/outfall area =	2.24	acres	# of Lots	SF/Lot			
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	6	6225	0.86	acres of IC for lots	
Post-development impervious area within drainage basin/outfall area =	0.86	acres		0	-	acres of street	
Post-development impervious fraction within drainage basin/outfall area =	0.38						
$L_{M\ THIS\ BASIN}$ =	770	lbs.					

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	2.24	acres				
A_I =	0.86	acres	# of Lots	SF/Lot		
A_P =	1.38	acres	6	6225	0.86	acres of IC for lots
L_R =	803	lbs		0	0	acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **770** lbs.

F = **0.96**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	**2.80**	inches
Post Development Runoff Coefficient =	**0.30**	
On-site Water Quality Volume =	**6799**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**1360**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**8159**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	**0.1**	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	**NA**	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**NA**	cubic feet	
Minimum filter basin area =	**NA**	square feet	
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

Water Quality Volume for combined basins =	**NA**	cubic feet	#VALUE!	sf at 4' of depth
Minimum filter basin area =	**NA**	square feet		
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet	
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet	

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	**NA**	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	**NA**	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	0.76	cfs	Error 1 =	#DIV/0!
Swale Width=	6.00	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	0.76	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.32	cfs		
Minimum Length =	97.48	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.24		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.26	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.26	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_3 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$	943.49	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{OR}
Rounded Overflow Rate =	#VALUE!	V_{OR}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs

TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7 10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	40.55	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				138,758	3.19
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.26		51	6,225		317,475	7.29
P =	33	inches					10.47
$L_{M\ TOTAL\ PROJECT}$ =	9401	lbs.					

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-6

Total drainage basin/outfall area =	1.55	acres	# of Lots	SF/Lot		
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	4	6225	0.57	acres of IC
Post-development impervious area within drainage basin/outfall area =	0.57	acres		0	0.00	acres of str
Post-development impervious fraction within drainage basin/outfall area =	0.37				0.57	**Total IC (a**
$L_{M\ THIS\ BASIN}$ =	513	lbs				

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = Vegetated Filter Strips
Removal efficiency = 80 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	1.55	acres	# of Lots	SF/Lot		
A_I =	0.57	acres	4	6225	0.57	acres of IC
A_P =	0.98	acres		0	0.00	acres of str
L_R =	536	lbs		0	0.57	**Total IC (a**

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **513** lbs.

F = **0.96**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth =	**2.80**	inches
Post Development Runoff Coefficient =	**0.29**	
On-site Water Quality Volume =	**4599**	cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP =	**0.00**	acres
Off-site Impervious cover draining to BMP =	**0.00**	acres
Impervious fraction of off-site area =	**0**	
Off-site Runoff Coefficient =	**0.00**	
Off-site Water Quality Volume =	**0**	cubic feet
Storage for Sediment =	**920**	
Total Capture Volume (required water quality volume(s) x 1.20) =	**5519**	cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = **NA** cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate =	**0.1**	in/hr	Enter determined permeability rate or assumed value of 0.1
Irrigation area =	**NA**	square feet	
	NA	acres	

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = **NA** cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin =	**NA**	cubic feet	
Minimum filter basin area =	**NA**	square feet	
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	
Water Quality Volume for combined basins =	**NA**	cubic feet	#VALUE!	5	60	
Minimum filter basin area =	**NA**	square feet				60
Maximum sedimentation basin area =	**NA**	square feet	For minimum water depth of 2 feet			60
	NA	square feet	For Given water depth			60
Minimum sedimentation basin area =	**NA**	square feet	For maximum water depth of 8 feet			60

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = **NA** cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool =	**NA**	cubic feet	Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation =	**NA**	cubic feet	Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = **NA** cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.01	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q = 0.76 cfs Error 1 = #DIV/0!
Swale Width= 6.00 ft

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft	
Design Discharge =	0.76	cfs	Error 2 = #DIV/0!
Design Depth =	0.33	ft	
Flow Velocity =	0.32	cfs	
Minimum Length =	97.48	ft	

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3 4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.23		C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour	
A = drainage area in acres =	1	acres	
Q = flow rate in cubic feet per second =	0.25	cubic feet/sec	

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.25	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$	94.01	percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00	percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00	percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00	percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X0.54) =$	629.94	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_{OR}
Rounded Overflow Rate =	#VALUE!	V_{OR}
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal						
Total project area included in plan * =	40.55	acres		Streets			
Predevelopment impervious area within the limits of the plan * =	0.00	acres				138,758	3.185
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots	SF/Lot			
Total post-development impervious cover fraction * =	0.26		51	6,225		317,475	7.288
P =	33	inches					10 47

$L_{M\ TOTAL\ PROJECT}$ = **9401** lbs.

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-12

Total drainage basin/outfall area =	0.22	acres	# of Lots	SF/Lot	
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0	6225	0.00 acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	0.15	acres		6344 5158	0.15 acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.66				**0.15 Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	131	lbs.			

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = 0 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.22	acres			
A_I =	0.15	acres	# of Lots	SF/Lot	
A_P =	0.07	acres	0	6225	0.00 acres of IC for lots
L_R =	0	lbs		6344.5158	0.15 acres of street

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = #DIV/0!

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = #DIV/0! inches
Post Development Runoff Coefficient = 0.47
On-site Water Quality Volume = #DIV/0! cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = #DIV/0! cubic feet

Storage for Sediment = #DIV/0!
Total Capture Volume (required water quality volume(s) x 1.20) = #DIV/0! cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	90	#VALUE!
Minimum filter basin area =	NA	square feet				90	#VALUE!
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			90	#VALUE!
	NA	square feet	For Given water depth			90	#VALUE!
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			90	#VALUE!

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation. $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ =	#DIV/0!	feet
Q = CiA =	#DIV/0!	cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} =	#DIV/0!	ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) =	#DIV/0!	feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA =	#DIV/0!	cfs		
Manning's Equation Q =	6.90	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	1.20	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.51	cfs		
Minimum Length =	154.12	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and
the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or
across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3 3 =	**NA**	lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area =	0.49	C = Runoff Coefficient = $0.546\ (IC)^2 + 0.328\ (IC) + 0.03$
i = design rainfall intensity =	1.1	in/hour
A = drainage area in acres =	1	acres
Q = flow rate in cubic feet per second =	0.54	cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above =	0.54	cubic feet/sec
A = Water surface area in the wet vault =	150	square feet
V_{OR} = Overflow Rate =	0.00	feet/sec
Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) =	53	percent
Load removed by Wet Vault =	#VALUE!	lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs =	0.5	in/hour
Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 =	0.75	percent
Efficiency Reduction for Actual Rainfall Intensity =	0.83	percent
Resultant TSS Load removed by Wet Vault =	#VALUE!	lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1)\ X\ (1 - 0.65E_2)\ x\ (1 - 0.25E_3))]\ X\ 100$ =	94.01 percent	NET EFFICIENCY OF THE BMPs IN THE SERIES
EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 =	89.00 percent	
EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 =	70.00 percent	
EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 =	0.00 percent	

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT}\ X\ P\ X\ (A_I\ X\ 34.6\ X\ A_P\ X0.54)$ =	157.58	lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area=	**NA**	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) =	0	Model Size
Surface Area =	#N/A	ft^2
Overflow Rate =	#VALUE!	V_α
Rounded Overflow Rate =	#VALUE!	V_α
BMP Efficiency % =	#VALUE!	%

L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_o
Rounded Overflow Rate =	#VALUE!	V_o
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: Manor Creek Unit 6
Date Prepared: 6/1/2015

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadsheet.

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where,

$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased load
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project

County =	Comal							
Total project area included in plan * =	40.55	acres			Streets		138,758	3.185
Predevelopment impervious area within the limits of the plan * =	0.00	acres						
Total post-development impervious area within the limits of the plan* =	10.47	acres	Lots		SF/Lot			
Total post-development impervious cover fraction * =	0.26			51	6,225		317,475	7.288
P =	33	inches						10 47
$L_{M\ TOTAL\ PROJECT}$ =	9401	lbs.						

* The values entered in these fields should be for the total project area.

