

# **The Road to Reuse: York County's Ash Management Program**

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## **ABSTRACT**

The decreasing availability of new waste disposal sites, difficulty in obtaining regulatory approval and public acceptance for such sites, coupled with the need to control solid waste management cost, continues to drive solid waste managers to develop more efficient and cost-effective programs. One aspect of municipal waste management that has been the subject of much debate is municipal waste combustor ash. The current combination of emerging technologies, project economics, and regulatory acceptance has led to the active consideration of beneficial use of ash as a viable management alternative.

This paper presents a case study of the development of York County's ash management program. Designed to coordinate with the existing integrated Solid Waste Management Plan, York County's Ash Management Planning Study evaluated long-term ash management options including alternatives such as disposal and recycling; treatment and processing technologies; markets; regulatory factors; comparative cost analyses; as well as comparative risk analyses. Using the Ash Management Planning Study as its road map, York County pursued the procurement of ash treatment and recycling services that resulted in the selection of the full-service ash recycling vendor, American Ash Recycling Corporation. This paper traces the process followed by York County to develop its comprehensive ash management program.

## **INTRODUCTION**

York County is located in Southcentral Pennsylvania, just north of Maryland and immediately west of the Susquehanna River. With a population approaching 360,000, approximately 420,000 tons of municipal solid waste (MSW) is generated each year. The majority of York County's populace resides in the vicinity of the County's seat, the City of York, located near its geographical center.

In 1971 the York County Commissioners chartered the York County Solid Waste and Refuse Authority (the Authority) to plan for and facilitate environmentally responsible, safe, and economically effective management of all MSW generated within York County. The County's 1971 Solid Waste Management Plan established the specific goal of minimizing dependence on landfilling by maximizing the use of environmentally responsible alternatives, including resource recovery through waste-to-energy and other recycling techniques. That goal has since been restated in both the 1985 and 1991 revisions of York County's original solid waste management plan.

In 1985, the Authority committed to waste-to-energy to serve the residents of York County. The York County Resource Recovery Center (York County RRC) commenced operations in 1989 and has since processed all of the combustible MSW generated within the County, as well as waste from out-of-county contract and spot market sources; a total averaging more than 440,000 tons per year for 1996 and 1997. The success of the York County RRC is complemented by other components of York County's integrated solid waste management system including leaf and yard waste composting, source-separated

recyclable collection, landfilling of non-combustible wastes and York County RRC ash residue, and public education programs emphasizing waste minimization and recycling. Beginning in 1998, the Authority will close the recycling loop on all waste processed at the York County RRC when they commence delivery of York County RRC ash to a recycling facility to be constructed, owned, and operated by the American Ash Recycling Corporation (AAR).

## **SURVEYING THE ROUTE**

From the time of facility startup through December 1997, the majority of ash from the York County RRC was disposed in a monofill cell at the York County Sanitary Landfill. During 1996 and 1997, a portion of the ash was used as daily cover material at Waste Management, Inc.'s Modern Landfill, also located in York County. With the York County Sanitary Landfill entering closure in early 1998, the Authority initiated the development of a comprehensive ash management program in 1995 to ensure continued ash management services that are both environmentally responsible and cost-effective. Several ash management strategies were investigated, including landfill disposal, treatment and processing technologies, and beneficial use.

To be certain that the ash management program was consistent with the overall solid waste management strategy, the Authority established a set of primary objectives on which the program would be based. These objectives are:

- 1) to maintain compliance with ash testing/characterization protocols in accordance with regulatory requirements and to maintain the status of the York County RRC ash as non-hazardous waste;
- 2) to maintain a cost-effective ash management program;
- 3) to allow for beneficial use to the greatest extent practicable; and
- 4) to incorporate flexibility so that currently developing and future ash management alternatives may be implemented.

## **Ash Management Planning Study**

York County's ash management program was developed based on a two-phased Ash Management Planning Study (Study). Phase I consisted of the identification and evaluation of potential ash treatment technologies that could satisfy the first objective listed above. Phase II evaluated ash management alternatives based on compliance with the four primary objectives. Only those technologies identified as acceptable in Phase I were considered in Phase II.

