

**DEMONSTRATION OF
NORTH DAKOTA LIGNITE BOTTOM ASH
IN ROAD CONSTRUCTION**

Submitted to:

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North Dakota Industrial Commission
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Bismarck, ND 58505

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DEMONSTRATION OF NORTH DAKOTA LIGNITE BOTTOM ASH IN ROAD CONSTRUCTION

ABSTRACT

EN-ROCK, Incorporated, a North Dakota Corporation, was established in 1996, as a marketing entity for the promotion of coal combustion byproducts (CCBs) produced by Cooperative Power including Coal Creek Station (CCS) Lignite bottom ash. EN-ROCK proposes to perform a demonstration of the use of CCS bottom ash in road base construction in conjunction with Moore Engineering at a site in Mapleton, North Dakota. The primary goal of this effort is to demonstrate the engineering performance of Lignite bottom ash in the construction of road base.

A section of road base will be constructed using CCS bottom ash while the remaining road base will be constructed using gravel. Conventional construction techniques will be used for all the road base placed. The road will be surfaced approximately twelve months following road base construction providing an excellent opportunity to monitor the performance of the bottom ash road base and compare its performance with conventional road base constructed at the same site with natural aggregate (gravel). Moore Engineering of West Fargo, North Dakota, has agreed to specify CCS bottom ash in the construction specifications to facilitate the proposed demonstration. In order to accomplish this demonstration, EN-ROCK is requesting support from the Industrial Commission of North Dakota and Cooperative Power. The total project cost is estimated at \$69,516.

With funding from the Industrial Commission of North Dakota and Cooperative Power, EN-ROCK, Inc., proposes to: 1) provide the bottom ash to the site at no cost; 2) to provide technical assistance during the placement of the bottom ash; 3) to conduct appropriate performance monitoring over the period prior to road surfacing in 1999; and 4) develop a promotional activity to inform local contractors about bottom ash utilization in road base construction. A technical project team will collaborate with Moore Engineering and contractors responsible for construction activities.

It is anticipated that the bottom ash road base will exhibit performance comparable to the gravel road base. Promotion of this activity is expected to provide appropriate information to government and industry representatives that will facilitate incorporation of Lignite bottom ash in future road base construction projects. Utilization of Lignite bottom ash has positive economic and environmental implications for the North Dakota Lignite and utility industries.

DEMONSTRATION OF NORTH DAKOTA LIGNITE BOTTOM ASH IN ROAD CONSTRUCTION

1.0 PROJECT SUMMARY

EN-ROCK, Incorporated proposes to demonstrate the use of CCS bottom ash in a road base construction project at Mapleton, North Dakota, where an industrial park will be developed in 1998-1999. The primary goal of this effort is to demonstrate the engineering performance of CCS bottom ash in the construction of road base. CCS bottom ash will be used to replace natural aggregate (gravel) in the road base construction at the site. A section of road base will be constructed in using CCS bottom ash while the remaining road base will be constructed using gravel. Construction techniques will be the same for all the road base placed. The road will be surfaced approximately twelve months following road base construction due to the schedule for placement of services to the site. This construction schedule provides an excellent opportunity to monitor the performance of the bottom ash road base and compare the performance with conventional road base constructed at the same site with natural aggregate (gravel). Moore Engineering of West Fargo, North Dakota, has agreed to specify CCS bottom ash in the construction specifications to facilitate the proposed demonstration. With funding from the Industrial Commission of North Dakota and Cooperative Power, EN-ROCK, Inc., proposes to: 1) provide the bottom ash to the site as no cost; 2) to provide technical assistance during the placement of the bottom ash; 3) to conduct appropriate performance monitoring over the period prior to road surfacing in 1999; and 4) develop a promotional activity to inform local contractors about bottom ash utilization in road base construction.