Number of drainage basins / outfalls areas leaving the plan area = 6

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = A 6-12

Total drainage basin/outfall area =	0.30	acres	# of Lots	SF/Lot	
Predevelopment impervious area within drainage basin/outfall area =	0.00	acres	0	6225	0.00 acres of IC for lots
Post-development impervious area within drainage basin/outfall area =	0.20	acres		8875 7696	0.20 acres of street
Post-development impervious fraction within drainage basin/outfall area =	0.68				**0.20 Total IC (acres)**
$L_{M\ THIS\ BASIN}$ =	183	lbs			

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = None
Removal efficiency = 0 percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_C \times 34.6 + A_P \times 0.54)$

where:

A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C =	0.30	acres				
A_I =	0.20	acres	# of Lots	SF/Lot		
A_P =	0.10	acres	0	6225	0.00 acres of IC for lots	
L_R =	0	lbs		8875.7696	0.20 acres of street	

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = 0 lbs.

F = #DIV/0!

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = #DIV/0! inches
Post Development Runoff Coefficient = 0.49
On-site Water Quality Volume = #DIV/0! cubic feet

Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = 0.00 acres
Off-site Impervious cover draining to BMP = 0.00 acres
Impervious fraction of off-site area = 0
Off-site Runoff Coefficient = 0.00
Off-site Water Quality Volume = #DIV/0! cubic feet

Storage for Sediment = #DIV/0!
Total Capture Volume (required water quality volume(s) x 1.20) = #DIV/0! cubic feet

The following sections are used to calculate the required water quality volume(s) for the selected BMP.
The values for BMP Types not selected in cell C45 will show NA.

7. Retention/Irrigation System Designed as Required in RG-348 Pages 3-42 to 3-46

Required Water Quality Volume for retention basin = NA cubic feet

Irrigation Area Calculations:

Soil infiltration/permeability rate = 0.1 in/hr Enter determined permeability rate or assumed value of 0.1
Irrigation area = NA square feet
NA acres

8. Extended Detention Basin System Designed as Required in RG-348 Pages 3-46 to 3-51

Required Water Quality Volume for extended detention basin = NA cubic feet

9. Filter area for Sand Filters Designed as Required in RG-348 Pages 3-58 to 3-63

9A. Full Sedimentation and Filtration System

Water Quality Volume for sedimentation basin = NA cubic feet

Minimum filter basin area = NA square feet

Maximum sedimentation basin area = NA square feet For minimum water depth of 2 feet
Minimum sedimentation basin area = NA square feet For maximum water depth of 8 feet

9B. Partial Sedimentation and Filtration System

			SF @ Given Depth	Given Depth	Width	Length	
Water Quality Volume for combined basins =	NA	cubic feet	#VALUE!		5	90	#VALUE!
Minimum filter basin area =	NA	square feet				90	#VALUE!
Maximum sedimentation basin area =	NA	square feet	For minimum water depth of 2 feet			90	#VALUE!
	NA	square feet	For Given water depth			90	#VALUE!
Minimum sedimentation basin area =	NA	square feet	For maximum water depth of 8 feet			90	#VALUE!

10. Bioretention System Designed as Required in RG-348 Pages 3-63 to 3-65

Required Water Quality Volume for Bioretention Basin = NA cubic feet

11. Wet Basins Designed as Required in RG-348 Pages 3-66 to 3-71

Required capacity of Permanent Pool = NA cubic feet Permanent Pool Capacity is 1.20 times the WQV
Required capacity at WQV Elevation = NA cubic feet Total Capacity should be the Permanent Pool Capacity plus a second WQV.

12. Constructed Wetlands Designed as Required in RG-348 Pages 3-71 to 3-73

Required Water Quality Volume for Constructed Wetlands = NA cubic feet

13. AquaLogic™ Cartridge System Designed as Required in RG-348 Pages 3-74 to 3-78

** 2005 Technical Guidance Manual (RG-348) does not exempt the required 20% increase with maintenance contract with AquaLogic™.

Required Sedimentation chamber capacity =	**NA**	cubic feet
Filter canisters (FCs) to treat WQV =	**NA**	cartridges
Filter basin area (RIA_F) =	**NA**	square feet

14. Stormwater Management StormFilter® by CONTECH

Required Water Quality Volume for Contech StormFilter System =	**NA**	cubic feet

THE SIZING REQUIREMENTS FOR THE FOLLOWING BMPs / LOAD REMOVALS ARE BASED UPON FLOW RATES - NOT CALCULATED WATER QUALITY VOLUMES

15. Grassy Swales Designed as Required in RG-348 Pages 3-51 to 3-54

Design parameters for the swale:

Drainage Area to be Treated by the Swale = A =	0.00	acres
Impervious Cover in Drainage Area =	0.00	acres
Rainfall intensity = i =	1.1	in/hr
Swale Slope =	0.025	ft/ft
Side Slope (z) =	3	
Design Water Depth = y =	0.33	ft
Weighted Runoff Coefficient = C =	#DIV/0!	

A_{CS} = cross-sectional area of flow in Swale =	#DIV/0!	sf
P_W = Wetted Perimeter =	#DIV/0!	feet
R_H = hydraulic radius of flow cross-section = A_{CS}/P_W =	#DIV/0!	feet
n = Manning's roughness coefficient =	0.2	

15A. Using the Method Described in the RG-348

Manning's Equation: $Q = \frac{1.49}{n} A_{CS} R_H^{2/3} S^{0.5}$

$b = \frac{0.134 \times Q}{y^{1.67} S^{0.5}} - zy$ = #DIV/0! feet

Q = CiA = #DIV/0! cfs

To calculate the flow velocity in the swale:

V (Velocity of Flow in the swale) = Q/A_{CS} = #DIV/0! ft/sec

To calculate the resulting swale length:

L = Minimum Swale Length = V (ft/sec) * 300 (sec) = #DIV/0! feet

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters must be modified and the solver rerun.

15B. Alternative Method using Excel Solver

Design Q = CiA = #DIV/0! cfs

Manning's Equation Q =	6.90	cfs	Error 1 =	5.82
Swale Width=	36.91	ft		

Instructions are provided to the right (green comments).

Flow Velocity	#DIV/0!	ft/s
Minimum Length =	#DIV/0!	ft

Instructions are provided to the right (blue comments).

Design Width =	6	ft		
Design Discharge =	1.20	cfs	Error 2 =	#DIV/0!
Design Depth =	0.33	ft		
Flow Velocity =	0.51	cfs		
Minimum Length =	154.12	ft		

If any of the resulting values do not meet the design requirement set forth in RG-348, the design parameters may be modified and the solver rerun.
If any of the resulting values still do not meet the design requirement set forth in RG-348, widening the swale bottom value may not be possible.

16. Vegetated Filter Strips Designed as Required in RG-348 Pages 3-55 to 3-57

There are no calculations required for determining the load or size of vegetative filter strips.
The 80% removal is provided when the contributing drainage area does not exceed 72 feet (direction of flow) and the sheet flow leaving the impervious cover is directed across 15 feet of engineered filter strips with maximum slope of 20% or across 50 feet of natural vegetation with a maximum slope of 10%. There can be a break in grade as long as no slope exceeds 20%.

If vegetative filter strips are proposed for an interim permanent BMP, they may be sized as described on Page 3-56 of RG-348.

