AS-1258

Instructions for Use of Fly Ash to Stabilize Soil in Livestock Facilities

Livestock production in the northern states is plagued by muddy, wet conditions during spring thaw and summer rainfall events. Animals in muddy feed yards have been observed to exhibit up to 30% reduction in growth rate and feed efficiency compared to animals in dry pens. Health challenges such as scours and pneumonia in young calves and foot rot in older animals can also be problematic in wet and muddy conditions. Stabilization with coal combustion fly ash can improve these conditions.

The ash-modified soil in the right pen provides improved drainage and stability, while wet, muddy conditions are evident in the untreated area (left).

Vern Anderson, Tera Buckley,
Debra Pflughoeft-Hassett and Andrew Stewart

Economics

The traditional feedlot or livestock pen material, consisting of packed soil, offers the most economical first cost; however, this method results in muddy pens during spring thaw and summer rainfall events. The loss of productive weight gain by animals housed in muddy pens far overshadows the low initial cost. A fully paved feedlot consisting of either concrete or asphalt carries a large capital investment, with high material and construction costs. A stabilized feedlot surface constructed with a mixture of soil and 15%–25% coal combustion fly ash offers the feedlot operator the benefits of a very stable surface and relatively low material and construction costs, with the price of fly ash well below that of traditional construction materials such as asphalt, cement, or lime. Construction of the pen surface with equipment commonly found on any farm or ranch also offers significant cost savings.

Keys to Successful Placement

- Optimum soil type of clay or clay/loam with minimal sand or gravel
- Uniform distribution of fly ash within the soil blend
- Proper compaction and thorough mixing
- Adequate moisture content
- Final compaction within 2 hours

Proper Siting of Feedlot Operations

North Dakota Department of Health (NDDH) criteria for siting feedlots are outlined in the North Dakota Administrative Code Section 33-16-03-04. Feedlots are required to abide by the Clean Waters Act, which prohibits discharging pollutants into waters of the state. The North Dakota State University Extension Service addresses feedlot-siting regulations and issues in “Beef Feeding Operation Siting and Design Basics,” NM-1155, October 2006.

UND University of North Dakota Grand Forks
EERC Energy & Environmental Research Center
NDSU North Dakota State University
ND Agricultural Experiment Station
Carrington Research Extension Center

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Planning for Fly Ash Stabilization

Fly ash placement, spillage, or disposal close to homes, wells, sources of water, or environmentally sensitive areas or improper use may raise health or environmental concerns. Construction with or placement of fly ash must be in accordance with local zoning authority or any other requirements of any political subdivision of the state. As noted in the NDDH Animal-Feeding Operation Program, environmentally sensitive locations, including areas near wetlands, drainageways, and steep slopes; areas with a high water table; areas close to water wells; and areas with highly permeable, coarse-textured (sand or gravel) soils, must be avoided. Sites should be nearly level to gently rolling and underlain with fine- to medium-textured soils, with a depth to groundwater or seasonally high water table greater than 3 feet. NDDH reserves the right to require appropriate modifications in use, application, siting, or construction, as deemed necessary.

Placement Procedure

Step 1 – Determine the Quantity of Fly Ash Required

- **Quick Method for In-Pen Ash Volumes**
  For in-pen placement, a general rule is to use 1 ton of fly ash for every 30 x 10 feet pen at a depth of 6 inches.
- **Detailed Method for In-Pen Ash Volumes**
  To determine the amount of fly ash required for a given area, determine volume of soil in the pen.

  Volume of soil is calculated as length x width x depth.
  Example: 100 feet long x 60 feet wide x 6 inches deep = 100 x 60 x .5 = 3000 cubic feet

  Divide cubic feet by 27 to get cubic yards.
  Example: 3000 cubic feet/27=111 cubic yards

  At 20% fly ash addition, multiply 20% by the number of cubic yards.
  Example: 111 cubic yards x .20 = 22.22 cubic yards
- **Quick Method for Outside-Pen Ash Volumes**
  When mixing fly ash with soil outside of the pen for in-pen placement, a general rule is to place 4 bucket loads of soil to 1 bucket load of fly ash.
- **Detailed Method for Outside-Pen Ash Volumes**
  When mixing fly ash with soil outside of the pen for in-pen placement, a more precise calculation can be made by determining the volume of the soil configuration (length x width x depth) and incorporating 20% of the soil volume as fly ash.
  Example: 100 feet long x 5 feet wide x 6 inches deep = 100 x 6 x .5 = 300 cubic feet
  300 cubic feet/27 = 11.11 cubic yards
  11.11 cubic yards x .20 = 2.22 cubic yards

Step 2 – Arrange for Ash Transport from the Power Plant

- Contact one of the power plants below to arrange for pickup.

Great River Energy
Coal Creek Station
Underwood, ND
Stanton Station
Stanton, ND
Contact: Mr. Dan Doschadis
ISG Resources/Headwaters
Phone: 701-371-6463

Otter Tail Power Company
Hoot Lake Station
Fergus Falls, MN
Contact: Jeff Olson
Phone: 218-739-8110
Coyote Station
Beulah, ND
Contact: Lowell Korbyn
Phone: 701-873-7511

- A material safety data sheet (MSDS) may be obtained for the material from the power plant. As noted in the MSDS for fly ash, appropriate measures to minimize dust generation and interaction of run-on and runoff water with fly ash during transportation, application, and incorporation should be taken. Material safety and health issues are also addressed by the by-product MSDSs, including the protection of workers, nearby residents, and animals from excessive dust, prolonged skin exposure, and direct contact with runoff. Respiratory protection as well as skin protection measures (long-sleeve shirts, pants, etc.) for users/workers must be addressed.
- Lined and covered bottom-dump grain trucks work well for transport and placement. Pneumatic trucks may be used only with gravity placement to prevent dusting at the time of placement.

