NORTH DAKOTA
ENGINEERING PRACTICE PLANNING GUIDE
Vegetated Treatment Area

PRACTICE STANDARDS: 635 (Vegetated Treatment Area)

REFERENCES

In addition to Section IV of the Field Office Technical Guide, the following are recommended technical references for planning a Vegetated Treatment Area:

- USDA/NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 14, Water Management (Drainage). 2001.
- USDA/NRCS, National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook.1992, Last revised, June 1999.
- USDA/NRCS, National Engineering Handbook, Part 652, National Irrigation Guide. 1997.
- Koelsch, R., B. Kintzer, and D. Meyer. (ed.) 2006. Vegetated Treatment Systems for Open Lot Runoff - A Collaborative Report. USDA, NRCS. http://www.heartlandwq.iastate.edu/ManureManagement/AlternativeTech/Avtsguidance/
- Schmidt, D., Christopherson, S., Fryer, P., and Janni, K. (2005). Paper Number 054103, 2005 ASAE Annual Meeting. "Design Recommendations for Milkhouse Wastewater Treatment Systems."

RESOURCE INVENTORY CONSIDERATIONS

The site and management assessment will determine the physical site characteristics that may influence the placement, construction, maintenance, and environmental integrity of the vegetated treatment area. The assessment shall include input from the owner/operators. The following is a list of recommended items to assess onsite during the planning process.

General Items

- Resource Concern
    - Resource to be protected
    - Waste sources which may impact the resource
    - Pathways which the waste can research the resource

- Equipment
    - Current equipment, labor and management capabilities
    - Expected changes to current equipment, labor, management and equipment including expansion needs
- Site
    - Identify location of buildings, roads, lanes, soil investigation locations, property lines, easements, wells, surface water flow paths, surface drains, drain tiles, utilities, cultural resources, wetlands, etc.

    - Identify potential impacts from proposed system or component failure.
    - Contributing Areas
        - Surface types
        - Dimensions
        - Slopes
        - Soils
    - Floodprone Areas
        - 25-year floodplain

- Vegetated Treatment Area
    - Slope, size, shape, drainage
    - Soils

<u>Design Specific Items</u>

- Open Lot Runoff
    - Waste Characterization
        - Animal type, size and quantity
        - Feed type
        - Nutrients in the runoff shall be evaluated based on sampling the livestock lot runoff or on published values of nutrient concentration in runoff.
    - Animal Lot Management
        - Cleaning methods and frequency
        - Feeding locations and methods
        - Animal time on lot
    - Lot
        - Slope, size, shape, drainage pattern, surfacing
        - Feeding location
        - Equipment - access, cleaning, etc.

- Milking Center Waste
    - Waste Characterization
        - Daily waste production volume
        - Describe current system including waste milk disposal
        - Potential sources of manure and solids
            - Examples include: tracking from barn/parlor to milkhouse, boot washing, holding areas wash down, parlor floor wash down
        - Sources and fate of waste
            - Examples include: colostrum milk not fed, milk from antibiotic treated cows, milk remaining in the milk line, bulk tank drain down,
    - Water Conservation Practices (current of planned)
        - Examples include: well water pre-cooler, reusing of pipeline waste or sanitize water reused, air injected washing, booster pump for washing floors and walls.

    - Future Changes
        - Examples include: longer pipeline, larger diameter pipeline, increase number or size of bulk tanks, adding more milking units, less recycling of water, herd expansion, etc.

- Feed Storage Areas
    - Current feed harvested (crop type and volume harvested)
    - Current feed storage
        - Describe the system including size, floor material, walls, drainage, etc.
    - Future needs and plans

<u>Double Ring Infiltrometer Test Procedure</u>

The location should be representative of the VTA area. The soils should be naturally occurring fine or course-grained soils. If the soil is very pervious or impervious, or if the soil is dry and fractures when the rings are installed, results should be reviewed to ensure they are representative of the site.

The test consists of driving two cylinders into the soil, one inside the other, and partially filling the rings with water and maintaining that water at a constant level. The outer ring is used to promote one dimensional flow of water under the inner ring. The water added to maintain the constant level in the inner ring is measured at timed intervals and is then converted to an incremental infiltration velocity (i.e. inches per hour). The data is then plotted to develop a curve (time vs infiltration rate) which the NRCS intake family can be derived from.