17. Wet Vaults — Designed as Required in RG-348 — Pages 3-30 to 3-32 & 3-79

Required Load Removal Based upon Equation 3.3 = **NA** lbs

First calculate the load removal at 1.1 in/hour

RG-348 Page 3-30 Equation 3.4: $Q = CiA$

C = runoff coefficient for the drainage area = 0.50 — C = Runoff Coefficient = $0.546 (IC)^2 + 0.328 (IC) + 0.03$
i = design rainfall intensity = 1.1 in/hour
A = drainage area in acres = 1 acres

Q = flow rate in cubic feet per second = 0.56 cubic feet/sec

RG-348 Page 3-31 Equation 3.5: $V_{OR} = Q/A$

Q = Runoff rate calculated above = 0.56 cubic feet/sec
A = Water surface area in the wet vault = 150 square feet

V_{CR} = Overflow Rate = 0.00 feet/sec

Percent TSS Removal from Figure 3-1 (RG-348 Page 3-31) = 53 percent

Load removed by Wet Vault = #VALUE! lbs

If a bypass occurs at a rainfall intensity of less than 1.1 in/hours
Calculate the efficiency reduction for the actual rainfall intensity rate

Actual Rainfall Intensity at which Wet Vault bypass Occurs = 0.5 in/hour

Fraction of rainfall treated from Figure 3-2 RG-348 Page 3-32 = 0.75 percent
Efficiency Reduction for Actual Rainfall Intensity = 0.83 percent

Resultant TSS Load removed by Wet Vault = #VALUE! lbs

18. Permeable Concrete — Designed as Required in RG-348 — Pages 3-79 to 3-83

PERMEABLE CONCRETE MAY ONLY BE USED ON THE CONTRIBUTING ZONE

19. BMPs Installed in a Series — Designed as Required in RG-348 — Pages 3-32

Michael E. Barrett, Ph.D., P.E. recommended that the coefficient for E_2 be changed from 0.5 to 0.65 on May 3, 2006

$E_{TOT} = [1 - ((1 - E_1) X (1 - 0.65E_2) x (1 - 0.25E_3))] X 100 =$ 94.01 percent — NET EFFICIENCY OF THE BMPs IN THE SERIES

EFFICIENCY OF FIRST BMP IN THE SERIES = E_1 = 89.00 percent

EFFICIENCY OF THE SECOND BMP IN THE SERIES = E_2 = 70.00 percent

EFFICIENCY OF THE THIRD BMP IN THE SERIES = E_3 = 0.00 percent

THEREFORE, THE NET LOAD REMOVAL WOULD BE:
(A_I AND A_P VALUES ARE FROM SECTION 3 ABOVE)

$L_R = E_{TOT} X P X (A_I X 34.6 X A_P X 0.54) =$ 220.32 lbs

20. Stormceptor

Required TSS Removal in BMP Drainage Area= **NA** lbs
Impervious Cover Overtreatment= 0.0000 ac
TSS Removal for Uncaptured Area = 0.00 lbs

BMP Sizing

Effective Area = NA EA
Calculated Model Size(s) = #N/A
Actual Model Size (if multiple values provided in Calculated Model Size or if you are choosing a larger model size) = 0 Model Size

Surface Area = #N/A ft^2
Overflow Rate = #VALUE! V_{or}
Rounded Overflow Rate = #VALUE! V_{or}
BMP Efficiency % = #VALUE! %

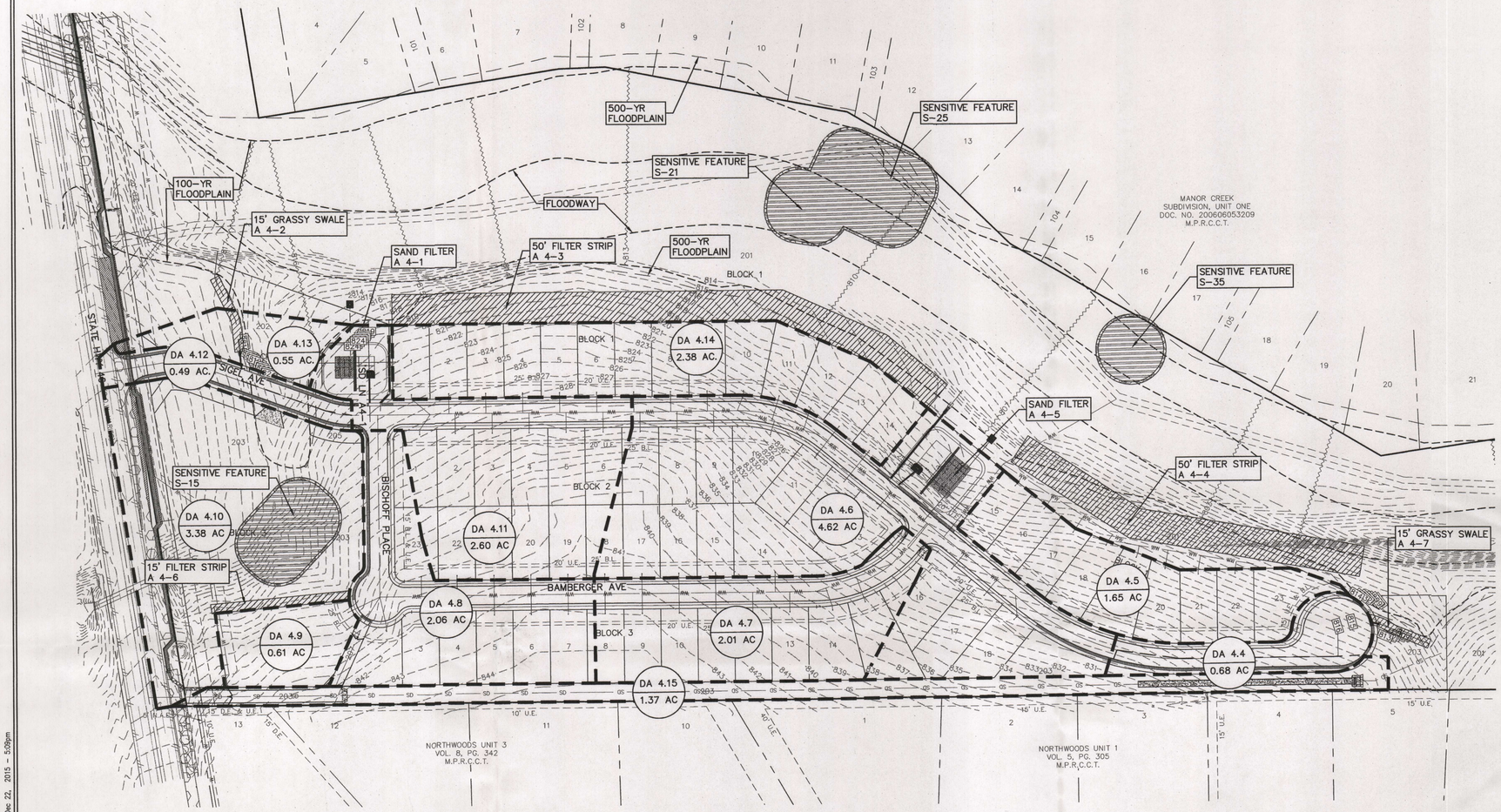
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	

21. Vortech

Required TSS Removal in BMP Drainage Area=	NA	lbs
Impervious Cover Overtreatment=	0.0000	ac
TSS Removal for Uncaptured Area =	0.00	lbs

BMP Sizing

Effective Area =	NA	EA
Calculated Model Size(s) =	#N/A	
Actual Model Size (if choosing larger model size) =	Vx1000	Pick Model Size
Surface Area =	7.10	ft^2
Overflow Rate =	#VALUE!	V_{or}
Rounded Overflow Rate =	#VALUE!	V_{or}
BMP Efficiency % =	#VALUE!	%
L_R Value =	#VALUE!	lbs
TSS Load Credit =	#VALUE!	lbs
Is Sufficient Treatment Available? (TSS Credit ≥ TSS Uncapt.)	#VALUE!	
TSS Treatment by BMP (LM + TSS Uncapt.) =	#VALUE!	



0 50 100

SCALE: 1" = 100'

LEGEND

- 700 — EXISTING CONTOURS
- 700 PROPOSED CONTOURS
- B.L. BUILDING SETBACK LINE
- U.E. UTILITY EASEMENT
- D.E. DRAINAGE EASEMENT
- DRAINAGE AREA
- TC — TC TIME OF CONCENTRATION
- DRAINAGE FLOW DIRECTION
- (A) POINT OF CONCENTRATION
- C-7 / 5.4 ac DRAINAGE AREA LABEL
- VEGETATED FILTER STRIP
- SAND FILTER BASIN
- DRAINAGE AND BUFFER AREA FOR SENSITIVE FEATURES

SENSITIVE FEATURE PROTECTION NOTES:

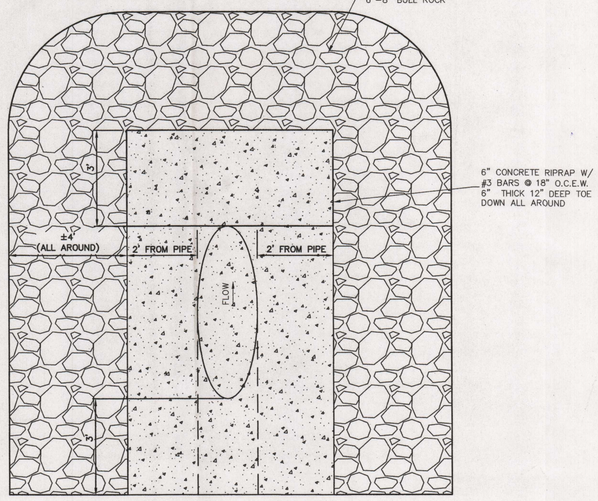
CONTRACTOR SHALL ENSURE THAT THE FOLLOWING ITEMS ASSOCIATED WITH THE SENSITIVE FEATURE PRIOR TO COMMENCING ANY CONSTRUCTION ACTIVITIES ARE IN GOOD WORKING ORDER. IF THEY ARE NOT IN ACCEPTABLE CONDITION IN THE OWNERS ESTIMATION, CONTRACTOR SHALL REPLACE OR REPAIR THESE ITEMS AS NECESSARY (AT NO ADDITIONAL EXPENSE TO OWNER):

- HIGH PERFORMANCE ROCK BERM IN LOT 203

Manor Creek Unit 4 Permanent BMP Summary Table

Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	LR (lbs)	LM (lbs)	LM (lbs) Desired
A 4-1	DA 4.8+DA 4.11	Sand Filter	4.66	4.67	2.38	51.0%	2,453	2,134	2,202
A 4-2	DA 4.12	Grassy Swale	0.49	0.49	0.36	73.3%	289	322	289
A 4-3	DA 4.14	Vegetated Filter Strips	2.38	2.38	1.06	44.6%	988	952	952
A 4-4	DA 4.5	Vegetated Filter Strips	1.65	1.64	0.68	41.3%	636	612	612
A 4-5	DA 4.6+ DA 4.7	Sand Filter	6.63	6.63	3.06	46.1%	3,166	2,744	3,020
A 4-6	DA 4.9	Vegetated Filter Strips	0.61	0.61	0.08	12.4%	77	68	68
A 4-7	DA 4.4	Grassy Swale	0.68	0.68	0.55	81.1%	437	495	437
A 4-15	DA 4.15	Untreated Release	1.37	1.37	0.24	17.7%	-	217	-
Total			**18.47**	**17.10**	**8.41**	**50.0%**	**8,046**	**7,544**	**7,580**
							Required TSS Removal		7,544

NOTE: AREAS DA 4.10 AND DA 4.13 DO NOT REQUIRE PERMANENT BMPs.



PVC SPLASH PAD DETAIL

NOT-TO-SCALE

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12/22/15

WATER QUALITY TREATMENT

CIVIL SITE CONSTRUCTION PLANS

MANOR CREEK, UNIT 4
CIVIL SITE CONSTRUCTION PLANS

DR HORTON
210 W. HUTCHISON STREET
SAN MARCOS, TEXAS 78666

TCEQ R-13 2

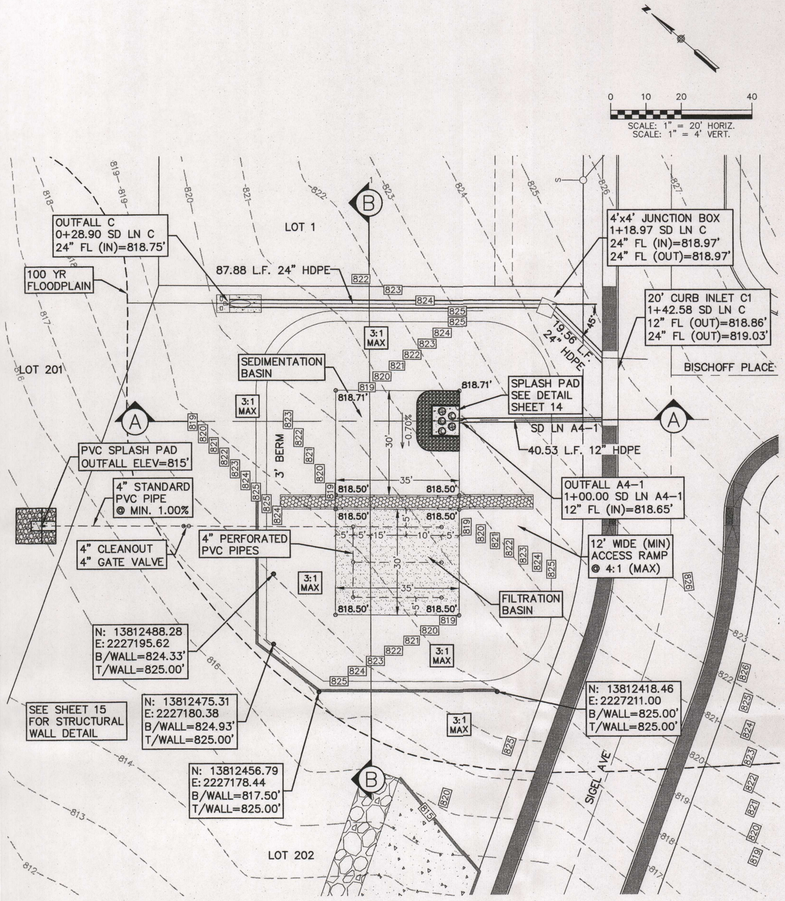
TCEQ R 13 2015 DEC 23 1554

DATE: DECEMBER 2015
DRAWN BY: KRK
DESIGNED BY: GJM
CHECKED BY: CVH
REVIEWED BY: SMH & SCH
PROJECT NO.: 031.023.106

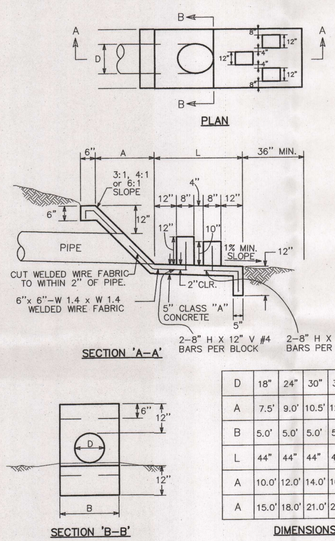
SHEET 11

Drawing Name: N:_Projects\031 - DR Horton\031.023 - Manor Creek Unit 4\031.023.106 - Construction Documents\031.023.106-WQTY.dwg User: gonnellm Dec 22, 2015 - 5:09pm

WATER QUALITY BASIN A4-1 DETAILS	
ITEM	QUANTITY
WQ VOLUME REQUIRED	12,542 CF
WQ VOLUME PROVIDED	20,432 CF
SEDIMENTATION AREA REQUIRED	1,045 SF
SEDIMENTATION AREA PROVIDED	1,050 SF
FILTER AREA REQUIRED	1,045 SF
FILTER AREA PROVIDED	1,050 SF
WQ STORAGE DEPTH	5.21 FEET
TSS REMOVED	2,202 LBS



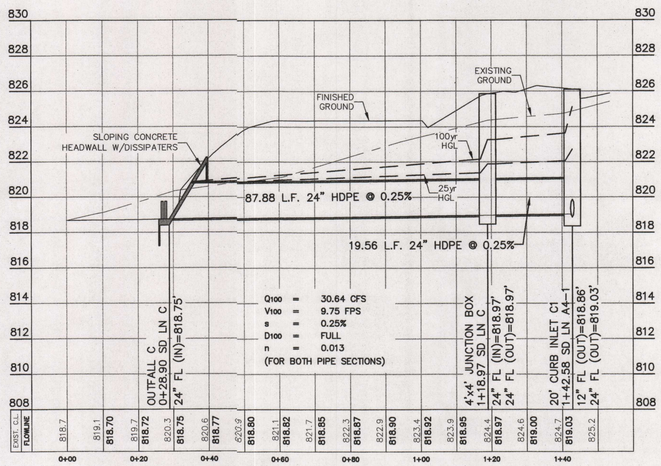
1 SAND FILTER BASIN A4-1 PLAN
SCALE: Horz. 1:20 Vert. 1:4



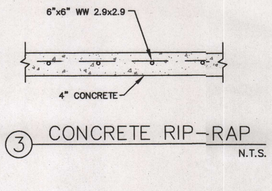
D	18"	24"	30"	36"	42"	
A	7.5'	9.0'	10.5'	12.0'	13.5'	for 3:1
B	5.0'	5.0'	5.0'	5.0'	5.0'	
L	44"	44"	44"	44"	44"	
A	10.0'	12.0'	14.0'	16.0'	18.0'	for 4:1
A	15.0'	18.0'	21.0'	24.0'	27.0'	for 6:1

DIMENSIONS

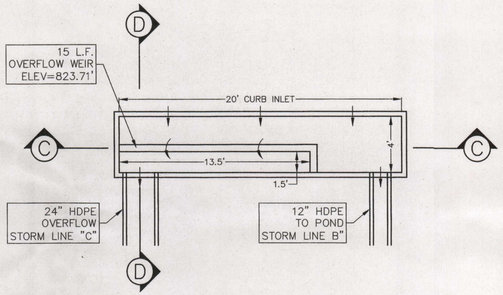
2 SLOPING CONCRETE HEADWALL
N.T.S.



