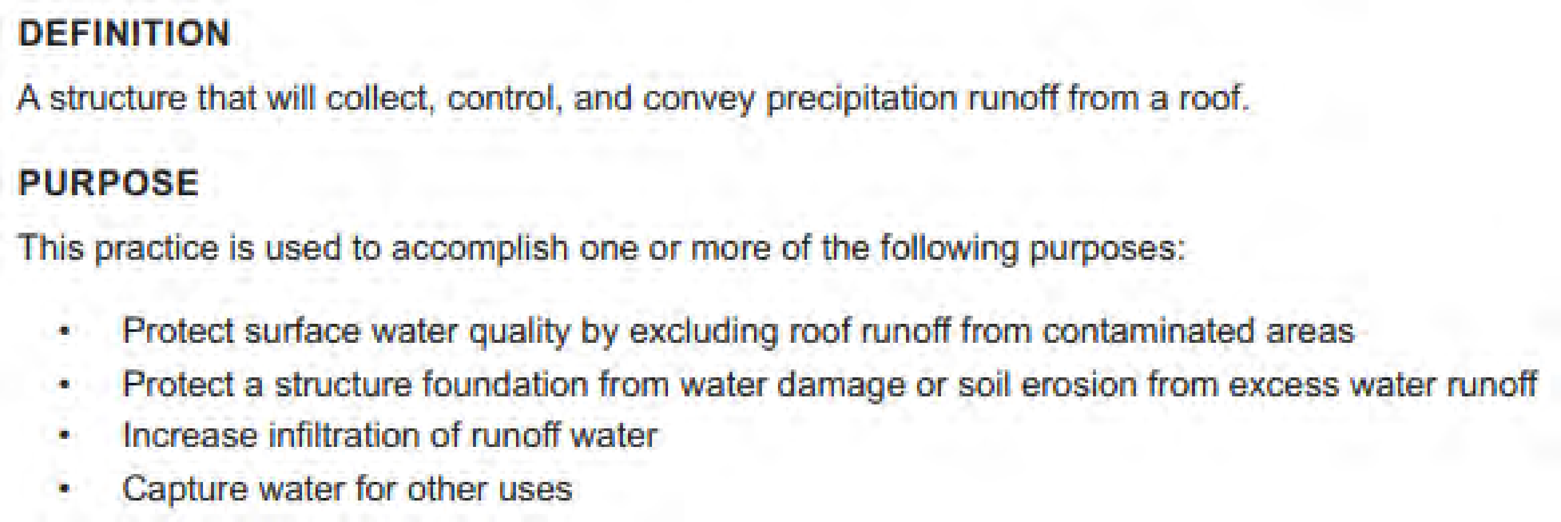
558 - ROOF RUNOFF STRUCTURE

Alberto Atienza

Civil Engineer - Arecibo FO

- Define practice 558 Roof Runoff Structure
- Where the practice applies
- Data gathering
- How to design a roof runoff structure
- Certification of the practice

OBJECTIVES



DEFINITION

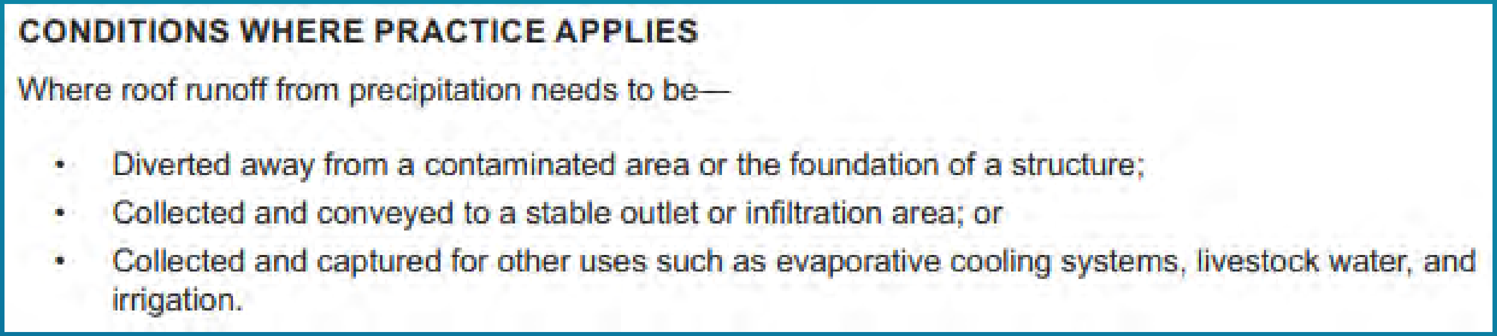
A structure that will collect, control, and convey precipitation runoff from a roof.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Protect surface water quality by excluding roof runoff from contaminated areas
- Protect a structure foundation from water damage or soil erosion from excess water runoff
- Increase infiltration of runoff water
- Capture water for other uses

STANDARD – 558 ROOF RUNOFF STRUCTURE

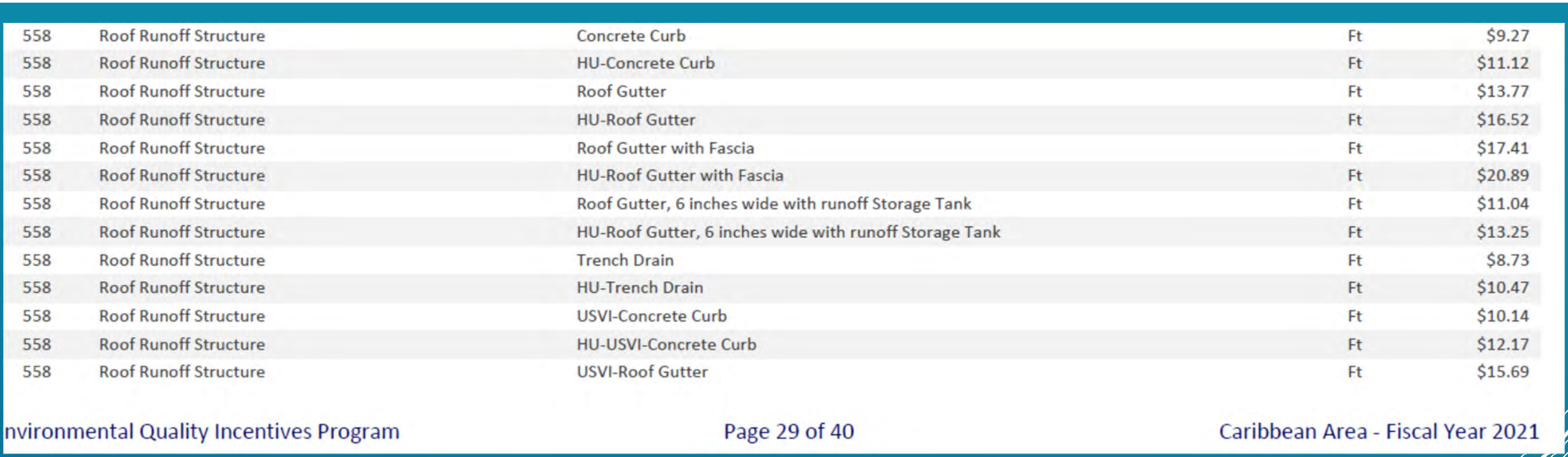


CONDITIONS WHERE PRACTICE APPLIES

Where roof runoff from precipitation needs to be—

- Diverted away from a contaminated area or the foundation of a structure;
- Collected and conveyed to a stable outlet or infiltration area; or
- Collected and captured for other uses such as evaporative cooling systems, livestock water, and irrigation.

STANDARD – 558 ROOF RUNOFF STRUCTURE



558	Roof Runoff Structure	Concrete Curb	Ft	$9.27
558	Roof Runoff Structure	HU-Concrete Curb	Ft	$11.12
558	Roof Runoff Structure	Roof Gutter	Ft	$13.77
558	Roof Runoff Structure	HU-Roof Gutter	Ft	$16.52
558	Roof Runoff Structure	Roof Gutter with Fascia	Ft	$17.41
558	Roof Runoff Structure	HU-Roof Gutter with Fascia	Ft	$20.89
558	Roof Runoff Structure	Roof Gutter, 6 inches wide with runoff Storage Tank	Ft	$11.04
558	Roof Runoff Structure	HU-Roof Gutter, 6 inches wide with runoff Storage Tank	Ft	$13.25
558	Roof Runoff Structure	Trench Drain	Ft	$8.73
558	Roof Runoff Structure	HU-Trench Drain	Ft	$10.47
558	Roof Runoff Structure	USVI-Concrete Curb	Ft	$10.14
558	Roof Runoff Structure	HU-USVI-Concrete Curb	Ft	$12.17
558	Roof Runoff Structure	USVI-Roof Gutter	Ft	$15.69

nvironmental Quality Incentives Program Page 29 of 40 Caribbean Area - Fiscal Year 2021

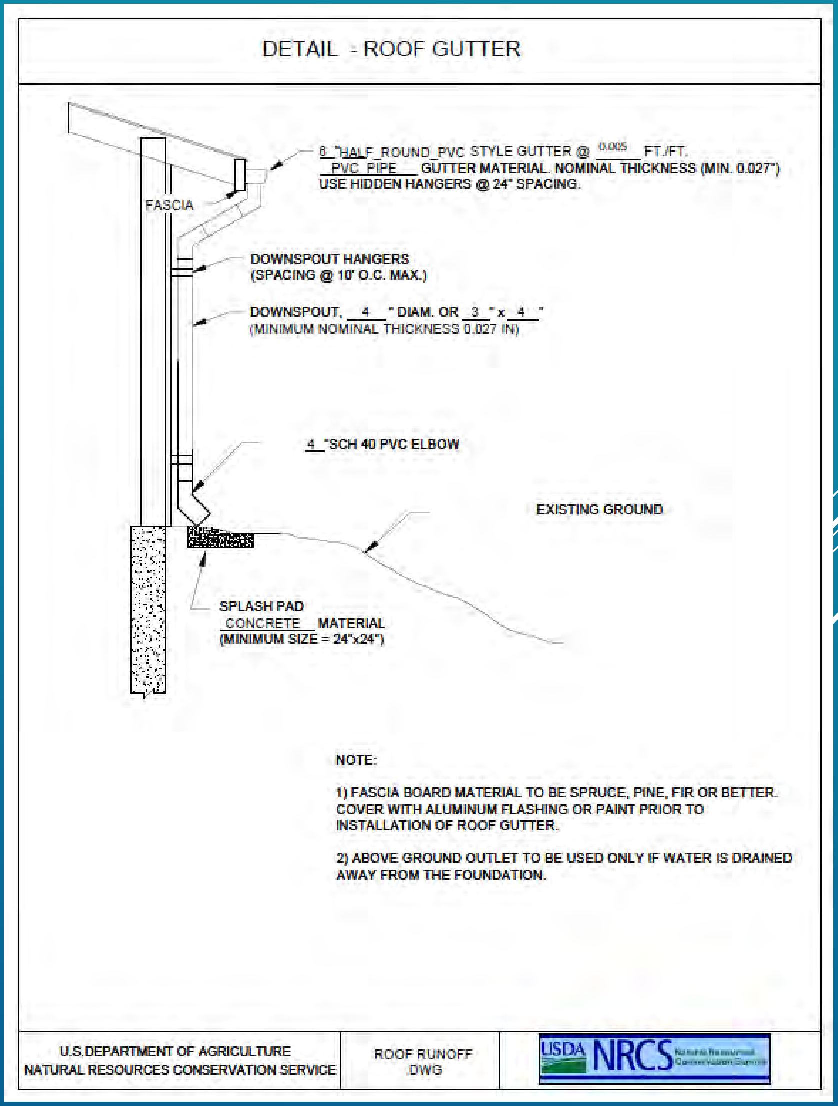
EXISTING SCENARIOS

CPS- 558 – ROOF RUNOFF STRUCTURE

- Scenario #1: Roof Gutter
  - A roof runoff structure, consisting of gutter(s), downspout(s), and appropriate outlet facilities.
  - Used to keep roof clean water runoff uncontaminated and provide a stable outlet to ground surface.
  - Facilitates waste management and protects environment by minimizing clean water additions to waste systems and addresses water quality concerns.
- Scenario #3 Roof Gutter with Fascia
  - Existing roof does not have adequate fascia material to support the required roof gutter for a roof runoff structure

Lifespan: 15 Yr.

- Design based on intensity of rainfall



DETAIL - ROOF GUTTER

NOTE:

1) FASCIA BOARD MATERIAL TO BE SPRUCE, PINE, FIR OR BETTER. COVER WITH ALUMINUM FLASHING OR PAINT PRIOR TO INSTALLATION OF ROOF GUTTER.

