*Energy & Environmental Research Center*

# DEMONSTRATION OF UTILITY AND INDUSTRIAL BYPRODUCTS FOR FEEDLOT SURFACES

EERC Proposal No. 99-0104-R1

*Submitted to:*

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# DEMONSTRATION OF UTILITY AND INDUSTRIAL BYPRODUCTS FOR FEEDLOT SURFACES

## ABSTRACT

The University of North Dakota Energy & Environmental Research Center (EERC), North Dakota State University (NDSU) Carrington Research Extension Center (CREC), and NDSU Agricultural & Biosystems Engineering Department propose to work with North Dakota utilities, the Industrial Commission of North Dakota, and the U.S. Department of Energy to demonstrate the use of utility and industrial byproducts for surfacing feedlots. These byproducts will include primarily North Dakota lignite and western coal ash. Byproduct lime may also be used.

Livestock producers in North Dakota are seeking a low-cost alternative to placing concrete in feedlots. Working closely with the North Dakota Department of Health (NDDH), the EERC proposes to demonstrate up to six different surface types at the NDSU CREC bison research facility.

Sufficient evidence exists to suggest that using coal ash can lead to significant improvements in pen and laneway conditions, and work performed at the EERC indicates that several regional ashes are appropriate for use in feedlot surfacing, either in constructing a concrete-like surface or in stabilizing the existing soils.

Surface treatments developed will be placed in field settings in Years 1 and 2 of the project. Environmental and engineering performance of the field sites will be monitored, and an economic evaluation will be performed. With assistance from the NDSU Extension Service, North Dakota feedlot operators will be made aware of the options identified for feedlot surfaces using ash in prescribed applications.

# DEMONSTRATION OF UTILITY AND INDUSTRIAL BYPRODUCTS FOR FEEDLOT SURFACES

## 1.0 PROJECT SUMMARY

Livestock producers in North Dakota are seeking a low-cost alternative to placing concrete in feedlots. With some limited use of concrete, the in situ soil usually serves as the surface in feedlot pens and laneways. However, this situation commonly results in reduced animal performance and health such as poor or low weight gain, as well as increased odor generation. Both the operation of the feedlot and the user's capacity for environmental stewardship will be improved by using a durable surface in areas subjected to stock and/or vehicular traffic.

A joint effort of several entities is proposed to demonstrate the use of ash for surfacing of feedlots. Criteria evaluated in the demonstration will include engineering performance, environmental performance, and economics of the materials and placement techniques. The participants in this effort are the University of North Dakota (UND) Energy & Environmental Research Center (EERC), the North Dakota State University (NDSU) Carrington Research Extension Center (CREC), the NDSU Agricultural & Biosystems Engineering Department, and several North Dakota utilities and ash marketers. The university-based participants will be responsible for the development, placement, and performance evaluation of the feedlot surfaces. The industrial partners are providing funding and ash for the demonstration. The participants will also be working closely with the North Dakota Department of Health to determine if and/or what environmental performance testing is needed. The EERC is requesting support from American Crystal Sugar and other industrial partners as matching funds provided by NDIC. Further funding will be requested from the U.S. Department of Energy (DOE) Jointly Sponsored Research Program (JSRP) at the EERC.

The primary goal of the proposed effort is to demonstrate the placement, engineering performance, and environmental performance of ash for feedlot surfaces. It is proposed to demonstrate up to six different surface types at the NDSU CREC bison research facility. It is anticipated that some of the surfaces will have properties similar to concrete for use in the feeding/watering areas. Other surfaces will be designed to provide a softer, more soil-like surface that provides drainage and support for cleaning equipment. Feed-roads will also be surfaced with lignite bottom ash.

The proposed 3-year effort will include the following activities:

**Year 1**

- Laboratory development and testing
- Field placement of ash surfaces at the bison research facility at CREC
- Pre- and postplacement groundwater and runoff monitoring
- Engineering monitoring of the placed surfaces
- Economic evaluation of the ash-based surfaces
- Development of standard feedlot surface mixtures and placement techniques that can be applied to ash, including ash from lignite and other coal sources.
- Collecting material for a video and publication outlining ash utilization in feedlots

**Year 2**

- Field placement of two to three ash surfaces at commercial feedlots
- Continued postplacement groundwater and runoff monitoring at CREC site
- Engineering monitoring of the placed surfaces
- Field day on CREC site

### Year 3

- Continued postplacement groundwater and runoff monitoring at CREC site
- Engineering monitoring of the placed surfaces
- Field days on commercial demonstration sites

The cost of this project will be approximately $531,290. Year 1 costs are approximately $225,900. Year 2 costs are approximately $193,200. Year 3 costs are approximately $112,190. Funding for this project is anticipated from several sources: utility and marketing companies, the Industrial Commission of North Dakota, and the EERC–DOE JSRP.

## 2.0 BACKGROUND

There is a significant level of interest from livestock producers in North Dakota and surrounding states in the use of ash for soil stabilization. The majority of the state's 12,000 beef producers and 800 dairy producers have at least some drylot areas subject to concentrated traffic by livestock. Earthen pens and laneways do not withstand this pressure—particularly when wet for any length of time such as during spring thaw. As the integrity of the pen or laneway's surface breaks down, deep mud and poor drainage reduce animal performance and health (as indicated by poor weight gain), increase odor emissions, and prevent regular maintenance operations such as manure removal. Commonly, the soil–manure interface layer is damaged, resulting in deeper leaching of nutrients and an increased risk of groundwater pollution.