2.0 BACKGROUND

Coal combustion bottom ash is an underutilized resource in the United States (ACAA, 1997) and in North Dakota (Bryggman and Nallick, 1993) despite the fact that bottom ash has been shown to have characteristics suitable to utilization (Pflughoeft-Hassett, et al, 1996; Flaagan, 1997). North Dakota Lignite bottom ash was included in an evaluation of the utilization potential of Lignite ash resources performed by

the Energy & Environmental Research Center (Pflughoeft-Hassett, et al. 1996) with funding from the Industrial Commission of North Dakota, Cooperative Power, and the Department of Energy. Results of that project indicated potential for Lignite bottom ash to be useful in road building applications especially as an alternative to natural aggregates. A follow up study, funded by the Industrial Commission of North Dakota and Cooperative Power, was performed by TRI-STAR, Inc., to determine the technical feasibility and market potential for Lignite bottom ash generated at Cooperative Power's Coal Creek Station (CCS) (Flaagan, 1997). The following conclusions were drawn from information collected and generated through TRI-STAR's effort:

- CCS bottom ash meets the specifications for several types of aggregate.
- CCS bottom ash leachates met Primary Drinking Water Standard limits, indicating no environmental threat in any of the utilization applications under consideration.
- The North Dakota Health Department has approved the use of CCS bottom ash in road subbase, surface and seal coats, CLSM, skid control, and other applications where the bottom ash is incorporated into a product matrix.
- The cost for CCS bottom ash will be less than competing materials with cost savings to end users varying from \$1/ton to \$20/ton depending on the application and the location.

As a result of that research, EN-ROCK, Inc., a North Dakota Corporation, was established on September 1, 1996, as a marketing entity for the promotion of certain coal combustion byproducts (CCBs) produced by Cooperative Power including CCS Lignite bottom ash. EN-ROCK has actively pursued opportunities to introduce CCS bottom ash to a variety of markets. Through their cooperative efforts with Cooperative

Power, CCS bottom ash was tested and approved for environmental appropriateness as a road deicing agent/skid control agent. Additionally, sieve tests have been performed to evaluate aggregate qualities of CCS bottom ash. Results of these tests are summarized in Table 1 with comparative information for various classifications of aggregate as specified by the North Dakota Department of Transportation and the American Society for Testing and Materials (ASTM).

TABLE 1
Select Results of Sieve Testing

Sieve Size Designation	CCS Bottom Ash Trials #1/#2	NDDOT Spec. Class III Aggregate	NDDOT Spec. Class V Aggregate	ASTM C 330 & C 331 Grading - Fine Aggregate
1 in.	96/98	---	---	---
¾ in.	95/96	---	---	---
⅝ in.	94/94	---	---	---
½ in.	92/91	100	100	---
⅜ in.	89/87	97	95 - 100	100
No. 4	80/73	86	20 - 85	85 - 100
No. 8	63/56	68	0 - 17	---
No. 16	49/41	---	---	40 - 80
No. 30	36/30	---	---	---
No. 50	22/18	---	---	10 - 35
No. 100	9.6/8.4	---	---	5 - 25
No. 200	4.2/3.6	4.5	0 - 3	---

EN-ROCK has been successful in demonstrating the use of CCS bottom ash in several projects in Eastern North Dakota. The CCS bottom ash was used to stabilize surface soils for commercial parking and

to provide hauling and support surfaces for construction equipment. The bottom ash is reportedly performing well in both projects, however these projects were relatively small in scale requiring a total of approximately 650 cubic yards or 680 tons. EN-ROCK, Inc., has identified another opportunity to demonstrate the use of CCS bottom ash in a road base construction project in an industrial park planned for development in 1998-1999.

Road base was one of the utilization applications identified in the work performed by TRI-STAR and funded jointly by the Industrial Commission of North Dakota and Cooperative Power, however only limited technical performance documentation (Culley and Smail, 1988) is publicly available to be used in marketing bottom ash into this high volume application. A full-scale demonstration will provide the technical information and initial experience for construction contractors to facilitate marketing of Lignite bottom ash. Road building is a key market for high volume materials such as bottom ash, so the proposed demonstration is anticipated to have broad implications for marketing CCS bottom ash and other Lignite bottom ash.