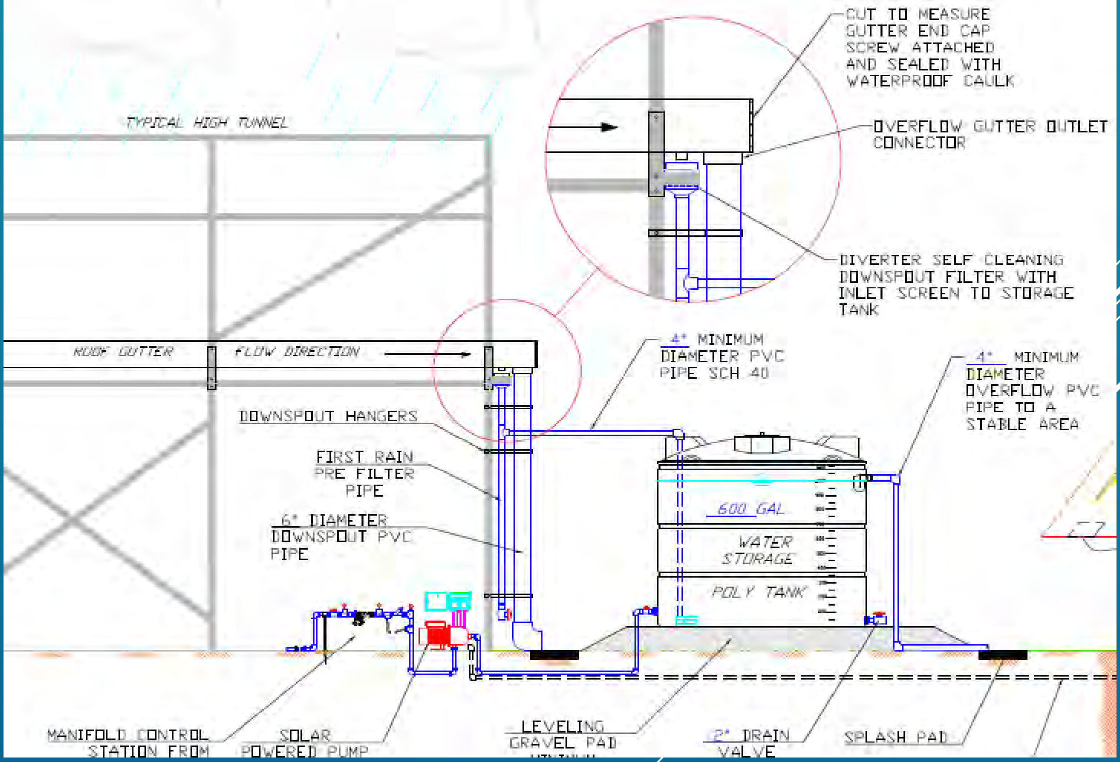
2) ABOVE GROUND OUTLET TO BE USED ONLY IF WATER IS DRAINED AWAY FROM THE FOUNDATION.

U.S.DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	ROOF RUNOFF .DWG	USDA NRCS

- Lifespan: 15 Yr.

CPS- 558 – ROOF RUNOFF STRUCTURE

- Scenario #11: Roof Gutter, 6 inches wide with runoff storage tank
  - A roof runoff structure, consisting of gutter(s), downspout(s), and storage tank.
  - Used to keep roof clean water runoff uncontaminated and provide a stable outlet to ground surface.
  - Facilitates waste management and protects environment by minimizing clean water additions to waste systems and addresses water quality concerns.



- This scenario considers a typical 1,500gal tank
- DO NOT CONTRACT TANK AS A SEPARATE CPS

- Lifespan: 15 Yr.

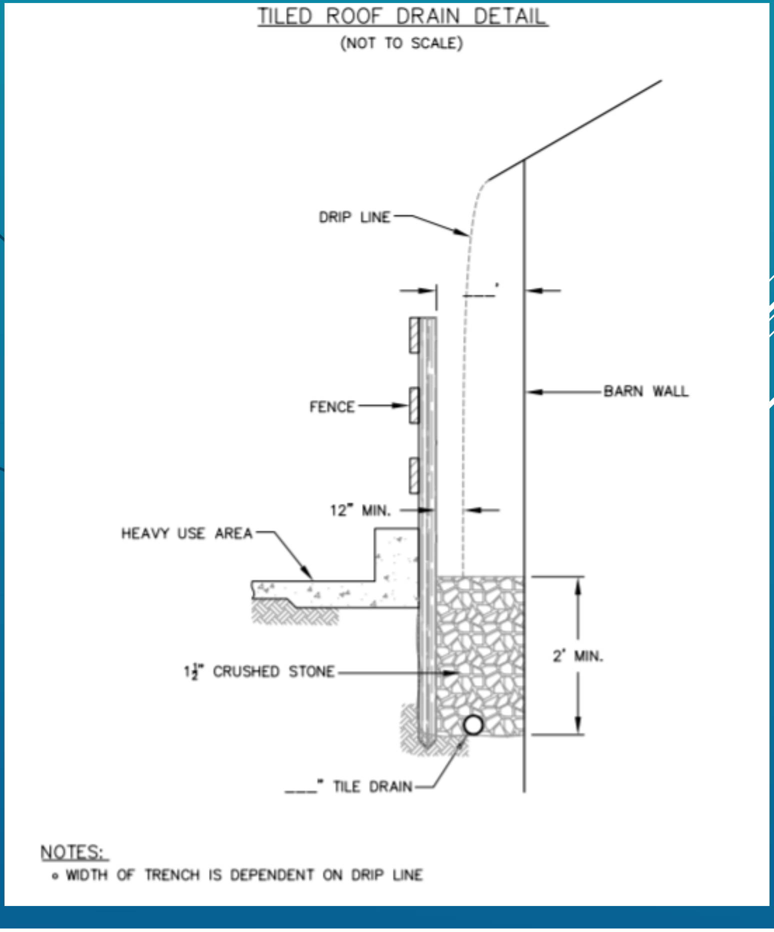
CPS- 558 – ROOF RUNOFF STRUCTURE

- Scenario #5: Concrete Curb
- Concrete curb or parabolic channel installed on existing impervious surface or the ground with appropriate outlet facilities.

- Scenario #7 Trench Drain
- Trench filled with rock, with a polyethylene, corrugated, perforated drain tile installed in trench bottom.

- Environmental/design considerations, for example –a building without proper structural support needed for gutters.

- Used to keep roof clean water runoff uncontaminated and provide a stable outlet to ground surface



CPS- 558 – ROOF RUNOFF STRUCTURE

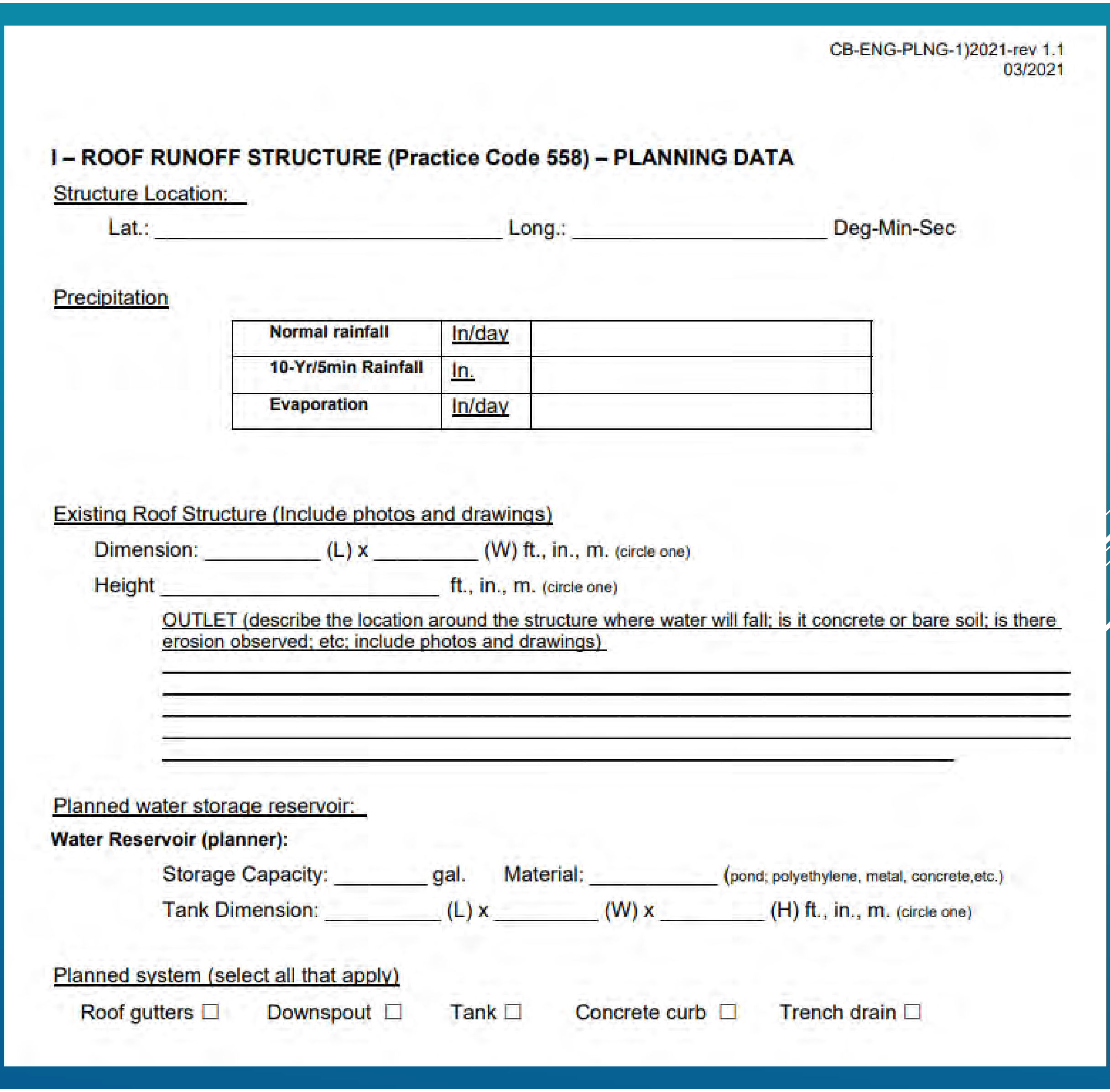
- Field Data Requirements –
- CB-ENG-PLNG-1 Roof Dimensions – Width and Length. Note, if the roof is divided in different planes (zones), measure each plane independently because each plane will drain to different sides of the structure.

1. Structure HEIGHT – to design the downspouts.

2. Outlet - Verify if there is any protected side in the floor to be used as an outlet. If there is not protected outlet, you will need to provide a concrete slab or rock revetment in the floor to avoid erosion.

3. Identify if a tank will be installed with this CPS - collected water in tanks for other uses in the farm.

CB-ENG-PLNG-1 PAGE 11



CB-ENG-PLNG-1)2021-rev 1.1
03/2021

I – ROOF RUNOFF STRUCTURE (Practice Code 558) – PLANNING DATA

Structure Location:

Lat.: ______________________________ Long.: ______________________ Deg-Min-Sec

Precipitation

Normal rainfall	In/day	
10-Yr/5min Rainfall	In.	
Evaporation	In/day	

Existing Roof Structure (Include photos and drawings)

Dimension: __________ (L) x _________ (W) ft., in., m. (circle one)

Height ________________________ ft., in., m. (circle one)

OUTLET (describe the location around the structure where water will fall; is it concrete or bare soil; is there erosion observed; etc; include photos and drawings)

Planned water storage reservoir:

Water Reservoir (planner):

Storage Capacity: ________ gal. Material: ___________ (pond; polyethylene, metal, concrete,etc.)

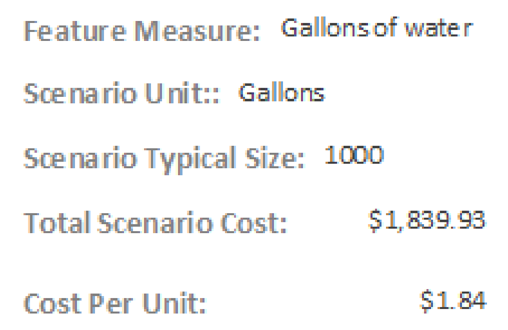
Tank Dimension: __________ (L) x _________ (W) x _________ (H) ft., in., m. (circle one)

Planned system (select all that apply)

Roof gutters ☐ Downspout ☐ Tank ☐ Concrete curb ☐ Trench drain ☐

NEW SCENARIO 2022

- Tank 500 gallons or more.
  - This scenario is to collect waster from an existing roof runoff structure.
  - Considers a poly tank with a concrete slab.
  - The purpose of this water can be use for
    - Livestock watering facilities,
    - Irrigation
    - Other conservation practices



