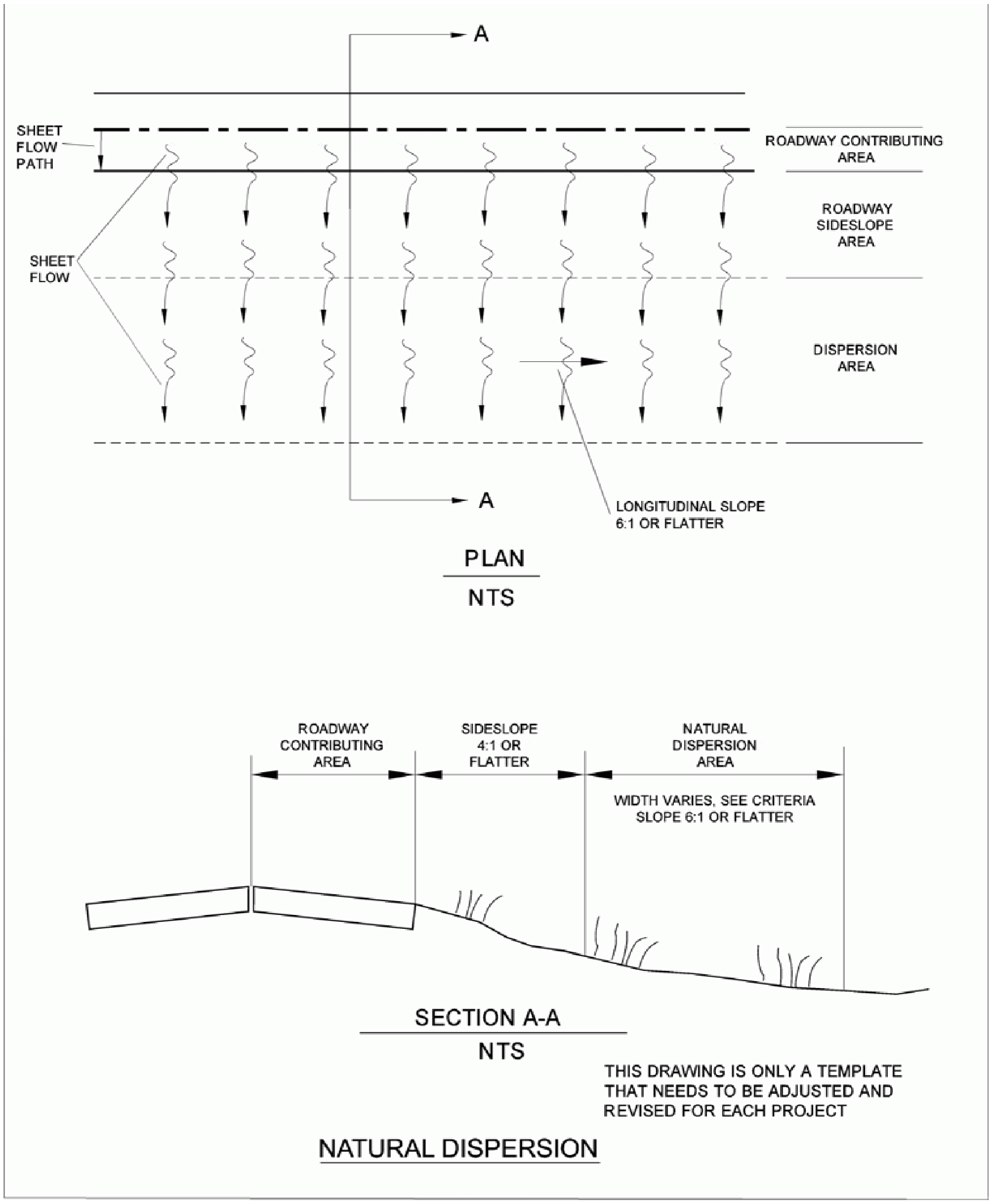
In this tutorial you will learn:

- The design criteria for Natural Dispersion.
- Acceptable methods for determining Ksat.
- Two options for sizing a natural dispersion area.

Sample Problem Description

A highway near the city of Spokane is being expanded by a lane and it has been determined that natural dispersion is the best BMP for the project. Design the BMP using the following parameters:

- The roadway is 40' wide and 1000' long.
- The roadway cross-section is sloped 2% and with a continuous 3% profile.
- The soil is type B.



**The dispersion area starts once the side slopes become 15% (6:1) or flatter. If the side slopes are already 6:1 or flatter, no buffer area is needed.

Figure FC.01.1. Natural dispersion area.

Natural Dispersion

Natural Dispersion is a simplest method of flow control and runoff treatment (unlike vegetative filter strips which only provide runoff treatment). This BMP uses the existing vegetative side slopes and generally requires little or no construction activity. The key to natural dispersion is that runoff maintains sheet flow and then pollutants are removed through vegetative filtration and shallow surface infiltration.

