SPM Version 3 Orientation
Learning Exercise - Vertical Separation
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 vertical separation (VS) and the limited information provided within each question. Assume that there are no further site/soil constraints or other unusual circumstances that affect VS. 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 minimum required VS for gravity distribution of type 1 effluent to coarse sand?

Notes:
- *Refer to Table II- 14.*

Answer: ***150 cm***

2. Determine the minimum required VS, given the following conditions:
   - uniform distribution
   - demand dosing
   - dose frequency of 6 times per day based on DDF
   - type 2 effluent, type 2 HLR
   - soil texture is loamy sand at the infiltrative surface and at least 30 cm below

   The minimum required VS in native soil is _____ (fill in the blank).

Notes:
- *Refer to Table II- 10, and Table II- 15.*
- *To determine VS, there are different tables for different types of distribution and different rows for type of dosing and type of effluent HLR. Determination of the minimum VS depth standard requires a 'two pronged approach.' In general, it requires first looking at the dosing frequency tables (Table II - 10, 11 and 12) and then looking at the distribution type tables (Table II- 14, 15, 16, 17, and 18).*
- *In this example, Table II- 10 determines that the proposed dosing is within the 'low' dosing category. Table II- 15 lists the VS standard of 90 cm.*

Answer: ***90 cm***

3. Determine the minimum required VS, given the following conditions:
   - uniform distribution
   - timed dosing
   - dose frequency of 10 times per day based on DDF
   - type 1 effluent, type 1 HLR
   - soil texture is loamy sand at the infiltrative surface and at least 30 cm below

   The minimum required VS in native soil is _____
   and the minimum as constructed VS is _____ (fill in the blanks).

Notes: Refer to Table II- 11, and Table II- 16.

Answer: The minimum required VS in native soil is ***45 cm*** and the minimum as constructed VS is ***60 cm.***

4. Determine the minimum required VS, given the following conditions:
   - uniform distribution
   - demand dosing
   - dose frequency of 14 times per day based on DDF
   - type 2 HLR
   - soil texture is loamy sand at the infiltrative surface and at least 30 cm below
   - sand media will not be used … is not a practical option due to high transport costs

   The minimum required VS is _____.

Notes:
- *Refer to Table II- 10, Table II- 15 and the notes to Table II- 15 and 16 on page II- 28.*
- *"Confirm that the vertical separation, as planned, meets both the minimum depth of native soil specified (in column 4) **and** the minimum required total depth of soil plus sand (as constructed VS, column 5)."*
- *Table II- 15 indicates 60 cm VS in native soil, and 85 cm as constructed VS, but since adding sand media to increase the total depth will not be an option, VS in native soil must be equal to or greater than the as constructed VS standard.*

Answer: ***85 cm****.*

5. Determine the minimum required VS and sand media thickness, given the following conditions:
   - sand mound dispersal system (must be uniform distribution, gravity dispersal not allowed)
   - the depth of unsaturated and permeable native soil above seasonal high water table is 30 cm
   - demand dosing
   - dose frequency of 11 times per day based on DDF
   - type 1 HLR is used for sizing the mound sand infiltrative surface (a type 2 HLR is used for the basal loading area check)

   The standard for minimum required as constructed VS is _____ and …

   the minimum sand media thickness is _____ …

   the depth of suitable soil above a limiting condition is _____ …

   therefore, the as constructed VS will have to be at least _____.

Notes:
- *Refer to Table II- 10, Table II- 17 and the note to Table II- 17.*
- *"Confirm that the vertical separation, as planned, meets the minimum depth of native soil specified (in column 4) **and** the minimum depth of sand (sand media thickness, column 5) **and** the minimum required total depth of soil plus sand (as constructed VS, column 6)."*
- *85 cm as constructed VS standard - 30 cm native soil depth = 55 cm sand media depth, but the required minimum sand media thickness is 60 cm … therefore the infiltrative surface will be placed at least 90 cm above the limiting condition resulting in 90 cm of as constructed VS.*

*Answer: The standard for minimum required as constructed VS is **85 cm**, the minimum sand media thickness is **60 cm**, the depth of suitable soil above a limiting condition is **30 cm** therefore the as constructed VS will have to at least **90 cm**.*

6. Determine the minimum required VS and sand media thickness, given the following conditions:
   - sand mound dispersal system (must be uniform distribution, gravity dispersal not allowed)
   - the depth of unsaturated and permeable native soil above seasonal high water table is 30 cm
   - timed dosing
   - dose frequency of 14 times per day based on DDF
   - type 1 HLR is used for sizing the mound sand infiltrative surface (a type 2 HLR is used for the basal loading area check)

   The standard for minimum as constructed VS is _____ and …

   the standard for minimum sand media thickness is _____ …

   the standard for minimum native soil VS is _____ …

   the actual depth of native soil above a limiting condition is _____ …

   therefore, the constructed mound must have at least _____ depth of mound sand

   under the infiltrative surface.

