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Project Summary

The Use of Alternative Materials for Daily Cover at Municipal Solid Waste Landfills

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This investigation was conducted to assess the applicability of currently available (ca. 1992) alternative materials for use as daily cover at landfills. Information on characteristics, material and equipment requirements, methods of preparation and application, climatic and operational considerations, effectiveness, and costs were evaluated with respect to present status and potential for use.

Results indicated that alternative daily cover materials (ADCMs) can augment management practices at municipal solid waste landfills while enhancing environmental control. Although applicability of ADCMs varied depending on site specificity and the particular material used, most were easily applied, satisfied operational and regulatory requirements, saved landfill capacity, decreased soil requirements, and facilitated leachate and gas management and control. Although most materials met established criteria for daily cover, differences exist that warrant development of consensus performance standards for use and application. Further development and integration into overall landfill management practices are also justified.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The diminishing availability of landfill sites and associated solid waste management challenges are major issues nationwide. In addition, landfilling costs are increasing as more stringent regulatory requirements make design and operation more complex and attentive to health and environmental safeguards. This has prompted recent changes in landfill management and operational practices to conserve space, improve efficiency, and enhance public acceptance. One such change is the emphasis being given to options for meeting daily cover requirements. These options include using alternative daily cover materials (ADCMs) that help conserve landfill space and reduce cover soil requirements without diminishing health, environmental aesthetics, and other site management and use standards.

Daily cover functions to control disease vectors, blowing litter, odors, scavenging, and fires. It should also be effective under various operating conditions, permit controlled management of leachates and gases, and improve aesthetics. Because of its usual availability and traditional use at landfills, soil remains the most commonly employed material for daily cover. However, soil tends to consume landfill capacity, is not always readily and economically available or suitable under various operational conditions, and requires allocation of equipment and personnel. Therefore, consideration of commercially available products and various indigenous

materials as alternatives for daily cover is warranted.

This investigation addresses the feasibility, benefits, and limitations of currently available ADCMs from operational, performance, environmental, and economic perspectives and identifies issues deserving further consideration and development.

Methods and Procedures

Consistent with project objectives, various types of ADCMs were identified and characterized with respect to use and performance by evaluating the technical literature, interviewing landfill owners/operators, and visiting landfills where ADCMs were being applied. Supplemented by a questionnaire sent to state regulatory agencies, U.S. Environmental Protection Agency's (EPA) regional offices, known manufacturers and suppliers of ADCMs, solid waste management associations, and owners/operators with ADCM experience, we identified 16 commercially available and 8 indigenous ADCMs.

Results and Discussion

Types of ADCMs

Commercially Available Products

There has been a significant recent growth in developing, marketing, and using commercially available ADCMs at solid waste landfills. Based on composition, method of application, and general performance, the 16 identified ADCMs were: four foam, three spray-on, and nine geosynthetic products; their general characteristics and costs are presented in Tables 1 through 3. Although it is recognized that individual products will vary with respect to performance under varying operational conditions (Table 4), key features of each of the principal groups are described below.

Foams

Foam ADCMs are usually applied to the landfill working face in 2- to 6-in.- (5- to 15-cm) thick layers by using self-propelled or towed foam generation and application equipment specifically designed for a particular foam. Both hardening and nonhardening foams are available, and they retain their structural integrity from 15 hr to 7 days depending on the specific product and the effect of climatic conditions (particularly rainfall). Effectiveness as a daily cover depends on the thickness of application and sufficiency of coverage, which may be stipulated by permit requirements. Foam ADCMs are effectively destroyed placing additional wastes on them on the next operating day.

Spray-ons

Slurry or emulsion spray-on ADCMs are applied to the working face using towed or skid-mounted application equipment, similar to hydroseeders but specifically designed for use with a particular product. These products are applied in a 1/16- to 1/2-in.- (0.16 to 1.27-cm) thick layer and allowed to dry to a crust or shell. Spray-ons can retain their matted structure from 1 wk to 3 mo depending on product and thickness and continuity of coverage. Working face preparation and operator proficiency during application are important factors in determining the effectiveness of cover. Spray-on ADCMs are also mechanically destroyed by placing additional wastes on them on the next operating day.