Feedlot cattle suffer reduced weight gain as a result of muddy pen conditions. In just 6 weeks of muddy conditions, this hidden cost may penalize producers by $11/head. Research at Texas A&M identified a 14% decrease in weight gain when the animal was coping with 4 to 6 inches of mud. When the mud depth was 24 inches, the decrease in weight gain was 25% (1).

Improving pen drainage will also reduce odor emissions. Sweeten (1) found that wet manure on the pen surface produced from 25 to 100 times greater odor concentration/intensity compared to a dry surface. A more durable pen surface would allow for more frequent manure removal, reducing the risk of having a significant depth of manure accumulated when rain occurs. A durable pen surface would also promote better drainage of runoff from the pens by limiting the formation of holes and low spots.

Researchers at Texas A&M University placed two types of ash (crushed ash and hopper ash) into feedlot pens in 1993. Pen conditions were evaluated visually for 2 years following placement. The crushed ash treatment proved superior to the control (earthen surface) for all four thicknesses tried. Crushed ash at 6- and 8-inch depths performed better than other treatments (although there was little difference between the two thicknesses). The hopper ash treatment (tilled into fill) deteriorated at areas of high pressure – feed bunks and water troughs (1).

In 1993, fluidized-bed combustor (FBC) ash was used to stabilize soil in a feedlot in Iowa (2). The study compared FBC-stabilized soil with nonstabilized soil by measuring strength, ability to withstand immersion in water, freeze–thaw resistance, and cone index. The results indicated that treated soil had greater strength than untreated soil, with one exception. (Air-dried cylinders of soil underwent an unconfined compression test, with the untreated sample exhibiting greater strength. The authors suggest that this anomaly is due to the high organic matter content in the soil). Three freeze–thaw cycles reduced the compression strength of all samples. Treated samples were better able to withstand immersion in water. The feedlot pen treatments were completed using machinery normally available locally at a cost of $\$0.23/ft^2$ (the fly ash was provided free of charge).

Another Iowa project was the subject of an ash-marketing bulletin (3). The ash marketer combined reclaimed Class C fly ash, with the consistency of aggregate, with fresh Class C fly ash

and placed the mixture directly on the surface of the feedlots. The combined material was conditioned with water, disked, and compacted to provide a dry solid platform for the feedlot. Two months of monitoring indicated good performance.

An Ohio feedlot project initiated in 1992 used lime-enriched flue gas desulfurization (FGD) material to construct both livestock pads and hay storage pads (4, 5). Placement activities varied, but in many cases, farmers were able to place the material using their own standard equipment. The demonstrations have been highly successful, and in 1997, 24 commercial pads were constructed after American Electric Power, the FGD producer, received a permit-to-install from the Ohio Environmental Protection Agency (EPA). Farmers are not required to obtain any further authorization to install pads covered by the Ohio EPA permit. The cost of the FGD pads is estimated to be 25% to 65% less expensive than that of concrete or stone aggregate.

Stout (6) investigated the use of FBC ash on an experimental dairy farm in Pennsylvania. Monitoring of heavy metal levels in the leachate under the pavement indicated these parameters were at or below acceptable levels.

Sufficient evidence exists to suggest that using coal ash can lead to significant improvements in pen and laneway conditions. Work performed at the EERC indicates that several regional ashes are appropriate for use in feedlot surfacing, either in constructing a concrete-like surface or in stabilizing the existing soils (7–9). The proposed effort will use ash from industrial partners to develop appropriate feedlot surfaces in a preliminary laboratory phase. Previous work referenced in this proposal will provide a basis for the development phase. Surface treatments developed will be placed in field settings in Years 1 and 2 of the project. Environmental and engineering performance of the field sites will be evaluated, and an economic evaluation will be performed. With assistance

from the NDSU Extension Service, North Dakota feedlot operators will be made aware of the options identified for feedlot surfaces using ash in prescribed applications.

## 3.0 PROJECT DESCRIPTION

### 3.1 Introduction

In 1998, the NDSU CREC began construction of feedlot facilities to hold 160 bison. The infrastructure will include 16 separate pens with feeding/watering areas. At this stage, most of the earthworks have been completed and include pens with a 4% slope, solids separation drains, and runoff storage ponds. Groundwater monitoring wells (five locations × three depths) have been installed, but data collection has not yet begun.

The CREC bison research facility presents an opportunity to develop the use of ash as a feedlot-surfacing material taking advantage of public information from similar demonstrations throughout the United States. The site has not previously been used for feeding livestock and would be suitable for any monitoring necessary. The CREC is highly visible to the public, and field days and educational seminars/courses are planned throughout the project duration, so the ash surfaces will be available for potential users to visit and visually inspect throughout the project and beyond.

Additionally, a number of producers have expressed an interest in this project and would be willing to try ash in their operations. Collection of research data from these participants may be more difficult, but the data would encompass a number of different soil types.

### 3.2 Goals and Objectives

The primary goal of the proposed effort is to demonstrate the use of ash in feedlot surfacing. Supporting objectives include:

- Develop durable, easy-to-place ash feedlot surfaces

- Demonstrate placement techniques using conventional farm equipment where possible
- Monitor engineering performance of the feedlot surfaces
- Monitor environmental performance of the feedlot surfaces
- Perform an economic evaluation of the various surfaces demonstrated
- Produce a "how to" manual for use of the various ashes and placement methods
- Report all information to North Dakota feedlot operators

## 3.3 Methodology

The proposed effort will be performed over 3 years. The highest level of effort is planned for Year 1, and the lowest level of effort is planned for Year 3. Several tasks will be performed in each project year. These tasks are detailed below.