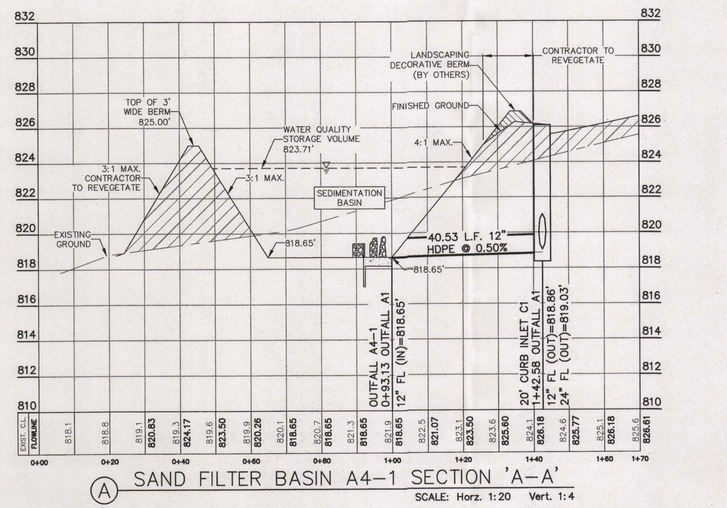
5 SAND FILTER BASIN A4-1 OVERFLOW
SCALE: Horz. 1:20 Vert. 1:4



3 CONCRETE RIP-RAP
N.T.S.



4 OVERFLOW WEIR PLAN
SCALE: 1:5



A SAND FILTER BASIN A4-1 SECTION 'A-A'
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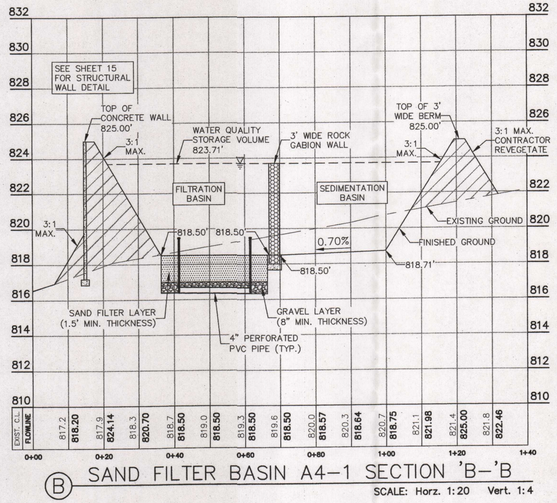

B SAND FILTER BASIN A4-1 SECTION 'B-'B
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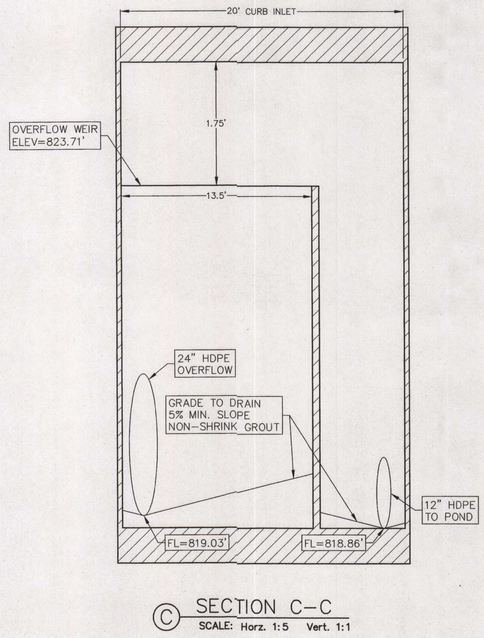
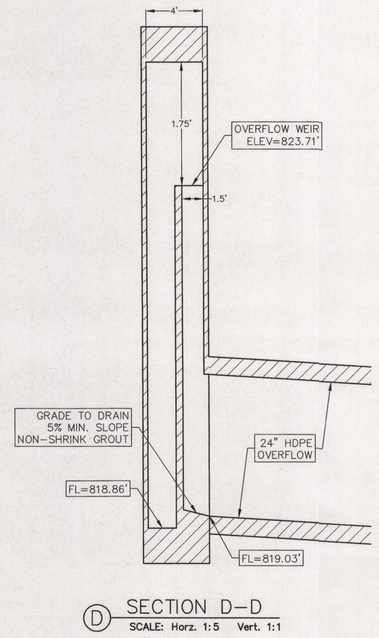


C SECTION C-C
SCALE: Horz. 1:5 Vert. 1:1



D SECTION D-D
SCALE: Horz. 1:5 Vert. 1:1

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STATE OF TEXAS
CHRISTOPHER P. VAN HEERDE
93047
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PROFESSIONAL ENGINEER
12/22/15