Applications and Limitations

- Natural dispersion is ideal for highways and linear roadway projects.
- There are two types of natural dispersion: sheet flow and channelized. This tutorial will focus on sheet flow. For flow that is channelized, designers should consult the Engineered Dispersion section of the HRM for design guidance.
- Natural dispersion areas meet basic and enhanced runoff treatment set forth in minimum requirement 5 of the HRM.
- Natural dispersion areas meet flow control criteria set forth in Minimum Requirement 6 of the HRM.
- Floodplains are not suitable areas for Natural Dispersion.
- Natural dispersion areas must be protected from future development. This can be done by adding the stormwater facility into the stormwater data base.

Design Criteria

The size of the natural dispersion area depends on the flow contributing area and the predicted rates of saturated hydraulic conductivity. Prior to starting a design, consult the Soil Suitability Criteria in Chapter 4 of the HRM to verify the site is suitable for use as a infiltration BMP.

- Natural dispersion areas should be well vegetated.
- Roadway side slopes that are leading to the natural dispersion area should be (4:1) 25% or flatter. Once the side slopes become (6:1) or 15%, the dispersion area starts.
- Natural dispersion areas should have an average longitudinal slope of 15 % and an average lateral slope of 15% or flatter.
- For any existing side slopes that shows evidence of channelized flow (rills or gullies), a flow-spreading device should be used before those flows are allowed to enter the dispersion area.
- Sheet flow path leading to the natural dispersion area should not be longer than 75 feet for impervious surfaces and 150 feet for pervious surfaces.
- The longitudinal pavement slope contributing flow to the dispersion area should be less than 5% and the lateral pavement slope should be less than 8%.
- The longitudinal length of the dispersion area should be equivalent to the longitudinal length of roadway that is contributing to the dispersion area.

Soil Testing

The saturated hydraulic conductivity (K_{sat})for natural dispersion is determined using the Guelph Permeameter. The Guelph Permeameter (GP) is a constant head device that is used to determine the in-situ field surface infiltration rates. Testing using the GP is only approved for Natural Dispersion BMP's in EWA and only on existing embankments that will remain mostly undisturbed during construction (minor widening).

The HRM recommends 5 tests for every 2500 linear feet of roadway. The average of the five K_{sat} should then be determined and a factor of safety of 2 applied. This final value should be used to size the Natural Dispersion area.

Construction and Maintenance Criteria

- Clearing and grubbing should be minimized to maintain plant root systems that are important to natural dispersion.
- The area around dispersion areas should not be compacted.
- Maintenance pullout areas should be considered to promote successful maintenance practices at dispersion areas. Pull out areas should be large enough to accommodate a typical maintenance vehicle. Contact the maintenance office to determine the typical size of maintenance vehicle used in the project area.

Sizing Criteria

There are two options for sizing natural dispersion areas. Option one considers the roadway width, K_{sat}, and rainfall intensity to derive the width required for natural dispersion. The second Option is based on the soil characteristics and K_{sat}. Both are discussed in further detail below.

Option 1

In order to use option 1, designers must use the Guelph Permeameter to determine K_{sat}. This option is based on a simplified equation termed the LID Design Equation.

$$LID = \frac{ACP}{\frac{K_{sat}}{r_i} - 1}$$

Where:

LID = width of natural dispersion area in feet

ACP = width of roadway in feet

K_{sat} = saturated hydraulic conductivity in in/hr

r_i = rainfall intensity in in/hr

Note: for natural dispersion to have a viable benefit the Ksat/ri ratio must be greater than 2. If the ratio is equal to or less than 1, the equation will result in negative values.

ACP

From the example problem statement, we are told that the roadway width is 40'.

K_{sat}

The HRM states 5 test must be performed for every 2500' of natural dispersion area. For our, project two tests were performed on the 1000' length. Using the Guelph Permeameter, the K_{sat} at each test whole were calculated to be: 12 and 10 in/hr. Next determine the average and then apply a factor of safety 2.

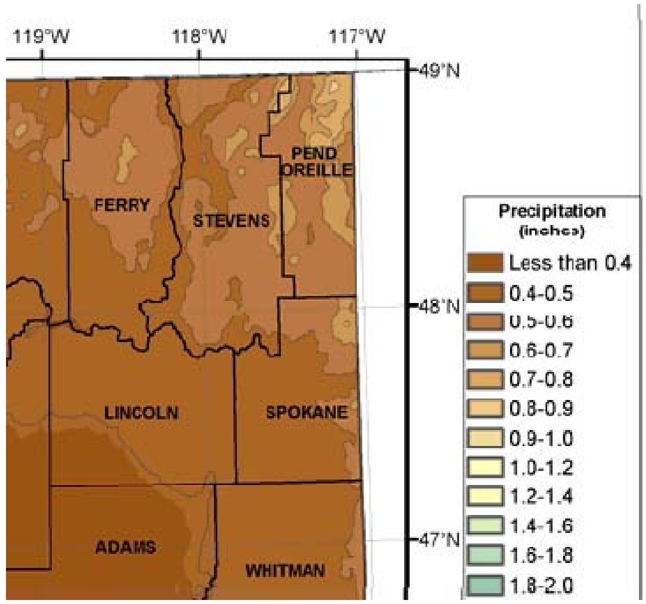
$$K_{sat} = (\frac{12+10}{2})/2 = 5.5 in/hr$$