### *Year 1*

*Task 1: Laboratory Development and Field Placement* – EERC research staff will work with NDSU CREC staff and evaluate collected literature to determine the engineering properties required for the feedlot surfaces required. Ash characteristics will be assembled from a previous NDIC study (7), from industrial partners, and added testing under this effort as needed. Additional literature will be obtained if necessary. Laboratory-scale products simulating the feedlot surfaces will be constructed and tested using standard techniques. These simulated products will take advantage of moisture conditioning, combining materials, compaction, and other techniques noted in the literature to produce candidate surfaces. The surfaces will be evaluated for strength development, permeability, freeze–thaw durability, erosion susceptibility, and other tests deemed appropriate. Standard test methods will be used where appropriate. Up to six surface treatments will be selected for placement at the Year 1 field site.

In Year 1, the ash feedlot surface treatments identified in Task 1 will be placed at the bison research facility at NDSU CREC. A diagram of the facility is shown in Figure 1. The facility includes the sloped feedlot area (16 pens, each pen 60 × 70 ft), feeding/watering areas, runoff collection systems, feed and work alleys, and groundwater monitoring wells. One series of four pens has been partly surfaced with concrete in the feeding/watering areas. This series of pens will serve as a project control for various performance criteria. Ash will be shipped to the site. Conventional farm tractors and equipment will be used to place the surfaces. CREC staff will perform the on-site materials handling with direction from EERC research staff and a consulting engineer with experience placing ash in full-scale applications.

*Task 2: Environmental Monitoring* – With input from the North Dakota Department of Health (NDDH), an environmental monitoring plan will be developed early in Year 1. Background leaching data will be collected from various sources, and additional leaching information will be generated if needed. It is anticipated that the monitoring plan will include sampling of both groundwater and runoff. The parameters for evaluation will be determined with assistance from the NDDH. The monitoring wells and runoff collection systems are indicated in Figure 1. It is proposed to collect and analyze two sets of background samples from the site prior to placement of the ash surfaces.

*Task 3: Performance Monitoring* – The engineering performance of the placed surfaces will be monitored both by observation by CREC staff during daily activities at the bison research facility and by periodic testing and evaluation on-site by EERC researchers and the consulting engineer. The engineering performance monitoring will continue throughout the duration of the

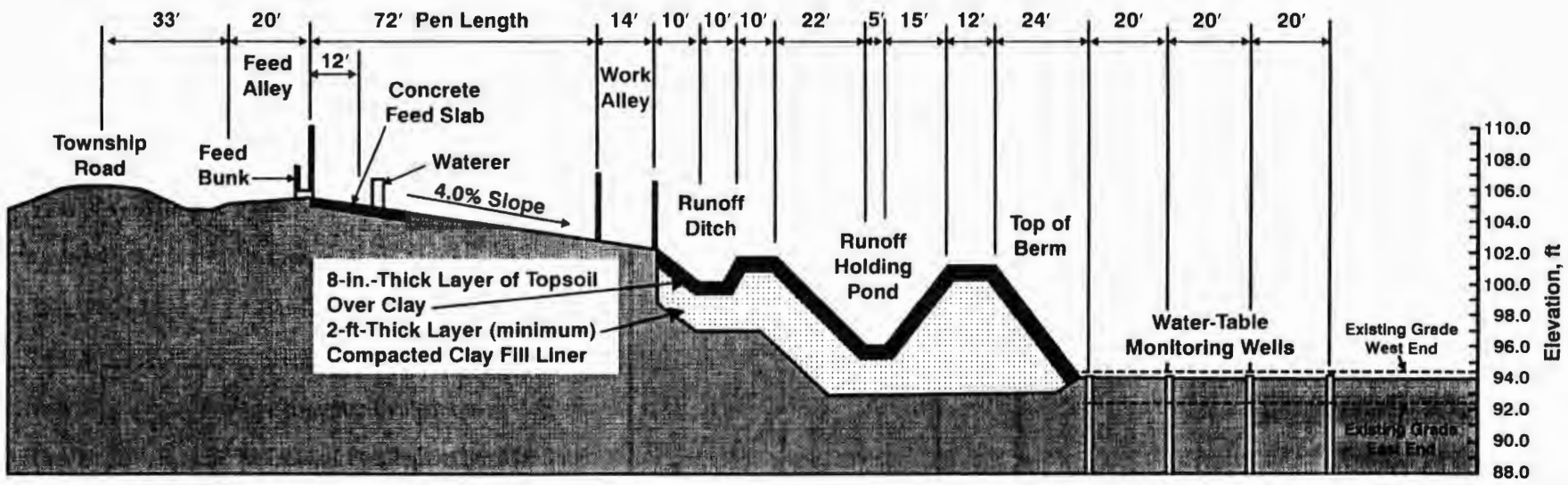



Figure 1. Diagram of NDSU CREC bison research facility.

project. Observational monitoring will include surface conditions, cracking, impact of cleaning procedures, and other general wear-related information. These observations will be dated and recorded. The formal performance monitoring will include standard tests to evaluate surface integrity, strength, and erosion. These data will be compared with observations made by CREC staff.

