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WASTE COMBUSTOR ASH UTILIZATION

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ABSTRACT

The incorporation of municipal solid waste combustor (MWC) ash into bituminous pavements has been investigated in the United States since the middle 1970s. Thus far, most, if not all of these projects, have attempted to answer the questions: Is it safe? Is it feasible? Or does it provide an acceptable product? Polk County Solid Waste located in Northwest Minnesota has now completed three Demonstration Research Projects (DRP) utilizing ash from its municipal solid waste combustor as a partial replacement of aggregate in asphalt road paving projects. The results of these projects show no negative environmental or worker safety issues, and demonstrate improved structural performance and greater flexibility from the ash-amended asphalt as compared to conventional asphalt. Polk County has submitted an application to the Minnesota Pollution Control Agency (MPCA) to obtain a Case-Specific Beneficial Use Determination (CSBUD), which would allow for continued use of ash in road paving projects without prior MPCA approval. However, concerns from the MPCA Air Quality Division regarding a slight increase in mercury emissions during ash amended asphalt production has resulted in a delay in receiving the CSBUD.

Polk County decided to take a different approach. In January 2008, Polk submitted and received approval for their fourth ash utilization DRP. This DRP differs from the first three in that the ash will be used as a component in the Class 5 gravel materials to be used for a Polk County Highway Department road rebuilding project. The project involves a 7.5 mile section of County State Aid Highway (CSAH) 41, which conveniently is located about 10 miles south of the Polk County Landfill, where the ash is stored. The CSAH 41 project includes the complete rebuilding and widening of an existing 7.5 mile paved road section. Ash amended Class 5 gravel would be used in the base course under the asphalt paving, and also in the widening and shouldering sections of the road. The top 2 inches of the widening and shouldering areas would be covered with virgin Class 5 and top soil, so that all ash amended materials would be encapsulated. This has been the procedure followed in previous projects. No ash will be used in the asphalt mix for this project.

This paper discusses production, cost, performance and environmental issues associated with this 2008 demonstration research project.

1.0 INTRODUCTION

The Polk County Solid Waste Department, located in Polk County, Minnesota, participates in an integrated solid waste management system that includes four other counties in Northwest Minnesota. One component of this system includes the operation of a Waste-To-Energy (WTE) plant that receives and processes approximately 33,500 tons per year of residential and commercial municipal solid waste. The plant consists of two 40 ton per day starved air, mass burn waste combustors with dry sorbent duct injection and electrostatic precipitators (ESP) as the air pollution control technology. The facility began full operation in 1988. The ash generated by the waste combustors is deposited in lined ash monofill cells at the Polk County Landfill.

In 1996, Polk designed and installed an up-front separation facility, or materials recovery facility (MRF), to remove recyclable, non-processible, and objectionable materials prior to incineration. Most of the extracted materials are recycled or reused.

In 2000, Polk began construction of an air pollution control retrofit project designed to meet EPA revised air emission guidelines. This project upgraded the ESP's and added dry sorbent reagent duct injection, and in 2003 Polk achieved compliance with the revised regulations. In 2008, Polk added a steam driven turbine generator to produce renewable energy with excess steam.

Beginning in 2000, Polk County has now performed three Demonstration Research Projects (DRP's) to determine the feasibility of utilizing combined MWC ash as a partial replacement of aggregate in bituminous paving materials. The projects consisted of building and evaluating sections of three separate county road construction projects using MWC ash-amended bituminous. The results of two of these demonstrations were published at previous NAWTECs in 2000 and 2002.

2.0 BACKGROUND

Significant environmental evaluations were performed as part of these original three demonstration projects. These comprehensive evaluations resulted in the only outstanding environmental issue being stack emissions from the asphalt plant that reported a minor increase in mercury emissions when adding MWC ash into the asphalt mix plant. Polk County is in discussions with the MPCA as how to address this matter, with the State looking to reduce mercury emissions as directed under the Total Maximum Daily Loading (TMDL) criteria set forth in Federal guidelines for all states. Since a solution to asphalt plant stack emissions has yet to be determined, a fourth demonstration project utilizing MWC ash in a different manner is addressed in this paper.