Geosynthetics

Geosynthetic ADCMs consist of various types of geosynthetic materials that have either been developed or adapted for use as daily landfill cover. Panels fabricated from these materials are placed over the working face at the end of the day and retrieved before the start of the next operating day. Panel placement and retrieval is done manually or with available landfill equipment. At some landfills, specially designed and fabricated ancillary equipment such as tow bars, lifting bars, reels, or rollers is used to facilitate panel placement and retrieval. Most panels are reused until they no longer provide an effective cover because of their physical deterioration resulting from tears and punctures during placement and retrieval from climatic stresses from wind, rain, and freezing temperatures. Effective life of panels is 1 to 3 mo, although some panels have been used for 12 to 18 mo.

Indigenous Materials

Indigenous ADCMs may consist of various types of locally available waste products, including ash-based materials, shredded automobile components and tires, sludges and sludge-derived products, dredged materials, foundry sand, petroleum-contaminated soils, and shredded green wastes. Many of these same materials are routinely disposed of at landfills. Demonstrating their acceptability may require physical modification, chemical conditioning, or special analysis, since each can vary significantly with respect to physical and chemical characteristics and effectiveness under various operational and climatic conditions. Moreover, although indigenous materials are usually applied with available landfill equipment at the same (or greater) thickness as soil cover, additional equipment/facilities may be required for processing and on-site storage. Indigenous materials are generally able to meet established criteria for daily landfill cover; however, some materials such as dredged material, sludges, and sludge-derived products can intensify odors when first applied, and other materials such as green wastes and shredded tires are combustible.

Site Operation and Management Implications for ADCMs

The merit of using of ADCMs at landfills is often determined by operational, performance, and economic comparisons with soil. These comparisons may include inspection of the effect on landfill capacity, soil requirements, application and performance considerations, climatic conditions, leachate and gas management, operational costs, and other site-specific requirements.

Effect on Landfill Capacity

Landfill owners/operators identify the potential savings in landfill capacity as the most important reason for using ADCMs, primarily because of extended landfill life and additional revenues from the space otherwise occupied by soil. Such savings are generally independent of the type of alternative cover material used but directly depend on how often the ADCM is actually used in lieu of soil. The latter is largely determined by climatic conditions, but availability of materials or constituents, the condition and/or age of the material, and the efficiency and reliability of the application equipment or methods are also important.

Effect on Soil Requirements

Use of ADCMs decreases the need and relative costs for soil as daily cover, so that on-site soils are conserved or offsite acquisition is reduced. Equipment and personnel costs for moving and placing soil cover also decreases, as does vehicular traffic, road maintenance (both offsite and onsite), and noise and dust generation.

Application and Performance Considerations

Ease of application with less equipment, personnel, and time than that required for soil cover is an important operational and economic consideration. This can be particularly significant for sites where adverse weather conditions such as rain or freezing temperatures can curtail use of soil cover to a greater degree than would occur with certain ADCMs. Moreover, since

less time may be needed to apply ADCMs, larger quantities of wastes can be received at the landfill for longer periods of time than would otherwise be possible, thereby extending service and increasing associated revenues.

Although most ADCMs are able to meet established criteria for daily cover from both operational and regulatory perspectives, distinctions exist among the various ADCMs with regard to their effectiveness for odor and fire control and for minimizing moisture infiltration under various climatic and operational conditions. In addition, site-specific circumstances will often dictate the approach to satisfy cover criteria. With few exceptions, performance-based standards for evaluating the effectiveness of ADCMs have not been established, and subjective judgement comparing the ADCM to a standard 6 in. (15 cm) of compacted soil is often used.

Effect of Climatic Conditions

Various conditions of rainfall, temperature, and wind affect ADCM use—the ease and frequency of application and retrieval and the effectiveness. Moderate to heavy rains can wash out nonhardening foams, and hardening foams and spray-ons cannot be applied under such conditions. Rain can also increase the weight of nonwoven geosynthetics and make them more difficult to handle. Under windy conditions, panel placement may not only require additional time and personnel but may also be unsafe or impractical. Geosynthetic panels can also freeze to the working face or be covered with snow, both of which increase the risk of loss or damage on retrieval.

Leachate and Gas Management

The use of ADCMs can enhance controlled leachate and gas management by limiting the development of intervening cover layers. Eliminating such layers facilitates unimpeded movement and collection of leachates and gases within and between the landfill cells and when leachate recycle for accelerated stabilization is practiced. Therefore, commercially available products may be preferred over some of the indigenous materials.