*Task 4: Technology Transfer* – In Year 1, CREC staff will collect material for a video and publication outlining ash utilization in feedlots. This information will be used to show feedlot operators how ash is being used in the demonstration project and make them aware of the potential for their operations. The NDSU CREC staff will have primary responsibility for this information transfer and will offer it through the NDSU Extension Service and at various locations and events in North Dakota. These materials will also be available to EERC staff for technology transfer activities.

### *Year 2*

*Task 1: Laboratory Development and Field Placement.* In Year 2, two or three commercial feedlots will be identified through the NDSU Extension Service, which will use ash treatment in their feedlot surfaces. Conventional farm tractors and equipment will be used to place and compact the surfaces. As in Year 1, EERC research staff and a consulting engineer with experience placing ash will oversee the placement.

*Task 2: Environmental Monitoring* – Groundwater and runoff water will continue to be monitored at the CREC site. This continued monitoring will possibly be modified from Year 1, depending on those results. The NDDH will provide the input for any parameters that no longer

need to be monitored or those that might be added from Year 1. Samples will be taken on a quarterly basis for a full suite of analyses.

*Task 3: Performance Monitoring* – During Year 2, the performance of the CREC site will be evaluated, having had 1 year of active use by bison. Performance monitoring of the site will primarily observe the integrity of the placement. Strength tests will be performed on intact cored samples, and determinations will be made of shrink/swell properties.

*Task 4: Technology Transfer* – With the assistance of the NDSU Extension Service, feedlot operators will be invited to visit the CREC site to see for themselves how the placements have performed.

***Year 3***

*Task 2: Environmental Monitoring at the CREC Site* – Quarterly samples of groundwater and runoff will continue to be monitored through Year 3. Any modification of parameters will be done in conjunction with the NDDH.

*Task 3: Performance Monitoring* – Performance of the placements will be evaluated for their durability. It has been reported that bison are considerably more active than cattle. Because of this activity, the performance of the CREC site will be critically evaluated for wear caused by the animals as well as the wear caused by 2 years of exposure to the elements. Two to three other placements will also be evaluated for comparative purposes.

*Task 4: Technology Transfer* – Interested feedlot operators will be asked to visit one of the commercial demonstration sites. It is anticipated that performance and environmental data will be available for 2 full years on the CREC site and 1 full year on the commercial sites. Preliminary economic evaluation data will also be available.

*Task 5: Economic Evaluation of the Feedlot Placements* – An economic evaluation will be done comparing the costs of placement using ashes and concrete. Construction costs will include materials and the equipment needed for the placements. Lack of weight gains by animals in extremely soft surfaces will be factored in as well.

*Task 6: Development of Feedlot Design Manual* – A manual will be produced describing how to best use the various ashes for feedlot placements. This manual will describe the mix design, mixing methods, and placement methods by conventional farm equipment.

## 4.0 STANDARDS OF SUCCESS

The standards of success for this effort include:

- Successful placement of ash feedlot surfaces at the NDSU CREC facility and commercial feedlots.
- Demonstrated and documented improvement of feedlot performance as compared to nonsurfaced feedlots.
- Published information detailing practices for placing ash feedlot surfaces.
- Coordination of the environmental aspects of the project with the NDDH and advancement of the NDDH acceptance of ash in bulk use applications.
- Dissemination of project results to potential users (feedlot operators).

## 5.0 QUALIFICATIONS

Ms. Pflughoeft-Hassett, EERC, will act as Project Manager for this effort. Ms. Pflughoeft-Hassett has several years' experience in management of technical research projects with an emphasis on investigation of the utilization of coal ash. She also has experience in the

environmental and engineering aspects of ash utilization projects and has participated in project teams evaluating the economic aspects of ash utilization. Ms. Pflughoeft-Hassett is familiar with North Dakota lignite ash producers and users. She is also familiar with the national and international ash industry. Lead EERC researchers will be Mr. David J. Hassett, leading the environmental evaluations, Mr. Bruce Dockter, leading the engineering evaluations and placement activities, and Mr. Kurt Eylands, leading evaluations of materials reactivity. Resumes of all lead EERC researchers are included in Appendix A.

Mr. Scott Birchall, NDSU CREC, will coordinate efforts for the NDSU activities related to this project. Mr. Birchall is experienced in the area of livestock waste management and with feedlot requirements. He is also familiar with the feedlot operators in North Dakota and their needs. Other NDSU staff participating in the project will be Dr. Vern Anderson and Dr. Jim Lindley, who have responsibilities in the operation of the bison research facility. Resumes of NDSU participants are also included in Appendix A.

Mr. Andrew Stewart, En-rock, Inc., will work with the project team in the field placement and engineering monitoring of the ash surfaces. Mr. Stewart has a wide range of experience in utilization of coal ash. Mr. Stewart's resume is also included in Appendix A.

## 6.0 MANAGEMENT

The project will be managed by Ms. Debra Pflughoeft-Hassett. Mr. Scott Birchall will coordinate efforts for the NDSU CREC activities and report to Ms. Pflughoeft-Hassett. Ms. Pflughoeft-Hassett will be assisted in project management duties by EERC staff whose duties include contract, budget, accounting, procurement, and office services. The EERC infrastructure has a long history of supporting effective project management. Ms. Pflughoeft-Hassett has

experience as a project manager and has successfully managed previous projects funded for the Industrial Commission of North Dakota, DOE, and numerous industrial clients. She also manages the coal combustion by-products program at the EERC. Ms. Pflughoeft-Hassett's resume is included in Appendix A of this proposal.