### **Phase I - Evaluation of Ash Treatment Technologies**

Based on the knowledge and experience of the Authority and their consultant, Malcolm Pirnie, Inc., potential ash treatment technologies were identified for consideration. The potential treatment technologies are listed in Table 1. Commercially available proprietary treatment technologies, for which either licensing agreements or vendor/operator service are required, were compared to non-proprietary technologies which the Authority could develop and implement on its own. Additionally, a no treatment option was included to serve as a basis of comparison to the other treatment technologies. The treatment technologies evaluated included both physical/chemical and thermal treatment methods. Detailed discussions of these ash treatment technologies have been widely reported and such discussions are not provided in this paper. For more information, the reader is referred to the literature, including the references listed at the end of this paper.<sup>1,2,3,4</sup>

As noted above, the evaluation criteria included regulatory, technical, and economic factors. While all potential treatment technologies listed in Table 1 were evaluated based on the regulatory and technical factors, the economics were evaluated for only those technologies considered feasible on a regulatory and technical basis. The following briefly describes these evaluation factors:

- Regulatory Factors - Evaluation through the review of regulatory requirements for ash management (25 PA Code Chapter 283 and related sections) and the status of treatment technology approvals in Pennsylvania and other states.
- Technical Factors - Evaluation of treatment technologies based on facility operating history and experience, impacts to the Authority's current ash management program, and related operational issues.
- Economic Factors - Evaluation of selected treatment technologies based on capital costs, operating and maintenance costs, and licensing fees and royalties.

Following the review of each technology with respect to regulatory and technical criteria, the Authority determined that economic evaluations should be completed on the following treatment options (listed alphabetically).

- American Ash Recycling Corporation
- American REF-FUEL
- McKaynite
- Resource Recycling, Inc.
- Rolite, Inc.
- WES-PHix.

The results of the economic evaluation of the selected ash treatment technologies are summarized in Table 2. These economic evaluations were supported in part by cost estimates provided by vendors to the Authority in response to a preliminary request for proposals for the beneficial use of ash from the York County RRC issued in October 1994. The complete evaluation of ash treatment technologies is discussed in the project report prepared for the Authority.<sup>5</sup> These six treatment technologies were further evaluated with respect to available ash management options in Phase II of the Study.

### **Phase II - Evaluation of Ash Management Alternatives**

Ash management alternatives including co-disposal, monofill disposal, and beneficial use were evaluated in Phase II of the Study. Alternative sites and vendors for the disposal and beneficial use of ash from the York County RRC were identified based on existing and planned facilities and projects in Pennsylvania. Critical to the evaluations conducted by the Authority was the compatibility between the treatment technologies and ash management alternatives being considered.

Co-disposal, a viable management alternative, provides for the disposal of ash in a mixed waste landfill. With significant co-disposal capacity available in Pennsylvania, costs for this option were expected to remain stable. Three potential co-disposal facilities were identified for this Study (two operating landfills, the Modern Landfill in York County and the Conestoga Landfill in Berks County; and one contemplated but undeveloped site, the Milton Grove site in Lancaster County). Potential treatment technologies considered compatible with co-disposal were those resulting in a reduction (or minimal increase) in the quantity of ash to be managed; including physical processing for removal of recoverable metals and combustibles, certain forms of chemical treatment, and no treatment.

Monofill landfill technology utilizes independent landfill cells to segregate landfilled wastes. With the closure of the York County Sanitary Landfill, the advantages of monofill disposal - the ability to control exposure to potential liabilities generally associated with waste disposal and the opportunity to recover materials for future beneficial use - could be preserved at another monofill facility. Potential monofill facilities considered included the expansion of the York County Sanitary Landfill, the Frey Farm Landfill in Lancaster County, and a new, unidentified site in York County. Preferred treatment options for monofill disposal were the same as those for co-disposal.

Beneficial use provides the advantage of reducing dependency on landfills. In order to implement a successful beneficial use program, the Authority understood that treatment and/or processing may be necessary, viable markets for the ash or ash products would need to be developed, and regulatory approval would be required. Potential sites for processing facilities included the York County Sanitary Landfill, the York County RRC, and a third party site. Recognizing that treatment and/or processing would depend on the intended use of the ash product and must not create any unacceptable environmental risks, the Authority evaluated various combinations of treatment, processing, and beneficial ash uses. The ash beneficial uses considered have demonstrated their ability to protect the environment and to provide an acceptable product for reuse. Beneficial uses considered in the Study include landfill gas venting material, structural fill, environmental restoration materials, and construction and paving aggregates.<sup>6,7,8</sup>

While evaluating beneficial use opportunities, including treatment alternatives and markets, the Authority focused on two fundamental approaches to ash management: Authority-controlled treatment, processing, and marketing or the procurement of limited or full-service vendors. The Authority, recognizing that it would otherwise be burdened with developing new markets, determined that vendors capable of marketing all or some of the components of the ash stream should be considered. Thus AAR, American REF-FUEL, Resource Recycling, Inc., and Rolite, Inc. were evaluated as potential vendors.