Although foam and spray-on covers are mechanically destroyed when additional wastes are placed over them on subsequent operating days, these and some indigenous materials remain within the landfill and may affect leachate composition and its subsequent disposition or otherwise affect the progress of landfill stabilization. Because stabilization processes within a landfill normally occur over extended periods, and many ADCMs have been available and used for only a relatively short time, potential long-term effects of constituents leached from alternative cover materials, although generally considered to be minimal, may need to be established.

Operational Costs and Site Requirements

Operational costs and other site-specific requirements may also affect the feasibility of using a particular ADCM. Although the determination of potential cost savings associated with ADCMs is usually made by comparing them with soil as a daily cover, additional factors such as availability of storage facilities for some ADCM constituents and application equipment, utility requirements, landfill working-face preparation needs, and operator skills and safety implications must also be evaluated.

Conclusions

Based on the results of these investigations, the following conclusions can be drawn:

- Use of alternative materials for daily cover in lieu of soil can result in operational, performance, environ-mental, and economic benefits at municipal solid waste landfills. These benefits include ease of application, improved effectiveness in meeting site operational and regulatory requirements, savings in landfill capacity, decreased requirements for soil, and more effective management of leachates and gases.
- Most alternative daily cover materials are able to meet established criteria for daily cover under various operational and climatic conditions. Certain materials are more effective than soil as a daily cover, especially with respect to control of vector access, blowing litter, and odor generation and to the minimization of moisture infiltration.
- The effectiveness of ADCMs depends on properly preparing the landfill working face preparation and on equipment-operator proficiency. Climatic conditions and other site-specific considerations will also influence the choice of ADCM, its method of application, and effectiveness as daily cover.
- Evaluation of the effectiveness of ADCMs in meeting operational and regulatory criteria for daily cover is generally based on subjective comparisons with soil cover. Lack of consensus, performance-based standards for various operational and climatic conditions limits the selection and regulation of ADCMs for landfill applications.

Recommendations

Recommendations regarding the future development and use of ADCMs include:

- integration of ADCMs as alternative cover options into the design, construction, and operation of landfills for solid waste management;
- establishment of performance-based standards to permit more objective evaluations of the short- and long-term effectiveness and suitability of ADCMs; and
- coordination between manufacturers of ADCMs and the regulatory and user communities to ensure appropriate use of ADCMs and to establish training and certification programs.

The report was submitted in fulfillment of Contract No. 68-C1-0018 by Eastern Research Group, Inc., under the sponsorship of the U.S. Environmental Protection Agency.

Table 1. *Foam Cover Products*

Product/ Manufacturer	Product Description	Material Cost*,†	Application Equipment Cost*	Comments
RUSMAR© RUSMAR, Inc. West Chester, PA	Nonhardening foam (consistency of shaving cream)	$0.06-0.07/ft² ($0.65-0.75/m²)	Self-propelled (includes BSD)- $250,000-$300,000 Towed- from $85,000	BSD Bulk Storage and Dilution Unit for foam concentrate. Self-propelled and large-capacity towed equipment are freeze protected. Average cover duration: 15-20 hr.‡
SaniFoam™ 3M Industrial Chemical Products Div. St. Paul, MN	Polyamino hardening foam (resembles Styrofoam® when cured)	$0.08-0.10/ft² ($0.86-1.08/m²)	Self-propelled- $130,000 Towed- $40,000-$70,000	Average cover duration: 3-6 days.‡
TerraFoam™ National Foam, Inc., Environmental Products Div. Exton, PA	Nonhardening foam (consistency of mousse)	$0.05-0.06/ft² ($0.54-0.65/m²)	Self-propelled- $300,000 Truck-mounted- $70,000	Average cover duration: 3-7 days.‡
TopCoat™ Central Fiber Corp. Wellsville, KS	Polymer-based hardening foam	$0.10-0.12/ft² ($1.08-1.29/m²)	Towed- $25,000	Cost information is based on limited field tests. Insufficient information is available on cover duration.

* 1992 cost information obtained from manufacturer's representative. Personnel costs associated with the application of the foam and application equipment maintenance costs are not included.
† Material cost is based on application of 3-in.-(7.5-cm) thick layer, except for SaniFoam™ which is based on a 2-in.-(5cm) thick layer.
‡ Duration of cover depends on climatic conditions, particularly rain.

