558 - ROOF RUNOFF STRUCTURE

Alberto Atienza
Civil Engineer - Arecibo FO
OBJECTIONS

- Define practice 558 Roof Runoff Structure
- Where the practice applies
- Data gathering
- How to design a roof runoff structure
- Certification of the practice
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.
<table>
<thead>
<tr>
<th>Scenario Description</th>
<th>Material Type</th>
<th>Quantity</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Roof Runoff Structure</td>
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</tr>
<tr>
<td>Roof Runoff Structure</td>
<td>HU-Concrete Curb</td>
<td>Ft</td>
<td>$11.12</td>
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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
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
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.
I. ROOF RUNOFF STRUCTURE (Practice Code 558) – PLANNING DATA

Structure Location:
Lat.: ____________________ Long.: ____________________ Deg-Min-Sec

Precipitation

<table>
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<td>10-Yr/5min Rainfall</td>
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<tr>
<td>Evaporation</td>
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</table>

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
Tank 500 gallons or more.

- This scenario is to collect water 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

**NEW SCENARIO 2022**

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<th>Feature Measure:</th>
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<td>Scenario Unit:</td>
<td>Gallons</td>
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<td>Scenario Typical Size:</td>
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<td>Total Scenario Cost:</td>
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<td>Cost Per Unit:</td>
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</table>
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 placed.
3) Ground gutter design could be used, if needed.
4) Protect roof runoff structure from damage by livestock or equipment.
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.
4. PROTECT ROOF RUNOFF STRUCTURE FROM DAMAGE BY LIVESTOCK OR EQUIPMENT

Alternatives

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

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**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.
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<th>ALUMINUM SHEET</th>
<th>COLD HOT ROLLED SHEET</th>
<th>TUBES COPPER SHEET</th>
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</table>

**Minimum Thickness**

[https://my.cia.edu/ICS/Fab_Studios/Reference.jnz?portlet=Free-form_Content_2](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](https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_pr.html)
Roof runoff design spreadsheet

Example
Structure 100’ x 50’
Roof on 2 slopes

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

DESIGN SHEET
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 in². The area can be bigger.

This could be a 8 in round pipe or 5” x 5” = 25 in² square section. Or 6” x 5” = 30 in² rectangular section.

The same is true for the downspouts.

This could be a 4 in round pipe or 4” x 4” = 16 in² square section. Or 3” x 4” = 12 in² rectangular section.
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.

FIELD DATA GATHERING
Differential Leveling

Definitions

Point A

BS = 6.32 ft
HI = 106.32 ft
FS = 3.10 ft

Point B

ΔE = BS - FS

Elevation = 103.22 ft

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

<table>
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<th>FS. or Grade Rod</th>
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#### Design & Const. Layout

- **Outlet—Yeg. W. W.**
  - Total length: 702 ft
  - Av.fill: 100 ft = 68.2 yd³
  - Total fill: 68.2 / (255 / 3) = 507 yd³

- **Design**
  - DA: 20 ac. / 2 = 30 ft²/s
  - Channel Grade: 0.4%
  - Velocity: 2 ft/s

---

W. A. Jones

Diversion #1

Design & Const. Layout

M. V. Ray

2-26-10
### Example of Survey Notes

**Sample D-4**

**Engineering notes for a diversion—Sheet 3 of 3**

<table>
<thead>
<tr>
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<th>Pace Rod</th>
<th>Ampl. Rate</th>
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**W. A. Jones, Diversion #1**

**Const. Check & Recheck**

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**Construction meets plans and specs.**

**V. Ray**

**Const. Tech.**

2-28-10
TBM #1 3.2 103.2 100.00

0+00 Point D 5.5 97.7

0+50 Point G 7.3 95.9

Roof Height at D 17' 114.7

Roof Height at G 19' 114.9

Gutter slope = 114.7 - 114.9

50

2 0.004 = 4.3
Slope of the gutter

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

Elevation point D = HI - FS₁ = 103.2' - 5.5' = 97.7'

Elevation point E = HI - FS₂ = 103.2' - 7.3' = 95.9'

Elevation roof on point D = Elev point D + Rod Reading = 97.7' + 17' = 114.7'

Elevation roof on point E = Elev point E + Rod Reading = 95.9' + 19' = 114.9'

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

Diagram:
- Point D
- Point E
- BS - Back sight
- 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?
3. **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.

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

Notes:
Preliminary design. Not for construction.
Contour lines 1 ft vertical difference.
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
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
   \[ \text{Slope} = \frac{2'}{220'} = 0.009 \]

2) Convert from gpm to cfs
   \[ (606 \text{ gpm})(\frac{1 \text{ ft}^3}{7.48 \text{ gal}})(\frac{1 \text{ min}}{60 \text{ s}}) = 1.35 \text{ ft}^3/\text{s} \]

EXAMPLE CONCRETE GUTTER DESIGN
3) Select Manning's n. According to the finish of the surface.


**EXAMPLE CONCRETE GUTTER DESIGN**
3) Use USDA-NRCS Hydraulics Formula Tool (app) to determine the capacity
   1.97 Cfs
4) 197 cfs > 135 cfs
   OK!

EXAMPLE CONCRETE GUTTER DESIGN
EXERCISE. ROOF NEEDS A RUNOFF STRUCTURE.

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