### **Additional Considerations**

In addition to the regulatory, technical, and economic factors considered in the evaluation of ash treatment and management alternatives, the Authority also considered how each selected alternative could impact the Authority's management of risk. As part of their review, the Authority identified a list of institutional and policy considerations that were critical to defining the risks associated with each ash management alternative. Those institutional and policy issues considered by the Authority as important to the selection of an appropriate ash management program included:

- 1) responsibility for and/or, involvement with selection, installation, and operation of the ash treatment system;
- 2) responsibility for permitting and obtaining regulatory approval;
- 3) ownership of technologies/facilities;
- 4) responsibility for procurement and costs of the ash treatment system;
- 5) responsibility for performance review and QA/QC of the treated ash product;
- 6) cost:benefit of using proprietary systems;
- 7) ownership of the ash;
- 8) environmental indemnification;
- 9) vendor compliance history;
- 10) vendor operating experience; and
- 11) vendor financial strength.

The Authority's decisions regarding the institutional and policy considerations listed above were guided by the four specific objectives of the Authority's ash management program. The incorporation of institutional and policy issues into the evaluation of ash management alternatives facilitated the Authority's identification of the potential risks and rewards of each available option.

### **Concepts for Implementation**

The review and evaluation of available ash management alternatives were completed to identify the optimum ash management program for the Authority, within the context of the County's Solid Waste Management Plan. As the final step in developing the Study, the Authority and Malcolm Pirnie developed five conceptual models of selected ash management programs to optimize its planning activities:



- 1) continued disposal of untreated ash;
- 2) disposal of treated ash;
- 3) beneficial use of treated ash by the Authority utilizing proprietary treatment and processing technologies;
- 4) beneficial use by a proprietary, full-service vendor; and
- 5) beneficial use by the Authority utilizing non-proprietary technologies.

Using the conceptual models and economic information obtained in Phase I of the Study, complemented by additional vendor cost data supplied to the Authority in response to a preliminary request for proposals for the beneficial utilization of ash issued in 1994, the Authority compared the feasibility of each ash management alternative. Since all alternatives were considered feasible based on regulatory and technical criteria, the evaluation focused primarily on the projected economic impacts of each alternative. Figure 1 illustrates the relative projected costs, including transportation from the York County RRC, for each ash management program modeled. This comparison indicates that the implementation of a beneficial use program operated directly by the Authority could have potentially minimized ash management costs. However, upon consideration of the institutional and policy issues discussed above and the Authority's risk management preferences, the Authority determined that York County would be best served by contracting with a qualified vendor to provide ash processing and reuse services. Based on its decision that beneficial use of York County RRC ash was environmentally and economically preferable to landfill disposal, the Authority focused on implementing beneficial use, its preferred ash management strategy.

## **REALIZING THE PROGRAM**

At its June 1996 meeting, the Authority took action aimed at achieving the four objectives established for the ash management program. Those actions focused on the following two aspects of the ash management program:

- Ash characterization: ash sampling, analysis and data evaluation, as well as assessing the need for and available means of accomplishing ash treatment to maintain non-hazardous status; and
- Ash materials management: including various specific ash reuse and disposal options for each component of the ash stream.

Planning to ensure that the ash remained characterized a non-hazardous waste, the Authority performed statistical analyses of existing ash characterization data in accordance with available regulatory guidance.<sup>9</sup> Based on the results of those analyses the Authority determined that it was not necessary to install a treatment process solely for the purpose of maintaining the non-hazardous status of York County RRC ash. Rather, continuation of ash characterization testing and proper attention to testing procedures and data trends would provide sufficient opportunity for implementation of ash treatment if it were to become necessary. This course of action was deemed appropriate largely due to the observed trends in ash quality and the results of sensitivity analyses which demonstrated a low probability that unfavorable conditions of ash quality would occur. Further, the Authority identified WES-PHix as the treatment technology to be implemented in the event of the occurrence of unfavorable trends in ash quality. WES-PHix was selected as the preferred contingency treatment technology because of the following benefits it affords:

- it is compatible with ash management options considered by the Authority;
- its impact on the quantity of ash would be minimal;
- it has been proven to be reliable and effective;
- it can be implemented upon relatively short notice;

- it can be installed within the York County RRC building, satisfying EPA's "four walls" criteria; and
- it was determined to be relatively cost effective.