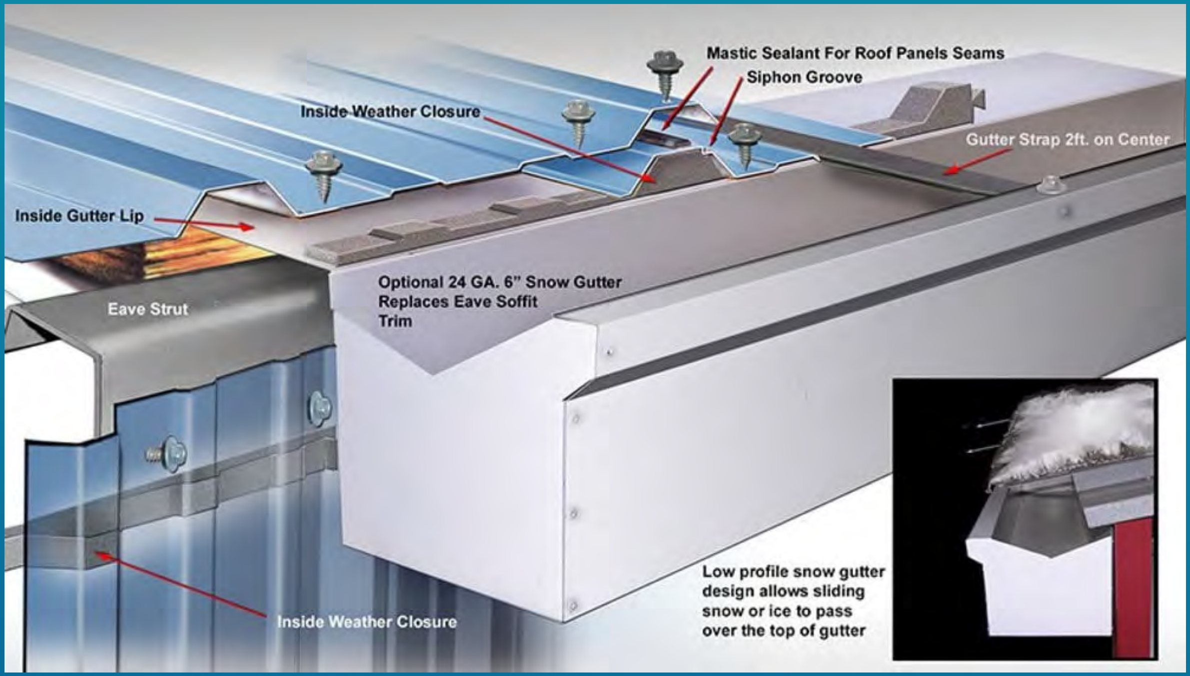
Feature Measure: Gallons of water

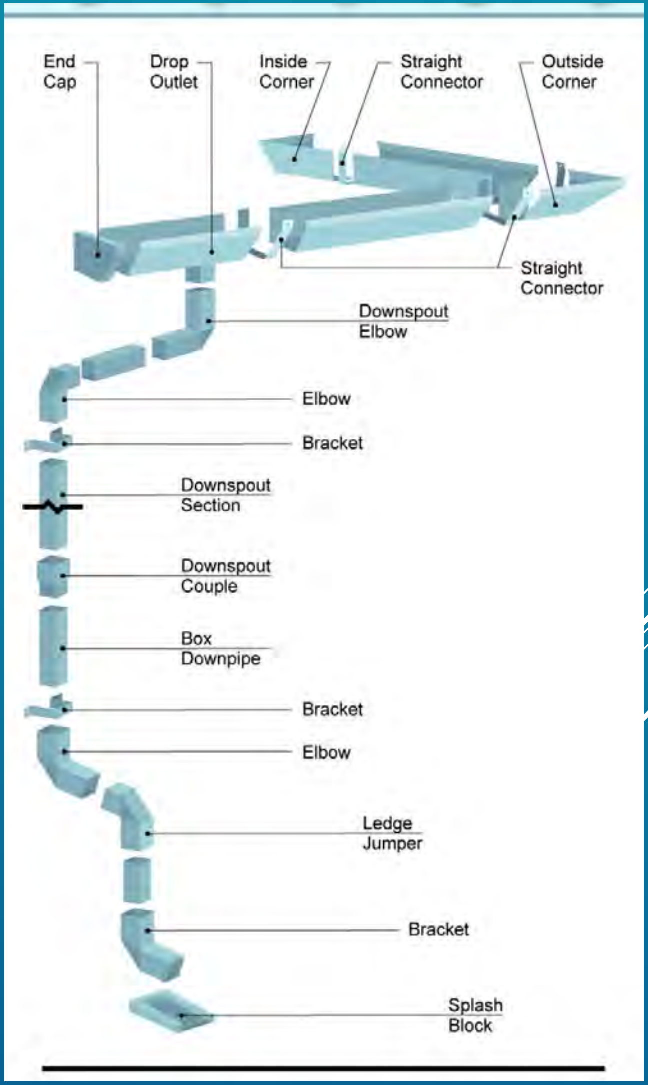
Scenario Unit:: Gallons

Scenario Typical Size: 1000

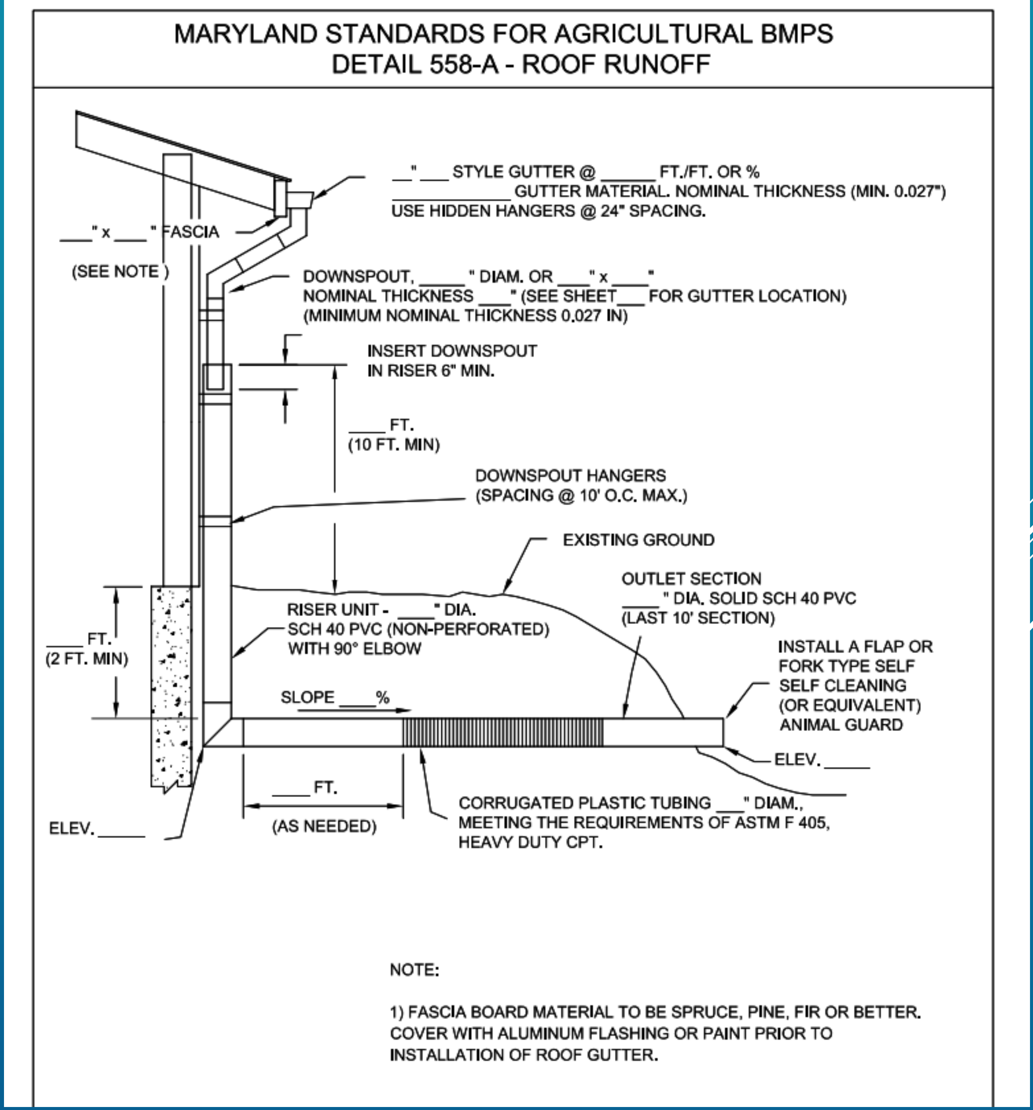
Total Scenario Cost: $1,839.93

Cost Per Unit: $1.84


Mastic Sealant For Roof Panels Seams
Siphon Groove
Inside Weather Closure
Gutter Strap 2ft. on Center
Inside Gutter Lip
Eave Strut
Optional 24 GA. 6" Snow Gutter Replaces Eave Soffit Trim
Low profile snow gutter design allows sliding snow or ice to pass over the top of gutter
Inside Weather Closure


End Cap
Drop Outlet
Inside Corner
Straight Connector
Outside Corner
Straight Connector
Downspout Elbow
Elbow
Bracket
Downspout Section
Downspout Couple
Box Downpipe
Bracket
Elbow
Ledge Jumper
Bracket
Splash Block

ANOTHER EXAMPLE WITH UNDERGROUND OUTLET



MARYLAND STANDARDS FOR AGRICULTURAL BMPS
DETAIL 558-A - ROOF RUNOFF

NOTE:

1) FASCIA BOARD MATERIAL TO BE SPRUCE, PINE, FIR OR BETTER. COVER WITH ALUMINUM FLASHING OR PAINT PRIOR TO INSTALLATION OF ROOF GUTTER.

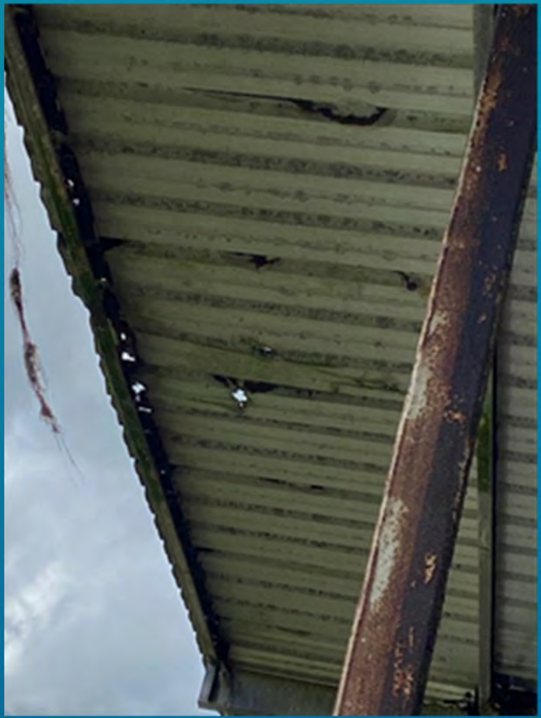
1) Evaluate condition of roof and area that the gutter will catch.

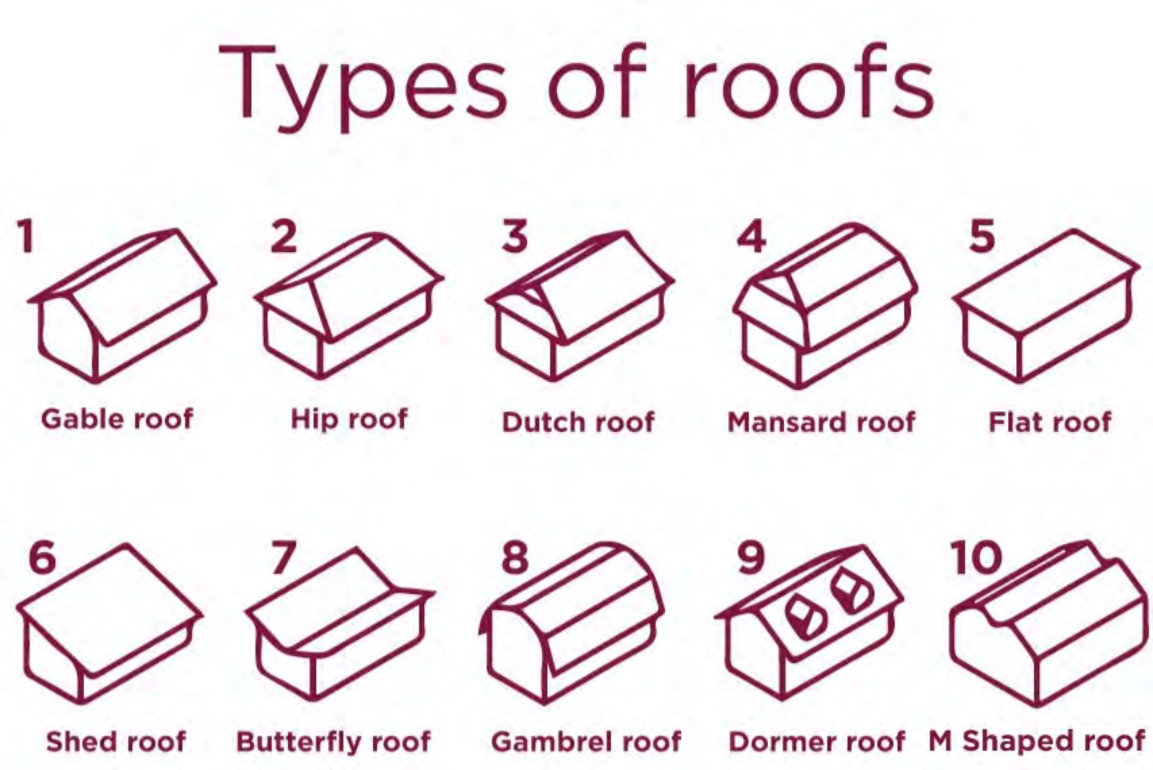
2) Look for where downspouts could be place.

3) Ground gutter design could be used, if needed.