This fourth demonstration project was approved by the MPCA and supported by the Minnesota Resource Recovery Association, the four partner counties adjacent to Polk County, the Polk County Board, the Polk County Highway Department, and the citizens of Polk County.

3.0 CSAH 41 DRP Project

The topic of this paper is a section of County State Aid Highway (CSAH) 41 located near Crookston, Minnesota. The Polk County Highway Department re-constructed a 7.5 mile section of this road in the summer of 2008.

Project Location - Crookston Minnesota

The design reflected an 8-inch thick ash amended Class 5 base course under new hot mix asphalt, and a 5 foot widening section on both sides, with new ditch construction (see Figure 1). The widening sections were constructed with 18" thick ash amended Class 5 materials tapering down to zero at the ditch slope. The ash amended materials were then covered with 2" of virgin Class 5 gravel, and the ditch slope covered with 2" of top soil. This construction design allowed for all ash amended Class 5 to be essentially encapsulated, which was the same conservative approach as taken in all previous ash utilization projects. For this demonstration project, MWC ash was incorporated only in the Class 5 materials, and not included in the asphalt.

In 2007, a similar DRP was approved, but it was later determined that the project was too small to meet the goals and objectives outlined in the application to the MPCA. However, since this was a new application, Polk was allowed to perform several trial methods of blending the ash with natural aggregate at a crusher plant during Class 5 production. Excess ash that was screened for a previous utilization project was added before and after the crusher, and at various percentages of substitution for natural aggregate materials. It was determined that the best method would be to add ash and aggregate together at the beginning of the crusher. This allowed for good initial blending, with additional mixing occurring in stock piling and load out operations. Laboratory analysis of the ash amended Class 5 mix under this mixing method showed that an acceptable Class 5 mix design (i.e., proper density and gradation) could be obtained by substituting up to 20% ash.

With the CSAH 41 project scheduled to begin construction mid-summer of 2008, a trommel screen was set up inside a lined ash cell in June, and landfill operators began screening and stockpiling ash for the project. Combined ash (bottom ash and fly ash) was mined and screened from previously landfilled areas within the ash cells. Approximately 95% of all ash run through the screen was stockpiled for use in the demonstration project. This high percentage of suitable ash can is attributed to the efficiency of the MRF.

The Highway Department and the contractor estimated a need to screen 10,000 tons of ash. This was based on the aggregate pit material composition. Two pits were used for Class 5 production for this project, and initially it was estimated that a 15% ash substitution rate from one pit and 12% from another would produce an acceptable Class 5 material. During initial Class 5 production and onsite testing, however, it was determined that a rate of 20% was permissible for both pits. This required screening an additional 5,300 tons of ash. This was good news, but landfill personnel had to work very long days to produce the required amount of ash to keep up with construction. In total, 15,380 tons of ash was used for this project.

In early July, construction began and the road contractor began hauling to and stockpiling ash at the crusher. The ash was stored in a separate bermed area. The crusher loader operator would take a full bucket of ash and disperse it in four equal amounts along the base of previously stockpiled aggregate. Then, the operator would take a full bucket of aggregate and ash for dumping into the crusher. This approximated a 20 percent addition of ash to the mix. Random samples of the ash amended Class 5 was taken during the crushing operation to determine if an acceptable compositional analysis was obtained. These tests consistently proved that the up to 20 percent addition of ash met the design criteria for the Class 5 mix. In fact, a higher percentage proved acceptable, but the addition was held to a maximum of 20 percent as previously agreed to with the MPCA and the Highway Department.

