Job Name: Date: Designer:

# Sand mound design worksheet

**UNITS: Liters and Meters**
***See diagrams page 6, below for dimension letters. See pressure distribution worksheet for conversions.***

## A. DESIGN INPUTS, FLOW AND SOIL/SITE DATA

Gather inputs using Design Inputs Worksheet, transfer necessary information below.

Soil: Type and structure ________________________

Soil depth: ___________ meters Type of restrictive layer: __________________

Effluent type: ___________ Design Flow: ___________ L/dy

Select minimum vertical separation to bed (including sand) and sand depth: See SPM Mound vertical separation table and mound sand depth standards. Consider downslope conditions, potential mounding, type of subsurface flow expected, type of restrictive layer, and consider reduction in LLR where original usable soil depth is very shallow. Note that sand depth needed is also affected by type of dosing.

Min. sand depth below bed, **D** = ____________ meters

Basal LLR: ___________ L/day/m *Must represent soil below mound AND in receiving area.*

Basal HLR: ___________ L/day/sqm (select from HLR table using Type 2 effluent type).

Site slope: __________ As decimal: __________ (in mound area)

Upslope correction factor: ___________ Downslope correction factor: ___________(See page 5, below)

Side slope for mound as a decimal: Normally 3:1 to permit mowing, can be 2:1, particularly on steep slopes where this avoids excessive toe length.

Side and upslope: **SS** = __________ Downslope: **DS** = __________

Select sand loading rate: For SPM standard Mound sand use 40 L/dy/sqm for Type 1 effluent.

Type of sand ____________________________________________________

Sand HLR: ___________ L/dy/sqm Effluent type: _____________

For timed dosing, calculate Hydraulic Application Rate (HAR) and dose. For mound sand base on 50mm/m water holding capacity (WHC). Round to nearest whole number of doses per day.

Sand Water holding capacity = _________ mm/m X 0.10 = 10% of WHC = _________ mm/m

Sand depth "**D**", Max. HAR = 10% of WHC X **D** = _______ mm/m x ________ m = ________mm

Dose frequency = $\frac{\text{Sand HLR}}{\text{Max. HAR}}$ = ______________ = _________ doses per day

HAR = $\frac{\text{Sand HLR}}{\text{Rounded Doses per day}}$ = ____________ = _____________ mm per dose

Dose volume = $\frac{\text{Daily Design Flow}}{\text{Doses per day}}$ = ____________ = _________ L per dose

B. **DESIGN OF THE INFILTRATION AREA (BED)**
**See diagram page 6, below for dimension letters.**

1. **Size the infiltration area (bed or infiltrator base AIS)**

Bottom area of bed = Daily design flow (L/dy) / Sand HLR (L/dy/sqm)

= ____________ L/day / ____________ L/dy/sqm = ____________ $m^2$

2. **Bed configuration**

Bed length = **B** = Design flow / LLR = ______L ÷ ________ L/dy/m

**B** =___________m

Bed width= **A** = Bed area / bed length = ______$m^2$ ÷ _________m

**A** =___________m

Note, on very flat site could consider full mound length for LLR, in this case ensure bed is under 3m (10') max width to address oxygen flux even where soil depth is such that flow is primarily vertical below the mound and groundwater mounding or toe breakout is not a concern.
If bed is shown to be very narrow, consider widening to practical construction width to reduce sand loading rate further.
For infiltrators consider effective length and plan bed to use whole number of units.

C. **DESIGN THE ENTIRE MOUND**

1. **Filter media height**

a. Filter media depth

1) Depth at upslope edge of bed (D) = 0.31 – 0.61 m depending on filter media and original soil and vertical separation needed.

**D** = ____________ m

2) Depth at downslope edge of bed (E)

= Depth at upslope edge of bed + (% slope expressed as decimal X bed width)

= D + (% slope expressed as decimal X A)

= ____________ m + (____________ X ____________ m)

**E** = ____________ m

b. Bed depth (F) = 0.23 m to 0.31m (9 to 12 inches) (9" min. for 1 in. laterals, 12" for infiltrators).