- Transportation and storage equipment must be loaded, moved, maintained, and covered so the contents will not fall, leak, or spill and to keep the fly ash dry prior to use. Should spillage occur, the collector or transporter must return spilled material to the vehicle or container.

Step 3 – Placement at the Site

- Remove all organic material, such as topsoil or manure, from the area.
- If the existing soil is wet and clumpy, it is likely that no water addition will be required. If the existing soil is dry, water can be added after the fly ash has been incorporated into the disced material; however, additional passes with the mixing equipment will be required to achieve uniform mixing. A typical garden sprinkler works well to achieve uniform distribution of water.

Option 1: In-Pen Mixing and Placement

- Break up the soil with a rototiller or similar type of equipment. It is recommended the soil be in a loose and moist condition prior to application of the fly ash. Controlled amounts of water may need to be sprayed during incorporation to minimize dust.
- Spread fly ash evenly over the loose material in even truck widths. Running the truck over the area with the bottom gates partially opened accomplishes this very well.
- Mix the fly ash and soil with a set of discs pulled by a tractor or with rototiller-type equipment. The material should "roll" off of the disc when it is adequately mixed; this normally requires three to four passes with the disc or rototiller.

Option 2: External Mixing and In-Pen Placement

- The pen surface should be loosened slightly.
- A windrow of soil adequate for a 6 inch lift to cover the pen should be laid down evenly outside of the pen.
- The appropriate quantity of ash should be placed on top of the soil.
- The ash and soil should be mixed using a rototiller, front-end loader, disc, or other appropriate equipment.

- The mixtures should be moistened as necessary.
- The mixture is then placed in the pen and spread evenly.

Step 4 – Compaction and Curing

Options 1 and 2 require the remaining steps.

- Compaction of the blended mixture should be accomplished as soon as possible following the final pass of the mixing equipment to achieve maximum stabilization. This is best accomplished with a sheepsfoot roller or the tires of the placement equipment.
- After all of the material is placed, the stabilized site should be maintained in a moist condition for approximately 5 days. This can be accomplished through periodic application of water to the surface of the site. After this watering period, the site should not be used for an additional week.

Postplacement Issues

- Manure removed from fly ash-amended pens can be spread on cropland according to current nutrient management guidelines.
- Fly ash-amended soils should provide an improved feedlot surface for several years, but if patching or resurfacing are required, follow the same protocol for Option 2, making sure an appropriate mixture of soil and fly ash is used.
- If or when a feedlot is to be converted to another use, the site may need to be reworked, deeply tilled, ripped, amended, etc., to loosen and restore the soil. The area may require placement of top soil for complete restoration.

Weather Concerns

- Cooler temperatures affect soil blending and compaction, and multiple passes of the mixing and roller equipment may be required to achieve adequate distribution and compaction. Effective stabilization can be accomplished as long as the soil temperature is above 0°C (32°F) and soil blending and compaction are modified to achieve proper mixing and compaction of the stabilized section.
- Placement should be avoided during periods of high winds and rainfall events.

Information presented is the result of a joint project of the University of North Dakota Energy & Environmental Research Center (EERC), the North Dakota State University Carrington Research Extension Center (CREC), and Power Products Engineering, Inc. (PPE). EERC researchers were Debra Pflughoeft-Hassett, Loreal Heebink, Bruce Dockter, David Hassett, Tera Buckley, and Jaroslav Solc. CREC researchers were Vern Anderson and Scott Birchall. The PPE researcher was Andrew Stewart. EERC, CREC, and PPE gratefully acknowledge the support of Great River Energy, Otter Tail Power Company, the North Dakota Industrial Commission, the North Dakota State Board of Agricultural Research and Education, the North Dakota Department of Agriculture, and the U.S. Department of Energy National Energy Technology Laboratory (NETL).

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Guidance and Assistance

- Guidance on proper siting of feedlots is available from NDDH and the NDSU Extension Service. If the material is mismanaged or used in an unapproved manner, the user is subject to North Dakota Century Code Section 23-29 and North Dakota Administrative Code Article 33-20 of the North Dakota Solid Waste Management Rules.
- Contact your local county extension agent for placement assistance.

Provisions for Use

- Fly ash from Great River Energy's Coal Creek and Stanton Stations and Otter Tail Power Company's Coyote and Hoot Lake Stations is NDDH approved for use.
- The above four fly ashes are approved for use within pen areas at NDDH-permitted feedlot facilities. Usage at other feedlot facilities may be allowed based on site condition and adequate environmental controls. To determine the appropriateness for use in your facility, contact your local county extension agent.
- Fly ash is a light, fine, powdery substance, and handling is similar to cement powder. People working with fly ash should wear appropriate masks for breathing and eye protection to minimize irritation. Vehicles may require more frequent air cleaner maintenance when working in a dusty environment.
- Excess material should be returned to the supplier. Materials spilled during placement should be incorporated into the feedlot pens or placed in an NDDH-permitted municipal solid waste, industrial, or special solid waste landfill.

For additional information contact:

Dr. Vern Anderson
North Dakota State University Carrington
Research Extension Center
PO Box 219
Carrington, ND 58421-0219
Phone: 701-652-2951
E-Mail: vern.anderson@ndsu.edu

Ms. Debra Pflughoeft-Hassett
University of North Dakota Energy & Environmental
Research Center
PO Box 9018
Grand Forks, ND 58202-9018
Phone: 701-777-5261
E-Mail: dphassett@undeerc.org

Visit www.ag.ndsu.nodak.edu/ctyweb.htm for a list of North Dakota county extension offices.