Stockpiled ash amended Class 5 mix was allowed to be stored for up to ten days prior to application at the road site. As it turned out, the contractor began moving the ash amended Class 5 to the project site almost immediately, initially to cover up new transverse culverts installed under the road, followed closely by placement to build up the widening sections of the road. Typical construction methods for the Class 5 materials utilized compaction of the road grade, followed by an application of water, and then more compaction. Ash amended Class 5 was then hauled to the road, distributed on top of the old pavement, and spread to a depth of approximately 2 inches. A re-claimer machine was then used to grind up the ash amended Class 5, along with the old asphalt, which was left in place and then compacted for the base under the new asphalt paving. This is a relatively unique process that worked very well for this project. Asphalt paving followed, and then virgin Class 5 and top soil to complete the shouldering, resulting in all ash amended Class 5 being totally encapsulated.

As it turned out, basically the ash replaced the clay which is used as a binder material in the Class 5 mix. No clay was needed for this project. Another advantage was that the ash contains significantly more moisture than clay, and acted as a dust inhibitor during the crushing operations. A total of 15,380 tons of screened ash was utilized for this project, which will dramatically extend the life of the ash cell facility at the landfill. The WTE plant generates approximately 6,000 tons of combined ash each year.

4.0 ENVIRONMENTAL

CSAH 41 - Class 5 Crusher Plant Monitoring

Operator Breathing Space

The crusher plant operators' breathing space was evaluated for personnel exposures while MWC ash was being blended with the Class 5 aggregate at the crushing operation. Air samples were collected for total airborne dust during addition of the MWC ash into the crusher, and (for comparison) during production of virgin (non-amended) Class 5 aggregate.

The personnel evaluated were the crusher operator and the loader operators. These employees wore a battery-operated air pump that drew air through a sample collection filter. The filter was positioned on the employees' shirt collar to collect a sample of the air in their "breathing zone." The sample collection period lasted at least four hours of the production day.

The collected samples were analyzed for the Time Weighted Average total dust, arsenic, cadmium and lead concentrations, and submitted to a laboratory accredited by the American Industrial Hygiene Association for analysis. The sampling and analytical methods followed were those published by the National Institute for Occupational Safety and Health (NIOSH). The specific methods are NIOSH Method 0500 for total dust (particulates) and NIOSH Method 7303 for arsenic, cadmium, and lead.

CSAH 41 – Project Site Monitoring

Operator Breathing Space

Airborne dust sampling was also performed during placement and compaction of the MWC ash amended Class 5 aggregate. The sampling included breathing space monitoring on three personnel working during placement, and area monitoring downwind of placement activities.

The personnel evaluated were selected at the project site on the basis of greatest dust exposure potential. Those employees wore a battery-operated air pump that also drew air through a sample collection filter. The filter was positioned in the "breathing zone" of the employees. The sample collection period lasted approximately four to six hours.

The area sample was collected in a similar manner, except that a high volume air pump was used to collect the sample. The sample device was located downwind of the placement area. As the placement work progressed, the filter, pump and generator were moved as necessary.
Similar to the personnel samples, the sample collection period was approximately four to six hours. All of the samples were analyzed for the Time Weighted Average total dust, arsenic, cadmium, and lead concentrations.
All sampling activities were conducted under the direction of a Certified Industrial Hygienist.

Breathing Space Sampling Results

Non-Ash- Amended Sampling

For purposes of comparing exposure levels between ash amended Class 5 and normal Class 5, the personal exposures of two operators were measured while processing non-ash-amended aggregate at the mine pit on August 6, 2008. The results are summarized in the following table.

Table 1

Description	Air Sampling Results, µg/m^3			
	Arsenic	Cadmium	Lead	Total Particulate
Loader Operator	< 2.4	< 2.4	< 2.4	< 0.6
Crusher Operator	< 2.2	< 2.2	< 2.2	< 0.6
Minnesota OSHA Action Levels	5	2.5	30	NE
Minnesota OSHA Permissible Exposure Limits	10	5	50	15,000

Note: "<" means Less Than; "NE" means Not Established

The sample results are presented in terms of micrograms of metal or dust per cubic meter of air, abbreviated "µg/m^3."

