

SPM Version 3 Orientation Learning Exercise - Loading Rates Answer Key

These exercises are intended to support your self-directed learning. Answer the questions based on the SPM Version 3 standards and guidelines for determination of hydraulic and linear loading rates and the limited information provided within each question. Assume that there are no further site/soil constraints or other unusual circumstances that affect loading rate selections. Then check the answer key - which includes some helpful SPM references and notes.

The correct answers are indicated in bold font.

1. What is the maximum allowable Type 1 HLR for loam texture, blocky structure shape, moderate grade, moderately hard dry consistence?

Notes:

- Refer to section II- 5.5 and II- 5.6. For this question, the relevant tables are Table II- 21 and Table II- 22.
- To determine HLR and LLR, there are different tables for loading rate selection based on either soil type or permeability and percolation rate, so a 'two pronged' approach is required. The lower loading rate from those two approaches is the required standard.
- You will note that the loading rate tables have different rates for different soil structure and consistence categories (F, P, VP or NA). So, to use those tables for loading rate selection (Table II- 22, 23, 27 and 28) it is first necessary to refer to Table II- 21 to determine the structure and consistence category.
- See the glossary in Volume I, if you need a refresher about the definitions for structure type, grade and consistence. The USDA Field Book for Describing and Sampling Soils has additional detail.
- Table II- 21 indicates the structure and consistence category is 'poor' (P).
- The question does not tell us the perc rate or permeability (to simplify learning - one thing at a time©). So we will base the answer on the limited information provided, but note that the two approaches are always required - determine the loading rate based on soil type AND percolation rate or permeability THEN choose the most conservative/lowest rate.
- In this example, with limited information (no perc or Kfs), Table II - 22 lists the maximum HLR as 15 L/m².

Answer: **15 L/m²**

2. What is the maximum allowable Type 1 LLR for loam texture, blocky structure shape, moderate grade, moderately hard dry consistence ... slope is 7%, depth of suitable soil is 95 cm?

Notes:

- For this question, the relevant tables are Table II- 21 and Table II- 27.
- Table II- 21 indicates the structure and consistence category is 'poor' (P).
- In this example, with limited information (no perc or Kfs), Table II - 27 lists the maximum LLR as 45 L/m².

Answer: **45 L/m²**

3. For conditions listed in #1 and #2 above, what is the minimum area of infiltrative surface for a system with 1500 L DDF?

Notes:

- As per SPM page II- 34, “Minimum Area of Infiltrative Surface (AIS) needed (m^2) = DDF (L/day) ÷ HLR (L/day/ m^2).”
- $AIS = 1500 \text{ L/day} \div 15\text{L}/m^2 = 100 \text{ m}^2$

Answer: **100m²**

4. For conditions listed in question #1 and #2 above, what is the minimum system length for a system with 1500 L DDF?

Notes:

- As per SPM page II- 38, “Minimum system contour length (m) = DDF (L/day) ÷ LLR (L/day/ m)”
- $Length = 1500 \text{ L/day} \div 45\text{L}/m = 33.3 \text{ m}$
- Note this means the system must be at least 33.3 m long along the level contour. This is not achieved by, for example, three - 11m trenches from an end feed manifold. It could be achieved by, for example, a 3 m wide bed (maximum allowable width of a bed) that is 33.3 m long (100 m^2 AIS) - and of course that would be too long for an end feed manifold.

Answer: **33.3 m minimum system contour length**

5. What is the maximum allowable Type 1 HLR for soil with fine sand texture, and with depth of that soil horizon extending to at least 30 cm below the infiltrative surface, single grain structure shape, loose consistence, and permeability of 2200 mm/day Kfs?

Notes:

- Refer to: Table II- 21, Table II- 22 and Table II- 23.
- Table II - 21 lists the structure and consistence category as ‘F’.
- Table II- 22 lists the maximum allowable HLR based on soil type as 27L/ m^2 .
- Table II- 23 lists the maximum allowable HLR based on permeability as 35L/ m^2 .
- Of those two loading rates, the lowest/most conservative is 27L/ m^2 .

Answer: **27 L/m²**

6. What is the maximum allowable Type 1 LLR for fine sand texture, single grain structure shape, loose consistence, slope is 2%, depth of suitable soil is 65 cm, and percolation rate is 4 minutes per inch?

Notes:

- Refer to: Table II- 21, Table II- 27 and Table II- 28.
- Table II - 21 lists the structure and consistence category as ‘F’.
- Table II- 27 lists the maximum allowable LLR based on soil type as 70 L/ m^2 .
- Table II- 28 lists the maximum allowable LLR based on percolation rate as 70 L/ m^2 .
- The two pronged approach resulted in the same LLR.

Answer: **70 L/m²**

7. For conditions listed in question #5 and #6 above, what is the minimum area of infiltrative surface for a system with 1300 L DDF?

Notes:

- $AIS = 1300 \text{ L/day} \div 27 \text{ L/m}^2 = 48 \text{ m}^2$

Answer: **48 m²**

8. For conditions listed in question #5 and #6 above, what is the minimum system length for a system with 1300 L DDF?

Notes:

- $\text{Minimum contour length} = 1300 \text{ L/day} \div 70 \text{ L/m} = 18.6 \text{ m}$
- *Note this means the system must be at least 18.6 m long along the level contour. Given the minimum AIS, the configuration could be $48 \text{ m}^2 \div 18.6 \text{ m} = 2.6 \text{ m}$ wide, 18.6 m long*

Answer: **18.6 m minimum system contour length**

9. Determine the minimum dimensions of a bed dispersal system given the following information:
- VS is easily met due to significant depth of suitable soil.
 - Soil texture to 50 cm depth below the infiltrative surface is loam.
 - The loam horizon has weak grade, blocky structure with moderately hard dry consistence.
 - The average percolation rate is 28 minutes per inch.
 - DDF is 1300 L/day, with type 2 effluent.
 - The slope within the dispersal area and the downslope receiving area is 7%.