Table 2. *Spray-on Cover Products*

Product/ Manufacturer	Product Description	Material Cost*	Application Equipment Cost*	Comments
ConCover© New Waste Concepts, Inc. (formerly Newastecon,Inc.) Perryburg, OH	Aqueous slurry of recycled newspaper/wood fibers and binding agent; hardens to form 1/8- to 1/4-in.- (0.32- to 0.64-cm) thick cover.	$0.07-0.09/ft² ($0.75-0.97/m²)	$18,000-$40,000	Small capacity application equipment is towed; large capacity units are skid-mounted. Average cover duration: 7-30 days.†
Land-Cover Formula 440 Enviro Group, Inc. Indianapolis, ID Bay Hill Marketing, Inc. Altamonte Springs, FL	Aqueous clay/polymer-based emulsion; hardens to form 1/16- to 1/8-in- (0.16- to 0.32-cm) thick cover.	$0.03-0.06/ft² ($0.32-0.65/m²)	$4,200-$12,500	Application equipment is skid-mounted. Average cover duration: 1-3 mo.†
Posi-Shell™ Landfill Services Corp. Apalachin, NY	Aqueous slurry of recycled newspaper/plastic fibers and cement kiln dust binder; hardens to form 1/4- to 1/2-in.- (0.64- to 1.27-cm) thick cover.	$0.03-0.05/ft² ($0.32-0.54/m²)	Equipment is leased for $4,700/mo.	Application equipment is towed. Storage silo required for cement kiln dust is also provided. Average cover duration: 1-3 mo.†

*1992 cost information obtained from manufacturer's representative. Personnel costs associated with spray-on application and application equipment maintenance costs are not included.
†Duration of cover depends on the thickness and continuity of application.

Table 3. *Geosynthetic Cover Products*

Product/ Manufacturer	Product Description	Material Cost*	Effective Cost†	Comments‡
Airspace Saver© Wire Rope Specialist Baton Rouge, LA	Woven, high-density polyethylene, coated with low-density polyethylene; 9 oz/yd^2 (305 g/m^2); reinforced with nylon strapping (one side)	$0.40/ft^2 ($4.31/m^2)	$0.0017-0.0020/ft^2 ($0.018-0.022/m^2)	Average duration of panels is 10-12 mo (200-240 reuses); some last 18 mo.
Aqua-Shed™ Aqua-Shed Manufacturing Corp. Florence, SC	Polyvinyl chloride coated on one side with adhesive; 7 oz/yd^2 (237 g/m^2)	$0.12-0.14/ft^2 ($1.29-1.51/m^2)	$0.12-0.14/ft^2 ($1.29-1.51/m^2)	Panels are only placed manually and adhere to the working face. They are not subsequently removed or reused. Average cover duration is 2-3 mo.
CORMIER Cormier Textile Products Sanford, ME	Woven, high-density polyethylene, coated with low-density polyethylene; WP-640 - 4.3 oz/yd^2 (146 g/m^2); WP-1440 - 5.2 oz/yd^2 (176 g/m^2)	$0.085-0.12/ft^2 ($0.015-0.032/m^2)	$0.0014-0.0030/ft^2 ($0.91-1.29/m^2)	Average duration of panels is 2-3 mo (40-60 reused); some last 6 mo.
COVERTECH C-440 COVERTECH Fabrication, Inc. Rexdale, Ontario	Woven, high-density polyethylene, coated with low-density polyethylene; 9 oz/yd^2 (305 g/m^2); reinforced with nylon strapping on both sides.	$0.55/ft^2 ($5.92/m^2)	$0.0023-0.0028/ft^2 ($0.025-0.030/m^2)	Average duration of panels is 10-12 mo (200-240 reuses); some last 14 mo.
FabriSoil® Phillips Fibers Corp. Greenville, SC	Nonwoven, needle-punched polypropylene; 6 oz/yd^2 (203 g/m^2)	$0.16-0.19/ft^2 ($1.72-2.05/m^2)	$0.0053-0.0095/ft^2 ($0.057-0.102/m^2)	Average duration of panels is 20-30 days (20-30 reuses).
Griffolyn® Reef Industries, Inc. Houston, TX	Low-density polyethylene-coated co-polymer and nylon yarn laminate; 4.9 oz/yd^2 (166 g/m^2)	$0.13-0.15/ft^2 ($1.40-1.61/m^2)	$0.0005-0.0008/ft^2 ($0.005-0.009/m^2)	Average duration of panel is 10-12 mo (200-240 reuses).
Polyfelt X0010 Polyfelt, Inc. Evergreen, AL	Nonwoven, spun-bonded, needle-punched polypropylene; 8 oz/yd^2 (271 g/m^2)	$0.22-0.25/ft^2 ($2.36-2.69/m^2)	$0.0037-0.0125/ft^2 ($0.040-0.135/m^2)	Average duration of panel is 1-3 mo (20-60 reuses).
SaniCover™ Fluid Systems, Inc. Cincinnati, OH	Polypropylene; 6 oz/yd^2 (203 g/m^2) (See comments)	$0.13-0.15/ft^2 ($1.40-1.61/m^2)	$0.004-0.008/ft^2 ($0.043-0.086/m^2)	SaniCover™ 150 is a nonwoven, needle-punched material while SaniCover™ 250 is a woven material. Average duration of panel is 20-30 days (20-30 reuses).
Typar® Exxon Chemical Company Old Hickory, TN	Nonwoven, spun-bonded, needle-punched polypropylene; 5.8 oz/yd^2 (197 g/m^2)	$0.15/ft^2 ($0.61/m^2)	$0.0025-0.0038/ft^2 ($0.027-0.041/m^2)	Average duration of panel is 2-3 mo (40-60 reuses).