All sample results were below established action levels and exposure limits.

Ash-Amended Sampling

Crushing Operation

The personal exposures of three operators were measured while producing ash-amended aggregate at the mine pit on July 22, 2008. The results are summarized in the following table.

Table 2

Description	Air Sampling Results, µg/m^3			
	Arsenic	Cadmium	Lead	Total Particulate
Loader Operator Number 1	< 2.7	< 2.7	< 2.7	< 0.6
Loader Operator Number 2	< 2.6	< 2.6	< 2.6	1.5
Crusher Operator	< 2.7	< 2.7	< 2.7	< 0.6
Minnesota OSHA Action Levels	5	2.5	30	NE
Minnesota OSHA Permissible Exposure Limits	10	5	50	15,000

Due to the short sampling time and sample volume, the "less than" cadmium results are slightly greater than the action level. Considering the lower sample results, i.e., non-detected during placing (see below), it is highly unlikely that the actual cadmium results are greater than the action level.

All other sample results were below established action levels and exposure limits.

Placing Operation

The personal exposures of two operators were measured and one area sample collected while placing ash-amended aggregate at the CSAH 41 construction site on July 24 & 29, 2008. The results are summarized in the following table.

Table 3

Description	Air Sampling Results, µg/m^3			
	Arsenic	Cadmium	Lead	Total Particulate
Blade Operator	< 2	< 2	< 2	< 0.5
Compactor Operator	< 2.2	< 2.2	< 2.2	< 0.5
Downwind Area Sample	< 2.2	< 2.2	< 2.2	< 0.5
Minnesota OSHA Action Levels	5	2.5	30	NE
Minnesota OSHA Permissible Exposure Limits	10	5	50	15,000

All sample results were below established action levels and exposure limits. These results are basically the same as for the previous DRP work, which also showed no significant impacts to operators when using ash-amended hot mix asphalt.

Surface Water Sampling

Ditch water sampling for eight (8) heavy metals was performed to investigate effects of the ash amended Class 5 on surface water runoff. This evaluation consisted of collecting and analyzing water samples from the surface water in the ditch parallel to the project. Both control and test site water samples were collected and analyzed.

In order to minimize unintended sample impacts, the control and test site water samples were collected at the same time, after construction and again a couple of week's later following significant rainfall events (total of 2 events). The intention was to collect water samples in the adjacent ditch, immediately upstream and at test sites alongside the road.

Water collection devices were installed in the base of the adjacent ditch and parallel to the project road to allow sampling of both upstream and downstream ditch water to better obtain representative samples. A collector was installed at test sites just upstream of the new construction for control sampling. Additionally, four collectors were installed in the ditch parallel to the ash amended road equally spaced at two mile intervals, with one at the end of the new construction. This totaled five collectors (see Figure 2), one for control sampling and four at test sites. The specific locations were field identified during installation and the locations staked and documented.

Clean 1-liter polyethylene bottles were used to collect the appropriate grab samples from each sample location to be analyzed. The samples were preserved with nitric acid as directed by the MDH-certified lab, and then iced to 4°C for shipment to the lab. Upon completion of the sample collection event, the collection devices were pumped dry for the next sampling event. Additionally, two composite samples of the ash amended Class 5 (5 sub-samples each) were collected from the material placed during the construction, iced to 4°C in a cooler, and shipped to an MDH-certified lab for total metals composition testing (EPA Method 3050B).

Surface Water Sampling Results

The results for the two rainfall events are summarized below in Table 4 for the eight (8) heavy metals tested for (i.e., the potential contaminants of concern for MWC ash), together with MDH Health Risk Limits (HRLs, or drinking water standards). None of the samples exceeded standards, nor did significant differences exist between control levels and the ash amended Class 5 collectors.