4) Protect roof runoff structure from damage by livestock or equipment

EVALUATION





1. EVALUATE CONDITION OF THE ROOF AND AREA THAT THE GUTTER WILL CATCH. LOOK IF FASCIA IS NEEDED

FOLLOW ALL MANUFACTURER INSTALLATION RECOMMENDATIONS

2. LOOK FOR WHERE DOWNSPOUTS COULD BE PLACED.

- Typically, The downspouts are attached to a column with steel braces.

3. GROUND GUTTER DESIGN COULD BE USED, IF NEEDED.

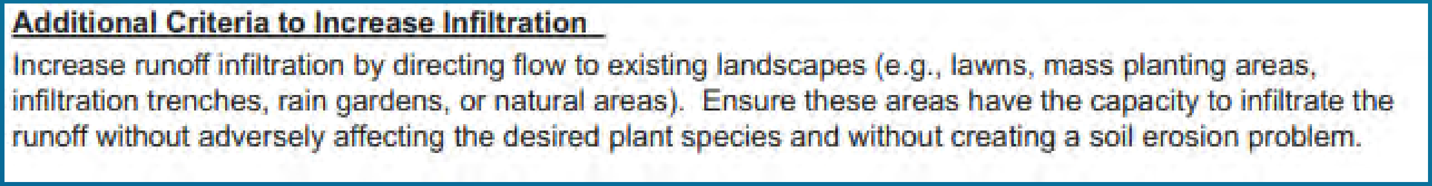
Alternatives

1. Roof Gutter
2. Typical downspouts
3. Overhead downspouts
4. Concrete Gutter

4. PROTECT ROOF RUNOFF STRUCTURE FROM DAMAGE BY LIVESTOCK OR EQUIPMENT

FROM STANDARD - 558

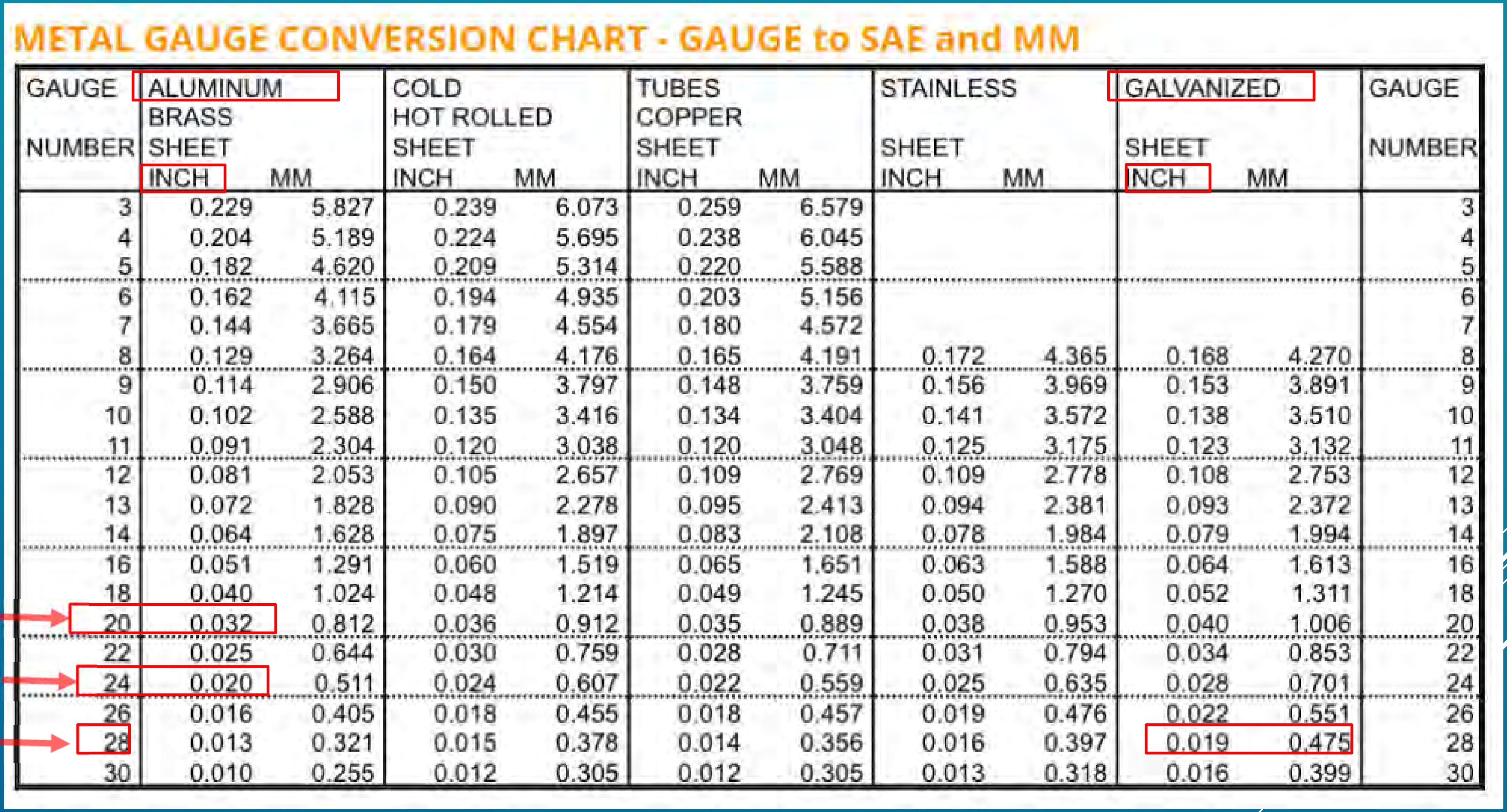
- Associated practices:
  - Underground outlet – 620
  - Diversion - 632
  - Watering facility - 614
  - Roof and Covers - 367
  - Any relevant irrigation practices
- Materials:
  - Aluminum gutters 0.027in and Aluminum downspouts 0.020in.
  - Galvanized steel, gutters and downspouts: 28 gauge.



Additional Criteria to Increase Infiltration

Increase runoff infiltration by directing flow to existing landscapes (e.g., lawns, mass planting areas, infiltration trenches, rain gardens, or natural areas). Ensure these areas have the capacity to infiltrate the runoff without adversely affecting the desired plant species and without creating a soil erosion problem.

MINIMUM THICKNESS



METAL GAUGE CONVERSION CHART - GAUGE to SAE and MM

GAUGE NUMBER	ALUMINUM BRASS SHEET		COLD HOT ROLLED SHEET		TUBES COPPER SHEET		STAINLESS SHEET		GALVANIZED SHEET		GAUGE NUMBER
	INCH	MM	INCH	MM	INCH	MM	INCH	MM	INCH	MM	
3	0.229	5.827	0.239	6.073	0.259	6.579					3
4	0.204	5.189	0.224	5.695	0.238	6.045					4
5	0.182	4.620	0.209	5.314	0.220	5.588					5
6	0.162	4.115	0.194	4.935	0.203	5.156					6
7	0.144	3.665	0.179	4.554	0.180	4.572					7
8	0.129	3.264	0.164	4.176	0.165	4.191	0.172	4.365	0.168	4.270	8
9	0.114	2.906	0.150	3.797	0.148	3.759	0.156	3.969	0.153	3.891	9
10	0.102	2.588	0.135	3.416	0.134	3.404	0.141	3.572	0.138	3.510	10
11	0.091	2.304	0.120	3.038	0.120	3.048	0.125	3.175	0.123	3.132	11
12	0.081	2.053	0.105	2.657	0.109	2.769	0.109	2.778	0.108	2.753	12
13	0.072	1.828	0.090	2.278	0.095	2.413	0.094	2.381	0.093	2.372	13
14	0.064	1.628	0.075	1.897	0.083	2.108	0.078	1.984	0.079	1.994	14
16	0.051	1.291	0.060	1.519	0.065	1.651	0.063	1.588	0.064	1.613	16
18	0.040	1.024	0.048	1.214	0.049	1.245	0.050	1.270	0.052	1.311	18
20	0.032	0.812	0.036	0.912	0.035	0.889	0.038	0.953	0.040	1.006	20
22	0.025	0.644	0.030	0.759	0.028	0.711	0.031	0.794	0.034	0.853	22
24	0.020	0.511	0.024	0.607	0.022	0.559	0.025	0.635	0.028	0.701	24
26	0.016	0.405	0.018	0.455	0.018	0.457	0.019	0.476	0.022	0.551	26
28	0.013	0.321	0.015	0.378	0.014	0.356	0.016	0.397	0.019	0.475	28
30	0.010	0.255	0.012	0.305	0.012	0.305	0.013	0.318	0.016	0.399	30

Aluminum Gutter

Aluminum Downspout

Steel Gutter and Downspout

https://my.cia.edu/ICS/Fab_Studios/Reference.jnz?portlet=Free-form_Content_2

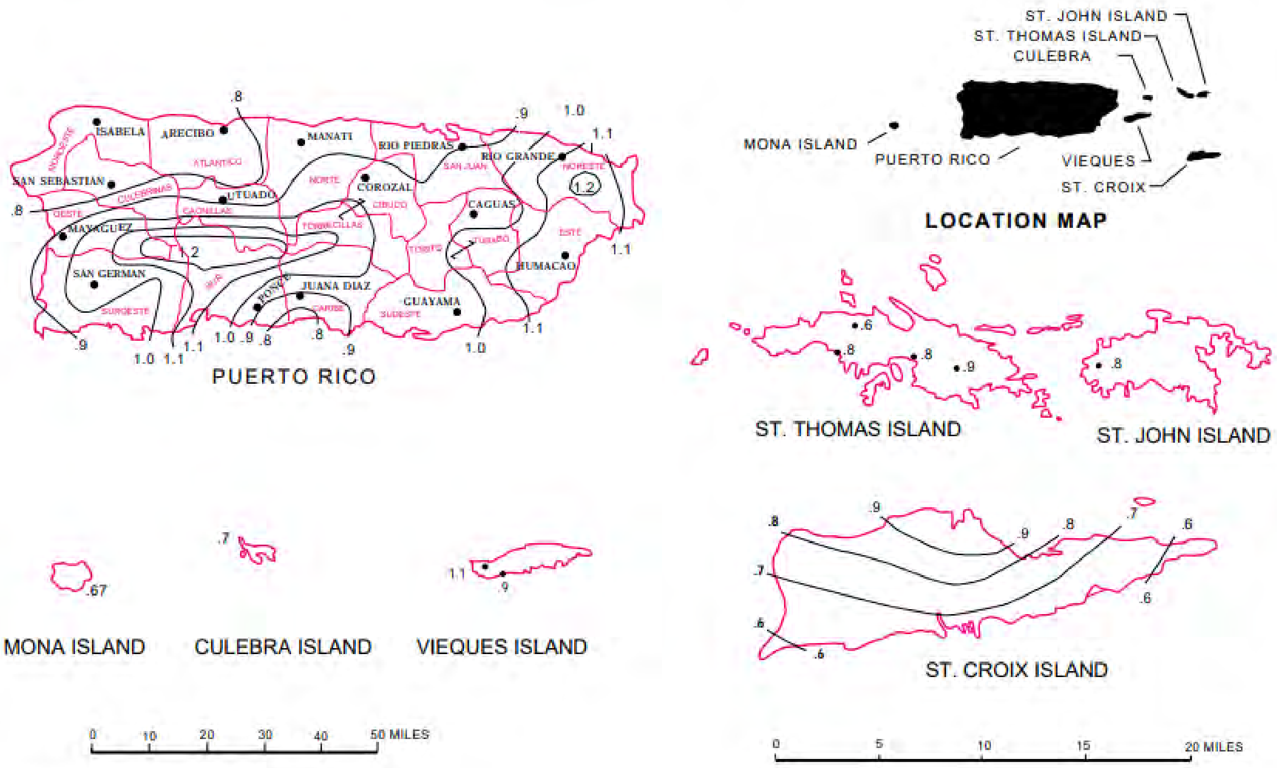
- When a roof runoff structure is used to protect roof runoff from contamination by **manure**, design the roof runoff structure to convey the flow rate generated from a **25-year, 5-minute rainfall** event. National Engineering Handbook (NEH) (Title 210), Part 651, "Agricultural Waste Management Field Handbook," Chapter 10, Appendix 10B.
- For other applications, design the roof runoff structure to convey the flow rate generated from a **10-year, 5- minute rainfall** event.
- Rainfall data from NOAA https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_pr.html

GUTTER DESIGN CAPACITY

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

FIGURE 10B-3b
10-YEAR 5-MINUTE RAINFALL (INCHES)



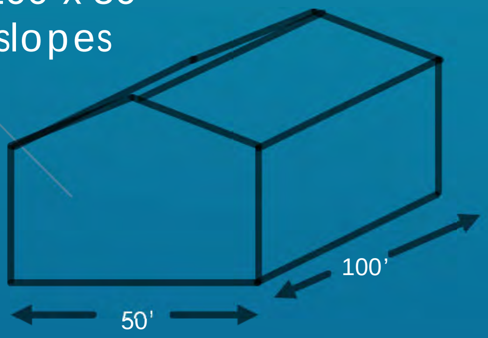
SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL,
NATIONAL CARTOGRAPHY AND GIS CENTER,
FORT WORTH, TEXAS

FEBRUARY 1994 1007913

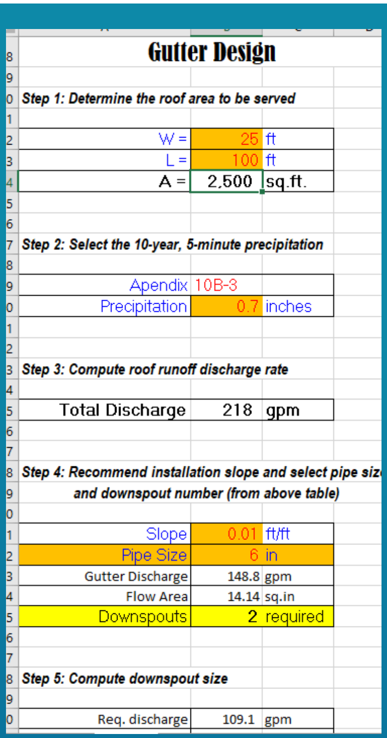
DESIGN SHEET

- Roof runoff design spreadsheet

Example
Structure 100’x 50’
Roof on 2 slopes



Gutter Recommended Slope
Slope=(1/16”) / ft
Slope = 0.005



Gutter Design

Step 1: Determine the roof area to be served

W =	25	ft
L =	100	ft
A =	2,500	sq.ft.