<u>Equipment</u>

- Two concentric rings (12” and 24” diameter)
- Driving Cap
    - Tick hard alloy aluminum which fits over the rings
    - Wood piece 2”x4” or 4”x4”, 2-3’ long
- 12 lb. sledge hammer or mall
- Rubber mallet
- Level (carpenter of bull’s eye)
- 6 foot steel measuring tape
- Shovel and trenching spade
- 3" hand auger
- Water containers
    - Large container(s) for main water supply
    - 3 gallon pail for initial filling
    - Calibrated head tanks for measurement of water during test (graduated cylinders or Mariotte tubes with minimum capacity of 3000mL)
- Water
- Hose with float device
- Splashguard (burlap, rubber sheets, sponge, etc) enough material to cover the inner ring and the annular space between rings
- Evaporation barrier (either driving cap or other material large enough to place over the rings)
- Clippers for vegetation removal
- Water or Stopwatch for high infiltration soils
- Recording materials (paper, pencil, clipboard)

Procedure

1. Find a representative location in the proposed VTA area. The test site should be a minimum of 10' X 10' and accessible by a truck if necessary (if a large water source is used, such as a 55 gallon barrel).

2. Protection from sunlight and temperature variations may be necessary, especially for tests lasting longer than a few hours, or those using Mariotte tubes.

3. Driving the Rings
    a. Place the outer ring on the soil surface, place the driving cap on the outer ring then place the wood block on the driving cap.
    b. Drive the outer ring in the soil by hitting the wood block with the sledge hammer to a depth that will prevent the water from leaking to the ground surface and is deeper than the inner ring, typically a depth of 6" is adequate. Use medium force when hitting the driving cap to prevent the soil from fracturing. If applicable, move the wood block around the ring every couple of hits to obtain uniform penetration in the soil.
    c. Center the smaller ring in the larger ring and drive to a depth that will prevent water from leaking at the ground surface, typically 2-4" is adequate. Use the same method as described for the outer ring.
    d. If extensive disturbance occurs during the process (extensive cracking, heaving, etc) reset the rings in another representative location. Modification to the installation process may be necessary (lighter blows, etc).
    e. If slight disturbance occurs tamp the disturbed soil adjacent to the inside and outside of the rings until soil regains the original appearance.
    f. Clip any vegetation that will affect measuring or free movement of the float. Ensure the soil is not disturbed when clipping vegetation.

4. Install the calibrated head tank (refer to the instruction manual for the tank if applicable)
    a. Place the tank so the reference head will be between 1"minimum to 6" maximum. Heads near the maximum range (6") are required for lower permeable soils.
    b. Place the tube from the tank in the inner ring.

5. Initial Filling
    a. If there is a potential for erosion to occur, place the splash guards in the center of the inner ring and in the annular space between rings during the initial filling.
    b. Connect the hose to the water supply container and the float valve. Place the float valve inside the outer ring at the desired depth. Allow water to flow into the outer ring.
    c. Use a pail to fill the inner ring with water to the desired depth.
    d. Do NOT record this initial volume of water.
    e. Remove the slash guards.