Table 4
Surface Water Runoff Sampling Results

Sample I.D.	Arsenic (ug/L)		Boron (ug/L)		Cadmium (ug/L)		Lead (ug/L)		Mercury (ng/L)		Molybdenum (ug/L)		Selenium (ug/L)		Vanadium (ug/L)	
	10/15/08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08	10\15\08	10/28/08
Control	<0.6	<2	<50	<50	<0.2	<0.2	<1	<1	1.3	1.3	5.02	5.78	<2	<2	<10	<10
#1	<0.6	<2	<50	<50	<0.2	0.23	<1	5.9	3.9	2.9	<5	<5	<2	<2	<10	<10
#2	<0.6	<2	<50	<50	<0.2	<0.2	<1	<1	4.1	1.1	<5	<5	<2	<2	<10	<10
#3	0.6	<2	<50	<50	<0.2	<0.2	<1	<1	3.1	1.4	<5	<5	<2	<2	<10	<10
#4	1.3	<2	61.4	69.5	<0.2	<0.2	2.2	1.1	4.0	2.1	<5	<5	<2	<2	<10	<10
Dup. (#2)	<0.6		<50		<0.2		<1		3.1		<5		<2		<10	
Dup. (#4)		<2		81.7		<0.2		1.6		2.5		<5		<2		<10
Fld. Blk (Hg only)									<0.5	<0.5						
MDH HRL	**10**		**600**		**4**		**15**		**6.9**		**30**		**30**		**50**	

Total Metals Composition Testing

Two samples of the finished, ash amended Class 5 material were collected and analyzed for the same eight (8) metals (plus antimony) done for the surface water samples, with the results shown in Table 5. The results show as very favorable also. Most metals concentrations are similar to normal soils (shown from various sources for comparison), and even for the few that exceed the normal soil ranges, are well below the MPCA's Tier 1 and 2 Risk-Based Site Evaluation Values (both residential and industrial) used to guide soil cleanups. Given that the ash amended Class 5 is encapsulated by pavement or virgin material, this is even more conservative in terms of environmental protectiveness.

Table 5
Total Metals Composition Test Results of Ash-Amended Class 5 – July 24, 2008

Parameter	Units	From Crusher Operation	From Construction Site	Expected Soil Concentrations (1): Western U.S. (2) Mean	Western U.S. (2) Range	Minnesota (3) Mean	Minnesota (3) Range	Lindsay (4) Average	Lindsay (4) Range	Risk-Based Site Eval Values (mg/kg): Tier 1 (Res) SLV (11/99)	Tier 1 (Res) SRV (10/99)	Tier II (Ind) SRV (10/99)
Mercury	mg/kg	0.25	0.23	0.046	0.01-4.6			0.03	0.01-0.3		0.7	2
Cadmium	mg/kg	4.31	3.52	0.06	0.01-7	0.66	0.08-3.6	0.06	0.01-0.7	4.4	35	250
Lead	mg/kg	139	103	17	<10-700	174	2-1,377	10	2-200	525	400	700
Boron	mg/kg	42.5	32.4	23	<20-300	3	<0.06-8			145	3,000	23,000
Antimony	mg/kg	7.70	5.84							2.7	14	100
Arsenic	mg/kg	2.52	2.07	6	<0.1-97			5	1-50	15.1	10	25
Molybdenum	mg/kg	2.06	1.05							6		
Selenium	mg/kg	<0.201	<0.2	0.23	<0.01-4.3			0.3	0.1-2	1.5	170	1,250
Vanadium	mg/kg	5.24	4.42							500	210	1,340

(1) Expected soil concentrations of metals in mg/kg in "normal" soils for various areas of the country. The mean concentration represents the geometric mean and the range the observed range found in background sampling for the area specified.

(2) Taken from "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States", H.T. Shacklette and J.G. Boerngen, USGS Professional Paper 1270, 1984.