* 1992 cost information obtained from manufacturer's representative. Equipment use and personnel costs associated with placement/retrieval of panels are not included.

† Effective cost = material cost/number of reuses. (For panels with effective life > 1 mo, 20 uses/mo were assumed).

‡ Unless indicated otherwise, geosynthetic panels are placed manually or with available landfill equipment. Specially designed and fabricated ancillary equipment (e.g., tow bar, lifting bar, reel, or roller) is used at some sites to facilitate panel placement/retrieval and reduce wear and tear.

Table 4. *Operational Considerations - Commercial Products*

Operational Feature	Foams	Spray-ons	Geo-synthetics	Comments
Access control (insects, birds and animals	Yes*	Yes*	Yes	The sticky consistency of nonhardening foams and hardening foam and spray-ons discourages insects and birds from landing and animals from digging. Hardening foams and spray-on subsequently form a resilient barrier. Geosynthetics completely cover wastes, denying access to insects, birds, and animals.
Fire retardation - Noncombustible	See comments	See comments	No	Nonhardening foams are noncombustible, and SaniFoam™, a hardening foam, is rated nonflammable and self-extinguishing. (Insufficient information is available regarding the combustibility of TopCoat™ foam.) Constituents of spray-ons may be combustible, but they are applied as an aqueous slurry/emulsion. Spray-ons are generally considered nonflammable when dry/hardened. Some geosynthetics are also rated nonflammable and self-extinguishing, while moisture absorbed by nonwoven materials can reduce their combustibility.
- Limits air intrusion	Yes*	Yes*	Yes†	Foams, spray-ons, and geosynthetics provide a barrier that can reduce/prevent the transfer of atmospheric oxygen to the working face.
- Provides barrier within landfill	No	No	No	Foams and spray-ons are destroyed and geosynthetics are removed before placement of wastes on subsequent days.
Blowing litter control	Yes*	Yes*	Yes	Foams and spray-ons adhere to and contain wastes, and geosynthetics completely cover the wastes, preventing blowing litter.
Odor and other air emission control	Yes*	Yes*	Yes†	Foams and spray-ons provide a barrier against odor and other emissions. Geosynthetics trap odors and emissions while in place; they may be released when panels are retrieved.
Dust control	Yes	Yes	Yes	Foams, spray-ons, and geosynthetics adhere to and/or contain materials prone to dusting. In addition, since the use of these materials eliminates the need to transport and place soil cover, that element of dust generation is also reduced.
Water infiltration control	See comments	Yes*	Yes†	Hardening foams and spray-ons form a cover that can shed rain-water when hardened whereas nonhardening foams are generally not as effective during moderate to heavy rain. Many geosynthetic materials effectively shed rainwater, particularly those that are water repellant. Although nonwoven geotextiles initially absorb some moisture, they are also able to subsequently shed rainwater.
Leachate and gas migration Control	See comments	See comments	See comments	Leachate and gas movement are not curtailed, since foams and spray-ons are destroyed and geosynthetics are removed on subsequent days.
Aesthetically pleasing appearance	Yes*	Yes*	Yes*	

* *Effectiveness depends on complete and continuous application onto the wastes.*
† *Effectiveness depends on the permeability of the particular material to air and water.*

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The complete report, entitled "The Use of Alternative Materials for Daily Cover at Municipal Solid Waste Landfills," (Order No. PB93-227197; Cost: $27.00, subject to change) will be available only from:
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