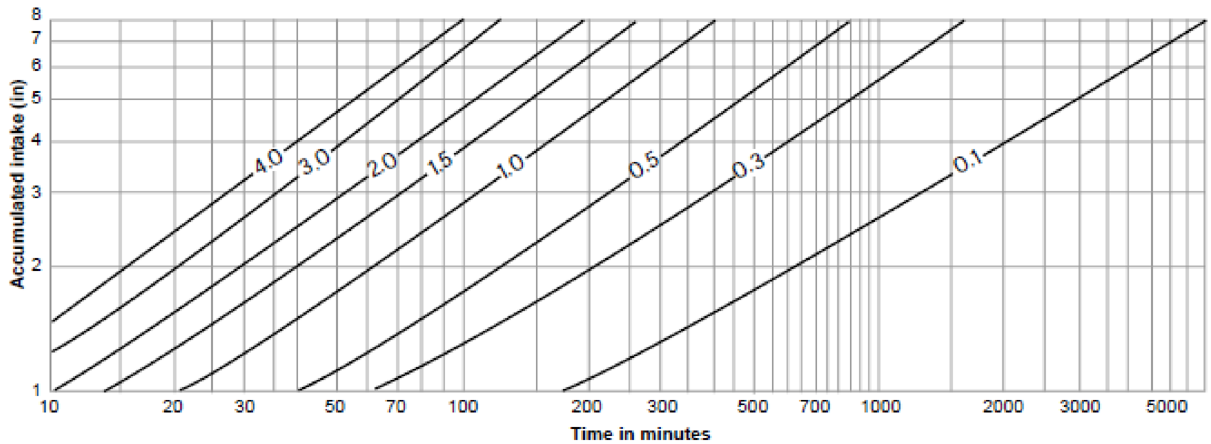
6. Maintain the Water Level
    a. Start the flow of water from the calibrated head tank.
    b. Once the water becomes constant determine the fluid depth in the inner ring.
        i. Measure the depth to the nearest 1/16 of an inch in the inner ring and in the annular space between rings.
            1. If the depths between the inner ring and the annual space vary more than ¼ inch raise the constant level float valve (if used), or the calibrated head tank if possible.
    c. Maintain the water level in the inner ring and annular space between the rings as near as possible throughout the test to prevent flow of water from one ring to the other.

7. Recording
    a. Record the volume of water that is added to maintain a constant head in the inner ring and annular space during each timing interval by measuring the change in elevation of water in the calibrated head tank. (may consider placing painters tape on the constant head device and marking the water level at each time interval.)
        i. Average soils record at 15 minute intervals for the first hour and 30 minute intervals for the second hour, and 60 minute intervals for the remainder of the period of at least 6 hours or until a relatively constant rate is obtained.
        ii. High permeability soils may require more frequent readings.
        iii. The volume of water used during any one reading interval should not be less than approximately 25 cubic centimeters.
    b. Place the driving cap or other material over the rings between measuring intervals to prevent evaporation.
    c. The following information should be recorded:
        i. Location of test site, date of test, start time and end time, weather conditions at start and finish, name of tester(s), description of test site, description of the equipment used, depth to water table, description of soils.
        ii. Area of rings
        iii. Annular space between the rings (nearest 1 cm2 or better)
        iv. Volume constants for calibrated head tanks (nearest 0.01cm3 or better)
        v. Depth of liquid in inner ring and annular space (nearest 2mm or better)
        vi. Incremental infiltration velocities (recorded to 3 significant digits) for the inner ring and the annular space.

8. When finished with the test remove the rings from the soil. Light hammering with a rubber mallet may be necessary on the sides of the rings.

9. Plot data from the intake test on the Intake Curve (from NEH Part 652 Chapter 9, Figure 9-36). Select the intake family that best represents the plotted curve within the normal irrigation range.

Intake curve



Additional Resources

ASTM D3385-09 "Standard Test Method for infiltration rate of Soils in Field Using Double-Ring Infiltrometer"

"Using a Double Ring Infiltrometer for Soils" YouTube Video found at: https://www.youtube.com/watch?v=YawF0W8PBA0

DEVELOPING AND EVALUATING ALTERNATIVES – OPEN LOT RUNOFF

1. Review the definition, purpose, and conditions where practice applies in the VTA standard. Compare with the identified resource concern. Proceed with the preliminary design if applicable.

2. Complete a site and management assessment along with a topography survey in adequate detail for preliminary siting and sizing of a VTA and estimating quantities. As with all preliminary computational work, input data may be refined in the final design so figures in the +/-20% range are acceptable for planning.

3. If the area is in a flood prone area, gather enough data to approximate the floodplain area.

4. Determine if the farm fits the definition of a small, medium, or large AFO.
    a. Small farms that meet the criteria in the 635 Standard part IV.B. shall reference the Filter Strip standard (Code 393) for the sizing of the VTA, which includes a RUSLE2 evaluation.

5. Roughly determine the size of the drainage area using a topographic map, LIDAR data, survey measurements in the field, or the current tool for watershed area in ArcMap. Determine the average watershed slope using the same data source.