3) Taken from "Memorandum from Dale Trippler, MPCA Site Response Section, Soil Data for Minnesota," September 25, 1990. Data represents urban areas influenced by a variety of contamination sources.

(4) Lindsay, W.H., "Chemical Equilibrium in Solids", John Wiley & Sons, New York, 1976, 24, 449.

Structural Considerations

Testing of the ash amended Class 5 by the MnDOT testing lab is shown in Table 6. Gradations of the ash itself, and the ash/aggregate blends from two pits are shown, together with Class 5 requirements. Results show that a 20% ash addition meets all Class 5 requirements for both pits. Proctor testing results of the various admixtures are also shown.

Table 6
Gradation Blending Sheet
District 2 MNDOT Lab

	Strata Class 5 Aggregate					J&S Class 5 Aggregate			Incinerator	Requirements
	VIRGIN	90/10	80/20	70/30	60/40	VIRGIN	90/10	80/20	Ash	3138 Class 5
1"	100	100	100	100	100	100	100	100	100	100
¾	97	97	98	98	98	100	100	100	100	90-100
5/8	94	94	93	93	93	99	98	97	92	
½	89	89	89	88	88	93	92	92	86	
3/8	85	85	84	84	83	88	87	86	80	50-90
#4	73	72	72	72	71	77	76	75	69	35-80
10	49	50	50	51	51	60	60	59	55	20-65
40	14	16	18	21	23	28	29	30	36	10-35
200	4.2	5.6	7	8.4	9.8	7.6	8.7	9.7	18.2	3.0-10.0
Max. Density	133	129.1	131.3	122.7	116.8	134.3	131.5	126.4		
Opt. H_20	8.2	9.5	11.5	12.6	14.6	7.6	8.3	10.9		

(1) Used screened ash 3/4" diameter and under.
(2) Ash screened once.
(3) Moisture Density Relationship: "The obvious trend is…The higher the % of ash, the more water is needed to compact the blend. The Maximum Density goes down with the higher % of ash due to the fact that the weight of ash and water are lighter than the aggregate".

5.0 ECONOMICS

Economic issues are obviously a critical component in the consideration to utilize MWC ash in Class 5 materials. If a potential user does not realize a financial benefit, there is not much incentive to use the ash. Components that must be considered in the financial equation include:

- The value of monofill cell space and ash disposal costs
- The production costs to utilize the ash including screening, and hauling
- Avoidance of use of traditional aggregate components
- Monitoring expense
- Long term pavement and shouldering performance.

Monofill Cell and Disposal Costs

Cost savings due to the extended life of the ash cells are estimated at $1.00 per ton of Class 5 produced. This is based on $5.00 per ton for landfill space, divided by approximately 5 tons of ash amended Class 5 made from a ton of MWC ash. A total of 77,000 tons of ash amended Class 5 was used for this project.

Production Costs of Class 5

Based on the Polk County demonstration, several cost factors were identified. These factors are summarized as follows:

- **Screening**

Cost to rent the screen, and operator and equipment time to screen the ash was $3.00 per ton of ash. Since 5 tons of ash amended Class 5 was produced from each ton of ash, this translates to $0.60 per ton of Class 5 produced.

- **Loading and Hauling**

Landfill personnel loaded the screened ash into trucks supplied by the contractor. Hauling costs were approximately $7.37 per ton to transport the ash to the crusher. Total costs for loading and hauling were $1.47 per ton of ash amended Class 5.

- **Crusher**

Once delivered to the crusher, costs to create a separate bermed area and manage the ash were judged "minimal" by the crusher operator (only a couple of hours to make a low berm).

- **Class 5 Production**

Nominal costs were identified from distributing and blending the ash with the aggregate for placement into the crusher. In fact, the high moisture content in the ash served to reduce dust, and also was less likely to "ball" up in the crusher, as can be the case with clay. This resulted in an increased production rate from the crusher (i.e., normal rate of 325 tons per hour increased to 400 tons per hour with the ash, for a 23 percent increase). According to the contractor, this saved him an estimated $0.44 per ton of ash amended Class 5.