Notes:
- *Refer to Table II- 11, Table II- 17 and the note to Table II- 17.*
- *75 cm as constructed VS standard - 30 cm native soil depth = 45 cm sand media depth, all three requirements are met*

*Answer: The standard for minimum as constructed VS is **75 cm**, the standard for minimum sand media thickness is **45 cm**, the standard for minimum native soil VS is **25 cm**, the actual depth of native soil above a limiting condition is **30 cm**, therefore, the constructed mound must have at least **45 cm** depth of mound sand under the infiltrative surface.*

7. The depth of permeable, unsaturated soil within a proposed dispersal area is 180 cm. Soil texture is loamy sand. What is the maximum depth from surface to trench bottom (i.e. how deep can the trench be) that will achieve VS standards for gravity dispersal trenches?

Notes:
- *Refer to Table II- 14 and section III- 5.3.2.1.*
- *SPM page III- 64 says: "If soil depth is limited, the infiltrative surface can be placed higher in the soil ("shallow placement"), at the surface ("at grade") or elevated above the surface on a layer of sand media fill ("above grade" or "raised").*
- *180 cm depth of suitable native soil - 150 cm VS standard = 30 cm maximum depth of infiltrative surface/bottom of trench.*

Answer: ***30 cm***

8. The native soil has a texture of loam, with 90 cm depth to a restrictive layer of clay loam. A type 1 pressure dispersal system is proposed, with demand dosing at 4 doses per day. What is the required elevation relative to original grade of the infiltrative surface (i.e. how deep?), to meet the minimum VS standards?

Notes:

- *Refer to Table II- 10 and Table II- 15, and section III- 5.3.2.1.*
- *90 cm depth of suitable native soil - 70 cm VS standard = 20 cm maximum depth of infiltrative surface (depth of trench or bed).*

Answer: ***20 cm***

9. The depth of suitable soil is 35 cm. A type 1 sand mound with timed dosing is proposed. Dose volume will be 1/12 th of DDF. What is the required elevation relative to original grade of the infiltrative surface, to meet the minimum VS standards?

Notes:

- *Refer to Table II- 11 and Table II- 17.*
- *12 doses per day 'qualifies' as normal timed dosing per Table II- 10, so relevant VS standards are 75 cm minimum as constructed VS, 45 cm min sand depth, 25 cm min native soil VS. There is 35 cm of suitable soil which suggests we need 40 cm of sand media to achieve 75 cm as constructed VS, but the minimum sand media depth is 45 cm, so we need to place the infiltrative surface at least 45 cm above grade.*

Answer: ***45 cm above original grade***

10. Answer the questions that follow, given the following conditions:
    - the configuration of the dispersal system will achieve better than 10% variation in effluent volume applied to each 0.5 sq m portion of the dispersal trenches
    - DDF is 2500 L/day
    - the dosing system will achieve consistent flow equalization throughout the day
    - the volume of each dose will be 155 L per dose
    - a type 2 HLR will be used to determine the area of infiltrative surface
    - soil texture is sandy loam to a depth of 120 cm, with wet clay under that
    - a 10 cm deep blinding layer of mound sand will be used to prevent crusting or "capping".

    a) Is the dosing characterized as 'normal' or 'low'?

    b) Which VS Table applies (Table II- 14, 15, 16, 17 or 18)?

    c) What is the minimum VS in native soil?

    d) What is the minimum as constructed VS?

    e) What is the maximum depth of the dispersal trench that will achieve VS standards?

Notes:

- *Refer to II- 5.2.1, II- 5.2.1.1, II- 5.2.2, II- 5.3, and III- 6.5.2.1.(e).*
- *The system 'qualifies' as uniform distribution (each 0.5 sq m gets even distribution) with timed dosing, not micro dosing (2500 L DDF ÷ 155 L/dose = 16 doses per day), the relevant row from Table II- 11 is 'other soils', dosing is 'normal', Table II- 16 applies since there will be less than 30*

cm sand media used, the relevant row from Table II- 16 is 'other soils', the timed dosing row applies (since 'normal' timed dosing is applicable, not low or micro), so the standards are 45 cm native VS and 60 cm as constructed VS.

- *The blinding layer "may be considered as part of the required native soil separation" as per the notes to Table II- 15. Therefore, the maximum depth of the trench is … 120 cm depth of suitable soil - 60 cm min. as constructed VS + 10 cm depth of blinding layer = 70 cm below original grade. This meets and exceeds the min. 45 cm native soil VS and the min. 60 cm as constructed VS (50 cm native soil plus the 10 cm blinding layer) … so trench depth can be max 70 cm below original grade, with 10 cm blinding layer added, placing the infiltrative surface at 60 cm.*

Answer:

a) ***normal***
b) ***Table II-16***
c) ***45 cm***
d) ***60 cm***
e) ***70 cm***