r_i

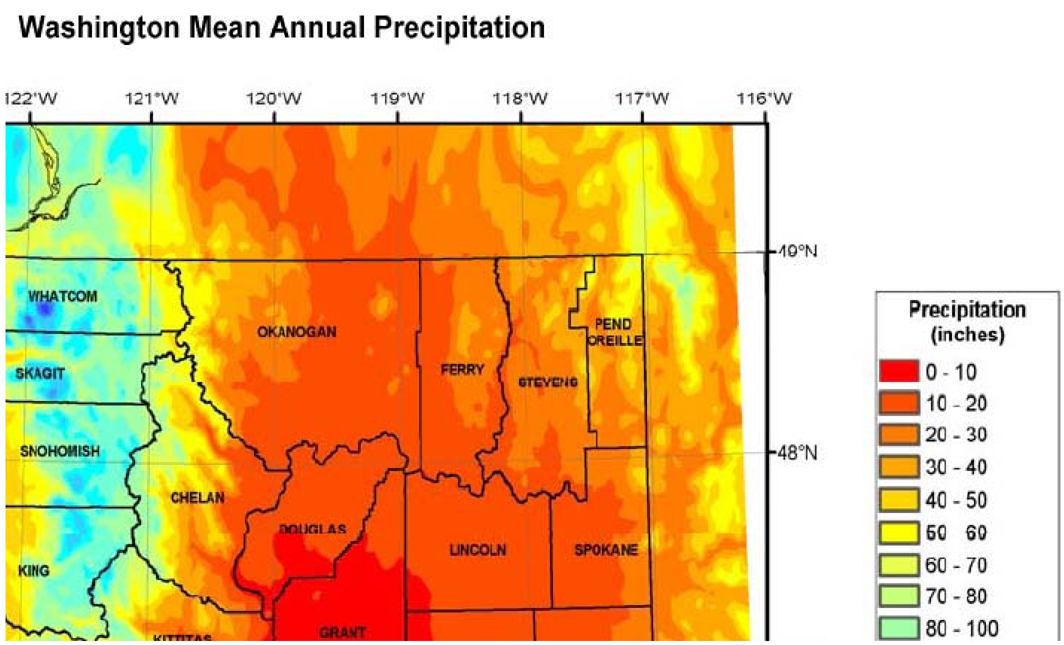
Next determine the rainfall intensity r_i, that is the peak 5-minute interval of the 6-month, 3 hour, short duration storm. In order to calculate this value we need three things from our project site: the 2 year 2 hour rainfall depth, mean annual precipitation, and the peak intensity factor (PIF)

1. The 2 year 2 hour rainfall depth was determined in Design Storm tutorial from the Isopluvial web links in Appendix 4A of the HRM.

   For Spokane, the 2 year, 2 hour rainfall depth is 0.48".



2. Next we go to the Mean Annual Precipitation Map for Washington State (web link is also found in Appendix A of the HRM). We find the MAP for Spokane to be 18".



From the Isopluvial to Peak Intensity Factor chart in the FC.01 Natural Dispersion section of the HRM, we find the PIF for Spokane (climatic region 3) to be 2.03in/hr.

DOE Climate Region #	Mean Annual Precipitation	Isopluvial to Peak Intensity Factor:
2		
	6-8	1.85
	8-10	1.88
	10-12	1.94
2-3	12-16	2.00
3	16-22	2.03
1-4	22-28	2.09
	28-40	2.12
	40-60	2.19
	60-120	2.25

Finally we can compute r_i as shown below:

$$r_i = 0.48\, in / hr \times 2.03 = 0.97\, in / hr$$

Compute LID – Width of the Natural Dispersion area.

$$LID = \frac{ACP}{\frac{K_{sat}}{r_i} - 1}$$

$$LID = \frac{40\, ft}{\frac{5.5}{0.97} - 1} = 8.6\, ft$$

Therefore we are required to build a 8.6 ft wide natural dispersion area parallel to the entire 1000' of pavement. Note, Figure FC.01.1Natural dispersion area show a buffer area before the natural dispersion area. The dispersion area starts once the side slopes become 15% (6:1) or flatter. If the side slopes are already 6:1 or flatter, no buffer area is needed.

Option 2

For Option 2 the width of the Natural Dispersion area is based on K_{sat} and the soil type. The following two paragraphs summarize the sizing criteria using Option 2.

The following applies to type A and B soils where K_{sat} is greater than 4 in/hr.

> For K_{sat} of 4 in/hr or greater and for the first 20 feet of impervious surface that drain to the dispersion area, there must be 10 lateral feet of dispersion area width. For each additional foot of impervious surface that drains to the dispersion area, 0.25 lateral feet of dispersion area should be provided.

The following apply to all C and D soils and type B soils and where K_{sat} is 4 in/hr or less.

> For every foot of contributing pavement width, 6.5 feet of dispersion area is needed. The dispersion area should have a minimum width of native vegetation of 100 feet.

Option 2 results

Since the soil type is B with a K_{sat} greater than 4in/hr, we follow the first paragraph as shown below:

$$ND_{width} = 10\,ft + 0.25x20 = 15\,ft$$