(Fill in the blanks) The structure and consistence category is _____ and ...

the maximum allowable HLR based on soil type is _____ ...

the maximum allowable HLR based on percolation rate is _____ ...

therefore, the applicable HLR is _____ ...

and the min. AIS is _____.

The maximum allowable LLR based on soil type is _____ ...

the maximum allowable LLR based on percolation rate is _____ ...

therefore, the applicable LLR is _____ ...

and the minimum system contour length is _____.

The minimum dimensions of a dispersal bed are _____ long and _____ wide.

Notes:

- *Refer to:*
 - *Table II- 21 for structure and consistence category.*
 - *Table II- 22 for HLR based on soil type.*
 - *Table II- 23 for HLR based on percolation rate.*
 - *Table II - 27 and 28 for LLR.*

Answers:

The structure and consistence category is **very poor** and ...

the maximum allowable HLR based on soil type is **25 L/day/m²** ...

the maximum allowable HLR based on percolation rate is **40 L/day/m²** ...

therefore, the applicable HLR is **25 L/day/m²** ...

and the min. AIS is $1300 \text{ L DDF} \div 25 \text{ L/m}^2 = \mathbf{52 \text{ m}^2}$.

The maximum allowable LLR based on soil type is **24 L/m** ...

the maximum allowable LLR based on percolation rate is **50 L/m** ...

therefore, the applicable LLR is **24 L/m** ...

and the minimum system contour length is $1300 \text{ L DDF} \div 24 \text{ L/m} = \mathbf{54 \text{ m}}$.

The minimum dimensions of the dispersal bed are **54 m long** and $52 \text{ m}^2 \text{ AIS} \div 54 \text{ m length} = \mathbf{1 \text{ m wide}}$.

10. Determine the minimum dimensions of a bed dispersal system on a raised sand mound given the following information:

- The proposed sand media meets the ASTM C33 specifications but there is 6% passing the No. 100 sieve and 2% passing the No. 200 sieve.
- Assume VS standards are met.
- Soil texture to 30 cm depth below the original grade is loam. Underlying soil is seasonally wet.
- The loam horizon has weak grade, blocky structure with friable moist consistence.
- The average percolation rate is 18 minutes per inch.
- DDF is 1300 L/day, with type 1 effluent.
- The slope within the dispersal area and the downslope receiving area is 7%.

The structure and consistence category of the underlying soil is _____ and ...

the maximum allowable basal HLR based on soil type is _____ ...

the maximum allowable basal HLR based on percolation rate is _____ ...

therefore, the applicable basal HLR is _____ ...

and the min. basal area is _____.

The maximum allowable LLR based on soil type is _____ ...

the maximum allowable LLR based on percolation rate is _____ ...

therefore, the applicable LLR is _____ ...

and the minimum system contour length is _____.

The maximum allowable sand media HLR is _____ ...

and the minimum AIS is _____ ...

the minimum dimensions of a dispersal bed are _____ long and _____ wide which meets / does not meet (select one) the basal loading check.

Notes:

- Refer to:
 - Section II- 5.5.3.1.(a) for standards related to basal area of a sand mound.
 - Section III- 5.5.3.1 for guidelines related to HLRs for sand media and basal soil.
 - Table II- 21 for structure and consistence category.
 - Table II- 22 for HLR based on soil type for the underlying loam basal soil.
 - Table II- 23 for HLR based on percolation rate of the underlying basal soil.
 - Table II - 27 and 28 for LLR, and section II- 5.6.5 for system contour length of raised systems.
 - Section III- 5.5.3.2 for guidance about sand media and HLR.
 - Table II- 25 to determine which category of sand media is applicable.
 - Table II- 24 for clean course sand HLR.

Answers:

The structure and consistence category of the underlying soil is **poor (P)** and ...

the maximum allowable basal HLR based on soil type is **30 L/m² (type 2 basal HLR)**...

the maximum allowable basal HLR based on percolation rate is **40 L/m²**...

therefore, the applicable basal HLR is **30 L/m²** ...

and the min. basal area is $1300 \text{ L DDF} \div 30 \text{ L/m}^2 = \mathbf{43 \text{ m}^2}$.

The maximum allowable LLR based on basal soil type is **35 L/m** ...

the maximum allowable LLR based on basal percolation rate is **45 L/m** ...

therefore, the applicable LLR is **35 L/m** ...

and the minimum system contour length is $1300 \text{ L DDF} \div 35 \text{ L/m} = \mathbf{37 \text{ m}}$.

The maximum allowable sand media HLR is **30 L/m²** ...

and the minimum AIS is $1300 \text{ L DDF} \div 30 \text{ L/m}^2 = \mathbf{43 \text{ m}^2}$...

the minimum dimensions of a dispersal bed are **37 m long** and $43 \text{ m}^2 \text{ AIS} \div 37 \text{ m length} = \mathbf{1.2 \text{ m}}$

wide, which easily **meets** the basal loading check (*since the sand media loading rate and basal loading rate are identical ... and the effective basal area is much greater than the bed area - the basal check is based on the bed area plus the area under the downslope toe of the mound*).