**F** = ____________ m

c. Cap and topsoil

1. Depth at bed center (H) = 0.31 to 0.46m (12 to 18 inches)
2) Depth at bed edges (G) = 0.15 to 0.31m (6 to 12 inches)

The lower depth range is minimum *AFTER* settling. *For infiltrators in single lateral layout may use 6”-12” soil cap over center and use dome shape to advantage (so H = 6 to 12” and G = 0 to 6”)*

**G** = ____________ m **H** = ___________m

2. **Filter media length**

a. End slope width (**K**) = Total filter media depth at bed center X horizontal gradient of mound side slope, side slope from section 1 **SS** = __________

Total media depth at bed center =

$$\frac{D + E}{2} + F + H$$

= (______+________) / 2 + __________ + ___________ = ___________

**K** = Media depth x **SS** = _______ x ________ = ___________m

b. Filter media length (L) = Bed length + (2 X end slope width **K** )

= B + 2**K** = ___________ m +(2 X __________ m)

**L** = _____________ m total length

3. **Filter media width**

a. Upslope width (**J**) = filter media depth at upslope edge of bed X horizontal gradient of mound side slope X up slope correction factor

= (D + F + G) X **SS** X up slope correction factor

**J** = (__________ m + ___________ m + ___________m) X ________ X ________

= ___________ m X ________ X _________

**J** = __________ m

b. Downslope width (**I**) = filter media depth at downslope edge of bed X horizontal gradient of downslope of sand mound X downslope correction factor

Down slope from section 1 **DS** = __________

**I** = (E + F + G) X **DS** X down slope correction factor

= (__________ m + _________ m + _________m) X _______ X _______

= ___________ m X _________ X __________

**I** = __________ m

c. Filter media width (**W**) = upslope width + Bed width + Downslope width

= J + A + **I** = ____________ m + ___________ m + __________m

**W** = ___________ m

4. **Check the basal area**

a. Minimum Basal area = $\frac{\text{Daily Design flow}}{\text{Basal HLR}}$

$= \frac{\_\_\_\_\_\_\_\_\_\_ \text{ L/day}}{\_\_\_\_\_\_\_\_\_\_ \text{ L/m}^2\text{/day}}$

= ____________ $m^2$

b. Basal area available — Is it sufficient?

1) Sloping site = Bed length X (Bed width + Downslope width)

= B X (A + I)

= ______ m X (_____ m + _____ m)

= ______ m X ______ m=

= ______ $m^2$

2) Level site = filter media length X Fill width

= L X W
= ______ m X _____ m

= ______ $m^2$

If insufficient, add toe area or length and correct dimensions. Enter critical dimensions on diagrams P. 6 below.

Note setback on sloping site considered from edge of **minimum** basal area. Calculate and draw on diagram.

Note: Reduce effective basal area by area occupied by boulders, large stumps.

For **flat sites**, slope correction factor = 1 and all side slopes and widths are the same

**Notes for Pressure Distribution System Design**
**Mound pressure distribution system is designed per standard pressure distribution worksheet. Timed dosing is preferred. Ensure minimum dose volume of 5 x draining volume of network and frequency of minimum 4 x per day at design flow, preferred more often. Keep network full if frost is not an issue. Use orifice shields**

## Summary of mound dimensions

Bed length (**B**) = _________m

Bed width (**A**) = __________m

Overall mound length (**L**) = ___________m

Overall mound width (**W**) = ___________m

*Developed by Ian Ralston, TRAX Developments Ltd. BASED ON: Wisconsin Mound Soil Absorption System Siting Design and Construction Manual by Converse and Tyler , Jan. 2000 and Washington State Mound Systems Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance. REV. August 2007*