SAND FILTER BASIN A4-1
CIVIL SITE CONSTRUCTION PLANS

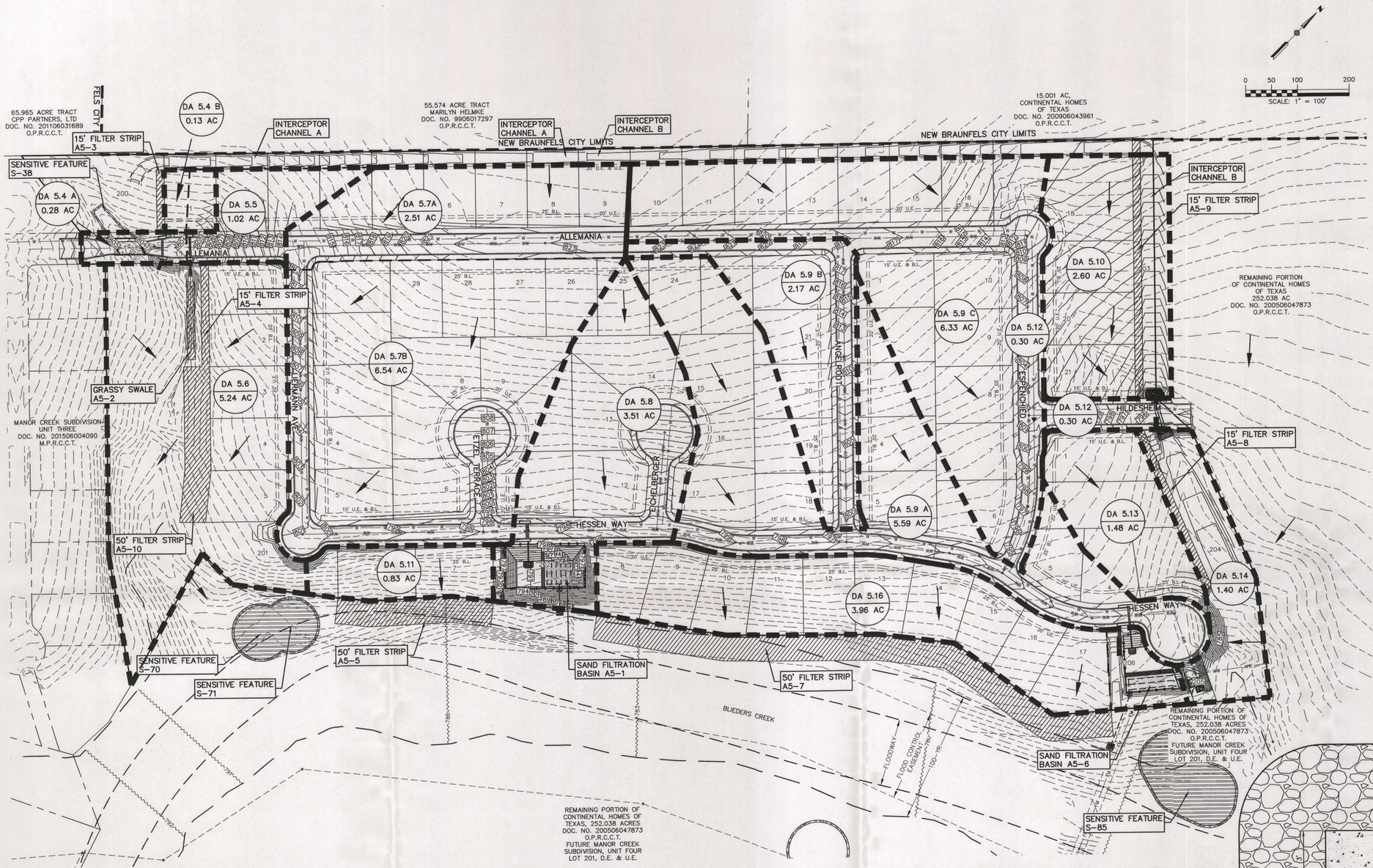
MANOR CREEK, UNIT 4
CIVIL SITE CONSTRUCTION PLANS

DR HORTON
210 W. HUTCHISON STREET
SAN MARCOS, TEXAS 78666

DATE: DECEMBER 2015
DRAWN BY: TJB
DESIGNED BY: GJM
CHECKED BY: CVH
REVIEWED BY: SWH & SCH
PROJECT NO.: 031.023.106

SHEET 12

Drawing Name: N:_Projects\031 - DR Horton\031.023 - Manor Creek Unit 4\031.023.106 - Construction Documents\031.023.106-WDTY.dwg User: gsmeltm Dec 22, 2015 - 5:10pm



LEGEND

- 700 — EXISTING CONTOURS
- 700 — PROPOSED CONTOURS
- B.L. — BUILDING SETBACK LINE
- U.E. — UTILITY EASEMENT
- D.E. — DRAINAGE EASEMENT
- DRAINAGE AREA
- TC — TC — TIME OF CONCENTRATION
- DRAINAGE FLOW DIRECTION
- (A) — POINT OF CONCENTRATION
- D-7 / 5.4 ac — DRAINAGE AREA LABEL
- VEGETATED FILTER STRIP
- DRAINAGE AND BUFFER AREA FOR SENSITIVE FEATURES
- HIGH SERVICE PERFORMANCE BERM

SENSITIVE FEATURE PROTECTION NOTES:

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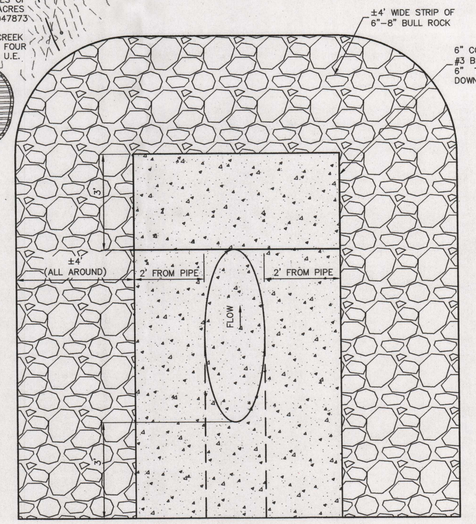
- HIGH PERFORMANCE ROCK BERM

Phase 5A & 5B Permanent BMP Summary Table

Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	LR (lbs)	LM (lbs)	Desired LM (lbs)
A 5-1	DA 5.8+DA5.7	Sand Filter	12.56	12.56	5.77	46.0%	5976	5183	5441
A 5-2	DA 5.5	Grassy Swale	1.02	0.86	0.68	66.6%	377	610	377
A 5-3	DA 5.4	Vegetated Filter Strips	0.28	0.28	0.07	25.5%	68	64	64
A 5-4	DA 5.6	Vegetated Filter Strips	5.24	5.24	0.71	13.6%	717	641	641
A 5-5	DA 5.11	Vegetated Filter Strips	0.83	0.83	0.29	34.4%	269	257	257
A 5-6	DA 5.9A +DA 5.9B+DA 5.9C	Sand Filter	14.39	14.09	6.66	46.3%	7033	5982	6294
A 5-7	DA 5.16	Vegetated Filter Strips	3.96	3.96	1.43	36.1%	1341	1283	1283
A 5-8	DA 5.13	Vegetated Filter Strips	2.88	2.88	0.57	19.8%	555	513	513
A 5-9	DA 5.10	Vegetated Filter Strips	2.6	2.6	0.57	22.0%	551	513	513
A 5-12	DA 5.12	Untreated Release	0.3	0.3	0.20	68.1%	0	183	0
A 5-4A	DA 5.4A	Untreated Release	0.28	0.28	0.17	60.6%	0	152	0
Total			**44.06**	**43.60**	**16.97**	**38.8%**	**16888**	**15383**	**15383**



PVC SPLASH PAD DETAIL

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12/22/15

WATER QUALITY TREATMENT PLAN OVERALL

CIVIL SITE CONSTRUCTION PLANS

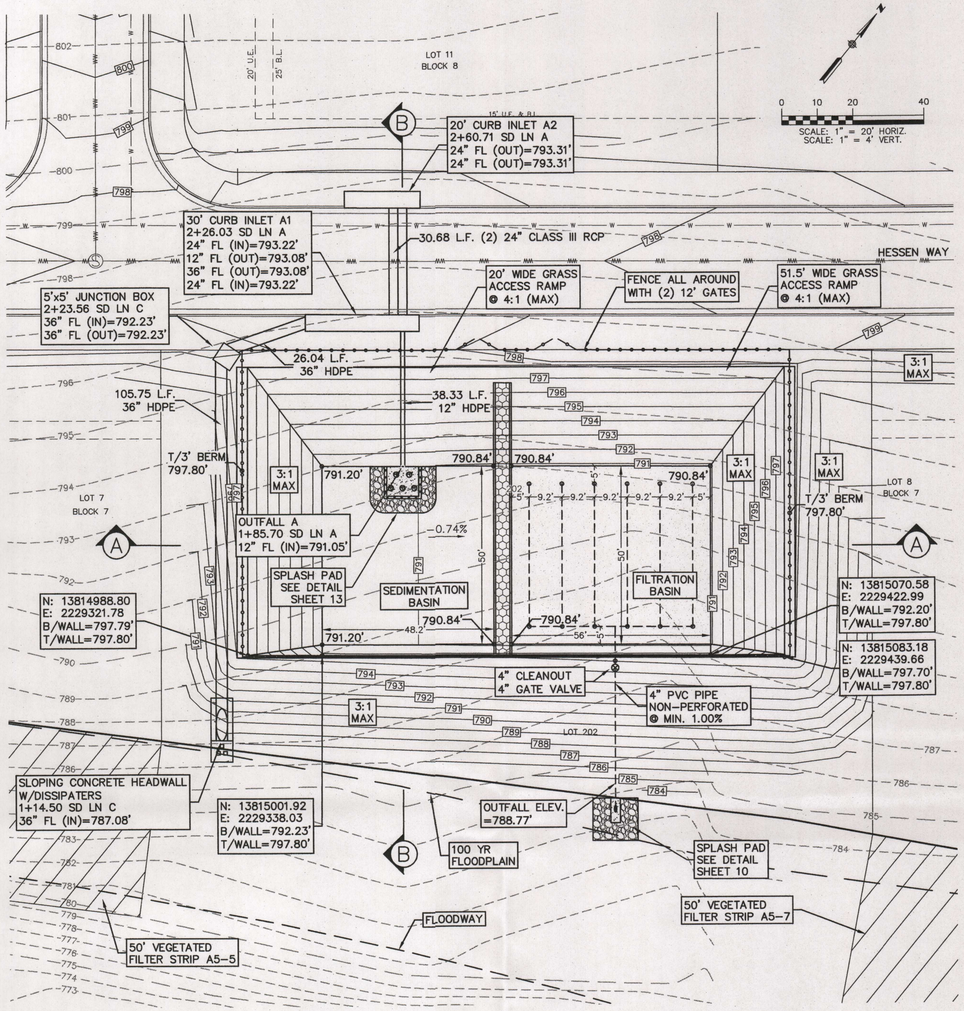
MANOR CREEK SUBDIVISION
UNIT 5

DR HORTON
210 W. HUTCHISON
SAN MARCOS, TEXAS 78666

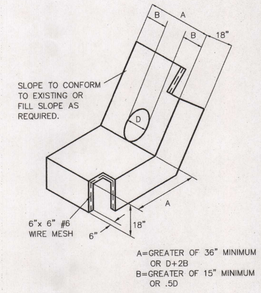
DATE: NOVEMBER 2015
DRAWN BY: TJB
DESIGNED BY: GJM
CHECKED BY: CVH
REVIEWED BY: SWH
PROJECT NO.: 031.024.105