6. Determine if a sediment basin will be used, per the requirements in the VTA standard. If a settling basin is needed refer to practice 350-Sediment Basin for design criteria.

7. Compute an estimated 25-year frequency, 24-hour duration storm peak flow, Runoff Curve Number, and Time of Concentration using an appropriate methodology such as EFH-2.

8. Compute data for any reaches (i.e. sediment basin, ditch from lot to VTA, etc) which may include the drainage area, curve number, time of concentration, stage storage, peak flow from culverts, etc. as appropriate.

9. Use TR-20 to determine the hydrograph for runoff that will enter the VTA. Compare the peak flow from TR-20 to the peak flow from the method used above (i.e. EFH-2), ensure the comparison is reasonable.

10. Complete soil investigations to characterize the soil in the proposed VTA site and ensure separation distance to seasonal high water table can be achieved.

11. Verify the intake family in the field using the Double Ring Infiltrometer Test Procedure, as described above.

12. Use SRFR to determine the flow through the soil profile and size the VTA based on the water balance.

13. Use one of the three methods from Chapter 6 of *Vegetative Treatment Systems for Open Lot Runoff – A Collaborative Report* to calculate the minimum size of the VTA based on nutrient balance.

14. Determine the minimum size of the VTA by comparing the water balance size to the nutrient balance size. Use the larger of the two sizes to determine the VTA size.

15. Work with a planner who has an adequate Vegetative Practice Proficiency Level to develop a vegetative mix for the VTA and other disturbed areas.

16. If additional support practices are needed, complete preliminary computations as necessary to confirm feasibility and to complete quantity estimates for the entire project.

17. Develop a plan view, cross-sections, profiles, and details as necessary to clearly communicate the preliminary plan with the landowner. The plan view should show sufficient detail including layout of the lot, VTA, delivery of the runoff to the VTA and associated practices (i.e. sediment basin, culverts, channels, etc). Show livestock and vehicle exclusion areas on the plan view.

18. Prior to sharing engineering alternatives with the producer, determine the engineering job approval authority for the practices involved. If you do not have adequate Planning (I&E) JAA for the practices, have your work reviewed by another individual in the NRCS who does to make sure you have correctly evaluated all of the options and determined feasible and implementable alternatives. At the point those are presented to a producer, the planner is making a commitment on behalf of the agency that we have provided technically sound, implementable engineering plans.

MILKING CENTER WASTE AND FEED STORAGE CONTAMINATED RUNOFF SYSTEMS

Involve the State Agricultural Engineer in milking center waste and feed storage contaminated runoff VTA projects. The State Agricultural Engineer can assist in the planning, design, and evaluation of VTA systems.

ASSISTING THE PRODUCER TO MAKE AN INFORMED DECISION

1. Put together some example detail drawings, photos, and/or portions of construction specifications that would be similar to the proposed project. Explaining exactly what following NRCS standards means in relation to construction of a particular project is very important, and anything you can use to communicate those to the producer is very helpful.

2. Estimate actual construction costs for the project, based on your knowledge of similar past projects (consult with other individuals as necessary). Calculate expected cost share, if planning is being done in conjunction with a program application.

3. Meet with the producer, and go through feasible alternatives discussing factors that will be important to them in their decision: installation requirements, initial investment, impacts on farming operations, lifespan, and maintenance needs. Encourage them to talk with potential contractors at this point, and offer your assistance to estimate their potential costs.

4. In the case of a program application, it is important that producers understand exactly how implementation would proceed and what restrictions they will operate under. Ensure they understand used materials are not acceptable, no construction may proceed until they have received final design drawings and specifications, and NRCS will be onsite during construction to ensure compliance with the design.

5. Provide adequate time for the producer to make an informed decision. If they don't have time to meet to discuss alternatives, they likely haven't had time to adequately complete a good decision making process resulting commitment to implement the plan. Offer and be willing to defer an application, to allow time for a quality planning process and good decision making on the part of the producer.

Provide documentation of above steps in the conservation plan narrative, assistance notes, and/or in separate documentation in Part 5 of the plan folder. Job class for each practice involved, and the approving individual for planning work, needs to be included.