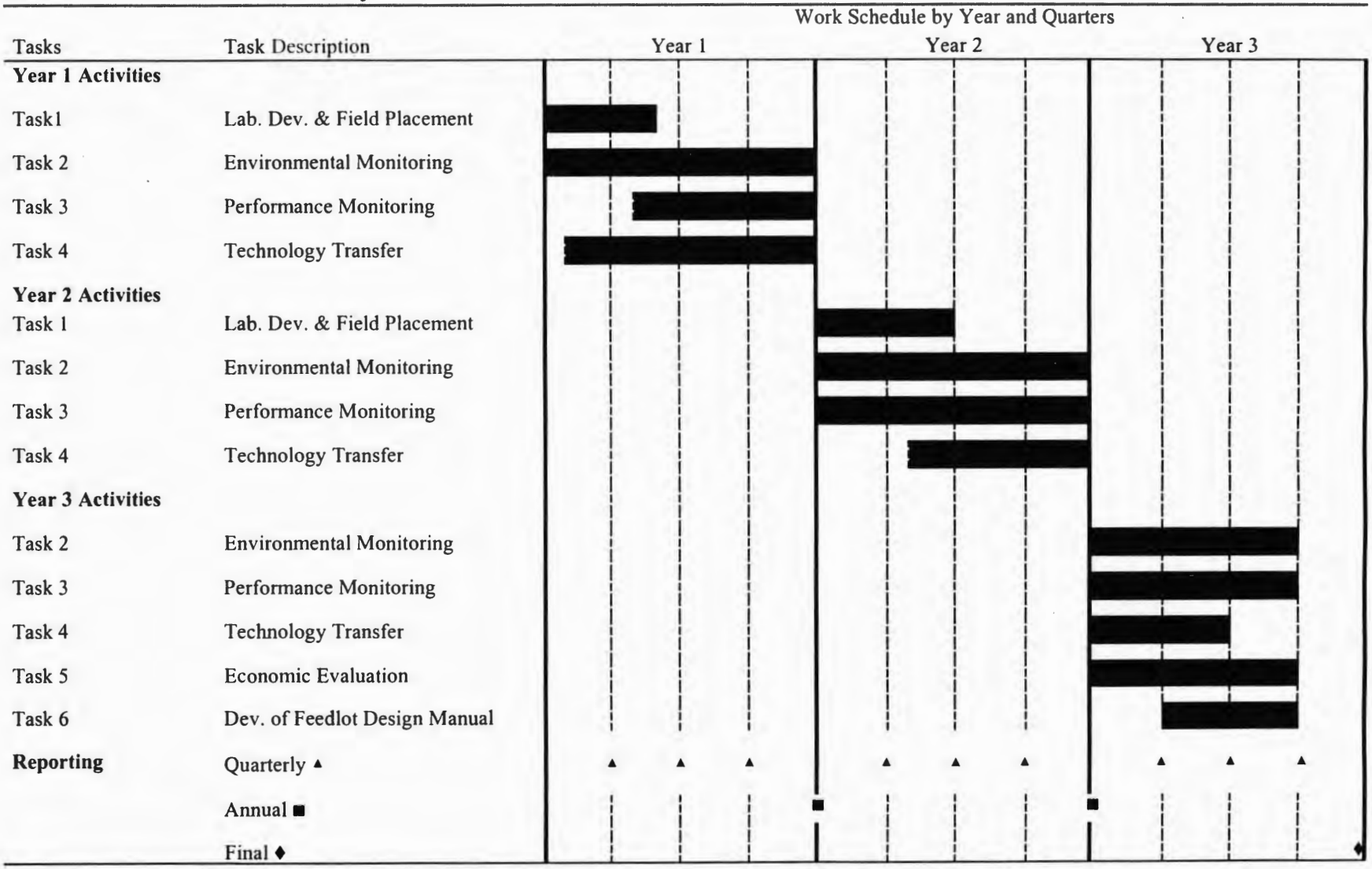
## 7.0 TIMETABLE

The project duration is 3 years. The target start date for this project is November 1, 1999. The greatest effort is planned for Year 1, with a reduction in effort in Year 2, and a further reduction in effort in Year 3. The following table indicates the proposed project schedule detailing task initiation and completion for each year. Project reporting is also included in the timetable. Project reports are expected to include 1) brief quarterly letter reports for the first three quarters of each year throughout the 3-year duration of the project; 2) annual reports at the end of Years 1 and 2; and 3) a comprehensive final report at the end of Year 3 (see Table 1).

## 8.0 BUDGET

The total cost of this project is $531,290. American Crystal Sugar's total fixed-cost contribution for the project is $43,200. Total Year 1 project costs are $225,900, and your contribution is $19,480. Total Year 2 project costs are $193,200 and your contribution is $14,367. Total Year 3 project costs are $112,190, with your contribution being $9353. A summary budget is included with budget notes for reference.

**Table 1**. Time Line for Feedlot Project



Additional in-kind dollars will be provided in Year 2 by the feedlot operators at the demonstration sites. This will involve personnel time, equipment use, and, potentially, shipping costs.

A subcontract will be issued to NDSU CREC for $17,200 to cover costs of equipment use and purchase. Mr. Andrew Stewart will consult on the project, and his costs will be $17,000. Included in Appendix B is a letter outlining a subcontract with NDSU CREC and another letter proposal for consulting by Andrew Stewart, PE.

An amount of $159,360 funding has been approved by the Industrial Commission of North Dakota. These funds match the industry cash and in-kind contributions noted.