## Down slope and up slope correction factors

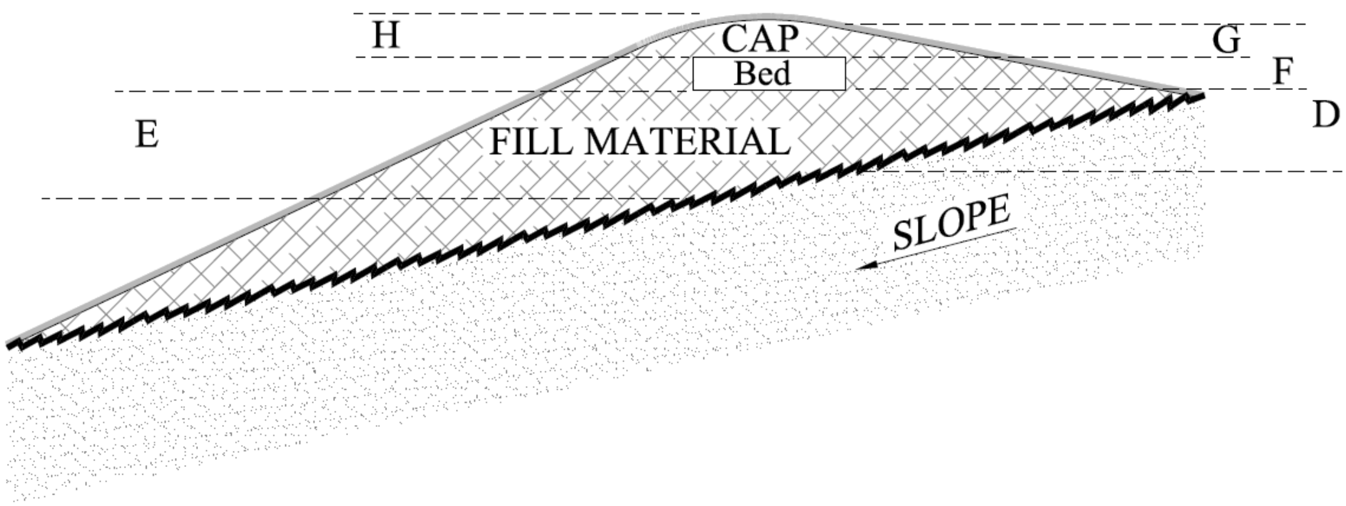
| Slope % | Down Slope Correction Factor | Up Slope Correction Factor |
|---|---|---|
| 0 | 1.00 | 1.00 |
| 1 | 1.03 | 0.97 |
| 2 | 1.06 | 0.94 |
| 3 | 1.10 | 0.92 |
| 4 | 1.14 | 0.89 |
| 5 | 1.18 | 0.88 |
| 6 | 1.22 | 0.85 |
| 7 | 1.27 | 0.83 |
| 8 | 1.32 | 0.80 |
| 9 | 1.38 | 0.79 |
| 10 | 1.44 | 0.77 |
| 11 | 1.51 | 0.75 |
| 12 | 1.57 | 0.73 |
| 13 | 1.64 | 0.72 |
| 14 | 1.72 | 0.71 |
| 15 | 1.82 | 0.69 |
| 16 | 1.92 | 0.68 |
| 17 | 2.04 | 0.66 |
| 18 | 2.17 | 0.65 |
| 19 | 2.33 | 0.64 |
| 20 | 2.50 | 0.62 |
| 21 | 2.70 | 0.61 |
| 22 | 2.94 | 0.60 |
| 23 | 3.23 | 0.59 |
| 24 | 3.57 | 0.58 |
| 25 | 4.00 | 0.5 |

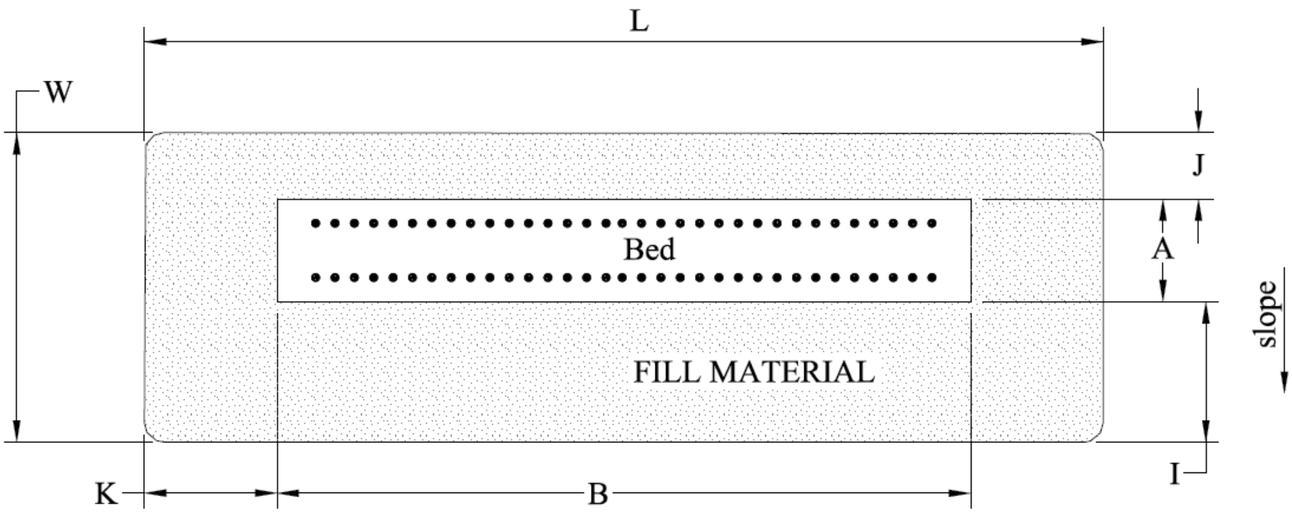
Based on *Wisconsin Mound Soil Absorption System Siting Design and Construction Manual by Converse and Tyler , Jan. 2000*