In addition to selecting WES-PHix as the appropriate contingency treatment technology, the Authority decided to complete certain up-front administrative tasks to reduce the implementation period in the event ash treatment were to become necessary to maintain non-hazardous ash status. Those activities included the development of an implementation plan for the design, procurement, installation, and operation of the WES-PHix process.

Besides chemical treatment to maintain the non-hazardous status of the ash and to facilitate beneficial use, the Authority was interested in enhancing the physical processing of ash from the York County RRC to increase the quantity and value of recovered metals while decreasing the quantity of ash to be managed. Existing equipment at the York County RRC fails to remove a significant portion of the ferrous metals from the ash residue, and, there is no non-ferrous metal recovery. Based on the economics of avoided costs and potential revenue from the sale of recoverable metals, the Authority determined that enhanced ash processing to increase the quantity and value of ferrous and non-ferrous metals removed from York County RRC ash residue was likely to be economically attractive, as well as environmentally desirable. Enhanced recovery of metals from the ash would also compliment ash management alternatives through homogenization and minimization of the amount of ash residue to be managed.

The ash management planning process conducted by the Authority to this point had concluded that beneficial use would be more consistent with the Authority's explicit ash management goals than would landfilling, and that existing ash reuse options could offer environmental as well as financial benefits. Therefore, in June 1996, the Authority decided to solicit proposals for beneficial use of two distinct components of the York County RRC ash residue stream: 1) recoverable metals and 2) recoverable ash. By considering these components separately and seeking proposals to recycle both, the Authority established a means of realizing its stated ash management objectives. Furthermore, by soliciting proposals in 1996, the Authority preserved their opportunity to make favorable landfilling arrangements in the event ash reuse did not prove feasible prior to closure of the York County Sanitary Landfill.

### **Ash Management Procurement**

On November 1, 1996 the Authority issued two requests for proposals (RFP). One RFP was for the processing of ash for recovery of ferrous and non-ferrous metals, marketing of recovered metals and sizing of the remaining ash material. The second RFP was for the beneficial use of the ash remaining after processing for metals recovery. While the Authority encouraged vendors to respond to both RFPs, thus providing comprehensive ash management services, the RFPs were issued separately to encourage responses from the maximum number of vendors, affording the Authority the greatest flexibility in constructing its ash management program. On December 2, 1996, the Authority received and opened three responses to their RFPs. Table 3 summarizes the key points of each proposal.

In January 1997, based on the relative merits of the proposals, the Authority elected to enter into contract negotiations with AAR of Pennsylvania. On June 2, 1997, the Authority and AAR signed an agreement for management of the ash from the York County RRC. Specific terms of that agreement include:

- AAR will obtain all necessary permits for ash reuse and facility operations;
- AAR will design, build, own, and operate the ash processing facility;
- AAR will finance facility construction. The Authority will pre-pay \$5.5 million in processing fees and will retain interest in the facility as collateral;

- AAR will accept, process, and reuse all ash from the York County RRC (so long as it is characterized as non-hazardous);
- the Authority is not subject to annual or lifetime minimum or maximum ash quantity deliveries;
- ten year contract term with options for extension;
- AAR will carry significant insurance including a minimum of \$5.0 million in pollution products liability protection;
- the Authority will pay AAR \$19.92 (1998\$) per ton of ash delivered, adjusted annually;
- the Authority receives a host fee for ash brought from other sources; and
- the Authority receives a share of profits above a specified level.

The terms of this agreement will result in an all-in ash management cost, including transportation, of approximately \$28 per ton for 1998, a cost significantly less than the Authority's 1998 contracted ash disposal rate at Modern Landfill of \$58 per ton.

### **Project Status**

In December 1996, AAR applied to PADEP for a Beneficial Use permit to use treated ash residue as a substitute for construction aggregate. In May 1997, AAR received the permit from the Southcentral Regional Office which permitted the proposed beneficial use within the 15-County Southcentral Region. In July 1997, AAR filed for a State-wide General Permit to construct and operate the ash recycling facility. In December 1997, PADEP issued General Permit Number WMGM003 for the processing of municipal waste ash and beneficial use of the treated ash aggregate as a base and sub-base under roads and other paved surfaces, aggregate for asphalt manufacturing, structural fill materials and substitute aggregate in concrete. Construction of the facility, located at the site of an active aggregate production plant, was initiated in February 1998. Commercial operations are scheduled for May 1, 1998. The treated ash product will be sold under contract to an aggregate producer.