SHEET
10

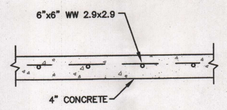
Drawing Name: N:_Projects\031 - DR Horton\031.024 - Manor Creek Unit 5\031.024.105_Construction Documents\031.024.105_WQTP.dwg User: tjb Dec 22, 2015 - 5:24pm



1 SAND FILTER BASIN A5-1 PLAN
SCALE: HORZ. 1:20 VERT. 1:4

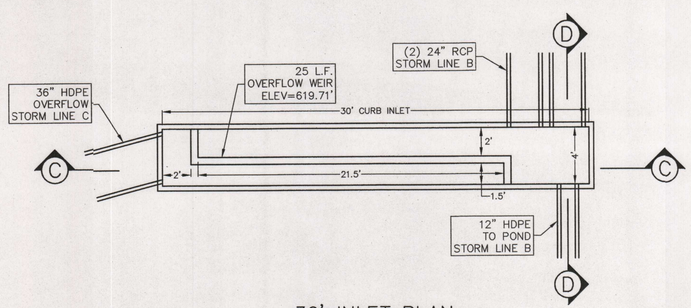


4 SLOPING CONCRETE HEADWALL
N.T.S.

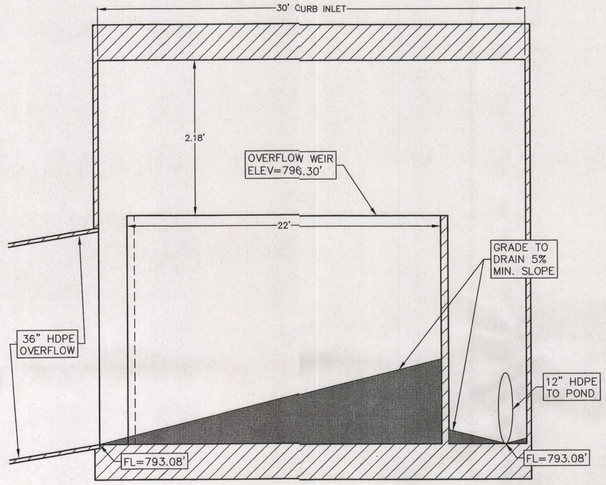


2 CONCRETE RIP-RAP
N.T.S.

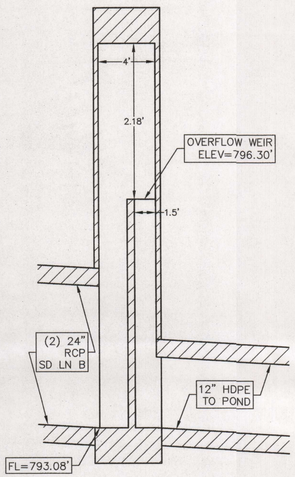
WATER QUALITY BASIN A5-1 DETAILS	
ITEM	QUANTITY
WQ VOLUME REQUIRED	33,114 CF
WQ VOLUME PROVIDED	41,474 CF
SEDIMENTATION AREA REQUIRED	2,759 SF
SEDIMENTATION AREA PROVIDED	2,800 SF
FILTER AREA REQUIRED	2,295 SF
FILTER AREA PROVIDED	2,435 SF
WQ STORAGE DEPTH	5.46 FEET
TSS REMOVED	5,441 LBS



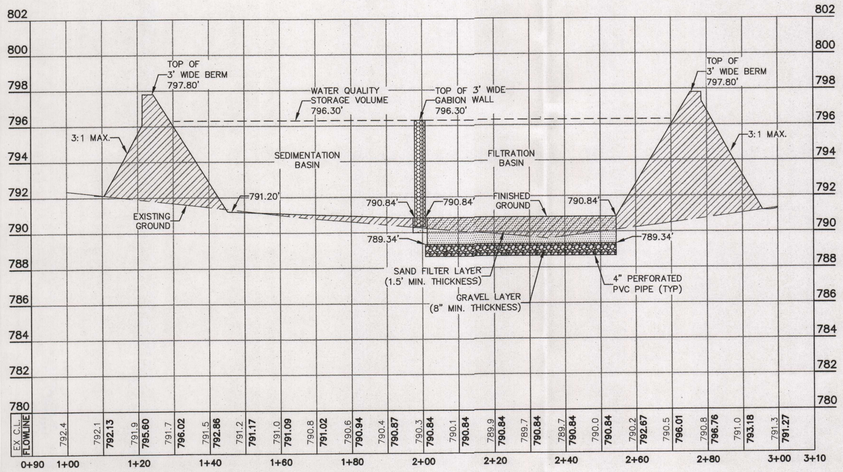
5 30' INLET PLAN
N.T.S.



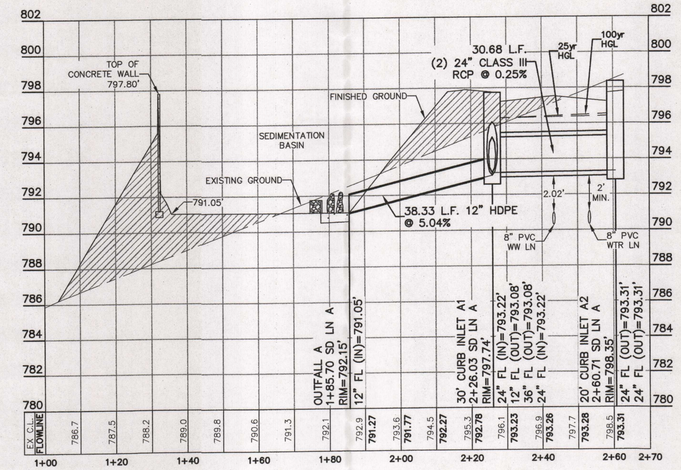
C SECTION C-C
SCALE: HORZ. 1:5 VERT. 1:1



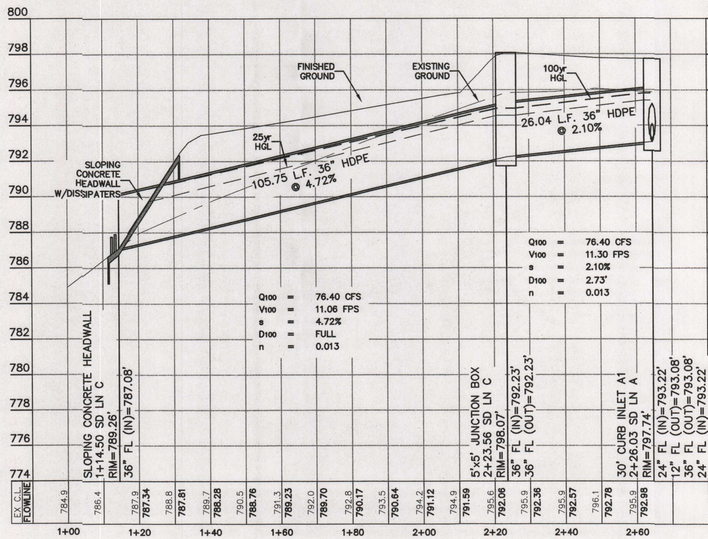
D SECTION D-D
SCALE: HORZ. 1:5 VERT. 1:1



A SAND FILTER BASIN A5-1 PROFILE
SCALE: HORZ. 1:20 VERT. 1:4



B SECTION B-B
SCALE: HORZ. 1:20 VERT. 1:4



3 SD LN 'C' PROFILE
SCALE: HORZ. 1:20 VERT. 1:4

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STATE OF TEXAS
CHRISTOPHER P. VAN HEERDE
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12/22/15