3.0 PROJECT DESCRIPTION

3.1 Introduction

Coal combustion bottom ash is one of the high volume coal combustion byproducts that is currently underutilized in North Dakota as well as in the entire United States. As indicated in a Department of Energy Report to Congress (U.S. DOE, 1994) and by anecdotal information, coal combustion byproducts are frequently not considered for use by government and commercial entities because of the lack of technical and engineering data on specific utilization applications. Demonstration projects have been identified as a primary means of providing the required information and also provide an opportunity for hands on experience by contractors and government agency representatives. A demonstration of Lignite bottom ash use in road base construction is proposed to accomplish these objectives in North Dakota and facilitate market development for this valuable North Dakota resource.

3.2 Goals and Objectives

The primary goal of this effort is to demonstrate the technical performance of CCS bottom ash in the construction of road base utilizing construction techniques typical for road building. Supporting objectives can be summarized as follows:

- Provide experience in using bottom ash to several construction contractors associated with the demonstration;
- Provide technical data to educate contractors to initiate market penetration for bottom ash in traditional natural aggregate markets;

3.3 Methodology

The following sections detail the proposed work plan to achieve the stated goals and objectives of this effort. It is important to note that the proposed work and schedule will be coordinated with representatives of Moore Engineering who is designing the site and overseeing construction. The following tasks are proposed:

Task 1: Construction Activities

Work for Task 1 will commence immediately on approval of funding. Three subtasks will be performed:

Subtask 1: Pre- and Post-Construction Technical Support

Representatives of the EN-ROCK project team will communicate with Moore Engineering on a regular basis to provide available technical information on bottom ash and its use in road base construction.

Requested test data on CCS bottom ash will be reported to Moore Engineering and appropriate contractors as designated by Moore Engineering. These data is expected to include sieve tests, compaction tests, and density testing. If additional tests are required, EN-ROCK will contract to have these tests performed and

reported to the project team and Moore Engineering. EN-ROCK team members will also report and explain performance monitoring data to appropriate individuals and groups.

Subtask 2: Provide CCS Bottom Ash to the Site

EN-ROCK will work with Cooperative Power to provide the appropriate amount of CCS bottom ash to the site on a schedule to be determined by Moore Engineering and construction contractors. It is requested that Cooperative Power provide the bottom ash as an in-kind contribution for this project as well as technical expertise through Cooperative Power staff, primarily Andrew Stewart, Manager of Engineering Services. EN-ROCK will provide in-kind contributions toward shipping and handling costs in the amount of \$7,516 to facilitate accomplishment of this project. A portion of the funds requested from the Industrial Commission of North Dakota will supplement the transportation costs for delivery of the bottom ash.

Subtask 3: Construction Technical Support

The EN-ROCK project team will provide technical support at the time of the road base construction. Mr. Oscar Manz will be present on the construction site at the time of bottom ash road base construction to offer technical advice and input to construction crew members. He will be available to ensure appropriate sampling is performed using approved procedures. Mr. Manz or other EN-ROCK team members will document the bottom ash road base construction with photographs and/or videotape. This documentation may be used in the Task 3 promotional activity.

Task 2: Performance Monitoring

Determination of the performance of the bottom ash road base will be accomplished through field sampling and laboratory testing of the collected samples. Sampling will be performed once in late Fall 1998 and Spring 1999 in an effort to evaluate the performance relative to both time and freeze-thaw cycles. Samples will be collected by coring at three separate locations in the bottom ash road base and three additional locations in the gravel road base. These samples will then be subjected to standard tests for appropriate performance parameters. These are expected to include: hydraulic conductivity, strength, and

density. Additional tests may be performed based on requests from Moore Engineering or the construction contractors. The test procedures used will be standard tests and the procedures will be documented. A comprehensive report of the test data will be prepared and included in reports to the Industrial Commission of North Dakota and Cooperative Power. These data will also be instrumental in developing the promotional activity in Task 3.