### **CONCLUSIONS**

The Ash Management Planning Study provided the Authority with a master plan for the evaluation and development of alternative ash management strategies. The Authority, through its focused review and evaluation of regulatory, technical, economic, and institutional and policy issues, has developed and implemented an ash management program specifically adapted to the needs of York County. York County's ash management program will not only provide York County citizens immediate benefits through stabilized solid waste management fees due to lower ash management costs, but will also reduce pressure on landfill capacity by eliminating landfill disposal of ash. York County's forward looking management program for ash from the York County RRC will also help to reduce society's burden on our limited natural resource base.

## REFERENCES

- <sup>1</sup>Oden, L.L.; O'Connor, W.K. *Vitrification of Residue (Ash) from Municipal Waste Combustion Systems*, ASME/U.S. Bureau of Mines Investigation Program, New York, NY, 1994; CRTD-Vol. 24.NREL/TP-430-7382.
- <sup>2</sup>Kosson, D.S.; Kosson, T. *Evaluation of Solidification/Stabilization Treatment Processes for Municipal Waste Combustion Residues*, U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH, 1993; EPA/600/R-93/167.
- <sup>3</sup>Hollander, H.I.; Plumley, A.L.; DeCesare, R.S. "Vitrification of Combustion Ash Residue for Beneficial Use", *Solid Waste Technologies*. 1995, Vol. 9 No. 3, 31-40.
- <sup>4</sup>Chesner, W.H. "Treating Ash to Reduce Metal Leaching", *Solid Waste Technologies*. 1994, Vol. 8 No. 6, 36-43.
- <sup>5</sup>Malcolm Pirnie, Inc. "Ash Management Planning: Evaluation of Ash Disposal/Management Alternatives"; Prepared for the York County Solid Waste and Refuse Authority, by Malcolm Pirnie, Inc., White Plains, NY. March 1996.
- <sup>6</sup>Sawyers, D.E.; Barbagallo, J.C.; Bolton, R.E. "Innovations in MWC Ash Management, The ASME 17th Biennial Waste Processing Conference, 1996, The American Society of Mechanical Engineers: New York, NY, 1996; pp 175-180.
- <sup>7</sup>Jones, C.M.; Hartman, R.M.; Kort, D.; Rapues, N. *Utilization of Ash From Municipal Solid Waste Combustion - Final Report, Phase I*; National Renewable Energy Laboratory, Golden, CO, 1994;
- <sup>8</sup>Breslin, V.T.; Roethal, F.J.; Schaeperkoetter, V.P. "Physical and Chemical Interactions of Stabilized incinerator Residue with the Marine Environment", *Marine Pollution Bulletin*. 1988, Vol. 19, No. 11B, 628-632.
- <sup>9</sup>Office of Solid Waste. *Guidance for the Sampling and Analysis of Municipal Waste Combustion Ash for the Toxicity Characteristic*; U.S. Environmental Protection Agency, Washington, D.C., 1995; EPA/530/R-95/036.



**Table 1.** Potential ash treatment technologies considered in Phase I.

<i>Vendor</i>	<i>Technology</i>
<b>Proprietary Technologies</b>	
American Ash Recycling Corporation	Physical/chemical treatment producing construction aggregates
American REF-FUEL	Physical/chemical treatment utilizing various waste materials to produce grout ad-mixtures for use in mine reclamation projects
Laidlaw Energy Technologies, Inc. SARP Industries, Inc.	Chemical stabilization process
Permabase, Inc. Rolite, Inc.	Chemical stabilization/physical treatment process producing construction aggregates
Resource Recycling, Inc.	Mechanical processing to remove metals and other oversize materials for recycling.
Wheelabrator Environmental Systems, Inc.	McKaynite Process - chemical stabilization/physical treatment process producing construction aggregates
	WES-PHix Process - Chemical stabilization process
Ausmelt Limited Corning, Inc. Geo-Tech Development Corporation	Vitrification (Smelting)
Plasma Technology Corporation	Vitrification (Electric Arc Furnace)
<b>Non-Proprietary Technologies</b>	
Chemical Treatment (Reuse of Cooling Tower Blowdown Water)	
Chemical Treatment (Lime Addition)	
Physical/Chemical Treatment (Portland Cement Addition)	
Metals Removal (Physical Processing via Screening/Separation)	
Materials Blending (Blending with soil/leaf and yard waste compost)	
<b>Other</b>	
No Treatment	