**Conversions:**

| US unit | X | = Metric Unit | X | = US Unit | X | = secondary unit |
|---|---|---|---|---|---|---|
| Gallons | 3.785412 | Litres | 0.264172 | Gallons | 0.8326738 | Imperial Gal. |
| | | | | Gallons | 0.1336806 | cu ft |
| | | Cu m | 35.31467 | cu ft | 7.480519 | gallons |
| GPD/sqft | 40.74648 | Lpd/sqm | 0.024542 | GPD/sqft | | |
| GPD/ft | 12.418 | Lpd/m | 0.080528 | GPD/ft | | |
| Sq ft | 0.0929 | Sq m | 10.76391 | Sq ft | | |
| Inches | 0.0254 | Meters | 39.36996 | Inches | | |
| Feet | 0.3048 | Meters | 3.28083 | Feet | | |

**Diagrams showing mound dimensions with letters as used in worksheet**




**Other dimensions:**

Side slope/upslope gradient of the sand mound, expressed as decimal **SS**

Downslope gradient of the sand mound, expressed as a decimal **SD**

**Setback, calculation of edge of required basal area on sloping site:**

Length from downslope edge of bed to edge required basal area.

= (Minimum basal area ***minus*** Bed Area) ÷ Bed Length

= ( ________$m^2$ – ________$m^2$ ) ÷ ______ m = ________ m

## Site Preparation and Construction

**Construction Procedures**—The following is a step by step procedure for mound system construction that has been tried and proven. If these procedures are followed, the potential for future problems should be minimized and the mound system should function properly. Other techniques may also work satisfactorily, but the basic principles of mound system design, construction and operation should not be violated.

1. Check the moisture content of the soil at 7-8 inches deep. If it is too wet, smearing and compaction will result, reducing the infiltration capacity of the soil. Soil moisture can be determined by rolling a soil sample between the hands. If it rolls into a wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. **If the site is too wet to prepare, do not proceed until the soil moisture decreases—THIS IS ESSENTIAL. Consider the receiving area as well as the mound area to ensure that there is no negative impact to the receiving area.**

2. Stake out the mound area on the site according to the system design, so the infiltration bed runs parallel to the contours. Reference stakes offset from the corner stakes are recommended in case corner stakes are disturbed during construction. If the site conditions do not allow for layout according to the approved design, contact the designer.

3. Measure the average ground elevation along the upslope edge of the bed or the upper trench and reference this to a benchmark for future use. This is necessary to determine the bottom elevation of the bed.

4. Determine where the pipe from the pump chamber connects to the distribution system in the filter media. The location and size of this transport pipe is determined from the pressure distribution guideline.

5. Trench and lay the effluent pipe from the pump chamber to the mound. Cut and cap the pipe one-foot beneath the ground surface. Lay pipe below frost line or sloping uniformly back to the pump chamber so that it drains after dosing.

6. Backfill and compact the soil around the pipe to prevent back seepage of effluent along pipe. This step must be done before plowing to avoid compaction and disturbance of the surface. Use Bentonite in trench if necessary.

7. Cut trees to ground level, remove excess vegetation by mowing. Rake cut vegetation if it is, or will become, matted. Prepare the site using a spring-loaded agricultural chisel plow and plowing parallel to contours. Note for sand or gravel soils, may wish to reduce disturbance in order to retain lower permeability surface layer, take care to avoid breakout and use surface layer for basal loading rate check.

If there is a compacted layer such as a plow pan consider deep ripping to remediate.

The function of this preparation is to provide a cleared ground surface with a series of vertical channels to enhance transfer of moisture from the sand fill to the original soil, while inhibiting lateral movement at the sand-soil interface. In addition the vertical furrows aid in stabilizing the sand at the sand-soil interface in an inter-locking fashion.