A proposal to perform this task under subcontract to EN-ROCK has been submitted by the Energy & Environmental Research Center (EERC) and is included in Appendix A. Mr. Oscar Manz will also be available for consultation with the EERC in the accomplishment of this task.

Task 3: Promotion and Reporting

The Task 3 activities will be performed in two subtasks:

Subtask 1: Development of a Promotional Activity

EN-ROCK will develop and sponsor a promotional activity to familiarize governmental and industrial representatives with the demonstration project. It is anticipated that this activity will be held at the Mapleton, North Dakota, site. The promotional activity will focus on the technical aspects of the demonstration to provide basic information that is required by engineers and others in specifying materials for construction projects. Technical data developed in the project will be presented. Photographic and/or videotape documentation developed in Task 1 may be incorporated into the activity. Additionally, EN-ROCK anticipates inviting representatives from Moore Engineering and participating contractors to share their hands on experiences with participants in an informal program. Information from the promotional activity will also be collected and made available to interested parties not in attendance.

Subtask 2: Reporting

EN-ROCK will prepare and submit two project progress (interim) reports and a final report for the proposed project. The progress reports will be prepared in months 6 and 12 of the project and will report activities and results for the six month period prior to submittal of the progress report. A comprehensive final report will be prepared and submitted to project sponsors on completion of the project in month 18. EN-ROCK project team members and subcontractors will contribute to all reports as appropriate to their role in the project.

4.0 STANDARDS OF SUCCESS

The standards of success for this effort include: 1) successful construction of road base with CCS bottom ash; 2) development of performance monitoring data on the road base with bottom ash and comparative data for standard road base; and 3) development and accomplishment of appropriate promotional activity for North Dakota construction companies and Department of Transportation officials. These standards will be discussed in a comprehensive final report of all activities performed in this effort.

5.0 QUALIFICATIONS

Mr. Mark Flaagan will act as Project Manager and Principal Investigator for this effort. Mr. Flaagan has experience in materials marketing and transportation as noted in his resume in Appendix B. Mr. Flaagan is the President of EN-ROCK, Incorporated and has developed marketing plans and performed economic evaluations for both bottom ash and other North Dakota Lignite byproducts. He has developed basic technical knowledge of bottom ash utilization and has played an active role in promotional activities for a variety of products. Mr. Flaagan has worked with the agricultural, manufacturing, and construction industries in North Dakota and surrounding states and has extensive contacts in these industries.

Mr. Andrew Stewart is department manager for Cooperative Power's engineering applications and byproduct marketing and promotion . He will act as the point of contact and team member coordinating activities at the CCS site, providing expertise in bottom ash utilization, reviewing quality control data for the bottom ash, and reviewing technical results from field and laboratory testing. Mr. Stewart has more than 15 years of experience at Cooperative Power and has been instrumental in the developing and implementing a progressive byproduct marketing plan for CCS. His resume is included in Appendix B.

Mr. Oscar Manz, Professor Emeritus, Civil Engineering, University of North Dakota, and Manz Associates, will be consulting on this project to provide technical assistance to Moore Engineering and the contractors associated with the road base construction. Mr. Manz will be available for consultation over the duration of the project and will be present at the time of the placement of the bottom ash. Mr. Manz has performed research and participated in demonstration projects on CCBs for more than 25 years both while at the University and in his consulting business. As indicated in his resume in Appendix B, he has extensive knowledge of engineering and construction applications for CCBs, properties and performance of North Dakota Lignite combustion byproducts, and the construction industry in North Dakota.