Step 2: Select the 10-year, 5-minute precipitation

Apendix	10B-3	
Precipitation	0.7	inches

Step 3: Compute roof runoff discharge rate

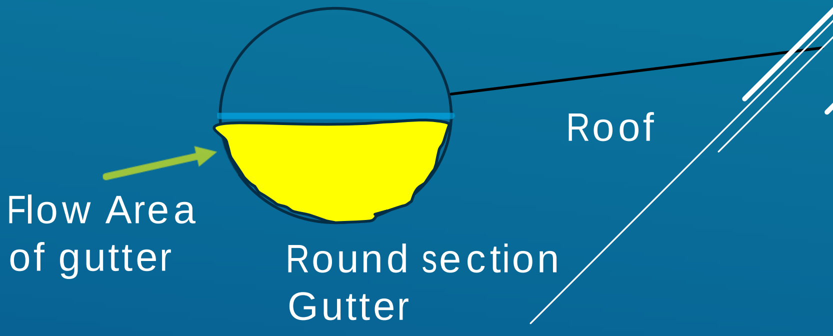
Total Discharge	218	gpm

Step 4: Recommend installation slope and select pipe siz
and downspout number (from above table)

Slope	0.01	ft/ft
Pipe Size	6	in
Gutter Discharge	148.8	gpm
Flow Area	14.14	sq.in
Downspouts	2	required

Step 5: Compute downspout size

Req. discharge	109.1	gpm



Roof

Flow Area
of gutter

Round section
Gutter

- Tool calculates gutter discharge and flow area. Also calculates the size and number of downspouts.
- Flow area is in square inches. Meaning, Depth x Width = Area
- For this example, a 25 in^2. The area can be bigger.

This could be a 8in round pipe or

5”x 5” = 25 in^2 square section. Or

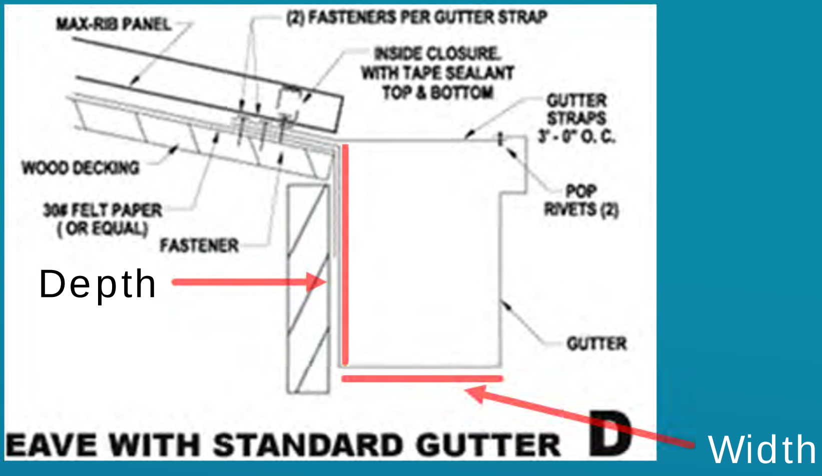
6”x5” = 30in^2 rectangular section

The same is true for the downspouts.

This could be a 4in round pipe or

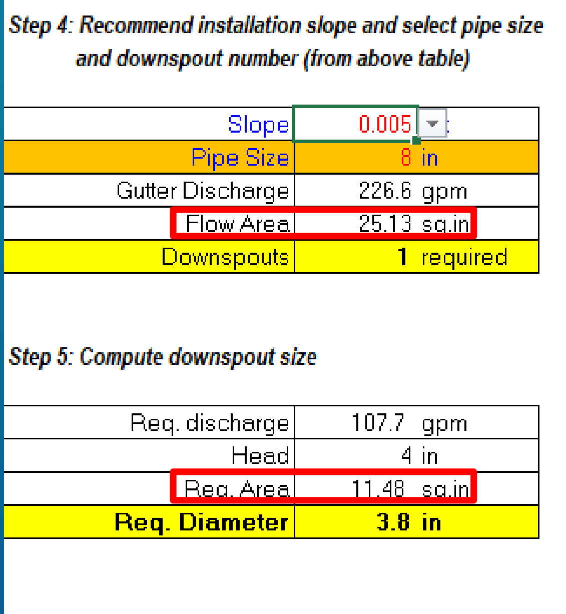
4”x 4” = 16 in^2 square section. Or

3”x4” = 12 in^2 rectangular section



Depth

Width



Step 4: Recommend installation slope and select pipe size and downspout number (from above table)

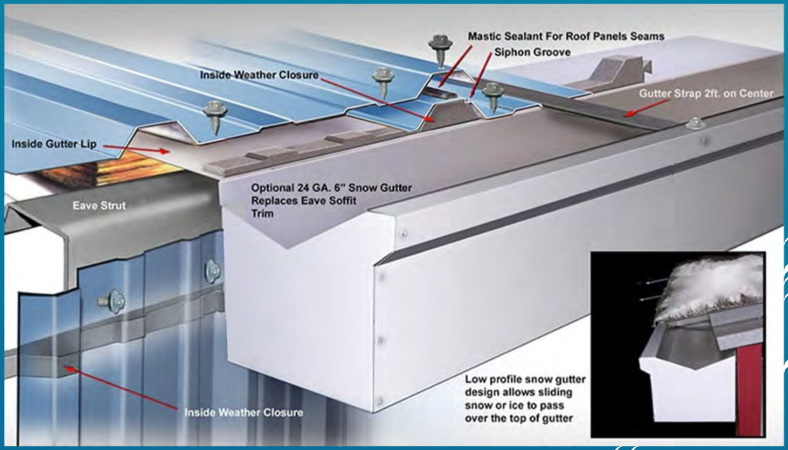
Slope	0.005
Pipe Size	8 in
Gutter Discharge	226.6 gpm
Flow Area	25.13 sq.in
Downspouts	1 required

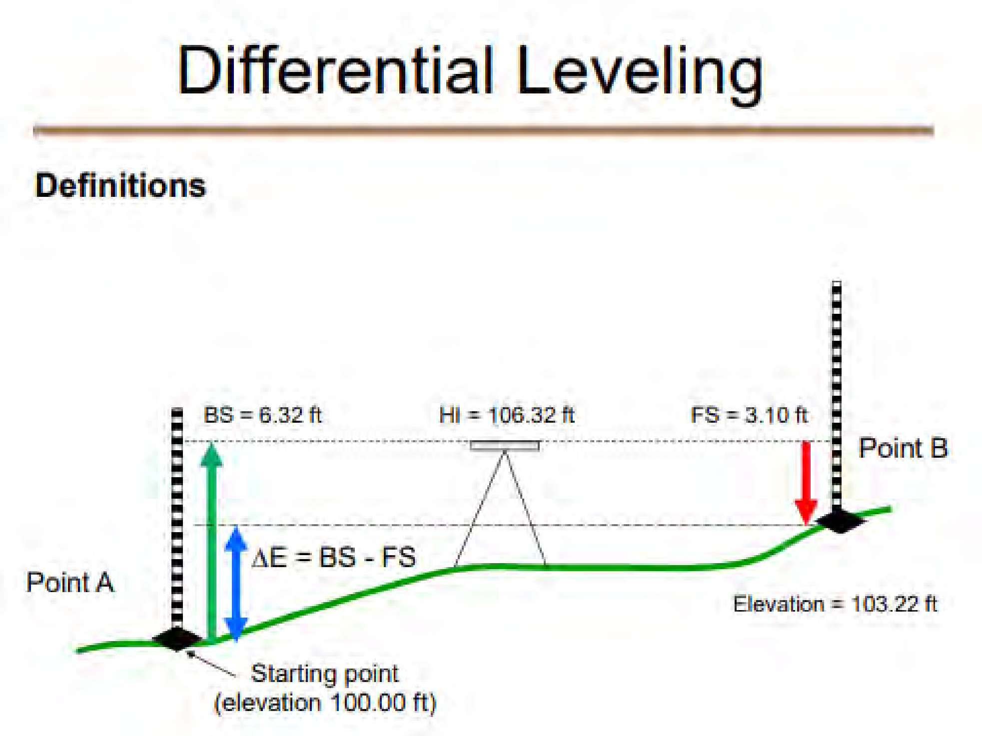
Step 5: Compute downspout size

Req. discharge	107.7 gpm
Head	4 in
Req. Area	11.48 sq.in
Req. Diameter	**3.8 in**

FIELD DATA GATHERING

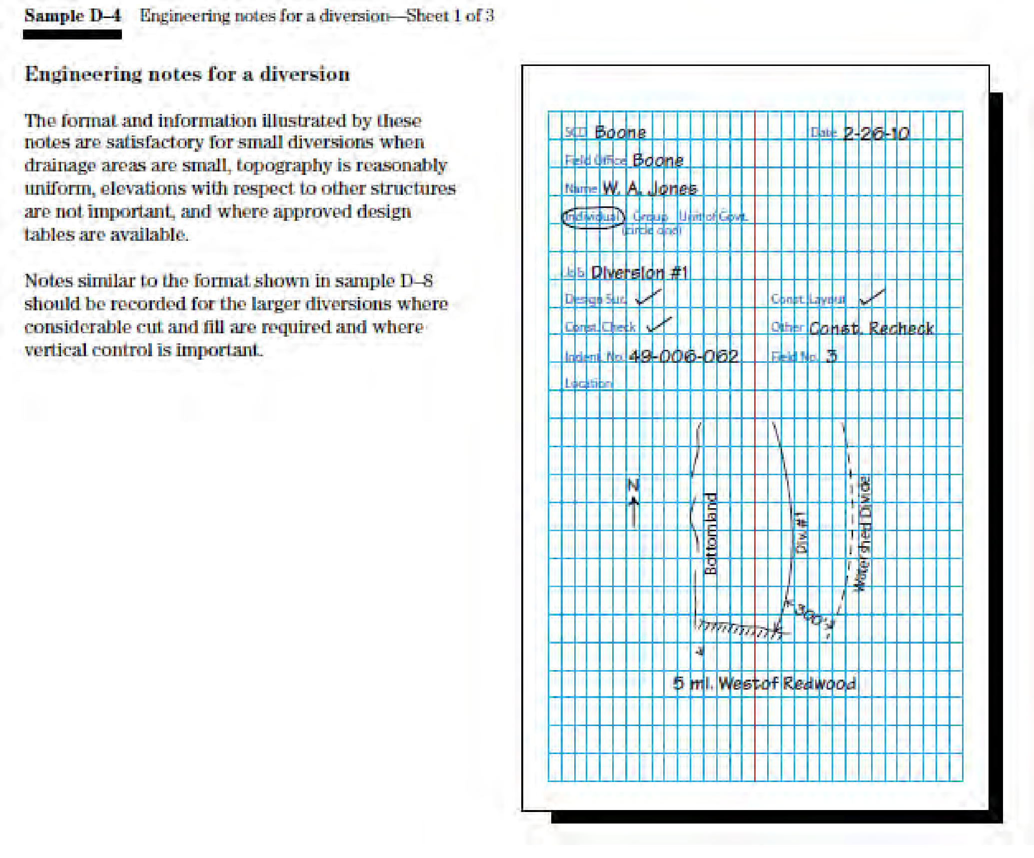
1. Area of the roof (width and length).
2. Roof is 1-slope, 2 slopes or more.
3. Downspouts where to locate them.
4. Look for a stable outlet.
5. Survey.





Differential Leveling

Definitions



Sample D–4 Engineering notes for a diversion—Sheet 1 of 3

Engineering notes for a diversion

The format and information illustrated by these notes are satisfactory for small diversions when drainage areas are small, topography is reasonably uniform, elevations with respect to other structures are not important, and where approved design tables are available.

Notes similar to the format shown in sample D–8 should be recorded for the larger diversions where considerable cut and fill are required and where vertical control is important.