Avoidance of Use of Traditional Clay Material

By using MWC ash in this project, no clay materials were needed. In some parts of Minnesota, satisfactory clay materials are in increasingly short supply. Assuming a clay cost of $5.00 per ton and a normal 20% substitution rate, this would equate to $1.00 per ton of Class 5 produced. Reducing the rate of depletion of this resource is an important consideration. The use of MWC ash does not add any damage to the environment, while excavation of natural aggregates and clay does cause significant environmental damage, and the need for remediation.

Long Term Performance

The long term performance of ash-amended Class 5 must be considered as part of an economics evaluation. Long term performance implications are further discussed in later sections of this paper.

Environmental Protection and Monitoring

The results of environmental evaluations performed in this demonstration indicate that no environmental protection outside of normal storm water protections should be needed for future projects that are performed under similar conditions.

Total Cost

Table 7 summarizes the above cost information. Basically, increased costs for using the MWC ash were due to screening, loading, and hauling the ash to the crusher, or approximately $2.07 per ton of Class 5 produced with ash. Partially offsetting this increased cost are the savings of $1.44, attributable to the 23% increase in production rate and avoided cost of hauling in clay binder. This causes a net increase in cost per ton of ash-amended Class 5 of $0.63. Assuming $1.00 per ton of ash-amended Class 5 produced is realized in avoided landfill costs, this translates to a net savings of $0.37 per ton of ash-amended Class 5 used, all without sacrificing any performance by the Class 5, or causing any environmental impacts. Indeed, clay resources are conserved, and environmental impacts cause by mining are reduced.

Table 7
Cost Summary for CSAH 41

	Cost Component	Cost per ton of Class 5 Aggregate	Savings per ton of Class 5 Aggregate
1	Ash screening and loading	$0.60	
2	Hauling ash to pit	$1.47	
3	Savings for increased production		$0.44
4	Savings due to replacement of traditional clay material		$1.00
5	Savings in landfill disposal costs (15,380 tons of ash @$5 per ton over 77,000 tons of Class 5 aggregate produced)		$1.00
	Totals-	$2.07	$2.44
Net Long-term Economic Impact = Savings of $0.37 per ton of Class 5 aggregate used			

6.0 UPDATES

Updates to the Polk County project are provided in this Section. These include:

- Post–construction structural testing,
- Additional Polk County projects
- Post–construction structural testing

In the summer of 2009, the Polk County Highway Department will perform Falling Weight Deflectometer (FWD) testing on the asphalt sections of the project. The FWD testing will be performed to provide a measurement of the Spring Season Axle-Load (SSAL) capacity of the roadway. Also strength testing of the Class 5 widening sections will be performed. The potential ramifications of this evaluation appears in the Discussion Section of this paper

Additional Polk County Projects

The Polk County Highway Department has plans to continue the reconstruction of CSAH 41 another 5.25 miles to the east in 2009. The Highway Department will include a provision in the bid documents for an alternate bid to incorporate ash amended Class 5 in the base construction. The alternate will include cost to haul the ash from the landfill to the crusher site. It is hoped that these bids will be opened and available for reporting at the NAWTEC17. Polk County Solid Waste will submit another DRP application to the MPCA to continue with the use of MWC ash in the Class 5 component of this upcoming project. This project is estimated to consume approximately 10,000 tons of ash using the ash in a similar manner in Class 5 mix.

7.0 DISCUSSION

Environmental Issues

No environmental or operator safety issues were identified with this research project.

Cost and Performance Issues

As it turned out, the economics for this project are very much to the contractors benefit. The costs incurred by the landfill were $82,390 while the contractor realized a savings of $110,880. Future projects should include the use of ash as a component in Class 5 as an alternate during the bidding process. This would better identify the hauling costs and the value of mined clay materials.