The site should be plowed using a spring loaded agricultural chisel plow, or other acceptable apparatus or method to prepare the soil before constructing the mound system. Shallow hand spading the surface is also an acceptable alternative and may be the preferred method on some sites. Rototilling is <u>not</u> an acceptable substitute and <u>should n</u>ot be done. Do not compact the infiltrative area.

The important point is that a rough, unsmeared surface should be left, especially in fine textured soils. Careful observation is required to assure that the soil moisture content is not so high that the soil surface is smeared by the action of the plow. Plowing should not proceed until the soil is sufficiently dry so as not to smear in the plowing process.

If stumps remain, care must be taken in preparing the site. The sod layer should be broken up, yet the topsoil should not be pulverized. The objective of this step is to break up any surface mat that could impede the vertical flow of liquid into the native soil.

Immediate construction after plowing is desirable. Avoid rutting and compaction of the plowed area by traffic. If it rains after the plowing is completed, wait until the soil dries out before continuing construction.

8. Reset the corner stakes, if necessary, using the offset reference stakes and locate the bed or trench areas by staking their boundaries. Extend the transport pipe from the pump chamber (which had previously been cut off) to several feet above the ground surface.

9. Install one or more standpipes (4 inch PVC with the bottom foot perforated, rebar and with gravel around the perforations). At least one must be in the downslope portion of the mound with the bottom at the original surface and the top extending above final grade where it can be capped. Another could be located in the bed extending only from the bottom of the bed to above the final grade. The standpipes allow observations to be made of the water levels. Slotting the caps will facilitate removing the caps to allow access.

10. Place the filter media that has been properly selected around the edge of the plowed area. Keep the wheels of trucks off plowed areas. Avoid traffic on the downslope side of the mound system. Work from the end and upslope sides. This will avoid compacting the soils on the downslope side, which, if compacted, would affect lateral movement away from the mound and possibly cause surface seepage at the toe of the mound.

11. Move the filter media into place using a small track-type tractor with a blade. Do not use a tractor/backhoe having rubber-tired wheels. Always keep a minimum of 6 inches of filter media beneath tracks to prevent compaction of the natural soil. Ensure placed sand is settled to a uniform density of approximately 1.3 to 1.4 g/cm3 (81.2 to 87.4 lb/ft3). Do not over compact the sand.

12. Place the filter media to the required depth, i.e., to the top of the bed. Shape sides to the desired slope.

13. With the blade of the tractor form the infiltration bed. Hand level the bottom of the bed to within ½ inch.

14. Place the pea gravel in the bed. Level the aggregate to the design depth. Ensure the side separation from bed to surface exposure will be obtained.

15. Place the distribution pipes, as determined from the pressure distribution guidelines, on the aggregate. Connect the manifold to the transport pipe. Slope the manifold to the transport pipe. Lay the laterals level, removing rises and dips.

16. Pressure test the distribution system for uniformity of flow.

17. Place 2 in. of aggregate (pea gravel) over the distribution pipe.

18. An approved geotextile material may be placed over the aggregate, however, increasing concerns of geotextile plugging with root mat have led to some practitioners discontinuing use of the fabric. If using no geotextile use a layer of C33 sand between the bed and the soil cap material, or a layer of birds eye gravel then a layer of C33.

19. Place the soil for the cap <u>and topsoil</u> on the top of the bed. This may be a subsoil or a topsoil. A depth after settling of 12 inches in the center and 6 inches at the outer edge of the bed is desired. This creates a slope that assists the surface run-off of precipitation. Also, this layer provides some frost protection. Do <u>not</u> drive over the top of the bed as the distribution system may be damaged. Use sandy loam, loamy sand soil, ensure oxygen can get in. If landscaping requires shallow slopes, ensure positive drainage from mound surface. With infiltrators installed as a single lateral (eg 36" wide) the soil cap may follow the upper curve of the infiltrator chamber, however, ensure the side vents are covered with C33 and that the bed to surface separation is adhered to.

20. Seed or sod the mound system.

21. Protect the receiving area for a minimum of 30' and preferably 50' downslope from the toe of the mound against disturbance and compaction, vegetate to enhance evapotranspiration in the area.

Diagrams based on *Washington State Mound Systems Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance (1999).*