**Table 2. Economic evaluation of ash treatment technologies.**

Vendor	Estimated Capital Cost Range	Capital Cost Recovery (1)		O&M Costs (per ton) (2)	Total Cost (1996\$) (per ton)	October 1994 Cost Proposal (3)
		Annual Payment	(per ton) (2)			
American Ash Recycling Corp. (4)	\$3,000,000 - \$3,500,000	\$410,000 - \$480,000	\$4 - \$5	\$25 - \$35	\$29 - \$40	\$31.50
American REF-FUEL (5)	Not Available	Not Available	Not Available	Not Available	<\$40	(6)
Resource Recycling, Inc.	\$500,000 - \$1,500,000	\$70,000 - \$200,000	\$1 - \$2	(7)	\$1 - \$2 (8)	(9)
Wheelabrator Environmental Systems, Inc.						
WES-PHix	\$400,000 - \$1,000,000	\$50,000 - \$140,000	\$1 - \$1	\$3 - \$7	\$4 - \$8	(6)
McKaynite	\$3,000,000 - \$4,000,000	\$410,000 - \$540,000	\$4 - \$5	\$25 - \$35	\$29 - \$40	(6)
Rolite, Inc.	\$1,500,000 - \$2,500,000	\$200,000 - \$340,000	\$2 - \$3	\$25 - \$35	\$27 - \$38	\$36.89

**Notes:**

1. Amortized Capital Cost assumes that all capital costs are financed at an annual interest rate of six percent for a period of 10 years. Per ton cost are rounded to nearest dollar.
2. Estimated ash production based on the following assumptions: 375,000 tons MSW processed annually and ash weight equals 28% of MSW weight (105,000 tons ash per year).
3. Cost proposals submitted in response to the Authority's October 1994 RFP for Beneficial Ash Utilization.
4. Utilizes the WES-PHix chemical treatment process.
5. American REF-FUEL data based on the Authority's discussions with the vendor.
6. Did not respond to the Authority's October 1994 RFP for Beneficial Ash Utilization.
7. Resource Recycling, Inc. reported O&M costs are recoverable through the sale of recyclable materials recovered from the ash stream.
8. Cost per ton of ash treated for capital cost recovery. Estimated O&M costs not provided by vendor. (See Note 7).
9. Cost proposal submitted as joint-venture with Rolite, Inc.

**Table 3.** Summary of proposals submitted in response to the Authority's June 1996 RFP for ash management services.

<i>Vendor</i>	<i>Proposal Highlights</i>
American Ash Recycling Corp.	<ul style="list-style-type: none"> <li>- processing for metals recovery and ash reuse in construction applications</li> <li>- manage all of the Authority ash</li> <li>- 10-year commitment</li> <li>- the Authority to receive host fees for ash brought to facility from other sources</li> <li>- \$30/ton (plus transportation estimated at \$3.00 per ton)</li> <li>- offer contingent on AAR receipt of permits</li> </ul>
Modern Landfill, Inc. (Subsidiary of Waste Management, Inc.)	<ul style="list-style-type: none"> <li>- portion of ash stream to be used as daily cover in co-disposal environment (remainder to be managed separately by the Authority)</li> <li>- proposal did not include processing for metals recovery</li> <li>- could divert ash to GROWS Landfill with the Authority paying higher tip fee plus transportation based on capacity constraints at Modern Landfill)</li> <li>- could terminate at their discretion (based on limited capacity at Modern Landfill)</li> <li>- \$22.35/ton (plus transportation estimated at \$3.00 per ton)</li> <li>- constraints on ash moisture and particle size.</li> </ul>
ARCNET (American REF-FUEL subsidiary)	<ul style="list-style-type: none"> <li>- proposal included transportation, processing for metals recovery and use of treated ash</li> <li>- 10-year commitment</li> <li>- permits already approved</li> <li>- proposal contingent on suitability of ash in grout formulation</li> <li>- \$40.37/ton of ash delivered (the Authority to share 25% of revenues from sale of recovered metal)</li> </ul>

Figure 1. Summary of projected costs for ash management alternatives.