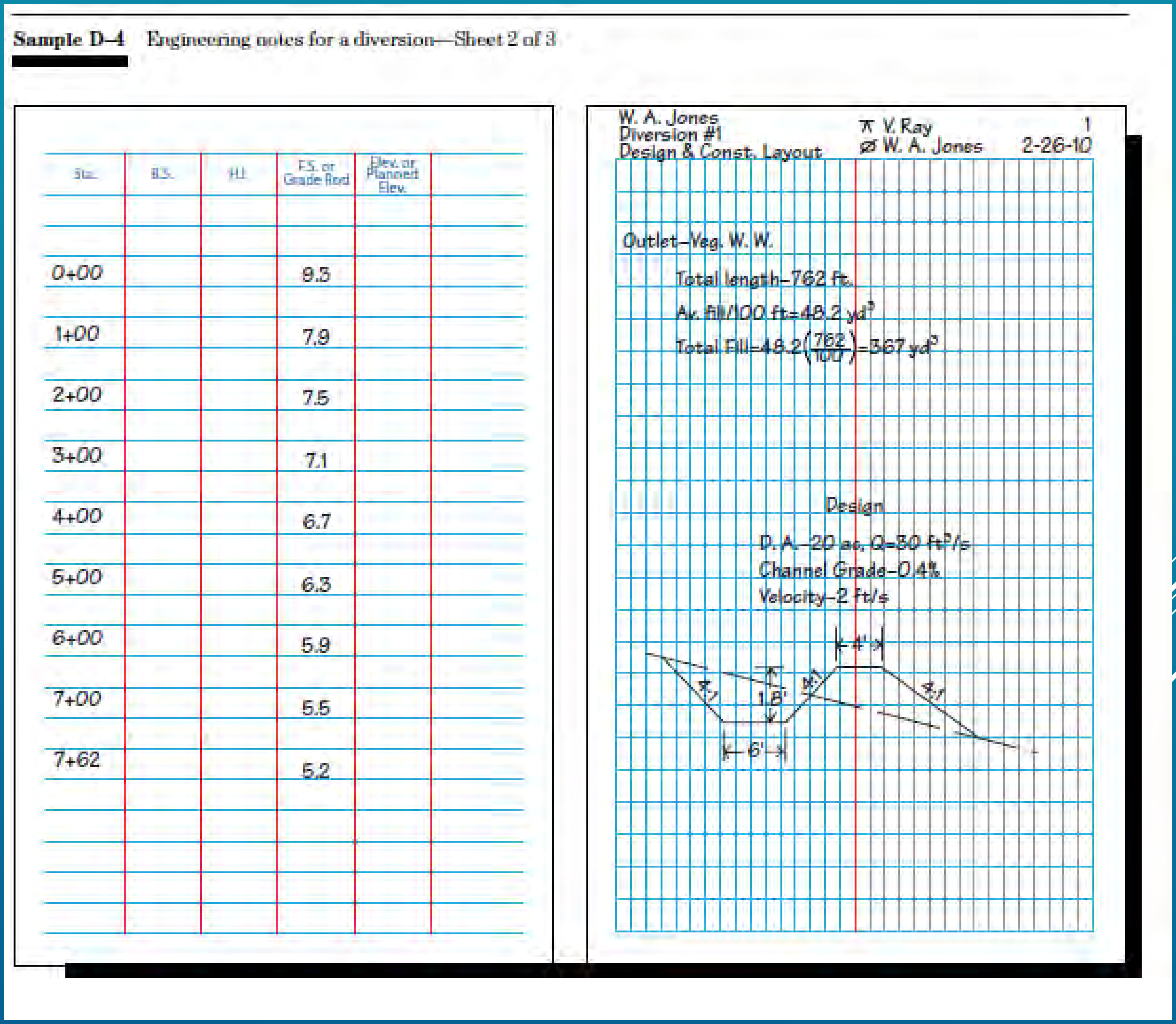
SCD Boone
Date 2-26-10
Field Office Boone
Name W. A. Jones
[✓ Individual] Group Unit of Govt. (circle one)
Job Diversion #1
Design Sur. ✓
Const. Layout ✓
Const. Check ✓
Other Const. Recheck
Ident. No. 49-006-062
Field No. 3
Location

5 mi. West of Redwood

SURVEY

Part 650 – Engineering Field Handbook
Chapter 1 – Surveying

EXAMPLE OF SURVEY NOTES



Sample D–4 Engineering notes for a diversion—Sheet 2 of 3

Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.
0+00			9.5	
1+00			7.9	
2+00			7.5	
3+00			7.1	
4+00			6.7	
5+00			6.3	
6+00			5.9	
7+00			5.5	
7+62			5.2	

W. A. Jones
Diversion #1
Design & Const. Layout

⊼ V. Ray
⌀ W. A. Jones

1
2-26-10

Outlet–Veg. W. W.

Total length–762 ft.

Av. fill/100 ft=48.2 yd^3

Total Fill=48.2$\left(\frac{762}{100}\right)$=367 yd^3

Design

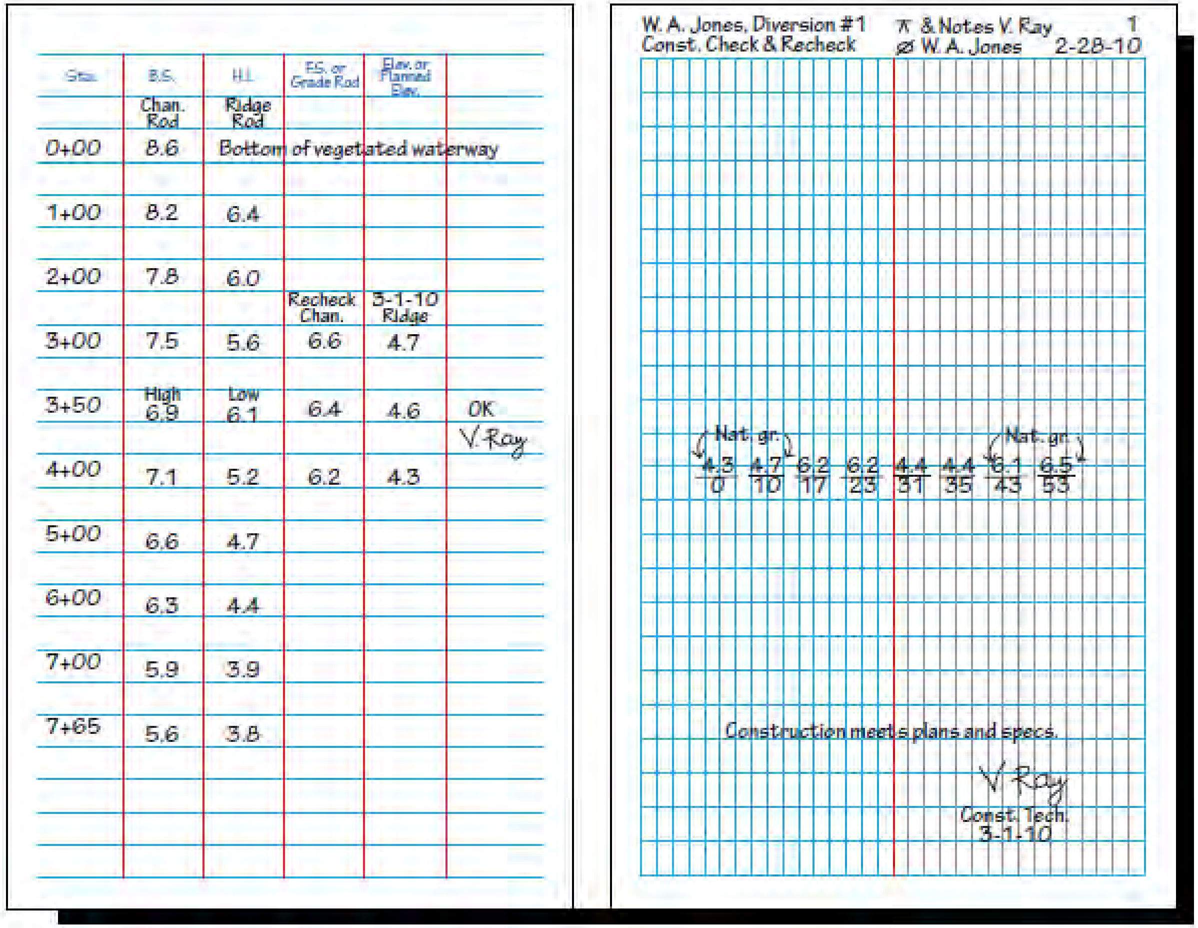
D. A.–20 ac, Q=30 ft^3/s

Channel Grade–0.4%

Velocity–2 ft/s

EXAMPLE OF SURVEY NOTES

Sample D–4 Engineering notes for a diversion—Sheet 3 of 3



Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.	
	Chan. Rod	Ridge Rod			
0+00	8.6	Bottom of vegetated waterway			
1+00	8.2	6.4			
2+00	7.8	6.0			
			Recheck Chan.	3-1-10 Ridge	
3+00	7.5	5.6	6.6	4.7	
3+50	High 6.9	Low 6.1	6.4	4.6	OK V. Ray
4+00	7.1	5.2	6.2	4.3	
5+00	6.6	4.7			
6+00	6.3	4.4			
7+00	5.9	3.9			
7+65	5.6	3.8			

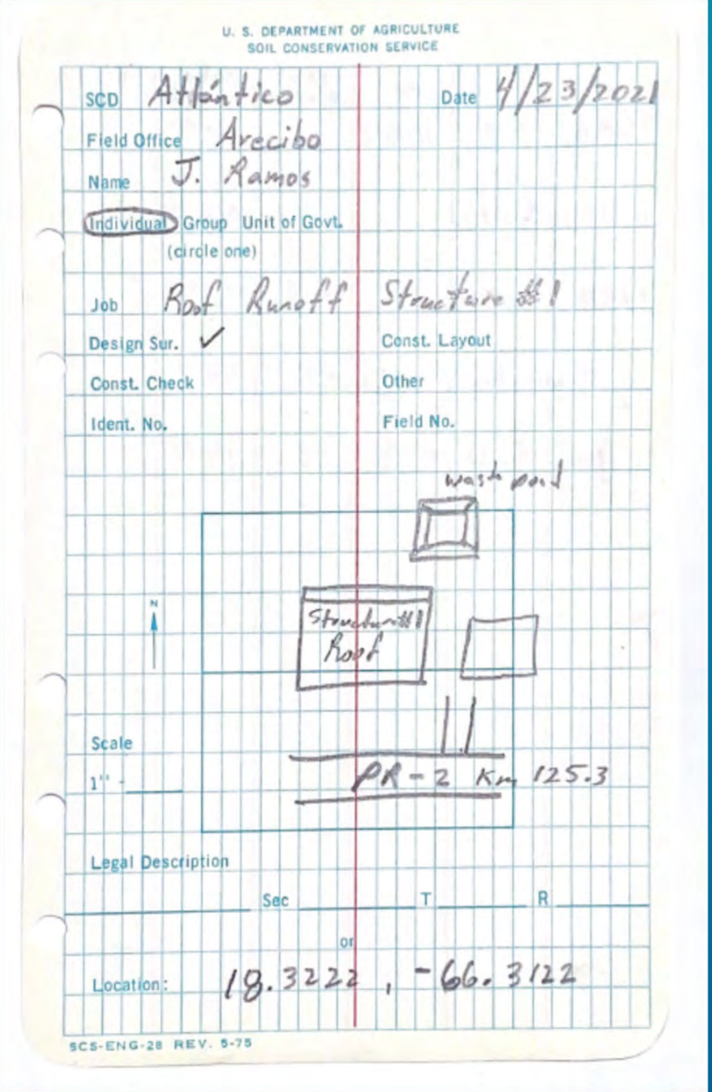
W. A. Jones, Diversion #1 ⊼ & Notes V. Ray 1
Const. Check & Recheck ⌀ W. A. Jones 2-28-10

Nat. gr. Nat. gr.

4.3	4.7	6.2	6.2	4.4	4.4	6.1	6.5
0	10	17	23	31	35	43	53

Construction meets plans and specs.

V. Ray
Const. Tech.
3-1-10



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCD Atlántico

Date 4/23/2021

Field Office Arecibo

Name J. Ramos

[✓ Individual] Group Unit of Govt.
(circle one)

Job Roof Runoff Structure #1

Design Sur. ✓

Const. Layout

Const. Check

Other

Ident. No.