The EERC will request $212,570 from the EERC–DOE JSRP to provide the remaining amount needed to perform the project as proposed. In order to submit this DOE–JSRP proposal, the EERC needs the following from each industrial sponsor:

1. A purchase order or letter of commitment
2. A biographical sketch or resume of the key technical contact
3. A short synopsis of the scope of American Crystal Sugar's operation

## 9.0 REFERENCES


1. Sweeten, J.W. *Feedlot Surface Condition – Coal Ash Surfacing versus Control*; Texas Agricultural Extension Service Result Demonstration Report; 1996.
2. Greenless, W.J.; Pitt, J.M.; Dawson; M.R.; Chriswell C.D.; Melvin, S.W. Stabilizing Cattle Feedlot Soil with Fluidized Bed Combustor Ash. *Trans ASAE*. **1998**, *41* (1), 203–211.
3. Midwest Fly Ash and Materials. *Use of Class C Fly Ash for Livestock Feedlot Applications;* Bulletin No. 1.

4. Daines, M. Lime-Enriched FGD Product for Feedlot and Hay Storage Base. Handout at the 1997 EERC CCB Utilization Workshop held in Minneapolis, MN, Sept. 29–30, 1997.

5. Stout, W.L. Low-Cost Way to Pave Feedlots. *Agricultural Research*, Jan. 1999; pp 22–23.

6. American Coal Ash Association. Livestock Pads Made from CCPs. *ACAA Ash at Work*, April 1999; p 21.

7. Pflughoeft-Hassett, D.F.; Dockter, B.A.; Eylands, K.E.; Hassett, D.J. *Survey and Demonstration of Utilization Potential of North Dakota Lignite Ash Resources*; EERC report 96-EERC-04-01 to the Industrial Commission of North Dakota; April 1996.

8. Moretti, C.J. *Fly Ash Utilization in McClean County, North Dakota*; Final Technical Report; March 1993.

9. Moretti, C.J. *Development of Fly Ash-Based Slope Protection Materials for Waste Disposal Ponds*; Final Technical Report, Feb. 1993.

**DEMONSTRATION OF UTILITY AND INDUSTRIAL BY-PRODUCTS FOR FEEDLOT SURFACES**

PROPOSED START DATE: 01-Nov-99

EERC PROPOSAL #99-0104-R1

| | 23-Sep-99 | TOTAL PROJECT HOURS | TOTAL PROJECT $ COST | NDIC SHARE HOURS | NDIC SHARE $ COST | UTILITY CONSORTIUM SHARE HOURS | UTILITY CONSORTIUM SHARE $ COST | EERC JSRP SHARE HOURS | EERC JSRP SHARE $ COST |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL DIRECT LABOR | | 4144 | $93,153 | 957 | $21,545 | 1272 | $28,523 | 1915 | $43,085 |
| FRINGE BENEFITS - % OF DIRECT LABOR | 52% | | $48,439 | | $11,203 | | $14,832 | | $22,404 |
| **TOTAL LABOR** | | | $141,592 | | $32,748 | | $43,355 | | $65,489 |
| **OTHER DIRECT COSTS** | | | | | | | | | |
| TRAVEL | | | $8,690 | | $2,573 | | $2,570 | | $3,547 |
| SUPPLIES | | | $7,385 | | $1,988 | | $2,110 | | $3,287 |
| COMMUNICATIONS - PHONES & POSTAGE | | | $2,247 | | $617 | | $668 | | $962 |
| OFFICE (PROJECT SPECIFIC SUPPLIES) | | | $3,750 | | $1,030 | | $1,074 | | $1,646 |
| FEES (AND SUBCONTRACTS) | | | $169,567 | | $64,524 | | $34,379 | | $70,664 |
| **TOTAL OTHER DIRECT COST** | | | $191,639 | | $70,732 | | $40,801 | | $80,106 |
| **TOTAL DIRECT COST** | | | $333,231 | | $103,480 | | $84,156 | | $145,595 |
| **INDIRECT COST - % OF MTDC** | | VAR | $168,299 | 54% | $55,880 | 54% | $45,444 | 46% | $66,975 |
| **TOTAL EERC ESTIMATED COST** | | | $501,530 | | $159,360 | | $129,600 * | | $212,570 |
| **NDSU -- SERVICES IN SUPPORT OF PROJECT** | | | $20,160 | | $0 | | $20,160 | | $0 |
| **FEEDLOT OPERATORS -- SERVICES & MATERIALS IN SUPPORT OF PROJECT** | | | $9,600 | | $0 | | $9,600 | | $0 |
| **TOTAL PROJECT** | | | $531,290 | | $159,360 | | $159,360 | | $212,570 |

* Breakdown of Utility Consortium:

| | |
|---|---|
| American Crystal Sugar | $43,200 |
| Great River Energy | $43,200 |
| Otter Tail Power | $43,200 |