SAND FILTER BASIN A5-1
CIVIL SITE CONSTRUCTION PLANS

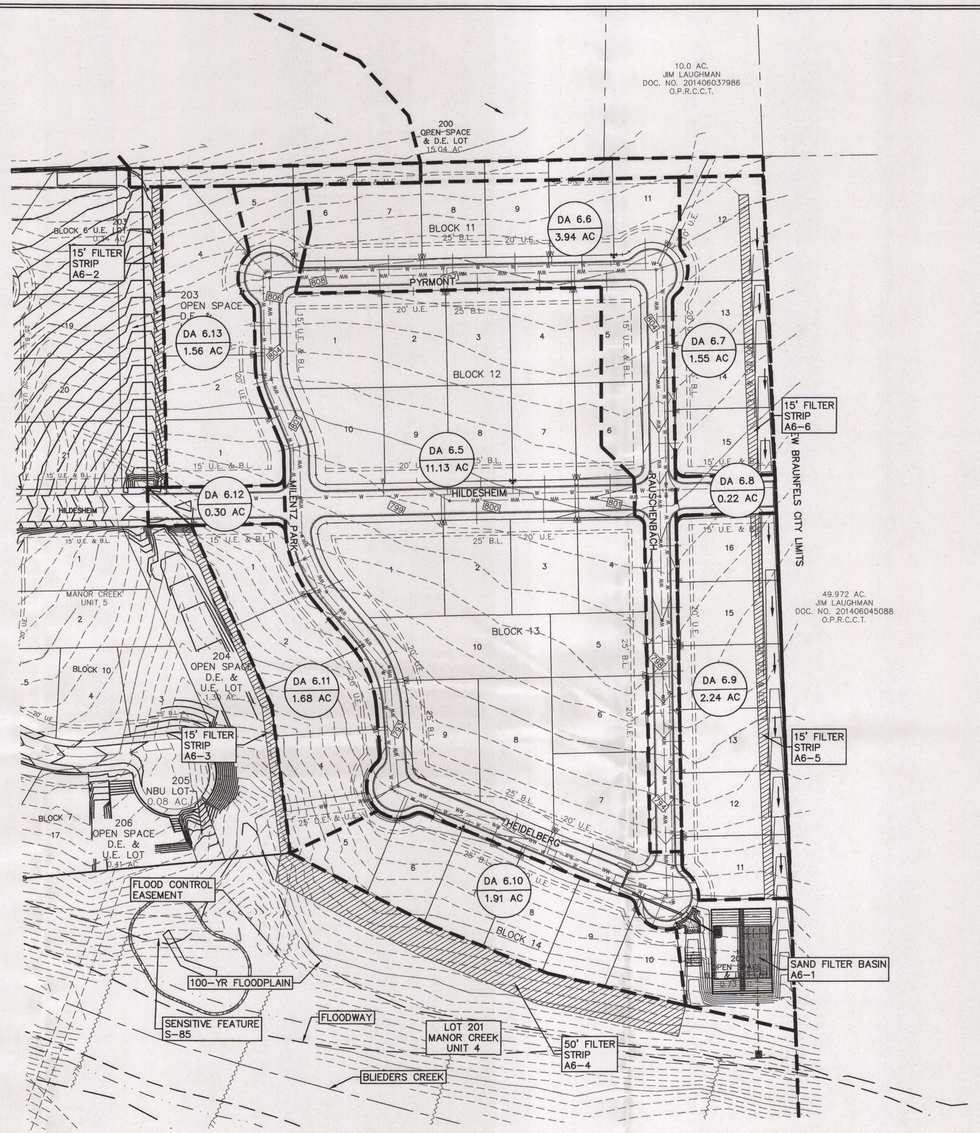
MANOR CREEK SUBDIVISION
UNIT 5

DR HORTON
210 W. HUTCHISON
SAN MARCOS, TEXAS 78666

DATE: NOVEMBER 2015
DRAWN BY: TJB
DESIGNED BY: GJM
CHECKED BY: CVH
REVIEWED BY: SNH
PROJECT NO.: 031.024.105

SHEET 11

Drawing Name: N:_Projects\031 - DR Horton\031.024 - Manor Creek Unit 5\031.024.105 Construction Documents\031.024.105_WQTY.dwg User: tjb Dec 22, 2015 - 5:10pm



Manor Creek 6 Permanent BMP Summary Table									
Subbasin Data	Area Treated	Treatment Method	Total Area (acres)	Acreage Treated	Impervious Area (acres)	Imp %	LR (lbs)	LM (lbs)	Desired LM (lbs)
A 6-1	DA 6.5 & DA 6.6	Sand Filter	15.59	15.07	6.695	42.9%	6936	6009	6323
A 6-2	DA 6.13	Vegetated Filter Strips	1.56	1.56	0.572	36.6%	536	513	513
A 6-3	DA 6.11	Vegetated Filter Strips	1.68	1.68	0.572	34.0%	538	513	513
A 6-4	DA 6.10	Vegetated Filter Strips	1.91	1.91	0.857	44.9%	798	770	770
A 6-5	DA 6.9	Vegetated Filter Strips	2.24	2.24	0.857	38.3%	803	770	770
A 6-6	DA 6.7	Vegetated Filter Strips	1.55	1.55	0.572	36.9%	536	513	513
A 6-8	DA 6.8	Untreated Release	0.22	0.22	0.15	66.2%	-	131	-
A 6-12	DA 6.12	Untreated Release	0.30	0.30	0.20	67.9%	-	183	-
Total			**25.05**	**24.53**	**10.47**	**46.0%**	**10147**	**9401**	**9402**

SCALE: 1" = 100'

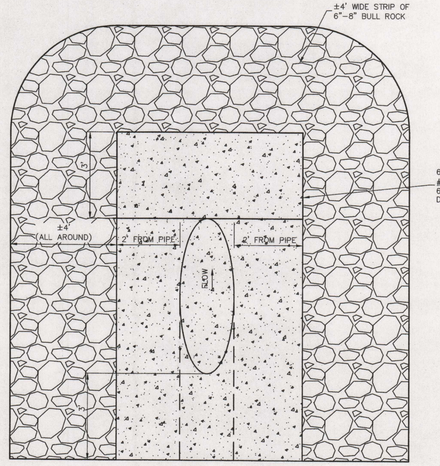
LEGEND

- EXISTING CONTOURS
- PROPOSED CONTOURS
- B.L. BUILDING SETBACK LINE
- U.E. UTILITY EASEMENT
- D.E. DRAINAGE EASEMENT
- DRAINAGE AREA
- TC — TC TIME OF CONCENTRATION
- DRAINAGE FLOW DIRECTION
- (A) POINT OF CONCENTRATION
- DA 6.7 / 1.55 AC DRAINAGE AREA LABEL
- VEGETATED FILTER STRIP
- SAND FILTER BASIN
- DRAINAGE AND BUFFER AREA FOR SENSITIVE FEATURES

SENSITIVE FEATURE PROTECTION NOTES:

CONTRACTOR SHALL ENSURE THAT THE FOLLOWING ITEMS ASSOCIATED WITH THE SENSITIVE FEATURE PRIOR TO COMMENCING ANY CONSTRUCTION ACTIVITIES ARE IN GOOD WORKING ORDER. IF THEY ARE NOT IN ACCEPTABLE CONDITION IN THE OWNERS ESTIMATION, CONTRACTOR SHALL REPLACE OR REPAIR THESE ITEMS AS NECESSARY (AT NO ADDITIONAL EXPENSE TO OWNER):

- **HIGH PERFORMANCE ROCK BERM ON LOT 201, MANOR CREEK SUBDIVISION UNIT 4**



PVC SPLASH PAD DETAIL

NOT-TO-SCALE

410 N. SEGUIN AVE.
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12/22/15

WATER QUALITY TREATMENT

CIVIL SITE CONSTRUCTION PLANS

MANOR CREEK SUBDIVISION,
UNIT 6

DR HORTON
210 W. HUTCHISON
SAN MARCOS, TEXAS 78666

DATE: OCTOBER 2015
DRAWN BY: TJB
DESIGNED BY: CJM
CHECKED BY: CVH
REVIEWED BY: SWH
PROJECT NO.: 031.028.102

SHEET
9

Drawing Name: N:_Projects\031 - DR Horton\031.028 - Manor Creek Unit 6 - Platting & Construction Drawings\031.028.102 - Construction Drawings\031.028.102_MOT7.dwg User: gcmittm Dec 22, 2015 - 5:17pm