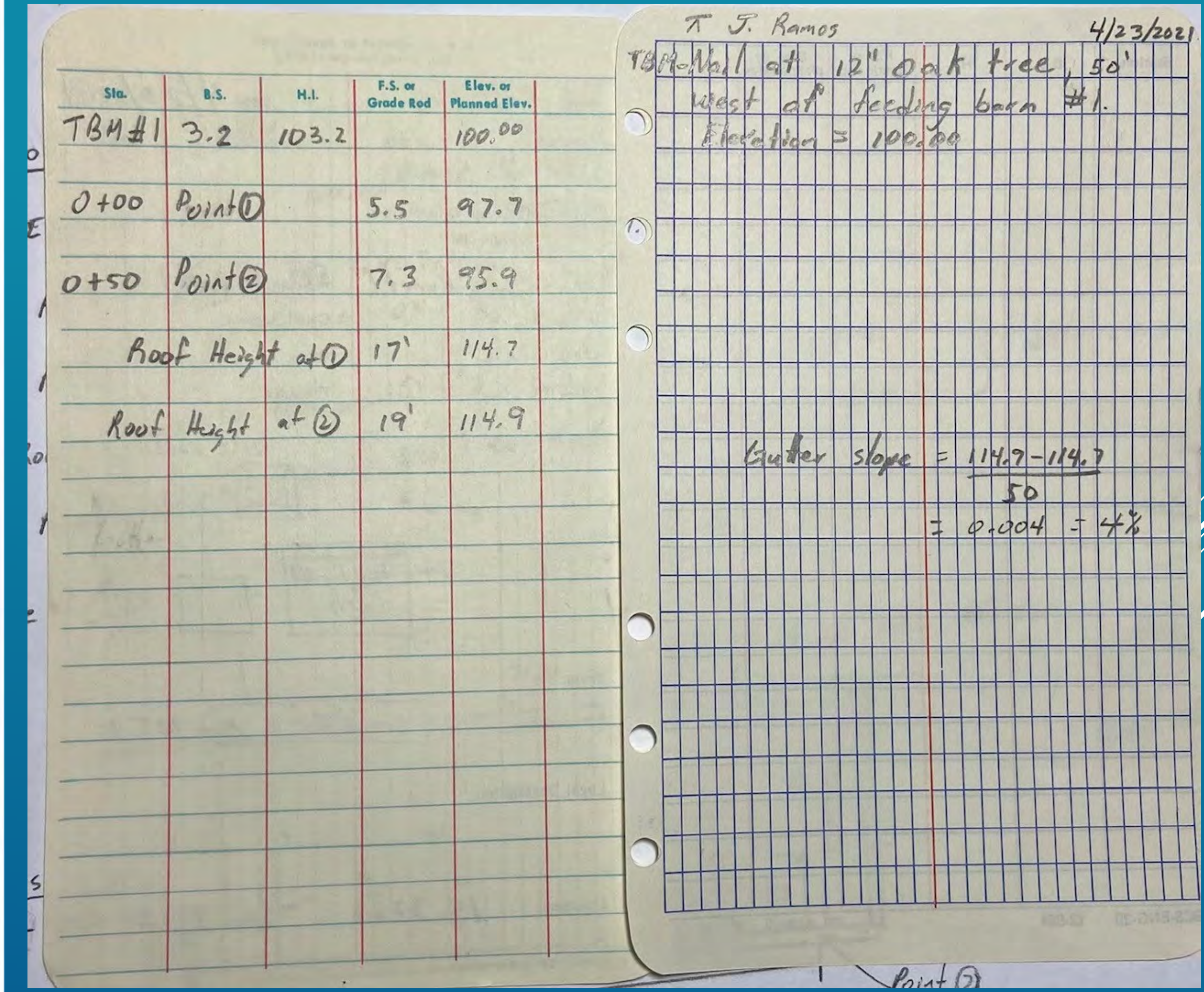
Field No.

Scale
1" -

Legal Description
Sec T R
or

Location: 18.3222, -66.3122

SCS-ENG-28 REV. 5-75



Sta.	B.S.	H.I.	F.S. or Grade Rod	Elev. or Planned Elev.
TBM#1	3.2	103.2		100.00
0+00	Point①		5.5	97.7
0+50	Point②		7.3	95.9
Roof Height at ①			17'	114.7
Roof Height at ②			19'	114.9

π J. Ramos 4/23/2021

TBM-Nail at 12" oak tree, 50' west of feeding barn #1.
Elevation = 100.00

Gutter slope $= \frac{114.9-114.7}{50}$

$= 0.004 = 4\%$

Slope of the gutter

HI = Elevation + BS = 100.00 + 3.2' = 103.2'

Elevation punto ① = HI − FS_1 = 103.2' − 5.5' = 97.7'

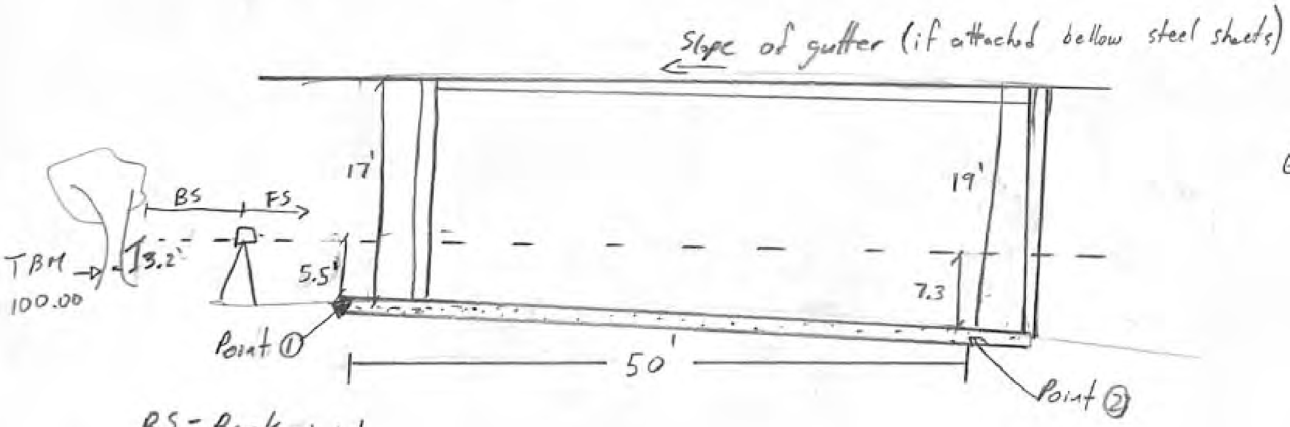
Elevation point ② = HI − FS_2 = 103.2' − 7.3' = 95.9'

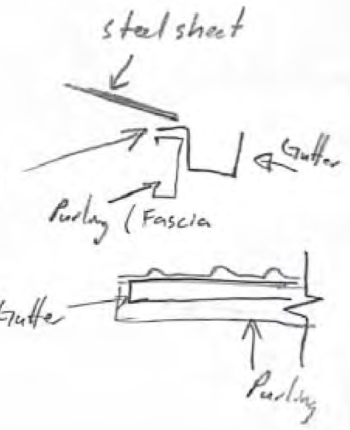
Elevation Roof on point ① = Elev point ① + Rod Reading = 97.7' + 17' = 114.7'

Elevation Roof on Point ② = Elev point ② + Rod Reading = 95.9' + 19' = 114.9'

} diff = 0.2'

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{114.9' - 114.7'}{50'} = 0.004 = 0.4\%$$

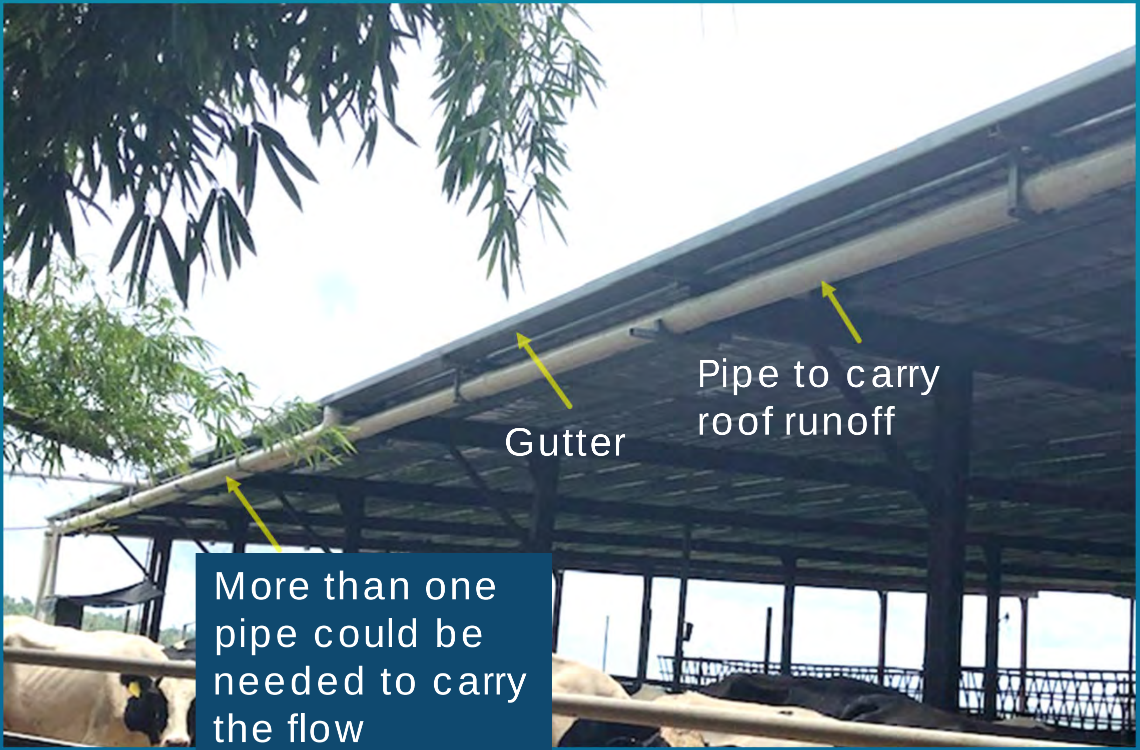




BS - Backsight

FS - Foresight

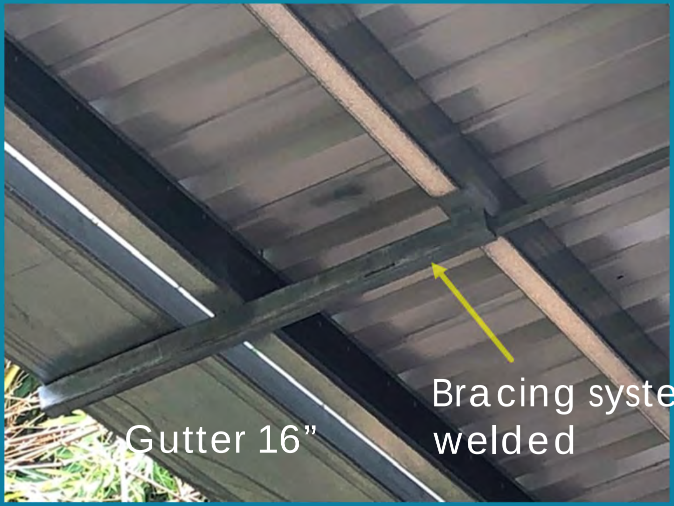
EXAMPLES



Gutter

Pipe to carry roof runoff

More than one pipe could be needed to carry the flow



Gutter 16”

Bracing system welded

- Waste Pond overfilling – Why?

- Waste Pond overfilling. How do we fix this?

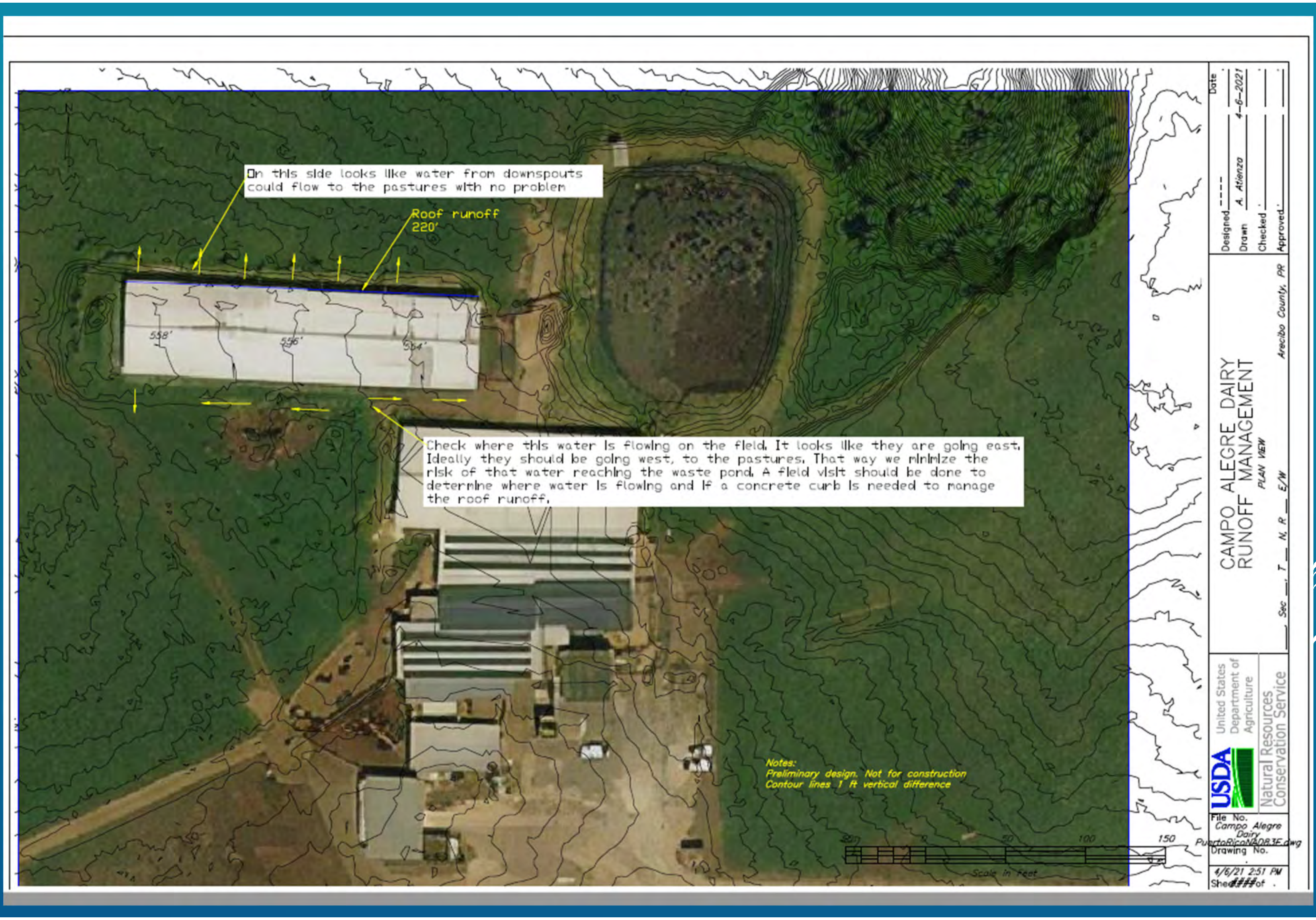
1. Install roof
2. Install Gutters
3. Install Downspouts
4. Is water out of the waste pond?
5. Use diversions, curbs or pipe to keep roof runoff from entering the waste pond.