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| | 23-Sep-99 | YEAR 1 | | NDIC SHARE | | UTILITY CONSORTIUM SHARE | | EERC JSRP SHARE | |
|---|---|---|---|---|---|---|---|---|---|
| | | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST |
| TOTAL DIRECT LABOR | | 1595 | $34,685 | 355 | $7,754 | 500 | $10,764 | 740 | $16,167 |
| FRINGE BENEFITS - % OF DIRECT LABOR | 52% | | $18,036 | | $4,032 | | $5,597 | | $8,407 |
| **TOTAL LABOR** | | | $52,721 | | $11,786 | | $16,361 | | $24,574 |
| **OTHER DIRECT COSTS** | | | | | | | | | |
| TRAVEL | | | $3,879 | | $820 | | $1,097 | | $1,962 |
| SUPPLIES | | | $3,000 | | $660 | | $948 | | $1,392 |
| COMMUNICATIONS - PHONES & POSTAGE | | | $896 | | $198 | | $284 | | $414 |
| OFFICE (PROJECT SPECIFIC SUPPLIES) | | | $1,500 | | $330 | | $460 | | $710 |
| FEES (AND SUBCONTRACTS) | | | $81,972 | | $30,102 | | $18,799 | | $33,071 |
| **TOTAL OTHER DIRECT COST** | | | $91,247 | | $32,110 | | $21,588 | | $37,549 |
| **TOTAL DIRECT COST** | | | $143,968 | | $43,896 | | $37,949 | | $62,123 |
| **INDIRECT COST - % OF MTDC** | | | $72,772 | | $23,704 | | $20,491 | | $28,577 |
| **TOTAL EERC ESTIMATED COST** | | | $216,740 | | $67,600 | | $58,440 * | | $90,700 |
| **NDSU -- SERVICES IN SUPPORT OF PROJECT** | | | $9,160 | | $0 | | $9,160 | | $0 |
| **FEEDLOT OPERATORS -- SERVICES & MATERIALS IN SUPPORT OF PROJECT** | | | $0 | | $0 | | $0 | | $0 |
| **TOTAL PROJECT** | | | $225,900 | | $67,600 | | $67,600 | | $90,700 |

* Breakdown of Utility Consortium:

| | |
|---|---|
| American Crystal Sugar | $19,480 |
| Great River Energy | $19,480 |
| Otter Tail Power | $19,480 |

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PROPOSED START DATE: 01-Nov-99
EERC PROPOSAL #99-0104-R1

| | 23-Sep-99 | YEAR 2 | | NDIC SHARE | | UTILITY CONSORTIUM SHARE | | EERC JSRP SHARE | |
|---|---|---|---|---|---|---|---|---|---|
| | | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST |
| TOTAL DIRECT LABOR | | 1518 | $34,321 | 382 | $8,595 | 464 | $10,379 | 672 | $15,347 |
| FRINGE BENEFITS - % OF DIRECT LABOR | 52% | | $17,847 | | $4,469 | | $5,397 | | $7,981 |
| **TOTAL LABOR** | | | $52,168 | | $13,064 | | $15,776 | | $23,328 |
| **OTHER DIRECT COSTS** | | | | | | | | | |
| TRAVEL | | | $3,470 | | $1,540 | | $1,204 | | $726 |
| SUPPLIES | | | $2,995 | | $1,058 | | $828 | | $1,109 |
| COMMUNICATIONS - PHONES & POSTAGE | | | $900 | | $332 | | $260 | | $308 |
| OFFICE (PROJECT SPECIFIC SUPPLIES) | | | $1,500 | | $554 | | $434 | | $512 |
| FEES (AND SUBCONTRACTS) | | | $57,348 | | $21,244 | | $9,485 | | $26,619 |
| **TOTAL OTHER DIRECT COST** | | | $66,213 | | $24,728 | | $12,211 | | $29,274 |
| **TOTAL DIRECT COST** | | | $118,381 | | $37,792 | | $27,987 | | $52,602 |
| **INDIRECT COST - % OF MTDC** | | | $59,719 | | $20,408 | | $15,113 | | $24,198 |
| **TOTAL EERC ESTIMATED COST** | | | $178,100 | | $58,200 | | $43,100 * | | $76,800 |
| **NDSU -- SERVICES IN SUPPORT OF PROJECT** | | | $5,500 | | $0 | | $5,500 | | $0 |
| **FEEDLOT OPERATORS -- SERVICES & MATERIALS IN SUPPORT OF PROJE** | | | $9,600 | | $0 | | $9,600 | | $0 |
| **TOTAL PROJECT** | | | $193,200 | | $58,200 | | $58,200 | | $76,800 |

* Breakdown of Utility Consortium:

| | |
|---|---|
| American Crystal Sugar | $14,367 |
| Great River Energy | $14,367 |
| Otter Tail Power | $14,366 |

**DEMONSTRATION OF UTILITY AND INDUSTRIAL BY-PRODUCTS FOR FEEDLOT SURFACES**
PROPOSED START DATE: 01-Nov-99
EERC PROPOSAL #99-0104-R1