Ms. Debra Pflughoeft-Hassett will consult on this effort to evaluate technical results and will be responsible for compiling technical data and preparing reports and other project documentation. Ms. Pflughoeft-Hassett has experience in working with the North Dakota utility industry and regional CCB marketing and construction industries. She also has over 20 years of experience in CCB research, the collection and evaluation of data on CCBs, and is an experienced technical writer. Her resume is also included in Appendix B.

6.0 VALUE TO NORTH DAKOTA

Two primary benefits to North Dakota are expected to be realized from accomplishment of this demonstration project:

- Utilization of Lignite bottom ash will reduce disposal of Lignite use byproducts which has direct economic benefit to Lignite-fired utilities and the Lignite industry.
- Environmental benefits are also expected to be realized from reduced disposal because of the resulting potential for improved land use and reductions in CO₂ production associated with mining activities to obtain natural aggregate. The conservation of natural resources is a key environmental benefit to North Dakota and the U.S., and reduced aggregate quarrying has a positive impact on the esthetics of any location where quarries are located and minimizes safety hazards and reclamation activities associated with these sites once abandoned.

While the outcome of the proposed demonstration effort is not definitive, EN-ROCK, Incorporated is committed to maximizing economic and environmental benefits for North Dakota, and has chosen to partner with the Industrial Commission of North Dakota and Cooperative Power in this effort because they are similarly committed.

7.0 MANAGEMENT

The proposed project will be managed and coordinated by Mr. Mark Flaagan who will serve as the contact point for the Industrial Commission of North Dakota and Cooperative Power. Mr. Flaagan is President of EN-ROCK, Incorporated and has experience in marketing, transportation, and new business development as detailed in his resume which is included in Appendix B. Mr. Flaagan has successfully managed and completed two previous projects funded by the Industrial Commission of North Dakota.

8.0 TIMETABLE

Table 2 lists the timetable for the proposed project. The target date for initiation of the effort is July 1, 1998. The overall period of performance is eighteen (18) months, so the completion date is projected to be December 31, 1999. Progress (interim) reports are scheduled for submission in project months 6 (December 31, 1998) and 12 (June 30, 1999). Submission of the final report is scheduled to for December 31, 1999.

TABLE 2
Project Timetable

Task No.	Task Description	Timetable by Project Months					
		1	6	9	12	15	18
1	Construction Activities	I	C				
2	Performance Monitoring		I			C	
3	Promotion & Reporting		I				C
	I=Initiation C=Completion						
	Reports		*		*		**
	* Progress (Interim) Report						
	**Final Report						

9.0 BUDGET

A budget detailing the costs associated with this proposed effort is included in Appendix C. The total project cost is estimated to be \$69,516. Cooperative Power has agreed to provide a total contribution of \$30,000 for this effort, including \$10,000 in-kind contribution of bottom ash and personnel time and \$20,000 cash contribution. A letter of intent from Cooperative Power is included in Appendix C. EN-ROCK, Incorporated, will provide \$7,516 in-kind contribution for personnel and materials handling. EN-ROCK is

requesting an additional \$32,000 from the Industrial Commission of North Dakota through the Lignite Research Council.

A proposal for a subcontract to the Energy & Environmental Research Center (see Appendix A) includes a budget estimate for the performance monitoring task. Letters detailing consulting fees are included in Appendix C. An affidavit stating that EN-ROCK, Incorporated, does not have an outstanding tax liability owed to the state of North Dakota or any of its political subdivisions is also included in Appendix C.

10.0 REFERENCES

American Coal Ash Association, Inc. "1996: Coal Combustion By-Product—Production and Consumption," Alexandria, Virginia, 1997.

Bryggman, T.; Nallick, J. "Use of Coal Combustion By-Products Status and Opportunities in Region 8," Associated Western Universities Fellowship, U.S. Department of Energy, Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming, 1993.

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Flaagan, M. "Technical and Economic Feasibility Study for Utilization of North Dakota Lignite Bottom Ash," TRI-STAR, Incorporated report to the Industrial Commission of North Dakota, November 1997.

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