Waste Pond

3. GROUND GUTTER DESIGN COULD BE USED, IF NEEDED.


Diversion
520' total
Concrete Curb
50.1
64.7
84.3
160.7
Roof runoff
400'Total
Roof and Cover
25,600 Sft
77.4
155.2
Preliminary design
Not for
construction
Scale in feet
Date
Designed ----
Drawn A. Atienzo 4-6-2021
Checked
Approved
IVAN MARTINEZ
RONOFF MANAGEMENT
PLAN VIEW
Arecibo County, PR
Sec T N, R E/W
USDA
United States Department of Agriculture
Natural Resources Conservation Service
File No.
Ivan Martinez Runoff Managemt Dwg
Drawing No.
4/6/21 10:42 AM
Sheet #### of

- Needs roof and gutters.



On this side looks like water from downspouts could flow to the pastures with no problem

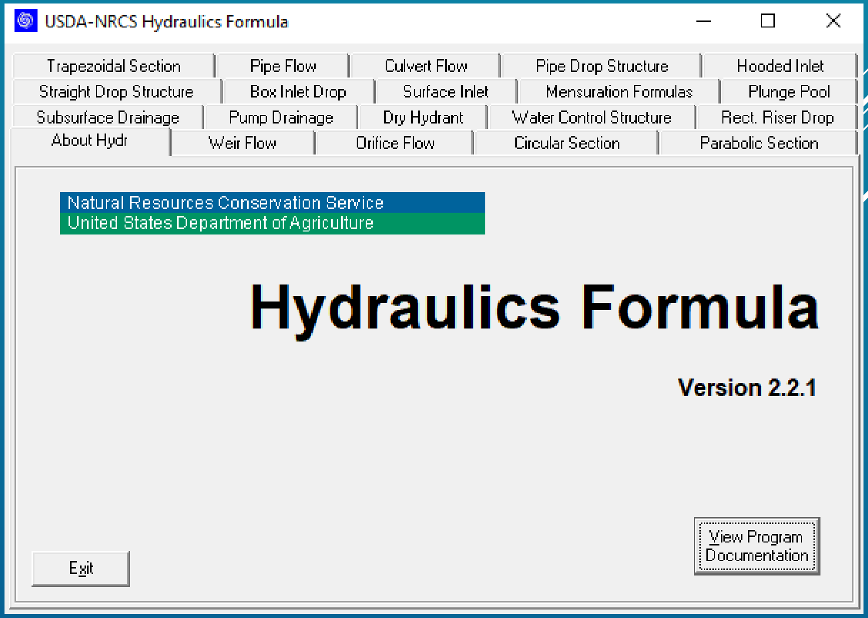
Check where this water is flowing on the field. It looks like they are going east. Ideally they should be going west, to the pastures. That way we minimize the risk of that water reaching the waste pond. A field visit should be done to determine where water is flowing and if a concrete curb is needed to manage the roof runoff.

- Measure the length of the gutter.
- Verify the dimensions of the cross section of the gutter is in accordance with design.
- Verify the number, location and dimensions of downspouts accordance with design.
- Check that the outlet of the runoff is in a stable area.
- Take pictures.
- Deliver O&M form to farmer

CHECK OUT AND PRACTICE CERTIFICATION

CONCRETE GUTTER DESIGN

1. Determine the slope
2. Use the total discharge flow from the spreadsheet
   - Convert the capacity from gpm to cfs
3. Select manning's n
4. Use USDA-NRCS Hydraulics Formula Tool (app)
   - Trapezoidal section
   - Use 0.1 bottom for a triangular section channel



1) Determine the slope

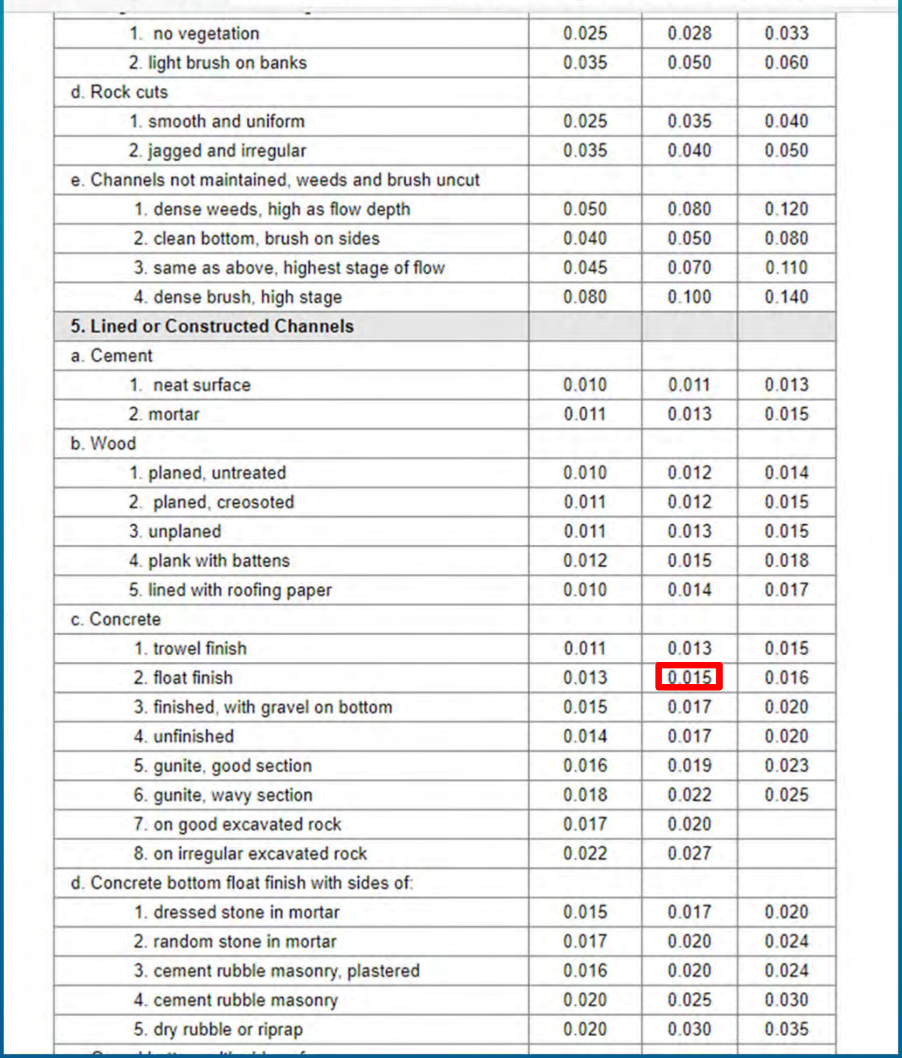
Slope = 2’/220’ = 0.009

2) Convert from gpm to cfs

(606 gpm)(1ft^3 / 7.48gal)(1min / 60s) = 1.35ft^3/s

EXAMPLE CONCRETE GUTTER DESIGN

EXAMPLE CONCRETE GUTTER DESIGN



1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.040
2. jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.050	0.080	0.120
2. clean bottom, brush on sides	0.040	0.050	0.080
3. same as above, highest stage of flow	0.045	0.070	0.110
4. dense brush, high stage	0.080	0.100	0.140
5. Lined or Constructed Channels			
a. Cement			
1. neat surface	0.010	0.011	0.013
2. mortar	0.011	0.013	0.015
b. Wood			
1. planed, untreated	0.010	0.012	0.014
2. planed, creosoted	0.011	0.012	0.015
3. unplaned	0.011	0.013	0.015
4. plank with battens	0.012	0.015	0.018
5. lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. trowel finish	0.011	0.013	0.015
2. float finish	0.013	0.015	0.016
3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035

3) Select Mannings n. According to the finish of the surface.

http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm

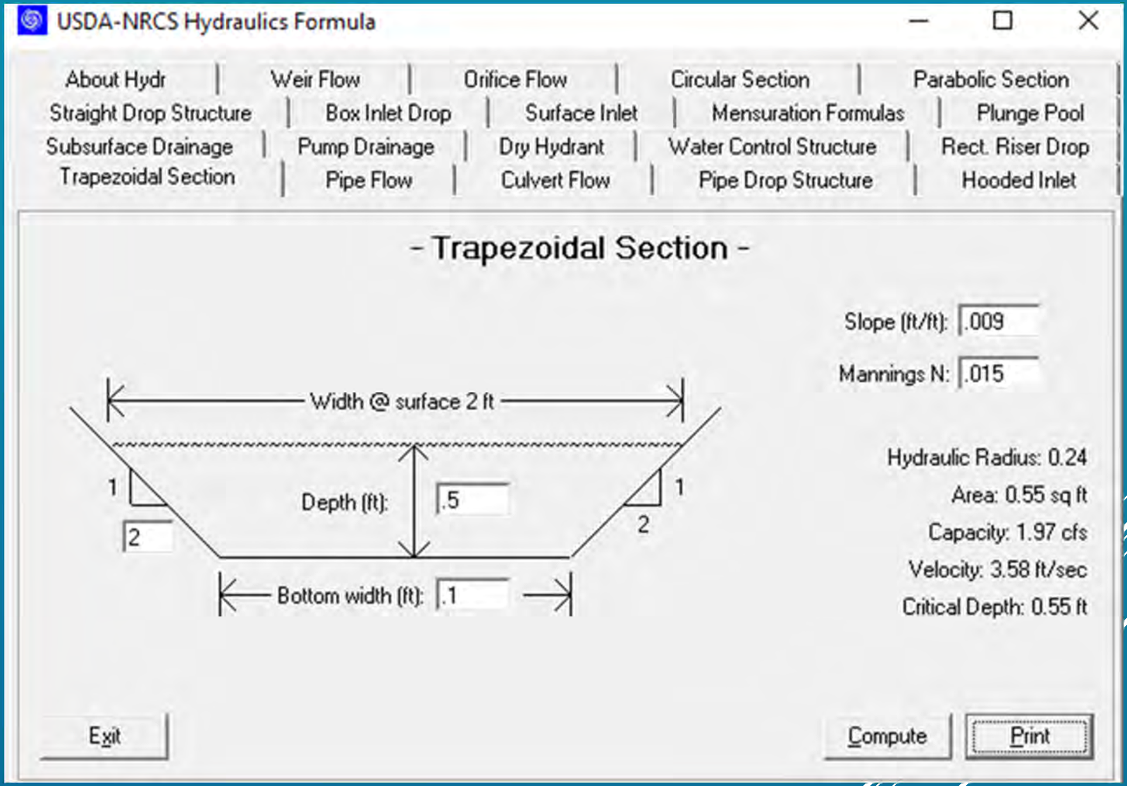
EXAMPLE CONCRETE GUTTER DESIGN

3) Use USDA-NRCS Hydraulics Formula Tool (app) to determined the capacity

1.97 Cfs

4) 197 cfs > 135cfs

OK!



- Trapezoidal Section -

Slope (ft/ft): .009

Mannings N: .015

Depth (ft): .5

Bottom width (ft): .1

Side slope: 2

Hydraulic Radius: 0.24
Area: 0.55 sq ft
Capacity: 1.97 cfs
Velocity: 3.58 ft/sec
Critical Depth: 0.55 ft

EXERCISE. ROOF NEEDS A RUNOFF STRUCTURE.

On this side looks like water from downspouts could flow to the pastures with no problem

Roof runoff 220'

Check where this water is flowing on the field. It looks like they are going east. Ideally they should be going west, to the pastures. That way we minimize the risk of that water reaching the waste pond. A field visit should be done to determine where water is flowing and if a concrete curb is needed to manage the roof runoff.

Notes:
Preliminary design. Not for construction
Contour lines 1 ft vertical difference

Determine the size of the gutter and downspouts. The roof is single slope located in Arecibo