Individual component costs for ash screening and hauling may be significantly different if included in the bid process.

Actual improvement (if any) in pavement life has yet to be identified.

It is anticipated that potential cost savings as identified above will result in a Class 5 that is cheaper, stronger and environmentally friendlier than that produced without ash.

8.0 RECOMMENDATIONS

Concluding recommendations of this paper are as follows:

Polk County should submit a Case Specific Beneficial Use Determination (CSBUD) application to the MPCA requesting the continued use of WTE ash in a similar manner in future road projects without obtaining prior approval.

Until a CSBUD is approved Polk should request approval for additional DRPs using the ash in Class 5 to further confirm the findings in the first DRP.

The Highway Department will include an alternate bid in the plans and specifications for future road rebuilding projects for the use of WTE ash in Class 5 materials. The alternate will require the contractor to provide equipment to haul the ash from the Polk County landfill to the crusher sites as part of his bid.

Polk County should perform an economic analysis to determine if it would be feasible to procure a screen for future projects versus renting. This will help confirm the economic conclusions of this DRP.

Continue to investigate the use of ash amended Class 5 with future County road projects.

Have discussions with MnDOT to include ash amended Class 5 in a similar manner in State road projects.

Figure 1 – Road Cross – Section

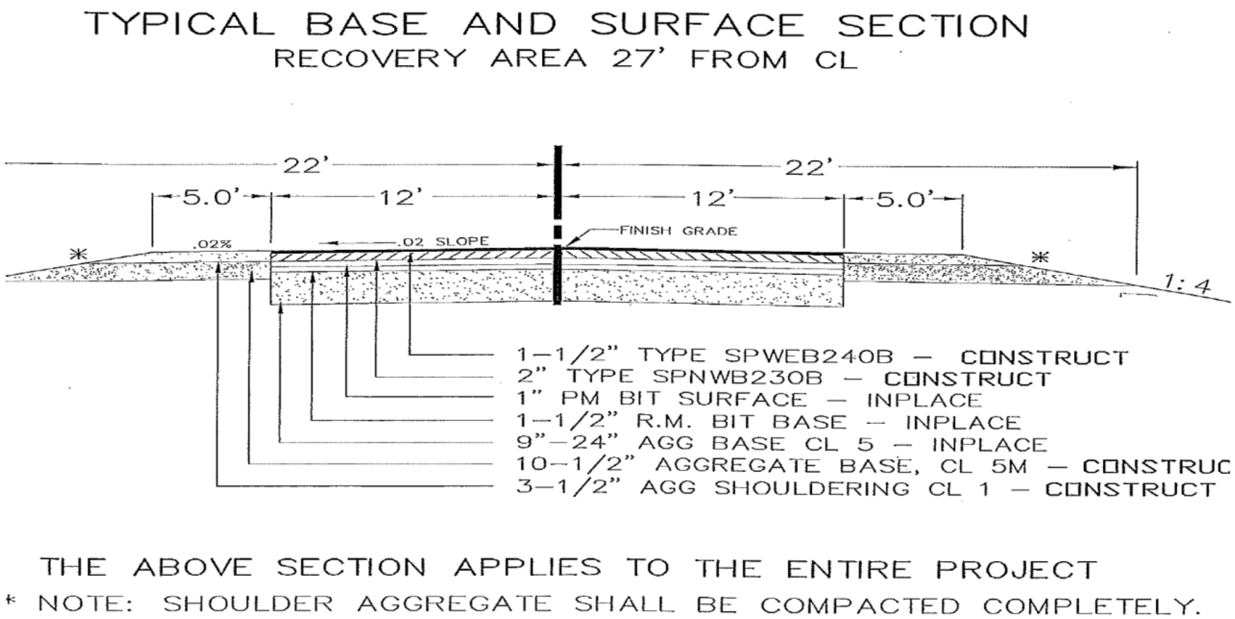

Figure 2 – Ditch – Bottom Water Collector