| | 23-Sep-99 | YEAR 3 | | NDIC SHARE | | UTILITY CONSORTIUM SHARE | | EERC JSRP SHARE | |
|---|---|---|---|---|---|---|---|---|---|
| | | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST | HOURS | $ COST |
| TOTAL DIRECT LABOR | | 1031 | $24,147 | 220 | $5,196 | 308 | $7,380 | 503 | $11,571 |
| FRINGE BENEFITS - % OF DIRECT LABOR | 52% | | $12,556 | | $2,702 | | $3,838 | | $6,016 |
| **TOTAL LABOR** | | | $36,703 | | $7,898 | | $11,218 | | $17,587 |
| **OTHER DIRECT COSTS** | | | | | | | | | |
| TRAVEL | | | $1,341 | | $213 | | $269 | | $859 |
| SUPPLIES | | | $1,390 | | $270 | | $334 | | $786 |
| COMMUNICATIONS - PHONES & POSTAGE | | | $451 | | $87 | | $124 | | $240 |
| OFFICE (PROJECT SPECIFIC SUPPLIES) | | | $750 | | $146 | | $180 | | $424 |
| FEES (AND SUBCONTRACTS) | | | $30,247 | | $13,178 | | $6,095 | | $10,974 |
| **TOTAL OTHER DIRECT COST** | | | $34,179 | | $13,894 | | $7,002 | | $13,283 |
| **TOTAL DIRECT COST** | | | $70,882 | | $21,792 | | $18,220 | | $30,870 |
| **INDIRECT COST - % OF MTDC** | | | $35,808 | | $11,768 | | $9,840 | | $14,200 |
| **TOTAL EERC ESTIMATED COST** | | | $106,690 | | $33,560 | | $28,060 * | | $45,070 |
| **NDSU -- SERVICES IN SUPPORT OF PROJECT** | | | $5,500 | | $0 | | $5,500 | | $0 |
| **FEEDLOT OPERATORS -- SERVICES & MATERIALS IN SUPPORT OF PROJE** | | | $0 | | $0 | | $0 | | $0 |
| **TOTAL PROJECT** | | | $112,190 | | $33,560 | | $33,560 | | $45,070 |

* Breakdown of Utility Consortium:

| | |
|---|---|
| American Crystal Sugar | $9,353 |
| Great River Energy | $9,353 |
| Otter Tail Power | $9,354 |

# BUDGET NOTES

## ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

### Background

The EERC is an independently organized multidisciplinary research center within the University of North Dakota. The EERC receives no appropriated funding from the state of North Dakota and is funded through federal and nonfederal grants, contracts, or other agreements. Although the EERC is not affiliated with any one academic department, university academic faculty may participate in a project based on the scope of work and expertise required to perform the project.

The proposed work will be done on a fixed-price basis. The budget for this proposal has been prepared based on a specific start date; this start date is indicated at the top of the EERC detail budget or identified in the body of the proposal. Please be aware that any delay in the start of this project may result in an increase in the budget.

### Salaries and Fringe Benefits

As an interdisciplinary, multiprogram, and multiproject research center, the EERC employs an administrative staff to provide required services for various direct and indirect support functions. Direct project salaries are estimated based on the scope of work and prior experience on projects of similar scope. Technical and administrative salaries are charged based on direct hourly effort on the project. For faculty, if the effort occurs during the academic year and crosses departmental lines, the salary will be in addition to the normal base salary. University policy allows faculty, who perform work in addition to their academic contract, to receive no more than 20% over the base salary. Costs for general support services, such as grants and contracts administration, accounting, personnel, purchasing and receiving, as well as clerical support of these functions, are included in the indirect cost of the EERC.

Fringe benefits are estimated based on historical data. The fringe benefits actually charged consist of two components. The first component covers average vacation, holiday, and sick leave (VSL) for the EERC. This component is approved by the UND cognizant audit agency and charged as a percentage of direct labor on permanent staff employees eligible for VSL benefits. The second component covers actual expenses for items such as health, life, and unemployment insurance; social security matching; worker's compensation; and UND retirement contributions.

### Travel

Travel is estimated based on UND travel policies, which include estimated GSA daily meal rates. Travel includes scheduled meetings and conference participation as indicated in the scope of work.

### Communications (Phones and Postage)

Monthly telephone services and fax telephone lines are included in indirect cost. Direct project cost includes long-distance telephone including fax-related long-distance calls; postage for regular, air, and express mail; and other data or document transportation costs.

### Office (Project Specific Supplies)

General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are provided through a central storeroom at no cost to individual projects. Budgeted project office supplies include items specifically related to the project: special research notebooks, binders, and other project organizational

materials; duplicating, printing, special covers or paper, and binding of reports; project data forms, transparencies or other presentation materials; literature searches and technical information procurement, including subscriptions; manuals, computer diskettes, memory chips, laser printer paper, and toner cartridges; and other miscellaneous supplies required to complete the project.

**Data Processing**

Data processing includes items such as site licenses and computer software.

**Supplies**

Supplies in this category include scientific supply items such as chemicals, gases, and glassware and/or other such as: items nuts, bolts, and piping necessary for pilot plant operations.

**Fees**

Laboratory and analytical fees are established and approved at the beginning of each fiscal year and are charged based on a per sample or hourly charge depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the University when necessary.

Engineering support fees are based on an established per hour rate for drafting services related to the production of drawings as part of EERC's quality assurance/quality control program for complying with piping and pressure vessel codes.

Graphic services fees are based on an established per hour rate for overall graphics production such as report figures, poster sessions, standard word or table slides, simple maps, schematic slides, desktop publishing, photographs, and printing or copying.

Shop and operation fees are for expenses directly associated with the operation of the pilot plant facility. These fees cover such items as training, safety (protective eye glasses, boots, gloves), and physicals for pilot plant and shop personnel.

**General**

Membership fees (if included) are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout development and execution of the project as well as by the research team directly involved in project activity.

General expenditures for workshops and conferences may include such items as food (some of which may exceed the institutional established limits), room amenities (e.g., place cards, music, banners, floral arrangements), speaker and participant gifts, security, interpreters, technical tour transportation, and room and equipment rental necessary to conduct workshops and conferences.

**Indirect Cost**

The indirect cost rate included in this proposal is the rate which became effective July 1, 1995. Indirect cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of $750 and subcontracts/subgrants in excess of the first $25,000 of each award.